
**THREE OAKS RENEWABLE
ENERGY PARK
EXTENSION**

**Environmental
Statement Appendix 7.8: Collision Risk
Modelling Calculations**

MAY 2026





THREE OAKS RENEWABLE ENERGY PARK EXTENSION APPENDIX 7-8: COLLISION RISK MODELLING CALCULATIONS

Report to Three Oaks Renewable Energy Park
Ltd.

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THREE OAKS RENEWABLE ENERGY PARK EXTENSION: COLLISION RISK MODELLING CALCULATIONS

INTRODUCTION

1. This Technical Appendix sets out the collision risk modelling that has been undertaken to support the ornithological assessment of the Three Oaks Renewable Energy Park Extension (the 'Proposed Development'). The collision risk modelling was carried out for all key target species recorded flying through the collision risk zone at rotor height, as per NatureScot (Band 2024) guidance. Rotor height would be 33-149.9 m above ground level.
2. The modelling included nine key target species (whooper swan, pink-footed goose, golden plover, lapwing, common gull, herring gull, black-headed gull, marsh harrier and red kite).
3. The industry-standard NatureScot (NS)-recommended collision risk model was used in this assessment (Band 2024), which is used in best practice across the UK. The model runs as a two-stage process. Firstly, the risk is calculated with the assumption that flight patterns are unaffected by the presence of the wind turbines, i.e. that no avoidance action is taken. This is essentially a mechanistic calculation, with the collision risk calculated as the product of (i) the probability of a bird flying through the rotor swept area, and (ii) the probability of a bird colliding if it does so. This probability is then multiplied by the estimated numbers of bird movements through the wind farm rotors at the risk height (i.e. the height of the rotating rotor blades) in order to estimate the theoretical numbers at risk of collision if they take no avoiding action.
4. The second stage then incorporates the probability that the birds, rather than flying blindly into the wind turbines, will actually take a degree of avoiding action, as shown to occur in all studies of birds at existing wind farms. NS has recommended a precautionary approach, using a value of 98% as a general default avoidance rate, 99% for some larger raptors (including red kite, Urquhart and Whitfield 2016) and 99.8% for geese (NatureScot 2025). This precautionary approach is useful as an initial filter to identify sites where collision risk is clearly not an issue but does not necessarily provide a realistic estimate of actual likely collision rates when compared with data from existing wind farms. The magnitude of the impact was determined as a percentage increase in the existing baseline mortality (to put the potential wind farm mortality into the ecological context of the birds' population dynamics), though professional judgement was also applied in the assessment of any non-negligible magnitude collision risks predicted.
5. Body sizes and baseline mortality rates were taken from Robinson (2005) and Billerman et al. (2026), and flight speeds from Alerstam *et al.* (2007). The input data are given below in each species' individual spreadsheet.
6. Bird flight data were extracted from the vantage point survey data, converted as set out in Band (2024) to flight densities for input to the model.
7. The model was run separately for each species for each of the two years' baseline data (2019-20 and 2024-25), and as a precautionary measure, the peak annual collision risk was used for the ornithological impact assessment. The model spreadsheets for each species are given below in Tables 7.8.1-7.8.9, for each year with recorded flights through the collision risk zone.

TABLE 7.8.1. Collision risk calculations for whooper swan using the Band (2024) model, using 2024-25 baseline flight data.

[illegible]

TABLE 7.8.2: Collision risk calculations for pink-footed goose using the Band (2024) model, using 2024-25 baseline flight data.

[illegible]

TABLE 7.8.3a: Collision risk calculations for golden plover using the Band (2024) model, using 2019-20 baseline flight data.

[illegible]

TABLE 7.8.3b: Collision risk calculations for golden plover using the Band (2024) model, using 2024-25 baseline flight data.

COLLISION RISK MODEL			Required input data is in		orange	boxes																						
			Calculated output is in		blue	boxes																						
					green	boxes are	for information only, to show variables used at each stage																					
			Value	Units			Value	Units											Value	Units								
Bird data			Windfarm data				Turbine data																					
Species name		Golden Plover	Site name		Three Oaks 2		Model		SMW type																			
Bird length	L	0.28	m	Latitude	54.01	degrees	Hub height	91	m																			
Wingspan	W	0.72	m	No of turbines	T	6	Rotor radius	R	58.5	m																		
Bird flight speed	v	13.7	m s ⁻¹	Width of windfarm	w	1.9	km	No of blades	b	3	Rotation speed	Ω	7.5	rpm														
Flight type, flapping or gliding		flapping							Max blade width	C	4.5	m	Blade pitch	λ	15	degrees												
% of flights upwind/downwind		50%	50%																									
Nocturnal activity ranking 1-5		2																										
Nocturnal activity factor		f _{night}	25%											Risk height range		33-150	m											
normal approach			Set to 'normal approach' to use survey data on bird density																									
			Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A																									
Stage A			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge													
Daytime bird density	D _A	birds/km ²	0	0	0.0170408	0	0	0	0	0	0.006839	0	0.0551647	0	0.0066													
Proportion at rotor risk height	Q _{2R}	85.00%																										
At latitude 54.		Daylight hours per month		248.5	272.1	366.2	419.9	494.4	511.2	513.8	461.0	383.1	328.7	258.5	232.1	4489.4												
		Nighttime hours per month		495.5	399.9	377.8	300.1	249.6	208.8	230.2	283.0	336.9	415.3	461.5	511.9	4270.6												
Stage B			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total													
No of turbines	T	6																										
Rotor radius	R	58.5	m																									
Total rotor frontal area m ²		64508																										
Nocturnal activity factor	f _{night}	25%																										
Bird flight speed	v	13.7	m s ⁻¹																									
Projected number of rotor transits		0.0		0.0	181.4	0.0	0.0	0.0	0.0	0.0	0.0	73.9	0.0	476.8	0.0	732												
Stage C			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total													
No of blades	b	3																										
Rotation speed	Ω	7.5	rpm																									
Rotor radius	R	58.5	m																									
Max blade width	C	4.5	m																									
Pitch	λ	15	degrees																									
Blade profile		see Blade profile sheet																										
Single transit risk		upwind		7.48%																								
		downwind		4.04%																								
		weighted mean		5.76%																								
Stage D			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge													
Proportion of time operational	Q _{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%													
			Collision rates before avoidance																									
			0.00	0.00	8.88	0.00	0.00	0.00	0.00	0.00	0.00	3.62	0.00	23.35	0.00	36												
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	1.9	km																									
large array correction																												
Avoidance rates modelled		98.00%	100.00%	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.47	0.00	0.717												
		99.00%	100.00%	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.23	0.00	0.358												
		99.50%	100.00%	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.12	0.00	0.179												
		99.80%	100.00%	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.05	0.00	0.072												

TABLE 7.8.4a: Collision risk calculations for lapwing using the Band (2024) model, using 2019-20 baseline flight data.

COLLISION RISK MODEL			Required input data is in		orange	boxes											
			Calculated output is in		blue	boxes											
					green	boxes are for information only, to show variables used at each stage											
			Value	Units		Value	Units										
Bird data			Windfarm data				Turbine data										
Species name		Lapwing	Site name		Three Oaks 2	Model		SMW type									
Bird length	L	0.3	m	Latitude	54.01	degrees	Hub height	91	m								
Wingspan	W	0.85	m	No of turbines	T	6	Rotor radius	R	58.5								
Bird flight speed	v	11.9	m s ⁻¹	Width of windfarm	w	1.9	km	No of blades	b	3							
Flight type, flapping or gliding		flapping					Rotation speed	Ω	7.5	rpm							
% of flights upwind/downwind		50%	50%				Max blade width	C	4.5	m							
Nocturnal activity ranking 1-5		2					Blade pitch	λ	15	degrees							
Nocturnal activity factor	f _{night}	25%					Risk height range	33-150	m								
normal approach		Set to 'normal approach' to use survey data on bird density															
		Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A															
Stage A				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
Daytime bird density	D _A		birds/km ²	0	0	0	0	0.0024341	0	0	0	0	0.0024206	0	0	0.0004	
Proportion at rotor risk height	Q _{2R}	83.00%															
At latitude 54.		Daylight hours per month			248.5	272.1	366.2	419.9	494.4	511.2	513.8	461.0	383.1	328.7	258.5	232.1	4489.4
		Nighttime hours per month			495.5	399.9	377.8	300.1	249.6	208.8	230.2	283.0	336.9	415.3	461.5	511.9	4270.6
Stage B																	
No of turbines	T	6															
Rotor radius	R	58.5	m														
		Total rotor frontal area m ²			64508												
Nocturnal activity factor	f _{night}	25%															
Bird flight speed	v	11.9	m s ⁻¹														
		Projected number of rotor transits			0.0	0.0	0.0	0.0	26.6	0.0	0.0	0.0	0.0	20.5	0.0	0.0	year total
																	47
Stage C																	
No of blades	b	3					Bird length	l	0.3	m							
Rotation speed	Ω	7.5	rpm				Wingspan	w	0.85	m							
Rotor radius	R	58.5	m				Bird flight speed	v	11.9	m s ⁻¹							
Max blade width	C	4.5	m				Flight type		flapping								
Pitch	λ	15	degrees			% of flights upwind/downwind			50%	50%							
Blade profile		see Blade profile sheet															
		Single transit risk			upwind	7.97%											
					downwind	4.02%											
					weighted mean	5.99%											
Stage D																	
Proportion of time operational	Q _{op}																year avge
																	85.0%
		Collision rates before avoidance															year total
																	2
Stage E																	
Allow for large array correction?		No															
Width of windfarm	w	1.9	km														
		large array correction															
Avoidance rates modelled																	
		98.00%	100.00%														0.048
		99.00%	100.00%														0.024
		99.50%	100.00%														0.012
		99.80%	100.00%														0.005

TABLE 7.8.4b: Collision risk calculations for lapwing using the Band (2024) model, using 2024-25 baseline flight data.

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		Three Oaks 2		Model		5MW type									
Bird length		L	0.3	m	Latitude		54.01		degrees		Hub height		91		m				
Wingspan		W	0.85	m	No of turbines		T	6			Rotor radius		R	58.5	m				
Bird flight speed		v	11.9	m s ⁻¹	Width of windfarm		w	1.9	km		No of blades		b	3					
Flight type, flapping or gliding		flapping								Rotation speed		Ω	7.5	rpm					
% of flights upwind/downwind		50%		50%						Max blade width		C	4.5	m					
Nocturnal activity ranking 1-5		2								Blade pitch		λ	15	degrees					
Nocturnal activity factor		f _{night}	25%								Risk height range		33-150		m				
normal approach		Set to 'normal approach' to use survey data on bird density																	
		Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A																	
Stage A																			
Daytime bird density		D _A	birds/km ²		0.0405313		0	0	0	0	0	0	0	0	0	0.0547105	0	year avge	
Proportion at rotor risk height		Q _{2R}	83.00%																
At latitude 54.		Daylight hours per month		248.5		272.1	366.2	419.9	494.4	511.2	513.8	461.0	383.1	328.7	258.5	232.1	4489.4		
		Nighttime hours per month		495.5		399.9	377.8	300.1	249.6	208.8	230.2	283.0	336.9	415.3	461.5	511.9	4270.6		
Stage B																			
No of turbines		T	6																
Rotor radius		R	58.5		m														
		Total rotor frontal area m ²		64508															
Nocturnal activity factor		f _{night}	25%																
Bird flight speed		v	11.9		m s ⁻¹														
		Projected number of rotor transits		295.9		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	401.0	0.0	697		
Stage C																			
No of blades		b	3				Bird length		l	0.3	m								
Rotation speed		Ω	7.5		rpm		Wingspan		w	0.85	m								
Rotor radius		R	58.5		m		Bird flight speed		v	11.9	m s ⁻¹								
Max blade width		C	4.5		m		Flight type		flapping										
Pitch		λ	15		degrees		% of flights upwind/downwind		50%		50%								
Blade profile		see Blade profile sheet																	
		Single transit risk		upwind		7.97%													
				downwind		4.02%													
				weighted mean		5.99%													
Stage D																			
Proportion of time operational		Q _{op}			85.0%		85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%		
						Collision rates before avoidance													
						15.07		0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.43	0.00	36		
Stage E																			
Allow for large array correction?		No																	
Width of windfarm		w	1.9		km														
		large array correction																	
						Jan		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Avoidance rates modelled		98.00%		100.00%		0.30		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.00	
		99.00%		100.00%		0.15		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	
		99.50%		100.00%		0.08		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	
		99.80%		100.00%		0.03		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	

TABLE 7.8.5a: Collision risk calculations for common gull using the Band (2024) model, using 2019-20 baseline flight data..

COLLISION RISK MODEL			Required input data is in		orange	boxes													
			Calculated output is in		blue	boxes													
					green	boxes are for information only, to show variables used at each stage													
			Value	Units				Value	Units				Value	Units					
Bird data					Windfarm data							Turbine data							
Species name		Common Gull			Site name				Three Oaks 2			Model				SMW type			
Bird length		L	0.44	m	Latitude				54.01			Hub height			91				
Wingspan		W	1.18	m	No of turbines				T	6			Rotor radius			R	58.5		
Bird flight speed		v	13.4	m s ⁻¹	Width of windfarm				w	1.9			No of blades			b	3		
Flight type, flapping or gliding		flapping										Rotation speed			Ω	7.5			
% of flights upwind/downwind		50%										Max blade width			C	4.5			
Nocturnal activity ranking 1-5		2										Blade pitch			λ	15			
Nocturnal activity factor		f _{night}	25%										Risk height range			33-150			
															m				
normal approach		Set to 'normal approach' to use survey data on bird density																	
		Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A																	
Stage A																			
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge					
Daytime bird density		D _A	birds/km ²	0.0043788	0.0693305	0.1223445	0	0	0	0	0	0.0296474	0.4053148	0.0310373	0	0.0552			
Proportion at rotor risk height		Q _{2R}	38.00%																
At latitude 54.		Daylight hours per month			248.5	272.1	366.2	419.9	494.4	511.2	513.8	461.0	383.1	328.7	258.5	232.1			
		Nighttime hours per month			495.5	399.9	377.8	300.1	249.6	208.8	230.2	283.0	336.9	415.3	461.5	511.9			
Stage B																			
No of turbines		T	6																
Rotor radius		R	58.5	m															
		Total rotor frontal area m ²			64508														
Nocturnal activity factor		f _{night}	25%																
Bird flight speed		v	13.4	m s ⁻¹															
		Projected number of rotor transits			16.5	260.7	569.6	0.0	0.0	0.0	0.0	0.0	140.0	1771.7	117.3	0.0			
					2876														
Stage C																			
No of blades		b	3				Bird length	l	0.44	m									
Rotation speed		Ω	7.5	rpm			Wingspan	w	1.18	m									
Rotor radius		R	58.5	m			Bird flight speed	v	13.4	m s ⁻¹									
Max blade width		C	4.5	m			Flight type	flapping											
Pitch		λ	15	degrees	% of flights upwind/downwind			50%		50%									
Blade profile		see Blade profile sheet																	
		Single transit risk			upwind		8.26%												
					downwind		4.76%												
					weighted mean		6.51%												
Stage D																			
Proportion of time operational		Q _{op}				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
						85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	
		Collision rates before avoidance																	
						0.91	14.43	31.52	0.00	0.00	0.00	0.00	0.00	7.75	98.04	6.49	0.00	year total	
																			159
Stage E																			
Allow for large array correction?		No																	
Width of windfarm		w	1.9	km															
		large array correction																	
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year		
Avoidance rates modelled			98.00%	100.00%	0.02	0.29	0.63	0.00	0.00	0.00	0.00	0.00	0.15	1.96	0.13	0.00	3.183		
			99.00%	100.00%	0.01	0.14	0.32	0.00	0.00	0.00	0.00	0.00	0.08	0.98	0.06	0.00	1.591		
			99.20%	100.00%	0.01	0.12	0.25	0.00	0.00	0.00	0.00	0.00	0.06	0.78	0.05	0.00	1.273		
			99.50%	100.00%	0.00	0.07	0.16	0.00	0.00	0.00	0.00	0.00	0.04	0.49	0.03	0.00	0.796		

TABLE 7.8.5b: Collision risk calculations for common gull using the Band (2024) model, using 2024-25 baseline flight data.

COLLISION RISK MODEL			Required input data is in		orange	boxes														
			Calculated output is in		blue	boxes														
					green	boxes are for information only, to show variables used at each stage														
			Value	Units			Value	Units					Value	Units						
Bird data			Windfarm data			Turbine data														
Species name		Common Gull	Site name		Three Oaks 2		Model		SMW type											
Bird length	L	0.44	m	Latitude		54.01	degrees	Hub height		91	m									
Wingspan	W	1.18	m	No of turbines		T	6	Rotor radius		R	58.5	m								
Bird flight speed	v	13.4	m s ⁻¹	Width of windfarm		w	1.9	km	No of blades		b	3								
Flight type, flapping or gliding		flapping							Rotation speed		Ω	7.5	rpm							
% of flights upwind/downwind		50%	50%							Max blade width		C	4.5	m						
Nocturnal activity ranking 1-5		2							Blade pitch		λ	15	degrees							
Nocturnal activity factor		f _{night}	25%	Risk height range										33-150	m					
normal approach			Set to 'normal approach' to use survey data on bird density																	
			Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A																	
Stage A			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge					
Daytime bird density	D _A	birds/km ²	0.7313233	0.4985291	0.179756	0.0416793	0.0187715	0	0	0	0.4564564	0.3733317	0.7923535	0.1718442	0.2720					
Proportion at rotor risk height	Q _{2R}	38.00%																		
At latitude 54,		Daylight hours per month		248.5	272.1	366.2	419.9	494.4	511.2	513.8	461.0	383.1	328.7	258.5	232.1	4489.4				
		Nighttime hours per month		495.5	399.9	377.8	300.1	249.6	208.8	230.2	283.0	336.9	415.3	461.5	511.9	4270.6				
Stage B																				
No of turbines	T	6																		
Rotor radius	R	58.5	m																	
		Total rotor frontal area m ²		64508																
Nocturnal activity factor	f _{night}	25%																		
Bird flight speed	v	13.4	m s ⁻¹			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total		
		Projected number of rotor transits		2752.2	1874.9	836.8	208.5	105.6	0.0	0.0	0.0	2155.9	1631.9	2994.3	625.3	13186				
Stage C																				
No of blades	b	3					Bird length	l	0.44	m										
Rotation speed	Ω	7.5	rpm					Wingspan	w	1.18	m									
Rotor radius	R	58.5	m					Bird flight speed	v	13.4	m s ⁻¹									
Max blade width	C	4.5	m					Flight type	flapping		50%		50%							
Pitch	λ	15	degrees			% of flights upwind/downwind														
Blade profile		see Blade profile sheet																		
		Single transit risk		upwind		8.26%														
				downwind		4.76%														
				weighted mean		6.51%														
Stage D			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge					
Proportion of time operational	Q _{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%					
			Collision rates before avoidance													year total				
			152.29	103.75	46.31	11.54	5.85	0.00	0.00	0.00	119.30	90.30	165.69	34.60	730					
Stage E																				
Allow for large array correction?		No																		
Width of windfarm	w	1.9	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		98.00%	100.00%	3.05	2.08	0.93	0.23	0.12	0.00	0.00	0.00	2.39	1.81	3.31	0.69	14.593				
		99.00%	100.00%	1.52	1.04	0.46	0.12	0.06	0.00	0.00	0.00	1.19	0.90	1.66	0.35	7.296				
		99.20%	100.00%	1.22	0.83	0.37	0.09	0.05	0.00	0.00	0.00	0.95	0.72	1.33	0.28	5.837				
		99.50%	100.00%	0.76	0.52	0.23	0.06	0.03	0.00	0.00	0.00	0.60	0.45	0.83	0.17	3.648				

TABLE 7.8.6a: Collision risk calculations for herring gull using the Band (2024) model, using 2019-20 data.

COLLISION RISK MODEL			Required input data is in		orange	boxes																
			Calculated output is in		blue	boxes																
					green	boxes are	for information only, to show variables used at each stage															
			Value	Units			Value	Units			Value	Units			Value	Units						
Bird data				Windfarm data								Turbine data										
Species name		Herring Gull		Site name		Three Oaks 2		Model		SMW type												
Bird length	L	0.61	m	Latitude		54.01		degrees		Hub height		91		m								
Wingspan	W	1.4	m	No of turbines		T		6		Rotor radius		R		58.5		m						
Bird flight speed	v	12.8	m s ⁻¹	Width of windfarm		w		1.9		km		No of blades		b		3						
Flight type, flapping or gliding		flapping								Rotation speed		Ω		7.5		rpm						
% of flights upwind/downwind		50%	50%							Max blade width		C		4.5		m						
Nocturnal activity ranking 1-5		2								Blade pitch		λ		15		degrees						
Nocturnal activity factor		f _{night}	25%									Risk height range				33-150		m				
normal approach		Set to 'normal approach' to use survey data on bird density																				
		Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A																				
Stage A				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year ave						
Daytime bird density		D _A	birds/km ²	0.0697719	0.4455142	0.3592603	0.5196017	0.7030809	0.0986396	0.1035602	0.141753	0.1419925	1.2800944	0.133222	0.16867	0.3471						
Proportion at rotor risk height		Q _{2R}	54.00%																			
At latitude 54.		Daylight hours per month			248.5	272.1	366.2	419.9	494.4	511.2	513.8	461.0	383.1	328.7	258.5	232.1	4489.4					
		Nighttime hours per month			495.5	399.9	377.8	300.1	249.6	208.8	230.2	283.0	336.9	415.3	461.5	511.9	4270.6					
Stage B																						
No of turbines		T	6																			
Rotor radius		R	58.5	m																		
		Total rotor frontal area m ²			64508																	
Nocturnal activity factor		f _{night}	25%																			
Bird flight speed		v	12.8	m s ⁻¹																		
		Projected number of rotor transits			356.4	2274.4	2270.3	3528.3	5370.6	762.4	811.7	1034.2	910.3	7595.5	683.4	833.2	26431					
Stage C																						
No of blades		b	3			Bird length		l	0.61	m												
Rotation speed		Ω	7.5	rpm			Wingspan		w	1.4	m											
Rotor radius		R	58.5	m			Bird flight speed		v	12.8	m s ⁻¹											
Max blade width		C	4.5	m			Flight type		flapping		50%		50%									
Pitch		λ	15	degrees			% of flights upwind/downwind															
Blade profile		see Blade profile sheet																				
		Single transit risk			upwind		8.87%															
					downwind		5.20%															
					weighted mean		7.03%															
Stage D				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year ave						
Proportion of time operational		Q _{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%						
		Collision rates before avoidance																				
					21.31	135.99	135.74	210.96	321.11	45.59	48.53	61.83	54.43	454.14	40.86	49.82	1580					
Stage E																						
Allow for large array correction?		No																				
Width of windfarm		w	1.9	km																		
		large array correction																				
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year					
Avoidance rates modelled					0.43	2.72	2.71	4.22	6.42	0.91	0.97	1.24	1.09	9.08	0.82	1.00	31.606					
					99.00%	100.00%											15.803					
					99.00%	100.00%											7.902					
					99.50%	100.00%											3.161					
					99.80%	100.00%											3.161					

TABLE 7.8.6b: Collision risk calculations for herring gull using the Band (2024) model, using 2024-25 data.

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			Herring Gull		Site name		Three Oaks 2		Model		5MW type									
Bird length		L	0.61	m	Latitude		54.01		degrees		Hub height		91		m					
Wingspan		W	1.4	m	No of turbines		T	6			Rotor radius		R	58.5	m					
Bird flight speed		v	12.8	m s ⁻¹	Width of windfarm		w	1.9	km		No of blades		b	3						
Flight type, flapping or gliding			flapping								Rotation speed		Ω	7.5	rpm					
% of flights upwind/downwind			50%								Max blade width		C	4.5	m					
Nocturnal activity ranking 1-5			2								Blade pitch		λ	15	degrees					
Nocturnal activity factor		f _{night}	25%		Risk height range										33-150		m			
normal approach			Set to 'normal approach' to use survey data on bird density																	
			Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A																	
Stage A					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge			
Daytime bird density		D _A		birds/km ²	0.5120257	0.6315388	0.6607523	0.8398363	0.517466	0.3962375	0.3602355	0.8301885	1.10687	1.2033562	1.2410457	0.4806473	0.7317			
Proportion at rotor risk height		Q _{2R}	54.00%																	
At latitude 54,			Daylight hours per month		248.5	272.1	366.2	419.9	494.4	511.2	513.8	461.0	383.1	328.7	258.5	232.1	4489.4			
			Nighttime hours per month		495.5	399.9	377.8	300.1	249.6	208.8	230.2	283.0	336.9	415.3	461.5	511.9	4270.6			
Stage B																				
No of turbines		T	6																	
Rotor radius		R	58.5	m																
			Total rotor frontal area m ²		64508															
Nocturnal activity factor		f _{night}	25%																	
Bird flight speed		v	12.8	m s ⁻¹		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total		
			Projected number of rotor transits		2615.6	3224.1	4175.6	5702.8	3952.7	3062.7	2823.5	6056.8	7096.4	7140.2	6366.3	2374.2	54591			
Stage C																				
No of blades		b	3			Bird length		l	0.61	m										
Rotation speed		Ω	7.5	rpm		Wingspan		w	1.4	m										
Rotor radius		R	58.5	m		Bird flight speed		v	12.8	m s ⁻¹										
Max blade width		C	4.5	m		Flight type		flapping												
Pitch		λ	15	degrees	% of flights upwind/downwind		50%		50%											
Blade profile			see Blade profile sheet																	
			Single transit risk		upwind		8.87%													
					downwind		5.20%													
					weighted mean		7.03%													
Stage D					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge			
Proportion of time operational		Q _{op}			85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%			
			Collision rates before avoidance															year total		
					156.39	192.77	249.66	340.97	236.34	183.12	168.82	362.14	424.30	426.92	380.65	141.96	3264			
Stage E																				
Allow for large array correction?			No																	
Width of windfarm		w	1.9	km	Collision rates allowing for avoidance													per year		
			large array correction		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec				
Avoidance rates modelled			98.00%	100.00%	3.13	3.86	4.99	6.82	4.73	3.66	3.38	7.24	8.49	8.54	7.61	2.84	65.281			
			99.00%	100.00%	1.56	1.93	2.50	3.41	2.36	1.83	1.69	3.62	4.24	4.27	3.81	1.42	32.640			
			99.50%	100.00%	0.78	0.96	1.25	1.70	1.18	0.92	0.84	1.81	2.12	2.13	1.90	0.71	16.320			
			99.80%	100.00%	0.31	0.39	0.50	0.68	0.47	0.37	0.34	0.72	0.85	0.85	0.76	0.28	6.528			

TABLE 7.8.7a: Collision risk calculations for black-headed gull using the Band (2024) model, using 2019-20 baseline flight data.

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		Three Oaks 2			Model		SMW type						
Bird length		L	0.4	m	Latitude		54.01 degrees			Hub height		91 m						
Wingspan		W	1.02	m	No of turbines		T	6		Rotor radius		R	58.5	m				
Bird flight speed		v	11.9	m s ⁻¹	Width of windfarm		w	1.9	km	No of blades		b	3					
Flight type, flapping or gliding		flapping								Rotation speed		Ω	7.5	rpm				
% of flights upwind/downwind		50%								Max blade width		C	4.5	m				
Nocturnal activity ranking 1-5		2								Blade pitch		λ	15	degrees				
Nocturnal activity factor		f _{night}	25%						Risk height range			33-150 m						
normal approach		Set to 'normal approach' to use survey data on bird density																
		Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A																
Stage A					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
Daytime bird density		D _A		birds/km ²	0	0.0175171	0.0263796	0	0	0	0	0	0.0296474	0.4405323	0.0299203	0	0.0453	
Proportion at rotor risk height		Q _{2R}	40.00%															
At latitude 54.		Daylight hours per month			248.5	272.1	366.2	419.9	494.4	511.2	513.8	461.0	383.1	328.7	258.5	232.1	4489.4	
		Nighttime hours per month			495.5	399.9	377.8	300.1	249.6	208.8	230.2	283.0	336.9	415.3	461.5	511.9	4270.6	
Stage B																		
No of turbines		T	6															
Rotor radius		R	58.5	m														
		Total rotor frontal area m ²			64508													
Nocturnal activity factor		f _{night}	25%															
Bird flight speed		v	11.9	m s ⁻¹														
		Projected number of rotor transits			0.0	61.6	114.8	0.0	0.0	0.0	0.0	0.0	130.9	1800.1	105.7	0.0	year total 2213	
Stage C																		
No of blades		b	3					Bird length	l	0.4	m							
Rotation speed		Ω	7.5	rpm				Wingspan	w	1.02	m							
Rotor radius		R	58.5	m				Bird flight speed	v	11.9	m s ⁻¹							
Max blade width		C	4.5	m				Flight type		flapping								
Pitch		λ	15	degrees			% of flights upwind/downwind			50%	50%							
Blade profile		see Blade profile sheet																
		Single transit risk					upwind	8.32%										
							downwind	4.37%										
		weighted mean					6.34%											
Stage D					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge	
Proportion of time operational		Q _{op}			85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	
					Collision rates before avoidance													year total 119
					0.00	3.32	6.19	0.00	0.00	0.00	0.00	0.00	7.06	97.04	5.70	0.00		
Stage E																		
Allow for large array correction?		No																
Width of windfarm		w	1.9	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													
		98.00%	100.00%		0.00	0.07	0.12	0.00	0.00	0.00	0.00	0.00	0.14	1.94	0.11	0.00	2.386	
		99.00%	100.00%		0.00	0.03	0.06	0.00	0.00	0.00	0.00	0.00	0.07	0.97	0.06	0.00	1.193	
		99.20%	100.00%		0.00	0.03	0.05	0.00	0.00	0.00	0.00	0.00	0.06	0.78	0.05	0.00	0.954	
		99.50%	100.00%		0.00	0.02	0.03	0.00	0.00	0.00	0.00	0.00	0.04	0.49	0.03	0.00	0.597	

TABLE 7.8.7b: Collision risk calculations for black-headed gull using the Band (2024) model, using 2024-25 baseline flight data.

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		Three Oaks 2			Model		SMW type						
Bird length		L	0.4	m	Latitude		54.01 degrees			Hub height		91 m						
Wingspan		W	1.02	m	No of turbines		T	6		Rotor radius		R	58.5	m				
Bird flight speed		v	11.9	m s ⁻¹	Width of windfarm		w	1.9	km	No of blades		b	3					
Flight type, flapping or gliding		flapping								Rotation speed		Ω	7.5	rpm				
% of flights upwind/downwind		50%								Max blade width		C	4.5	m				
Nocturnal activity ranking 1-5		2								Blade pitch		λ	15	degrees				
Nocturnal activity factor		f _{night}	25%						Risk height range			33-150 m						
normal approach		Set to 'normal approach' to use survey data on bird density																
		Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A																
Stage A			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge			
Daytime bird density		D _A		birds/km ²	0.2201913	0.112501	0.0517557	0	0	0	0.0172704	0	0.2201748	0.1590841	0.2535748	0.0861189	0.0934	
Proportion at rotor risk height		Q _{2R}	40.00%															
At latitude 54.		Daylight hours per month			248.5	272.1	366.2	419.9	494.4	511.2	513.8	461.0	383.1	328.7	258.5	232.1	4489.4	
		Nighttime hours per month			495.5	399.9	377.8	300.1	249.6	208.8	230.2	283.0	336.9	415.3	461.5	511.9	4270.6	
Stage B																		
No of turbines		T	6															
Rotor radius		R	58.5 m															
		Total rotor frontal area m ²			64508													
Nocturnal activity factor		f _{night}	25%															
Bird flight speed		v	11.9 m s ⁻¹															
		Projected number of rotor transits			774.6	395.5	225.2	0.0	0.0	0.0	93.2	0.0	972.1	650.0	895.8	293.0	year total	
Stage C																		
No of blades		b	3															
Rotation speed		Ω	7.5 rpm															
Rotor radius		R	58.5 m															
Max blade width		C	4.5 m															
Pitch		λ	15 degrees															
Blade profile		see Blade profile sheet																
		Single transit risk			upwind	8.32%												
					downwind	4.37%												
					weighted mean	6.34%												
Stage D			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge			
Proportion of time operational		Q _{op}	85.0%			85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	
		Collision rates before avoidance																
					41.76	21.32	12.14	0.00	0.00	0.00	5.03	0.00	52.40	35.04	48.29	15.79	year total	
Stage E																		
Allow for large array correction?		No																
Width of windfarm		w	1.9 km															
		large array correction																
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year	
Avoidance rates modelled		98.00%			0.84	0.43	0.24	0.00	0.00	0.00	0.10	0.00	1.05	0.70	0.97	0.32	4.636	
		99.00%			0.42	0.21	0.12	0.00	0.00	0.00	0.05	0.00	0.52	0.35	0.48	0.16	2.318	
		99.20%			0.33	0.17	0.10	0.00	0.00	0.00	0.04	0.00	0.42	0.28	0.39	0.13	1.854	
		99.50%			0.21	0.11	0.06	0.00	0.00	0.00	0.03	0.00	0.26	0.18	0.24	0.08	1.159	

TABLE 7.8.8a: Collision risk calculations for marsh harrier using the Band (2024) model, using 2019-20 baseline flight data.

COLLISION RISK MODEL			Required input data is in		orange	boxes																
			Calculated output is in		blue	boxes																
					green	boxes are	for information only, to show variables used at each stage															
			Value	Units											Value	Units						
Bird data			Windfarm data				Turbine data															
Species name		Marsh Harrier	Site name		Three Oaks 2		Model		SMW type													
Bird length	L	0.48	m	Latitude	54.01	degrees	Hub height	91	m													
Wingspan	W	1.3	m	No of turbines	T	6	Rotor radius	R	58.5	m												
Bird flight speed	v	11.2	m s ⁻¹	Width of windfarm	w	1.9	No of blades	b	3	Rotation speed	Ω	7.5	rpm									
Flight type, flapping or gliding		flapping					Max blade width	C	4.5	m	Blade pitch	λ	15	degrees								
% of flights upwind/downwind		50%	50%																			
Nocturnal activity ranking 1-5		1																				
Nocturnal activity factor		f _{night}	0%	Risk height range										33-150	m							
normal approach			Set to 'normal approach' to use survey data on bird density																			
			Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A																			
Stage A			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge							
Daytime bird density		D _A	birds/km ²	0	0	0	0	0.0217457	0	0.0129682	0.1339108	0.0590345	0	0	0	0.0190						
Proportion at rotor risk height		Q _{2R}	11.00%																			
At latitude 54.		Daylight hours per month			248.5	272.1	366.2	419.9	494.4	511.2	513.8	461.0	383.1	328.7	258.5	232.1	4489.4					
		Nighttime hours per month			495.5	399.9	377.8	300.1	249.6	208.8	230.2	283.0	336.9	415.3	461.5	511.9	4270.6					
Stage B																						
No of turbines		T	6																			
Rotor radius		R	58.5	m																		
		Total rotor frontal area m ²			64508																	
Nocturnal activity factor		f _{night}	0%																			
Bird flight speed		v	11.2	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	26.3	0.0	16.3	151.0	55.3	0.0	0.0	0.0	249					
Stage C																						
No of blades		b	3	Bird length		l	0.48	m														
Rotation speed		Ω	7.5	rpm	Wingspan		w	1.3	m													
Rotor radius		R	58.5	m	Bird flight speed		v	11.2	m s ⁻¹													
Max blade width		C	4.5	m	Flight type		flapping															
Pitch		λ	15	degrees	% of flights upwind/downwind		50%		50%													
Blade profile		see Blade profile sheet																				
		Single transit risk			upwind		8.93%															
					downwind		4.74%															
					weighted mean		6.83%															
Stage D			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge							
Proportion of time operational		Q _{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%						
			Collision rates before avoidance												year total							
			0.00	0.00	0.00	0.00	1.53	0.00	0.95	8.77	3.21	0.00	0.00	0.00	14							
Stage E																						
Allow for large array correction?		No																				
Width of windfarm		w	1.9	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	0.03	0.00	0.02	0.18	0.06	0.00	0.00	0.00	0.289					
					0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.09	0.03	0.00	0.00	0.00	0.145					
					0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.04	0.02	0.00	0.00	0.00	0.072					
					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.029					

TABLE 7.8.8b: Collision risk calculations for marsh harrier using the Band (2024) model, using 2024-25 baseline flight data.

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		Marsh Harrier			Site name				Three Oaks 2				Model				SMW type					
Bird length		L	0.48	m	Latitude				54.01				Hub height				91					
Wingspan		W	1.3	m	No of turbines				T	6				Rotor radius				R	58.5			
Bird flight speed		v	11.2	m s ⁻¹	Width of windfarm				w	1.9				No of blades				b	3			
Flight type, flapping or gliding		flapping											Rotation speed				Ω	7.5				
% of flights upwind/downwind		50%											Max blade width				C	4.5				
Nocturnal activity ranking 1-5		1											Blade pitch				λ	15				
Nocturnal activity factor		f _{night}	0%											Risk height range				33-150				
normal approach		Set to 'normal approach' to use survey data on bird density																				
		Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A																				
Stage A																			year avge			
Daytime bird density		D _A	birds/km ²			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec					
Proportion at rotor risk height		Q _{2R}	11.00%			0	0	0.026962	0	0.12841	0.062131	0.1002096	0.2608019	0.0521961	0	0	0	0.0526				
At latitude 54.		Daylight hours per month			248.5	272.1	366.2	419.9	494.4	511.2	513.8	461.0	383.1	328.7	258.5	232.1	4489.4					
		Nighttime hours per month			495.5	399.9	377.8	300.1	249.6	208.8	230.2	283.0	336.9	415.3	461.5	511.9	4270.6					
Stage B																						
No of turbines		T	6																			
Rotor radius		R	58.5 m																			
		Total rotor frontal area m ²			64508																	
Nocturnal activity factor		f _{night}	0%																			
Bird flight speed		v	11.2 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	24.1	0.0	155.2	77.7	125.9	294.0	48.9	0.0	0.0	0.0	726					
Stage C																						
No of blades		b	3			Bird length			l	0.48			m									
Rotation speed		Ω	7.5 rpm			Wingspan			w	1.3			m									
Rotor radius		R	58.5 m			Bird flight speed			v	11.2			m s ⁻¹									
Max blade width		C	4.5 m			Flight type			flapping			50%			50%							
Pitch		λ	15 degrees			% of flights upwind/downwind																
Blade profile		see Blade profile sheet																				
		Single transit risk			upwind			8.93%														
					downwind			4.74%														
					weighted mean			6.83%														
Stage D																						
Proportion of time operational		Q _{op}				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge				
					85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%				
					Collision rates before avoidance												year total					
					0.00	0.00	1.40	0.00	9.01	4.51	7.31	17.07	2.84	0.00	0.00	0.00	42					
Stage E																						
Allow for large array correction?		No																				
Width of windfarm		w	1.9 km																			
		large array correction			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	per year					
Avoidance rates modelled		98.00%			100.00%	0.00	0.00	0.03	0.00	0.18	0.09	0.15	0.34	0.06	0.00	0.00	0.00	0.843				
		99.00%			100.00%	0.00	0.00	0.01	0.00	0.09	0.05	0.07	0.17	0.03	0.00	0.00	0.00	0.422				
		99.50%			100.00%	0.00	0.00	0.01	0.00	0.05	0.02	0.04	0.09	0.01	0.00	0.00	0.00	0.211				
		99.80%			100.00%	0.00	0.00	0.00	0.00	0.02	0.01	0.01	0.03	0.01	0.00	0.00	0.00	0.084				

TABLE 7.8.9: Collision risk calculations for red kite using the Band (2024) model, using 2024-24 baseline flight data.

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			Red Kite		Site name		Three Oaks 2		Model		SMW type											
Bird length	L	0.66	m	Latitude		54.01		degrees		Hub height		91		m								
Wingspan	W	1.57	m	No of turbines		T		6		Rotor radius		R		58.5		m						
Bird flight speed	v	12	m s ⁻¹	Width of windfarm		w		1.9		km		No of blades		b		3						
Flight type, flapping or gliding		flapping									Rotation speed		Ω		7.5		rpm					
% of flights upwind/downwind		50%	50%								Max blade width		C		4.5		m					
Nocturnal activity ranking 1-5		1									Blade pitch		λ		15		degrees					
Nocturnal activity factor		f _{night}	0%								Risk height range			33-150		m						
normal approach			Set to 'normal approach' to use survey data on bird density																			
			Set to 'birds on migration' to use 'Migrant collision risk' sheet in place of Stage A																			
Stage A			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge							
Daytime bird density	D _A		birds/km ²	0	0.1365505	0.0575547	0.0232413	0.076096	0	0.2494523	0.1383864	0.0515401	0	0.013025	0	0.0622						
Proportion at rotor risk height	Q _{2R}	29.00%																				
At latitude 54.		Daylight hours per month			248.5	272.1	366.2	419.9	494.4	511.2	513.8	461.0	383.1	328.7	258.5	232.1	4489.4					
		Nighttime hours per month			495.5	399.9	377.8	300.1	249.6	208.8	230.2	283.0	336.9	415.3	461.5	511.9	4270.6					
Stage B																						
No of turbines	T	6																				
Rotor radius	R	58.5	m	Total rotor frontal area m ²			64508															
Nocturnal activity factor	f _{night}	0%																				
Bird flight speed	v	12	m s ⁻¹	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year total						
		Projected number of rotor transits			0.0	256.7	145.6	67.4	259.9	0.0	885.2	440.7	136.4	0.0	23.3	0.0	2215					
Stage C																						
No of blades	b	3					Bird length	l	0.66	m												
Rotation speed	Ω	7.5	rpm				Wingspan	w	1.57	m												
Rotor radius	R	58.5	m				Bird flight speed	v	12	m s ⁻¹												
Max blade width	C	4.5	m				Flight type		flapping													
Pitch	λ	15	degrees	% of flights upwind/downwind			50%			50%												
Blade profile		see Blade profile sheet																				
		Single transit risk			upwind			9.33%														
					downwind			5.41%														
		weighted mean			7.37%																	
Stage D			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avge							
Proportion of time operational	Q _{op}	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%						
		Collision rates before avoidance															year total					
		0.00	16.08	9.12	4.22	16.28	0.00	55.44	27.60	8.54	0.00	1.46	0.00	139								
Stage E																						
Allow for large array correction?		No																				
Width of windfarm	w	1.9	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																				
		98.00%	100.00%	100.00%	100.00%	100.00%	0.00	0.32	0.18	0.08	0.33	0.00	1.11	0.55	0.17	0.00	0.03	0.00	2.775			
		99.00%	100.00%	100.00%	100.00%	100.00%	0.00	0.16	0.09	0.04	0.16	0.00	0.55	0.28	0.09	0.00	0.01	0.00	1.387			
		99.50%	100.00%	100.00%	100.00%	100.00%	0.00	0.08	0.05	0.02	0.08	0.00	0.28	0.14	0.04	0.00	0.01	0.00	0.694			
		99.80%	100.00%	100.00%	100.00%	100.00%	0.00	0.03	0.02	0.01	0.03	0.00	0.11	0.06	0.02	0.00	0.00	0.00	0.277			



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