Environmental Impact Statement
Uungula Wind Farm

Appendix I: Collision Risk Model (Environmental Resources Management, 2013)

May 2020

Annex H

Avian Collision Risk Model

H.1 COLLISION RISK MODEL

H.1.1 *Calculating Bird Collision Risk*

The Collision Risk Model (CRM) used in this assessment has been developed by Scottish National Heritage and is referred to as the Band Model (SNH 2000 & 2010, Band 2000). This model provides a means of estimating collision risks and hence the potential bird mortality, which may be caused by a wind farm.

Stage 1

The first stage is to determine the risk (probability) of a bird being hit by a turbine blade when making a transit through a rotor without any avoidance. The probability depends on the bird length, wingspan, likely traveling speed (Spaar & Bruderer 1996) and if they are likely to be flapping or soaring. The operational measures of the wind turbine are also considered and are specified below;

- Maximum chord width of rotor = 2m

- Pitch angle of rotor = 24 degrees

- Rotor diameter = 144 m

- Rotation period = 4.29 m/s

Collision risk was estimated for the identified species recorded within the Study Area. However, some bird species were not included in the assessment because all individuals recorded within the Study Area were below the rotor height during the surveys and thus the risk cannot be determined by the adopted calculations. The predicted collision risk from the CRM therefore generated an average collision risk for each of the subject species of upwind flying direction and downwind flying direction. The tables below are taken from the Band Model for the calculation of collision risk for each of the subject species.

Table H.1   Collision Risk for White-Throated Needletail

CALCULATION OF COLLISION RISK FOR WHITE-THROATED NEEDLETAIL PASSING THROUGH ROTOR AREA

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
No Blades	3						Upwind:			Downwind:	
Max Chord	2	m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)	24		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
Bird Length	0.23	m	0.025	0.575	6.83	11.12	0.43	0.00054	10.19	0.40	0.00049
Wingspan	0.51	m	0.075	0.575	2.28	4.02	0.16	0.00117	3.08	0.12	0.00090
F: Flapping (0) or gliding (+1)	0		0.125	0.702	1.37	3.02	0.12	0.00147	1.88	0.07	0.00091
			0.175	0.860	0.98	2.73	0.11	0.00186	1.33	0.05	0.00090
Bird speed	18	m/sec	0.225	0.994	0.76	2.57	0.10	0.00225	0.96	0.04	0.00084
Rotor Diameter	144	m	0.275	0.947	0.62	2.16	0.08	0.00231	0.62	0.02	0.00066
Rotation Period	4.29	sec	0.325	0.899	0.53	1.86	0.07	0.00235	0.40	0.02	0.00050
			0.375	0.851	0.46	1.63	0.06	0.00238	0.25	0.01	0.00036
			0.425	0.804	0.40	1.47	0.06	0.00243	0.29	0.01	0.00049
			0.475	0.756	0.36	1.34	0.05	0.00247	0.35	0.01	0.00064
Bird aspect ratio	0.45		0.525	0.708	0.33	1.23	0.05	0.00250	0.39	0.01	0.00079
			0.575	0.660	0.30	1.13	0.04	0.00251	0.41	0.02	0.00091
			0.625	0.613	0.27	1.03	0.04	0.00251	0.42	0.02	0.00103
			0.675	0.565	0.25	0.95	0.04	0.00249	0.43	0.02	0.00112
			0.725	0.517	0.24	0.87	0.03	0.00246	0.43	0.02	0.00121
			0.775	0.470	0.22	0.80	0.03	0.00241	0.42	0.02	0.00127
			0.825	0.422	0.21	0.73	0.03	0.00235	0.41	0.02	0.00133
			0.875	0.374	0.20	0.67	0.03	0.00227	0.40	0.02	0.00136
			0.925	0.327	0.18	0.61	0.02	0.00218	0.39	0.01	0.00139
			0.975	0.279	0.18	0.55	0.02	0.00207	0.37	0.01	0.00139
						Overall p(collision) =	**Upwind**	**4.3%**		**Downwind**	**1.8%**
										Average	**3.1%**

Table H.2

CALCULATION OF COLLISION RISK FOR WEDGE-TAILED EAGLE PASSING THROUGH ROTOR AREA

						Upwind:			**Downwind:**		
K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
No Blades	3										
Max Chord	2	m	r/R	c/C	⬚	collide		contribution	collide		contribution
Pitch (degrees)	24		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
Bird Length	1.06	m	0.025	0.575	5.69	14.85	0.69	0.00087	13.91	0.65	0.00081
Wingspan	2.32	m	0.075	0.575	1.90	5.26	0.25	0.00184	4.33	0.20	0.00151
F: Flapping (0) or gliding (+1)	1		0.125	0.702	1.14	3.71	0.17	0.00216	2.57	0.12	0.00150
			0.175	0.860	0.81	3.18	0.15	0.00259	1.78	0.08	0.00145
Bird speed	15	m/sec	0.225	0.994	0.63	2.89	0.13	0.00303	1.27	0.06	0.00134
Rotor Diameter	144	m	0.275	0.947	0.52	2.43	0.11	0.00311	0.89	0.04	0.00114
Rotation Period	4.29	sec	0.325	0.899	0.44	2.51	0.12	0.00380	1.07	0.05	0.00162
			0.375	0.851	0.38	2.34	0.11	0.00410	1.16	0.05	0.00203
			0.425	0.804	0.33	2.21	0.10	0.00437	1.22	0.06	0.00242
			0.475	0.756	0.30	2.09	0.10	0.00462	1.26	0.06	0.00279
Bird aspect ratio: ⬚	0.46		0.525	0.708	0.27	1.99	0.09	0.00486	1.29	0.06	0.00315
			0.575	0.660	0.25	1.90	0.09	0.00508	1.30	0.06	0.00348
			0.625	0.613	0.23	1.81	0.08	0.00528	1.30	0.06	0.00380
			0.675	0.565	0.21	1.74	0.08	0.00547	1.30	0.06	0.00410
			0.725	0.517	0.20	1.67	0.08	0.00563	1.30	0.06	0.00438
			0.775	0.470	0.18	1.60	0.07	0.00578	1.28	0.06	0.00464
			0.825	0.422	0.17	1.54	0.07	0.00591	1.27	0.06	0.00489
			0.875	0.374	0.16	1.48	0.07	0.00602	1.25	0.06	0.00511
			0.925	0.327	0.15	1.42	0.07	0.00611	1.23	0.06	0.00532
			0.975	0.279	0.15	1.36	0.06	0.00619	1.21	0.06	0.00551
						Overall p(collision) =	**Upwind**	**8.7%**		**Downwind**	**6.1%**
								Average	**7.4%**		

Stage 2

The second stage is to estimate the number of birds flying through rotors (ie number of bird at risk) per month. The Study Area measures approximately 35 km across and the number of birds at risk will be estimated for this area. This is to provide a more conservative approach by assuming all birds recorded in close proximity will pass through the Study Site. The flight risk window was first estimated by multiplying the width of the assessment area (35 km) with the maximum height of the turbine (192 m). The total rotor area as proportion to the flight risk window was then calculated by considering the total number of wind turbine (249) and the maximum area of each rotor.

The number of birds at risk in each month was then estimated using adapted methodology from ERM (2005). The number of birds flying at RSA height was divided by the total number of BUS surveys, giving the number of birds per BUS survey. As each BUS survey was 15 minutes long, this number was quadrupled to give the number of birds per hour. The *birds at risk per day* was then calculated by multiplying by the flying time, which was 13.5 hrs flying time per day for the White throated Needletail (average daylight period) and 10 hours for the Wedge-tailed Eagle. The flying time was reduced for the Wedge-tailed Eagle, as the species is most active when thermals are present, and was not recorded during the early morning period flying at RSA height. This figure was then multiplied by 30.4 to give the number of birds per month flying at RSA height. The number of birds passing through the rotor area was calculated by multiplying the amount of birds at risk per month by the proportion of the area risk window that was made up of the rotor area.

Finally, the number of bird collisions per year will be predicted by multiplying the risk (1st stage) with the number of birds at risk (2nd stage). This number, however, assumes the birds fly as if the wind turbine structures and rotors were not there and take no avoiding action (ie death). In reality most birds do take avoiding action and therefore the predicted number is usually adjusted by the avoidance factor. An avoidance rate of 99 % was also applied as this rate assumes that moist species would avoid collision 99 % of the time (Smales & Muir 2005; Smales 2006).

1.1.2 *Results*

The results of the collision risk model are presented in *Table H.3* below. A summary of the results is discussed separately for the two species modeled.

White-Throated Needletail

The results of the collision risk model for White-throated Needletail indicate that between 1.06 and 0.21 birds per month will collide with turbines across the entire Study Area.

Wedge-Tailed Eagle

The results of the collision risk model for Wedge-tailed Eagle indicate that between 0.20 and 0.04 birds per month will collide with turbines across the entire Study Area, based on a 95% to 99% avoidance band.

Table H.3 Collision Risk Model Results

Species	Band Collision	Birds within RSA	Number of Surveys	Birds at risk per BUS survey (15 mins)	Birds at risk per BUS survey (per hour)	Birds at risk per day	Birds at risk per month	Birds passing through rotor area	No Avoidance	95% Avoidance	99% Avoidance
White-throated Needletail	0.031	45	65	0.692307692	2.769230769	37.38461538	1137.24	686.2732425	21.2744705	1.0637235	0.212745
Wedge-tailed Eagle	**0.074**	19	65	0.292307692	1.169230769	2.923076923	87.69230769	52.91836758	3.9159592	0.195798	0.03916

Risk Window - 4.055218063, Rotor Area Proportion - 0.603455069