Hornsea Offshore Wind Farm

Project Two

Clarification Note Environmental Impact Assessment for offshore ornithological receptors

Appendix CC to the Response submitted for Deadline IV

Application Reference: EN010053

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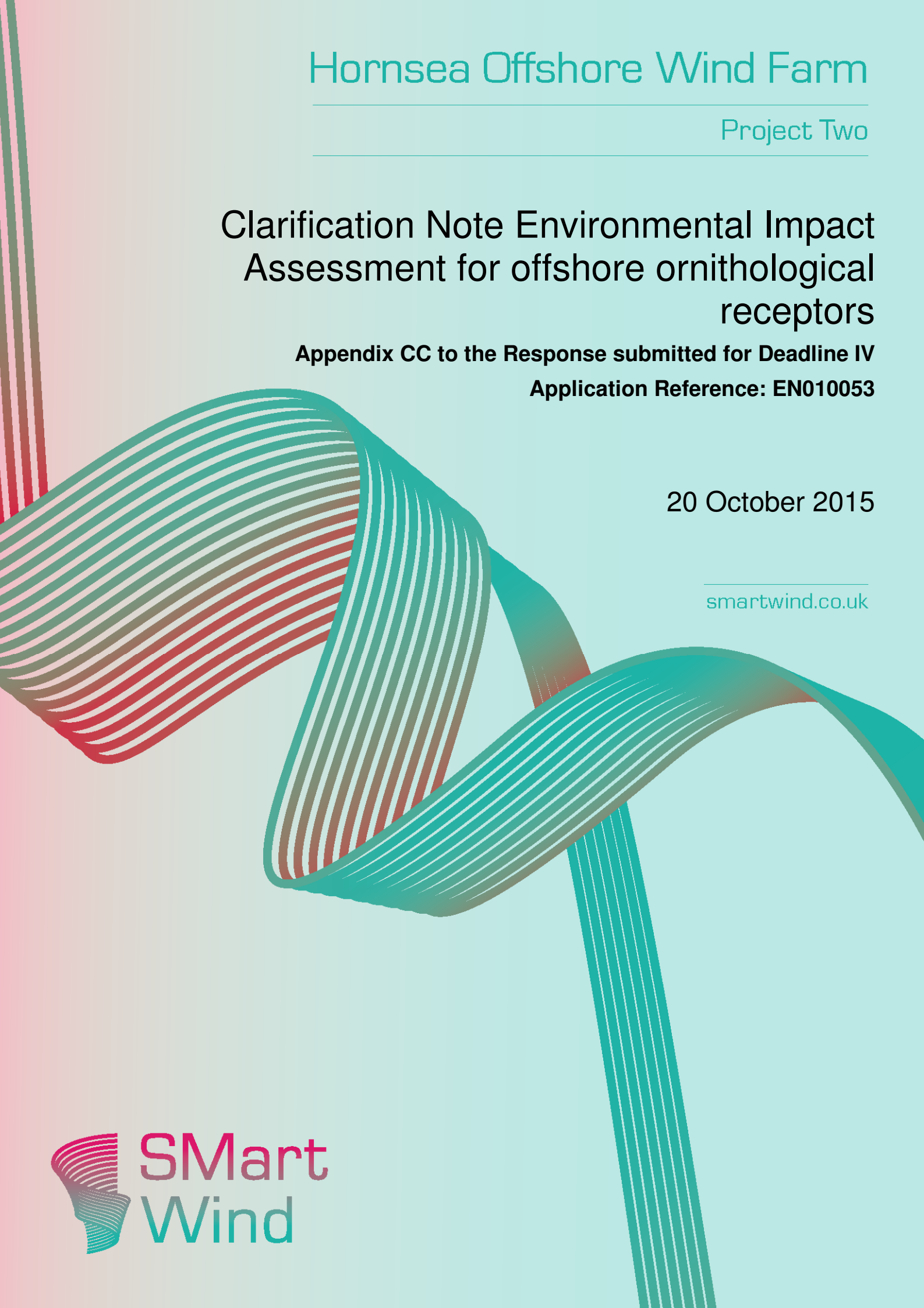

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1 Environmental Impact Assessment

1.1 Introduction

1.1.1 This Clarification Note has been prepared in respect of the application for a development consent order (DCO) to the Secretary of State under the Planning Act 2008 ('the Application') by SMart Wind Ltd on behalf of Optimus Wind Ltd and Breesea Ltd (the 'Applicant') for the Hornsea Project Two Offshore Wind Farm (the 'Project').

1.1.2 This Note has been prepared in response to queries raised by Natural England in their Relevant and Written Representations regarding the relevant biogeographic populations of seabird species against which Environmental Impact Assessment (EIA) should be made. The Note therefore provides an appropriate update to the EIA in terms of both the parameters applied to the analysis and subsequent assessment of significance.

1.1.3 The species and associated impacts to be considered for EIA were agreed with Natural England during Section 42 consultation:

- Gannet – collision and displacement
- Kittiwake – collision
- Lesser black-backed gull – collision
- Great black-backed gull – collision
- Guillemot – displacement
- Razorbill – displacement
- Puffin – displacement

1.1.4 Since the submission of the EIA within the Application, as submitted in January 2015, a number of aspects of the EIA methodology and supporting assessments have been updated following consultation with Natural England. These primarily concern the relevant Biologically Defined Minimum Population Scale (BDMPS) populations against which impacts should be assessed.

1.1.5 This report presents an updated collision risk assessment which includes consideration of annual collision risk estimates assessed against the largest BDMPS population estimate. The BDMPS populations used for assessment have also been updated for some of the species considered here since submission of the Offshore Ornithology Environmental Statement Chapter (Doc ref No. 7.2.5) due to the consideration of immature birds present in regional populations and the use of population data from Furness (2015).

1.1.6 Data from other projects that informs the cumulative collision risk assessment has also been reviewed following the submission of the Offshore Ornithology ES Chapter (Doc ref No. 7.2.5).

1.1.7 The demographic rates used for the Potential Biological Removal (PBR) analysis have also been updated following the publication of Horswill and Robinson (2015) following the advice of Natural England.

1.1.8 Natural England informed the Applicant at a meeting on the 14th October 2015 that they are yet to develop their position on a number of issues relating to the EIA assessment. It was therefore agreed that this Note should focus on the Applicant's position only. However, it does aim to include all relevant information to enable Natural England to draw their own conclusions once they have formulated a methodology they choose to employ.

1.2 BDMPS populations

1.2.1 In the Offshore Ornithology Environmental Statement Chapter (Doc ref No. 7.2.5) the Applicant assessed impacts on a seasonal basis. This followed discussions with Natural England during Section 42 consultation in anticipation of the publication of Furness (2015) which was commissioned by Natural England.

1.2.2 In their Relevant Representations Natural England stated that as defined populations are not *'entirely discrete populations*' that any assessment should be basis and assessed against the largest BDMPS. Although the Applicant considers that there is a possibility that some of the same birds may be present in each of the relevant BDMPS populations throughout the year, assessing an impact on an annual basis against the largest BDMPS population does not solve this issue.

1.2.3 The use of the largest BDMPS population still assumes that the populations upon which impacts are acting are discrete populations and does not account for turnover of birds which is likely to occur between seasons. For example, with gannet, a proportion of birds present in the breeding season at the Project site may be present at various points of the annual cycle. However, a proportion of birds exhibiting connectivity with the Project site during the post-breeding or pre-breeding seasons (i.e. birds on passage) may only do so in one of these seasons. Therefore conducting an assessment using the largest BDMPS population underestimates the number of birds that may exhibit connectivity with the Project site with the cohort of birds present in one season likely to contain individual birds that may not be present in other seasons. Implications of this are that PBR thresholds would be higher as a result of a greater BDMPS than currently stated.

Table 1.1: Seasonal BDMPS populations (adapted from Furness, 2015)

Species	Season	Population used in ES	Population	1% baseline mortality
Gannet	Breeding	19,894	23,565	19
	Post-breeding	319,556	**411,126**	333
	Pre-breeding	167,112	226,483	183
Kittiwake	Breeding	126,468	234,090	342
	Post-breeding	843,077	**843,077**	1,231
	Pre-breeding	639,742	639,742	934
Lesser black-backed gull	Breeding	3,084	3,084	4

Species	Season	Population used in ES	Population	1% baseline mortality
	Post-breeding	209,007	**209,007**	240
	Non-breeding	39,314	39,314	45
	Pre-breeding	197,483	197,483	227
Great black-backed gull	Breeding	34,000	34,000[1]	24
	Non-breeding	91,399	**91,399**	64
Guillemot	Breeding	83,214	688,032	420
	Non-breeding	1,623,172	**1,623,172**	990
Razorbill	Breeding	21,159	56,929	60
	Post/pre-breeding	593,779	**593,779**	623
	Non-breeding	219,049	219,049	230
Puffin	Breeding	1,960	33,945	32
	Non-breeding	231,980	**231,980**	218

1.2.4 The largest BDMPS population for each species in Table 1.1 as shown in bold, is used to assess annual impact (i.e. collision). The Applicant has conducted a seasonal assessment of effects on different spatial scales be it at regional or national levels in line with standard industry practice and agreed with Natural England within the HRA evidence plan, see Table 5.4 (Doc Ref 12.6.1). It is not considered appropriate to add monthly mortality rates together to generate an 'annual' mortality as the impacts in different seasons or months are on different biological populations. Any summation of mortality rates has to take account of the duration of any defined period and the ultimate annual result highly dependent on the number of periods defined rather than any insight from species population dynamics.

1.2.5 In order to determine if population modelling is required to assess an impact, annual collision risk mortality or seasonal displacement impacts were compared to a 1% threshold of baseline mortality of the relevant BDMPS population in Table 1.1 as advised by Natural England through their advice at section 42. If the annual mortality exceeded the 1% threshold of baseline mortality further investigation incorporating PBR analysis is conducted.

1.3 Assessment of Project Two alone

Collision

1.3.1 Collision risk estimates for the relevant EIA species are presented in Table 1.2. Collision risk estimates calculated using all Options of the Band (2012) CRM are presented to enable assessment by both the Applicant and other interested parties.

[1] The national population of great black-backed gull is used here as there are no regional breeding colonies

Table 1.2: Collision risk estimates calculated using all Options of the Band (2012) CRM

Species	Option 1		Option 2		Option 3		Option 4	
	Avoidance rate (%)	No. of collisions	Avoidance rate (%)	No. of collisions	Avoidance rate (%)	No. of collisions	Avoidance rate (%)	No. of collisions
Gannet	98.9	102	98.9	72	98	45	98	63
Kittiwake	99.2	65	99.2	167	98	128	98	28
	98.9	89	98.9	230				
Lesser black-backed gull	99.5	4	99.5	7	98.9	7	98.9	2
Great black-backed gull	99.5	41	99.5	40	98.9	47	98.9	30

1.3.2 The assessment of seasonal collision risk calculated using all Options of the Band (2012) CRM against the relevant 1% threshold of baseline mortality of BDMPS populations is presented in Table 1.3. The collision risk estimates from the Project alone do not surpass the 1% threshold of baseline mortality for any of the four species under any Band (2012) option. Therefore further analysis incorporating PBR is not required for the assessment of effects from the Project alone.

Table 1.3: Assessment of collision risk estimates against the 1% threshold of baseline mortality for relevant BDMPS populations

Species	Collision risk				> 1% baseline mortality (Y/N)	PBR required (Y/N)
	Option 1	Option 2	Option 3	Option 4		
Gannet	102	72	45	63	333	N
Kittiwake	65	167	128	28	1,231	N
	89	230				
Lesser black-backed gull	4	7	7	2	240	N
Great black-backed gull	41	40	47	30	64	N

Displacement

1.3.3 Seasonal displacement mortality values calculated using both the displacement and mortality rates advocated by the Applicant and Natural England for relevant species are presented in Table 1.4. The displacement rates advocated by the Applicant are 70% for gannet, 30% for guillemot and 40% for razorbill and puffin. Mortality rates advocated by the Applicant are 10% in the breeding season, 2% in post-breeding and pre-breeding seasons and 1% in the non-breeding season for the three auk species. For gannet

mortality rates are 2% in the breeding season and 1% in the post-breeding and pre-breeding seasons. These rates are unchanged from the application submission.

1.3.4 Natural England are yet to formalise their position in relation to EIA species but have consistently advised that they will consider a range of displacement rates between 30-70% and mortality rates between 1-10%. Therefore the precautionary limits of these ranges (70%, 10%) are presented in Table 1.4.

Table 1.4: Seasonal displacement mortality calculated using the displacement and mortality rates advocated by the Applicant and Natural England

Species	Applicant/Natural England	Breeding	Post-breeding	Non-breeding	Pre-breeding
Gannet	Applicant	5	5		1
	70/10	1-23	2-54		1-12
Guillemot	Applicant	232		40	
	70/10	23-541		39-921	
Razorbill	Applicant	100	34	3	13
	70/10	8-176	13-295	2-50	5-117
Puffin	Applicant	19		8	
	70/10	1-33		6-143	

1.3.5 The assessment of seasonal displacement mortality values calculated using the displacement and mortality rates advocated by the Applicant are presented in Table 1.5.

Table 1.5: Assessment of displacement mortality against the 1% threshold of baseline mortality for relevant BDMPS populations (Applicant's position).

Species	Season	Displacement mortality (no. of birds)	1% baseline mortality	PBR (Y/N)
Gannet	Breeding	5	19	N
	Post-breeding	5	333	N
	Pre-breeding	1	183	N
Guillemot	Breeding	232	420	N
	Non-breeding	40	990	N
Razorbill	Breeding	100	60	Y
	Post-breeding	34	623	N
	Non-breeding	3	230	N
	Pre-breeding	13	623	N
Puffin	Breeding	19	32	N
	Non-breeding	8	218	N

1.3.6 The 1% threshold of baseline mortality of the relevant population is not surpassed for any species in any season with the exception of razorbill in the breeding season using the displacement and mortality rates advocated by the Applicant. Therefore PBR analysis has been conducted for the breeding season population of razorbill (Table 1.6).

Table 1.6: PBR for the breeding season regional population of razorbill

Species	Population (Nmin)	*f* = 0.1	*f* = 0.2	*f* = 0.3	*f* = 0.4	*f* = 0.5	*f* = 1.0
Razorbill	52,332	285	570	855	1,140	1,424	2,849

1.3.7 Estimated razorbill mortality of 100 birds in the breeding season represents an equivalent *f* value of 0.04 which is considerably lower than the *f* value considered appropriate for this population (*f*=0.5; SMart Wind, 2014). Such predicted mortality is not however expected to occur on a year on year basis as a result of displacement; it is considered more likely to relate to a singular event following which seabirds will respond to by either redistribution or habituation.

1.4 Assessment of Cumulative effects

1.4.1 There have been a number of changes to the cumulative assessment of collision impacts based on the Relevant Representations and Written Representations of Natural England and discussions between the Applicant and Natural England during the examination process. These include the following:

- Consent capacity corrections;
- Consideration of operational projects; and
- The foraging ranges used to identify projects to be considered cumulatively in the breeding season.

Consented capacity of projects considered cumulatively

1.4.2 In their Relevant and Written Representations, Natural England state that changes to collision risk estimates due to a reduction in the capacity at projects considered cumulatively should be applied only where the reduction in project capacity is reflected in the consent granted for the project. The Applicant has outlined the capacity corrections applied to collision risk values from projects considered cumulatively in Appendix N and Appendix P submitted at Deadline IIa.

1.4.3 In their response to the Applicant's Deadline IIa submissions Natural England query the correction factor applied to collision risk estimates from the Moray offshore wind farm. The Applicant refers the reader to the documents referenced in Appendix N and Appendix P of the Applicant's submission at Deadline IIa, specifically Natural Power (2013). This document states that the original CRM for Moray offshore wind farm incorporated 139 x 3.6 MW turbines for the three individual wind farms (Telford, MacColl and Stevenson) that form the Moray Offshore Wind Farm (i.e. 417 turbines). The three projects were ultimately consented for 62 turbines each giving a total of 186 turbines and

representing a 55% reduction in the number of turbines incorporated into collision risk modelling.

Collision

1.4.4 Table 1.7 and Table 1.8 present annual collision risk estimates for all projects considered cumulatively for all relevant species. Table 1.7 presents collision risk estimates from the Extended Model (Options 3 or 4) of Band (2012) where available with collision risk estimates in Table 1.8 from the Basic model (Options 1 or 2) of Band (2012). The projects included are consistent with those incorporated in Appendix N and Appendix P of the Applicant's Deadline IIa submission. References for all figures are included in the reference list at the end of this document.

Table 1.7: Annual collision risk estimates for all relevant species using estimates from the Extended model of Band (2012), where available[2][3]

Project	Option	Gannet	Kittiwake	Lesser black-backed gull	Great black-backed gull
Aberdeen European Offshore Wind Deployment Centre	2	9.4	13.6	-	3
Beatrice	3	42	17.6	-	53
Beatrice Demonstrator	1	2.8	3.6	-	-
Blyth Demonstration Project	1	8.4	3.9	-	8
Dogger Bank Creyke Beck A and B	3	121	218	19	29
Dogger Bank Teesside A and B	3	136	135	18	32
Dudgeon	1	36.6	0	13	-
East Anglia One	3	67.9	24.4	43	47
Galloper	1	61.6	47.9	139	22
Greater Gabbard	1	27.5	20	62	-
Hornsea Project One	4	38	20.7	9	49
Hornsea Project Two	4	63	28.1	2	30

[2] Avoidance rates: Options 1 and 2: 98.9% for gannet and kittiwake, 99.5% for lesser black-backed gull and great black-backed gull, Options 3 and 4: 98% for gannet and kittiwake, 98.9% for lesser black-backed gull and great black-backed gull.

[3] Sources for cumulative data comprise: APEM (2013); Arcus (2013); Forewind (2014); Moray Offshore Renewables (2012); Natural Power (2013); Royal Haskoning (2011) and RWE (2011).

Project	Option	Gannet	Kittiwake	Lesser black-backed gull	Great black-backed gull
Humber Gateway	1	4.4	5.6	2	7
Inch Cape	1	371.3	219.2	-	37
Kentish Flats Extension	1	3.3	1.6	2	0
Lincs	1	5	2	9	-
London Array	1	5.5	4	-	-
Moray Firth Project One (MORL)	3	18.1	43.3	-	19
Neart na Gaoithe	1	569.8	67.9	1	5
Race Bank	1	49.5	22.8	54	-
Seagreen Alpha	1/3	494	172	3	37
Seagreen Bravo	1/3	332	121	7	30
Sheringham Shoal	1	17.6		8	-
Teesside	1	6.6	56.1	-	44
Thanet	1	1.1	0.8	16	0
Triton Knoll	1	121.6	152	32	122
Westermost Rough	1	0.6	0.4	0	0
Total	-	**2,615**	**1,402**	**439**	**574**

Table 1.8: Annual collision risk estimates for all relevant species using estimates from the Basic model of Band (2012)[4]

Project	Option	Gannet	Kittiwake	Lesser black-backed gull	Great black-backed gull
Aberdeen European Offshore Wind Deployment Centre	2	9	19	-	3
Beatrice	1	96	58	-	60
Beatrice Demonstrator	1	3	5	-	-
Blyth Demonstration Project	1	8	5	-	8
Dogger Bank Creyke Beck A and B	2	17	719	13	33
Dogger Bank	2	35	444	12	37

[4] Avoidance rates: 98.9% for gannet, 99.2% for kittiwake, 99.5% for lesser black-backed gull and great black-backed gull.

Project	Option	Gannet	Kittiwake	Lesser black-backed gull	Great black-backed gull
Teesside A and B					
Dudgeon	1	37	0	13	-
East Anglia One	1/2	132	317	73	92
Galloper	1	62	66	139	22
Greater Gabbard	1	28	28	62	-
Hornsea Project One	1	66	122	22	86
Hornsea Project Two	2	102	230	7	40
Humber Gateway	1	4	8	2	7
Inch Cape	1	371	301	-	37
Kentish Flats Extension	1	3	2	2	0
Lincs	1	5	3	9	-
London Array	1	6	6	-	-
Moray Firth Project One (MORL)	1	56	37	-	16
Neart na Gaoithe	1	570	93	1	5
Race Bank	1	50	31	54	-
Seagreen Alpha	1	552	371	3	37
Seagreen Bravo	1	364	343	7	30
Sheringham Shoal	1	18		8	-
Teesside	1	7	77	-	44
Thanet	1	1	1	16	0
Triton Knoll	1	122	209	32	122
Westermost Rough	1	1	1	0	0
Total	-	**2,721**	**3,496**	**475**	**679**

1.4.5 The assessment of annual collision risk calculated using both the basic and extended model scenarios of the Band (2012) CRM against the relevant 1% threshold of baseline mortality of BDMPS populations for each species is presented in Table 1.9.

Table 1.9: Assessment of annual collision risk estimates against the 1% threshold of baseline mortality for relevant BDMPS populations

Species	Cumulative collision risk		> 1% baseline mortality (Y/N)		PBR required (Y/N)	
	Extended	Basic	Extended	Basic	Extended	Basic
Gannet	2,615	2,721	333	370	Y	Y
Kittiwake	1,402	3,496	1,231	1,212	Y	Y
Lesser black-backed gull	439	475	240	240	Y	Y
Great black-backed gull	574	679	64	64	Y	Y

1.4.6 The cumulative collision risk for all species exceeds the 1% threshold of baseline mortality using both the Extended and Basic model scenarios (Table 1.9). Therefore PBR analysis has been conducted for all four species (Table 1.10). For each species considered in Table 1.10, the PBR value that is considered to be sustainable has been defined based on the UK population trend for each species from JNCC (2015). The *f* value at which PBR is considered sustainable based on information in JNCC (2015) is highlighted in bold in Table 1.10. Although these trends are for the UK population of each species, in the absence of data relating to the population trend of the BDMPS population it is considered appropriate to apply these here.

Table 1.10: PBR analyses for the largest BDMPS populations for species considered for assessment of cumulative collision risk

Species	Population (Nmin)	*f* = 0.1	*f* = 0.2	*f* = 0.3	*f* = 0.4	*f* = 0.5	*f* = 1.0
Gannet	377,927	1,870	3,739	5,609	7,478	**9,348**	18,696
Kittiwake	774,996	5,580	**11,159**	16,739	22,318	27,898	55,796
Lesser black-backed gull	192,129	1,081	2,161	**3,242**	4,322	5,403	10,805
Great black-backed gull	84,018	393	786	**1,180**	1,573	1,966	3,932

1.4.7 The annual predicted collision risk for gannet is 2,615 collisions using the Extended model, where available or 2,721 collisions when the Basic model is used, where available. These figures represent equivalent *f* values of 0.14 and 0.15, respectively. These values are considerably below the *f* value considered sustainable for this population (*f* = 0.5).

1.4.8 The Population Viability Analysis (PVA) of the UK gannet population produced under the SOSS initiative (WWT Consulting 2012) considered the likely effects of built and planned offshore wind farms in the UK (and elsewhere) indicates that the predicted cumulative impact (using either Basic or Extended versions) will not have a significant impact. The report concluded that:

"The density-independent model predicted that, on average, gannet numbers will continue to increase with additional gannet mortality due to collisions with offshore wind farms, up to a threshold of approximately 10,000 additional birds killed per year. At this level of additional mortality 50% of simulations would have negative population growth. A much lower level of risk, when 95% of simulations maintain positive population growth (i.e. >1), was achieved with a threshold additional mortality of approximately 3,500 birds per year."

1.4.9 It should be noted that this study did not identify substantial differences between the predictions of the density independent and density dependent versions of the model.

1.4.10 The annual predicted collision risk for kittiwake is 1,402 collisions using the Extended, where available model or 3,496 collisions when the Basic model is used. These figures represent equivalent *f* values of 0.03 and 0.06, respectively. These values are considerably lower than the *f* value considered sustainable for the UK kittiwake population ($f = 0.2$).

1.4.11 The annual predicted collision risk for lesser black-backed gull is 439 collisions using the Extended model, where available or 475 collisions when the Basic model is used. These figures represent equivalent *f* values of 0.04 using both model scenarios. This value is well below the *f* value considered sustainable for the UK population of lesser black-backed gull ($f = 0.3$).

1.4.12 The annual predicted collision risk for great black-backed gull is 574 collisions using the Extended model, where available or 679 collisions when the Basic model is used. These figures represent equivalent *f* values of 0.15 and 0.17, respectively. This value is well below the *f* value considered sustainable for the UK population of great black-backed gull ($f = 0.3$).

Displacement

1.4.13 The Applicant considers that the addition of seasonal displacement impacts significantly over-estimates the annual displacement impact. This is compounded when considering cumulative impacts when multiple projects are involved. Therefore the Applicant has assessed cumulative displacement impacts on a seasonal basis following the approach previously presented in the Offshore Ornithology ES Chapter (Doc ref No. 7.2.5). Seasonal displacement matrices are presented in Appendix 1.

1.4.14 In the breeding season, projects considered cumulatively are only included in the assessment if they are within foraging range of colonies from which birds may interact with the Project. This approach is consistent with that previously used in the Offshore Ornithology ES Chapter (Doc ref No. 7.2.5) which has been updated in submissions at Deadline IIa for the three auk species. Table 1.11 presents the seasonal assessment of displacement for relevant species.

Table 1.11: Assessment of displacement mortality against the 1% threshold of baseline mortality for relevant BDMPS populations

Species	Season	Cumulative displacement mortality[5]	> 1% baseline mortality (Y/N)	PBR required (Y/N)
Guillemot	Breeding	1,094.4	420	Y
	Non-breeding	189.3	990	N
Razorbill	Breeding	107.4	60	Y
	Post-breeding	211.0	623	N
	Non-breeding	52.0	230	N
	Pre-breeding	162.3	623	N
Puffin	Breeding	67.0	32	Y
	Non-breeding	52.9	218	N

1.4.15 Seasonal displacement mortality surpasses the 1% threshold of baseline mortality of relevant regional breeding populations for all three species, the 1% threshold is not surpassed outside of the breeding season. Therefore PBR analyses for these populations have been conducted (Table 1.12).

Table 1.12: PBR analyses for relevant seasonal regional populations for species considered for assessment of cumulative displacement

Species	Population (Nmin)	*f* = 0.1	*f* = 0.2	*f* = 0.3	*f* = 0.4	*f* = 0.5	*f* = 1.0
Guillemot	632,472	2,485	4,969	7,454	**9,938**	12,423	24,846
Razorbill	52,332	285	**570**	855	1,140	1,424	2,849
Puffin	31,204	163	**326**	490	653	816	1,632

1.4.16 Seasonal predicted displacement mortality using the Applicant's advocated displacement and mortality rates (30% and 10%) for guillemot surpasses the 1% threshold of baseline mortality in the breeding season only. This level of predicted displacement mortality (1,094.4 birds) represents an equivalent *f* value of 0.04, which is considerably below the *f* value considered appropriate for this population (*f* = 0.4, SMart Wind, 2014).

1.4.17 For razorbill, the 1% threshold of baseline mortality is surpassed in the breeding season only using the displacement and mortality rates advocated by the Applicant. The breeding season predicted displacement mortality for razorbill represents an equivalent *f* value of 0.04 which is considerably below the *f* value considered appropriate for this population (*f* = 0.2; SMart Wind, 2014).

1.4.18 Seasonal predicted displacement mortality using the Applicant's advocated displacement and mortality rates for puffin surpasses the 1% threshold of baseline mortality in the breeding season only. The predicted displacement mortality represents

[5] Assessment made based on displacement mortality calculated using the Applicant's rates only

an equivalent *f* value of 0.04, which is below the *f* value considered appropriate for this population (*f* = 0.2; SMart Wind, 2014).

1.5 Conclusions

1.5.1 In light of the information presented in this note the conclusions of the EIA as submitted by the Applicant remain unchanged:

Gannet

1.5.2 For all projects combined, a cumulative mortality impact of **low** magnitude in the breeding season will produce a minor to moderate adverse effect on the regional breeding population. Based on professional judgment of the predicted level of collision mortality when compared against likely sustainable take calculated by PBR, significance is considered to tend towards **minor** which is not significant in EIA terms.

1.5.3 For all projects combined, a cumulative mortality impact of **low** magnitude in the post- and pre-breeding seasons will produce a **minor** adverse effect on the North Sea populations assessed, which is not significant in EIA terms.

Kittiwake

1.5.4 For all projects considered, a cumulative mortality impact of **low** magnitude on a medium to high sensitivity receptor such as kittiwake is predicted to produce a minor to moderate adverse effect on the regional population in all seasons assessed. Based on professional judgment of the predicted level of collision mortality when compared against likely sustainable take calculated by PBR, significance is considered to tend towards **minor** which is not significant in EIA terms.

Lesser Black-backed Gull

1.5.5 When considering all projects, a cumulative mortality impact of **low** magnitude in the breeding season is predicted to produce a **minor** adverse effect on the regional population, which is not considered significant in EIA terms.

1.5.6 For all projects, a cumulative mortality impact of **low** magnitude in the non-breeding season on a medium to high sensitivity receptor is predicted to produce a **minor** adverse effect on the North Sea flyway population, which is considered not significant in EIA terms.

Great Black-backed Gull

1.5.7 For all projects combined, a cumulative mortality impact of low or low to medium magnitude on a low to medium sensitivity receptor such as great black-backed gull will produce a **minor** adverse effect, tending towards minor on the regional and flyway populations.

Guillemot

1.5.8 Predicted displacement mortality is not expected to occur on a year on year basis; it is considered more likely to relate to a singular event following which seabirds will respond to by either redistribution or habituation.

1.5.9 Cumulative displacement impact of **low** magnitude on a medium sensitivity receptor such as guillemot will produce a **minor** to **moderate** adverse effect on the regional breeding population. However, when the regional population including immature birds is incorporated into the assessment it is considered that cumulative displacement in the breeding season does not represent a significant impact in EIA terms.

1.5.10 Cumulative displacement impact of **low** or **negligible** magnitude on a medium sensitivity receptor such as guillemot will produce a **minor** adverse effect on the regional post and non-breeding populations, which is not considered significant in EIA terms.

Razorbill

1.5.11 Predicted displacement mortality is not expected to occur on a year on year basis; it is considered more likely to relate to a singular event following which seabirds such as razorbill will respond to by either redistribution or habituation. Cumulative displacement impact of **low** magnitude on a medium sensitivity receptor such as razorbill will produce a **minor** adverse effect on the regional populations assessed, which is not considered significant in EIA terms.

Puffin

1.5.12 Cumulative displacement impact of **negligible** or **low** magnitude on a medium to high sensitivity receptor such as puffin would produce a **minor** adverse effect on the wider regional breeding population. This conclusion is based on the assumption that mortality during the breeding season is to puffins from the a wider pool of breeding and non-breeding individuals not limited to colonies within mean-maximum foraging range. This impact is therefore considered to be not significant in EIA terms.

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1.7 Appendix 1 – Cumulative displacement matrices

Table 1.13: Cumulative displacement matrix for guillemot in the breeding season compared to the 1% baseline mortality threshold for the regional breeding population

Guillemot (Breeding)	Mortality (%)													
Displacement level (%)		**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
	1	4	7	18	36	73	109	146	182	219	255	292	328	365
	2	7	15	36	73	146	219	292	365	438	511	584	657	730
	5	18	36	91	182	365	547	730	912	1094	1277	1459	1642	1824
	10	36	73	182	365	730	1094	1459	1824	2189	2554	2919	3283	3648
	20	73	146	365	730	1459	2189	2919	3648	4378	5107	5837	6567	7296
	25	91	182	456	912	1824	2736	3648	4560	5472	6384	7296	8208	9121
	30	109	219	547	1094	2189	3283	4378	5472	6567	7661	8756	9850	10945
	40	146	292	730	1459	2919	4378	5837	7296	8756	10215	11674	13134	14593
	50	182	365	912	1824	3648	5472	7296	9121	10945	12769	14593	16417	18241
	60	219	438	1094	2189	4378	6567	8756	10945	13134	15322	17511	19700	21889
	70	255	511	1277	2554	5107	7661	10215	12769	15322	17876	20430	22984	25537
	75	274	547	1368	2736	5472	8208	10945	13681	16417	19153	21889	24625	27362
	80	292	584	1459	2919	5837	8756	11674	14593	17511	20430	23348	26267	29186
	90	328	657	1642	3283	6567	9850	13134	16417	19700	22984	26267	29550	32834
	100	365	730	1824	3648	7296	10945	14593	18241	21889	25537	29186	32834	36482
			< 1% threshold of baseline mortality					> 1% threshold of baseline mortality				> PBR value at advocated *f* value		

Table 1.14: Cumulative displacement matrix for guillemot in the non-breeding season compared to the 1% baseline mortality threshold for the non-breeding BDMPS population

Guillemot (Non-breeding)	Mortality (%)													
Displacement level (%)		1	2	5	10	20	30	40	50	60	70	80	90	100
	1	6	13	32	63	126	189	252	316	379	442	505	568	631
	2	13	25	63	126	252	379	505	631	757	884	1010	1136	1262
	5	32	63	158	316	631	947	1262	1578	1893	2209	2525	2840	3156
	10	63	126	316	631	1262	1893	2525	3156	3787	4418	5049	5680	6311
	20	126	252	631	1262	2525	3787	5049	6311	7574	8836	10098	11361	12623
	25	158	316	789	1578	3156	4734	6311	7889	9467	11045	12623	14201	15779
	30	189	379	947	1893	3787	5680	7574	9467	11361	13254	15147	17041	18934
	40	252	505	1262	2525	5049	7574	10098	12623	15147	17672	20196	22721	25246
	50	316	631	1578	3156	6311	9467	12623	15779	18934	22090	25246	28401	31557
	60	379	757	1893	3787	7574	11361	15147	18934	22721	26508	30295	34082	37868
	70	442	884	2209	4418	8836	13254	17672	22090	26508	30926	35344	39762	44180
	75	473	947	2367	4734	9467	14201	18934	23668	28401	33135	37868	42602	47336
	80	505	1010	2525	5049	10098	15147	20196	25246	30295	35344	40393	45442	50491
	90	568	1136	2840	5680	11361	17041	22721	28401	34082	39762	45442	51122	56803
	100	631	1262	3156	6311	12623	18934	25246	31557	37868	44180	50491	56803	63114
			< 1% threshold of baseline mortality							> 1% threshold of baseline mortality				

Table 1.15: Cumulative displacement matrix for razorbill in the breeding season compared to the 1% baseline mortality threshold for the regional breeding population

Razorbill (Breeding)	Mortality (%)													
Displacement level (%)		**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
	1	0	1	1	3	5	8	11	13	16	19	21	24	27
	2	1	1	3	5	11	16	21	27	32	38	43	48	54
	5	1	3	7	13	27	40	54	67	81	94	107	121	134
	10	3	5	13	27	54	81	107	134	161	188	215	242	268
	20	5	11	27	54	107	161	215	268	322	376	429	483	537
	25	7	13	34	67	134	201	268	336	403	470	537	604	671
	30	8	16	40	81	161	242	322	403	483	564	644	725	805
	40	11	21	54	107	215	322	429	537	644	752	859	966	1074
	50	13	27	67	134	268	403	537	671	805	939	1074	1208	1342
	60	16	32	81	161	322	483	644	805	966	1127	1288	1449	1610
	70	19	38	94	188	376	564	752	939	1127	1315	1503	1691	1879
	75	20	40	101	201	403	604	805	1007	1208	1409	1610	1812	2013
	80	21	43	107	215	429	644	859	1074	1288	1503	1718	1932	2147
	90	24	48	121	242	483	725	966	1208	1449	1691	1932	2174	2416
	100	27	54	134	268	537	805	1074	1342	1610	1879	2147	2416	2684
		< 1% threshold of baseline mortality						> 1% threshold of baseline mortality				> PBR value at advocated *f* value		

Table 1.16: Cumulative displacement matrix for razorbill in the post-breeding season compared to the 1% baseline mortality threshold for the post-breeding BDMPS population

Razorbill (Post-breeding)	Mortality (%)													
Displacement level (%)		1	2	5	10	20	30	40	50	60	70	80	90	100
	1	3	5	13	26	53	79	105	132	158	185	211	237	264
	2	5	11	26	53	105	158	211	264	316	369	422	475	527
	5	13	26	66	132	264	396	527	659	791	923	1055	1187	1319
	10	26	53	132	264	527	791	1055	1319	1582	1846	2110	2373	2637
	20	53	105	264	527	1055	1582	2110	2637	3165	3692	4220	4747	5274
	25	66	132	330	659	1319	1978	2637	3297	3956	4615	5274	5934	6593
	30	79	158	396	791	1582	2373	3165	3956	4747	5538	6329	7120	7912
	40	105	211	527	1055	2110	3165	4220	5274	6329	7384	8439	9494	10549
	50	132	264	659	1319	2637	3956	5274	6593	7912	9230	10549	11867	13186
	60	158	316	791	1582	3165	4747	6329	7912	9494	11076	12659	14241	15823
	70	185	369	923	1846	3692	5538	7384	9230	11076	12922	14768	16614	18460
	75	198	396	989	1978	3956	5934	7912	9890	11867	13845	15823	17801	19779
	80	211	422	1055	2110	4220	6329	8439	10549	12659	14768	16878	18988	21098
	90	237	475	1187	2373	4747	7120	9494	11867	14241	16614	18988	21361	23735
	100	264	527	1319	2637	5274	7912	10549	13186	15823	18460	21098	23735	26372
			< 1% threshold of baseline mortality							> 1% threshold of baseline mortality				

Table 1.17: Cumulative displacement matrix for razorbill in the non-breeding season compared to the 1% baseline mortality threshold for the non-breeding BDMPS population

Razorbill (Non-breeding)	Mortality (%)													
Displacement level (%)		**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
	1	1	3	7	13	26	39	52	65	78	91	104	117	130
	2	3	5	13	26	52	78	104	130	156	182	208	234	260
	5	7	13	33	65	130	195	260	325	390	455	520	585	650
	10	13	26	65	130	260	390	520	650	780	911	1041	1171	1301
	20	26	52	130	260	520	780	1041	1301	1561	1821	2081	2341	2602
	25	33	65	163	325	650	976	1301	1626	1951	2276	2602	2927	3252
	30	39	78	195	390	780	1171	1561	1951	2341	2732	3122	3512	3902
	40	52	104	260	520	1041	1561	2081	2602	3122	3642	4163	4683	5203
	50	65	130	325	650	1301	1951	2602	3252	3902	4553	5203	5854	6504
	60	78	156	390	780	1561	2341	3122	3902	4683	5463	6244	7024	7805
	70	91	182	455	911	1821	2732	3642	4553	5463	6374	7284	8195	9106
	75	98	195	488	976	1951	2927	3902	4878	5854	6829	7805	8780	9756
	80	104	208	520	1041	2081	3122	4163	5203	6244	7284	8325	9366	10406
	90	117	234	585	1171	2341	3512	4683	5854	7024	8195	9366	10536	11707
	100	130	260	650	1301	2602	3902	5203	6504	7805	9106	10406	11707	13008
			< 1% threshold of baseline mortality							> 1% threshold of baseline mortality				

Table 1.18: Cumulative displacement matrix for razorbill in the pre-breeding season compared to the 1% baseline mortality threshold for the pre-breeding BDMPS population

Razorbill (pre-breeding)	Mortality (%)													
Displacement level (%)		**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
	1	2	4	10	20	41	61	81	101	122	142	162	183	203
	2	4	8	20	41	81	122	162	203	243	284	325	365	406
	5	10	20	51	101	203	304	406	507	608	710	811	913	1014
	10	20	41	101	203	406	608	811	1014	1217	1420	1623	1825	2028
	20	41	81	203	406	811	1217	1623	2028	2434	2840	3245	3651	4057
	25	51	101	254	507	1014	1521	2028	2535	3042	3550	4057	4564	5071
	30	61	122	304	608	1217	1825	2434	3042	3651	4259	4868	5476	6085
	40	81	162	406	811	1623	2434	3245	4057	4868	5679	6491	7302	8113
	50	101	203	507	1014	2028	3042	4057	5071	6085	7099	8113	9127	10142
	60	122	243	608	1217	2434	3651	4868	6085	7302	8519	9736	10953	12170
	70	142	284	710	1420	2840	4259	5679	7099	8519	9939	11358	12778	14198
	75	152	304	761	1521	3042	4564	6085	7606	9127	10649	12170	13691	15212
	80	162	325	811	1623	3245	4868	6491	8113	9736	11358	12981	14604	16226
	90	183	365	913	1825	3651	5476	7302	9127	10953	12778	14604	16429	18255
	100	203	406	1014	2028	4057	6085	8113	10142	12170	14198	16226	18255	20283
			< 1% threshold of baseline mortality							> 1% threshold of baseline mortality				

Table 1.19: Cumulative displacement matrix for puffin in the breeding season compared to PBR and the 1% baseline mortality threshold for the regional breeding population

Puffin (Breeding)	Mortality (%)													
Displacement level (%)		**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
	1	0	0	1	2	3	5	7	8	10	12	13	15	17
	2	0	1	2	3	7	10	13	17	20	23	27	30	34
	5	1	2	4	8	17	25	34	42	50	59	67	75	84
	10	2	3	8	17	34	50	67	84	101	117	134	151	168
	20	3	7	17	34	67	101	134	168	201	235	268	302	335
	25	4	8	21	42	84	126	168	210	251	293	335	377	419
	30	5	10	25	50	101	151	201	251	302	352	402	453	503
	40	7	13	34	67	134	201	268	335	402	469	536	603	670
	50	8	17	42	84	168	251	335	419	503	587	670	754	838
	60	10	20	50	101	201	302	402	503	603	704	804	905	1006
	70	12	23	59	117	235	352	469	587	704	821	939	1056	1173
	75	13	25	63	126	251	377	503	629	754	880	1006	1131	1257
	80	13	27	67	134	268	402	536	670	804	939	1073	1207	1341
	90	15	30	75	151	302	453	603	754	905	1056	1207	1358	1508
	100	17	34	84	168	335	503	670	838	1006	1173	1341	1508	1676
			< 1% threshold of baseline mortality					> 1% threshold of baseline mortality				> PBR value at advocated *f* value		

Table 1.20: Cumulative displacement matrix for puffin in the non-breeding season compared to the 1% baseline mortality threshold for the non-breeding BDMPS population

Puffin (Non-breeding)	Mortality (%)													
Displacement level (%)		**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
	1	1	3	7	13	26	40	53	66	79	93	106	119	132
	2	3	5	13	26	53	79	106	132	159	185	212	238	265
	5	7	13	33	66	132	199	265	331	397	463	529	596	662
	10	13	26	66	132	265	397	529	662	794	926	1059	1191	1324
	20	26	53	132	265	529	794	1059	1324	1588	1853	2118	2382	2647
	25	33	66	165	331	662	993	1324	1654	1985	2316	2647	2978	3309
	30	40	79	199	397	794	1191	1588	1985	2382	2779	3176	3573	3971
	40	53	106	265	529	1059	1588	2118	2647	3176	3706	4235	4765	5294
	50	66	132	331	662	1324	1985	2647	3309	3971	4632	5294	5956	6618
	60	79	159	397	794	1588	2382	3176	3971	4765	5559	6353	7147	7941
	70	93	185	463	926	1853	2779	3706	4632	5559	6485	7412	8338	9265
	75	99	199	496	993	1985	2978	3971	4963	5956	6948	7941	8934	9926
	80	106	212	529	1059	2118	3176	4235	5294	6353	7412	8470	9529	10588
	90	119	238	596	1191	2382	3573	4765	5956	7147	8338	9529	10720	11912
	100	132	265	662	1324	2647	3971	5294	6618	7941	9265	10588	11912	13235
			< 1% threshold of baseline mortality							> 1% threshold of baseline mortality				