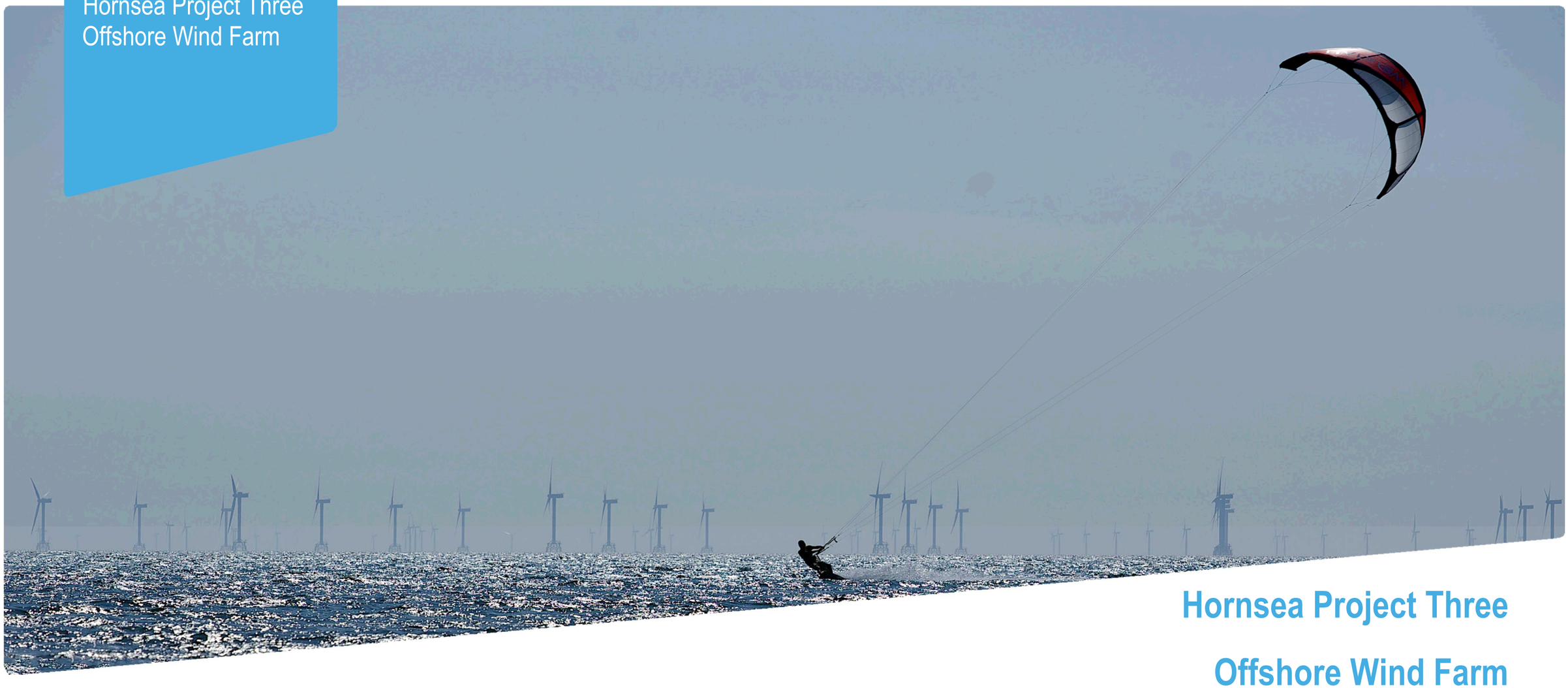
Hornsea Project Three
Offshore Wind Farm



Hornsea Project Three

Offshore Wind Farm

Environmental Statement:
Volume 5, Annex 5.2 - Analysis of Displacement Impacts on Seabirds

PINS Document Reference: A6.5.5.2
AFPF Regulation 5(2)(a)

Date: May 2018

Hornsea 3
Offshore Wind Farm

Ørsted

Environmental Impact Assessment

Environmental Statement

Volume 5

Annex 5.2 - Analysis of displacement impacts on seabirds

Report Number: A6.5.5.2

Version: Final

Date: May 2018

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1. Analysis of displacement impacts on seabirds

1.1 Introduction

1.1.1.1 The presence of wind turbines has the potential to directly disturb and displace birds from within and around Hornsea Three. This in effect represents indirect habitat loss which would reduce the area available for feeding, loafing and moulting for seabird species that may occur at Hornsea Three.

1.1.1.2 This Annex presents data to inform assessments presented in Volume 2, Chapter 5: Offshore Ornithology which determine the significance of displacement impacts. The analyses presented in this Annex have been informed by recent guidance published jointly by the UK Statutory Nature Conservation Bodies (SNCBs)[1] (JNCC *et al.,* 2017).

1.1.1.3 Only displacement impacts associated with the wind farm array area are considered in this Annex. For disturbance/displacement impacts associated with the export cable, including those on red-throated diver, common scoter and Sandwich tern, see Volume 2, Chapter 5: Offshore Ornithology.

1.2 Background

1.2.1.1 Many groups of seabirds exhibit species-specific behavioural responses to operational offshore wind farms. These responses generally constitute an avoidance reaction in response to rotating turbines or vessel movements. Such a response can result in indirect habitat loss as species avoid areas in which operational wind farms are present (Maclean *et al.,* 2009; Langston, 2010). The vulnerability of the Valued Ornithological Receptors (VORs) identified in Annex 5.1: Baseline Characterisation Report to displacement effects is shown in Table 1.1 with this information derived from Wade *et al.* (2016) or Garthe and Hüppop (2004). Also included in Table 1.1 is the uncertainty level associated with the vulnerability scores from Wade *et al.* (2016). The uncertainty levels were defined by Wade *et al* (2016) based on the quantity and quality of available data informing the respective vulnerability score. These uncertainty levels are considered as part of the process to identify VORs for inclusion in displacement analyses.

Table 1.1: Vulnerability of Valued Ornithological Receptors (VORs) to displacement from structures (Wade *et al.,* 2016; Garthe and Hüppop, 2004)[2].

Species	Vulnerability	Uncertainty Level (Wade *et al.,* 2016)
Fulmar	Very Low	High
Gannet	High	Very low
Arctic skua	Very Low	Very High
Great skua	Very Low	High
Puffin	Moderate	Moderate
Razorbill	High	Very low
Guillemot	High	Very low
Common tern	Low	Low
Arctic tern	Low	Moderate
Kittiwake	Low	Very Low
Little gull	Very Low	Not included in Wade *et al.* (2016)
Lesser black-backed gull	Low	Very low
Great black-backed gull	Low	Very low

1.2.1.2 Displacement may impact bird populations by affecting site usage which may be for foraging, resting or moulting purposes. As a result of displacement an individual bird may experience a decrease in fitness, due to the effect of re-locating to alternative foraging grounds and/or changes to energy budgets due to the increased energy expenditure when avoiding a wind farm. These impacts, in turn, may have indirect effects on birds in areas that may be some distance from the wind farm including reduced energy acquisition as a result of increased competition at other foraging sites which can result in further reductions in fitness affecting reproductive success. However, due to limited empirical evidence quantifying the likely energetic consequences of displacement, Statutory Nature Conservation Bodies advice is to consider displacement impacts in terms of direct mortality on bird populations (JNCC *et al.,* 2017). While this advice has been followed within this Annex it is noted that it represents an approach that is considerably precautionary.

[1] Comprising Natural Resources Wales, Department of Agriculture Environment and Rural Affairs/Northern Ireland Environment Agency, Natural England, Scottish Natural Heritage and the Joint Nature Conservation Committee.

[2] Wade *et al.* (2016) use a numerical scale (1-5) to define vulnerability consistent with that used in Furness (2013). In Table 1.1, scores of 1 are considered to be very low vulnerability with scores of 5 considered to be very high vulnerability

1.2.1.3 Recent advice published by UK SNCBs (JNCC *et al.,* 2017) suggests that in addition to the defined vulnerability of seabirds, habitat use flexibility can, in-combination with other factors including expert opinion, be used to propose an appropriate rate of mortality that occurs as a result of displacement. The defined habitat use flexibility of a number of species/species groups is presented in Table 1.2.

Table 1.2: Habitat use flexibility of VORs (Wade *et al.,* 2016; Langston, 2010).

Habitat use flexibility	Species / species group
Very High	Gannet, lesser black-backed gull, fulmar
High	Kittiwake, great black-backed gull, Arctic skua, great skua
Medium	Guillemot, razorbill, puffin, Arctic tern, common tern
Low	Little gull
Very Low	None

1.2.1.4 Due to the evidence relating to the extended disturbance distances of divers and seaducks (Fox and Petersen, 2006; Petersen *et al*., 2006; Percival, 2010) the assessments for these species would be conducted using site-specific data incorporating a 4 km buffer. For all other species a buffer of 2 km is applied. This approach is consistent with the guidance from JNCC *et al.* (2017).

1.3 Methodology

1.3.1 Species for consideration

1.3.1.1 The full process applied to identify VORs that may be affected by impacts associated with Hornsea Three is documented in the Baseline Characterisation Report (Annex 5.1: Offshore Ornithology Baseline Characterisation Report). Those VORs that are potentially affected by displacement are those:

- Known to be vulnerable to displacement impacts (based on Wade *et al.,* 2016; Bradbury *et al.,* 2014) (Table 1.2); and
- Where the population of the species observed at the development site plus a 4 km buffer is considered to be of importance, when compared against a relevant population scale thresholds (regional, national or international).

1.3.1.2 Table 1.3 identifies those VORs for which displacement analysis is required based on the above criteria. The following species were selected for displacement analysis:

- Fulmar (low vulnerability (high uncertainty level), regionally important population)
- Gannet (high vulnerability, regionally important population);
- Puffin (high vulnerability, regionally important population);
- Razorbill (high vulnerability, regionally important population); and
- Guillemot (high vulnerability, regionally important population).

Table 1.3: Identification of VORs for which analysis of displacement for the Hornsea Three array area is required.

VOR	Vulnerability to displacement impacts	Importance of population at Hornsea Three	Displacement analysis required (Yes/No)
Fulmar	Very Low	Regional	Yes – species recorded in regionally important numbers, high uncertainty level associated with vulnerability score[3].
Gannet	High	Regional	Yes – high vulnerability, species recorded in regionally important numbers at Hornsea Three.
Arctic skua	Very Low	Local	No – low vulnerability, recorded in only low numbers at Hornsea Three.
Great skua	Very Low	Local	No – low vulnerability, recorded in only low numbers at Hornsea Three.
Puffin	Moderate	Regional	Yes – moderate vulnerability, species recorded in regionally important numbers at Hornsea Three.
Razorbill	High	Regional	Yes – high vulnerability, species recorded in regionally important numbers at Hornsea Three.
Guillemot	High	Regional	Yes – high vulnerability, species recorded in regionally important numbers at Hornsea Three.
Common tern	Low	Local	No – low vulnerability, species recorded in only low numbers at Hornsea Three.
Arctic tern	Low	Local	No – low vulnerability, species recorded in only low numbers at Hornsea Three.
Kittiwake	Low	National	No – low vulnerability with a very low uncertainty level associated with vulnerability score.
Little gull	Very Low	Local	No – very low vulnerability, species recorded in only low numbers at Hornsea Three.
Lesser black-backed gull	Low	Regional	No – low vulnerability with a very low uncertainty level associated with vulnerability score.
Great black-backed gull	Low	National	No – low vulnerability with a very low uncertainty level associated with vulnerability score.

[3] Note that the inclusion of fulmar is based on the advice of Natural England and the inclusion of fulmar in displacement analyses at previous offshore wind farm projects

1.3.2 Population estimates

1.3.2.1 Project-specific data for Hornsea Three has been collected by twenty digital aerial surveys carried out between April 2016 and November 2017 encompassing the wind farm array area plus a 4 km buffer. Further information on the aerial surveys undertaken for Hornsea Three and the methodologies used to derive population estimates is provided in the Annex 5.1: Offshore Ornithology Baseline Characterisation Report.

1.3.2.2 The primary data that informs the basis for the assessment are monthly population estimates (corrected for survey coverage and availability bias) including birds both on the water and in flight. For those species identified in Section 1.3.1, a 2 km buffer is considered appropriate to inform assessment of displacement. No species for which a 4 km displacement buffer around the wind farm would typically be applied (i.e. those with a Very High vulnerability to displacement) were selected for inclusion in the analyses presented in this Annex due to insignificant observations (less than 10 birds) of these species during aerial surveys at Hornsea Three.

1.3.2.3 Natural England recommend that two years of baseline survey data be collected in order to capture the inherent variability in seabird populations within assessments presented in an EIA/HRA. The Hornsea Three aerial surveys have collected two years of data for the eight month period April to November and this is considered to adequately capture the variability in seabird populations for assessment purposes.

1.3.2.4 However, only one year of baseline data is available for the period December to March. To further understand the inherent variability in seabird populations at Hornsea Three, a detailed analysis investigating the variability in seabird populations at Hornsea Three has been conducted (including the period where only one year of data is available). This uses both the site-specific aerial survey data and boat-based survey data collected as part of the application process for previous projects in the former Hornsea Zone (see Annex 5.4: Data Hierarchy Report). The results of this analysis have been used to identify appropriate population estimates for use in displacement analyses for Hornsea Three. The full approach applied is presented in Annex 5.4: Data Hierarchy Report alongside the resulting seasonal mean-peak population estimates to be used for displacement analyses (Table 1.4).

Table 1.4: Seasonal mean-peak population estimates for species under consideration.[4]

Species	Breeding	Post-breeding	Non-breeding	Pre-breeding
Fulmar	1,423 (Apr – Aug)	977 (Sep-Oct)	352 (Nov)	525 (Dec – Mar)
Gannet	1,333 (Apr – Aug)	984 (Sep – Nov)		406 (Dec- Mar)
Puffin	253 (May – Jul)		127 (Aug – Apr)	
Razorbill	630 (Apr – Jul)	2,020 (Sep – Oct)	3,649 (Nov – Dec)	1,236 (Jan – Mar)
Guillemot	13,374 (Mar – Jul)		17,772 (Aug – Feb)	

[4] Grey cells indicate not relevant for the species.

1.3.3 Displacement and mortality rates

1.3.3.1 Displacement matrices are presented in Section 1.4 for each species and associated seasons identified in Section 1.3. Potential displacement impacts for each species are presented here based on a wide range of potential displacement (0-100%) and mortality rates (0-100%) following recent SNCB guidance (JNCC *et al.,* 2017). Consideration of the appropriate displacement and mortality rates to apply for assessment is provided in Volume 2, Chapter 5: Offshore Ornithology.

1.3.3.2 In Chapter 5: Offshore Ornithology the degree of change predicted to occur at the population level for a species is further explored by comparing the predicted displacement mortality to the relevant 1% threshold of background mortality for each species (as advised by Natural England for Hornsea Project Two in July 2014 (Natural England, 2014)). Assessment approaches investigating the potential change in background mortality have also been used at other offshore wind farm projects (e.g. East Anglia three) and is therefore considered appropriate for the assessments conducted for Hornsea Three. As such, each matrix in the following species-specific sections is shaded to indicate where the predicted displacement mortality surpasses the 1% threshold of background mortality of the relevant regional or national population for each species. The relevant population against which displacement mortality is compared and the background mortality for each species (inverse of adult survival from Horswill and Robinson (2015)) are presented in each matrix.

1.4 Results

1.4.1 Fulmar

1.4.1.1 Four seasons were defined for fulmar in Annex 5.1: Offshore Ornithology Baseline Characterisation Report. Displacement matrices for each of these seasons, using the mean-peak populations presented in Table 1.4 are presented in Table 1.5 to Table 1.8. The potential level of displacement mortality for fulmar is assessed in Volume 2, Chapter 5: Offshore Ornithology.

Table 1.5: Predicted fulmar mortality as a result of displacement from Hornsea Three and 2 km buffer during the breeding season.

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	3	7	14	28	43	57	71	85	100	114	128	142
20	3	6	14	28	57	85	114	142	171	199	228	256	285
30	4	9	21	43	85	128	171	213	256	299	341	384	427
40	6	11	28	57	114	171	228	285	341	398	455	512	569
50	7	14	36	71	142	213	285	356	427	498	569	640	711
60	9	17	43	85	171	256	341	427	512	597	683	768	854
70	10	20	50	100	199	299	398	498	597	697	797	896	996
80	11	23	57	114	228	341	455	569	683	797	910	1024	1138
90	13	26	64	128	256	384	512	640	768	896	1024	1152	1280
100	14	28	71	142	285	427	569	711	854	996	1138	1280	1423
Regional BDMPS population = 11,745 breeding individuals Background mortality = 0.064					< 1% background mortality					> 1% background mortality			

Table 1.6: Predicted fulmar mortality as a result of displacement from Hornsea Three and 2 km buffer during the post-breeding season.

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	2	5	10	20	29	39	49	59	68	78	88	98
20	2	4	10	20	39	59	78	98	117	137	156	176	195
30	3	6	15	29	59	88	117	146	176	205	234	264	293
40	4	8	20	39	78	117	156	195	234	273	312	352	391
50	5	10	24	49	98	146	195	244	293	342	391	439	488
60	6	12	29	59	117	176	234	293	352	410	469	527	586
70	7	14	34	68	137	205	273	342	410	479	547	615	684
80	8	16	39	78	156	234	312	391	469	547	625	703	781
90	9	18	44	88	176	264	352	439	527	615	703	791	879
100	10	20	49	98	195	293	391	488	586	684	781	879	977
Regional BDMPS population = 957,502 individuals Background mortality = 0.064					< 1% background mortality					> 1% background mortality			

Table 1.7: Predicted fulmar mortality as a result of displacement from Hornsea Three and 2 km buffer during the non-breeding season.

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	1	2	4	7	11	14	18	21	25	28	32	35
20	1	1	4	7	14	21	28	35	42	49	56	63	70
30	1	2	5	11	21	32	42	53	63	74	85	95	106
40	1	3	7	14	28	42	56	70	85	99	113	127	141
50	2	4	9	18	35	53	70	88	106	123	141	159	176
60	2	4	11	21	42	63	85	106	127	148	169	190	211
70	2	5	12	25	49	74	99	123	148	173	197	222	247
80	3	6	14	28	56	85	113	141	169	197	226	254	282
90	3	6	16	32	63	95	127	159	190	222	254	285	317
100	4	7	18	35	70	106	141	176	211	247	282	317	352
Regional BDMPS population = 568,736 Background mortality = 0.064					< 1% background mortality					> 1% background mortality			

Table 1.8: Predicted fulmar mortality as a result of displacement from Hornsea Three and 2 km buffer during the pre-breeding season.

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	1	3	5	10	16	21	26	31	37	42	47	52
20	1	2	5	10	21	31	42	52	63	73	84	94	105
30	2	3	8	16	31	47	63	79	94	110	126	142	157
40	2	4	10	21	42	63	84	105	126	147	168	189	210
50	3	5	13	26	52	79	105	131	157	184	210	236	262
60	3	6	16	31	63	94	126	157	189	220	252	283	315
70	4	7	18	37	73	110	147	184	220	257	294	331	367
80	4	8	21	42	84	126	168	210	252	294	336	378	420
90	5	9	24	47	94	142	189	236	283	331	378	425	472
100	5	10	26	52	105	157	210	262	315	367	420	472	525

Regional BDMPS population = 957,502 individuals Background mortality = 0.064		< 1% background mortality	> 1% background mortality

1.4.2 Gannet

1.4.2.1 Three seasons were defined for gannet in Annex 5.1: Offshore Ornithology Baseline Characterisation Report. Displacement matrices for each of these seasons, using the mean-peak populations presented in Table 1.4 are presented in Table 1.9 to Table 1.11. The potential level of displacement mortality for gannet is assessed in Volume 2, Chapter 5: Offshore Ornithology.

Table 1.9: Predicted gannet mortality as a result of displacement from Hornsea Three and 2 km buffer during the breeding season.

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	3	7	13	27	40	53	67	80	93	107	120	133
20	3	5	13	27	53	80	107	133	160	187	213	240	267
30	4	8	20	40	80	120	160	200	240	280	320	360	400
40	5	11	27	53	107	160	213	267	320	373	427	480	533
50	7	13	33	67	133	200	267	333	400	467	533	600	667
60	8	16	40	80	160	240	320	400	480	560	640	720	800
70	9	19	47	93	187	280	373	467	560	653	747	840	933
80	11	21	53	107	213	320	427	533	640	747	853	960	1066
90	12	24	60	120	240	360	480	600	720	840	960	1080	1200
100	13	27	67	133	267	400	533	667	800	933	1066	1200	1333
Regional BDMPS population = 24,998 breeding individuals Background mortality = 0.081					< 1% background mortality					> 1% background mortality			

Table 1.10: Predicted gannet mortality as a result of displacement from Hornsea Three and 2 km buffer during the post-breeding season.

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	2	5	10	20	30	39	49	59	69	79	89	98
20	2	4	10	20	39	59	79	98	118	138	157	177	197
30	3	6	15	30	59	89	118	148	177	207	236	266	295
40	4	8	20	39	79	118	157	197	236	276	315	354	394
50	5	10	25	49	98	148	197	246	295	344	394	443	492
60	6	12	30	59	118	177	236	295	354	413	472	531	591
70	7	14	34	69	138	207	276	344	413	482	551	620	689
80	8	16	39	79	157	236	315	394	472	551	630	709	787
90	9	18	44	89	177	266	354	443	531	620	709	797	886
100	10	20	49	98	197	295	394	492	591	689	787	886	984
Regional BDMPS population = 456,298 individuals Background mortality = 0.081					< 1% background mortality					> 1% background mortality			

Table 1.11: Predicted gannet mortality as a result of displacement from Hornsea Three and 2 km buffer during the pre-breeding season.

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	1	2	4	8	12	16	20	24	28	32	37	41
20	1	2	4	8	16	24	32	41	49	57	65	73	81
30	1	2	6	12	24	37	49	61	73	85	97	110	122
40	2	3	8	16	32	49	65	81	97	114	130	146	162
50	2	4	10	20	41	61	81	102	122	142	162	183	203
60	2	5	12	24	49	73	97	122	146	171	195	219	244
70	3	6	14	28	57	85	114	142	171	199	227	256	284
80	3	6	16	32	65	97	130	162	195	227	260	292	325
90	4	7	18	37	73	110	146	183	219	256	292	329	366
100	4	8	20	41	81	122	162	203	244	284	325	366	406

Regional BDMPS population = 248,385 individuals
Background mortality = 0.081

< 1% background mortality

> 1% background mortality

1.4.3 Puffin

1.4.3.1 Two seasons were defined for puffin in Annex 5.1: Offshore Ornithology Baseline Characterisation Report. Displacement matrices for each of these seasons, using the mean-peak populations presented in Table 1.4 are presented in Table 1.12 and Table 1.13. The potential level of displacement mortality for puffin is assessed in Volume 2, Chapter 5: Offshore Ornithology.

Table 1.12: Predicted puffin mortality as a result of displacement from Hornsea Three and 2 km buffer during the breeding season.

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	1	1	3	5	8	10	13	15	18	20	23	25
20	1	1	3	5	10	15	20	25	30	35	41	46	51
30	1	2	4	8	15	23	30	38	46	53	61	68	76
40	1	2	5	10	20	30	41	51	61	71	81	91	101
50	1	3	6	13	25	38	51	63	76	89	101	114	127
60	2	3	8	15	30	46	61	76	91	106	122	137	152
70	2	4	9	18	35	53	71	89	106	124	142	160	177
80	2	4	10	20	41	61	81	101	122	142	162	182	203
90	2	5	11	23	46	68	91	114	137	160	182	205	228
100	3	5	13	25	51	76	101	127	152	177	203	228	253

Regional BDMPS population = 1,960 breeding individuals Background mortality = 0.094		< 1% background mortality	> 1% background mortality

Table 1.13: Predicted puffin mortality as a result of displacement from Hornsea Three and 2 km buffer during the non-breeding season.

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	1	1	3	4	5	6	8	9	10	11	13
20	0	1	1	3	5	8	10	13	15	18	20	23	25
30	0	1	2	4	8	11	15	19	23	27	30	34	38
40	1	1	3	5	10	15	20	25	30	36	41	46	51
50	1	1	3	6	13	19	25	32	38	44	51	57	63
60	1	2	4	8	15	23	30	38	46	53	61	69	76
70	1	2	4	9	18	27	36	44	53	62	71	80	89
80	1	2	5	10	20	30	41	51	61	71	81	91	102
90	1	2	6	11	23	34	46	57	69	80	91	103	114
100	1	3	6	13	25	38	51	63	76	89	102	114	127
Regional BDMPS population = 231,957 individuals Background mortality = 0.094					< 1% background mortality					> 1% background mortality			

1.4.4 Razorbill

1.4.4.1 Four seasons were defined for razorbill in Annex 5.1: Offshore Ornithology Baseline Characterisation Report. Displacement matrices for each of these seasons, using the mean-peak populations presented in Table 1.4 are presented in Table 1.14 to Table 1.17. The potential level of displacement mortality for razorbill is assessed in Volume 2, Chapter 5: Offshore Ornithology.

Table 1.14: Predicted razorbill mortality as a result of displacement from Hornsea Three and 2 km buffer during the breeding season.

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	1	3	6	13	19	25	32	38	44	50	57	63
20	1	3	6	13	25	38	50	63	76	88	101	113	126
30	2	4	9	19	38	57	76	95	113	132	151	170	189
40	3	5	13	25	50	76	101	126	151	176	202	227	252
50	3	6	16	32	63	95	126	158	189	221	252	284	315
60	4	8	19	38	76	113	151	189	227	265	303	340	378
70	4	9	22	44	88	132	176	221	265	309	353	397	441
80	5	10	25	50	101	151	202	252	303	353	403	454	504
90	6	11	28	57	113	170	227	284	340	397	454	511	567
100	6	13	32	63	126	189	252	315	378	441	504	567	630

National breeding population = 260,000 breeding individuals
Background mortality = 0.105

< 1% background mortality

> 1% background mortality

Table 1.15: Predicted razorbill mortality as a result of displacement from Hornsea Three and 2 km buffer during the post-breeding season.

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	2	4	10	20	40	61	81	101	121	141	162	182	202
20	4	8	20	40	81	121	162	202	242	283	323	364	404
30	6	12	30	61	121	182	242	303	364	424	485	545	606
40	8	16	40	81	162	242	323	404	485	566	646	727	808
50	10	20	51	101	202	303	404	505	606	707	808	909	1010
60	12	24	61	121	242	364	485	606	727	849	970	1091	1212
70	14	28	71	141	283	424	566	707	849	990	1131	1273	1414
80	16	32	81	162	323	485	646	808	970	1131	1293	1455	1616
90	18	36	91	182	364	545	727	909	1091	1273	1455	1636	1818
100	20	40	101	202	404	606	808	1010	1212	1414	1616	1818	2020
Regional BDMPS population = 591,874 individuals Background mortality = 0.105					< 1% background mortality					> 1% background mortality			

Table 1.16: Predicted razorbill mortality as a result of displacement from Hornsea Three and 2 km buffer during the non-breeding season.

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	4	7	18	36	73	109	146	182	219	255	292	328	365
20	7	15	36	73	146	219	292	365	438	511	584	657	730
30	11	22	55	109	219	328	438	547	657	766	876	985	1095
40	15	29	73	146	292	438	584	730	876	1022	1168	1314	1460
50	18	36	91	182	365	547	730	912	1095	1277	1460	1642	1825
60	22	44	109	219	438	657	876	1095	1314	1533	1752	1970	2189
70	26	51	128	255	511	766	1022	1277	1533	1788	2043	2299	2554
80	29	58	146	292	584	876	1168	1460	1752	2043	2335	2627	2919
90	33	66	164	328	657	985	1314	1642	1970	2299	2627	2956	3284
100	36	73	182	365	730	1095	1460	1825	2189	2554	2919	3284	3649
Regional BDMPS population = 218,622 individuals Background mortality = 0.105					< 1% background mortality					> 1% background mortality			

Table 1.17: Predicted razorbill mortality as a result of displacement from Hornsea Three and 2 km buffer during the pre-breeding season.

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	2	6	12	25	37	49	62	74	87	99	111	124
20	2	5	12	25	49	74	99	124	148	173	198	223	247
30	4	7	19	37	74	111	148	185	223	260	297	334	371
40	5	10	25	49	99	148	198	247	297	346	396	445	495
50	6	12	31	62	124	185	247	309	371	433	495	556	618
60	7	15	37	74	148	223	297	371	445	519	593	668	742
70	9	17	43	87	173	260	346	433	519	606	692	779	865
80	10	20	49	99	198	297	396	495	593	692	791	890	989
90	11	22	56	111	223	334	445	556	668	779	890	1001	1113
100	12	25	62	124	247	371	495	618	742	865	989	1113	1236
Regional BDMPS population = 591,874 individuals Background mortality = 0.105					< 1% background mortality					> 1% background mortality			

1.4.5 Guillemot

1.4.5.1 Two seasons were defined for guillemot in Annex 5.1: Offshore Ornithology Baseline Characterisation Report. Displacement matrices for each of these seasons, using the mean-peak populations presented in Table 1.4 are presented in Table 1.18 and Table 1.19. The potential level of displacement mortality for guillemot is assessed in Volume 2, Chapter 5: Offshore Ornithology.

Table 1.18: Predicted guillemot mortality as a result of displacement from Hornsea Three and 2 km buffer during the breeding season.

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	13	27	67	134	267	401	535	669	802	936	1070	1204	1337
20	27	53	134	267	535	802	1070	1337	1605	1872	2140	2407	2675
30	40	80	201	401	802	1204	1605	2006	2407	2809	3210	3611	4012
40	53	107	267	535	1070	1605	2140	2675	3210	3745	4280	4815	5350
50	67	134	334	669	1337	2006	2675	3344	4012	4681	5350	6018	6687
60	80	160	401	802	1605	2407	3210	4012	4815	5617	6420	7222	8024
70	94	187	468	936	1872	2809	3745	4681	5617	6553	7489	8426	9362
80	107	214	535	1070	2140	3210	4280	5350	6420	7489	8559	9629	10699
90	120	241	602	1204	2407	3611	4815	6018	7222	8426	9629	10833	12037
100	134	267	669	1337	2675	4012	5350	6687	8024	9362	10699	12037	13374

National breeding population = 1,900,000 breeding individuals
Background mortality = 0.061

< 1% background mortality

> 1% background mortality

Table 1.19: Predicted guillemot mortality as a result of displacement from Hornsea Three and 2 km buffer during the non-breeding season.

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	18	36	89	178	355	533	711	889	1066	1244	1422	1599	1777
20	36	71	178	355	711	1066	1422	1777	2133	2488	2843	3199	3554
30	53	107	267	533	1066	1599	2133	2666	3199	3732	4265	4798	5332
40	71	142	355	711	1422	2133	2843	3554	4265	4976	5687	6398	7109
50	89	178	444	889	1777	2666	3554	4443	5332	6220	7109	7997	8886
60	107	213	533	1066	2133	3199	4265	5332	6398	7464	8530	9597	10663
70	124	249	622	1244	2488	3732	4976	6220	7464	8708	9952	11196	12440
80	142	284	711	1422	2843	4265	5687	7109	8530	9952	11374	12796	14217
90	160	320	800	1599	3199	4798	6398	7997	9597	11196	12796	14395	15995
100	178	355	889	1777	3554	5332	7109	8886	10663	12440	14217	15995	17772
Regional BDMPS population = 1,617,306 individuals Background mortality = 0.061					< 1% background mortality					> 1% background mortality			

1.5 References

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