Hornsea Project Four

Revised Ornithological Figures
Hornsea Project Four
Request for Further Information
Date: 17 April 2023
Document Reference: G12.2
Revision: 01

Prepared APEM Limited, April 2023
Checked Felicity Le Page, Orsted, April 2023
Accepted Natalie Bown, Orsted, April 2023
Approved Jamie Baldwin, Orsted, April 2023

G12.2
Ver A

Document Properties	
Author	APEM Limited, April 2023
Checked by	Felicity Le Page, Orsted, April 2023
Approved by	Jamie Baldwin, Orsted, April 2023
Title	Revised Ornithological Figures

Version History			
Date	*Version*	*Status*	*Description / Changes*
17/04/2023	A	-	Submitted in response to RFI#4 – letter dated 20 March 2023

Table of Contents

List of Tables

List of Figures

Glossary

Term	Definition
Bio-season	Bird behaviour and abundance is recognised to differ across a calendar year, with particular months recognised as being part of different seasons. The biologically defined minimum population scales (BDMPS) bio-seasons used in this report are based on those in Furness (2015), hereafter referred to as bio-seasons.
Collision	An instance of one moving object or individual striking violently against another.
Collision Risk Model (CRM)	General term to describe the method of estimating the collision risk of seabirds (estimated mortality) to operational turbines, which could be either deterministic or stochastic.
Confidence intervals	Range of values that with a specified certainty contains the true mean of the population that a sample was taken from. For example, 95% confidence intervals states a range of values with a 95% certainty those values contain the population mean.
In-Combination Effect	The combined effect of Hornsea Four with the effects from one or more other projects on the same feature/receptor.
Macro Avoidance	Avoidance response prior to entry of the OWF array area.
Stochastic Collision Risk Model (sCRM)	A program used to assess the collision risk (estimated mortality) of seabirds to operational turbines of offshore wind farms. A stochastic CRM is used to account for uncertainty around input variables.

Acronyms

Term	Definition
AEoI	Adverse Effect on Integrity
CFGR	Counterfactual of Growth Rate
CFPS	Counterfactual of Final Population Size
CRM	Collision Risk Modelling
DESNZ	Department for Energy Security and Net Zero
EIA	Environmental Impact Assessment
ExA	Examining Authority
FFC	Flamborough and Filey Coast
HRA	Habitats Regulations Assessment
OWF	Offshore Wind Farm
PVA	Population Viability Analysis
sCRM	Stochastic Collision Risk Modelling
SD	Standard Deviation
SoS	Secretary of State

SPA	Special Protection Area

1 Introduction

1.1.1.1 The Secretary of State (SoS) for the Department for Energy Security and Net Zero (DESNZ) issued a Request For Information (RFI) letter to Ørsted Hornsea Project Four Limited (Hereon after referred to as "the Applicant") on the 20th March 2023. Within the RFI the SoS requested the following information be provided by the Applicant:

1.1.1.2 "In relation to collision impacts on the gannet and kittiwake features of the Flamborough and Filey Coast SPA, the Applicant is requested to provide revised mortality estimates by applying Natural England's interim avoidance rates to the collision risk models for the Project alone; and to confirm the updated in-combination totals and any changes to the counterfactual growth rate (CFGR) and counterfactual population size (CFPS) figures for these species."

1.1.1.3 In order to accommodate this request the Applicant has undertaken revised collision risk modelling (CRM) for gannet, *Morus bassanus*, and kittiwake, *Rissa tridactyla*, in accordance with the Natural England interim guidance note provided (Natural England, 2023). This report presents the revised CRM estimates apportioned to the gannet and kittiwake features of the Flamborough and Filey Coast (FFC) Special Protection Area (SPA). The revised CRM estimates are also compared to previous CRM estimates used to inform assessment conclusions through the Hornsea Four Planning Inspectorate's examination, any subsequent changes to the FFC SPA in-combination totals and associated Population Viability Analysis (PVA) results.

2 Revised Collision Risk Modelling

2.1 Methodology

2.1.1.1 The interim guidance supplied by Natural England, within Annex 1 of their formal statutory response to the SoS's request for information dated 9th February (Natural England, 2023), recommends changes in comparison to previous guidance (SNCBs, 2014) to the CRM for different seabirds. With regards to this report and in response to the SoS's request for information on gannet and kittiwake CRM the Applicant's revised CRM applied the following changes according to the Natural England interim guidance:

- Natural England are now in support of the Stochastic Collision Risk Model (sCRM) developed by Marine Scotland (Donovan, 2018) being run stochastically. Previous advice to Hornsea Four was to run the model deterministically (agreement **OFF-ORN-2.38** – as set out in Evidence Plan Logs, which are appendices to the Hornsea Four Evidence Plan (**B1.1.1: Evidence Plan** (**APP-130**));
- Avoidance rates have been revised following the evidence reviews undertaken by Cook (2021) and Ozsanlev-Harris et al. (in prep). With respect to gannet and kittiwake, the new guidance now recommends significantly higher avoidance rates than previously advocated;
- Inclusion of the seabird biometric standard deviations (SDs) within sCRM;
- A reduction in the nocturnal activity rate recommended for gannet; and
- The inclusion of consideration of macro avoidance behavior exhibited by gannets within modelling by reducing the monthly seabird density input value of gannets in flight within

the model by a range of 65% to 85% or by selecting a single rate of 70% within the sCRM.

2.1.1.2 In accordance with Natural England's interim guidance (Natural England, 2023), CRM has been modelled using the sCRM, run stochastically. A summary of the sCRM input parameters are presented in detail in **Appendix A**. All parameters remain the same as previously modelled, with the exception of the changes noted above, to inform impacts provided by the Applicant at the end of Planning Inspectorate's examination.

2.1.1.3 A summary of the predicted monthly EIA collision risk mortality values before apportionment are presented in **Appendix B** and **Appendix C**.

2.2 Apportionment of revised collision risk results to the FFC SPA

2.2.1 Apportionment approaches

2.2.1.1 Revised collision mortality rates were apportioned to the gannet and kittiwake features of the FFC SPA. Due to disagreement between the Applicant and Natural England on the most appropriate seasonal apportioning rates, predicted impacts following both parties preferred apportionment approaches are presented within this report.

2.2.1.2 For further details on the two different apportioning approaches, with any evidence in support of the approaches, are provided within **G5.25 Ornithology Environmental Impact Assessment (EIA) and Habitats Regulations Assessment (HRA) (REP6-029)** and **G4.7 Ornithological Assessment Sensitivity Report (REP6-026)**.

2.3 Revised FFC SPA apportioned CRM results

2.3.1.1 Revised CRM results following Natural England's interim guidance note (Natural England, 2023) apportioned to the gannet and kittiwake features of the FFC SPA are provided seasonally within **Table 1** to **Table 4**. For both features a comparison is provided (**Figure 1** and **Figure 2**) between the revised CRM results and those used to inform impacts at the end of Planning Inspectorate's examination following both the Applicant's and Natural England's approach.

2.3.1.2 For gannet, apportioned CRM results are provided excluding consideration of macro avoidance and considering of a 65%, 70% and 85% reduction in monthly seabird densities, as advised following Natural England's interim guidance note (Natural England, 2023).

2.3.2 Gannet

Table 1: Comparison of revised seasonal predicted collisions apportioned to the FFC SPA (Applicant's Approach).

Season	Gannet apportioned collision estimates to the FFC SPA											
	Revised apportioned CRM totals Applicant's approach				End of Examination Applicant's approach apportioned CRM totals				End of Examination Natural England's approach apportioned CRM totals			
	Excl.	65%	70%	85%	Excl.	65%	70%	85%	Excl.	65%	70%	85%
Return Migration	0.4	0.1	0.1	0.1	0.1 (+0.3)	N/A	N/A	N/A	0.1 (+0.3)	N/A	N/A	N/A
Migration-free breeding	5.0	1.7	1.5	0.7	6.7 (-1.8)	N/A	N/A	N/A	14.3 (-9.3)	N/A	N/A	N/A
Post-breeding migration	0.2	0.1	0.0	0.0	0.2 (-0.1)	N/A	N/A	N/A	0.3 (-0.1)	N/A	N/A	N/A
Annual	5.5	1.9	1.7	0.8	7.1 (-1.6)	N/A	N/A	N/A	14.6 (-9.09)	N/A	N/A	N/A

Note: Numbers in brackets refer to the difference between the End of Examination apportioned CRM totals and revised apportioned CRM totals (Applicant's approach).

Table 2: Comparison of revised seasonal predicted collisions apportioned to the FFC SPA (Natural England's Approach).

Season	Gannet apportioned collision estimates to the FFC SPA											
	Revised CRM totals Natural England's approach				End of Examination Applicant's approach apportioned CRM totals				End of Examination Natural England's approach apportioned CRM totals			
	Excl.	65%	70%	85%	Excl.	65%	70%	85%	Excl.	65%	70%	85%
Return Migration	0.3	0.1	0.1	0.0	0.1 (+0.2)	N/A	N/A	N/A	0.1 (+0.2)	N/A	N/A	N/A
Breeding	8.6	3.0	2.6	1.3	6.7 (+1.9)	N/A	N/A	N/A	14.3 (-5.6)	N/A	N/A	N/A
Post-breeding migration	0.1	0.0	0.0	0.0	0.2 (-0.1)	N/A	N/A	N/A	0.3 (-0.1)	N/A	N/A	N/A
Annual	9.1	3.2	2.7	1.4	7.1 (+2.0)	N/A	N/A	N/A	14.6 (-5.5)	N/A	N/A	N/A

Note: Numbers in brackets refer to the difference between the End of Examination apportioned CRM totals and revised apportioned CRM totals (Natural England's approach).

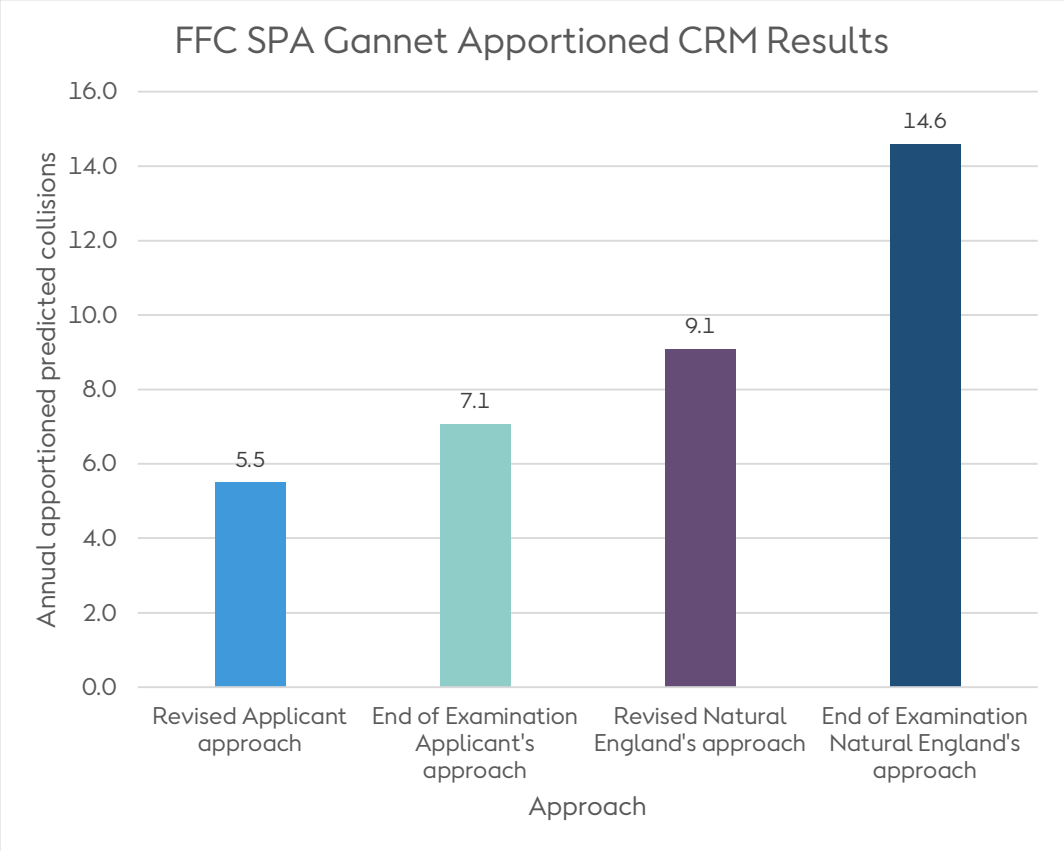

Figure 1: Graphical representation of the revised annual predicted collisions for gannet apportioned to the FFC SPA following the Applicant's and Natural England's preferred approaches.

2.3.3 Kittiwake

Table 3: Comparison of revised seasonal predicted collisions apportioned to the FFC SPA (Applicant's Approach).

Season	Kittiwake apportioned collision estimates to the FFC SPA		
	Revised apportioned CRM totals Applicant's approach	End of Examination Applicant's approach apportioned CRM totals	End of Examination Natural England's approach apportioned CRM totals
Return Migration	0.7	1.0 (-0.3)	0.3 (+0.4)
Migration-free breeding	13.8	20.6 (-6.8)	70.3 (-56.5)
Post-breeding migration	1.2	1.7 (-0.5)	0.8 (+0.5)
Annual	15.7	23.3 (-7.6)	71.4 (-55.7)

Note: Numbers in brackets refer to the difference between the End of Examination apportioned CRM totals and revised apportioned CRM totals (Applicant's approach).

Table 4: Comparison of revised seasonal predicted collisions apportioned to the FFC SPA (Natural England's Approach).

Season	Kittiwake apportioned collision estimates to the FFC SPA		
	Revised apportioned CRM totals Applicant's approach	End of Examination Applicant's approach apportioned CRM totals	End of Examination Natural England's approach apportioned CRM totals
Return Migration	0.2	1.0 (-0.8)	0.3 (-0.1)
Breeding	42.4	20.6 (+21.8)	70.3 (-27.9)
Post-breeding migration	0.5	1.7 (-1.3)	0.8 (-0.3)
Annual	43.1	23.3 (+19.8)	71.4 (-28.3)

Note: Numbers in brackets refer to the difference between the End of Examination apportioned CRM totals and revised apportioned CRM totals (Natural England's approach).

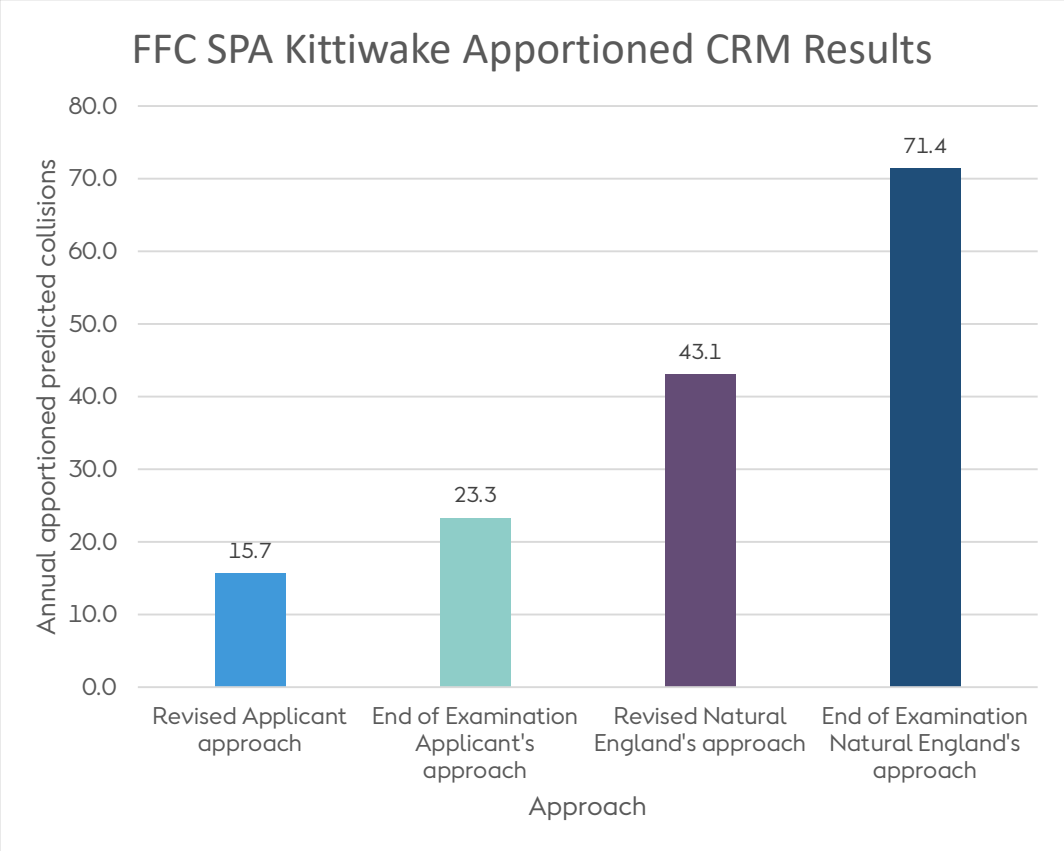

Figure 2: Graphical representation of the revised annual predicted collisions for kittiwake, apportioned to the FFC SPA.

3 Updated in-combination impacts apportioned to the FFC SPA and corresponding PVA results

3.1.1.1 The Applicant previously submitted updated in-combination totals with respect to impacts apportioned to qualifying features of the FFC SPA within Appendix D of the **G9.2 Applicant's Response to RFI dated 16 December**. Since then, one additional project (Berwick Bank offshore wind farm) has submitted a marine license application of relevance. Therefore, Hornsea Four's in-combination impact contribution has been included within **Table 5** and **Table 7** below based on the values presented within the Berwick Bank Report to Inform Appropriate Assessment (RIAA) (SSER, 2022a). With respect to the kittiwake feature of the FFC SPA, as detailed within the Berwick Bank derogation case (SSER, 2022b) the project has proposed to compensate for impacts and therefore impacts have been presented including and excluding Berwick Bank's in-combination impact contribution.

3.1.1.2 As detailed within the **G4.7 Ornithological Assessment Sensitivity Report (REP6-026)**, the Applicant ran a wide range of generic impact scenarios on the FFC SPA population for PVA to account for any potential changes in the in-combination totals through the Planning Inspectorate's Examination and pre-decision period. A summary of the closest generic impact scenario results are presented in **Table 6** and **Table Note**: *In-combination impact contribution set as zero due to the project committing to compensating for the projects level of predicted impact, which is provided in parentheses for reference.

3.1.1.3 Table 8 below for the updated in-combination totals for gannet and kittiwake, respectively. Details of the CRM parameters, model validation and appropriate model interpretation are provided in **G4.7 Ornithological Assessment Sensitivity Report (REP6-026)**.

Table 5: FFC SPA gannet in-combination bio-season and total abundance estimates from all Tier 1 &2 projects.

Project	Breeding	Autumn	Spring	Annual	Annual (including macro avoidance rate of 65%)	Annual (including macro avoidance rate of 70%)	Annual (including macro avoidance rate of 85%)	Tier
Beatrice	0.0	2.3	0.6	2.9	1.0	0.9	0.4	1a
Blyth Demonstration Site	0.0	0.1	0.2	0.3	0.1	0.1	0.0	1a
Dudgeon	22.3	1.9	1.2	25.3	8.9	7.6	3.8	1a
East Anglia One	3.4	6.3	0.4	10.1	3.5	3.0	1.5	1a
EOWDC	0.0	0.3	0.0	0.3	0.1	0.1	0.0	1a
Galloper	0.0	1.5	0.8	2.3	0.8	0.7	0.3	1a
Greater Gabbard	0.0	0.4	0.3	0.7	0.2	0.2	0.1	1a
Gunfleet Sands	-	-	-	-	-	-	-	1a
Hornsea Project One	11.5	1.5	1.4	14.4	5.0	4.3	2.2	1a
Humber Gateway	1.9	0.1	0.1	2.0	0.7	0.6	0.3	1a
Hywind 2 Demonstration	0.0	0.0	0.1	0.1	0.0	0.0	0.0	1a
Kentish Flats	0.0	0.0	0.1	0.1	0.0	0.0	0.0	1a
Kentish Flats Extension	-	-	-	-	-	-	-	1a
Kincardine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1a
Lincs, Lynn and Inner Dowsing	2.3	0.1	0.1	2.5	0.9	0.8	0.4	1a
London Array	0.0	0.1	0.1	0.2	0.1	0.1	0.0	1a
Methil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1a
Race Bank	33.7	0.6	0.3	34.5	12.1	10.4	5.2	1a
Rampion	0.0	3.1	0.1	3.2	1.1	1.0	0.5	1a
Scroby Sands	-	-	-	-	-	-	-	1a
Sheringham Shoal	14.1	0.2	0.0	14.3	5.0	4.3	2.1	1a
Teesside	2.4	0.1	0.0	2.5	0.9	0.8	0.4	1a
Thanet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1a
Westermost Rough	0.2	0.0	0.0	0.2	0.1	0.1	0.0	1a

Project	Breeding	Autumn	Spring	Annual	Annual (including macro avoidance rate of 65%)	Annual (including macro avoidance rate of 70%)	Annual (including macro avoidance rate of 85%)	Tier
Hornsea Project Two	7.0	0.7	0.4	8.0	2.8	2.4	1.2	1b
Moray East	0.0	1.7	0.6	2.3	0.8	0.7	0.3	1b
Neart na Gaoithe	0.0	2.3	1.4	3.7	1.3	1.1	0.6	1b
Seagreen Alpha & Bravo	0.0	2.4	4.1	6.4	2.2	1.9	1.0	1b
Triton Knoll	26.8	3.1	1.9	31.7	11.1	9.5	4.8	1b
Dogger Bank A & B	40.6	4.0	3.4	47.9	16.8	14.4	7.2	1c
Dogger Bank C & Sofia	7.4	0.5	0.7	8.5	3.0	2.6	1.3	1c
East Anglia Three	6.1	1.6	0.6	8.3	2.9	2.5	1.2	1c
Hornsea Three	6.4	0.2	0.3	6.9	2.4	2.1	1.0	1c
Inch Cape	0.0	1.4	0.3	1.7	0.6	0.5	0.3	1c
Moray West	0.0	0.1	0.1	0.2	0.1	0.1	0.0	1c
Norfolk Boreas	14.2	0.6	0.2	15.1	5.3	4.5	2.3	1c
Norfolk Vanguard	8.2	0.9	0.3	9.4	3.3	2.8	1.4	1c
East Anglia ONE North	12.4	0.5	0.1	13.0	4.6	3.9	2.0	1c
East Anglia TWO	12.5	1.1	0.2	13.8	4.8	4.1	2.1	1c
Total (consented projects only)	**233.4**	**39.4**	**20.1**	**292.8**	**102.5**	**87.8**	**43.9**	
Hornsea Four (Applicant's Approach)	5.0	0.2	0.4	5.5	1.9	1.7	0.8	1d
Hornsea Four (Natural England's Approach)	8.6	0.1	0.3	9.1	3.2	2.7	1.4	1d
Total Applicant's Approach (Hornsea Four plus all consented projects only)	**238.3**	**39.6**	**20.5**	**298.3**	**104.4**	**89.5**	**44.7**	

Project	Breeding	Autumn	Spring	Annual	Annual (including macro avoidance rate of 65%)	Annual (including macro avoidance rate of 70%)	Annual (including macro avoidance rate of 85%)	Tier
Total Natural England's Approach (Hornsea Four plus all consented projects only)	**242.0**	**39.6**	**20.4**	**301.9**	**105.7**	**90.6**	**45.3**	
Dudgeon Extension Project	1.4	0.1	0.0	1.6	0.6	0.5	0.2	1d
Berwick Bank	2.0	0.4	0.1	2.5	0.9	0.8	0.4	1d
Sheringham Shoal Extension Project	0.2	0.0	0.0	0.2	0.1	0.1	0.0	1d
Rampion 2	0.0	16.6	8.9	25.5	8.9	7.7	3.8	2
Total Applicant's Approach (All Projects)	**241.9**	**56.7**	**29.5**	**328.1**	**114.8**	**98.4**	**49.2**	
Total Natural England's Approach (All Projects)	**245.6**	**56.7**	**29.4**	**331.7**	**116.1**	**99.5**	**49.8**	

Table 6: FFC SPA gannet population modelling results.

Increase in mortality (per annum)	Total mortality (per annum)	Density independent counterfactual		Reduction in the final population size compared to baseline population (after 35 years)	Reduction in growth rate (per annum)
		Final population size (CFPS)	Growth rate (CFGR)		
50	2,220	0.998	0.924	0.22%	7.64%
100	2,270	0.996	0.853	0.44%	14.74%
125	2,295	0.994	0.819	0.55%	18.06%
300	2,470	0.987	0.619	1.32%	38.10%
325	2,495	0.986	0.595	1.43%	40.55%
350	2,520	0.985	0.571	1.55%	42.90%

Table 7: FFC SPA kittiwake in-combination bio-season and total abundance estimates from all Tier 1 &2 projects.

Project	Breeding	Autumn	Spring	Annual	Tier
Beatrice	0.0	0.6	2.9	3.5	1a
Blyth Demonstration Site	0.0	0.1	0.1	0.2	1a
Dudgeon	-	-	-	-	1a
East Anglia One	0.0	8.7	3.4	12.0	1a
EOWDC	0.0	0.3	0.1	0.4	1a
Galloper	0.0	1.5	2.3	3.8	1a
Greater Gabbard	0.0	0.8	0.8	1.6	1a
Gunfleet Sands	-	-	-	-	1a
Hornsea Project One	36.5	3.0	1.5	41.0	1a
Humber Gateway	1.9	0.2	0.1	2.2	1a
Hywind 2 Demonstration	0.0	0.1	0.1	0.1	1a
Kentish Flats	0.0	0.1	0.1	0.1	1a
Kentish Flats Extension	0.0	0.0	0.2	0.2	1a
Kincardine	0.0	0.5	0.1	0.6	1a
Lincs, Lynn and Inner Dowsing	0.7	0.1	0.1	0.8	1a
London Array	0.0	0.1	0.1	0.3	1a
Methil	0.0	0.0	0.0	0.0	1a
Race Bank	1.9	1.3	0.4	3.6	1a
Rampion	0.0	2.0	2.1	4.2	1a
Scroby Sands	-	-	-	-	1a
Sheringham Shoal	-	-	-	-	1a
Teesside	0.0	1.3	0.2	1.5	1a
Thanet	0.0	0.0	0.0	0.1	1a
Westermost Rough	0.1	0.0	0.0	0.1	1a
Hornsea Project Two	13.3	0.5	0.2	14.0	1b
Moray East	0.0	0.1	1.4	1.5	1b
Neart na Gaoithe	0.0	3.0	0.3	3.4	1b
Seagreen Alpha & Bravo	0.0	16.9	17.8	34.7	1b
Triton Knoll	24.6	7.5	3.3	35.4	1b

Project	Breeding	Autumn	Spring	Annual	Tier
Dogger Bank A & B	55.8	7.3	21.3	84.3	1c
Dogger Bank C & Sofia	26.4	4.9	15.6	46.9	1c
East Anglia Three	0.0	3.7	2.7	6.4	1c
Hornsea Three*	0.0 (72.0)	0.0 (2.0)	0.0 (1.0)	0.0 (75.0)	1c
Inch Cape	0.0	12.1	4.6	16.7	1c
Moray West	0.0	1.3	0.5	1.8	1c
Norfolk Boreas*	0.0 (11.4)	0.0 (1.7)	0.0 (0.9)	0.0 (14.0)	1c
Norfolk Vanguard*	0.0 (18.7)	0.0 (0.9)	0.0 (1.4)	0.0 (21.0)	1c
East Anglia ONE North*	0.0 (0.0)	0.0 (0.4)	0.0 (0.3)	0.0 (0.7)	1c
East Anglia TWO*	0.0 (0.0)	0.0 (0.3)	0.0 (0.5)	0.0 (0.8)	1c
Total (consented projects only)	**161.2 (263.3)**	**78.0 (83.3)**	**82.3 (86.4)**	**321.4 (432.9)**	
Hornsea Four (Applicant's Approach)*	0.0 (13.8)	0.0 (1.2)	0.0 (0.7)	0.0 (15.7)	1d
Hornsea Four (Natural England's Approach)*	0.0 (42.4)	0.0 (0.5)	0.0 (0.2)	0.0 (43.1)	1d
Total Applicant's Approach (Hornsea Four plus all consented projects only)	**161.2 (277.1)**	**78.0 (84.5)**	**82.3 (87.1)**	**321.4 (337.1)**	
Total Natural England's Approach (Hornsea Four plus all consented projects only)	**161.2 (305.7)**	**78.0 (83.8)**	**82.3 (86.6)**	**321.4 (476.0)**	
Dudgeon Extension Project	7.6	0.3	0.1	8.1	1d
Berwick Bank*	0.0 (0.5)	0.0 (9.7)	0.0 (13.7)	0.0 (23.9)	1d
Sheringham Shoal Extension Project	0.7	0.1	0.0	0.8	1d
Rampion 2	0.0	0.1	0.5	0.6	2
Total Applicant's Approach (All Projects)	**169.5 (285.9)**	**78.5 (94.7)**	**82.9 (101.4)**	**330.9 (370.5)**	
Total Natural England's Approach (All Projects)	**169.5 (314.5)**	**78.5 (94.0)**	**82.9 (100.9)**	**330.9 (509.4)**	

Table Note: *In-combination impact contribution set as zero due to the project committing to compensating for the projects level of predicted impact, which is provided in parentheses for reference.

Table 8: FFC SPA kittiwake population modelling results.

Increase in mortality (per annum)	Total mortality (per annum)	Density independent counterfactual		Reduction in the final population size compared to baseline population (after 35 years)	Reduction in growth rate (per annum)
		Final population size (CFPS)	Growth rate (CFGR)		
300	15,348	0.996	0.879	0.36%	12.11%
325	15,373	0.996	0.869	0.39%	13.09%
350	15,398	0.996	0.860	0.42%	14.01%

4 Discussion

4.1 Changes to predicted collision impacts values for Hornsea Four Alone

4.1.1.1 As presented in Section 2, predicted collision risk impacts apportioned to the FFC SPA gannet and kittiwake feature were lower than previously predicted, when modelling impacts following Natural England's interim guidance note (Natural England, 2023), as summarised below:

- Gannet predicted collision impacts apportioned to the FFC SPA following the Applicant's approach to apportionment was predicted to be approximately two (1.6) mortalities lower, equating to a reduction in collisions of 22.5% per annum. If macro avoidance is considered as now recommended within the Natural England's interim guidance note (Natural England, 2023), then collision impacts were found to between approximately five (5.2) to six (6.3) predicted mortalities lower, equating to a 73.2% to 88.7% per annum reduction in collisions.
- Gannet predicted collision impacts apportioned to the FFC SPA following Natural England's approach to apportionment was predicted to be approximately six (5.5) mortalities lower, equating to a reduction in collisions of 37.6% per annum. If macro avoidance is considered as now recommended within the Natural England's interim guidance note (Natural England, 2023), then collision impacts were found to between approximately 11 (11.4) to 13 (13.2) predicted mortalities lower, equating to a 78.1% to 90.4% per annum reduction in collisions.
- Kittiwake predicted collision impacts apportioned to the FFC SPA following the Applicant's approach to apportionment was predicted to be approximately eight (7.6) mortalities lower, equating to a 32.6% per annum reduction in collisions.
- Kittiwake predicted collision impacts apportioned to the FFC SPA following Natural England's approach to apportionment was predicted to be approximately 28 (28.3) mortalities lower, equating to a 39.6% per annum reduction in collisions.

4.1.1.2 In relation to the conservation objectives of the FFC SPA for the gannet and kittiwake features, as the revised collision risk modelling resulted in reductions in predicted impacts, the Applicant's position remains unchanged that an Adverse Effect on Integrity (AEoI) can be confidently ruled out in relation to predicted impact from Hornsea Four alone.

4.2 Changes to predicted collision impact values for Hornsea Four in-combination

4.2.1.1 As detailed in Section 3, excluding changes in Hornsea Four's predicted impacts, the only other changes to the in-combination totals since examination was the addition of Berwick Bank.

4.2.1.2 In relation to gannet, the in-combination collision impact totals have reduced slightly (approximately six mortalities per annum at most) since examination. Given the minor reduction, the Applicant's position remains unchanged that an AEoI can be confidently ruled out in relation to predicted impact from Hornsea Four in-combination with other projects.

4.2.1.3 In relation to kittiwake, during examination the Applicant concluded an AEoI in relation to predicted impacts from Hornsea Four in-combination with other projects (AS-023). Although the revised modelling has resulted in a significant reduction in Hornsea Four's contribution to

any in-combination total, the predicted impact can still be considered material. Therefore, the Applicant's position remains unchanged.

5 References

Donovan, C. (2018) Stochastic Band CRM – GUI User Manual, Draft V1.0, 31/03/2017.

Natural England (2023). Natural England SoS Consultation Response. Annex 1: Interim guidance on collision risk modelling avoidance rates.

JNCC, NE, SNH, NRW, NIEA. (2014) Joint Response from the Statutory Nature Conservation Bodies to the Marine Scotland Science Avoidance Rate Review.

SSER (2022a). Berwick Bank Wind Farm Report To Inform Appropriate Assessment. Part Three: Special Protection Areas.

SSER (2022b). Berwick Bank Wind Farm Derogation Case.

Appendix A Collision Risk Input Parameters

Table A1: Maximum Design Scenario for Hornsea Four Wind Turbine Generator Parameters used for revised CRM for gannet and kittiwake.

Input Parameter (units in brackets)	Central Estimate	SD	Source/document references
Number of Turbines	180	-	APP-076
Hub Height (m)	190.22 (HAT)	-	APP-076
	192.50 (MSL)	-	APP-076
Number of Blades	3	-	APP-076
Rotor Radius (m)	152.5	-	APP-076
Air Gap (m)	37.72 (HAT)	-	APP-076
	40.00 (MSL)	-	APP-076
Maximum Blade Width (m)	6	-	APP-076
Tidal Offset (m)	2.28	-	APP-076
Wind Farm Width (km)	37.75	-	APP-076
Latitude (degrees)	54.11	-	APP-076
Rotation speed (rpm)	6.5	±0.2	APP-076
Large Array Correction	Yes	-	Standard procedure.
Pitch (o)	4.6	±1.0	APP-076
Wind speed (ms-1)	11.2	±0.5	APP-076

Table A2: Theoretical operational time of Hornsea Four turbines as provided by the Applicant.

Month	Wind Availability (%)
January	92.15
February	92.58
March	92.42
April	91.46
May	91.25
June	90.04
July	89.87
August	90.49
September	91.75
October	92.61
November	92.60
December	92.45

Table A3: Gannet sampled bird input parameters for revised sCRM.

Input Parameter	Estimate	SD
Body Length (m)	0.94	0.0325
Wingspan (m)	1.72	0.0375
Flight Speed (ms-1)	14.9	0
Nocturnal Activity	0.08	0.1
Flight Type	Flapping	-
Site-specific PCH/Proportion at PCH	0.0284	-
Basic Avoidance Rates	0.993	0.0003
Extended Avoidance Rates	1	0

Table A4: Kittiwake sampled bird input parameters for revised sCRM.

Input Parameter	Estimate	SD
Body Length (m)	0.39	0.005
Wingspan (m)	1.08	0.0625
Flight Speed (ms-1)	13.1	0.4
Nocturnal Activity	0.375	0.0637
Flight Type	Flapping	-
Site-specific PCH/Proportion at PCH	0.0038	-
Basic Avoidance Rates	0.993	0.0003
Extended Avoidance Rates	1	0

Table A5: Monthly densities of birds in flight – Gannet

Month	Mean Density (Birds/km^2)	SD
January	0.025	1.882
February	0.034	0.031
March	0.180	0.052
April	0.063	0.023
May	0.096	0.161
June	0.453	0.072
July	0.448	0.109
August	0.394	0.086
September	0.156	0.039
October	0.167	0.037
November	0.643	0.120
December	0.155	0.047

Table A6: Monthly densities of birds in flight – Gannet 65% macro avoidance

Month	Mean Density (Birds/km²)	SD
January	0.009	0.659
February	0.012	0.011
March	0.063	0.018
April	0.022	0.008
May	0.034	0.056
June	0.159	0.025
July	0.157	0.038
August	0.138	0.030
September	0.055	0.013
October	0.059	0.013
November	0.225	0.042
December	0.054	0.016

Table A7: Monthly densities of birds in flight – Gannet 70% macro avoidance

Month	Mean Density (Birds/km²)	SD
January	0.008	0.565
February	0.010	0.009
March	0.054	0.016
April	0.019	0.007
May	0.029	0.048
June	0.136	0.022
July	0.134	0.033
August	0.118	0.026
September	0.047	0.012
October	0.050	0.011
November	0.193	0.036
December	0.047	0.014

Table A8: Monthly densities of birds in flight – Gannet 85% macro avoidance

Month	Mean Density (Birds/km²)	SD
January	0.004	0.282
February	0.005	0.005
March	0.027	0.008
April	0.009	0.003
May	0.014	0.024
June	0.068	0.011
July	0.067	0.016
August	0.059	0.013
September	0.023	0.006
October	0.025	0.006
November	0.097	0.018
December	0.023	0.007

Table A9: Monthly densities of birds in flight – Kittiwake

Month	Mean Density (Birds/km²)	SD
January	0.292	0.084
February	0.307	0.098
March	0.375	0.059
April	0.940	0.533
May	1.638	0.601
June	1.674	0.325
July	0.771	0.136
August	2.556	0.799
September	0.295	0.295
October	0.130	0.031
November	0.379	0.098
December	0.956	0.542

Appendix B Gannet monthly collision rates – Revised sCRM outputs

Table B1: Monthly gannet collision risk estimates excluding Macro Avoidance.

Month	Mean	Mean - 1SD	Mean + 1SD	Lower CI (2.5%)	Upper CI (97.5%)
Jan	4.525	1.078	7.972	0.203	13.580
Feb	0.134	0.050	0.218	0.010	0.328
Mar	0.749	0.518	0.980	0.312	1.207
Apr	0.291	0.181	0.401	0.082	0.507
May	0.927	0.301	1.553	0.052	2.354
Jun	2.474	2.049	2.899	1.720	3.341
Jul	2.453	1.832	3.074	1.220	3.682
Aug	1.974	1.512	2.436	1.136	2.998
Sep	0.678	0.500	0.856	0.339	1.038
Oct	0.637	0.479	0.795	0.351	0.976
Nov	2.027	1.520	2.534	1.218	3.205
Dec	0.447	0.291	0.603	0.177	0.825

Table B2: Monthly gannet collision risk estimates including 65% Macro Avoidance.

Month	Mean	Mean - 1SD	Mean + 1SD	Lower CI (2.5%)	Upper CI (97.5%)
Jan	1.582	0.329	2.835	0.051	4.467
Feb	0.048	0.017	0.079	0.003	0.118
Mar	0.266	0.182	0.350	0.106	0.432
Apr	0.102	0.064	0.140	0.030	0.185
May	0.318	0.106	0.530	0.013	0.792
Jun	0.870	0.723	1.017	0.583	1.149
Jul	0.861	0.638	1.084	0.448	1.346
Aug	0.697	0.536	0.858	0.407	1.029
Sep	0.239	0.178	0.300	0.116	0.368
Oct	0.226	0.169	0.283	0.120	0.342
Nov	0.706	0.534	0.878	0.424	1.094
Dec	0.158	0.101	0.215	0.066	0.282

Table B3: Monthly gannet collision risk estimates including 70% Macro Avoidance.

Month	Mean	Mean - 1SD	Mean + 1SD	Lower CI (2.5%)	Upper CI (97.5%)
Jan	1.438	0.313	2.563	0.057	4.057
Feb	0.040	0.016	0.064	0.004	0.094
Mar	0.228	0.155	0.301	0.091	0.382
Apr	0.089	0.056	0.122	0.027	0.159
May	0.281	0.086	0.476	0.014	0.730
Jun	0.735	0.606	0.864	0.494	1.009
Jul	0.743	0.552	0.934	0.377	1.111
Aug	0.595	0.450	0.740	0.326	0.888
Sep	0.206	0.150	0.262	0.108	0.327
Oct	0.193	0.142	0.244	0.101	0.306
Nov	0.605	0.449	0.761	0.350	0.990
Dec	0.136	0.085	0.187	0.048	0.240

Table B4: Monthly gannet collision risk estimates including 85% Macro Avoidance.

Month	Mean	Mean - 1SD	Mean + 1SD	Lower CI (2.5%)	Upper CI (97.5%)
Jan	0.690	0.165	1.215	0.029	1.997
Feb	0.020	0.007	0.033	0.002	0.049
Mar	0.113	0.078	0.148	0.049	0.189
Apr	0.044	0.027	0.061	0.011	0.076
May	0.141	0.045	0.237	0.008	0.354
Jun	0.373	0.310	0.436	0.262	0.509
Jul	0.368	0.282	0.454	0.199	0.528
Aug	0.296	0.228	0.364	0.166	0.428
Sep	0.102	0.075	0.129	0.052	0.155
Oct	0.097	0.072	0.122	0.053	0.150
Nov	0.302	0.227	0.377	0.183	0.487
Dec	0.068	0.044	0.092	0.027	0.119

Appendix C Kittiwake Monthly Collision Rates – Revised sCRM outputs

Table C1: Monthly kittiwake collision risk estimates.

Month	Mean	Mean - 1SD	Mean + 1SD	Lower CI (2.5%)	Upper CI (97.5%)
Jan	1.264	0.88	1.65	0.54	2.07
Feb	1.285	0.86	1.71	0.45	2.18
Mar	1.909	1.58	2.24	1.25	2.62
Apr	5.301	2.64	7.96	0.57	10.54
May	9.579	6.06	13.10	2.91	16.69
Jun	9.59	7.66	11.52	6.00	13.32
Jul	4.51	3.67	5.36	2.90	6.17
Aug	14.03	9.48	18.59	5.37	23.44
Sep	1.851	0.65	3.06	0.10	4.55
Oct	0.639	0.48	0.80	0.33	0.95
Nov	1.644	1.21	2.08	0.83	2.50
Dec	4.241	2.14	6.34	0.67	8.43