

Bellrock Offshore Wind Farm

Wind Farm Development Area

Environmental Impact Assessment Report - Volume IV

Appendix 10.2: Offshore Ornithology Collision Risk Modelling Technical Report

Date: April 2026

Document Number: RHDV_BEL_CST_REP_0004_011

Revision Number: 1

Classification: Public

Revision History

Rev.	Prepared By	Checked By	Approved By	Date
1	Haskoning	SA	BMcG	01/04/2026

This page is intentionally blank

Contents

1	Introduction	1
2	Methods	2
2.1	Overview of Modelling Approach	2
2.2	Wind Turbine Generator Design Scenarios Modelled.....	3
2.3	Species Modelled for Collision Risk.....	3
2.4	Input Parameters.....	7
2.4.1	Bellrock Wind Farm Development Area and Wind Turbine Generator Parameters	7
2.4.2	Species Parameters and Avoidance Rates	11
2.4.3	Bird Densities and Flight Heights.....	11
3	CRM Results.....	17
3.1	Stochastic Model – Monthly and Annual Collision Estimates	17
3.2	Deterministic Model – Monthly and Annual Collision Estimates	25
3.3	Collision Estimates by Seasonal Periods.....	29
4	References.....	33

List of Annexes

Annex A:	Bootstrap Samples
Annex B:	CRM Raw Outputs

List of Tables

Table 2.1:	Raw Number of Records of Each Species Scoped In for Collision Risk Assessment in Flight within the Bellrock Wind Farm Development Area in Each Survey Month Across the Two Years of Baseline Aerial Survey Data ¹	5
Table 2.2:	Mean Monthly In-flight Densities (Number of Individuals per km ²) and Standard Deviation (SD) within the Bellrock Wind Farm Development Area for Each Species Scoped In for Collision Risk and for Which There Were Any In-flight Records within the Bellrock Wind Farm Development Area During the Baseline Surveys.....	6
Table 2.3:	Bellrock Wind Farm Development Area and Wind Turbine Generator Parameters Used for the Collision Risk Model.....	7
Table 2.4:	Wind Availability and Mean Downtime.....	9
Table 2.5:	Species Input Parameters and Avoidance Rates for the Stochastic Collision Risk Models	13

Table 2.6:	Species Input Parameters and Avoidance Rates for the Deterministic Collision Risk Models..	14
Table 2.7:	Mean Monthly In-flight Densities (Number of Individuals per km ²) and Standard Deviation (SD) for Gannet within the Wind Farm Development Area for the Months in the Non-breeding Periods, With and Without Macro-avoidance Applied.....	15
Table 3.1:	Mean Number of Predicted Kittiwake Collisions (With Associated Statistical Outputs – See Section 3.1) for the Two Wind Turbine Generator Design Scenarios, as Derived from the Stochastic Collision Risk Model Run on the Basis of Producing (i) Monthly and (ii) Annual Estimates	19
Table 3.2:	Mean Number of Predicted Great Black-backed Gull Collisions (With Associated Statistical Outputs – See Section 3.1) for the Two Wind Turbine Generator Design Scenarios, as Derived from the Stochastic Collision Risk Model Run on the Basis of Producing (i) Monthly and (ii) Annual Estimates	20
Table 3.3:	Mean Number of Predicted Arctic tern Collisions (With Associated Statistical Outputs – See Section 3.1) for the Two Wind Turbine Generator Design Scenarios, as Derived from the Stochastic Collision Risk Model Run on the Basis of Producing (i) Monthly and (ii) Annual Estimates	21
Table 3.4:	Mean Number of Predicted Arctic skua Collisions (With Associated Statistical Outputs – See Section 3.1) for the Two Wind Turbine Generator Design Scenarios, as Derived from the Stochastic Collision Risk Model Run on the Basis of Producing (i) Monthly and (ii) Annual Estimates	22
Table 3.5:	Mean Number of Predicted Gannet Collisions (With Associated Statistical Outputs – See Section 3.1) for the Two Wind Turbine Generator Design Scenarios, as Derived from the Stochastic Collision Risk Model Run on the Basis of Producing (i) Monthly and (ii) Annual Estimates	23
Table 3.6:	Number of Monthly and Annual Collisions Predicted for Each of the Five Assessed Species and Two Wind Turbine Generator Design Scenarios, as Derived from the Deterministic Collision Risk Model.....	27
Table 3.7:	Number of Predicted Kittiwake Collisions by Seasonal Period for Two Wind Turbine Generator Design Scenarios, as Derived from Stochastic and Deterministic Collision Risk Models ¹	30
Table 3.8:	Number of Predicted Great Black-backed Gull Collisions by Seasonal Period for Two Wind Turbine Generator Design Scenarios, as Derived from Stochastic and Deterministic Collision Risks.....	30
Table 3.9:	Number of Predicted Arctic Tern Collisions by Seasonal Period for Two Wind Turbine Generator Design Scenarios, as Derived from Stochastic and Deterministic Collision Risk Models.....	31
Table 3.10:	Number of Predicted Arctic Skua Collisions by Seasonal Period for Two Wind Turbine Generator Design Scenarios, as Derived from Stochastic and Deterministic Collision Risk Models.....	31
Table 3.11:	Number of Predicted Gannet Collisions by Seasonal Period for Two Wind Turbine Generator Design Scenarios, as Derived from Stochastic and Deterministic Collision Risk Models. Outputs for the Stochastic Collision Risk Model Include Confidence Limit Values	32

Glossary of Terminology

Term	Definition
Air gap	The lowest blade tip point of a wind turbine generator to sea clearance distance (see individual chapters for the relevant tidal levels).
Applicant	Bellrock Offshore Wind Farm Limited, the legal entity submitting Section 36 Consent and Marine Licence applications for the Bellrock Wind Farm Development Area.
Bellrock Offshore Wind Farm (or the Bellrock Project)	<p>An offshore wind farm capable of exporting up to 1.8 GW of renewable energy to the National Electricity Transmission System.</p> <p>The Wind Farm Development Area is located 120 km east of Stonehaven, and will connect to the National Electricity Transmission System at the proposed SSEN Transmission Hurlie substation, west of Stonehaven in Aberdeenshire. The Bellrock Offshore Wind Farm comprises of the following Development Areas:</p> <ul style="list-style-type: none"> ▪ Wind Farm Development Area; ▪ Offshore Transmission Development Area; and ▪ Onshore Transmission Development Area.
Development Area	<p>For consenting purposes, the area for which separate consents and/or Marine Licences will be sought by the Applicant, comprising:</p> <ul style="list-style-type: none"> ▪ Wind Farm Development Area; ▪ Offshore Transmission Development Area; and ▪ Onshore Transmission Development Area.
Project design envelope	Includes all relevant technical, spatial and temporal elements of the Wind Farm Infrastructure, and the proposed methodology to be employed for construction, operations and maintenance, and decommissioning.
SSEN Transmission Hurlie substation	The onshore substation to be developed by SSEN Transmission, which will receive renewable electricity from the Bellrock Project onshore substation and allow supply of renewable electricity from the wind farm to the National Electricity Transmission System.
Wind Farm Development Area	The boundary within which the Wind Farm Infrastructure will be constructed, operated and maintained, and decommissioned.
Wind Farm Infrastructure	Infrastructure located within the Wind Farm Development Area including wind turbine generators; floating substructures, station keeping systems and associated scour protection; inter-array cables and associated cable protection; subsea cable hubs; and ancillary infrastructure including buoys (including activities associated with the Wind Farm Infrastructure construction, operation and maintenance, and decommissioning).
Wind turbine generator	A wind turbine generator converts wind energy into electrical energy. The main components include rotor assembly (composed of three blades and a hub); nacelle (containing the generator, shaft and gearbox, power electronic converter and transformer); and a tower (containing lifting equipment and switchgear).

Glossary of Abbreviations

Term	Definition
CI	Confidence interval
CL	Confidence level
CRM	Collision risk model
CV	Coefficient of variance
EIA	Environmental impact assessment
GW	Gigawatt
Km	Kilometre
Km ²	Kilometre squared
LCL	Lower confidence limit
MSL	Mean sea level
RPM	Rotations per minute
sCRM	Stochastic collision risk model
SD	Standard deviation
SNCBs	Statutory Nature Conservation Bodies
TLP	Tension leg platform
UCL	Upper confidence limit
WFDA	Wind Farm Development Area
WTG	Wind turbine generator

1 Introduction

1. This Offshore Ornithology Collision Risk Modelling Technical Report is an Appendix to **Chapter 10: Offshore Ornithology (Volume II)** of the Bellrock Wind Farm Development Area (WFDA) environmental impact assessment (EIA) Report. The collision risk modelling (CRM) presented in this report was undertaken following NatureScot's guidance on assessing collision risk of marine birds (SNCBs, 2024). In March 2025, subsequent to the commencement of the CRM, NatureScot updated its guidance on assessing collision risk of marine birds (NatureScot, 2025). Therefore, in agreement with NatureScot¹, the CRM was undertaken following the 2024 Statutory Nature Conservation Bodies guidance (SNCBs, 2024)). Further Project-specific advice was provided by NatureScot² as detailed in Section 10.3 of **Chapter 10: Offshore Ornithology (Volume II)**.
2. This report details the potential effects of collision risk on seabirds during the operational phase of the Bellrock Wind Farm Infrastructure. In relation to offshore wind farms, collision risk can be defined as direct mortality of flying seabirds as a result of colliding with rotating turbine blades (NatureScot, 2023a). As such, this analysis is integral to informing the offshore ornithology assessment for the Bellrock Wind Farm Infrastructure.
3. In the following sections, the analysis of both deterministic and stochastic collision risk modelling for five seabird species is presented (**Section 3**). The site-specific digital aerial survey campaign gathered baseline data (collected from March 2022 to February 2024), has been used to represent the relevant species populations in the Bellrock WFDA (see **Appendix 10.1: Offshore Ornithology Digital Aerial Survey Baseline Report (Volume IV)** for further detail on these surveys).
4. The analysis covers two wind turbine generator (WTG) design scenarios, WTG type 1 and WTG type 2. As recommended in relevant guidance (NatureScot, 2025), these represent the worst-case designs from the perspective of the predicted collision mortality and the 'most likely' design³ options. The maximum number of WTGs is predicted to be between 90 (WTG type 1) and 132 (WTG type 2), dependent on the export capacity of the selected WTG, with both design scenarios based on a total export capacity for the Bellrock Wind Farm Infrastructure of 1.8 GW.

¹ Email of 10 December 2024 from NatureScot to the Applicant. Please see Section 10.3 in **Chapter 10: Offshore Ornithology (Volume II)**.

² Email of 12 July 2024 from NatureScot to the Applicant. Please see Section 10.3 in **Chapter 10: Offshore Ornithology (Volume II)**.

³ Given potential (but as yet unconfirmed) future developments in WTG design and availability, it is not possible to identify an actual 'most likely' design for the Bellrock WFDA at this time of writing. The two WTG design scenarios presented are considered by the Applicant to represent reasonable and credible WTG designs which will be available in the development timeline of the Bellrock Project and therefore been used to represent the maximum extent of the WTG design envelope.

2 Methods

2.1 Overview of Modelling Approach

5. The 'standard' offshore collision risk model (CRM), as based upon Band (2012), was used to predict the collision mortality of seabird species at the Bellrock WFDA. This model is applied to density estimates derived from baseline aerial survey data of seabirds in flight within the Bellrock WFDA. Following advice received from NatureScot², all CRMs for the Bellrock Wind Farm Infrastructure have been run in the Caneco (2022) shiny app, with both deterministic and stochastic models undertaken for each species and WTG design scenario that have been considered. The deterministic models do not consider statistical variability in the various input parameters for the CRM (so giving a single point estimate of the mean collision mortality), whilst the stochastic models do account for statistical variability in (some) of the input parameters (so providing outputs which include a measure of the statistical confidence associated with the estimated mean collision mortality).
6. In all cases, Option 2 of the model has been used, as advised by NatureScot². Both annual and monthly outputs were produced. For the stochastic models, this required separate model runs in each case, with the model output options set to 'Per Annum' and 'By Month', respectively. Estimates for the species-specific seasonal periods were calculated by summing the relevant estimates from the monthly outputs (NatureScot, 2025). The seasonal periods that were used for each species are as defined in **Table 2.2 of Appendix 10.1: Offshore Ornithology Digital Aerial Survey Baseline Report (Volume IV)** (and as those proposed in the **Bellrock WFDA Scoping Report (Appendix 1.1 (Volume IV))**), which are aligned with NatureScot (2020; 2023b; 2024).
7. For the stochastic CRMs (sCRMs), details of the model input parameters for which measures of statistical variability were incorporated, and the derivation of these, are provided below in **Section 2.4**. Bird density estimates were input as the raw bootstrap samples using the 'random draws' option for inputting the monthly in-flight densities. For each month, 1,000 bootstrap estimates of density were input, selecting these as a random sample from the combined 2,000 bootstrap estimates available for each month (with 1,000 such estimates derived for each month in each survey year – see **Appendix 10.1: Offshore Ornithology Digital Aerial Survey Baseline Report (Volume IV)**). Each model run was based upon 5,000 iterations, with a random seed value of 10 specified in each case.

2.2 Wind Turbine Generator Design Scenarios Modelled

8. As stated in **Section 1**, two WTG design scenarios have been considered, WTG type 1 and WTG type 2. These were modelled for each species of bird for which collision assessment was required (see **Section 2.3** below). These two WTG design scenarios are considered the 'worst-case' and 'most-likely' designs for the Bellrock Wind Farm Infrastructure design envelope (see **Table 2.3**).

2.3 Species Modelled for Collision Risk

9. In the **Bellrock WFDA Scoping Report (Appendix 1.1, Volume IV)**, both kittiwake and gannet were scoped in for collision risk assessment based upon the occurrence and abundance of species for which collision mortality is a relevant effect pathway during the first year of baseline aerial surveys. Following completion of the second year of baseline aerial survey data, a further three species were also selected for modelling: great black-backed gull, Arctic tern, and Arctic skua. This encompasses all species for which collision mortality is considered a relevant effect pathway and for which individuals of the species were recorded in flight within the Bellrock WFDA during the baseline aerial surveys (see **Appendix 1.1: Bellrock WFDA Scoping Report (Volume IV)**, Annex A in **Appendix 10.1: Offshore Ornithology Digital Aerial Survey Baseline Report (Volume IV)** and NatureScot, 2024). Details of the number of each species recorded in flight within the Bellrock WFDA in each survey month across the two years can be found in **Table 2.1**.
10. For each species scoped in for collision risk assessment and which was recorded in flight within the Bellrock WFDA in the baseline aerial surveys, the mean monthly densities of flying birds within the Bellrock WFDA were calculated using design-based methods (as detailed in **Appendix 10.1: Offshore Ornithology Digital Aerial Survey Baseline Report (Volume IV)**)⁴. These are presented in **Table 2.2**, and were derived from the 2,000 bootstrap estimates of the densities of flying birds in each month (i.e. as obtained by combining the 1,000 bootstrap estimates for the corresponding month in each of survey years one and two).

⁴ As agreed with NatureScot in email of 19 July 2024 from NatureScot to the Applicant. Please see Section 10.3 in **Chapter 10: Offshore Ornithology (Volume II)**.

This page is intentionally blank

Table 2.1: Raw Number of Records of Each Species Scoped In for Collision Risk Assessment in Flight within the Bellrock Wind Farm Development Area in Each Survey Month Across the Two Years of Baseline Aerial Survey Data¹

Species	Survey Year	Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Kittiwake	Year 1	0	0	4	2	6	16	0	0	0	1	1	4
	Year 2	0	0	1	6	1	0	0	0	0	5	1	0
Great black-backed gull	Year 1	0	0	0	0	0	0	0	0	0	0	0	0
	Year 2	0	0	1	0	0	0	0	0	0	0	0	0
Arctic tern	Year 1	0	0	0	0	0	0	2	0	0	0	0	0
	Year 2	0	0	0	0	0	0	0	0	0	0	0	0
Arctic skua	Year 1	0	0	0	0	0	1	0	0	0	0	0	0
	Year 2	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	Year 1	0	0	1	3	7	3	2	1	0	1	0	1
	Year 2	0	0	8	2	5	0	2	1	0	19	0	0

Notes:

¹ Data are numbers of records identified to species and prior to any apportioning of those records identified only to the level of broader species groups. Thus, these numbers do not always translate exactly to the densities in **Table 2.2** which account for apportioning to species (e.g. for Arctic tern there is an August density estimate in **Table 2.2** despite no records indicated above because the density estimate derives from a single Arctic/common tern recorded in flight within the Bellrock WFDA which was subsequently apportioned to Arctic tern – see **Section 2.2.2 of Appendix 10.1: Offshore Ornithology Digital Aerial Survey Baseline Report (Volume IV)** and HiDef (2024)).

Table 2.2: Mean Monthly In-flight Densities (Number of Individuals per km²) and Standard Deviation (SD) within the Bellrock Wind Farm Development Area for Each Species Scoped In for Collision Risk and for Which There Were Any In-flight Records within the Bellrock Wind Farm Development Area During the Baseline Surveys

Species		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Kittiwake	Mean	0.000	0.000	0.086	0.088	0.119	0.290	0.000	0.000	0.000	0.104	0.034	0.070
	SD	0.000	0.000	0.075	0.072	0.102	0.309	0.000	0.000	0.000	0.095	0.032	0.086
Great black-backed gull	Mean	0.000	0.000	0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	SD	0.000	0.000	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Arctic tern	Mean	0.000	0.000	0.000	0.000	0.000	0.000	0.035	0.018	0.000	0.000	0.000	0.000
	SD	0.000	0.000	0.000	0.000	0.000	0.000	0.044	0.029	0.000	0.000	0.000	0.000
Arctic skua	Mean	0.000	0.000	0.000	0.000	0.000	0.017	0.000	0.000	0.000	0.000	0.000	0.000
	SD	0.000	0.000	0.000	0.000	0.000	0.029	0.000	0.000	0.000	0.000	0.000	0.000
Gannet	Mean	0.000	0.000	0.150	0.086	0.206	0.050	0.068	0.035	0.000	0.353	0.000	0.017
	SD	0.000	0.000	0.146	0.053	0.121	0.066	0.037	0.034	0.000	0.426	0.000	0.027

2.4 Input Parameters

2.4.1 Bellrock Wind Farm Development Area and Wind Turbine Generator Parameters

11. The Bellrock WFDA and WTG parameters used in the collision risk modelling are presented in **Table 2.3** and **Table 2.4** for two WTG design scenarios (WTG type (WTG type 1 and WTG type 2). These represent the ‘worst-case’ and ‘most-likely’ designs for the Bellrock WFDA.
12. In terms of the Bellrock WFDA and WTG parameters, blade pitch and rotation speed were input in the model with the truncated normal distribution option specified but with the value for the standard deviation (SD) set at zero in both cases. The tidal offset was set to zero (**Table 2.3**) because the design is for floating WTGs and not fixed bottom substructure, so hub height (and hence air gap) will not vary according to tidal conditions. In the case of Tension Leg Platform (TLP) floating substructure, a 22 m minimum air gap above Highest Astronomical Tide (HAT) will be maintained, therefore the model has assumed a worst-case scenario.
13. Maintenance downtime (**Table 2.4**) has been assumed to be 3%, and to be constant through the annual period and across both WTG designs considered. Monthly wind availability (**Table 2.4**) was estimated from ERA5 reanalysis wind data at the Bellrock WFDA, combined with actual/predicted information on cut-in and cut-out wind speeds of the WTG type 1 and WTG type 2 respectively. No measures of the statistical variability for these estimates were available. Therefore, none of the Bellrock WFDA and WTG parameters include estimates of the associated statistical variability.

Table 2.3: Bellrock Wind Farm Development Area and Wind Turbine Generator Parameters Used for the Collision Risk Model

Parameter	WTG Type 1	WTG Type 2
Number of WTGs	132	90
Latitude (deg)	56.846	56.846
Width (km) ¹	18.88	18.88
Tidal offset (m)	0	0
Upwind flights %	50%	50%
Number of WTG blades	3	3
Rotor radius (m)	118	150
Minimum air gap (m) ²	22	22
Maximum blade width (m)	6.5	8
Rotations per minute (RPM)	8.4	6.3
SD of rotation RPM	0 – not available	0 – not available

Parameter	WTG Type 1	WTG Type 2
Pitch (deg)	1.5	1.5
SD of pitch (deg)	0 – not available	0 – not available
Notes: ¹ Taken as the diameter of a circle of area equal to that of the Bellrock WFDA, following SOSS (2012). ² For all FSS designs (semi-submersible platform and barge that move with the tide and tension leg platform FSS design, which is restrained by tensioned moorings and does not notably move with the tide), the air gap will be maintained relative to the sea surface and will be minimum 22 m above all tidal levels.		

Table 2.4: Wind Availability and Mean Downtime

Parameter		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind availability (%)	WTG type 1	97.31	97.01	95.66	93.52	93.17	91.08	90.01	92.16	93.67	96.48	97.16	96.69
	WTG type 2	97.36	97.08	95.76	93.68	93.40	91.31	90.28	92.35	93.83	96.58	97.22	96.78
Mean downtime (%) – both WTG types		3	3	3	3	3	3	3	3	3	3	3	3

This page is intentionally blank

2.4.2 Species Parameters and Avoidance Rates

14. Input parameters for the CRM also include several species-specific biological parameters (e.g. flight speed, body length and nocturnal activity, with the latter expressed as a proportion of the measured diurnal activity), whilst an avoidance rate is also applied to the outputs of the CRM. As well as being species-specific, the advised values for these parameters may also differ according to whether the CRM is run in its stochastic or deterministic form. The species input parameters (**Table 2.5** and **Table 2.6**) for the CRMs were based upon the recent joint SNCBs collision risk guidance and additional advice provided by NatureScot², whilst the avoidance rates also followed the SNCBs guidance (SNCBs, 2024). For the sCRMs, the estimates for the input parameters and avoidance rates include a SD value (**Table 2.5**). Where no SD is specified then the mean value is entered without the incorporation of any measure of statistical variability in that parameter.

2.4.3 Bird Densities and Flight Heights

15. As detailed above (see **Section 2.3**), the CRMs use the monthly densities of birds in flight within the Bellrock WFDA as derived from the baseline aerial surveys, with these being estimated using design-based methods (**Appendix 10.1: Offshore Ornithology Digital Aerial Survey Baseline Report (Volume IV)**). The use of design-based methods for determining the in-flight densities for use in the CRMs follows agreement on this with NatureScot⁴. The mean monthly densities (and associated SDs) for each of the species on which CRMs were undertaken are presented in **Table 2.2** above. However, for the sCRM the actual inputs to the model rely on the bootstrap samples using the 'random draws' input option, as opposed to the mean and SD values (using 1,000 bootstrap estimates randomly selected from the 2,000 such estimates available for each month – see **Section 2.1**). The bootstrap samples used in each month for each species are presented in **Annex A** of this Appendix. The deterministic CRM uses the mean monthly density estimates as the inputs.
16. For gannet, NatureScot advice is to apply a 70% macro-avoidance rate to the density estimates for the autumn and spring passage periods². Thus, the mean monthly in-flight densities for gannet were reduced accordingly for the months of October to March. For all of the passage period months except March, this involved multiplying the relevant bootstrap density estimates by 0.3. For March, only the first half of the month is included in the spring passage period (with the latter half assigned to the breeding period). Thus, for March, the 70% macro-avoidance was applied to half the value of each bootstrap density estimate only (with the resultant value then added to half the value of the estimate). **Table 2.7** presents the comparison of the mean density values before and after application of the macro-avoidance rate for the months occurring in the non-breeding periods. This reduction was applied to the raw bootstrap samples for these months prior to being entered as inputs for the sCRMs for gannet.
17. As stated above (**Section 2.1**), all CRMs were undertaken using Option 2 of the model. Thus, the species-specific 'generic' flight height data from Johnston et. al. (2014a, b) were used in each case.

This page is intentionally blank

Table 2.5: Species Input Parameters and Avoidance Rates for the Stochastic Collision Risk Models

Species	Body Length (m)	Wingspan (m)	Flight Type	% of Flights Upwind	Flight Speed (m/s)	Nocturnal Activity Factor	Avoidance Rate
Kittiwake	0.39 (0.005)	1.08 (0.0625)	Flapping	50	13.1 (0.40)	0.40 (0.12)	0.9929 (0.0003)
Great black-backed gull	0.71 (0.035)	1.58 (0.0375)	Flapping	50	13.7 (1.20)	0.375 (0.0637)	0.9940 (0.0004)
Arctic tern	0.34 (0.005)	0.8 (0.025)	Flapping	50	10.9 (0.9)	0.125 (0)	0.9908 (0.0004)
Arctic skua	0.435 (0.0125)	1.18 (0.0375)	Flapping	50	13.8 (0)	0.125 (0)	0.9929 (0.0003)
Gannet	0.94 (0.0325)	1.72 (0.0375)	Flapping	50	14.9 (0)	0.14 (0.10)	0.9929 (0.0003)

Notes:
Species input parameters and avoidance rates for the stochastic CRMs, as derived from SNCBs (2024) and project-specific advice from NatureScot (email of 12 July 2024 to the Applicant. Please see Section 10.3 in **Chapter 10: Offshore Ornithology (Volume II)**). Values are given as the mean with the standard deviation given in brackets (where applied).

Table 2.6: Species Input Parameters and Avoidance Rates for the Deterministic Collision Risk Models

Species	Body Length (m)	Wingspan (m)	Flight Type	% of Flights Upwind	Flight Speed (m/s)	Nocturnal Activity Factor	Avoidance Rate
Kittiwake	0.39	1.08	Flapping	50	13.1	0.40	0.9923
Great black-backed gull	0.71	1.58	Flapping	50	13.7	0.375 ^[1]	0.9936
Arctic tern	0.34	0.8	Flapping	50	10.9	0.125	0.9902
Arctic skua	0.435	1.18	Flapping	50	13.8	0.125	0.9923
Gannet	0.94	1.72	Flapping	50	14.9	0.14	0.9923

Notes:

Species input parameters and avoidance rates for the deterministic CRMs, as derived from SNCBs (2024) and project-specific advice from NatureScot (Email of 12 July to Bellrock Project. Please see Section 10.3 in **Chapter 10: Offshore Ornithology (Volume II)**).

¹ A value of 0.375 is used for the nocturnal activity factor, following project-specific advice from NatureScot (see Note 1 above). The SNCB (2024) guidance is to run models for values of both 0.25 and 0.50 but this would have made virtually no difference to outputs given the scarcity of the species in the baseline aerial surveys (see **Section 3**).

Table 2.7: Mean Monthly In-flight Densities (Number of Individuals per km²) and Standard Deviation (SD) for Gannet within the Wind Farm Development Area for the Months in the Non-breeding Periods, With and Without Macro-avoidance Applied

Macro-avoidance		October	November	December	January	February	March ^[1]
No macro-avoidance	Mean	0.353	0.000	0.017	0.000	0.000	0.150
	SD	0.426	0.000	0.027	0.000	0.000	0.146
70% macro-avoidance	Mean	0.106	0.000	0.005	0.000	0.000	0.098
	SD	0.128	0.000	0.008	0.000	0.000	0.095

Notes:

The CRMs assume macro-avoidance during the non-breeding periods.

¹ The spring passage period extends to mid-March only, so the macro-avoidance 'correction' is applied to 50% of the value for the March density estimate (see **Section 2.4.3**). All other months shown are fully encompassed by the non-breeding periods.

This page is intentionally blank

3 CRM Results

18. Raw outputs of the CRM are provided in **Annex B** of this Appendix.

3.1 Stochastic Model – Monthly and Annual Collision Estimates

19. Species-specific results from the sCRM can be found in **Table 3.1** through to **Table 3.4**. These tables display the monthly and annual mean collision estimates for both WTG design scenarios (i.e. WTG type 1 and WTG type 2), together with the associated values for SD, coefficient of variance (CV), median, lower and upper confidence limits (LCL and UCL). As outlined above, the monthly estimates were derived independently of the annual estimates, with separate model runs undertaken for the output options set to 'Per Month' and 'Per Annum'.
20. For the sCRM outputs, the mean annual collision estimates were less than a single individual for three of the five species for which modelling was undertaken (i.e. great black-backed gull, Arctic tern and Arctic skua). This was irrespective of the WTG design scenario.
21. Collision estimates were higher for kittiwake and gannet, with the mean annual estimates for WTG type 1 being 12.58 individuals (95% confidence interval (CI): 0.00 – 37.98) and 11.98 birds (95% CI: 0.00 – 38.82), respectively (**Table 3.1** and **Table 3.5**). The mean estimates for WTG type 2 were lower by approximately 2.5 individuals for both of these species.
22. For all five species, the collision estimates were higher for the design based upon WTG type 1, which is expected on the basis of the greater number of WTGs (giving a higher total swept area) associated with this design. Summation of the mean monthly collision estimates equated to (or very close to) the mean annual estimates in all cases.

This page is intentionally blank

Table 3.1: Mean Number of Predicted Kittiwake Collisions (With Associated Statistical Outputs – See Section 3.1) for the Two Wind Turbine Generator Design Scenarios, as Derived from the Stochastic Collision Risk Model Run on the Basis of Producing (i) Monthly and (ii) Annual Estimates

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
WTG type 1													
Mean	0.00	0.00	1.88	2.00	3.01	7.74	0.00	0.00	0.00	2.24	0.66	1.36	18.87
SD	0.00	0.00	1.71	1.62	2.65	7.96	0.00	0.00	0.00	2.16	0.62	1.66	17.99
CV	N/A	N/A	91.11	81.10	88.24	102.93	N/A	N/A	N/A	96.34	92.80	122.48	95.32
Median	0.00	0.00	1.43	1.89	2.27	8.37	0.00	0.00	0.00	1.47	0.61	0.45	16.27
2.5% confidence level (CL)	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
97.5% CL	0.00	0.00	6.08	5.80	8.61	22.39	0.00	0.00	0.00	7.33	2.08	5.15	56.96
WTG type 2													
Mean	0.00	0.00	1.50	1.60	2.41	6.19	0.00	0.00	0.00	1.79	0.53	1.08	15.10
SD	0.00	0.00	1.37	1.29	2.12	6.37	0.00	0.00	0.00	1.72	0.49	1.33	14.39
CV	N/A	N/A	91.09	81.08	88.22	102.91	N/A	N/A	N/A	96.32	92.77	122.45	95.29
Median	0.00	0.00	1.14	1.51	1.82	6.70	0.00	0.00	0.00	1.17	0.49	0.36	13.04
2.5% CL	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
97.5% CL	0.00	0.00	4.85	4.64	6.89	17.95	0.00	0.00	0.00	5.86	1.67	4.11	45.54
Notes:													
It is noted that the annual total for the 97.5% CL may not always equate to the sum of all the monthly results for the same measure. This is put down to stochastic difference between model runs.													

Table 3.2: Mean Number of Predicted Great Black-backed Gull Collisions (With Associated Statistical Outputs – See Section 3.1) for the Two Wind Turbine Generator Design Scenarios, as Derived from the Stochastic Collision Risk Model Run on the Basis of Producing (i) Monthly and (ii) Annual Estimates

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
WTG type 1													
Mean	0.00	0.00	1.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.14
SD	0.00	0.00	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.90
CV	N/A	N/A	166.80	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	166.80
Median	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
2.5% CL	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
97.5% CL	0.00	0.00	6.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.19
WTG type 2													
Mean	0	0	0.88	0	0	0	0	0	0	0	0	0	0.88
SD	0	0	1.46	0	0	0	0	0	0	0	0	0	1.46
CV	N/A	N/A	166.81	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	166.81
Median	0	0	0.00	0	0	0	0	0	0	0	0	0	0.00
2.5% CL	0	0	0.00	0	0	0	0	0	0	0	0	0	0.00
97.5% CL	0	0	4.78	0	0	0	0	0	0	0	0	0	4.78
Notes:													
It is noted that the annual total for the 97.5% CL may not always equate to the sum of all the monthly results for the same measure. This is put down to stochastic difference between model runs.													

Table 3.3: Mean Number of Predicted Arctic tern Collisions (With Associated Statistical Outputs – See Section 3.1) for the Two Wind Turbine Generator Design Scenarios, as Derived from the Stochastic Collision Risk Model Run on the Basis of Producing (i) Monthly and (ii) Annual Estimates

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
WTG type 1													
Mean	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.12	0.00	0.00	0.00	0.00	0.35
SD	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.25	0.00	0.00	0.00	0.00	0.68
CV	N/A	N/A	N/A	N/A	N/A	N/A	185.97	210.79	N/A	N/A	N/A	N/A	192.88
Median	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
2.5% CL	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
97.5% CL	0.00	0.00	0.00	0.00	0.00	0.00	1.43	0.79	0.00	0.00	0.00	0.00	2.22
WTG type 2													
Mean	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.10	0.00	0.00	0.00	0.00	0.29
SD	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.20	0.00	0.00	0.00	0.00	0.55
CV	N/A	N/A	N/A	N/A	N/A	N/A	184.11	208.80	N/A	N/A	N/A	N/A	190.98
Median	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
2.5% CL	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
97.5% CL	0.00	0.00	0.00	0.00	0.00	0.00	1.16	0.64	0.00	0.00	0.00	0.00	1.79
Notes:													
It is noted that the annual total for the 97.5% CL may not always equate to the sum of all the monthly results for the same measure. This is put down to stochastic difference between model runs.													

Table 3.4: Mean Number of Predicted Arctic skua Collisions (With Associated Statistical Outputs – See Section 3.1) for the Two Wind Turbine Generator Design Scenarios, as Derived from the Stochastic Collision Risk Model Run on the Basis of Producing (i) Monthly and (ii) Annual Estimates

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
WTG type 1													
Mean	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.08
SD	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.18
CV	N/A	N/A	N/A	N/A	N/A	218.01	N/A	N/A	N/A	N/A	N/A	N/A	218.01
Median	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
2.5% CL	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
97.5% CL	0.00	0.00	0.00	0.00	0.00	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.55
WTG type 2													
Mean	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.07
SD	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.15
CV	N/A	N/A	N/A	N/A	N/A	215.73	N/A	N/A	N/A	N/A	N/A	N/A	215.73
Median	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
2.5% CL	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
97.5% CL	0.00	0.00	0.00	0.00	0.00	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.45
Notes:													
It is noted that the annual total for the 97.5% CL may not always equate to the sum of all the monthly results for the same measure. This is put down to stochastic difference between model runs.													

Table 3.5: Mean Number of Predicted Gannet Collisions (With Associated Statistical Outputs – See Section 3.1) for the Two Wind Turbine Generator Design Scenarios, as Derived from the Stochastic Collision Risk Model Run on the Basis of Producing (i) Monthly and (ii) Annual Estimates

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
WTG type 1													
Mean	0.00	0.00	2.27	2.22	6.34	1.46	2.03	0.98	0.00	2.46	0.00	0.08	17.84
SD	0.00	0.00	2.47	1.61	4.51	2.08	1.41	1.05	0.00	3.17	0.00	0.14	16.04
CV	N/A	N/A	108.99	72.64	71.19	142.32	69.64	107.04	N/A	128.61	N/A	172.77	89.90
Median	0.00	0.00	1.34	1.86	5.50	0.00	1.74	0.81	0.00	0.97	0.00	0.00	13.07
2.5% CL	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
97.5% CL	0.00	0.00	8.51	6.10	16.78	6.80	5.45	3.66	0.00	10.68	0.00	0.48	58.22
WTG type 2													
Mean	0.00	0.00	1.74	1.71	4.88	1.12	1.57	0.75	0.00	1.89	0.00	0.06	13.73
SD	0.00	0.00	1.90	1.23	3.46	1.60	1.08	0.80	0.00	2.43	0.00	0.11	12.30
CV	N/A	N/A	108.67	72.31	70.86	141.97	69.31	106.73	N/A	128.27	N/A	172.39	89.57
Median	0.00	0.00	1.03	1.44	4.25	0.00	1.34	0.63	0.00	0.75	0.00	0.00	10.11
2.5% CL	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
97.5% CL	0.00	0.00	6.52	4.68	12.88	5.21	4.18	2.81	0.00	8.19	0.00	0.37	44.60
Notes:													
It is noted that the annual total for the 97.5% CL may not always equate to the sum of all the monthly results for the same measure. This is put down to stochastic difference between model runs.													

This page is intentionally blank

3.2 Deterministic Model – Monthly and Annual Collision Estimates

23. Species specific results from the deterministic CRM can be found in **Table 3.6**. This table displays the monthly and annual collision estimates for both WTG design scenarios (i.e. WTG type 1 and WTG type 2).
24. For kittiwake and gannet, the collision estimates from the deterministic CRM are slightly higher than the mean estimates calculated by the sCRM for the equivalent design. This is likely to be due, in part at least, to the higher avoidance rates used with sCRM (**Table 2.5** and **Table 2.6**). The opposite is true for the other three species (great black-backed gull, Arctic tern, Arctic skua) in terms of differences between the estimates generated by the deterministic CRM and sCRM but the collision estimates for these three species are extremely small in all instances. Otherwise, the estimates from the deterministic CRM are similar to the mean estimates from the sCRM, with the same pattern of differences between species and designs being apparent.

This page is intentionally blank

Table 3.6: Number of Monthly and Annual Collisions Predicted for Each of the Five Assessed Species and Two Wind Turbine Generator Design Scenarios, as Derived from the Deterministic Collision Risk Model

Species	WTG Design Scenario	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Kittiwake	WTG type 1	0.00	0.00	2.11	2.22	3.32	7.95	0.00	0.00	0.00	2.45	0.72	1.43	20.21
	WTG type 2	0.00	0.00	1.69	1.78	2.66	6.37	0.00	0.00	0.00	1.96	0.57	1.15	16.17
Great black-backed gull	WTG type 1	0.00	0.00	1.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.07
	WTG type 2	0.00	0.00	0.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.82
Arctic tern	WTG type 1	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.10	0.00	0.00	0.00	0.00	0.33
	WTG type 2	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.09	0.00	0.00	0.00	0.00	0.27
Arctic skua	WTG type 1	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.07
	WTG type 2	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.06
Gannet	WTG type 1	0.00	0.00	2.38	2.28	6.30	1.54	2.08	1.00	0.00	2.37	0.00	0.08	18.03
	WTG type 2	0.00	0.00	1.83	1.76	4.86	1.19	1.61	0.77	0.00	1.83	0.00	0.06	13.90

This page is intentionally blank

3.3 Collision Estimates by Seasonal Periods

25. The collision estimates as derived from the sCRM (mean with LCL and UCL) and deterministic CRM are presented according to the defined seasonal periods (following NatureScot 2020; 2023b; 2024) for each of the five species on which CRMs were undertaken (**Table 3.7** to **Table 3.11**). The seasonal periods for each species are as defined in Table 2.2 of **Appendix 10.1: Offshore Ornithology Digital Aerial Survey Baseline Report (Volume IV)**.
26. As stated in **Section 2.1**, the collision estimates for the seasonal periods are calculated by summing the relevant monthly values for each species and design combination (as presented in **Table 3.1** to **Table 3.5**). Where seasonal periods encompass a split month (e.g. for kittiwake, where the spring passage period ends and the breeding period begins in mid-April), half of the estimated collisions are typically assigned to each of the two seasonal periods which encompass that month. However, in the case of gannet, the density values attributed to the non-breeding passage periods (but not the breeding period) have been reduced to account for the 70% macro-avoidance rate prior to being entered into the CRMs (**Section 2.4.3**)². For gannet, the spring passage period ends and the breeding period begins in mid-March, so that the allocation of the March collision estimates to each of the spring passage and breeding periods has to account for the fact that the macro-avoidance effect is only considered relevant to the spring passage period. As described in **Section 2.4.3**, this is addressed with the input density values by applying the macro-avoidance correction (i.e. 0.3) to half of the value of the density estimate and then adding the resultant value to half of the value of the density estimate. Consequently, the proportion of the March collision estimates that is assigned to the spring passage period is 0.23, whilst the proportion assigned to the breeding period is 0.77 (based on the ratio of 0.5 to 0.5 multiplied by 0.3 (= 0.15)).

Table 3.7: Number of Predicted Kittiwake Collisions by Seasonal Period for Two Wind Turbine Generator Design Scenarios, as Derived from Stochastic and Deterministic Collision Risk Models¹

WTG Design Scenario	Model		Seasonal Period		
			Breeding	Autumn Passage	Spring Passage
WTG type 1	Stochastic	Mean estimate	11.74	4.26	2.87
		2.5% CL	0.00	0.00	0.00
		97.5% CL	33.89	14.56	8.98
	Deterministic		12.39	4.60	3.22
WTG type 2	Stochastic	Mean estimate	9.40	3.40	2.30
		2.5% CL	0.00	0.00	0.00
		97.5% CL	27.15	11.64	7.17
	Deterministic		9.92	3.68	2.58
Notes:					
¹ Outputs for the stochastic CRM include confidence limit values.					

Table 3.8: Number of Predicted Great Black-backed Gull Collisions by Seasonal Period for Two Wind Turbine Generator Design Scenarios, as Derived from Stochastic and Deterministic Collision Risks

WTG Design Scenario	Model		Seasonal Period			
			Breeding	Autumn Passage	Winter	Spring Passage
WTG type 1	Stochastic	Mean estimate	0.00	0.00	0.00	1.14
		2.5% CL	0.00	0.00	0.00	0.00
		97.5% CL	0.00	0.00	0.00	6.19
	Deterministic		0.00	0.00	0.00	1.07
WTG type 2	Stochastic	Mean estimate	0.00	0.00	0.00	0.88
		2.5% CL	0.00	0.00	0.00	0.00
		97.5% CL	0.00	0.00	0.00	4.78
	Deterministic		0.00	0.00	0.00	0.82
Notes:						
Outputs for the stochastic CRM include confidence limit values.						

Table 3.9: Number of Predicted Arctic Tern Collisions by Seasonal Period for Two Wind Turbine Generator Design Scenarios, as Derived from Stochastic and Deterministic Collision Risk Models

WTG Design Scenario	Model		Seasonal Period			
			Breeding	Autumn Passage	Winter	Spring Passage
WTG type 1	Stochastic	Mean estimate	0.35	0.00	0.00	0.00
		2.5% CL	0.00	0.00	0.00	0.00
		97.5% CL	2.22	0.00	0.00	0.00
	Deterministic		0.33	0.00	0.00	0.00
WTG type 2	Stochastic	Mean estimate	0.29	0.00	0.00	0.00
		2.5% CL	0.00	0.00	0.00	0.00
		97.5% CL	1.80	0.00	0.00	0.00
	Deterministic		0.27	0.00	0.00	0.00
Notes:						
Outputs for the stochastic CRM include confidence limit values.						

Table 3.10: Number of Predicted Arctic Skua Collisions by Seasonal Period for Two Wind Turbine Generator Design Scenarios, as Derived from Stochastic and Deterministic Collision Risk Models

WTG Design Scenario	Model		Seasonal Period			
			Breeding	Autumn Passage	Winter	Spring Passage
WTG type 1	Stochastic	Mean estimate	0.08	0.00	0.00	0.00
		2.5% CL	0.00	0.00	0.00	0.00
		97.5% CL	0.55	0.00	0.00	0.00
	Deterministic		0.07	0.00	0.00	0.00
WTG type 2	Stochastic	Mean estimate	0.07	0.00	0.00	0.00
		2.5% CL	0.00	0.00	0.00	0.00
		97.5% CL	0.45	0.00	0.00	0.00
	Deterministic		0.06	0.00	0.00	0.00
Notes:						
Outputs for the stochastic CRM include confidence limit values.						

Table 3.11: Number of Predicted Gannet Collisions by Seasonal Period for Two Wind Turbine Generator Design Scenarios, as Derived from Stochastic and Deterministic Collision Risk Models. Outputs for the Stochastic Collision Risk Model Include Confidence Limit Values

WTG Design Scenario	Model		Seasonal Period		
			Breeding	Autumn Passage	Spring Passage
WTG type 1	Stochastic	Mean estimate	14.77	2.46	0.60
		2.5% CL	0.00	0.00	0.00
		97.5% CL	45.34	10.68	2.44
	Deterministic		15.02	2.37	0.63
WTG type 2	Stochastic	Mean estimate	11.37	1.89	0.46
		2.5% CL	0.00	0.00	0.00
		97.5% CL	34.78	8.19	1.87
	Deterministic		11.59	1.83	0.49
Notes:					
Outputs for the stochastic CRM include confidence limit values.					

4 References

Band, B., (2012). Using a collision risk model to assess bird collision risks for offshore windfarms. British Trust for Ornithology.

Caneco (2022). CRM. Available at: <https://dmpstats.shinyapps.io/sCRM/>.

HiDef (2024). Digital Video Aerial Surveys of Seabirds and Marine Megafauna at Bellrock Offshore Wind Farm Wind Farm Development Area: 2-year Annual Report (March 2022 to February 2024). 28 May 2024.

Johnston, A., Cook, A.S., Wright, L.J., Humphreys, E.M. and Burton, N.H.K. (2014a). Modelling flight heights of marine birds to more accurately assess collision risk with offshore wind turbines. *Journal of Applied Ecology*, 51, 31–41.

Johnston, A., Cook, A.S.C.P., Wright, L.J., Humphreys, E.M. and Burton, N.H.K. (2014b) Corrigendum. *Journal of Applied Ecology*, 51, 1126–1130.

NatureScot (2020). Seasonal Periods for Birds in the Scottish Marine Environment. Short Guidance Note, version 2. Available at: <https://www.nature.scot/sites/default/files/2020-10/Guidance%20note%20-%20Seasonal%20definitions%20for%20birds%20in%20the%20Scottish%20Marine%20Environment.pdf>.

NatureScot (2023a). Guidance Note 6: Guidance to support Offshore Wind Applications - Marine Ornithology Impact Pathways for Offshore Wind Developments. Available at: <https://www.nature.scot/doc/guidance-note-6-guidance-support-offshore-wind-applications-marine-ornithology-impact-pathways#:~:text=The%20two%20key%20impact%20pathways%20identified%20for%20offshore,consequences%20on%20fitness%20including%20survival%20rates%20and%20productivity>.

NatureScot (2023b). Guidance Note 10: Guidance to support Offshore Wind Applications: Marine Ornithology. Advice for apportioning impacts to breeding colonies. Available at: <https://www.nature.scot/doc/guidance-note-10-guidance-support-offshore-wind-applications-marine-ornithology-advice-apportioning>.

NatureScot (2024). Bellrock Offshore Windfarm – Scotwind E1E. NatureScot advice on the Environmental Impact Assessment (EIA) Scoping Report and Habitats Regulations Appraisal (HRA) Screening Report – wind farm development area only. Appendix C – Marine ornithology. Available at: https://marine.gov.scot/sites/default/files/bellrock_wind_farm_development_area_scop_0043_-_appendix_1_-_consultation_responses_and_advice_-_august_2024.pdf.

NatureScot (2025). Guidance Note 7, Version 2: Guidance to support Offshore Wind Applications: Marine Ornithology – Advice for assessing collision risk of marine birds. Available at: <https://www.nature.scot/doc/guidance-note-7-guidance-support-offshore-wind-applications-marine-ornithology-advice-assessing>.

SNCBs (2024). Joint advice note from the Statutory Nature Conservation Bodies (SNCBs) regarding bird collision risk modelling for offshore wind developments. JNCC, Peterborough. <https://hub.jncc.gov.uk/f7892820-0f84-4e96-9eff-168f93bd343d>.

SOSS (2012). Using a collision risk model to assess bird collision risks for offshore windfarms – with extended method. Worked example. Available at: Microsoft Word - worked example - Feb 2012 with flight height..

Annex A: Bootstrap Samples

See zip folder (**Appendix 10.2 Annex A - Bootstrap Samples.zip (RHDV_BEL_CST_REP_0004_009)**) of the digital version of this document for the associated excel spreadsheets. The Excel files are included in hard copy.

This page is intentionally blank

Annex B: CRM Raw Outputs

See zip folder (**Appendix 10.2 Annex B CRM Raw Outputs (RHDV_BEL_CST_REP_0004_008)**) of the digital version of this document for the associated excel spreadsheets. The Excel files are included in hard copy.

This page is intentionally blank