

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA – STAGE 2

Обикновен мишелов / Buteo buteo

K: [1D or [3D] (0 or 1)	1	
NoBlades	3	
MaxChord	5.2	m
Pitch (degrees)	15	

BirdLength	0.55	m
Wingspan	1.25	m
F: Flapping (0) or gliding (+1)	1	

Bird speed	11	m/sec
RotorDiam	180	m
RotationPeriod	4.90	sec

Bird aspect ratio: β	0.44	

Collision risk						
$C = Nb \cdot \text{Overall}(p) \cdot 0.85$	Cavoid			Cavoid/WTG		
$C_{\text{avoid}} = C \cdot (1 - (Af/100))$	Up	Dwn	Avg	Up	Dwn	Avg
C - colission	1.9E-2	9.6E-3	1.5E-2	2.5E-4	1.2E-4	1.8E-4
Cavoid – collision with avoidance						
Af – avoidance rate 98%						
Nb – number of bird						
85% - WTG annual operation time						
WTG – wind turbine						

Calculation of alpha and p(collision) as a function of radius

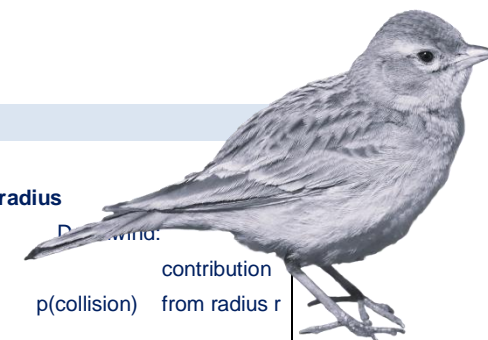
r/R radius	c/C chord	α alpha	Upwind:			Downwind:		
			collide length	p(collision)	contribution from radius r	collide length	p(collision)	contribution from radius r
0.025	0.575	3.81	14.82	0.82	0.00103	13.27	0.74	0.0005
0.075	0.575	1.27	5.46	0.30	0.00228	3.91	0.22	0.00163
0.125	0.702	0.76	4.24	0.24	0.00295	2.35	0.13	0.00163
0.175	0.860	0.54	3.94	0.22	0.00384	1.63	0.09	0.00159
0.225	0.994	0.42	4.00	0.22	0.00501	1.33	0.07	0.00166
0.275	0.947	0.35	3.47	0.19	0.00531	0.92	0.05	0.00141
0.325	0.899	0.29	3.08	0.17	0.00558	0.66	0.04	0.00120
0.375	0.851	0.25	2.78	0.15	0.00581	0.61	0.03	0.00127
0.425	0.804	0.22	2.54	0.14	0.00600	0.73	0.04	0.00172
0.475	0.756	0.20	2.33	0.13	0.00616	0.81	0.04	0.00213
0.525	0.708	0.18	2.15	0.12	0.00628	0.86	0.05	0.00251
0.575	0.660	0.17	1.99	0.11	0.00636	0.89	0.05	0.00285
0.625	0.613	0.15	1.84	0.10	0.00641	0.91	0.05	0.00315
0.675	0.565	0.14	1.71	0.10	0.00643	0.91	0.05	0.00342
0.725	0.517	0.13	1.59	0.09	0.00641	0.90	0.05	0.00365
0.775	0.470	0.12	1.47	0.08	0.00635	0.89	0.05	0.00385
0.825	0.422	0.12	1.36	0.08	0.00626	0.87	0.05	0.00401
0.875	0.374	0.11	1.26	0.07	0.00613	0.85	0.05	0.00413
0.925	0.327	0.10	1.16	0.06	0.00596	0.82	0.05	0.00422
0.975	0.279	0.10	1.06	0.06	0.00576	0.79	0.04	0.00428

Overall p(collision) =	Upwind	10.6%	Downwind	5.1%
	Average	7.9%		



CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA – STAGE 2

Късопръстата чучулига / *Calandrella brachydactyla*



K: [1D or [3D] (0 or 1)	1	
NoBlades	3	
MaxChord	5.2	m
Pitch (degrees)	15	

BirdLength	0.14	m
Wingspan	0.27	m
F: Flapping (0) or gliding (+1)	0	

Bird speed	10	m/sec
RotorDiam	180	m
RotationPeriod	4.90	sec

Bird aspect ratio: β	0.52	

Collision risk						
$C = Nb \cdot \text{Overall}(p) \cdot 0.85$	Cavoid			Cavoid/WTG		
$C_{\text{avoid}} = C \cdot (1 - (Af/100))$	Up	Dwn	Avg	Up	Dwn	Avg
C - colission	1.5E-3	5.4E-4	1.0E-3	1.9E-5	6.7E-6	1.3E-5
Cavoid – collision with avoidance						
Af – avoidance rate 98%						
Nb – number of bird						
85% - WTG annual operation time						
WTG – wind turbine						

Calculation of alpha and p(collision) as a function of radius

r/R radius	c/C chord	α alpha	Upwind:			Downwind:		
			collide length	p(collision)	contribution from radius r	collide length	p(collision)	contribution from radius r
0.025	0.575	3.47	11.72	0.72	0.00090	10.17	0.62	0.00078
0.075	0.575	1.16	4.42	0.27	0.00203	2.87	0.18	0.00132
0.125	0.702	0.69	3.57	0.22	0.00274	1.69	0.10	0.00129
0.175	0.860	0.50	3.44	0.21	0.00368	1.12	0.07	0.00120
0.225	0.994	0.39	3.40	0.21	0.00469	0.73	0.04	0.00100
0.275	0.947	0.32	2.91	0.18	0.00490	0.36	0.02	0.00061
0.325	0.899	0.27	2.55	0.16	0.00508	0.15	0.01	0.00029
0.375	0.851	0.23	2.27	0.14	0.00522	0.30	0.02	0.00068
0.425	0.804	0.20	2.04	0.13	0.00532	0.40	0.02	0.00104
0.475	0.756	0.18	1.85	0.11	0.00538	0.46	0.03	0.00135
0.525	0.708	0.17	1.68	0.10	0.00540	0.51	0.03	0.00163
0.575	0.660	0.15	1.53	0.09	0.00538	0.53	0.03	0.00186
0.625	0.613	0.14	1.39	0.09	0.00532	0.54	0.03	0.00206
0.675	0.565	0.13	1.26	0.08	0.00523	0.54	0.03	0.00222
0.725	0.517	0.12	1.15	0.07	0.00509	0.53	0.03	0.00233
0.775	0.470	0.11	1.04	0.06	0.00491	0.51	0.03	0.00241
0.825	0.422	0.11	0.93	0.06	0.00470	0.49	0.03	0.00245
0.875	0.374	0.10	0.83	0.05	0.00445	0.46	0.03	0.00245
0.925	0.327	0.09	0.73	0.04	0.00415	0.43	0.03	0.00241
0.975	0.279	0.09	0.64	0.04	0.00382	0.39	0.02	0.00233

Overall p(collision) =	Upwind	8.8%	Downwind	3.2%
	Average	6.0%		



CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA – STAGE 2

Черен щъркел / *Ciconia nigra*

K: [1D or [3D] (0 or 1)	1	
NoBlades	3	
MaxChord	5.2	m
Pitch (degrees)	15	

BirdLength	0.96	m
Wingspan	1.49	m
F: Flapping (0) or gliding (+1)	1	

Bird speed	12.5	m/sec
RotorDiam	180	m
RotationPeriod	4.90	sec

Bird aspect ratio: β	0.64	

Collision risk						
$C = Nb \cdot Overall(p) \cdot 0.85$	Cavoid			Cavoid/WTG		
$Cavoid = C \cdot (1 - (Af/100))$	Up	Dwn	Avg	Up	Dwn	Avg
C - colission	2.4E-3	1.3E-3	1.9E-3	3.0E-5	1.6E-5	2.3E-5
Cavoid – collision with avoidance						
Af – avoidance rate 98%						
Nb – number of bird						
85% - WTG annual operation time						
WTG – wind turbine						

Calculation of alpha and p(collision) as a function of radius

r/R radius	c/C chord	α alpha	Upwind:			Downwind:		
			collide length	p(collision)	contribution from radius r	collide length	p(collision)	contribution from radius r
0.025	0.575	4.33	17.40	0.85	0.00107	15.85	0.78	0.0009
0.075	0.575	1.44	6.31	0.31	0.00232	4.77	0.23	0.00175
0.125	0.702	0.87	4.82	0.24	0.00295	2.93	0.14	0.00179
0.175	0.860	0.62	4.79	0.23	0.00411	2.48	0.12	0.00212
0.225	0.994	0.48	4.70	0.23	0.00518	2.03	0.10	0.00223
0.275	0.947	0.39	4.11	0.20	0.00553	1.56	0.08	0.00210
0.325	0.899	0.33	3.67	0.18	0.00585	1.25	0.06	0.00200
0.375	0.851	0.29	3.34	0.16	0.00614	1.05	0.05	0.00193
0.425	0.804	0.25	3.07	0.15	0.00639	1.01	0.05	0.00211
0.475	0.756	0.23	2.84	0.14	0.00661	1.11	0.05	0.00259
0.525	0.708	0.21	2.65	0.13	0.00681	1.18	0.06	0.00303
0.575	0.660	0.19	2.47	0.12	0.00697	1.22	0.06	0.00345
0.625	0.613	0.17	2.32	0.11	0.00710	1.25	0.06	0.00383
0.675	0.565	0.16	2.18	0.11	0.00719	1.27	0.06	0.00418
0.725	0.517	0.15	2.04	0.10	0.00726	1.27	0.06	0.00450
0.775	0.470	0.14	1.92	0.09	0.00729	1.26	0.06	0.00479
0.825	0.422	0.13	1.81	0.09	0.00730	1.25	0.06	0.00505
0.875	0.374	0.12	1.70	0.08	0.00727	1.23	0.06	0.00528
0.925	0.327	0.12	1.59	0.08	0.00721	1.21	0.06	0.00547
0.975	0.279	0.11	1.49	0.07	0.00712	1.18	0.06	0.00563

Overall p(collision) =	Upwind	11.8%	Downwind	6.5%
	Average	9.1%		

