CALEDONIA
Offshore Wind Farm

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Volume 7B Proposed Development (Offshore) Appendices

Appendix 6-3 Offshore Ornithology Collision Risk Modelling Technical Report

Annex 2 Collision Risk Modelling Results (Caledonia North)

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Volume 7B Appendix 6-3 Annex 2 Collision Risk Modelling Results (Caledonia North)

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Acronyms and Abbreviations

CI	Confidence Interval
CRM	Collision Risk Modelling
HAT	Highest Astronomical Tide
km	Kilometre
m	Metre
NAF	Nocturnal Activity Factor
OWF	Offshore Wind Farm
rpm	Revolutions Per Minute
SD	Standard Deviation
WTG	Wind Turbine Generator

1 Introduction

1.1.1.1 The results of Collision Risk Modelling (CRM) for the Caledonia Offshore Wind Farm (OWF), specifically Caledonia North, are presented within this annex. Two Wind Turbine Generator (WTG) options have been modelled using both the deterministic and stochastic basic Band (2012[1]) model, Option 2. The full CRM methodology is outlined in Volume 7B, Appendix 6-3: Offshore Ornithology Collision Risk Modelling Technical Report.

1.1.1.2 The WTG parameters used within the CRM for the Caledonia North Site (Array Area) are presented in Table 1-1, with further information presented in Section 2.6 of Volume 7B, Appendix 6-3: Offshore Ornithology Collision Risk Modelling Technical Report. Estimated collisions are presented in Section 2.

Table 1-1: OWF and WTG parameters used for CRM for the Caledonia North Site.

Parameter	WTG 1 (N)	WTG 2 (N)
Number of WTGs	47	77
Latitude (degrees)	58.26	58.26
Width (km)	29.5	29.5
Tidal offset (m)	2.19	2.19
Number of blades	3	3
Rotor radius (m)	155	118
Air gap relative to HAT (m)	35	35
Blade width (m)	7.5	7.5
Average pitch (º)	2	2
Average pitch SD (º)	No data (assumed 0)	No data (assumed 0)
Rotation speed (rpm)	8.4	8.4
Rotation speed SD (rpm)	No data (assumed 0)	No data (assumed 0)

2 Results

2.1 Overview

2.1.1.1 CRM outputs for the two WTG scenarios for the Caledonia North Site have been presented in the following sections for five species:

- Kittiwake (*Rissa tridactyla*) (Section 2.2);
- Great blacked-back gull (*Larus marinus*) (Section 2.3);
- Herring gull (*Larus argentatus*) (Section 2.4);
- Great skua (*Stercorarius skua*) (Section 2.5); and
- Gannet (*Morus bassanus*) (Sections 2.6, 2.7 and 2.8).

2.1.1.2 For gannet, an Applicant Approach was assessed in addition to the Guidance Approach. For the Applicant Approach, a macro-avoidance rate of 70% was applied to gannet CRM results; however, the macro-avoidance rate was only applied to the CRM results in the non-breeding season for the Guidance Approach. This accounts for the potential overestimation of impacts due to double counting of gannets that are likely to be displaced. Further information can be found in Volume 7B, Appendix 6-3: Offshore Ornithology Collision Risk Modelling Technical Report. The CRM results for gannet, without applying the macro-avoidance correction factor, are presented in Section 2.8.

2.2 Kittiwake

Table 2-1: Estimated monthly collisions for kittiwake in the Caledonia North Site for the two WTG scenarios (WTG 1 (N) and WTG 2 (N)) using the deterministic Band (2012[1]) model.

Scenario	NAF (%)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
WTG 1 (N)	25	0.18	0.27	0.36	0.79	4.87	4.81	2.15	2.06	0.56	0.60	1.99	0.28	**18.91**
	50	0.24	0.35	0.44	0.90	5.35	5.17	2.33	2.31	0.66	0.75	2.65	0.39	**21.54**
WTG 2 (N)	25	0.27	0.41	0.55	1.18	7.33	7.25	3.24	3.10	0.84	0.91	3.00	0.42	**28.49**
	50	0.37	0.52	0.66	1.36	8.05	7.79	3.51	3.48	0.99	1.13	4.00	0.58	**32.46**

Table 2-2: Estimated monthly collisions for kittiwake in the Caledonia North Site for the two WTG scenarios (WTG 1 (N) and WTG 2 (N)) using the stochastic Band (2012[1]) model.

Scenario	CI	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
WTG 1 (N)	Mean	0.19	0.28	0.35	0.74	4.41	4.46	1.94	1.88	0.54	0.60	1.99	0.30	**17.67**
	2.5%	0.03	0.05	0.06	0.22	1.43	0.94	0.73	0.80	0.08	0.14	0.91	0.03	**5.41**
	97.5%	0.39	0.60	0.71	1.38	8.00	8.92	3.43	3.16	1.23	1.23	3.52	0.66	**33.23**
WTG 2 (N)	Mean	0.29	0.40	0.53	1.10	6.58	6.82	2.92	2.87	0.82	0.88	3.01	0.45	**26.69**
	2.5%	0.05	0.04	0.07	0.36	1.93	1.38	1.05	1.26	0.10	0.18	1.23	0.05	**7.72**
	97.5%	0.59	0.87	1.11	2.01	12.28	13.37	5.10	4.73	1.77	1.78	5.22	0.95	**49.79**

2.3 Great Black-Backed Gull

Table 2-3: Estimated monthly collisions for great black-backed gull in the Caledonia North Site for the two WTG scenarios (WTG 1 (N) and WTG 2 (N)) using the deterministic Band (2012[1]) model.

Scenario	NAF (%)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
WTG 1 (N)	25	1.25	0.85	0	0	0	0	0	0	0.84	0.49	1.03	0.32	**4.77**
	50	1.72	1.09	0	0	0	0	0	0	0.98	0.61	1.37	0.45	**6.22**
WTG 2 (N)	25	1.85	1.25	0	0	0	0	0	0	1.23	0.73	1.52	0.47	**7.05**
	50	2.53	1.60	0	0	0	0	0	0	1.45	0.91	2.03	0.66	**9.18**

Table 2-4: Estimated monthly collisions for great black-backed gull in the Caledonia North Site for the two WTG scenarios (WTG 1 (N) and WTG 2 (N)) using the stochastic Band (2012[1]) model.

Scenario	CI	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
WTG 1 (N)	Mean	1.70	1.12	0	0	0	0	0	0	1.12	0.64	1.39	0.49	**6.46**
	2.5%	0.59	0.30	0	0	0	0	0	0	0.14	0.13	0.30	0.04	**1.50**
	97.5%	3.23	2.35	0	0	0	0	0	0	2.59	1.32	2.89	1.20	**13.58**
WTG 2 (N)	Mean	2.59	1.63	0	0	0	0	0	0	1.68	0.95	2.06	0.75	**9.66**
	2.5%	0.86	0.38	0	0	0	0	0	0	0.22	0.24	0.42	0.06	**2.17**
	97.5%	5.02	3.46	0	0	0	0	0	0	3.98	2.00	4.33	1.95	**20.75**

2.4 Herring Gull

Table 2-5: Estimated monthly collisions for herring gull in the Caledonia North Site for the two WTG scenarios (WTG 1 (N) and WTG 2 (N)) using the deterministic Band (2012[1]) model.

Scenario	NAF (%)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
WTG 1 (N)	25	0	0	0	0	0	0	0	0	0.27	0.25	0	0.27	**0.80**
	50	0	0	0	0	0	0	0	0	0.32	0.32	0	0.38	**1.01**
WTG 2 (N)	25	0	0	0	0	0	0	0	0	0.40	0.38	0	0.41	**1.18**
	50	0	0	0	0	0	0	0	0	0.47	0.47	0	0.57	**1.51**

Tabe 2-6: Estimated monthly collisions for herring gull in the Caledonia North Site for the two WTG scenarios (WTG 1 (N) and WTG 2 (N)) using the stochastic Band (2012) model.

Scenario	CI	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
WTG 1 (N)	Mean	0	0	0	0	0	0	0	0	0.33	0.32	0	0.34	**0.99**
	2.5%	0	0	0	0	0	0	0	0	0.02	0.03	0	0.04	**0.10**
	97.5%	0	0	0	0	0	0	0	0	0.82	0.79	0	0.74	**2.35**
WTG 2 (N)	Mean	0	0	0	0	0	0	0	0	0.50	0.48	0	0.54	**1.52**
	2.5%	0	0	0	0	0	0	0	0	0.06	0.04	0	0.07	**0.17**
	97.5%	0	0	0	0	0	0	0	0	1.20	1.21	0	1.15	**3.56**

2.5 Great Skua

Table 2-7: Estimated monthly collisions for great skua in the Caledonia North Site for the two WTG scenarios (WTG 1 (N) and WTG 2 (N)) using the deterministic Band (2012[1]) model.

Scenario	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
WTG 1 (N)	0	0	0	0	0.02	0.02	0.02	0.05	0	0	0	0	**0.12**
WTG 2 (N)	0	0	0	0	0.03	0.03	0.03	0.08	0	0	0	0	**0.17**

Table 2-8: Estimated monthly collisions for great skua in the Caledonia North Site for the two WTG scenarios (WTG 1 (N) and WTG 2 (N)) using the stochastic Band (2012[1]) model.

Scenario	CI	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
WTG 1 (N)	Mean	0	0	0	0	0.02	0.02	0.02	0.05	0	0	0	0	**0.11**
	2.5%	0	0	0	0	0	0	0	0.01	0	0	0	0	**0.01**
	97.5%	0	0	0	0	0.05	0.05	0.05	0.09	0	0	0	0	**0.23**
WTG 2 (N)	Mean	0	0	0	0	0.03	0.03	0.03	0.07	0	0	0	0	**0.16**
	2.5%	0	0	0	0	0	0	0	0.01	0	0	0	0	**0.02**
	97.5%	0	0	0	0	0.06	0.07	0.07	0.13	0	0	0	0	**0.33**

2.6 Gannet (Guidance Approach)

Table 2-9: Estimated monthly collisions for gannet in the Caledonia North Site for the two WTG scenarios (WTG 1 (N) and WTG 2 (N)) using the deterministic Band (2012[1]) model for the Guidance Approach.

Scenario	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
WTG 1 (N)	0	0.02	0	0.15	0	1.08	0.37	0.44	0.90	0.25	0.03	0.03	**3.26**
WTG 2 (N)	0	0.03	0	0.21	0	1.54	0.53	0.62	1.27	0.36	0.04	0.04	**4.64**

Table 2-10: Estimated monthly collisions for gannet in the Caledonia North Site for the two WTG scenarios (WTG 1 (N) and WTG 2 (N)) using the stochastic Band (2012[1]) model for the Guidance Approach.

Scenario	CI	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
WTG 1 (N)	Mean	0	0.02	0	0.16	0	1.10	0.41	0.44	0.92	0.26	0.03	0.03	**3.37**
	2.5%	0	0	0	0.01	0	0.14	0.03	0.05	0.12	0.04	0	0	**0.39**
	97.5%	0	0.06	0	0.49	0	2.98	1.25	1.23	2.48	0.67	0.11	0.09	**9.35**
WTG 2 (N)	Mean	0	0.03	0	0.23	0	1.52	0.59	0.62	1.33	0.37	0.05	0.04	**4.78**
	2.5%	0	0	0	0.02	0	0.19	0.05	0.07	0.16	0.05	0	0	**0.55**
	97.5%	0	0.09	0	0.70	0	4.29	1.74	1.75	3.68	1.04	0.17	0.12	**13.58**

2.7 Gannet (Applicant Approach)

Table 2-11: Estimated monthly collisions for gannet in the Caledonia North Site for the two WTG scenarios (WTG 1 (N) and WTG 2 (N)) using the deterministic Band (2012[1]) model for the Applicant Approach.

Scenario	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
WTG 1 (N)	0	0.02	0	0.05	0	0.32	0.11	0.13	0.27	0.25	0.03	0.03	**1.21**
WTG 2 (N)	0	0.03	0	0.06	0	0.46	0.16	0.19	0.38	0.36	0.04	0.04	**1.72**

Table 2-12: Estimated monthly collisions for gannet in the Caledonia North Site for the two WTG scenarios (WTG 1 (N) and WTG 2 (N)) using the stochastic Band (2012[1]) model for the Applicant Approach.

Scenario	CI	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
WTG 1 (N)	Mean	0	0.02	0	0.05	0	0.33	0.12	0.13	0.28	0.26	0.03	0.03	**1.25**
	2.5%	0	0	0	0	0	0.04	0.01	0.02	0.03	0.04	0	0	**0.15**
	97.5%	0	0.06	0	0.15	0	0.89	0.37	0.37	0.74	0.67	0.11	0.09	**3.46**
WTG 2 (N)	Mean	0	0.03	0	0.07	0	0.46	0.18	0.19	0.40	0.37	0.05	0.04	**1.78**
	2.5%	0	0	0	0.01	0	0.06	0.01	0.02	0.05	0.05	0	0	**0.21**
	97.5%	0	0.09	0	0.21	0	1.29	0.52	0.52	1.10	1.04	0.17	0.12	**5.07**

2.8 Gannet (excluding macro-avoidance)

Table 2-13: Estimated monthly collisions for gannet in the Caledonia North Site for the two WTG scenarios (WTG 1 (N) and WTG 2 (N)) using the deterministic Band (2012[1]) model excluding macro-avoidance correction factor.

Scenario	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
WTG 1 (N)	0	0.06	0	0.15	0	1.08	0.37	0.44	0.90	0.84	0.10	0.09	**4.03**
WTG 2 (N)	0	0.09	0	0.21	0	1.54	0.53	0.62	1.27	1.20	0.14	0.12	**5.73**

Table 2-14: Estimated monthly collisions for gannet in the Caledonia North Site for the two WTG scenarios (WTG 1 (N) and WTG 2 (N)) using the stochastic Band (2012[1]) model excluding macro-avoidance correction factor.

Scenario	CI	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
WTG 1 (N)	Mean	0	0.07	0	0.16	0	1.10	0.41	0.44	0.92	0.86	0.12	0.09	**4.17**
	2.5%	0	0	0	0.01	0	0.14	0.03	0.05	0.12	0.13	0.01	0.01	**0.49**
	97.5%	0	0.21	0	0.49	0	2.98	1.25	1.23	2.48	2.25	0.37	0.29	**11.53**
WTG 2 (N)	Mean	0	0.10	0	0.23	0	1.52	0.59	0.62	1.33	1.25	0.17	0.13	**5.93**
	2.5%	0	0.01	0	0.02	0	0.19	0.05	0.07	0.16	0.18	0.01	0.01	**0.69**
	97.5%	0	0.30	0	0.70	0	4.29	1.74	1.75	3.68	3.47	0.56	0.41	**16.89**

3 References

[1] Band, W. (2012) 'Using a Collision Risk Model to Assess Bird Collision Risks for Offshore Wind Farms'. Report by BTO. Report for The Crown Estate

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