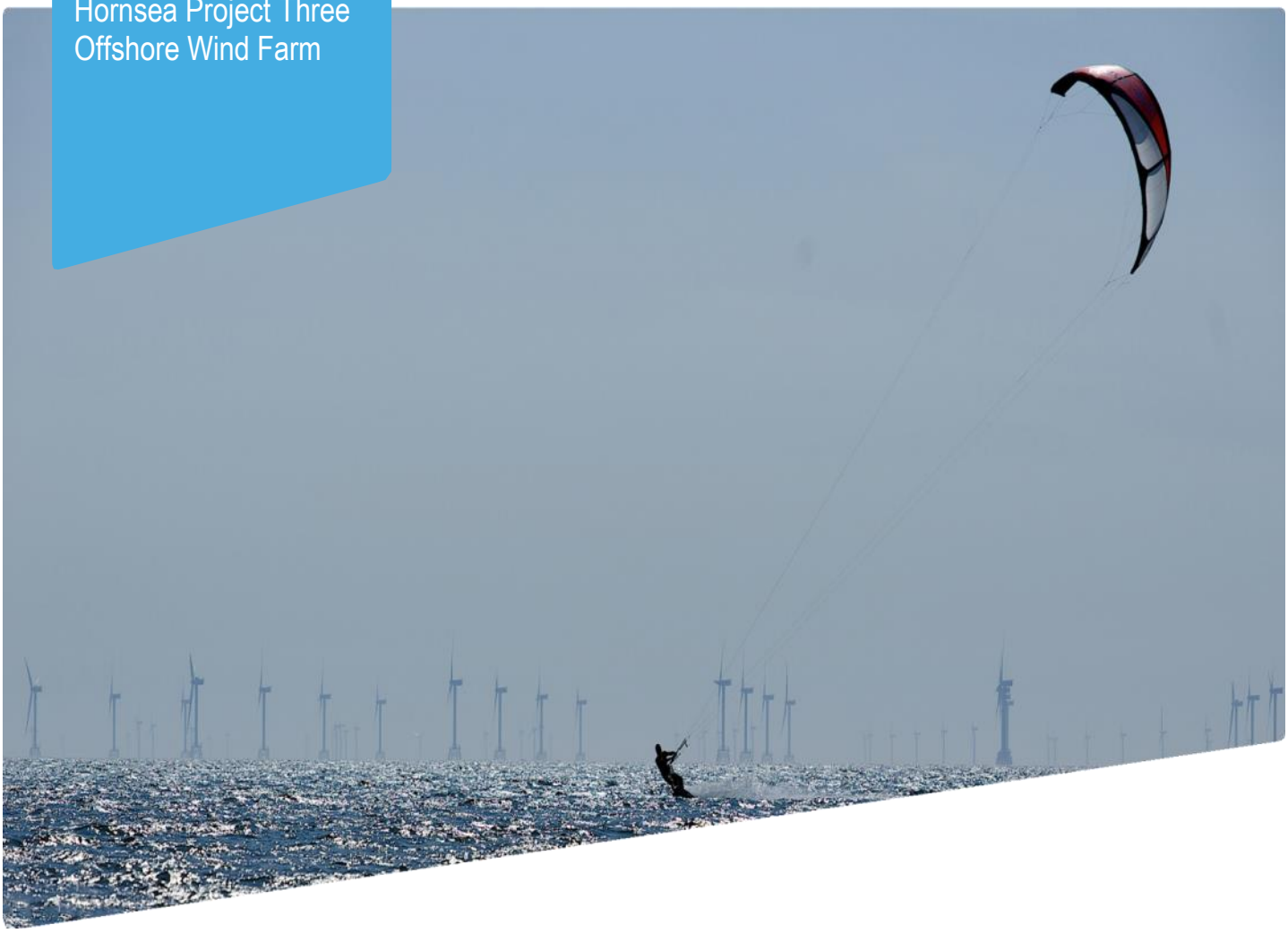
Hornsea Project Three
Offshore Wind Farm



Hornsea Project Three

Offshore Wind Farm

Appendix 15 to Deadline 7 submission - Ornithological Data Request and Tabulation of Collision Risk Modelling Parameters

Date: 14th March 2019

Hornsea 3
Offshore Wind Farm

Ørsted

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Front cover picture: Kite surfer near a UK offshore wind farm © Orsted Hornsea Project Three (UK) Ltd., 2018.

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1. Coefficients of variation

Introduction

1.1 At Deadline 4, Natural England suggested that the Applicant supply various data that Natural England's contends would allow the Competent Authority to conduct a full assessment. The Applicant has presented all data considered relevant to the analyses and assessments presented throughout the application and examination and, when requested the Applicant has sought to provide additional data that were used to inform relevant analyses and assessments.

1.2 As can be seen from the explanatory notes in the sequence summary tables which follow in this report, the majority of the data that Natural England suggest should be provided are either not used to inform the analyses and assessments conducted by the Applicant, would not be used to inform assessments based on SNCB guidance or are not directly used to inform analyses and assessments (e.g. raw data which is processed to calculate population estimates/densities). Where possible, however, these data have been provided in this report and associated appendices.

1.3 In addition to the data request provided by Natural England, the Examining Authority at Issue Specific Hearing 7 (6th March 2019) requested that the Applicant provide a tabulation of the parameters used for collision risk modelling (CRM). These are therefore also provided in Table 1.3 in this report.

Baseline characterisation data

1.4 The data to provide, as suggested by Natural England are presented in Table 1.1 alongside where these data can be found.

Table 1.1: Data request in relation to baseline characterisation data

Data	Where provided	Notes
Raw digital aerial survey data giving the number of birds of each species recorded on each survey day and each transect, with birds in flight and birds on the water presented separately.	Provided as Annex A to this report.	These data are not used to directly inform any analyses or assessments presented by the Applicant and are not required when following guidance from SNCBs (e.g. JNCC *et al.* 2017).
Tables of raw numbers of birds recorded in each year and month of the baseline surveys – presented for Hornsea Three, Hornsea Three plus 2 km buffer and Hornsea Three plus 4 km buffer. With numbers presented separately for birds in flight and birds on the water at each scale	All raw data, with associated coordinate data is provided in Annex A to this report	These data are not used to directly inform any analyses or assessments presented by the Applicant and are not required when following guidance from SNCBs

Data	Where provided	Notes
Tables of population estimates for birds in each year and month of the baseline surveys – presented for Hornsea Three, Hornsea Three plus 2 km buffer and Hornsea Three plus 4 km buffer. With numbers presented separately for birds in flight and birds on the water (availability bias corrected) and upper and lower 95% confidence intervals around each population estimate provided and the coefficient of variation presented for each estimate.	Not provided – it is not possible to provide these data in a timescale consistent with the deadlines of the examination.	These data have not been used for the analyses or assessments presented by the Applicant.
Tables of population estimates with 95% confidence intervals, generated by bootstrapping all the transect data (i.e. from all four cameras used for the digital aerial surveys) for a given month and year (i.e. two separate monthly estimates where there are data from two years) calculated for birds on the water (with availability bias correction) and birds in flight combined. Presented for Hornsea Three, Hornsea Three plus 2km buffer and Hornsea Three plus 4 km buffer. Standard deviations and coefficients of variation should also be presented for each population estimate.	The requested data are presented in Annex A to this report for the analyses conducted for data from two cameras. The methodology for aerial surveys was agreed as part of the Evidence Plan process (APP-035) and further analyses are unlikely to provide any greater benefit in assessment terms (REP4-096). The requested data for Hornsea Three plus a 4 km buffer are presented in Annex 5.1: Baseline Characterisation Report (APP-107).	Population estimates for Hornsea Three alone have not been used to inform any analyses or assessments presented by the Applicant and are not required when following guidance from SNCBs. Population estimates for Hornsea Three plus a 2 km buffer are used to derive mean-peak populations for use in displacement analyses following SNCB guidance. Population estimates for Hornsea Three plus a 4 km buffer are used to identify Valued Ornithological Receptors in Annex 5.1: Baseline Characterisation Report (APP-107).
Tables of density estimates for birds in flight for each year and month of the baseline surveys - presented for Hornsea Three, Hornsea Three plus 2km buffer and Hornsea Three plus 4 km buffer. With upper and lower 95% confidence intervals around each density estimate provided. Standard deviations and coefficients of variation should also be presented for each population estimate	Not provided – it is not possible to provide these data in a timescale consistent with the deadlines of the examination.	These data have not been used for the analyses or assessments presented by the Applicant.

Data	Where provided	Notes
Tables of density estimates for birds in flight for each year and month of the baseline surveys with 95% confidence intervals, generated by bootstrapping all the transect data (i.e. from all four cameras used for the digital aerial surveys) for a given month and year (i.e. two separate monthly estimates where there are data from two years). Presented for Hornsea Three, Hornsea Three plus 2km buffer and Hornsea Three plus 4 km buffer. Standard deviations and coefficients of variation should also be presented for each density estimate	The requested data are presented in Annex A for the analyses conducted for data from two cameras. The methodology for aerial surveys was agreed as part of the Evidence Plan process (APP-035) and further analyses are unlikely to provide any greater benefit in assessment terms (REP4-096). The requested data for Hornsea Three plus a 4 km buffer are presented in Annex 5.1: Baseline Characterisation Report (APP-107).	Density data for Hornsea Three alone are used in collision risk modelling. Density data for Hornsea Three plus a 2 km buffer have not been used to inform any analyses or assessments presented by the Applicant and are not required when following guidance from SNCBs. Density data for Hornsea Three plus a 4 km buffer have not been used to inform any analyses or assessments presented by the Applicant and are not required when following guidance from SNCBs.

1.5 In response to ExA written question 2.2.3, the Applicant previously presented a comparison between the coefficient of variation values derived for monthly abundance metrics for Hornsea Three plus a 4 km buffer alongside those associated with abundance metrics calculated at two other offshore wind farms, namely East Anglia Three and Moray East (REP4-096). The Applicant has identified two further projects at which coefficient of variation values were calculated with these added to the graphs below.

1.6 These figures continue to illustrate two points. First, the CVs recorded are highly variable by species and month. Consistently achieving a target CV is extremely difficult, if not impossible, in practice and it is necessary to make a judgement at the outset of the survey programme about a strategy that is likely to deliver sufficient precision for the purposes of impact assessment. Second, the values achieved for Hornsea Three are similar to and, in many cases superior, to those achieved at other projects.

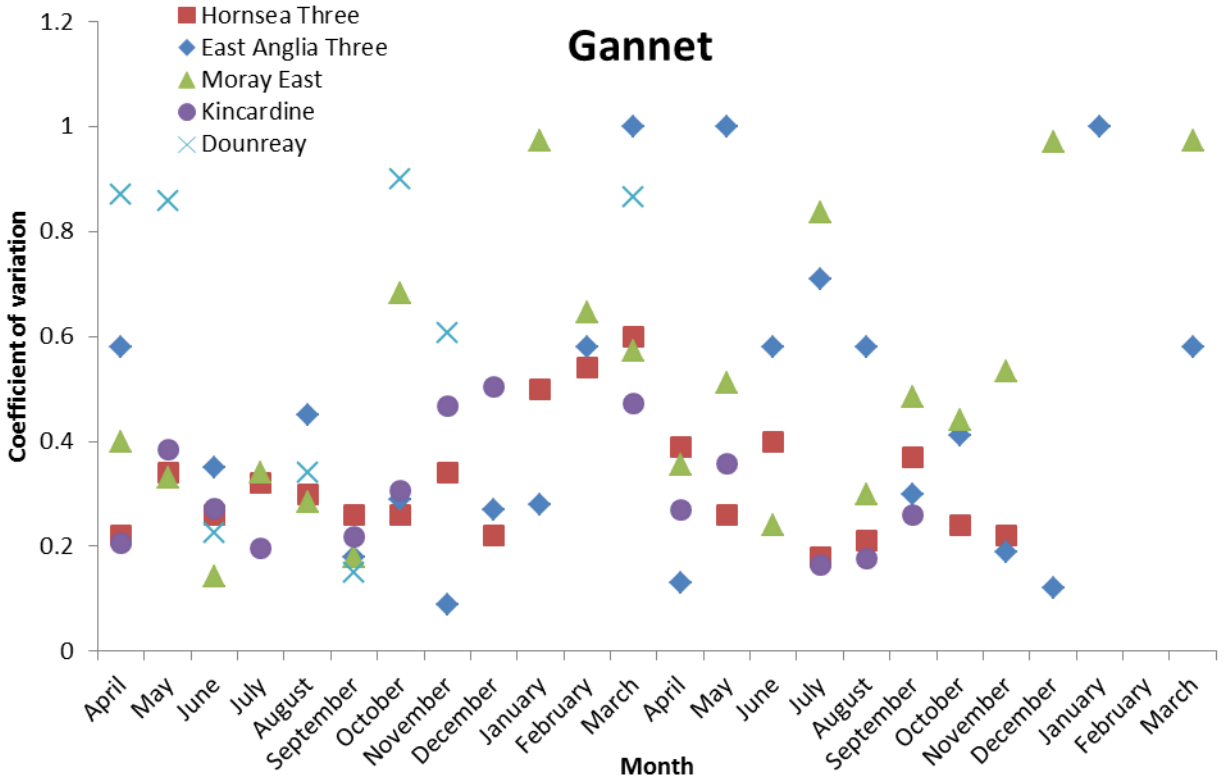

Figure 1.1: CoVs associated with abundance metrics calculated for Moray East, East Anglia Three, Kincardine, Dounreay Tri and Hornsea Three on a monthly basis: gannet

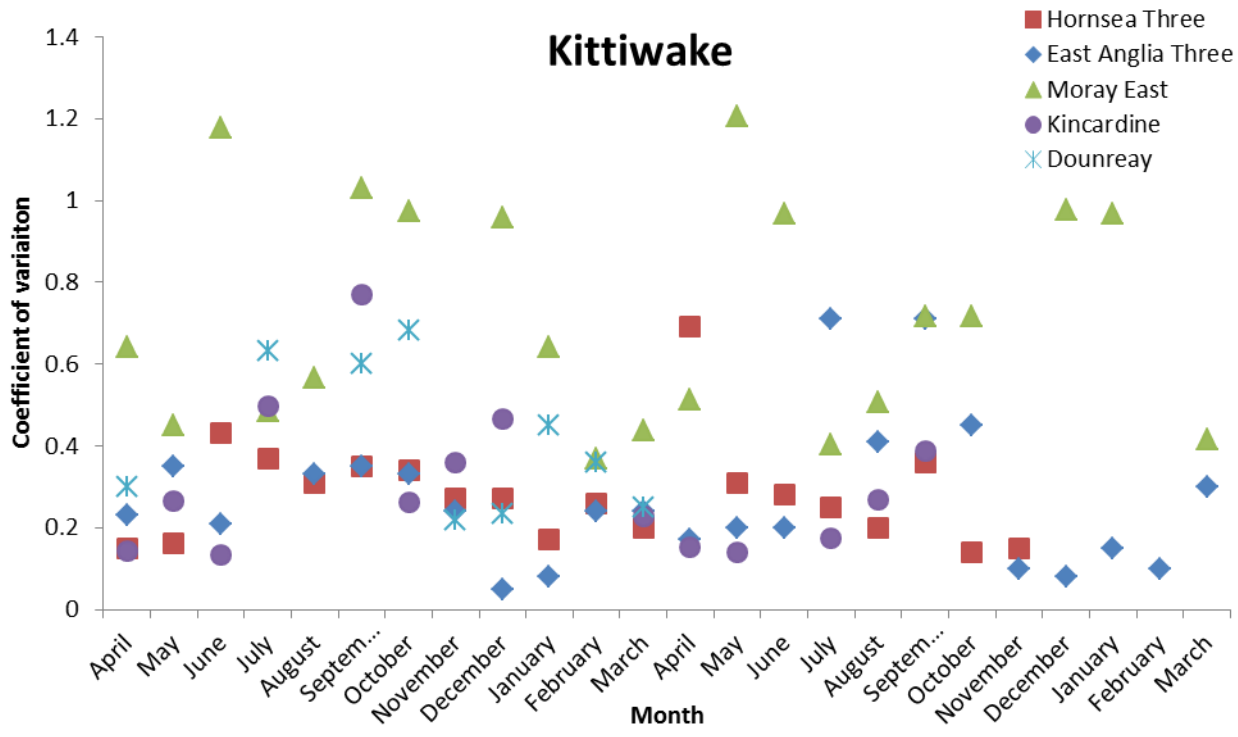

Figure 1.2: CoVs associated with abundance metrics calculated for Moray East, East Anglia Three, Kincardine, Dounreay Tri and Hornsea Three on a monthly basis: kittiwake

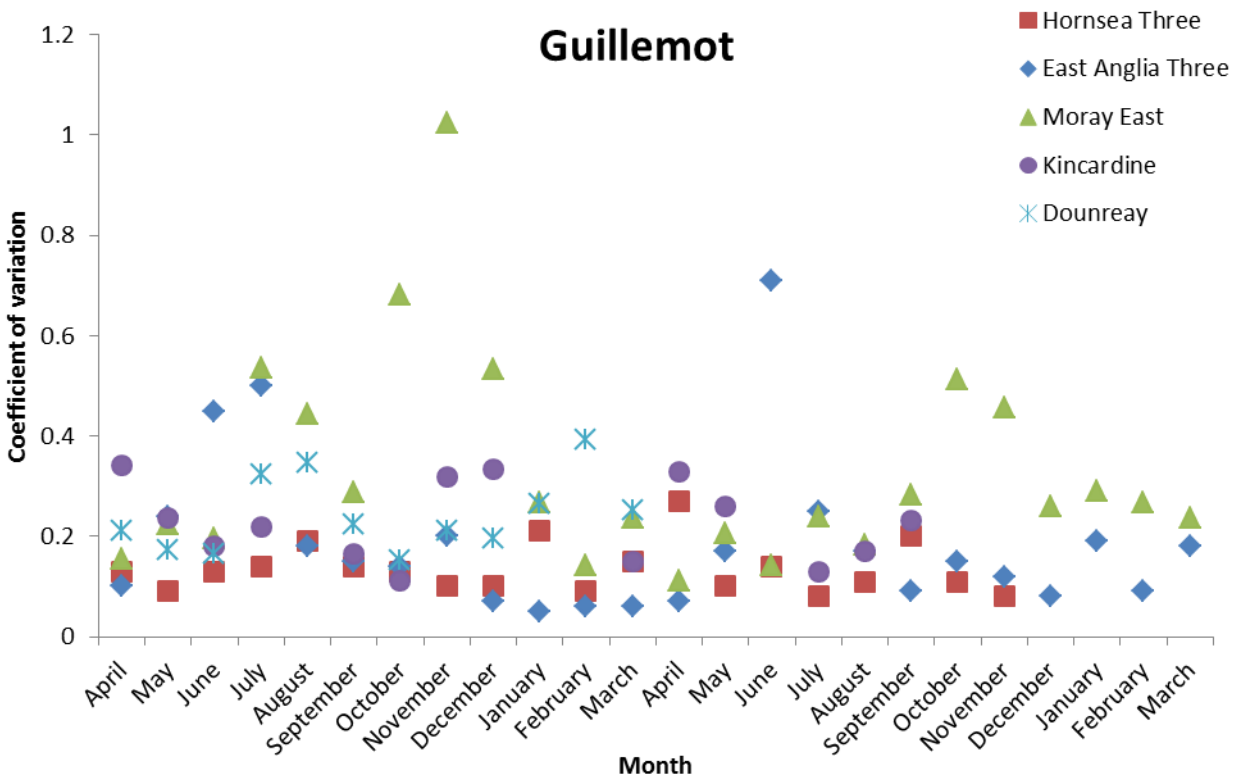

Figure 1.3: CoVs associated with abundance metrics calculated for Moray East, East Anglia Three, Kincardine, Dounreay Tri and Hornsea Three on a monthly basis: guillemot

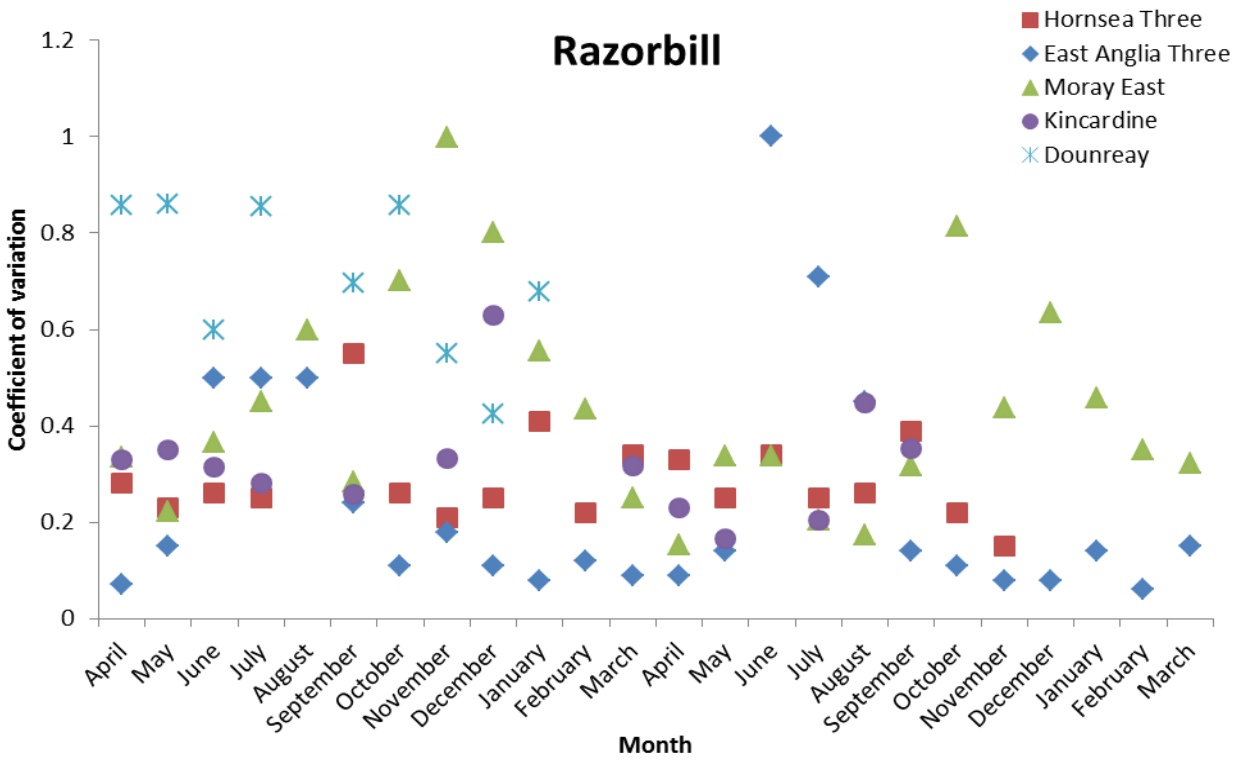

Figure 1.4: CoVs associated with abundance metrics calculated for Moray East, East Anglia Three, Kincardine, Dounreay Tri and Hornsea Three on a monthly basis: razorbill

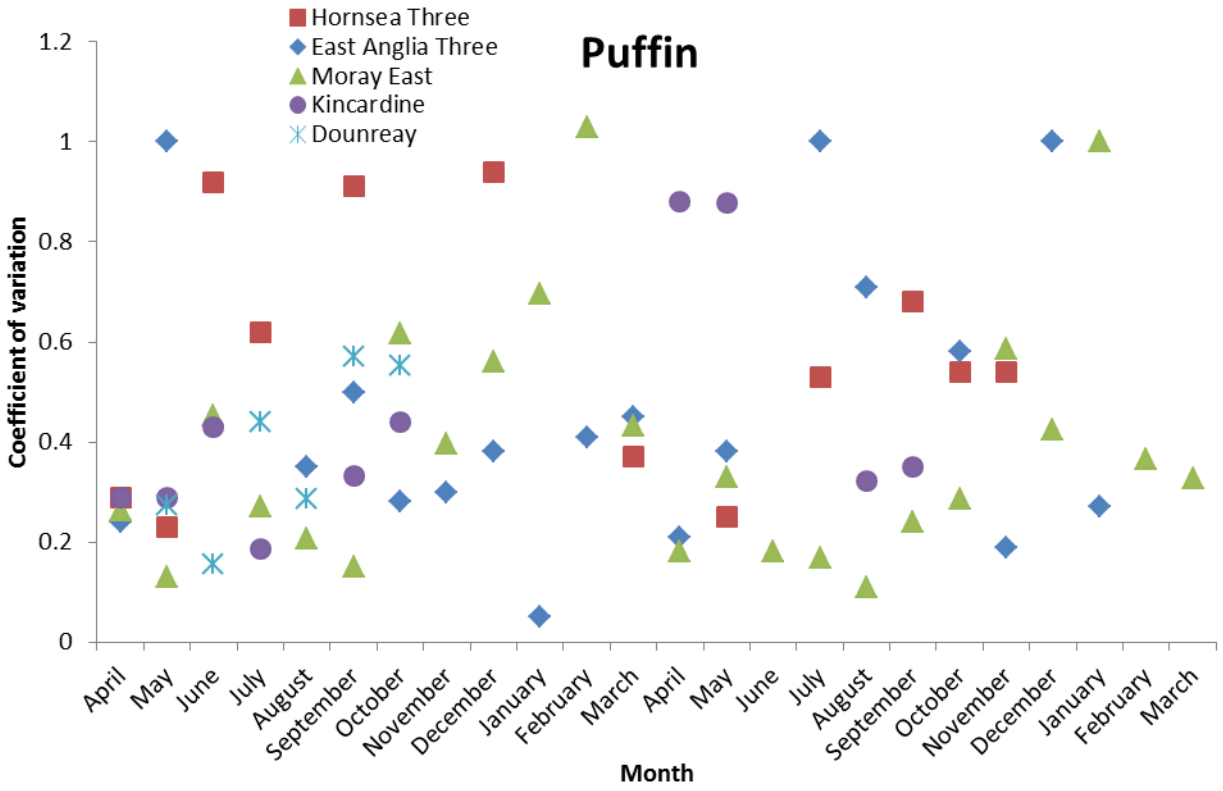

Figure 1.5: CoVs associated with abundance metrics calculated for Moray East, East Anglia Three, Kincardine, Dounreay Tri and Hornsea Three on a monthly basis: puffin

Collision Risk Modelling

1.7 The data to provide, as suggested by Natural England are presented in Table 1.2 alongside where these data can be found.

Table 1.2: Data request in relation to collision risk modelling

Data	Where provided	Notes
Band Model spreadsheets populated with all the project, turbine and bird parameters and data used for CRM for each species (gannet, kittiwake, lesser black-backed gull, great black-backed gull and herring gull);	Appendix A	Due to the large number of collision risk models required to model the various parameter iterations throughout the examination process it is not possible to provide all collision risk models. The models used to calculate Natural England's position (as interpreted by the Applicant) and the Applicant's position are presented in Appendix B. These models present collision risk estimates calculated using the mean estimate for all parameters.

Data	Where provided	Notes
Natural England advises that monthly density estimates and confidence intervals for the CRM assessments should be derived using only data collected from the digital aerial surveys of Hornsea Three, and that the precision of the density estimates is improved by analysing the data collected from all four cameras, rather than the data from just two cameras.	N/A	Density estimates for Hornsea Three alone alongside upper and lower confidence intervals are presented in REP4-049. It is not possible to provide data from four cameras in a timescale consistent with the deadlines of the examination.
Natural England requests that the Applicant presents collision outputs for each species that reflect the variability and uncertainty around densities, flight heights and avoidance rates as a minimum. This should include presentation of collisions calculated using the relevant mean avoidance rate and ± 2SD of the mean avoidance rate as given in JNCC et al. (2014); presentation of collisions using mean, upper and lower 95% confidence intervals around the mean flight density data by month; presentation of collisions using mean, upper and lower flight height distribution data from Johnston et al. (2014), and presentation of collisions that reflect variability in Nocturnal Activity Factors as set out in REP1-211 for species where relevant.	This is the approach followed by the Applicant throughout the application and examination submissions, where relevant.	

1.8 At Issue Specific Hearing 7 (6th March 2019) in relation to Offshore Ecology, the Examining Authority requested that the Applicant provide a tabulated comparison of the parameters incorporated into collision risk modelling as part of the application (APP-109 and REP1-189) and those included in the submissions at Deadline 6 confirming the Applicant's position on CRM (REP-042) and the Applicant's interpretation of Natural England's position on CRM (REP-043) or the equivalent values for those species not included in these submissions. These are provided in Table 1.3 for each species.

Table 1.3: Parameters used for collision risk modelling

Parameter	Position	Parameter value					Source
Bird parameters							
Species	-	Gannet	Kittiwake	Lesser black-backed gull	Herring gull	Great black-backed gull	-
Bird length (m)	Application	0.94	0.39	0.58	0.6	0.71	Robinson (2017)
	REP6-042						
	REP6-043						
Wingspan (m)	Application	1.72	1.08	1.42	1.44	1.58	Robinson (2017)
	REP6-042						
	REP6-043						
Flight speed (m/s)	Application	14.9	13.1	13.1	12.8	13.7	Alerstam *et al.* (2007) or Pennycuick (1987)
	REP6-042	13.33	8.71	9.80	9.80	9.80	Skov *et al.* (2018)
	REP6-043	14.9	13.1	13.1	12.8	13.7	Alerstam *et al.* (2007) or Pennycuick (1987)
Nocturnal activity factor	Application	1	2	3	3	3	Empirically derived/King et al. (2009) (APP-109/REP1-189)
	REP6-042	8% breeding 3% non-breeding	20% breeding 17% non-breeding	3	3	3	Furness *et al.* (2018)/MacArthur Green (2018)/Garthe and Hüppop (2004)
	REP6-043	1-2	2-3	2-3	2-3	2-3	REP1-211

Parameter	Position	Parameter value					Source
Flight type	All	Flapping	Flapping	Flapping	Flapping	Flapping	[1]
Proportion of flights upwind	All	50	50	50	50	50	[2]
Avoidance rate (%)	Application	98.9 (±0.2) 98.0	98.9 (±0.2)/ 99.2 (±0.2) 98.0	99.5 (±0.1) 98.9 (±0.2)	99.5 (±0.1) 98.9 (±0.2)	99.5 (±0.1) 98.9 (±0.2)	Cook *et al*. (2014) JNCC *et al.* (2014)
	REP6-042	99.5	99.0	99.5	99.5	99.5	Bowgen and Cook (2018)
	REP6-043	98.9 (±0.2)	98.9 (±0.2)	99.5 (±0.1)	99.5 (±0.1)	99.5 (±0.1)	JNCC *et al.* (2014)
Proportion at rotor height	Application	All Options presented utilising information from boat-based surveys undertaken from Hornsea Project One and Two (Option 1) and Johnston *et al.* (2014) (Options 2 and 3)					-
	REP6-042	Boat-based flight height data (Option 1) and Johnston *et al.* (2014) (Option 3)					-
	REP6-043	Johnston *et al.* (2014) – Option 2 only					-
Wind farm parameters							
Latitude (degrees)	All	53.87					-
Number of turbines	All	300					-

[1] Based on expert opinion - the input parameters for flight type are either 'flapping' or 'gliding' with flapping representing the worst case scenario
[2] Assumed that there is a 50:50 split in flights upwind and downwind this is the default parameterisation suggested by the Band (2012) guidance

Parameter	Position	Parameter value											Source
Tidal offset (m)	All	1.8											-
No. of blades	All	3											-
Average rotation speed (rpm)	All	8.1											-
Rotor radius (m)	All	97.5											-
Hub height (m)	All	128.87											-
Max blade width (m)	All	6											-
Average pitch (°)	All	4.3											-
Proportion of time operational (%)	All	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		92.50	92.61	92.14	90.96	90.71	89.36	89.18	89.86	91.29	92.57	92.59	92.61

Data to inform displacement assessment

1.9 The data to provide, as suggested by Natural England are presented in Table 1.4 alongside where these data can be found.

Table 1.4: Data request in relation to displacement assessment

Data	Where provided	Notes
Natural England advises that monthly abundance estimates and confidence intervals for use in the displacement assessments (prior to calculating seasonal mean of peaks) should: • be derived using only data collected from the digital aerial surveys of Hornsea Three; and • be presented as population estimates of the Hornsea Three footprint and a 2km buffer (total birds in flight and on the water, after correcting for survey effort and availability bias) on a month by month basis for all 20 months individually with associated upper and lower confidence intervals. Natural England advises that the precision of the population estimates is improved by analysing the data collected from all four cameras, rather than the data from just two cameras.	Population estimates for relevant species for Hornsea Three plus a 2 km buffer for use in displacement analyses are presented in Table 1.3 in REP4-049. It is not possible to provide data from four cameras in a timescale consistent with the deadlines of the examination. The methodology for aerial surveys was agreed as part of the Evidence Plan process (APP-035) and further analyses are unlikely to provide any greater benefit in assessment terms (REP4-096).	SNCB guidance on displacement states that the use of a mean-peak population "*allows for year-to-year variation in the precise time (and magnitude) of peak abundance estimates to be taken into account in arriving at a mean peak population estimate*". The use of confidence intervals as applied by Natural England in previous assessments (i.e. averaging separate confidence intervals) is not recommended in the SNCB displacement guidance (JNCC *et al.,* 2017) and is not a statistically appropriate way in which to utilise confidence intervals.

Age class data

1.10 The Applicant has previously provided all data requested by Natural England (see REP1-169 and REP3-026). In relation to revised list of suggested data provided by Natural England (REP4-130) the following applies:

- Guillemot and razorbill cannot be aged during boat-based or aerial surveys as immature birds are indistinguishable from adult birds. Juvenile guillemot and razorbill can be identified for a short period after fledging but data associated with these birds is not relevant to the assessments conducted for Hornsea Three; and
- It is not possible to provide data from four cameras in a timescale consistent with the deadlines of the examination.

1.11 Age class data from digital aerial surveys has previously been provided for Hornsea Three plus a 4 km buffer. These are the only data used in assessments and provide the largest, most robust dataset from the aerial survey data.

Population modelling

1.12 The Applicant has provided a large number of outputs from Population Viability Modelling at Deadline 1 and 4 (REP1-135 and REP4-092). These were provided in order to address a previous request from Natural England and are considered to represent all outputs that will be required to formulate conclusions.

Cumulative and in-combination project figures

1.13 The Applicant has provided cumulative and in-combination collision risk estimates on a seasonal basis in APP-051, APP-065, REP1-005, REP1-139 and REP1-148.

1.14 The Applicant has provided cumulative and in-combination displacement values on a seasonal basis in APP-051 and APP-065.

Appendix A – Collision Risk Modelling

Collision risk models – Applicant's interpretation of Natural England's position

COLLISION RISK ASSESSMENT
Sheet 1 - Input data

used in overall collision risk sheet
used in migrant collision risk sheet
used in single transit collision risk sheet or extended model
used in available hours sheet
used in large array correction sheet
not used in calculation but stated for reference

	Units	Value
Bird data		
Species name		Gannet
Bird length	m	0.94
Wingspan	m	1.72
Flight speed	m/sec	14.9
Nocturnal activity factor (1-5)		1
Flight type, flapping or gliding		flapping

Bird survey data			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daytime bird density	birds/sq km	Mean	0.0164	0	0.0827	0.0927	0.0165	0.0543	0.2497	0.3448	0.1582	0.4257	0.1159	0.59
Proportion at rotor height	%	1.4%												
Proportion of flights upwind	%	50.0%												

Birds on migration data		
Migration passages	birds	
Width of migration corridor	km	
Proportion at rotor height	%	
Proportion of flights upwind	%	

	Units	Value
Windfarm data		
Name of windfarm site		Hornsea P3
Latitude	degrees	53.87
Number of turbines		300
Width of windfarm	km	36
Tidal offset	m	1.8

	Units	Value	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Turbine data														
Turbine model		8 MW												
No of blades		3												
Rotation speed	rpm	8.1												
Rotor radius	m	97.5												
Hub height	m	128.87												
Monthly proportion of time operational	%		92.50%	92.61%	92.14%	90.96%	90.71%	89.36%	89.18%	89.86%	91.29%	92.57%	92.59%	92.61%
Max blade width	m	6.000												
Pitch	degrees	4.3												

Avoidance rates used in presenting results	**Data sources (if applicable)**
98.00%	
98.70%	
98.90%	
99.10%	

Figure 1.6: Input data spreadsheet from the Band (2012) CRM for gannet using the Applicant's interpretation of Natural England's position (using mean estimates for density and flight height distribution and a nocturnal activity of 1)

COLLISION RISK ASSESSMENT
Sheet 2 - Overall collision risk

All data input on Sheet 1:
no data entry needed on this sheet!

from Sheet 1 - input data
from Sheet 6 - available hours
from Sheet 3 - single transit collision risk
from survey data
calculated field

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year average
Bird details:															
Species		Gannet													
Flight speed	m/sec	14.9													
Nocturnal activity factor (1-5)		1													
Nocturnal activity (% of daytime)		0%													
Windfarm data:															
Latitude	degrees	53.9													
Number of turbines		300													
Rotor radius	m	97.5													
Minimum height of rotor	m	128.87													
Total rotor frontal area	sq m	8959430													
Proportion of time operational	%		93%	93%	92%	91%	91%	89%	89%	90%	91%	93%	93%	93%	91.4%
Stage A - flight activity															
Daytime areal bird density	birds/sq km		0.02	0.00	0.08	0.09	0.02	0.05	0.25	0.34	0.16	0.43	0.12	0.59	
Proportion at rotor height	%	1.4%													
Total daylight hours per month	hrs		249	272	366	420	494	510	513	461	383	329	259	233	
Total night hours per month	hrs		495	400	378	300	250	210	231	283	337	415	461	511	
Flux factor			10093	0	74609	95839	20082	68261	315604	391343	149350	345054	73982	338648	
Option 1 -Basic model - Stages B, C and D															per annum
Potential bird transits through rotors			142	0	1051	1350	283	961	4445	5512	2104	4860	1042	4770	26519
Collision risk for single rotor transit	(from sheet 3)	6.6%													
Collisions for entire windfarm, allowing for non-op time, assuming no avoidance	birds per month or year		**9**	**0**	**64**	**81**	**17**	**56**	**260**	**325**	**126**	**296**	**63**	**290**	**1587**
Option 2-Basic model using proportion from flight distribution			**19**	**0**	**140**	**177**	**37**	**124**	**571**	**714**	**277**	**648**	**139**	**636**	**3482**
Option 3-Extended model using flight height distribution		Gannet_MLS													
Proportion at rotor height	(from sheet 4)	3.1%													
Potential bird transits through rotors	Flux integral	0.0133	134	0	991	1273	267	906	4191	5197	1983	4582	982	4497	25002
Collisions assuming no avoidance	Collision integral	0.00046	**4**	**0**	**32**	**40**	**8**	**28**	**130**	**163**	**63**	**148**	**32**	**145**	**795**
Average collision risk for single rotor transit		3.5%													
Stage E - applying avoidance rates															
Using which of above options?	**Option 2**	0.00%	19	0	140	177	37	124	571	714	277	648	139	636	**3482**
	birds per month														
Collisions assuming avoidance rate	or year	98.00%	0	0	3	4	1	2	11	14	6	13	3	13	**70**
		98.70%	0	0	2	2	0	2	7	9	4	8	2	8	**45**
		98.90%	0	0	2	2	0	1	6	8	3	7	2	7	**38**
		99.10%	0	0	1	2	0	1	5	6	2	6	1	6	**31**
Collisions after applying large array correction		98.00%	0	0	3	4	1	2	11	14	6	13	3	13	**70**
		98.70%	0	0	2	2	0	2	7	9	4	8	2	8	**45**
		98.90%	0	0	2	2	0	1	6	8	3	7	2	7	**38**
		99.10%	0	0	1	2	0	1	5	6	2	6	1	6	**31**

Figure 1.7: Overall collision risk spreadsheet from the Band (2012) CRM for gannet using the Applicant's interpretation of Natural England's position (using mean estimates for density and flight height distribution and a nocturnal activity of 1)

COLLISION RISK ASSESSMENT
Sheet 1 – Input data

used in overall collision risk sheet
used in migrant collision risk sheet
used in single transit collision risk sheet or extended model
used in available hours sheet
used in large array correction sheet
not used in calculation but stated for reference

	Units	Value
Bird data		
Species name		**Kittiwake**
Bird length	m	0.39
Wingspan	m	1.08
Flight speed	m/sec	13.1
Nocturnal activity factor (1-5)		2
Flight type, flapping or gliding		flapping

Bird survey data			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daytime bird density	birds/sq km	Mean	0.4661	0.1835	1.3449	1.4746	1.1519	0.3378	1.9064	0.6002	1.1687	0.3098	0.5086	1.9532
Proportion at rotor height	%	0.8%												
Proportion of flights upwind	%	50.0%												

Birds on migration data		
Migration passages	birds	
Width of migration corridor	km	
Proportion at rotor height	%	
Proportion of flights upwind	%	

	Units	Value
Windfarm data		
Name of windfarm site		**Hornsea P3**
Latitude	degrees	53.87
Number of turbines		300
Width of windfarm	km	36
Tidal offset	m	1.8

	Units	Value	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Turbine data														
Turbine model		**8 MW**												
No of blades		3												
Rotation speed	rpm	8.1												
Rotor radius	m	97.5												
Hub height	m	128.87												
Monthly proportion of time operational	%		92.50%	92.61%	92.14%	90.96%	90.71%	89.36%	89.18%	89.86%	91.29%	92.57%	92.59%	92.61%
Max blade width	m	6.000												
Pitch	degrees	4.3												

Avoidance rates used in presenting results	**Data sources (if applicable)**
98.00%	
98.70%	
98.90%	
99.10%	
98.90%	
99.20%	
99.50%	

Figure 1.8: Input data spreadsheet from the Band (2012) CRM for kittiwake using the Applicant's interpretation of Natural England's position (using mean estimates for density and flight height distribution and a nocturnal activity of 2)

COLLISION RISK ASSESSMENT
Sheet 2 – Overall collision risk

All data input on Sheet 1:
no data entry needed on this sheet!

from Sheet 1 – input data
from Sheet 6 – available hours
from Sheet 3 – single transit collision risk
from survey data
calculated field

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year average
Bird details:															
Species		Kittiwake													
Flight speed	m/sec	13.1													
Nocturnal activity factor (1-5)		2													
Nocturnal activity (% of daytime)		25%													
Windfarm data:															
Latitude	degrees	53.9													
Number of turbines		300													
Rotor radius	m	97.5													
Minimum height of rotor	m	128.87													
Total rotor frontal area	sq m	8959430													
Proportion of time operational	%		93%	93%	92%	91%	91%	89%	89%	90%	91%	93%	93%	93%	91.4%
Stage A – flight activity															
Daytime areal bird density	birds/sq km		0.47	0.18	1.34	1.47	1.15	0.34	1.91	0.60	1.17	0.31	0.51	1.95	
Proportion at rotor height	%	0.8%													
Total daylight hours per month	hrs		249	272	366	420	494	510	513	461	383	329	259	233	
Total night hours per month	hrs		495	400	378	300	250	210	231	283	337	415	461	511	
Flux factor			376584	148067	1342350	1580695	1388386	411859	2357506	691081	1183169	290454	412566	1526432	
Option 1 –Basic model – Stages B, C and D															**per annum**
Potential bird transits through rotors			2954	1161	10528	12398	10889	3230	18490	5420	9280	2278	3236	11972	**91836**
Collision risk for single rotor transit	(from sheet 3)	5.2%													
Collisions for entire windfarm, allowing for non-op time, assuming no avoidance	birds per month or year		**142**	**56**	**503**	**585**	**513**	**150**	**856**	**253**	**440**	**109**	**155**	**575**	**4336**
Option 2–Basic model using proportion from flight distribution			**745**	**293**	**2646**	**3076**	**2694**	**787**	**4497**	**1328**	**2311**	**575**	**817**	**3024**	**22794**
Option 3–Extended model using flight height distribution		Kittiwake_MLS													
Proportion at rotor height	(from sheet 4)	4.1%													
Potential bird transits through rotors	Flux integral	0.0187	7033	2765	25069	29520	25929	7692	44027	12906	22096	5424	7705	28507	**218673**
Collisions assuming no avoidance	Collision integral	0.00041	**143**	**56**	**506**	**589**	**516**	**151**	**861**	**254**	**442**	**110**	**156**	**579**	**4363**
Average collision risk for single rotor transit		2.2%													
Stage E – applying avoidance rates															
Using which of above options?	**Option 2**	0.00%	745	293	2646	3076	2694	787	4497	1328	2311	575	817	3024	**22794**
Collisions assuming avoidance rate	birds per month or year	98.00%	15	6	53	62	54	16	90	27	46	12	16	60	**456**
		98.70%	10	4	34	40	35	10	58	17	30	7	11	39	**296**
		98.90%	8	3	29	34	30	9	49	15	25	6	9	33	**251**
		99.10%	7	3	24	28	24	7	40	12	21	5	7	27	**205**
		98.90%	8	3	29	34	30	9	49	15	25	6	9	33	**251**
		99.20%	6	2	21	25	22	6	36	11	18	5	7	24	**182**
		99.50%	4	1	13	15	13	4	22	7	12	3	4	15	**114**
Collisions after applying large array correction		98.00%	15	6	53	61	54	16	90	27	46	11	16	60	**456**
		98.70%	10	4	34	40	35	10	58	17	30	7	11	39	**296**
		98.90%	8	3	29	34	30	9	49	15	25	6	9	33	**251**
		99.10%	7	3	24	28	24	7	40	12	21	5	7	27	**205**

Figure 1.9: Overall collision risk spreadsheet from the Band (2012) CRM for kittiwake using the Applicant's interpretation of Natural England's position (using mean estimates for density and flight height distribution and a nocturnal activity of 2)

COLLISION RISK ASSESSMENT
Sheet 1 – Input data

used in overall collision risk sheet
used in migrant collision risk sheet
used in single transit collision risk sheet or extended model
used in available hours sheet
used in large array correction sheet
not used in calculation but stated for reference

	Units	Value
Bird data		
Species name		LBBG
Bird length	m	0.58
Wingspan	m	1.42
Flight speed	m/sec	13.1
Nocturnal activity factor (1-5)		2
Flight type, flapping or gliding		flapping

Bird survey data			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daytime bird density	birds/sq km	Mean	0	0	0	0.0206	0.0081	0.2138	0.1361	0.041	0	0	0	0
Proportion at rotor height	%	9.8%												
Proportion of flights upwind	%	50.0%												

Birds on migration data		
Migration passages	birds	
Width of migration corridor	km	
Proportion at rotor height	%	
Proportion of flights upwind	%	

	Units	Value
Windfarm data		
Name of windfarm site		Hornsea P3
Latitude	degrees	53.87
Number of turbines		300
Width of windfarm	km	36
Tidal offset	m	1.8

	Units	Value	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Turbine data														
Turbine model		8 MW												
No of blades		3												
Rotation speed	rpm	8.1												
Rotor radius	m	97.5												
Hub height	m	128.87												
Monthly proportion of time operational	%		92.50%	92.61%	92.14%	90.96%	90.71%	89.36%	89.18%	89.86%	91.29%	92.57%	92.59%	92.61%
Max blade width	m	6.000												
Pitch	degrees	4.3												

Avoidance rates used in presenting results	**Data sources (if applicable)**
98.00%	
99.40%	
99.50%	
99.60%	
98.00%	
98.70%	
98.90%	
99.10%	

Figure 1.10: Input data spreadsheet from the Band (2012) CRM for lesser black-backed gull using the Applicant's interpretation of Natural England's position (using mean estimates for density and flight height distribution and a nocturnal activity of 2)

COLLISION RISK ASSESSMENT
Sheet 2 – Overall collision risk

All data input on Sheet 1:
no data entry needed on this sheet!

from Sheet 1 – input data
from Sheet 6 – available hours
from Sheet 3 – single transit collision risk
from survey data
calculated field

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year average
Bird details:															
Species		LBBG													
Flight speed	m/sec	13.1													
Nocturnal activity factor (1-5)		2													
Nocturnal activity (% of daytime)		25%													
Windfarm data:															
Latitude	degrees	53.9													
Number of turbines		300													
Rotor radius	m	97.5													
Minimum height of rotor	m	128.87													
Total rotor frontal area	sq m	8959430													
Proportion of time operational	%		93%	93%	92%	91%	91%	89%	89%	90%	91%	93%	93%	93%	91.4%
Stage A – flight activity															
Daytime areal bird density	birds/sq km		0.00	0.00	0.00	0.02	0.01	0.21	0.14	0.04	0.00	0.00	0.00	0.00	
Proportion at rotor height	%	9.8%													
Total daylight hours per month	hrs		249	272	366	420	494	510	513	461	383	329	259	233	
Total night hours per month	hrs		495	400	378	300	250	210	231	283	337	415	461	511	
Flux factor			0	0	0	22085	9780	260661	168350	47204	0	0	0	0	
Option 1 –Basic model – Stages B, C and D															**per annum**
Potential bird transits through rotors			0	0	0	2155	954	25430	16424	4605	0	0	0	0	**49569**
Collision risk for single rotor transit	(from sheet 3)	5.8%													
Collisions for entire windfarm, allowing for non-op time, assuming no avoidance	birds per month or year		**0**	**0**	**0**	**114**	**50**	**1319**	**850**	**240**	**0**	**0**	**0**	**0**	**2574**
Option 2–Basic model using proportion from flight distribution			**0**	**0**	**0**	**139**	**61**	**1609**	**1037**	**293**	**0**	**0**	**0**	**0**	**3140**
Option 3–Extended model using flight height distribution		LBBG_MLS													
Proportion at rotor height	(from sheet 4)	11.9%													
Potential bird transits through rotors	Flux integral	0.0672	0	0	0	1485	657	17523	11317	3173	0	0	0	0	**34156**
Collisions assuming no avoidance	Collision integral	0.00210	**0**	**0**	**0**	**42**	**19**	**489**	**315**	**89**	**0**	**0**	**0**	**0**	**954**
Average collision risk for single rotor transit		3.1%													
Stage E – applying avoidance rates															
Using which of above options?	**Option 2**	0.00%	0	0	0	139	61	1609	1037	293	0	0	0	0	**3140**
Collisions assuming avoidance rate	birds per month or year	98.00%	0	0	0	3	1	32	21	6	0	0	0	0	**63**
		99.40%	0	0	0	1	0	10	6	2	0	0	0	0	**19**
		99.50%	0	0	0	1	0	8	5	1	0	0	0	0	**16**
		99.60%	0	0	0	1	0	6	4	1	0	0	0	0	**13**
		98.00%	0	0	0	3	1	32	21	6	0	0	0	0	**63**
		98.70%	0	0	0	2	1	21	13	4	0	0	0	0	**41**
		98.90%	0	0	0	2	1	18	11	3	0	0	0	0	**35**
		99.10%	0	0	0	1	1	14	9	3	0	0	0	0	**28**
Collisions after applying large array correction		98.00%	0	0	0	3	1	32	21	6	0	0	0	0	**63**
		99.40%	0	0	0	1	0	10	6	2	0	0	0	0	**19**
		99.50%	0	0	0	1	0	8	5	1	0	0	0	0	**16**
		99.60%	0	0	0	1	0	6	4	1	0	0	0	0	**13**

Figure 1.11: Overall collision risk spreadsheet from the Band (2012) CRM for lesser black-backed gull using the Applicant's interpretation of Natural England's position (using mean estimates for density and flight height distribution and a nocturnal activity of 2)

COLLISION RISK ASSESSMENT
Sheet 1 - Input data

used in overall collision risk sheet
used in migrant collision risk sheet
used in single transit collision risk sheet or extended model
used in available hours sheet
used in large array correction sheet
not used in calculation but stated for reference

	Units	Value
Bird data		
Species name		HG
Bird length	m	0.60
Wingspan	m	1.44
Flight speed	m/sec	12.8
Nocturnal activity factor (1-5)		2
Flight type, flapping or gliding		flapping

Bird survey data			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daytime bird density	birds/sq km	Mean	0	0.04	0	0	0	0.01	0.01	0	0.055	0	0	0.1
Proportion at rotor height	%	10.5%												
Proportion of flights upwind	%	50.0%												

Birds on migration data		
Migration passages	birds	
Width of migration corridor	km	
Proportion at rotor height	%	
Proportion of flights upwind	%	

	Units	Value
Windfarm data		
Name of windfarm site		Hornsea P3
Latitude	degrees	53.87
Number of turbines		300
Width of windfarm	km	36
Tidal offset	m	1.8

	Units	Value	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Turbine data														
Turbine model		8 MW												
No of blades		3												
Rotation speed	rpm	8.1												
Rotor radius	m	97.5												
Hub height	m	128.87												
Monthly proportion of time operational	%		92.50%	92.61%	92.14%	90.96%	90.71%	89.36%	89.18%	89.86%	91.29%	92.57%	92.59%	92.61%
Max blade width	m	6.000												
Pitch	degrees	4.3												

Avoidance rates used in presenting results	**Data sources (if applicable)**
98.00%	
99.40%	
99.50%	
99.60%	
98.00%	
98.80%	
99.00%	
99.20%	

Figure 1.12: Input data spreadsheet from the Band (2012) CRM for herring gull using the Applicant's interpretation of Natural England's position using mean estimates for density and flight height distribution and a (nocturnal activity of 2)

COLLISION RISK ASSESSMENT
Sheet 2 – Overall collision risk

All data input on Sheet 1:
no data entry needed on this sheet!

from Sheet 1 – input data
from Sheet 6 – available hours
from Sheet 3 – single transit collision risk
from survey data
calculated field

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year average
Bird details:															
Species		HG													
Flight speed	m/sec	12.8													
Nocturnal activity factor (1-5)		2													
Nocturnal activity (% of daytime)		25%													
Windfarm data:															
Latitude	degrees	53.9													
Number of turbines		300													
Rotor radius	m	97.5													
Minimum height of rotor	m	128.87													
Total rotor frontal area	sq m	8959430													
Proportion of time operational	%		93%	93%	92%	91%	91%	89%	89%	90%	91%	93%	93%	93%	91.4%
Stage A – flight activity															
Daytime areal bird density	birds/sq km		0.00	0.04	0.00	0.00	0.00	0.01	0.01	0.00	0.06	0.00	0.00	0.10	
Proportion at rotor height	%	10.5%													
Total daylight hours per month	hrs		249	272	366	420	494	510	513	461	383	329	259	233	
Total night hours per month	hrs		495	400	378	300	250	210	231	283	337	415	461	511	
Flux factor			0	31535	0	0	0	11914	12083	0	54407	0	0	76361	
Option 1 -Basic model – Stages B, C and D															per annum
Potential bird transits through rotors			0	3313	0	0	0	1252	1269	0	5716	0	0	8022	19572
Collision risk for single rotor transit	(from sheet 3)	5.3%													
Collisions for entire windfarm, allowing for non-op time, assuming no avoidance	birds per month or year		**0**	**181**	**0**	**0**	**0**	**66**	**67**	**0**	**308**	**0**	**0**	**439**	**1061**
Option 2-Basic model using proportion from flight distribution			**0**	**253**	**0**	**0**	**0**	**92**	**93**	**0**	**430**	**0**	**0**	**612**	**1480**
Option 3-Extended model using flight height distribution		HG_MLS													
Proportion at rotor height	(from sheet 4)	14.7%													
Potential bird transits through rotors	Flux integral	0.0870	0	2744	0	0	0	1037	1052	0	4735	0	0	6645	**16213**
Collisions assuming no avoidance	Collision integral	0.00291	**0**	**85**	**0**	**0**	**0**	**31**	**31**	**0**	**145**	**0**	**0**	**206**	**498**
Average collision risk for single rotor transit		3.3%													
Stage E – applying avoidance rates															
Using which of above options?	**Option 2**	0.00%	0	253	0	0	0	92	93	0	430	0	0	612	**868**
	birds per month														
Collisions assuming avoidance rate	or year	98.00%	0	5	0	0	0	2	2	0	9	0	0	12	**17**
		99.40%	0.00	1.52	0.00	0.00	0.00	0.55	0.56	0.00	2.58	0.00	0.00	3.67	**5**
		99.50%	0.00	1.26	0.00	0.00	0.00	0.46	0.47	0.00	2.15	0.00	0.00	3.06	**4**
		99.60%	0.00	1.01	0.00	0.00	0.00	0.37	0.37	0.00	1.72	0.00	0.00	2.45	**3**
		98.00%	0.00	5.06	0.00	0.00	0.00	1.84	1.87	0.00	8.60	0.00	0.00	12.24	**17**
		98.80%	0.00	3.03	0.00	0.00	0.00	1.11	1.12	0.00	5.16	0.00	0.00	7.35	**10**
		99.00%	0.00	2.53	0.00	0.00	0.00	0.92	0.93	0.00	4.30	0.00	0.00	6.12	**9**
		99.20%	0.00	2.02	0.00	0.00	0.00	0.74	0.75	0.00	3.44	0.00	0.00	4.90	**7**
Collisions after applying large array correction		98.00%	0	5	0	0	0	2	2	0	9	0	0	12	**17**
		99.40%	0	2	0	0	0	1	1	0	3	0	0	4	**5**
		99.50%	0	1	0	0	0	0	0	0	2	0	0	3	**4**
		99.60%	0	1	0	0	0	0	0	0	2	0	0	2	**3**

Figure 1.13: Overall collision risk spreadsheet from the Band (2012) CRM for herring gull using the Applicant's interpretation of Natural England's position (using mean estimates for density and flight height distribution and a nocturnal activity of 2)

COLLISION RISK ASSESSMENT
Sheet 1 – Input data

used in overall collision risk sheet
used in migrant collision risk sheet
used in single transit collision risk sheet or extended model
used in available hours sheet
used in large array correction sheet
not used in calculation but stated for reference

	Units	Value
Bird data		
Species name		GBBG
Bird length	m	0.71
Wingspan	m	1.58
Flight speed	m/sec	13.7
Nocturnal activity factor (1-5)		2
Flight type, flapping or gliding		flapping

Bird survey data			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daytime bird density	birds/sq km	Mean	0.1325	0.0368	0.034	0.0081	0	0.0203	0.2451	0.0248	0.0943	0.0807	0.1503	0.4572
Proportion at rotor height	%	7.3%												
Proportion of flights upwind	%	50.0%												

Birds on migration data		
Migration passages	birds	
Width of migration corridor	km	
Proportion at rotor height	%	
Proportion of flights upwind	%	

	Units	Value
Windfarm data		
Name of windfarm site		Hornsea P3
Latitude	degrees	53.87
Number of turbines		300
Width of windfarm	km	36
Tidal offset	m	1.8

	Units	Value	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Turbine data														
Turbine model		8 MW												
No of blades		3												
Rotation speed	rpm	8.1												
Rotor radius	m	97.5												
Hub height	m	128.87												
Monthly proportion of time operational	%		92.50%	92.61%	92.14%	90.96%	90.71%	89.36%	89.18%	89.86%	91.29%	92.57%	92.59%	92.61%
Max blade width	m	6.000												
Pitch	degrees	4.3												

Avoidance rates used in presenting results	**Data sources (if applicable)**
98.00%	
99.40%	
99.50%	
99.60%	
98.00%	
98.70%	
98.90%	
99.10%	

Figure 1.14: Input data spreadsheet from the Band (2012) CRM for great black-backed gull using the Applicant's interpretation of Natural England's position (using mean estimates for density and flight height distribution and a nocturnal activity of 2)

COLLISION RISK ASSESSMENT
Sheet 2 – Overall collision risk

All data input on Sheet 1:
no data entry needed on this sheet!

from Sheet 1 – input data
from Sheet 6 – available hours
from Sheet 3 – single transit collision risk
from survey data
calculated field

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year average
Bird details:															
Species		GBBG													
Flight speed	m/sec	13.7													
Nocturnal activity factor (1-5)		2													
Nocturnal activity (% of daytime)		25%													
Windfarm data:															
Latitude	degrees	53.9													
Number of turbines		300													
Rotor radius	m	97.5													
Minimum height of rotor	m	128.87													
Total rotor frontal area	sq m	8959430													
Proportion of time operational	%		93%	93%	92%	91%	91%	89%	89%	90%	91%	93%	93%	93%	91.4%
Stage A – flight activity															
Daytime areal bird density	birds/sq km		0.13	0.04	0.03	0.01	0.00	0.02	0.25	0.02	0.09	0.08	0.15	0.46	
Proportion at rotor height	%	7.3%													
Total daylight hours per month	hrs		249	272	366	420	494	510	513	461	383	329	259	233	
Total night hours per month	hrs		495	400	378	300	250	210	231	283	337	415	461	511	
Flux factor			111959	31022	35452	9123	0	25861	316950	29812	99853	79112	127470	373662	
Option 1 –Basic model – Stages B, C and D															**per annum**
Potential bird transits through rotors			8223	2278	2604	670	0	1899	23279	2190	7334	5810	9362	27444	**91094**
Collision risk for single rotor transit	(from sheet 3)	6.1%													
Collisions for entire windfarm, allowing for non-op time, assuming no avoidance	birds per month or year		**466**	**129**	**147**	**37**	**0**	**104**	**1271**	**120**	**410**	**329**	**531**	**1556**	**5101**
Option 2–Basic model using proportion from flight distribution			**968**	**269**	**305**	**78**	**0**	**216**	**2643**	**251**	**852**	**685**	**1104**	**3236**	**10608**
Option 3–Extended model using flight height distribution		GBBG_MLS													
Proportion at rotor height	(from sheet 4)	15.3%													
Potential bird transits through rotors	Flux integral	0.0927	10383	2877	3288	846	0	2398	29394	2765	9260	7337	11822	34654	**115024**
Collisions assuming no avoidance	Collision integral	0.00337	**349**	**97**	**110**	**28**	**0**	**78**	**953**	**90**	**307**	**247**	**398**	**1167**	**3826**
Average collision risk for single rotor transit		3.6%													
Stage E – applying avoidance rates															
Using which of above options?	**Option 2**	0.00%	968	269	305	78	0	216	2643	251	852	685	1104	3236	**7371**
Collisions assuming avoidance rate	birds per month or year	98.00%	19	5	6	2	0	4	53	5	17	14	22	65	**212**
		99.40%	5.81	1.61	1.83	0.47	0.00	1.30	15.86	1.50	5.11	4.11	6.62	19.42	**64**
		99.50%	4.84	1.34	1.53	0.39	0.00	1.08	13.22	1.25	4.26	3.42	5.52	16.18	**53**
		99.60%	3.87	1.07	1.22	0.31	0.00	0.86	10.57	1.00	3.41	2.74	4.41	12.94	**42**
		98.00%	19.37	5.37	6.11	1.55	0.00	4.32	52.87	5.01	17.05	13.70	22.07	64.72	**212**
		98.70%	12.59	3.49	3.97	1.01	0.00	2.81	34.36	3.26	11.08	8.90	14.35	42.07	**138**
		98.90%	10.65	2.96	3.36	0.85	0.00	2.38	29.08	2.76	9.38	7.53	12.14	35.60	**117**
		99.10%	8.72	2.42	2.75	0.70	0.00	1.95	23.79	2.25	7.67	6.16	9.93	29.13	**95**
Collisions after applying large array correction		98.00%	19	5	6	2	0	4	53	5	17	14	22	65	**212**
		99.40%	6	2	2	0	0	1	16	2	5	4	7	19	**64**
		99.50%	5	1	2	0	0	1	13	1	4	3	6	16	**53**
		99.60%	4	1	1	0	0	1	11	1	3	3	4	13	**42**

Figure 1.15: Overall collision risk spreadsheet from the Band (2012) CRM for great black-backed gull using the Applicant's interpretation of Natural England's position (using mean estimates for density and flight height distribution and a nocturnal activity of 2)

Collision risk models – Applicant's position

COLLISION RISK ASSESSMENT
Sheet 1 - Input data

used in overall collision risk sheet
used in migrant collision risk sheet
used in single transit collision risk sheet or extended model
used in available hours sheet
used in large array correction sheet
not used in calculation but stated for reference

	Units	Value	
Bird data			
Species name		Gannet	
Bird length	m	0.94	
Wingspan	m	1.72	
Flight speed	m/sec	13.3	
Nocturnal activity factor (1-5)			Input in Overall collision risk spreadsheet
Flight type, flapping or gliding		flapping	

Bird survey data			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daytime bird density	birds/sq km	Mean	0.01644		0	0.08267	0.09267	0.01651	0.05428	0.24966	0.34477	0.15823	0.42569	0.11585	0.59
Proportion at rotor height	%	1.4%													
Proportion of flights upwind	%	50.0%													

Birds on migration data		
Migration passages	birds	
Width of migration corridor	km	
Proportion at rotor height	%	
Proportion of flights upwind	%	

	Units	Value
Windfarm data		
Name of windfarm site		Hornsea P3
Latitude	degrees	53.87
Number of turbines		300
Width of windfarm	km	36
Tidal offset	m	1.8

	Units	Value	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Turbine data														
Turbine model		8 MW												
No of blades		3												
Rotation speed	rpm	8.1												
Rotor radius	m	97.5												
Hub height	m	128.87												
Monthly proportion of time operational	%		92.50%	92.61%	92.14%	90.96%	90.71%	89.36%	89.18%	89.86%	91.29%	92.57%	92.59%	92.61%
Max blade width	m	6.000												
Pitch	degrees	4.3												

Avoidance rates used in presenting results	**Data sources (if applicable)**
98.70%	
98.90%	
99.10%	
99.50%	

Figure 1.16: Input data spreadsheet from the Band (2012) CRM for gannet using the Applicant's position (using mean estimates for density and PCH)

COLLISION RISK ASSESSMENT
Sheet 2 – Overall collision risk

All data input on Sheet 1:
no data entry needed on this sheet!

from Sheet 1 – input data
from Sheet 6 – available hours
from Sheet 3 – single transit collision risk
from survey data
calculated field

Bird details:

			Nocturnal activity factor	
Species		Gannet	Breeding	Non-breeding
Flight speed	m/sec	13.3	1.32	1.12
Nocturnal activity factor (1-5)		1.12		
Nocturnal activity (% of daytime)		3%		

Windfarm data:

Latitude	degrees	53.9
Number of turbines		300
Rotor radius	m	97.5
Minimum height of rotor	m	128.87
Total rotor frontal area	sq m	8959430

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year average
Proportion of time operational	%		93%	93%	92%	91%	91%	89%	89%	90%	91%	93%	93%	93%	91.4%
Stage A – flight activity															
Daytime areal bird density	birds/sq km		0.02	0.00	0.08	0.09	0.02	0.05	0.25	0.34	0.16	0.43	0.12	0.59	
Proportion at rotor height	%	1.4%													
Total daylight hours per month	hrs		249	272	366	420	494	510	513	461	383	329	259	233	
Total night hours per month	hrs		495	400	378	300	250	210	231	283	337	415	461	511	
Flux factor			9567	0	68814	87582	18239	61822	286165	356571	137141	320384	69718	322912	
Option 1 –Basic model – Stages B, C and D															**per annum**
Potential bird transits through rotors			135	0	969	1234	257	871	4030	5022	1932	4512	982	4548	**24492**
Collision risk for single rotor transit	(from sheet 3)	6.8%													
Collisions for entire windfarm, allowing for non-op time, assuming no avoidance	birds per month or year		**9**	**0**	**61**	**77**	**16**	**53**	**246**	**309**	**121**	**286**	**62**	**288**	**1527**
Option 2–Basic model using proportion from flight distribution			**19**	**0**	**134**	**168**	**35**	**117**	**539**	**677**	**265**	**627**	**136**	**632**	**3349**
Option 3–Extended model using flight height distribution		Gannet_MLS													
Proportion at rotor height	(from sheet 4)	3.1%													
Potential bird transits through rotors	Flux integral	0.0133	127	0	914	1163	242	821	3800	4735	1821	4254	926	4288	**23091**
Collisions assuming no avoidance	Collision integral	0.00050	**4**	**0**	**32**	**40**	**8**	**28**	**128**	**161**	**63**	**149**	**32**	**151**	**798**
Average collision risk for single rotor transit		3.8%													
Stage E – applying avoidance rates															
Using which of above options?	**Option 1**	0.00%	9	0	61	77	16	53	246	309	121	286	62	288	**1527**
Collisions assuming avoidance rate	birds per month or year	98.70%	0	0	1	1	0	1	3	4	2	4	1	4	**20**
		98.90%	0	0	1	1	0	1	3	3	1	3	1	3	**17**
		99.10%	0	0	1	1	0	0	2	3	1	3	1	3	**14**
		99.50%	0	0	0	0	0	0	1	2	1	1	0	1	**8**
Collisions after applying large array correction		98.70%	0	0	1	1	0	1	3	4	2	4	1	4	**20**
		98.90%	0	0	1	1	0	1	3	3	1	3	1	3	**17**
		99.10%	0	0	1	1	0	0	2	3	1	3	1	3	**14**
		99.50%	0	0	0	0	0	0	1	2	1	1	0	1	**8**

Figure 1.17: Overall collision risk spreadsheet from the Band (2012) CRM for gannet using the Applicant's position (using mean estimates for density and PCH)

COLLISION RISK ASSESSMENT
Sheet 1 – Input data

used in overall collision risk sheet
used in migrant collision risk sheet
used in single transit collision risk sheet or extended model
used in available hours sheet
used in large array correction sheet
not used in calculation but stated for reference

	Units	Value	
Bird data			
Species name		**Kittiwake**	
Bird length	m	0.39	
Wingspan	m	1.08	
Flight speed	m/sec	8.7	
Nocturnal activity factor (1-5)			Input in Overall collision risk spreadsheet
Flight type, flapping or gliding		flapping	

Bird survey data			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daytime bird density	birds/sq km	Mean	0.4661	0.1835	1.3449	1.4746	1.1519	0.3378	1.9064	0.6002	1.1687	0.3098	0.5086	1.9532
Proportion at rotor height	%	0.8%												
Proportion of flights upwind	%	50.0%												

Birds on migration data		
Migration passages	birds	
Width of migration corridor	km	
Proportion at rotor height	%	
Proportion of flights upwind	%	

	Units	Value
Windfarm data		
Name of windfarm site		**Hornsea P3**
Latitude	degrees	53.87
Number of turbines		300
Width of windfarm	km	36
Tidal offset	m	1.8

	Units	Value												
Turbine data														
Turbine model		**8 MW**												
No of blades		3												
Rotation speed	rpm	8.1												
Rotor radius	m	97.5												
Hub height	m	128.87	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly proportion of time operational	%		92.50%	92.61%	92.14%	90.96%	90.71%	89.36%	89.18%	89.86%	91.29%	92.57%	92.59%	92.61%
Max blade width	m	6.000												
Pitch	degrees	4.3												

Avoidance rates used in presenting results	**Data sources (if applicable)**
98.70%	
98.90%	
99.10%	
98.90%	
99.20%	
99.50%	
99.00%	

Figure 1.18: Input data spreadsheet from the Band (2012) CRM for kittiwake using the Applicant's position (using mean estimates for density and PCH)

COLLISION RISK ASSESSMENT
Sheet 2 - Overall collision risk

All data input on Sheet 1:
no data entry needed on this sheet!

from Sheet 1 - input data
from Sheet 6 - available hours
from Sheet 3 - single transit collision risk
from survey data
calculated field

Bird details:

			Nocturnal activity factors	
Species		Kittiwake	Breeding	Non-breeding
Flight speed	m/sec	8.7	1.8	1.68
Nocturnal activity factor (1-5)		1.68		
Nocturnal activity (% of daytime)		17%		

Windfarm data:

Latitude	degrees	53.9
Number of turbines		300
Rotor radius	m	97.5
Minimum height of rotor	m	128.87
Total rotor frontal area	sq m	8959430

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year average
Proportion of time operational	%		93%	93%	92%	91%	91%	89%	89%	90%	91%	93%	93%	93%	91.4%
Stage A - flight activity															
Daytime areal bird density	birds/sq km		0.47	0.18	1.34	1.47	1.15	0.34	1.91	0.60	1.17	0.31	0.51	1.95	
Proportion at rotor height	%	0.8%													
Total daylight hours per month	hrs		249	272	366	420	494	510	513	461	383	329	259	233	
Total night hours per month	hrs		495	400	378	300	250	210	231	283	337	415	461	511	
Flux factor			223803	89998	833950	999931	889887	265675	1516701	439884	741276	178297	247291	899846	
Option 1 -Basic model - Stages B, C and D															**per annum**
Potential bird transits through rotors			1755	706	6541	7843	6980	2084	11896	3450	5814	1398	1940	7058	**57463**
Collision risk for single rotor transit	(from sheet 3)	5.7%													
Collisions for entire windfarm, allowing for non-op time, assuming no avoidance	birds per month or year		**93**	**37**	**345**	**408**	**362**	**106**	**607**	**177**	**304**	**74**	**103**	**374**	**2989**
Option 2-Basic model using proportion from flight distribution			**488**	**197**	**1812**	**2144**	**1903**	**560**	**3189**	**932**	**1595**	**389**	**540**	**1965**	**15714**
Option 3-Extended model using flight height distribution		Kittiwake_MLS													
Proportion at rotor height	(from sheet 4)	4.1%													
Potential bird transits through rotors	Flux integral	0.0187	4180	1681	15574	18674	16619	4962	28325	8215	13844	3330	4618	16805	**136826**
Collisions assuming no avoidance	Collision integral	0.00052	**108**	**44**	**402**	**476**	**422**	**124**	**707**	**207**	**354**	**86**	**120**	**436**	**3485**
Average collision risk for single rotor transit		2.8%													
Stage E - applying avoidance rates															
Using which of above options?	**Option 1**	0.00%	93	37	345	408	362	106	607	177	304	74	103	374	**2989**
	birds per month														
Collisions assuming avoidance rate	or year	98.70%	1	0	4	5	5	1	8	2	4	1	1	5	**39**
		98.90%	1	0	4	4	4	1	7	2	3	1	1	4	**33**
		99.10%	1	0	3	4	3	1	5	2	3	1	1	3	**27**
		98.90%	1	0	4	4	4	1	7	2	3	1	1	4	**33**
		99.20%	1	0	3	3	3	1	5	1	2	1	1	3	**24**
		99.50%	0	0	2	2	2	1	3	1	2	0	1	2	**15**
		99.00%	1	0	3	4	4	1	6	2	3	1	1	4	**30**
Collisions after applying large array correction		98.70%	1	0	4	5	5	1	8	2	4	1	1	5	**39**
		98.90%	1	0	4	4	4	1	7	2	3	1	1	4	**33**
		99.10%	1	0	3	4	3	1	5	2	3	1	1	3	**27**
		98.90%	1	0	4	4	4	1	7	2	3	1	1	4	**33**

Figure 1.19: Overall collision risk spreadsheet from the Band (2012) CRM for kittiwake using the Applicant's position (using mean estimates for density and PCH)

COLLISION RISK ASSESSMENT
Sheet 1 – Input data

used in overall collision risk sheet
used in migrant collision risk sheet
used in single transit collision risk sheet or extended model
used in available hours sheet
used in large array correction sheet
not used in calculation but stated for reference

	Units	Value
Bird data		
Species name		LBBG
Bird length	m	0.58
Wingspan	m	1.42
Flight speed	m/sec	9.8
Nocturnal activity factor (1-5)		3
Flight type, flapping or gliding		flapping

Bird survey data			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daytime bird density	birds/sq km	Mean	0	0	0	0.0206	0.0081	0.2138	0.1361	0.041	0	0	0	0
Proportion at rotor height	%	9.8%												
Proportion of flights upwind	%	50.0%												

Birds on migration data		
Migration passages	birds	
Width of migration corridor	km	
Proportion at rotor height	%	
Proportion of flights upwind	%	

	Units	Value
Windfarm data		
Name of windfarm site		Hornsea P3
Latitude	degrees	53.87
Number of turbines		300
Width of windfarm	km	36
Tidal offset	m	1.8

	Units	Value	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Turbine data														
Turbine model		8 MW												
No of blades		3												
Rotation speed	rpm	8.1												
Rotor radius	m	97.5												
Hub height	m	128.87												
Monthly proportion of time operational	%		92.50%	92.61%	92.14%	90.96%	90.71%	89.36%	89.18%	89.86%	91.29%	92.57%	92.59%	92.61%
Max blade width	m	6.000												
Pitch	degrees	4.3												

Avoidance rates used in presenting results	**Data sources (if applicable)**
98.00%	
99.40%	
99.50%	
99.60%	
98.00%	
98.70%	
98.90%	
99.10%	

Figure 1.20: Input data spreadsheet from the Band (2012) CRM for lesser black-backed gull using the Applicant's position (using mean estimates for density and PCH)

COLLISION RISK ASSESSMENT
Sheet 2 – Overall collision risk

All data input on Sheet 1:
no data entry needed on this sheet!

from Sheet 1 - input data
from Sheet 6 - available hours
from Sheet 3 - single transit collision risk
from survey data
calculated field

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year average
Bird details:															
Species		LBBG													
Flight speed	m/sec	9.8													
Nocturnal activity factor (1-5)		3													
Nocturnal activity (% of daytime)		50%													
Windfarm data:															
Latitude	degrees	53.9													
Number of turbines		300													
Rotor radius	m	97.5													
Minimum height of rotor	m	128.87													
Total rotor frontal area	sq m	8959430													
Proportion of time operational	%		93%	93%	92%	91%	91%	89%	89%	90%	91%	93%	93%	93%	91.4%
Stage A – flight activity															
Daytime areal bird density	birds/sq km		0.00	0.00	0.00	0.02	0.01	0.21	0.14	0.04	0.00	0.00	0.00	0.00	
Proportion at rotor height	%	9.8%													
Total daylight hours per month	hrs		249	272	366	420	494	510	513	461	383	329	259	233	
Total night hours per month	hrs		495	400	378	300	250	210	231	283	337	415	461	511	
Flux factor			0	0	0	19030	8139	213165	138689	40021	0	0	0	0	
Option 1 -Basic model – Stages B, C and D															**per annum**
Potential bird transits through rotors			0	0	0	1857	794	20797	13531	3905	0	0	0	0	**40882**
Collision risk for single rotor transit	(from sheet 3)	6.3%													
Collisions for entire windfarm, allowing for non-op time, assuming no avoidance	birds per month or year		**0**	**0**	**0**	**107**	**46**	**1179**	**765**	**223**	**0**	**0**	**0**	**0**	**2319**
Option 2-Basic model using proportion from flight distribution			**0**	**0**	**0**	**131**	**56**	**1438**	**933**	**271**	**0**	**0**	**0**	**0**	**2829**
Option 3-Extended model using flight height distribution		LBBG_MLS													
Proportion at rotor height	(from sheet 4)	11.9%													
Potential bird transits through rotors	Flux integral	0.0672	0	0	0	1279	547	14330	9323	2690	0	0	0	0	**28170**
Collisions assuming no avoidance	Collision integral	0.00250	**0**	**0**	**0**	**43**	**18**	**477**	**310**	**90**	**0**	**0**	**0**	**0**	**938**
Average collision risk for single rotor transit		3.7%													
Stage E – applying avoidance rates															
Using which of above options?	**Option 1**	0.00%	0	0	0	107	46	1179	765	223	0	0	0	0	**2319**
Collisions assuming avoidance rate	birds per month or year	98.00%	0	0	0	2	1	24	15	4	0	0	0	0	**46**
		99.40%	0	0	0	1	0	7	5	1	0	0	0	0	**14**
		99.50%	0	0	0	1	0	6	4	1	0	0	0	0	**12**
		99.60%	0	0	0	0	0	5	3	1	0	0	0	0	**9**
		98.00%	0	0	0	2	1	24	15	4	0	0	0	0	**46**
		98.70%	0	0	0	1	1	15	10	3	0	0	0	0	**30**
		98.90%	0	0	0	1	1	13	8	2	0	0	0	0	**26**
		99.10%	0	0	0	1	0	11	7	2	0	0	0	0	**21**
Collisions after applying large array correction		98.00%	0	0	0	2	1	24	15	4	0	0	0	0	**46**
		99.40%	0	0	0	1	0	7	5	1	0	0	0	0	**14**
		99.50%	0	0	0	1	0	6	4	1	0	0	0	0	**12**
		99.60%	0	0	0	0	0	5	3	1	0	0	0	0	**9**

Figure 1.21: Overall collision risk spreadsheet from the Band (2012) CRM for lesser black-backed gull using the Applicant's position (using mean estimates for density and PCH)

COLLISION RISK ASSESSMENT
Sheet 1 – Input data

used in overall collision risk sheet
used in migrant collision risk sheet
used in single transit collision risk sheet or extended model
used in available hours sheet
used in large array correction sheet
not used in calculation but stated for reference

	Units	Value
Bird data		
Species name		HG
Bird length	m	0.60
Wingspan	m	1.44
Flight speed	m/sec	9.8
Nocturnal activity factor (1-5)		3
Flight type, flapping or gliding		flapping

Bird survey data			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daytime bird density	birds/sq km	Mean	0	0.04	0	0	0	0.01	0.01	0	0.055	0	0	0.1
Proportion at rotor height	%	10.5%												
Proportion of flights upwind	%	50.0%												

Birds on migration data		
Migration passages	birds	
Width of migration corridor	km	
Proportion at rotor height	%	
Proportion of flights upwind	%	

	Units	Value
Windfarm data		
Name of windfarm site		Hornsea P3
Latitude	degrees	53.87
Number of turbines		300
Width of windfarm	km	36
Tidal offset	m	1.8

	Units	Value	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Turbine data														
Turbine model		8 MW												
No of blades		3												
Rotation speed	rpm	8.1												
Rotor radius	m	97.5												
Hub height	m	128.87												
Monthly proportion of time operational	%		92.50%	92.61%	92.14%	90.96%	90.71%	89.36%	89.18%	89.86%	91.29%	92.57%	92.59%	92.61%
Max blade width	m	6.000												
Pitch	degrees	4.3												

Avoidance rates used in presenting results	**Data sources (if applicable)**
98.00%	
99.40%	
99.50%	
99.60%	
98.00%	
98.80%	
99.00%	
99.20%	

Figure 1.22: Input data spreadsheet from the Band (2012) CRM for herring gull using the Applicant's position (using mean estimates for density and PCH)

COLLISION RISK ASSESSMENT
Sheet 2 – Overall collision risk

All data input on Sheet 1:
no data entry needed on this sheet!

from Sheet 1 – input data
from Sheet 6 – available hours
from Sheet 3 – single transit collision risk
from survey data
calculated field

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year average
Bird details:															
Species		HG													
Flight speed	m/sec	9.8													
Nocturnal activity factor (1-5)		3													
Nocturnal activity (% of daytime)		50%													
Windfarm data:															
Latitude	degrees	53.9													
Number of turbines		300													
Rotor radius	m	97.5													
Minimum height of rotor	m	128.87													
Total rotor frontal area	sq m	8959430													
Proportion of time operational	%		93%	93%	92%	91%	91%	89%	89%	90%	91%	93%	93%	93%	91.4%
Stage A – flight activity															
Daytime areal bird density	birds/sq km		0	0.04	0	0	0	0.01	0.01	0	0.055	0	0	0.1	
Proportion at rotor height	%	10.5%													
Total daylight hours per month	hrs		249	272	366	420	494	510	513	461	383	329	259	233	
Total night hours per month	hrs		495	400	378	300	250	210	231	283	337	415	461	511	
Flux factor			0	30620	0	0	0	9371	10187	0	49167	0	0	79176	
Option 1 -Basic model – Stages B, C and D															**per annum**
Potential bird transits through rotors			0	3217	0	0	0	1048	1070	0	5165	0	0	8318	**18818**
Collision risk for single rotor transit	(from sheet 3)	6.4%													
Collisions for entire windfarm, allowing for non-op time, assuming no avoidance	birds per month or year		**0**	**191**	**0**	**0**	**0**	**60**	**61**	**0**	**303**	**0**	**0**	**495**	**1110**
Option 2-Basic model using proportion from flight distribution			**0**	**267**	**0**	**0**	**0**	**84**	**86**	**0**	**423**	**0**	**0**	**691**	**1550**
Option 3-Extended model using flight height distribution		HG_MLS													
Proportion at rotor height	(from sheet 4)	14.7%													
Potential bird transits through rotors	Flux integral	0.0870	0	2665	0	0	0	868	887	0	4279	0	0	6890	**15588**
Collisions assuming no avoidance	Collision integral	0.00341	**0**	**97**	**0**	**0**	**0**	**30**	**31**	**0**	**153**	**0**	**0**	**250**	**561**
Average collision risk for single rotor transit		3.9%													
Stage E – applying avoidance rates															
Using which of above options?	**Option 1**	0.00%	0	191	0	0	0	60	61	0	303	0	0	495	**616**
Collisions assuming avoidance rate	birds per month or year	98.00%	0	4	0	0	0	1	1	0	6	0	0	10	**12**
		99.40%	0	1	0	0	0	0	0	0	2	0	0	3	**4**
		99.50%	0	1	0	0	0	0	0	0	2	0	0	2	**3**
		99.60%	0	1	0	0	0	0	0	0	1	0	0	2	**2**
		98.00%	0	4	0	0	0	1	1	0	6	0	0	10	**12**
		98.80%	0	2	0	0	0	1	1	0	4	0	0	6	**7**
		99.00%	0	2	0	0	0	1	1	0	3	0	0	5	**6**
		99.20%	0	2	0	0	0	0	0	0	2	0	0	4	**5**
Collisions after applying large array correction		98.00%	0	4	0	0	0	1	1	0	6	0	0	10	**12**
		99.40%	0	1	0	0	0	0	0	0	2	0	0	3	**4**
		99.50%	0	1	0	0	0	0	0	0	2	0	0	2	**3**
		99.60%	0	1	0	0	0	0	0	0	1	0	0	2	**2**

Figure 1.23: Overall collision risk spreadsheet from the Band (2012) CRM for herring gull using the Applicant's position (using mean estimates for density and PCH)

COLLISION RISK ASSESSMENT
Sheet 1 – Input data

used in overall collision risk sheet
used in migrant collision risk sheet
used in single transit collision risk sheet or extended model
used in available hours sheet
used in large array correction sheet
not used in calculation but stated for reference

	Units	Value
Bird data		
Species name		GBBG
Bird length	m	0.71
Wingspan	m	1.58
Flight speed	m/sec	13.7
Nocturnal activity factor (1-5)		2
Flight type, flapping or gliding		flapping

Bird survey data			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daytime bird density	birds/sq km	Mean	0.1325	0.0368	0.034	0.0081	0	0.0203	0.2451	0.0248	0.0943	0.0807	0.1503	0.4572
Proportion at rotor height	%	7.3%												
Proportion of flights upwind	%	50.0%												

Birds on migration data		
Migration passages	birds	
Width of migration corridor	km	
Proportion at rotor height	%	
Proportion of flights upwind	%	

	Units	Value
Windfarm data		
Name of windfarm site		Hornsea P3
Latitude	degrees	53.87
Number of turbines		300
Width of windfarm	km	36
Tidal offset	m	1.8

	Units	Value	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Turbine data														
Turbine model		8 MW												
No of blades		3												
Rotation speed	rpm	8.1												
Rotor radius	m	97.5												
Hub height	m	128.87												
Monthly proportion of time operational	%		92.50%	92.61%	92.14%	90.96%	90.71%	89.36%	89.18%	89.86%	91.29%	92.57%	92.59%	92.61%
Max blade width	m	6.000												
Pitch	degrees	4.3												

Avoidance rates used in presenting results	**Data sources (if applicable)**
98.00%	
99.40%	
99.50%	
99.60%	
98.00%	
98.70%	
98.90%	
99.10%	

Figure 1.24: Input data spreadsheet from the Band (2012) CRM for great black-backed gull using the Applicant's position (using mean estimates for density and PCH)

COLLISION RISK ASSESSMENT
Sheet 2 – Overall collision risk

All data input on Sheet 1:
no data entry needed on this sheet!

from Sheet 1 – input data
from Sheet 6 – available hours
from Sheet 3 – single transit collision risk
from survey data
calculated field

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year average
Bird details:															
Species		GBBG													
Flight speed	m/sec	9.8													
Nocturnal activity factor (1-5)		3													
Nocturnal activity (% of daytime)		50%													
Windfarm data:															
Latitude	degrees	53.9													
Number of turbines		300													
Rotor radius	m	97.5													
Minimum height of rotor	m	128.87													
Total rotor frontal area	sq m	8959430													
Proportion of time operational	%		93%	93%	92%	91%	91%	89%	89%	90%	91%	93%	93%	93%	91.4%
Stage A – flight activity															
Daytime areal bird density	birds/sq km		0.13	0.04	0.03	0.01	0.00	0.02	0.25	0.02	0.09	0.08	0.15	0.46	
Proportion at rotor height	%	7.3%													
Total daylight hours per month	hrs		249	272	366	420	494	510	513	461	383	329	259	233	
Total night hours per month	hrs		495	400	378	300	250	210	231	283	337	415	461	511	
Flux factor			106657	28143	30560	7517	0	20223	249672	24169	84308	70164	119249	361985	
Option 1 -Basic model – Stages B, C and D															**per annum**
Potential bird transits through rotors			7834	2067	2245	552	0	1485	18338	1775	6192	5153	8758	26586	**80985**
Collision risk for single rotor transit	(from sheet 3)	6.3%													
Collisions for entire windfarm, allowing for non-op time, assuming no avoidance	birds per month or year		**498**	**132**	**142**	**35**	**0**	**91**	**1125**	**110**	**389**	**328**	**558**	**1693**	**5101**
Option 2-Basic model using proportion from flight distribution			**1036**	**274**	**296**	**72**	**0**	**190**	**2339**	**228**	**808**	**682**	**1160**	**3521**	**10606**
Option 3-Extended model using flight height distribution		GBBG_MLS													
Proportion at rotor height	(from sheet 4)	15.3%													
Potential bird transits through rotors	Flux integral	0.0927	9891	2610	2834	697	0	1875	23155	2241	7819	6507	11059	33571	**102260**
Collisions assuming no avoidance	Collision integral	0.00414	**408**	**108**	**117**	**28**	**0**	**75**	**922**	**90**	**319**	**269**	**457**	**1388**	**4180**
Average collision risk for single rotor transit		4.5%													
Stage E – applying avoidance rates															
Using which of above options?	**Option 1**	0.00%	498	132	142	35	0	91	1125	110	389	328	558	1693	**3407**
Collisions assuming avoidance rate	birds per month or year	98.00%	10	3	3	1	0	2	22	2	8	7	11	34	**102**
		99.40%	3	1	1	0	0	1	7	1	2	2	3	10	**31**
		99.50%	2	1	1	0	0	0	6	1	2	2	3	8	**26**
		99.60%	2	1	1	0	0	0	4	0	2	1	2	7	**20**
		98.00%	10	3	3	1	0	2	22	2	8	7	11	34	**102**
		98.70%	6	2	2	0	0	1	15	1	5	4	7	22	**66**
		98.90%	5	1	2	0	0	1	12	1	4	4	6	19	**56**
		99.10%	4	1	1	0	0	1	10	1	3	3	5	15	**46**
Collisions after applying large array correction		98.00%	10	3	3	1	0	2	22	2	8	7	11	34	**102**
		99.40%	3	1	1	0	0	1	7	1	2	2	3	10	**31**
		99.50%	2	1	1	0	0	0	6	1	2	2	3	8	**25**
		99.60%	2	1	1	0	0	0	4	0	2	1	2	7	**20**

Figure 1.25: Overall collision risk spreadsheet from the Band (2012) CRM for great black-backed gull using the Applicant's position (using mean estimates for density and PCH)