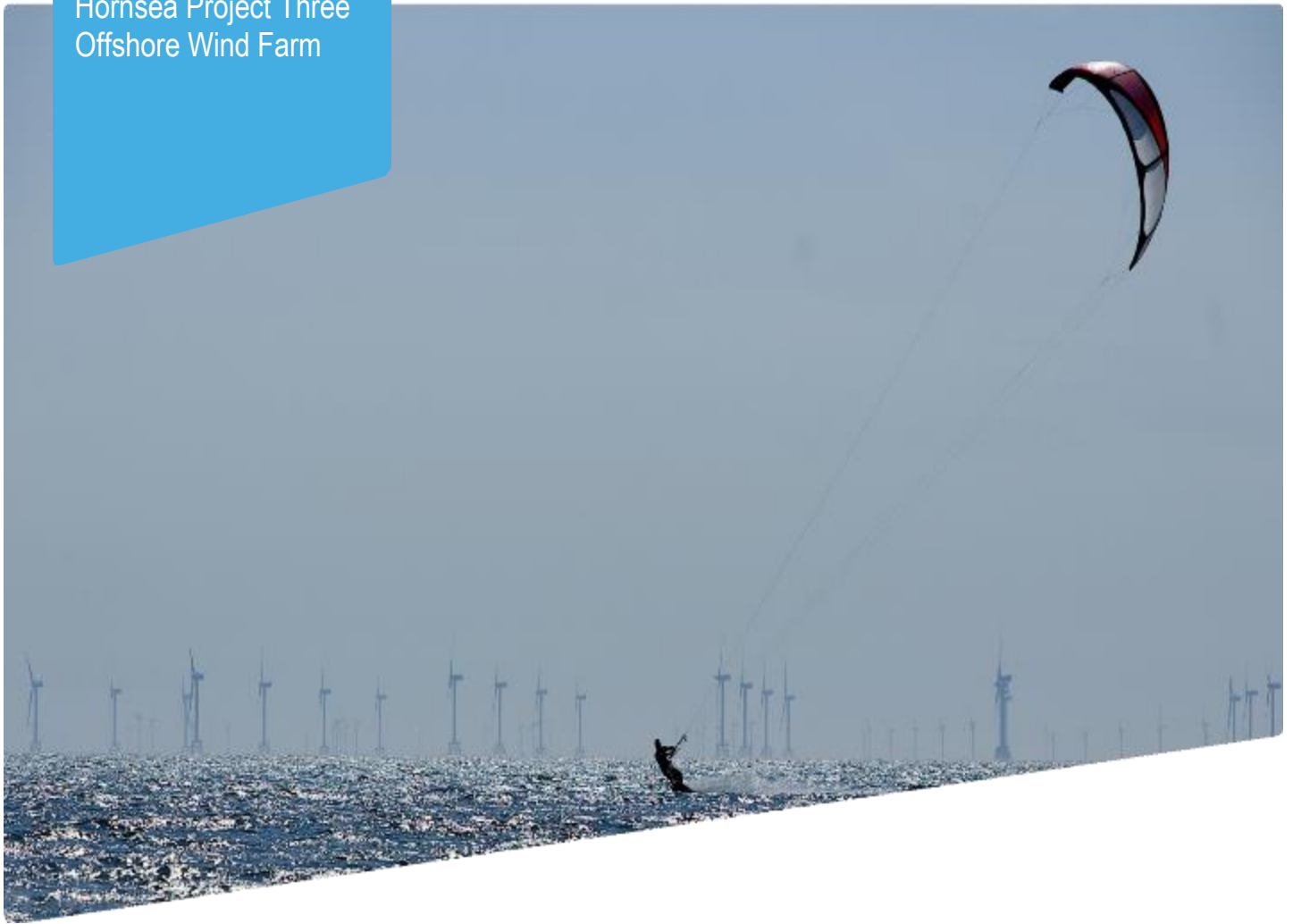


Hornsea Project Three
Offshore Wind Farm



Hornsea Project Three Offshore Wind Farm

Appendix 7 to Deadline I submission –
Alternative approach to sourcing cumulative and in-
combination collision risk estimates – Clarification Note

Date: 7th November 2018

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1. Alternative approach to sourcing cumulative and in-combination collision risk estimates

Introduction

- 1.1 In the Hornsea Three Application, Volume 2, Chapter 5: Offshore Ornithology (Document 6.2.5) and the Report to Inform Appropriate Assessment (RIAA) (Document 5.2) presented cumulative and in-combination assessments using collision risk estimates calculated using the Extended Band model. An alternative, but more precautionary approach to cumulative and in-combination assessments, is to utilise collision risk estimates calculated using the Basic Band model. The Basic Band model does not take into account the differential collision risk across the rotor swept area of a turbine, which can have a considerable effect on resulting collision risk estimates. The Statutory Nature Conservation Bodies have outstanding concerns in relation to the Extended Band model, especially in relation to the appropriate avoidance rates to apply. This report therefore presents the cumulative and in-combination collision mortality obtained when collision risk estimates from the Basic Band model are used.
- 1.2 The Basic model assumes a uniform distribution of flights across the rotor with a consistent risk of collision across the whole rotor swept area. The Extended model of Band (2012) takes into account the distribution of birds in addition to the differential risk across the rotor swept area.
- 1.3 This is particularly relevant for gannet and kittiwake for which the SNCBs have outstanding concerns in relation to the use the Extended model, especially in relation to the appropriate avoidance rate to use for these species. For lesser black-backed gull and great black-backed gull, an appropriate avoidance rate is available for use with both the Basic and Extended Band models, with the results from the Basic Band model presented here to allow consideration of the uncertainty in cumulative collision risk estimates
- 1.4 This report considers the cumulative and in-combination totals in terms of the assessments conducted in Volume 2, Chapter 5 Offshore Ornithology (Document 6.2.5) and RIAA (Document 5.2), comparing totals presented in this report to those used in Volume 2, Chapter 5 Offshore Ornithology (Document 6.2.5) and the Report to Inform Appropriate Assessment (Document 5.2) and identifying whether there are any implications for the assessment conclusions reached if the precautionary approach presented in this document is applied.

Methodology

- 1.5 Collision risk estimates calculated using the Basic Band model (Options 1 or 2) have been sourced from project-specific literature. Where required, collision risk estimates have been corrected to a common currency using the avoidance rates advocated in JNCC *et al.* (2014):

- Gannet and kittiwake = 98.9%; and
- Lesser black-backed gull and great black-backed gull = 99.5%.

1.6 The apportioning values used to calculate the collision risk attributable to Flamborough and Filey Coast (FFC) potential Special Protection Area (pSPA) are consistent with those applied in the RIAA for all projects. In the breeding season, for those projects with connectivity (based on either mean-maximum foraging range or tracking data) a precautionary assumption that 100% of birds within the project sites originate from the pSPA has been applied with the exception of the three Hornsea projects and all four Dogger Bank projects, for which project-specific apportioning values have been used.

1.7 In the post-breeding and pre-breeding seasons, apportioning values calculated using the population data presented in Furness (2015) have been applied to the collision risk estimates for all projects. The apportioning values for all projects in all seasons are summarised in Table 1.1.

Table 1.1: FFC pSPA apportioning values applied to in-combination collision risk estimates

Project	Gannet			Kittiwake		
	Breeding season	Post-breeding season	Pre-breeding season	Breeding season	Post-breeding season	Pre-breeding season
Dogger Bank Creyke Beck A&B	50	4.8	6.2	16.8	5.4	7.2
Dogger Bank Teesside A and Sofia	50	4.8	6.2	-	5.4	7.2
Hornsea Project One	72	4.8	6.2	83	5.4	7.2
Hornsea Project Two	72	4.8	6.2	83	5.4	7.2
Hornsea Three	40.4	4.8	6.2	41.7	5.4	7.2
All other projects with breeding season connectivity	100	-	-	100	-	-
All other projects	-	4.8	6.2	-	5.4	7.2

- 1.8 The apportioning values presented in Table 1.1 for Dogger Bank Creyke Beck A&B and Hornsea Project One have been updated to reflect updates to certain aspects of the approaches used to originally calculate apportioning values for the breeding season. The apportioning approach used for kittiwake in the breeding season at Dogger Bank Creyke Beck A&B has been updated as part of the assessments undertaken for the East Anglia Three offshore wind farm (MacArthur Green, 2015a). The apportioning value calculated at East Anglia Three has therefore been used for Dogger Bank Creyke Beck A&B. For Hornsea Project One, additional survey data has been collected subsequent to the assessments produced for the project. A dataset incorporating the additional data, collected using the same survey methodology and comparable survey area, was analysed as part of the assessments undertaken for the Hornsea Project Two offshore wind farm. The apportioning values calculated at Hornsea Project Two are considered equally applicable to Hornsea Project One as both projects are located adjacent to each other and are the same distance from FFC pSPA.
- 1.9 For a number of projects, collision risk estimates have been corrected to account for legally secured reductions in the number of turbines. These reductions were identified in Volume 2, Chapter 5: Offshore Ornithology (Document 6.2.5) and the RIAA (Document 5.2) and are based on differences between assessed and consented turbine scenarios. Reductions have been applied to:
- Beatrice (gannet = 142 to 125 turbines; other species = 277 to 125 turbines);
 - Dudgeon (168 to 77 turbines);
 - East Anglia One (325 to 240 turbines);
 - Moray East (339 to 186 turbines); and
 - Neart na Gaoithe (128 to 75 turbines).
- 1.10 These corrections were applied to the collision risk estimates presented in Volume 2, Chapter 5: Offshore Ornithology (Document 6.2.5) and the RIAA (Document 5.2) and have been applied as part of previous assessments for offshore wind farms both by relevant applicants and Natural England.
- 1.11 All collision risk estimates have been rounded to the nearest whole number throughout this document.

Consideration of further areas of uncertainty

- 1.12 1.11 Volume 2, Chapter 5: Offshore Ornithology (Document 6.2.5) and the RIAA (Document 5.2) both considered additional areas of uncertainty and potential over-estimation inherent in the cumulative and in-combination totals presented. These included:

- The use of precautionary avoidance rates;
- The use of precautionary nocturnal activity factors in CRM undertaken for projects considered cumulatively and in-combination;
- Worst case assumptions about the effects on a breeding regional population that is based only on breeding adult birds (excluding immature and non-breeding adult birds) whereas predicted collision estimates are based on the observed birds at Hornsea Three which will include immature and non-breeding adults. This has differing effects at projects located at different distances from breeding colonies; and
- The assumption that all projects, if constructed, will be built out to the maximum design scenario assumptions made in the respective impact assessments.

1.13 Appendix 4 to the Applicants response to Deadline I provides more information in relation to the implications for cumulative and in-combination assessments as a result of the differences between assessed and as-built turbine scenarios. The results presented in Appendix 4 to the Applicants response to Deadline I are considered in the following species-specific sections as part of the 'Consideration of uncertainty' sections. The differences between assessed and as-built turbine scenarios have not been applied to the collision risk estimates presented in the 'Cumulative and in-combination totals' sections for gannet and kittiwake or the 'Cumulative totals' sections for lesser black-backed gull and great black-backed gull.

1.14 In addition, Appendix 10 to the Applicants response to Deadline I, has investigated the use of recently published information relating to nocturnal activity factors (Furness *et al.*, 2018; MacArthur Green, 2018), flight speed and avoidance rates (Skov *et al.*, 2018) as part of collision risk modelling undertaken for Hornsea Three. The results of this exercise, which is considered to provide collision risk estimates that are calculated using the best available evidence in relation to the aforementioned parameters is considered as part of the 'Consideration of uncertainty' sections for each species.

Gannet

Cumulative and in-combination totals

1.15 The cumulative and in-combination collision risk for gannet using collision risk estimates calculated using the Basic Band model is presented in Table 1.2 and Table 1.3 respectively.

Table 1.2: Seasonal breakdown of predicted cumulative collision mortality using results from the Basic Band model, for gannet.

Project	Option	Avoidance rate (%)	Annual collisions	Breeding	Post-breeding	Pre-breeding	Notes
Hornsea Three	2	98.9	37	18	12	8	
Tier 1							
Aberdeen Demo	2	98.9	9		5	0	
Beatrice	1	98.9	84		44	10	Turbine correction applied
Blyth Demo	1	98.9	8	4	2	3	
Dudgeon	1	98.9	37	10	18	9	Turbine correction applied
East Anglia One	2	98.9	132		123	7	Turbine correction applied
Galloper	1	98.9	56		28	11	
Greater Gabbard	1	98.9	28		8	9	
Hornsea Project One	1	98.9	6	1	3	2	
Hornsea Project Two	2	98.9	27	7	14	6	
Humber Gateway	1	98.9	4	2	1	1	
Hywind	1	98.9	7		2	2	
Kentish Flats Extension	1	98.9	0		0	0	
Lincs	1	98.9	5	2	1	2	
London Array	1	98.9	6		2	0	

Project	Option	Avoidance rate (%)	Annual collisions	Breeding	Post-breeding	Pre-breeding	Notes
Moray East	1	98.9	69		19	5	Turbine correction applied
Nearr na Gaoithe	1	98.9	334		57	64	Turbine correction applied
Race Bank	1	98.9	50	34	12	4	
Sheringham Shoal	1	98.9	18	14	3	0	
Teesside	1	98.9	7	5	2	0	
Thanet	1	98.9	1		0	0	
Triton Knoll	1	98.9	122	17	65	40	
Westermost Rough	1	98.9	1	0	0	0	
Tier 1 total				113	420	183	
Tier 2							
Dogger Bank Creyke Beck A&B	2	98.9	17	6	7	4	
Dogger Bank Teesside A and Sofia	2	98.9	36	15	10	11	
East Anglia Three	1	98.9	56		38	11	
Inch Cape	1	98.9	365		29	5	
Kincardine	1	98.9	21		8	1	
Methil	1	98.9	1		0	0	
Seagreen Alpha	1	98.9	552		101	37	

Project	Option	Avoidance rate (%)	Annual collisions	Breeding	Post-breeding	Pre-breeding	Notes
Seagreen Bravo	1	98.9	364		71	40	
Tier 2 total				20	264	109	
Total				134	684	292	

Table 1.3: Predicted in-combination collision mortality for gannet using the Basic Band model

Project	Option	Avoidance rate (%)	Annual collisions	Breeding season		Post-breeding season		Pre-breeding season	
				Apportioning	pSPA collisions	Apportioning	pSPA collisions	Apportioning	pSPA collisions
Hornsea Three	2	98.9	37	40.4	7	4.8	1	6.2	0
Tier 1									
Aberdeen Demo	2	98.9	9			4.8	0	6.2	0
Beatrice	1	98.9	84			4.8	2	6.2	1
Blyth Demo	1	98.9	8	100	4	4.8	0	6.2	0
Dudgeon	1	98.9	37	100	10	4.8	1	6.2	1
East Anglia One	2	98.9	132			4.8	7	6.2	0
Galloper	1	98.9	56			4.8	1	6.2	1
Greater Gabbard	1	98.9	28			4.8	0	6.2	1
Hornsea Project One	1	98.9	6	72	1	4.8	0	6.2	0
Hornsea Project Two	2	98.9	27	72	5	4.8	1	6.2	0
Humber Gateway	1	98.9	4	100	2	4.8	0	6.2	0
Hywind	1	98.9	7			4.8	0	6.2	0
Kentish Flats Extension	1	98.9	0			4.8	0	6.2	0

Project	Option	Avoidance rate (%)	Annual collisions	Breeding season		Post-breeding season		Pre-breeding season	
Lincs	1	98.9	5	100	2	4.8	0	6.2	0
London Array	1	98.9	6			4.8	0	6.2	0
Moray East	1	98.9	69			4.8	1	6.2	0
Neart na Gaoithe	1	98.9	334			4.8	3	6.2	4
Race Bank	1	98.9	50	100	34	4.8	1	6.2	0
Sheringham Shoal	1	98.9	18	100	14	4.8	0	6.2	0
Teesside	1	98.9	7	100	5	4.8	0	6.2	0
Thanet	1	98.9	1			4.8	0	6.2	0
Triton Knoll	1	98.9	122	100	17	4.8	3	6.2	2
Westermost Rough	1	98.9	1	100	0	4.8	0	6.2	0
Tier 1 total					100		20		11
Tier 2									
Dogger Bank Creyke Beck A&B	2	98.9	17	50	3	4.8	0	6.2	0
Dogger Bank Teesside A and Sofia	2	98.9	36	50	7	4.8	0	6.2	1
East Anglia Three	1	98.9	56			4.8	2	6.2	1
Inch Cape	1	98.9	365			4.8	1	6.2	0
Kincardine	1	98.9	21			4.8	0	6.2	0

Project	Option	Avoidance rate (%)	Annual collisions	Breeding season		Post-breeding season		Pre-breeding season	
Methil	1	98.9	1			4.8	0	6.2	0
Seagreen Alpha	1	98.9	552			4.8	5	6.2	2
Seagreen Bravo	1	98.9	364			4.8	3	6.2	2
Tier 2 total					10		13		7
Total					110		33		18

Implications for assessments

1.16 A comparison between the cumulative collision risk estimated for gannet using collision risk estimates calculated using the Basic and Extended models of Band (2012) is presented in Table 1.4.

Table 1.4: Comparison of the seasonal cumulative collision risk for gannet calculated using the Basic and Extended models of the Band (2012) Collision Risk Model (CRM)

Band (2012) model	Breeding season	Post-breeding season	Pre-breeding season
Tier 1 projects			
Basic	113	420	183
Extended	100	309	163
Tier 2 projects			
Basic	20	264	109
Extended	97	317	158
All projects			
Basic	134	684	292
Extended	197	626	321

1.17 Volume 2, Chapter 5: Offshore Ornithology (Document 6.2.5) concluded that the impact from Tier 1 projects was of Minor significance. When Tier 2 projects were included the impact was considered to be of minor or moderate significance. The cumulative totals estimated using collision risk estimates from the Basic Band model are lower than those estimated when using the Extended model. If the precautionary approach presented here were to be applied the conclusions drawn in Volume 2, Chapter 5: Offshore Ornithology (Document 6.2.5) would be unchanged.

1.18 A comparison between the in-combination collision risk estimated for the gannet feature of FFC pSPA using collision risk estimates calculated using the Basic and Extended models of Band (2012) is presented in Table 1.5.

Table 1.5: Comparison of in-combination collision risk for gannet at FFC pSPA calculated using the Basic and Extended models of the Band (2012) CRM

Band (2012) model	Breeding season	Post-breeding season	Pre-breeding season	Annual
Tier 1 projects				
Basic	100	20	11	132
Extended	94	15	10	119

Band (2012) model	Breeding season	Post-breeding season	Pre-breeding season	Annual
Tier 2 projects				
Basic	10	13	7	30
Extended	48	15	10	74
All projects				
Basic	110	33	18	162
Extended	142	30	20	193

1.19 The RIAA concluded no adverse effect on the site integrity of FFC pSPA due to in-combination collision risk impacts. The in-combination collision risk predicted when using collision risk estimates from the Basic Band model are lower than or similar to those calculated when using the Extended model. If the precautionary approach presented here were to be applied the conclusions drawn in Volume 2, Chapter 5: Offshore Ornithology (Document 6.2.5) would therefore be unchanged.

Consideration of uncertainty

1.20 Appendix 4 to the Applicants response to Deadline I considers the implications for the cumulative and in-combination totals calculated for gannet as a result of differences between the assessed and as-built scenarios at many of the projects considered cumulatively/in-combination. Table 1.6 presents the potential overall reductions that occur when as-built scenarios are considered when using collision risk estimates from the Basic Band model. There are considerable differences between the collision risk estimates for gannet calculated using assessed turbine scenarios and those corrected to reflect the as-built turbine scenarios for relevant projects.

Table 1.6: Percentage reductions in cumulative and in-combination collision risk calculated for gannet

Season	Tiers	Basic model (%) reduction	
		EIA	pSPA
Breeding	1	26	29
	All	22	26
Post-breeding	1	34	35
	All	21	21
Pre-breeding	1	43	36
	All	43	36
Annual	1	35	31

Season	Tiers	Basic model (%) reduction	
	All	23	25

1.21 Document ### presents collision risk estimates for Hornsea Three calculated using the best available evidence in relation to nocturnal activity factor, flight speed and avoidance rate for gannet. The collision risk estimates in Document ### calculated using Option 2 are presented in Table 1.7 alongside the cumulative and in-combination totals from all other projects combined. The use of these collision risk estimates makes a minimal difference to the overall cumulative and in-combination totals for gannet.

Table 1.7: Cumulative and in-combination totals for gannet taking account of Hornsea Three collision risk estimates informed by best available evidence

Project	Breeding		Post-breeding		Pre-breeding	
	EIA	pSPA	EIA	pSPA	EIA	pSPA
Hornsea Three	17	7	11	1	8	0
All Tier 1 projects	96	93	409	20	175	11
Tier 1 total	113	100	420	20	182	11
All Tier 2 projects	20	10	264	13	109	7
All tiers total	133	110	684	33	291	18

Kittiwake

Cumulative and in-combination totals

1.22 The cumulative and in-combination collision risk for kittiwake using collision risk estimates calculated using the Basic Band model is presented in Table 1.8 and Table 1.9 respectively.

Table 1.8: Seasonal breakdown of predicted cumulative collision mortality using results from the Basic Band model, for kittiwake.

Project	Option	Avoidance rate (%)	Annual collisions	Breeding	Post-breeding	Pre-breeding	Notes
Hornsea Three	1	98.9	45	23	14	8	
Tier 1							
Aberdeen Demo	2	98.9	19		6	0	
Beatrice	1	98.9	65		6	6	Turbine correction applied
Blyth Demo	1	98.9	5		2	1	
East Anglia One	2	98.9	429		295	105	Turbine correction applied
Galloper	1	98.9	66		28	27	
Greater Gabbard	1	98.9	28		7	17	
Hornsea Project One	1	98.9	7	3	3	1	
Hornsea Project Two	1	98.9	27	16	9	3	
Humber Gateway	1	98.9	7	2	3	2	
Hywind	1	98.9	10		2	0	
Kentish Flats Extension	1	98.9	3		1	1	
Lincs	1	98.9	3	1	1	1	
London Array	1	98.9	6		2	3	
Moray East	1	98.9	45		2	6	Turbine correction applied

Project	Option	Avoidance rate (%)	Annual collisions	Breeding	Post-breeding	Pre-breeding	Notes
Neart na Gaoithe	1	98.9	55		24	15	Turbine correction applied
Race Bank	1	98.9	31	2	24	6	
Teesside	1	98.9	81		25	3	
Thanet	1	98.9	0		0	0	
Triton Knoll	1	98.9	209	16	126	67	
Westermost Rough	1	98.9	0	0	0	0	
Tier 1 total				64	581	272	
Tier 2							
Dogger Bank Creyke Beck A&B	2	98.9	719	288	135	295	
Dogger Bank Teesside A and Sofia	2	98.9	445		91	217	
East Anglia Three	1	98.9	106		64	31	
Inch Cape	1	98.9	301		225	63	
Kincardine	2	98.9	21		8	1	
Methil	Unknown	98.9	1		0	0	
Seagreen Alpha	1	98.9	371		171	112	
Seagreen Bravo	1	98.9	343		142	85	
Tier 2 total				288	837	804	

Project	Option	Avoidance rate (%)	Annual collisions	Breeding	Post-breeding	Pre-breeding	Notes
Total				352	1418	1076	

Table 1.9: Predicted in-combination collision mortality for kittiwake using the Basic Band model

Project	Option	Avoidance rate (%)	Annual collisions	Breeding season		Post-breeding season		Pre-breeding season	
				Apportioning	pSPA collisions	Apportioning	pSPA collisions	Apportioning	pSPA collisions
Hornsea Three	1	98.9	45	41.7	10	5.4	1	7.2	1
Tier 1									
Aberdeen Demo	2	98.9	19			5.4	0	7.2	0
Beatrice	1	98.9	58			5.4	0	7.2	0
Blyth Demo	1	98.9	5			5.4	0	7.2	0
East Anglia One	2	98.9	429			5.4	16	7.2	8
Galloper	1	98.9	66			5.4	2	7.2	2
Greater Gabbard	1	98.9	28			5.4	0	7.2	1
Hornsea Project One	1	98.9	7	83	2	5.4	0	7.2	0
Hornsea Project Two	1	98.9	27	83	14	5.4	0	7.2	0
Humber Gateway	1	98.9	7	100	2	5.4	0	7.2	0
Hywind	1	98.9	10			5.4	0	7.2	0
Kentish Flats Extension	1	98.9	3			5.4	0	7.2	0
Lincs	1	98.9	3	100	1	5.4	0	7.2	0

Project	Option	Avoidance rate (%)	Annual collisions	Breeding season		Post-breeding season		Pre-breeding season	
London Array	1	98.9	6			5.4	0	7.2	0
Moray East	1	98.9	45			5.4	0	7.2	0
Neart na Gaoithe	1	98.9	55			5.4	1	7.2	1
Race Bank	1	98.9	31	100	2	5.4	1	7.2	0
Teesside	1	98.9	81			5.4	1	7.2	0
Thanet	1	98.9	0			5.4	0	7.2	0
Triton Knoll	1	98.9	209	100	16	5.4	7	7.2	5
Westermost Rough	1	98.9	0	100	0	5.4	0	7.2	0
Tier 1 total					47		32		20
Tier 2									
Dogger Bank Creyke Beck A&B	2	98.9	719	16.8	48	5.4	7	7.2	21
Dogger Bank Teesside A and Sofia	2	98.9	445			5.4	5	7.2	16
East Anglia Three	1	98.9	106			5.4	3	7.2	2
Inch Cape	1	98.9	301			5.4	12	7.2	4
Kincardine	2	98.9	21			5.4	0	7.2	0
Methil	Unknown	98.9	1			5.4	0	7.2	0
Seagreen Alpha	1	98.9	371			5.4	9	7.2	8

Project	Option	Avoidance rate (%)	Annual collisions	Breeding season		Post-breeding season		Pre-breeding season	
Seagreen Bravo	1	98.9	343			5.4	8	7.2	6
Tier 2 total					48		46		58
Total					95		77		77

Implications for assessments

1.23 A comparison between the cumulative collision risk estimated for kittiwake using collision risk estimates calculated using the Basic and Extended models of Band (2012) is presented in Table 1.10.

Table 1.10: Comparison of the seasonal cumulative collision risk for kittiwake calculated using the Basic and Extended models of the Band (2012) CRM

Band (2012) model	Breeding season	Post-breeding season	Pre-breeding season
Tier 1 projects			
Basic	64	581	272
Extended	60	232	134
Tier 2 projects			
Basic	288	837	804
Extended	87	441	312
All projects			
Basic	352	1418	1076
Extended	148	673	446

1.24 Volume 2, Chapter 5 Offshore Ornithology (Document 6.2.5) concluded that the impact from Tier 1 projects was of Minor significance. When Tier 2 projects were included the impact was also considered to be of minor significance. The cumulative totals estimated using collision risk estimates from the Basic Band model are higher than those estimated when using the Extended model and as such consideration is provided here as to the effect this may have on assessment conclusions.

1.25 In the breeding season, the cumulative collision risk total from Tier 1 projects (64 birds), of which Hornsea Three contributes approximately 36%, represents 0.06% of the regional breeding population and a 0.43% increase in the baseline mortality of the same population. When including Tier 2 projects the cumulative collision risk total in the breeding season (352 birds), of which Hornsea Three contributes approximately 7%, represents 0.35% of the regional breeding population and a 2.4% increase in baseline mortality of the same population.

1.26 In the post-breeding season, Hornsea Three contributes approximately 2.5% of the Tier 1 cumulative collision risk total (581 birds) with this representing 0.07% of the regional post-breeding population and a 0.48% increase in the baseline mortality of the same population. Hornsea Three contributes approximately 1% of the total cumulative collision risk when considering Tier 1 and Tier 2 projects, with the total representing 0.17% of the regional post-breeding population and a 1.2% increase in baseline mortality of the same population.

- 1.27 Hornsea Three contributes approximately 2.8% of the pre-breeding cumulative collision risk total from Tier 1 projects (272 birds) with this representing 0.04% of the regional pre-breeding population and a 0.29% increase in the baseline mortality of the same population. The cumulative total from Tier 1 and Tier 2 projects in the pre-breeding season (1,076 birds), of which Hornsea Three contributes approximately 0.72%, represents 0.17% of the regional pre-breeding population and a 1.2% increase in the baseline mortality of the same population.
- 1.28 The predicted cumulative collision risk estimates are based on conservative assumptions including:
- The use of precautionary collision risk estimates (i.e. from the Basic Band model).
 - The use of precautionary avoidance rates (Cook *et al.*, 2014 recommends an avoidance rate of 99.2% for kittiwake representing an 18% reduction in collision risk);
 - The use of precautionary nocturnal activity factors in CRM undertaken for projects considered cumulatively with this likely to reduce collision risk estimates by approximately 8% (see Volume 2, Chapter 5 Offshore Ornithology (Document 6.2.5) and the RIAA (Document 5.2));
 - Worst case assumptions about the effects on a breeding regional population that is based only on breeding adult birds (excluding immature and non-breeding adult birds) whereas predicted collision estimates are based on the observed birds at a project which will include immature and non-breeding adults; and
 - The assumption that all projects, if constructed, will be built out to the maximum design scenario assumptions made in the respective impact assessments, which, if taken into account, could lead to considerable reductions in the predicted in-combination collision risk.
- 1.29 It is considered likely that a substantial proportion of all birds recorded in the breeding season at many projects are immature or non-breeding individuals (see RIAA Annex 3: Phenology, connectivity and apportioning for features of FFC pSPA (Document 5.2.3)). In addition, a further proportion are likely to be non-breeding adult birds. The presence of these birds would significantly increase the population against which impacts are considered which represents only breeding adult birds. Analyses undertaken in RIAA Annex 3: Phenology, connectivity and apportioning for features of FFC pSPA (Document 5.2.3) suggest that 12-58% of birds at Hornsea Three in the breeding season will be immature birds.
- 1.30 Hornsea Three is located a considerable distance (149 km) from the nearest breeding colony and therefore the proportion of immatures present at Hornsea Three may not be directly applicable to projects located closer to breeding colonies. However, immature and non-breeding birds are known to visit colonies prior to first breeding (Coulson, 2011) and the majority of collisions predicted in the breeding season occur at those projects with limited connectivity to breeding colonies (i.e. Hornsea Three, Triton Knoll and Dogger Bank Creyke Beck A&B) based on tracking data (see Figure 1.22 in RIAA Annex 3: Phenology, connectivity and apportioning for features of FFC pSPA (Document 5.2.3)). The application of the immature proportion calculated for Hornsea Three is therefore still considered applicable to these projects and would represent a significant dilution of impact on the regional breeding population that is composed of breeding adult birds only.

- 1.31 If the precautionary approach presented here were to be applied the conclusions drawn in Volume 2, Chapter 5: Offshore Ornithology (Document 6.2.5) would be unchanged.
- 1.32 A comparison between the in-combination collision risk estimated for kittiwake using collision risk estimates calculated using the Basic and Extended models of Band (2012) is presented in Table 1.11.

Table 1.11: Comparison of in-combination collision risk for kittiwake at FFC pSPA calculated using the Basic and Extended models of the Band (2012) CRM

Band (2012) model	Breeding season	Post-breeding season	Pre-breeding season	Annual
<i>Tier 1 projects</i>				
Basic	45	32	20	96
Extended	35	13	10	58
<i>Tier 2 projects</i>				
Basic	48	46	58	152
Extended	15	24	22	61
<i>All projects</i>				
Basic	93	77	77	248
Extended	50	37	32	119

- 1.33 The RIAA concluded no adverse effect on the site integrity of the FFC pSPA as a result of in-combination collision risk impacts. The in-combination mortality estimated using collision risk estimates from the Basic Band model are higher than those estimated when using the Extended model and as such consideration is provided here as to the effect this may have on the conclusions presented in the RIAA.
- 1.34 The annual in-combination collision risk total from Tier 1 projects for FFC pSPA is 96 birds (Table 1.11) of which Hornsea Three contributes approximately 11.5%. This level of mortality represents 0.11% of the pSPA population and a 0.74% increase in the baseline mortality of the same population. When Tier 2 projects are included in the annual in-combination collision risk total, mortality increases to 248 birds with Hornsea Three contributing approximately 4.4%. This level of mortality represents 0.28% of the pSPA population and a 1.9% increase in baseline mortality of the same population.

- 1.35 PVA modelling (MacArthur Green, 2015b) indicates that at an additional mortality of 250 birds (the closest modelled output to the predicted in-combination total for Tier 1 and 2 projects), a slight reduction in the growth rate of the kittiwake population at FFC pSPA would occur (0.29 – 0.34%). The predicted median population size after 25 years would be approximately 93.4 – 93.8% (and when extrapolated to 35 years, approximately 91%) of that which the model predicts would occur in the in the absence of any additional impact from Hornsea Three.
- 1.36 PVA modelling (MacArthur Green, 2015b) indicates that the levels of in-combination mortality predicted to arise (Table 1.11) would not be sufficient to prevent continued growth of the kittiwake population at FFC pSPA and therefore the population would not decline below the FFC pSPA citation for this species. This level of in-combination mortality does not include consideration of the conservative assumptions identified in paragraph 1.28 especially as-built scenarios (Table 7.37) or nocturnal activity factors (Table 7.38) which, if taken into account, could lead to considerable reductions in the predicted in-combination collision risk.
- 1.37 The current population at the pSPA is 13% higher than the cited population and the population has increased 7% since the Seabird 2000 survey (Mitchell *et al.*, 2004). Recent years suggest a positive growth rate (e.g. 0.7% between 2016 and 2017, although note that this is only two years). PVA modelling predicts (without any density-dependence, consideration of which is likely to provide a more realistic representation, in terms of model outputs, of the likely population trends) that the population of kittiwake at FFC pSPA would still continue to increase however, over the lifetime of Hornsea Three the resultant population would be approximately 9% lower than the population that would occur without the presence of additional in-combination mortality. Therefore there is no indication that additional mortality from Hornsea Three alone or in-combination would result in the population declining below the cited population.
- 1.38 On this basis, there is no indication that, at the level of mortality predicted to arise from Hornsea Three in-combination with other projects, the population is likely to decline, over a period of 35 years, to an extent that would mean that there would be an adverse effect on the site integrity of FFC pSPA. This level of mortality would therefore not prevent the conservation objectives defined for the pSPA from being met.

Consideration of uncertainty

- 1.39 Appendix 4 to the Applicants response to Deadline I considers the implications for the cumulative and in-combination totals calculated for kittiwake as a result of differences between the assessed and as-built scenarios at many of the projects considered cumulatively/in-combination. Table 1.12 presents the potential overall reductions that occur when as-built scenarios are considered when using collision risk estimates from the Basic Band model. There are considerable differences between the collision risk estimates for kittiwake calculated using assessed turbine scenarios and those corrected to reflect the as-built turbine scenarios for relevant projects.

Table 1.12: Percentage reductions in cumulative and in-combination collision risk calculated for kittiwake

Season	Tiers	Basic model (%) reduction	
		EIA	pSPA
Breeding	1	22	32
	All	4	15
Post-breeding	1	44	44
	All	18	18
Pre-breeding	1	46	45
	All	12	12
Annual	1	43	38
	All	14	15

1.40 Appendix 10 to the Applicants response to Deadline I presents collision risk estimates for Hornsea Three calculated using the best available evidence in relation to nocturnal activity factor, flight speed and avoidance rate for kittiwake. The collision risk estimates in Appendix 10 to the Applicants response to Deadline I calculated using Option 1 are presented in Table 1.13 alongside the cumulative and in-combination totals from all other projects combined. There is a slight reduction in the predicted total cumulative and in-combination collision risk estimates for kittiwake when these collision risk estimates are used. It is important to note that the use of best available evidence to inform the parameters used in collision risk modelling would also reduce the collision risk at all other projects considered cumulatively/in-combination with this likely to result in significant reductions in cumulative and in-combination totals for kittiwake. This is discussed further in Appendix 10 to the Applicants response to Deadline I.

Table 1.13: Cumulative and in-combination totals for kittiwake taking account of Hornsea Three collision risk estimates informed by best available evidence

Project	Breeding		Post-breeding		Pre-breeding	
	EIA	pSPA	EIA	pSPA	EIA	pSPA
Hornsea Three	17	7	10	1	5	0
All Tier 1 projects	41	37	567	31	264	19
Tier 1 total	57	44	577	31	269	19

Project	Breeding		Post-breeding		Pre-breeding	
All Tier 2 projects	288	48	837	46	804	58
All tiers total	346	92	1414	77	1073	77

Lesser black-backed gull

Cumulative totals

- 1.41 The cumulative collision risk for lesser black-backed gull using collision risk estimates calculated using the Basic Band model is presented in Table 1.14.

Table 1.14: Seasonal breakdown of predicted cumulative collision mortality using results from the Basic Band model, for lesser black-backed gull.

Project	Option	Avoidance rate (%)	Annual collisions	Breeding	Post-breeding	Non-breeding	Pre-breeding	Notes
Hornsea Three	2	99.5	17	15	2	0	1	
Tier 1								
Dudgeon	1	99.5	12	4	3	4	2	Turbine correction applied
East Anglia One	1	99.5	73	11	10	51	1	Turbine correction applied
Galloper	1	99.5	139	63	24	31	22	
Greater Gabbard	1	99.5	62	12	13	23	14	
Hornsea Project One	2	99.5	21	12	5	2	2	
Hornsea Project Two	2	99.5	4	2	1	0	1	
Humber Gateway	1	99.5	2	0	0	1	0	
Kentish Flats Extension	1	99.5	2	0	0	1	0	
Lincs	1	99.5	9	2	2	3	2	
Neart na Gaoithe	1	99.5	1		0	0	0	Turbine correction applied
Race Bank	1	99.5	54	11	13	27	2	
Sheringham Shoal	1	99.5	8	6	1	0	1	
Thanet	1	99.5	6	2	2	1	0	
Triton Knoll	1	99.5	32	16	4	10	3	

Project	Option	Avoidance rate (%)	Annual collisions	Breeding	Post-breeding	Non-breeding	Pre-breeding	Notes
Westermost Rough	1	99.5	0	0	0	0	0	
Tier 1 total				157	81	153	49	
Tier 2								
Dogger Bank Creyke Beck A&B	2	99.5	13	9	1	0	3	
Dogger Bank Teesside A and Sofia	2	99.5	12		5	3	0	
East Anglia Three	1	99.5	20	4	11	4	2	
Seagreen Alpha	2	99.5	3		1	1	0	
Seagreen Bravo	2	99.5	7		0	0	1	
Tier 2 total				12	18	8	6	
Total				169	99	161	55	

Implications for assessments

1.42 A comparison between the cumulative collision risk estimated for lesser black-backed gull using collision risk estimates calculated using the Basic and Extended models of Band (2012) is presented in Table 1.15.

Table 1.15: Comparison of the seasonal cumulative collision risk for lesser black-backed gull calculated using the Basic and Extended models of the Band (2012) CRM

Band (2012) model	Breeding season	Post-breeding season	Non-breeding season	Pre-breeding season
Tier 1 projects				
Basic	157	81	153	49
Extended	139	73	131	47
Tier 2 projects				
Basic	12	18	8	6
Extended	14	16	9	10
All projects				
Basic	169	99	161	55
Extended	153	89	140	57

1.43 Volume 2, Chapter 5: Offshore Ornithology (Document 6.2.5) concluded that the impact from Tier 1 projects was of Moderate significance, although the contribution of Hornsea Three to this total was considered to not materially alter the current cumulative impact with a similar conclusion reached when all projects (Tiers 1 and 2) were considered. The cumulative impacts predicted when using collision risk estimates from the Basic Band model are of a similar magnitude to those predicted using the Extended model. If the precautionary approach presented here were to be applied the conclusions drawn in Volume 2, Chapter 5: Offshore Ornithology (Document 6.2.5) would be unchanged.

Consideration of uncertainty

1.44 Appendix 4 to the Applicants response to Deadline I considers the implications for the cumulative totals calculated for lesser black-backed gull as a result of differences between the assessed and as-built scenarios at many of the projects considered cumulatively. Table 1.16 presents the potential overall reductions that occur when as-built scenarios are considered when using collision risk estimates from the Basic Band model. There are considerable differences between the collision risk estimates for lesser black-backed gull calculated using assessed turbine scenarios and those corrected to reflect the as-built turbine scenarios for relevant projects.

Table 1.16: Percentage reductions in cumulative collision risk calculated for lesser black-backed gull

Season	Tiers	Basic model (%) reduction
Breeding	1	36
	All	36
Post-breeding	1	32
	All	26
Non-breeding	1	39
	All	36
Pre-breeding	1	31
	All	27
Annual	1	35
	All	33

1.45 Appendix 10 to the Applicants response to Deadline I presents collision risk estimates for Hornsea Three calculated using the best available evidence in relation to flight speed and avoidance rate for lesser black-backed gull. The collision risk estimates in Appendix 10 to the Applicants response to Deadline I calculated using Option 2 are presented in Table 1.17 alongside the cumulative and in-combination totals from all other projects combined. There is a slight reduction in the predicted total cumulative and in-combination collision risk estimates for lesser black-backed gull when these collision risk estimates are used. It is important to note that the use of best available evidence to inform the parameters used in collision risk modelling would also reduce the collision risk at all other projects considered cumulatively/in-combination with this likely to result in significant reductions in cumulative and in-combination totals for lesser black-backed gull. This is discussed further in Appendix 10 to the Applicants response to Deadline I.

Table 1.17: Cumulative totals for lesser black-backed gull taking account of Hornsea Three collision risk estimates informed by best available evidence

Project	Breeding	Post-breeding	Non-breeding	Pre-breeding
Hornsea Three	12	1	0	1
All Tier 1 projects	142	79	153	48
Tier 1 total	154	81	153	49
All Tier 2 projects	12	18	8	6
All tiers total	166	99	161	55

Great black-backed gull

Cumulative totals

- 1.46 The cumulative collision risk for great black-backed gull using collision risk estimates calculated using the Basic Band model is presented in Table 1.18.

Table 1.18: Seasonal breakdown of predicted cumulative collision mortality using results from the Basic Band model, for great black-backed gull.

Project	Option	Avoidance rate (%)	Annual collisions	Breeding	Non-breeding	Notes
Hornsea Three	1	99.5	66	16	50	
Tier 1						
Aberdeen Demo	1	99.5	3	0	3	
Beatrice	1	99.5	68	6	62	Turbine correction applied
Blyth Demo	1	99.5	8	2	6	
East Anglia One	2	99.5	92	1	90	Turbine correction applied
Galloper	1	99.5	22	0	22	
Hornsea Project One	2	99.5	68	7	61	
Hornsea Project Two	2	99.5	23	3	20	
Humber Gateway	1	99.5	6	2	5	
Hywind	1	99.5	5	0	5	
Kentish Flats Extension	1	99.5	0	0	0	
Moray East	1	99.5	19	7	12	Turbine correction applied
Near na Gaoithe	1	99.5	5	0	4	Turbine correction applied
Teesside	1	99.5	44	3	41	
Thanet	1	99.5	0	0	0	

Project	Option	Avoidance rate (%)	Annual collisions	Breeding	Non-breeding	Notes
Triton Knoll	1	99.5	122	9	112	
Westermost Rough	1	99.5	0	0	0	
Tier 1 total				56	495	
Tier 2						
Dogger Bank Creyke Beck A&B	2	99.5	33	2	30	
Dogger Bank Teesside A and Sofia	2	99.5	37	4	33	
East Anglia Three	1	99.5	55	3	52	
Inch Cape	1	99.5	37	0	37	
Seagreen Alpha	2	99.5	37	1	36	
Seagreen Bravo	2	99.5	30	3	27	
Tier 2 total				13	215	
Total				68	709	

Implications for assessments

1.47 A comparison between the cumulative collision risk estimated for great black-backed gull using collision risk estimates calculated using the Basic and Extended models of Band (2012) is presented in Table 1.19.

Table 1.19: Comparison of the seasonal cumulative collision risk for great black-backed gull calculated using the Basic and Extended models of the Band (2012) CRM

Band (2012) model	Breeding season	Non-breeding season
Tier 1 projects		
Basic	35	390
Extended	49	407
Tier 2 projects		
Basic	13	215
Extended	11	198
All projects		
Basic	47	605
Extended	60	606

1.48 Volume 2, Chapter 5: Offshore Ornithology (Document 6.2.5) concluded that the impact from Tier 1 projects was of Moderate significance with a similar conclusion reached when all projects (Tiers 1 and 2) were considered. The cumulative impacts predicted when using collision risk estimates from the Basic Band model are of a similar magnitude to those predicted using the Extended model. If the precautionary approach presented here were to be applied the conclusions drawn in Volume 2, Chapter 5: Offshore Ornithology (Document 6.2.5) would be unchanged.

Consideration of uncertainty

1.49 Appendix 4 to the Applicants response to Deadline I considers the implications for the cumulative totals calculated for great black- as a result of differences between the assessed and as-built scenarios at many of the projects considered cumulatively. Table 1.20 presents the potential overall reductions that occur when as-built scenarios are considered when using collision risk estimates from the Basic Band model. There are considerable differences between the collision risk estimates for great black-backed gull calculated using assessed turbine scenarios and those corrected to reflect the as-built turbine scenarios for relevant projects.

Table 1.20: Percentage reductions in cumulative collision risk calculated for great black-backed gull

Season	Tiers	Basic model (%) reduction)
Breeding	1	18
	All	13
Non-breeding	1	38
	All	27
Annual	1	36
	All	25

1.50 Appendix 10 to the Applicants response to Deadline I presents collision risk estimates for Hornsea Three calculated using the best available evidence in relation to flight speed and avoidance rate for great black-backed gull. The collision risk estimates in Appendix 10 to the Applicants response to Deadline I calculated using Option 2 are presented in Table 1.21 alongside the cumulative and in-combination totals from all other projects combined. There is a slight reduction in the predicted total cumulative and in-combination collision risk estimates for great black-backed gull when these collision risk estimates are used. It is important to note that the use of best available evidence to inform the parameters used in collision risk modelling would also reduce the collision risk at all other projects considered cumulatively/in-combination with this likely to result in significant reductions in cumulative and in-combination totals for great black-backed gull. This is discussed further in Appendix 10 to the Applicants response to Deadline I.

Table 1.21: Cumulative totals for great black-backed gull taking account of Hornsea Three collision risk estimates informed by best available evidence

Project	Breeding	Non-breeding
Hornsea Three	13	40
All Tier 1 projects	40	444
Tier 1 total	53	485
All Tier 2 projects	13	215
All tiers total	65	700

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