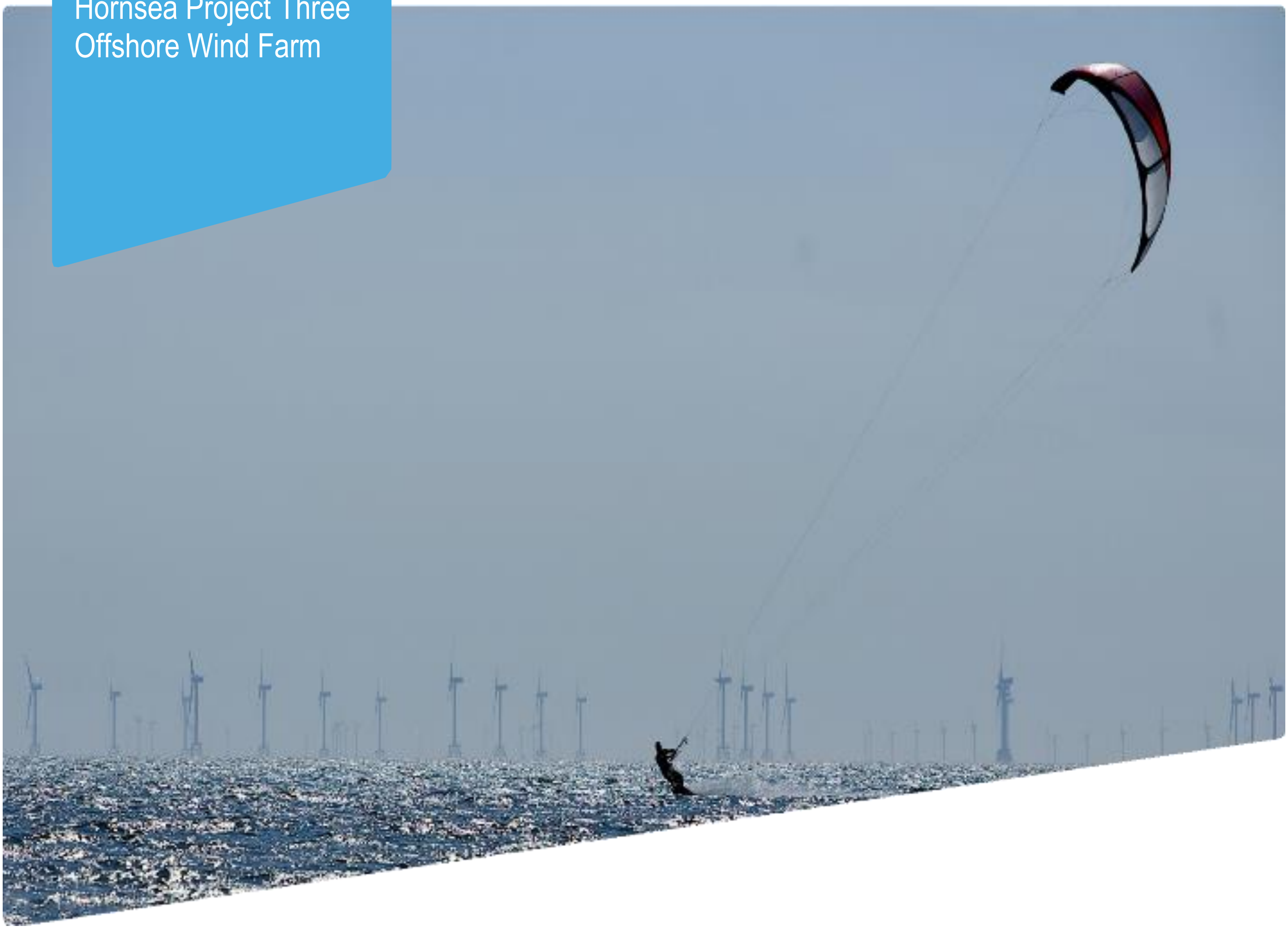
Hornsea Project Three
Offshore Wind Farm



Hornsea Project Three

Offshore Wind Farm

Appendix 19 to Deadline 9 submission – Response to ExA FQ3.1 Rule 17 – Collision Risk Modelling

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Table of Contents

1. Introduction

1.1 This report presents the information requested by the Examining Authority as part of reference F3.1 in PD-020 in relation to collision risk modelling. Collision risk estimates are presented for the four species for which collision risk modelling was conducted as part of the Hornsea Three application (APP-051 and APP-065) (gannet, kittiwake, lesser black-backed gull and great black-backed gull) and herring gull which was considered during the examination (REP1-189). Collision risk impacts are considered at an EIA scale for all species and at a RIAA scale in relation to impacts on FFC SPA for relevant species. These impacts are considered against relevant reference populations and compared to the outputs from Population Viability Analysis, where relevant.

2. Methodology

Overview

2.1 The parameters used for collision risk modelling have been set out by the Examining Authority in PD-020 and are presented here for clarity.

Species parameters

Bird biometric and behavioural data

2.2 Table 2.1 presents the species-specific parameters for each species used in collision risk modelling.

Table 2.1: Seabird parameters used for collision risk modelling.

Parameter	Gannet	Kittiwake	Lesser black-backed gull	Herring gull	Great black-backed gull
Bird length (m)	0.94	0.39	0.58	0.60	0.71
Wingspan (m)	1.72	1.08	1.42	1.44	1.58
Flight speed (m/s)	14.9	13.1	13.1	12.8	13.7
Nocturnal activity factor	1-2	2-3	3	3	3
Flight type	Flapping	Flapping	Flapping	Flapping	Flapping
Proportion of flights upwind	50	50	50	50	50
Avoidance rate (%)	99.5	99.0	99.3	99.3	99.3

Density data

2.3 The density data used for collision risk modelling has been taken from aerial surveys only and is consistent with the density data used by the Applicant in REP7-031.

Hornsea Three design and turbine parameters

2.4 The turbine design scenario used in collision risk modelling is consistent with that used for collision risk modelling presented in APP-109 for the original turbine scenario (33.17 m lower rotor tip height) and REP7-031 for the two mitigation scenarios (lower rotor tip heights of 37.5 m and 40 m) (Table 2.2 and Table 2.3). The three lower tip heights (33.17, 37.5 and 40 m (MSL)) are included in Table 2.2 as the corresponding hub heights.

Table 2.2: Wind farm and turbine parameters used for collision risk modelling.

Parameter	Value
Wind farm	
Latitude (degrees)	53.87
Number of turbines	300
Tidal offset (m)	1.8
Turbine	
Average rotational speed (rpm)	8.1
Rotor radius (m)	97.5
Hub height (m)	128.87 / 133.2 / 135.7 (HAT)
Max blade width (m)	6
Average pitch (°)	4.3

Table 2.3: Monthly proportion of time turbines at Hornsea Three will be operational.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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

Apportioning and seasonality

2.5 In order to identify the potential impact on species that are qualifying features of FFC SPA it is necessary to apportion impacts on a seasonal basis. The Examining Authority has identified apportioning rates and seasonal definitions in PD-020 and these are applied where relevant. The rates and definitions used are summarised in Table 2.4. The Examining Authority has provided non-breeding seasons and identified Furness (2015) as the publication from which these are taken. For the purposes of apportioning these non-breeding seasons have been split into post-breeding and pre-breeding seasons following the definitions for the autumn and spring migration periods defined in Furness (2015) minus any months included in the breeding seasons defined by the Examining Authority in PD-020.

Table 2.4: Seasonal definitions and apportioning rates used in analyses

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Gannet	Pre-breeding = 6.2%		Breeding = 63.3%							Post-breeding = 4.8%		
Kittiwake	Pre-breeding = 7.2%		Breeding = 41.7%						Post-breeding = 5.4%			

3. Results

3.1 Predicted collision rates are presented utilising the model Options of Band (2012) identified by the Examining Authority in PD-020, which are:

- Option 1:
  - Gannet
  - Kittiwake
- Option 3:
  - Lesser black-backed gull
  - Herring gull
  - Great black-backed gull

3.2 When using Option 1 there is no reduction in collision risk estimates when moving from a rotor with a 37.5 m lower tip height (at MSL) and one with a 40 m lower tip height as there would be no change in the proportion of birds at collision height (PCH) value for these lower tip heights. Boat-based data were assigned to 5 m bands and consequently lower rotor heights of 37.5 and 40 m fall within the same band and therefore indicate the same proportion of birds at potential collision height for both scenarios (although, in practice, fewer birds would be expected to be at risk for the 40m scenario). In order to provide consideration of variability in flight height data, the approach described in paragraph 1.3.4.7 in APP-109 has been applied for each turbine scenario, where relevant.

3.3 As requested in PD-020, collision risk estimates calculated using Option 3 are presented for lesser black-backed gull, herring gull and great black-backed gull. Flight height distributions for these species have been taken from Johnston *et al.* (2014).

3.4 The range of collision risk estimates presented for gannet and kittiwake describe the estimates obtained when using the range of nocturnal activity factors. Where a range is not presented this is due to the values being the same when applying the different assumptions.

3.5 In the following results tables the increase in baseline mortality is considered for the mean collision risk estimates and the upper and lower confidence limits associated with either density of flight height data. The baseline mortality values are provided for whichever of these two parameters (density or flight height data) provides the largest range.

Gannet

3.6 Collision risk estimates for gannet on an EIA scale and in relation to FFC SPA at an RIAA scale are presented in Table 3.1 and Table 3.2 for lower rotor tip heights of 33.17 m and 37.5 and 40 m, respectively.

Table 3.1: Collision risk estimates for gannet calculated using Option 1 and using a turbine with a 33.17 m lower rotor tip height

Collision risk estimates	EIA	RIAA
Annual collision rate – variability associated with density values		
LCL	5-6	2
Mean	8-10	3-4
UCL	11-14	4-5
Annual collision rate – variability associated with flight height data		
LCL	-	-
Mean	8-10	3-4
UCL	24-30	9-11
% increase in baseline mortality using largest range of variability (density or flight height distribution)		
LCL	-	-
Mean	0.02-0.03	0.23-0.27
UCL	0.06-0.08	0.68-0.80
PVA (CPS 35)		
LCL	N/A	
Mean	N/A	0.997-0.998
UCL	N/A	0.992-0.993
PVA (CGR)		
LCL	N/A	-
Mean	N/A	1.000
UCL	N/A	1.000

Table 3.2: Collision risk estimates for gannet calculated using Option 1 applicable to turbines with 37.5 and 40 m lower rotor tip heights

Collision risk estimates	EIA	RIAA
Annual collision rate – variability associated with density values		
LCL	5-6	2
Mean	8-10	3-4
UCL	11-14	4-5
Annual collision rate – variability associated with flight height data		
LCL	-	-
Mean	8-10	3-4
UCL	8-10	3-4
% increase in baseline mortality using largest range of variability		
LCL	0.01-0.02	0.13-0.15
Mean	0.02-0.03	0.23-0.27
UCL	0.03-0.04	0.33-0.38
PVA (CPS 35)		
LCL	N/A	0.998
Mean	N/A	0.997-0.998
UCL	N/A	0.996-0.997
PVA (CGR)		
LCL	N/A	1.000
Mean	N/A	1.000
UCL	N/A	1.000

3.7 The conclusions reached in relation to collision risk impacts on gannet in APP-065 were based on collision risk estimates calculated using Options 1 and 3 of the Band (2012) CRM. This provided annual collision risk estimates of 17 and 15 birds respectively. The collision risk modelling undertaken for this report predicts impacts of 8-10 collisions/annum when using any of the three lower rotor tip heights. This is therefore lower than that predicted in APP-065 (due to the avoidance rates applied). A conclusion of negligible significance was reached in APP-065 and this is also considered applicable to the collision risk estimates calculated in this report.

3.8 The cumulative assessment for gannet in APP-065 predicted an impact of minor or moderate adverse significance. Whilst it is considered that this conclusion will remain applicable to the cumulative collision impact on gannet regardless of the predicted magnitude of impact from Hornsea Three both in APP-065 and this report, the collision risk estimates calculated in this report are not considered to materially contribute to the current level of cumulative collision mortality.

3.9 In APP-051 an annual impact of between 3 and 4 collisions was predicted on FFC SPA when using Options 3 and 1 respectively. This is identical to the range of collision risk estimates predicted in this report and therefore the conclusion of no adverse effect on the integrity of FFC SPA, as reached in APP-051, would also be drawn for the collision risk estimates in this report.

3.10 As the number of collisions is identical between APP-051 and this report the conclusions in relation to in-combination impacts on FFC SPA in APP-051 are also considered to remain unchanged, although the Applicant would suggest that at the impact magnitude predicted that the level of effect from Hornsea Three could be considered to not materially contribute to the current level of in-combination mortality.

Kittiwake

3.11 Collision risk estimates for kittiwake on an EIA scale and in relation to FFC SPA at an RIAA scale are presented in Table 3.3 and Table 3.4 for lower rotor tip heights of 33.17 m and 37.5 and 40 m, respectively.

Table 3.3: Collision risk estimates for gannet calculated using Option 1 and using a turbine with a 33.17 m lower rotor tip height

Collision risk estimates	EIA	RIAA
Annual collision rate – variability associated with density values		
LCL	27-32	8-9
Mean	43-51	13-15
UCL	62-74	18-21
Annual collision rate – variability associated with flight height data		
LCL	-	
Mean	43-51	13-15
UCL	98-116	29-33
% increase in baseline mortality using largest range of variability		
LCL	-	
Mean	0.04	0.10-0.11
UCL	0.08-0.10	0.22-0.25
PVA (CPS 35)		
LCL	N/A	-
Mean	N/A	0.994-0.995
UCL	N/A	0.987-0.989
PVA (CGR)		
LCL	N/A	-
Mean	N/A	1.000
UCL	N/A	0.999

Table 3.4: Collision risk estimates for kittiwake calculated using Option 1 applicable to turbines with 37.5 and 40 m lower rotor tip heights

Collision risk estimates	EIA	RIAA
Annual collision rate – variability associated with density values		
LCL	20-24	6-7
Mean	33-39	10-11
UCL	46-55	14-16
Annual collision rate – variability associated with flight height data		
LCL	-	-
Mean	33-39	10-11
UCL	43-51	13-15
% increase in baseline mortality using largest range of variability		
LCL	0.02	0.05
Mean	0.03	0.07-0.08
UCL	0.04-0.05	0.10-0.12
PVA (CPS 35)		
LCL	N/A	0.997-0.998
Mean	N/A	0.996
UCL	N/A	0.994-0.995
PVA (CGR)		
LCL	N/A	1.000
Mean	N/A	1.000
UCL	N/A	1.000

3.12 The conclusions reached in relation to collision risk impacts on kittiwake in APP-065 were based on collision risk estimates calculated using Options 1 and 3 of the Band (2012) CRM. This provided annual collision risk estimates of 33 and 83 birds respectively. The collision risk modelling undertaken for this report predicts impacts of 43-51 collisions/annum when using a 33.17 m lower rotor tip height or 33-39 birds when using a 37.5 m or 40 m lower tip height. This is therefore lower than that predicted using Option 3 in APP-065 and lower than or similar to that predicted using Option 1. A conclusion of minor significance was reached in APP-065 and this is also considered applicable to the collision risk estimates calculated in this report.

3.13 The cumulative assessment for kittiwake in APP-065 predicted an impact of minor adverse significance. It is considered that this conclusion will remain applicable to the cumulative collision impact on kittiwake when using the collision risk estimates for Hornsea Three calculated in this report.

3.14 In APP-051 an annual impact of between 8 and 20 collisions was predicted on FFC SPA when using Options 1 and 3 respectively. The collision risk estimates calculated in this report are similar to those calculated in APP-051 and therefore the conclusion of no adverse effect reached in APP-051 remains unchanged.

3.15 As the number of collisions is similar between APP-051 and this report the conclusions in relation to in-combination impacts on FFC SPA in APP-051 are also considered to remain unchanged.

3.16 The Applicant would highlight that the impact predicted for Hornsea Three when using a lower rotor tip height of 37.5 m (and a 40 m lower rotor tip height) is similar to that predicted for the Hornsea Project Two offshore wind farm (14.2 collisions). This level of impact was considered by Natural England for that project to be so small as to not materially alter the significance of the overall in-combination mortality figure or the likelihood of an adverse effect on the integrity of the SPA (this was stated in Appendix Q to the Deadline 7 submission of the Hornsea Project Two examination which was submitted as REP2-023).

Lesser black-backed gull

3.17 Collision risk estimates for lesser black-backed gull on an EIA scale are presented in Table 3.5 Table 3.6 and Table 3.7 for lower rotor tip heights of 33.17, 37.5 and 40 m, respectively.

Table 3.5: Collision risk estimates for lesser black-backed gull calculated using Option 1 and using a turbine with a 33.17 m lower rotor tip height

Collision risk estimates	EIA
Annual collision rate – variability associated with density values	
LCL	2
Mean	7
UCL	13
Annual collision rate – variability associated with flight height data	
LCL	3
Mean	7
UCL	22
% increase in baseline mortality using largest range of variability	
LCL	0.01
Mean	0.03
UCL	0.09

Table 3.6: Collision risk estimates for lesser black-backed gull calculated using Option 1 and using a turbine with a 37.5 m lower rotor tip height

Collision risk estimates	EIA
Annual collision rate – variability associated with density values	
LCL	2
Mean	6
UCL	9
Annual collision rate – variability associated with flight height data	
LCL	2
Mean	6
UCL	18
% increase in baseline mortality using largest range of variability	
LCL	0.01
Mean	0.02
UCL	0.07

Table 3.7: Collision risk estimates for lesser black-backed gull calculated using Option 1 and using a turbine with a 40 m lower rotor tip height

Collision risk estimates	EIA
Annual collision rate – variability associated with density values	
LCL	1
Mean	5
UCL	8
Annual collision rate – variability associated with flight height data	
LCL	2
Mean	5
UCL	16
% increase in baseline mortality using largest range of variability	
LCL	0.01
Mean	0.02
UCL	0.07

3.18 The conclusions reached in relation to collision risk impacts on lesser black-backed gull in APP-065 were based on collision risk estimates calculated using Options 1 and 3 of the Band (2012) CRM. This provided annual collision risk estimates of 12 and 14 birds respectively. The collision risk modelling undertaken for this report predicts impacts of 5, 6 and 7 collisions/annum when using the 40, 37.5 and 33.17 m lower rotor tip heights respectively. This is therefore lower than that predicted in APP-065. A conclusion of minor significance was reached in APP-065 and this is also considered applicable to the collision risk estimates calculated in this report.

3.19 The cumulative assessment for lesser black-backed gull in APP-065 predicted an impact of moderate adverse significance. Whilst it is considered that this conclusion will remain applicable to the cumulative collision impact on lesser black-backed gull regardless of the predicted magnitude of impact from Hornsea Three both in APP-065 and this report, the collision risk estimates calculated in this report are not considered to materially contribute to the current level of cumulative collision mortality.

Herring gull

3.20 Collision risk estimates for herring gull on an EIA scale are presented in Table 3.8, Table 3.9 and Table 3.10 for lower rotor tip heights of 33.17, 37.5 and 40 m, respectively.

Table 3.8: Collision risk estimates for herring gull calculated using Option 1 and using a turbine with a 33.17 m lower rotor tip height

Collision risk estimates	EIA
Annual collision rate – variability associated with density values	
LCL	1
Mean	4
UCL	9
Annual collision rate – variability associated with flight height data	
LCL	3
Mean	4
UCL	10
% increase in baseline mortality using largest range of variability	
LCL	<0.01
Mean	0.01
UCL	0.01

Table 3.9: Collision risk estimates for herring gull calculated using Option 1 and using a turbine with a 37.5 m lower rotor tip height

Collision risk estimates	**EIA**
Annual collision rate – variability associated with density values	
LCL	0
Mean	3
UCL	7
Annual collision rate – variability associated with flight height data	
LCL	2
Mean	3
UCL	9
% increase in baseline mortality using largest range of variability	
LCL	<0.01
Mean	<0.01
UCL	0.01

Table 3.10: Collision risk estimates for herring gull calculated using Option 1 and using a turbine with a 40 m lower rotor tip height

Collision risk estimates	EIA
Annual collision rate – variability associated with density values	
LCL	0
Mean	3
UCL	6
Annual collision rate – variability associated with flight height data	
LCL	2
Mean	3
UCL	8
% increase in baseline mortality using largest range of variability	
LCL	<0.01
Mean	<0.01
UCL	0.01

3.21 Herring gull was not assessed in APP-065 as the species was not identified as a Valued Ornithological Receptor in APP-107. Following a request from the RSPB, collision risk modelling was conducted for herring gull in REP1-189. The collision risk estimates for herring gull calculated in REP1-189 ranged between six and eight birds when using any of the three Band model Options. The collision risk modelling undertaken for this report predicts impacts of three of four collisions/annum when using the different lower tip heights. This is therefore lower than that predicted in REP1-189. REP1-189 considered that there would be no significant impact on herring gull as a result of collision risk impacts associated with Hornsea Three. This conclusion remains unchanged based on the collision risk estimates presented in this report.

3.22 The most recent appraisal of cumulative collision risk impacts on herring gull is presented as part of the consent application for the Moray West offshore wind farm (Moray Offshore Windfarm (West) Limited, 2018). This provides a total cumulative mortality of 406 collisions/annum. It is considered that the collision risk estimates calculated in this report do not materially contribute to the current level of cumulative collision mortality.

Great black-backed gull

3.23 Collision risk estimates for great black-backed gull on an EIA scale are presented in Table 3.11, Table 3.12 and Table 3.13 for lower rotor tip heights of 33.17, 37.5 and 40 m, respectively.

Table 3.11: Collision risk estimates for great black-backed gull calculated using Option 1 and using a turbine with a 33.17 m lower rotor tip height

Collision risk estimates	EIA
Annual collision rate – variability associated with density values	
LCL	10
Mean	33
UCL	57
Annual collision rate – variability associated with flight height data	
LCL	23
Mean	33
UCL	80
% increase in baseline mortality using largest range of variability	
LCL	0.36
Mean	0.52
UCL	1.26

Table 3.12: Collision risk estimates for great black-backed gull calculated using Option 1 and using a turbine with a 37.5 m lower rotor tip height

Collision risk estimates	EIA
Annual collision rate – variability associated with density values	
LCL	8
Mean	26
UCL	45
Annual collision rate – variability associated with flight height data	
LCL	18
Mean	26
UCL	69
% increase in baseline mortality using largest range of variability	
LCL	0.27
Mean	0.41
UCL	1.08

Table 3.13: Collision risk estimates for great black-backed gull calculated using Option 1 and using a turbine with a 40 m lower rotor tip height

Collision risk estimates	EIA
Annual collision rate – variability associated with density values	
LCL	7
Mean	23
UCL	39
Annual collision rate – variability associated with flight height data	
LCL	15
Mean	23
UCL	63
% increase in baseline mortality using largest range of variability	
LCL	0.23
Mean	0.35
UCL	0.99

3.24 The conclusions reached in relation to collision risk impacts on great black-backed gull in APP-065 were based on collision risk estimates calculated using Options 1 and 3 of the Band (2012) CRM. This provided annual collision risk estimates of 32 and 52 birds respectively. The collision risk modelling undertaken for this report predicts impacts of 23, 26 and 33 collisions/annum when using the 40, 37.5 and 33.17 m lower rotor tip heights respectively. This is therefore similar to or lower than that predicted in APP-065. A conclusion of minor significance was reached in APP-065 and this is also considered applicable to the collision risk estimates calculated in this report.

3.25 The cumulative assessment for great black-backed gull in APP-065 predicted an impact of moderate adverse significance. It is considered that this conclusion remains applicable to the cumulative collision impact on great black-backed gull regardless of the predicted magnitude of impact from Hornsea Three both in APP-065 and this report.

3.26 A cumulative impact similar to that predicted in the assessments for Hornsea Three has previously been considered during the examination for the Hornsea Project Two offshore wind farm (see REP9-024). Natural England, using a cumulative impact of 679 collisions/annum, concluded that an impact of this magnitude could be considered unlikely to give rise to a significant effect at a North Sea population scale.

4. References

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