Technical Appendix 5-8
Avian Collision Risk Model report

EIAR – Volume 3

Muingmore Wind Farm

SLR Project No.: 501.065301.00001

April 2026

Revision Record

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Executive Summary

The aim of this report is to describe the collision risk modelling process undertaken for the Muingmore Wind Farm project in Co. Mayo, and to provide outputs such that any potentially significant collision-related effects on birds can be identified in the accompanying EIAR and NIS reports. Modelling was undertaken based on ornithological data collected by Woodrow over the period from April 2021 to May 2024 for 19 bird species and three candidate turbine models. 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 was highest for the Nordex N163 candidate turbine model for all bird species. Common kestrel had the highest level of collision risk, followed by greylag goose and lesser black-backed gull. 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. Furthermore, the modelling is subject to several limitations and qualifications, which are discussed in the report.

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Acronyms and Abbreviations

CIEEM	Chartered Institute of Ecologists and Environmental Managers
CRM	Collision Risk Model
GIS	Geographical Information Systems
MW	Megawatt
NS	NatureScot
PCH	Potential Collision Heights
RWE	RWE Renewables Ireland Ltd
SCI	Special Conservation Interest
SPA	Special Protection Area
The Project	Muingmore Wind Farm
VP	Vantage Point
WP	Wind Farm Polygon

1.0 Introduction

This report presents the results of Collision Risk Modelling (CRM) undertaken for 19 bird species to inform the assessment of potential ornithological impacts relating to the proposed Muingmore Wind Farm (hereafter "the Project"), which has a layout comprising 13 turbines in one array.

As advised by RWE Renewables Ireland Ltd (hereafter "RWE"), modelling was based on the use of three turbine models:

- Vestas V150 turbine type: 6 MW, each with a rotor diameter of 150 m, tip height of 180 m, and hub height of 105 m;
- Nordex N163 turbine type: 7 MW, each with a rotor diameter of 163 m, tip height of 180 m, and hub height of 98.5 m; and
- Nordex N149 turbine type: 5.7 MW, each with a rotor diameter of 149 m, tip height of 179 m, and hub height of 104.5 m.

The CRM was undertaken in accordance with current NatureScot (NS) (formerly Scottish Natural Heritage guidance[1], 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, Appendix B and Appendix C.

[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 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.

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) guidance[2]. Bird species of high conservation importance are those which are Annex I species and other species of high conservation importance which are vulnerable to impacts from wind farm developments. The following species are 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

The updated Band CRM (Band et. al. 2024[3]) 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 CRM[3] 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;
- 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

[2] NatureScot (2025). Recommended Bird Survey Methods to Inform Impact Assessment of Onshore Wind Farms. Version 2

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

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 are given in the NS (2024)[1] guidance.

We have employed a non-directional (i.e. randomly distributed flights) CRM. 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 each wind farm polygon (WP)[4], are summarised in Table 2-1. Separate analyses were undertaken for each turbine model as follows.

For the Vestas V150 and Nordex N149, based on an offset of 30 m, the combined viewshed area (minus overlap) from VPs 1 - 4 (V150: 7,076,331 m^2; N149: 7,069,378 m^2) represents 100% of the survey WP for the V150 and N149 models, respectively (V150: 7,076,331 m^2; N149: 7,069,378 m^2) (Table 2-1).

For the Nordex N163, based on an offset of 17 m, the combined viewshed area (minus overlap) from VPs 1 - 4 (7,122,924 m^2) represents 99.9% of the survey WP (7,132,836 m^2) (Table 2-1).

Table 2-1: VP Viewshed Data

VP / Viewshed Number	WGS 84 Coordinates (x,y)	Area of visibility[5] (m^2)		
		Vestas V150	Nordex N163	Nordex N149
VP 1	54.142541, -9.893851	4,030,074	4,069,129	4,023,863
VP 2	54.134320, -9.893301	4,473,766	4,502,369	4,471,909
VP 3	54.138095, -9.903836	5,270,414	4,390,366	5,266,706
VP 4	54.129013, -9.888069	2,922,095	2,978,745	2,920,231
VPs 1-4 viewshed combined (minus overlap)		7,076,331	7,122,924	7,069,378

[4] The survey wind farm polygon (WP) includes the area within 500 m of the turbine blades, extending from within each turbine, 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 offset of 17 m above ground level for Nordex 164, and 30 m for Vestas V150 and Nordex 149

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 as April – August (breeding season) and September – March (non-breeding season).

Additional survey effort was undertaken for spring (March and April) and autumn (September and October) migration periods; however, unless otherwise specified, the migration period survey effort and flight activity results have been subsumed into the breeding and non-breeding season categories for CRM.

2.4.3 Year 1, Year 2 and Year 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 Woodrow during April 2021 to May 2024 over a period of three years, comprising three breeding and three non-breeding periods, including one additional partially completed breeding season.

The total number of hours of survey are as shown in Table 2-2 (Woodrow, 2024[6]), which are far in excess of the minimum of 144 per VP over a two-year period required by NS guidance[2].

Table 2-2: VP Surveys undertaken at the Project, April 2021 to May 2024

VP Number	Hours of Survey Completed per Survey Period							
	Apr – Aug 2021	**Sep 2021 – Mar 2022**	**Apr – Aug 2022**	**Sep 2022 – Mar 2023**	**Apr – Aug 2023**	**Sep 2023 – March 2024**	**Apr – May 2024**	**Total**
1	38.00	40.50	36.00	60.00	48.00	62.50	12.00	**297.00**
2	36.00	42.50	36.00	58.50	53.00	63.00	9.00	**298.00**
3	36.00	40.60	39.00	63.00	45.00	64.00	9.00	**296.50**
4	36.00	40.50	36.00	60.00	48.00	59.75	9.00	**289.25**

The raw number of flight lines, cumulative number of birds and flying time in each height category per VP for each survey period is shown below in Table 2-3. Note that only data for survey periods and VPs where flight activity was recorded are shown for brevity.

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

Species	Survey Period	VP No.	No. of Flight Lines	No. of Birds	Total Flying Time (s)	Time in height category (s)		
						0-10 m	10 – 150 m	>150 m
Black-headed gull	Breeding 2021	1	4	4	178	101	77	0
		2	6	7	609	0	609	0
		3	19	20	863	132	731	0

[6] Woodrow APEM Group (2024). Ornithology Results Report for Muingmore Wind Farm 2021- 24. EIAR Technical Appendix. Woodrow APEM Report P00008408. RWE, December 2024

Species	Survey Period	VP No.	No. of Flight Lines	No. of Birds	Total Flying Time (s)	Time in height category (s)		
						0-10 m	10 – 150 m	>150 m
		4	18	19	769	99	670	0
	Breeding 2022	1	2	4	180	0	180	0
		2	1	1	70	0	70	0
		3	1	2	0	0	0	0
		4	2	3	260	0	260	0
	Non-breeding 2022/23	4	3	4	100	0	100	0
	Breeding 2023	2	3	3	161	0	161	0
		3	5	5	335	0	335	0
		4	4	5	2670	2520	150	0
	Non-breeding 2023/24	2	1	1	20	0	20	0
Black-legged kittiwake	Breeding 2023	2	1	1	40	0	40	0
Common gull	Breeding 2021	4	1	2	580	0	580	0
	Non-breeding 2022/23	4	2	3	109	0	109	0
	Non-breeding 2023/24	3	1	1	10	0	10	0
Common kestrel	Breeding 2021	1	15	16	818	0	818	0
		2	6	6	668	0	668	0
		3	17	17	1486	33	1453	0
		4	10	10	807	397	410	0
	Non-breeding 2021/22	1	10	10	452	0	452	0
		3	4	4	93	0	93	0
		4	1	1	47	0	47	0
	Breeding 2022	1	15	20	1043	0	1043	0
		2	11	18	4384	0	2324	2060
		3	3	4	285	0	285	0
		4	1	1	20	0	20	0
	Non-breeding 2022/23	1	20	25	2500	385	2115	0
		2	6	7	495	0	495	0
		3	6	6	440	15	425	0
		4	3	3	155	80	75	0
		1	25	29	1814	10	1804	0

Species	Survey Period	VP No.	No. of Flight Lines	No. of Birds	Total Flying Time (s)	Time in height category (s)		
						0-10 m	10 – 150 m	>150 m
	Breeding 2023	2	3	3	125	0	125	0
		3	3	3	35	0	35	0
		4	2	2	105	0	105	0
	Non-breeding 2023/24	1	7	8	220	5	215	0
		3	3	3	70	0	70	0
		4	1	1	160	0	160	0
Common snipe	Non-breeding 2021/22	1	1	1	5	5	0	0
		2	3	3	33	0	33	0
		3	1	1	12	0	12	0
	Non-breeding 2022/23	1	1	5	425	0	425	0
		2	3	4	285	0	285	0
		3	2	38	980	0	980	0
		4	2	3	150	0	150	0
	Breeding 2023	2	1	1	30	0	30	0
		3	1	2	16	0	16	0
		4	5	6	154	0	154	0
	Non-breeding 2023/24	1	1	2	60	0	60	0
		2	1	1	8	0	8	0
Common tern	Breeding 2022	3	2	2	54	0	54	0
Eurasian teal	Breeding 2021	2	1	1	12	0	12	0
	Non-breeding 2022/24	3	1	2	40	40	0	0
	Breeding 2023	4	1	5	75	0	75	0
Eurasian woodcock	Non-breeding 2021/22	1	2	2	21	0	21	0
		3	1	1	9	9	0	0
		4	1	1	5	5	0	0
European golden plover	Breeding 2023	4	1	3	36	0	36	0
Great cormorant	Non-breeding 2022/23	1	1	1	160	0	160	0
		2	1	1	165	0	165	0
		3	1	1	115	0	115	0
		4	2	2	70	0	70	0

Species	Survey Period	VP No.	No. of Flight Lines	No. of Birds	Total Flying Time (s)	Time in height category (s)		
						0-10 m	10 – 150 m	>150 m
Greenland white-fronted goose	Non-breeding 2022/23	2	1	18	1080	0	1080	0
Greylag goose	Non-breeding 2022/23	3	1	17	4335	0	4335	0
Hen harrier	Breeding 2022	1	1	1	210	0	210	0
		3	1	1	15	0	15	0
	Non-breeding 2022	2	2	2	450	450	0	0
		4	3	3	240	160	80	0
	Non-breeding 2023_24	2	1	1	40	40	0	0
		4	1	1	20	20	0	0
Herring gull	Breeding 2021	1	1	1	9	0	9	0
		2	5	5	233	0	233	0
		4	9	11	334	0	334	0
	Breeding 2022	1	2	2	215	0	215	0
		2	3	3	136	0	136	0
		3	15	17	353	23	330	0
		4	9	9	132	0	132	0
	Non-breeding 2022_23	3	1	1	55	0	55	0
		4	2	2	115	0	115	0
	Breeding 2023	3	5	12	367	0	367	0
		4	8	17	584	0	584	0
	Non-breeding 2023_24	2	2	2	95	0	95	0
Lesser black-backed gull	Breeding 2021	1	18	20	1094	29	1065	0
		2	7	11	759	78	681	0
		3	15	16	588	64	524	0
		4	13	13	586	0	586	0
	Breeding 2022	1	3	3	127	0	127	0
		2	1	1	70	0	70	0
		3	4	5	85	0	85	0
		4	2	3	285	45	240	0
	Non-breeding 2022/23	1	1	2	250	0	250	0
	Breeding 2023	1	1	2	8	0	8	0
		2	4	7	1230	90	1140	0

Species	Survey Period	VP No.	No. of Flight Lines	No. of Birds	Total Flying Time (s)	Time in height category (s)		
						0-10 m	10 – 150 m	>150 m
		3	5	6	290	0	290	0
		4	2	5	245	0	245	0
	Non-breeding 2023/24	1	2	2	110	0	110	0
		2	1	1	50	0	50	0
		4	2	2	220	0	220	0
Mallard	Breeding 2021	3	4	4	90	44	46	0
	Breeding 2022	1	1	1	45	0	45	0
		3	3	4	88	0	88	0
		4	4	4	145	0	145	0
	Non-breeding 2022/23	3	1	3	45	45	0	0
		4	1	4	40	0	10	0
	Breeding 2023	3	3	4	50	10	40	0
		4	1	4	400	0	400	0
	Non-breeding 2023/24	4	1	2	60	0	60	0
Merlin	Non-breeding 2021/22	1	1	1	26	0	26	0
	Non-breeding 2022/23	3	1	1	30	30	0	0
	Breeding 2023	4	2	2	23	23	0	0
	Non-breeding 2023/24	4	1	1	35	35	0	0
Peregrine falcon	Non-breeding 2022/23	3	4	4	240	0	240	0
		4	5	5	205	0	205	0
Whooper swan	Non-breeding 2021/22	3	1	3	120	0	120	0
	Non-breeding 2022/23	1	1	5	875	0	875	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 WP[4]. 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 guidance[2]).

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

The proportion of each clipped 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.

2.4.5 Bird Density

Flying time estimated to occur within 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 are given in Table 2-4 to Table 2-6, as 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 to Table 2-6 vs. Table 2-3, which displays all flights, regardless of whether they are within the WP or not.

2.4.5.1 Total Flying Time

Vesta V150

Table 2-4: Total Flying Time – Vestas V150

Species	Survey Period	VP No.	Total Flying Time (bird-secs)
Black-headed gull	Breeding 2021	1	150.00
		2	569.54
		3	525.88
		4	509.57
	Breeding 2022	1	224.34
		2	70.00
		4	52.64
	Breeding 2023	2	143.15
		3	228.64
		4	5136.44
	Non-breeding 2023/24	2	11.14
Black-legged kittiwake	Breeding 2023	2	40.00
Common gull	Breeding 2021	4	594.49

Species	Survey Period	VP No.	Total Flying Time (bird-secs)
	Breeding 2023	2	107.83
Common kestrel	Breeding 2021	1	355.72
		2	614.87
		3	715.02
		4	807.00
	Non-breeding 2021/22	1	317.67
		3	64.41
	Breeding 2022	1	1058.37
		2	7517.81
		3	266.79
		4	10.55
	Non-breeding 2022/23	1	1550.81
		2	273.09
		3	256.08
		4	100.40
	Breeding 2023	1	1772.29
		2	110.37
		3	23.30
		4	34.62
	Non-breeding 2023/24	1	188.53
		3	43.01
		4	45.75
Common snipe	Non-breeding 2021/22	2	31.84
	Non-breeding 2022/23	1	1942.48
		2	291.84
		3	2542.64
		4	57.91
	Breeding 2023	2	30.00
	Non-breeding 2023/24	1	120.00
		2	8.00

Species	Survey Period	VP No.	Total Flying Time (bird-secs)
Common tern	Breeding 2022	3	18.76
Eurasian teal	Breeding 2021	2	12.00
	Non-breeding 2022/23	3	4.53
	Breeding 2023	4	129.49
Eurasian woodcock	Non-breeding 2021/22	1	21.00
		3	1.83
		4	5.00
European golden plover	Breeding 2023	4	12.32
Great cormorant	Non-breeding 2022/23	1	139.49
		2	132.68
		3	68.88
		4	38.80
Greenland white-fronted goose	Non-breeding 2022/23	2	7395.11
Greylag goose	Non-breeding 2022/23	3	64827.33
Hen harrier	Breeding 2022	1	210.00
	Non-breeding 2022/24	2	448.38
		4	173.19
	Non-breeding 2023/24	2	40.00
		4	20.00
Herring gull	Breeding 2021	1	9.00
		2	184.44
		4	243.09
	Breeding 2022	1	160.86
		2	126.88
		3	80.53
		4	37.85

Species	Survey Period	VP No.	Total Flying Time (bird-secs)
	Non-breeding 2022/23	4	72.60
	Breeding 2023	3	603.33
		4	1374.35
	Non-breeding 23023/24	2	92.26
Lesser black-backed gull	Breeding 2021	1	952.33
		2	1275.88
		3	264.26
		4	413.01
	Breeding 2022	1	72.32
		2	70.00
		3	52.18
	Non-breeding 2022/23	1	443.53
	Breeding 2023	1	12.81
		2	2159.12
		3	141.97
		4	122.16
	Non-breeding 23023/24	1	74.49
		2	50.00
		4	209.91
Mallard	Breeding 2021	3	28.62
	Breeding 2022	1	35.69
		3	64.18
		4	67.63
	Breeding 2023	3	35.46
		4	1053.74
Merlin	Non-breeding 2021/22	1	26.00
	Breeding 2023	4	7.37

Species	Survey Period	VP No.	Total Flying Time (bird-secs)
Peregrine falcon	Non-breeding 2022/23	3	176.22
		4	88.09
Whooper swan	Non-breeding 2021/22	3	237.31
	Non-breeding 2022/23	1	3281.94

Nordex N163

Table 2-5: Total Flying Time – Nordex N163

Species	Survey Period	VP No.	Total Flying Time (bird-secs)
Black-headed gull	Breeding 2021	1	151.16
		2	580.75
		3	539.91
		4	513.69
	Breeding 2022	1	228.75
		2	70.00
		4	58.64
	Breeding 2023	2	143.78
		3	232.61
		4	5137.00
	Non-breeding 2023/24	2	11.23
Black-legged kittiwake	Breeding 2023	2	40.00
Common gull	Breeding 2021	4	599.06
	Breeding 2023	2	108.00
Common kestrel	Breeding 2021	1	373.31
		2	617.02
		3	742.37
		4	807.00
		1	320.51

Species	Survey Period	VP No.	Total Flying Time (bird-secs)
	Non-breeding 2021/22	3	66.02
	Breeding 2022	1	1075.34
		2	7550.57
		3	268.73
		4	10.70
	Non-breeding 2022/23	1	1599.16
		2	277.84
		3	260.10
		4	101.13
	Breeding 2023	1	1805.97
		2	110.70
		3	23.81
		4	35.79
	Non-breeding 2023/24	1	191.76
		3	43.56
		4	52.28
Common snipe	Non-breeding 2021/22	1	0.18
		2	32.15
	Non-breeding 2022/23	1	1949.12
		2	294.95
		3	2599.86
		4	59.58
	Breeding 2023	2	30.00
	Non-breeding 2023/24	1	120.00
		2	8.00
Common tern	Breeding 2022	3	20.11
Eurasian teal	Breeding 2021	2	12.00
	Non-breeding 2022/23	3	6.30

Species	Survey Period	VP No.	Total Flying Time (bird-secs)
	Breeding 2023	4	133.05
Eurasian woodcock	Non-breeding 2021/22	1	21.00
		3	1.95
		4	5.00
European golden plover	Breeding 2023	4	13.15
Great cormorant	Non-breeding 2022/23	1	140.09
		2	133.67
		3	69.78
		4	39.37
Greenland white-fronted goose	Non-breeding 2022/23	2	7506.41
Greylag goose	Non-breeding 2022/23	3	65177.37
Hen harrier	Breeding 2022	1	210.00
	Non-breeding 2022/24	2	448.67
		4	177.01
	Non-breeding 2023/24	2	40.00
		4	20.00
Herring gull	Breeding 2021	1	9.00
		2	186.68
		4	247.36
	Breeding 2022	1	169.19
		2	127.50
		3	114.49
		4	38.70
	Non-breeding 2022/23	4	72.97
	Breeding 2023	3	627.26
		4	1385.50

Species	Survey Period	VP No.	Total Flying Time (bird-secs)
	Non-breeding 23023/24	2	92.41
Lesser black-backed gull	Breeding 2021	1	965.30
		2	1283.65
		3	268.50
		4	414.64
	Breeding 2022	1	73.17
		2	70.00
		3	53.81
	Non-breeding 2022/23	1	447.52
	Breeding 2023	1	12.98
		2	2165.95
		3	148.67
		4	123.40
	Non-breeding 23023/24	1	74.68
		2	50.00
		4	210.33
Mallard	Breeding 2021	3	29.41
	Breeding 2022	1	35.97
		3	65.36
		4	68.15
	Breeding 2023	3	37.62
		4	1076.59
Merlin	Non-breeding 2021/22	1	26.00
	Breeding 2023	4	11.32
Peregrine falcon	Non-breeding 2022/23	3	177.80
		4	88.96
Whooper swan	Non-breeding 2021/22	3	238.76

Species	Survey Period	VP No.	Total Flying Time (bird-secs)
	Non-breeding 2022/23	1	3293.00

Nordex N149

Table 2-6: Total Flying Time – Nordex N149

Species	Survey Period	VP No.	Total Flying Time (bird-secs)
Black-headed gull	Breeding 2021	1	150.00
		2	569.54
		3	525.88
		4	509.57
	Breeding 2022	1	224.34
		2	70.00
		4	52.64
	Breeding 2023	2	143.15
		3	228.64
		4	5136.44
	Non-breeding 2023/24	2	11.14
Black-legged kittiwake	Breeding 2023	2	40.00
Common gull	Breeding 2021	4	594.49
	Breeding 2023	2	107.83
Common kestrel	Breeding 2021	1	355.72
		2	614.87
		3	715.02
		4	807.00
	Non-breeding 2021/22	1	317.67
		3	64.41
	Breeding 2022	1	1058.37
		2	7517.81

Species	Survey Period	VP No.	Total Flying Time (bird-secs)
		3	266.79
		4	10.55
	Non-breeding 2022/23	1	1550.81
		2	273.09
		3	256.08
		4	100.40
	Breeding 2023	1	1772.29
		2	110.37
		3	23.30
		4	34.62
	Non-breeding 2023/24	1	188.53
		3	43.01
		4	45.75
Common snipe	Non-breeding 2021/22	2	31.84
	Non-breeding 2022/23	1	1942.48
		2	291.84
		3	2542.64
		4	57.91
	Breeding 2023	2	30.00
	Non-breeding 2023/24	1	120.00
		2	8.00
Common tern	Breeding 2022	3	18.76
Eurasian teal	Breeding 2021	2	12.00
	Non-breeding 2022/23	3	4.53
	Breeding 2023	4	129.49
Eurasian woodcock	Non-breeding 2021/22	1	21.00
		3	1.83
		4	5.00

Species	Survey Period	VP No.	Total Flying Time (bird-secs)
European golden plover	Breeding 2023	4	12.32
Great cormorant	Non-breeding 2022/23	1	139.49
		2	132.68
		3	68.88
		4	38.80
Greenland white-fronted goose	Non-breeding 2022/23	2	7395.11
Greylag goose	Non-breeding 2022/23	3	64827.33
Hen harrier	Breeding 2022	1	210.00
	Non-breeding 2022/24	2	448.38
		4	173.19
	Non-breeding 2023/24	2	40.00
		4	20.00
Herring gull	Breeding 2021	1	9.00
		2	184.44
		4	243.09
	Breeding 2022	1	160.86
		2	126.88
		3	80.53
		4	37.85
	Non-breeding 2022/23	4	72.60
	Breeding 2023	3	603.33
		4	1374.35
	Non-breeding 23023/24	2	92.26
Lesser black-backed gull	Breeding 2021	1	952.33
		2	1275.88
		3	264.26
		4	413.01

Species	Survey Period	VP No.	Total Flying Time (bird-secs)
	Breeding 2022	1	72.32
		2	70.00
		3	52.18
	Non-breeding 2022/23	1	443.53
	Breeding 2023	1	12.81
		2	2159.12
		3	141.97
		4	122.16
	Non-breeding 23023/24	1	74.49
		2	50.00
		4	209.91
Mallard	Breeding 2021	3	28.62
	Breeding 2022	1	35.69
		3	64.18
		4	67.63
	Breeding 2023	3	35.46
		4	1053.74
Merlin	Non-breeding 2021/22	1	26.00
	Breeding 2023	4	7.37
Peregrine falcon	Non-breeding 2022/23	3	176.22
		4	88.09
Whooper swan	Non-breeding 2021/22	3	237.31
	Non-breeding 2022/23	1	3281.94

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 above, 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 VP number as outlined in NS (2024) guidance[1] 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 VPs with the viewshed from VP4 covering much less 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.

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:

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

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. conifer plantation and peat habitats), so a turbine-weighted average bird density was not used.

The results of this process are given in Table 2-7, Table 2-8 and Table 2-9. 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.

Vestas V150

Table 2-7: Bird Density Results – Vestas V150

Species	Survey Period	Month	Bird Density (birds / km^2)		
			Mean	**Standard Deviation**	**Weighted Mean**
Black-headed gull	Breeding_2021	6	0.003460769	0.002050878	0.003242273
		7	0.000437971	0.000616288	0.000420247
	Breeding_2022	5	0.000181097	0.00025611	0.0001867
		6	0.000833938	0	0.000833938
		7	0.002577209	0	0.002577209
	Breeding_2023	5	0.00096807	0	0.00096807
		6	0.018445926	0.031010254	0.015538876
		7	0.000410408	0	0.000410408
	Non-breeding_2023_2024	11	5.76258E-05	0	5.76258E-05
Common gull	Breeding_2021	7	0.004347158	0	0.004347158
	Breeding_2023	7	0.001115879	0	0.001115879
Common tern	Breeding_2022	6	0.000109866	0	0.000109866
Cormorant		1	0.001373074	0	0.001373074

Species	Survey Period	Month	Bird Density (birds / km^2)		
			Mean	**Standard Deviation**	**Weighted Mean**
	Non-breeding_2022_2023	3	0.000403352	0	0.000403352
		10	0.000554285	0.000349199	0.000574088
Golden plover	Breeding_2023	7	0.000195241	0	0.000195241
Greenland white-fronted goose	Non-breeding_2022_2023	10	0.038263782	0	0.038263782
Greylag goose	Non-breeding_2022_2023	3	0.379636882	0	0.379636882
Hen harrier	Breeding_2022	8	0.000804139	0.001137225	0.000693077
	Non-breeding_2022_2023	2	0.001948817	0.001618612	0.002070231
		3	0.001537541	0	0.001537541
	Non-breeding_2023_2024	10	0.000206968	0	0.000206968
Herring gull	Breeding_2021	6	0.001148449	0.001523953	0.000986587
		7	0.000719683	0	0.000719683
	Breeding_2022	4	9.27179E-05	0.000131123	9.8311E-05
		5	0.00025871	0.000365871	0.000266715
		6	0.00042753	6.23319E-05	0.000438276
		7	0.000688057	0.001010237	0.000763888
		10	0.000287549	0.000406656	0.000245454
	Breeding_2023	4	0.000358405	0	0.000358405
		6	0.001329198	0	0.001329198
		7	0.012181812	0.009732725	0.011174327
	Non-breeding_2023_2024	11	0.000477346	0	0.000477346
Kestrel	Breeding_2021	4	0.003962356	0.004319645	0.003706242
		5	0.000374777	0	0.000374777
		6	0.000843963	0.000797673	0.000883602
		7	0.000830764	0	0.000830764
		8	0.002509285	0.002194929	0.002454848
	Non-breeding_2021_2022	1	0.000547907	0	0.000547907
		2	8.04139E-05	0	8.04139E-05
		3	0.001259912	0.001634055	0.001182519
		9	0.003078705	0	0.003078705
		10	6.58409E-06	9.3113E-06	7.54795E-06
		11	0.000165703	0.000234339	0.000193354

Species	Survey Period	Month	Bird Density (birds / km^2)		
			Mean	**Standard Deviation**	**Weighted Mean**
	Breeding_2022	4	0.013793004	0.023508402	0.015530291
		5	0.0075507	0	0.0075507
		6	0.000275842	0.000251926	0.000258705
		7	0.001890988	0.002294825	0.001719294
		8	0.010927905	0	0.010927905
	Non-breeding_2022_2023	1	0.007277256	0.010291594	0.00786088
		2	0.001060451	0	0.001060451
		3	0.002477972	0.001568112	0.002232842
		9	4.9168E-06	6.9534E-06	5.24613E-06
		10	0.000365803	0.000285829	0.000379341
	Breeding_2023	4	0.000399603	0.000500053	0.000376775
		5	0.002120771	0	0.002120771
		6	0.002487577	0.002542309	0.002440647
		7	0.007911552	0	0.007911552
		8	0.000695272	0.000578072	0.000679031
	Non-breeding_2023_2024	2	0.00080314	0	0.00080314
		3	0.000589526	0	0.000589526
		9	0.000154992	0.000169439	0.000146967
		11	0.000362412	0	0.000362412
		12	0.000307447	0	0.000307447
Kittiwake	Breeding_2023	4	0.000177401	0	0.000177401
Lesser black-backed gull	Breeding_2021	4	0.003068269	0.000957742	0.003139925
		5	0.003076192	0.003702159	0.002969001
		6	0.003254804	0.003374114	0.003197155
		7	0.000624355	0.000246425	0.000593497
		8	0.000356661	0.00034983	0.000352243
		6	0.000465187	0.000384156	0.000469607
	Non-breeding_2022_2023	1	0.005095179	0	0.005095179
	Breeding_2023	4	0.001082606	0.000162424	0.001099146
		5	0.005939583	0.007843614	0.00585845
		6	0.000201763	0.000193299	0.000218459
	Non-breeding_2023_2024	9	0.00096067	0.000993055	0.000904355
		10	0.000215861	6.05974E-05	0.000217205
Mallard	Breeding_2021	4	0.000292846	0	0.000292846

Species	Survey Period	Month	Bird Density (birds / km^2)		
			Mean	**Standard Deviation**	**Weighted Mean**
		8	6.99719E-05	0	6.99719E-05
	Breeding_2022	4	0.000359319	0.000289174	0.000368735
		5	0.000279756	0.000395635	0.000238802
		8	0.000273318	0	0.000273318
	Breeding_2023	4	0.004173725	0.005902539	0.003562723
		8	0.000311457	0	0.000311457
Merlin	Non-breeding_2021_2022	2	0.00029868	0	0.00029868
	Breeding_2023	4	5.83951E-05	0	5.83951E-05
Peregrine	Non-breeding_2022_2023	1	0.000337772	0.000477681	0.000288324
		9	0.000420999	0.000595383	0.000482631
		10	0.000142471	0	0.000142471
		11	0.000375728	0	0.000375728
Snipe	Non-breeding_2021_2022	2	0.000277728	0	0.000277728
		10	1.37979E-05	2.38986E-05	1.3641E-05
	Non-breeding_2022_2023	1	0.00094419	0	0.00094419
		2	0.00019221	0	0.00019221
		10	0.005750404	0.006249263	0.006070521
		11	0.000675774	0	0.000675774
		6	0.000206968	0	0.000206968
	Non-breeding_2023_2024	10	0.000703927	0	0.000703927
		11	4.13936E-05	0	4.13936E-05
Teal	Breeding_2021	7	6.77349E-05	0	6.77349E-05
	Non-breeding_2022_2023	3	2.65004E-05	0	2.65004E-05
	Breeding_2023	7	0.002051545	0	0.002051545
Whooper swan	Non-breeding_2021_2022	12	0.002084537	0	0.002084537
	Non-breeding_2022_2023	1	0.037701965	0	0.037701965
Woodcock	Non-breeding_2021_2022	1	0.000120023	5.77071E-05	0.000127358
		12	1.60586E-05	0	1.60586E-05

Nordex N163

Table 2-8: Bird Density Results – Nordex N163

Species	Survey Period	Month	Bird Density (birds / km^2)		
			Mean	**Standard Deviation**	**Weighted Mean**
Black-headed gull	Breeding_2021	6	0.003685193	0.002137879	0.003447005
		7	0.000441699	0.000616768	0.000438122
	Breeding_2022	5	0.000179946	0.000254483	0.000193993
		6	0.000911416	0	0.000911416
		7	0.002602642	0	0.002602642
	Breeding_2023	5	0.00116908	0	0.00116908
		6	0.018134629	0.030391052	0.015875473
		7	0.000412223	0	0.000412223
	Non-breeding_2023_2024	11	5.77558E-05	0	5.77558E-05
Common gull	Breeding_2021	7	0.004297224	0	0.004297224
	Breeding_2023	7	0.001110507	0	0.001110507
Common tern	Breeding_2022	6	0.00014136	0	0.00014136
Cormorant	Non-breeding_2022_2023	1	0.001374485	0	0.001374485
		3	0.000490523	0	0.000490523
		10	0.000551444	0.000347135	0.000570547
Golden plover	Breeding_2023	7	0.00020444	0	0.00020444
Greenland white-fronted goose	Non-breeding_2022_2023	10	0.038592915	0	0.038592915
Greylag goose	Non-breeding_2022_2023	3	0.458195792	0	0.458195792
Hen harrier	Breeding_2022	8	0.000796421	0.00112631	0.000724212
	Non-breeding_2022_2023	2	0.001934718	0.001613529	0.002052132
		3	0.001560435	0	0.001560435
	Non-breeding_2023_2024	10	0.000205653	0	0.000205653
Herring gull	Breeding_2021	6	0.001150618	0.00151859	0.000991641
		7	0.000717864	0	0.000717864
	Breeding_2022	4	9.4273E-05	0.000133322	0.000104384
		5	0.000257066	0.000363547	0.000277133
		6	0.000593565	0.000298793	0.000634929
		7	0.000714702	0.001053775	0.000815593

Species	Survey Period	Month	Bird Density (birds / km^2)		
			Mean	**Standard Deviation**	**Weighted Mean**
	Non-breeding_2022_2023	10	0.000283531	0.000400973	0.00025612
	Breeding_2023	4	0.000361327	0	0.000361327
		6	0.001319513	0	0.001319513
		7	0.012723101	0.008638924	0.01213255
	Non-breeding_2023_2024	11	0.000475109	0	0.000475109
Kestrel	Breeding_2021	4	0.004702738	0.005565441	0.004215527
		5	0.000453726	0	0.000453726
		6	0.000874231	0.000803065	0.000934014
		7	0.000837407	0	0.000837407
		8	0.002549685	0.002069189	0.002539191
	Non-breeding_2021_2022	1	0.000545235	0	0.000545235
		2	7.96421E-05	0	7.96421E-05
		3	0.001294464	0.001632912	0.001272533
		9	0.003049156	0	0.003049156
		10	8.53981E-06	1.20771E-05	9.36539E-06
		11	0.000201626	0.000285142	0.000225778
	Breeding_2022	4	0.013811996	0.023461693	0.016004839
		5	0.007553639	0	0.007553639
		6	0.000309739	0.000283271	0.000300441
		7	0.002243035	0.002793008	0.001940713
		8	0.010858481	0	0.010858481
	Non-breeding_2022_2023	1	0.007252116	0.010256041	0.007816505
		2	0.001047842	0	0.001047842
		3	0.002574091	0.001506576	0.002396023
		9	8.01665E-06	1.13373E-05	8.16891E-06
		10	0.00051199	0.000248415	0.000515326
	Breeding_2023	4	0.000409283	0.000512137	0.000386199
		5	0.002111342	0	0.002111342
		6	0.00248956	0.002551312	0.002443939
		7	0.008064996	0	0.008064996
		8	0.000713138	0.000557344	0.000714783
	Non-breeding_2023_2024	2	0.000816265	0	0.000816265
		3	0.000592242	0	0.000592242
		9	0.000160493	0.000163167	0.000158302

Species	Survey Period	Month	Bird Density (birds / km^2)		
			Mean	**Standard Deviation**	**Weighted Mean**
		11	0.000406308	0	0.000406308
		12	0.000369074	0	0.000369074
Kittiwake	Breeding_2023	4	0.000176274	0	0.000176274
Lesser black-backed gull	Breeding_2021	4	0.003326478	0.00062739	0.003394389
		5	0.003121584	0.003625383	0.003137728
		6	0.003243318	0.003358081	0.003258239
		7	0.000645826	0.000210286	0.00062674
		8	0.000359827	0.000343718	0.000367386
	Breeding_2022	6	0.000482657	0.000375274	0.000495482
	Non-breeding_2022_2023	1	0.005091594	0	0.005091594
	Breeding_2023	4	0.001074414	0.000163251	0.001090676
		5	0.005972607	0.007749996	0.006151401
		6	0.000230691	0.000242239	0.000242831
	Non-breeding_2023_2024	9	0.000945259	0.00097477	0.000891617
		10	0.00021476	5.98306E-05	0.000216052
Mallard	Breeding_2021	4	0.000358025	0	0.000358025
		8	8.7377E-05	0	8.7377E-05
	Breeding_2022	4	0.000422358	0.000377392	0.000421187
		5	0.000275309	0.000389345	0.000248693
		8	0.000272816	0	0.000272816
	Breeding_2023	4	0.004183132	0.005915842	0.003778729
		8	0.000396663	0	0.000396663
Merlin	Non-breeding_2021_2022	2	0.000295814	0	0.000295814
	Breeding_2023	4	8.79937E-05	0	8.79937E-05
Peregrine	Non-breeding_2022_2023	1	0.000335803	0.000474897	0.000303339
		9	0.000510076	0.000721356	0.000559387
		10	0.000172334	0	0.000172334
		11	0.000370937	0	0.000370937
Snipe	Non-breeding_2021_2022	2	0.00027915	0	0.00027915
		10	1.42585E-05	2.32864E-05	1.4531E-05
	Non-breeding_2022_2023	1	0.000961501	0	0.000961501
		2	0.000191704	0	0.000191704
		10	0.006368714	0.007043557	0.006583098
		11	0.000675785	0	0.000675785

Species	Survey Period	Month	Bird Density (birds / km^2)		
			Mean	**Standard Deviation**	**Weighted Mean**
	Breeding_2023	6	0.000205653	0	0.000205653
	Non-breeding_2023_2024	10	0.000697171	0	0.000697171
		11	4.11306E-05	0	4.11306E-05
Teal	Breeding_2021	7	6.73046E-05	0	6.73046E-05
	Non-breeding_2022_2023	3	4.43102E-05	0	4.43102E-05
	Breeding_2023	7	0.002067919	0	0.002067919
Whooper swan	Non-breeding_2021_2022	12	0.002517681	0	0.002517681
	Non-breeding_2022_2023	1	0.037465884	0	0.037465884
Woodcock	Non-breeding_2021_2022	1	0.000118498	5.76809E-05	0.000125735
		12	2.05486E-05	0	2.05486E-05

Nordex N149

Table 2-9: Bird Density Results – Nordex N149

Species	Survey Period	Month	Bird Density (birds / km^2)		
			Mean	**Standard Deviation**	**Weighted Mean**
Black-headed gull	Breeding_2021	6	0.003463056	0.002051901	0.003244781
		7	0.000438166	0.000616533	0.000420464
	Breeding_2022	5	0.000181172	0.000256216	0.000186791
		6	0.00083447	0	0.00083447
		7	0.002581187	0	0.002581187
	Breeding_2023	5	0.000968752	0	0.000968752
		6	0.018457655	0.031030086	0.015548365
		7	0.000410579	0	0.000410579
	Non-breeding_2023_2024	11	5.76497E-05	0	5.76497E-05
Common gull	Breeding_2021	7	0.004349933	0	0.004349933
	Breeding_2023	7	0.001116343	0	0.001116343
Common tern	Breeding_2022	6	0.000109944	0	0.000109944
Cormorant	Non-breeding_2022_2023	1	0.001373644	0	0.001373644
		3	0.000403636	0	0.000403636
		10	0.000555002	0.000349935	0.00057479

Species	Survey Period	Month	Bird Density (birds / km^2)		
			Mean	**Standard Deviation**	**Weighted Mean**
Golden plover	Breeding_2023	7	0.000195366	0	0.000195366
Greenland white-fronted goose	Non-breeding_2022_2023	10	0.038279671	0	0.038279671
Greylag goose	Non-breeding_2022_2023	3	0.379904163	0	0.379904163
Hen harrier	Breeding_2022	8	0.00080538	0.00113898	0.000693981
	Non-breeding_2022_2023	2	0.001949716	0.001619157	0.002071234
		3	0.001538522	0	0.001538522
	Non-breeding_2023_2024	10	0.000207054	0	0.000207054
Herring gull	Breeding_2021	6	0.00114916	0.001524932	0.000987351
		7	0.000719982	0	0.000719982
	Breeding_2022	4	9.27564E-05	0.000131177	9.83585E-05
		5	0.000258817	0.000366023	0.000266844
		6	0.000427819	6.23936E-05	0.000438575
		7	0.000689053	0.001011842	0.000764828
	Non-breeding_2022_2023	10	0.000287733	0.000406915	0.000245615
	Breeding_2023	4	0.000358634	0	0.000358634
		6	0.001330046	0	0.001330046
		7	0.012189762	0.009738691	0.01118177
	Non-breeding_2023_2024	11	0.000477545	0	0.000477545
Kestrel	Breeding_2021	4	0.00396492	0.004322705	0.003709214
		5	0.000375041	0	0.000375041
		6	0.000844723	0.00079833	0.000884411
		7	0.000832046	0	0.000832046
		8	0.0025108	0.002196385	0.002456299
	Non-breeding_2021_2022	1	0.000548753	0	0.000548753
		2	8.0538E-05	0	8.0538E-05
		3	0.001261813	0.001636639	0.001184056
		9	0.003083457	0	0.003083457
		10	6.58872E-06	9.31786E-06	7.55315E-06
		11	0.00016582	0.000234504	0.000193524
	Breeding_2022	4	0.013798774	0.023518128	0.015540058

Species	Survey Period	Month	Bird Density (birds / km^2)		
			Mean	**Standard Deviation**	**Weighted Mean**
		5	0.007562355	0	0.007562355
		6	0.00027619	0.000252377	0.000258989
		7	0.001892432	0.002296282	0.001720966
		8	0.010932443	0	0.010932443
	Non-breeding_2022_2023	1	0.007288488	0.010307479	0.007871376
		2	0.001061128	0	0.001061128
		3	0.002480175	0.001569127	0.00223483
		9	4.92026E-06	6.95829E-06	5.25085E-06
		10	0.00036613	0.000285933	0.000379714
	Breeding_2023	4	0.000400194	0.000500862	0.00037723
		5	0.002124044	0	0.002124044
		6	0.002491027	0.002546783	0.002443508
		7	0.007923764	0	0.007923764
		8	0.000696122	0.0005791	0.000679779
	Non-breeding_2023_2024	2	0.00080438	0	0.00080438
		3	0.000590436	0	0.000590436
		9	0.000155217	0.000169721	0.000147153
		11	0.000362643	0	0.000362643
		12	0.000307663	0	0.000307663
Kittiwake	Breeding_2023	4	0.000177475	0	0.000177475
Lesser black-backed gull	Breeding_2021	4	0.003072002	0.000960639	0.003143734
		5	0.003077536	0.003703602	0.002970491
		6	0.003257055	0.003375295	0.003199721
		7	0.000624895	0.000246685	0.000593977
		8	0.000357001	0.00035006	0.000352582
	Breeding_2022	6	0.000465637	0.000384601	0.000470019
	Non-breeding_2022_2023	1	0.005103043	0	0.005103043
	Breeding_2023	4	0.001083164	0.000162339	0.001099701
		5	0.005942106	0.007846791	0.00586134
		6	0.000201906	0.000193411	0.000218625
	Non-breeding_2023_2024	9	0.0009614	0.000993524	0.000905216
		10	0.000216048	6.04846E-05	0.000217402
Mallard	Breeding_2021	4	0.000293052	0	0.000293052
		8	7.00211E-05	0	7.00211E-05

Species	Survey Period	Month	Bird Density (birds / km^2)		
			Mean	**Standard Deviation**	**Weighted Mean**
	Breeding_2022	4	0.000359567	0.000289385	0.000368987
		5	0.000279935	0.000395888	0.000238959
		8	0.000273739	0	0.000273739
	Breeding_2023	4	0.004176389	0.005906307	0.003565064
		8	0.000311676	0	0.000311676
Merlin	Non-breeding_2021_2022	2	0.000299141	0	0.000299141
	Breeding_2023	4	5.84324E-05	0	5.84324E-05
Peregrine	Non-breeding_2022_2023	1	0.000337987	0.000477986	0.000288514
		9	0.000421296	0.000595802	0.000482964
		10	0.000142572	0	0.000142572
		11	0.000375968	0	0.000375968
Snipe	Non-breeding_2021_2022	2	0.000277843	0	0.000277843
		10	1.38036E-05	2.39085E-05	1.36497E-05
	Non-breeding_2022_2023	1	0.000944583	0	0.000944583
		2	0.000192332	0	0.000192332
		10	0.005756763	0.006256402	0.006076295
		11	0.000676055	0	0.000676055
	Breeding_2023	6	0.000207054	0	0.000207054
	Non-breeding_2023_2024	10	0.000705014	0	0.000705014
		11	4.14108E-05	0	4.14108E-05
Teal	Breeding_2021	7	6.77631E-05	0	6.77631E-05
	Non-breeding_2022_2023	3	2.65191E-05	0	2.65191E-05
	Breeding_2023	7	0.002052854	0	0.002052854
Whooper swan	Non-breeding_2021_2022	12	0.002086005	0	0.002086005
	Non-breeding_2022_2023	1	0.03776016	0	0.03776016
Woodcock	Non-breeding_2021_2022	1	0.000120172	5.78469E-05	0.000127516
		12	1.60699E-05	0	1.60699E-05

2.4.6 Proportion of Birds Flying at Risk Height

The baseline surveys utilised the following three height bands:

1. 0-10 m;
2. 10 – 150 m; and

3. >150 m.

2.4.6.1 Vestas V150

The potential collision heights (PCH) for the Vestas V150 turbines are 30 m to 180 m, based on a tip height of 180 m, hub height of 105 m and rotor diameter of 150 m. As such, all flight lines with a survey PCH of 30 to 180 m must be included for CRM.

Thus, the proportion of flights within each of the relevant height bands within the WP were calculated based on PCH, as shown in Table 2-10.

For example, 120 m of the 30-180 m PCH span falls within the 10-150 m height range (height band 2), so 120/140 of birds flying within that height range would be at rotor risk height. The remaining 30 m of the PCH span is within the >150 m height range (height band 3), so 100% of flights at band 3 would also fall within rotor risk height (see section 3.4 for further discussion on this as a limitation). As none of the PCH span falls within the 0-10 m height range (band 1), none of the birds flying within that height range would be at rotor risk height.

To account for a rotor diameter of 150 m, the model adjusted the occupancy by rotor diameter as a proportion of survey risk height as described in NS (2024) guidance[1]. This assumes that in each of the height ranges within which flight height was classified, flight heights were distributed uniformly.

Note that data have been aggregated by year and season as has been done in NS (2024) guidance[1]. Only seasons where flight time is >0 have been included for brevity.

Table 2-10: Proportion of Flights at PCH – Vestas V150

Species	Season	Duration of flights observed within WP across all viewsheds (s)	% of flight durations observed within WP			% of flight durations at PCH (17 – 180 m) within WP
			Height band 1 (0 – 10 m)	**Height band 2 (10 – 150 m)**	**Height band 3 (>150 m)**	
Black-headed gull	Breeding_2021	2419	13.72	86.28	0.00	73.95
	Breeding_2022	510	0.00	100.00	0.00	85.71
	Breeding_2023	3166	79.60	20.40	0.00	17.49
	Non-breeding_2022_2023	100	0.00	100.00	0.00	85.71
	Non-breeding_2023_2024	20	0.00	100.00	0.00	85.71
Common gull	Breeding_2021	580	0.00	100.00	0.00	85.71
	Breeding_2023	109	0.00	100.00	0.00	85.71
	Non-breeding_2023_2024	10	0.00	100.00	0.00	85.71
Common tern	Breeding_2022	54	0.00	100.00	0.00	85.71
Cormorant	Non-breeding_2022_2023	510	0.00	100.00	0.00	85.71

Species	Season	Duration of flights observed within WP across all viewsheds (s)	% of flight durations observed within WP			% of flight durations at PCH (17 – 180 m) within WP
			Height band 1 (0 – 10 m)	**Height band 2 (10 – 150 m)**	**Height band 3 (>150 m)**	
Golden plover	Breeding_2023	36	0.00	100.00	0.00	85.71
Greenland white-fronted goose	Non-breeding_2022_2023	1080	0.00	100.00	0.00	85.71
Greylag goose	Non-breeding_2022_2023	4335	0.00	100.00	0.00	85.71
Hen harrier	Breeding_2022	225	0.00	100.00	0.00	85.71
Hen harrier	Non-breeding_2022_2023	690	88.41	11.59	0.00	9.94
Hen harrier	Non-breeding_2023_2024	60	100.00	0.00	0.00	0.00
Herring gull	Breeding_2021	576	0.00	100.00	0.00	85.71
	Breeding_2022	836	2.75	97.25	0.00	83.36
	Breeding_2023	951	0.00	100.00	0.00	85.71
	Non-breeding_2022_2023	170	0.00	100.00	0.00	85.71
	Non-breeding_2023_2024	95	0.00	100.00	0.00	85.71
Kestrel	Breeding_2021	3779	11.38	88.62	0.00	75.96
	Breeding_2022	5732	0.00	64.06	35.94	90.85
	Breeding_2023	2079	0.48	99.52	0.00	85.30
	Non-breeding_2021_2022	592	0.00	100.00	0.00	85.71
	Non-breeding_2022_2023	3590	13.37	86.63	0.00	74.25
	Non-breeding_2023_2024	450	1.11	98.89	0.00	84.76
Kittiwake	Breeding_2023	40	0.00	100.00	0.00	85.71
Lesser black-backed gull	Breeding_2021	3027	5.65	94.35	0.00	80.87
	Breeding_2022	567	7.94	92.06	0.00	78.91
	Breeding_2023	1773	5.08	94.92	0.00	81.36
	Non-breeding_2022_2023	250	0.00	100.00	0.00	85.71
	Non-breeding_2023_2024	380	0.00	100.00	0.00	85.71
Mallard	Breeding_2021	90	48.89	51.11	0.00	43.81

Species	Season	Duration of flights observed within WP across all viewsheds (s)	% of flight durations observed within WP			% of flight durations at PCH (17 – 180 m) within WP
			Height band 1 (0 – 10 m)	**Height band 2 (10 – 150 m)**	**Height band 3 (>150 m)**	
	Breeding_2022	278	0.00	100.00	0.00	85.71
	Breeding_2023	450	2.22	97.78	0.00	83.81
	Non-breeding_2022_2023	85	52.94	47.06	0.00	40.34
	Non-breeding_2023_2024	60	0.00	100.00	0.00	85.71
Merlin	Breeding_2023	23	100.00	0.00	0.00	0.00
	Non-breeding_2021_2022	26	0.00	100.00	0.00	85.71
	Non-breeding_2022_2023	30	100.00	0.00	0.00	0.00
	Non-breeding_2023_2024	35	100.00	0.00	0.00	0.00
Peregrine	Non-breeding_2022_2023	445	0.00	100.00	0.00	85.71
Snipe	Breeding_2023	200	0.00	100.00	0.00	85.71
	Non-breeding_2021_2022	50	10.00	90.00	0.00	77.14
	Non-breeding_2022_2023	1840	0.00	100.00	0.00	85.71
	Non-breeding_2023_2024	68	0.00	100.00	0.00	85.71
Teal	Breeding_2021	12	0.00	100.00	0.00	85.71
	Breeding_2023	75	0.00	100.00	0.00	85.71
	Non-breeding_2022_2023	40	100.00	0.00	0.00	0.00
Whooper swan	Non-breeding_2021_2022	120	0.00	100.00	0.00	85.71
	Non-breeding_2022_2023	875	0.00	100.00	0.00	85.71
Woodcock	Non-breeding_2021_2022	35	40.00	60.00	0.00	51.43

2.4.6.2 Nordex N163

The potential collision heights (PCH) for the Nordex N163 turbines is 17 m to 180 m, based on a tip height of 180 m, hub height of 98.5 m and rotor diameter of 163 m. As such, all flight lines with a survey PCH of 17 to 180 m must be included for CRM.

Thus, the proportion of flights within each of the relevant height bands within the WP were calculated based on PCH, as shown in Table 2-11.

For example, 133 m of the 17-180 m PCH span falls within the 10-150 m height range (height band 2), so 133/140 of birds flying within that height range would be at rotor risk height. The remaining 30 m of the PCH span is within the >150 m height range (height band 3), so 100% of flights at band 3 would also fall within rotor risk height (see section 3.4 for further discussion on this as a limitation). As none of the PCH span falls within the 0-10 m height range (band 1), none of the birds flying within that height range would be at rotor risk height.

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) guidance[1]. This assumes that in each of the height ranges within which flight height was classified, flight heights were distributed uniformly.

Note that data have been aggregated by year and season as has been done in NS (2024) guidance[1]. Only seasons where flight time is >0 have been included for brevity.

Table 2-11: Proportion of Flights at PCH – Nordex N163

Species	Season	Duration of flights observed within WP across all viewsheds (s)	% of flight durations observed within WP			% of flight durations at PCH (17 – 180 m) within WP
			Height band 1 (0 – 10 m)	**Height band 2 (10 – 150 m)**	**Height band 3 (>150 m)**	
Black-headed gull	Breeding_2021	2419	13.72	86.28	0.00	81.96
	Breeding_2022	510	0.00	100.00	0.00	95.00
	Breeding_2023	3166	79.60	20.40	0.00	19.38
	Non-breeding_2022_2023	100	0.00	100.00	0.00	95.00
	Non-breeding_2023_2024	20	0.00	100.00	0.00	95.00
Common gull	Breeding_2021	580	0.00	100.00	0.00	95.00
	Breeding_2023	109	0.00	100.00	0.00	95.00
	Non-breeding_2022_2023	0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	Non-breeding_2023_2024	10	0.00	100.00	0.00	95.00
Common tern	Breeding_2022	54	0.00	100.00	0.00	95.00
Cormorant	Non-breeding_2022_2023	510	0.00	100.00	0.00	95.00
Golden plover	Breeding_2023	36	0.00	100.00	0.00	95.00
Greenland white-fronted goose	Non-breeding_2022_2023	1080	0.00	100.00	0.00	95.00

Species	Season	Duration of flights observed within WP across all viewsheds (s)	% of flight durations observed within WP			% of flight durations at PCH (17 – 180 m) within WP
			Height band 1 (0 – 10 m)	**Height band 2 (10 – 150 m)**	**Height band 3 (>150 m)**	
Greylag goose	Non-breeding_2022_2023	4335	0.00	100.00	0.00	95.00
Hen harrier	Breeding_2022	225	0.00	100.00	0.00	95.00
	Non-breeding_2022_2023	690	88.41	11.59	0.00	11.01
	Non-breeding_2023_2024	60	100.00	0.00	0.00	0.00
Herring gull	Breeding_2021	576	0.00	100.00	0.00	95.00
	Breeding_2022	836	2.75	97.25	0.00	92.39
	Breeding_2023	951	0.00	100.00	0.00	95.00
	Non-breeding_2022_2023	170	0.00	100.00	0.00	95.00
	Non-breeding_2023_2024	95	0.00	100.00	0.00	95.00
Kestrel	Breeding_2021	3779	11.38	88.62	0.00	84.19
	Breeding_2022	5732	0.00	64.06	35.94	96.80
	Breeding_2023	2079	0.48	99.52	0.00	94.54
	Non-breeding_2021_2022	592	0.00	100.00	0.00	95.00
	Non-breeding_2022_2023	3590	13.37	86.63	0.00	82.30
	Non-breeding_2023_2024	450	1.11	98.89	0.00	93.94
Kittiwake	Breeding_2023	40	0.00	100.00	0.00	95.00
Lesser black-backed gull	Breeding_2021	3027	5.65	94.35	0.00	89.63
	Breeding_2022	567	7.94	92.06	0.00	87.46
	Breeding_2023	1773	5.08	94.92	0.00	90.18
	Non-breeding_2022_2023	250	0.00	100.00	0.00	95.00
	Non-breeding_2023_2024	380	0.00	100.00	0.00	95.00
Mallard	Breeding_2021	90	48.89	51.11	0.00	48.56
	Breeding_2022	278	0.00	100.00	0.00	95.00
	Breeding_2023	450	2.22	97.78	0.00	92.89
	Non-breeding_2022_2023	85	52.94	47.06	0.00	44.71

Species	Season	Duration of flights observed within WP across all viewsheds (s)	% of flight durations observed within WP			% of flight durations at PCH (17 – 180 m) within WP
			Height band 1 (0 – 10 m)	**Height band 2 (10 – 150 m)**	**Height band 3 (>150 m)**	
	Non-breeding_2023_2024	60	0.00	100.00	0.00	95.00
Merlin	Breeding_2023	23	100.00	0.00	0.00	0.00
	Non-breeding_2021_2022	26	0.00	100.00	0.00	95.00
	Non-breeding_2022_2023	30	100.00	0.00	0.00	0.00
	Non-breeding_2023_2024	35	100.00	0.00	0.00	0.00
Peregrine	Non-breeding_2022_2023	445	0.00	100.00	0.00	95.00
Snipe	Breeding_2023	200	0.00	100.00	0.00	95.00
	Non-breeding_2021_2022	50	10.00	90.00	0.00	85.50
	Non-breeding_2022_2023	1840	0.00	100.00	0.00	95.00
	Non-breeding_2023_2024	68	0.00	100.00	0.00	95.00
Teal	Breeding_2021	12	0.00	100.00	0.00	95.00
	Breeding_2023	75	0.00	100.00	0.00	95.00
	Non-breeding_2022_2023	40	100.00	0.00	0.00	0.00
Whooper swan	Non-breeding_2021_2022	120	0.00	100.00	0.00	95.00
	Non-breeding_2022_2023	875	0.00	100.00	0.00	95.00
Woodcock	Non-breeding_2021_2022	35	40.00	60.00	0.00	57.00

2.4.6.3 Nordex N149

The potential collision heights (PCH) for the Nordex V150 turbines is 30 m to 179 m, based on a tip height of 179 m, hub height of 104.5 m and rotor diameter of 149 m. As such, all flight lines with a survey PCH of 30 to 179 m must be included for CRM.

Thus, the proportion of flights within each of the relevant height bands within the WP were calculated based on PCH, as shown in Table 2-12.

For example, 120 m of the 30-179 m PCH span falls within the 10-150 m height range (height band 2), so 120/140 of birds flying within that height range would be at rotor risk height. The remaining 29 m of the PCH span is within the >150 m height range (height band

3), so 100% of flights at band 3 would also fall within rotor risk height (see section 3.4 for further discussion on this as a limitation). As none of the PCH span falls within the 0-10 m height range (band 1), none of the birds flying within that height range would be at rotor risk height.

To account for a rotor diameter of 150 m, the model adjusted the occupancy by rotor diameter as a proportion of survey risk height as described in NS (2024) guidance[1]. This assumes that in each of the height ranges within which flight height was classified, flight heights were distributed uniformly.

Note that data have been aggregated by year and season as has been done in NS (2024) guidance[1]. Only seasons where flight time is >0 have been included for brevity.

Table 2-12: Proportion of Flights at PCH – Nordex N149

Species	Season	Duration of flights observed within WP across all viewsheds (s)	% of flight durations observed within WP			% of flight durations at PCH (17 – 180 m) within WP
			Height band 1 (0 – 10 m)	**Height band 2 (10 – 150 m)**	**Height band 3 (>150 m)**	
Black-headed gull	Breeding_2021	2419	13.72	86.28	0.00	81.96
	Breeding_2022	510	0.00	100.00	0.00	95.00
	Breeding_2023	3166	79.60	20.40	0.00	19.38
	Non-breeding_2022_2023	100	0.00	100.00	0.00	95.00
	Non-breeding_2023_2024	20	0.00	100.00	0.00	95.00
Common gull	Breeding_2021	580	0.00	100.00	0.00	95.00
	Breeding_2023	109	0.00	100.00	0.00	95.00
	Non-breeding_2022_2023	0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	Non-breeding_2023_2024	10	0.00	100.00	0.00	95.00
Common tern	Breeding_2022	54	0.00	100.00	0.00	95.00
Cormorant	Non-breeding_2022_2023	510	0.00	100.00	0.00	95.00
Golden plover	Breeding_2023	36	0.00	100.00	0.00	95.00
Greenland white-fronted goose	Non-breeding_2022_2023	1080	0.00	100.00	0.00	95.00
Greylag goose	Non-breeding_2022_2023	4335	0.00	100.00	0.00	95.00
Hen harrier	Breeding_2022	225	0.00	100.00	0.00	95.00

Species	Season	Duration of flights observed within WP across all viewsheds (s)	% of flight durations observed within WP			% of flight durations at PCH (17 – 180 m) within WP
			Height band 1 (0 – 10 m)	**Height band 2 (10 – 150 m)**	**Height band 3 (>150 m)**	
	Non-breeding_2022_2023	690	88.41	11.59	0.00	11.01
	Non-breeding_2023_2024	60	100.00	0.00	0.00	0.00
Herring gull	Breeding_2021	576	0.00	100.00	0.00	95.00
	Breeding_2022	836	2.75	97.25	0.00	92.39
	Breeding_2023	951	0.00	100.00	0.00	95.00
	Non-breeding_2022_2023	170	0.00	100.00	0.00	95.00
	Non-breeding_2023_2024	95	0.00	100.00	0.00	95.00
Kestrel	Breeding_2021	3779	11.38	88.62	0.00	84.19
	Breeding_2022	5732	0.00	64.06	35.94	96.80
	Breeding_2023	2079	0.48	99.52	0.00	94.54
	Non-breeding_2021_2022	592	0.00	100.00	0.00	95.00
	Non-breeding_2022_2023	3590	13.37	86.63	0.00	82.30
	Non-breeding_2023_2024	450	1.11	98.89	0.00	93.94
Kittiwake	Breeding_2023	40	0.00	100.00	0.00	95.00
Lesser black-backed gull	Breeding_2021	3027	5.65	94.35	0.00	89.63
	Breeding_2022	567	7.94	92.06	0.00	87.46
	Breeding_2023	1773	5.08	94.92	0.00	90.18
	Non-breeding_2022_2023	250	0.00	100.00	0.00	95.00
	Non-breeding_2023_2024	380	0.00	100.00	0.00	95.00
Mallard	Breeding_2021	90	48.89	51.11	0.00	48.56
	Breeding_2022	278	0.00	100.00	0.00	95.00
	Breeding_2023	450	2.22	97.78	0.00	92.89
	Non-breeding_2022_2023	85	52.94	47.06	0.00	44.71
	Non-breeding_2023_2024	60	0.00	100.00	0.00	95.00
Merlin	Breeding_2023	23	100.00	0.00	0.00	0.00

Species	Season	Duration of flights observed within WP across all viewsheds (s)	% of flight durations observed within WP			% of flight durations at PCH (17 – 180 m) within WP
			Height band 1 (0 – 10 m)	**Height band 2 (10 – 150 m)**	**Height band 3 (>150 m)**	
	Non-breeding_2021_2022	26	0.00	100.00	0.00	95.00
	Non-breeding_2022_2023	30	100.00	0.00	0.00	0.00
	Non-breeding_2023_2024	35	100.00	0.00	0.00	0.00
Peregrine	Non-breeding_2022_2023	445	0.00	100.00	0.00	95.00
Snipe	Breeding_2023	200	0.00	100.00	0.00	95.00
	Non-breeding_2021_2022	50	10.00	90.00	0.00	85.50
	Non-breeding_2022_2023	1840	0.00	100.00	0.00	95.00
	Non-breeding_2023_2024	68	0.00	100.00	0.00	95.00
Teal	Breeding_2021	12	0.00	100.00	0.00	95.00
	Breeding_2023	75	0.00	100.00	0.00	95.00
	Non-breeding_2022_2023	40	100.00	0.00	0.00	0.00
Whooper swan	Non-breeding_2021_2022	120	0.00	100.00	0.00	95.00
Whooper swan	Non-breeding_2022_2023	875	0.00	100.00	0.00	95.00
Woodcock	Non-breeding_2021_2022	35	40.00	60.00	0.00	57.00

2.5 Stages B - D

For stages B-D, the following parameters were entered into the NS (2024) guidance[1] modelling spreadsheet:

- Day time bird density D_A for each month aggregated by each survey year, season and VP (taken from section 2.4.5);
- The proportion of flights at risk height Q_{2R} aggregated by each survey year and season (taken from section 2.4.6);
- Species-specific bird parameters (Table 2-13); and
- Wind farm parameters (Table 2-14).

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)[7], Cochran & Applegate (1986)[8], Cramp & Simmons (1977-1994)[9], Provan & Whitfield (2007)[10], Bruderer & Boldt (2001)[11] and Alerstram et al. (2007)[12]. The avoidance rates for these species are taken from NS (2018)[13]. Where species do not have a defined avoidance rate, the default avoidance rate of 98% has been applied.

Flight type was obtained 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.

For wildfowl (i.e., Eurasian teal, Greenland-white fronted goose, mallard and whooper swan), and waders (i.e., common snipe and Eurasian woodcock), which could be active nocturnally, an additional 25% (and 50% in the case of Eurasian woodcock) of nocturnal hours were added to the daylight hours to give a more accurate representation of the available hours for these species (as per Band et al., 2024[3]).

Details of these species-specific parameters are given in Table 2-13.

Table 2-13: Bird Biometrics, Flight Type, Nocturnal Activity and Avoidance Rates used in CRM

Common Name	Bird Length (m)	Wingspan (m)	Flight Speed (m/s)	Flight Type (0 or 1)[14]	Nocturnal Activity Factor (1-5)[15]	Avoidance Rate (%)
Black-headed gull	0.355	1.05	11.9	0	1	98.0
Black-legged kittiwake	0.39	1.075	13.1	0	1	98.0
Common gull	0.41	1.15	13.4	0	1	98.0
Common tern	0.33	0.875	10.2	0	1	98.0

[7] https://www.bto.org/understanding-birds/birdfacts [Accessed in November 2024].

[8] William W. Cochran and Roger D. Applegate. (1986). TheCondor 88:398-401 The Cooper Ornithological Society

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

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

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

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

[13] SNH (2018) 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% [Accessed in November 2024].

[14] Key: 0=flapping and 1=gliding

[15] 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)[14]	Nocturnal Activity Factor (1-5)[15]	Avoidance Rate (%)
Common kestrel	0.34	0.755	12.7	0	1	95.0
Common snipe	0.26	0.455	16.0	0	2	98.0
Eurasian teal	0.39	0.55	19.7	0	2	98.0
Eurasian woodcock	0.28	0.6	3.33	0	3	98.0
European golden plover	0.275	0.715	13.7	0	2	98.0
Great cormorant	0.9	1.45	14.5	0	1	98.0
Greenland white-fronted goose	0.71	1.47	16.1	0	2	99.8
Greylag goose	0.83	1.64	17.1	0	2	99.8
Hen harrier	0.48	1.1	8	0	1	99.0
Herring gull	0.61	1.465	12.8	1	1	98.0
Lesser black-backed gull	0.6	1.45	13.1	1	1	98.0
Mallard	0.58	0.9	22	0	2	98.0
Merlin	0.275	0.56	13.47	0	1	98.0
Peregrine falcon	0.42	1.025	12.1	0	1	98.0
Whooper swan	1.525	2.305	17.3	0	2	99.5

2.5.2 Wind Farm Parameters

The wind turbine parameters used in the CRM are detailed in Table 2-14, based on the information provided by RWE.

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) guidance[1] spreadsheet.

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

Table 2-14: Wind Farm and Turbine Parameters

Parameter	Value		
	Vestas V150	**Nordex N163**	**Nordex N149**
Wind farm width (km)	2	2	2
Number of turbines	13	13	13
Rotor radius / diameter (m)	75 / 150	81.5 / 163	74.5 / 149
Hub height (m)	105	98.5	104.5
Maximum blade chord width (m)	4.2	4.15	4.15
Blade pitch (°)	15	15	15
Rotation speed (r.p.m)	8.8	8.8	9.2
Turbine operation time (%)	85	85	85

3.0 Results

Table 3-1 to Table 3-3 summarises the predicted collision rates for the 19 species under consideration using the avoidance rates given in Table 2-13 for each candidate turbine model. Copies of the NS model calculations for each species are included in Appendix A to Appendix C.

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. E.g. for whooper swan, which is a winter visitor, only the non-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).

3.1 Vestas V150 Results

Table 3-1: Summary of CRM Outputs – Vestas V150

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	Breeding 2021	0.08	12.50	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.06 (0.04)	16.67 (25.00)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.08	12.50			
	Non-breeding 2022/23	0.00	N/A			
	Breeding 2023	0.08	12.50			
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	0.00	N/A			
Black-legged kittiwake	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023 and 2024	0.00	N/A
	Breeding 2022	0.00	N/A			
	Breeding 2023	0.00	N/A			
	Breeding 2024	0.00	N/A			
Common gull	Breeding 2021	0.12	8.33	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.04 (0.06)	26.67 (17.61)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.00	N/A			
	Non-breeding 2022/23	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
	Breeding 2023	0.03	33.33			
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	0.00	N/A			
Common kestrel	Breeding 2021	0.41	2.44	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	1.05 (1.01)	0.95 (0.99)
	Non-breeding 2021/20	0.22	4.55			
	Breeding 2022	2.10	0.48			
	Non-breeding 2022/23	0.34	2.94			
	Breeding 2023	0.83	1.20			
	Non-breeding 2023/24	0.09	11.11			
	Breeding 2024	0.00	N/A			
Common snipe	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.07 (0.08)	15.19 (12.37)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.00	N/A			
	Non-breeding 2022/23	0.17	5.88			
	Breeding 2023	0.01	100.00			
	Non-breeding 2023/24	0.02	50.00			

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
	Breeding 2024	0.00	N/A			
Common tern	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023 and 2024	0.00	N/A
	Breeding 2022	0.00	N/A			
	Breeding 2023	0.00	N/A			
	Breeding 2024	0.00	N/A			
Eurasian teal	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.02 (0.04)	50.00 (25.00)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.00	N/A			
	Non-breeding 2022/23	0.00	N/A			
	Breeding 2023	0.08	12.50			
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	0.00	N/A			
Eurasian woodcock	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.00	N/A
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.00	N/A			
	Non-breeding 2022/23	0.00	N/A			
	Breeding 2023	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
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	0.00	N/A			
European golden plover	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.00 (0.01)	400.00 (200.00)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.00	N/A			
	Non-breeding 2022/23	0.00	N/A			
	Breeding 2023	0.01	100.00			
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	0.00	N/A			
Great cormorant	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.02 (0.02)	60.00 (42.43)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.00	N/A			
	Non-breeding 2022/23	0.05	20.00			
	Breeding 2023	0.00	N/A			
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	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
Greenland white-fronted goose	Non-breeding 2021/22	0.00	N/A	Non-breeding 2021/22, 2022/23 and 2023/24	0.04 (0.06)	25.00 (17.68)
	Non-breeding 2022/23	0.12	8.33			
	Non-breeding 2023/24	0.00	N/A			
Greylag goose	Non-breeding 2021/22	0.00	N/A	Non-breeding 2021/22, 2022/23 and 2023/24	0.48 (0.67)	2.10 (1.48)
	Non-breeding 2022/23	1.43	0.70			
	Non-breeding 2023/24	0.00	N/A			
Hen harrier	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.00 (0.01)	400.00 (200.00)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.01	100.00			
	Non-breeding 2022/23	0.00	N/A			
	Breeding 2023	0.00	N/A			
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	0.00	N/A			
Herring gull	Breeding 2021	0.05	20.00	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22,	0.12 (0.19)	8.11 (5.38)
	Non-breeding 2021/20	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
	Breeding 2022	0.04	25.00	2022/23 and 2023/24		
	Non-breeding 2022/23	0.00	N/A			
	Breeding 2023	0.39	2.56			
	Non-breeding 2023/24	0.01	100.00			
	Breeding 2024	0.00	N/A			
Lesser black-backed gull	Breeding 2021	0.27	3.70	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.15 (0.17)	6.67 (6.05)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.01	100.00			
	Non-breeding 2022/23	0.07	14.29			
	Breeding 2023	0.20	5.00			
	Non-breeding 2023/24	0.02	50.00			
	Breeding 2024	0.00	N/A			
Mallard	Breeding 2021	0.01	100.00	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.05 (0.07)	20.00 (14.54)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.04	25.00			
	Non-breeding 2022/23	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
	Breeding 2023	0.15	6.67			
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	0.00	N/A			
Merlin	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.00	N/A
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.00	N/A			
	Non-breeding 2022/23	0.00	N/A			
	Breeding 2023	0.00	N/A			
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	0.00	N/A			
Peregrine falcon	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.00 (0.00)	300 (212.13)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.00	N/A			
	Non-breeding 2022/23	0.01	100.00			
	Breeding 2023	0.00	N/A			
	Non-breeding 2023/24	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
	Breeding 2024	0.00	N/A			
Whooper swan	Non-breeding 2021/22	0.02	50.00	Non-breeding 2021/22, 2022/23 and 2023/24	0.13 (0.17)	7.69 (5.89)
	Non-breeding 2022/23	0.37	2.70			
	Non-breeding 2023/24	0.00	N/A			

3.2 Nordex N163 Results

Table 3-2: Summary of CRM Outputs – Nordex N163

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	Breeding 2021	0.09	11.11	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.08 (0.05)	13.33 (19.74)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.11	9.09			
	Non-breeding 2022/23	0.00	N/A			
	Breeding 2023	0.10	10.00			
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	0.00	N/A			
	Breeding 2021	0.00	N/A		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
Black-legged kittiwake	Breeding 2022	0.00	N/A	Breeding 2021, 2022, 2023 and 2024		
	Breeding 2023	0.00	N/A			
	Breeding 2024	0.00	N/A			
Common gull	Breeding 2021	0.14	7.14	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.05 (0.07)	22.22 (15.13)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.00	N/A			
	Non-breeding 2022/23	0.00	N/A			
	Breeding 2023	0.04	25.00			
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	0.00	N/A			
Common kestrel	Breeding 2021	0.50	2.00	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	1.19 (1.13)	0.84 (0.88)
	Non-breeding 2021/20	0.25	4.00			
	Breeding 2022	2.35	0.43			
	Non-breeding 2022/23	0.39	2.56			
	Breeding 2023	0.95	1.05			
	Non-breeding 2023/24	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
	Breeding 2024	0.00	N/A			
Common snipe	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.09 (0.09)	11.65 (10.53)
	Non-breeding 2021/20	0.01	100.00			
	Breeding 2022	0.00	N/A			
	Non-breeding 2022/23	0.21	4.76			
	Breeding 2023	0.01	100.00			
	Non-breeding 2023/24	0.03	33.33			
	Breeding 2024	0.00	N/A			
Common tern	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023 and 2024	0	N/A
	Breeding 2022	0.00	N/A			
	Breeding 2023	0.00	N/A			
	Breeding 2024	0.00	N/A			
Eurasian teal	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.02 (0.05)	44.44 (22.22)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.00	N/A			
	Non-breeding 2022/23	0.00	N/A			
	Breeding 2023	0.09	0.02			

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
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	0.00	N/A			
Eurasian woodcock	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.00	N/A
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.00	N/A			
	Non-breeding 2022/23	0.00	N/A			
	Breeding 2023	0.00	N/A			
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	0.00	N/A			
European golden plover	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.00 (0.01)	400.00 (200.00)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.00	N/A			
	Non-breeding 2022/23	0.00	N/A			
	Breeding 2023	0.01	100.00			
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	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
Great cormorant	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.02 (0.03)	42.86 (30.30)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.00	N/A			
	Non-breeding 2022/23	0.07	14.29			
	Breeding 2023	0.00	N/A			
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	0.00	N/A			
Greenland white-fronted goose	Non-breeding 2021/22	0.14	7.14	Non-breeding 2021/22, 2022/23 and 2023/24	0.05 (0.07)	21.43 (15.15)
	Non-breeding 2022/23	0.0	N/A			
	Non-breeding 2023/24	0.0	N/A			
Greylag goose	Non-breeding 2021/22	0.00	N/A	Non-breeding 2021/22, 2022/23 and 2023/24	0.65 (0.91)	1.55 (1.10)
	Non-breeding 2022/23	1.94	0.52			
	Non-breeding 2023/24	0.00	N/A			
Hen harrier	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22,	0.00 (0.01)	400.00 (200.00)
	Non-breeding 2021/20	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
	Breeding 2022	0.01	100.00	2022/23 and 2023/24		
	Non-breeding 2022/23	0.00	N/A			
	Breeding 2023	0.00	N/A			
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	0.00	N/A			
Herring gull	Breeding 2021	0.05	20.00	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.15 (0.23)	6.49 (4.39)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.06	16.67			
	Non-breeding 2022/23	0.01	100.00			
	Breeding 2023	0.48	2.08			
	Non-breeding 2023/24	0.01	100.00			
	Breeding 2024	0.00	N/A			
Lesser black-backed gull	Breeding 2021	0.33	3.03	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.18 (0.20)	5.50 (5.00)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.02	50.00			
	Non-breeding 2022/23	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
	Breeding 2023	0.23	4.35			
	Non-breeding 2023/24	0.02	50.00			
	Breeding 2024	0.00	N/A			
Mallard	Breeding 2021	0.01	100.00	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.06 (0.09)	16.67 (11.32)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.04	25.00			
	Non-breeding 2022/23	0.00	N/A			
	Breeding 2023	0.19	5.26			
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	0.00	N/A			
Merlin	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.00 (0.00)	N/A (N/A)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.00	N/A			
	Non-breeding 2022/23	0.00	N/A			
	Breeding 2023	0.00	N/A			
	Non-breeding 2023/24	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
	Breeding 2024	0.00	N/A			
Peregrine falcon	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.01 (0.01)	150.00 (106.07)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.00	N/A			
	Non-breeding 2022/23	0.02	50.00			
	Breeding 2023	0.00	N/A			
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	0.00	N/A			
Whooper swan	Non-breeding 2021/22	0.03	33.33	Non-breeding 2021/22, 2022/23 and 2023/24	0.15 (0.20)	6.52 (5.10)
	Non-breeding 2022/23	0.43	2.33			
	Non-breeding 2023/24	0.0	N/A			

3.3 Nordex N149 Results

Table 3-3: Summary of CRM Outputs – Nordex N149

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	Breeding 2021	0.08	12.50	Breeding 2021, 2022, 2023,	0.06 (0.04)	16.00 (23.85)

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
	Non-breeding 2021/20	0.00	N/A	2024 and non-breeding 2021/22, 2022/23 and 2023/24		
	Breeding 2022	0.09	11.11			
	Non-breeding 2022/23	0.00	N/A			
	Breeding 2023	0.08	12.50			
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	0.00	N/A			
Black-legged kittiwake	Breeding 2021			Breeding 2021, 2022, 2023 and 2024	0.00	N/A
	Breeding 2022	0.00	N/A			
	Breeding 2023	0.00	N/A			
	Breeding 2024	0.00	N/A			
Common gull	Breeding 2021	0.12	8.33	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.04 (0.06)	26.67 (17.61)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.00	N/A			
	Non-breeding 2022/23	0.00	N/A			
	Breeding 2023	0.03	33.33			
	Non-breeding 2023/24	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
	Breeding 2024	0.00	N/A			
Common kestrel	Breeding 2021	0.41	2.44	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	1.06 (1.03)	0.94 (0.97)
	Non-breeding 2021/20	0.22	4.55			
	Breeding 2022	2.14	0.47			
	Non-breeding 2022/23	0.34	2.94			
	Breeding 2023	0.84	1.19			
	Non-breeding 2023/24	0.09	11.11			
	Breeding 2024	0.00	N/A			
Common snipe	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.07 (0.08)	15.19 (12.37)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.00	N/A			
	Non-breeding 2022/23	0.17	2.94			
	Breeding 2023	0.01	100.00			
	Non-breeding 2023/24	0.02	50.00			
	Breeding 2024	0.00	N/A			
Common tern	Breeding 2021	0.00	N/A		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
	Breeding 2022	0.00	N/A	Breeding 2021, 2022, 2023 and 2024		
	Breeding 2023	0.00	N/A			
	Breeding 2024	0.00	N/A			
Eurasian teal	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.02 (0.04)	50.00 (25.00)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.00	N/A			
	Non-breeding 2022/23	0.00	N/A			
	Breeding 2023	0.08	12.50			
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	0.00	N/A			
Eurasian woodcock	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.00	N/A
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.00	N/A			
	Non-breeding 2022/23	0.00	N/A			
	Breeding 2023	0.00	N/A			
	Non-breeding 2023/24	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
	Breeding 2024	0.00	N/A			
European golden plover	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.00 (0.01)	400.00 (200.00)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.00	N/A			
	Non-breeding 2022/23	0.00	N/A			
	Breeding 2023	0.01	100.00			
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	0.00	N/A			
Great cormorant	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.02 (0.02)	60.00 (42.43)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.00	N/A			
	Non-breeding 2022/23	0.05	20.00			
	Breeding 2023	0.00	N/A			
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	0.00	N/A			
Greenland white-	Non-breeding 2021/22	0.00	N/A	Non-breeding 2021/22,	0.04 (0.06)	25.00 (17.68)

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
fronted goose	Non-breeding 2022/23	0.04	8.33	2022/23 and 2023/24		
	Non-breeding 2023/24	0.00	N/A			
Greylag goose	Non-breeding 2021/22	0.00	N/A	Non-breeding 2021/22, 2022/23 and 2023/24	0.48 (0.67)	2.10 (1.48)
	Non-breeding 2022/23	1.43	N/A			
	Non-breeding 2023/24	0.00	N/A			
Hen harrier	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.00 (0.01)	400.00 (200.00)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.01	100.00			
	Non-breeding 2022/23	0.00	N/A			
	Breeding 2023	0.00	N/A			
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	0.00	N/A			
Herring gull	Breeding 2021	0.05	20.00	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.12 (0.19)	8.11 (5.38)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.04	25.00			

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
	Non-breeding 2022/23	0.00	N/A			
	Breeding 2023	0.39				
	Non-breeding 2023/24	0.01	100.00			
	Breeding 2024	0.00	N/A			
Lesser black-backed gull	Breeding 2021	0.27	3.70	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.15 (0.17)	6.52 (5.89)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.01	100.00			
	Non-breeding 2022/23	0.08	12.50			
	Breeding 2023	0.20	5.00			
	Non-breeding 2023/24	0.02	50.00			
	Breeding 2024	0.00	N/A			
Mallard	Breeding 2021	0.01	100.00	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.05 (0.07)	20.00 (14.54)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.04	25.00			
	Non-breeding 2022/23	0.00	N/A			
	Breeding 2023	0.15	6.67			

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
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	0.00	N/A			
Merlin	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.00	N/A
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.00	N/A			
	Non-breeding 2022/23	0.00	N/A			
	Breeding 2023	0.00	N/A			
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	0.00	N/A			
Peregrine falcon	Breeding 2021	0.00	N/A	Breeding 2021, 2022, 2023, 2024 and non-breeding 2021/22, 2022/23 and 2023/24	0.00 (0.00)	300.00 (212.13)
	Non-breeding 2021/20	0.00	N/A			
	Breeding 2022	0.00	N/A			
	Non-breeding 2022/23	0.01	100.00			
	Breeding 2023	0.00	N/A			
	Non-breeding 2023/24	0.00	N/A			
	Breeding 2024	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
Whooper swan	Non-breeding 2021/22	0.02	50.00	Non-breeding 2021/22, 2022/23 and 2023/24	0.13 (0.17)	7.50 (5.73)
	Non-breeding 2022/23	0.38	2.63			
	Non-breeding 2023/24	0.00	N/A			

3.4 Comparison of Results by Candidate Turbine Model

Table 3-4 provides a summary comparison of the modelled collision estimates for all species by candidate turbine model.

In almost all cases, the modelled collision results from the N163 candidate turbine were larger than for the V150 and N149 models. This is perhaps unsurprising given that the N163 candidate turbine has the largest swept height range. The results where this turbine has been considered should be interpreted as a 'worst-case' scenario. The other two candidate turbines have smaller swept height ranges, resulting in a greater ground clearance, and so collision risk estimates are less, especially for lower flying birds. The results for the V150 and N163 turbines are almost identical.

Table 3-4: Comparison of Collision Estimates Between Candidate Turbines

Species	Mean Collisions per Year			Mean Years per Collision		
	V150	**N163**	**N149**	**V150**	**N163**	**N149**
Black-headed gull	0.06	0.08	0.06	16.67	13.33	16.00
Black-legged kittiwake	0.00	0.00	0.00	N/A	N/A	N/A
Common gull	0.04	0.05	0.04	26.67	22.22	26.67
Common kestrel	1.05	1.19	1.06	0.95	0.84	0.94
Common snipe	0.07	0.09	0.07	15.19	11.65	15.19
Common tern	0.00	0.00	0.00	N/A	N/A	N/A
Eurasian teal	0.02	0.02	0.02	50.00	44.44	50.00

Species	Mean Collisions per Year			Mean Years per Collision		
	V150	**N163**	**N149**	**V150**	**N163**	**N149**
Eurasian woodcock	0.00	0.00	0.00	N/A	N/A	N/A
European golden plover	0.00	0.00	0.00	400.00	400.00	400.00
Great cormorant	0.02	0.02	0.02	60.00	42.86	60.00
Greenland white-fronted goose	0.04	0.05	0.04	25.00	21.43	25.00
Greylag goose	0.48	0.65	0.48	2.10	1.55	2.10
Hen harrier	0.00	0.00	0.00	400.00	400.00	400.00
Herring gull	0.12	0.15	0.12	8.11	6.49	8.11
Lesser black-backed gull	0.15	0.18	0.15	6.67	5.50	6.52
Mallard	0.05	0.06	0.05	20.00	16.67	20.00
Merlin	0.00	0.00	0.00	N/A	N/A	N/A
Peregrine falcon	0.00	0.01	0.00	300.00	150.00	300.00
Whooper swan	0.13	0.15	0.13	7.69	6.25	7.50

3.5 Uncertainty in Outputs

It should be acknowledged that there are several 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 knowledge regarding night-time behaviour for all 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.

There was a limitation in the way the flight height data were collected during surveys, as the third height band was for all flights >150 m; however, the turbine tip heights for all three candidate turbine models were >150 m also. This meant that all flights from the third height band had to be included in the modelling, which likely has resulted in an overestimate of true collision risk.

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 must be undertaken to contextualise the outputs presented here in this manner.

Appendix A NatureScot Spreadsheets – Vestas V150

Avian Collision Risk Report

Muingmore Wind Farm

RWE Renewables Ireland Ltd

SLR Project No.: 501.065301.00001

9 July 2025

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		Value	Units
Species name		Black-headed gull	
Bird length	L	0.355	m
Wingspan	W	1.05	m
Bird flight speed	v	11.9	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0	0.003242	0.00042	0					0.0003
Proportion at rotor risk height	Q_{2R}	73.95%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
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	80.5	10.5	0.0	0.0	0.0	0.0	0.0	91

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	75	m	Bird flight speed	v	11.9	m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.11%
	downwind	3.09%
	weighted mean	5.10%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	3.49	0.45	0.00	0.00	0.00	0.00	0.00	4

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.00	0.00	3.49	0.45	0.00	0.00	0.00	0.00	0.00	3.9
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.07	0.01	0.00	0.00	0.00	0.00	0.00	0.1
		100.00%	0.00	0.00	0.00	0.00	0.00	3.49	0.45	0.00	0.00	0.00	0.00	0.00	3.9
		100.00%	0.00	0.00	0.00	0.00	0.00	3.49	0.45	0.00	0.00	0.00	0.00	0.00	3.9

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		Value	Units
Species name		Black-headed gull	
Bird length	L	0.355	m
Wingspan	W	1.05	m
Bird flight speed	v	11.9	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0.000187	0.000834	0.002577	0					0.0003
Proportion at rotor risk height	Q_{2R}	85.71%													
At latitude 54.1		Daylight hours per month	247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month	496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13														
Rotor radius	R	75	m													
		Total rotor frontal area m^2	229729													
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	5.2	24.0	74.6	0.0	0.0	0.0	0.0	0.0	104

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	75	m	Bird flight speed	v	11.9 m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping
Pitch	λ	15	degrees	% of flights upwind/downwind		50% 50%
Blade profile		see Blade profile sheet				

Single transit risk		
	upwind	7.11%
	downwind	3.09%
	weighted mean	5.10%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.23	1.04	3.23	0.00	0.00	0.00	0.00	0.00	4

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.23	1.04	3.23	0.00	0.00	0.00	0.00	0.00	4.5
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.02	0.06	0.00	0.00	0.00	0.00	0.00	0.1
		100.00%	0.00	0.00	0.00	0.00	0.23	1.04	3.23	0.00	0.00	0.00	0.00	0.00	4.5
		100.00%	0.00	0.00	0.00	0.00	0.23	1.04	3.23	0.00	0.00	0.00	0.00	0.00	4.5

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		Value	Units
Species name		Black-headed gull	
Bird length	L	0.355	m
Wingspan	W	1.05	m
Bird flight speed	v	11.9	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0.000968	0.015539	0.00041	0					0.0014
Proportion at rotor risk height	Q_{2R}	17.49%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
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	5.5	91.3	2.4	0.0	0.0	0.0	0.0	0.0	99

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	75	m	Bird flight speed	v	11.9	m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.11%
	downwind	3.09%
	weighted mean	5.10%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.24	3.96	0.10	0.00	0.00	0.00	0.00	0.00	4

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.00	0.24	3.96	0.10	0.00	0.00	0.00	0.00	0.00	4.3
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.1
		100.00%	0.00	0.00	0.00	0.00	0.24	3.96	0.10	0.00	0.00	0.00	0.00	0.00	4.3
		100.00%	0.00	0.00	0.00	0.00	0.24	3.96	0.10	0.00	0.00	0.00	0.00	0.00	4.3

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		Value	Units
Species name		Black-headed gull	
Bird length	L	0.355	m
Wingspan	W	1.05	m
Bird flight speed	v	11.9	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0	0						0	0	0.0000576	0	0.0000
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
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	0.0	0.0	0.8	0.0	1

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	75	m	Bird flight speed	v	11.9	m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk		
	upwind	7.11%
	downwind	3.09%
	weighted mean	5.10%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.0
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.0
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	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

Bird data		Value	Units
Species name		Great cormorant	
Bird length	L	0.9	m
Wingspan	W	1.45	m
Bird flight speed	v	14.5	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0.001373	0	0.000403						0	0.000574	0	0	0.0002
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	14.5	m s^{-1}														
		Projected number of rotor transits			23.3	0.0	10.1	0.0	0.0	0.0	0.0	0.0	0.0	12.9	0.0	0.0	46

Stage C

No of blades	b	3		Bird length	l	0.9	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	1.45	m
Rotor radius	R	75	m	Bird flight speed	v	14.5	m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	8.10%
	downwind	4.62%
	weighted mean	6.36%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		1.26	0.00	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.70	0.00	0.00	3

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			Collision rates allowing for avoidance												
		100.00%	1.26	0.00	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.70	0.00	0.00	2.5
		100.00%	1.26	0.00	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.70	0.00	0.00	2.5
		100.00%	1.26	0.00	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.70	0.00	0.00	2.5
	98.00%	100.00%	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	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		Value	Units
Species name		Common gull	
Bird length	L	0.41	m
Wingspan	W	1.15	m
Bird flight speed	v	13.4	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0	0	0.004347	0					0.0004
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	13.4	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	0.0	141.6	0.0	0.0	0.0	0.0	0.0	142

Stage C

No of blades	b	3		Bird length	l	0.41	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	1.15	m
Rotor radius	R	75	m	Bird flight speed	v	13.4	m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	6.96%
	downwind	3.26%
	weighted mean	5.11%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	6.15	0.00	0.00	0.00	0.00	0.00	6

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	6.15	0.00	0.00	0.00	0.00	0.00	6.1
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.1
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	6.15	0.00	0.00	0.00	0.00	0.00	6.1
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	6.15	0.00	0.00	0.00	0.00	0.00	6.1

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		Value	Units
Species name		Common gull	
Bird length	L	0.41	m
Wingspan	W	1.15	m
Bird flight speed	v	13.4	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0	0	0.001116	0					0.0001
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	13.4	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	0.0	36.4	0.0	0.0	0.0	0.0	0.0	36

Stage C

No of blades	b	3		Bird length	l	0.41	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	1.15	m
Rotor radius	R	75	m	Bird flight speed	v	13.4	m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	6.96%
	downwind	3.26%
	weighted mean	5.11%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	1.58	0.00	0.00	0.00	0.00	0.00	2

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	1.58	0.00	0.00	0.00	0.00	0.00	1.6
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.0
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	1.58	0.00	0.00	0.00	0.00	0.00	1.6
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	1.58	0.00	0.00	0.00	0.00	0.00	1.6

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		Value	Units
Species name		Common tern	
Bird length	L	0.33	m
Wingspan	W	0.875	m
Bird flight speed	v	10.2	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0	0.00011	0	0					0.0000
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	10.2	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	3

Stage C

No of blades	b	3		Bird length	l	0.33	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.875	m
Rotor radius	R	75	m	Bird flight speed	v	10.2	m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.47%
	downwind	3.05%
	weighted mean	5.26%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

	large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
		Collision rates allowing for avoidance												
Avoidance rates modelled	100.00%	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.1
	100.00%	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.1
	100.00%	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.1
98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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

Bird data		Value	Units
Species name		Greylag goose	
Bird length	L	0.83	m
Wingspan	W	1.64	m
Bird flight speed	v	17.1	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0	0.379637						0	0	0	0	0.0316
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	17.1	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	14035.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14036

Stage C

No of blades	b	3		Bird length	l	0.83	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	1.64	m
Rotor radius	R	74.5	m	Bird flight speed	v	17.1	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	7.54%	
downwind	4.44%	
weighted mean	5.99%	

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	714.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	715

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

	large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled		Collision rates allowing for avoidance												
	100.00%	0.00	0.00	714.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	715.0
	100.00%	0.00	0.00	714.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	715.0
	100.00%	0.00	0.00	714.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	715.0
99.80%	100.00%	0.00	0.00	1.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.4

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		Value	Units
Species name		Golden plover	
Bird length	L	0.275	m
Wingspan	W	0.715	m
Bird flight speed	v	13.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0	0	0.000195	0					0.0000
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
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	7.2	0.0	0.0	0.0	0.0	0.0	7

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	75	m	Bird flight speed	v	13.7	m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk		
	upwind	6.30%
	downwind	2.66%
	weighted mean	4.48%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
Collision rates before avoidance													
	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.3
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.3
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0
	99.80%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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

Bird data		Value	Units
Species name		Herring gull	
Bird length	L	0.61	m
Wingspan	W	1.465	m
Bird flight speed	v	12.8	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0	0.000987	0.00072	0					0.0001
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
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	30.6	22.4	0.0	0.0	0.0	0.0	0.0	53

Stage C

No of blades	b	3		Bird length	l	0.61	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	1.465	m
Rotor radius	R	75	m	Bird flight speed	v	12.8	m s^{-1}
Max blade width	C	4.2	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.62%
	downwind	3.79%
	weighted mean	5.70%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	1.48	1.09	0.00	0.00	0.00	0.00	0.00	3

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.00	0.00	1.48	1.09	0.00	0.00	0.00	0.00	0.00	2.6
		100.00%	0.00	0.00	0.00	0.00	0.00	1.48	1.09	0.00	0.00	0.00	0.00	0.00	2.6
		100.00%	0.00	0.00	0.00	0.00	0.00	1.48	1.09	0.00	0.00	0.00	0.00	0.00	2.6
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.03	0.02	0.00	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		Value	Units
Species name		Herring gull	
Bird length	L	0.61	m
Wingspan	W	1.465	m
Bird flight speed	v	12.8	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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				0.0000983	0.000267	0.000438	0.000764	0					0.0001
Proportion at rotor risk height	Q_{2R}	83.36%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
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	2.4	7.8	13.2	23.1	0.0	0.0	0.0	0.0	0.0	47

Stage C

No of blades	b	3		Bird length	l	0.61	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	1.465	m
Rotor radius	R	75	m	Bird flight speed	v	12.8	m s^{-1}
Max blade width	C	4.2	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.62%
	downwind	3.79%
	weighted mean	5.70%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.12	0.38	0.64	1.12	0.00	0.00	0.00	0.00	0.00	2

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.12	0.38	0.64	1.12	0.00	0.00	0.00	0.00	0.00	2.3
		100.00%	0.00	0.00	0.00	0.12	0.38	0.64	1.12	0.00	0.00	0.00	0.00	0.00	2.3
		100.00%	0.00	0.00	0.00	0.12	0.38	0.64	1.12	0.00	0.00	0.00	0.00	0.00	2.3
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.01	0.01	0.02	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

Bird data		Value	Units
Species name		Herring gull	
Bird length	L	0.61	m
Wingspan	W	1.465	m
Bird flight speed	v	12.8	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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				0.000358	0	0.001329	0.011174	0					0.0011
Proportion at rotor risk height	Q_{2R}	85.71%													
At latitude 54.1		Daylight hours per month	247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month	496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

No of turbines	T	13													
Rotor radius	R	75	m												
		Total rotor frontal area m^2	229729												
Nocturnal activity factor	f_{night}	0%													
Bird flight speed	v	12.8	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	9.1	0.0	41.2	347.8	0.0	0.0	0.0	0.0	0.0	398

Stage C

No of blades	b	3		Bird length	l	0.61 m
Rotation speed	Ω	8.8	rpm	Wingspan	w	1.465 m
Rotor radius	R	75	m	Bird flight speed	v	12.8 m s^{-1}
Max blade width	C	4.2	m	Flight type		gliding
Pitch	λ	15	degrees	% of flights upwind/downwind		50% 50%
Blade profile		see Blade profile sheet				

Single transit risk		
upwind		7.62%
downwind		3.79%
weighted mean		5.70%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.44	0.00	2.00	16.86	0.00	0.00	0.00	0.00	0.00	19

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.44	0.00	2.00	16.86	0.00	0.00	0.00	0.00	0.00	19.3
		100.00%	0.00	0.00	0.00	0.44	0.00	2.00	16.86	0.00	0.00	0.00	0.00	0.00	19.3
		100.00%	0.00	0.00	0.00	0.44	0.00	2.00	16.86	0.00	0.00	0.00	0.00	0.00	19.3
	98.00%	100.00%	0.00	0.00	0.00	0.01	0.00	0.04	0.34	0.00	0.00	0.00	0.00	0.00	0.4

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		Value	Units
Species name		Herring gull	
Bird length	L	0.61	m
Wingspan	W	1.465	m
Bird flight speed	v	12.8	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0	0						0	0.000245	0	0	0.0000
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
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	0.0	0.0	4.9	0.0	0.0	5

Stage C

No of blades	b	3		Bird length	l	0.61	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	1.465	m
Rotor radius	R	75	m	Bird flight speed	v	12.8	m s^{-1}
Max blade width	C	4.2	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.62%
	downwind	3.79%
	weighted mean	5.70%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.00	0.2
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.00	0.2
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.00	0.2
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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

Bird data		Value	Units
Species name		Herring gull	
Bird length	L	0.61	m
Wingspan	W	1.465	m
Bird flight speed	v	12.8	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0	0						0	0	0.000477	0	0.0000
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
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	0.0	0.0	0.0	7.4	0.0	7

Stage C

No of blades	b	3		Bird length	l	0.61	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	1.465	m
Rotor radius	R	75	m	Bird flight speed	v	12.8	m s^{-1}
Max blade width	C	4.2	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.62%
	downwind	3.79%
	weighted mean	5.70%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.00	0.4
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.00	0.4
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.00	0.4
	98.00%	100.00%	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

Bird data		Value	Units
Species name		Hen harrier	
Bird length	L	0.48	m
Wingspan	W	1.1	m
Bird flight speed	v	8	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0	0	0	0.000693					0.0001
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
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	0.0	0.0	0.0	0.0	12.1	0.0	0.0	0.0	0.0	12

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	75	m	Bird flight speed	v	8	m s^{-1}
Max blade width	C	4.2	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	9.26%
	downwind	4.31%
	weighted mean	6.78%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.00	1

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

			large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled				Collision rates allowing for avoidance												
			100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.00	0.7
			100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.00	0.7
			100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.00	0.7
		99.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	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
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Bird data		Value	Units
Species name		Hen harrier	
Bird length	L	0.48	m
Wingspan	W	1.1	m
Bird flight speed	v	8	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0.00207	0.001538						0	0	0	0	0.0003
Proportion at rotor risk height	Q_{2R}	9.94%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	8	m s^{-1}														
		Projected number of rotor transits			0.0	2.5	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5

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	75	m	Bird flight speed	v	8	m s^{-1}
Max blade width	C	4.2	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	9.26%
	downwind	4.31%
	weighted mean	6.78%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

			large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled				Collision rates allowing for avoidance												
			100.00%	0.00	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.3
			100.00%	0.00	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.3
			100.00%	0.00	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.3
		99.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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
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Bird data		Value	Units
Species name		Common kestrel	
Bird length	L	0.34	m
Wingspan	W	0.755	m
Bird flight speed	v	12.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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				0.003706	0.000375	0.000884	0.000831	0.002455					0.0007
Proportion at rotor risk height	Q_{2R}	75.96%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
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	82.8	9.9	24.1	22.7	60.3	0.0	0.0	0.0	0.0	200

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	75	m	Bird flight speed	v	12.7	m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk		
	upwind	6.71%
	downwind	2.86%
	weighted mean	4.78%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	3.37	0.40	0.98	0.92	2.45	0.00	0.00	0.00	0.00	8

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	3.37	0.40	0.98	0.92	2.45	0.00	0.00	0.00	0.00	8.1
	95.00%	100.00%	0.00	0.00	0.00	0.17	0.02	0.05	0.05	0.12	0.00	0.00	0.00	0.00	0.4
		100.00%	0.00	0.00	0.00	3.37	0.40	0.98	0.92	2.45	0.00	0.00	0.00	0.00	8.1
		100.00%	0.00	0.00	0.00	3.37	0.40	0.98	0.92	2.45	0.00	0.00	0.00	0.00	8.1

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		Value	Units
Species name		Common kestrel	
Bird length	L	0.34	m
Wingspan	W	0.755	m
Bird flight speed	v	12.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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				0.01553	0.007551	0.000259	0.001719	0.010928					0.0030
Proportion at rotor risk height	Q_{2R}	90.85%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
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	415.1	237.8	8.4	56.3	320.8	0.0	0.0	0.0	0.0	1038

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	75	m	Bird flight speed	v	12.7	m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	6.71%
	downwind	2.86%
	weighted mean	4.78%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	16.88	9.67	0.34	2.29	13.04	0.00	0.00	0.00	0.00	42

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	16.88	9.67	0.34	2.29	13.04	0.00	0.00	0.00	0.00	42.2
	95.00%	100.00%	0.00	0.00	0.00	0.84	0.48	0.02	0.11	0.65	0.00	0.00	0.00	0.00	2.1
		100.00%	0.00	0.00	0.00	16.88	9.67	0.34	2.29	13.04	0.00	0.00	0.00	0.00	42.2
		100.00%	0.00	0.00	0.00	16.88	9.67	0.34	2.29	13.04	0.00	0.00	0.00	0.00	42.2

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		Value	Units
Species name		Common kestrel	
Bird length	L	0.34	m
Wingspan	W	0.755	m
Bird flight speed	v	12.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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}				0.000377	0.002121	0.002441	0.007912	0.000679					0.0011
Proportion at rotor risk height	Q_{2R}	85.30%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
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	9.5	62.7	74.7	243.2	18.7	0.0	0.0	0.0	0.0	409

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	75	m	Bird flight speed	v	12.7 m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping
Pitch	λ	15	degrees	% of flights upwind/downwind		50% 50%
Blade profile		see Blade profile sheet				
		Single transit risk	upwind	6.71%		
			downwind	2.86%		
			weighted mean	4.78%		

Stage D		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.38	2.55	3.03	9.88	0.76	0.00	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	2	km														
			large array correction	Collision rates allowing for avoidance													
Avoidance rates modelled			100.00%		0.00	0.00	0.00	0.38	2.55	3.03	9.88	0.76	0.00	0.00	0.00	0.00	16.6
		95.00%	100.00%		0.00	0.00	0.00	0.02	0.13	0.15	0.49	0.04	0.00	0.00	0.00	0.00	0.8
			100.00%		0.00	0.00	0.00	0.38	2.55	3.03	9.88	0.76	0.00	0.00	0.00	0.00	16.6
			100.00%		0.00	0.00	0.00	0.38	2.55	3.03	9.88	0.76	0.00	0.00	0.00	0.00	16.6

COLLISION RISK MODEL

Required input data is in orange boxes
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Bird data		Value	Units
Species name		Common kestrel	
Bird length	L	0.34	m
Wingspan	W	0.755	m
Bird flight speed	v	12.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0.000548	0.0000804	0.001183						0.003079	0.00000755	0.000193	0	0.0004
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	12.7	m s^{-1}														
		Projected number of rotor transits			8.1	1.3	26.0	0.0	0.0	0.0	0.0	0.0	70.8	0.1	3.0	0.0	109

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	75	m	Bird flight speed	v	12.7	m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	6.71%
	downwind	2.86%
	weighted mean	4.78%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.33	0.05	1.06	0.00	0.00	0.00	0.00	0.00	2.88	0.01	0.12	0.00	4

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			Collision rates allowing for avoidance												
		100.00%	0.33	0.05	1.06	0.00	0.00	0.00	0.00	0.00	2.88	0.01	0.12	0.00	4.4
	95.00%	100.00%	0.02	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.01	0.00	0.2
		100.00%	0.33	0.05	1.06	0.00	0.00	0.00	0.00	0.00	2.88	0.01	0.12	0.00	4.4
		100.00%	0.33	0.05	1.06	0.00	0.00	0.00	0.00	0.00	2.88	0.01	0.12	0.00	4.4

COLLISION RISK MODEL

Required input data is in orange boxes
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Bird data		Value	Units
Species name		Common kestrel	
Bird length	L	0.34	m
Wingspan	W	0.755	m
Bird flight speed	v	12.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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}	0.007861	0.00106	0.002233						0.00000525	0.000379	0	0	0.0010
Proportion at rotor risk height	Q_{2R}	74.25%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	12.7	m s^{-1}														
		Projected number of rotor transits			101.3	15.0	42.5	0.0	0.0	0.0	0.0	0.0	0.1	6.5	0.0	0.0	165

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	75	m	Bird flight speed	v	12.7	m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	6.71%
	downwind	2.86%
	weighted mean	4.78%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		4.12	0.61	1.73	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00	7

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	4.12	0.61	1.73	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00	6.7
	95.00%	100.00%	0.21	0.03	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.3
		100.00%	4.12	0.61	1.73	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00	6.7
		100.00%	4.12	0.61	1.73	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00	6.7

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		Value	Units
Species name		Common kestrel	
Bird length	L	0.34	m
Wingspan	W	0.755	m
Bird flight speed	v	12.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0.000803	0.00059						0.000147	0	0.000362	0.000307	0.0002
Proportion at rotor risk height	Q_{2R}	84.76%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	12.7	m s^{-1}														
		Projected number of rotor transits			0.0	13.0	12.8	0.0	0.0	0.0	0.0	0.0	3.3	0.0	5.5	4.2	39

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	75	m	Bird flight speed	v	12.7	m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	6.71%
	downwind	2.86%
	weighted mean	4.78%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.53	0.52	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.23	0.17	2

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.53	0.52	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.23	0.17	1.6
	95.00%	100.00%	0.00	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.1
		100.00%	0.00	0.53	0.52	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.23	0.17	1.6
		100.00%	0.00	0.53	0.52	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.23	0.17	1.6

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		Value	Units
Species name		Black-legged kittiwake	
Bird length	L	0.39	m
Wingspan	W	1.075	m
Bird flight speed	v	13.1	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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				0.000177	0	0	0	0					0.0000
Proportion at rotor risk height	Q_{2R}	85.71%													
At latitude 54.1		Daylight hours per month	247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month	496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
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	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5

Stage C

No of blades	b	3		Bird length	l	0.39	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	1.075	m
Rotor radius	R	75	m	Bird flight speed	v	13.1	m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	6.93%
	downwind	3.16%
	weighted mean	5.05%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
Collision rates before avoidance													
	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		100.00%	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2
		100.00%	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2

COLLISION RISK MODEL

Required input data is in orange boxes
Calculated output is in blue boxes
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Bird data		Value	Units
Species name		Lesser black-backed gull	
Bird length	L	0.6	m
Wingspan	W	1.45	m
Bird flight speed	v	13.1	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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				0.00314	0.002969	0.003197	0.000593	0.000352					0.0009
Proportion at rotor risk height	Q_{2R}	80.87%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
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	77.1	85.8	95.6	17.8	9.5	0.0	0.0	0.0	0.0	286

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	75	m	Bird flight speed	v	13.1	m s^{-1}
Max blade width	C	4.2	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.49%
	downwind	3.73%
	weighted mean	5.61%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	3.68	4.09	4.56	0.85	0.45	0.00	0.00	0.00	0.00	14

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	3.68	4.09	4.56	0.85	0.45	0.00	0.00	0.00	0.00	13.6
		100.00%	0.00	0.00	0.00	3.68	4.09	4.56	0.85	0.45	0.00	0.00	0.00	0.00	13.6
		100.00%	0.00	0.00	0.00	3.68	4.09	4.56	0.85	0.45	0.00	0.00	0.00	0.00	13.6
	98.00%	100.00%	0.00	0.00	0.00	0.07	0.08	0.09	0.02	0.01	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		Value	Units
Species name		Lesser black-backed gull	
Bird length	L	0.6	m
Wingspan	W	1.45	m
Bird flight speed	v	13.1	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0	0.00047	0	0					0.0000
Proportion at rotor risk height	Q_{2R}	78.91%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
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	13.7	0.0	0.0	0.0	0.0	0.0	0.0	14

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	75	m	Bird flight speed	v	13.1	m s^{-1}
Max blade width	C	4.2	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.49%
	downwind	3.73%
	weighted mean	5.61%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.65	0.00	0.00	0.00	0.00	0.00	0.00	1

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.7
		100.00%	0.00	0.00	0.00	0.00	0.00	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.7
		100.00%	0.00	0.00	0.00	0.00	0.00	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.7
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.01	0.00	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
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Bird data		Value	Units
Species name		Lesser black-backed gull	
Bird length	L	0.6	m
Wingspan	W	1.45	m
Bird flight speed	v	13.1	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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				0.001099	0.005858	0.000218	0	0					0.0006
Proportion at rotor risk height	Q_{2R}	81.36%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
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	27.1	170.4	6.6	0.0	0.0	0.0	0.0	0.0	0.0	204

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	75	m	Bird flight speed	v	13.1	m s^{-1}
Max blade width	C	4.2	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.49%
	downwind	3.73%
	weighted mean	5.61%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
Collision rates before avoidance														year total
		0.00	0.00	0.00	1.29	8.13	0.31	0.00	0.00	0.00	0.00	0.00	0.00	10

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	1.29	8.13	0.31	0.00	0.00	0.00	0.00	0.00	0.00	9.7
		100.00%	0.00	0.00	0.00	1.29	8.13	0.31	0.00	0.00	0.00	0.00	0.00	0.00	9.7
		100.00%	0.00	0.00	0.00	1.29	8.13	0.31	0.00	0.00	0.00	0.00	0.00	0.00	9.7
	98.00%	100.00%	0.00	0.00	0.00	0.03	0.16	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.2

COLLISION RISK MODEL

Required input data is in orange boxes
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Bird data		Value	Units
Species name		Lesser black-backed gull	
Bird length	L	0.6	m
Wingspan	W	1.45	m
Bird flight speed	v	13.1	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0.005095	0	0						0	0	0	0	0.0004
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	13.1	m s^{-1}														
		Projected number of rotor transits			78.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	78

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	75	m	Bird flight speed	v	13.1	m s^{-1}	
Max blade width	C	4.2	m	Flight type		gliding		
Pitch	λ	15	degrees	% of flights upwind/downwind		50%		50%
Blade profile		see Blade profile sheet						

Single transit risk	upwind	7.49%
	downwind	3.73%
	weighted mean	5.61%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		3.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

			large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled				Collision rates allowing for avoidance												
			100.00%	3.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.7
			100.00%	3.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.7
			100.00%	3.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.7
		98.00%	100.00%	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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		Value	Units
Species name		Lesser black-backed gull	
Bird length	L	0.6	m
Wingspan	W	1.45	m
Bird flight speed	v	13.1	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0	0						0.000904	0.000217	0	0	0.0001
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
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	0.0	21.4	4.4	0.0	0.0	26

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	75	m	Bird flight speed	v	13.1	m s^{-1}	
Max blade width	C	4.2	m	Flight type		gliding		
Pitch	λ	15	degrees	% of flights upwind/downwind		50%		50%
Blade profile		see Blade profile sheet						

Single transit risk	upwind	7.49%
	downwind	3.73%
	weighted mean	5.61%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.02	0.21	0.00	0.00	1

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.02	0.21	0.00	0.00	1.2
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.02	0.21	0.00	0.00	1.2
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.02	0.21	0.00	0.00	1.2
98.00%		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	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

Bird data		Value	Units
Species name		Mallard	
Bird length	L	0.58	m
Wingspan	W	0.9	m
Bird flight speed	v	22	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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				0.000293	0	0	0	0.00007					0.0000
Proportion at rotor risk height	Q_{2R}	43.81%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	22	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	7.7	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	10

Stage C

No of blades	b	3		Bird length	l	0.58	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.9	m
Rotor radius	R	75	m	Bird flight speed	v	22	m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	5.91%
	downwind	3.57%
	weighted mean	4.74%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.4
		100.00%	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.4
		100.00%	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.4
	98.00%	100.00%	0.00	0.00	0.00	0.01	0.00	0.00	0.00	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

Bird data		Value	Units
Species name		Mallard	
Bird length	L	0.58	m
Wingspan	W	0.9	m
Bird flight speed	v	22	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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				0.000369	0.000239	0	0	0.000273					0.0001
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	22	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	19.0	13.8	0.0	0.0	15.1	0.0	0.0	0.0	0.0	48

Stage C

No of blades	b	3		Bird length	l	0.58	m	
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.9	m	
Rotor radius	R	75	m	Bird flight speed	v	22	m s^{-1}	
Max blade width	C	4.2	m	Flight type		flapping		
Pitch	λ	15	degrees	% of flights upwind/downwind		50%		50%
Blade profile		see Blade profile sheet						

Single transit risk		
upwind		5.91%
downwind		3.57%
weighted mean		4.74%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.77	0.56	0.00	0.00	0.61	0.00	0.00	0.00	0.00	2

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.77	0.56	0.00	0.00	0.61	0.00	0.00	0.00	0.00	1.9
		100.00%	0.00	0.00	0.00	0.77	0.56	0.00	0.00	0.61	0.00	0.00	0.00	0.00	1.9
		100.00%	0.00	0.00	0.00	0.77	0.56	0.00	0.00	0.61	0.00	0.00	0.00	0.00	1.9
	98.00%	100.00%	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.01	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

Bird data		Value	Units
Species name		Mallard	
Bird length	L	0.58	m
Wingspan	W	0.9	m
Bird flight speed	v	22	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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				0.003563	0	0	0	0.000311					0.0003
Proportion at rotor risk height	Q_{2R}	83.81%													
At latitude 54.1		Daylight hours per month	247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month	496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

No of turbines	T	13													
Rotor radius	R	75	m												
		Total rotor frontal area m^2	229729												
Nocturnal activity factor	f_{night}	25%													
Bird flight speed	v	22	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	179.4	0.0	0.0	0.0	16.8	0.0	0.0	0.0	0.0	196

Stage C

No of blades	b	3		Bird length	l	0.58	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.9	m
Rotor radius	R	75	m	Bird flight speed	v	22	m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					
		Single transit risk	upwind	5.91%			
			downwind	3.57%			
			weighted mean	4.74%			

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	7.23	0.00	0.00	0.00	0.68	0.00	0.00	0.00	0.00	8

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	7.23	0.00	0.00	0.00	0.68	0.00	0.00	0.00	0.00	7.9
		100.00%	0.00	0.00	0.00	7.23	0.00	0.00	0.00	0.68	0.00	0.00	0.00	0.00	7.9
		100.00%	0.00	0.00	0.00	7.23	0.00	0.00	0.00	0.68	0.00	0.00	0.00	0.00	7.9
	98.00%	100.00%	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.2

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		Value	Units
Species name		Merlin	
Bird length	L	0.275	m
Wingspan	W	0.56	m
Bird flight speed	v	13.47	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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				0.0000584	0	0	0	0					0.0000
Proportion at rotor risk height	Q_{2R}	0.00%													
At latitude 54.1		Daylight hours per month	247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month	496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

No of turbines	T	13	
Rotor radius	R	75	m
Total rotor frontal area m^2		229729	
Nocturnal activity factor	f_{night}	0%	
Bird flight speed	v	13.47	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	0.0	0.0	0.0	0.0	0.0	0.0	0

Stage C

No of blades	b	3		Bird length	l	0.275 m
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.56 m
Rotor radius	R	75	m	Bird flight speed	v	13.47 m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping
Pitch	λ	15	degrees	% of flights upwind/downwind		50% 50%
Blade profile		see Blade profile sheet				

Single transit risk	
upwind	6.26%
downwind	2.58%
weighted mean	4.42%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
Collision rates before avoidance														year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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

Bird data		Value	Units
Species name		Merlin	
Bird length	L	0.275	m
Wingspan	W	0.56	m
Bird flight speed	v	13.47	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0.000299	0						0	0	0	0	0.0000
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	13.47	m s^{-1}														
		Projected number of rotor transits			0.0	5.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5

Stage C

No of blades	b	3		Bird length	l	0.275	m	
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.56	m	
Rotor radius	R	75	m	Bird flight speed	v	13.47	m s^{-1}	
Max blade width	C	4.2	m	Flight type		flapping		
Pitch	λ	15	degrees	% of flights upwind/downwind		50%		50%
Blade profile		see Blade profile sheet						

Single transit risk	upwind	6.26%
	downwind	2.58%
	weighted mean	4.42%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			Collision rates allowing for avoidance												
		100.00%	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2
		100.00%	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2
		100.00%	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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

Bird data		Value	Units
Species name		nd white-fronted goose	
Bird length	L	0.71	m
Wingspan	W	1.47	m
Bird flight speed	v	16.1	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0	0						0	0.038264	0	0	0.0032
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	16.1	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1258.6	0.0	0.0	1259

Stage C

No of blades	b	3		Bird length	l	0.71	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	1.47	m
Rotor radius	R	75	m	Bird flight speed	v	16.1	m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk		
upwind		7.27%
downwind		4.09%
weighted mean		5.68%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	60.80	0.00	0.00	61

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled	large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
		Collision rates allowing for avoidance												
	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	60.80	0.00	0.00	60.8
	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	60.80	0.00	0.00	60.8
	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	60.80	0.00	0.00	60.8
99.80%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	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		Value	Units
Species name		Peregrine falcon	
Bird length	L	0.42	m
Wingspan	W	1.025	m
Bird flight speed	v	12.1	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0.000288	0	0						0.000483	0.000142	0.000376	0	0.0001
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	12.1	m s^{-1}														
		Projected number of rotor transits			4.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.6	2.7	5.5	0.0	23

Stage C

No of blades	b	3		Bird length	l	0.42	m	
Rotation speed	Ω	8.8	rpm	Wingspan	w	1.025	m	
Rotor radius	R	75	m	Bird flight speed	v	12.1	m s^{-1}	
Max blade width	C	4.2	m	Flight type		flapping		
Pitch	λ	15	degrees	% of flights upwind/downwind		50%		50%
Blade profile		see Blade profile sheet						

Single transit risk	upwind	7.23%
	downwind	3.25%
	weighted mean	5.24%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.12	0.25	0.00	1

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.12	0.25	0.00	1.0
		100.00%	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.12	0.25	0.00	1.0
		100.00%	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.12	0.25	0.00	1.0
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	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

Bird data		Value	Units
Species name		Common snipe	
Bird length	L	0.26	m
Wingspan	W	0.455	m
Bird flight speed	v	16	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0	0.000207	0	0					0.0000
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	16	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	8.8	0.0	0.0	0.0	0.0	0.0	0.0	9

Stage C

No of blades	b	3		Bird length	l	0.26	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.455	m
Rotor radius	R	75	m	Bird flight speed	v	16	m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	5.76%
	downwind	2.56%
	weighted mean	4.16%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

	large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
		Collision rates allowing for avoidance												
Avoidance rates modelled	100.00%	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.3
	100.00%	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.3
	100.00%	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.3
98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.01	0.00	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

Bird data		Value	Units
Species name		Common snipe	
Bird length	L	0.26	m
Wingspan	W	0.455	m
Bird flight speed	v	16	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0.000278	0						0	0.0000136	0	0	0.0000
Proportion at rotor risk height	Q_{2R}	77.14%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

No of turbines	T	13														
Rotor radius	R	75	m													
		Total rotor frontal area m^2	229729													
Nocturnal activity factor	f_{night}	25%														
Bird flight speed	v	16	m s^{-1}	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
		Projected number of rotor transits		0.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	7

Stage C

No of blades	b	3		Bird length	l	0.26	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.455	m
Rotor radius	R	75	m	Bird flight speed	v	16	m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk		
	upwind	5.76%
	downwind	2.56%
	weighted mean	4.16%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

	large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
		Collision rates allowing for avoidance												
Avoidance rates modelled	100.00%	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.3
	100.00%	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.3
	100.00%	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.3
98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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

Bird data		Value	Units
Species name		Common snipe	
Bird length	L	0.26	m
Wingspan	W	0.455	m
Bird flight speed	v	16	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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}	0.000944	0.000192	0						0	0.006071	0.000676	0	0.0007
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	16	m s^{-1}														
		Projected number of rotor transits			26.5	5.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	198.4	19.1	0.0	249

Stage C

No of blades	b	3		Bird length	l	0.26	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.455	m
Rotor radius	R	75	m	Bird flight speed	v	16	m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	5.76%
	downwind	2.56%
	weighted mean	4.16%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.94	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.01	0.67	0.00	9

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

	large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
		Collision rates allowing for avoidance												
Avoidance rates modelled	100.00%	0.94	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.01	0.67	0.00	8.8
	100.00%	0.94	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.01	0.67	0.00	8.8
	100.00%	0.94	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.01	0.67	0.00	8.8
98.00%	100.00%	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.01	0.00	0.2

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		Value	Units
Species name		Common snipe	
Bird length	L	0.26	m
Wingspan	W	0.455	m
Bird flight speed	v	16	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0	0						0	0.000704	0.0000414	0	0.0001
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	16	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.0	1.2	0.0	24

Stage C

No of blades	b	3		Bird length	l	0.26	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.455	m
Rotor radius	R	75	m	Bird flight speed	v	16	m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	5.76%
	downwind	2.56%
	weighted mean	4.16%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.04	0.00	1

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.04	0.00	0.9
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.04	0.00	0.9
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.04	0.00	0.9
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	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

Bird data		Value	Units
Species name		Eurasian teal	
Bird length	L	0.39	m
Wingspan	W	0.55	m
Bird flight speed	v	19.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0	0	0.0000677	0					0.0000
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B																
No of turbines	T	13														
Rotor radius	R	75	m													
		Total rotor frontal area m^2	229729													
Nocturnal activity factor	f_{night}	25%														
Bird flight speed	v	19.7	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	3.6	0.0	0.0	0.0	0.0	0.0	4

Stage C							
No of blades	b	3		Bird length	l	0.39	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.55	m
Rotor radius	R	75	m	Bird flight speed	v	19.7	m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					
		Single transit risk	upwind	5.63%			
			downwind	3.02%			
			weighted mean	4.32%			

Stage D		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0

Stage E																
Allow for large array correction?		No														
Width of windfarm	w	2	km													
			large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
				Collision rates allowing for avoidance												
Avoidance rates modelled			100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.1
			100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.1
			100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.1
		98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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
Bird data			
Species name		Eurasian teal	
Bird length	L	0.39	m
Wingspan	W	0.55	m
Bird flight speed	v	19.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

		Value	Units
Windfarm data			
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

		Value	Units
Turbine data			
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0	0	0.002052	0					0.0002
Proportion at rotor risk height	Q_{2R}	85.71%													
At latitude 54.1		Daylight hours per month	247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month	496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13														
Rotor radius	R	75	m													
		Total rotor frontal area m^2	229729													
Nocturnal activity factor	f_{night}	25%														
Bird flight speed	v	19.7	m s^{-1}													
		Projected number of rotor transits		0.0	0.0	0.0	0.0	0.0	0.0	109.2	0.0	0.0	0.0	0.0	0.0	109

Stage C

No of blades	b	3		Bird length	l	0.39 m
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.55 m
Rotor radius	R	75	m	Bird flight speed	v	19.7 m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping
Pitch	λ	15	degrees	% of flights upwind/downwind		50% 50%
Blade profile		see Blade profile sheet				
		Single transit risk	upwind	5.63%		
			downwind	3.02%		
			weighted mean	4.32%		

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	4.01	0.00	0.00	0.00	0.00	0.00	4

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

	large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
		Collision rates allowing for avoidance												
Avoidance rates modelled	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	4.01	0.00	0.00	0.00	0.00	0.00	4.0
	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	4.01	0.00	0.00	0.00	0.00	0.00	4.0
	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	4.01	0.00	0.00	0.00	0.00	0.00	4.0
98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	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		Value	Units
Species name		Eurasian teal	
Bird length	L	0.39	m
Wingspan	W	0.55	m
Bird flight speed	v	19.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0	0.0000265						0	0	0	0	0.0000
Proportion at rotor risk height	Q_{2R}	0.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	19.7	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0

Stage C

No of blades	b	3		Bird length	l	0.39	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.55	m
Rotor radius	R	75	m	Bird flight speed	v	19.7	m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	5.63%
	downwind	3.02%
	weighted mean	4.32%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

			large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
				Collision rates allowing for avoidance												
Avoidance rates modelled			100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
			100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
			100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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

Bird data		Value	Units
Species name		Eurasian woodcock	
Bird length	L	0.28	m
Wingspan	W	0.6	m
Bird flight speed	v	3.33	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		3	
Nocturnal activity factor	f_{night}	50%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0.000127	0	0						0	0	0	0.0000161	0.0000
Proportion at rotor risk height	Q_{2R}	51.43%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
Nocturnal activity factor	f_{night}	50%															
Bird flight speed	v	3.33	m s^{-1}														
		Projected number of rotor transits			0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1

Stage C

No of blades	b	3		Bird length	l	0.28	m	
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.6	m	
Rotor radius	R	75	m	Bird flight speed	v	3.33	m s^{-1}	
Max blade width	C	4.2	m	Flight type		flapping		
Pitch	λ	15	degrees	% of flights upwind/downwind		50%		50%
Blade profile		see Blade profile sheet						

Single transit risk	upwind	14.78%
	downwind	8.65%
	weighted mean	11.72%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			Collision rates allowing for avoidance												
		100.00%	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.1
		100.00%	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.1
		100.00%	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.1
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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
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Bird data		Value	Units
Species name		Whooper swan	
Bird length	L	1.525	m
Wingspan	W	2.304	m
Bird flight speed	v	17.3	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0	0						0	0	0	0.002085	0.0002
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	17.3	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	61.3	61

Stage C

No of blades	b	3		Bird length	l	1.525	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	2.304	m
Rotor radius	R	75	m	Bird flight speed	v	17.3	m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk		
upwind		9.18%
downwind		6.21%
weighted mean		7.69%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
Collision rates before avoidance													
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.01	4

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.01	4.0
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.01	4.0
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.01	4.0
	99.50%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	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

Bird data		Value	Units
Species name		Whooper swan	
Bird length	L	1.525	m
Wingspan	W	2.304	m
Bird flight speed	v	17.3	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		V150	
Hub height		105	m
Rotor radius	R	75	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.2	m
Blade pitch	λ	15	degrees
Risk height range		30-180	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	0.037702	0	0						0	0	0	0	0.0031
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	75	m														
		Total rotor frontal area m^2		229729													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	17.3	m s^{-1}														
		Projected number of rotor transits			1146.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1146

Stage C

No of blades	b	3		Bird length	l	1.525	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	2.304	m
Rotor radius	R	75	m	Bird flight speed	v	17.3	m s^{-1}
Max blade width	C	4.2	m	Flight type		flapping	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk		
upwind		9.18%
downwind		6.21%
weighted mean		7.69%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		74.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	75

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	74.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	74.9
		100.00%	74.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	74.9
		100.00%	74.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	74.9
	99.50%	100.00%	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.4

Appendix B NatureScot Spreadsheets – Nordex N163

Avian Collision Risk Report

Muingmore Wind Farm

RWE Renewables Ireland Ltd

SLR Project No.: 501.065301.00001

9 July 2025

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		Value	Units
Species name		Black-headed gull	
Bird length	L	0.355	m
Wingspan	W	1.05	m
Bird flight speed	v	11.9	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0	0.003447	0.000438	0					0.0003
Proportion at rotor risk height	Q_{2R}	81.96%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
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	103.1	13.2	0.0	0.0	0.0	0.0	0.0	116

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%	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}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	4.22	0.54	0.00	0.00	0.00	0.00	0.00	5

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.00	0.00	4.22	0.54	0.00	0.00	0.00	0.00	0.00	4.8
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.08	0.01	0.00	0.00	0.00	0.00	0.00	0.1
		100.00%	0.00	0.00	0.00	0.00	0.00	4.22	0.54	0.00	0.00	0.00	0.00	0.00	4.8
		100.00%	0.00	0.00	0.00	0.00	0.00	4.22	0.54	0.00	0.00	0.00	0.00	0.00	4.8

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		Value	Units
Species name		Black-headed gull	
Bird length	L	0.355	m
Wingspan	W	1.05	m
Bird flight speed	v	11.9	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0.000194	0.000911	0.002603	0					0.0003
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
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	6.5	31.6	90.7	0.0	0.0	0.0	0.0	0.0	129

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%	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}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.27	1.29	3.71	0.00	0.00	0.00	0.00	0.00	5

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.00	0.27	1.29	3.71	0.00	0.00	0.00	0.00	0.00	5.3
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.01	0.03	0.07	0.00	0.00	0.00	0.00	0.00	0.1
		100.00%	0.00	0.00	0.00	0.00	0.27	1.29	3.71	0.00	0.00	0.00	0.00	0.00	5.3
		100.00%	0.00	0.00	0.00	0.00	0.27	1.29	3.71	0.00	0.00	0.00	0.00	0.00	5.3

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		Value	Units
Species name		Black-headed gull	
Bird length	L	0.355	m
Wingspan	W	1.05	m
Bird flight speed	v	11.9	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0.001169	0.015875	0.000412	0					0.0015
Proportion at rotor risk height	Q_{2R}	19.38%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
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	8.0	112.3	2.9	0.0	0.0	0.0	0.0	0.0	123

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%	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}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%

Collision rates before avoidance													year total
0.00	0.00	0.00	0.00	0.33	4.59	0.12	0.00	0.00	0.00	0.00	0.00		5

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.33	4.59	0.12	0.00	0.00	0.00	0.00	0.00	5.0
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.01	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.1
		100.00%	0.00	0.00	0.00	0.00	0.33	4.59	0.12	0.00	0.00	0.00	0.00	0.00	5.0
		100.00%	0.00	0.00	0.00	0.00	0.33	4.59	0.12	0.00	0.00	0.00	0.00	0.00	5.0

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

Bird data		Value	Units
Species name		Black-headed gull	
Bird length	L	0.355	m
Wingspan	W	1.05	m
Bird flight speed	v	11.9	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0	0						0	0	5.77558E-05	0	0.0000
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
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	0.0	0.0	1.0	0.0	1

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%	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}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.0
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.0
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	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

Bird data		Value	Units
Species name		Great cormorant	
Bird length	L	0.9	m
Wingspan	W	1.45	m
Bird flight speed	v	14.5	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0.001374	0	0.000491						0	0.000571	0	0	0.0002
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	14.5	m s^{-1}														
		Projected number of rotor transits			28.1	0.0	14.8	0.0	0.0	0.0	0.0	0.0	0.0	15.5	0.0	0.0	58

Stage C

No of blades	b	3		Bird length	l	0.9	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	1.45	m
Rotor radius	R	81.5	m	Bird flight speed	v	14.5	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	7.74%
	downwind	4.36%
	weighted mean	6.05%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		1.44	0.00	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.00	0.00	3

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			Collision rates allowing for avoidance												
		100.00%	1.44	0.00	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.00	0.00	3.0
		100.00%	1.44	0.00	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.00	0.00	3.0
		100.00%	1.44	0.00	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.00	0.00	3.0
	98.00%	100.00%	0.03	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	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		Value	Units
Species name		Common gull	
Bird length	L	0.41	m
Wingspan	W	1.15	m
Bird flight speed	v	13.4	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0	0	0.004297	0					0.0004
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	13.4	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	0.0	168.6	0.0	0.0	0.0	0.0	0.0	169

Stage C

No of blades	b	3		Bird length	l	0.41	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	1.15	m
Rotor radius	R	81.5	m	Bird flight speed	v	13.4	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	6.58%
	downwind	3.00%
	weighted mean	4.79%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	6.86	0.00	0.00	0.00	0.00	0.00	7

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	6.86	0.00	0.00	0.00	0.00	0.00	6.9
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.1
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	6.86	0.00	0.00	0.00	0.00	0.00	6.9
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	6.86	0.00	0.00	0.00	0.00	0.00	6.9

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		Value	Units
Species name		Common gull	
Bird length	L	0.41	m
Wingspan	W	1.15	m
Bird flight speed	v	13.4	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0	0	0.001111	0					0.0001
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	13.4	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	0.0	43.6	0.0	0.0	0.0	0.0	0.0	44

Stage C

No of blades	b	3		Bird length	l	0.41	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	1.15	m
Rotor radius	R	81.5	m	Bird flight speed	v	13.4	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	6.58%
	downwind	3.00%
	weighted mean	4.79%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	1.77	0.00	0.00	0.00	0.00	0.00	2

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	1.77	0.00	0.00	0.00	0.00	0.00	1.8
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.0
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	1.77	0.00	0.00	0.00	0.00	0.00	1.8
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	1.77	0.00	0.00	0.00	0.00	0.00	1.8

COLLISION RISK MODEL

Required input data is in orange boxes
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Bird data		Value	Units
Species name		Common tern	
Bird length	L	0.33	m
Wingspan	W	0.875	m
Bird flight speed	v	10.2	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0	0.000141	0	0					0.0000
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	10.2	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0	4

Stage C

No of blades	b	3		Bird length	l	0.33	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.875	m
Rotor radius	R	81.5	m	Bird flight speed	v	10.2	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	7.10%
	downwind	2.91%
	weighted mean	5.01%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

	large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
		Collision rates allowing for avoidance												
Avoidance rates modelled	100.00%	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.2
	100.00%	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.2
	100.00%	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.2
98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

COLLISION RISK MODEL

Required input data is in orange boxes
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Bird data		Value	Units
Species name		Greylag goose	
Bird length	L	0.83	m
Wingspan	W	1.64	m
Bird flight speed	v	17.1	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0	0.458196						0	0	0	0	0.0382
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

No of turbines	T	13														
Rotor radius	R	81.5	m													
		Total rotor frontal area m^2	271274													
Nocturnal activity factor	f_{night}	25%														
Bird flight speed	v	17.1	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	20540.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20540

Stage C

No of blades	b	3		Bird length	l	0.83	m	
Rotation speed	Ω	8.8	rpm	Wingspan	w	1.64	m	
Rotor radius	R	81.5	m	Bird flight speed	v	17.1	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	7.03%				
			downwind	4.08%				
			weighted mean	5.56%				

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	970.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	970

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	970.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	970.4
		100.00%	0.00	0.00	970.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	970.4
		100.00%	0.00	0.00	970.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	970.4
99.80%		100.00%	0.00	0.00	1.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.9

COLLISION RISK MODEL

Required input data is in orange boxes
Calculated output is in blue boxes
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		Value	Units
Bird data			
Species name		Golden plover	
Bird length	L	0.275	m
Wingspan	W	0.715	m
Bird flight speed	v	13.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

		Value	Units
Windfarm data			
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

		Value	Units
Turbine data			
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0	0	0.000204	0					0.0000
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
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	9.1	0.0	0.0	0.0	0.0	0.0	9

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%	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}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.3
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.3
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0
	99.80%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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
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Bird data		Value	Units
Species name		Herring gull	
Bird length	L	0.61	m
Wingspan	W	1.465	m
Bird flight speed	v	12.8	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0	0.000992	0.000718	0					0.0001
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
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	37.0	26.9	0.0	0.0	0.0	0.0	0.0	64

Stage C

No of blades	b	3		Bird length	l	0.61	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	1.465	m
Rotor radius	R	81.5	m	Bird flight speed	v	12.8	m s^{-1}
Max blade width	C	4.15	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.26%
	downwind	3.58%
	weighted mean	5.42%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	1.70	1.24	0.00	0.00	0.00	0.00	0.00	3

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.00	0.00	1.70	1.24	0.00	0.00	0.00	0.00	0.00	2.9
		100.00%	0.00	0.00	0.00	0.00	0.00	1.70	1.24	0.00	0.00	0.00	0.00	0.00	2.9
		100.00%	0.00	0.00	0.00	0.00	0.00	1.70	1.24	0.00	0.00	0.00	0.00	0.00	2.9
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.03	0.02	0.00	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		Value	Units
Species name		Herring gull	
Bird length	L	0.61	m
Wingspan	W	1.465	m
Bird flight speed	v	12.8	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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				0.000104	0.000277	0.000635	0.000816	0					0.0002
Proportion at rotor risk height	Q_{2R}	92.34%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
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	3.1	9.7	23.0	29.7	0.0	0.0	0.0	0.0	0.0	66

Stage C

No of blades	b	3		Bird length	l	0.61	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	1.465	m
Rotor radius	R	81.5	m	Bird flight speed	v	12.8	m s^{-1}
Max blade width	C	4.15	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.26%
	downwind	3.58%
	weighted mean	5.42%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.14	0.45	1.06	1.37	0.00	0.00	0.00	0.00	0.00	3

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.14	0.45	1.06	1.37	0.00	0.00	0.00	0.00	0.00	3.0
		100.00%	0.00	0.00	0.00	0.14	0.45	1.06	1.37	0.00	0.00	0.00	0.00	0.00	3.0
		100.00%	0.00	0.00	0.00	0.14	0.45	1.06	1.37	0.00	0.00	0.00	0.00	0.00	3.0
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.00	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		Value	Units
Species name		Herring gull	
Bird length	L	0.61	m
Wingspan	W	1.465	m
Bird flight speed	v	12.8	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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				0.000361	0	0.00132	0.012133	0					0.0012
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
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	11.1	0.0	49.2	454.8	0.0	0.0	0.0	0.0	0.0	515

Stage C

No of blades	b	3		Bird length	l	0.61	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	1.465	m
Rotor radius	R	81.5	m	Bird flight speed	v	12.8	m s^{-1}
Max blade width	C	4.15	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.26%
	downwind	3.58%
	weighted mean	5.42%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.51	0.00	2.27	20.95	0.00	0.00	0.00	0.00	0.00	24

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.51	0.00	2.27	20.95	0.00	0.00	0.00	0.00	0.00	23.7
		100.00%	0.00	0.00	0.00	0.51	0.00	2.27	20.95	0.00	0.00	0.00	0.00	0.00	23.7
		100.00%	0.00	0.00	0.00	0.51	0.00	2.27	20.95	0.00	0.00	0.00	0.00	0.00	23.7
	98.00%	100.00%	0.00	0.00	0.00	0.01	0.00	0.05	0.42	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		Value	Units
Species name		Herring gull	
Bird length	L	0.61	m
Wingspan	W	1.465	m
Bird flight speed	v	12.8	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0	0						0	0.000256	0	0	0.0000
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
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	0.0	0.0	6.1	0.0	0.0	6

Stage C

No of blades	b	3		Bird length	l	0.61	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	1.465	m
Rotor radius	R	81.5	m	Bird flight speed	v	12.8	m s^{-1}
Max blade width	C	4.15	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.26%
	downwind	3.58%
	weighted mean	5.42%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.3
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.3
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.3
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	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

Bird data		Value	Units
Species name		Herring gull	
Bird length	L	0.61	m
Wingspan	W	1.465	m
Bird flight speed	v	12.8	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0	0						0	0	0.000475	0	0.0000
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
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	0.0	0.0	0.0	8.9	0.0	9

Stage C

No of blades	b	3		Bird length	l	0.61	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	1.465	m
Rotor radius	R	81.5	m	Bird flight speed	v	12.8	m s^{-1}
Max blade width	C	4.15	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.26%
	downwind	3.58%
	weighted mean	5.42%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

			large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled				Collision rates allowing for avoidance												
			100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.00	0.4
			100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.00	0.4
			100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.00	0.4
		98.00%	100.00%	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

Bird data		Value	Units
Species name		Hen harrier	
Bird length	L	0.48	m
Wingspan	W	1.1	m
Bird flight speed	v	8	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0	0	0	0.000724					0.0001
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
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	0.0	0.0	0.0	0.0	15.2	0.0	0.0	0.0	0.0	15

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		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	8.91%
	downwind	4.25%
	weighted mean	6.58%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.85	0.00	0.00	0.00	0.00	1

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.85	0.00	0.00	0.00	0.00	0.9
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.85	0.00	0.00	0.00	0.00	0.9
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.85	0.00	0.00	0.00	0.00	0.9
	99.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	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

Bird data		Value	Units
Species name		Hen harrier	
Bird length	L	0.48	m
Wingspan	W	1.1	m
Bird flight speed	v	8	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0.002052	0.00156						0	0	0	0	0.0003
Proportion at rotor risk height	Q_{2R}	11.01%													
At latitude 54.1		Daylight hours per month	247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month	496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

No of turbines	T	13	
Rotor radius	R	81.5	m
		Total rotor frontal area m^2	271274
Nocturnal activity factor	f_{night}	0%	
Bird flight speed	v	8	m s^{-1}

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
Projected number of rotor transits	0.0	2.9	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6

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		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	8.91%
	downwind	4.25%
	weighted mean	6.58%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.16	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			Collision rates allowing for avoidance												
		100.00%	0.00	0.16	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.3
		100.00%	0.00	0.16	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.3
		100.00%	0.00	0.16	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.3
	99.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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

Bird data		Value	Units
Species name		Hen harrier	
Bird length	L	0.48	m
Wingspan	W	1.1	m
Bird flight speed	v	8	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0	0						0	0.000206	0	0	0.0000
Proportion at rotor risk height	Q_{2R}	0.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0

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		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	8.91%
	downwind	4.25%
	weighted mean	6.58%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

			large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
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	0.00	0.00	0.00	0.00	0.0
			100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
			100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		99.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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

Bird data		Value	Units
Species name		Common kestrel	
Bird length	L	0.34	m
Wingspan	W	0.755	m
Bird flight speed	v	12.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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				0.004216	0.000454	0.000934	0.000837	0.002539					0.0007
Proportion at rotor risk height	Q_{2R}	84.19%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
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	113.5	14.4	30.6	27.6	75.1	0.0	0.0	0.0	0.0	261

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}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	4.34	0.55	1.17	1.06	2.87	0.00	0.00	0.00	0.00	10

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	4.34	0.55	1.17	1.06	2.87	0.00	0.00	0.00	0.00	10.0
	95.00%	100.00%	0.00	0.00	0.00	0.22	0.03	0.06	0.05	0.14	0.00	0.00	0.00	0.00	0.5
		100.00%	0.00	0.00	0.00	4.34	0.55	1.17	1.06	2.87	0.00	0.00	0.00	0.00	10.0
		100.00%	0.00	0.00	0.00	4.34	0.55	1.17	1.06	2.87	0.00	0.00	0.00	0.00	10.0

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

Bird data		Value	Units
Species name		Common kestrel	
Bird length	L	0.34	m
Wingspan	W	0.755	m
Bird flight speed	v	12.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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				0.016005	0.007554	0.0003	0.001941	0.010858					0.0031
Proportion at rotor risk height	Q_{2R}	96.80%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
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	495.4	275.4	11.3	73.6	369.1	0.0	0.0	0.0	0.0	1225

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}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	18.96	10.54	0.43	2.82	14.12	0.00	0.00	0.00	0.00	47

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	18.96	10.54	0.43	2.82	14.12	0.00	0.00	0.00	0.00	46.9
	95.00%	100.00%	0.00	0.00	0.00	0.95	0.53	0.02	0.14	0.71	0.00	0.00	0.00	0.00	2.3
		100.00%	0.00	0.00	0.00	18.96	10.54	0.43	2.82	14.12	0.00	0.00	0.00	0.00	46.9
		100.00%	0.00	0.00	0.00	18.96	10.54	0.43	2.82	14.12	0.00	0.00	0.00	0.00	46.9

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		Value	Units
Species name		Common kestrel	
Bird length	L	0.34	m
Wingspan	W	0.755	m
Bird flight speed	v	12.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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}				0.000386	0.002111	0.002444	0.008065	0.000715					0.0011
Proportion at rotor risk height	Q_{2R}	94.50%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
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	11.7	75.1	90.0	298.4	23.7	0.0	0.0	0.0	0.0	499

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}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.45	2.88	3.44	11.42	0.91	0.00	0.00	0.00	0.00	19

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.45	2.88	3.44	11.42	0.91	0.00	0.00	0.00	0.00	19.1
	95.00%	100.00%	0.00	0.00	0.00	0.02	0.14	0.17	0.57	0.05	0.00	0.00	0.00	0.00	1.0
		100.00%	0.00	0.00	0.00	0.45	2.88	3.44	11.42	0.91	0.00	0.00	0.00	0.00	19.1
		100.00%	0.00	0.00	0.00	0.45	2.88	3.44	11.42	0.91	0.00	0.00	0.00	0.00	19.1

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		Value	Units
Species name		Common kestrel	
Bird length	L	0.34	m
Wingspan	W	0.755	m
Bird flight speed	v	12.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0.000545	0.0000796	0.001273						0.003049	0.00000937	0.000226	0	0.0004
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	12.7	m s^{-1}														
		Projected number of rotor transits			9.8	1.6	33.7	0.0	0.0	0.0	0.0	0.0	84.5	0.2	4.2	0.0	134

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}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.37	0.06	1.29	0.00	0.00	0.00	0.00	0.00	3.23	0.01	0.16	0.00	5

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			Collision rates allowing for avoidance												
		100.00%	0.37	0.06	1.29	0.00	0.00	0.00	0.00	0.00	3.23	0.01	0.16	0.00	5.1
	95.00%	100.00%	0.02	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.01	0.00	0.3
		100.00%	0.37	0.06	1.29	0.00	0.00	0.00	0.00	0.00	3.23	0.01	0.16	0.00	5.1
		100.00%	0.37	0.06	1.29	0.00	0.00	0.00	0.00	0.00	3.23	0.01	0.16	0.00	5.1

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		Value	Units
Species name		Common kestrel	
Bird length	L	0.34	m
Wingspan	W	0.755	m
Bird flight speed	v	12.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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}	0.007817	0.001048	0.002396						0.00000817	0.000515	0	0	0.0010
Proportion at rotor risk height	Q_{2R}	82.30%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	12.7	m s^{-1}														
		Projected number of rotor transits			121.3	17.8	54.9	0.0	0.0	0.0	0.0	0.0	0.2	10.6	0.0	0.0	205

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}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		4.64	0.68	2.10	0.00	0.00	0.00	0.00	0.00	0.01	0.41	0.00	0.00	8

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	4.64	0.68	2.10	0.00	0.00	0.00	0.00	0.00	0.01	0.41	0.00	0.00	7.8
	95.00%	100.00%	0.23	0.03	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.4
		100.00%	4.64	0.68	2.10	0.00	0.00	0.00	0.00	0.00	0.01	0.41	0.00	0.00	7.8
		100.00%	4.64	0.68	2.10	0.00	0.00	0.00	0.00	0.00	0.01	0.41	0.00	0.00	7.8

COLLISION RISK MODEL

Required input data is in orange boxes
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Bird data		Value	Units
Species name		Common kestrel	
Bird length	L	0.34	m
Wingspan	W	0.755	m
Bird flight speed	v	12.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0.000816	0.000592						0.000158	0	0.000406	0.000369	0.0002
Proportion at rotor risk height	Q_{2R}	93.94%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	12.7	m s^{-1}														
		Projected number of rotor transits			0.0	15.9	15.5	0.0	0.0	0.0	0.0	0.0	4.3	0.0	7.5	6.1	49

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}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.61	0.59	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.29	0.23	2

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.61	0.59	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.29	0.23	1.9
	95.00%	100.00%	0.00	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.1
		100.00%	0.00	0.61	0.59	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.29	0.23	1.9
		100.00%	0.00	0.61	0.59	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.29	0.23	1.9

COLLISION RISK MODEL

Required input data is in orange boxes
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Bird data		Value	Units
Species name		Black-legged kittiwake	
Bird length	L	0.39	m
Wingspan	W	1.075	m
Bird flight speed	v	13.1	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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				0.000176	0	0	0	0					0.0000
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
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	5.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6

Stage C

No of blades	b	3		Bird length	l	0.39	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	1.075	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%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	6.55%
	downwind	2.92%
	weighted mean	4.74%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		100.00%	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2
		100.00%	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2

COLLISION RISK MODEL

Required input data is in orange boxes
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Bird data		Value	Units
Species name		Lesser black-backed gull	
Bird length	L	0.6	m
Wingspan	W	1.45	m
Bird flight speed	v	13.1	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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				0.003394	0.003138	0.003258	0.000627	0.000367					0.0009
Proportion at rotor risk height	Q_{2R}	89.63%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
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	100.3	109.3	117.4	22.7	11.9	0.0	0.0	0.0	0.0	362

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		gliding		
Pitch	λ	15	degrees	% of flights upwind/downwind		50%		50%
Blade profile		see Blade profile sheet						

Single transit risk	upwind	7.14%
	downwind	3.51%
	weighted mean	5.32%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	4.54	4.94	5.31	1.03	0.54	0.00	0.00	0.00	0.00	16

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	4.54	4.94	5.31	1.03	0.54	0.00	0.00	0.00	0.00	16.4
		100.00%	0.00	0.00	0.00	4.54	4.94	5.31	1.03	0.54	0.00	0.00	0.00	0.00	16.4
		100.00%	0.00	0.00	0.00	4.54	4.94	5.31	1.03	0.54	0.00	0.00	0.00	0.00	16.4
	98.00%	100.00%	0.00	0.00	0.00	0.09	0.10	0.11	0.02	0.01	0.00	0.00	0.00	0.00	0.3

COLLISION RISK MODEL

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Bird data		Value	Units
Species name		Lesser black-backed gull	
Bird length	L	0.6	m
Wingspan	W	1.45	m
Bird flight speed	v	13.1	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0	0.000495	0	0					0.0000
Proportion at rotor risk height	Q_{2R}	87.46%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
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	17.4	0.0	0.0	0.0	0.0	0.0	0.0	17

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		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.14%
	downwind	3.51%
	weighted mean	5.32%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.79	0.00	0.00	0.00	0.00	0.00	0.00	1

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.8
		100.00%	0.00	0.00	0.00	0.00	0.00	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.8
		100.00%	0.00	0.00	0.00	0.00	0.00	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.8
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.0

COLLISION RISK MODEL

Required input data is in orange boxes
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Bird data		Value	Units
Species name		Lesser black-backed gull	
Bird length	L	0.6	m
Wingspan	W	1.45	m
Bird flight speed	v	13.1	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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				0.001091	0.006151	0.000243	0	0					0.0006
Proportion at rotor risk height	Q_{2R}	90.12%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
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	32.4	215.4	8.8	0.0	0.0	0.0	0.0	0.0	0.0	257

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		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.14%
	downwind	3.51%
	weighted mean	5.32%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	1.47	9.74	0.40	0.00	0.00	0.00	0.00	0.00	0.00	12

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	1.47	9.74	0.40	0.00	0.00	0.00	0.00	0.00	0.00	11.6
		100.00%	0.00	0.00	0.00	1.47	9.74	0.40	0.00	0.00	0.00	0.00	0.00	0.00	11.6
		100.00%	0.00	0.00	0.00	1.47	9.74	0.40	0.00	0.00	0.00	0.00	0.00	0.00	11.6
	98.00%	100.00%	0.00	0.00	0.00	0.03	0.19	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.2

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		Value	Units
Species name		Lesser black-backed gull	
Bird length	L	0.6	m
Wingspan	W	1.45	m
Bird flight speed	v	13.1	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0.005092	0	0						0	0	0	0	0.0004
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	13.1	m s^{-1}														
		Projected number of rotor transits			94.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	94

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		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.14%
	downwind	3.51%
	weighted mean	5.32%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		4.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			Collision rates allowing for avoidance												
		100.00%	4.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.3
		100.00%	4.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.3
		100.00%	4.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.3
	98.00%	100.00%	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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		Value	Units
Species name		Lesser black-backed gull	
Bird length	L	0.6	m
Wingspan	W	1.45	m
Bird flight speed	v	13.1	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0	0						0.000892	0.000216	0	0	0.0001
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
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	0.0	25.5	5.3	0.0	0.0	31

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		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.14%
	downwind	3.51%
	weighted mean	5.32%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.15	0.24	0.00	0.00	1

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
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	1.15	0.24	0.00	0.00	1.4
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.15	0.24	0.00	0.00	1.4
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.15	0.24	0.00	0.00	1.4
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	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

Bird data		Value	Units
Species name		Mallard	
Bird length	L	0.58	m
Wingspan	W	0.9	m
Bird flight speed	v	22	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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				0.000358	0	0	0	0.0000874					0.0000
Proportion at rotor risk height	Q_{2R}	48.56%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	22	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	11.3	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	14

Stage C

No of blades	b	3		Bird length	l	0.58	m	
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.9	m	
Rotor radius	R	81.5	m	Bird flight speed	v	22	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		5.56%
downwind		3.24%
weighted mean		4.40%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	1

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.5
		100.00%	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.5
		100.00%	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.5
	98.00%	100.00%	0.00	0.00	0.00	0.01	0.00	0.00	0.00	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

Bird data		Value	Units
Species name		Mallard	
Bird length	L	0.58	m
Wingspan	W	0.9	m
Bird flight speed	v	22	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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				0.000421	0.000249	0	0	0.000273					0.0001
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	22	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	26.1	17.4	0.0	0.0	18.2	0.0	0.0	0.0	0.0	62

Stage C

No of blades	b	3		Bird length	l	0.58	m	
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.9	m	
Rotor radius	R	81.5	m	Bird flight speed	v	22	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	5.56%
	downwind	3.24%
	weighted mean	4.40%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.98	0.65	0.00	0.00	0.68	0.00	0.00	0.00	0.00	2

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.98	0.65	0.00	0.00	0.68	0.00	0.00	0.00	0.00	2.3
		100.00%	0.00	0.00	0.00	0.98	0.65	0.00	0.00	0.68	0.00	0.00	0.00	0.00	2.3
		100.00%	0.00	0.00	0.00	0.98	0.65	0.00	0.00	0.68	0.00	0.00	0.00	0.00	2.3
	98.00%	100.00%	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.01	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

Bird data		Value	Units
Species name		Merlin	
Bird length	L	0.275	m
Wingspan	W	0.56	m
Bird flight speed	v	13.47	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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				0.000088	0	0	0	0					0.0000
Proportion at rotor risk height	Q_{2R}	0.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	13.47	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0

Stage C

No of blades	b	3		Bird length	l	0.275	m	
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.56	m	
Rotor radius	R	81.5	m	Bird flight speed	v	13.47	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		5.92%
downwind		2.36%
weighted mean		4.14%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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

Bird data		Value	Units
Species name		Merlin	
Bird length	L	0.275	m
Wingspan	W	0.56	m
Bird flight speed	v	13.47	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0.000296	0						0	0	0	0	0.0000
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	13.47	m s^{-1}														
		Projected number of rotor transits			0.0	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6

Stage C

No of blades	b	3		Bird length	l	0.275	m	
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.56	m	
Rotor radius	R	81.5	m	Bird flight speed	v	13.47	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	5.92%
	downwind	2.36%
	weighted mean	4.14%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2
		100.00%	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2
		100.00%	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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

Bird data		Value	Units
Species name		nd white-fronted goose	
Bird length	L	0.71	m
Wingspan	W	1.47	m
Bird flight speed	v	16.1	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0	0						0	0.038593	0	0	0.0032
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	16.1	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1528.9	0.0	0.0	1529

Stage C

No of blades	b	3		Bird length	l	0.71	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	1.47	m
Rotor radius	R	81.5	m	Bird flight speed	v	16.1	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		6.89%
downwind		3.78%
weighted mean		5.33%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	69.29	0.00	0.00	69

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	69.29	0.00	0.00	69.3
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	69.29	0.00	0.00	69.3
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	69.29	0.00	0.00	69.3
99.80%		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	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		Value	Units
Species name		Peregrine falcon	
Bird length	L	0.42	m
Wingspan	W	1.025	m
Bird flight speed	v	12.1	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0.000303	0	0						0.000559	0.000172	0.000371	0	0.0001
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	12.1	m s^{-1}														
		Projected number of rotor transits			5.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.8	3.9	6.6	0.0	30

Stage C

No of blades	b	3		Bird length	l	0.42	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	1.025	m
Rotor radius	R	81.5	m	Bird flight speed	v	12.1	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	6.86%
	downwind	3.05%
	weighted mean	4.95%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.62	0.16	0.28	0.00	1

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.62	0.16	0.28	0.00	1.3
		100.00%	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.62	0.16	0.28	0.00	1.3
		100.00%	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.62	0.16	0.28	0.00	1.3
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	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

Bird data		Value	Units
Species name		Common snipe	
Bird length	L	0.26	m
Wingspan	W	0.455	m
Bird flight speed	v	16	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0	0.000206	0	0					0.0000
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	16	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	10.6	0.0	0.0	0.0	0.0	0.0	0.0	11

Stage C

No of blades	b	3		Bird length	l	0.26	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.455	m
Rotor radius	R	81.5	m	Bird flight speed	v	16	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	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}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

	large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled		Collision rates allowing for avoidance												
	100.00%	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.3
	100.00%	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.3
	100.00%	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.3
98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.01	0.00	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
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Bird data		Value	Units
Species name		Common snipe	
Bird length	L	0.26	m
Wingspan	W	0.455	m
Bird flight speed	v	16	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0.000279	0						0	0.0000145	0	0	0.0000
Proportion at rotor risk height	Q_{2R}	85.50%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	16	m s^{-1}														
		Projected number of rotor transits			0.0	8.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	9

Stage C

No of blades	b	3		Bird length	l	0.26	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.455	m
Rotor radius	R	81.5	m	Bird flight speed	v	16	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	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}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

	large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
		Collision rates allowing for avoidance												
Avoidance rates modelled	100.00%	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.3
	100.00%	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.3
	100.00%	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.3
98.00%	100.00%	0.00	0.01	0.00	0.00	0.00	0.00	0.00	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

Bird data		Value	Units
Species name		Common snipe	
Bird length	L	0.26	m
Wingspan	W	0.455	m
Bird flight speed	v	16	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0.000962	0.000192	0						0	0.006583	0.000676	0	0.0007
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	16	m s^{-1}														
		Projected number of rotor transits			32.6	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	259.2	23.0	0.0	321

Stage C

No of blades	b	3		Bird length	l	0.26	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.455	m
Rotor radius	R	81.5	m	Bird flight speed	v	16	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	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}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		1.07	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.49	0.75	0.00	11

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	1.07	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.49	0.75	0.00	10.5
		100.00%	1.07	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.49	0.75	0.00	10.5
		100.00%	1.07	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.49	0.75	0.00	10.5
	98.00%	100.00%	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.02	0.00	0.2

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		Value	Units
Species name		Common snipe	
Bird length	L	0.26	m
Wingspan	W	0.455	m
Bird flight speed	v	16	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0	0						0	0.000697	0.000411	0	0.0001
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	16	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.4	14.0	0.0	41

Stage C

No of blades	b	3		Bird length	l	0.26	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.455	m
Rotor radius	R	81.5	m	Bird flight speed	v	16	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	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}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.90	0.46	0.00	1

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

	large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
		Collision rates allowing for avoidance												
Avoidance rates modelled	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.90	0.46	0.00	1.4
	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.90	0.46	0.00	1.4
	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.90	0.46	0.00	1.4
98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	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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		Value	Units
Bird data			
Species name		Eurasian teal	
Bird length	L	0.39	m
Wingspan	W	0.55	m
Bird flight speed	v	19.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

		Value	Units
Windfarm data			
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

		Value	Units
Turbine data			
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0	0	0.0000673	0					0.0000
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	19.7	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0	0.0	4

Stage C

No of blades	b	3		Bird length	l	0.39	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.55	m
Rotor radius	R	81.5	m	Bird flight speed	v	19.7	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	5.29%			
			downwind	2.71%			
			weighted mean	4.00%			

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

	large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
		Collision rates allowing for avoidance												
Avoidance rates modelled	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.1
	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.1
	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.1
98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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

Bird data		Value	Units
Species name		Eurasian teal	
Bird length	L	0.39	m
Wingspan	W	0.55	m
Bird flight speed	v	19.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0	0	0.002068	0					0.0002
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B																
No of turbines	T	13														
Rotor radius	R	81.5	m													
		Total rotor frontal area m^2	271274													
Nocturnal activity factor	f_{night}	25%														
Bird flight speed	v	19.7	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	132.6	0.0	0.0	0.0	0.0	0.0	133

Stage C							
No of blades	b	3		Bird length	l	0.39	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.55	m
Rotor radius	R	81.5	m	Bird flight speed	v	19.7	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	5.29%			
			downwind	2.71%			
			weighted mean	4.00%			

Stage D		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	4.51	0.00	0.00	0.00	0.00	0.00	5

Stage E																
Allow for large array correction?		No														
Width of windfarm	w	2	km													
			large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
				Collision rates allowing for avoidance												
Avoidance rates modelled			100.00%	0.00	0.00	0.00	0.00	0.00	0.00	4.51	0.00	0.00	0.00	0.00	0.00	4.5
			100.00%	0.00	0.00	0.00	0.00	0.00	0.00	4.51	0.00	0.00	0.00	0.00	0.00	4.5
			100.00%	0.00	0.00	0.00	0.00	0.00	0.00	4.51	0.00	0.00	0.00	0.00	0.00	4.5
		98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	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		Value	Units
Species name		Eurasian teal	
Bird length	L	0.39	m
Wingspan	W	0.55	m
Bird flight speed	v	19.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0	0.000043						0	0	0	0	0.0000
Proportion at rotor risk height	Q_{2R}	0.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	19.7	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0

Stage C

No of blades	b	3		Bird length	l	0.39	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.55	m
Rotor radius	R	81.5	m	Bird flight speed	v	19.7	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	5.29%
	downwind	2.71%
	weighted mean	4.00%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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

Bird data		Value	Units
Species name		Eurasian woodcock	
Bird length	L	0.28	m
Wingspan	W	0.6	m
Bird flight speed	v	3.33	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		3	
Nocturnal activity factor	f_{night}	50%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0.000126	0	0						0	0	0	0.0000205	0.0000
Proportion at rotor risk height	Q_{2R}	57.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
Nocturnal activity factor	f_{night}	50%															
Bird flight speed	v	3.33	m s^{-1}														
		Projected number of rotor transits			0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1

Stage C

No of blades	b	3		Bird length	l	0.28	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.6	m
Rotor radius	R	81.5	m	Bird flight speed	v	3.33	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	14.38%
	downwind	8.75%
	weighted mean	11.57%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.1
		100.00%	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.1
		100.00%	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.1
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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

Bird data		Value	Units
Species name		Whooper swan	
Bird length	L	1.525	m
Wingspan	W	2.304	m
Bird flight speed	v	17.3	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0	0						0	0	0	0.002518	0.0002
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

No of turbines	T	13														
Rotor radius	R	81.5	m													
		Total rotor frontal area m^2	271274													
Nocturnal activity factor	f_{night}	25%														
Bird flight speed	v	17.3	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	0.0	0.0	0.0	0.0	0.0	89.1	89

Stage C

No of blades	b	3		Bird length	l	1.525	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	2.304	m
Rotor radius	R	81.5	m	Bird flight speed	v	17.3	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	8.78%
	downwind	5.86%
	weighted mean	7.32%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
Collision rates before avoidance													
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.54	6

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled	large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
		Collision rates allowing for avoidance												
	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.54	5.5
	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.54	5.5
	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.54	5.5
99.50%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	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
Bird data			
Species name		Whooper swan	
Bird length	L	1.525	m
Wingspan	W	2.304	m
Bird flight speed	v	17.3	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

		Value	Units
Windfarm data			
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

		Value	Units
Turbine data			
Model		N163	
Hub height		98.5	m
Rotor radius	R	81.5	m
No of blades	b	3	
Rotation speed	Ω	8.8	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		17-180	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	0.037466	0	0						0	0	0	0	0.0031
Proportion at rotor risk height	Q_{2R}	95.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	81.5	m														
		Total rotor frontal area m^2		271274													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	17.3	m s^{-1}														
		Projected number of rotor transits			1371.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1372

Stage C

No of blades	b	3		Bird length	l	1.525	m
Rotation speed	Ω	8.8	rpm	Wingspan	w	2.304	m
Rotor radius	R	81.5	m	Bird flight speed	v	17.3	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	8.78%
	downwind	5.86%
	weighted mean	7.32%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		85.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	85

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	85.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	85.3
		100.00%	85.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	85.3
		100.00%	85.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	85.3
	99.50%	100.00%	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.4

Appendix C NatureScot Spreadsheets – Nordex N149

Avian Collision Risk Report

Muingmore Wind Farm

RWE Renewables Ireland Ltd

SLR Project No.: 501.065301.00001

9 July 2025

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		Value	Units
Species name		Black-headed gull	
Bird length	L	0.355	m
Wingspan	W	1.05	m
Bird flight speed	v	11.9	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0	0.003245	0.00042	0					0.0003
Proportion at rotor risk height	Q_{2R}	73.95%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
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	80.1	10.4	0.0	0.0	0.0	0.0	0.0	90

Stage C

No of blades	b	3		Bird length	l	0.355	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	1.05	m
Rotor radius	R	74.5	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%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.22%
	downwind	3.12%
	weighted mean	5.17%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
Collision rates before avoidance													
	0.00	0.00	0.00	0.00	0.00	3.52	0.46	0.00	0.00	0.00	0.00	0.00	4

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	3.52	0.46	0.00	0.00	0.00	0.00	0.00	4.0
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.07	0.01	0.00	0.00	0.00	0.00	0.00	0.1
		100.00%	0.00	0.00	0.00	0.00	0.00	3.52	0.46	0.00	0.00	0.00	0.00	0.00	4.0
		100.00%	0.00	0.00	0.00	0.00	0.00	3.52	0.46	0.00	0.00	0.00	0.00	0.00	4.0

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

Bird data		Value	Units
Species name		Black-headed gull	
Bird length	L	0.355	m
Wingspan	W	1.05	m
Bird flight speed	v	11.9	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0.000187	0.000834	0.002581	0					0.0003
Proportion at rotor risk height	Q_{2R}	85.70%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
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	5.2	23.9	74.2	0.0	0.0	0.0	0.0	0.0	103

Stage C

No of blades	b	3		Bird length	l	0.355	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	1.05	m
Rotor radius	R	74.5	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%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.22%
	downwind	3.12%
	weighted mean	5.17%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.23	1.05	3.26	0.00	0.00	0.00	0.00	0.00	5

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.00	0.23	1.05	3.26	0.00	0.00	0.00	0.00	0.00	4.5
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.02	0.07	0.00	0.00	0.00	0.00	0.00	0.1
		100.00%	0.00	0.00	0.00	0.00	0.23	1.05	3.26	0.00	0.00	0.00	0.00	0.00	4.5
		100.00%	0.00	0.00	0.00	0.00	0.23	1.05	3.26	0.00	0.00	0.00	0.00	0.00	4.5

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		Value	Units
Species name		Black-headed gull	
Bird length	L	0.355	m
Wingspan	W	1.05	m
Bird flight speed	v	11.9	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0.000969	0.015548	0.000411	0					0.0014
Proportion at rotor risk height	Q_{2R}	17.49%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
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	5.5	90.7	2.4	0.0	0.0	0.0	0.0	0.0	99

Stage C

No of blades	b	3		Bird length	l	0.355	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	1.05	m
Rotor radius	R	74.5	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%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.22%
	downwind	3.12%
	weighted mean	5.17%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.24	3.98	0.11	0.00	0.00	0.00	0.00	0.00	4

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.00	0.24	3.98	0.11	0.00	0.00	0.00	0.00	0.00	4.3
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.1
		100.00%	0.00	0.00	0.00	0.00	0.24	3.98	0.11	0.00	0.00	0.00	0.00	0.00	4.3
		100.00%	0.00	0.00	0.00	0.00	0.24	3.98	0.11	0.00	0.00	0.00	0.00	0.00	4.3

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		Value	Units
Species name		Black-headed gull	
Bird length	L	0.355	m
Wingspan	W	1.05	m
Bird flight speed	v	11.9	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0	0						0	0	0.0000576	0	0.0000
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
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	0.0	0.0	0.8	0.0	1

Stage C

No of blades	b	3		Bird length	l	0.355	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	1.05	m
Rotor radius	R	74.5	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%	50%
Blade profile		see Blade profile sheet					

Single transit risk		
upwind	7.22%	
downwind	3.12%	
weighted mean	5.17%	

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled	large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
		Collision rates allowing for avoidance												
	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.0
98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.0
	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	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

Bird data		Value	Units
Species name		Great cormorant	
Bird length	L	0.9	m
Wingspan	W	1.45	m
Bird flight speed	v	14.5	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0.001374	0	0.000404						0	0.000575	0	0	0.0002
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	14.5	m s^{-1}														
		Projected number of rotor transits			23.2	0.0	10.1	0.0	0.0	0.0	0.0	0.0	0.0	12.9	0.0	0.0	46

Stage C

No of blades	b	3		Bird length	l	0.9	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	1.45	m
Rotor radius	R	74.5	m	Bird flight speed	v	14.5	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	8.26%
	downwind	4.69%
	weighted mean	6.47%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		1.28	0.00	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	3

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	1.28	0.00	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	2.5
		100.00%	1.28	0.00	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	2.5
		100.00%	1.28	0.00	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	2.5
	98.00%	100.00%	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	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		Value	Units
Species name		Common gull	
Bird length	L	0.41	m
Wingspan	W	1.15	m
Bird flight speed	v	13.4	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0	0	0.00435	0					0.0004
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	13.4	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	0.0	140.8	0.0	0.0	0.0	0.0	0.0	141

Stage C

No of blades	b	3		Bird length	l	0.41	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	1.15	m
Rotor radius	R	74.5	m	Bird flight speed	v	13.4	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	7.05%
	downwind	3.27%
	weighted mean	5.16%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
Collision rates before avoidance													
	0.00	0.00	0.00	0.00	0.00	0.00	6.18	0.00	0.00	0.00	0.00	0.00	6

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	6.18	0.00	0.00	0.00	0.00	0.00	6.2
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.1
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	6.18	0.00	0.00	0.00	0.00	0.00	6.2
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	6.18	0.00	0.00	0.00	0.00	0.00	6.2

COLLISION RISK MODEL

Required input data is in orange boxes
Calculated output is in blue boxes
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Bird data		Value	Units
Species name		Common gull	
Bird length	L	0.41	m
Wingspan	W	1.15	m
Bird flight speed	v	13.4	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0	0	0.001116	0					0.0001
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	13.4	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	0.0	36.1	0.0	0.0	0.0	0.0	0.0	36

Stage C

No of blades	b	3		Bird length	l	0.41	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	1.15	m
Rotor radius	R	74.5	m	Bird flight speed	v	13.4	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	7.05%
	downwind	3.27%
	weighted mean	5.16%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	1.58	0.00	0.00	0.00	0.00	0.00	2

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	1.58	0.00	0.00	0.00	0.00	0.00	1.6
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.0
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	1.58	0.00	0.00	0.00	0.00	0.00	1.6
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	1.58	0.00	0.00	0.00	0.00	0.00	1.6

COLLISION RISK MODEL

Required input data is in orange boxes
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Bird data		Value	Units
Species name		Common tern	
Bird length	L	0.33	m
Wingspan	W	0.875	m
Bird flight speed	v	10.2	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0	0.00011	0	0					0.0000
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	10.2	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	3

Stage C

No of blades	b	3		Bird length	l	0.33	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	0.875	m
Rotor radius	R	74.5	m	Bird flight speed	v	10.2	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	7.59%
	downwind	3.11%
	weighted mean	5.35%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

	large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
		Collision rates allowing for avoidance												
Avoidance rates modelled	100.00%	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.1
	100.00%	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.1
	100.00%	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.1
98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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
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Bird data		Value	Units
Species name		Greylag goose	
Bird length	L	0.83	m
Wingspan	W	1.64	m
Bird flight speed	v	17.1	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0	0.379904						0	0	0	0	0.0317
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	17.1	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	14045.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14046

Stage C

No of blades	b	3		Bird length	l	0.83	m	
Rotation speed	Ω	9.2	rpm	Wingspan	w	1.64	m	
Rotor radius	R	74.5	m	Bird flight speed	v	17.1	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	7.54%			
				downwind	4.44%			
				weighted mean	5.99%			

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	715.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	715

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	715.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	715.5
		100.00%	0.00	0.00	715.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	715.5
		100.00%	0.00	0.00	715.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	715.5
	99.80%	100.00%	0.00	0.00	1.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.4

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		Value	Units
Species name		Golden plover	
Bird length	L	0.275	m
Wingspan	W	0.715	m
Bird flight speed	v	13.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0	0	0.000195	0					0.0000
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
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	7.2	0.0	0.0	0.0	0.0	0.0	7

Stage C

No of blades	b	3		Bird length	l	0.275	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	0.715	m
Rotor radius	R	74.5	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%	50%
Blade profile		see Blade profile sheet					

Single transit risk		
upwind	6.38%	
downwind	2.66%	
weighted mean	4.52%	

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%

Collision rates before avoidance												year total
0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.3
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.3
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0
	99.80%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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

Bird data		Value	Units
Species name		Herring gull	
Bird length	L	0.61	m
Wingspan	W	1.465	m
Bird flight speed	v	12.8	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0	0.000987	0.00072	0					0.0001
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
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	30.4	22.3	0.0	0.0	0.0	0.0	0.0	53

Stage C

No of blades	b	3		Bird length	l	0.61	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	1.465	m
Rotor radius	R	74.5	m	Bird flight speed	v	12.8	m s^{-1}
Max blade width	C	4.15	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.75%
	downwind	3.84%
	weighted mean	5.80%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	1.50	1.10	0.00	0.00	0.00	0.00	0.00	3

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	1.50	1.10	0.00	0.00	0.00	0.00	0.00	2.6
		100.00%	0.00	0.00	0.00	0.00	0.00	1.50	1.10	0.00	0.00	0.00	0.00	0.00	2.6
		100.00%	0.00	0.00	0.00	0.00	0.00	1.50	1.10	0.00	0.00	0.00	0.00	0.00	2.6
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.03	0.02	0.00	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		Value	Units
Species name		Herring gull	
Bird length	L	0.61	m
Wingspan	W	1.465	m
Bird flight speed	v	12.8	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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				0.0000984	0.000267	0.000439	0.000765	0					0.0001
Proportion at rotor risk height	Q_{2R}	83.36%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
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	2.4	7.7	13.1	23.0	0.0	0.0	0.0	0.0	0.0	46

Stage C

No of blades	b	3		Bird length	l	0.61	m	
Rotation speed	Ω	9.2	rpm	Wingspan	w	1.465	m	
Rotor radius	R	74.5	m	Bird flight speed	v	12.8	m s^{-1}	
Max blade width	C	4.15	m	Flight type		gliding		
Pitch	λ	15	degrees	% of flights upwind/downwind		50%		50%
Blade profile		see Blade profile sheet						
		Single transit risk	upwind	7.75%				
			downwind	3.84%				
			weighted mean	5.80%				

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.12	0.38	0.65	1.13	0.00	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	2	km														
			large array correction		Collision rates allowing for avoidance												
Avoidance rates modelled			100.00%		0.00	0.00	0.00	0.12	0.38	0.65	1.13	0.00	0.00	0.00	0.00	0.00	2.3
			100.00%		0.00	0.00	0.00	0.12	0.38	0.65	1.13	0.00	0.00	0.00	0.00	0.00	2.3
			100.00%		0.00	0.00	0.00	0.12	0.38	0.65	1.13	0.00	0.00	0.00	0.00	0.00	2.3
		98.00%	100.00%		0.00	0.00	0.00	0.00	0.01	0.01	0.02	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

Bird data		Value	Units
Species name		Herring gull	
Bird length	L	0.61	m
Wingspan	W	1.465	m
Bird flight speed	v	12.8	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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				0.000359	0	0.00133	0.011182	0					0.0011
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

No of turbines	T	13	
Rotor radius	R	74.5	m
		Total rotor frontal area m^2	226676
Nocturnal activity factor	f_{night}	0%	
Bird flight speed	v	12.8	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	9.1	0.0	40.9	345.7	0.0	0.0	0.0	0.0	0.0	396

Stage C

No of blades	b	3		Bird length	l	0.61	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	1.465	m
Rotor radius	R	74.5	m	Bird flight speed	v	12.8	m s^{-1}
Max blade width	C	4.15	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.75%
	downwind	3.84%
	weighted mean	5.80%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.45	0.00	2.02	17.04	0.00	0.00	0.00	0.00	0.00	20

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.45	0.00	2.02	17.04	0.00	0.00	0.00	0.00	0.00	19.5
		100.00%	0.00	0.00	0.00	0.45	0.00	2.02	17.04	0.00	0.00	0.00	0.00	0.00	19.5
		100.00%	0.00	0.00	0.00	0.45	0.00	2.02	17.04	0.00	0.00	0.00	0.00	0.00	19.5
	98.00%	100.00%	0.00	0.00	0.00	0.01	0.00	0.04	0.34	0.00	0.00	0.00	0.00	0.00	0.4

COLLISION RISK MODEL

Required input data is in **orange** boxes
Calculated output is in **blue** boxes
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Bird data		Value	Units
Species name		Herring gull	
Bird length	L	0.61	m
Wingspan	W	1.465	m
Bird flight speed	v	12.8	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0	0						0	0.000246	0	0	0.0000
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
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	0.0	0.0	4.9	0.0	0.0	5

Stage C

No of blades	b	3		Bird length	l	0.61	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	1.465	m
Rotor radius	R	74.5	m	Bird flight speed	v	12.8	m s^{-1}
Max blade width	C	4.15	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.75%
	downwind	3.84%
	weighted mean	5.80%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.00	0.2
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.00	0.2
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.00	0.2
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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

Bird data		Value	Units
Species name		Herring gull	
Bird length	L	0.61	m
Wingspan	W	1.465	m
Bird flight speed	v	12.8	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0	0						0	0	0.000478	0	0.0000
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
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	0.0	0.0	0.0	7.4	0.0	7

Stage C

No of blades	b	3		Bird length	l	0.61	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	1.465	m
Rotor radius	R	74.5	m	Bird flight speed	v	12.8	m s^{-1}
Max blade width	C	4.15	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.75%
	downwind	3.84%
	weighted mean	5.80%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

			large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled				Collision rates allowing for avoidance												
			100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.00	0.4
			100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.00	0.4
			100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.00	0.4
		98.00%	100.00%	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

Bird data		Value	Units
Species name		Hen harrier	
Bird length	L	0.48	m
Wingspan	W	1.1	m
Bird flight speed	v	8	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0	0	0	0.000694					0.0001
Proportion at rotor risk height	Q_{2R}	85.71%													
At latitude 54.1		Daylight hours per month	247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month	496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

No of turbines	T	13	
Rotor radius	R	74.5	m
		Total rotor frontal area m^2	226676
Nocturnal activity factor	f_{night}	0%	
Bird flight speed	v	8	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	0.0	12.0	0.0	0.0	0.0	0.0	12

Stage C

No of blades	b	3		Bird length	l	0.48	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	1.1	m
Rotor radius	R	74.5	m	Bird flight speed	v	8	m s^{-1}
Max blade width	C	4.15	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	9.47%
	downwind	4.46%
	weighted mean	6.96%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
Collision rates before avoidance		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	year total 1

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.7
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.7
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.7
	99.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	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

Bird data		Value	Units
Species name		Hen harrier	
Bird length	L	0.48	m
Wingspan	W	1.1	m
Bird flight speed	v	8	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0.002071	0.001539						0	0	0	0	0.0003
Proportion at rotor risk height	Q_{2R}	9.94%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	8	m s^{-1}														
		Projected number of rotor transits			0.0	2.5	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5

Stage C

No of blades	b	3		Bird length	l	0.48	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	1.1	m
Rotor radius	R	74.5	m	Bird flight speed	v	8	m s^{-1}
Max blade width	C	4.15	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	9.47%
	downwind	4.46%
	weighted mean	6.96%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
Collision rates before avoidance														year total
		0.00	0.15	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.15	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.3
		100.00%	0.00	0.15	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.3
		100.00%	0.00	0.15	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.3
	99.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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

Bird data		Value	Units
Species name		Hen harrier	
Bird length	L	0.48	m
Wingspan	W	1.1	m
Bird flight speed	v	8	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0	0						0	0.000207	0	0	0.0000
Proportion at rotor risk height	Q_{2R}	0.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0

Stage C

No of blades	b	3		Bird length	l	0.48	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	1.1	m
Rotor radius	R	74.5	m	Bird flight speed	v	8	m s^{-1}
Max blade width	C	4.15	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	9.47%
	downwind	4.46%
	weighted mean	6.96%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	99.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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
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Bird data		Value	Units
Species name		Common kestrel	
Bird length	L	0.34	m
Wingspan	W	0.755	m
Bird flight speed	v	12.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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				0.003709	0.000375	0.000884	0.000832	0.002456					0.0007
Proportion at rotor risk height	Q_{2R}	75.96%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
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	82.3	9.8	23.9	22.6	59.9	0.0	0.0	0.0	0.0	199

Stage C

No of blades	b	3		Bird length	l	0.34	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	0.755	m
Rotor radius	R	74.5	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	6.80%
	downwind	2.87%
	weighted mean	4.84%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	3.39	0.40	0.98	0.93	2.46	0.00	0.00	0.00	0.00	8

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	3.39	0.40	0.98	0.93	2.46	0.00	0.00	0.00	0.00	8.2
	95.00%	100.00%	0.00	0.00	0.00	0.17	0.02	0.05	0.05	0.12	0.00	0.00	0.00	0.00	0.4
		100.00%	0.00	0.00	0.00	3.39	0.40	0.98	0.93	2.46	0.00	0.00	0.00	0.00	8.2
		100.00%	0.00	0.00	0.00	3.39	0.40	0.98	0.93	2.46	0.00	0.00	0.00	0.00	8.2

COLLISION RISK MODEL

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Bird data		Value	Units
Species name		Common kestrel	
Bird length	L	0.34	m
Wingspan	W	0.755	m
Bird flight speed	v	12.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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				0.01554	0.007562	0.000259	0.001721	0.010932					0.0030
Proportion at rotor risk height	Q_{2R}	90.85%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
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	412.6	236.5	8.4	56.0	318.8	0.0	0.0	0.0	0.0	1032

Stage C

No of blades	b	3		Bird length	l	0.34	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	0.755	m
Rotor radius	R	74.5	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	6.80%
	downwind	2.87%
	weighted mean	4.84%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	16.97	9.73	0.34	2.30	13.11	0.00	0.00	0.00	0.00	42

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	16.97	9.73	0.34	2.30	13.11	0.00	0.00	0.00	0.00	42.5
	95.00%	100.00%	0.00	0.00	0.00	0.85	0.49	0.02	0.12	0.66	0.00	0.00	0.00	0.00	2.1
		100.00%	0.00	0.00	0.00	16.97	9.73	0.34	2.30	13.11	0.00	0.00	0.00	0.00	42.5
		100.00%	0.00	0.00	0.00	16.97	9.73	0.34	2.30	13.11	0.00	0.00	0.00	0.00	42.5

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		Value	Units
Species name		Common kestrel	
Bird length	L	0.34	m
Wingspan	W	0.755	m
Bird flight speed	v	12.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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				0.000377	0.002124	0.002444	0.007924	0.00068					0.0011
Proportion at rotor risk height	Q_{2R}	85.30%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
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	9.4	62.4	74.2	241.9	18.6	0.0	0.0	0.0	0.0	407

Stage C

No of blades	b	3		Bird length	l	0.34	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	0.755	m
Rotor radius	R	74.5	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	6.80%
	downwind	2.87%
	weighted mean	4.84%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.39	2.57	3.05	9.95	0.77	0.00	0.00	0.00	0.00	17

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.39	2.57	3.05	9.95	0.77	0.00	0.00	0.00	0.00	16.7
	95.00%	100.00%	0.00	0.00	0.00	0.02	0.13	0.15	0.50	0.04	0.00	0.00	0.00	0.00	0.8
		100.00%	0.00	0.00	0.00	0.39	2.57	3.05	9.95	0.77	0.00	0.00	0.00	0.00	16.7
		100.00%	0.00	0.00	0.00	0.39	2.57	3.05	9.95	0.77	0.00	0.00	0.00	0.00	16.7

COLLISION RISK MODEL

Required input data is in orange boxes
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Bird data		Value	Units
Species name		Common kestrel	
Bird length	L	0.34	m
Wingspan	W	0.755	m
Bird flight speed	v	12.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0.000549	0.0000805	0.001184						0.003083	0.00000755	0.000194	0	0.0004
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	12.7	m s^{-1}														
		Projected number of rotor transits			8.1	1.3	25.8	0.0	0.0	0.0	0.0	0.0	70.4	0.1	3.0	0.0	109

Stage C

No of blades	b	3		Bird length	l	0.34	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	0.755	m
Rotor radius	R	74.5	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	6.80%
	downwind	2.87%
	weighted mean	4.84%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.33	0.05	1.06	0.00	0.00	0.00	0.00	0.00	2.90	0.01	0.12	0.00	4

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			Collision rates allowing for avoidance												
		100.00%	0.33	0.05	1.06	0.00	0.00	0.00	0.00	0.00	2.90	0.01	0.12	0.00	4.5
	95.00%	100.00%	0.02	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.01	0.00	0.2
		100.00%	0.33	0.05	1.06	0.00	0.00	0.00	0.00	0.00	2.90	0.01	0.12	0.00	4.5
		100.00%	0.33	0.05	1.06	0.00	0.00	0.00	0.00	0.00	2.90	0.01	0.12	0.00	4.5

COLLISION RISK MODEL

Required input data is in orange boxes
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Bird data		Value	Units
Species name		Common kestrel	
Bird length	L	0.34	m
Wingspan	W	0.755	m
Bird flight speed	v	12.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0.007871	0.001061	0.002235						0.00000525	0.00038	0	0	0.0010
Proportion at rotor risk height	Q_{2R}	74.25%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	12.7	m s^{-1}														
		Projected number of rotor transits			100.7	14.9	42.3	0.0	0.0	0.0	0.0	0.0	0.1	6.4	0.0	0.0	164

Stage C

No of blades	b	3		Bird length	l	0.34	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	0.755	m
Rotor radius	R	74.5	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	6.80%
	downwind	2.87%
	weighted mean	4.84%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		4.14	0.61	1.74	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	7

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	4.14	0.61	1.74	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	6.8
	95.00%	100.00%	0.21	0.03	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.3
		100.00%	4.14	0.61	1.74	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	6.8
		100.00%	4.14	0.61	1.74	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	6.8

COLLISION RISK MODEL

Required input data is in orange boxes
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Bird data		Value	Units
Species name		Common kestrel	
Bird length	L	0.34	m
Wingspan	W	0.755	m
Bird flight speed	v	12.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0.000804	0.00059						0.000147	0	0.000363	0.000308	0.0002
Proportion at rotor risk height	Q_{2R}	84.76%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	12.7	m s^{-1}														
		Projected number of rotor transits			0.0	12.9	12.7	0.0	0.0	0.0	0.0	0.0	3.3	0.0	5.5	4.2	39

Stage C

No of blades	b	3		Bird length	l	0.34	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	0.755	m
Rotor radius	R	74.5	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	6.80%
	downwind	2.87%
	weighted mean	4.84%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.53	0.52	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.23	0.17	2

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.53	0.52	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.23	0.17	1.6
	95.00%	100.00%	0.00	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.1
		100.00%	0.00	0.53	0.52	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.23	0.17	1.6
		100.00%	0.00	0.53	0.52	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.23	0.17	1.6

COLLISION RISK MODEL

Required input data is in orange boxes
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Bird data		Value	Units
Species name		Black-legged kittiwake	
Bird length	L	0.39	m
Wingspan	W	1.075	m
Bird flight speed	v	13.1	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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				0.000177	0	0	0	0					0.0000
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
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	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5

Stage C

No of blades	b	3		Bird length	l	0.39	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	1.075	m
Rotor radius	R	74.5	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%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.02%
	downwind	3.18%
	weighted mean	5.10%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		100.00%	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2
		100.00%	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2

COLLISION RISK MODEL

Required input data is in orange boxes
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Bird data		Value	Units
Species name		Lesser black-backed gull	
Bird length	L	0.6	m
Wingspan	W	1.45	m
Bird flight speed	v	13.1	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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				0.003144	0.00297	0.0032	0.000594	0.000353					0.0009
Proportion at rotor risk height	Q_{2R}	80.87%													
At latitude 54.1		Daylight hours per month	247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month	496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

No of turbines	T	13													
Rotor radius	R	74.5	m												
		Total rotor frontal area m^2	226676												
Nocturnal activity factor	f_{night}	0%													
Bird flight speed	v	13.1	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	76.7	85.3	95.1	17.7	9.5	0.0	0.0	0.0	0.0	284

Stage C

No of blades	b	3		Bird length	l	0.6	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	1.45	m
Rotor radius	R	74.5	m	Bird flight speed	v	13.1	m s^{-1}
Max blade width	C	4.15	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.63%
	downwind	3.78%
	weighted mean	5.70%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	3.72	4.13	4.61	0.86	0.46	0.00	0.00	0.00	0.00	14

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	3.72	4.13	4.61	0.86	0.46	0.00	0.00	0.00	0.00	13.8
		100.00%	0.00	0.00	0.00	3.72	4.13	4.61	0.86	0.46	0.00	0.00	0.00	0.00	13.8
		100.00%	0.00	0.00	0.00	3.72	4.13	4.61	0.86	0.46	0.00	0.00	0.00	0.00	13.8
	98.00%	100.00%	0.00	0.00	0.00	0.07	0.08	0.09	0.02	0.01	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
green boxes are for information only, to show variables used at each stage

Bird data		Value	Units
Species name		Lesser black-backed gull	
Bird length	L	0.6	m
Wingspan	W	1.45	m
Bird flight speed	v	13.1	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0	0.00047	0	0					0.0000
Proportion at rotor risk height	Q_{2R}	78.91%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
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	13.6	0.0	0.0	0.0	0.0	0.0	0.0	14

Stage C

No of blades	b	3		Bird length	l	0.6	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	1.45	m
Rotor radius	R	74.5	m	Bird flight speed	v	13.1	m s^{-1}
Max blade width	C	4.15	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.63%
	downwind	3.78%
	weighted mean	5.70%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.66	0.00	0.00	0.00	0.00	0.00	0.00	1

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	0.66	0.00	0.00	0.00	0.00	0.00	0.00	0.7
		100.00%	0.00	0.00	0.00	0.00	0.00	0.66	0.00	0.00	0.00	0.00	0.00	0.00	0.7
		100.00%	0.00	0.00	0.00	0.00	0.00	0.66	0.00	0.00	0.00	0.00	0.00	0.00	0.7
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.01	0.00	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

Bird data		Value	Units
Species name		Lesser black-backed gull	
Bird length	L	0.6	m
Wingspan	W	1.45	m
Bird flight speed	v	13.1	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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				0.0011	0.005861	0.000219	0	0					0.0006
Proportion at rotor risk height	Q_{2R}	81.60%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
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	27.1	169.9	6.6	0.0	0.0	0.0	0.0	0.0	0.0	203

Stage C

No of blades	b	3		Bird length	l	0.6	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	1.45	m
Rotor radius	R	74.5	m	Bird flight speed	v	13.1	m s^{-1}
Max blade width	C	4.15	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.63%
	downwind	3.78%
	weighted mean	5.70%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
Collision rates before avoidance														year total
		0.00	0.00	0.00	1.31	8.23	0.32	0.00	0.00	0.00	0.00	0.00	0.00	10

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	1.31	8.23	0.32	0.00	0.00	0.00	0.00	0.00	0.00	9.9
		100.00%	0.00	0.00	0.00	1.31	8.23	0.32	0.00	0.00	0.00	0.00	0.00	0.00	9.9
		100.00%	0.00	0.00	0.00	1.31	8.23	0.32	0.00	0.00	0.00	0.00	0.00	0.00	9.9
	98.00%	100.00%	0.00	0.00	0.00	0.03	0.16	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.2

COLLISION RISK MODEL

Required input data is in orange boxes
Calculated output is in blue boxes
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Bird data		Value	Units
Species name		Lesser black-backed gull	
Bird length	L	0.6	m
Wingspan	W	1.45	m
Bird flight speed	v	13.1	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0.005103	0	0						0	0	0	0	0.0004
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	13.1	m s^{-1}														
		Projected number of rotor transits			77.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	78

Stage C

No of blades	b	3		Bird length	l	0.6	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	1.45	m
Rotor radius	R	74.5	m	Bird flight speed	v	13.1	m s^{-1}
Max blade width	C	4.15	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.63%
	downwind	3.78%
	weighted mean	5.70%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		3.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

			large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled				Collision rates allowing for avoidance												
			100.00%	3.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.8
			100.00%	3.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.8
			100.00%	3.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.8
		98.00%	100.00%	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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		Value	Units
Species name		Lesser black-backed gull	
Bird length	L	0.6	m
Wingspan	W	1.45	m
Bird flight speed	v	13.1	m s^{-1}
Flight type, flapping or gliding		gliding	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0	0						0.000905	0.000217	0	0	0.0001
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
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	0.0	21.3	4.4	0.0	0.0	26

Stage C

No of blades	b	3		Bird length	l	0.6	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	1.45	m
Rotor radius	R	74.5	m	Bird flight speed	v	13.1	m s^{-1}
Max blade width	C	4.15	m	Flight type		gliding	
Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%
Blade profile		see Blade profile sheet					

Single transit risk	upwind	7.63%
	downwind	3.78%
	weighted mean	5.70%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.03	0.21	0.00	0.00	1

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.03	0.21	0.00	0.00	1.2
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.03	0.21	0.00	0.00	1.2
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.03	0.21	0.00	0.00	1.2
98.00%		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	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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Bird data		Value	Units
Species name		Mallard	
Bird length	L	0.58	m
Wingspan	W	0.9	m
Bird flight speed	v	22	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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				0.000293	0	0	0	0.00007					0.0000
Proportion at rotor risk height	Q_{2R}	43.81%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	22	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	7.7	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	10

Stage C

No of blades	b	3		Bird length	l	0.58	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	0.9	m
Rotor radius	R	74.5	m	Bird flight speed	v	22	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	5.98%
	downwind	3.56%
	weighted mean	4.77%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
	large array correction		Collision rates allowing for avoidance												
Avoidance rates modelled	100.00%		0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.4
	100.00%		0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.4
	100.00%		0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.4
	100.00%	98.00%	0.00	0.00	0.00	0.01	0.00	0.00	0.00	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

Bird data		Value	Units
Species name		Mallard	
Bird length	L	0.58	m
Wingspan	W	0.9	m
Bird flight speed	v	22	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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				0.000369	0.000239	0	0	0.000274					0.0001
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	22	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	18.9	13.8	0.0	0.0	15.1	0.0	0.0	0.0	0.0	48

Stage C

No of blades	b	3		Bird length	l	0.58	m	
Rotation speed	Ω	9.2	rpm	Wingspan	w	0.9	m	
Rotor radius	R	74.5	m	Bird flight speed	v	22	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	5.98%
	downwind	3.56%
	weighted mean	4.77%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.77	0.56	0.00	0.00	0.61	0.00	0.00	0.00	0.00	2

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.77	0.56	0.00	0.00	0.61	0.00	0.00	0.00	0.00	1.9
		100.00%	0.00	0.00	0.00	0.77	0.56	0.00	0.00	0.61	0.00	0.00	0.00	0.00	1.9
		100.00%	0.00	0.00	0.00	0.77	0.56	0.00	0.00	0.61	0.00	0.00	0.00	0.00	1.9
	98.00%	100.00%	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.01	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

Bird data		Value	Units
Species name		Mallard	
Bird length	L	0.58	m
Wingspan	W	0.9	m
Bird flight speed	v	22	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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				0.003565	0	0	0	0.000312					0.0003
Proportion at rotor risk height	Q_{2R}	83.81%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	22	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	178.3	0.0	0.0	0.0	16.8	0.0	0.0	0.0	0.0	195

Stage C

No of blades	b	3		Bird length	l	0.58	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	0.9	m
Rotor radius	R	74.5	m	Bird flight speed	v	22	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	5.98%
	downwind	3.56%
	weighted mean	4.77%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	7.23	0.00	0.00	0.00	0.68	0.00	0.00	0.00	0.00	8

Stage E

Allow for large array correction? No
Width of windfarm w = 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	7.23	0.00	0.00	0.00	0.68	0.00	0.00	0.00	0.00	7.9
		100.00%	0.00	0.00	0.00	7.23	0.00	0.00	0.00	0.68	0.00	0.00	0.00	0.00	7.9
		100.00%	0.00	0.00	0.00	7.23	0.00	0.00	0.00	0.68	0.00	0.00	0.00	0.00	7.9
	98.00%	100.00%	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.2

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		Value	Units
Species name		Merlin	
Bird length	L	0.275	m
Wingspan	W	0.56	m
Bird flight speed	v	13.47	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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				0.0000584	0	0	0	0					0.0000
Proportion at rotor risk height	Q_{2R}	0.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	13.47	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0

Stage C

No of blades	b	3		Bird length	l	0.275	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	0.56	m
Rotor radius	R	74.5	m	Bird flight speed	v	13.47	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	2.57%
	weighted mean	4.46%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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

Bird data		Value	Units
Species name		Merlin	
Bird length	L	0.275	m
Wingspan	W	0.56	m
Bird flight speed	v	13.47	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0.000299	0						0	0	0	0	0.0000
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	13.47	m s^{-1}														
		Projected number of rotor transits			0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5

Stage C

No of blades	b	3		Bird length	l	0.275	m	
Rotation speed	Ω	9.2	rpm	Wingspan	w	0.56	m	
Rotor radius	R	74.5	m	Bird flight speed	v	13.47	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	2.57%
	weighted mean	4.46%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

	large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled		Collision rates allowing for avoidance												
	100.00%	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2
	100.00%	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2
	100.00%	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2
98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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

Bird data		Value	Units
Species name		nd white-fronted goose	
Bird length	L	0.71	m
Wingspan	W	1.47	m
Bird flight speed	v	16.1	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0	0						0	0.03828	0	0	0.0032
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	16.1	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1250.7	0.0	0.0	1251

Stage C

No of blades	b	3		Bird length	l	0.71	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	1.47	m
Rotor radius	R	74.5	m	Bird flight speed	v	16.1	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	7.38%
	downwind	4.11%
	weighted mean	5.75%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
Collision rates before avoidance													
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	61.10	0.00	0.00	61

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	61.10	0.00	0.00	61.1
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	61.10	0.00	0.00	61.1
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	61.10	0.00	0.00	61.1
	99.80%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	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		Value	Units
Species name		Peregrine falcon	
Bird length	L	0.42	m
Wingspan	W	1.025	m
Bird flight speed	v	12.1	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		1	
Nocturnal activity factor	f_{night}	0%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0.000289	0	0						0.000483	0.000143	0.000376	0	0.0001
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
Nocturnal activity factor	f_{night}	0%															
Bird flight speed	v	12.1	m s^{-1}														
		Projected number of rotor transits			4.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.5	2.7	5.5	0.0	23

Stage C

No of blades	b	3		Bird length	l	0.42	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	1.025	m
Rotor radius	R	74.5	m	Bird flight speed	v	12.1	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	7.34%
	downwind	3.29%
	weighted mean	5.32%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.12	0.25	0.00	1

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.12	0.25	0.00	1.0
		100.00%	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.12	0.25	0.00	1.0
		100.00%	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.12	0.25	0.00	1.0
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	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
Bird data			
Species name		Common snipe	
Bird length	L	0.26	m
Wingspan	W	0.455	m
Bird flight speed	v	16	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

		Value	Units
Windfarm data			
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

		Value	Units
Turbine data			
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0.000207	0	0	0					0.0000
Proportion at rotor risk height	Q_{2R}	85.71%													
At latitude 54.1		Daylight hours per month	247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month	496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

No of turbines	T	13													
Rotor radius	R	74.5	m												
		Total rotor frontal area m^2	226676												
Nocturnal activity factor	f_{night}	25%													
Bird flight speed	v	16	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	8.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9

Stage C

No of blades	b	3		Bird length	l	0.26 m
Rotation speed	Ω	9.2	rpm	Wingspan	w	0.455 m
Rotor radius	R	74.5	m	Bird flight speed	v	16 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 5.82%
	downwind 2.53%
	weighted mean 4.18%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction?		No													
Width of windfarm	w	2	km												
			large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
				Collision rates allowing for avoidance												
Avoidance rates modelled			100.00%	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.3
			100.00%	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.3
			100.00%	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.3
		98.00%	100.00%	0.00	0.00	0.00	0.00	0.01	0.00	0.00	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

Bird data		Value	Units
Species name		Common snipe	
Bird length	L	0.26	m
Wingspan	W	0.455	m
Bird flight speed	v	16	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0.000278	0						0	0.0000136	0	0	0.0000
Proportion at rotor risk height	Q_{2R}	77.14%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	16	m s^{-1}														
		Projected number of rotor transits			0.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	7

Stage C

No of blades	b	3		Bird length	l	0.26	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	0.455	m
Rotor radius	R	74.5	m	Bird flight speed	v	16	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	5.82%
	downwind	2.53%
	weighted mean	4.18%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

	large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
		Collision rates allowing for avoidance												
Avoidance rates modelled	100.00%	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.3
	100.00%	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.3
	100.00%	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.3
98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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

Bird data		Value	Units
Species name		Common snipe	
Bird length	L	0.26	m
Wingspan	W	0.455	m
Bird flight speed	v	16	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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}	0.000945	0.000192	0						0	0.006076	0.000676	0	0.0007
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

No of turbines	T	13														
Rotor radius	R	74.5	m													
		Total rotor frontal area m^2	226676													
Nocturnal activity factor	f_{night}	25%														
Bird flight speed	v	16	m s^{-1}	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
		Projected number of rotor transits		26.4	5.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	197.3	19.0	0.0	248

Stage C

No of blades	b	3		Bird length	l	0.26	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	0.455	m
Rotor radius	R	74.5	m	Bird flight speed	v	16	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	5.82%
	downwind	2.53%
	weighted mean	4.18%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.94	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.00	0.67	0.00	9

Stage E

Allow for large array correction?		No														
Width of windfarm	w	2	km													
			large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
				Collision rates allowing for avoidance												
Avoidance rates modelled			100.00%	0.94	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.00	0.67	0.00	8.8
			100.00%	0.94	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.00	0.67	0.00	8.8
			100.00%	0.94	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.00	0.67	0.00	8.8
		98.00%	100.00%	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.01	0.00	0.2

COLLISION RISK MODEL

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Bird data		Value	Units
Species name		Common snipe	
Bird length	L	0.26	m
Wingspan	W	0.455	m
Bird flight speed	v	16	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0	0						0	0.000705	0.0000414	0	0.0001
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	16	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.9	1.2	0.0	24

Stage C

No of blades	b	3		Bird length	l	0.26	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	0.455	m
Rotor radius	R	74.5	m	Bird flight speed	v	16	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	5.82%			
			downwind	2.53%			
			weighted mean	4.18%			

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.04	0.00	1

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.04	0.00	0.9
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.04	0.00	0.9
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.04	0.00	0.9
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.0

COLLISION RISK MODEL

Required input data is in orange boxes
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Bird data		Value	Units
Species name		Eurasian teal	
Bird length	L	0.39	m
Wingspan	W	0.55	m
Bird flight speed	v	19.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0	0	0.0000678	0					0.0000
Proportion at rotor risk height	Q_{2R}	85.71%													
At latitude 54.1		Daylight hours per month	247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month	496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

No of turbines	T	13	
Rotor radius	R	74.5	m
		Total rotor frontal area m^2	226676
Nocturnal activity factor	f_{night}	25%	
Bird flight speed	v	19.7	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	3.6	0.0	0.0	0.0	0.0	0.0	4

Stage C

No of blades	b	3		Bird length	l	0.39 m
Rotation speed	Ω	9.2	rpm	Wingspan	w	0.55 m
Rotor radius	R	74.5	m	Bird flight speed	v	19.7 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	5.69%
	downwind	2.99%
	weighted mean	4.34%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
Collision rates before avoidance		0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	year total 0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled	large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
		Collision rates allowing for avoidance												
	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.1
	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.1
	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.1
98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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
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Bird data		Value	Units
Species name		Eurasian teal	
Bird length	L	0.39	m
Wingspan	W	0.55	m
Bird flight speed	v	19.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0	0	0.002053	0					0.0002
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	19.7	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	0.0	108.6	0.0	0.0	0.0	0.0	0.0	109

Stage C

No of blades	b	3		Bird length	l	0.39	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	0.55	m
Rotor radius	R	74.5	m	Bird flight speed	v	19.7	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	5.69%
	downwind	2.99%
	weighted mean	4.34%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	4.01	0.00	0.00	0.00	0.00	0.00	4

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	4.01	0.00	0.00	0.00	0.00	0.00	4.0
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	4.01	0.00	0.00	0.00	0.00	0.00	4.0
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	4.01	0.00	0.00	0.00	0.00	0.00	4.0
	98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	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		Value	Units
Species name		Eurasian teal	
Bird length	L	0.39	m
Wingspan	W	0.55	m
Bird flight speed	v	19.7	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0	0.0000265						0	0	0	0	0.0000
Proportion at rotor risk height	Q_{2R}	0.00%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	19.7	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0

Stage C

No of blades	b	3		Bird length	l	0.39	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	0.55	m
Rotor radius	R	74.5	m	Bird flight speed	v	19.7	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	5.69%
	downwind	2.99%
	weighted mean	4.34%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

			large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
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	0.00	0.00	0.00	0.00	0.0
			100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
		98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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

Bird data		Value	Units
Species name		Eurasian woodcock	
Bird length	L	0.28	m
Wingspan	W	0.6	m
Bird flight speed	v	3.33	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		3	
Nocturnal activity factor	f_{night}	50%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0.000128	0	0						0	0	0	0.0000161	0.0000
Proportion at rotor risk height	Q_{2R}	51.43%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
Nocturnal activity factor	f_{night}	50%															
Bird flight speed	v	3.33	m s^{-1}														
		Projected number of rotor transits			0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1

Stage C

No of blades	b	3		Bird length	l	0.28	m	
Rotation speed	Ω	9.2	rpm	Wingspan	w	0.6	m	
Rotor radius	R	74.5	m	Bird flight speed	v	3.33	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	15.19%
	downwind	9.06%
	weighted mean	12.12%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

			large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled				Collision rates allowing for avoidance												
			100.00%	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.1
			100.00%	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.1
			100.00%	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.1
		98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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
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Bird data		Value	Units
Species name		Whooper swan	
Bird length	L	1.525	m
Wingspan	W	2.304	m
Bird flight speed	v	17.3	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0	0						0	0	0	0.002086	0.0002
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	17.3	m s^{-1}														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.9	61

Stage C

No of blades	b	3		Bird length	l	1.525	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	2.304	m
Rotor radius	R	74.5	m	Bird flight speed	v	17.3	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		9.37%
downwind		6.30%
weighted mean		7.84%

Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.06	4

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

Avoidance rates modelled		large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance												
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.06	4.1
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.06	4.1
		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.06	4.1
	99.50%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	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

Bird data		Value	Units
Species name		Whooper swan	
Bird length	L	1.525	m
Wingspan	W	2.304	m
Bird flight speed	v	17.3	m s^{-1}
Flight type, flapping or gliding		flapping	
% of flights upwind/downwind		50%	50%
Nocturnal activity ranking 1-5		2	
Nocturnal activity factor	f_{night}	25%	

Windfarm data		Value	Units
Site name		Muingmore	
Latitude		54.143	degrees
No of turbines	T	13	
Width of windfarm	w	2	km

Turbine data		Value	Units
Model		N149	
Hub height		104.5	m
Rotor radius	R	74.5	m
No of blades	b	3	
Rotation speed	Ω	9.2	rpm
Max blade width	C	4.15	m
Blade pitch	λ	15	degrees
Risk height range		30-179	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	0.03776	0	0						0	0	0	0	0.0031
Proportion at rotor risk height	Q_{2R}	85.71%														
At latitude 54.1		Daylight hours per month		247.8	271.8	366.1	420.2	495.0	512.0	514.5	461.5	383.2	328.4	258.0	231.3	4489.9
		Nighttime hours per month		496.2	400.2	377.9	299.8	249.0	208.0	229.5	282.5	336.8	415.6	462.0	512.7	4270.1

Stage B

					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	13															
Rotor radius	R	74.5	m														
		Total rotor frontal area m^2		226676													
Nocturnal activity factor	f_{night}	25%															
Bird flight speed	v	17.3	m s^{-1}														
		Projected number of rotor transits			1140.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1140

Stage C

No of blades	b	3		Bird length	l	1.525	m
Rotation speed	Ω	9.2	rpm	Wingspan	w	2.304	m
Rotor radius	R	74.5	m	Bird flight speed	v	17.3	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		9.37%
downwind		6.30%
weighted mean		7.84%

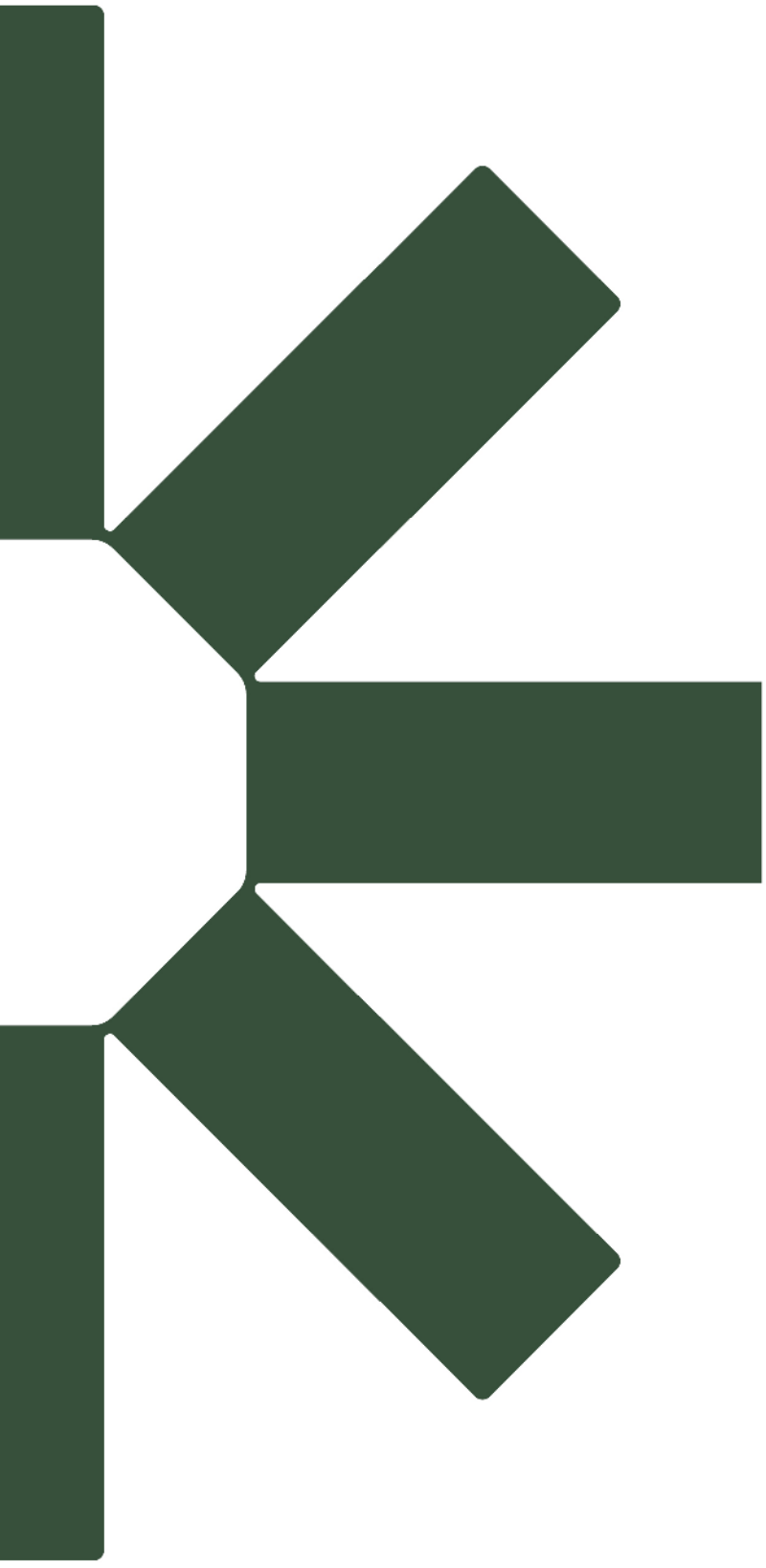
Stage D

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q_{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
		Collision rates before avoidance												year total
		75.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76

Stage E

Allow for large array correction? No
Width of windfarm w 2 km

	large array correction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled		Collision rates allowing for avoidance												
	100.00%	75.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	75.9
	100.00%	75.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	75.9
	100.00%	75.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	75.9
99.50%	100.00%	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.4



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