



Cush Wind Farm
Phase II

Environmental Impact Assessment Report

Annex 5.9: Avian Collision Risk Report

Cush Wind Limited



Avian Collision Risk Report

Cush Wind Farm Phase II

Cush Wind Limited

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Basis of Report

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Executive Summary

The aim of this report is to describe the collision risk modelling process undertaken for the Cush Wind Farm Phase II project in Co. Offaly, and to provide outputs such that any potentially significant collision-related effects on birds can be identified in the accompanying Environmental Impact Assessment (EIA) and Natura Impact Statement (NIS) reports. Modelling was undertaken using ornithological data collected by SLR between May 2022 and March 2024 for 14 bird species. The final turbine model has not yet been selected and will be chosen from within the turbine dimension range assessed for the Project. For the purposes of the CRM, two representative turbine permutations within that range were modelled: a minimum rotor diameter / maximum ground-clearance permutation, represented by the 'GE158' turbine, and a maximum rotor diameter / minimum ground-clearance permutation, represented by the 'E175' turbine.

These permutations were selected to represent the outer limits of rotor diameter and rotor ground clearance within the turbine dimension range and thereby assess the effect of differing rotor-swept areas and potential collision heights on predicted avian collision rates.

The collision risk model chosen was a random (i.e. non-directional) model and was implemented following NatureScot (2024) best-practice guidance. At the primary avoidance rates adopted, predicted collision rates were highest for European golden plover, followed by common kestrel, with all other species predicted to incur fewer than 0.21 or fewer collisions per year under either turbine permutation. Predicted collision rates were negligible for hen harrier and whooper swan. While the model outputs provide a theoretical estimate of collision risk, they do not directly reflect whether collision is likely to have significant effects on avian populations, which is addressed within the accompanying EIA and NIS reports. Furthermore, the modelling is subject to various limitations and qualifications, which are discussed in the report.



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Appendices

**Appendix A NatureScot Spreadsheets – 158m RD Representative Permutation
(GE158)**

**Appendix B NatureScot Spreadsheets – 175 m RD Representative Permutation
(E175)**



Acronyms and Abbreviations

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



1.0 Introduction

This report presents the results of Collision Risk Modelling (CRM) undertaken for 14 bird species to inform the assessment of potential ornithological effects associated with the proposed Cush Wind Farm Phase II (hereafter ‘the Project’), which comprises a 3 no. wind turbine extension to the permitted Cush Wind Farm Phase I.

The final turbine model has not yet been selected and will be chosen from within the turbine dimension range assessed for the Project. For the purposes of the CRM, two representative turbine permutations within that range have been modelled:

- **Minimum rotor diameter / maximum ground-clearance permutation** – represented by the GE158 turbine, comprising a rotor diameter of 158 m, an overall tip height of 199.9 m and a hub height of 120.9 m; and
- **Maximum rotor diameter / minimum ground-clearance permutation** – represented by the E175 turbine, comprising a rotor diameter of 175 m, an overall tip height of 199.1 m and a hub height of 111.6 m.

These permutations were selected to represent the outer limits of rotor diameter and rotor ground clearance within the turbine dimension range. The 158 m rotor diameter permutation provides the smallest rotor-swept area and greatest ground clearance, while the 175 m rotor diameter permutation provides the largest rotor-swept area and lowest ground clearance. These parameters influence the degree of overlap between the rotor-swept height range and the flight heights recorded for target bird species and, consequently, the level of exposure incorporated within the CRM.

Other turbine-specific parameters, including blade chord width and rotational speed, can also influence the calculated collision probability. These parameters have therefore been incorporated into the modelling using the specifications of the representative turbines assessed. The suitability of the selected permutations to represent the range of potential collision-risk outcomes is considered further within the methodology below.

The CRM was undertaken in accordance with current NatureScot (NS) guidance¹, which is recognised as established best-practice guidance for the assessment of avian collision risk associated with onshore wind energy development in Ireland and the UK. Further details of the methodology, including the assumptions and parameters applied within the modelling, are provided in Section 2.0. The modelling results are presented in Section 3.0, while copies of the modelling calculations for each species and representative turbine permutation are provided in Appendix A and Appendix B.



2.0 Methods

2.1 Statement of Authority

The modelling and report writing were conducted by Dr Jonathon Dunn MCIEEM. Jonathon is a Principal Ornithologist with SLR and has over 10 years' experience in the environmental sector and has completed CRM training delivered by the Chartered Institute of Ecology and Environmental Management (CIEEM). He has conducted CRMs for multiple 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 potentially vulnerable to impacts from wind farm developments. The following species were therefore considered relevant as primary target species:

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

2.3 Overview of CRM Process

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

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

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

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



- Stage E takes account of the proportion of birds likely to avoid the wind farm or its turbines, either because they have been displaced from the site or because they take evasive action or are attracted to the wind farm, e.g. in response to changing habitats.

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

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

The modelling was carried out using the spreadsheet supplied with the NS (2024) guidance. The data used for the different stages of CRM are outlined below.

2.4 Stage A

2.4.1 Viewshed Data

One vantage point (VP), VP3, was used for flight activity surveys. VP3 is the identifier used in the original survey records, the baseline survey reports and the associated mapping, and has been retained here for consistency with those documents.

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

Viewshed calculations were undertaken separately for each of the two representative turbine permutations because the differing rotor ground-clearance heights result in different areas of visibility from the VP.

For the minimum rotor diameter / maximum ground-clearance permutation (GE158), based on a lower rotor height of 41.9m, the visible area from VP3 is 2,045,553 m², representing 98.82% of the relevant wind farm polygon (2,070,079 m²).

For the maximum rotor diameter / minimum ground-clearance permutation (E175), based on a lower rotor height of 24.1 m, the visible area from VP3 is 2,087,642 m², representing 98.67% of the relevant wind farm polygon (2,115,782 m²).

Table 2-1: VP Viewshed Data

VP / Viewshed Number	ITM Coordinates (x,y)	Area of visibility ⁵ (m ²)	
		158 m RD permutation	175 m RD permutation
VP3	607798, 711305	2,045,553	2,087,642

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

⁵ Areas calculated in GIS using offset of 41.9 m and 24.1 m above ground level for the GE158 and E175 candidate turbines, respectively



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 October – March (non-breeding season).

2.4.3 Year 1 and Year 2 Flight Activity Survey Data

Flight activity data from the one VP described in Section 2.4.1 were collected during baseline surveys carried out by SLR during May 2022 to March 2024 over a period of two years, comprising two complete breeding and non-breeding periods, respectively.

The total number of hours of survey at each VP are as shown in Table 2-2, which meet the minimum of 144 hours per VP over a two-year period required by NS guidance².

Table 2-2: VP Surveys undertaken at the Project, May 2022 to March 2024

VP Number	Hours of Survey Completed per Survey Period				
	May – Aug 22	Oct 22 – Mar 23	Apr – Aug 23	Oct 23 – Mar 24	Total
3	36	36	36	36	144

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

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

Species	Survey Period	No. of Flight Lines	No. of Birds	Total Flying Time (s)	Time in height category (s)			
					HB1	HB2	HB3	HB4
Black-headed gull	Breeding 2022	68	230	3825	2985	840	0	0
	Breeding 2023	8	23	525	75	450	0	0
Common kestrel	Breeding 2022	31	31	4245	750	3495	0	0
	Non-breeding 2022/23	12	12	1365	330	1035	0	0
	Breeding 2023	9	9	1380	120	1260	0	0
	Non-breeding 2023/24	8	9	510	270	240	0	0
Common snipe	Breeding 2022	27	29	2820	1710	1110	0	0



Species	Survey Period	No. of Flight Lines	No. of Birds	Total Flying Time (s)	Time in height category (s)			
					HB1	HB2	HB3	HB4
	Non-breeding 2022/23	7	8	315	90	225	0	0
	Breeding 2023	13	17	1080	105	975	0	0
Eurasian teal	Breeding 2023	4	8	210	75	135	0	0
European golden plover	Non-breeding 2022/23	9	178	1560	270	1290	0	0
Great cormorant	Non-breeding 2022/23	2	2	120	90	30	0	0
Great white egret	Non-breeding 2022/23	1	1	15	15	0	0	0
Hen harrier	Non-breeding 2022/23	5	5	765	585	180	0	0
	Non-breeding 2023/24	2	2	225	225	0	0	0
Little egret	Breeding 2023	2	2	120	0	120	0	0
Mallard	Non-breeding 2022/23	1	5	135	30	105	0	0
	Breeding 2023	3	6	150	45	105	0	0
Merlin	Non-breeding 2022/23	4	4	150	105	45	0	0
Northern lapwing	Breeding 2022	95	154	3630	2880	750	0	0
	Non-breeding 2022/23	11	48	585	450	135	0	0
	Breeding 2023	17	25	870	495	375	0	0
	Non-breeding 2023/24	6	28	330	210	120	0	0



Species	Survey Period	No. of Flight Lines	No. of Birds	Total Flying Time (s)	Time in height category (s)			
					HB1	HB2	HB3	HB4
Peregrine falcon	Breeding 2022	4	4	285	45	240	0	0
	Non-breeding 2022/23	1	1	75	75	0	0	0
	Non-breeding 2023/24	1	1	60	60	0	0	0
Whooper swan	Non-breeding 2022/23	1	2	30	30	0	0	0

2.4.4 Flight Selection for CRM

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

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

The proportion of each flight line inside vs. outside the WP was also calculated using GIS.

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

2.4.5 Bird Density

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

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

The total flying time (aggregated across all survey height bands) of species taken forward to CRM is given in Table 2-4, split by survey period and VP number. As this step only involves flights within the WP, there may be some differences in Table 2-4 vs. Table 2-3, which displays all flights, regardless of whether they were within the WP or not.



2.4.5.1 Total Flying Time

Table 2-4: Total Flying Time within the WP

Species	Survey Period	Total Flying Time within the WP (bird-secs)	
		158 m RD permutation	175 m RD permutation
Black-headed gull	Breeding 2022	14273.43	14916.68
	Breeding 2023	3761.67	3761.67
Common kestrel	Breeding 2022	2190.00	2715.00
	Non-breeding 2022/23	797.50	797.50
	Breeding 2023	690.71	725.00
	Non-breeding 2023/24	24.00	24.00
Common snipe	Breeding 2022	2588.57	3150.00
	Non-breeding 2022/23	330.00	330.00
	Breeding 2023	1134.38	1134.38
Eurasian teal	Breeding 2023	435.00	435.00
European golden plover	Non-breeding 2022/23	54300.00	52260.00
Great cormorant	Non-breeding 2022/23	107.14	113.57
Great white egret	Non-breeding 2022/23	10.00	10.00
Hen harrier	Non-breeding 2022/23	765.00	765.00
	Non-breeding 2023/24	157.50	225.00
Little egret	Breeding 2023	120.00	120.00
Mallard	Non-breeding 2022/23	675.00	675.00
	Breeding 2023	450.00	450.00
Merlin	Non-breeding 2022/23	150.00	150.00
Northern lapwing	Breeding 2022	12248.38	12572.38
	Non-breeding 2022/23	2400.00	2400.00
	Breeding 2023	1225.00	1225.00



Species	Survey Period	Total Flying Time within the WP (bird-secs)	
		158 m RD permutation	175 m RD permutation
	Non-breeding 2023/24	1027.50	1155.00
Peregrine falcon	Breeding 2022	245.00	245.00
	Non-breeding 2022/23	58.33	58.33
	Non-breeding 2023/24	60.00	60.00
Whooper swan	Non-breeding 2022/23	60.00	60.00

2.4.5.2 Bird Density Results

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

These data were calculated for each month, VP number and survey period per species.

The results of this process are given in Table 2-5. Note only months with a density of >0 birds/km² are shown for brevity.

Note that as only one VP was used bird density could not be averaged across VPs as is typical for larger projects.

Table 2-5: Bird Density Results

Species	Survey Period	Month	Bird Density (birds / km ²)	
			158 m RD permutation	175 m RD permutation
Black-headed gull	Breeding 2022	May	1.53E-01	1.53E-01
		Jun	8.25E-03	1.24E-02
	Breeding 2023	Apr	5.53E-02	5.42E-02
		Jun	2.98E-02	2.92E-02
Common kestrel	Breeding 2022	May	5.77E-03	6.15E-03
		Jun	1.78E-02	2.28E-02
		Jul	2.38E-03	2.33E-03
	Non-breeding 2022/23	Jan	9.05E-04	8.87E-04
		Oct	1.03E-02	1.01E-.02
		Nov	5.69E-03	5.57E-03
		Dec	6.79E-04	6.65E-04
		Apr	4.19E-03	4.10E-03



Species	Survey Period	Month	Bird Density (birds / km ²)	
			158 m RD permutation	175 m RD permutation
	Breeding 2023	May	1.14E-02	1.20E-02
	Non-breeding 2023/24	Dec	5.43E-04	5.32E-04
Common snipe	Breeding 2022	May	1.70E-04	1.66E-04
		Jun	1.80E-02	1.76E-02
		Jul	2.23E-02	3.43E-02
	Non-breeding 2022/23	Jan	2.49E-03	2.44E-03
		Oct	3.06E-03	2.99E-03
		Dec	6.79E-04	6.65E-04
	Breeding 2023	May	1.24E-02	1.22E-02
		Jun	1.05E-02	1.03E-02
		Jul	1.36E-03	1.33E-03
Eurasian teal	Breeding 2023	Apr	9.85E-03	9.65E-03
European golden plover	Non-breeding 2022/23	Oct	1.23E+00	1.16E+00
Great cormorant	Non-breeding 2022/23	Dec	2.42E-03	2.52E-03
Great white egret	Non-breeding 2022/23	Oct	2.26E-04	2.22E-04
Hen harrier	Non-breeding 2022/23	Jan	1.15E-02	1.13E-02
	Non-breeding 2023/24	Feb	1.53E-03	2.99E-03
		Dec	2.04E-03	2.00E-03
Little egret	Breeding 2023	Jun	2.17E-02	2.13E-02
Mallard	Non-breeding 2022/23	Nov	2.29E-02	2.25E-02
	Breeding 2023	Apr	4.07E-03	3.99E-03
		May	4.07E-03	3.99E-03



Species	Survey Period	Month	Bird Density (birds / km ²)	
			158 m RD permutation	175 m RD permutation
		Jun	2.04E-03	2.00E-03
Merlin	Non-breeding 2022/23	Oct	3.39E-04	3.33E-04
		Nov	7.64E-04	7.48E-04
		Dec	1.39E-02	1.53E-02
Northern lapwing	Breeding 2022	May	2.93E-02	3.13E-02
		Jun	2.32E-02	2.28E-02
		Jul	1.72E-01	1.70E-01
	Non-breeding 2022/23	Nov	2.85E-02	2.79E-02
		Dec	2.58E-02	2.53E-02
	Breeding 2023	Apr	1.70E-03	1.66E-03
		May	5.43E-03	5.32E-03
		Jun	9.17E-03	8.98E-03
		Jul	2.55E-03	2.49E-03
		Aug	6.34E-03	6.21E-03
	Non-breeding 2023/24	Feb	1.48E-02	1.73E-02
		Mar	8.49E-03	8.32E-03
Peregrine falcon	Breeding 2022	Jun	1.24E-03	1.22E-03
		Jul	3.06E-03	2.99E-03
	Non-breeding 2022/23	Nov	1.32E-03	1.29E-03
	Non-breeding 2023/24	Feb	4.07E-03	1.33E-03
Whooper swan	Non-breeding 2022/23	Jan	9.05E-04	8.87E-04

2.4.6 Proportion of Birds Flying at Risk Height

The baseline surveys in year 1 utilised the following four height bands:

1. 0-20 m;
2. 20 – 160 m;
3. 160 – 200 m; and
4. >200 m.

All subsequent surveys in year 2 used the following height bands:



1. 0-20 m;
2. 20 – 150 m;
3. 150 – 200 m; and
4. >200 m.

Flight heights were recorded at 15-second intervals and allocated to 15 m height classes, which were then aggregated to the survey height bands above.

The potential collision height (PCH) varies across the turbine dimension range as a consequence of the differing rotor diameters and hub heights.

For the minimum rotor diameter / maximum ground-clearance permutation (GE158), the PCH extends from 41.9 m to 199.9 m above ground level, based on a rotor diameter of 158 m and hub height of 120.9 m.

For the maximum rotor diameter / minimum ground-clearance permutation (E175), the PCH extends from 24.1 m to 199.1 m above ground level, based on a rotor diameter of 175 m and hub height of 111.6 m.

The proportion of observed flight activity occurring within PCH was therefore calculated separately for each representative turbine permutation. This allows the CRM to account for the differing degree of overlap between the rotor-swept height range and the flight-height bands recorded during the baseline surveys.

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

Thus, the proportion of flights within each of the relevant height bands within the WP that are considered to have occurred at PCH has been calculated, as shown in Table 2-6 and Table 2-7.

Table 2-6: PCH overlap by survey height band

Survey year	Height band	Height band range (m)	Height band width (m)	158 m RD permutation		175 m RD permutation	
				Overlap (m)	Overlap (%)	Overlap (m)	Overlap (%)
Year 1	1	0–20	20	0	0.00%	0	0.00%
	2	20–160	140	118.1	84.36%	135.9	97.07%
	3	160–200	40	39.9	99.75%	39.1	97.75%
	4	>200	N/A ⁶	0	0.00%	0	0.00%
Year 2	1	0–20	20	0	0.00%	0	0.00%
	2	20–150	130	108.1	83.15%	125.9	96.85%
	3	150–200	50	49.9	99.80%	49.1	98.20%
	4	>200	N/A ⁶	0	0.00%	0	0.00%

⁶ Band 4 (>200 m) is open-ended and has no finite width against which to calculate an overlap percentage. As both CRH ranges top out below 200 m, overlap with Band 4 is nil in both scenarios.



Note that data have been aggregated by year and season as has been done in NS (2024) guidance. Only seasons where flight time is >0 have been included in Table 2-7 for brevity.



Table 2-7: Proportion of Flights at PCH

Species	Season	158 m RD permutation						175 m RD permutation					
		No. of flock-weighted height records within WP across all viewsheds (records)	% of flight durations observed within WP				% of flight durations at PCH (41.9 – 199.9 m) within WP	No. of flock-weighted height records within WP across all viewsheds (records)	% of flight durations observed within WP				% of flight durations at PCH (24.1 – 199.1 m) within WP
			Height band 1 (0 – 20 m)	Height band 2 (20 – 160 m year 1, 20 – 150 m year 2)	Height band 3 (160 – 200 m year 1, 150 – 200 m year 2)	Height band 4 (>200 m)			Height band 1 (0 – 20 m)	Height band 2 (20 – 160 m year 1, 20 – 150 m year 2)	Height band 3 (160 – 200 m year 1, 150 – 200 m year 2)	Height band 4 (>200 m)	
Black-headed gull	Breeding 2022	1140.86	32.57	62.29	2.34	2.80	54.88	1213.54	32.68	62.48	2.20	2.64	62.80
	Breeding 2023	438.56	33.48	66.52	0.00	0.00	55.32	438.56	33.48	66.52	0.00	0.00	64.43
Common kestrel	Breeding 2022	253.00	15.90	62.58	9.05	12.47	61.82	322.50	14.95	61.71	9.84	13.51	69.51
	Non-breeding 2022/23	89.92	18.47	71.15	2.97	7.41	62.98	89.92	18.47	71.15	2.97	7.41	71.96
	Breeding 2023	91.76	10.12	63.41	17.85	8.61	70.55	96.33	10.03	62.98	17.99	9.00	78.66
	Non-breeding 2023/24	2.80	16.67	83.33	0.00	0.00	69.29	2.80	16.67	83.33	0.00	0.00	80.71



Species	Season	158 m RD permutation						175 m RD permutation					
		No. of flock-weighted height records within WP across all viewsheds (records)	% of flight durations observed within WP				% of flight durations at PCH (41.9 – 199.9 m) within WP	No. of flock-weighted height records within WP across all viewsheds (records)	% of flight durations observed within WP				% of flight durations at PCH (24.1 – 199.1 m) within WP
			Height band 1 (0 – 20 m)	Height band 2 (20 – 160 m year 1, 20 – 150 m year 2)	Height band 3 (160 – 200 m year 1, 150 – 200 m year 2)	Height band 4 (>200 m)			Height band 1 (0 – 20 m)	Height band 2 (20 – 160 m year 1, 20 – 150 m year 2)	Height band 3 (160 – 200 m year 1, 150 – 200 m year 2)	Height band 4 (>200 m)	
Common snipe	Breeding 2022	270.57	18.90	59.66	8.87	12.57	59.18	308.00	17.53	58.55	9.52	14.39	66.14
	Non-breeding 2022/23	40.33	38.57	61.43	0.00	0.00	51.82	40.33	38.57	61.43	0.00	0.00	59.63
	Breeding 2023	141.25	21.47	47.55	4.13	26.84	43.66	115.00	26.38	58.41	5.07	10.14	61.54
Eurasian teal	Breeding 2023	49.00	38.10	61.90	0.00	0.00	51.48	49.00	38.10	61.90	0.00	0.00	59.95
European golden plover	Non-breeding 2022/23	6140.00	13.27	67.34	7.71	11.68	64.50	6220.00	12.75	68.10	7.61	11.53	73.55
Great cormorant	Non-breeding 2022/23	9.14	25.00	75.00	0.00	0.00	63.27	9.57	25.87	74.13	0.00	0.00	71.96



Species	Season	158 m RD permutation						175 m RD permutation					
		No. of flock-weighted height records within WP across all viewsheds (records)	% of flight durations observed within WP				% of flight durations at PCH (41.9 – 199.9 m) within WP	No. of flock-weighted height records within WP across all viewsheds (records)	% of flight durations observed within WP				% of flight durations at PCH (24.1 – 199.1 m) within WP
			Height band 1 (0 – 20 m)	Height band 2 (20 – 160 m year 1, 20 – 150 m year 2)	Height band 3 (160 – 200 m year 1, 150 – 200 m year 2)	Height band 4 (>200 m)			Height band 1 (0 – 20 m)	Height band 2 (20 – 160 m year 1, 20 – 150 m year 2)	Height band 3 (160 – 200 m year 1, 150 – 200 m year 2)	Height band 4 (>200 m)	
Great white egret	Non-breeding 2022/23	0.67	100.00	0.00	0.00	0.00	0.00	0.67	100.00	0.00	0.00	0.00	0.00
Hen harrier	Non-breeding 2022/23	63.00	10.58	82.01	7.41	0.00	76.57	63.00	10.58	82.01	7.41	0.00	86.85
	Non-breeding 2023/24	10.50	19.05	80.95	0.00	0.00	67.32	15.00	17.78	82.22	0.00	0.00	79.63
Little egret	Breeding 2023	128.00	33.33	66.67	0.00	0.00	55.44	128.00	33.33	66.67	0.00	0.00	64.56
Mallard	Non-breeding 2022/23	120.00	16.67	83.33	0.00	0.00	70.30	120.00	16.67	83.33	0.00	0.00	80.89
	Breeding 2023	54.00	39.51	60.49	0.00	0.00	50.30	54.00	39.51	60.49	0.00	0.00	58.59



Species	Season	158 m RD permutation						175 m RD permutation					
		No. of flock-weighted height records within WP across all viewsheds (records)	% of flight durations observed within WP				% of flight durations at PCH (41.9 – 199.9 m) within WP	No. of flock-weighted height records within WP across all viewsheds (records)	% of flight durations observed within WP				% of flight durations at PCH (24.1 – 199.1 m) within WP
			Height band 1 (0 – 20 m)	Height band 2 (20 – 160 m year 1, 20 – 150 m year 2)	Height band 3 (160 – 200 m year 1, 150 – 200 m year 2)	Height band 4 (>200 m)			Height band 1 (0 – 20 m)	Height band 2 (20 – 160 m year 1, 20 – 150 m year 2)	Height band 3 (160 – 200 m year 1, 150 – 200 m year 2)	Height band 4 (>200 m)	
Merlin	Non-breeding 2022/23	46.50	31.54	68.46	0.00	0.00	57.75	51.50	31.07	68.93	0.00	0.00	66.91
Northern lapwing	Breeding 2022	1153.93	24.03	74.67	0.72	0.58	63.71	1175.53	24.15	74.12	0.94	0.79	72.87
	Non-breeding 2022/23	176.00	32.58	67.42	0.00	0.00	56.88	176.00	32.58	67.42	0.00	0.00	65.45
	Breeding 2023	121.00	40.04	59.96	0.00	0.00	49.86	121.00	40.04	59.96	0.00	0.00	58.07
	Non-breeding 2023/24	90.50	37.94	62.06	0.00	0.00	51.61	99.00	40.40	59.60	0.00	0.00	57.72
Peregrine falcon	Breeding 2022	30.00	21.48	78.52	0.00	0.00	66.24	30.00	21.48	78.52	0.00	0.00	76.22



Species	Season	158 m RD permutation						175 m RD permutation					
		No. of flock-weighted height records within WP across all viewsheds (records)	% of flight durations observed within WP				% of flight durations at PCH (41.9 – 199.9 m) within WP	No. of flock-weighted height records within WP across all viewsheds (records)	% of flight durations observed within WP				% of flight durations at PCH (24.1 – 199.1 m) within WP
			Height band 1 (0 – 20 m)	Height band 2 (20 – 160 m year 1, 20 – 150 m year 2)	Height band 3 (160 – 200 m year 1, 150 – 200 m year 2)	Height band 4 (>200 m)			Height band 1 (0 – 20 m)	Height band 2 (20 – 160 m year 1, 20 – 150 m year 2)	Height band 3 (160 – 200 m year 1, 150 – 200 m year 2)	Height band 4 (>200 m)	
	Non-breeding 2022/23	3.89	26.67	73.33	0.00	0.00	61.86	3.89	26.67	73.33	0.00	0.00	71.19
	Non-breeding 2023/24	12.00	33.33	66.67	0.00	0.00	55.44	4.00	33.33	66.67	0.00	0.00	64.56
Whooper swan	Non-breeding 2022/23	4.00	66.67	33.33	0.00	0.00	28.12	4.00	66.67	33.33	0.00	0.00	32.36

Flight height was recorded at the start of each flight and at 15-second intervals thereafter. The proportions in each height band were calculated from the number of height records within the WP, weighted by flock size and by the proportion of each flight line within the WP. These values are therefore not directly comparable with the flying times in Table 2-4, which are expressed in bird-seconds and were used to derive bird density. Only the proportions at PCH were carried forward to the CRM. Because the two approaches allocate flight height differently, the height-band breakdown of short flights can differ between Table 2-3 and Table 2-7. For example, the single whooper swan flight (two birds, 30 seconds, non-breeding 2022/23) is allocated wholly to HB1 by flying time in Table 2-3, but one of the three height records for that flight was in HB2. This record accounts for the non-zero proportions at PCH shown for whooper swan in Table 2-7 (28.12% and 32.36% for the 158 m and



175 m RD permutations, respectively), which were the values used in the CRM. The resulting collision prediction for whooper swan is therefore very small but not zero (see Section 3.0).



farms in England¹⁴, (Blood Hill, Goole Fields I and Goole Fields II) and found empirical evidence supporting avoidance rates substantially higher than 98%, in the region of 99.5–99.8%, for wintering golden plover. This evidence was subsequently considered in the Environmental Impact Assessment for the permitted Brittas Wind Farm, Co. Tipperary (ABP-321454-24), which retained 98% as a reference/default scenario but modelled European golden plover using higher avoidance rates of 99.5% (precautionary higher-avoidance scenario) and 99.8% (higher/anticipated scenario). The Inspectorate of An Coimisiún Pleanála reviewed this approach and concluded, based on the scientific rationale and available post-construction evidence, that an avoidance rate of 99.5% was acceptable for collision risk modelling of European golden plover¹⁵. The Brittas application was subsequently granted permission by An Coimisiún Pleanála in April 2026.

On this basis, it is considered appropriate to depart from the generic 98% default for European golden plover in the present assessment. An avoidance rate of 99.5% is considered an evidence-supported and precautionary species-specific assumption, and has been adopted as the primary rate applied for this assessment, while retaining 98% as a sensitivity/reference scenario. A 99.8% scenario is additionally presented to illustrate the sensitivity of predicted collision mortality to the higher avoidance rates indicated at the upper end of the post-construction evidence reviewed by Gittings (2022). This approach aligns with NS guidance¹³, which states that text should "*point to any evidence from existing post-construction monitoring on the respective or similar bird species which might indicate what levels of avoidance are best supported by evidence*".

While the empirical evidence is based on a study of three wind farms in a different habitat type, it should be noted that the avoidance rates presented in the NS guidance are not dependant on habitat type and are consistently used for all wind farms throughout Ireland and the UK, regardless of habitat type. NatureScot accepts that species-specific avoidance rates can be based on data from any country in which the species occurs. For example, the species-specific avoidance rate for kestrel is derived from raptor data from a wind farm in Spain, the white-tailed eagle avoidance rate is based on "*sufficient evidence from flight behaviour and collision monitoring studies in Norway for vulnerability to collisions*", and the avoidance rate for swans is derived from a study conducted in the Netherlands.

A comparable evidence-based departure from the 98% default has also been applied for northern lapwing. Two of the three wind farms reviewed by Gittings (2022), Blood Hill and one of the Goole Fields sites, also supported northern lapwing, and post-construction monitoring at these sites demonstrated very high turbine avoidance by this species, consistent with the golden plover evidence discussed above. This evidence was also considered in the Brittas Wind Farm assessment (ABP-321454-24), where northern lapwing was similarly modelled using avoidance rates of 99.5% and 99.8%, and the Inspectorate concluded that 99.5% was acceptable for collision risk modelling of northern lapwing on the same basis. On this basis, an avoidance rate of 99.5% has been adopted as the primary rate for northern lapwing for this assessment, with 98% retained as a reference/sensitivity scenario and 99.8% presented to illustrate sensitivity to the upper end of the evidence range identified by Gittings (2022). The use of 99.5% should not be interpreted as implying that this rate has been directly estimated for northern lapwing from a dedicated species-specific collision study; rather, it represents an evidence-informed, species-specific assumption supported by post-construction monitoring of wind farms supporting both species, the Gittings (2022) review, and its explicit acceptance by the Inspectorate of An Coimisiún Pleanála in the Brittas Wind Farm assessment.

¹⁴ https://www.ballivorwindfarmplanning.ie/wp-content/uploads/sites/38/2023/04/Appendix_7-6_Collision_Risk_Assessment.pdf [Accessed in July 2026]

¹⁵ <https://www.pleanala.ie/anbordpleanala/media/abp/cases/reports/321/r321454.pdf?r=057637> [Accessed in September 2026]



Details of these species-specific parameters are given in Table 2-8.

Table 2-8: 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) ¹⁶	Nocturnal Activity Factor (1-5) ¹⁷	Avoidance Rate (%)
Black-headed gull	0.355	1.05	11.9	0	1	99.2
Common kestrel	0.34	0.755	12.7	0	1	95.0
Common snipe	0.26	0.455	16.0	0	3	98.0
Eurasian teal	0.39	0.55	19.7	0	2	98.0
European golden plover	0.275	0.715	13.7	0	3	98.0, 99.5 and 99.8
Great cormorant	0.9	1.45	14.5	0	1	98.0
Great white egret	0.935	1.55	9.2	0	1	98.0
Little egret	0.60	0.915	10.4	0	1	98.0
Hen harrier	0.48	1.1	8	0	1	99.0
Mallard	0.58	0.9	22.0	0	2	98.0
Merlin	0.275	0.56	13.47	0	1	98.0
Northern lapwing	0.30	0.84	12.3	0	2	98.0, 99.5 and 99.8
Peregrine falcon	0.45	1.1	14.0	0	1	98.0
Whooper swan	1.52	2.3	17.3	0	2	99.5

2.5.2 Wind Farm Parameters

The turbine-specific parameters used in the CRM for the two representative turbine permutations are presented in Table 2-9. These parameters include rotor dimensions, hub height, blade chord, blade pitch and rotational speed, all of which can influence the calculated collision probability.

The two permutations represent the outer limits of rotor diameter and ground clearance within the turbine dimension range assessed for the Project. The 158 m rotor diameter

¹⁶ Key: 0=flapping and 1=gliding

¹⁷ Key: 1=0%, 2=25%, 3=50%, 4=75% and 5=100% of daytime activity



permutation is represented by the GE158 turbine, and the 175 m rotor diameter permutation is represented by the E175 turbine.

The final turbine model has not yet been selected. The use of these representative permutations is intended to test the effect of the principal dimensional differences across the turbine dimension range on the CRM outputs.

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

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

Table 2-9: Wind Farm and Turbine Parameters

Parameter	Value	
	158 m RD permutation	175 m RD permutation
Wind farm width (km)	0.7	
Number of turbines	3	
Rotor radius / diameter (m)	79/158	87.5/175
Hub height (m)	120.9	111.6
Maximum blade chord width (m)	4.00	4.01
Blade pitch (°)	15	15
Rotation speed (r.p.m)	8.4	6.7
Turbine operation time (%) (calculated per month but mean value over whole year given here)	86.3	



3.0 Results

Table 3-1 summarises the predicted collision estimates for the 14 species assessed under the two representative turbine permutations, using the avoidance rates presented in Table 2-8. Results are presented separately for the 158 m rotor diameter permutation and the 175 m rotor diameter permutation to demonstrate the influence of the differing turbine dimensions and associated parameters on predicted collision rates. Copies of the NatureScot model calculations for each species and turbine permutation are included at Appendix A and Appendix B.

In addition to predicted collision estimates for each period of analysis, mean annual collision estimates have also been presented. For resident species, mean annual estimates are based on all breeding and non-breeding season data, and for non-resident species, mean annual estimates are based on all instances of the relevant season. For example, for whooper swan, which is a winter visitor, only the non-breeding seasons have been considered.

To calculate mean annual collision estimates for resident species, the modelled predictions for each season were summed for each year, which were then averaged across years.

Collision estimates are presented rounded to two decimal places. Period estimates were derived by summing the monthly estimates, each rounded to two decimal places, and minor differences from the unrounded totals may therefore arise. Values presented as 0.00 may represent negligible, non-zero predicted collision rates. Mean years per collision were calculated from the unrounded mean annual collision estimates and may therefore differ slightly from the reciprocal of the rounded values presented. Mean annual collision estimates were calculated from the period totals and are presented rounded half up to two decimal places. For example, the mean annual estimate for northern lapwing at 99.5% avoidance under the 175 m RD permutation is $(0.31 + 0.04) / 2 = 0.175$ collisions per year, which is presented as 0.18. The rounded values in Table 3-1 are those carried forward to the EIAR and NIS. For whooper swan, the predicted collision rate for non-breeding 2022/23 is greater than zero but falls below the two-decimal-place resolution of the NS spreadsheet output. It is therefore presented as <0.01 rather than 0.00, and should be interpreted as a negligible, non-zero collision risk (fewer than one collision in more than 100 years) rather than as an absolute zero..



Table 3-1: Summary of CRM Outputs

Common Name	Period	158 m RD permutation				175 m RD permutation			
		Collision Estimates Per Period		Mean (Standard Deviation) Collision Estimates Per Year		Collision Estimates Per Period		Mean (Standard Deviation) Collision Estimates Per Year	
		Collisions Per Period	No. Years Per Collision (Period)	Collisions Per Year	No. Years Per Collision	Collisions Per Period	No. Years Per Collision (Period)	Collisions Per Year	No. Years Per Collision
Black-headed gull	Breeding 2022	0.22	4.55	0.17 (0.08)	6.06 (3.21)	0.25	4.00	0.19 (0.09)	5.41 (3.06)
	Non-breeding 2022/23	0.00	N/A			0.00	N/A		
	Breeding 2023	0.11	9.09			0.12	8.33		
	Non-breeding 2023/24	0.00	N/A			0.00	N/A		
Common kestrel	Breeding 2022	0.25	4.00	0.26 (0.13)	3.85 (2.14)	0.32	3.13	0.31 (0.18)	3.23 (2.32)
	Non-breeding 2022/23	0.10	10.00			0.12	8.33		
	Breeding 2023	0.17	5.88			0.18	5.56		
	Non-breeding 2023/24	0.00	N/A			0.00	N/A		



Common Name	Period	158 m RD permutation				175 m RD permutation			
		Collision Estimates Per Period		Mean (Standard Deviation) Collision Estimates Per Year		Collision Estimates Per Period		Mean (Standard Deviation) Collision Estimates Per Year	
		Collisions Per Period	No. Years Per Collision (Period)	Collisions Per Year	No. Years Per Collision	Collisions Per Period	No. Years Per Collision (Period)	Collisions Per Year	No. Years Per Collision
Common snipe	Breeding 2022	0.20	5.00	0.16 (0.09)	6.45 (4.64)	0.27	3.70	0.21 (0.12)	4.88 (3.45)
	Non-breeding 2022/23	0.02	50.00			0.02	50.00		
	Breeding 2023	0.09	11.11			0.12	8.33		
	Non-breeding 2023/24	0.00	N/A			0.00	N/A		
Eurasian teal	Breeding 2022	0.00	N/A	0.02 (0.03)	50.00 (N/A)	0.00	N/A	0.03 (0.04)	40.00 (N/A)
	Non-breeding 2022/23	0.00	N/A			0.00	N/A		
	Breeding 2023	0.04	25.00			0.05	20.00		
	Non-breeding 2023/24	0.00	N/A			0.00	N/A		



Common Name	Period	158 m RD permutation				175 m RD permutation			
		Collision Estimates Per Period		Mean (Standard Deviation) Collision Estimates Per Year		Collision Estimates Per Period		Mean (Standard Deviation) Collision Estimates Per Year	
		Collisions Per Period	No. Years Per Collision (Period)	Collisions Per Year	No. Years Per Collision	Collisions Per Period	No. Years Per Collision (Period)	Collisions Per Year	No. Years Per Collision
European golden plover (98% avoidance)	Breeding 2022	0.00	N/A	2.89 (4.08)	0.35 (N/A)	0.00	N/A	3.03 (4.28)	0.33 (N/A)
	Non-breeding 2022/23	5.77	0.17			6.05	0.17		
	Breeding 2023	0.00	N/A			0.00	N/A		
	Non-breeding 2023/24	0.00	N/A			0.00	N/A		
European golden plover (99.5% avoidance)	Breeding 2022	0.00	N/A	0.72 (1.02)	1.39 (N/A)	0.00	N/A	0.76 (1.07)	1.32 (N/A)
	Non-breeding 2022/23	1.44	0.69			1.51	0.66		
	Breeding 2023	0.00	N/A			0.00	N/A		
	Non-breeding 2023/24	0.00	N/A			0.00	N/A		



Common Name	Period	158 m RD permutation				175 m RD permutation			
		Collision Estimates Per Period		Mean (Standard Deviation) Collision Estimates Per Year		Collision Estimates Per Period		Mean (Standard Deviation) Collision Estimates Per Year	
		Collisions Per Period	No. Years Per Collision (Period)	Collisions Per Year	No. Years Per Collision	Collisions Per Period	No. Years Per Collision (Period)	Collisions Per Year	No. Years Per Collision
European golden plover (99.8% avoidance)	Breeding 2022	0.00	N/A	0.29 (0.41)	3.45 (N/A)	0.00	N/A	0.31 (0.43)	3.28 (N/A)
	Non-breeding 2022/23	0.58	1.72			0.61	1.64		
	Breeding 2023	0.00	N/A			0.00	N/A		
	Non-breeding 2023/24	0.00	N/A			0.00	N/A		
Great cormorant	Breeding 2022	0.00	N/A	<0.01 (0.01)	200.00 (N/A)	0.00	N/A	<0.01 (0.01)	200.00 (N/A)
	Non-breeding 2022/23	0.01	100.00			0.01	100.00		
	Breeding 2023	0.00	N/A			0.00	N/A		
	Non-breeding 2023/24	0.00	N/A			0.00	N/A		



Common Name	Period	158 m RD permutation				175 m RD permutation			
		Collision Estimates Per Period		Mean (Standard Deviation) Collision Estimates Per Year		Collision Estimates Per Period		Mean (Standard Deviation) Collision Estimates Per Year	
		Collisions Per Period	No. Years Per Collision (Period)	Collisions Per Year	No. Years Per Collision	Collisions Per Period	No. Years Per Collision (Period)	Collisions Per Year	No. Years Per Collision
Great white egret	Breeding 2022	0.00	N/A	0.00 (N/A)	N/A	0.00	N/A	0.00 (N/A)	N/A
	Non-breeding 2022/23	0.00	N/A			0.00	N/A		
	Breeding 2023	0.00	N/A			0.00	N/A		
	Non-breeding 2023/24	0.00	N/A			0.00	N/A		
Little egret	Breeding 2022	0.00	N/A	0.04 (0.06)	25.00 (N/A)	0.00	N/A	0.05 (0.06)	22.22 (N/A)
	Non-breeding 2022/23	0.00	N/A			0.00	N/A		
	Breeding 2023	0.08	12.50			0.09	11.11		
	Non-breeding 2023/24	0.00	N/A			0.00	N/A		



Common Name	Period	158 m RD permutation				175 m RD permutation			
		Collision Estimates Per Period		Mean (Standard Deviation) Collision Estimates Per Year		Collision Estimates Per Period		Mean (Standard Deviation) Collision Estimates Per Year	
		Collisions Per Period	No. Years Per Collision (Period)	Collisions Per Year	No. Years Per Collision	Collisions Per Period	No. Years Per Collision (Period)	Collisions Per Year	No. Years Per Collision
Hen harrier	Breeding 2022	0.00	N/A	<0.01 (0.01)	200.00 (N/A)	0.00	N/A	<0.01 (0.01)	200.00 (N/A)
	Non-breeding 2022/23	0.01	100.00			0.01	100.00		
	Breeding 2023	0.00	N/A			0.00	N/A		
	Non-breeding 2023/24	0.00	N/A			0.00	N/A		
Mallard	Breeding 2022	0.00	N/A	0.10 (0.06)	10.53 (9.09)	0.00	N/A	0.11 (0.06)	9.52 (7.07)
	Non-breeding 2022/23	0.14	7.14			0.15	6.67		
	Breeding 2023	0.05	20.00			0.06	16.67		
	Non-breeding 2023/24	0.00	N/A			0.00	N/A		



Common Name	Period	158 m RD permutation				175 m RD permutation			
		Collision Estimates Per Period		Mean (Standard Deviation) Collision Estimates Per Year		Collision Estimates Per Period		Mean (Standard Deviation) Collision Estimates Per Year	
		Collisions Per Period	No. Years Per Collision (Period)	Collisions Per Year	No. Years Per Collision	Collisions Per Period	No. Years Per Collision (Period)	Collisions Per Year	No. Years Per Collision
Merlin	Breeding 2022	0.00	N/A	0.01 (0.01)	100.00 (N/A)	0.00	N/A	0.02 (0.02)	66.67 (N/A)
	Non-breeding 2022/23	0.02	50.00			0.03	33.33		
	Breeding 2023	0.00	N/A			0.00	N/A		
	Non-breeding 2023/24	0.00	N/A			0.00	N/A		
Northern lapwing (98% avoidance)	Breeding 2022	0.96	1.04	0.64 (0.67)	1.57 (3.78)	1.05	0.95	0.69 (0.73)	1.46 (3.57)
	Non-breeding 2022/23	0.15	6.67			0.15	6.67		
	Breeding 2023	0.09	11.11			0.09	11.11		
	Non-breeding 2023/24	0.07	14.29			0.08	12.50		



Common Name	Period	158 m RD permutation				175 m RD permutation			
		Collision Estimates Per Period		Mean (Standard Deviation) Collision Estimates Per Year		Collision Estimates Per Period		Mean (Standard Deviation) Collision Estimates Per Year	
		Collisions Per Period	No. Years Per Collision (Period)	Collisions Per Year	No. Years Per Collision	Collisions Per Period	No. Years Per Collision (Period)	Collisions Per Year	No. Years Per Collision
Northern lapwing (99.5% avoidance)	Breeding 2022	0.23	4.35	0.15 (0.17)	6.67 (20.95)	0.27	3.70	0.18 (0.19)	5.71 (15.40)
	Non-breeding 2022/23	0.04	25.00			0.04	25.00		
	Breeding 2023	0.01	100.00			0.02	50.00		
	Non-breeding 2023/24	0.02	50.00			0.02	50.00		
Northern lapwing (99.8% avoidance)	Breeding 2022	0.08	12.50	0.05 (0.07)	20.00 (N/A)	0.11	9.09	0.07 (0.09)	15.38 (N/A)
	Non-breeding 2022/23	0.02	50.00			0.02	50.00		
	Breeding 2023	0.00	N/A			0.00	N/A		
	Non-breeding 2023/24	0.00	N/A			0.00	N/A		



Common Name	Period	158 m RD permutation				175 m RD permutation			
		Collision Estimates Per Period		Mean (Standard Deviation) Collision Estimates Per Year		Collision Estimates Per Period		Mean (Standard Deviation) Collision Estimates Per Year	
		Collisions Per Period	No. Years Per Collision (Period)	Collisions Per Year	No. Years Per Collision	Collisions Per Period	No. Years Per Collision (Period)	Collisions Per Year	No. Years Per Collision
Peregrine	Breeding 2022	0.02	50.00	0.02 (0.01)	66.67 (35.36)	0.03	33.33	0.02 (0.02)	66.67 (N/A)
	Non-breeding 2022/23	0.00	N/A			0.00	N/A		
	Breeding 2023	0.00	N/A			0.00	N/A		
	Non-breeding 2023/24	0.01	100.00			0.00	N/A		
Whooper swan	Non-breeding 2022/23	<0.01	>100	<0.01 (<0.01)	>100	<0.01	>100	<0.01 (<0.01)	>100
	Non-breeding 2023/24	0.00	N/A			0.00	N/A		



3.1 Limitations and Uncertainty in Outputs

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

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

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

For two species in particular, this variability warrants further explanation to aid interpretation of the results, as set out below.

For European golden plover, the collision risk estimate is derived entirely from flight activity recorded during a single survey period (non-breeding 2022/23), during which 178 birds were recorded across nine flight lines, an average of approximately 20 birds per flight line consistent with flock-scale movements. No golden plover flight activity was recorded within the site during the other three survey periods, despite equal survey effort (36 hours) across all four periods. The mean annual collision estimate for this species should therefore be interpreted as reflecting the occurrence of a small number of large flock movements during one non-breeding season, rather than a sustained pattern of site usage across the survey programme.

Northern lapwing showed elevated flight activity during the breeding 2022 survey period relative to subsequent periods, which is reflected in the collision estimate for that period. Flight activity was recorded across all four survey periods, indicating consistent, if variable, use of the site by this species across the survey programme.

A further source of uncertainty arises from turbine-specific parameters within the turbine dimension range. The two representative permutations capture the outer limits of rotor diameter and ground clearance, and predicted mean annual collision rates under the maximum rotor diameter permutation (E175) were up to 30% higher than under the minimum rotor diameter permutation (GE158), depending on species (approximately 50% higher for merlin, for which absolute values are very small at 0.01-0.02 collisions per year). Other parameters, particularly rotational speed and blade chord, also influence collision probability, and a final turbine model with a higher rotational speed or wider blade chord than those modelled could produce marginally higher estimates. Given the small absolute values involved, this is not expected to alter the conclusions of the EIAR or NIS.

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



Appendix A NatureScot Spreadsheets – 158m RD Representative Permutation (GE158)

Avian Collision Risk Report

Cush Wind Farm Phase II

Cush Wind Limited

SLR Project No.: 501.065723.00001

23 October 2026



COLLISION RISK MODEL

Required input data is in

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Calculated output is in

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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	Cush WF			Model	GE158								
	Bird length	L	0.355	m		Latitude	53.15028		degrees		Hub height	120.9		m					
	Wingspan	W	1.05	m		No of turbines	T	3			Rotor radius	R	79	m					
	Bird flight speed	v	11.9	m s-1		Width of windfarm	w	0.7	km		No of blades	b	3						
	Flight type, flapping or gliding	flapping									Rotation speed	Ω	8.4	rpm					
	% of flights upwind/downwind	50%			50%						Max blade width	C	4	m					
	Nocturnal activity ranking 1-5	1									Blade pitch	λ	15	degrees					
	Nocturnal activity factor	fnight	0%								Risk height range	42-200			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	DA	birds/km2			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
	Proportion at rotor risk height	Q2R	54.88%			0.153												0.00825	0.0134
	At latitude 53.2	Daylight hours per month			252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2		
		Nighttime hours per month			491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8		
Stage B																			
	No of turbines	T	3																
	Rotor radius	R	79 m																
		Total rotor frontal area m2			58820														
	Nocturnal activity factor	fnight	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	656.6	36.5	0.0	0.0	0.0	0.0	0.0	0.0	693		
Stage C																			
	No of blades	b	3				Bird length	l	0.355 m										
	Rotation speed	Ω	8.4 rpm				Wingspan	w	1.05 m										
	Rotor radius	R	79 m				Bird flight speed	v	11.9 m s-1										
	Max blade width	C	4 m				Flight type	flapping											
	Pitch	λ	15 degrees				% of flights upwind/downwind	50%		50%									
	Blade profile	see Blade profile sheet																	
		Single transit risk			upwind	6.52%													
					downwind	2.87%													
					weighted mean	4.69%													
Stage D																			
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge		
	Proportion of time operational	Qop	88.8% 90.5% 86.9% 85.6% 85.7% 83.1% 80.8% 82.4% 85.1% 89.8% 88.0% 88.9%												86.3%				
		Collision rates before avoidance																	
		0.00 0.00 0.00 0.00 26.41 1.42 0.00 0.00 0.00 0.00 0.00 0.00												year total					
														28					
Stage E																			
	Allow for large array correction?	No																	
	Width of windfarm	w	0.7 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	26.41	1.42	0.00	0.00	0.00	0.00	0.00	0.00	27.8		
		100.00%			0.00	0.00	0.00	0.00	26.41	1.42	0.00	0.00	0.00	0.00	0.00	0.00	27.8		
		100.00%			0.00	0.00	0.00	0.00	26.41	1.42	0.00	0.00	0.00	0.00	0.00	0.00	27.8		
		99.20%			0.00	0.00	0.00	0.00	0.21	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.2		

COLLISION RISK MODEL

Required input data is in

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Calculated output is in

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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		Cush WF		Model		GE158								
	Bird length	L	0.355	m	Latitude		53.15028		degrees		Hub height		120.9		m				
	Wingspan	W	1.05	m	No of turbines		T	3		Rotor radius		R	79		m				
	Bird flight speed	v	11.9	m s-1	Width of windfarm		w	0.7		km		No of blades		b	3				
	Flight type, flapping or gliding	flapping									Rotation speed		Ω	8.4	rpm				
	% of flights upwind/downwind	50%		50%							Max blade width		C	4	m				
	Nocturnal activity ranking 1-5	1									Blade pitch		λ	15	degrees				
	Nocturnal activity factor	fnight	0%								Risk height range		42-200		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	DA	birds/km2				0.0553		0.0298								0.0071		
	Proportion at rotor risk height	Q2R	55.32%																
	At latitude 53.2	Daylight hours per month			252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2		
		Nighttime hours per month			491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8		
Stage B					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total		
	No of turbines	T	3																
	Rotor radius	R	79 m																
		Total rotor frontal area m2		58820															
	Nocturnal activity factor	fnight	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	204.0	0.0	133.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	337	
Stage C					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total		
	No of blades	b	3				Bird length	l	0.355	m									
	Rotation speed	Ω	8.4 rpm				Wingspan	w	1.05	m									
	Rotor radius	R	79 m				Bird flight speed	v	11.9	m s-1									
	Max blade width	C	4 m				Flight type	flapping											
	Pitch	λ	15 degrees				% of flights upwind/downwind	50%		50%									
	Blade profile	see Blade profile sheet																	
		Single transit risk		upwind	6.52%														
				downwind	2.87%														
				weighted mean	4.69%														
Stage D					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge		
	Proportion of time operational	Qop			88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%		
		Collision rates before avoidance															year total		
					0.00	0.00	0.00	8.20	0.00	5.19	0.00	0.00	0.00	0.00	0.00	0.00	13		
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	0.7	km															
		large array correction																	
	Avoidance rates modelled			100.00%	0.00	0.00	0.00	8.20	0.00	5.19	0.00	0.00	0.00	0.00	0.00	0.00	13.4		
				100.00%	0.00	0.00	0.00	8.20	0.00	5.19	0.00	0.00	0.00	0.00	0.00	0.00	13.4		
				100.00%	0.00	0.00	0.00	8.20	0.00	5.19	0.00	0.00	0.00	0.00	0.00	0.00	13.4		
		99.20%		100.00%	0.00	0.00	0.00	0.07	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.1		

COLLISION RISK MODEL

Required input data is in

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Calculated output is in

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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		Cormorant		Site name		Cush WF		Model		GE158																								
Bird length		L	0.9	m		Latitude		53.15028		degrees		Hub height		120.9		m																		
Wingspan		W	1.45	m		No of turbines		T	3				Rotor radius		R	79		m																
Bird flight speed		v	14.5	m s-1		Width of windfarm		w	0.7		km		No of blades		b	3																		
Flight type, flapping or gliding		flapping										Rotation speed		Ω	8.4		rpm																	
% of flights upwind/downwind		50%		50%								Max blade width		C	4		m																	
Nocturnal activity ranking 1-5		1										Blade pitch		λ	15		degrees																	
Nocturnal activity factor		fnight	0%										Risk height range		42-200		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		DA	birds/km2		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		year avge					
Proportion at rotor risk height		Q2R	63.27%																						0.00242		0.0002							
At latitude 53.2		Daylight hours per month				252.7		274.3		366.4		418.1		490.3		505.8		508.9		458.2		382.4		330.1		262.0		237.0		4486.2				
		Nighttime hours per month				491.3		397.7		377.6		301.9		253.7		214.2		235.1		285.8		337.6		413.9		458.0		507.0		4273.8				
Stage B																																		
No of turbines		T	3																															
Rotor radius		R	79		m																													
		Total rotor frontal area m2		58820																														
Nocturnal activity factor		fnight	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				0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		7.1		7		
Stage C																																		
No of blades		b	3						Bird length		l	0.9		m																				
Rotation speed		Ω	8.4		rpm				Wingspan		w	1.45		m																				
Rotor radius		R	79		m				Bird flight speed		v	14.5		m s-1																				
Max blade width		C	4		m				Flight type		flapping		50%		50%																			
Pitch		λ	15		degrees				% of flights upwind/downwind		50%		50%																					
Blade profile		see Blade profile sheet																																
		Single transit risk																																
		upwind				7.48%																												
		downwind				4.32%																												
		weighted mean				5.90%																												
Stage D																																		
Proportion of time operational		Qop			Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		year avge					
		88.8%		90.5%		86.9%		85.6%		85.7%		83.1%		80.8%		82.4%		85.1%		89.8%		88.0%		88.9%				86.3%						
		Collision rates before avoidance																												year total				
		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.37		0						
Stage E																																		
Allow for large array correction?		No																																
Width of windfarm		w	0.7		km																													
		large array correction																																
						Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		per year				
		Collision rates allowing for avoidance																																
Avoidance rates modelled				100.00%		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.37		0.4				
				100.00%		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.37		0.4				
				100.00%		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.37		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		0.00		0.01		0.0				

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

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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		Little egret			Site name		Cush WF			Model		GE158					
	Bird length	L	0.6	m		Latitude		53.15028	degrees		Hub height		120.9	m				
	Wingspan	W	0.915	m		No of turbines	T	3			Rotor radius	R	79	m				
	Bird flight speed	v	10.4	m s-1		Width of windfarm	w	0.7	km		No of blades	b	3					
	Flight type, flapping or gliding		flapping								Rotation speed	Ω	8.4	rpm				
	% of flights upwind/downwind		50%	50%							Max blade width	C	4	m				
	Nocturnal activity ranking 1-5		1								Blade pitch	λ	15	degrees				
	Nocturnal activity factor	fnight	0%								Risk height range		42-200	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	DA	birds/km2			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
	Proportion at rotor risk height	Q2R	55.44%			0.0217												0.0018
	At latitude 53.2		Daylight hours per month			252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2
			Nighttime hours per month			491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8
Stage B																		
	No of turbines	T	3															
	Rotor radius	R	79	m														
			Total rotor frontal area m2			58820												
	Nocturnal activity factor	fnight	0%															
	Bird flight speed	v	10.4	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	84.8	0.0	0.0	0.0	0.0	0.0	0.0	85
Stage C																		
	No of blades	b	3															
	Rotation speed	Ω	8.4	rpm														
	Rotor radius	R	79	m														
	Max blade width	C	4	m														
	Pitch	λ	15	degrees														
	Blade profile		see Blade profile sheet															
			Single transit risk															
				upwind		7.78%												
				downwind		3.82%												
				weighted mean		5.80%												
Stage D																		
	Proportion of time operational	Qop				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
						88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	
						Collision rates before avoidance										year total		
						0.00	0.00	0.00	0.00	0.00	4.09	0.00	0.00	0.00	0.00	0.00	0.00	4
Stage E																		
	Allow for large array correction?		No															
	Width of windfarm	w	0.7	km														
				large array correction														
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
						Collision rates allowing for avoidance												
	Avoidance rates modelled					0.00	0.00	0.00	0.00	0.00	4.09	0.00	0.00	0.00	0.00	0.00	0.00	4.1
						0.00	0.00	0.00	0.00	0.00	4.09	0.00	0.00	0.00	0.00	0.00	0.00	4.1
						0.00	0.00	0.00	0.00	0.00	4.09	0.00	0.00	0.00	0.00	0.00	0.00	4.1
			98.00%			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

COLLISION RISK MODEL

Required input data is in

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Calculated output is in

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boxes are for information only, to show variables used at each stage

		Value		Units			Value		Units			Value		Units				
Bird data					Windfarm data							Turbine data						
Species name		Golden plover			Site name		Cush WF		Model		GE158							
Bird length		L	0.275	m	Latitude		53.15028		degrees		Hub height		120.9	m				
Wingspan		W	0.715	m	No of turbines		T	3		Rotor radius		R	79	m				
Bird flight speed		v	13.7	m s-1	Width of windfarm		w	0.7		km		No of blades		b	3			
Flight type, flapping or gliding		flapping									Rotation speed		Ω	8.4	rpm			
% of flights upwind/downwind		50%									Max blade width		C	4	m			
Nocturnal activity ranking 1-5		3									Blade pitch		λ	15	degrees			
Nocturnal activity factor		fnight	50%									Risk height range		42-200		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		DA	birds/km2			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion at rotor risk height		Q2R	64.50%			1.23												0.1025
At latitude 53.2		Daylight hours per month			252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2	
		Nighttime hours per month			491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8	
Stage B																		
No of turbines		T	3															
Rotor radius		R	79 m															
		Total rotor frontal area m2			58820													
Nocturnal activity factor		fnight	50%															
Bird flight speed		v	13.7 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	0.0	0.0	0.0	7822.9	0.0	0.0	7823	
Stage C																		
No of blades		b	3			Bird length		l	0.275 m									
Rotation speed		Ω	8.4 rpm			Wingspan		w	0.715 m									
Rotor radius		R	79 m			Bird flight speed		v	13.7 m s-1									
Max blade width		C	4 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	2.46%												
					weighted mean	4.11%												
Stage D																		
Proportion of time operational		Qop				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
					88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%	
					Collision rates before avoidance													year total
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	288.53	0.00	0.00	289
Stage E																		
Allow for large array correction?		No																
Width of windfarm		w	0.7 km															
		large array correction			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year	
		Collision rates allowing for avoidance																
Avoidance rates modelled					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	288.53	0.00	0.00	288.5	
		98.00%			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.77	0.00	0.00	5.8	
		99.50%			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.44	0.00	0.00	1.4	
		99.80%			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.58	0.00	0.00	0.6	

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			Value		Units								
Bird data					Windfarm data							Turbine data										
Species name		Hen harrier			Site name		Cush WF			Model		GE158										
Bird length		L	0.48	m	Latitude		53.15028			degrees	Hub height		120.9	m								
Wingspan		W	1.1	m	No of turbines		T	3			Rotor radius		R	79	m							
Bird flight speed		v	8	m s-1	Width of windfarm		w	0.7			km	No of blades		b	3							
Flight type, flapping or gliding		flapping								Rotation speed		Ω	8.4	rpm								
% of flights upwind/downwind		50%			50%					Max blade width		C	4	m								
Nocturnal activity ranking 1-5		1								Blade pitch		λ	15	degrees								
Nocturnal activity factor		fnight	0%								Risk height range		42-200			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		DA	birds/km2			Jan		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge			
Proportion at rotor risk height		Q2R	76.57%			0.0115														0.0010		
At latitude 53.2		Daylight hours per month			252.7		274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2				
		Nighttime hours per month			491.3		397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8				
Stage B																						
No of turbines		T	3																			
Rotor radius		R	79			m																
		Total rotor frontal area m2			58820																	
Nocturnal activity factor		fnight	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			23.9		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24
Stage C																						
No of blades		b	3			Bird length		l	0.48			m										
Rotation speed		Ω	8.4			rpm			Wingspan		w	1.1			m							
Rotor radius		R	79			m			Bird flight speed		v	8			m s-1							
Max blade width		C	4			m			Flight type		flapping											
Pitch		λ	15			degrees			% of flights upwind/downwind		50%			50%								
Blade profile		see Blade profile sheet																				
		Single transit risk			upwind			8.60%														
					downwind			4.11%														
					weighted mean			6.36%														
Stage D																						
Proportion of time operational		Qop	Jan			Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge					
		88.8%			90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%						
		Collision rates before avoidance														year total						
		1.35			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1					
Stage E																						
Allow for large array correction?		No																				
Width of windfarm		w	0.7			km																
		large array correction																				
					Jan		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year				
		Collision rates allowing for avoidance																				
Avoidance rates modelled		100.00%			1.35		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.3				
		100.00%			1.35		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.3				
		100.00%			1.35		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.3				
		99.00%			0.01		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0				

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

green

boxes are for information only, to show variables used at each stage

		Value		Units			Value		Units			Value		Units					
Bird data					Windfarm data				Turbine data										
Species name		Hen harrier			Site name		Cush WF		Model		GE158								
Bird length		L	0.48	m	Latitude		53.15028		degrees		Hub height		120.9	m					
Wingspan		W	1.1	m	No of turbines		T	3			Rotor radius		R	79	m				
Bird flight speed		v	8	m s-1	Width of windfarm		w	0.7	km		No of blades		b	3					
Flight type, flapping or gliding		flapping									Rotation speed		Ω	8.4	rpm				
% of flights upwind/downwind		50%			50%						Max blade width		C	4	m				
Nocturnal activity ranking 1-5		1									Blade pitch		λ	15	degrees				
Nocturnal activity factor		fnight	0%									Risk height range		42-200 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		DA	birds/km2			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
Proportion at rotor risk height		Q2R	67.32%			0.00153												0.00204	0.0003
At latitude 53.2		Daylight hours per month			252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2		
		Nighttime hours per month			491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8		
Stage B																			
No of turbines		T	3																
Rotor radius		R	79 m																
		Total rotor frontal area m2			58820														
Nocturnal activity factor		fnight	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	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5	7	
Stage C																			
No of blades		b	3			Bird length		l	0.48 m										
Rotation speed		Ω	8.4 rpm			Wingspan		w	1.1 m										
Rotor radius		R	79 m			Bird flight speed		v	8 m s-1										
Max blade width		C	4 m			Flight type		flapping											
Pitch		λ	15 degrees			% of flights upwind/downwind		50%		50%									
Blade profile		see Blade profile sheet																	
		Single transit risk			upwind	8.60%													
					downwind	4.11%													
					weighted mean	6.36%													
Stage D																			
Proportion of time operational		Qop				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
					88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%		
					Collision rates before avoidance														
					0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	year total	
					0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0	
Stage E																			
Allow for large array correction?		No																	
Width of windfarm		w	0.7 km																
		large array correction			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year		
					Collision rates allowing for avoidance														
Avoidance rates modelled		100.00%			0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.4	
		100.00%			0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.4	
		100.00%			0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.4	
		99.00%			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	

Required input data is in
Calculated output is in

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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		Kestrel		Site name		Cush WF		Model		GE158							
Bird length		L	0.34	Latitude		53.15028		Hub height		120.9		m					
Wingspan		W	0.755	No of turbines		T	3	Rotor radius		R	79	m					
Bird flight speed		v	12.7	Width of windfarm		w	0.7	No of blades		b	3						
Flight type, flapping or gliding		flapping						Rotation speed		Ω	8.4	rpm					
% of flights upwind/downwind		50%						Max blade width		C	4	m					
Nocturnal activity ranking 1-5		1						Blade pitch		λ	15	degrees					
Nocturnal activity factor		fnight	0%					Risk height range		42-200		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		DA	birds/km2	0.00577 0.0178 0.00238												0.0022	
Proportion at rotor risk height		Q2R	61.82%														
At latitude 53.2		Daylight hours per month		252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2	
		Nighttime hours per month		491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8	
Stage B				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total	
No of turbines		T	3														
Rotor radius		R	79 m														
		Total rotor frontal area m2		58820													
Nocturnal activity factor		fnight	0%														
Bird flight speed		v	12.7 m s-1														
		Projected number of rotor transits		0.0	0.0	0.0	0.0	29.8	94.7	12.7	0.0	0.0	0.0	0.0	0.0	137	
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	8.4 rpm	Wingspan		w	0.755	m									
Rotor radius		R	79 m	Bird flight speed		v	12.7	m s-1									
Max blade width		C	4 m	Flight type		flapping											
Pitch		λ	15 degrees	% of flights upwind/downwind		50%		50%									
Blade profile		see Blade profile sheet															
		Single transit risk		upwind	6.14%												
				downwind	2.65%												
				weighted mean	4.39%												
Stage D				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year ave	
Proportion of time operational		Qop		88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%	
		Collision rates before avoidance														year total	
				0.00	0.00	0.00	0.00	1.12	3.46	0.45	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	0.7 km														
		large array correction															
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year	
		Collision rates allowing for avoidance															
Avoidance rates modelled		100.00%		0.00	0.00	0.00	0.00	1.12	3.46	0.45	0.00	0.00	0.00	0.00	0.00	5.0	
		100.00%		0.00	0.00	0.00	0.00	1.12	3.46	0.45	0.00	0.00	0.00	0.00	0.00	5.0	
		100.00%		0.00	0.00	0.00	0.00	1.12	3.46	0.45	0.00	0.00	0.00	0.00	0.00	5.0	
		95.00%		0.00	0.00	0.00	0.00	0.06	0.17	0.02	0.00	0.00	0.00	0.00	0.00	0.3	

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

green

boxes are for information only, to show variables used at each stage

Value				Units		Value				Units		Value				Units		
Bird data				Windfarm data				Turbine data										
Species name		Kestrel		Site name		Cush WF		Model		GE158								
Bird length		L	0.34	m		Latitude		53.15028		degrees		Hub height		120.9		m		
Wingspan		W	0.755	m		No of turbines		T	3				Rotor radius		R	79	m	
Bird flight speed		v	12.7	m s-1		Width of windfarm		w	0.7		km		No of blades		b	3		
Flight type, flapping or gliding		flapping										Rotation speed		Ω	8.4		rpm	
% of flights upwind/downwind		50%		50%								Max blade width		C	4		m	
Nocturnal activity ranking 1-5		1										Blade pitch		λ	15		degrees	
Nocturnal activity factor		fnight	0%										Risk height range		42-200		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		DA	birds/km2		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
Proportion at rotor risk height		Q2R	70.55%		0.00419												0.0114	0.0013
At latitude 53.2		Daylight hours per month		252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2		
		Nighttime hours per month		491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8		
Stage B																		
No of turbines		T	3															
Rotor radius		R	79 m															
		Total rotor frontal area m2		58820														
Nocturnal activity factor		fnight	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	21.0	67.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	88	
Stage C																		
No of blades		b	3		Bird length		l	0.34 m										
Rotation speed		Ω	8.4 rpm		Wingspan		w	0.755 m										
Rotor radius		R	79 m		Bird flight speed		v	12.7 m s-1										
Max blade width		C	4 m		Flight type		flapping											
Pitch		λ	15 degrees		% of flights upwind/downwind		50%		50%									
Blade profile		see Blade profile sheet																
		Single transit risk		upwind	6.14%													
				downwind	2.65%													
				weighted mean	4.39%													
Stage D																		
Proportion of time operational		Qop			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
				88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%		
				Collision rates before avoidance												year total		
				0.00	0.00	0.00	0.79	2.53	0.00	0.00	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	0.7 km															
		large array correction		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year		
				Collision rates allowing for avoidance														
Avoidance rates modelled				100.00%	0.00	0.00	0.00	0.79	2.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.3	
				100.00%	0.00	0.00	0.00	0.79	2.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.3	
				100.00%	0.00	0.00	0.00	0.79	2.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.3	
		95.00%		100.00%	0.00	0.00	0.00	0.04	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2	

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

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	Kestrel			Site name	Cush WF			Model	GE158								
	Bird length	L	0.34	m		Latitude	53.15028	degrees		Hub height	120.9	m						
	Wingspan	W	0.755	m		No of turbines	T	3		Rotor radius	R	79	m					
	Bird flight speed	v	12.7	m s-1		Width of windfarm	w	0.7	km		No of blades	b	3					
	Flight type, flapping or gliding		flapping								Rotation speed	Ω	8.4	rpm				
	% of flights upwind/downwind		50%	50%							Max blade width	C	4	m				
	Nocturnal activity ranking 1-5		1								Blade pitch	λ	15	degrees				
	Nocturnal activity factor	fnight	0%								Risk height range		42-200	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	DA	birds/km2		0.000905										0.0103	0.00569	0.000679	0.0015
	Proportion at rotor risk height	Q2R	62.98%															
	At latitude 53.2	Daylight hours per month		252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2		
		Nighttime hours per month		491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8		
Stage B																		
	No of turbines	T	3															
	Rotor radius	R	79 m															
		Total rotor frontal area m2		58820														
	Nocturnal activity factor	fnight	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		2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.4	16.0	1.7	57	
Stage C																		
	No of blades	b	3			Bird length	l	0.34 m										
	Rotation speed	Ω	8.4 rpm			Wingspan	w	0.755 m										
	Rotor radius	R	79 m			Bird flight speed	v	12.7 m s-1										
	Max blade width	C	4 m			Flight type		flapping										
	Pitch	λ	15 degrees			% of flights upwind/downwind		50%		50%								
	Blade profile		see Blade profile sheet															
		Single transit risk		upwind	6.14%													
				downwind	2.65%													
				weighted mean	4.39%													
Stage D					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
	Proportion of time operational	Qop	88.8% 90.5% 86.9% 85.6% 85.7% 83.1% 80.8% 82.4% 85.1% 89.8% 88.0% 88.9%														86.3%	
		Collision rates before avoidance														year total		
		0.10 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 1.44 0.62 0.07														2		
Stage E																		
	Allow for large array correction?		No															
	Width of windfarm	w	0.7 km															
		large array correction																
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year		
		Collision rates allowing for avoidance																
	Avoidance rates modelled			0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.44	0.62	0.07	2.2		
				0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.44	0.62	0.07	2.2		
				0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.44	0.62	0.07	2.2		
		95.00%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.03	0.00	0.1		

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

green

boxes are for information only, to show variables used at each stage

		Value		Units			Value		Units			Value		Units					
Bird data						Windfarm data				Turbine data									
	Species name		Kestrel				Site name		Cush WF		Model		GE158						
	Bird length	L	0.34		m		Latitude		53.15028	degrees	Hub height		120.9		m				
	Wingspan	W	0.755		m		No of turbines	T	3		Rotor radius	R	79		m				
	Bird flight speed	v	12.7		m s-1		Width of windfarm	w	0.7	km	No of blades	b	3						
	Flight type, flapping or gliding		flapping								Rotation speed	Ω	8.4		rpm				
	% of flights upwind/downwind		50%		50%						Max blade width	C	4		m				
	Nocturnal activity ranking 1-5		1								Blade pitch	λ	15		degrees				
	Nocturnal activity factor	fnight	0%								Risk height range		42-200		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	DA		birds/km2			0.000543												0.0000
	Proportion at rotor risk height	Q2R	69.29%																
	At latitude 53.2		Daylight hours per month				252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2
			Nighttime hours per month				491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8
Stage B																			
	No of turbines	T	3																
	Rotor radius	R	79	m															
			Total rotor frontal area m2				58820												
	Nocturnal activity factor	fnight	0%																
	Bird flight speed	v	12.7	m s-1			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
			Projected number of rotor transits				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	2
Stage C																			
	No of blades	b	3				Bird length	l	0.34	m									
	Rotation speed	Ω	8.4	rpm			Wingspan	w	0.755	m									
	Rotor radius	R	79	m			Bird flight speed	v	12.7	m s-1									
	Max blade width	C	4	m			Flight type		flapping										
	Pitch	λ	15	degrees			% of flights upwind/downwind		50%	50%									
	Blade profile		see Blade profile sheet																
			Single transit risk				upwind	6.14%											
							downwind	2.65%											
			weighted mean				4.39%												
Stage D							Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
	Proportion of time operational	Qop					88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%
							Collision rates before avoidance												year total
							0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0
Stage E																			
	Allow for large array correction?		No																
	Width of windfarm	w	0.7	km															
				large array correction			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
							Collision rates allowing for avoidance												
	Avoidance rates modelled			100.00%			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.1
				100.00%			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.1
				100.00%			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.1
			95.00%	100.00%			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

green

boxes are for information only, to show variables used at each stage

Value			Units		Value			Units		Value			Units				
Bird data			Windfarm data				Turbine data										
Species name		Lapwing	Site name		Cush WF		Model		GE158								
Bird length		L	0.3	m	Latitude		53.15028	degrees	Hub height		120.9	m					
Wingspan		W	0.84	m	No of turbines		T	3	Rotor radius		R	79	m				
Bird flight speed		v	12.3	m s-1	Width of windfarm		w	0.7	km	No of blades		b	3				
Flight type, flapping or gliding		flapping						Rotation speed		Ω	8.4	rpm					
% of flights upwind/downwind		50%		50%				Max blade width		C	4	m					
Nocturnal activity ranking 1-5		2						Blade pitch		λ	15	degrees					
Nocturnal activity factor		fnight	25%					Risk height range		42-200		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		DA	birds/km2		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year ave
Proportion at rotor risk height		Q2R	63.71%		0.0293 0.0232 0.172												0.0187
At latitude 53.2		Daylight hours per month		252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2	
		Nighttime hours per month		491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8	
Stage B																	
No of turbines		T	3														
Rotor radius		R	79 m														
		Total rotor frontal area m2		58820													
Nocturnal activity factor		fnight	25%														
Bird flight speed		v	12.3 m s-1		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
		Projected number of rotor transits		0.0	0.0	0.0	0.0	170.4	136.3	1025.4	0.0	0.0	0.0	0.0	0.0	0.0	1332
Stage C																	
No of blades		b	3		Bird length		l	0.3 m									
Rotation speed		Ω	8.4 rpm		Wingspan		w	0.84 m									
Rotor radius		R	79 m		Bird flight speed		v	12.3 m s-1									
Max blade width		C	4 m		Flight type		flapping										
Pitch		λ	15 degrees		% of flights upwind/downwind		50%		50%								
Blade profile		see Blade profile sheet															
		Single transit risk		upwind	6.16%												
				downwind	2.59%												
				weighted mean	4.38%												
Stage D																	
Proportion of time operational		Qop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year ave		
		88.8% 90.5% 86.9% 85.6% 85.7% 83.1% 80.8% 82.4% 85.1% 89.8% 88.0% 88.9%												86.3%			
		Collision rates before avoidance												year total			
		0.00 0.00 0.00 0.00 6.39 4.96 36.27 0.00 0.00 0.00 0.00 0.00												48			
Stage E																	
Allow for large array correction?		No															
Width of windfarm		w	0.7 km		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
		large array correction		Collision rates allowing for avoidance													
Avoidance rates modelled		100.00%		0.00	0.00	0.00	0.00	6.39	4.96	36.27	0.00	0.00	0.00	0.00	0.00	0.00	47.6
		99.80%		0.00	0.00	0.00	0.00	0.01	0.01	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.1
		99.50%		0.00	0.00	0.00	0.00	0.03	0.02	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.2
		98.00%		0.00	0.00	0.00	0.00	0.13	0.10	0.73	0.00	0.00	0.00	0.00	0.00	0.00	1.0

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		Lapwing			Site name		Cush WF			Model		GE158					
	Bird length	L	0.3	m		Latitude		53.15028	degrees		Hub height		120.9	m				
	Wingspan	W	0.84	m		No of turbines	T	3			Rotor radius	R	79	m				
	Bird flight speed	v	12.3	m s-1		Width of windfarm	w	0.7	km		No of blades	b	3					
	Flight type, flapping or gliding		flapping								Rotation speed	Ω	8.4	rpm				
	% of flights upwind/downwind		50%	50%							Max blade width	C	4	m				
	Nocturnal activity ranking 1-5		2								Blade pitch	λ	15	degrees				
	Nocturnal activity factor	fnight	25%								Risk height range		42-200	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	DA	birds/km2						0.0017	0.00543	0.00917	0.00255	0.00634					0.0021
	Proportion at rotor risk height	Q2R	49.86%															
	At latitude 53.2		Daylight hours per month			252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2
			Nighttime hours per month			491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8
Stage B																		
	No of turbines	T	3															
	Rotor radius	R	79	m														
			Total rotor frontal area m2		58820													
	Nocturnal activity factor	fnight	25%															
	Bird flight speed	v	12.3	m s-1														
			Projected number of rotor transits			0.0	0.0	0.0	6.9	24.7	42.2	11.9	27.6	0.0	0.0	0.0	0.0	113
Stage C																		
	No of blades	b	3															
	Rotation speed	Ω	8.4	rpm														
	Rotor radius	R	79	m														
	Max blade width	C	4	m														
	Pitch	λ	15	degrees														
	Blade profile		see Blade profile sheet															
			Single transit risk															
			upwind		6.16%													
			downwind		2.59%													
			weighted mean		4.38%													
Stage D						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year ave
	Proportion of time operational	Qop				88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%
			Collision rates before avoidance															
						0.00	0.00	0.00	0.26	0.93	1.53	0.42	1.00	0.00	0.00	0.00	0.00	year total
																		4
Stage E																		
	Allow for large array correction?		No															
	Width of windfarm	w	0.7	km														
			large array correction															
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance															
Avoidance rates modelled						0.00	0.00	0.00	0.26	0.93	1.53	0.42	1.00	0.00	0.00	0.00	0.00	4.1
			99.80%		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
			99.50%		100.00%	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.0
			98.00%		100.00%	0.00	0.00	0.00	0.01	0.02	0.03	0.01	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

			Value	Units				Value	Units				Value	Units				
Bird data					Windfarm data							Turbine data						
	Species name		Lapwing			Site name		Cush WF			Model		GE158					
	Bird length	L	0.3	m		Latitude		53.15028	degrees		Hub height		120.9	m				
	Wingspan	W	0.84	m		No of turbines	T	3			Rotor radius	R	79	m				
	Bird flight speed	v	12.3	m s-1		Width of windfarm	w	0.7	km		No of blades	b	3					
	Flight type, flapping or gliding		flapping								Rotation speed	Ω	8.4	rpm				
	% of flights upwind/downwind		50%	50%							Max blade width	C	4	m				
	Nocturnal activity ranking 1-5		2								Blade pitch	λ	15	degrees				
	Nocturnal activity factor	fnight	25%								Risk height range		42-200	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	DA	birds/km2												0.0285	0.0258	0.0045	
	Proportion at rotor risk height	Q2R	56.88%															
	At latitude 53.2		Daylight hours per month		252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2	
			Nighttime hours per month		491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8	
Stage B																		
	No of turbines	T	3															
	Rotor radius	R	79	m														
			Total rotor frontal area m2	58820														
	Nocturnal activity factor	fnight	25%															
	Bird flight speed	v	12.3	m s-1		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
			Projected number of rotor transits		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.6	88.0	189	
Stage C																		
	No of blades	b	3															
	Rotation speed	Ω	8.4	rpm														
	Rotor radius	R	79	m														
	Max blade width	C	4	m														
	Pitch	λ	15	degrees														
	Blade profile		see Blade profile sheet															
			Single transit risk															
			upwind	6.16%														
			downwind	2.59%														
			weighted mean	4.38%														
Stage D					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year ave	
	Proportion of time operational	Qop			88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%	
			Collision rates before avoidance															
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.88	3.43	7	
Stage E																		
	Allow for large array correction?		No															
	Width of windfarm	w	0.7	km														
			large array correction															
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year	
			Collision rates allowing for avoidance															
Avoidance rates modelled					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.88	3.43	7.3	
			99.80%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.0	
			99.50%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.0	
			98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.07	0.1	

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

green

boxes are for information only, to show variables used at each stage

Value			Units	Value			Units	Value			Units					
Bird data				Windfarm data				Turbine data								
Species name		Lapwing		Site name		Cush WF		Model		GE158						
Bird length		L	0.3	Latitude		53.15028		Hub height		120.9						
Wingspan		W	0.84	No of turbines		T	3	Rotor radius		R	79					
Bird flight speed		v	12.3	Width of windfarm		w	0.7	No of blades		b	3					
Flight type, flapping or gliding		flapping						Rotation speed		Ω	8.4					
% of flights upwind/downwind		50%						Max blade width		C	4					
Nocturnal activity ranking 1-5		2						Blade pitch		λ	15					
Nocturnal activity factor		fnight	25%					Risk height range		42-200						
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		DA	birds/km2		0.0148										0.0019	
Proportion at rotor risk height		Q2R	51.61%													
At latitude 53.2		Daylight hours per month		252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2
		Nighttime hours per month		491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8
Stage B			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total	
No of turbines		T	3													
Rotor radius		R	79 m													
		Total rotor frontal area m2		58820												
Nocturnal activity factor		fnight	25%													
Bird flight speed		v	12.3 m s-1													
		Projected number of rotor transits		0.0	47.1	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	80	
Stage C			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total	
No of blades		b	3		Bird length		l	0.3 m								
Rotation speed		Ω	8.4 rpm		Wingspan		w	0.84 m								
Rotor radius		R	79 m		Bird flight speed		v	12.3 m s-1								
Max blade width		C	4 m		Flight type		flapping									
Pitch		λ	15 degrees		% of flights upwind/downwind		50%		50%							
Blade profile		see Blade profile sheet														
		Single transit risk		upwind	6.16%											
				downwind	2.59%											
				weighted mean	4.38%											
Stage D			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
Proportion of time operational		Qop	88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%	
		Collision rates before avoidance												year total		
				0.00	1.86	1.27	0.00	0.00	0.00	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?		No														
Width of windfarm		w	0.7 km													
		large array correction														
Avoidance rates modelled				100.00%	0.00	1.86	1.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.1	
		99.80%		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	
		99.50%		100.00%	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	
		98.00%		100.00%	0.00	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.1	

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

green

boxes are for information only, to show variables used at each stage

Value				Units	Value				Units	Value				Units		
Bird data		Windfarm data			Turbine data											
Species name		Mallard		Site name		Cush WF		Model		GE158						
Bird length	L	0.58	m	Latitude		53.15028	degrees	Hub height		120.9	m					
Wingspan	W	0.9	m	No of turbines	T	3		Rotor radius	R	79	m					
Bird flight speed	v	22	m s-1	Width of windfarm	w	0.7	km	No of blades	b	3						
Flight type, flapping or gliding		flapping						Rotation speed	Ω	8.4	rpm					
% of flights upwind/downwind		50%	50%					Max blade width	C	4	m					
Nocturnal activity ranking 1-5		2						Blade pitch	λ	15	degrees					
Nocturnal activity factor	fnight	25%						Risk height range		42-200	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	DA	birds/km2		0.00407												0.0008
Proportion at rotor risk height	Q2R	50.30%														
At latitude 53.2		Daylight hours per month		252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2
		Nighttime hours per month		491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8
Stage B				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	3														
Rotor radius	R	79 m														
		Total rotor frontal area m2		58820												
Nocturnal activity factor	fnight	25%														
Bird flight speed	v	22 m s-1														
		Projected number of rotor transits		0.0	0.0	0.0	29.8	33.4	16.9	0.0	0.0	0.0	0.0	0.0	0.0	80
Stage C				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3		Bird length	l	0.58 m										
Rotation speed	Ω	8.4 rpm		Wingspan	w	0.9 m										
Rotor radius	R	79 m		Bird flight speed	v	22 m s-1										
Max blade width	C	4 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	3.29%											
				weighted mean	4.36%											
Stage D				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational	Qop	88.8% 90.5% 86.9% 85.6% 85.7% 83.1% 80.8% 82.4% 85.1% 89.8% 88.0% 88.9%												86.3%		
		Collision rates before avoidance														
		0.00 0.00 0.00 1.11 1.25 0.61 0.00 0.00 0.00 0.00 0.00 0.00												year total		
														3		
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	0.7 km														
		large array correction														
Avoidance rates modelled		100.00%		0.00	0.00	0.00	1.11	1.25	0.61	0.00	0.00	0.00	0.00	0.00	0.00	3.0
		100.00%		0.00	0.00	0.00	1.11	1.25	0.61	0.00	0.00	0.00	0.00	0.00	0.00	3.0
		100.00%		0.00	0.00	0.00	1.11	1.25	0.61	0.00	0.00	0.00	0.00	0.00	0.00	3.0
		98.00%		0.00	0.00	0.00	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.1

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

green

boxes are for information only, to show variables used at each stage

Bird data				Value	Units	Windfarm data				Value	Units	Turbine data				Value	Units	
Species name			Mallard			Site name			Cush WF			Model			GE158			
Bird length		L	0.58	m	Latitude			53.15028	degrees	Hub height			120.9	m				
Wingspan		W	0.9	m	No of turbines		T	3		Rotor radius		R	79	m				
Bird flight speed		v	22	m s-1	Width of windfarm		w	0.7	km	No of blades		b	3					
Flight type, flapping or gliding			flapping			Rotation speed		Ω	8.4	rpm	Max blade width		C	4	m			
% of flights upwind/downwind			50%	50%	Blade pitch		λ	15	degrees									
Nocturnal activity ranking 1-5			2			Risk height range				42-200		m						
Nocturnal activity factor		fnight	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																		
Daytime bird density		DA	birds/km2		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
Proportion at rotor risk height		Q2R	70.00%		0.0229												0.0019	
At latitude 53.2		Daylight hours per month		252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2		
		Nighttime hours per month		491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8		
Stage B																		
No of turbines		T	3															
Rotor radius		R	79 m															
		Total rotor frontal area m2		58820														
Nocturnal activity factor		fnight	25%															
Bird flight speed		v	22 m s-1		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total	
		Projected number of rotor transits		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	177.9	0.0	178	
Stage C																		
No of blades		b	3		Bird length		l	0.58	m									
Rotation speed		Ω	8.4 rpm		Wingspan		w	0.9	m									
Rotor radius		R	79 m		Bird flight speed		v	22	m s-1									
Max blade width		C	4 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	3.29%													
				weighted mean	4.36%													
Stage D																		
Proportion of time operational		Qop			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
				88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%		
				Collision rates before avoidance												year total		
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.83	0.00	7	
Stage E																		
Allow for large array correction?			No															
Width of windfarm		w	0.7 km															
		large array correction		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year		
				Collision rates allowing for avoidance														
Avoidance rates modelled				100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.83	0.00	6.8	
				100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.83	0.00	6.8	
				100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.83	0.00	6.8	
				98.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.1	

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

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COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

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boxes

green

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Value				Units		Value				Units		Value				Units		
Bird data				Windfarm data				Turbine data										
Species name		Peregrine		Site name		Cush WF		Model		GE158								
Bird length		L	0.45	m		Latitude		53.15028		degrees		Hub height		120.9		m		
Wingspan		W	1.1	m		No of turbines		T	3				Rotor radius		R	79	m	
Bird flight speed		v	14	m s-1		Width of windfarm		w	0.7		km		No of blades		b	3		
Flight type, flapping or gliding		flapping										Rotation speed		Ω	8.4		rpm	
% of flights upwind/downwind		50%		50%								Max blade width		C	4		m	
Nocturnal activity ranking 1-5		1										Blade pitch		λ	15		degrees	
Nocturnal activity factor		fnight	0%										Risk height range		42-200		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		DA	birds/km2		0.00124										0.00306		0.0004	
Proportion at rotor risk height		Q2R	66.24%															
At latitude 53.2		Daylight hours per month		252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2		
		Nighttime hours per month		491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8		
Stage B				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total		
No of turbines		T	3															
Rotor radius		R	79 m															
		Total rotor frontal area m2		58820														
Nocturnal activity factor		fnight	0%															
Bird flight speed		v	14 m s-1															
		Projected number of rotor transits		0.0	0.0	0.0	0.0	0.0	7.8	19.4	0.0	0.0	0.0	0.0	0.0	27		
Stage C				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total		
No of blades		b	3		Bird length		l	0.45 m										
Rotation speed		Ω	8.4 rpm		Wingspan		w	1.1 m										
Rotor radius		R	79 m		Bird flight speed		v	14 m s-1										
Max blade width		C	4 m		Flight type		flapping											
Pitch		λ	15 degrees		% of flights upwind/downwind		50%		50%									
Blade profile		see Blade profile sheet																
		Single transit risk		upwind		6.33%												
				downwind		3.07%												
				weighted mean		4.70%												
Stage D				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge		
Proportion of time operational		Qop	88.8% 90.5% 86.9% 85.6% 85.7% 83.1% 80.8% 82.4% 85.1% 89.8% 88.0% 88.9%										86.3%					
		Collision rates before avoidance												year total				
		0.00 0.00 0.00 0.00 0.00 0.30 0.74 0.00 0.00 0.00 0.00 0.00										1						
Stage E				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year		
Allow for large array correction?		No																
Width of windfarm		w	0.7 km															
		large array correction		Collision rates allowing for avoidance														
Avoidance rates modelled		100.00%		0.00	0.00	0.00	0.00	0.00	0.30	0.74	0.00	0.00	0.00	0.00	0.00	1.0		
		100.00%		0.00	0.00	0.00	0.00	0.00	0.30	0.74	0.00	0.00	0.00	0.00	0.00	1.0		
		100.00%		0.00	0.00	0.00	0.00	0.00	0.30	0.74	0.00	0.00	0.00	0.00	0.00	1.0		
		98.00%		0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.0		

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

green

boxes are for information only, to show variables used at each stage

		Value		Units			Value		Units			Value		Units				
Bird data					Windfarm data							Turbine data						
	Species name		Peregrine			Site name		Cush WF			Model		GE158					
	Bird length	L	0.45	m		Latitude		53.15028	degrees		Hub height		120.9	m				
	Wingspan	W	1.1	m		No of turbines	T	3			Rotor radius	R	79	m				
	Bird flight speed	v	14	m s-1		Width of windfarm	w	0.7	km		No of blades	b	3					
	Flight type, flapping or gliding		flapping								Rotation speed	Ω	8.4	rpm				
	% of flights upwind/downwind		50%	50%							Max blade width	C	4	m				
	Nocturnal activity ranking 1-5		1								Blade pitch	λ	15	degrees				
	Nocturnal activity factor	fnight	0%								Risk height range		42-200	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	DA	birds/km2												0.00132		0.0001	
	Proportion at rotor risk height	Q2R	61.86%															
	At latitude 53.2		Daylight hours per month		252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2	
			Nighttime hours per month		491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8	
Stage B																		
	No of turbines	T	3															
	Rotor radius	R	79	m														
			Total rotor frontal area m2	58820														
	Nocturnal activity factor	fnight	0%															
	Bird flight speed	v	14	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	4.0	0.0	4
Stage C																		
	No of blades	b	3			Bird length	l	0.45	m									
	Rotation speed	Ω	8.4	rpm		Wingspan	w	1.1	m									
	Rotor radius	R	79	m		Bird flight speed	v	14	m s-1									
	Max blade width	C	4	m		Flight type		flapping										
	Pitch	λ	15	degrees		% of flights upwind/downwind		50%	50%									
	Blade profile		see Blade profile sheet															
			Single transit risk															
			upwind	6.33%														
			downwind	3.07%														
			weighted mean	4.70%														
Stage D					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
	Proportion of time operational	Qop			88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%	
			Collision rates before avoidance														year total	
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0	
Stage E																		
	Allow for large array correction?		No															
	Width of windfarm	w	0.7	km														
			large array correction															
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year	
			Collision rates allowing for avoidance															
	Avoidance rates modelled			100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.2	
				100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.2	
				100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.2	
		98.00%		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

green

boxes are for information only, to show variables used at each stage

Bird data					Value	Units	Windfarm data					Value	Units	Turbine data					Value	Units
Species name			Peregrine				Site name		Cush WF				Model		GE158					
Bird length		L	0.45		m		Latitude		53.15028		degrees		Hub height		120.9		m			
Wingspan		W	1.1		m		No of turbines		T	3				Rotor radius		R	79 m			
Bird flight speed		v	14		m s-1		Width of windfarm		w	0.7		km		No of blades		b	3			
Flight type, flapping or gliding			flapping											Rotation speed		Ω	8.4 rpm			
% of flights upwind/downwind			50%		50%									Max blade width		C	4 m			
Nocturnal activity ranking 1-5			1											Blade pitch		λ	15 degrees			
Nocturnal activity factor		fnight	0%											Risk height range		42-200 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		DA	birds/km2				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year ave	
Proportion at rotor risk height		Q2R	55.44%				0.00407												0.0003	
At latitude 53.2			Daylight hours per month				252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2	
			Nighttime hours per month				491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8	
Stage B																				
No of turbines		T	3																	
Rotor radius		R	79 m																	
Total rotor frontal area m2			58820																	
Nocturnal activity factor		fnight	0%																	
Bird flight speed		v	14 m s-1				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total	
Projected number of rotor transits							0.0	11.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12	
Stage C																				
No of blades		b	3				Bird length		l	0.45 m										
Rotation speed		Ω	8.4 rpm				Wingspan		w	1.1 m										
Rotor radius		R	79 m				Bird flight speed		v	14 m s-1										
Max blade width		C	4 m				Flight type			flapping										
Pitch		λ	15 degrees				% of flights upwind/downwind			50%		50%								
Blade profile			see Blade profile sheet																	
Single transit risk							upwind		6.33%											
							downwind		3.07%											
weighted mean							4.70%													
Stage D																				
Proportion of time operational		Qop					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year ave	
							88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%	
Collision rates before avoidance																				year total
							0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
Stage E																				
Allow for large array correction?			No																	
Width of windfarm		w	0.7 km																	
large array correction							Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year	
Collision rates allowing for avoidance																				
Avoidance rates modelled							0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.5	
							0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.5	
							0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.5	
			98.00%				0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

green

boxes are for information only, to show variables used at each stage

Value			Units	Value			Units	Value			Units					
Bird data				Windfarm data				Turbine data								
Species name		Snipe		Site name		Cush WF		Model		GE158						
Bird length	L	0.26	m	Latitude		53.15028	degrees	Hub height		120.9	m					
Wingspan	W	0.455	m	No of turbines	T	3		Rotor radius	R	79	m					
Bird flight speed	v	16	m s-1	Width of windfarm	w	0.7	km	No of blades	b	3						
Flight type, flapping or gliding		flapping						Rotation speed	Ω	8.4	rpm					
% of flights upwind/downwind		50%	50%					Max blade width	C	4	m					
Nocturnal activity ranking 1-5		3						Blade pitch	λ	15	degrees					
Nocturnal activity factor	fnight	50%						Risk height range		42-200	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	DA	birds/km2		0.00017												0.0034
Proportion at rotor risk height	Q2R	59.18%														
At latitude 53.2		Daylight hours per month		252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2
		Nighttime hours per month		491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8
Stage B				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines	T	3														
Rotor radius	R	79 m														
		Total rotor frontal area m2		58820												
Nocturnal activity factor	fnight	50%														
Bird flight speed	v	16 m s-1														
		Projected number of rotor transits		0.0	0.0	0.0	0.0	1.3	140.0	177.3	0.0	0.0	0.0	0.0	0.0	319
Stage C				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades	b	3		Bird length	l	0.26 m										
Rotation speed	Ω	8.4 rpm		Wingspan	w	0.455 m										
Rotor radius	R	79 m		Bird flight speed	v	16 m s-1										
Max blade width	C	4 m		Flight type		flapping										
Pitch	λ	15 degrees		% of flights upwind/downwind		50%		50%								
Blade profile		see Blade profile sheet														
		Single transit risk		upwind	5.25%											
				downwind	2.35%											
				weighted mean	3.80%											
Stage D				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year ave
Proportion of time operational	Qop	88.8% 90.5% 86.9% 85.6% 85.7% 83.1% 80.8% 82.4% 85.1% 89.8% 88.0% 88.9%												86.3%		
		Collision rates before avoidance														
		0.00 0.00 0.00 0.00 0.04 4.42 5.44 0.00 0.00 0.00 0.00 0.00												year total 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	0.7 km														
		large array correction														
Avoidance rates modelled		100.00%		0.00	0.00	0.00	0.00	0.04	4.42	5.44	0.00	0.00	0.00	0.00	0.00	9.9
		100.00%		0.00	0.00	0.00	0.00	0.04	4.42	5.44	0.00	0.00	0.00	0.00	0.00	9.9
		100.00%		0.00	0.00	0.00	0.00	0.04	4.42	5.44	0.00	0.00	0.00	0.00	0.00	9.9
		98.00%		0.00	0.00	0.00	0.00	0.00	0.09	0.11	0.00	0.00	0.00	0.00	0.00	0.2

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

green

boxes are for information only, to show variables used at each stage

			Value	Units				Value	Units				Value	Units				
Bird data					Windfarm data							Turbine data						
	Species name		Snipe			Site name		Cush WF			Model		GE158					
	Bird length	L	0.26	m		Latitude		53.15028	degrees		Hub height		120.9	m				
	Wingspan	W	0.455	m		No of turbines	T	3			Rotor radius	R	79	m				
	Bird flight speed	v	16	m s-1		Width of windfarm	w	0.7	km		No of blades	b	3					
	Flight type, flapping or gliding		flapping								Rotation speed	Ω	8.4	rpm				
	% of flights upwind/downwind		50%	50%							Max blade width	C	4	m				
	Nocturnal activity ranking 1-5		3								Blade pitch	λ	15	degrees				
	Nocturnal activity factor	fnight	50%								Risk height range		42-200	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	DA	birds/km2						0.0124	0.0105	0.00136						0.0020	
	Proportion at rotor risk height	Q2R	43.66%															
	At latitude 53.2		Daylight hours per month		252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2	
			Nighttime hours per month		491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8	
Stage B																		
	No of turbines	T	3															
	Rotor radius	R	79	m														
			Total rotor frontal area m2		58820													
	Nocturnal activity factor	fnight	50%															
	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	71.6	60.3	8.0	0.0	0.0	0.0	0.0	0.0	140	
Stage C																		
	No of blades	b	3															
	Rotation speed	Ω	8.4	rpm														
	Rotor radius	R	79	m														
	Max blade width	C	4	m														
	Pitch	λ	15	degrees														
	Blade profile		see Blade profile sheet															
			Single transit risk		upwind	5.25%												
					downwind	2.35%												
					weighted mean	3.80%												
Stage D					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year ave	
	Proportion of time operational	Qop			88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%	
			Collision rates before avoidance														year total	
					0.00	0.00	0.00	0.00	2.33	1.90	0.24	0.00	0.00	0.00	0.00	0.00	4	
Stage E																		
	Allow for large array correction?		No															
	Width of windfarm	w	0.7	km														
			large array correction															
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year	
			Collision rates allowing for avoidance															
	Avoidance rates modelled			100.00%	0.00	0.00	0.00	0.00	2.33	1.90	0.24	0.00	0.00	0.00	0.00	0.00	4.5	
				100.00%	0.00	0.00	0.00	0.00	2.33	1.90	0.24	0.00	0.00	0.00	0.00	0.00	4.5	
				100.00%	0.00	0.00	0.00	0.00	2.33	1.90	0.24	0.00	0.00	0.00	0.00	0.00	4.5	
			98.00%	100.00%	0.00	0.00	0.00	0.00	0.05	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.1	

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

green

boxes are for information only, to show variables used at each stage

			Value	Units				Value	Units				Value	Units				
Bird data					Windfarm data							Turbine data						
	Species name		Snipe		Site name		Cush WF		Model		GE158							
	Bird length	L	0.26	m	Latitude		53.15028	degrees	Hub height		120.9	m						
	Wingspan	W	0.455	m	No of turbines	T	3		Rotor radius	R	79	m						
	Bird flight speed	v	16	m s-1	Width of windfarm	w	0.7	km	No of blades	b	3							
	Flight type, flapping or gliding		flapping						Rotation speed	Ω	8.4	rpm						
	% of flights upwind/downwind		50%	50%					Max blade width	C	4	m						
	Nocturnal activity ranking 1-5		3						Blade pitch	λ	15	degrees						
	Nocturnal activity factor	fnight	50%						Risk height range		42-200	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	DA	birds/km2		0.00249									0.00306		0.000679	0.0005	
	Proportion at rotor risk height	Q2R	51.82%															
	At latitude 53.2		Daylight hours per month		252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2	
			Nighttime hours per month		491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8	
Stage B																		
	No of turbines	T	3															
	Rotor radius	R	79	m														
			Total rotor frontal area m2	58820														
	Nocturnal activity factor	fnight	50%															
	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		13.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.3	0.0	3.7	36
Stage C																		
	No of blades	b	3		Bird length	l	0.26	m										
	Rotation speed	Ω	8.4	rpm	Wingspan	w	0.455	m										
	Rotor radius	R	79	m	Bird flight speed	v	16	m s-1										
	Max blade width	C	4	m	Flight type		flapping											
	Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%										
	Blade profile		see Blade profile sheet															
			Single transit risk		upwind	5.25%												
					downwind	2.35%												
					weighted mean	3.80%												
Stage D					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
	Proportion of time operational	Qop			88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%	
			Collision rates before avoidance														year total	
					0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.62	0.00	0.13	1	
Stage E																		
	Allow for large array correction?		No															
	Width of windfarm	w	0.7	km														
			large array correction		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year	
			Collision rates allowing for avoidance															
	Avoidance rates modelled			100.00%	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.62	0.00	0.13	1.2	
				100.00%	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.62	0.00	0.13	1.2	
				100.00%	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.62	0.00	0.13	1.2	
			98.00%	100.00%	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.0	

Required input data is in
Calculated output is in

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COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

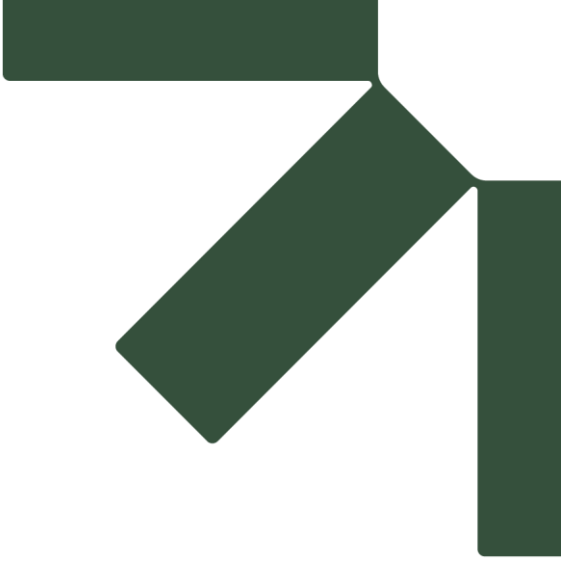
blue

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		Whooper swan						Site name		Cush WF						Model		GE158					
Bird length	L	1.52	m					Latitude		53.15028	degrees					Hub height		120.9	m				
Wingspan	W	2.3	m					No of turbines	T	3						Rotor radius	R	79	m				
Bird flight speed	v	17.3	m s ⁻¹					Width of windfarm	w	0.7	km					No of blades	b	3					
Flight type, flapping or gliding		flapping														Rotation speed	Ω	8.4	rpm				
% of flights upwind/downwind		50%	50%													Max blade width	C	4	m				
Nocturnal activity ranking 1-5		2														Blade pitch	λ	15	degrees				
Nocturnal activity factor	fnight	25%														Risk height range		42-200	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	DA	birds/km2						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		year avge		
Proportion at rotor risk height	Q2R	28.12%						0.000905													0.0001		
At latitude 53.2		Daylight hours per month						252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0		4486.2		
		Nighttime hours per month						491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0		4273.8		
Stage B																							
No of turbines	T	3																					
Rotor radius	R	79	m																				
		Total rotor frontal area m2						58820															
Nocturnal activity factor	fnight	25%																					
Bird flight speed	v	17.3	m s ⁻¹																				
		Projected number of rotor transits						2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		year total		
																					2		
Stage C																							
No of blades	b	3																					
Rotation speed	Ω	8.4	rpm																				
Rotor radius	R	79	m																				
Max blade width	C	4	m																				
Pitch	λ	15	degrees																				
Blade profile		see Blade profile sheet																					
		Single transit risk																					
		upwind						8.51%															
		downwind						5.81%															
		weighted mean						7.16%															
Stage D																							
Proportion of time operational	Qop							88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%		year avge		
		Collision rates before avoidance																			year total		
								0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0		
Stage E																							
Allow for large array correction?		No																					
Width of windfarm	w	0.7	km																				
		large array correction																					
								Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		per year		
								Collision rates allowing for avoidance															
Avoidance rates modelled			100.00%					0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.1		
			100.00%					0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.1		
			100.00%					0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.1		
		99.50%	100.00%					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0		



Appendix B NatureScot Spreadsheets – 175 m RD Representative Permutation (E175)

Avian Collision Risk Report

Cush Wind Farm Phase II

Cush Wind Limited

SLR Project No.: 501.065723.00001

23 October 2026

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

green

boxes are for information only, to show variables used at each stage

Value				Units		Value				Units		Value				Units																		
Bird data		Windfarm data				Turbine data																												
Species name		Black-headed gull		Site name		Cush WF		Model		E175																								
Bird length		L	0.355	m		Latitude		53.15028		degrees		Hub height		111.6		m																		
Wingspan		W	1.05	m		No of turbines		T	3				Rotor radius		R	87.5		m																
Bird flight speed		v	11.9	m s-1		Width of windfarm		w	0.7		km		No of blades		b	3																		
Flight type, flapping or gliding		flapping										Rotation speed		Ω	6.7		rpm																	
% of flights upwind/downwind		50%		50%								Max blade width		C	4.01		m																	
Nocturnal activity ranking 1-5		1										Blade pitch		λ	15		degrees																	
Nocturnal activity factor		fnight	0%										Risk height range		24-199		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		DA	birds/km2								0.153		0.0124														0.0138							
Proportion at rotor risk height		Q2R	62.80%																															
At latitude 53.2		Daylight hours per month		252.7		274.3		366.4		418.1		490.3		505.8		508.9		458.2		382.4		330.1		262.0		237.0		4486.2						
		Nighttime hours per month		491.3		397.7		377.6		301.9		253.7		214.2		235.1		285.8		337.6		413.9		458.0		507.0		4273.8						
Stage B																																		
No of turbines		T	3																															
Rotor radius		R	87.5		m																													
		Total rotor frontal area m2		72158																														
Nocturnal activity factor		fnight	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		832.1		69.6		0.0		0.0		0.0		0.0		0.0		0.0		0.0		902				
Stage C																																		
No of blades		b	3						Bird length		l	0.355		m																				
Rotation speed		Ω	6.7		rpm				Wingspan		w	1.05		m																				
Rotor radius		R	87.5		m				Bird flight speed		v	11.9		m s-1																				
Max blade width		C	4.01		m				Flight type		flapping		50%		50%																			
Pitch		λ	15		degrees				% of flights upwind/downwind		50%		50%																					
Blade profile		see Blade profile sheet																																
		Single transit risk		upwind		5.60%																												
				downwind		2.57%																												
				weighted mean		4.08%																												
Stage D																																		
Proportion of time operational		Qop	88.8%		90.5%		86.9%		85.6%		85.7%		83.1%		80.8%		82.4%		85.1%		89.8%		88.0%		88.9%		86.3%							
		Collision rates before avoidance		0.00		0.00		0.00		0.00		29.11		2.36		0.00		0.00		0.00		0.00		0.00		0.00		0.00		year total				
				0.00		0.00		0.00		0.00		29.11		2.36		0.00		0.00		0.00		0.00		0.00		0.00		0.00		31				
Stage E																																		
Allow for large array correction?		No																																
Width of windfarm		w	0.7		km																													
		large array correction																																
				Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		per year						
Avoidance rates modelled		Collision rates allowing for avoidance		0.00		0.00		0.00		0.00		29.11		2.36		0.00		0.00		0.00		0.00		0.00		0.00		31.5						
				0.00		0.00		0.00		0.00		29.11		2.36		0.00		0.00		0.00		0.00		0.00		0.00		31.5						
				0.00		0.00		0.00		0.00		29.11		2.36		0.00		0.00		0.00		0.00		0.00		0.00		31.5						
		99.20%		0.00		0.00		0.00		0.00		0.23		0.02		0.00		0.00		0.00		0.00		0.00		0.00		0.3						

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

green

boxes are for information only, to show variables used at each stage

		Value		Units			Value		Units			Value		Units				
Bird data					Windfarm data				Turbine data									
	Species name	Black-headed gull			Site name	Cush WF			Model	E175								
	Bird length	L	0.355	m	Latitude	53.15028			degrees	Hub height	111.6			m				
	Wingspan	W	1.05	m	No of turbines	T	3			Rotor radius	R	87.5			m			
	Bird flight speed	v	11.9	m s-1	Width of windfarm	w	0.7			km	No of blades	b	3					
	Flight type, flapping or gliding	flapping								Rotation speed	Ω	6.7			rpm			
	% of flights upwind/downwind	50%								Max blade width	C	4.01			m			
	Nocturnal activity ranking 1-5	1								Blade pitch	λ	15			degrees			
	Nocturnal activity factor	fnight	0%								Risk height range	24-199			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	DA	birds/km2		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
	Proportion at rotor risk height	Q2R	64.43%		0.0542												0.0292	0.0070
	At latitude 53.2	Daylight hours per month			252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2	
		Nighttime hours per month			491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8	
Stage B																		
	No of turbines	T	3															
	Rotor radius	R	87.5 m															
		Total rotor frontal area m2			72158													
	Nocturnal activity factor	fnight	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	257.9	0.0	168.1	0.0	0.0	0.0	0.0	0.0	0.0	426	
Stage C																		
	No of blades	b	3		Bird length	l	0.355 m											
	Rotation speed	Ω	6.7 rpm		Wingspan	w	1.05 m											
	Rotor radius	R	87.5 m		Bird flight speed	v	11.9 m s-1											
	Max blade width	C	4.01 m		Flight type	flapping												
	Pitch	λ	15 degrees		% of flights upwind/downwind	50%		50%										
	Blade profile	see Blade profile sheet																
		Single transit risk			upwind	5.60%												
					downwind	2.57%												
					weighted mean	4.08%												
Stage D																		
	Proportion of time operational	Qop			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
					88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%	
					Collision rates before avoidance												year total	
					0.00	0.00	0.00	9.02	0.00	5.70	0.00	0.00	0.00	0.00	0.00	0.00	15	
Stage E																		
	Allow for large array correction?	No																
	Width of windfarm	w	0.7 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												14.7	
				100.00%	0.00	0.00	0.00	9.02	0.00	5.70	0.00	0.00	0.00	0.00	0.00	0.00	14.7	
				100.00%	0.00	0.00	0.00	9.02	0.00	5.70	0.00	0.00	0.00	0.00	0.00	0.00	14.7	
		99.20%		100.00%	0.00	0.00	0.00	0.07	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.1	

Required input data is in
Calculated output is in

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COLLISION RISK MODEL

Required input data is in

orange

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Calculated output is in

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			Value	Units				Value	Units				Value	Units						
Bird data						Windfarm data						Turbine data								
Species name			Little egret				Site name		Cush WF		Model		E175							
Bird length		L	0.6	m			Latitude		53.15028		Hub height		111.6	m						
Wingspan		W	0.915	m			No of turbines		T	3	Rotor radius		R	87.5	m					
Bird flight speed		v	10.4	m s-1			Width of windfarm		w	0.7	No of blades		b	3						
Flight type, flapping or gliding			flapping								Rotation speed		Ω	6.7	rpm					
% of flights upwind/downwind			50%		50%						Max blade width		C	4.01	m					
Nocturnal activity ranking 1-5			1								Blade pitch		λ	15	degrees					
Nocturnal activity factor			fnight	0%							Risk height range		24-199		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		DA	birds/km2		Jan		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge		
Proportion at rotor risk height		Q2R	64.56%		0.0213													0.0018		
At latitude 53.2		Daylight hours per month		252.7		274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2			
		Nighttime hours per month		491.3		397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8			
Stage B																				
No of turbines		T	3																	
Rotor radius		R	87.5		m															
		Total rotor frontal area m2		72158																
Nocturnal activity factor		fnight	0%																	
Bird flight speed		v	10.4		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	107.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	107
Stage C																				
No of blades		b	3				Bird length		l	0.6		m								
Rotation speed		Ω	6.7		rpm		Wingspan		w	0.915		m								
Rotor radius		R	87.5		m		Bird flight speed		v	10.4		m s-1								
Max blade width		C	4.01		m		Flight type		flapping											
Pitch		λ	15		degrees		% of flights upwind/downwind		50%		50%									
Blade profile		see Blade profile sheet																		
		Single transit risk		upwind		6.56%														
				downwind		3.23%														
				weighted mean		4.90%														
Stage D																				
Proportion of time operational		Qop	88.8%		90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%			year avge		
		Collision rates before avoidance		0.00		0.00	0.00	0.00	0.00	4.37	0.00	0.00	0.00	0.00	0.00	0.00				
																		year total		
																		4		
Stage E																				
Allow for large array correction?			No																	
Width of windfarm		w	0.7		km															
		large array correction																		
						Jan		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year	
		Collision rates allowing for avoidance																		
Avoidance rates modelled				100.00%		0.00		0.00	0.00	0.00	0.00	4.37	0.00	0.00	0.00	0.00	0.00	0.00	4.4	
				100.00%		0.00		0.00	0.00	0.00	0.00	4.37	0.00	0.00	0.00	0.00	0.00	0.00	4.4	
				100.00%		0.00		0.00	0.00	0.00	0.00	4.37	0.00	0.00	0.00	0.00	0.00	0.00	4.4	
		98.00%		100.00%		0.00		0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.1	

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COLLISION RISK MODEL

Required input data is in

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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	Hen harrier				Site name	Cush WF			Model	E175							
	Bird length	L	0.48	m		Latitude	53.15028		degrees	Hub height		111.6	m					
	Wingspan	W	1.1	m		No of turbines	T	3		Rotor radius	R	87.5	m					
	Bird flight speed	v	8	m s-1		Width of windfarm	w	0.7	km	No of blades	b	3						
	Flight type, flapping or gliding	flapping								Rotation speed	Ω	6.7	rpm					
	% of flights upwind/downwind	50%			50%					Max blade width	C	4.01	m					
	Nocturnal activity ranking 1-5	1								Blade pitch	λ	15	degrees					
	Nocturnal activity factor	fnight	0%							Risk height range	24-199			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	DA	birds/km2			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
	Proportion at rotor risk height	Q2R	86.85%			0.0113												0.0009
	At latitude 53.2	Daylight hours per month			252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2	
		Nighttime hours per month			491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8	
Stage B																		
	No of turbines	T	3															
	Rotor radius	R	87.5 m															
		Total rotor frontal area m2			72158													
	Nocturnal activity factor	fnight	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			29.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29
Stage C																		
	No of blades	b	3			Bird length	l	0.48 m										
	Rotation speed	Ω	6.7 rpm			Wingspan	w	1.1 m										
	Rotor radius	R	87.5 m			Bird flight speed	v	8 m s-1										
	Max blade width	C	4.01 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	3.38%												
					weighted mean	5.30%												
Stage D																		
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
	Proportion of time operational	Qop	88.8% 90.5% 86.9% 85.6% 85.7% 83.1% 80.8% 82.4% 85.1% 89.8% 88.0% 88.9%												86.3%			
		Collision rates before avoidance																
		1.39 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00												year total				
														1				
Stage E																		
	Allow for large array correction?	No																
	Width of windfarm	w	0.7 km															
				large array correction		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
					Collision rates allowing for avoidance													
	Avoidance rates modelled			100.00%	1.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.4
				100.00%	1.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.4
				100.00%	1.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.4
		99.00%		100.00%	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

COLLISION RISK MODEL

Required input data is in

orange

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Calculated output is in

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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	Hen harrier				Site name	Cush WF			Model	E175								
	Bird length	L	0.48	m		Latitude	53.15028		degrees		Hub height		111.6	m					
	Wingspan	W	1.1	m		No of turbines	T	3			Rotor radius	R	87.5	m					
	Bird flight speed	v	8	m s-1		Width of windfarm	w	0.7	km		No of blades	b	3						
	Flight type, flapping or gliding	flapping									Rotation speed	Ω	6.7	rpm					
	% of flights upwind/downwind	50%			50%						Max blade width	C	4.01	m					
	Nocturnal activity ranking 1-5	1									Blade pitch	λ	15	degrees					
	Nocturnal activity factor	fnight	0%								Risk height range	24-199			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	DA	birds/km2			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
	Proportion at rotor risk height	Q2R	79.63%			0.00299												0.002	0.0004
	At latitude 53.2	Daylight hours per month			252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2		
		Nighttime hours per month			491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8		
Stage B																			
	No of turbines	T	3																
	Rotor radius	R	87.5		m														
		Total rotor frontal area m2			72158														
	Nocturnal activity factor	fnight	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	7.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	12	
Stage C																			
	No of blades	b	3																
	Rotation speed	Ω	6.7		rpm														
	Rotor radius	R	87.5		m														
	Max blade width	C	4.01		m														
	Pitch	λ	15		degrees														
	Blade profile	see Blade profile sheet																	
		Single transit risk			upwind	7.22%													
					downwind	3.38%													
					weighted mean	5.30%													
Stage D																			
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
	Proportion of time operational	Qop	88.8% 90.5% 86.9% 85.6% 85.7% 83.1% 80.8% 82.4% 85.1% 89.8% 88.0% 88.9%												86.3%				
		Collision rates before avoidance																	
						0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	year total	
																		1	
Stage E																			
	Allow for large array correction?		No																
	Width of windfarm	w	0.7		km														
			large array correction																
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year	
		Collision rates allowing for avoidance																	
	Avoidance rates modelled				100.00%	0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.6	
					100.00%	0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.6	
					100.00%	0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.6	
					99.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

green

boxes are for information only, to show variables used at each stage

		Value		Units				Value		Units				Value		Units																	
Bird data						Windfarm data						Turbine data																					
Species name		Great white egret				Site name		Cush WF		degrees		Model		E175																			
Bird length		L	0.935	m		Latitude		53.15028				Hub height		111.6		m																	
Wingspan		W	1.55	m		No of turbines		T	3				Rotor radius		R	87.5 m																	
Bird flight speed		v	9.2	m s-1		Width of windfarm		w	0.7		km		No of blades		b	3																	
Flight type, flapping or gliding		flapping										Rotation speed		Ω	6.7 rpm																		
% of flights upwind/downwind		50%		50%								Max blade width		C	4.01 m																		
Nocturnal activity ranking 1-5		1										Blade pitch		λ	15 degrees																		
Nocturnal activity factor		fnight	0%										Risk height range		24-199 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		DA	birds/km2																				0.000222						0.0000				
Proportion at rotor risk height		Q2R	0.00%																														
At latitude 53.2		Daylight hours per month				252.7		274.3		366.4		418.1		490.3		505.8		508.9		458.2		382.4		330.1		262.0		237.0		4486.2			
		Nighttime hours per month				491.3		397.7		377.6		301.9		253.7		214.2		235.1		285.8		337.6		413.9		458.0		507.0		4273.8			
Stage B																																	
No of turbines		T	3																														
Rotor radius		R	87.5 m																														
		Total rotor frontal area m2		72158																													
Nocturnal activity factor		fnight	0%																														
Bird flight speed		v	9.2 m s-1				Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		year total		
		Projected number of rotor transits				0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0			
Stage C																																	
No of blades		b	3				Bird length		l	0.935 m																							
Rotation speed		Ω	6.7 rpm				Wingspan		w	1.55 m																							
Rotor radius		R	87.5 m				Bird flight speed		v	9.2 m s-1																							
Max blade width		C	4.01 m				Flight type		flapping																								
Pitch		λ	15 degrees				% of flights upwind/downwind		50%		50%																						
Blade profile		see Blade profile sheet																															
		Single transit risk				upwind		8.33%																									
						downwind		4.75%																									
						weighted mean		6.54%																									
Stage D								Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		year avge	
Proportion of time operational		Qop					88.8%		90.5%		86.9%		85.6%		85.7%		83.1%		80.8%		82.4%		85.1%		89.8%		88.0%		88.9%		86.3%		
								Collision rates before avoidance																								year total	
								0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0			
Stage E																																	
Allow for large array correction?		No																															
Width of windfarm		w	0.7 km																														
				large array correction				Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		per year	
								Collision rates allowing for avoidance																									
Avoidance rates modelled				100.00%				0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00			
				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			
				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			
		98.00%		100.00%				0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00			

COLLISION RISK MODEL

Required input data is in

orange

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Calculated output is in

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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		Kestrel		Site name		Cush WF		Model		E175							
Bird length		L	0.34	m		Latitude		53.15028		degrees		Hub height		111.6 m			
Wingspan		W	0.755	m		No of turbines		T	3				Rotor radius		R	87.5 m	
Bird flight speed		v	12.7	m s-1		Width of windfarm		w	0.7		km		No of blades		b	3	
Flight type, flapping or gliding		flapping										Rotation speed		Ω	6.7	rpm	
% of flights upwind/downwind		50%		50%								Max blade width		C	4.01	m	
Nocturnal activity ranking 1-5		1										Blade pitch		λ	15	degrees	
Nocturnal activity factor		fnight	0%										Risk height range		24-199 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		DA	birds/km2		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion at rotor risk height		Q2R	69.51%		0.00615 0.0228 0.00233												0.0026
At latitude 53.2		Daylight hours per month		252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2	
		Nighttime hours per month		491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8	
Stage B																	
No of turbines		T	3														
Rotor radius		R	87.5 m														
		Total rotor frontal area m2		72158													
Nocturnal activity factor		fnight	0%														
Bird flight speed		v	12.7 m s-1		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
		Projected number of rotor transits		0.0	0.0	0.0	0.0	39.5	151.1	15.5	0.0	0.0	0.0	0.0	0.0	0.0	206
Stage C																	
No of blades		b	3		Bird length		l	0.34 m									
Rotation speed		Ω	6.7 rpm		Wingspan		w	0.755 m									
Rotor radius		R	87.5 m		Bird flight speed		v	12.7 m s-1									
Max blade width		C	4.01 m		Flight type		flapping										
Pitch		λ	15 degrees		% of flights upwind/downwind		50%		50%								
Blade profile		see Blade profile sheet															
		Single transit risk		upwind	5.26%												
				downwind	2.38%												
				weighted mean	3.82%												
Stage D																	
Proportion of time operational		Qop			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
				88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%	
				Collision rates before avoidance												year total	
				0.00	0.00	0.00	0.00	1.29	4.80	0.48	0.00	0.00	0.00	0.00	0.00	0.00	7
Stage E																	
Allow for large array correction?		No															
Width of windfarm		w	0.7 km														
		large array correction		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year	
				Collision rates allowing for avoidance													
Avoidance rates modelled				0.00	0.00	0.00	0.00	1.29	4.80	0.48	0.00	0.00	0.00	0.00	0.00	6.6	
				0.00	0.00	0.00	0.00	1.29	4.80	0.48	0.00	0.00	0.00	0.00	0.00	6.6	
				0.00	0.00	0.00	0.00	1.29	4.80	0.48	0.00	0.00	0.00	0.00	0.00	6.6	
		95.00%		0.00	0.00	0.00	0.00	0.06	0.24	0.02	0.00	0.00	0.00	0.00	0.00	0.3	

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

green

boxes are for information only, to show variables used at each stage

				Value	Units					Value	Units					Value	Units	
Bird data					Windfarm data							Turbine data						
	Species name		Kestrel		Site name		Cush WF		Model		E175							
	Bird length	L	0.34	m	Latitude		53.15028	degrees	Hub height		111.6	m						
	Wingspan	W	0.755	m	No of turbines	T	3		Rotor radius	R	87.5	m						
	Bird flight speed	v	12.7	m s-1	Width of windfarm	w	0.7	km	No of blades	b	3							
	Flight type, flapping or gliding		flapping						Rotation speed	Ω	6.7	rpm						
	% of flights upwind/downwind		50%	50%					Max blade width	C	4.01	m						
	Nocturnal activity ranking 1-5		1						Blade pitch	λ	15	degrees						
	Nocturnal activity factor	fnight	0%						Risk height range		24-199	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	DA	birds/km2		0.0041												0.012	0.0013
	Proportion at rotor risk height	Q2R	78.66%															
	At latitude 53.2		Daylight hours per month		252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2	
			Nighttime hours per month		491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8	
Stage B																		
	No of turbines	T	3															
	Rotor radius	R	87.5	m														
			Total rotor frontal area m2		72158													
	Nocturnal activity factor	fnight	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	25.4	87.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	113	
Stage C																		
	No of blades	b	3		Bird length	l	0.34	m										
	Rotation speed	Ω	6.7	rpm	Wingspan	w	0.755	m										
	Rotor radius	R	87.5	m	Bird flight speed	v	12.7	m s-1										
	Max blade width	C	4.01	m	Flight type		flapping											
	Pitch	λ	15	degrees	% of flights upwind/downwind		50%	50%										
	Blade profile		see Blade profile sheet															
			Single transit risk		upwind	5.26%												
					downwind	2.38%												
					weighted mean	3.82%												
Stage D					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year ave	
	Proportion of time operational	Qop			88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%	
					Collision rates before avoidance													
					0.00	0.00	0.00	0.83	2.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	year total	
																	4	
Stage E																		
	Allow for large array correction?		No															
	Width of windfarm	w	0.7	km														
				large array correction														
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year	
					Collision rates allowing for avoidance													
Avoidance rates modelled					0.00	0.00	0.00	0.83	2.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.7	
					0.00	0.00	0.00	0.83	2.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.7	
					0.00	0.00	0.00	0.83	2.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.7	
					0.00	0.00	0.00	0.04	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2	

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

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		Kestrel		Site name		Cush WF		Model		E175								
Bird length		L	0.34	Latitude		53.15028		Hub height		111.6		m						
Wingspan		W	0.755	No of turbines		T	3	Rotor radius		R	87.5	m						
Bird flight speed		v	12.7	Width of windfarm		w	0.7	No of blades		b	3							
Flight type, flapping or gliding		flapping						Rotation speed		Ω	6.7	rpm						
% of flights upwind/downwind		50%						Max blade width		C	4.01	m						
Nocturnal activity ranking 1-5		1						Blade pitch		λ	15	degrees						
Nocturnal activity factor		fnight	0%					Risk height range		24-199		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		DA	birds/km2	0.000887										0.0101	0.00557	0.000665	0.0014	
Proportion at rotor risk height		Q2R	71.96%															
At latitude 53.2		Daylight hours per month		252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2		
		Nighttime hours per month		491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8		
Stage B				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total		
No of turbines		T	3															
Rotor radius		R	87.5 m															
		Total rotor frontal area m2		72158														
Nocturnal activity factor		fnight	0%															
Bird flight speed		v	12.7 m s-1															
		Projected number of rotor transits		3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.2	19.8	2.1	70		
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	6.7 rpm	Wingspan		w	0.755	m										
Rotor radius		R	87.5 m	Bird flight speed		v	12.7	m s-1										
Max blade width		C	4.01 m	Flight type		flapping												
Pitch		λ	15 degrees	% of flights upwind/downwind		50%		50%										
Blade profile		see Blade profile sheet																
		Single transit risk		upwind	5.26%													
				downwind	2.38%													
				weighted mean	3.82%													
Stage D				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge		
Proportion of time operational		Qop		88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%		
				Collision rates before avoidance												year total		
				0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.55	0.67	0.07	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	0.7 km															
		large array correction																
Avoidance rates modelled		100.00%		0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.55	0.67	0.07	2.4		
		100.00%		0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.55	0.67	0.07	2.4		
		100.00%		0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.55	0.67	0.07	2.4		
		95.00%		0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.03	0.00	0.1		

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

green

boxes are for information only, to show variables used at each stage

Value				Units	Value				Units	Value				Units			
Bird data				Windfarm data				Turbine data									
Species name		Kestrel		Site name		Cush WF		Model		E175							
Bird length		L	0.34	Latitude		53.15028		Hub height		111.6		m					
Wingspan		W	0.755	No of turbines		T	3	Rotor radius		R	87.5	m					
Bird flight speed		v	12.7	Width of windfarm		w	0.7	No of blades		b	3						
Flight type, flapping or gliding		flapping						Rotation speed		Ω	6.7	rpm					
% of flights upwind/downwind		50%						Max blade width		C	4.01	m					
Nocturnal activity ranking 1-5		1						Blade pitch		λ	15	degrees					
Nocturnal activity factor		fnight	0%					Risk height range		24-199		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		DA	birds/km2	0.000532												0.0000	
Proportion at rotor risk height		Q2R	80.71%														
At latitude 53.2		Daylight hours per month		252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2	
		Nighttime hours per month		491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8	
Stage B				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total	
No of turbines		T	3														
Rotor radius		R	87.5 m														
		Total rotor frontal area m2		72158													
Nocturnal activity factor		fnight	0%														
Bird flight speed		v	12.7 m s-1														
		Projected number of rotor transits		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	2	
Stage C				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
No of blades		b	3	Bird length		l	0.34	m									
Rotation speed		Ω	6.7 rpm	Wingspan		w	0.755	m									
Rotor radius		R	87.5 m	Bird flight speed		v	12.7	m s-1									
Max blade width		C	4.01 m	Flight type		flapping											
Pitch		λ	15 degrees	% of flights upwind/downwind		50%		50%									
Blade profile		see Blade profile sheet															
		Single transit risk		upwind	5.26%												
				downwind	2.38%												
				weighted mean	3.82%												
Stage D				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
Proportion of time operational		Qop		88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%	
		Collision rates before avoidance														year total	
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0	
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	0.7 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	0.00	0.07	0.1	
		100.00%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.1	
		100.00%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.1	
		95.00%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

green

boxes are for information only, to show variables used at each stage

			Value	Units				Value	Units				Value	Units				
Bird data					Windfarm data							Turbine data						
	Species name		Lapwing			Site name		Cush WF			Model		E175					
	Bird length	L	0.3	m		Latitude		53.15028	degrees		Hub height		111.6	m				
	Wingspan	W	0.84	m		No of turbines	T	3			Rotor radius	R	87.5	m				
	Bird flight speed	v	12.3	m s-1		Width of windfarm	w	0.7	km		No of blades	b	3					
	Flight type, flapping or gliding		flapping								Rotation speed	Ω	6.7	rpm				
	% of flights upwind/downwind		50%	50%							Max blade width	C	4.01	m				
	Nocturnal activity ranking 1-5		2								Blade pitch	λ	15	degrees				
	Nocturnal activity factor	fnight	25%								Risk height range		24-199	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	DA	birds/km2						0.0313	0.0228	0.17						0.0187	
	Proportion at rotor risk height	Q2R	72.87%															
	At latitude 53.2		Daylight hours per month		252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2	
			Nighttime hours per month		491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8	
Stage B																		
	No of turbines	T	3															
	Rotor radius	R	87.5	m														
			Total rotor frontal area m2	72158														
	Nocturnal activity factor	fnight	25%															
	Bird flight speed	v	12.3	m s-1		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
			Projected number of rotor transits		0.0	0.0	0.0	0.0	230.6	169.7	1283.9	0.0	0.0	0.0	0.0	0.0	1684	
Stage C																		
	No of blades	b	3															
	Rotation speed	Ω	6.7	rpm														
	Rotor radius	R	87.5	m														
	Max blade width	C	4.01	m														
	Pitch	λ	15	degrees														
	Blade profile		see Blade profile sheet															
			Single transit risk															
			upwind	5.30%														
			downwind	2.34%														
			weighted mean	3.82%														
Stage D					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year ave	
	Proportion of time operational	Qop			88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%	
			Collision rates before avoidance															
					0.00	0.00	0.00	0.00	7.55	5.38	39.63	0.00	0.00	0.00	0.00	0.00	year total	
																	53	
Stage E																		
	Allow for large array correction?		No															
	Width of windfarm	w	0.7	km														
			large array correction															
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year	
			Collision rates allowing for avoidance															
Avoidance rates modelled				100.00%	0.00	0.00	0.00	0.00	7.55	5.38	39.63	0.00	0.00	0.00	0.00	0.00	52.6	
			99.80%	100.00%	0.00	0.00	0.00	0.00	0.02	0.01	0.08	0.00	0.00	0.00	0.00	0.00	0.1	
			99.50%	100.00%	0.00	0.00	0.00	0.00	0.04	0.03	0.20	0.00	0.00	0.00	0.00	0.00	0.3	
			98.00%	100.00%	0.00	0.00	0.00	0.00	0.15	0.11	0.79	0.00	0.00	0.00	0.00	0.00	1.1	

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

green

boxes are for information only, to show variables used at each stage

				Value	Units					Value	Units					Value	Units	
Bird data					Windfarm data							Turbine data						
	Species name		Lapwing			Site name		Cush WF			Model		E175					
	Bird length	L	0.3	m		Latitude		53.15028	degrees		Hub height		111.6	m				
	Wingspan	W	0.84	m		No of turbines	T	3			Rotor radius	R	87.5	m				
	Bird flight speed	v	12.3	m s-1		Width of windfarm	w	0.7	km		No of blades	b	3					
	Flight type, flapping or gliding		flapping								Rotation speed	Ω	6.7	rpm				
	% of flights upwind/downwind		50%	50%							Max blade width	C	4.01	m				
	Nocturnal activity ranking 1-5		2								Blade pitch	λ	15	degrees				
	Nocturnal activity factor	fnight	25%								Risk height range		24-199	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	DA	birds/km2						0.00166	0.00532	0.00898	0.00249	0.00621					0.0021
	Proportion at rotor risk height	Q2R	58.07%															
	At latitude 53.2		Daylight hours per month			252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2
			Nighttime hours per month			491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8
Stage B																		
	No of turbines	T	3															
	Rotor radius	R	87.5	m														
			Total rotor frontal area m2		72158													
	Nocturnal activity factor	fnight	25%															
	Bird flight speed	v	12.3	m s-1														
			Projected number of rotor transits			0.0	0.0	0.0	8.7	31.2	53.3	15.0	34.9	0.0	0.0	0.0	0.0	year total 143
Stage C																		
	No of blades	b	3															
	Rotation speed	Ω	6.7	rpm														
	Rotor radius	R	87.5	m														
	Max blade width	C	4.01	m														
	Pitch	λ	15	degrees														
	Blade profile		see Blade profile sheet															
			Single transit risk															
			upwind		5.30%													
			downwind		2.34%													
			weighted mean		3.82%													
Stage D						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year ave
	Proportion of time operational	Qop				88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%
			Collision rates before avoidance															
						0.00	0.00	0.00	0.28	1.02	1.69	0.46	1.10	0.00	0.00	0.00	0.00	year total 5
Stage E																		
	Allow for large array correction?		No															
	Width of windfarm	w	0.7	km														
			large array correction															
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
			Collision rates allowing for avoidance															
	Avoidance rates modelled					0.00	0.00	0.00	0.28	1.02	1.69	0.46	1.10	0.00	0.00	0.00	0.00	4.6
			99.80%		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
			99.50%		100.00%	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.0
			98.00%		100.00%	0.00	0.00	0.00	0.01	0.02	0.03	0.01	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

			Value	Units				Value	Units				Value	Units			
Bird data			Windfarm data				Turbine data										
	Species name		Lapwing		Site name		Cush WF		Model		E175						
	Bird length	L	0.3	m	Latitude		53.15028	degrees	Hub height		111.6	m					
	Wingspan	W	0.84	m	No of turbines	T	3		Rotor radius	R	87.5	m					
	Bird flight speed	v	12.3	m s-1	Width of windfarm	w	0.7	km	No of blades	b	3						
	Flight type, flapping or gliding		flapping						Rotation speed	Ω	6.7	rpm					
	% of flights upwind/downwind		50%	50%					Max blade width	C	4.01	m					
	Nocturnal activity ranking 1-5		2						Blade pitch	λ	15	degrees					
	Nocturnal activity factor	fnight	25%						Risk height range		24-199	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	DA	birds/km2		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
	Proportion at rotor risk height	Q2R	65.45%		0.0279											0.0253	0.0044
	At latitude 53.2		Daylight hours per month		252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2
			Nighttime hours per month		491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8
Stage B																	
	No of turbines	T	3														
	Rotor radius	R	87.5	m													
			Total rotor frontal area m2	72158													
	Nocturnal activity factor	fnight	25%														
	Bird flight speed	v	12.3	m s-1	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
			Projected number of rotor transits		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	125.5	110.0	236
Stage C																	
	No of blades	b	3														
	Rotation speed	Ω	6.7	rpm													
	Rotor radius	R	87.5	m													
	Max blade width	C	4.01	m													
	Pitch	λ	15	degrees													
	Blade profile		see Blade profile sheet														
			Single transit risk														
			upwind	5.30%													
			downwind	2.34%													
			weighted mean	3.82%													
Stage D																	
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
	Proportion of time operational	Qop			88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%
					Collision rates before avoidance												year total
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.22	3.74	8
Stage E																	
	Allow for large array correction?		No														
	Width of windfarm	w	0.7	km													
			large array correction		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year
					Collision rates allowing for avoidance												
	Avoidance rates modelled				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.22	3.74	8.0
			99.80%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.0
			99.50%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.0
			98.00%	100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.07	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				Value		Units																
Bird data						Windfarm data								Turbine data																		
Species name		Lapwing				Site name		Cush WF				Model		E175																		
Bird length		L	0.3	m		Latitude		53.15028		degrees		Hub height		111.6		m																
Wingspan		W	0.84	m		No of turbines		T	3				Rotor radius		R	87.5 m																
Bird flight speed		v	12.3	m s-1		Width of windfarm		w	0.7		km		No of blades		b	3																
Flight type, flapping or gliding		flapping										Rotation speed		Ω	6.7 rpm																	
% of flights upwind/downwind		50%		50%								Max blade width		C	4.01 m																	
Nocturnal activity ranking 1-5		2										Blade pitch		λ	15 degrees																	
Nocturnal activity factor		fnight	25%										Risk height range		24-199 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		DA	birds/km2		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		year avge			
Proportion at rotor risk height		Q2R	57.72%		0.0173		0.00832																						0.0021			
At latitude 53.2		Daylight hours per month		252.7		274.3		366.4		418.1		490.3		505.8		508.9		458.2		382.4		330.1		262.0		237.0		4486.2				
		Nighttime hours per month		491.3		397.7		377.6		301.9		253.7		214.2		235.1		285.8		337.6		413.9		458.0		507.0		4273.8				
Stage B																																
No of turbines		T	3																													
Rotor radius		R	87.5 m																													
		Total rotor frontal area m2		72158																												
Nocturnal activity factor		fnight	25%																													
Bird flight speed		v	12.3 m s-1				Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		year total	
		Projected number of rotor transits		0.0		68.1		40.4		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		109		
Stage C																																
No of blades		b	3				Bird length		l	0.3 m																						
Rotation speed		Ω	6.7 rpm				Wingspan		w	0.84 m																						
Rotor radius		R	87.5 m				Bird flight speed		v	12.3 m s-1																						
Max blade width		C	4.01 m				Flight type		flapping																							
Pitch		λ	15 degrees				% of flights upwind/downwind		50%		50%																					
Blade profile		see Blade profile sheet																														
		Single transit risk		upwind		5.30%																										
				downwind		2.34%																										
				weighted mean		3.82%																										
Stage D																																
Proportion of time operational		Qop	88.8%		90.5%		86.9%		85.6%		85.7%		83.1%		80.8%		82.4%		85.1%		89.8%		88.0%		88.9%		86.3%					
		Collision rates before avoidance		0.00		2.36		1.34		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		year total				
				0.00		2.36		1.34		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		4				
Stage E																																
Allow for large array correction?		No																														
Width of windfarm		w	0.7 km																													
				large array correction																												
						Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		per year		
Avoidance rates modelled						Collision rates allowing for avoidance		0.00		2.36		1.34		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		3.7		
						99.80%		100.00%		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.0		
						99.50%		100.00%		0.00		0.01		0.01		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.0		
						98.00%		100.00%		0.00		0.05		0.03		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.1		

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

green

boxes are for information only, to show variables used at each stage

Value				Units		Value				Units		Value				Units									
Bird data				Windfarm data				Turbine data																	
Species name		Mallard		Site name		Cush WF		Model		E175															
Bird length		L	0.58	m		Latitude		53.15028		degrees		Hub height		111.6		m									
Wingspan		W	0.9	m		No of turbines		T	3				Rotor radius		R	87.5		m							
Bird flight speed		v	22	m s-1		Width of windfarm		w	0.7		km		No of blades		b	3									
Flight type, flapping or gliding		flapping										Rotation speed		Ω	6.7		rpm								
% of flights upwind/downwind		50%		50%								Max blade width		C	4.01		m								
Nocturnal activity ranking 1-5		2										Blade pitch		λ	15		degrees								
Nocturnal activity factor		fnight	25%										Risk height range		24-199		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		DA	birds/km2		0.00399											0.00399		0.002				0.0008			
Proportion at rotor risk height		Q2R	58.59%																						
At latitude 53.2		Daylight hours per month		252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2									
		Nighttime hours per month		491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8									
Stage B				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total									
No of turbines		T	3																						
Rotor radius		R	87.5		m																				
		Total rotor frontal area m2		72158																					
Nocturnal activity factor		fnight	25%																						
Bird flight speed		v	22		m s-1																				
		Projected number of rotor transits		0.0	0.0	0.0	37.7	42.3	21.4	0.0	0.0	0.0	0.0	0.0	0.0	101									
Stage C				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total									
No of blades		b	3		Bird length		l	0.58		m															
Rotation speed		Ω	6.7		rpm		Wingspan		w	0.9		m													
Rotor radius		R	87.5		m		Bird flight speed		v	22		m s-1													
Max blade width		C	4.01		m		Flight type		flapping																
Pitch		λ	15		degrees		% of flights upwind/downwind		50%		50%														
Blade profile		see Blade profile sheet																							
		Single transit risk		upwind		4.71%																			
				downwind		3.01%																			
				weighted mean		3.86%																			
Stage D				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge									
Proportion of time operational		Qop	88.8%											90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%
				Collision rates before avoidance																year total					
				0.00	0.00	0.00	1.24	1.40	0.69	0.00	0.00	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?		No																							
Width of windfarm		w	0.7		km																				
		large array correction																							
		Collision rates allowing for avoidance																							
Avoidance rates modelled		100.00%		0.00	0.00	0.00	1.24	1.40	0.69	0.00	0.00	0.00	0.00	0.00	0.00	3.3									
		100.00%		0.00	0.00	0.00	1.24	1.40	0.69	0.00	0.00	0.00	0.00	0.00	0.00	3.3									
		100.00%		0.00	0.00	0.00	1.24	1.40	0.69	0.00	0.00	0.00	0.00	0.00	0.00	3.3									
		98.00%		0.00	0.00	0.00	0.02	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.1									

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

green

boxes are for information only, to show variables used at each stage

		Value	Units			Value	Units			Value	Units							
Bird data		Windfarm data			Turbine data													
	Species name	Mallard			Site name	Cush WF		Model	E175									
	Bird length	L	0.58	m	Latitude	53.15028	degrees	Hub height	111.6	m								
	Wingspan	W	0.9	m	No of turbines	T	3	Rotor radius	R	87.5	m							
	Bird flight speed	v	22	m s-1	Width of windfarm	w	0.7	km	No of blades	b	3							
	Flight type, flapping or gliding		flapping					Rotation speed	Ω	6.7	rpm							
	% of flights upwind/downwind		50%	50%				Max blade width	C	4.01	m							
	Nocturnal activity ranking 1-5		2					Blade pitch	λ	15	degrees							
	Nocturnal activity factor	fnight	25%					Risk height range		24-199	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	DA	birds/km2														0.0225	0.0019
	Proportion at rotor risk height	Q2R	80.89%															
	At latitude 53.2		Daylight hours per month		252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2	
			Nighttime hours per month		491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8	
Stage B																		
	No of turbines	T	3															
	Rotor radius	R	87.5	m														
			Total rotor frontal area m2		72158													
	Nocturnal activity factor	fnight	25%															
	Bird flight speed	v	22	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	223.8	0.0	year total	
																	224	
Stage C																		
	No of blades	b	3															
	Rotation speed	Ω	6.7	rpm														
	Rotor radius	R	87.5	m														
	Max blade width	C	4.01	m														
	Pitch	λ	15	degrees														
	Blade profile		see Blade profile sheet															
			Single transit risk															
			upwind		4.71%													
			downwind		3.01%													
			weighted mean		3.86%													
Stage D																		
	Proportion of time operational	Qop			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year ave	
					88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%	
					Collision rates before avoidance												year total	
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.60	0.00	8	
Stage E																		
	Allow for large array correction?		No															
	Width of windfarm	w	0.7	km														
			large array correction															
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year	
	Avoidance rates modelled				Collision rates allowing for avoidance													
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.60	0.00	7.6	
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.60	0.00	7.6	
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.60	0.00	7.6	
			98.00%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	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				Value	Units						
Bird data					Windfarm data						Turbine data									
	Species name		Merlin			Site name		Cush WF			Model		E175							
	Bird length	L	0.275	m		Latitude		53.15028	degrees		Hub height		111.6	m						
	Wingspan	W	0.56	m		No of turbines	T	3			Rotor radius	R	87.5	m						
	Bird flight speed	v	13.47	m s-1		Width of windfarm	w	0.7	km		No of blades	b	3							
	Flight type, flapping or gliding		flapping								Rotation speed	Ω	6.7	rpm						
	% of flights upwind/downwind		50%	50%							Max blade width	C	4.01	m						
	Nocturnal activity ranking 1-5		1								Blade pitch	λ	15	degrees						
	Nocturnal activity factor	fnight	0%								Risk height range		24-199	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	DA	birds/km2			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge		
	Proportion at rotor risk height	Q2R	66.91%														0.000333	0.000748	0.0153	0.0014
	At latitude 53.2		Daylight hours per month			252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2		
			Nighttime hours per month			491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8		
Stage B																				
	No of turbines	T	3																	
	Rotor radius	R	87.5 m																	
			Total rotor frontal area m2			72158														
	Nocturnal activity factor	fnight	0%																	
	Bird flight speed	v	13.47 m s-1			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total		
			Projected number of rotor transits			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	2.6	48.5	53		
Stage C																				
	No of blades	b	3																	
	Rotation speed	Ω	6.7 rpm																	
	Rotor radius	R	87.5 m																	
	Max blade width	C	4.01 m																	
	Pitch	λ	15 degrees																	
	Blade profile		see Blade profile sheet																	
			Single transit risk																	
					upwind	4.92%														
					downwind	2.17%														
					weighted mean	3.55%														
Stage D																				
	Proportion of time operational	Qop				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge		
						88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%		
						Collision rates before avoidance														
						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.08	1.53	2		
Stage E																				
	Allow for large array correction?		No																	
	Width of windfarm	w	0.7 km																	
			large array correction																	
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year		
			Collision rates allowing for avoidance																	
	Avoidance rates modelled					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.08	1.53	1.7		
						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.08	1.53	1.7		
						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.08	1.53	1.7		
			98.00%			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.0		

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

green

boxes are for information only, to show variables used at each stage

Value				Units		Value				Units		Value				Units	
Bird data		Windfarm data				Turbine data											
Species name		Peregrine		Site name		Cush WF		Model		E175							
Bird length		L	0.45	m		Latitude		53.15028	degrees		Hub height		111.6	m			
Wingspan		W	1.1	m		No of turbines		T	3	Rotor radius		R	87.5	m			
Bird flight speed		v	14	m s-1		Width of windfarm		w	0.7	km		No of blades		b	3		
Flight type, flapping or gliding		flapping								Rotation speed		Ω	6.7	rpm			
% of flights upwind/downwind		50%		50%						Max blade width		C	4.01	m			
Nocturnal activity ranking 1-5		1								Blade pitch		λ	15	degrees			
Nocturnal activity factor		fnight	0%							Risk height range		24-199		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		DA	birds/km2		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion at rotor risk height		Q2R	76.22%		0.00122 0.00299												0.0004
At latitude 53.2		Daylight hours per month		252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2	
		Nighttime hours per month		491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8	
Stage B																	
No of turbines		T	3														
Rotor radius		R	87.5 m														
		Total rotor frontal area m2		72158													
Nocturnal activity factor		fnight	0%														
Bird flight speed		v	14 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	9.8	24.1	0.0	0.0	0.0	0.0	0.0	34
Stage C																	
No of blades		b	3		Bird length		l	0.45 m									
Rotation speed		Ω	6.7 rpm		Wingspan		w	1.1 m									
Rotor radius		R	87.5 m		Bird flight speed		v	14 m s-1									
Max blade width		C	4.01 m		Flight type		flapping										
Pitch		λ	15 degrees		% of flights upwind/downwind		50%		50%								
Blade profile		see Blade profile sheet															
		Single transit risk		upwind	5.44%												
				downwind	2.79%												
				weighted mean	4.12%												
Stage D																	
Proportion of time operational		Qop			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
				88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%	
				Collision rates before avoidance												year total	
				0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.80	0.00	0.00	0.00	0.00	0.00	1
Stage E																	
Allow for large array correction?		No															
Width of windfarm		w	0.7 km														
		large array correction		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year	
				Collision rates allowing for avoidance													
Avoidance rates modelled		100.00%		0.00	0.00	0.00	0.00	0.00	0.33	0.80	0.00	0.00	0.00	0.00	0.00	1.1	
		100.00%		0.00	0.00	0.00	0.00	0.00	0.33	0.80	0.00	0.00	0.00	0.00	0.00	1.1	
		100.00%		0.00	0.00	0.00	0.00	0.00	0.33	0.80	0.00	0.00	0.00	0.00	0.00	1.1	
		98.00%		0.00	0.00	0.00	0.00	0.00	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

Value				Units		Value				Units		Value				Units																		
Bird data				Windfarm data				Turbine data																										
Species name		Peregrine		Site name		Cush WF		Model		E175																								
Bird length		L	0.45	m		Latitude		53.15028		degrees		Hub height		111.6		m																		
Wingspan		W	1.1	m		No of turbines		T	3				Rotor radius		R	87.5		m																
Bird flight speed		v	14	m s-1		Width of windfarm		w	0.7		km		No of blades		b	3																		
Flight type, flapping or gliding		flapping										Rotation speed		Ω	6.7		rpm																	
% of flights upwind/downwind		50%		50%								Max blade width		C	4.01		m																	
Nocturnal activity ranking 1-5		1										Blade pitch		λ	15		degrees																	
Nocturnal activity factor		fnight	0%										Risk height range		24-199		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		DA	birds/km2		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		year avge					
Proportion at rotor risk height		Q2R	71.19%																								0.00129		0.0001					
At latitude 53.2		Daylight hours per month				252.7		274.3		366.4		418.1		490.3		505.8		508.9		458.2		382.4		330.1		262.0		237.0		4486.2				
		Nighttime hours per month				491.3		397.7		377.6		301.9		253.7		214.2		235.1		285.8		337.6		413.9		458.0		507.0		4273.8				
Stage B																																		
No of turbines		T	3																															
Rotor radius		R	87.5		m																													
Total rotor frontal area m2				72158																														
Nocturnal activity factor		fnight	0%																															
Bird flight speed		v	14		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		5.0		0.0		5		
Stage C																																		
No of blades		b	3						Bird length		l	0.45		m																				
Rotation speed		Ω	6.7		rpm				Wingspan		w	1.1		m																				
Rotor radius		R	87.5		m				Bird flight speed		v	14		m s-1																				
Max blade width		C	4.01		m				Flight type		flapping		50%		50%																			
Pitch		λ	15		degrees				% of flights upwind/downwind		50%		50%																					
Blade profile		see Blade profile sheet																																
Single transit risk				upwind		5.44%																												
				downwind		2.79%																												
weighted mean						4.12%																												
Stage D																																		
Proportion of time operational		Qop			Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		year avge					
				88.8%		90.5%		86.9%		85.6%		85.7%		83.1%		80.8%		82.4%		85.1%		89.8%		88.0%		88.9%		86.3%						
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		0.18		0.00		year total				
																														0				
Stage E																																		
Allow for large array correction?		No																																
Width of windfarm		w	0.7		km																													
large array correction																																		
Avoidance rates modelled				100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		per year				
				98.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		0.2				
						100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		0.2				
						100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		0.2				
						100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		100.00%		0.0				

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

green

boxes are for information only, to show variables used at each stage

Bird data				Value	Units	Windfarm data				Value	Units	Turbine data				Value	Units	
Species name		Peregrine				Site name		Cush WF				Model		E175				
Bird length		L	0.45	m		Latitude		53.15028		degrees		Hub height		111.6		m		
Wingspan		W	1.1	m		No of turbines		T	3				Rotor radius		R	87.5	m	
Bird flight speed		v	14	m s-1		Width of windfarm		w	0.7		km		No of blades		b	3		
Flight type, flapping or gliding		flapping										Rotation speed		Ω	6.7	rpm		
% of flights upwind/downwind		50%		50%								Max blade width		C	4.01	m		
Nocturnal activity ranking 1-5		1										Blade pitch		λ	15	degrees		
Nocturnal activity factor		fnight	0%									Risk height range		24-199		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		DA	birds/km2		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
Proportion at rotor risk height		Q2R	64.56%		0.00133												0.0001	
At latitude 53.2		Daylight hours per month		252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2		
		Nighttime hours per month		491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8		
Stage B																		
No of turbines		T	3															
Rotor radius		R	87.5 m															
		Total rotor frontal area m2		72158														
Nocturnal activity factor		fnight	0%															
Bird flight speed		v	14 m s-1		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total	
		Projected number of rotor transits		0.0	4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5	
Stage C																		
No of blades		b	3		Bird length		l	0.45 m										
Rotation speed		Ω	6.7 rpm		Wingspan		w	1.1 m										
Rotor radius		R	87.5 m		Bird flight speed		v	14 m s-1										
Max blade width		C	4.01 m		Flight type		flapping											
Pitch		λ	15 degrees		% of flights upwind/downwind		50%		50%									
Blade profile		see Blade profile sheet																
		Single transit risk		upwind	5.44%													
				downwind	2.79%													
				weighted mean	4.12%													
Stage D																		
Proportion of time operational		Qop			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
				88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%		
				Collision rates before avoidance												year total		
				0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
Stage E																		
Allow for large array correction?		No																
Width of windfarm		w	0.7 km															
		large array correction		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year		
				Collision rates allowing for avoidance														
Avoidance rates modelled				100.00%	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2	
				100.00%	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2	
				100.00%	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2	
		98.00%		100.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

green

boxes are for information only, to show variables used at each stage

Value				Units	Value				Units	Value				Units					
Bird data				Windfarm data				Turbine data											
Species name		Snipe		Site name		Cush WF		Model		E175									
Bird length		L	0.26	m		Latitude		53.15028		degrees		Hub height		111.6	m				
Wingspan		W	0.455	m		No of turbines		T	3				Rotor radius		R	87.5	m		
Bird flight speed		v	16	m s-1		Width of windfarm		w	0.7		km		No of blades		b	3			
Flight type, flapping or gliding		flapping										Rotation speed		Ω	6.7		rpm		
% of flights upwind/downwind		50%		50%								Max blade width		C	4.01		m		
Nocturnal activity ranking 1-5		3										Blade pitch		λ	15		degrees		
Nocturnal activity factor		fnight	50%										Risk height range		24-199		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		DA	birds/km2		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge		
Proportion at rotor risk height		Q2R	66.14%		0.000166												0.0176	0.0343	0.0043
At latitude 53.2		Daylight hours per month		252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2			
		Nighttime hours per month		491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8			
Stage B																			
No of turbines		T	3																
Rotor radius		R	87.5 m																
		Total rotor frontal area m2		72158															
Nocturnal activity factor		fnight	50%																
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	1.6	169.5	337.5	0.0	0.0	0.0	0.0	0.0	509			
Stage C																			
No of blades		b	3		Bird length		l	0.26 m											
Rotation speed		Ω	6.7 rpm		Wingspan		w	0.455 m											
Rotor radius		R	87.5 m		Bird flight speed		v	16 m s-1											
Max blade width		C	4.01 m		Flight type		flapping												
Pitch		λ	15 degrees		% of flights upwind/downwind		50%		50%										
Blade profile		see Blade profile sheet																	
		Single transit risk		upwind	4.54%														
				downwind	2.20%														
				weighted mean	3.37%														
Stage D																			
Proportion of time operational		Qop			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge		
				88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%			
				Collision rates before avoidance												year total			
				0.00	0.00	0.00	0.00	0.05	4.74	9.19	0.00	0.00	0.00	0.00	0.00	14			
Stage E																			
Allow for large array correction?		No																	
Width of windfarm		w	0.7 km																
		large array correction		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year			
				Collision rates allowing for avoidance															
Avoidance rates modelled				0.00	0.00	0.00	0.00	0.05	4.74	9.19	0.00	0.00	0.00	0.00	0.00	14.0			
				0.00	0.00	0.00	0.00	0.05	4.74	9.19	0.00	0.00	0.00	0.00	0.00	14.0			
				0.00	0.00	0.00	0.00	0.05	4.74	9.19	0.00	0.00	0.00	0.00	0.00	14.0			
		98.00%		0.00	0.00	0.00	0.00	0.00	0.09	0.18	0.00	0.00	0.00	0.00	0.00	0.3			

COLLISION RISK MODEL

Required input data is in

orange

boxes

Calculated output is in

blue

boxes

green

boxes are for information only, to show variables used at each stage

			Value	Units				Value	Units				Value	Units			
Bird data					Windfarm data							Turbine data					
Species name		Snipe			Site name		Cush WF		Model		E175						
Bird length		L	0.26	m	Latitude		53.15028	degrees <th colspan="2">Hub height</th> <td></td> <td>111.6</td> <td>m</td>	Hub height			111.6	m				
Wingspan		W	0.455	m	No of turbines		T	3	Rotor radius		R	87.5	m				
Bird flight speed		v	16	m s-1	Width of windfarm		w	0.7	km	No of blades		b	3				
Flight type, flapping or gliding		flapping							Rotation speed		Ω	6.7	rpm				
% of flights upwind/downwind		50%			50%				Max blade width		C	4.01	m				
Nocturnal activity ranking 1-5		3							Blade pitch		λ	15	degrees				
Nocturnal activity factor		fnight	50%						Risk height range		24-199 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		DA	birds/km2						0.0122	0.0103	0.00133				0.0020		
Proportion at rotor risk height		Q2R	61.54%														
At latitude 53.2		Daylight hours per month			252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2
		Nighttime hours per month			491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8
Stage B					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of turbines		T	3														
Rotor radius		R	87.5 m														
		Total rotor frontal area m2			72158												
Nocturnal activity factor		fnight	50%														
Bird flight speed		v	16 m s-1														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	110.0	92.3	12.2	0.0	0.0	0.0	0.0	0.0	214
Stage C					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total
No of blades		b	3			Bird length		l	0.26	m							
Rotation speed		Ω	6.7 rpm			Wingspan		w	0.455	m							
Rotor radius		R	87.5 m			Bird flight speed		v	16	m s-1							
Max blade width		C	4.01 m			Flight type		flapping									
Pitch		λ	15 degrees			% of flights upwind/downwind		50%			50%						
Blade profile		see Blade profile sheet															
		Single transit risk			upwind			4.54%									
					downwind			2.20%									
					weighted mean			3.37%									
Stage D					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge
Proportion of time operational		Qop	88.8%			90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%
		Collision rates before avoidance												year total			
					0.00	0.00	0.00	0.00	3.18	2.58	0.33	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	0.7 km														
		large array correction															
Avoidance rates modelled		100.00%			0.00	0.00	0.00	0.00	3.18	2.58	0.33	0.00	0.00	0.00	0.00	0.00	6.1
		100.00%			0.00	0.00	0.00	0.00	3.18	2.58	0.33	0.00	0.00	0.00	0.00	0.00	6.1
		100.00%			0.00	0.00	0.00	0.00	3.18	2.58	0.33	0.00	0.00	0.00	0.00	0.00	6.1
		98.00%			0.00	0.00	0.00	0.00	0.06	0.05	0.01	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

		Value	Units			Value	Units			Value	Units						
Bird data		Windfarm data			Turbine data												
Species name		Snipe		Site name		Cush WF		Model		E175							
Bird length	L	0.26	m	Latitude		53.15028	degrees	Hub height		111.6	m						
Wingspan	W	0.455	m	No of turbines	T	3		Rotor radius	R	87.5	m						
Bird flight speed	v	16	m s-1	Width of windfarm	w	0.7	km	No of blades	b	3							
Flight type, flapping or gliding		flapping						Rotation speed	Ω	6.7	rpm						
% of flights upwind/downwind		50%	50%					Max blade width	C	4.01	m						
Nocturnal activity ranking 1-5		3						Blade pitch	λ	15	degrees						
Nocturnal activity factor	fnight	50%						Risk height range		24-199	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	DA	birds/km2		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
Proportion at rotor risk height	Q2R	59.63%		0.00244								0.00299		0.000665		0.0005	
At latitude 53.2		Daylight hours per month		252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2	
		Nighttime hours per month		491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8	
Stage B																	
No of turbines	T	3															
Rotor radius	R	87.5	m														
		Total rotor frontal area m2		72158													
Nocturnal activity factor	fnight	50%															
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		17.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.7	0.0	4.6	45
Stage C																	
No of blades	b	3					Bird length	l	0.26	m							
Rotation speed	Ω	6.7	rpm				Wingspan	w	0.455	m							
Rotor radius	R	87.5	m				Bird flight speed	v	16	m s-1							
Max blade width	C	4.01	m				Flight type		flapping								
Pitch	λ	15	degrees				% of flights upwind/downwind		50%	50%							
Blade profile		see Blade profile sheet															
		Single transit risk		upwind	4.54%												
				downwind	2.20%												
				weighted mean	3.37%												
Stage D																	
Proportion of time operational	Qop			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
				88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%	86.3%	
				Collision rates before avoidance												year total	
				0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.69	0.00	0.14	1	
Stage E																	
Allow for large array correction?		No															
Width of windfarm	w	0.7	km														
			large array correction														
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year	
				Collision rates allowing for avoidance													
Avoidance rates modelled				0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.69	0.00	0.14	1.3	
				0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.69	0.00	0.14	1.3	
				0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.69	0.00	0.14	1.3	
		98.00%		0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.0	

Required input data is in
Calculated output is in

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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		Whooper swan						Site name		Cush WF				Model		E175							
Bird length	L	1.52	m					Latitude		53.15028	degrees			Hub height		111.6	m						
Wingspan	W	2.3	m					No of turbines	T	3				Rotor radius	R	87.5	m						
Bird flight speed	v	17.3	m s ⁻¹					Width of windfarm	w	0.7	km			No of blades	b	3							
Flight type, flapping or gliding		flapping												Rotation speed	Ω	6.7	rpm						
% of flights upwind/downwind		50%	50%											Max blade width	C	4.01	m						
Nocturnal activity ranking 1-5		2												Blade pitch	λ	15	degrees						
Nocturnal activity factor	fnight	25%												Risk height range		24-199	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	DA	birds/km2						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		year avge		
Proportion at rotor risk height	Q2R	32.36%						0.000887													0.0001		
At latitude 53.2								Daylight hours per month	252.7	274.3	366.4	418.1	490.3	505.8	508.9	458.2	382.4	330.1	262.0	237.0	4486.2		
								Nighttime hours per month	491.3	397.7	377.6	301.9	253.7	214.2	235.1	285.8	337.6	413.9	458.0	507.0	4273.8		
Stage B																							
No of turbines	T	3																					
Rotor radius	R	87.5	m																				
		Total rotor frontal area m2	72158																				
Nocturnal activity factor	fnight	25%																					
Bird flight speed	v	17.3	m s ⁻¹																				
		Projected number of rotor transits						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		year total		
								2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		3		
Stage C																							
No of blades	b	3						Bird length	l	1.52	m												
Rotation speed	Ω	6.7	rpm					Wingspan	w	2.3	m												
Rotor radius	R	87.5	m					Bird flight speed	v	17.3	m s ⁻¹												
Max blade width	C	4.01	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	5.06%														
								weighted mean	6.14%														
Stage D																							
Proportion of time operational	Qop							Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		year avge		
								88.8%	90.5%	86.9%	85.6%	85.7%	83.1%	80.8%	82.4%	85.1%	89.8%	88.0%	88.9%		86.3%		
								Collision rates before avoidance															
								0.15	0.00	0.00	0.00	0.00	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	0.7	km																				
			large array correction					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		per year		
Avoidance rates modelled								Collision rates allowing for avoidance															
								0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.2		
								0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.2		
								0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.2		
								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		



Making Sustainability Happen