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Dear Kay, K-J

Please find attached the 3rd instalment of documents.

Best regards,

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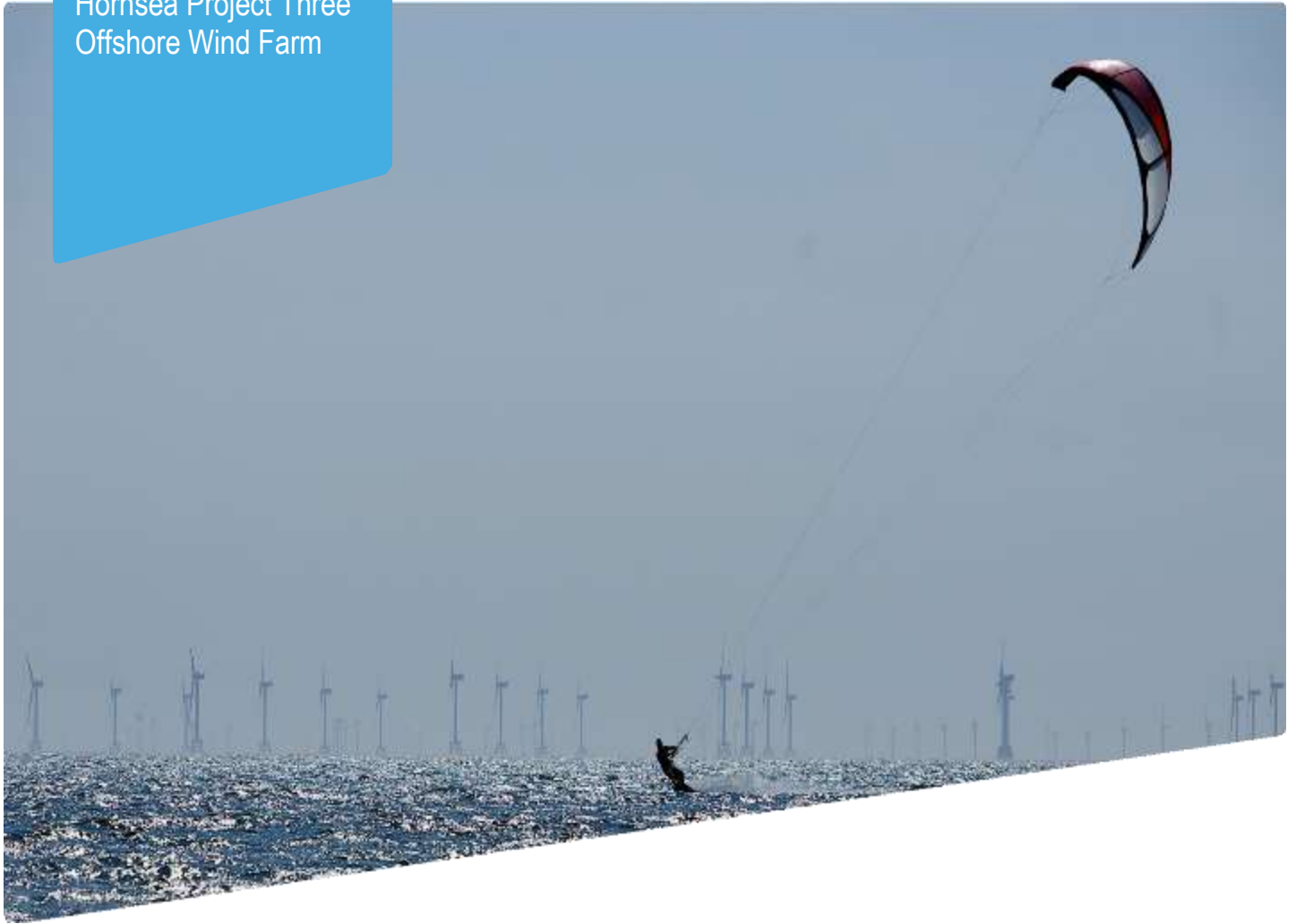
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Appendix 6 to Deadline 5 Submission - Apportioning Immature Auks to Colonies

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1. Introduction

Overview

- 1.1 In Volume 2, Chapter 5: Offshore Ornithology (APP-065) and the RIAA (APP-051) the Applicant presented a qualitative assessment on the potential impacts on immature guillemot, razorbill and puffin. A qualitative assessment was used as information on the origin, distribution and movements of immature birds is limited and as a result a quantitative assessment was not considered possible. As part of their submission at Deadline 2 (REP2-025), the RSPB suggested that an approach similar to the Scottish Natural Heritage (SNH) approach to apportioning breeding seabirds to colonies could be used to calculate the proportion of immature birds present at Hornsea Three attributable to Flamborough and Filey Coast (FFC) SPA. The Applicant welcomed this suggestion and, at Issue Specific Hearing 2 (ornithological matters) (5th December 2018) confirmed that they would explore the applicability of the approach to immature auks.
- 1.2 This report therefore presents an apportioning approach for immature auks based on the SNH apportioning approach for breeding seabirds, as suggested by the RSPB.

Immature auks at Hornsea Three

- 1.3 Hornsea Three is located approximately 149 km from FFC SPA, the closest breeding colony for the three auk species, guillemot, razorbill and puffin. This distance exceeds the foraging range of guillemot and razorbill (Thaxter *et al.* 2012) with Wakefield *et al.* (2017) showing that Hornsea Three is beyond the 95% foraging utilisation boundary for these species (see APP-054 for more information). It is therefore considered that no adult breeding guillemot or razorbill will be present at Hornsea Three during the breeding season, and so it is assumed that the population affected will consist of immature and non-breeding birds.
- 1.4 Hornsea Three is beyond the mean-maximum foraging range of puffin from FFC SPA but is just inside of foraging range if the standard deviation associated with the mean-maximum foraging range is used. This therefore suggests the potential for connectivity between Hornsea Three and breeding individuals from this colony but also indicates that Hornsea Three is likely to be towards the very outer limit of the foraging range of puffins from FFC SPA. This conclusion is consistent with Webb *et al.* (1985) that reported few observations of puffin bringing fish back to their chicks from beyond 30 km offshore from what is now FFC SPA (Brown and Grice, 2005). It is therefore considered likely that a significant proportion of the population of puffin present at Hornsea Three during the breeding season is composed of immature birds. In addition, a further proportion are likely to be non-breeding adult birds.
- 1.5 During non-breeding seasons, the population of auks for all three species at Hornsea Three is predicted to comprise a mixture of adults and immatures, representative of that well documented on a wider scale for the North Sea (Furness 2015).

Origin of immature auks

- 1.6 It is possible that not all immature auks at Hornsea Three during the breeding season will be associated with UK North Sea breeding colonies with immature birds present from elsewhere (breeding colonies in UK western waters and foreign colonies may be present). Guillemot is a dispersive rather than a migratory species with birds overwintering in sea areas close to their breeding colonies, although immature birds do disperse further than adults (Wernham *et al.*, 2002). Immature birds are known to visit colonies before age at first breeding (Furness 2015), but the population observed there could comprise birds from colonies around the UK, with birds likely to visit multiple colonies before age at first breeding. Within the non-breeding seasons, Furness (2015) suggests that reasonably high proportions (up to 80%) of immature guillemots from colonies bordering the North Sea remain in the North Sea during winter.
- 1.7 A large proportion of immature razorbill winter outside of the North Sea, especially the youngest age classes, but older immatures tend to move back to breeding colonies in summer (Furness 2015). During non-breeding seasons, the population at Hornsea Three is predicted to comprise a mixture of adults and immatures from colonies on the east coast of the UK with smaller proportions from colonies further afield during the non-breeding season.
- 1.8 As immatures, puffins may visit several colonies before deciding where to settle to breed. These prospecting movements can take immatures to colonies hundreds of kilometres apart during the breeding season. During the non-breeding seasons, ring recoveries suggest that puffins from colonies in north-east England and south-east Scotland winter predominantly within the North Sea, with very few of those birds passing through the English Channel (Furness 2015). Approximately two-thirds of immature puffins in the North Sea during the non-breeding season are estimated to have moved into UK waters, mostly into northern waters, from elsewhere, principally Norway and Faroe (Furness, 2015).

Apportioning impacts between SPA colonies

- 1.9 Connectivity is the occurrence of birds from an SPA at Hornsea Three. Those immatures present at Hornsea Three in both the breeding and non-breeding season are likely to be associated with a number of large breeding colonies on the east coast of the UK. This report outlines the methodology and results for calculating apportioning values to be used to apportion impacts arising on seabirds from Hornsea Three to immature bird populations of relevant species at FFC SPA with potential connectivity to Hornsea Three. For apportioning impacts associated with Hornsea Three that may occur in the breeding season to immature auks from FFC SPA at the suggestion of RSPB (REP2-025), a comparable approach to that used for Scottish projects for breeding adult birds is applied (SNH 2018). In the non-breeding season, population data from Furness (2015) has been used to determine the proportion of immature birds from the SPAs with connectivity, present in the relevant Biologically Defined Minimum Population Scales (BDMPS) population.

Sabbaticals

- 1.10 In addition to immature birds, non-breeding birds are likely to be present at Hornsea Three. Reed *et al.* (2015) indicate that at the Isle of May approximately 7% of the breeding population of guillemot skip breeding and take a sabbatical. While there is uncertainty around the proportion of adults taking sabbaticals from breeding in a given year for auks of all three species, SNH were content to advise in 2017, for the Moray East Offshore Wind Farms to adopt 7% with Scottish Ministers recommending this value for the Inch Cape, Neart na Gaoithe and Seagreen offshore wind farms (Marine Scotland 2017a, b, c and d). These are considered likely to be underestimates and are therefore precautionary. However, in using the method applied for apportioning impacts between breeding colonies of non-breeding birds present at Hornsea Three during the breeding season, the adults taking sabbaticals are not differentiated. Identification of adult birds from most age classes of immature birds is not discernible in the field.

2. Methods: Calculation of Apportioning Values for Non-Breeding Seasons

Introduction

- 2.1 For apportioning impacts associated with an offshore wind farm that may occur in the breeding season to seabirds from those SPAs within a species' foraging range of the proposed development, Scottish Ministers have advised recent projects to follow the SNH apportioning approach (e.g. Marine Scotland 2017a, b). This is the approach that has been adapted and applied in this paper to the assessment of impacts on immature auks from the Hornsea Three Offshore Wind Farm as suggested by the RSPB.
- 2.2 For breeding adults, the recommended process is to apportion impacts between SPA and non-SPA breeding colonies within foraging range of the wind farm. This is done using Seabird 2000 data as this provides a common reference point and many of the non-SPA breeding colonies have not been counted since this time. Immature birds are not constrained to certain areas during the breeding season, unlike breeding birds which are central place foragers. For all species, the 'foraging range' of immatures associated with a colony is defined for the purposes of this analysis to incorporate those colonies from which it is considered that immature birds may occur at Hornsea Three in the breeding season. Information on the origin, distribution and movements of immature birds is limited and, as such the colonies identified from which immature birds may originate is open to discussion, however it is considered that immature birds that may occur at Hornsea Three are most likely to be associated with a number of large breeding colonies on the east coast of the UK, inclusively north to the Firth of Forth.
- 2.3 The remainder of this section describes the methodology used to perform this process.

Apportioning impacts between SPA and non-SPA breeding colonies

- 2.4 The current method for apportioning impacts between breeding colonies (SPA and other) within foraging range of the proposed offshore wind farm is SNH (2018) "*Interim Guidance on Apportioning Impacts from Marine Renewable Developments to Breeding Seabird Populations in Special Protection Areas*". As discussed in paragraphs 1.6 to 1.8, the origin of immature birds is considered to be from those colonies those between Flamborough and the Firth of Forth for all auk species. For the purposes of this analysis, a surrogate 'foraging range' of 470 km is therefore used for the immatures of all three species of auk which incorporates all of the breeding colonies from which immatures that may occur at Hornsea Three are considered to originate. The theoretical approach of SNH (2018) is followed with using the surrogate foraging range for immatures and generalised models.
- 2.5 The method is based on foraging range and three colony-specific weighting factors:

- i. Colony size (with consistent count unit used between colonies for a species e.g. individuals, breeding pairs or apparently occupied sites);
- ii. Distance of colony from the development site (using the geometric centre of both); and
- iii. Sea area (the areal extent of the open sea within the foraging range of the relevant species).

2.6 Large colonies will contribute more individuals to the number of seabirds found at Hornsea Three, all other factors being equal. To account for this, a weighting factor based on colony size is derived. For all colonies considered, colony size has been calculated from Seabird 2000 data with this providing a common reference point as all count data is contemporaneous. Seabird 2000 data is comprised of separate count sections with long stretches of coastline e.g. FFC SPA, made up of several count sections. For the purposes of this analysis each count section is treated as a separate colony. The combined proportion for FFC SPA is reconstructed after the weighting for each count section is completed.

2.7 Weighting by distance from the colony is calculated using the measured distance between the geometric centre of the development to the geometric centre of the colony. As birds radiate out from a colony density will decrease by a factor proportional to $1/\text{distance}^2$ as area increases proportionally by πr^2 . For the purposes of this assessment, a weighting factor based on $1/\text{distance}^2$ is used as advised by SNH (2018). For the purposes of this analysis any area over land has been discounted (as auk species do not fly at any distance over land) and all sea areas within the defined foraging range of colonies that are south of Dover, are not included. This is a precautionary assumption which will lead to a greater density of birds present in the North Sea and therefore at Hornsea Three.

2.8 The available sea area for foraging is measured by plotting a circle defined by the foraging range around the colony in ArcGIS and calculating the area of sea available to each seabird species. The fraction of the disc centred on the colony that is occupied by sea surface is then expressed as a decimal. As the density of birds will increase as the area of available foraging area decreases this is used in the formula as 1-estimated area.

2.9 The three weighting factors (weightings by colony size, distance from the colony and sea area) are combined to produce an overall weighting for each colony. Each factor is given equal weight in the combined weighting. The calculation is made as follows:

$$\text{Colony Weight} = \frac{\text{Colony Population}}{\text{Sum of Populations}} \times \frac{\text{Sum of Distance}^2}{\text{Colony Distance}^2} \times 1 - \frac{1/\text{Colony Sea Proportion}}{\text{Sum of 1/Sea Proportions}}$$

2.10 The weighting is then used to calculate the proportion of birds attributed to each colony ("proportional weight of colony") by calculating colony weight divided by sum of all colony weights. As noted in paragraph 2.6, FFC SPA is made up of several count sections with the combined weight for the SPA reconstructed after the combined weighting for each count section is completed by summation of the colony weights.

2.11 These proportions can then be used to calculate the number of birds impacted at Hornsea Three. It should be re-iterated that the Hornsea Three site count has not been adjusted to account for the presence of adult birds taking sabbaticals and therefore resulting apportioning values are potentially over-estimating the impact on immature birds from FFC SPA.

3. Results: Apportioning of immature auks at Hornsea Three across multiple SPAs within connectivity

3.1 Table 3.1, Table 3.2 and Table 3.3 present the apportioning values to be used to apportion impacts from Hornsea Three to breeding populations of relevant species of auk at FFC SPA for which connectivity has been identified.

Table 3.1: The proportion of immature guillemots at Hornsea Three apportioned to FFC SPA and all other colonies.

SPA name	Count of adult birds on SPA (Seabird 2000)	1 / Proportion of foraging range at sea	Resulting weight for SPA	Proportional weight of SPA
Flamborough and Filey Coast	47,155	2.17	0.79	0.64
All other colonies	112,550	2.28	0.45	0.36

Table 3.2. The proportion of immature razorbills at Hornsea Three apportioned to FFC SPA and all other colonies.

SPA name	Count of adult birds on SPA (Seabird 2000)	1 / Proportion of foraging range at sea	Resulting weight for SPA	Proportional weight of SPA
Flamborough and Filey Coast	8,611	2.17	1.36	0.82
All other colonies	8,576	2.28	0.30	0.18

Table 3.3. The proportion of immature puffin at Hornsea Three apportioned to FFC SPA and all other colonies.

SPA name	Count of adult birds on SPA (Seabird 2000)	1 / Proportion of foraging range at sea	Resulting weight for SPA	Proportional weight of SPA
Flamborough and Filey Coast	2,650	2.17	0.04	0.08
All other colonies	127,810	2.46	0.48	0.92

4. Methods: Calculation of Apportioning Values for Non-Breeding Seasons

Methodology

- 4.1 The calculation of apportioning values for non-breeding seasons (post-breeding, non-breeding and pre-breeding) follows the approach used previously in the application and examination documentation for multiple offshore wind farms (e.g. East Anglia THREE Ltd. 2015, Forewind 2013, SMart Wind 2015a). The contribution of immature birds from an individual SPA, as estimated by Furness (2015), to the relevant BDMPS population for each species/season combination is divided by the total BDMPS population to calculate the proportion of the BDMPS population represented by adult birds from the SPA considered. An example of the computation involved is given in paragraph 4.2. It should be noted that no updates have been made to the population data presented in Furness (2015) as any updates will not be contemporaneous with those data not updated.

Worked example

- 4.2 The following calculations are an example, in this case for guillemot, of the approach used to assess the contribution of the focal colony to the BDMPS population (i.e. what proportion of the immatures in the BDMPS region consist of birds from the focal colony). Furness (2015) defines the guillemot non-breeding season (winter BDMPS) as one period. The population of guillemot in the relevant BDMPS region for Hornsea Three, i.e. 'UK North Sea and Channel waters', is estimated in the non-breeding season to be 1,617,306 birds (Furness 2015, p374, table 62). The immature population associated with the Flamborough and Filey Coast SPA is 58,669 individuals. The proportion of Flamborough and Filey Coast SPA immature population present in the non-breeding season BDMPS region is 0.8 (Furness 2015, p374, table 62). Therefore:

- The number of Flamborough and Filey Coast SPA immature birds in the BDMPS =

(Immature population associated with the Flamborough and Filey Coast SPA) * (proportion of Flamborough and Filey Coast SPA immature population present in the non-breeding season BDMPS region) = $58,669 * 0.8 = 46,935$
- The proportion of the non-breeding BDMPS population comprising immature birds associated with Flamborough and Filey Coast SPA =

(No. of Flamborough and Filey Coast SPA immature birds in the BDMPS) / (Total no. of birds in the BDMPS) = $46,935 / 1,617,306 = 0.03$ (to two significant figures)

5. Results: Calculation of Apportioning Values for Non-Breeding Seasons

- 5.1 Table 5.1 presents the calculated proportion of the relevant BDMPS population represented by immature birds of FFC SPA for which connectivity has been identified in the breeding season with Hornsea Three.

Table 5.1. The contribution of immature auks from FFC SPA to the UK North Sea and Channel Waters BDMPS population.

Species	Season		
	Post-breeding	Non-breeding	Pre-breeding
Guillemot	N/A	0.03	N/A
Razorbill	0.02	0.01	0.02
Puffin	N/A	0.00	N/A

6. Calculation of impacts on immature birds

6.1 In this Section the apportioning values presented in Section 3 and 5 have been used to calculate the impacts attributable to the FFC SPA population for guillemot, razorbill and puffin. This is conducted for each season relevant to the three species.

Methodology

6.2 Displacement analysis has been conducted for guillemot, razorbill and puffin incorporating the seasonal mean-peak populations presented in Appendix 28 to the Applicant's submission at Deadline 4 (REP4-049) incorporating those populations calculated using Natural England's advocated approach to the use of population data. These are summarised in Table 6.1.

Table 6.1: Seasonal mean-peak populations used for displacement analysis

Species	Seasonal mean-peak populations (no. of birds)			
	Breeding	Post-breeding	Non-breeding	Pre-breeding
Guillemot	13,374	N/A	17,772 / 19,174	N/A
Razorbill	630	2,020	3,649 / 5,024	1,236 / 1,754
Puffin	253	N/A	127 / 77	N/A

6.3 These populations have been apportioned to FFC SPA utilising the apportioning values presented in Section 3 and 5 A range of displacement and mortality rates are used to calculate displacement mortality with the results presented in the following species-specific sections those calculated when applying the displacement and mortality rates identified through the literature review presented in Volume 2, Chapter 5: Offshore Ornithology (APP-065) and the RIAA (APP-051).

Displacement analysis

6.4 Displacement analysis has been conducted for each species utilising the seasonal mean-peak populations presented in Table 6.1. Displacement matrices using each mean-peak population are presented in Table 7.1 to Table 7.12 in Appendix A. The displacement mortality attributable to FFC SPA is presented in Table 6.2.

Table 6.2: Seasonal displacement mortality for immature guillemot, razorbill and puffin associated with FFC SPA

Species	Season			
	Breeding	Post-breeding	Non-breeding	Pre-breeding
Guillemot	85-425	N/A	3 / 3	N/A
Razorbill	4-21	0	0 / 0	0 / 0
Puffin	0-1 / 0-1	N/A	0 / 0	N/A

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Appendix A Displacement matrices

Guillemot

Table 7.1: Displacement analysis for guillemot at FFC SPA in the breeding season

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	9	17	43	85	170	255	340	425	510	595	680	765	850
20	17	34	85	170	340	510	680	850	1020	1190	1360	1530	1700
30	26	51	128	255	510	765	1020	1275	1530	1785	2040	2295	2551
40	34	68	170	340	680	1020	1360	1700	2040	2381	2721	3061	3401
50	43	85	213	425	850	1275	1700	2125	2551	2976	3401	3826	4251
60	51	102	255	510	1020	1530	2040	2551	3061	3571	4081	4591	5101
70	60	119	298	595	1190	1785	2381	2976	3571	4166	4761	5356	5951
80	68	136	340	680	1360	2040	2721	3401	4081	4761	5441	6121	6801
90	77	153	383	765	1530	2295	3061	3826	4591	5356	6121	6886	7652
100	85	170	425	850	1700	2551	3401	4251	5101	5951	6801	7652	8502

Table 7.2: Displacement analysis for guillemot at FFC SPA in the non-breeding season

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	1	3	5	10	15	21	26	31	36	41	46	52
20	1	2	5	10	21	31	41	52	62	72	83	93	103
30	2	3	8	15	31	46	62	77	93	108	124	139	155
40	2	4	10	21	41	62	83	103	124	144	165	186	206
50	3	5	13	26	52	77	103	129	155	181	206	232	258
60	3	6	15	31	62	93	124	155	186	217	248	279	309
70	4	7	18	36	72	108	144	181	217	253	289	325	361
80	4	8	21	41	83	124	165	206	248	289	330	371	413
90	5	9	23	46	93	139	186	232	279	325	371	418	464
100	5	10	26	52	103	155	206	258	309	361	413	464	516

Table 7.3: Displacement analysis for guillemot at FFC SPA in the non-breeding season using population data derived through the alternative analysis

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	1	3	6	11	17	22	28	33	39	45	50	56
20	1	2	6	11	22	33	45	56	67	78	89	100	111
30	2	3	8	17	33	50	67	83	100	117	134	150	167
40	2	4	11	22	45	67	89	111	134	156	178	200	223
50	3	6	14	28	56	83	111	139	167	195	223	250	278
60	3	7	17	33	67	100	134	167	200	234	267	300	334
70	4	8	19	39	78	117	156	195	234	273	312	351	390
80	4	9	22	45	89	134	178	223	267	312	356	401	445
90	5	10	25	50	100	150	200	250	300	351	401	451	501
100	6	11	28	56	111	167	223	278	334	390	445	501	556

Razorbill

Table 7.4: Displacement analysis for razorbill at FFC SPA in the breeding season

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	1	3	5	10	15	21	26	31	36	41	46	52
20	1	2	5	10	21	31	41	52	62	72	83	93	103
30	2	3	8	15	31	46	62	77	93	108	124	139	155
40	2	4	10	21	41	62	83	103	124	144	165	186	206
50	3	5	13	26	52	77	103	129	155	181	206	232	258
60	3	6	15	31	62	93	124	155	186	217	248	279	310
70	4	7	18	36	72	108	144	181	217	253	289	325	361
80	4	8	21	41	83	124	165	206	248	289	330	372	413
90	5	9	23	46	93	139	186	232	279	325	372	418	464
100	5	10	26	52	103	155	206	258	310	361	413	464	516

Table 7.5: Displacement analysis for razorbill at FFC SPA in the post-breeding season

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	1	1	2	2	3	3	4	4	5
20	0	0	0	1	2	3	4	5	6	6	7	8	9
30	0	0	1	1	3	4	6	7	8	10	11	12	14
40	0	0	1	2	4	6	7	9	11	13	15	17	18
50	0	0	1	2	5	7	9	12	14	16	18	21	23
60	0	1	1	3	6	8	11	14	17	19	22	25	28
70	0	1	2	3	6	10	13	16	19	23	26	29	32
80	0	1	2	4	7	11	15	18	22	26	29	33	37
90	0	1	2	4	8	12	17	21	25	29	33	37	41
100	0	1	2	5	9	14	18	23	28	32	37	41	46

Table 7.6: Displacement analysis for razorbill at FFC SPA in the non-breeding season

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	1	1	1	1	2	2	2	2	3
20	0	0	0	1	1	2	2	3	3	4	4	5	5
30	0	0	0	1	2	2	3	4	5	5	6	7	8
40	0	0	1	1	2	3	4	5	6	7	8	9	10
50	0	0	1	1	3	4	5	6	8	9	10	11	13
60	0	0	1	2	3	5	6	8	9	11	12	14	15
70	0	0	1	2	4	5	7	9	11	12	14	16	18
80	0	0	1	2	4	6	8	10	12	14	16	18	20
90	0	0	1	2	5	7	9	11	14	16	18	20	23
100	0	1	1	3	5	8	10	13	15	18	20	23	25

Table 7.7: Displacement analysis for razorbill at FFC SPA in the non-breeding season using population data derived through the alternative analysis

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	1	1	1	2	2	2	3	3	3
20	0	0	0	1	1	2	3	3	4	5	6	6	7
30	0	0	1	1	2	3	4	5	6	7	8	9	10
40	0	0	1	1	3	4	6	7	8	10	11	12	14
50	0	0	1	2	3	5	7	9	10	12	14	16	17
60	0	0	1	2	4	6	8	10	12	14	17	19	21
70	0	0	1	2	5	7	10	12	14	17	19	22	24
80	0	1	1	3	6	8	11	14	17	19	22	25	28
90	0	1	2	3	6	9	12	16	19	22	25	28	31
100	0	1	2	3	7	10	14	17	21	24	28	31	34

Table 7.8: Displacement analysis for razorbill at FFC SPA in the pre-breeding season

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	1	1	1	1	2	2	2	3	3
20	0	0	0	1	1	2	2	3	3	4	5	5	6
30	0	0	0	1	2	3	3	4	5	6	7	8	8
40	0	0	1	1	2	3	5	6	7	8	9	10	11
50	0	0	1	1	3	4	6	7	8	10	11	13	14
60	0	0	1	2	3	5	7	8	10	12	14	15	17
70	0	0	1	2	4	6	8	10	12	14	16	18	20
80	0	0	1	2	5	7	9	11	14	16	18	20	23
90	0	1	1	3	5	8	10	13	15	18	20	23	25
100	0	1	1	3	6	8	11	14	17	20	23	25	28

Table 7.9: Displacement analysis for razorbill at FFC SPA in the pre-breeding season using population data derived through the alternative analysis

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	1	1	2	2	2	3	3	4	4
20	0	0	0	1	2	2	3	4	5	6	6	7	8
30	0	0	1	1	2	4	5	6	7	8	10	11	12
40	0	0	1	2	3	5	6	8	10	11	13	14	16
50	0	0	1	2	4	6	8	10	12	14	16	18	20
60	0	0	1	2	5	7	10	12	14	17	19	22	24
70	0	1	1	3	6	8	11	14	17	20	22	25	28
80	0	1	2	3	6	10	13	16	19	22	26	29	32
90	0	1	2	4	7	11	14	18	22	25	29	32	36
100	0	1	2	4	8	12	16	20	24	28	32	36	40

Puffin

Table 7.10: Displacement analysis for puffin at FFC SPA in the breeding season

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	0	1	1	1	1	1	2	2	2
20	0	0	0	0	1	1	2	2	2	3	3	4	4
30	0	0	0	1	1	2	2	3	4	4	5	5	6
40	0	0	0	1	2	2	3	4	5	6	6	7	8
50	0	0	0	1	2	3	4	5	6	7	8	9	10
60	0	0	1	1	2	4	5	6	7	8	10	11	12
70	0	0	1	1	3	4	6	7	8	10	11	13	14
80	0	0	1	2	3	5	6	8	10	11	13	14	16
90	0	0	1	2	4	5	7	9	11	13	14	16	18
100	0	0	1	2	4	6	8	10	12	14	16	18	20

Table 7.11: Displacement analysis for puffin at FFC SPA in the non-breeding season

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0	0	0	0
80	0	0	0	0	0	0	0	0	0	0	0	0	0
90	0	0	0	0	0	0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 7.12: Displacement analysis for puffin at FFC SPA in the non-breeding season using population data derived through the alternative analysis

	Mortality rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0	0	0	0
80	0	0	0	0	0	0	0	0	0	0	0	0	0
90	0	0	0	0	0	0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0	0	0	0	0	0	0