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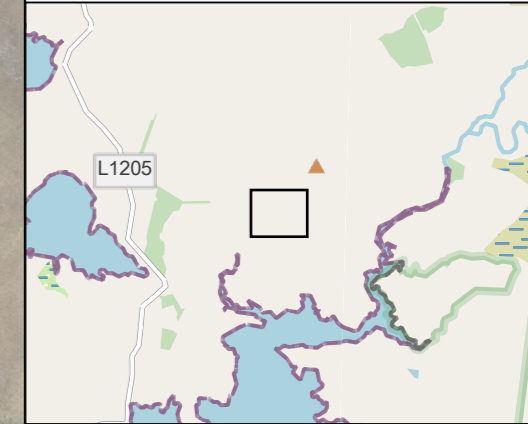
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402.064443.00001.0194.0 HMP ORA



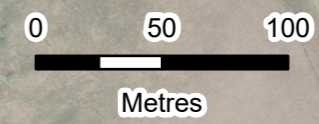
LEGEND

-  Proposed Development Site Boundary
-  Proposed Over-run Area Access Track
-  Proposed Turbine Delivery Route (TDR)



MUINGMORE WIND FARM
 HABITAT MANAGEMENT PLAN
 INTERVENTION LOCATIONS
 OVER-RUN AREA 1

FIGURE 2b



Scale 1:3,000 @ A3 Date APRIL 2026

497500

497750



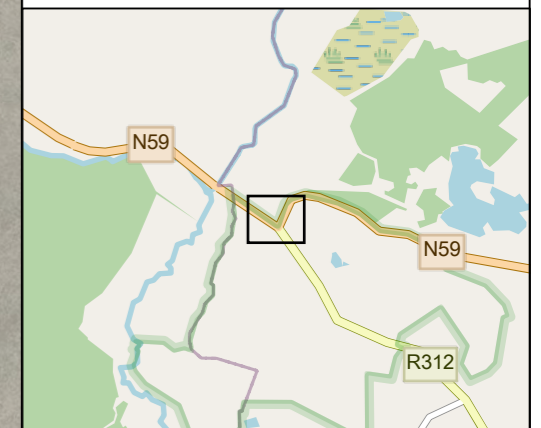
LEGEND

- Proposed Development Site Boundary
- Proposed Over-run Area Access Track
- Proposed Turbine Delivery Route (TDR)

819750

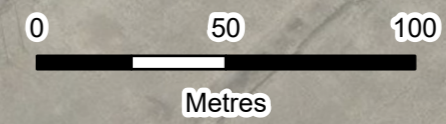
819500

402.064443:00001.0194:0 HMP ORA



MUINGMORE WIND FARM
HABITAT MANAGEMENT PLAN
INTERVENTION LOCATIONS
OVER-RUN AREA 2

FIGURE 2c



Scale 1:2,000 @ A3	Date APRIL 2026
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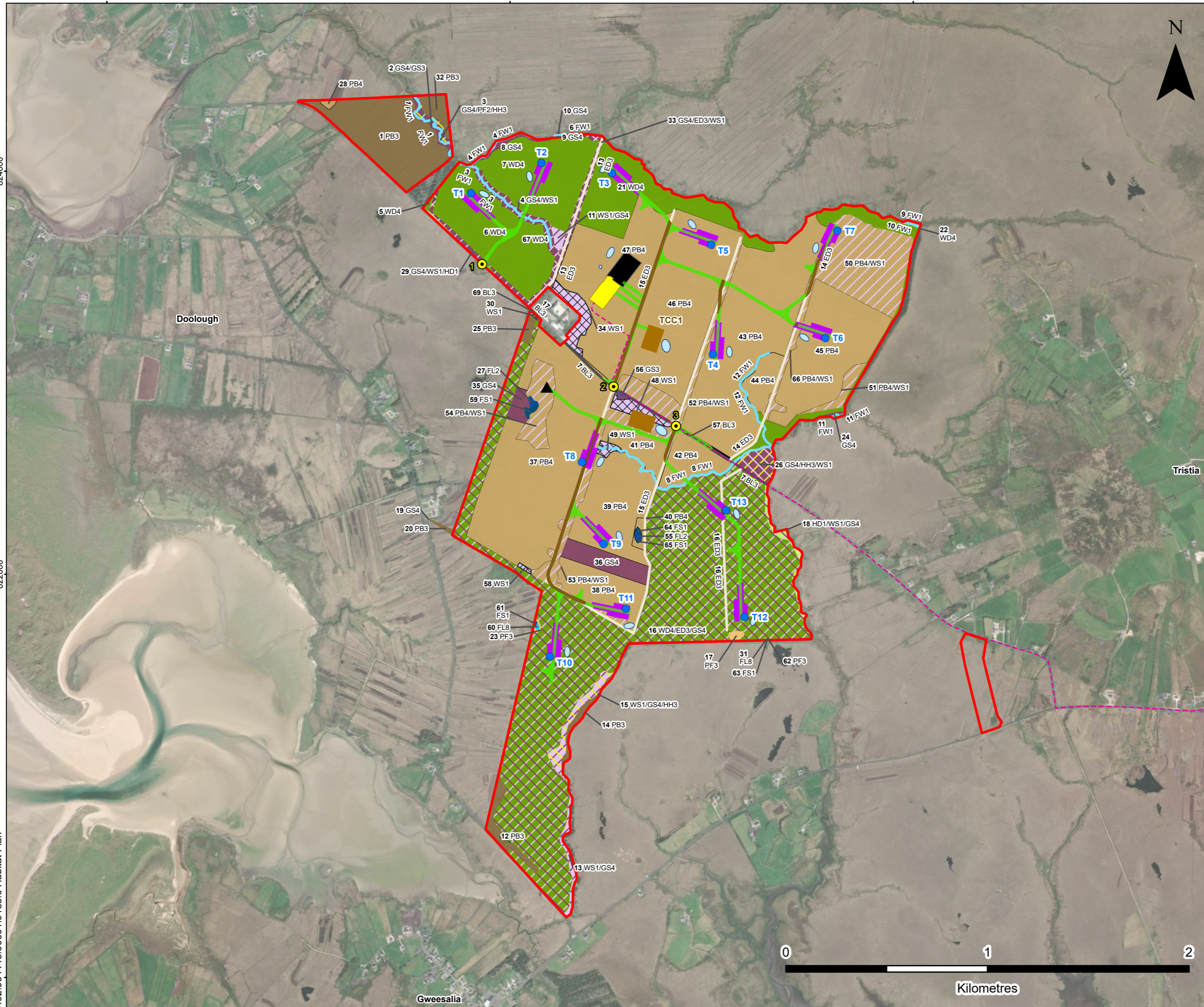


Appendix B Additional Figures

RWE Renewables Ireland Limited

SLR Project No.: 501.065301.00001

27 February 2026



LEGEND

Proposed Development Site Boundary	FW1 - Eroding/Upland Rivers
Proposed Turbine Location	GS3 - Dry-humid Acid Grassland
Proposed Site Access Location	GS4 - Wet Grassland
Proposed Met Mast Location	GS4/ED3/WS1 - Wet Grassland / Recolonising Bareground / Scrub
Proposed New Access Track	GS4/GS3 - Wet Grassland / Dry-humid Acid Grassland
Proposed Upgraded Access Track	GS4/HH3/WS1 - Wet Grassland / Wet Heath / Scrub
Proposed Grid Connection Route (Subject to Separate Planning Application)	GS4/PF2/HH3 - Wet Grassland / Poor Fen and Flush / Wet Heath
Proposed Crane Pad	GS4/WS1 - Wet Grassland / Scrub
Proposed Substation	GS4/WS1/HD1 - Wet Grassland / Scrub / Dense Bracken
Proposed Battery Energy Storage System (BESS) Compound	HD1/WS1/GS4 - Dense Bracken / Scrub / Wet Grassland
Proposed Attenuation Basin	PB3 - Lowland Blanket Bog
Fossit Habitats (Linear)	PB4 - Cutover Bog / Scrub
BL3 - Buildings and Artificial Surfaces	PB4/WS1 - Cutover Bog / Scrub
ED3 - Recolonising Bare Ground	PF3 - Transition Mire and Quaking Bog
FW1 - Eroding / Upland Rivers	WD4 - Conifer Plantation
FL8 - Other Artificial Lakes and Ponds	WD4/ED3/GS4 - Conifer Plantation / Recolonising Bareground / Wet Grassland
FS1 - Reed and Large Sedge Swamps	WS1 - Scrub
	WS1/GS4 - Scrub / Wet Grassland
	WS1/GS4/HH3 - Scrub / Wet Grassland / Wet Heath



MUINGMORE WIND FARM
 PEAT RESTORATION PLAN
 HABITAT FOSSIT PLAN
 MAIN WIND FARM DEVELOPMENT
 SITE BOUNDARY

FIGURE 1a

Scale 1:18,000 @ A3 Date APRIL 2026

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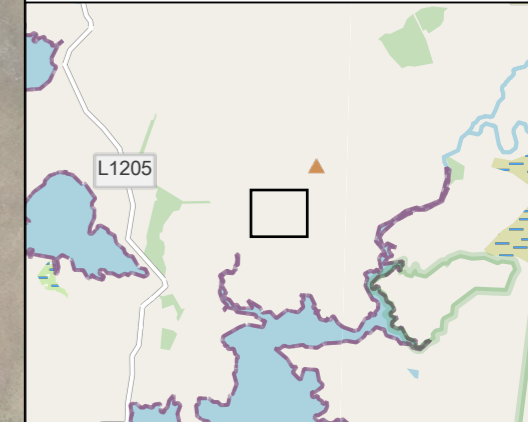
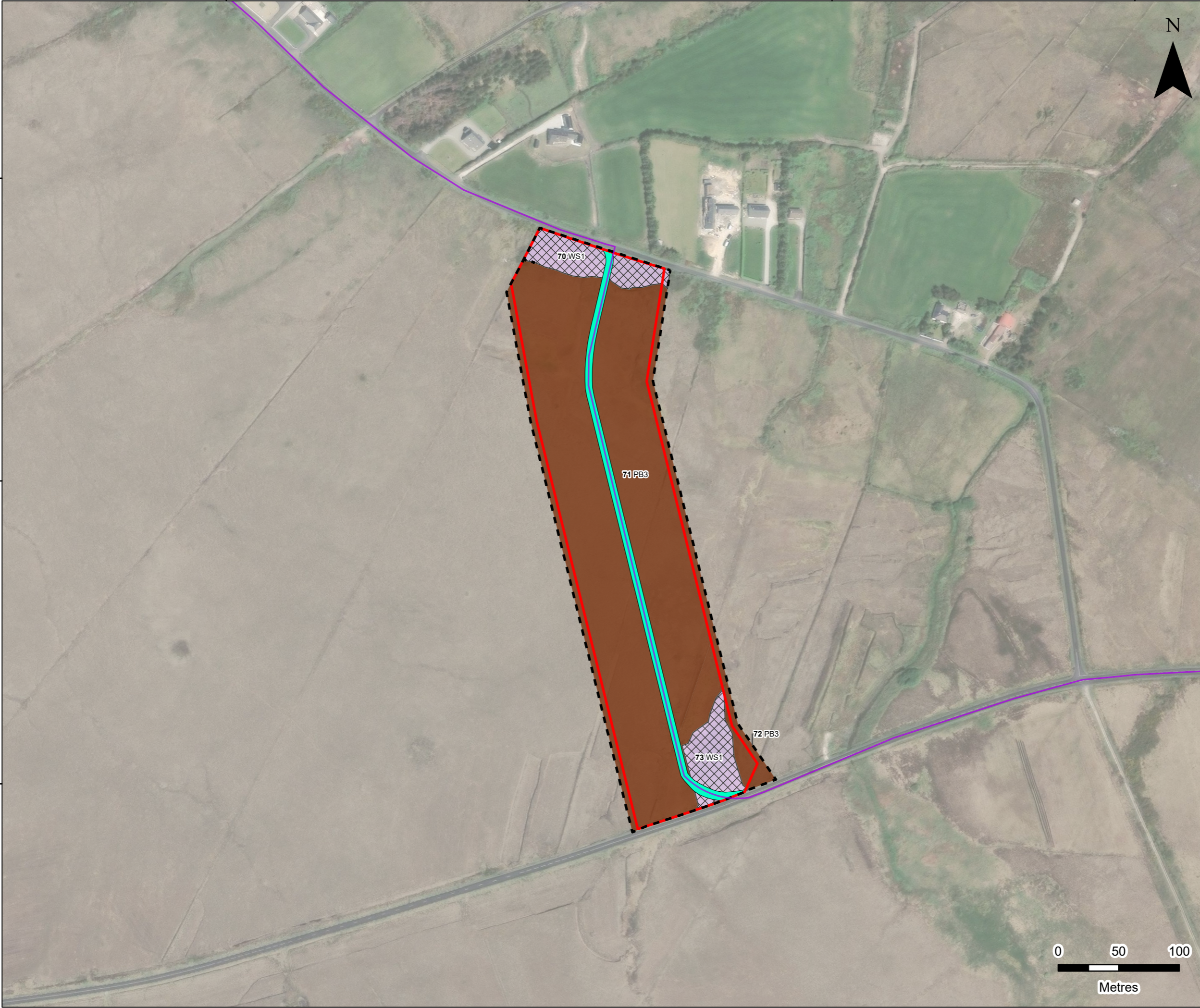
LEGEND

-  Proposed Development Site Boundary
-  Proposed Over-run Area Access Track
-  Proposed Turbine Delivery Route (TDR)
-  Fossitt Habitat Survey Area
- Fossitt Habitats (Area)**
-  PB3 - Lowland Blanket Bog
-  WS1 - Scrub

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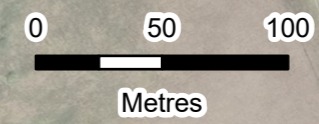
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402.064443.00001.0189.0 Habitat Fossitt Map OFR



MUINGMORE WIND FARM
 PEAT RESTORATION PLAN
 HABITAT FOSSITT PLAN:
 OVER-RUN AREA 1

FIGURE 1b







Scale 1:3,000 @ A3 Date MAY 2026

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LEGEND

-  Proposed Development Site Boundary
-  Proposed Over-run Area Access Track
-  Proposed Turbine Delivery Route (TDR)
-  Fossitt Habitat Survey Area

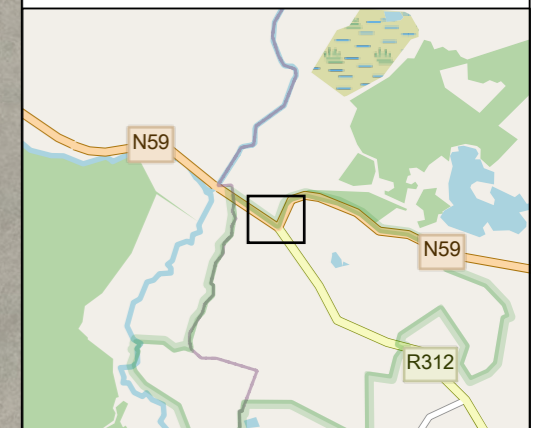
Fossitt Habitats (Area)

-  PB3 / GS2 / WS1- Lowland Blanket Bog / Dry Meadow and Grassy Verges / Scrub
-  BL3 - Buildings and Artificial Surfaces
-  FW4 - Drainage Ditches
-  GS2 - Dry Meadows & Grassy Verges

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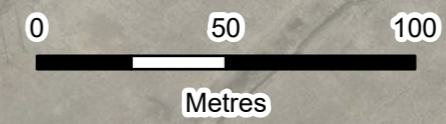
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402.064443.00001.0188.0 Habitat Fossitt Map OFR



MUINGMORE WIND FARM
 PEAT RESTORATION PLAN
**HABITAT FOSSITT PLAN:
 OVER-RUN AREA 2**

FIGURE 1c



Scale 1:2,000 @ A3 Date MAY 2026

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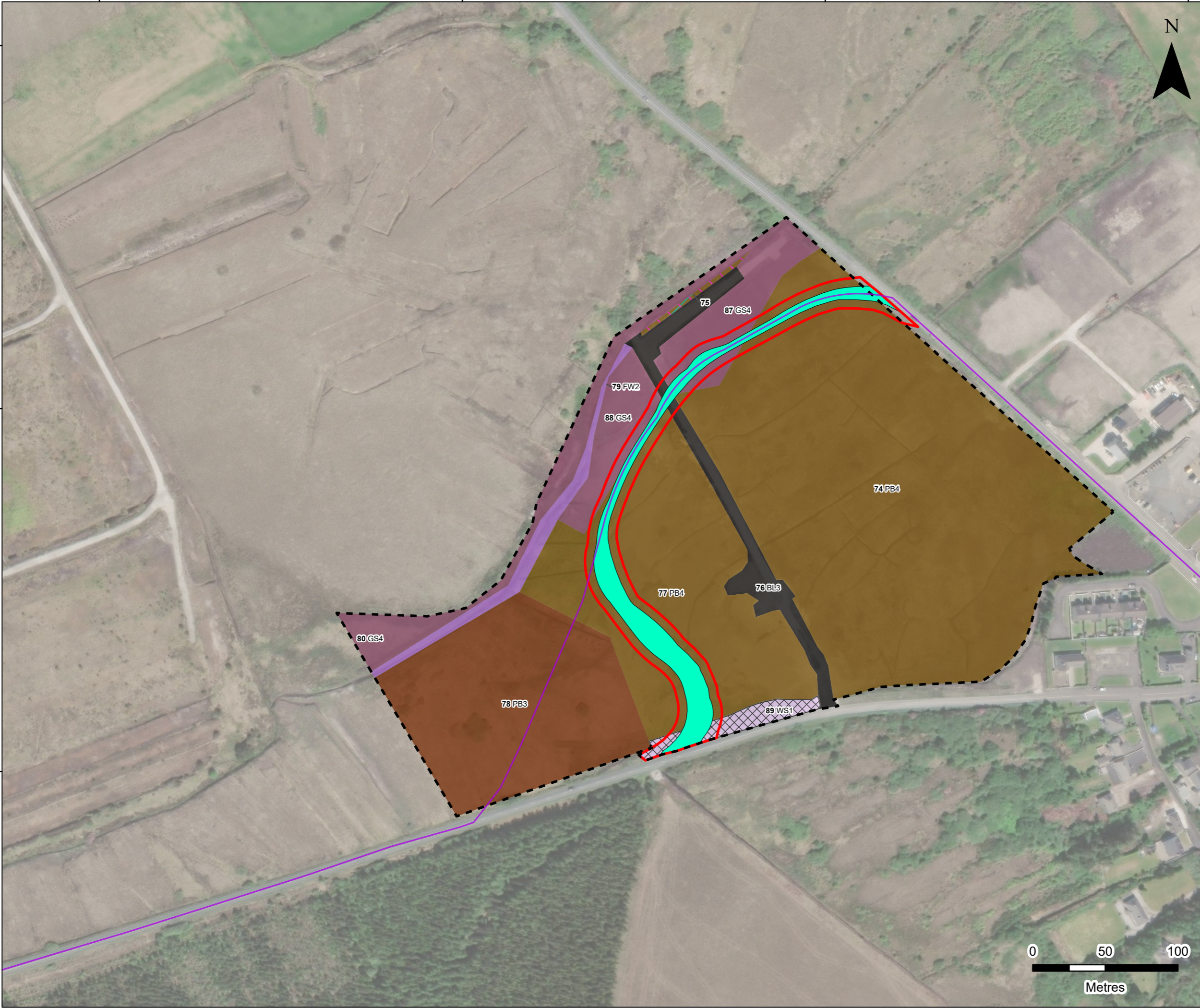
485500

485750

823750

823500

402.064443.00001.0189.0 Habitat Fossitt Map OFR



LEGEND

- Proposed Development Site Boundary
- Proposed Over-run Area Access Track
- Proposed Turbine Delivery Route (TDR)
- Fossitt Habitat Survey Area

Fossitt Habitats (Area)

- PB3 / GS2 / WS1- Lowland Blanket Bog / Dry Meadow and Grassy Verge / Scrub
- BL3 - Buildings and Artificial Surfaces
- FW2- Depositing Lowland Rivers
- GS4 - Wet Grassland
- PB3 - Lowland Blanket Bog
- PB4 - Cutover Bog
- WS1 - Scrub

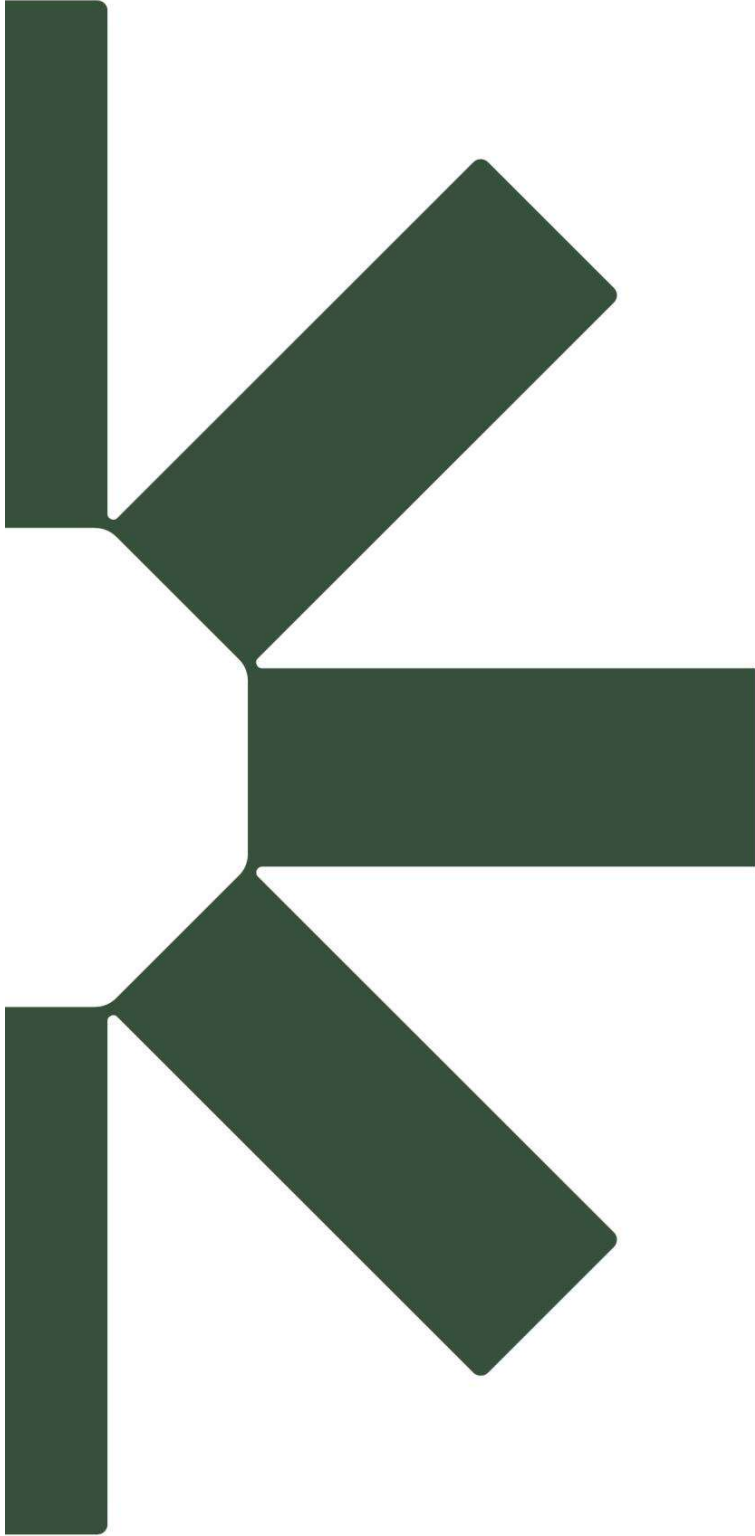


MUINGMORE WIND FARM
 PEAT RESTORATION PLAN
**HABITAT FOSSITT PLAN:
 OVER-RUN AREA 3**

FIGURE 1d



Scale 1:2,500 @ A3 Date MAY 2026



Making Sustainability Happen

Appendix 8 Collision Risk Model Report

AA Screening and Natura Impact Statement

Muingmore Wind Farm

RWE Renewables Ireland Limited

SLR Project No.: 501.065301.00001



Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
0	9 July 2025	Jonathon Dunn	Michael Austin	Jonathon Dunn
	Click to enter a date.			
	Click to enter a date.			
	Click to enter a date.			
	Click to enter a date.			

Basis of Report

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Executive Summary

The aim of this report is to describe the collision risk modelling process undertaken for the 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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- Appendix A NatureScot Spreadsheets – Vestas V150**
- Appendix B NatureScot Spreadsheets – Nordex N163**
- Appendix C NatureScot Spreadsheets – Nordex N149**



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 guidance¹, which is recognised as standard best practice guidance through the UK and Ireland to inform impact assessment for onshore wind farms. Further details regarding the methodology used, including details of assumptions used and any corrections applied, are provided in section 2.0. The modelling results are presented in section 3.0 and copies of the modelling calculations for each species modelled are included in Appendix A, 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) guidance². 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. 2024³) was used to estimate collision risk based on recorded primary target species activity levels and flight behaviour, proposed turbine numbers and specifications, and the relevant species biometrics and flight characteristics. Modelling collision risk under the Band CRM³ is summarised below:

- Stage A uses bird survey data to establish the density of flying birds in the vicinity of the turbines, and the proportion flying at a risk height, between the lowest and highest points of the rotors;
- Stage B provides an estimate, based on the bird density and proportion at risk height, of the potential number of bird passages through rotors in the period in question;
- 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 m²; N149: 7,069,378 m²) represents 100% of the survey WP for the V150 and N149 models, respectively (V150: 7,076,331 m²; N149: 7,069,378 m²) (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 m²) represents 99.9% of the survey WP (7,132,836 m²) (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, 2024⁶), which are far in excess of the minimum of 144 per VP over a two-year period required by NS guidance².

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

VP Number	Hours of Survey Completed per Survey Period							Total
	Apr – Aug 2021	Sep 2021 – Mar 2022	Apr – Aug 2022	Sep 2022 – Mar 2023	Apr – Aug 2023	Sep 2023 – March 2024	Apr – May 2024	
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
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 WP⁴. It is known that bird detection rates vary between species. To ensure the CRM used robust measures of flight activity, a 2 km distance truncation was used in the viewshed from each VP, i.e., only flights within 2 km of each VP were included (as per NS 2025 guidance²).

Analysis in Excel and GIS identified those flights described in Table 2-3 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
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		31.84
		2	
	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
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		31.84
		2	
	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		4.53
		3	
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	
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) guidance¹ for each species, season and month to provide a mean figure of bird density per month per season, along with the standard deviation.

As there were significant differences in the area covered by 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 :

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

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

There were no notable differences between underlying habitats in each VP viewshed (i.e. 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



Species	Survey Period	Month	Bird Density (birds / km ²)		
			Mean	Standard Deviation	Weighted Mean
	Breeding_2022	8	6.99719E-05	0	6.99719E-05
		4	0.000359319	0.000289174	0.000368735
		5	0.000279756	0.000395635	0.000238802
	Breeding_2023	8	0.000273318	0	0.000273318
		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
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) guidance¹. 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) guidance¹. 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) guidance¹. 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) guidance¹. 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) guidance¹. 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) guidance¹. 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) guidance¹ 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., 2024³).

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). The Condor 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%20> [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) guidance¹ 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

Value				Units		Value				Units	
Bird data				Windfarm data				Turbine data			
Species name	Black-headed gull			Site name	Muingmore			Model	V150		
Bird length	L	0.355	m	Latitude	54.143 degrees			Hub height	105 m		
Wingspan	W	1.05	m	No of turbines	T	13		Rotor radius	R	75	m
Bird flight speed	v	11.9	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3	
Flight type, flapping or gliding	flapping			Rotation speed	Ω	8.8	rpm	Max blade width	C	4.2	m
% of flights upwind/downwind	50%			Blade pitch	λ	15	degrees	Risk height range	30-180 m		
Nocturnal activity ranking 1-5	1										
Nocturnal activity factor	f _{night}	0%									

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												0.0003
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				Bird length				Wingspan				Bird flight speed				Flight type			
No of blades	b	3		0.355 m				1.05 m				11.9 m s ⁻¹				flapping			
Rotation speed	Ω	8.8 rpm																	
Rotor radius	R	75 m																	
Max blade width	C	4.2 m																	
Pitch	λ	15 degrees																	
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															
			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				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															
Avoidance rates modelled	98.00%		100.00%													
			100.00%													
			100.00%													
			100.00%													
	Collision rates allowing for avoidance		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	
			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	
			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	
			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

		Value	Units			Value	Units			Value	Units					
Bird data				Windfarm data				Turbine data								
Species name		Black-headed gull		Site name		Muingmore		Model		V150						
Bird length	L	0.355	m	Latitude		54.143	degrees	Hub height		105	m					
Wingspan	W	1.05	m	No of turbines	T	13		Rotor radius	R	75	m					
Bird flight speed	v	11.9	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3						
Flight type, flapping or gliding		flapping						Rotation speed	Ω	8.8	rpm					
% of flights upwind/downwind		50%	50%					Max blade width	C	4.2	m					
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees					
Nocturnal activity factor	f _{night}	0%						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																
Daytime bird density	D _A	birds/km ²	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year ave	
Proportion at rotor risk height	Q _{2R}	85.71%	0	0	0						0	0	0.0000576	0	0.0000	
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	11.9	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	0.8	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																
Proportion of time operational	Q _{op}		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year ave	
			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	0.00	0.00	0.00	0.00	0.04	0.00	
			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	
Stage E																
Allow for large array correction?		No														
Width of windfarm	w	2	km													
		large array correction														
Avoidance rates modelled		98.00%	100.00%	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			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	0.00	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

Value			Units	Value			Units	Value			Units				
Bird data				Windfarm data				Turbine data							
Species name	Great cormorant			Site name	Muingmore			Model	V150						
Bird length	L	0.9	m	Latitude	54.143		degrees	Hub height	105		m				
Wingspan	W	1.45	m	No of turbines	T	13		Rotor radius	R	75	m				
Bird flight speed	v	14.5	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3					
Flight type, flapping or gliding	flapping							Rotation speed	Ω	8.8	rpm				
% of flights upwind/downwind	50%							Max blade width	C	4.2	m				
Nocturnal activity ranking 1-5	1							Blade pitch	λ	15	degrees				
Nocturnal activity factor	f _{night}	0%						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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
		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			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3													
Rotation speed	Ω	8.8 rpm													
Rotor radius	R	75 m													
Max blade width	C	4.2 m													
Pitch	λ	15 degrees													
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			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No													
Width of windfarm	w	2 km													
		large array correction													
Avoidance rates modelled		100.00%	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			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
			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
			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%	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

Value				Units				Value				Units				
Bird data				Windfarm data				Turbine data								
Species name		Common gull		Site name		Muingmore		Model		V150						
Bird length	L	0.41	m	Latitude		54.143	degrees	Hub height		105	m					
Wingspan	W	1.15	m	No of turbines	T	13		Rotor radius	R	75	m					
Bird flight speed	v	13.4	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3						
Flight type, flapping or gliding		flapping						Rotation speed	Ω	8.8	rpm					
% of flights upwind/downwind		50%	50%					Max blade width	C	4.2	m					
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees					
Nocturnal activity factor	f _{night}	0%						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													0.0004
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			Bird length			Wingspan			Bird flight speed			Flight type			% of flights upwind/downwind			
No of blades	b	3	0.41 m			1.15 m			13.4 m s ⁻¹			flapping			50%			
Rotation speed	Ω	8.8 rpm																
Rotor radius	R	75 m																
Max blade width	C	4.2 m																
Pitch	λ	15 degrees																
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			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													
Avoidance rates modelled		98.00%													
		100.00%													
		100.00%													
		100.00%													
		Collision rates allowing for avoidance	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
			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
			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
			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

Value				Units				Value				Units				
Bird data				Windfarm data				Turbine data								
Species name		Common gull		Site name		Muingmore		Model		V150						
Bird length	L	0.41	m	Latitude		54.143	degrees	Hub height		105	m					
Wingspan	W	1.15	m	No of turbines	T	13		Rotor radius	R	75	m					
Bird flight speed	v	13.4	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3						
Flight type, flapping or gliding		flapping						Rotation speed	Ω	8.8	rpm					
% of flights upwind/downwind		50%	50%					Max blade width	C	4.2	m					
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees					
Nocturnal activity factor	f _{night}	0%						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													0.0001
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			Bird length			Wingspan			Bird flight speed			Flight type			
No of blades	b	3	0.41 m			1.15 m			13.4 m s ⁻¹			flapping			
Rotation speed	Ω	8.8 rpm										50%			
Rotor radius	R	75 m													
Max blade width	C	4.2 m													
Pitch	λ	15 degrees													
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	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			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													
Avoidance rates modelled		98.00%													
		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	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

Value				Units				Value				Units					
Bird data				Windfarm data				Turbine data									
Species name	Herring gull			Site name	Muingmore			Model	V150								
Bird length	L	0.61	m	Latitude	54.143 degrees			Hub height	105 m								
Wingspan	W	1.465	m	No of turbines	T	13		Rotor radius	R	75	m						
Bird flight speed	v	12.8	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3							
Flight type, flapping or gliding	gliding			Rotation speed	Ω	8.8	rpm	Max blade width	C	4.2	m						
% of flights upwind/downwind	50%			Blade pitch	λ	15	degrees	Risk height range	30-180			m					
Nocturnal activity ranking 1-5	1																
Nocturnal activity factor	f _{night}	0%															
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												0.0001	
Proportion at rotor risk height	Q _{2R}	85.71%		0												0.000987	
At latitude 54.1				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	
				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	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%	85.0%	
				Collision rates before avoidance													
				0.00	0.00	0.00	0.00	0.00	1.48	1.09	0.00	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													
				0.00	0.00	0.00	0.00	0.00	1.48	1.09	0.00	0.00	0.00	0.00	0.00	0.00	2.6
				0.00	0.00	0.00	0.00	0.00	1.48	1.09	0.00	0.00	0.00	0.00	0.00	0.00	2.6
				0.00	0.00	0.00	0.00	0.00	1.48	1.09	0.00	0.00	0.00	0.00	0.00	0.00	2.6
				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				Windfarm data				Turbine data			
	Value	Units		Value	Units	Value	Units	Value	Units	Value	Units
Species name	Herring gull		Site name	Muingmore		Model	V150				
Bird length	L	0.61	m	Latitude	54.143	degrees	Hub height	105	m		
Wingspan	W	1.465	m	No of turbines	T	13	Rotor radius	R	75	m	
Bird flight speed	v	12.8	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3	
Flight type, flapping or gliding		gliding						Rotation speed	Ω	8.8	rpm
% of flights upwind/downwind		50%						Max blade width	C	4.2	m
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees
Nocturnal activity factor	f _{night}	0%						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												0.0001
Proportion at rotor risk height	Q _{2R}	83.36%												0.0001
At latitude 54.1		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
		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												
		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		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3												
Rotation speed	Ω	8.8 rpm												
Rotor radius	R	75 m												
Max blade width	C	4.2 m												
Pitch	λ	15 degrees												
Blade profile		see Blade profile sheet												
		Bird length l 0.61 m												
		Wingspan w 1.465 m												
		Bird flight speed v 12.8 m s ⁻¹												
		Flight type gliding												
		% of flights upwind/downwind 50% 50%												
		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%
		Collision rates before avoidance												
		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		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												
Avoidance rates modelled		Collision rates allowing for avoidance												
		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
		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
		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
		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				Windfarm data				Turbine data			
	Value	Units		Value	Units	Value	Units	Value	Units	Value	Units
Species name	Herring gull		Site name	Muingmore		Model	V150				
Bird length	L	0.61	m	Latitude	54.143	degrees	Hub height	105	m		
Wingspan	W	1.465	m	No of turbines	T	13	Rotor radius	R	75	m	
Bird flight speed	v	12.8	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3	
Flight type, flapping or gliding		gliding						Rotation speed	Ω	8.8	rpm
% of flights upwind/downwind		50%						Max blade width	C	4.2	m
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees
Nocturnal activity factor	f _{night}	0%						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												
Proportion at rotor risk height	Q _{2R}	0.000358												
At latitude 54.1		0.001329	0	0.001174	0	0.001174	0	0.001174	0	0.001174	0	0.001174	0	0.001174
		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
		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												
		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		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3												
Rotation speed	Ω	8.8 rpm												
Rotor radius	R	75 m												
Max blade width	C	4.2 m												
Pitch	λ	15 degrees												
Blade profile		see Blade profile sheet												
		Bird length l 0.61 m												
		Wingspan w 1.465 m												
		Bird flight speed v 12.8 m s ⁻¹												
		Flight type gliding												
		% of flights upwind/downwind 50% 50%												
		7.62%												
		3.79%												
		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%												
		Collision rates before avoidance												
		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		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												
Avoidance rates modelled		100.00%	100.00%	100.00%	0.44	0.00	2.00	16.86	0.00	0.00	0.00	0.00	0.00	19.3
		100.00%	100.00%	100.00%	0.44	0.00	2.00	16.86	0.00	0.00	0.00	0.00	0.00	19.3
		100.00%	100.00%	100.00%	0.44	0.00	2.00	16.86	0.00	0.00	0.00	0.00	0.00	19.3
		98.00%	100.00%	100.00%	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
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Value				Units				Value				Units				
Bird data				Windfarm data				Turbine data								
Species name		Herring gull		Site name		Muingmore		Model		V150						
Bird length	L	0.61	m	Latitude		54.143	degrees	Hub height		105	m					
Wingspan	W	1.465	m	No of turbines	T	13		Rotor radius	R	75	m					
Bird flight speed	v	12.8	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3						
Flight type, flapping or gliding		gliding						Rotation speed	Ω	8.8	rpm					
% of flights upwind/downwind		50%						Max blade width	C	4.2	m					
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees					
Nocturnal activity factor	f _{night}	0%						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				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3														
Rotation speed	Ω	8.8	rpm													
Rotor radius	R	75	m													
Max blade width	C	4.2	m													
Pitch	λ	15	degrees													
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														
				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				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No														
Width of windfarm	w	2	km													
		large array correction														
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	0.36	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%		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
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Value			Units	Value			Units	Value			Units					
Bird data			Windfarm data			Turbine data										
Species name	Hen harrier		Site name	Muingmore		Model	V150									
Bird length	L	0.48	m	Latitude	54.143	degrees	Hub height	105	m							
Wingspan	W	1.1	m	No of turbines	T	13	Rotor radius	R	75	m						
Bird flight speed	v	8	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3						
Flight type, flapping or gliding	gliding						Rotation speed	Ω	8.8	rpm						
% of flights upwind/downwind	50%						Max blade width	C	4.2	m						
Nocturnal activity ranking 1-5	1						Blade pitch	λ	15	degrees						
Nocturnal activity factor	f _{night}	0%					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												0.0001	
Proportion at rotor risk height	Q _{2R}	85.71%	0												0.000693	
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	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	12.1	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%												
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%	85.0%	
	Collision rates before avoidance		0.00													
			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.00	1	
Stage E																
Allow for large array correction?	No															
Width of windfarm	w	2 km														
	large array correction															
Avoidance rates modelled			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year	
	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%		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

Value				Units		Value				Units		Value				Units	
Bird data				Windfarm data				Turbine data									
Species name	Common kestrel			Site name	Muingmore			Model	V150								
Bird length	L	0.34	m	Latitude	54.143	degrees	Hub height	105	m								
Wingspan	W	0.755	m	No of turbines	T	13	Rotor radius	R	75	m							
Bird flight speed	v	12.7	m s ⁻¹	Width of windfarm	w	2	No of blades	b	3								
Flight type, flapping or gliding	flapping							Rotation speed	Ω	8.8	rpm						
% of flights upwind/downwind	50%							Max blade width	C	4.2	m						
Nocturnal activity ranking 1-5	1							Blade pitch	λ	15	degrees						
Nocturnal activity factor	f _{night}	0%						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														0.0007	
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%										
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%	85.0%
	Collision rates before avoidance			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				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															
Avoidance rates modelled	95.00%			Collision rates allowing for avoidance												
	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	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

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Value			Units	Value			Units	Value			Units
Bird data				Windfarm data				Turbine data			
Species name	Common kestrel			Site name	Muingmore			Model	V150		
Bird length	L	0.34	m	Latitude	54.143	degrees	Hub height	105	m		
Wingspan	W	0.755	m	No of turbines	T	13	Rotor radius	R	75	m	
Bird flight speed	v	12.7	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3	
Flight type, flapping or gliding		flapping						Rotation speed	Ω	8.8	rpm
% of flights upwind/downwind		50%	50%					Max blade width	C	4.2	m
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees
Nocturnal activity factor	f _{night}	0%						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			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3													
Rotation speed	Ω	8.8 rpm													
Rotor radius	R	75 m													
Max blade width	C	4.2 m													
Pitch	λ	15 degrees													
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													
			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			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													
Avoidance rates modelled		95.00%													
		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	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

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Value			Units	Value			Units	Value			Units				
Bird data				Windfarm data				Turbine data							
Species name	Common kestrel			Site name	Muingmore			Model	V150						
Bird length	L	0.34	m	Latitude	54.143 degrees			Hub height	105 m						
Wingspan	W	0.755	m	No of turbines	T	13		Rotor radius	R	75	m				
Bird flight speed	v	12.7	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3					
Flight type, flapping or gliding	flapping			Rotation speed	Ω	8.8	rpm	Max blade width	C	4.2	m				
% of flights upwind/downwind	50%			Blade pitch	λ	15	degrees	Risk height range	30-180 m						
Nocturnal activity ranking 1-5	1														
Nocturnal activity factor	f _{night}	0%													
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												
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	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	9.5	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%	85.0%
Collision rates before avoidance															
			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															
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	95.00%		Collision rates allowing for avoidance												
	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	0.02	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

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Value			Units	Value			Units	Value			Units
Bird data				Windfarm data				Turbine data			
Species name	Common kestrel			Site name	Muingmore			Model	V150		
Bird length	L	0.34	m	Latitude	54.143	degrees		Hub height	105	m	
Wingspan	W	0.755	m	No of turbines	T	13		Rotor radius	R	75	m
Bird flight speed	v	12.7	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3	
Flight type, flapping or gliding		flapping						Rotation speed	Ω	8.8	rpm
% of flights upwind/downwind		50%	50%					Max blade width	C	4.2	m
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees
Nocturnal activity factor	f _{night}	0%						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			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3													
Rotation speed	Ω	8.8 rpm													
Rotor radius	R	75 m													
Max blade width	C	4.2 m													
Pitch	λ	15 degrees													
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															
			0.33	0.05	1.06	0.00	0.00	0.00	0.00	0.00	2.88	0.01	0.12	0.00	year total
															4

Stage E			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No													
Width of windfarm		2 km													
Avoidance rates modelled		95.00%													
		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%	0.02	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

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Value			Units	Value			Units	Value			Units									
Bird data				Windfarm data				Turbine data												
Species name	Common kestrel			Site name	Muingmore			Model	V150											
Bird length	L	0.34	m	Latitude	54.143 degrees			Hub height	105 m											
Wingspan	W	0.755	m	No of turbines	T	13		Rotor radius	R	75 m										
Bird flight speed	v	12.7	m s ⁻¹	Width of windfarm	w	2 km		No of blades	b	3										
Flight type, flapping or gliding	flapping			Rotation speed	Ω	8.8 rpm		Max blade width	C	4.2 m										
% of flights upwind/downwind	50%			Blade pitch	λ	15 degrees		Risk height range	30-180 m											
Nocturnal activity ranking 1-5	1																			
Nocturnal activity factor	f _{night}	0%																		
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		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total				
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%				
Collision rates before avoidance																				
				4.12	0.61	1.73	0.00	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				
Avoidance rates modelled	95.00%			100.00%			Collision rates allowing for avoidance									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	0.3				
	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	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				
	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

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Value			Units	Value			Units	Value			Units					
Bird data				Windfarm data				Turbine data								
Species name	Common kestrel			Site name	Muingmore			Model	V150							
Bird length	L	0.34	m	Latitude	54.143 degrees			Hub height	105 m							
Wingspan	W	0.755	m	No of turbines	T	13		Rotor radius	R	75	m					
Bird flight speed	v	12.7	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3						
Flight type, flapping or gliding	flapping			Rotation speed	Ω	8.8	rpm	Max blade width	C	4.2	m					
% of flights upwind/downwind	50%			Blade pitch	λ	15	degrees	Risk height range	30-180 m							
Nocturnal activity ranking 1-5	1															
Nocturnal activity factor	f _{night}	0%														
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	0.0	3.3	0.0	5.5	4.2	39
Stage C																
No of blades	b	3														
Rotation speed	Ω	8.8 rpm														
Rotor radius	R	75 m														
Max blade width	C	4.2 m														
Pitch	λ	15 degrees														
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															
			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															
Avoidance rates modelled																
	95.00%															
	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	0.03	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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Value			Units			Value			Units			Value			Units							
Bird data						Windfarm data						Turbine data										
Species name	Lesser black-backed gull					Site name	Muingmore					Model	V150									
Bird length	L	0.6	m		Latitude	54.143 degrees					Hub height	105 m										
Wingspan	W	1.45	m		No of turbines	T	13					Rotor radius	R	75 m								
Bird flight speed	v	13.1	m s ⁻¹		Width of windfarm	w	2 km					No of blades	b	3								
Flight type, flapping or gliding	gliding					Rotation speed	Ω	8.8 rpm					Max blade width	C	4.2 m							
% of flights upwind/downwind	50%					Blade pitch	λ	15 degrees					Risk height range	30-180 m								
Nocturnal activity ranking 1-5	1																					
Nocturnal activity factor	f _{night}	0%																				
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																						
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				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	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%	85.0%			
						Collision rates before avoidance																
						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				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	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%					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

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Value			Units	Value			Units	Value			Units
Bird data				Windfarm data				Turbine data			
Species name	Lesser black-backed gull			Site name	Muingmore			Model	V150		
Bird length	L	0.6	m	Latitude	54.143	degrees		Hub height	105	m	
Wingspan	W	1.45	m	No of turbines	T	13		Rotor radius	R	75	m
Bird flight speed	v	13.1	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3	
Flight type, flapping or gliding	gliding							Rotation speed	Ω	8.8	rpm
% of flights upwind/downwind	50%							Max blade width	C	4.2	m
Nocturnal activity ranking 1-5	1							Blade pitch	λ	15	degrees
Nocturnal activity factor	f _{night}	0%						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			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3													
Rotation speed	Ω	8.8 rpm													
Rotor radius	R	75 m													
Max blade width	C	4.2 m													
Pitch	λ	15 degrees													
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%	85.0%
	Collision rates before avoidance														
			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			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No													
Width of windfarm	w	2 km													
	large array correction														
	Collision rates allowing for avoidance														
Avoidance rates modelled	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	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	9.7	
	98.00%		0.00	0.00	0.00	0.03	0.16	0.01	0.00	0.00	0.00	0.00	0.00	0.2	

COLLISION RISK MODEL

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Value			Units			Value			Units			Value			Units		
Bird data						Windfarm data						Turbine data					
Species name	Lesser black-backed gull					Site name	Muingmore					Model	V150				
Bird length	L	0.6	m	Latitude	54.143	degrees	Hub height	105	m	No of turbines	T	13	Rotor radius	R	75	m	
Wingspan	W	1.45	m	No of turbines	13	Width of windfarm	w	2	km	No of blades	b	3	Rotation speed	Ω	8.8	rpm	
Bird flight speed	v	13.1	m s ⁻¹	Width of windfarm	2	km	Rotation speed	8.8	rpm	Max blade width	C	4.2	Blade pitch	λ	15	degrees	
Flight type, flapping or gliding	gliding					Rotation speed	8.8	rpm	Max blade width	4.2	m	Blade pitch	15	degrees	Risk height range	30-180	m
% of flights upwind/downwind	50%					Blade pitch	15	degrees	Risk height range	30-180	m						
Nocturnal activity ranking 1-5	1																
Nocturnal activity factor	f_{night}	0%															
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											0.0001	
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	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	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%	85.0%		
Collision rates before avoidance			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	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		
Collision rates allowing for avoidance			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		
			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		
			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		
			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

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Bird data				Windfarm data				Turbine data			
	Value	Units		Value	Units	Value	Units	Value	Units	Value	Units
Species name	Mallard		Site name	Muingmore		Model	V150				
Bird length	L	0.58	m	Latitude	54.143	degrees	Hub height	105	m		
Wingspan	W	0.9	m	No of turbines	T	13	Rotor radius	R	75	m	
Bird flight speed	v	22	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3	
Flight type, flapping or gliding		flapping						Rotation speed	Ω	8.8	rpm
% of flights upwind/downwind		50%	50%					Max blade width	C	4.2	m
Nocturnal activity ranking 1-5		2						Blade pitch	λ	15	degrees
Nocturnal activity factor	f _{night}	25%						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	0.000369												0.000239	0	0	0.000273	0.0001
Proportion at rotor risk height	Q _{2R}	85.71%																
At latitude 54.1		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		229729 m ²												
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		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3												
Rotation speed	Ω	8.8 rpm												
Rotor radius	R	75 m												
Max blade width	C	4.2 m												
Pitch	λ	15 degrees												
Blade profile		see Blade profile sheet												
Bird length	l	0.58 m												
Wingspan	w	0.9 m												
Bird flight speed	v	22 m s ⁻¹												
Flight type		flapping												
% of flights upwind/downwind		50% 50%												
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%
Collision rates before avoidance		0.00												0.77
		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		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		100.00%												
Avoidance rates modelled		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
		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
		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
		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

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Bird data				Windfarm data				Turbine data			
	Value	Units		Value	Units	Value	Units	Value	Units	Value	Units
Species name	Mallard		Site name	Muingmore		Model	V150				
Bird length	L	0.58	m	Latitude	54.143	degrees	Hub height	105	m		
Wingspan	W	0.9	m	No of turbines	T	13	Rotor radius	R	75	m	
Bird flight speed	v	22	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3	
Flight type, flapping or gliding		flapping						Rotation speed	Ω	8.8	rpm
% of flights upwind/downwind		50%	50%					Max blade width	C	4.2	m
Nocturnal activity ranking 1-5		2						Blade pitch	λ	15	degrees
Nocturnal activity factor	f _{night}	25%						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	0.003563												0.0003
Proportion at rotor risk height	Q _{2R}	0.000311												
At latitude 54.1		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
		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												
		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
		Projected number of rotor transits												

Stage C		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3												
Rotation speed	Ω	8.8 rpm												
Rotor radius	R	75 m												
Max blade width	C	4.2 m												
Pitch	λ	15 degrees												
Blade profile		see Blade profile sheet												
		Bird length 0.58 m												
		Wingspan 0.9 m												
		Bird flight speed 22 m s ⁻¹												
		Flight type flapping												
		% of flights upwind/downwind 50% 50%												
		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%
		Collision rates before avoidance												
		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		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		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
		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
		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
		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

Value				Units				Value				Units				
Bird data				Windfarm data				Turbine data								
Species name	nd	white-fronted	goose	Site name	Muingmore			Model	V150							
Bird length	L	0.71	m	Latitude	54.143	degrees			Hub height	105	m					
Wingspan	W	1.47	m	No of turbines	T	13			Rotor radius	R	75	m				
Bird flight speed	v	16.1	m s ⁻¹	Width of windfarm	w	2	km			No of blades	b	3				
Flight type, flapping or gliding	flapping								Rotation speed	Ω	8.8	rpm				
% of flights upwind/downwind	50%		50%						Max blade width	C	4.2	m				
Nocturnal activity ranking 1-5	2								Blade pitch	λ	15	degrees				
Nocturnal activity factor	f _{night}	25%								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%											
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%	85.0%
	Collision rates before avoidance		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	60.80	0.00	0.00	year total
			61												

Stage E			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No													
Width of windfarm	w	2 km													
	large array correction														
Avoidance rates modelled	100.00%		Collision rates allowing for avoidance												
	100.00%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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%		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
			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				Windfarm data				Turbine data			
	Value	Units		Value	Units	Value	Units	Value	Units	Value	Units
Species name	Peregrine falcon		Site name	Muingmore		Model	V150				
Bird length	L	0.42	m	Latitude	54.143	degrees	Hub height	105	m		
Wingspan	W	1.025	m	No of turbines	T	13	Rotor radius	R	75	m	
Bird flight speed	v	12.1	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3	
Flight type, flapping or gliding		flapping						Rotation speed	Ω	8.8	rpm
% of flights upwind/downwind		50%	50%					Max blade width	C	4.2	m
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees
Nocturnal activity factor	f _{night}	0%						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	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		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
		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		229729	m ²											
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		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3												
Rotation speed	Ω	8.8	rpm											
Rotor radius	R	75	m											
Max blade width	C	4.2	m											
Pitch	λ	15	degrees											
Blade profile		see Blade profile sheet												
Bird length	l	0.42	m											
Wingspan	w	1.025	m											
Bird flight speed	v	12.1	m s ⁻¹											
Flight type		flapping												
% of flights upwind/downwind		50%	50%											
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		0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.12	0.25	0.00	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		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											
Avoidance rates modelled		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	1.0
		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	1.0
		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	1.0
		98.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	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			Value	Units			Value	Units				
Bird data				Windfarm data				Turbine data							
Species name		Common snipe		Site name		Muingmore		Model		V150					
Bird length	L	0.26	m	Latitude		54.143	degrees	Hub height		105	m				
Wingspan	W	0.455	m	No of turbines	T	13		Rotor radius	R	75	m				
Bird flight speed	v	16	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3					
Flight type, flapping or gliding		flapping						Rotation speed	Ω	8.8	rpm				
% of flights upwind/downwind		50%	50%					Max blade width	C	4.2	m				
Nocturnal activity ranking 1-5		2						Blade pitch	λ	15	degrees				
Nocturnal activity factor	f _{night}	25%						Risk height range		30-180	m				
<div style="border: 1px solid black; display: inline-block; padding: 2px;">normal approach</div> 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															
Daytime bird density	D _A	birds/km ²	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion at rotor risk height	Q _{2R}	85.71%	0.000944	0.000192	0						0	0.006071	0.000676	0	0.0007
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	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															
Proportion of time operational	Q _{op}		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
			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												
			0.94	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.01	0.67	0.00	year total 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
Avoidance rates modelled		100.00%	Collision rates allowing for avoidance												
		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%	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
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Bird data				Windfarm data				Turbine data			
	Value	Units		Value	Units	Value	Units	Value	Units	Value	Units
Species name	Common snipe		Site name	Muingmore		Model	V150				
Bird length	L 0.26	m	Latitude	54.143	degrees	Hub height	105	m			
Wingspan	W 0.455	m	No of turbines	T 13		Rotor radius	R 75	m			
Bird flight speed	v 16	m s ⁻¹	Width of windfarm	w 2	km	No of blades	b 3				
Flight type, flapping or gliding	flapping					Rotation speed	Ω 8.8	rpm			
% of flights upwind/downwind	50%	50%				Max blade width	C 4.2	m			
Nocturnal activity ranking 1-5	2					Blade pitch	λ 15	degrees			
Nocturnal activity factor	f _{night} 25%					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		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b 3													
Rotation speed	Ω 8.8 rpm													
Rotor radius	R 75 m													
Max blade width	C 4.2 m													
Pitch	λ 15 degrees													
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%	85.0%
	Collision rates before avoidance													
		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		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													
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%	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

Value			Units	Value			Units	Value			Units
Bird data				Windfarm data				Turbine data			
Species name		Eurasian teal		Site name		Muingmore		Model		V150	
Bird length	L	0.39	m	Latitude		54.143	degrees	Hub height		105	m
Wingspan	W	0.55	m	No of turbines	T	13		Rotor radius	R	75	m
Bird flight speed	v	19.7	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3	
Flight type, flapping or gliding		flapping						Rotation speed	Ω	8.8	rpm
% of flights upwind/downwind		50%	50%					Max blade width	C	4.2	m
Nocturnal activity ranking 1-5		2						Blade pitch	λ	15	degrees
Nocturnal activity factor	f _{night}	25%						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													0.0002
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			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3													
Rotation speed	Ω	8.8 rpm													
Rotor radius	R	75 m													
Max blade width	C	4.2 m													
Pitch	λ	15 degrees													
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 total
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%	85.0%
		Collision rates before avoidance													
			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			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													
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%	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



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

Value				Units		Value				Units	
Bird data				Windfarm data				Turbine data			
Species name	Black-headed gull			Site name	Muingmore			Model	N163		
Bird length	L	0.355	m	Latitude	54.143	degrees	Hub height	98.5	m		
Wingspan	W	1.05	m	No of turbines	T	13	Rotor radius	R	81.5	m	
Bird flight speed	v	11.9	m s ⁻¹	Width of windfarm	w	2	No of blades	b	3		
Flight type, flapping or gliding		flapping					Rotation speed	Ω	8.8	rpm	
% of flights upwind/downwind		50%	50%				Max blade width	C	4.15	m	
Nocturnal activity ranking 1-5		1					Blade pitch	λ	15	degrees	
Nocturnal activity factor	f _{night}	0%					Risk height range		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												0.0003
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			Bird length			Wingspan			Bird flight speed			Flight type		
No of blades	b	3	0.355 m			1.05 m			11.9 m s ⁻¹			flapping		
Rotation speed	Ω	8.8 rpm										50%		
Rotor radius	R	81.5 m												
Max blade width	C	4.15 m												
Pitch	λ	15 degrees												
Blade profile		see Blade profile sheet												
		Single transit risk	upwind		6.74%	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	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			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No													
Width of windfarm	w	2 km													
		large array correction													
Avoidance rates modelled		98.00%	Collision rates allowing for avoidance												
		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	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

Value				Units		Value				Units	
Bird data				Windfarm data				Turbine data			
Species name	Black-headed gull			Site name	Muingmore			Model	N163		
Bird length	L	0.355	m	Latitude	54.143	degrees	Hub height	98.5	m		
Wingspan	W	1.05	m	No of turbines	T	13	Rotor radius	R	81.5	m	
Bird flight speed	v	11.9	m s ⁻¹	Width of windfarm	w	2	No of blades	b	3		
Flight type, flapping or gliding		flapping					Rotation speed	Ω	8.8	rpm	
% of flights upwind/downwind		50%	50%				Max blade width	C	4.15	m	
Nocturnal activity ranking 1-5		1					Blade pitch	λ	15	degrees	
Nocturnal activity factor	f _{night}	0%					Risk height range		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												0.0003
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			Bird length			Wingspan			Bird flight speed			Flight type		
No of blades	b	3	0.355 m			1.05 m			11.9 m s ⁻¹			flapping		
Rotation speed	Ω	8.8 rpm							50%					
Rotor radius	R	81.5 m												
Max blade width	C	4.15 m												
Pitch	λ	15 degrees												
Blade profile		see Blade profile sheet												
		Single transit risk	upwind		6.74%									
			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	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			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No													
Width of windfarm		2 km													
		large array correction													
Avoidance rates modelled		98.00%	Collision rates allowing for avoidance												
		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	0.01	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

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Value				Units		Value				Units		Value				Units	
Bird data				Windfarm data				Turbine data									
Species name		Black-headed gull		Site name		Muingmore		Model		N163							
Bird length	L	0.355	m	Latitude		54.143	degrees	Hub height		98.5	m						
Wingspan	W	1.05	m	No of turbines	T	13		Rotor radius	R	81.5	m						
Bird flight speed	v	11.9	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3							
Flight type, flapping or gliding		flapping						Rotation speed	Ω	8.8	rpm						
% of flights upwind/downwind		50%	50%					Max blade width	C	4.15	m						
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees						
Nocturnal activity factor	f _{night}	0%						Risk height range		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												0.0015
Proportion at rotor risk height	Q _{2R}	19.38%	0												0.0015
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%										
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	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			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													
Avoidance rates modelled		98.00%	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
		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

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Value			Units	Value			Units	Value			Units				
Bird data				Windfarm data				Turbine data							
Species name	Great cormorant			Site name	Muingmore			Model	N163						
Bird length	L	0.9	m	Latitude	54.143		degrees	Hub height	98.5		m				
Wingspan	W	1.45	m	No of turbines	T	13		Rotor radius	R	81.5	m				
Bird flight speed	v	14.5	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3					
Flight type, flapping or gliding	flapping							Rotation speed	Ω	8.8	rpm				
% of flights upwind/downwind	50%							Max blade width	C	4.15	m				
Nocturnal activity ranking 1-5	1							Blade pitch	λ	15	degrees				
Nocturnal activity factor	f _{night}	0%						Risk height range	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	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
		Projected number of rotor transits													
Stage C			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3													
Rotation speed	Ω	8.8 rpm													
Rotor radius	R	81.5 m													
Max blade width	C	4.15 m													
Pitch	λ	15 degrees													
Blade profile	see Blade profile sheet														
		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	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			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No													
Width of windfarm	w	2 km													
		large array correction													
Avoidance rates modelled		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%	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

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Value				Units				Value				Units				
Bird data				Windfarm data				Turbine data								
Species name		Common gull		Site name		Muingmore		Model		N163						
Bird length	L	0.41	m	Latitude		54.143	degrees	Hub height		98.5	m					
Wingspan	W	1.15	m	No of turbines	T	13		Rotor radius	R	81.5	m					
Bird flight speed	v	13.4	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3						
Flight type, flapping or gliding		flapping						Rotation speed	Ω	8.8	rpm					
% of flights upwind/downwind		50%	50%					Max blade width	C	4.15	m					
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees					
Nocturnal activity factor	f _{night}	0%						Risk height range		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												0.0004
Proportion at rotor risk height	Q _{2R}	95.00%	0.004297												0
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			Bird length			Wingspan			Bird flight speed			Flight type		
No of blades	b	3	0.41 m			1.15 m			13.4 m s ⁻¹			flapping		
Rotation speed	Ω	8.8 rpm										50%		
Rotor radius	R	81.5 m												
Max blade width	C	4.15 m												
Pitch	λ	15 degrees												
Blade profile		see Blade profile sheet												
		Single transit risk	upwind		6.58%	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	0.00												
			0.00	0.00	0.00	0.00	0.00	0.00	6.86	0.00	0.00	0.00	0.00	0.00	7

Stage E			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?		No													
Width of windfarm	w	2 km													
		large array correction													
Avoidance rates modelled		98.00%	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
		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

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 Calculated output is in blue boxes
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Value				Units	Value				Units	Value				Units
Bird data					Windfarm data					Turbine data				
Species name		Common gull			Site name	Muingmore			Model	N163				
Bird length	L	0.41	m		Latitude	54.143	degrees		Hub height	98.5	m			
Wingspan	W	1.15	m		No of turbines	T	13		Rotor radius	R	81.5	m		
Bird flight speed	v	13.4	m s ⁻¹		Width of windfarm	w	2	km	No of blades	b	3			
Flight type, flapping or gliding		flapping							Rotation speed	Ω	8.8	rpm		
% of flights upwind/downwind		50%	50%						Max blade width	C	4.15	m		
Nocturnal activity ranking 1-5		1							Blade pitch	λ	15	degrees		
Nocturnal activity factor	f _{night}	0%							Risk height range		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														0.0001
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				Stage D			
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														
				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				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														
Avoidance rates modelled		98.00%	100.00%													
			100.00%													
			100.00%													
			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
				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
				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
				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

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Value				Units				Value				Units								
Bird data				Windfarm data				Turbine data												
Species name		Herring gull		Site name		Muingmore		Model		N163										
Bird length	L	0.61	m	Latitude		54.143	degrees	Hub height		98.5	m									
Wingspan	W	1.465	m	No of turbines	T	13		Rotor radius	R	81.5	m									
Bird flight speed	v	12.8	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3										
Flight type, flapping or gliding		gliding						Rotation speed	Ω	8.8	rpm									
% of flights upwind/downwind		50%						Max blade width	C	4.15	m									
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees									
Nocturnal activity factor	f _{night}	0%						Risk height range		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	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	3.1	9.7	23.0	29.7	0.0	0.0	0.0	0.0	0.0	66				
Stage C				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total				
No of blades	b	3																		
Rotation speed	Ω	8.8	rpm																	
Rotor radius	R	81.5	m																	
Max blade width	C	4.15	m																	
Pitch	λ	15	degrees																	
Blade profile		see Blade profile sheet																		
		Single transit risk																		
		upwind														7.26%				
		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																		
				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				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year				
Allow for large array correction?	w	No																		
Width of windfarm	w	2	km																	
		large array correction																		
Avoidance rates modelled				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				
				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				
				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
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Value				Units				Value				Units				
Bird data				Windfarm data				Turbine data								
Species name		Herring gull		Site name		Muingmore		Model		N163						
Bird length	L	0.61	m	Latitude		54.143	degrees	Hub height		98.5	m					
Wingspan	W	1.465	m	No of turbines	T	13		Rotor radius	R	81.5	m					
Bird flight speed	v	12.8	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3						
Flight type, flapping or gliding		gliding						Rotation speed	Ω	8.8	rpm					
% of flights upwind/downwind		50%						Max blade width	C	4.15	m					
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees					
Nocturnal activity factor	f _{night}	0%						Risk height range		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												0.0012
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				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3														
Rotation speed	Ω	8.8	rpm													
Rotor radius	R	81.5	m													
Max blade width	C	4.15	m													
Pitch	λ	15	degrees													
Blade profile		see Blade profile sheet														
		Single transit risk														
		upwind		7.26%												
		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														
				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				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No														
Width of windfarm	w	2	km													
		large array correction														
Avoidance rates modelled		100.00%														
		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%		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

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Bird data				Windfarm data				Turbine data			
	Value	Units		Value	Units	Value	Units	Value	Units		
Species name	Herring gull		Site name	Muingmore		Model	N163				
Bird length	L	0.61	m	Latitude	54.143	degrees	Hub height	98.5	m		
Wingspan	W	1.465	m	No of turbines	T	13	Rotor radius	R	81.5	m	
Bird flight speed	v	12.8	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3	
Flight type, flapping or gliding		gliding					Rotation speed	Ω	8.8	rpm	
% of flights upwind/downwind		50%					Max blade width	C	4.15	m	
Nocturnal activity ranking 1-5		1					Blade pitch	λ	15	degrees	
Nocturnal activity factor	f _{night}	0%					Risk height range		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	0	0	0						0	0.000256	0	0	0.0000	
Proportion at rotor risk height	Q _{2R}	95.00%													
At latitude 54.1		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	
		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 m² 271274													
Nocturnal activity factor	f _{night}	0%													
Bird flight speed	v	12.8 m s⁻¹													
		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		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total	
No of blades	b	3													
Rotation speed	Ω	8.8 rpm													
Rotor radius	R	81.5 m													
Max blade width	C	4.15 m													
Pitch	λ	15 degrees													
Blade profile		see Blade profile sheet													
		Bird length 0.61 m													
		Wingspan 1.465 m													
		Bird flight speed 12.8 m s⁻¹													
		Flight type gliding													
		% of flights upwind/downwind 50% 50%													
		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													
		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		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year	
Allow for large array correction?	w	No													
Width of windfarm	w	2 km													
		large array correction													
		Collision rates allowing for avoidance													
Avoidance rates modelled		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.3	
		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	
		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	
		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

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Value			Units	Value			Units	Value			Units				
Bird data				Windfarm data				Turbine data							
Species name	Herring gull			Site name	Muingmore			Model	N163						
Bird length	L	0.61	m	Latitude	54.143	degrees		Hub height	98.5	m					
Wingspan	W	1.465	m	No of turbines	T	13		Rotor radius	R	81.5	m				
Bird flight speed	v	12.8	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3					
Flight type, flapping or gliding		gliding						Rotation speed	Ω	8.8	rpm				
% of flights upwind/downwind		50%						Max blade width	C	4.15	m				
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees				
Nocturnal activity factor	f _{night}	0%						Risk height range		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	0.0	8.9	0.0
Stage C			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3													
Rotation speed	Ω	8.8 rpm													
Rotor radius	R	81.5 m													
Max blade width	C	4.15 m													
Pitch	λ	15 degrees													
Blade profile		see Blade profile sheet													
		Single transit risk													
		upwind	7.26%												
		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													
			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			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No													
Width of windfarm	w	2 km													
		large array correction													
		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	0.41	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%	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

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Bird data				Windfarm data				Turbine data			
	Value	Units		Value	Units	Value	Units	Value	Units	Value	Units
Species name	Hen harrier		Site name	Muingmore		Model	N163				
Bird length	L	0.48	m	Latitude	54.143	degrees	Hub height	98.5	m		
Wingspan	W	1.1	m	No of turbines	T	13	Rotor radius	R	81.5	m	
Bird flight speed	v	8	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3	
Flight type, flapping or gliding		gliding						Rotation speed	Ω	8.8	rpm
% of flights upwind/downwind		50%						Max blade width	C	4.15	m
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees
Nocturnal activity factor	f _{night}	0%						Risk height range		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												0.0001	
Proportion at rotor risk height	Q _{2R}	95.00%												0.0001	
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		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3												
Rotation speed	Ω	8.8 rpm												
Rotor radius	R	81.5 m												
Max blade width	C	4.15 m												
Pitch	λ	15 degrees												
Blade profile		see Blade profile sheet												
		Single transit risk												upwind 8.91%
														downwind 4.25%
														weighted mean 6.58%
			0.0	0.0	0.0	0.0	0.0	0.0	0.85	0.0	0.0	0.0	0.0	1

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

Stage E		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No												
Width of windfarm	w	2 km												
		large array correction												
		Collision rates allowing for avoidance												
Avoidance rates modelled		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	0.85	0.00	0.00	0.00	0.00	0.9
		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	0.85	0.00	0.00	0.00	0.00	0.9
		99.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	0.01	0.00	0.00	0.00	0.00	0.0

COLLISION RISK MODEL

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Value				Units		Value				Units	
Bird data				Windfarm data				Turbine data			
Species name	Common kestrel			Site name	Muingmore			Model	N163		
Bird length	L	0.34	m	Latitude	54.143	degrees	Hub height	98.5	m		
Wingspan	W	0.755	m	No of turbines	T	13	Rotor radius	R	81.5	m	
Bird flight speed	v	12.7	m s ⁻¹	Width of windfarm	w	2	No of blades	b	3		
Flight type, flapping or gliding	flapping						Rotation speed	Ω	8.8	rpm	
% of flights upwind/downwind	50%						Max blade width	C	4.15	m	
Nocturnal activity ranking 1-5	1						Blade pitch	λ	15	degrees	
Nocturnal activity factor	f _{night}	0%					Risk height range	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			Bird length			Wingspan			Bird flight speed			Flight type		
No of blades	b	3	0.34 m			0.755 m			12.7 m s ⁻¹			flapping		
Rotation speed	Ω	8.8 rpm										50%		
Rotor radius	R	81.5 m												
Max blade width	C	4.15 m												
Pitch	λ	15 degrees												
Blade profile	see Blade profile sheet													
	Single transit risk		upwind		6.35%	downwind		2.65%	weighted mean		4.50%			

Stage D			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q _{op}		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	4.34	0.55	1.17	1.06	2.87	0.00	0.00	0.00	0.00	10

Stage E			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	No														
Width of windfarm	w	2 km													
	large array correction														
Avoidance rates modelled	95.00%														
	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	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
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Value			Units	Value			Units	Value			Units
Bird data				Windfarm data				Turbine data			
Species name	Common kestrel			Site name	Muingmore			Model	N163		
Bird length	L	0.34	m	Latitude	54.143	degrees		Hub height	98.5	m	
Wingspan	W	0.755	m	No of turbines	T	13		Rotor radius	R	81.5	m
Bird flight speed	v	12.7	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3	
Flight type, flapping or gliding		flapping						Rotation speed	Ω	8.8	rpm
% of flights upwind/downwind		50%	50%					Max blade width	C	4.15	m
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees
Nocturnal activity factor	f _{night}	0%						Risk height range		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			Bird length			Wingspan			Bird flight speed			% of flights upwind/downwind		
No of blades	b	3	0.34 m			0.755 m			12.7 m s ⁻¹			50%		
Rotation speed	Ω	8.8 rpm												
Rotor radius	R	81.5 m												
Max blade width	C	4.15 m												
Pitch	λ	15 degrees												
Blade profile		see Blade profile sheet												
		Single transit risk	upwind 6.35%			downwind 2.65%			weighted mean 4.50%					

Stage D			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q _{op}		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 18.96 10.54 0.43 2.82 14.12 0.00 0.00 0.00 0.00												year total 47

Stage E			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No													
Width of windfarm		2 km													
		large array correction													
Avoidance rates modelled		95.00%	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
			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
			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
			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

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Value			Units	Value			Units	Value			Units					
Bird data				Windfarm data				Turbine data								
Species name	Common kestrel			Site name	Muingmore			Model	N163							
Bird length	L	0.34	m	Latitude	54.143 degrees			Hub height	98.5 m							
Wingspan	W	0.755	m	No of turbines	T	13		Rotor radius	R	81.5 m						
Bird flight speed	v	12.7	m s ⁻¹	Width of windfarm	w	2 km		No of blades	b	3						
Flight type, flapping or gliding	flapping			Rotation speed	Ω	8.8 rpm		Max blade width	C	4.15 m						
% of flights upwind/downwind	50%			Blade pitch	λ	15 degrees		Risk height range	17-180 m							
Nocturnal activity ranking 1-5	1															
Nocturnal activity factor	f _{night}	0%														
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				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3		Bird length	l	0.34 m										
Rotation speed	Ω	8.8	rpm	Wingspan	w	0.755 m										
Rotor radius	R	81.5	m	Bird flight speed	v	12.7 m s ⁻¹										
Max blade width	C	4.15 m		Flight type	flapping											
Pitch	λ	15	degrees	% of flights upwind/downwind	50%											
Blade profile	see Blade profile sheet															
	Single transit risk			upwind	6.35%											
				downwind	2.65%											
				weighted mean	4.50%											
Stage D				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q _{op}	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%	85.0%
	Collision rates before avoidance															
				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				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															
Avoidance rates modelled	95.00%															
	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	0.02	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

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Value			Units	Value			Units	Value			Units
Bird data				Windfarm data				Turbine data			
Species name	Common kestrel			Site name	Muingmore			Model	N163		
Bird length	L	0.34	m	Latitude	54.143	degrees	Hub height	98.5	m		
Wingspan	W	0.755	m	No of turbines	T	13	Rotor radius	R	81.5	m	
Bird flight speed	v	12.7	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3	
Flight type, flapping or gliding		flapping						Rotation speed	Ω	8.8	rpm
% of flights upwind/downwind		50%	50%					Max blade width	C	4.15	m
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees
Nocturnal activity factor	f _{night}	0%						Risk height range		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 ave
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			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3													
Rotation speed	Ω	8.8 rpm													
Rotor radius	R	81.5 m													
Max blade width	C	4.15 m													
Pitch	λ	15 degrees													
Blade profile		see Blade profile sheet													
		Single transit risk													
		upwind	6.35%												
		downwind	2.65%												
		weighted mean	4.50%												

Stage D			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year ave
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													
			0.37	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			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No													
Width of windfarm		2 km													
		large array correction													
Avoidance rates modelled		95.00%													
		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%	0.02	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

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Value			Units	Value			Units	Value			Units									
Bird data				Windfarm data				Turbine data												
Species name	Common kestrel			Site name	Muingmore			Model	N163											
Bird length	L	0.34	m	Latitude	54.143 degrees			Hub height	98.5 m											
Wingspan	W	0.755	m	No of turbines	T	13			Rotor radius	R	81.5 m									
Bird flight speed	v	12.7	m s ⁻¹	Width of windfarm	w	2 km			No of blades	b	3									
Flight type, flapping or gliding	flapping			Rotation speed	Ω	8.8 rpm			Max blade width	C	4.15 m									
% of flights upwind/downwind	50%			Blade pitch	λ	15 degrees			Risk height range	17-180 m										
Nocturnal activity ranking 1-5	1																			
Nocturnal activity factor	f _{night}	0%																		
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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total				
	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%															
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%				
				Collision rates before avoidance																
				4.64	0.68	2.10	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.41	0.00	0.00	year total			
				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				
Avoidance rates modelled	100.00%			Collision rates allowing for avoidance			4.64	0.68	2.10	0.00	0.00	0.00	0.00	0.00	0.00	7.8				
	95.00%			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

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Value			Units	Value			Units	Value			Units					
Bird data				Windfarm data				Turbine data								
Species name	Common kestrel			Site name	Muingmore			Model	N163							
Bird length	L	0.34	m	Latitude	54.143 degrees			Hub height	98.5 m							
Wingspan	W	0.755	m	No of turbines	T	13		Rotor radius	R	81.5 m						
Bird flight speed	v	12.7	m s ⁻¹	Width of windfarm	w	2 km		No of blades	b	3						
Flight type, flapping or gliding	flapping			Rotation speed	Ω	8.8 rpm		Max blade width	C	4.15 m						
% of flights upwind/downwind	50% 50%			Blade pitch	λ	15 degrees		Risk height range	17-180 m							
Nocturnal activity ranking 1-5	1															
Nocturnal activity factor	f _{night}	0%														
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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
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				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
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%	85.0%
Collision rates before avoidance																
				0.00	0.61	0.59	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.29	0.23	year total
				2												
Stage E				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	No															
Width of windfarm	w	2	km													
large array correction																
Avoidance rates modelled	95.00%															
	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	0.03	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

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		Value	Units			Value	Units			Value	Units					
Bird data		Species name Lesser black-backed gull		Windfarm data		Site name Muingmore		Turbine data		Model N163						
Bird length	L	0.6	m	Latitude		54.143	degrees	Hub height		98.5	m					
Wingspan	W	1.45	m	No of turbines	T	13		Rotor radius	R	81.5	m					
Bird flight speed	v	13.1	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3						
Flight type, flapping or gliding		gliding						Rotation speed	Ω	8.8	rpm					
% of flights upwind/downwind		50%						Max blade width	C	4.15	m					
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees					
Nocturnal activity factor	f _{night}	0%						Risk height range		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		Daytime bird density D _A		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion at rotor risk height Q _{2R}		89.63%		0.003394 0.003138 0.003258 0.000627 0.000367												0.0009
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%		Projected number of rotor transits												
Bird flight speed v		13.1 m s ⁻¹		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
				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		Bird length l		3 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		Proportion of time operational Q _{op}		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
				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% 85.0%												85.0%
		Collision rates before avoidance		0.00 0.00 0.00 4.54 4.94 5.31 1.03 0.54 0.00 0.00 0.00 0.00												year total 16
Stage E		Allow for large array correction?		No												
Width of windfarm w		2 km		large array correction												
Avoidance rates modelled		98.00%		Collision rates allowing for avoidance												
		100.00%		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
		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	0.09	0.10	0.11	0.02	0.01	0.00	0.00	0.00	0.00	0.3

COLLISION RISK MODEL

Required input data is in orange boxes
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Value			Units			Value			Units			Value			Units		
Bird data						Windfarm data						Turbine data					
Species name	Lesser black-backed gull					Site name	Muingmore					Model	N163				
Bird length	L	0.6	m	Latitude	54.143 degrees					Hub height	98.5 m						
Wingspan	W	1.45	m	No of turbines	T	13					Rotor radius	R	81.5 m				
Bird flight speed	v	13.1	m s ⁻¹	Width of windfarm	w	2 km					No of blades	b	3				
Flight type, flapping or gliding	gliding					Rotation speed	Ω	8.8 rpm									
% of flights upwind/downwind	50%					Max blade width	C	4.15 m									
Nocturnal activity ranking 1-5	1					Blade pitch	λ	15 degrees									
Nocturnal activity factor	f _{night}	0%					Risk height range	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	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	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%	85.0%		
Collision rates before avoidance																	
			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			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year		
Allow for large array correction?	w	No															
Width of windfarm	w	2 km															
large array correction																	
Avoidance rates modelled	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	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	11.6			
	98.00%		0.00	0.00	0.00	0.03	0.19	0.01	0.00	0.00	0.00	0.00	0.00	0.2			

COLLISION RISK MODEL

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Value			Units			Value			Units			Value			Units		
Bird data						Windfarm data						Turbine data					
Species name	Lesser black-backed gull					Site name	Muingmore					Model	N163				
Bird length	L	0.6	m	Latitude	54.143	degrees	Hub height	98.5	m	No of turbines	T	13	Rotor radius	R	81.5	m	
Wingspan	W	1.45	m	No of turbines	13	Width of windfarm	w	2	km	No of blades	b	3	Rotation speed	Ω	8.8	rpm	
Bird flight speed	v	13.1	m s ⁻¹	Width of windfarm	2	km	Rotation speed	8.8	rpm	Max blade width	C	4.15	Blade pitch	λ	15	degrees	
Flight type, flapping or gliding	gliding					Risk height range	17-180					m					
% of flights upwind/downwind	50%					Nocturnal activity factor	f _{night}					0%					
Nocturnal activity ranking 1-5	1																
Nocturnal activity factor	f _{night}										0%						
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	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	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%	85.0%		
Collision rates before avoidance																	
			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?	w	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%		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%		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

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Bird data			Windfarm data			Turbine data		
	Value	Units		Value	Units		Value	Units
Species name	Mallard		Site name	Muingmore		Model	N163	
Bird length L	0.58	m	Latitude	54.143	degrees	Hub height	98.5	m
Wingspan W	0.9	m	No of turbines T	13		Rotor radius R	81.5	m
Bird flight speed v	22	m s ⁻¹	Width of windfarm w	2	km	No of blades b	3	
Flight type, flapping or gliding	flapping					Rotation speed Ω	8.8	rpm
% of flights upwind/downwind	50%	50%				Max blade width C	4.15	m
Nocturnal activity ranking 1-5	2					Blade pitch λ	15	degrees
Nocturnal activity factor f _{night}	25%					Risk height range	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		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades b	3													
Rotation speed Ω	8.8 rpm													
Rotor radius R	81.5 m													
Max blade width C	4.15 m													
Pitch λ	15 degrees													
Blade profile	see Blade profile sheet													
	Bird length l	0.58 m												
	Wingspan w	0.9 m												
	Bird flight speed v	22 m s ⁻¹												
	Flight type	flapping												
	% of flights upwind/downwind	50% 50%												
	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	0.00 0.00 0.00 0.98 0.65 0.00 0.00 0.68 0.00 0.00 0.00 0.00												year total 2

Stage E		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	No													
Width of windfarm w	2 km													
	large array correction													
Avoidance rates modelled		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%	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

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Value				Units				Value				Units			
Bird data				Windfarm data				Turbine data							
Species name	nd	white-fronted	goose	Site name	Muingmore	Model	N163								
Bird length	L	0.71	m	Latitude	54.143	Hub height	98.5	m							
Wingspan	W	1.47	m	No of turbines	T	13	Rotor radius	R	81.5	m					
Bird flight speed	v	16.1	m s ⁻¹	Width of windfarm	w	2	No of blades	b	3	Rotation speed	Ω	8.8	rpm		
Flight type, flapping or gliding		flapping					Max blade width	C	4.15	m	Blade pitch	λ	15	degrees	
% of flights upwind/downwind		50%	50%				Risk height range		17-180	m					
Nocturnal activity ranking 1-5		2													
Nocturnal activity factor	f _{night}	25%													

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			Bird length			Wingspan			Bird flight speed			Flight type		
No of blades	b	3	0.71	m	1.47	m	16.1	m s ⁻¹	flapping	50%	50%			
Rotation speed	Ω	8.8 rpm												
Rotor radius	R	81.5 m												
Max blade width	C	4.15 m												
Pitch	λ	15 degrees												
Blade profile		see Blade profile sheet												
		Single transit risk	upwind	6.89%	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	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			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													
Avoidance rates modelled		100.00%													
		100.00%													
		100.00%													
		99.80%	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
			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
			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
			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

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Bird data				Windfarm data				Turbine data			
	Value	Units		Value	Units	Value	Units	Value	Units	Value	Units
Species name	Peregrine falcon		Site name	Muingmore		Model	N163				
Bird length	L	0.42	m	Latitude	54.143	degrees	Hub height	98.5	m		
Wingspan	W	1.025	m	No of turbines	T	13	Rotor radius	R	81.5	m	
Bird flight speed	v	12.1	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3	
Flight type, flapping or gliding		flapping						Rotation speed	Ω	8.8	rpm
% of flights upwind/downwind		50%	50%					Max blade width	C	4.15	m
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees
Nocturnal activity factor	f _{night}	0%						Risk height range		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	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		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3												
Rotation speed	Ω	8.8	rpm											
Rotor radius	R	81.5	m											
Max blade width	C	4.15	m											
Pitch	λ	15	degrees											
Blade profile		see Blade profile sheet												
		Bird length	l	0.42	m									
		Wingspan	w	1.025	m									
		Bird flight speed	v	12.1	m s ⁻¹									
		Flight type		flapping										
		% of flights upwind/downwind		50%	50%									
		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												
			0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.62	0.16	0.28	0.00
														year total
														1

Stage E		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No												
Width of windfarm		2	km											
		large array correction												
			Collision rates allowing for avoidance											
Avoidance rates modelled		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
		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
		100.00%	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.62	0.16	0.28	0.00	1.3
		98.00%	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

		Value	Units			Value	Units			Value	Units			Value	Units		
Bird data		Species name	Common snipe		Windfarm data		Site name	Muingmore		Turbine data		Model	N163				
	Bird length	L	0.26	m		Latitude	54.143	degrees		Hub height	98.5	m					
	Wingspan	W	0.455	m		No of turbines	T	13		Rotor radius	R	81.5	m				
	Bird flight speed	v	16	m s ⁻¹		Width of windfarm	w	2	km	No of blades	b	3					
	Flight type, flapping or gliding		flapping							Rotation speed	Ω	8.8	rpm				
	% of flights upwind/downwind		50%	50%						Max blade width	C	4.15	m				
	Nocturnal activity ranking 1-5		2							Blade pitch	λ	15	degrees				
	Nocturnal activity factor	f _{night}	25%							Risk height range		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													0.0000	
	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		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	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	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%	85.0%	
		Collision rates before avoidance		0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
																year total	
																0	
Stage E		Allow for large array correction?	No														
	Width of windfarm	w	2	km													
		large array correction		100.00%	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
				100.00%													0.3
				100.00%													0.3
				100.00%													0.3
				98.00%													0.0

COLLISION RISK MODEL

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

		Value	Units			Value	Units			Value	Units					
Bird data				Windfarm data				Turbine data								
Species name		Common snipe		Site name		Muingmore		Model		N163						
Bird length	L	0.26	m	Latitude		54.143	degrees	Hub height		98.5	m					
Wingspan	W	0.455	m	No of turbines	T	13		Rotor radius	R	81.5	m					
Bird flight speed	v	16	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3						
Flight type, flapping or gliding		flapping						Rotation speed	Ω	8.8	rpm					
% of flights upwind/downwind		50%	50%					Max blade width	C	4.15	m					
Nocturnal activity ranking 1-5		2						Blade pitch	λ	15	degrees					
Nocturnal activity factor	f _{night}	25%						Risk height range		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																
Daytime bird density	D _A	birds/km ²	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
Proportion at rotor risk height	Q _{2R}	95.00%	0.000962	0.000192	0						0	0.006583	0.000676	0	0.0007	
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	16	m s ⁻¹	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
		Projected number of rotor transits	32.6	6.5	0.0	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																
Proportion of time operational	Q _{op}		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
			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														
Avoidance rates modelled			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year	
		Collision rates allowing for avoidance	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	
			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	
			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%	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
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Value					Units					Value					Units						
Bird data					Windfarm data					Turbine data											
Species name	Common snipe				Site name	Muingmore				Model	N163										
Bird length	L	0.26	m		Latitude	54.143 degrees				Hub height	98.5 m										
Wingspan	W	0.455	m		No of turbines	T	13				Rotor radius	R	81.5 m								
Bird flight speed	v	16	m s ⁻¹		Width of windfarm	w	2 km				No of blades	b	3								
Flight type, flapping or gliding	flapping				Rotation speed	Ω	8.8 rpm				Max blade width	C	4.15 m								
% of flights upwind/downwind	50%		50%		Blade pitch	λ	15 degrees				Risk height range	17-180 m									
Nocturnal activity ranking 1-5	2																				
Nocturnal activity factor	f _{night}	25%																			
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		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	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%	85.0%				
					Collision rates before avoidance																
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.90	0.46	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	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	0.90	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%				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
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Bird data				Windfarm data				Turbine data			
	Value	Units		Value	Units	Value	Units	Value	Units	Value	Units
Species name	Eurasian teal		Site name	Muingmore		Model	N163				
Bird length	L 0.39	m	Latitude	54.143	degrees	Hub height	98.5	m			
Wingspan	W 0.55	m	No of turbines	T 13		Rotor radius	R 81.5	m			
Bird flight speed	v 19.7	m s ⁻¹	Width of windfarm	w 2	km	No of blades	b 3				
Flight type, flapping or gliding	flapping					Rotation speed	Ω 8.8	rpm			
% of flights upwind/downwind	50%	50%				Max blade width	C 4.15	m			
Nocturnal activity ranking 1-5	2					Blade pitch	λ 15	degrees			
Nocturnal activity factor	f _{night} 25%					Risk height range	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		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	132.6	0.0	0.0	0.0	0.0	0.0	133

Stage C		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b 3													
Rotation speed	Ω 8.8 rpm													
Rotor radius	R 81.5 m													
Max blade width	C 4.15 m													
Pitch	λ 15 degrees													
Blade profile	see Blade profile sheet													
	Single transit risk													
	upwind													5.29%
	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%	85.0%
	Collision rates before avoidance													
		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		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													
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%	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



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
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Value				Units				Value				Units			
Bird data				Windfarm data				Turbine data							
Species name	Black-headed gull			Site name	Muingmore			Model	N149						
Bird length	L	0.355	m	Latitude	54.143 degrees			Hub height	104.5 m						
Wingspan	W	1.05	m	No of turbines	T	13		Rotor radius	R	74.5	m				
Bird flight speed	v	11.9	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3					
Flight type, flapping or gliding	flapping							Rotation speed	Ω	9.2	rpm				
% of flights upwind/downwind	50%							Max blade width	C	4.15	m				
Nocturnal activity ranking 1-5	1							Blade pitch	λ	15	degrees				
Nocturnal activity factor	f _{night}	0%						Risk height range	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														0.0003
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%										
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%	85.0%
	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				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No														
Width of windfarm	w	2	km													
	large array correction															
Avoidance rates modelled	98.00%			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
	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
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Value				Units		Value				Units	
Bird data				Windfarm data				Turbine data			
Species name	Black-headed gull			Site name	Muingmore			Model	N149		
Bird length	L	0.355	m	Latitude	54.143	degrees	Hub height	104.5	m		
Wingspan	W	1.05	m	No of turbines	T	13	Rotor radius	R	74.5	m	
Bird flight speed	v	11.9	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3	
Flight type, flapping or gliding	flapping							Rotation speed	Ω	9.2	rpm
% of flights upwind/downwind	50%		50%					Max blade width	C	4.15	m
Nocturnal activity ranking 1-5	1							Blade pitch	λ	15	degrees
Nocturnal activity factor	f _{night}	0%						Risk height range	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												0.0003
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%											
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%	85.0%
	Collision rates before avoidance		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			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														
Avoidance rates modelled	98.00%														
	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	0.00	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
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Value				Units		Value				Units	
Bird data				Windfarm data				Turbine data			
Species name	Black-headed gull			Site name	Muingmore			Model	N149		
Bird length	L	0.355	m	Latitude	54.143 degrees			Hub height	104.5	m	
Wingspan	W	1.05	m	No of turbines	T	13		Rotor radius	R	74.5	m
Bird flight speed	v	11.9	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3	
Flight type, flapping or gliding	flapping							Rotation speed	Ω	9.2	rpm
% of flights upwind/downwind	50%		50%					Max blade width	C	4.15	m
Nocturnal activity ranking 1-5	1							Blade pitch	λ	15	degrees
Nocturnal activity factor	f _{night}	0%						Risk height range	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												0.0014
Proportion at rotor risk height	Q _{2R}	17.49%	0												0.0014
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			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3													
Rotation speed	Ω	9.2 rpm													
Rotor radius	R	74.5 m													
Max blade width	C	4.15 m													
Pitch	λ	15 degrees													
Blade profile	see Blade profile sheet														
	Bird length		0.355 m												
	Wingspan		1.05 m												
	Bird flight speed		11.9 m s ⁻¹												
	Flight type		flapping												
	% of flights upwind/downwind		50%												
	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		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			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														
Avoidance rates modelled	98.00%		Collision rates allowing for avoidance												
	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	0.00	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
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		Value	Units			Value	Units			Value	Units					
Bird data				Windfarm data				Turbine data								
Species name		Black-headed gull		Site name		Muingmore		Model		N149						
Bird length	L	0.355	m	Latitude		54.143	degrees	Hub height		104.5	m					
Wingspan	W	1.05	m	No of turbines	T	13		Rotor radius	R	74.5	m					
Bird flight speed	v	11.9	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3						
Flight type, flapping or gliding		flapping						Rotation speed	Ω	9.2	rpm					
% of flights upwind/downwind		50%	50%					Max blade width	C	4.15	m					
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees					
Nocturnal activity factor	f _{night}	0%						Risk height range		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																
Daytime bird density	D _A	birds/km ²	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year ave	
Proportion at rotor risk height	Q _{2R}	85.71%	0	0	0						0	0	0.0000576	0	0.0000	
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	11.9	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	0.8	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																
Proportion of time operational	Q _{op}		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year ave	
			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	0.00	0.00	0.00	0.00	0.04	0.00	
			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	
Stage E																
Allow for large array correction?		No														
Width of windfarm	w	2	km													
		large array correction														
Avoidance rates modelled		98.00%	100.00%	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			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	0.00	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
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Value				Units				Value				Units				
Bird data				Windfarm data				Turbine data								
Species name		Common gull		Site name		Muingmore		Model		N149						
Bird length	L	0.41	m	Latitude		54.143	degrees	Hub height		104.5	m					
Wingspan	W	1.15	m	No of turbines	T	13		Rotor radius	R	74.5	m					
Bird flight speed	v	13.4	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3						
Flight type, flapping or gliding		flapping						Rotation speed	Ω	9.2	rpm					
% of flights upwind/downwind		50%	50%					Max blade width	C	4.15	m					
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees					
Nocturnal activity factor	f _{night}	0%						Risk height range		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													0.0004
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			Bird length			Wingspan			Bird flight speed			Flight type		
No of blades	b	3	0.41 m			1.15 m			13.4 m s ⁻¹			flapping		
Rotation speed	Ω	9.2 rpm							50%					
Rotor radius	R	74.5 m												
Max blade width	C	4.15 m												
Pitch	λ	15 degrees												
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													
			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			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													
Avoidance rates modelled		98.00%													
		100.00%													
		100.00%													
		100.00%													
		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
			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
			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
			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

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Value				Units				Value				Units				
Bird data				Windfarm data				Turbine data								
Species name		Common gull		Site name		Muingmore		Model		N149						
Bird length	L	0.41	m	Latitude		54.143	degrees	Hub height		104.5	m					
Wingspan	W	1.15	m	No of turbines	T	13		Rotor radius	R	74.5	m					
Bird flight speed	v	13.4	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3						
Flight type, flapping or gliding		flapping						Rotation speed	Ω	9.2	rpm					
% of flights upwind/downwind		50%	50%					Max blade width	C	4.15	m					
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees					
Nocturnal activity factor	f _{night}	0%						Risk height range		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												0.0001
Proportion at rotor risk height	Q _{2R}	85.71%	0												
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			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3													
Rotation speed	Ω	9.2 rpm													
Rotor radius	R	74.5 m													
Max blade width	C	4.15 m													
Pitch	λ	15 degrees													
Blade profile		see Blade profile sheet													
		Bird length	0.41 m												
		Wingspan	1.15 m												
		Bird flight speed	13.4 m s ⁻¹												
		Flight type	flapping												
		% of flights upwind/downwind	50%												
		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%
		Collision rates before avoidance	0.00												
			0.00	0.00	0.00	0.00	0.00	0.00	1.58	0.00	0.00	0.00	0.00	0.00	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													
Avoidance rates modelled		98.00%	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
		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

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Value			Units	Value			Units	Value			Units				
Bird data				Windfarm data				Turbine data							
Species name	Common tern			Site name	Muingmore			Model	N149						
Bird length	L	0.33	m	Latitude	54.143 degrees			Hub height	104.5 m						
Wingspan	W	0.875	m	No of turbines	T	13		Rotor radius	R	74.5	m				
Bird flight speed	v	10.2	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3					
Flight type, flapping or gliding	flapping			Rotation speed	Ω	9.2	rpm	Max blade width	C	4.15	m				
% of flights upwind/downwind	50% 50%			Blade pitch	λ	15	degrees	Risk height range	30-179 m						
Nocturnal activity ranking 1-5	1														
Nocturnal activity factor	f _{night}	0%													
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												
Proportion at rotor risk height	Q _{2R}	85.71%	0.00011												
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	0.0												
Rotor radius	R	74.5 m	0.0												
Total rotor frontal area	m ²		226676												
Nocturnal activity factor	f _{night}	0%	0.0												
Bird flight speed	v	10.2 m s ⁻¹	0.0												
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			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3	0.0												
Rotation speed	Ω	9.2 rpm	0.0												
Rotor radius	R	74.5 m	0.0												
Max blade width	C	4.15 m	0.0												
Pitch	λ	15 degrees	0.0												
Blade profile	see Blade profile sheet			0.0											
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%												
Stage E			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
Allow for large array correction?	No		0.00												
Width of windfarm	w	2 km	0.00												
Avoidance rates modelled	large array correction		0.12												
	100.00%		0.00												
	100.00%		0.00												
	100.00%		0.00												
	98.00%		0.00												
	100.00%		0.00												

COLLISION RISK MODEL

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Value				Units				Value				Units				
Bird data				Windfarm data				Turbine data								
Species name		Herring gull		Site name		Muingmore		Model		N149						
Bird length	L	0.61	m	Latitude		54.143	degrees	Hub height		104.5	m					
Wingspan	W	1.465	m	No of turbines	T	13		Rotor radius	R	74.5	m					
Bird flight speed	v	12.8	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3						
Flight type, flapping or gliding		gliding						Rotation speed	Ω	9.2	rpm					
% of flights upwind/downwind		50%						Max blade width	C	4.15	m					
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees					
Nocturnal activity factor	f _{night}	0%						Risk height range		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												0.0001
Proportion at rotor risk height	Q _{2R}	85.71%	0												0.0001
At latitude 54.1			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
			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	0												53
Rotor radius	R	74.5 m	0												53
Total rotor frontal area	m ²	226676	0												53
Nocturnal activity factor	f _{night}	0%	0												53
Bird flight speed	v	12.8 m s ⁻¹	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
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			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3	0												3
Rotation speed	Ω	9.2 rpm	0												3
Rotor radius	R	74.5 m	0												3
Max blade width	C	4.15 m	0												3
Pitch	λ	15 degrees	0												3
Blade profile		see Blade profile sheet	0												3
Bird length	l	0.61 m	0												3
Wingspan	w	1.465 m	0												3
Bird flight speed	v	12.8 m s ⁻¹	0												3
Flight type		gliding	0												3
% of flights upwind/downwind		50% 50%	0												3
Single transit risk			0												3
upwind		7.75%	0												3
downwind		3.84%	0												3
weighted mean		5.80%	0												3

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	1.50	1.10	0.00	0.00	0.00	0.00	0.00	3

Stage E			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No	0												3
Width of windfarm	w	2 km	0												3
large array correction			0												3
Collision rates allowing for avoidance			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
Avoidance rates modelled			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
			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%	0.00	0.00	0.00	0.00	0.00	0.03	0.02	0.00	0.00	0.00	0.00	0.1	

COLLISION RISK MODEL

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

Bird data				Windfarm data				Turbine data			
	Value	Units		Value	Units	Value	Units	Value	Units	Value	Units
Species name	Herring gull		Site name	Muingmore		Model	N149				
Bird length	L	0.61	m	Latitude	54.143	degrees	Hub height	104.5	m		
Wingspan	W	1.465	m	No of turbines	T	13	Rotor radius	R	74.5	m	
Bird flight speed	v	12.8	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3	
Flight type, flapping or gliding		gliding					Rotation speed	Ω	9.2	rpm	
% of flights upwind/downwind		50%					Max blade width	C	4.15	m	
Nocturnal activity ranking 1-5		1					Blade pitch	λ	15	degrees	
Nocturnal activity factor	f _{night}	0%					Risk height range		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												0.0001
Proportion at rotor risk height	Q _{2R}	83.36%												0.0001
At latitude 54.1		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
		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												
		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		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3												
Rotation speed	Ω	9.2 rpm												
Rotor radius	R	74.5 m												
Max blade width	C	4.15 m												
Pitch	λ	15 degrees												
Blade profile		see Blade profile sheet												
		Bird length l 0.61 m												
		Wingspan w 1.465 m												
		Bird flight speed v 12.8 m s ⁻¹												
		Flight type gliding												
		% of flights upwind/downwind 50% 50%												
		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%
		Collision rates before avoidance												
		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												
Avoidance rates modelled		Collision rates allowing for avoidance												
		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
		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
		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
		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				Windfarm data				Turbine data			
	Value	Units		Value	Units	Value	Units	Value	Units	Value	Units
Species name	Herring gull		Site name	Muingmore		Model	N149				
Bird length	L	0.61	m	Latitude	54.143	degrees	Hub height	104.5	m		
Wingspan	W	1.465	m	No of turbines	T	13	Rotor radius	R	74.5	m	
Bird flight speed	v	12.8	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3	
Flight type, flapping or gliding		gliding					Rotation speed	Ω	9.2	rpm	
% of flights upwind/downwind		50%					Max blade width	C	4.15	m	
Nocturnal activity ranking 1-5		1					Blade pitch	λ	15	degrees	
Nocturnal activity factor	f _{night}	0%					Risk height range		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	0.000359												0.0011
Proportion at rotor risk height	Q _{2R}	85.71%												
At latitude 54.1		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
		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												
		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		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3												
Rotation speed	Ω	9.2 rpm												
Rotor radius	R	74.5 m												
Max blade width	C	4.15 m												
Pitch	λ	15 degrees												
Blade profile		see Blade profile sheet												
		Bird length l 0.61 m												
		Wingspan w 1.465 m												
		Bird flight speed v 12.8 m s ⁻¹												
		Flight type gliding												
		% of flights upwind/downwind 50% 50%												
		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%
		Collision rates before avoidance												
		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		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												
Avoidance rates modelled		Collision rates allowing for avoidance												
		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
		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
		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
		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

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Value				Units				Value				Units				
Bird data				Windfarm data				Turbine data								
Species name		Herring gull		Site name		Muingmore		Model		N149						
Bird length	L	0.61	m	Latitude		54.143	degrees	Hub height		104.5	m					
Wingspan	W	1.465	m	No of turbines	T	13		Rotor radius	R	74.5	m					
Bird flight speed	v	12.8	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3						
Flight type, flapping or gliding		gliding						Rotation speed	Ω	9.2	rpm					
% of flights upwind/downwind		50%						Max blade width	C	4.15	m					
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees					
Nocturnal activity factor	f _{night}	0%						Risk height range		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	0.0	7.4	0.0
Stage C				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3														
Rotation speed	Ω	9.2	rpm													
Rotor radius	R	74.5	m													
Max blade width	C	4.15	m													
Pitch	λ	15	degrees													
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														
				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				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No														
Width of windfarm	w	2	km													
		large array correction														
		Collision rates allowing for avoidance														
Avoidance rates modelled				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.00	0.4
				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
				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

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Bird data				Windfarm data				Turbine data			
	Value	Units		Value	Units	Value	Units	Value	Units	Value	Units
Species name	Hen harrier		Site name	Muingmore		Model	N149				
Bird length	L	0.48	m	Latitude	54.143	degrees	Hub height	104.5	m		
Wingspan	W	1.1	m	No of turbines	T	13	Rotor radius	R	74.5	m	
Bird flight speed	v	8	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3	
Flight type, flapping or gliding		gliding						Rotation speed	Ω	9.2	rpm
% of flights upwind/downwind		50%						Max blade width	C	4.15	m
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees
Nocturnal activity factor	f _{night}	0%						Risk height range		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												0.0001
Proportion at rotor risk height	Q _{2R}	0												0.000694
At latitude 54.1		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
		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												
		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		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3												
Rotation speed	Ω	9.2 rpm												
Rotor radius	R	74.5 m												
Max blade width	C	4.15 m												
Pitch	λ	15 degrees												
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%
		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	1

Stage E		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No												
Width of windfarm	w	2 km												
		large array correction												
		Collision rates allowing for avoidance												
Avoidance rates modelled		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.7
		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
		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
		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

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Value				Units		Value				Units				
Bird data				Windfarm data				Turbine data						
Species name	Common kestrel			Site name	Muingmore			Model	N149					
Bird length	L	0.34	m	Latitude	54.143	degrees	Hub height	104.5	m					
Wingspan	W	0.755	m	No of turbines	T	13	Rotor radius	R	74.5	m				
Bird flight speed	v	12.7	m s ⁻¹	Width of windfarm	w	2	No of blades	b	3	Rotation speed	Ω	9.2	rpm	
Flight type, flapping or gliding	flapping						Max blade width	C	4.15	m	Blade pitch	λ	15	degrees
% of flights upwind/downwind	50%													
Nocturnal activity ranking 1-5	1													
Nocturnal activity factor	f _{night}	0%					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	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	82.3	9.8	23.9	22.6	59.9	0.0	0.0	0.0	0.0	199	

Stage C				Bird length				Wingspan				Bird flight speed				Flight type			
No of blades	b	3		0.34				0.755				12.7				flapping			
Rotation speed	Ω	9.2 rpm																	
Rotor radius	R	74.5 m																	
Max blade width	C	4.15 m																	
Pitch	λ	15 degrees																	
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		0.00	0.00	0.00	3.39	0.40	0.98	0.93	2.46	0.00	0.00	0.00	0.00	year total	
			8													

Stage E				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No														
Width of windfarm	w	2	km													
	large array correction															
Avoidance rates modelled	95.00%		100.00%	Collision rates allowing for avoidance			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	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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Value			Units	Value			Units	Value			Units
Bird data				Windfarm data				Turbine data			
Species name	Common kestrel			Site name	Muingmore			Model	N149		
Bird length	L	0.34	m	Latitude	54.143	degrees	Hub height	104.5	m		
Wingspan	W	0.755	m	No of turbines	T	13	Rotor radius	R	74.5	m	
Bird flight speed	v	12.7	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3	
Flight type, flapping or gliding		flapping						Rotation speed	Ω	9.2	rpm
% of flights upwind/downwind		50%	50%					Max blade width	C	4.15	m
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees
Nocturnal activity factor	f _{night}	0%						Risk height range		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			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3													
Rotation speed	Ω	9.2 rpm													
Rotor radius	R	74.5 m													
Max blade width	C	4.15 m													
Pitch	λ	15 degrees													
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%	
		Collision rates before avoidance													
			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			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													
Avoidance rates modelled		95.00%													
		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	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
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Value			Units	Value			Units	Value			Units					
Bird data				Windfarm data				Turbine data								
Species name	Common kestrel			Site name	Muingmore			Model	N149							
Bird length	L	0.34	m	Latitude	54.143 degrees			Hub height	104.5 m							
Wingspan	W	0.755	m	No of turbines	T	13		Rotor radius	R	74.5 m						
Bird flight speed	v	12.7	m s ⁻¹	Width of windfarm	w	2 km		No of blades	b	3						
Flight type, flapping or gliding	flapping			Rotation speed	Ω	9.2 rpm		Max blade width	C	4.15 m						
% of flights upwind/downwind	50%			Blade pitch	λ	15 degrees		Risk height range	30-179 m							
Nocturnal activity ranking 1-5	1															
Nocturnal activity factor	f _{night}	0%														
normal approach				Set to 'normal approach' to use survey data on bird density Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A												
Stage A				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year ave
Daytime bird density	D _A	birds/km ²		0.000377 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	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	9.4	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%											
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 ave
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%	85.0%
Collision rates before avoidance																
				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
Avoidance rates modelled	95.00%			Collision rates allowing for avoidance												
	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 0.00 0.00 0.00 16.7													
	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 0.00 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 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 0.00 0.00 0.00 16.7													

COLLISION RISK MODEL

Required input data is in orange boxes
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Value			Units	Value			Units	Value			Units
Bird data				Windfarm data				Turbine data			
Species name	Common kestrel			Site name	Muingmore			Model	N149		
Bird length	L	0.34	m	Latitude	54.143	degrees		Hub height	104.5	m	
Wingspan	W	0.755	m	No of turbines	T	13		Rotor radius	R	74.5	m
Bird flight speed	v	12.7	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3	
Flight type, flapping or gliding		flapping						Rotation speed	Ω	9.2	rpm
% of flights upwind/downwind		50%	50%					Max blade width	C	4.15	m
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees
Nocturnal activity factor	f _{night}	0%						Risk height range		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	0.000805	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			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3													
Rotation speed	Ω	9.2 rpm													
Rotor radius	R	74.5 m													
Max blade width	C	4.15 m													
Pitch	λ	15 degrees													
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															
			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			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													
Avoidance rates modelled		95.00%													
		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%	0.02	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

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Value			Units	Value			Units	Value			Units											
Bird data				Windfarm data				Turbine data														
Species name	Common kestrel			Site name	Muingmore			Model	N149													
Bird length	L	0.34	m	Latitude	54.143 degrees			Hub height	104.5 m													
Wingspan	W	0.755	m	No of turbines	T	13		Rotor radius	R	74.5 m												
Bird flight speed	v	12.7	m s ⁻¹	Width of windfarm	w	2 km		No of blades	b	3												
Flight type, flapping or gliding	flapping			Rotation speed	Ω	9.2 rpm		Max blade width	C	4.15 m												
% of flights upwind/downwind	50%			Blade pitch	λ	15 degrees		Risk height range	30-179 m													
Nocturnal activity ranking 1-5	1																					
Nocturnal activity factor	f _{night}	0%																				
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																						
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	0.0	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%																	
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%						
	Collision rates before avoidance																					
				4.14	0.61	1.74	0.00	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																					
Avoidance rates modelled	95.00%			100.00%			100.00%			100.00%			100.00%			6.8						
				100.00%			100.00%			100.00%			100.00%			0.3						
				100.00%			100.00%			100.00%			100.00%			6.8						
				100.00%			100.00%			100.00%			100.00%			6.8						

COLLISION RISK MODEL

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Value			Units	Value			Units	Value			Units					
Bird data				Windfarm data				Turbine data								
Species name	Common kestrel			Site name	Muingmore			Model	N149							
Bird length	L	0.34	m	Latitude	54.143 degrees			Hub height	104.5 m							
Wingspan	W	0.755	m	No of turbines	T	13		Rotor radius	R	74.5 m						
Bird flight speed	v	12.7	m s ⁻¹	Width of windfarm	w	2 km		No of blades	b	3						
Flight type, flapping or gliding	flapping			Rotation speed	Ω	9.2 rpm		Max blade width	C	4.15 m						
% of flights upwind/downwind	50%			Blade pitch	λ	15 degrees		Risk height range	30-179 m							
Nocturnal activity ranking 1-5	1															
Nocturnal activity factor	f _{night}	0%														
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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
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%											
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%	85.0%
Collision rates before avoidance																
				0.00	0.53	0.52	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.23	0.17	year total
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
Avoidance rates modelled	large array correction			Collision rates allowing for avoidance												
	100.00%		0.00													
	100.00%		0.00													
	100.00%		0.00													
	100.00%		0.00													
	95.00%		0.00													
	100.00%		0.53													
	100.00%		0.52													
	100.00%		0.00													
	100.00%		0.00													
	100.00%		0.00													
	100.00%		0.00													
	100.00%		0.14													
	100.00%		0.00													
	100.00%		0.23													
	100.00%		0.17													
	100.00%		1.6													
	100.00%		0.1													
	100.00%		1.6													
	100.00%		1.6													

COLLISION RISK MODEL

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Value			Units	Value			Units	Value			Units
Bird data				Windfarm data				Turbine data			
Species name	Lesser black-backed gull			Site name	Muingmore			Model	N149		
Bird length	L	0.6	m	Latitude	54.143	degrees		Hub height	104.5	m	
Wingspan	W	1.45	m	No of turbines	T	13		Rotor radius	R	74.5	m
Bird flight speed	v	13.1	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3	
Flight type, flapping or gliding	gliding							Rotation speed	Ω	9.2	rpm
% of flights upwind/downwind	50%							Max blade width	C	4.15	m
Nocturnal activity ranking 1-5	1							Blade pitch	λ	15	degrees
Nocturnal activity factor	f _{night}	0%						Risk height range	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			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	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			Bird length		Wingspan		Bird flight speed		Flight type	
No of blades	b	3	l	0.6	w	1.45	v	13.1	gliding	50%
Rotation speed	Ω	9.2 rpm							50%	
Rotor radius	R	74.5 m								
Max blade width	C	4.15 m								
Pitch	λ	15 degrees								
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%	85.0%
	Collision rates before avoidance		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			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No													
Width of windfarm	w	2 km													
	large array correction		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Avoidance rates modelled			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
			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
			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%		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
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Value			Units			Value			Units			Value			Units		
Bird data						Windfarm data						Turbine data					
Species name	Lesser black-backed gull					Site name	Muingmore					Model	N149				
Bird length	L	0.6	m	Latitude	54.143	degrees	Hub height	104.5	m	No of turbines	T	13	Rotor radius	R	74.5	m	
Wingspan	W	1.45	m	No of turbines	13	Width of windfarm	w	2	km	No of blades	b	3	Rotation speed	Ω	9.2	rpm	
Bird flight speed	v	13.1	m s ⁻¹	Width of windfarm	2	km	Rotation speed	9.2	rpm	Max blade width	C	4.15	Blade pitch	λ	15	degrees	
Flight type, flapping or gliding	gliding					Rotation speed	9.2	rpm	Max blade width	C	4.15	Blade pitch	λ	15	degrees		
% of flights upwind/downwind	50%					Max blade width	C	4.15	Blade pitch	λ	15	degrees					
Nocturnal activity ranking 1-5	1					Blade pitch	λ	15	degrees								
Nocturnal activity factor	f _{night}	0%	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												0.0000		
Proportion at rotor risk height	Q _{2R}	78.91%	0												0		
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	0.0												14		
Rotor radius	R	74.5 m	0.0												0.0		
Total rotor frontal area	m ²		226676														
Nocturnal activity factor	f _{night}	0%	0.0												0.0		
Bird flight speed	v	13.1 m s ⁻¹	0.0												13.6		
Projected number of rotor transits			0.0												0.0		
Stage C			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total		
No of blades	b	3	0.0												0.0		
Rotation speed	Ω	9.2 rpm	0.0												0.0		
Rotor radius	R	74.5 m	0.0												0.0		
Max blade width	C	4.15 m	0.0												0.0		
Pitch	λ	15 degrees	0.0												0.0		
Blade profile	see Blade profile sheet		0.0												0.0		
Bird length	l	0.6 m	0.0												0.0		
Wingspan	w	1.45 m	0.0												0.0		
Bird flight speed	v	13.1 m s ⁻¹	0.0												0.0		
Flight type	gliding		0.0												0.0		
% of flights upwind/downwind	50% 50%		0.0												0.0		
Single transit risk	upwind		0.0												7.63%		
	downwind		0.0												3.78%		
	weighted mean		0.0												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%		
Collision rates before avoidance			0.00												0.66		
Collision rates allowing for avoidance			0.00												0.00		
Stage E			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year		
Allow for large array correction?	w	No	0.00												0.00		
Width of windfarm	w	2 km	0.00												0.00		
large array correction			0.00												0.00		
Avoidance rates modelled	100.00%		0.00												0.66		
	100.00%		0.00												0.00		
	100.00%		0.00												0.66		
	100.00%		0.00												0.00		
	98.00%		0.00												0.01		

COLLISION RISK MODEL

Required input data is in orange boxes
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Bird data				Windfarm data				Turbine data			
	Value	Units		Value	Units	Value	Units	Value	Units	Value	Units
Species name	Mallard		Site name	Muingmore		Model	N149				
Bird length	L 0.58	m	Latitude	54.143	degrees	Hub height	104.5	m			
Wingspan	W 0.9	m	No of turbines	T 13		Rotor radius	R 74.5	m			
Bird flight speed	v 22	m s ⁻¹	Width of windfarm	w 2	km	No of blades	b 3				
Flight type, flapping or gliding	flapping					Rotation speed	Ω 9.2	rpm			
% of flights upwind/downwind	50%	50%				Max blade width	C 4.15	m			
Nocturnal activity ranking 1-5	2					Blade pitch	λ 15	degrees			
Nocturnal activity factor	f _{night} 25%					Risk height range	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		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b 3													
Rotation speed	Ω 9.2 rpm													
Rotor radius	R 74.5 m													
Max blade width	C 4.15 m													
Pitch	λ 15 degrees													
Blade profile	see Blade profile sheet													
	Bird length	0.58 m												
	Wingspan	0.9 m												
	Bird flight speed	22 m s ⁻¹												
	Flight type	flapping												
	% of flights upwind/downwind	50% 50%												
	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	0.00 0.00 0.00 0.77 0.56 0.00 0.00 0.61 0.00 0.00 0.00 0.00												year total 2

Stage E		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	No													
Width of windfarm	w 2 km													
	large array correction													
Avoidance rates modelled		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%	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

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Bird data			Windfarm data			Turbine data		
	Value	Units		Value	Units		Value	Units
Species name	Mallard		Site name	Muingmore		Model	N149	
Bird length	L 0.58	m	Latitude	54.143	degrees	Hub height	104.5	m
Wingspan	W 0.9	m	No of turbines	T 13		Rotor radius	R 74.5	m
Bird flight speed	v 22	m s ⁻¹	Width of windfarm	w 2	km	No of blades	b 3	
Flight type, flapping or gliding	flapping					Rotation speed	Ω 9.2	rpm
% of flights upwind/downwind	50%	50%				Max blade width	C 4.15	m
Nocturnal activity ranking 1-5	2					Blade pitch	λ 15	degrees
Nocturnal activity factor	f _{night} 25%					Risk height range	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												0.0003
Proportion at rotor risk height	Q _{2R} 83.81%	0.000312												
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		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b 3													
Rotation speed	Ω 9.2 rpm													
Rotor radius	R 74.5 m													
Max blade width	C 4.15 m													
Pitch	λ 15 degrees													
Blade profile	see Blade profile sheet													
	Bird length	0.58 m												
	Wingspan	0.9 m												
	Bird flight speed	22 m s ⁻¹												
	Flight type	flapping												
	% of flights upwind/downwind	50% 50%												
	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%
	Collision rates before avoidance	0.00												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		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													
Avoidance rates modelled		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%	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

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Value				Units				Value				Units				
Bird data				Windfarm data				Turbine data								
Species name	nd	white-fronted	goose	Site name	Muingmore			Model	N149							
Bird length	L	0.71	m	Latitude	54.143	degrees	Hub height	104.5	m							
Wingspan	W	1.47	m	No of turbines	T	13	Rotor radius	R	74.5	m						
Bird flight speed	v	16.1	m s ⁻¹	Width of windfarm	w	2	No of blades	b	3	Rotation speed	Ω	9.2	rpm			
Flight type, flapping or gliding	flapping						Max blade width	C	4.15	m						
% of flights upwind/downwind	50%		50%				Blade pitch	λ	15	degrees						
Nocturnal activity ranking 1-5	2						Risk height range	30-179		m						
Nocturnal activity factor	f _{night}	25%														

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			Bird length			Wingspan			Bird flight speed			Flight type				
No of blades	b	3	0.71 m			1.47 m			16.1 m s ⁻¹			flapping				
Rotation speed	Ω	9.2 rpm										50%				
Rotor radius	R	74.5 m														
Max blade width	C	4.15 m														
Pitch	λ	15 degrees														
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%
	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			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
Allow for large array correction?	w	No													
Width of windfarm	w	2 km													
	large array correction														
Avoidance rates modelled	100.00%		Collision rates allowing for avoidance		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%		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

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Bird data				Windfarm data				Turbine data			
	Value	Units		Value	Units	Value	Units	Value	Units	Value	Units
Species name	Peregrine falcon		Site name	Muingmore		Model	N149				
Bird length	L	0.42	m	Latitude	54.143	degrees	Hub height	104.5	m		
Wingspan	W	1.025	m	No of turbines	T	13	Rotor radius	R	74.5	m	
Bird flight speed	v	12.1	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3	
Flight type, flapping or gliding		flapping						Rotation speed	Ω	9.2	rpm
% of flights upwind/downwind		50%	50%					Max blade width	C	4.15	m
Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees
Nocturnal activity factor	f _{night}	0%						Risk height range		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	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		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
		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		226676	m ²											
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		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3												
Rotation speed	Ω	9.2	rpm											
Rotor radius	R	74.5	m											
Max blade width	C	4.15	m											
Pitch	λ	15	degrees											
Blade profile		see Blade profile sheet												
Bird length	l	0.42	m											
Wingspan	w	1.025	m											
Bird flight speed	v	12.1	m s ⁻¹											
Flight type		flapping												
% of flights upwind/downwind		50%	50%											
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		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		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											
Avoidance rates modelled		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	1.0
		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	1.0
		98.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	1.0
		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
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		Value	Units			Value	Units			Value	Units					
Bird data				Windfarm data				Turbine data								
Species name		Common snipe		Site name		Muingmore		Model		N149						
Bird length	L	0.26	m	Latitude		54.143	degrees	Hub height		104.5	m					
Wingspan	W	0.455	m	No of turbines	T	13		Rotor radius	R	74.5	m					
Bird flight speed	v	16	m s ⁻¹	Width of windfarm	w	2	km	No of blades	b	3						
Flight type, flapping or gliding		flapping						Rotation speed	Ω	9.2	rpm					
% of flights upwind/downwind		50%	50%					Max blade width	C	4.15	m					
Nocturnal activity ranking 1-5		2						Blade pitch	λ	15	degrees					
Nocturnal activity factor	f _{night}	25%						Risk height range		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																
Daytime bird density	D _A	birds/km ²	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
Proportion at rotor risk height	Q _{2R}	85.71%	0.000945	0.000192	0						0	0.006076	0.000676	0	0.0007	
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																
Proportion of time operational	Q _{op}		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
			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	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	
Avoidance rates modelled		100.00%	Collision rates allowing for avoidance													
		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%	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				Windfarm data				Turbine data			
	Value	Units		Value	Units	Value	Units	Value	Units	Value	Units
Species name	Common snipe		Site name	Muingmore		Model	N149				
Bird length	L 0.26	m	Latitude	54.143	degrees	Hub height	104.5	m			
Wingspan	W 0.455	m	No of turbines	T 13		Rotor radius	R 74.5	m			
Bird flight speed	v 16	m s ⁻¹	Width of windfarm	w 2	km	No of blades	b 3				
Flight type, flapping or gliding	flapping					Rotation speed	Ω 9.2	rpm			
% of flights upwind/downwind	50%	50%				Max blade width	C 4.15	m			
Nocturnal activity ranking 1-5	2					Blade pitch	λ 15	degrees			
Nocturnal activity factor	f _{night} 25%					Risk height range	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		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b 3													
Rotation speed	Ω 9.2 rpm													
Rotor radius	R 74.5 m													
Max blade width	C 4.15 m													
Pitch	λ 15 degrees													
Blade profile	see Blade profile sheet													
	Single transit risk													
	upwind	5.82%												
	downwind	2.53%												
	weighted mean	4.18%												

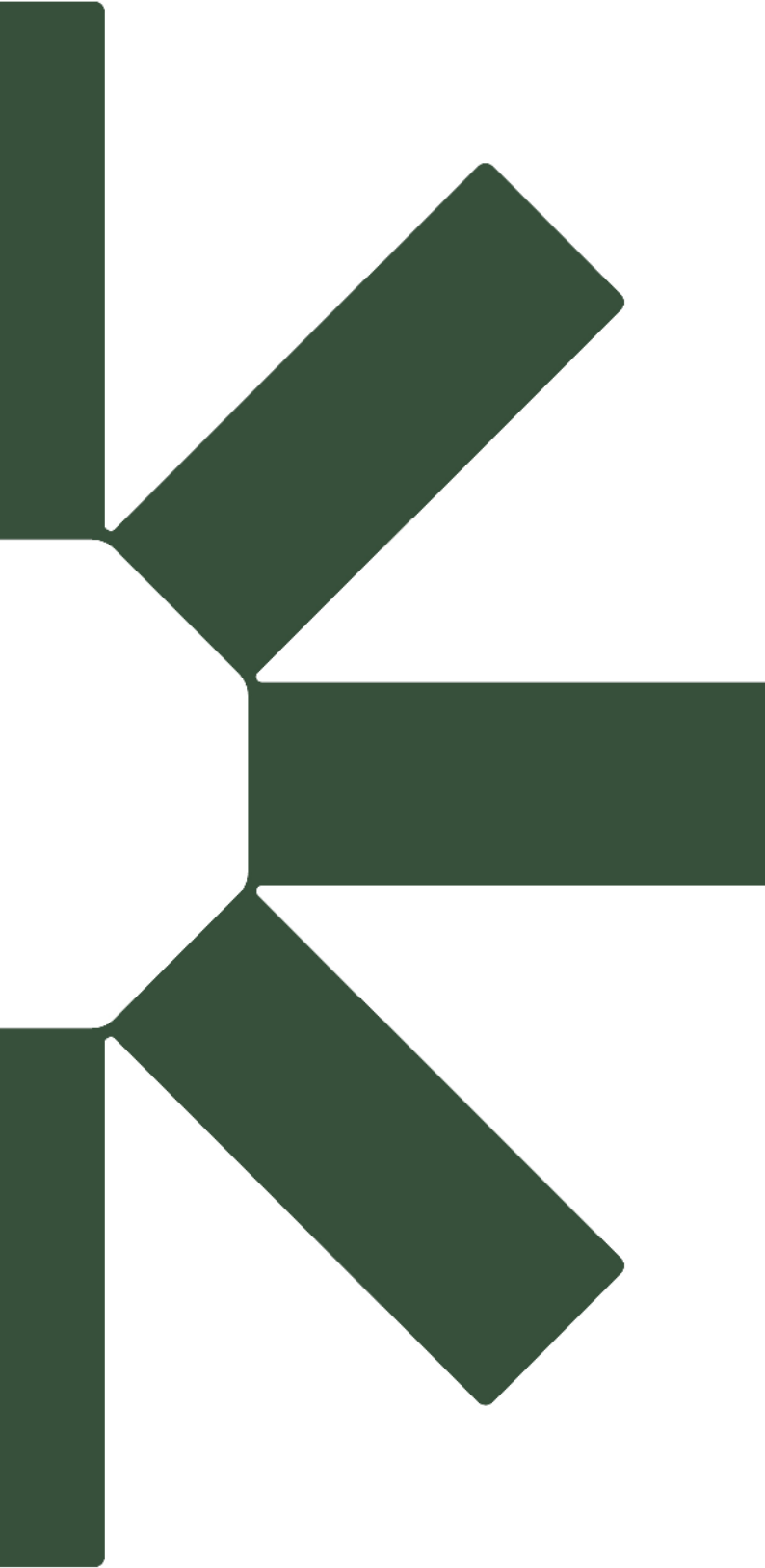
Stage D		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Q _{op} 85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%
	Collision rates before avoidance													
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.04	0.00	1

Stage E		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													
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%	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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		Value	Units			Value	Units			Value	Units			Value	Units		
Bird data		Species name	Eurasian teal	Windfarm data		Site name	Muingmore	Turbine data		Model	N149						
	Bird length	L	0.39	m		Latitude	54.143	degrees		Hub height	104.5	m					
	Wingspan	W	0.55	m		No of turbines	T	13		Rotor radius	R	74.5	m				
	Bird flight speed	v	19.7	m s ⁻¹		Width of windfarm	w	2	km	No of blades	b	3					
	Flight type, flapping or gliding		flapping							Rotation speed	Ω	9.2	rpm				
	% of flights upwind/downwind		50%	50%						Max blade width	C	4.15	m				
	Nocturnal activity ranking 1-5		2							Blade pitch	λ	15	degrees				
	Nocturnal activity factor	f _{night}	25%							Risk height range		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		Daytime bird density	D _A	birds/km ²	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
	Proportion at rotor risk height	Q _{2R}	85.71%					0	0	0	0.002053	0					0.0002
	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	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		Proportion of time operational	Q _{op}		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
					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	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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			large array correction														
	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%		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



Making Sustainability Happen