

Hornsea Offshore Wind Farm

Project Two

Clarification Note – Apportioning of predicted razorbill mortality to the Flamborough and Filey Coast pSPA population

Appendix R to the Response submitted for Deadline IIA

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1 Apportioning and Assessment of predicted razorbill mortality to the Flamborough and Filey Coast pSPA population

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 SMartWind 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 notes basis is to respond to queries raised by Natural England in their Relevant and Written Representations regarding the apportioning of razorbill present within the Project site to the Flamborough and Filey Coast (FFC) pSPA during the breeding season. Specifically, this note explores the assumptions made regarding the spatial and numerical distribution of non-breeding (including immature) birds during the breeding season and the foraging range used to identify colonies from which birds may interact with the Project site.

1.1.3 Natural England have not raised any queries about the methodologies used to apportion birds in any other seasons defined for razorbill (i.e. pre-breeding, non-breeding and post-breeding) and therefore this note does not provide any exploration of alternative apportioning approaches during these seasons.

1.1.4 The apportioning methodology for razorbill that informed the assessment was presented in Appendix E of the HRA Report (Doc ref No. 12.6). This clarification note builds on the razorbill apportioning and assessment that is presented in the HRA Report.

1.1.5 The note provides details of the applicants considered position and deemed implications for the FFC pSPA in addition to the position of Natural England. Where differences between the Applicant and Natural England occur, these are explored to provide appropriate clarity.

1.1.6 The report is structured to include the following sections:

- A description of consultation with Natural England from the Section 42 submission through to final submission and consultation that has taken place as part of the examination process (Section **Error! Reference source not found.**);
- Razorbill phenology – definition of seasonal extents (Section **Error! Reference source not found.**);
- Breeding season apportioning – Project Two alone (Section **Error! Reference source not found.**);
- Annual predicted mortality apportioning to FFC pSPA from Project Two alone (Section 0);
- Assessment of predicted razorbill mortality from Project Two in combination with other plans or project (Section **Error! Reference source not found.**); and
- Conclusions – implications for FFC pSPA (Section 1.6).

1.2 Consultation with Natural England

1.2.1 This section outlines the assessment evolution of the breeding razorbill feature of FFC pSPA, including; consultation and development of the Biologically Defined Minimum Population Scale (BDMPS) approach, and finally the apportioning methodologies incorporated into assessment for razorbill from the Section 42 submission to Deadline II of the Project examination. During this period there have been ongoing discussions with Natural England that have informed the BDMPS and apportioning methodologies presented in the submitted application and subsequently within this clarification note.

1.2.2 The remaining text in Section 1.2 of this note details queries raised by Natural England at various stages of the application and which are clarified within this note.

Section 42 and application submission

1.2.3 In the Section 42 submission, razorbill was screened out of further assessment during the breeding season as the Project site falls beyond the mean-maximum (and maximum) foraging range of the species (Thaxter *et al.*, 2012). Natural England did not agree with the exclusion of razorbill and stated that as FFC pSPA was the nearest SPA colony to the Project site designated for razorbill then it should be screened into the assessment regardless of any published foraging range. Natural England also referenced a recent example from the Dogger Bank Creyke Beck project where razorbill had been screened into the assessment despite lying beyond the mean-maximum foraging range for the species and defined a BDMPS for the species in the North Sea to calculate the proportion of birds originating from different SPA sites. The HRA Report (Doc Ref. 12.6) aligned with this approach.

Natural England's Relevant Representation

1.2.4 Natural England raised a number of queries within their Relevant Representation in relation to the apportioning methodology applied to auk species (paragraphs 59-71) and specifically to razorbill in paragraphs 65 to 67.

1.2.5 Two main issues were highlighted by Natural England in the species-specific sections of their Relevant Representation and repeated in their Written Representation that are applicable to the apportioning exercise undertaken for razorbill in the breeding season:

- *“Natural England do not agree that the estimates of numbers of immatures from UK, Faeroes and Norwegian colonies predicted to be in the North Sea in winter can be used in the breeding season...”*
- *“Natural England does not agree with the 200km foraging range that has been applied to scope in adults from breeding colonies...”*

1.2.6 Natural England do however note that:

- *“adult birds recorded in the project area in the breeding season period are not necessarily birds that are provisioning young.”*

- “later in the breeding season some adults could be failed breeders...”
- “immature birds show natal philopatry and for several species are likely to start prospecting for sites within the colony during the breeding season.”

Pre-examination and examination consultation

1.2.7 At a consultation meeting on the 3rd June 2015, the apportioning of impacts to the FFC pSPA razorbill population was discussed. The implications of these discussions (including revision to foraging range applied) are detailed with respect to the positions of both the Applicant and Natural England in the remainder of this note.

1.3 Razorbill phenology – seasonal definitions

1.3.1 Following Section 42 consultation with Natural England, four seasons were defined for razorbill based on information presented in Furness (2015), these are presented in Table 1.1.

Table 1.1: Seasonal extents used for razorbill throughout the assessment of Hornsea Project Two.

Season	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Breeding												
Post-breeding												
Non-breeding												
Pre-breeding												

1.3.2 Natural England have not raised any disagreements with the seasonal definitions presented in **Error! Reference source not found.** within their Relevant and Written Representations. Therefore, the Applicant and Natural England are aligned in their application for all assessment purposes.

1.4 Breeding season apportioning – Project Two alone

Foraging range

1.4.1 In Appendix E of the HRA Report (Doc ref No. 12.6) the Applicant presented evidence that indicated it was unlikely that razorbill present at the Project site during the breeding season originated from the FFC pSPA. This evidence incorporated information on foraging range and breeding productivity of razorbill at the FFC pSPA. However, Natural England advised that they did not agree that there were no breeding season impacts on the razorbill population at the FFC pSPA.

1.4.2 In order to address these concerns an alternative scenario was formulated which involved the calculation of the maximum number of razorbill present at the Project site that could be attributed to FFC pSPA. This highly precautionary value took the form of the assumption that razorbill from the pSPA could forage out to a distance of 200 km (Thaxter *et al.*, 2012).

1.4.3 However, as part of their Relevant Representations, Natural England question the use of the 200 km foraging range to inform the assessment. There is evidence that suggests the use of the maximum foraging range of razorbill from Thaxter *et al.* (2012) considerably precautionary. High densities of razorbill have been recorded up to 30 km offshore at FFC pSPA (Brown and Grice, 2005), indicating that foraging range, at least of birds from this colony is lower than that reported in Thaxter *et al.* (2012). Detailed cumulative foraging range data for razorbill indicates that less than 5% of foraging trips from the FFC pSPA occur beyond 25 km and that none would interact with the Project site (Figure 1-1). If razorbills were to consistently forage at a distance from the colony coincident with the Project site location, this would likely have negative impacts on the productivity of the colony to such an extent as to reduce overall productivity to zero. This has previously been documented at colonies in Shetland and on Fair Isle in years where food supply was poor resulting in extended foraging trips by breeding birds (Heubeck and Parnaby, 2012).

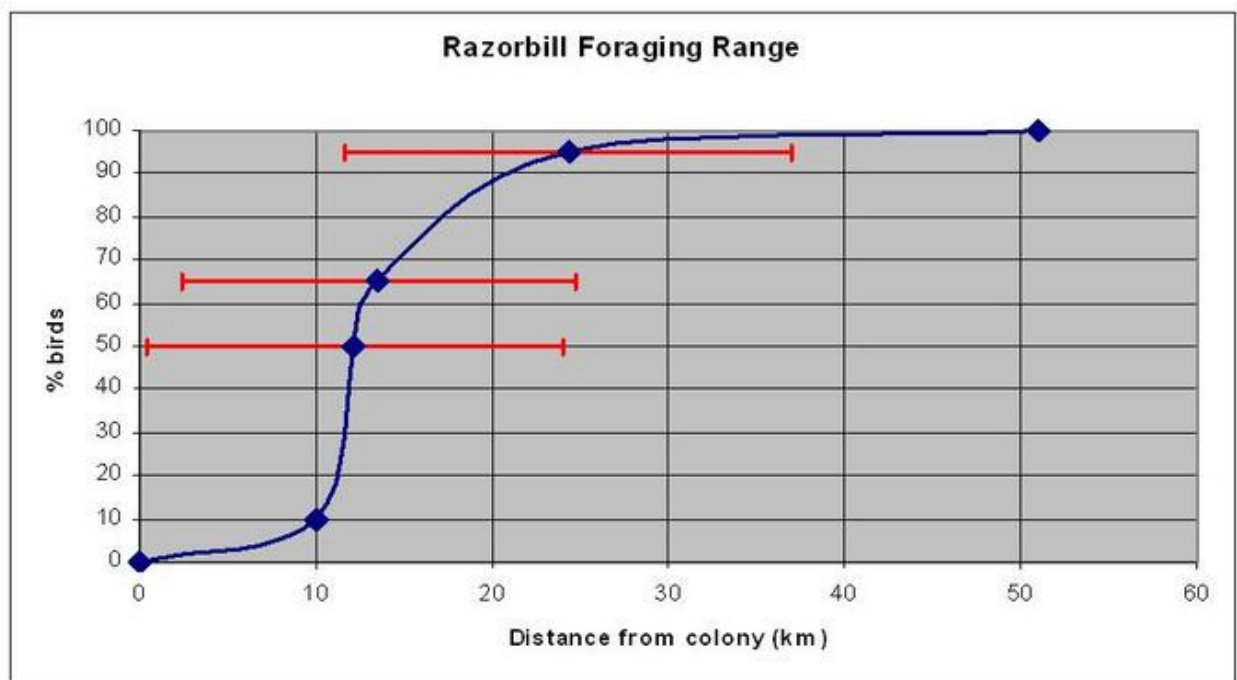


Figure 1-1: Cumulative frequency and proportion of razorbills found foraging at different distances from colony (Birdlife International, 2014¹).

1.4.4 Natural England suggest that evidence from recent tracking studies (e.g. the Future of the Atlantic Marine Environment (FAME) project) have recorded greater maximum foraging ranges from some colonies. The colonies from which tracking has been

¹ Seabirdwikispaces.com

undertaken are all Scottish colonies, except one in Wales. In recent decades breeding success has been notably good at colonies between Humberside and south-east Scotland. This is in contrast to colonies further north where breeding success has been comparatively low (JNCC, 2014). High breeding success at colonies between Humberside and south-east Scotland implies that food supply, and as such foraging opportunities, are good. This would result in foraging breeding adults having to travel shorter distances than those cited in the tracking literature in order to acquire food.

1.4.5 Although the Applicant considers that it is unlikely that breeding adult razorbills from the pSPA reach the Project site on a regular basis in the breeding season, a precautionary 100 km foraging range from the FFC pSPA has been defined in agreement with Natural England. This foraging range is the minimum distance at which breeding adult razorbill from the FFC pSPA could interact with the Project site. This revised foraging range does therefore have the implication of excluding particular projects from the in-combination assessment (see Section 1.6).

Population age structure

1.4.6 The proportion of breeding adult razorbills present at the Project site originating from the FFC pSPA during the breeding season was derived in the HRA Report (Doc. ref. 12.6) with the following steps (with reference to Furness 2015):

1. The total number of immature birds associated with colonies in the North Sea during the non-breeding season was calculated. It was assumed that these immatures remain in the North Sea during the breeding season;
2. The total number of immature birds from foreign colonies that overwinter in the North Sea was calculated. It was again assumed that these birds remain in the North Sea during the breeding season;
3. The estimated number of breeding birds within the extended 200 km foraging range was calculated using data from the JNCC's Seabird Monitoring Programme database;
4. The resulting immature population from Step 1, a precautionary 25% of the immature population from Step 2 and the breeding adult population calculated in Step 3 were totalled to provide the total number of birds with potential connectivity to Subzone 2 in the breeding season; and
5. The Flamborough and Filey Coast pSPA population was then compared to the total population calculated in Step 4 to determine the proportion of the total population represented by birds from the pSPA colony.

1.4.7 By applying the five steps outlined above, the total population of razorbill with predicted connectivity to the Project site was calculated as 56,929 birds. The contribution of breeding adults from FFC pSPA to this population is 37.13%.

1.4.8 As part of their Relevant Representations, Natural England stated that they do not agree with the application of non-breeding immature proportions as presented in Furness (2015) to the breeding season population recorded at Project Two.

- 1.4.9 The presence of immature birds in the North Sea during the breeding season is supported by ringing recoveries presented in Mead (1974) and Lloyd (1974). This literature indicates that birds from all immature age classes are present in the North Sea either during the breeding season or in the autumn (Lloyd, 1974). Immature birds from northern colonies are predominantly recovered from the south Norwegian coast with many 2 to 4 year old birds also recovered in the North Sea meaning these birds could be present at the Project site (Lloyd, 1974). Mead (1974) alludes to an immature population that summers in the North Sea and also suggests that birds from North Sea colonies remain in the North Sea throughout the year.
- 1.4.10 This evidence suggests that a population of immatures larger than that incorporated into the apportioning approach presented in the HRA Report (Doc ref No. 12.6), may be present in the North Sea during the breeding season. An assessment of razorbill population age structure based on Lloyd (1974) and Mead (1974) including all immature birds from North Sea colonies and a proportion of birds from western UK colonies, implies that 90,138 razorbill are present in the North Sea during the breeding season. Of this population FFC pSPA would provide a proportion of 23.5% breeding adults. On this basis the calculation provided in the HRA Report of 37.1% breeding adults is considered precautionary and maintained for the purposes of this assessment.
- 1.4.11 Natural England's position is that the application of Project Two site specific data is suitable to calculate the proportion of breeding adults present. During the breeding season the proportion of adult breeding birds present at the Project site was 48.2%. However, whilst one year old razorbills can be easily identified during boat-based surveys, older immature birds, which have not yet reached the age of first breeding, cannot be easily separated from adult birds. Therefore data on age class, collected during boat-based surveys, will potentially represent a considerable underestimate of the proportion of immatures present at the Project site.
- 1.4.12 It is highly unlikely that breeding adult birds will be evenly distributed throughout their defined foraging range, with the density of foraging birds likely to be highest closest to the colony as birds attempt to reduce energetic costs associated with provisioning young (MacArthur Green, 2014). High densities of razorbill have been recorded up to 30 km offshore at the FFC pSPA (Brown and Grice, 2005) indicating that few birds may be foraging out to the maximum foraging range as presented in Thaxter et al. (2012). Detailed cumulative foraging range data indicates that 95% of foraging trips occur within 25 km of a colony (Figure 1-1). This infers that only 5% of foraging trips would occur beyond this distance with the percentage decreasing as distance from colony increases up to a maximum foraging range of just over 50 km.
- 1.4.13 It is likely that consistently foraging at such a distance would negatively impact the productivity of the colony to such an extent as to reduce overall productivity to zero (Heubeck and Parnaby, 2012). High breeding success at colonies between Humberside and south-east Scotland implies that food supply, and as such foraging opportunities, are good. This would result in foraging breeding adults having to travel shorter distances than those cited in the literature in order to acquire food. This information indicates that foraging trips of razorbill from the FFC pSPA are more

likely to occur closer to the colony with less than 5% of foraging trips interacting with the Project site.

Summary of the Applicant and Natural England's positions

1.4.14 Notwithstanding the Applicants consideration that it is likely that few breeding adult Razorbill from FFC pSPA, if any, reach the Project site in the breeding season, the application of a precautionary 100 km foraging range has been used within the assessment. With regard to population age structure, Natural England's position is the use of a 48.2% proportion of breeding adult birds derived from Project Two specific data. The Applicant considers that this data was not designed for use in this manner and cannot provide a true indication of the number of a immatures present.

1.4.15 The step-wise calculation of likely proportions of immature and non-breeding adult birds likely present in the North Sea based on Furness (2015) and applied within the HRA Report (Doc Ref. 12.6) was found to be precautionary and maintained as the Applicant's position in this Note. This suggests that a proportion of 37.1% attributable to breeding adult razorbills from the pSPA is appropriate to apply to the breeding season apportioning exercise.

1.4.16 Apportioned predicted displacement mortality to FFC pSPA is shown in Table 1.2.

Table 1.2: Predicted razorbill displacement mortality from Project Two alone apportioned to FFC pSPA.

Position	Displacement mortality (No. birds)		Percentage of breeding adults	Apportioned mortality to pSPA	
	40% displacement / 10% mortality	70% displacement; 10% mortality		30% displacement / 10% mortality	70% displacement; 10% mortality
Applicant	100	176	37.1	37	65
Natural England	100	176	48.2	48	85

1.5 Annual predicted mortality apportioning to FFC pSPA – Project Two alone

1.5.1 Natural England have noted within their Relevant and Written Representations that the displacement mortality estimated for each season should be summed to provide an annual level of risk. The Applicant considers that displacement represents a different mechanism to collision and that seasonal estimates should not be summed due to the clear potential for 'double-counting' of effects; it is highly unlikely that seasonal mortality is additive in this way and in any case, this approach takes no account of the relative duration of the displacement effect in each season. This disagreement is captured in Table 3.3 of the Statement of Common Ground submitted by the Applicant in their second response (Appendix R).

- 1.5.2 In the post- and pre--breeding seasons, population data from Furness (2015) were used to calculate the contribution of birds from FFC pSPA to a wider non-breeding population present within the North Sea. Based on the proportion of birds from UK and foreign colonies considered to be present in the North Sea during the non-breeding season, as presented in Furness (2015), the North Sea population of razorbill was calculated as 593,779 individuals. The contribution of the pSPA to this population is 3.56%.
- 1.5.3 This represents displacement mortality apportioned to the pSPA of 1 bird in the post-breeding season and 0 birds in the pre-breeding season applying the Applicants favoured rates (40% displacement; 2% mortality). When applying the maximum end of Natural England's advocated range of rates (70% displacement; 10% mortality) mortality of 11 and 4 birds are predicted during post- and pre-breeding seasons respectively.
- 1.5.4 The North Sea population of razorbill was calculated as 219,049 individuals in the non-breeding season. The contribution of the pSPA to this population is 2.90%. This represents displacement mortality apportioned to the pSPA of 0 birds applying the Applicants favoured rates (40% displacement; 1% mortality). When applying the maximum end of Natural England's favoured rates (70% displacement; 10% mortality) the mortality of 1 bird is predicted in the non-breeding season.
- 1.5.5 Natural England therefore consider annual displacement mortality would represent 101 birds apportioned to FFC pSPA according to their favoured maximum displacement and mortality rates. The Applicant considers an assessment on a seasonal basis to be appropriate with the season with the worst case scenario appropriate to assess against the FFC pSPA (mortality of 37 birds in the breeding season).

Table 1.3: Apportioned razorbill displacement mortality to FFC pSPA for each defined biological season.

Season	Percentage of breeding adults	Displacement (no. of birds)	
		Applicant favoured rates	Natural England (70% displacement; 10% mortality)
Breeding	37.13	37	n/a
	48.2	n/a	85
Post-breeding	3.56	1	11
Non-breeding	2.90	0	1
Pre-breeding	3.56	0	4

1.6 Assessment of impacts attributable to the FFC pSPA – In-combination

Projects considered in-combination

- 1.6.1 As described for Project Two alone, a 100 km foraging range is applied to the in-combination assessment in order to identify the breeding colonies from which breeding adult guillemots may forage within the Project site. This foraging range is also applied within the in-combination assessment to identify other offshore wind farm projects to be considered (see **Error! Reference source not found.**).
- 1.6.2 The reduction in foraging range from the 200 km applied in the HRA to 100 km results in changes to the suite of projects considered in the in-combination assessment during the breeding season. As a result of this change, the only projects included within the in-combination assessment during the breeding season are Humber Gateway, Teesside, Triton Knoll, Hornsea Project One and Westernmost Rough.

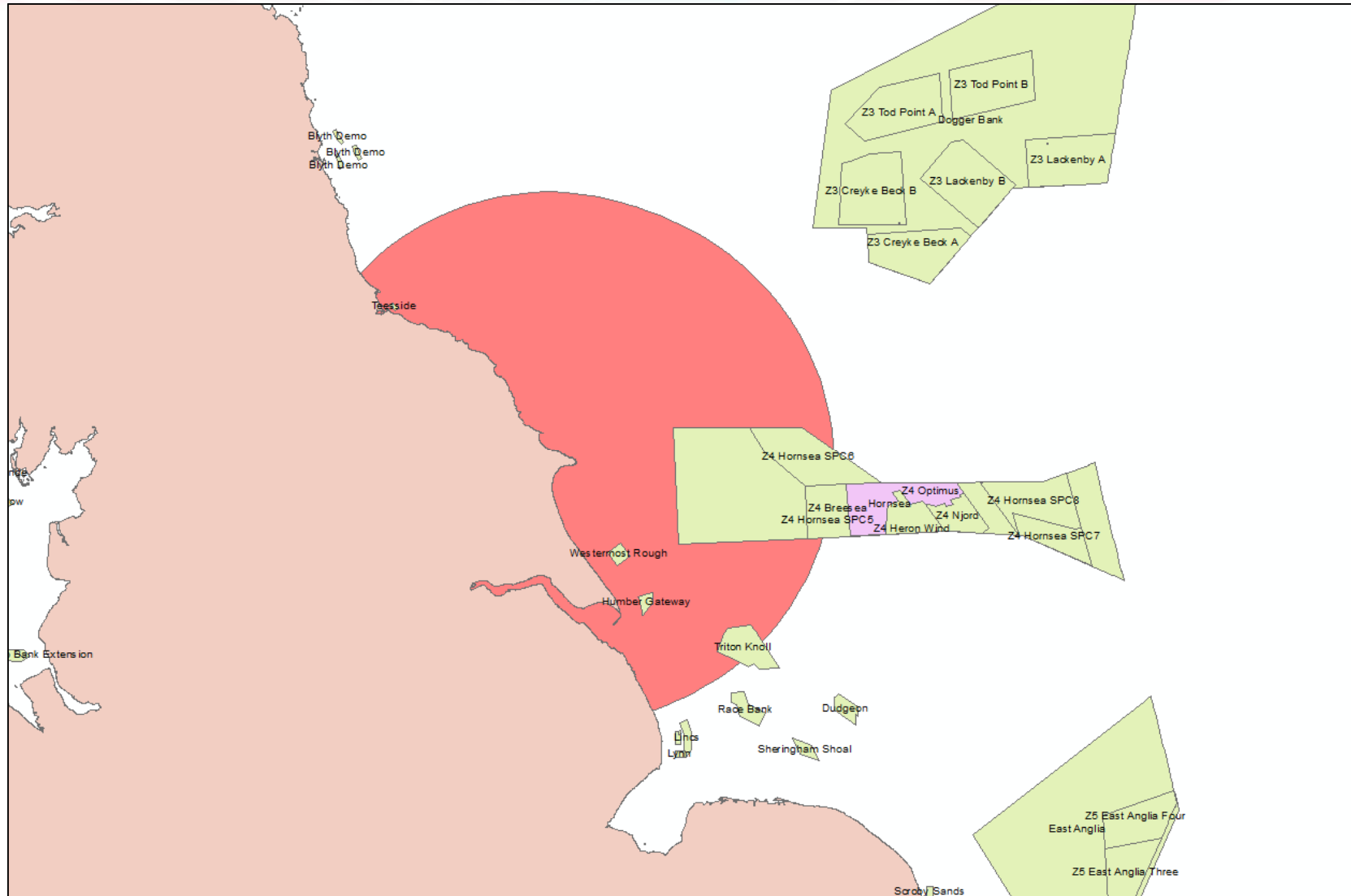



Figure 1-2 Foraging range of 100km for razorbill from FFC pSPA and projects included in the in-combination assessment during the breeding season.



1.6.3 **Error! Reference source not found.** presents the following information for each project considered in-combination:

- Mean-peak guillemot population calculated for each season;
- The percentage used to apportion birds present to the pSPA; and
- The resultant population at the projects considered associated with the pSPA.

1.6.4 The Applicant has applied an apportioning value of 37.10% in the breeding season for Project Two and 100% for all other projects that fall within the 100 km foraging to the breeding season figures.

1.6.5 Table 1.5 to Table 1.8 present displacement matrices using the apportioned populations in the all seasons as advocated by the Applicant.

Table 1.4 Razorbill seasonal mean peak populations and apportioning values for project within the in-combination assessment (Applicant's position).

Project	Mean peak breeding population Breeding	Breeding apportioning (%)	Mean peak population apportioned to PSPA in the breeding season	Mean peak post-breeding population	Post-breeding apportioning (%)	Mean peak population apportioned to PSPA in the post-breeding season	Mean peak non-breeding population	Non-breeding apportioning (%)	Mean peak population apportioned to PSPA in the non-breeding season	Pre-breeding mean peak population	Pre-breeding apportioning (%)	Mean peak population apportioned to PSPA in the non-breeding season
Aberdeen	161	0.00	0.00	64.37	3.56	2.29	7.33	2.90	0.21	25.72	3.56	0.92
Beatrice	873	0.00	0.00	833.01	3.56	29.66	555.34	2.90	16.08	833.01	3.56	29.66
Blyth Demonstration	121	0.00	0.00	90.94	3.56	3.24	60.63	2.90	1.76	90.94	3.56	3.24
Dogger Bank Creyke Beck A	1250	0.00	0.00	1576.00	3.56	56.11	1728.00	2.90	50.03	4149.00	3.56	147.71
Dogger Bank Creyke Beck B	1538	0.00	0.00	2097.00	3.56	74.66	2143.00	2.90	62.04	5118.67	3.56	182.24
Dogger Bank Teesside A	834	0.00	0.00	310.33	3.56	11.05	958.50	2.90	27.75	1919.00	3.56	68.32
Dogger Bank Teesside B	1153	0.00	0.00	592.33	3.56	21.09	1426.00	2.90	41.29	2953.33	3.56	105.15
Dudgeon	256	0.00	0.00	346.05	3.56	12.32	745.35	2.90	21.58	346.05	3.56	12.32
East Anglia ONE	16	0.00	0.00	26.00	3.56	0.93	154.50	2.90	4.47	336.00	3.56	11.96
Galloper	44	0.00	0.00	43.00	3.56	1.53	105.50	2.90	3.05	394.00	3.56	14.03
Greater Gabbard	0	0.00	0.00	0.00	3.56	0.00	387.25	2.90	11.21	83.76	3.56	2.98
Hornsea Project One	1109	0.00	0.00	4812.33	3.56	171.33	1517.50	2.90	43.94	1802.76	3.56	64.18
Hornsea Project Two	2511	37.10	931.40	4220.50	3.56	150.26	719.50	2.90	20.83	1668.00	3.56	59.38
Humber Gateway	27	100.00	26.69	20.02	3.56	0.71	13.35	2.90	0.39	20.02	3.56	0.71
Inch Cape	1436	0.00	0.00	2870.00	3.56	102.18	651.00	2.90	18.85		3.56	0.00
Lincs and LID6	45	0.00	0.00	33.50	3.56	1.19	22.33	2.90	0.65	33.50	3.56	1.19
London Array I & II	14	0.00	0.00	20.42	3.56	0.73	13.61	2.90	0.39	20.42	3.56	0.73
Moray	2423	0.00	0.00	1102.64	3.56	39.26	30.24	2.90	0.88	168.26	3.56	5.99
Neart na Gaoithe	331	0.00	0.00	5492.42	3.56	195.54	507.81	2.90	14.70		3.56	0.00
Race Bank	28	0.00	0.00	42.00	3.56	1.50	28.00	2.90	0.81	42.00	3.56	1.50
Seagreen A	3208	0.00	0.00		3.56	0.00		2.90	0.00		3.56	0.00

Project	Mean peak breeding population Breeding	Breeding apportioning (%)	Mean peak population apportioned to pSPA in the breeding season	Mean peak post-breeding population	Post-breeding apportioning (%)	Mean peak population apportioned to pSPA in the post-breeding season	Mean peak non-breeding population	Non-breeding apportioning (%)	Mean peak population apportioned to pSPA in the non-breeding season	Pre-breeding mean peak population	Pre-breeding apportioning (%)	Mean peak population apportioned to pSPA in the non-breeding season
Seagreen B	886	0.00	0.00		3.56	0.00		2.90	0.00		3.56	0.00
Sheringham Shoal	106	0.00	0.00	1342.95	3.56	47.81	211.25	2.90	6.12	30.18	3.56	1.07
Teesside	16	100.00	15.54	61.48	3.56	2.19	1.94	2.90	0.06	20.04	3.56	0.71
Thanet	3	0.00	0.00	0.00	3.56	0.00	13.59	2.90	0.39	20.86	3.56	0.74
Triton Knoll	40	100.00	40.25	253.67	3.56	9.03	854.50	2.90	24.74	116.67	3.56	4.15
Westermost Rough	91	100.00	90.94	121.25	3.56	4.32	151.57	2.90	4.39	90.94	3.56	3.24
Total			1104.82			938.92			376.60			722.13

Table 1.5 In-combination displacement matrix for razorbill in the breeding season apportioned to the pSPA (Applicant's position).

Razorbill (Breeding)	Mortality (%)													
		0	1	2	10	20	30	40	50	60	70	80	90	100
Displacement level (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	1	2	11	22	33	44	55	66	77	88	99	110
	20	0	2	4	22	44	66	88	110	133	155	177	199	221
	30	0	3	7	33	66	99	133	166	199	232	265	298	331
	40	0	4	9	44	88	133	177	221	265	309	354	398	442
	50	0	6	11	55	110	166	221	276	331	387	442	497	552
	60	0	7	13	66	133	199	265	331	398	464	530	597	663
	70	0	8	15	77	155	232	309	387	464	541	619	696	773
	80	0	9	18	88	177	265	354	442	530	619	707	795	884
	90	0	10	20	99	199	298	398	497	597	696	795	895	994
	100	0	11	22	110	221	331	442	552	663	773	884	994	1105

Table 1.6 In-combination displacement matrix for razorbill in the post- breeding season apportioned to the pSPA (Applicant’s position).

Razorbill (Post-breeding)		Mortality (%)												
Displacement level (%)		0	1	2	10	20	30	40	50	60	70	80	90	100
	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	1	2	9	19	28	38	47	56	66	75	84	94
	20	0	2	4	19	38	56	75	94	113	131	150	169	188
	30	0	3	6	28	56	84	113	141	169	197	225	253	281
	40	0	4	8	38	75	113	150	188	225	263	300	338	375
	50	0	5	9	47	94	141	188	235	281	328	375	422	469
	60	0	6	11	56	113	169	225	281	338	394	450	507	563
	70	0	7	13	66	131	197	263	328	394	460	525	591	657
	80	0	8	15	75	150	225	300	375	450	525	600	675	750
	90	0	8	17	84	169	253	338	422	507	591	675	760	844
	100	0	9	19	94	188	281	375	469	563	657	750	844	938

Table 1.7 In-combination displacement matrix for razorbill in the non- breeding season apportioned to the pSPA (Applicant’s position).

Razorbill (Non-breeding)		Mortality (%)												
Displacement level (%)		0	1	2	10	20	30	40	50	60	70	80	90	100
	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	0	1	4	8	11	15	19	23	26	30	34	38
	20	0	1	2	8	15	23	30	38	45	53	60	68	75
	30	0	1	2	11	23	34	45	56	68	79	90	102	113
	40	0	2	3	15	30	45	60	75	90	105	120	135	150
	50	0	2	4	19	38	56	75	94	113	132	150	169	188
	60	0	2	5	23	45	68	90	113	135	158	180	203	226
	70	0	3	5	26	53	79	105	132	158	184	211	237	263
	80	0	3	6	30	60	90	120	150	180	211	241	271	301
	90	0	3	7	34	68	102	135	169	203	237	271	305	338
	100	0	4	8	38	75	113	150	188	226	263	301	338	376

Table 1.8 In-combination displacement matrix for razorbill in the pre-breeding season apportioned to the pSPA (Applicant's position).

Razorbill (pre-breeding)	Mortality (%)													
		0	1	2	10	20	30	40	50	60	70	80	90	100
Displacement level (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	1	1	7	14	22	29	36	43	51	58	65	72
	20	0	1	3	14	29	43	58	72	87	101	116	130	144
	30	0	2	4	22	43	65	87	108	130	152	173	195	217
	40	0	3	6	29	58	87	116	144	173	202	231	260	289
	50	0	4	7	36	72	108	144	181	217	253	289	325	361
	60	0	4	9	43	87	130	173	217	260	303	347	390	433
	70	0	5	10	51	101	152	202	253	303	354	404	455	505
	80	0	6	12	58	116	173	231	289	347	404	462	520	578
	90	0	6	13	65	130	195	260	325	390	455	520	585	650
	100	0	7	14	72	144	217	289	361	433	505	578	650	722


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- 1.6.6 Table 1.9 presents identical information as given in Table 1.4 and updated to provide Natural England's view on apportioning. Natural England advocate an apportioning value of 48.2% during the breeding season, this has been applied to the Project and Hornsea Project One. For those projects that fall within the 100 km foraging range 100% birds are apportioned to the pSPA.
- 1.6.7 Table 1.10 - Table 1.13 present displacement matrices using the apportioned populations in all seasons as advocated by Natural England .

Table 1.9 Razorbill seasonal mean peak populations and apportioning values for project within the in-combination assessment (Natural England's position).

Project	Mean peak breeding population	Breeding apportioning (%)	Mean peak population apportioned to pSPA in the breeding season	Mean peak post-breeding population	Post-breeding apportioning (%)	Mean peak population apportioned to pSPA in the post-breeding season	Mean peak non-breeding population	Non-breeding apportioning (%)	Mean peak population apportioned to pSPA in the non-breeding season	Pre-breeding mean peak population	Pre-breeding apportioning (%)	Mean peak population apportioned to pSPA in the non-breeding season
Aberdeen	161	0.00	0.00	64.37	3.56	2.29	7.33	2.90	0.21	25.72	3.56	0.92
Beatrice	873	0.00	0.00	833.01	3.56	29.66	555.34	2.90	16.08	833.01	3.56	29.66
Blyth Demonstration	121	0.00	0.00	90.94	3.56	3.24	60.63	2.90	1.76	90.94	3.56	3.24
Dogger Bank Creyke Beck A	1250	30.00	374.85	1576.00	3.56	56.11	1728.00	2.90	50.03	4149.00	3.56	147.71
Dogger Bank Creyke Beck B	1538	30.00	461.33	2097.00	3.56	74.66	2143.00	2.90	62.04	5118.67	3.56	182.24
Dogger Bank Teesside A	834	30.00	250.13	310.33	3.56	11.05	958.50	2.90	27.75	1919.00	3.56	68.32
Dogger Bank Teesside B	1153	30.00	345.90	592.33	3.56	21.09	1426.00	2.90	41.29	2953.33	3.56	105.15
Dudgeon	256	0.00	0.00	346.05	3.56	12.32	745.35	2.90	21.58	346.05	3.56	12.32
East Anglia ONE	16	0.00	0.00	26.00	3.56	0.93	154.50	2.90	4.47	336.00	3.56	11.96
Galloper	44	0.00	0.00	43.00	3.56	1.53	105.50	2.90	3.05	394.00	3.56	14.03
Greater Gabbard	0	0.00	0.00	0.00	3.56	0.00	387.25	2.90	11.21	83.76	3.56	2.98
Hornsea Project One	1109	48.20	534.50	4812.33	3.56	171.33	1517.50	2.90	43.94	1802.76	3.56	64.18
Hornsea Project Two	2511	48.20	1209.98	4220.50	3.56	150.26	719.50	2.90	20.83	1668.00	3.56	59.38
Humber Gateway	27	100.00	26.69	20.02	3.56	0.71	13.35	2.90	0.39	20.02	3.56	0.71
Inch Cape	1436	0.00	0.00	2870.00	3.56	102.18	651.00	2.90	18.85		3.56	0.00
Lincs and LID6	45	0.00	0.00	33.50	3.56	1.19	22.33	2.90	0.65	33.50	3.56	1.19
London Array I & II	14	0.00	0.00	20.42	3.56	0.73	13.61	2.90	0.39	20.42	3.56	0.73
Moray	2423	0.00	0.00	1102.64	3.56	39.26	30.24	2.90	0.88	168.26	3.56	5.99
Near na Gaoithe	331	0.00	0.00	5492.42	3.56	195.54	507.81	2.90	14.70		3.56	0.00
Race Bank	28	0.00	0.00	42.00	3.56	1.50	28.00	2.90	0.81	42.00	3.56	1.50
Seagreen A	3208	0.00	0.00	N/A	3.56	N/A	N/A	2.90	N/A		3.56	0.00
Seagreen B	886	0.00	0.00	N/A	3.56	N/A	N/A	2.90	N/A		3.56	0.00
Sheringham Shoal	106	0.00	0.00	1342.95	3.56	47.81	211.25	2.90	6.12	30.18	3.56	1.07

Project	Mean peak breeding population	Breeding apportioning (%)	Mean peak population apportioned to pSPA in the breeding season	Mean peak post-breeding population	Post-breeding apportioning (%)	Mean peak population apportioned to pSPA in the post-breeding season	Mean peak non-breeding population	Non-breeding apportioning (%)	Pre-breeding mean peak population apportioned to pSPA in the non-breeding season	Pre-breeding apportioning (%)	Mean peak population apportioned to pSPA in the non-breeding season	
Teesside	16	100.00	15.54	61.48	3.56	2.19	1.94	2.90	0.06	20.04	3.56	0.71
Thanet	3	0.00	0.00	0.00	3.56	0.00	13.59	2.90	0.39	20.86	3.56	0.74
Triton Knoll	40	100.00	40.25	253.67	3.56	9.03	854.50	2.90	24.74	116.67	3.56	4.15
Westermost Rough	91	100.00	90.94	121.25	3.56	4.32	151.57	2.90	4.39	90.94	3.56	3.24
TOTAL			3350.10			938.92			376.60			722.13

Table 1.10 In-combination displacement matrix for razorbill in the breeding season apportioned to the pSPA (Natural England's position).

Razorbill (Breeding)	Mortality (%)													
	0	1	2	10	20	30	40	50	60	70	80	90	100	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	3	7	34	67	101	134	168	201	235	268	302	335	
20	0	7	13	67	134	201	268	335	402	469	536	603	670	
30	0	10	20	101	201	302	402	503	603	704	804	905	1005	
40	0	13	27	134	268	402	536	670	804	938	1072	1206	1340	
50	0	17	34	168	335	503	670	838	1005	1173	1340	1508	1675	
60	0	20	40	201	402	603	804	1005	1206	1407	1608	1809	2010	
70	0	23	47	235	469	704	938	1173	1407	1642	1876	2111	2345	
80	0	27	54	268	536	804	1072	1340	1608	1876	2144	2412	2680	
90	0	30	60	302	603	905	1206	1508	1809	2111	2412	2714	3015	
100	0	34	67	335	670	1005	1340	1675	2010	2345	2680	3015	3350	

Table 1.11 In-combination displacement matrix for razorbill in the post-breeding season apportioned to the pSPA (Natural England's position).

Razorbill (Post-breeding)		Mortality (%)													
Displacement level (%)		0	1	2	10	20	30	40	50	60	70	80	90	100	
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	10	0	1	2	9	19	28	38	47	56	66	75	84	94	
	20	0	2	4	19	38	56	75	94	113	131	150	169	188	
	30	0	3	6	28	56	84	113	141	169	197	225	253	281	
	40	0	4	8	38	75	113	150	188	225	263	300	338	375	
	50	0	5	9	47	94	141	188	235	281	328	375	422	469	
	60	0	6	11	56	113	169	225	281	338	394	450	507	563	
	70	0	7	13	66	131	197	263	328	394	460	525	591	657	
	80	0	8	15	75	150	225	300	375	450	525	600	675	750	
	90	0	8	17	84	169	253	338	422	507	591	675	760	844	
	100	0	9	19	94	188	281	375	469	563	657	750	844	938	

Table 1.12 In-combination displacement matrix for razorbill in the non-breeding season apportioned to the pSPA (Natural England's position).

Razorbill (Non-breeding)		Mortality (%)													
Displacement level (%)		0	1	2	10	20	30	40	50	60	70	80	90	100	
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	10	0	0	1	4	8	11	15	19	23	26	30	34	38	
	20	0	1	2	8	15	23	30	38	45	53	60	68	75	
	30	0	1	2	11	23	34	45	56	68	79	90	102	113	
	40	0	2	3	15	30	45	60	75	90	105	120	135	150	
	50	0	2	4	19	38	56	75	94	113	132	150	169	188	
	60	0	2	5	23	45	68	90	113	135	158	180	203	226	

Razorbill (Non-breeding)	Mortality (%)													
	70	0	3	5	26	53	79	105	132	158	184	211	237	263
	80	0	3	6	30	60	90	120	150	180	211	241	271	301
	90	0	3	7	34	68	102	135	169	203	237	271	305	338
	100	0	4	8	38	75	113	150	188	226	263	301	338	376

Table 1.13 In-combination displacement matrix for razorbill in the pre-breeding season apportioned to the pSPA (Natural England's position).

Razorbill (pre-breeding)	Mortality (%)													
Displacement level (%)		0	1	2	10	20	30	40	50	60	70	80	90	100
	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	1	1	7	14	22	29	36	43	51	58	65	72
	20	0	1	3	14	29	43	58	72	87	101	116	130	144
	30	0	2	4	22	43	65	87	108	130	152	173	195	217
	40	0	3	6	29	58	87	116	144	173	202	231	260	289
	50	0	4	7	36	72	108	144	181	217	253	289	325	361
	60	0	4	9	43	87	130	173	217	260	303	347	390	433
	70	0	5	10	51	101	152	202	253	303	354	404	455	505
	80	0	6	12	58	116	173	231	289	347	404	462	520	578
	90	0	6	13	65	130	195	260	325	390	455	520	585	650
	100	0	7	14	72	144	217	289	361	433	505	578	650	722

1.7 Summary and conclusions

Summary

- 1.7.1 At the Applicants favoured rates (40% displacement, 10% mortality) mortality of 44 razorbill are apportioned to FFC pSPA in the breeding season from Project Two and other projects considered in-combination.
- 1.7.2 At the maximum of Natural England's advocated range of rates (70% displacement, 10% mortality) mortality of 235 razorbill is apportioned to FFC pSPA in the breeding season from Project Two and other projects considered in-combination. Natural England consider it appropriate to sum seasonal estimates of displacement risk. Post-, non- and pre- breeding season displacement apportioned to FFC pSPA represent 66, 26 and 50 razorbill respectively resulting in an annual total of 377 birds.
- 1.7.3 The Applicant assesses displacement on a seasonal rather than annual basis and therefore predicted seasonal mortality cannot be summed. The Applicant considers that displacement has the potential to result in mortality of 44 birds apportioned to FFC pSPA during the breeding season only (lower mortality is predicted for the post-, pre- and non-breeding seasons).
- 1.7.4 Nevertheless, either under the Applicants or Natural England's position, 1% of baseline mortality of FFC pSPA is surpassed. Therefore Population Viability Analysis (PVA) has been undertaken.

Conclusion

- 1.7.5 The population of razorbills at the FFC pSPA has grown at an average of 7.2% since 2000. The maximum predicted growth rate for this species of 9.7%, calculated using the method proposed by Niel & Lebreton (2005).
- 1.7.6 PVA modelling (MacArthur Green 2015) predicts a growth rate of 6.9% (density independent and excluding any immigration). If additional mortality of 50 birds annum is assumed (the Applicant predicts that this will be no more than 45 in-combination) then the model predicts a very slight reduction of 0.25%. Under this scenario, the predicted median impacted population size after 25 years would be approximately 95% of that which the model predicts would occur in the in the absence of any additional impact from the Project. This is a relative reduction in population size (compared to that which might otherwise have arisen). The model predicts a positive growth rate, and so the impacted population after 25 years would still be larger than that which was assumed for the initiation of the modelling exercise.
- 1.7.7 A density dependent model was also run. This model predicts a much lower change in growth rate, approximately 0.07 – 0.18% and consequently a higher ratio of impacted to unimpacted median population size after 25 years (approximately 96 - 98%).
- 1.7.8 On this basis, there is no indication that, at the level of mortality predicted to arise from the Project, that the population is likely to decline, over a period of 25 years, to an extent that would mean that the breeding razorbill population of the FFC pSPA would no longer be considered to be in favourable condition.

1.8 References

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