BERWICK BANK WIND FARM
OFFSHORE ENVIRONMENTAL IMPACT ASSESSMENT

APPENDIX 11.4: ORNITHOLOGY DISPLACEMENT TECHNICAL REPORT

EOR0766
Environmental Impact Assessment – Appendix 11.4
Final

Document Status

Version	Purpose of Document	Authored by	Reviewed by	Approved by	Review Date
Final	SSER Review	Ruth Peters-Grundy Will Peden	Dr Kelly Macleod	Dr Kelly Macleod	10 November 2022

Approval for Issue

[Redacted] 14 November 2022

Prepared by:	**HiDef Aerial Surveying Ltd.**
Prepared for:	**SSE Renewables**
Checked by:	**Emily Nelson**
Accepted by:	**Andrew Logie**
Approved by:	**Sarah Edwards**

Compiled by HiDef Aerial Surveying Ltd.

Confidential until approved by the Client.

CONTENTS

TABLES

FIGURES

1. INTRODUCTION

1. Berwick Bank Wind Farm Limited (BBWFL) is a wholly owned subsidiary of SSE Renewables Limited and will hereafter be referred to as 'the Applicant'. The Applicant is developing the Berwick Bank Wind Farm (hereafter referred to as 'the Project') located in the outer Forth and Tay region.

2. The Project is located adjacent to the consented Forth and Tay offshore wind farms (OWFs) consisting of Seagreen to the north, Inch Cape to the northwest and Neart na Gaoithe to the west (Figure 1.1).

3. The proposed Berwick Bank development will, if consented, provide an estimated 4.1 GW of renewable energy, making it one of the largest offshore wind farms in the world. Given the anticipated operational life span of 35 years, the development will make a critical contribution to Scotland's renewable energy target of 11 GW of new offshore wind by 2030.

4. Turbine capacity will range from 14 – 24 MW per machine, with a maximum number of turbines on site to be 179 - 307. As part of ensuring minimised impacts to wildlife, such as potential displacement of seabirds, the Berwick Bank Development array area was reduced by approximately 20% in May 2022, from 1,314 km^2 to 1,010 km^2.

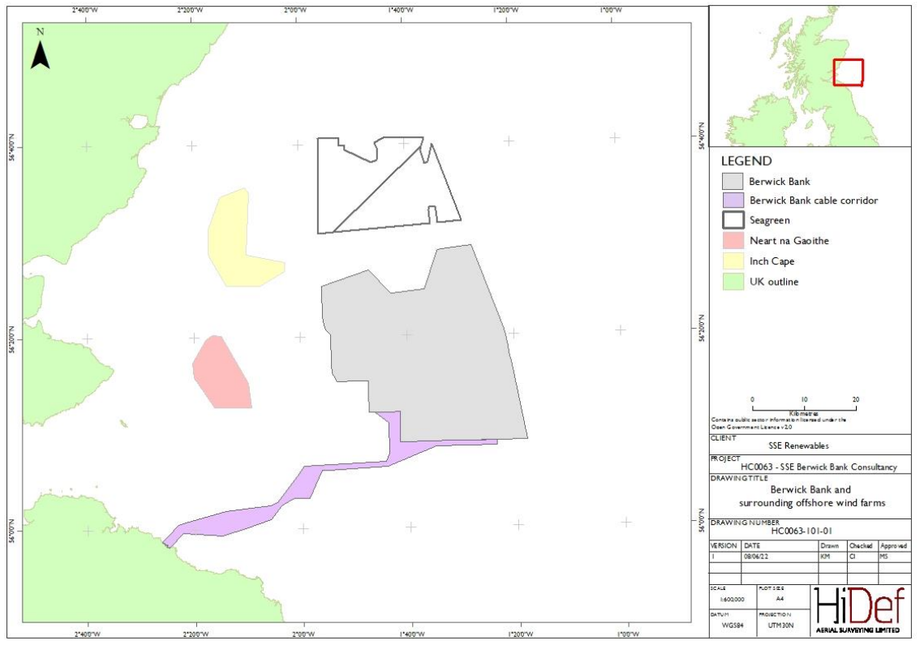

Figure 1.1: Site boundaries for all consented and proposed wind farms currently within the Outer Firth of Forth.

2. PURPOSE OF THE REPORT

5. This Technical Report assesses the potential effects of displacement on seabirds during the operational phase of the proposed Berwick Bank OWF primarily based on the interim advice of the joint Statutory Nature Conservation Bodies (SNCBs, 2017) on a Matrix Approach to assessment. Further analyses are presented using the SeabORD modelling tool (Searle *et al.,* 2018) as requested in the Scoping Opinion (4 February 2022), for context. These approaches are described in Section 3 and full results provided in Annex D.

6. Furness *et al.* (2013) defines displacement as 'a reduced number of birds occurring within or immediately adjacent to an offshore wind farm', involving birds present in the air and on the water (SNCBs, 2017). Birds that do not intend to utilise an offshore wind farm, but would have previously flown through the area, and which either stop short or detour around a development, are subject to barrier effects (SNCBs, 2017). For the purposes of assessment, it is usually not possible to distinguish between displacement and barrier effects (e.g., to determine if individual birds may have intended to travel to, or beyond an offshore wind farm, even when tracking data are available). Vessel and helicopter traffic associated with OWFs also have the potential to cause temporary disturbance to sensitive species, with some species avoiding the area altogether, potentially resulting in a loss of optimal rafting, foraging and moulting habitat. Displacement affects species differently, with the potential to have population level impacts for species which are less adaptive or highly constrained in their foraging range, such as in the breeding season.

3. ASSESSMENT APPROACHES

3.1. OVERVIEW OF APPROACHES

7. Consultation Representations and Advice from MSS and NatureScot (4 February 2022) and discussions through the Ornithology Road Map process (Appendix 11.8), led to agreement that displacement assessment was required for five species:

   - kittiwake *Rissa tridactyla*;
   - guillemot *Uria aalge*;
   - razorbill *Alca torda*;
   - puffin *Fratercula arctica*; and
   - gannet *Morus bassanus*.

8. Species were selected based on their abundance in the proposed Berwick Bank Development Array area, highlighted by the two years of baseline data (Appendix 11.1: Ornithology Baseline Technical Report), and on evidence about their sensitivity to displacement and barrier effects (Furness *et al*., 2013; Bradbury *et al*., 2014; SNCB, 2017)).

9. The Scoping Opinion recommended that estimates of displacement and barrier effects as generated by the publicly available individual-based modelling approach "SeabORD" should be presented for kittiwake, guillemot, razorbill and puffin, where feasible (Searle *et al*., 2018).

10. SeabORD is intended to simulate the behaviour and energetics of individual birds from breeding seabird populations under baseline conditions (i.e. with no offshore wind farm present) and compares the resulting demographic estimates to model runs undertaken in scenarios which have the offshore wind farm(s) of

interest present (so that birds undertaking foraging trips from the colony have the potential to incur energetic costs from barrier effects and of increased intra-specific competition for food if they are displaced). These effects are estimated in terms of changes to adult and chick mortality, with the available outputs relating to the individual SPA populations that are of interest to the assessment. The estimated mortality to adult birds relates only to the breeding period.

11. SeabORD relies upon predictions of the distribution of seabird prey resources and of foraging birds. Both of these aspects are determined by the availability of Global Position System (GPS) tracking data from breeding birds associated with the colonies of interest. In addition, the model is underpinned by a range of other assumptions and predictions (e.g. on the relationships between adult body mass and survival), each of which have associated uncertainties (Vallejo *et al.,* 2022 (volume 3, appendix 11.4, annex H)).

12. Details of the SeabORD modelling undertaken for the Proposed Development are provided in Annex D. An assessment of the uncertainty and validity of the underlying model parameters and assumptions is presented in Vallejo *et al.,* 2022 ((volume 3, appendix 11.4, annex H)).

13. Since SeabORD does not include gannet, Marine Scotland Science, in their scoping representation of 16th December 2021, advised that an analysis of the extensive GPS tracking data be undertaken to inform assessment of displacement and barrier effects for this species. Details of the analysis undertaken are given in Annex E, following the approach agreed through the Ornithology Roadmap Process (RM6; Appendix 11.8).

14. Given the issues encountered with SeabORD, as outlined in Annexes D and H, and discussed during the Ornithology Roadmap Process (RM4 and RM5; Appendix 11.8), the SNCB matrix method was used as the primary method for assessment of displacement effects for each of the five relevant species (SNCBs, 2017). The matrix provides a table of the displacement rates, from zero per cent to 100 per cent, against mortality rates, again from zero per cent to 100 per cent. For a given population-size and any combined value of displacement rate and mortality rate, the matrix provides a prediction of the number of birds that may die as a result of displacement from an offshore wind farm. Although the estimated effects are derived by applying specified displacement rates, the resulting predicted impacts are assumed to encompass both displacement and barrier effects.

15. Seasonally specific displacement and mortality rates were recommended by NatureScot and Marine Scotland Science in their scoping representations of 7 and 16 December 2021, respectively (the “Scoping Approach”; Section 3.5). In line with the evidence presented in Annex G, an additional set of displacement and mortality rates have also been taken forward for assessment (the “Developer Approach”; Section 3.5).

16. Displacement matrices were produced for each of the five species, using a number of species-specific parameters:

    i. spatial extent – the distance from turbines that displacement impacts are considered likely to affect the species;

    ii. mean seasonal peak population – a mean of the estimated number of birds within the impacted area in each appropriate bio-season;

    iii. displacement level - the percentage of the population assumed to be displaced from the impacted area; and

    iv. mortality level – the percentage of displaced birds assumed to die as a consequence.

3.2. SPATIAL SCALES

17. Following the joint SNCB interim advice (SNCB, 2017), and as advised in the Scoping Opinion (4 February 2022), displacement matrices were formulated for two separate spatial scales:

- the proposed Berwick Bank Development Array; and
- the proposed Berwick Bank Development Array plus a 2 km buffer.

18. The Project Design Envelope (PDE) is based on the following design principles: minimum turbine spacing of four rotor diameters; and maximum turbine spacing of 15 rotor diameters. The Development Array covers 1,010 km^2, with between 179 and 307 turbines. As such, there are likely to be large distances between the largest turbines, with each turbine potentially spaced between a minimum of 1km and a maximum of 3.33 km (14MW) or 4.65 km (24 MW) apart.

3.3. SEASONAL DEFINITIONS

19. The Matrix Approach requires potential displacement to be assessed separately for species in the breeding season and non-breeding season, where appropriate.

20. In previous assessments for consented Forth and Tay OWFs, displacement of guillemot, razorbill, puffin and kittiwake were assessed quantitatively in the breeding season. In the non-breeding season, guillemot and razorbill were also assessed quantitatively, with only a qualitative assessment required for puffin and kittiwake for some projects. This is because displacement is not considered to limit these species in the non-breeding periods when birds are not constrained by having to return to colonies, or, in the case of puffin, because they disperse rapidly and widely after the breeding season. This is the basis of the “Developer Approach” presented.

21. However, following the Scoping representations from MSS and NatureScot (December 2021) and Scoping Opinion (4 February 2022) non-breeding season displacement has been assessed quantitatively for kittiwake and gannet; there is no requirement to assess non-breeding season impacts for puffin (“Scoping Approach”).

22. Seasonal definitions are based on NatureScot guidance (2020); this was agreed through the Ornithology Roadmap process (RM1). Seasonality is complex and periods differ between species based on life history traits, with timings an approximation.

23. Bio-seasons used are:

- **Breeding season:** birds are strongly associated with a nest site, including nesting, egg-laying and provisioning young.
- **Non-breeding season:** period of time where no breeding takes place, which may encompass birds over-wintering in an area and migration periods between breeding and wintering sites, dependent on the species.

24. The bio-seasons based on NatureScot (2020) identified for each species are summarised in Table 3.1. However, the use of NatureScot non-breeding season definitions presents issues for non-breeding season apportioning (Technical Appendix 11.5: Ornithology Apportioning Technical Report). Since non-breeding season apportioning is reliant on information for Biologically Defined Minimum Population Scales (BDMPS) (Furness, 2015), mean seasonal peaks and displacement mortality was also estimated for the non-breeding seasons defined in Furness (2015) for those species where the autumn and spring passage and winter periods are defined within the non-breeding season (gannet, kittiwake and razorbill). This was conducted for the Berwick Bank Development Array plus a 2 km buffer only; as only the 2km assessment

informs the apportioning analysis. These outputs are reported in section 4.1 and further used within the Technical Appendix 11.5: Ornithology Apportioning Technical Report. Non-breeding displacement for these three species within the Berwick Bank Development Array plus a 2 km buffer, as defined by NatureScot (2020), are presented in Annex F for reference.

Table 3.1: Species-specific breeding and non-breeding seasons based on NatureScot guidance (2020) and Furness (2015). Start and end months are inclusive unless stated otherwise.

Species	NatureScot (2020)		Furness (2015)		
	Breeding season	Non-breeding season	Spring migration	Autumn migration	Winter
Kittiwake	Mid Apr - Aug	Sep – Mid Apr	Jan – Apr	Aug - Dec	-
Guillemot	Apr – Mid Aug	Mid Aug – Mar	-	-	-
Razorbill	Apr – Mid Aug	Mid Aug – Mar	Jan – Mar	Aug – Oct	Nov - Dec
Puffin	Apr – Mid Aug	-	-	-	-
Gannet	Mid Mar - Sep	Oct – Mid Mar	Dec - Mar	Sep - Nov	-

MEAN SEASONAL PEAK POPULATION ESTIMATES

25. As per the joint SNCB interim guidance (SCNBs, 2017), assessment of displacement impacts were conducted on the mean seasonal peak (MSP) population estimates, calculated as the peak count for each species in each appropriate bio-season, and then taken as an average over two years of surveying (March 2019 – March 2021). For example, the MSP population estimate for the breeding season was calculated as the average of the peak count in the breeding season in year one and the peak count in the breeding season in year two.

26. For all estimates, unidentified birds recorded in a category (e.g., large auk) have been apportioned to species based on the relative abundance ratios of identified species within the category (e.g. guillemot and razorbill). For the three auk species (guillemot, razorbill and puffin), the estimates were also adjusted for availability bias to account for birds likely to be diving at the time of survey. A full description of survey methodology and how monthly population estimates were calculated and apportioned for non-ID species groups, can be found in section 3 of Technical Appendix 11:1: Ornithology Baseline Technical Report.

27. For seasons starting or ending halfway through the month, the 15/16 was used as a mid-month cut off. Surveys were assigned to a season based on the day that the survey was flown. This approach avoids duplicative use of a single monthly estimate which could artificially inflate seasonal abundance estimates.

28. To account for missed and later rescheduled flights during the survey programme, some flights were assigned to different months or years to ensure even coverage of seasons in both years (Table 3.3). The Applicant discussed this allocation during the Ornithology Road Map process (RM4, Technical Appendix 11.8) and followed subsequent joint advice from Marine Scotland and NatureScot received through email 14 January 2022. Further information on flight scheduling can be found in section 3.1 of Technical Appendix 11:1: Ornithology Baseline Technical Report.

Table 3.2: Treatment of rescheduled surveys for calculation of mean-seasonal peaks (MSPs)

Survey name	Date flown	Used to represent	Date used in analysis
Jan-20	05/02/20	January 2020	30/01/20
Feb-20	19/02/20	February 2020	19/02/20
May S01 20	05/05/20	April 2020	30/04/20
May S02 20	16/05/20	May 2020	16/05/20
Apr S02 21	24/04/21	April 2019	24/04/19

29. The SNCB interim guidance (SNCBs, 2017) defines displacement as affecting both birds on the water *and* in flight, therefore, the mean seasonal peaks were calculated from monthly population estimates for all birds present within the assessment boundaries. The monthly population estimates for each species in the Development Array (apportioned for unidentified birds), from which the mean-peaks have been calculated, can be found in Annex A. The monthly apportioned population estimates for each species in the Development Array plus 2 km buffer, from which the mean-peaks have been calculated, can be found in Annex B.

30. The MSP population estimates for each species, in each appropriate bio-season and for each of the Development array and Development array plus 2 km buffer, are presented in Table 3.3.

Table 3.3: Mean seasonal peak (MSP) population estimates for the Berwick Bank Development Array and Development Array plus a 2 km buffer. Data include "no-identification" birds apportioned to species and auk species estimates are corrected for availability bias. Seasonal peaks are presented for reference.

Species *Bio-season*	Development array Seasonal peaks	MSP	Development array (+ 2 km buffer) Seasonal peaks	MSP
Kittiwake				
Breeding season	20,923 (Apr 19); 13,464 (Aug 20)	17,194	24,949 (Apr 19); 17,333 (Aug 20)	21,141
Non-breeding season	15,358 (Mar 19); 16,282 (Sept 20)	15,820	17,174 (Mar 19); 19,383 (Sep 20)	18,279
Spring migration	-	-	17,174 (Mar 19); 10,358 (Apr 21)	13,766
Autumn migration	-	-	2,997 (Sep 19); 19,383 (Sep 20)	11,190
Guillemot				
Breeding season	71,881 (Apr 19); 47,499 (Jun 20)	59,690	94,806 (April 19); 53,499 (June 20)	74,154
Non-breeding season	32,163 (May 20); 35,912 (Sep 20)	34,038	44,146 (Mar 20); 44,194 (Sep 20)	44,171
Razorbill				
Breeding season	2,563 (Jul 19); 3,520 (Aug 20)	3,042	3,258 (Jul 19); 4,820 (Aug 20)	4,040
Non-breeding season	6,449 (Mar 20); 10,994 (Sep 20)	8,722	9,130 (Mar 20); 15,587 (Sep 20)	12,359

Species *Bio-season*	Development array Seasonal peaks	MSP	Development array (+ 2 km buffer) Seasonal peaks	MSP
Spring migration	-	-	9,130 (Mar 20); 5,830 (Apr 21)	7,480
Autumn migration	-	-	2,111 (Sep 19); 15,587 (Sep 20)	8,849
Winter	-	-	632 (Dec 19); 2,165 (Dec 20)	1,399
Puffin				
Breeding season	4,850 (Apr 19); 1,929 (Apr 20)	3,390	6,280 (Apr 19); 2,745 (Aug 20)	4,513
Gannet				
Breeding season	3,624 (Jul 19); 3,520 (Jul 20)	3,572	5,020 (Aug 19); 4,449 (Jul 20)	4,735
Non-breeding season	799 (Oct 19); 1,239 (Nov 20)	1,019	1,081 (Oct 19); 1,919 (Nov 20)	1,500
Spring migration	-	-	321 (Mar 19); 216 (Dec 20)	269
Autumn migration	-	-	1,081 (Oct 19); 1,919 (Nov 20)	1,500

3.4. DISPLACMENT AND MORTALITY RATES USED FOR ASSESSMENT

31. For both displacement and mortality rates, a sub-set of the most likely species-specific rates were highlighted in each species matrix. These include the displacement and mortality rates used in both the Scoping Approach and the Developer Approach (Table 3.5).

32. A detailed justification of the displacement and mortality rates selected for the Developer approach can be found in Annex G. Displacement and mortality rates used for the Scoping Approach were as advised in the Scoping Opinion.

33. Assessment of displacement during the non-breeding season was not required for puffin, in either approach, as advised through the Scoping Opinion (4 February 2022). Lower mortality rates were advised for auk species in the non-breeding season in the Scoping Opinion, based on birds being less constrained to nest sites and no longer central-placed foragers. For the Scoping Approach, both advised mortality rates have been assessed and potential mortalities due to displacement identified in the relevant matrices. A displacement rate of 60% has been applied, as advised in the NatureScot scoping representation (December 2021).

34. For the Developer Approach, a displacement rate of 50% and mortality rate of 1% for auks was considered suitably precautionary for both the breeding and non-breeding season. APEM (2022) undertook a review of auk displacement rates, and the Developer Approach aligns with their recommended maximum rate.

35. For the Developer Approach, the displacement and mortality rates for puffin (50% and 1% respectively) follow rates applied at the Norfolk Vanguard Offshore Wind Farm (MacArthur Green, 2019a). The displacement rate for gannet (70%) was as advised in the Scoping Opinion (4 February 2022), whilst the mortality rate for gannet (1%) was chosen on the basis of previous recommendations from Natural England at the same development (MacArthur Green, 2019b).

36. The displacement rate for kittiwake (30%) was advised in the Scoping Opinion (4 February 2022) and is consistent with previous advice on Forth and Tay Projects (Marine Scotland, 2017); this has been applied in both the Scoping and Developer Approach. However, the Developer Approach applies a single mortality rate of 2%, which is within the range advised under the Scoping Approach (1-3%). The mortality rate of 2% follows previous advice from the Marine Scotland on previous Forth & Tay projects (Marine Scotland, 2017).

37. In addition, the Applicant has further applied the Matrix method to auks using a more nuanced approach; with lower displacement rates applied to the 2km buffer than the Development Array. The relevant methods and results are presented in Annex C and are discussed within Annex G.

Table 3.4: Displacement and mortality rates used for the Scoping Approach (Scoping Opinion 4 February 2022) and the Developer Approach.

Species	Displacement Rate	Mortality Rate – Breeding Season	Mortality Rate – Non-breeding Seasons
Scoping Opinion (February 2022)			
Guillemot, Razorbill & Puffin	60%	3% and 5%	1% and 3% (Puffin not assessed)
Gannet	70%	1% and 3%	1% and 3%
Kittiwake	30%	1% and 3%	1% and 3%
Developer Approach			
Guillemot and Razorbill	50% within WF area and 2km buffer [1]	1% [1]	1% [1]
Puffin	50% within WF area & 2km buffer 2	1% 2	Not assessed
Gannet	70%	1% [3]	1% [3]
Kittiwake	30% [4]	2% [4]	Not assessed

[1] Recommended maximum displacement rate from APEM (2022). Review of evidence to support auk displacement and mortality rates in relation to offshore wind farms. APEM Scientific Report P00007416. Ørsted, January 2022

[2] Recommended displacement rates from MacArthur Green (2019a). Norfolk Vanguard Offshore Wind Farm. The Applicant Responses to First Written Questions. Appendix 3.3 – Operational Auk and Gannet Displacement: update and clarification

[3] Natural England recommended displacement and mortality rates for Gannet for Norfolk Vanguard Offshore Wind Farm. MacArthur Green (2019b). Norfolk Vanguard Offshore Wind Farm Offshore Ornithology Assessment Update for Deadline 6.

[4] Based on MS Scoping Opinion for Forth & Tay projects (2017)

4. RESULTS

4.1. DISPLACEMENT MATRICES

38. The displacement matrices provide, for each species and relevant bio-season, the estimated mortality of birds predicted to occur due to displacement, as determined by the relevant specified rates of displacement and mortality (Table 3.4).

39. Displacement matrices for each species, in each bio-season and in both the Berwick Bank Development Array and the Berwick Bank Development Array plus a 2 km buffer are presented in Table 4.1 to Table 4.22.

40. Each cell presents potential bird mortality following displacement from the proposed Berwick Bank OWF during a bio-season given; i) the seasonal mean peak population within the impacted area; ii) the percentage assumed to be displaced from the impacted area; and iii) the assumed percentage mortality amongst the displaced birds. The outputs highlighted in colour are those based on the displacement and mortality rates in Table 3.4 and are deemed the 'most realistic' mortality estimates as advised by the: i) Scoping Opinion (highlighted in dark teal) and ii) the Developer Approach (highlighted in orange). Outputs highlighted in light teal reflect potential uncertainty associated with the selected figures, as advised by the SNCB (2017) guidance with regards to presenting the matrices. No adjustments for age classes of birds have been made.

KITTIWAKE

Table 4.1: **Potential kittiwake mortality following displacement from the Berwick Bank Development Array in the breeding season. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; orange representing rates defined by the Developer Approach; and light teal representing uncertainty around these figures.**

Kittiwake (Breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	18	35	52	69	86	172	258	344	516	860	1376	1720
20%	0	35	69	104	138	172	344	516	688	1032	1720	2752	3439
30%	0	52	104	155	207	258	516	774	1032	1548	2580	4127	5159
40%	0	69	138	207	276	344	688	1032	1376	2064	3439	5503	6878
50%	0	86	172	258	344	430	860	1290	1720	2580	4299	6878	8597
60%	0	104	207	310	413	516	1032	1548	2064	3095	5159	8254	10317
70%	0	121	241	362	482	602	1204	1806	2408	3611	6018	9629	12036
80%	0	138	276	413	551	688	1376	2064	2752	4127	6878	11005	13756
90%	0	155	310	465	619	774	1548	2322	3095	4643	7738	12380	15475
100%	0	172	344	516	688	860	1720	2580	3439	5159	8597	13756	17194

Table 4.2: **Potential kittiwake mortality following displacement from the Berwick Bank Development Array plus 2 km buffer in the breeding season. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; orange representing rates defined by the Developer Approach; and light teal representing uncertainty around these figures.**

Kittiwake (Breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	22	43	64	85	106	212	318	423	635	1058	1692	2115
20%	0	43	85	127	170	212	423	635	846	1269	2115	3383	4229
30%	0	64	127	191	254	318	635	952	1269	1903	3172	5074	6343
40%	0	85	170	254	339	423	846	1269	1692	2537	4229	6766	8457
50%	0	106	212	318	423	529	1058	1586	2115	3172	5286	8457	10571
60%	0	127	254	381	508	635	1269	1903	2537	3806	6343	10148	12685
70%	0	148	296	444	592	740	1480	2220	2960	4440	7400	11839	14799
80%	0	170	339	508	677	846	1692	2537	3383	5074	8457	13531	16913
90%	0	191	381	571	762	952	1903	2855	3806	5709	9514	15222	19027
100%	0	212	423	635	846	1058	2115	3172	4229	6343	10571	16913	21141

Table 4.3: **Potential kittiwake mortality following displacement from the Berwick Bank Development Array in the non-breeding season. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion and light teal representing uncertainty around these figures. A quantitative assessment is not being made for kittiwake in the non-breeding season under the Developer Approach (see Annex G for justification).**

Kittiwake (Non-breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	16	32	48	64	80	159	238	317	475	791	1266	1582
20%	0	32	64	95	127	159	317	475	633	950	1582	2532	3164
30%	0	48	95	143	190	238	475	712	950	1424	2374	3797	4747
40%	0	64	127	190	254	317	633	950	1266	1899	3164	5063	6328
50%	0	80	159	238	317	396	791	1187	1582	2373	3955	6328	7910
60%	0	95	190	285	380	475	950	1424	1899	2848	4747	7594	9493
70%	0	111	222	333	443	554	1108	1662	2215	3323	5538	8860	11075
80%	0	127	254	380	507	633	1266	1899	2532	3797	6328	10125	12656
90%	0	143	285	428	570	712	1424	2136	2848	4272	7119	11391	14238
100%	0	159	317	475	633	791	1582	2373	3164	4746	7910	12656	15820

Table 4.4: **Potential kittiwake mortality following displacement from the Berwick Bank Development Array plus 2km buffer in the spring migration (non-breeding) period. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion and light teal representing uncertainty around these figures. A quantitative assessment is not being made for kittiwake in the non-breeding season under the Developer Approach (see Annex G for justification).**

Kittiwake (Spring migration)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	14	28	41	55	69	138	206	275	413	688	1101	1377
20%	0	28	55	83	110	138	275	413	551	826	1377	2203	2753
30%	0	41	83	124	165	206	413	619	826	1239	2065	3304	4130
40%	0	55	110	165	220	275	551	826	1101	1652	2753	4405	5506
50%	0	69	138	206	275	344	688	1032	1377	2065	3442	5506	6883
60%	0	83	165	248	330	413	826	1239	1652	2478	4130	6608	8260
70%	0	96	193	289	385	482	964	1445	1927	2891	4818	7709	9636
80%	0	110	220	330	441	551	1101	1652	2203	3304	5506	8810	11013
90%	0	124	248	372	496	619	1239	1858	2478	3717	6195	9912	12389
100%	0	138	275	413	551	688	1377	2065	2753	4130	6883	11013	13766

Table 4.5: **Potential kittiwake mortality following displacement from the Berwick Bank Development Array plus 2km buffer in the autumn migration (non-breeding) period. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion and light teal representing uncertainty around these figures. A quantitative assessment is not being made for kittiwake in the non-breeding season under the Developer Approach (see Annex G for justification).**

Kittiwake (Autumn migration)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	11	22	34	45	56	112	168	224	336	560	895	1119
20%	0	22	45	67	90	112	224	336	448	671	1119	1790	2238
30%	0	34	67	101	134	168	336	504	671	1007	1679	2686	3357
40%	0	45	90	134	179	224	448	671	895	1343	2238	3581	4476
50%	0	56	112	168	224	280	560	839	1119	1678	2798	4476	5595
60%	0	67	134	201	269	336	671	1007	1343	2014	3357	5371	6714
70%	0	78	157	235	313	392	783	1175	1567	2350	3917	6266	7833
80%	0	90	179	269	358	448	895	1343	1790	2686	4476	7162	8952
90%	0	101	201	302	403	504	1007	1511	2014	3021	5036	8057	10071
100%	0	112	224	336	448	560	1119	1678	2238	3357	5595	8952	11190

GUILLEMOT

Table 4.6: **Potential guillemot mortality following displacement from the Berwick Bank Development Array in the breeding season. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; orange representing rates defined by the Developer Approach; and light teal representing uncertainty around these figures.**

Guillemot (Breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	60	120	180	239	299	597	896	1194	1791	2985	4776	5969
20%	0	120	239	359	478	597	1194	1791	2388	3582	5969	9551	11938
30%	0	180	359	538	717	896	1791	2687	3582	5373	8954	14326	17908
40%	0	239	478	717	956	1194	2388	3582	4776	7163	11938	19101	23876
50%	0	299	597	896	1194	1493	2985	4477	5969	8954	14923	23876	29845
60%	0	359	717	1075	1433	1791	3582	5373	7163	10745	17908	28652	35815
70%	0	418	836	1254	1672	2090	4179	6268	8357	12535	20892	33427	41784
80%	0	478	956	1433	1911	2388	4776	7163	9551	14326	23876	38202	47752
90%	0	538	1075	1612	2149	2687	5373	8059	10745	16117	26861	42977	53721
100%	0	597	1194	1791	2388	2985	5969	8954	11938	17907	29845	47752	59690

Table 4.7: **Potential guillemot mortality following displacement from the Berwick Bank Development Array plus 2 km buffer in the breeding season. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; orange representing rates defined by the Developer Approach; and light teal representing uncertainty around these figures.**

Guillemot (Breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	75	149	223	297	371	742	1113	1484	2225	3708	5933	7416
20%	0	149	297	445	594	742	1484	2225	2967	4450	7416	11865	14831
30%	0	223	445	668	890	1113	2225	3337	4450	6674	11124	17797	22247
40%	0	297	594	890	1187	1484	2967	4450	5933	8899	14831	23730	29662
50%	0	371	742	1113	1484	1854	3708	5562	7416	11124	18539	29662	37077
60%	0	445	890	1335	1780	2225	4450	6674	8899	13348	22247	35594	44493
70%	0	520	1039	1558	2077	2596	5191	7787	10382	15573	25954	41527	51908
80%	0	594	1187	1780	2373	2967	5933	8899	11865	17797	29662	47459	59324
90%	0	668	1335	2003	2670	3337	6674	10011	13348	20022	33370	53391	66739
100%	0	742	1484	2225	2967	3708	7416	11124	14831	22247	37077	59324	74154

Table 4.8: **Potential guillemot mortality following displacement from the Berwick Bank Development Array in the non-breeding season. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; orange representing rates defined by the Developer Approach; and light teal representing uncertainty around these figures.**

Guillemot (Non-breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	35	69	103	137	171	341	511	681	1022	1702	2724	3404
20%	0	69	137	205	273	341	681	1022	1362	2043	3404	5447	6808
30%	0	103	205	307	409	511	1022	1532	2043	3064	5106	8170	10212
40%	0	137	273	409	545	681	1362	2043	2724	4085	6808	10893	13616
50%	0	171	341	511	681	851	1702	2553	3404	5106	8510	13616	17019
60%	0	205	409	613	817	1022	2043	3064	4085	6127	10212	16339	20423
70%	0	239	477	715	954	1192	2383	3574	4766	7148	11914	19062	23827
80%	0	273	545	817	1090	1362	2724	4085	5447	8170	13616	21785	27231
90%	0	307	613	920	1226	1532	3064	4596	6127	9191	15318	24508	30635
100%	0	341	681	1022	1362	1702	3404	5106	6808	10212	17019	27231	34038

Table 4.9: **Potential guillemot mortality following displacement from the Berwick Bank Development Array plus 2 km buffer in the non-breeding season. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; orange representing rates defined by the Developer Approach; and light teal representing uncertainty around these figures.**

Guillemot (Non-breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	45	89	133	177	221	442	663	884	1326	2209	3534	4418
20%	0	89	177	266	354	442	884	1326	1767	2651	4418	7068	8835
30%	0	133	266	398	531	663	1326	1988	2651	3976	6626	10602	13252
40%	0	177	354	531	707	884	1767	2651	3534	5301	8835	14135	17669
50%	0	221	442	663	884	1105	2209	3313	4418	6626	11043	17669	22086
60%	0	266	531	796	1061	1326	2651	3976	5301	7951	13252	21203	26503
70%	0	310	619	928	1237	1546	3092	4638	6184	9276	15460	24736	30920
80%	0	354	707	1061	1414	1767	3534	5301	7068	10602	17669	28270	35337
90%	0	398	796	1193	1591	1988	3976	5964	7951	11927	19877	31804	39754
100%	0	442	884	1326	1767	2209	4418	6626	8835	13252	22086	35337	44171

Table 4.10: **Potential razorbill mortality following displacement from the Berwick Bank Development Array in the breeding season. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; orange representing rates defined by the Developer Approach; and light teal representing uncertainty around these figures.**

Razorbill (Breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	4	7	10	13	16	31	46	61	92	153	244	305
20%	0	7	13	19	25	31	61	92	122	183	305	487	609
30%	0	10	19	28	37	46	92	137	183	274	457	731	913
40%	0	13	25	37	49	61	122	183	244	366	609	974	1217
50%	0	16	31	46	61	77	153	229	305	457	761	1217	1521
60%	0	19	37	55	74	92	183	274	366	548	913	1461	1826
70%	0	22	43	64	86	107	213	320	426	639	1065	1704	2130
80%	0	25	49	74	98	122	244	366	487	731	1217	1947	2434
90%	0	28	55	83	110	137	274	411	548	822	1369	2191	2738
100%	0	31	61	92	122	153	305	457	609	913	1521	2434	3042

Table 4.11: **Potential razorbill mortality following displacement from the Berwick Bank Development Array plus 2 km buffer in the breeding season. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; orange representing rates defined by the Developer Approach; and light teal representing uncertainty around these figures.**

Razorbill (Breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	5	9	13	17	21	41	61	81	122	202	324	404
20%	0	9	17	25	33	41	81	122	162	243	404	647	808
30%	0	13	25	37	49	61	122	182	243	364	607	970	1213
40%	0	17	33	49	65	81	162	243	324	485	808	1293	1616
50%	0	21	41	61	81	101	202	303	404	606	1010	1616	2020
60%	0	25	49	73	97	122	243	364	485	728	1213	1940	2425
70%	0	29	57	85	114	142	283	425	566	849	1415	2263	2829
80%	0	33	65	97	130	162	324	485	647	970	1616	2586	3232
90%	0	37	73	110	146	182	364	546	728	1091	1818	2909	3636
100%	0	41	81	122	162	202	404	606	808	1212	2020	3232	4040

Table 4.12: **Potential razorbill mortality following displacement from the Berwick Bank Development array in the non-breeding season. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; orange representing rates defined by the Developer Approach; and light teal representing uncertainty around these figures.**

Razorbill (Non-breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	9	18	27	35	44	88	131	175	262	437	698	873
20%	0	18	35	53	70	88	175	262	349	524	873	1396	1745
30%	0	27	53	79	105	131	262	393	524	785	1309	2094	2617
40%	0	35	70	105	140	175	349	524	698	1047	1745	2792	3489
50%	0	44	88	131	175	219	437	655	873	1309	2181	3489	4361
60%	0	53	105	157	210	262	524	785	1047	1570	2617	4187	5234
70%	0	62	123	184	245	306	611	916	1222	1832	3053	4885	6106
80%	0	70	140	210	280	349	698	1047	1396	2094	3489	5583	6978
90%	0	79	157	236	314	393	785	1178	1570	2355	3925	6280	7850
100%	0	88	175	262	349	437	873	1309	1745	2617	4361	6978	8722

Table 4.13: **Potential razorbill mortality following displacement from the Berwick Bank Development array plus 2 km buffer in the spring migration (non-breeding) period. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; orange representing rates defined by the Developer Approach; and light teal representing uncertainty around these figures.**

Razorbill (Spring migration)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	7	15	22	30	37	75	112	150	224	374	598	748
20%	0	15	30	45	60	75	150	224	299	449	748	1197	1496
30%	0	22	45	67	90	112	224	337	449	673	1122	1795	2244
40%	0	30	60	90	120	150	299	449	598	898	1496	2394	2992
50%	0	37	75	112	150	187	374	561	748	1122	1870	2992	3740
60%	0	45	90	135	180	224	449	673	898	1346	2244	3590	4488
70%	0	52	105	157	209	262	524	785	1047	1571	2618	4189	5236
80%	0	60	120	180	239	299	598	898	1197	1795	2992	4787	5984
90%	0	67	135	202	269	337	673	1010	1346	2020	3366	5386	6732
100%	0	75	150	224	299	374	748	1122	1496	2244	3740	5984	7480

Table 4.14: **Potential razorbill mortality following displacement from the Berwick Bank Development array plus 2 km buffer in the autumn migration (non-breeding) period. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; orange representing rates defined by the Developer Approach; and light teal representing uncertainty around these figures.**

Razorbill (Autumn migration)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	9	18	27	35	44	88	133	177	265	442	708	885
20%	0	18	35	53	71	88	177	265	354	531	885	1416	1770
30%	0	27	53	80	106	133	265	398	531	796	1327	2124	2655
40%	0	35	71	106	142	177	354	531	708	1062	1770	2832	3540
50%	0	44	88	133	177	221	442	664	885	1327	2212	3540	4424
60%	0	53	106	159	212	265	531	796	1062	1593	2655	4248	5309
70%	0	62	124	186	248	310	619	929	1239	1858	3097	4955	6194
80%	0	71	142	212	283	354	708	1062	1416	2124	3540	5663	7079
90%	0	80	159	239	319	398	796	1195	1593	2389	3982	6371	7964
100%	0	88	177	265	354	442	885	1327	1770	2655	4424	7079	8849

Table 4.15: **Potential razorbill mortality following displacement from the Berwick Bank Development array plus 2 km buffer in the winter (non-breeding) period. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; orange representing rates defined by the Developer Approach; and light teal representing uncertainty around these figures.**

Razorbill (Winter)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	1	3	4	6	7	14	21	28	42	70	112	140
20%	0	3	6	8	11	14	28	42	56	84	140	224	280
30%	0	4	8	13	17	21	42	63	84	126	210	336	420
40%	0	6	11	17	22	28	56	84	112	168	280	448	560
50%	0	7	14	21	28	35	70	105	140	210	350	560	700
60%	0	8	17	25	34	42	84	126	168	252	420	672	839
70%	0	10	20	29	39	49	98	147	196	294	490	783	979
80%	0	11	22	34	45	56	112	168	224	336	560	895	1119
90%	0	13	25	38	50	63	126	189	252	378	630	1007	1259
100%	0	14	28	42	56	70	140	210	280	420	700	1119	1399

PUFFIN

Table 4.16: **Potential puffin mortality following displacement from the Berwick Bank Development array in the breeding season. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; orange representing rates defined by the Developer Approach; and light teal representing uncertainty around these figures.**

Puffin (Breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	4	7	11	14	17	34	51	68	102	170	272	339
20%	0	7	14	21	28	34	68	102	136	204	339	543	678
30%	0	11	21	31	41	51	102	153	204	306	509	814	1018
40%	0	14	28	41	55	68	136	204	272	407	678	1085	1356
50%	0	17	34	51	68	85	170	255	339	509	848	1356	1695
60%	0	21	41	62	82	102	204	306	407	611	1018	1628	2035
70%	0	24	48	72	95	119	238	356	475	712	1187	1899	2373
80%	0	28	55	82	109	136	272	407	543	814	1356	2170	2712
90%	0	31	62	92	123	153	306	458	611	916	1526	2441	3051
100%	0	34	68	102	136	170	339	509	678	1017	1695	2712	3390

Table 4.17: **Potential puffin mortality following displacement from the Berwick Bank Development Array plus 2 km buffer in the breeding season. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; orange representing rates defined by the Developer Approach; and light teal representing uncertainty around these figures.**

Puffin (Breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	5	10	14	19	23	46	68	91	136	226	362	452
20%	0	10	19	28	37	46	91	136	181	271	452	723	903
30%	0	14	28	41	55	68	136	204	271	407	677	1084	1354
40%	0	19	37	55	73	91	181	271	362	542	903	1445	1806
50%	0	23	46	68	91	113	226	339	452	677	1129	1806	2257
60%	0	28	55	82	109	136	271	407	542	813	1354	2167	2708
70%	0	32	64	95	127	158	316	474	632	948	1580	2528	3160
80%	0	37	73	109	145	181	362	542	723	1084	1806	2889	3611
90%	0	41	82	122	163	204	407	610	813	1219	2031	3250	4062
100%	0	46	91	136	181	226	452	677	903	1354	2257	3611	4513

GANNET

41. In addition to the Matrix method, GPS tracking data of gannets from the Bass Rock colony 2010 - 2019 were analysed to contribute to understanding how the proposed Project may lead to displacement and barrier effects on this colony population. Data from breeding adults from Bass Rock were used to estimate behavioural states using Hidden Markov Models, and the proportion of time spent in each behavioural state and within and outwith the windfarm, split by sex. The analysis demonstrates the extensive spatial range of gannets from the colony and showed that males spent on average 10.5% less time transiting than females across all trips. When sex and behaviour were considered within the Development Array are only, males spent on average 38% more time foraging within the area than females.

42. Random resampling of the dataset using size of the Development Array area was used to explore the distribution of the data and whether there was evidence of it being used preferentially to other equivalently sized areas. The number of observations counted out of 863 samples of the dataset, showed that the proposed Development Array area had a higher count than 94% of the samples. However, this resampling does not account for proximity to colony or landmasses. Annex E details analysis of GPS tracks of gannet tracked from Bass rock in the Forth and Tay. It was found that of the 682 birds tracked, only 26.2% of those individuals entered the development area, and of those only 52.5% (94 birds) engaged in any foraging activities (see table 3.3). Figure 3.3 illustrates the locations of predicted foraging behaviour (as identified by hidden Markov modelling) and that due to the large home ranges (median 3,909 km2), most foraging activity occurs outside the development site.

Table 4.18: Potential gannet mortality following displacement from the Berwick Bank Development array in the breeding season. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; dark teal and orange coloured hatching representing overlapping estimates from both the Scoping Opinion and Developer Approach.; and light teal representing uncertainty around these figures.

Gannet (Breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	4	8	11	15	18	36	54	72	108	179	286	358
20%	0	8	15	22	29	36	72	108	143	215	358	572	715
30%	0	11	22	33	43	54	108	161	215	322	536	858	1072
40%	0	15	29	43	58	72	143	215	286	429	715	1144	1429
50%	0	18	36	54	72	90	179	268	358	536	893	1429	1786
60%	0	22	43	65	86	108	215	322	429	643	1072	1715	2144
70%	0	26	51	76	101	126	251	376	501	751	1251	2001	2501
80%	0	29	58	86	115	143	286	429	572	858	1429	2287	2858
90%	0	33	65	97	129	161	322	483	643	965	1608	2572	3215
100%	0	36	72	108	143	179	358	536	715	1072	1786	2858	3572

Table 4.19: Potential gannet mortality following displacement from the Berwick Bank Development Array plus 2 km buffer in the breeding season. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; dark teal and orange coloured hatching representing overlapping estimates from both the Scoping Opinion and Developer Approach.; and light teal representing uncertainty around these figures.

Gannet (Breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	5	10	15	19	24	48	72	95	143	237	379	474
20%	0	10	19	29	38	48	95	143	190	285	474	758	947
30%	0	15	29	43	57	72	143	214	285	427	711	1137	1421
40%	0	19	38	57	76	95	190	285	379	569	947	1516	1894
50%	0	24	48	72	95	119	237	356	474	711	1184	1894	2368
60%	0	29	57	86	114	143	285	427	569	853	1421	2273	2842
70%	0	34	67	100	133	166	332	498	663	995	1658	2652	3315
80%	0	38	76	114	152	190	379	569	758	1137	1894	3031	3788
90%	0	43	86	128	171	214	427	640	853	1279	2131	3410	4262
100%	0	48	95	143	190	237	474	711	947	1421	2368	3788	4735

Table 4.20: **Potential gannet mortality following displacement from the Berwick Bank Development Array in the non-breeding season. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; dark teal and orange coloured hatching representing overlapping estimates from both the Scoping Opinion and Developer Approach.; and light teal representing uncertainty around these figures.**

Gannet (Non-breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	2	3	4	5	6	11	16	21	31	51	82	102
20%	0	3	5	7	9	11	21	31	41	62	102	164	204
30%	0	4	7	10	13	16	31	46	62	92	153	245	306
40%	0	5	9	13	17	21	41	62	82	123	204	327	408
50%	0	6	11	16	21	26	51	77	102	153	255	408	510
60%	0	7	13	19	25	31	62	92	123	184	306	490	612
70%	0	8	15	22	29	36	72	107	143	214	357	571	714
80%	0	9	17	25	33	41	82	123	164	245	408	653	816
90%	0	10	19	28	37	46	92	138	184	276	459	734	918
100%	0	11	21	31	41	51	102	153	204	306	510	816	1019

Table 4.21: **Potential gannet mortality following displacement from the Berwick Bank Development array plus 2 km buffer in the spring migration (non-breeding) period. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; dark teal and orange coloured hatching representing overlapping estimates from both the Scoping Opinion and Developer Approach; and light teal representing uncertainty around these figures.**

Gannet (Spring migration)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	0	1	1	1	1	3	4	5	8	13	22	27
20%	0	1	1	2	2	3	5	8	11	16	27	43	54
30%	0	1	2	2	3	4	8	12	16	24	40	65	81
40%	0	1	2	3	4	5	11	16	22	32	54	86	108
50%	0	1	3	4	5	7	13	20	27	40	67	108	134
60%	0	2	3	5	6	8	16	24	32	48	81	129	161
70%	0	2	4	6	8	9	19	28	38	56	94	151	188
80%	0	2	4	6	9	11	22	32	43	65	108	172	215
90%	0	2	5	7	10	12	24	36	48	73	121	194	242
100%	0	3	5	8	11	13	27	40	54	81	134	215	269

Table 4.22: **Potential gannet mortality following displacement from the Berwick Bank Development array plus 2 km buffer in the autumn migration (non-breeding) period. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; dark teal and orange coloured hatching representing overlapping estimates from both the Scoping Opinion and Developer Approach; and light teal representing uncertainty around these figures.**

Gannet (Autumn migration)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	2	3	4	6	8	15	22	30	45	75	120	150
20%	0	3	6	9	12	15	30	45	60	90	150	240	300
30%	0	5	9	14	18	23	45	68	90	135	225	360	450
40%	0	6	12	18	24	30	60	90	120	180	300	480	600
50%	0	8	15	22	30	38	75	112	150	225	375	600	750
60%	0	9	18	27	36	45	90	135	180	270	450	720	900
70%	0	11	21	32	42	53	105	158	210	315	525	840	1050
80%	0	12	24	36	48	60	120	180	240	360	600	960	1200
90%	0	14	27	40	54	68	135	202	270	405	675	1080	1350
100%	0	15	30	45	60	75	150	225	300	450	750	1200	1500

4.2. DISPLACEMENT ESTIMATES

43. A summary of the final estimates of likely seabird mortality from displacement derived through the Matrix Approach for each species and bio-season for the Berwick Bank Development Array and Berwick Bank Development Array plus 2km buffer following the Scoping Approach and Developer Approach is shown in Table 4.23.

Table 4.23: **Potential bird mortality per bio-season following displacement and barrier effects from the Berwick Bank Development Array and the Berwick Bank Development Array plus 2 km buffer, for the mortality and displacement rates selected in Table 3.4. Figures are presented for both the "Scoping Approach" and the "Developer Approach". Estimates are separated by a '/' where the Scoping Opinion instructs the use of multiple mortality rates.**

Species	Development Array		Development Array + 2 km buffer				
	Breeding season	Non-breeding season	Breeding season	Non-breeding season	Spring migration	Winter	Autumn migration
Scoping Approach							
Kittiwake	52 / 155	48 / 143	64 / 191	N/A	41 / 124	N/A	34 / 101
Guillemot	1,075 / 1,791	205 / 613	1,335 / 2,225	266 / 795	N/A	N/A	N/A
Razorbill	55 / 92	53 / 157	73 / 122	N/A	45 / 135	8 / 25	53 / 159
Puffin	62 / 102	N/A	82 / 136	N/A	N/A	N/A	N/A
Gannet	26 / 76	8 / 22	34 /100	N/A	2 / 6	N/A	11 / 32
Developer Approach							
Kittiwake	104	N/A	127	N/A	N/A	N/A	N/A
Guillemot	299	171	371	221	N/A	N/A	N/A
Razorbill	16	44	21	N/A	37	7	44
Puffin	17	N/A	23	N/A	N/A	N/A	N/A
Gannet	26	8	34	N/A	2	N/A	11

5. SUMMARY

44. Following the joint SNCB interim advice (SNCBs, 2017), the impact of displacement on seabird species predicted to result from an operational Berwick Bank OWF was assessed using the Matrix method. This approach was agreed with MSS and NatureScot during the Ornithology Roadmap Process (RM1, July 2021). Assessment was conducted on five species: kittiwake, guillemot, razorbill, puffin and gannet. Displacement matrices were created to show the potential bird mortality following displacement, dependent on the percentage of birds considered likely to be displaced and subsequent potential mortality rates. Outputs were generated for each species, in each bio-season, and for two spatial scales: the Berwick Bank Development array and the Berwick Bank Development array plus a 2 km buffer.

45. Additional analyses using SeabORD for kittiwake and the auks was also conducted (Annex D).

46. The results for gannet are supplemented with analyses of GPS tagging data from the Bass Rock colony 2010 – 2019 (Annex E).

47. The Applicant undertook a parallel approach to the assessment, with two sets of final mortality figures selected: one set based on parameters advised by the Scoping Opinion ("Scoping Approach") and one set based on the parameters considered to be most plausible by the Project and defined as the "Developer Approach".

48. The Scoping Approach followed displacement and mortality rates advised within the Scoping Opinion (4 February 2022). Displacement rates of 30% for kittiwake, 60% for guillemot, razorbill and puffin, and 70% for gannet were used. Mortality rates of 1 and 3% were advised for kittiwake and gannet in both the breeding and non-breeding season. Mortality rates of 3 and 5% were advised for all auks (guillemot, razorbill and puffin) in the breeding season and a 1 and 3% mortality rate used for guillemot and razorbill in the non-breeding season. Puffin was not assessed in the non-breeding season.

49. In contrast, the Developer Approach followed displacement and mortality rates supported by other cited evidence and previous precedents of consented projects. A displacement rate of 30% was used for kittiwake in the breeding season, 50% used for guillemot and razorbill in both breeding and non-breeding seasons, 50% puffin in the breeding season and 70% used for gannet in both breeding and non-breeding seasons. A mortality rate of 1% was used for guillemot, razorbill and gannet in both the breeding and non-breeding season, and for puffin in the breeding season only. Puffin was not assessed in the non-breeding season. A mortality rate of 2% was used for kittiwake in the breeding season. A quantitative assessment was not undertaken for kittiwakes in the non-breeding season.

50. The final mortality values from displacement selected via the two approaches are presented in Table 4.23.

51. The mortality estimates arising from both approaches are apportioned to SPA populations (Technical Appendix 11.5: Ornithological Apportioning Technical Report) and used to model impact scenarios in the Population Viability Analyses (Appendix 11.6: Ornithology Population Viability Analysis Technical Report). This includes the breeding season mortality estimates for all species presented here, and the non-breeding mortality estimates for guillemots and puffins. For those species where the autumn and spring passage and winter periods are defined within the non-breeding season (gannet, kittiwake and razorbill), appropriate displacement matrices were conducted for non-breeding seasons defined by Furness (2015).

6. REFERENCES

APEM (2022). *Review of evidence to support auk displacement and mortality rates in relation to offshore wind farms.* APEM Scientific Report P00007416. Ørsted, January 2022, Final, 49.

Bradbury, G., Trinder, M., Furness, B., Banks, A.N, Caldow, R.W.G. and Hume, D. (2014). Mapping Seabird Sensitivity to Offshore Wind Farms. *PLoS ONE,* 9(9): e106366.

Furness R. W., Wade, H. M. and Masden E.A. (2013). Assessing vulnerability of marine bird populations to offshore wind farms. *Journal of Environmental Management,* 119, 56-66.

MacArthur Green (2019a). Norfolk Vanguard Offshore Wind Farm Offshore Ornithology Assessment Update for Deadline 6.

MacArthur Green (2019b). Norfolk Vanguard Offshore Wind Farm. The Applicant Responses to First Written Questions. Appendix 3.3 - Operational Auk and Gannet Displacement: update and clarification

Marine Scotland (2017). *Marine Scotland Licensing Operations Team: Scoping Opinion for Seagreen Phase 1 Offshore Project*. Scottish Government, Edinburgh.

NatureScot (2020). *Seasonal Periods for Birds in the Scottish Marine Environment*. Short Guidance Note Version 2.

Searle, K., Mobbs, D., Butler, A., Bogdanova, M., Freeman, S., Wanless, S. and Daunt, F. (2014). *Population consequences of displacement from proposed offshore wind energy developments for seabirds breeding at Scottish SPAs (CR/2012/03). Final Report to Marine Scotland*. Marine Scotland, Edinburgh.

SNCB (2017). *Joint SNCB Interim Displacement Advice Note.* [Online]. JNCC, Natural Resources Wales, Department of Agriculture, Environment and Rural Affairs/Northern Ireland Environment Agency, Natural England and Scottish Natural Heritage. http://jncc.defra.gov.uk/pdf/Joint_SNCB_Interim_Displacement_AdviceNote_2017.pdf. Accessed 28/10/2021.

Vallejo, G., Robbins, J., Hickey, J., Moullier, A., Slater, S., Dinwoodie, I., Cook, G. & Pendlebruy C.Dinwoodie, I. (2022). Sensitivity analysis of parameters and assumptions in the SeabORD model. Natural Power Report to SSE Renewables.

ANNEX A DESIGN BASED ANALYSIS – MONTHLY APPORTIONED POPULATION ESTIMATES (BERWICK BANK DEVELOPMENT ARRAY)

Table A.1: **Monthly density and population estimates of kittiwakes in the Berwick Bank Development array, calculated using design-based analysis. Data include "no-identification" birds apportioned to species.**

Kittiwake	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	15.19	8.29	23.38	15358	8377	23629	3977	25.89%
May-19	4.13	2.93	5.57	4176	2958	5632	673	16.1%
Jun-19	2.65	2.09	3.35	2681	2113	3382	319	11.88%
Jul-19	5.02	4.34	5.69	5075	4389	5753	360	7.08%
Aug-19	6.93	5.72	8.22	7004	5783	8307	646	9.21%
Sep-19	2.15	1.45	2.98	2173	1466	3016	410	18.85%
Oct-19	0.62	0.46	0.78	625	467	794	83	13.18%
Nov-19	0.29	0.18	0.41	295	178	415	65	22.03%
Dec-19	0.28	0.15	0.49	288	156	491	90	31.05%
Jan-20	2.19	1.11	3.59	2215	1125	3632	642	28.98%
Feb-20	1.91	0.97	3.08	1929	977	3116	557	28.86%
Mar-20	5.59	4	7.1	5648	4046	7179	796	14.09%
May S01 20	6.53	2.37	11.29	6601	2399	11410	2208	33.45%
May S02 20	8.41	6.19	10.81	8498	6258	10925	1273	14.98%
Jun-20	9.06	7.45	10.72	9159	7534	10841	884	9.65%
Jul-20	8.69	6.95	10.84	8785	7022	10958	1054	11.99%
Aug-20	13.32	9.56	17.38	13464	9666	17568	2033	15.1%
Sep-20	16.11	10.67	22.37	16282	10789	22614	3135	19.25%
Oct-20	1.49	0.88	2.23	1508	885	2255	361	23.89%
Nov-20	4.84	2.72	7.03	4888	2749	7106	1174	24.01%
Dec-20	1.09	0.68	1.63	1104	690	1644	251	22.69%
Jan-21	2.19	1.35	3.22	2210	1369	3257	484	21.87%
Feb-21	2.83	0.58	5.72	2857	586	5785	1445	50.57%
Apr S01 21	6.85	4.91	9.08	6924	4969	9179	1059	15.28%
Apr S02 21	20.7	10.61	32.66	20923	10721	33018	5943	28.4%

Table A.2: **Monthly absolute density and population estimates of guillemots in the Berwick Bank Development array, calculated using design-based analysis and adjusted for availability bias. Data include "no-identification" birds apportioned to species.**

Guillemot	Adjusted Density Estimate (birds/ km²)	Adjusted Lower 95% CI (birds/ km²)	Adjusted Upper 95% CI (birds/ km²)	Adjusted Population Estimate (number)	Adjusted Lower 95% CI (number)	Adjusted Upper 95% CI (number)	Adjusted SD	Adjusted CV (%)
Survey								
Mar-19	12.52	8.67	18.05	12659	8768	18244	2395	18.92%
May-19	29.66	23.38	37.93	29981	23642	38342	4391	14.65%
Jun-19	7.45	4.93	10.5	7535	4977	10614	1512	20.07%
Jul-19	32.12	26.35	38.28	32466	26630	38703	3328	10.25%
Aug-19	35.81	22.12	52.11	36195	22357	52676	8685	24%
Sep-19	5.05	3.9	6.15	5101	3934	6205	583	11.43%
Oct-19	1.99	1.04	3.4	2009	1053	3429	586	29.17%
Nov-19	0.92	0.66	1.21	931	662	1230	134	14.39%
Dec-19	1.8	1.21	2.47	1822	1221	2501	349	19.15%
Jan-20	13.26	8.95	19.43	13406	9048	19643	2705	20.18%
Feb-20	9.45	6.2	12.78	9555	6269	12926	1852	19.38%
Mar-20	31.82	22.15	41.13	32162	22398	41575	4987	15.51%
May S01 20	22.19	12.82	33	22434	12965	33362	5177	23.08%
May S02 20	20.47	13.94	27.91	20690	14085	28214	4120	19.91%
Jun-20	46.98	37.11	57.49	47498	37513	58112	5706	12.01%
Jul-20	11.72	9.13	14.14	11857	9235	14301	1486	12.53%
Aug-20	31.51	27.49	35.26	31851	27796	35641	2179	6.84%
Sep-20	35.52	25.87	45.7	35912	26150	46199	5353	14.91%
Oct-20	3.12	2.33	3.99	3152	2362	4040	458	14.53%
Nov-20	2.22	1.57	3.05	2245	1581	3093	383	17.06%
Dec-20	14.93	9.69	22.15	15099	9793	22400	3416	22.62%
Jan-21	10.77	8.33	13.05	10893	8424	13192	1221	11.21%
Feb-21	6.59	4.12	9.37	6658	4168	9474	1442	21.66%
Apr S01 21	27.45	22.68	32.06	27752	22925	32409	2592	9.34%
Apr S02 21	71.1	50.84	91.42	71881	51383	92410	10741	14.94%

Table A.3: **Monthly absolute density and population estimates of razorbills in the Berwick Bank Development array, calculated using design-based analysis and adjusted for availability bias. Data include "no-identification" birds apportioned to species.**

Razorbill	Adjusted Density Estimate (birds/ km²)	Adjusted Lower 95% CI (birds/ km²)	Adjusted Upper 95% CI (birds/ km²)	Adjusted Population Estimate (number)	Adjusted Lower 95% CI (number)	Adjusted Upper 95% CI (number)	Adjusted SD	Adjusted CV (%)
Survey								
Mar-19	1.53	0.77	2.58	1548	788	2599	463	29.91%
May-19	1.44	1.08	1.91	1458	1090	1926	251	17.22%
Jun-19	0.22	0.05	0.5	226	55	508	136	60.18%
Jul-19	2.53	1.66	3.54	2563	1684	3588	595	23.21%
Aug-19	1.82	1.1	2.64	1838	1113	2663	441	23.99%
Sep-19	1.48	1.06	1.93	1496	1074	1957	274	18.32%
Oct-19	0.87	0.48	1.37	872	482	1381	238	27.29%
Nov-19	0.14	0.07	0.23	141	75	233	35	24.82%
Dec-19	0.46	0.2	0.82	472	197	822	167	35.38%
Jan-20	1.77	0.99	2.63	1794	1000	2663	457	25.47%
Feb-20	1.21	0.78	1.73	1228	788	1749	284	23.13%
Mar-20	6.38	4.19	8.48	6448	4239	8570	1158	17.96%
May S01 20	0.95	0.56	1.43	967	565	1451	264	27.3%
May S02 20	0.57	0.32	0.92	585	318	924	199	34.02%

Razorbill	Adjusted Density Estimate (birds/ km²)	Adjusted Lower 95% CI (birds/ km²)	Adjusted Upper 95% CI (birds/ km²)	Adjusted Population Estimate (number)	Adjusted Lower 95% CI (number)	Adjusted Upper 95% CI (number)	Adjusted SD	Adjusted CV (%)
Survey								
Jun-20	1.04	0.7	1.44	1049	704	1456	216	20.59%
Jul-20	1.87	1	2.88	1890	1014	2916	582	30.79%
Aug-20	3.48	2.53	4.82	3520	2563	4866	675	19.18%
Sep-20	10.88	7.31	15.12	10994	7387	15290	2330	21.19%
Oct-20	0.87	0.46	1.38	888	464	1395	228	25.68%
Nov-20	0.33	0.17	0.52	331	175	533	92	27.79%
Dec-20	1.82	1.03	2.65	1845	1041	2671	453	24.55%
Jan-21	3.84	2.77	5.23	3889	2797	5280	631	16.23%
Feb-21	1.65	0.9	2.44	1658	916	2460	419	25.27%
Apr S01 21	3.76	2.39	5.46	3805	2416	5517	824	21.66%
Apr S02 21	1.62	1.21	2.07	1633	1229	2087	238	14.57%

Table A.4: Monthly absolute density and population estimates of puffins in the Berwick Bank Development array, calculated using design-based analysis and adjusted for availability bias. Data include "no-identification" birds apportioned to species.

Puffin	Adjusted Density Estimate (birds/ km²)	Adjusted Lower 95% CI (birds/ km²)	Adjusted Upper 95% CI (birds/ km²)	Adjusted Population Estimate (number)	Adjusted Lower 95% CI (number)	Adjusted Upper 95% CI (number)	Adjusted SD	Adjusted CV (%)
Survey								
Mar-19	1.36	0.85	1.93	1375	859	1959	314	22.84%
May-19	2.31	1.86	2.81	2342	1881	2836	281	12%
Jun-19	0.38	0.17	0.63	385	177	645	129	33.51%
Jul-19	3.35	2.46	4.25	3381	2484	4296	598	17.69%
Aug-19	3.99	2.98	4.91	4033	3017	4965	569	14.11%
Sep-19	1.08	0.63	1.79	1100	642	1815	368	33.45%
Oct-19	0.29	0.19	0.42	287	190	418	67	23.34%
Nov-19	0.02	0.01	0.05	29	10	51	14	48.28%
Dec-19	0	0	0	0	0	0	0	0
Jan-20	0.06	0.02	0.09	54	26	93	22	40.74%
Feb-20	0.19	0.09	0.33	190	90	330	78	41.05%
Mar-20	0.57	0.29	0.91	576	289	921	157	27.26%
May S01 20	1.9	1.05	2.61	1929	1065	2643	490	25.4%
May S02 20	0.73	0.52	0.94	737	536	955	132	17.91%
Jun-20	0.86	0.59	1.13	864	603	1142	176	20.37%
Jul-20	1.03	0.51	1.79	1049	517	1809	390	37.18%
Aug-20	1.91	1.34	2.62	1927	1356	2648	400	20.76%
Sep-20	13.7	11.47	16.33	13854	11598	16513	1530	11.04%
Oct-20	0.14	0.1	0.19	142	101	188	28	19.72%
Nov-20	0.14	0.07	0.21	143	77	218	45	31.47%
Dec-20	0.03	0.01	0.06	31	15	55	12	38.71%
Jan-21	0.02	0.01	0.05	27	13	47	12	44.44%
Feb-21	0.41	0.26	0.58	412	255	585	109	26.46%
Apr S01 21	0.98	0.64	1.37	992	645	1397	210	21.17%

Puffin	Adjusted Density Estimate (birds/ km²)	Adjusted Lower 95% CI (birds/ km²)	Adjusted Upper 95% CI (birds/ km²)	Adjusted Population Estimate (number)	Adjusted Lower 95% CI (number)	Adjusted Upper 95% CI (number)	Adjusted SD	Adjusted CV (%)
Survey								
Apr S02 21	4.8	3.56	6.08	4849	3608	6145	840	17.32%

Table A.5: Monthly density and population estimates of gannets in the Berwick Bank Development array, calculated using design-based analysis. Data include "no-identification" birds apportioned to species.

Gannet	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.27	0.13	0.45	276	136	454	85	30.62%
May-19	0.74	0.48	1.08	751	490	1093	159	21.09%
Jun-19	1.62	1.18	2.17	1641	1198	2190	233	14.2%
Jul-19	3.58	2.94	4.21	3624	2967	4257	324	8.93%
Aug-19	3.37	2.83	3.94	3408	2857	3982	291	8.51%
Sep-19	2.65	2.17	3.24	2684	2196	3278	274	10.17%
Oct-19	0.79	0.62	0.96	799	627	971	94	11.73%
Nov-19	0.16	0.1	0.24	166	99	245	40	23.61%
Dec-19	0	0	0	0	0	0	0	0
Jan-20	0.01	0	0.02	8	0	24	8	99.39%
Feb-20	0.01	0	0.02	8	0	24	8	95.9%
Mar-20	0.26	0.12	0.43	264	120	435	83	31.47%
May S01 20	0.42	0.22	0.68	421	221	688	122	28.9%
May S02 20	0.81	0.57	1.12	823	573	1136	146	17.69%
Jun-20	1.14	0.82	1.54	1153	828	1560	197	17.01%
Jul-20	3.48	2.92	4.1	3520	2951	4141	313	8.87%
Aug-20	2.44	1.84	3.05	2463	1860	3086	320	12.96%
Sep-20	1.42	1.02	1.9	1435	1036	1919	237	16.48%
Oct-20	0.8	0.57	1.06	814	579	1071	130	15.95%
Nov-20	1.23	0.9	1.62	1239	915	1639	185	14.88%
Dec-20	0.19	0.02	0.46	195	23	469	122	62.83%
Jan-21	0.09	0.03	0.15	87	32	148	32	36.12%
Feb-21	0.12	0.01	0.29	127	16	291	71	55.76%
Apr S01 21	0.57	0.43	0.69	576	438	698	69	11.89%
Apr S02 21	1.41	0.42	2.82	1428	421	2849	651	45.57%

ANNEX B DESIGN BASED ANALYSIS – MONTHLY APPORTIONED POPULATION ESTIMATES (BERWICK BANK DEVELOPMENT ARRAY PLUS 2KM BUFFER)

Table B.1: **Monthly density and population estimates of kittiwakes in the Berwick Bank Development array plus 2km buffer, calculated using design-based analysis. Data include "no-identification" birds apportioned to species.**

Kittiwake	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	13.12	6.68	20.85	17174	8743	27281	4774	27.8%
May-19	3.97	2.93	5.11	5191	3829	6684	723	13.92%
Jun-19	2.22	1.78	2.77	2903	2325	3626	338	11.63%
Jul-19	4.8	4.09	5.44	6288	5352	7114	463	7.36%
Aug-19	8.55	7	10.16	11185	9168	13295	1082	9.67%
Sep-19	2.29	1.59	3.08	2997	2084	4029	496	16.53%
Oct-19	0.78	0.43	1.28	1016	557	1672	301	29.56%
Nov-19	0.32	0.22	0.42	419	288	554	68	16.19%
Dec-19	0.28	0.16	0.44	371	209	578	100	26.72%
Jan-20	1.95	1.11	2.96	2547	1453	3879	660	25.88%
Feb-20	1.99	1.02	3.15	2608	1335	4127	708	27.12%
Mar-20	7.52	4.94	10.86	9838	6472	14209	1969	20.01%
May S01 20	5.73	2.96	9.02	7498	3874	11808	2087	27.83%
May S02 20	7.95	5.74	10.06	10405	7519	13162	1437	13.81%
Jun-20	7.83	6.6	9.25	10248	8634	12108	900	8.78%
Jul-20	8.63	6.83	10.68	11292	8942	13975	1307	11.57%
Aug-20	13.24	9.86	16.91	17333	12899	22127	2392	13.8%
Sep-20	14.81	9.92	20.62	19383	12984	26980	3580	18.47%
Oct-20	1.53	0.96	2.21	2009	1256	2891	404	20.07%
Nov-20	5.15	3.11	7.21	6744	4064	9437	1335	19.79%
Dec-20	1.02	0.64	1.46	1331	839	1917	270	20.24%
Jan-21	2.63	1.8	3.52	3442	2362	4608	564	16.38%
Feb-21	2.3	0.56	4.93	3010	732	6448	1527	50.74%
Apr S01 21	7.91	5.85	10.24	10358	7653	13406	1457	14.06%
Apr S02 21	19.06	9.21	30.19	24949	12055	39510	7162	28.71%

Table B.2: **Monthly absolute density and population estimates of guillemots in the Berwick Bank Development array plus 2km buffer, calculated using design-based analysis and adjusted for availability bias. Data include "no-identification" birds apportioned to species.**

Guillemot	Adjusted Density Estimate (birds/ km²)	Adjusted Lower 95% CI (birds/ km²)	Adjusted Upper 95% CI (birds/ km²)	Adjusted Population Estimate (number)	Adjusted Lower 95% CI (number)	Adjusted Upper 95% CI (number)	Adjusted SD	Adjusted CV (%)
Survey								
Mar-19	11.07	7.8	15.03	14497	10220	19670	2491	17.18%
May-19	30.02	23.25	38.63	39287	30434	50550	5287	13.46%
Jun-19	6.4	4.17	9.01	8374	5451	11802	1715	20.48%
Jul-19	30.64	25.66	35.91	40107	33585	46999	3846	9.59%
Aug-19	48	26.66	75.96	62815	34898	99414	17552	27.94%
Sep-19	5.23	4.23	6.19	6842	5525	8105	637	9.31%
Oct-19	2.36	1.33	3.6	3091	1744	4718	784	25.36%
Nov-19	0.94	0.68	1.26	1247	893	1641	178	14.27%
Dec-19	1.9	1.28	2.57	2489	1679	3361	460	18.48%
Jan-20	15.02	10.37	21.08	19662	13578	27578	4117	20.94%
Feb-20	10.21	7.02	13.61	13365	9192	17822	2462	18.42%
Mar-20	33.74	24.28	44.27	44146	31775	57936	6553	14.84%
May S01 20	25.17	16.61	33.56	32945	21735	43918	6020	18.27%
May S02 20	20.87	14.73	27.3	27296	19289	35742	4485	16.43%
Jun-20	40.87	32.36	49.04	53499	42359	64177	5732	10.71%
Jul-20	11.88	9.47	14.78	15547	12390	19329	1926	12.39%
Aug-20	32.19	28.15	36.55	42128	36841	47824	3025	7.18%
Sep-20	33.77	24.81	43.33	44194	32462	56716	6583	14.9%
Oct-20	3.75	2.99	4.59	4902	3921	6021	565	11.53%
Nov-20	3.34	2.18	4.74	4386	2846	6204	843	19.22%
Dec-20	14.26	10.22	19.55	18659	13374	25584	3473	18.61%
Jan-21	11.66	9.73	13.75	15250	12734	17990	1363	8.94%
Feb-21	6.19	3.96	8.69	8116	5177	11367	1578	19.44%
Apr S01 21	28.26	22.71	34.87	36970	29727	45635	4486	12.13%
Apr S02 21	72.45	49.61	97.54	94806	64933	127644	17830	18.81%

Table B.3: **Monthly absolute density and population estimates of razorbills in the Berwick Bank Development array plus 2km buffer, calculated using design-based analysis and adjusted for availability bias. Data include "no-identification" birds apportioned to species.**

Razorbill	Adjusted Density Estimate (birds/ km²)	Adjusted Lower 95% CI (birds/ km²)	Adjusted Upper 95% CI (birds/ km²)	Adjusted Population Estimate (number)	Adjusted Lower 95% CI (number)	Adjusted Upper 95% CI (number)	Adjusted SD	Adjusted CV (%)
Survey								
Mar-19	1.52	0.88	2.36	1985	1149	3078	530	26.7%
May-19	1.38	1.01	1.83	1812	1333	2399	313	17.27%
Jun-19	0.21	0.06	0.44	269	83	564	139	51.67%
Jul-19	2.49	1.53	3.59	3258	2006	4705	818	25.11%
Aug-19	1.99	1.37	2.7	2594	1787	3529	506	19.51%
Sep-19	1.61	1.16	2.08	2111	1527	2728	355	16.82%
Oct-19	1.12	0.56	1.82	1469	738	2387	409	27.84%
Nov-19	0.11	0.06	0.19	141	74	237	36	25.53%
Dec-19	0.48	0.26	0.77	632	336	1014	193	30.54%
Jan-20	1.85	1.13	2.71	2419	1470	3545	588	24.31%
Feb-20	1.34	0.9	1.83	1760	1179	2398	331	18.81%
Mar-20	6.98	4.9	8.91	9130	6427	11657	1480	16.21%
May S01 20	0.95	0.6	1.27	1249	782	1667	269	21.54%
May S02 20	0.68	0.4	1.07	894	524	1399	243	27.18%
Jun-20	0.94	0.66	1.25	1230	858	1637	221	17.97%
Jul-20	1.86	1.12	2.72	2420	1467	3559	641	26.49%
Aug-20	3.68	2.68	4.94	4820	3500	6459	861	17.86%

Razorbill	Adjusted Density Estimate (birds/ km²)	Adjusted Lower 95% CI (birds/ km²)	Adjusted Upper 95% CI (birds/ km²)	Adjusted Population Estimate (number)	Adjusted Lower 95% CI (number)	Adjusted Upper 95% CI (number)	Adjusted SD	Adjusted CV (%)
Survey								
Sep-20	11.9	7.76	16.35	15587	10159	21408	3282	21.06%
Oct-20	1.13	0.59	1.76	1479	768	2305	350	23.66%
Nov-20	0.3	0.17	0.45	401	232	589	92	22.94%
Dec-20	1.66	1.04	2.29	2165	1366	3007	503	23.23%
Jan-21	4.45	3.46	5.82	5830	4529	7614	914	15.68%
Feb-21	1.42	0.84	2.05	1868	1101	2692	429	22.97%
Apr S01 21	3.83	2.43	5.44	5007	3172	7131	1001	19.99%
Apr S02 21	1.79	1.42	2.17	2335	1851	2845	262	11.22%

Table B.4: **Monthly absolute density and population estimates of puffins in the Berwick Bank Development array plus 2km buffer, calculated using design-based analysis and adjusted for availability bias. Data include "no-identification" birds apportioned to species.**

Puffin	Adjusted Density Estimate (birds/ km²)	Adjusted Lower 95% CI (birds/ km²)	Adjusted Upper 95% CI (birds/ km²)	Adjusted Population Estimate (number)	Adjusted Lower 95% CI (number)	Adjusted Upper 95% CI (number)	Adjusted SD	Adjusted CV (%)
Survey								
Mar-19	1.34	0.95	1.84	1756	1247	2398	302	17.2%
May-19	2.24	1.77	2.69	2932	2321	3517	349	11.9%
Jun-19	0.32	0.16	0.53	434	219	692	136	31.34%
Jul-19	3.25	2.33	4.01	4246	3056	5250	655	15.43%
Aug-19	4.41	3.23	5.65	5770	4231	7386	922	15.98%
Sep-19	1.12	0.62	1.77	1463	805	2334	468	31.99%
Oct-19	0.3	0.19	0.43	393	246	567	91	23.16%
Nov-19	0.02	0.01	0.03	27	8	52	14	51.85%
Dec-19	0	0	0	0	0	0	0	0
Jan-20	0.06	0.02	0.09	70	35	116	28	40%
Feb-20	0.19	0.09	0.31	243	121	412	96	39.51%
Mar-20	0.68	0.32	1.09	900	407	1427	295	32.78%
May S01 20	1.85	1.1	2.57	2420	1428	3369	568	23.47%
May S02 20	0.65	0.47	0.84	842	617	1089	143	16.98%
Jun-20	0.81	0.52	1.09	1054	694	1435	227	21.54%
Jul-20	1.11	0.55	1.92	1445	723	2518	509	35.22%
Aug-20	2.1	1.55	2.68	2745	2025	3501	466	16.98%
Sep-20	12.48	10.47	14.74	16321	13707	19286	1749	10.72%
Oct-20	0.15	0.1	0.2	198	141	261	38	19.19%
Nov-20	0.14	0.09	0.19	176	116	238	41	23.3%
Dec-20	0.02	0.01	0.05	35	20	56	12	34.29%
Jan-21	0.02	0.01	0.05	31	19	57	13	41.94%
Feb-21	0.38	0.26	0.51	500	330	669	112	22.4%
Apr S01 21	1.04	0.7	1.48	1374	911	1935	289	21.03%
Apr S02 21	4.8	3.6	6.05	6280	4708	7927	1040	16.56%

Table B.5: **Monthly density and population estimates of gannets in the Berwick Bank Development array plus 2km buffer, calculated using design-based analysis. Data include "no-identification" birds apportioned to species.**

Gannet	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.24	0.1	0.42	321	137	553	109	33.8%
May-19	0.75	0.48	1.07	980	631	1396	196	19.94%
Jun-19	1.4	1.06	1.8	1837	1388	2352	243	13.22%
Jul-19	3.55	3.06	4.05	4649	4001	5296	336	7.22%
Aug-19	3.84	3.06	4.8	5020	4011	6281	567	11.29%
Sep-19	2.58	2.11	3.03	3376	2758	3968	307	9.09%
Oct-19	0.83	0.67	1.02	1081	876	1329	123	11.34%
Nov-19	0.15	0.09	0.2	192	113	263	40	20.62%
Dec-19	0	0	0	0	0	0	0	0
Jan-20	0.01	0	0.02	8	0	25	8	99.09%
Feb-20	0.01	0	0.03	16	0	40	11	69.29%
Mar-20	0.23	0.12	0.38	304	154	492	89	29.04%
May S01 20	0.52	0.27	0.76	676	358	995	170	25.09%
May S02 20	1.14	0.72	1.69	1495	946	2218	329	21.97%
Jun-20	0.99	0.68	1.37	1302	885	1794	235	17.99%
Jul-20	3.4	2.87	3.96	4449	3751	5185	359	8.05%
Aug-20	2.52	1.97	3.06	3293	2583	4002	373	11.32%
Sep-20	1.45	1.13	1.77	1895	1486	2322	220	11.6%
Oct-20	0.79	0.59	0.99	1035	772	1296	137	13.21%
Nov-20	1.47	1.03	2.02	1919	1343	2644	325	16.9%
Dec-20	0.16	0.03	0.38	216	40	500	129	59.31%
Jan-21	0.09	0.04	0.13	114	54	177	31	26.84%
Feb-21	0.11	0.02	0.23	141	23	301	72	50.67%
Apr S01 21	0.56	0.42	0.72	738	555	937	95	12.83%
Apr S02 21	1.33	0.53	2.52	1745	700	3296	721	41.3%

ANNEX C AUK DISPLACEMENT MORTALITY FOR THE BERWICK BANK DEVELOPMENT ARRAY PLUS 2KM BUFFER: SPATIAL APPROACH

1. For context, the Applicant has used the Matrix method, to explore outputs based on different displacement rates applied spatially ("Spatial Approach") across the Array area and buffer. The approach has been applied to auks, and area-specific displacement rates applied within the 2km buffer and the Development Array (see 'Spatial Approach" in Table 3.4).

2. Matrices for the '2km buffer only' were formulated by subtracting the matrices for the Development Array from the matrices for the Development Array plus 2km buffer (displayed in sections 0 to 0) and are presented below in Table C.1 to Table C.6.

3. The outputs highlighted in colour are those deemed the 'most realistic' mortality estimates, based on the displacement and mortality rates as advised by the: i) Scoping Opinion (highlighted in dark teal; rates outlined in Table 3.4) and ii) the "Spatial Approach" (highlighted in orange). For the Spatial Approach, the Developer uses a displacement rate of 30% and mortality rate of 1% for all auk species in all seasons within the 2km buffer. Cells highlighted in light teal outline the potential associated uncertainty around these figures.

4. The figures highlighted in orange from the Development Array matrices based on a displacement rate of 50% and mortality rate of 1% for all auk species in all season) and the 2km buffer only matrices were then summed to get the final mortality values across the Development Array plus 2km buffer with regards to the Spatial Approach. These are displayed in Table C.7 along with the outputs from the Developer Approach for comparison.

Table C.1: **Potential guillemot mortality in the 2km buffer only, following displacement from the Berwick Bank Development Array in the breeding season. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; orange representing rates defined by the Spatial Approach; and light teal representing uncertainty around these figures.**

Guillemot (Breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	15	29	43	58	72	145	217	290	434	723	1157	1447
20%	0	29	58	86	116	145	290	434	579	868	1447	2314	2893
30%	0	43	86	130	173	217	434	650	868	1301	2170	3471	4339
40%	0	58	116	173	231	290	579	868	1157	1736	2893	4629	5786
50%	0	72	145	217	290	361	723	1085	1447	2170	3616	5786	7232
60%	0	86	173	260	347	434	868	1301	1736	2603	4339	6942	8678
70%	0	102	203	304	405	506	1012	1519	2025	3038	5062	8100	10124
80%	0	116	231	347	462	579	1157	1736	2314	3471	5786	9257	11572
90%	0	130	260	391	521	650	1301	1952	2603	3905	6509	10414	13018
100%	0	145	290	434	579	723	1447	2170	2893	4340	7232	11572	14464

Table C.2: **Potential guillemot mortality in the 2km buffer only, following displacement from the Berwick Bank Development Array in the non-breeding season. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; orange representing rates defined by the Spatial Approach; and light teal representing uncertainty around these figures.**

Guillemot (Non-breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	10	20	30	40	50	101	152	203	304	507	810	1014
20%	0	20	40	61	81	101	203	304	405	608	1014	1621	2027
30%	0	30	61	91	122	152	304	456	608	912	1520	2432	3040
40%	0	40	81	122	162	203	405	608	810	1216	2027	3242	4053
50%	0	50	101	152	203	254	507	760	1014	1520	2533	4053	5067
60%	0	61	122	183	244	304	608	912	1216	1824	3040	4864	6080
70%	0	71	142	213	283	354	709	1064	1418	2128	3546	5674	7093
80%	0	81	162	244	324	405	810	1216	1621	2432	4053	6485	8106
90%	0	91	183	273	365	456	912	1368	1824	2736	4559	7296	9119
100%	0	101	203	304	405	507	1014	1520	2027	3040	5067	8106	10133

Table C.3: **Potential razorbill mortality in the 2km buffer only, following displacement from the Berwick Bank Development Array in the breeding season. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; orange representing rates defined by the Spatial Approach; and light teal representing uncertainty around these figures.**

Razorbill (Breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	1	2	3	4	5	10	15	20	30	49	80	99
20%	0	2	4	6	8	10	20	30	40	60	99	160	199
30%	0	3	6	9	12	15	30	45	60	90	150	239	300
40%	0	4	8	12	16	20	40	60	80	119	199	319	399
50%	0	5	10	15	20	24	49	74	99	149	249	399	499
60%	0	6	12	18	23	30	60	90	119	180	300	479	599
70%	0	7	14	21	28	35	70	105	140	210	350	559	699
80%	0	8	16	23	32	40	80	119	160	239	399	639	798
90%	0	9	18	27	36	45	90	135	180	269	449	718	898
100%	0	10	20	30	40	49	99	149	199	299	499	798	998

Table C.4: **Potential razorbill mortality in the 2km buffer only, following displacement from the Berwick Bank Development Array in the non-breeding season. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; orange representing rates defined by the Spatial Approach; and light teal representing uncertainty around these figures.**

Razorbill (Non-breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	4	7	11	15	18	36	55	73	109	181	291	363
20%	0	7	15	22	29	36	73	109	146	218	363	582	727
30%	0	11	22	33	44	55	109	164	218	328	545	873	1091
40%	0	15	29	44	58	73	146	218	291	437	727	1163	1455
50%	0	18	36	55	73	90	181	272	363	545	909	1455	1819
60%	0	22	44	66	87	109	218	328	437	655	1091	1746	2182
70%	0	25	51	76	102	127	255	382	509	764	1273	2037	2546
80%	0	29	58	87	116	146	291	437	582	873	1455	2327	2910
90%	0	33	66	98	131	164	328	491	655	982	1637	2619	3274
100%	0	36	73	109	146	181	363	545	727	1091	1819	2910	3637

Table C.5: **Potential puffin mortality in the 2km buffer only, following displacement from the Berwick Bank Development Array in the breeding season. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; orange representing rates defined by the Spatial Approach; and light teal representing uncertainty around these figures.**

Puffin (Breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	1	3	3	5	6	12	17	23	34	56	90	113
20%	0	3	5	7	9	12	23	34	45	67	113	180	225
30%	0	3	7	10	14	17	34	51	67	101	168	270	336
40%	0	5	9	14	18	23	45	67	90	135	225	360	450
50%	0	6	12	17	23	28	56	84	113	168	281	450	562
60%	0	7	14	20	27	34	67	101	135	202	336	539	673
70%	0	8	16	23	32	39	78	118	157	236	393	629	787
80%	0	9	18	27	36	45	90	135	180	270	450	719	899
90%	0	10	20	30	40	51	101	152	202	303	505	809	1011
100%	0	12	23	34	45	56	113	168	225	337	562	899	1123

Table C.6: **Potential puffin mortality in the 2km buffer only, following displacement from the Berwick Bank Development Array in the non-breeding season. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; orange representing rates defined by the Spatial Approach; and light teal representing uncertainty around these figures.**

Puffin (Non-breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	2	3	5	6	7	14	21	28	43	71	114	142
20%	0	3	6	9	12	14	28	43	57	86	142	228	285
30%	0	5	9	13	17	21	43	64	86	128	214	342	428
40%	0	6	12	17	23	28	57	86	114	171	285	456	570
50%	0	7	14	21	28	35	71	106	142	213	356	570	712
60%	0	9	17	25	34	43	86	128	171	257	428	684	855
70%	0	10	20	30	40	50	99	150	199	299	499	798	998
80%	0	12	23	34	46	57	114	171	228	342	570	912	1140
90%	0	13	25	39	51	64	128	192	257	384	641	1026	1282
100%	0	14	28	43	57	71	142	213	285	427	712	1140	1425

Table C.7: **Potential auk mortality per bio-season following displacement and barrier effects from the Berwick Bank Development array plus 2km buffer, for the Spatial Approach and Spatial Approach mortality and displacement rates listed under the Spatial Approach in Table 3.5.**

Species	Developer Approach		Spatial Approach	
	Breeding season	Non-breeding season	Breeding season	Non-breeding season
Developer Approach				
Guillemot	371	221	342	201
Razorbill	21	62	19	55
Puffin	34	N/A	20	N/A

ANNEX D APPLICATION OF SEABORD

Full Annex provided in separate document.

ANNEX E ANALYSIS OF GANNET GPS TRACKING DATA FROM THE BASS ROCK COLONY

Full Annex provided in separate document.

ANNEX F NATURESCOT (2020) NON-BREEDING SEASON MATRICES FOR KITTIWAKE, RAZORBILL AND GANNET

1. As described in section 3.3, use of NatureScot non-breeding season definitions presents issues for non-breeding season apportioning (Technical Appendix 11.5: Ornithology Apportioning Technical Report) for those species where the autumn and spring passage and winter periods are defined within the non-breeding season (gannet, kittiwake and razorbill). This is only true for assessment of the Berwick Bank Development Array plus a 2 km buffer; the mortality figures of which are used within the apportioning analysis.

2. The non-breeding season displacement for kittiwake, razorbill and gannet, as defined by NatureScot (2020), are presented here for reference only. These outputs are not used within the Technical Appendix 11.5: Ornithology Apportioning Technical Report.

Table F.1: **Potential kittiwake mortality following displacement from the Berwick Bank Development array plus 2 km buffer in the non-breeding season. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion and light teal representing uncertainty around these figures. A quantitative assessment is not being made for kittiwake in the non-breeding season under the Developer Approach (see Annex G for justification).**

Kittiwake (Non-breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	19	37	55	74	92	183	275	366	549	914	1463	1828
20%	0	37	74	110	147	183	366	549	732	1097	1828	2925	3656
30%	0	55	110	165	220	275	549	823	1097	1646	2742	4387	5484
40%	0	74	147	220	293	366	732	1097	1463	2194	3656	5850	7312
50%	0	92	183	275	366	457	914	1371	1828	2742	4570	7312	9140
60%	0	110	220	330	439	549	1097	1646	2194	3291	5484	8774	10968
70%	0	128	256	384	512	640	1280	1920	2560	3839	6398	10237	12796
80%	0	147	293	439	585	732	1463	2194	2925	4387	7312	11699	14624
90%	0	165	330	494	659	823	1646	2468	3291	4936	8226	13161	16452
100%	0	183	366	549	732	914	1828	2742	3656	5484	9140	14624	18279

Table F.2: **Potential razorbill mortality following displacement from the Berwick Bank Development array plus 2 km buffer in the non-breeding season. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; orange representing rates defined by the Developer Approach; and light teal representing uncertainty around these figures.**

Razorbill (Non-breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	13	25	38	50	62	124	186	248	371	618	989	1236
20%	0	25	50	75	99	124	248	371	495	742	1236	1978	2472
30%	0	38	75	112	149	186	371	557	742	1113	1854	2967	3708
40%	0	50	99	149	198	248	495	742	989	1484	2472	3955	4944
50%	0	62	124	186	248	309	618	927	1236	1854	3090	4944	6180
60%	0	75	149	223	297	371	742	1113	1484	2225	3708	5933	7416
70%	0	87	174	260	347	433	866	1298	1731	2596	4326	6922	8652
80%	0	99	198	297	396	495	989	1484	1978	2967	4944	7910	9888
90%	0	112	223	334	445	557	1113	1669	2225	3337	5562	8899	11124
100%	0	124	248	371	495	618	1236	1854	2472	3708	6180	9888	12359

Table F.3: **Potential gannet mortality following displacement from the Berwick Bank Development array plus 2 km buffer in the non-breeding season. Estimates considered, in light of empirical evidence, to represent the most realistic scenarios are colour coded, with dark teal representing rates advised by the Scoping Opinion; dark teal and orange coloured hatching representing overlapping estimates from both the Scoping Opinion and Developer Approach.; and light teal representing uncertainty around these figures.**

Gannet (Non-breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	2	3	5	6	8	15	23	30	45	75	120	150
20%	0	3	6	9	12	15	30	45	60	90	150	240	300
30%	0	5	10	14	19	23	46	68	91	136	226	361	451
40%	0	6	12	18	24	30	60	90	120	180	300	480	600
50%	0	8	15	23	30	38	75	113	150	225	375	600	750
60%	0	10	19	28	37	46	91	136	181	271	451	721	901
70%	0	11	22	32	43	53	106	158	211	316	525	841	1050
80%	0	12	24	36	48	60	120	180	240	360	600	960	1200
90%	0	14	27	41	54	68	135	203	270	405	675	1080	1350
100%	0	15	30	45	60	75	150	225	300	450	750	1200	1500

ANNEX G JUSTIFICATION OF DEVELOPER AND SCOPING APPROACH

Full Annex provided in separate document.

ANNEX H SEABORD SENSITIVITY ANALYSIS REPORT

Full Annex provided in separate document.

sse Renewables

Berwick Bank Wind Farm

HiDef
AERIAL SURVEYING LIMITED