Morven North Offshore Wind Array Project

Environmental Impact Assessment Report

Volume 3, Annex 11.4: Offshore Ornithology Displacement Modelling Report (Matrix Approach)

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1 Introduction

1.1 Background

1.1.1.1 Seabirds can be impacted by offshore wind farm developments in a number of ways, including collision, displacement, barrier effects and disturbance, as well as indirect impacts such as changes to prey availability. Disturbance as the result of activities during the construction, operations and maintenance and decommissioning phases of an offshore wind farm has the potential to displace seabirds from an area of sea in which the activity is occurring. In relation to offshore wind farm development, displacement is defined as a reduction in the number of seabirds occurring within or immediately adjacent to an offshore wind farm (Furness *et al*., 2013).

1.1.1.2 Species differ greatly in their susceptibility to disturbance. Species sensitivity to disturbance in response to offshore wind farms has been quantified by Garthe and Hüppop (2004), Furness *et al*. (2013), Bradbury *et al*. (2014) and Wade *et al*. (2016). During the operations and maintenance phase, the presence of operational wind turbines has the potential to directly disturb seabirds leading to displacement from the Morven North Offshore Wind Array Project (hereafter 'Morven North') Boundary, including a buffer around it.

1.1.1.3 As the result of disturbance, displaced birds may move to areas already occupied by other birds and thus face higher intra/inter-specific competition due to a higher density of individuals competing for the same resource. Alternatively, displaced birds may be forced to move into areas of lower quality (e.g. areas of lower prey availability). Such disturbance and resulting displacement could ultimately affect their demographic fitness (i.e. survival rates and breeding productivity) as well as potentially impacting on other birds in areas that displaced birds move to. Changes in mortality levels of displaced birds have been established for waders (e.g. Burton *et al*., 2006).

1.1.1.4 There is however a lack of empirical evidence on the consequence of displacement of seabirds, in terms of both their survival and productivity. In waterbirds such as waders, geese and seaducks, simulations using Individual-Based Models (IBMs) have demonstrated changes to mortality as the result of changes in energy budgets of individuals (Pettifor *et al*., 2000; West *et al*., 2003; Kaiser *et al*., 2002). IBMs are rarely used to predict the fate of displaced seabirds due to offshore wind farms and impacts on fitness (Topping and Petersen, 2011).

1.1.1.5 Statutory Nature Conservation Bodies (SNCBs) have produced joint guidance to assess seabird displacement associated with offshore wind farms (Joint Nature Conservation Committee (JNCC) *et al*., 2022) with NatureScot also having produced guidance specific to assessments in Scottish waters (NatureScot, 2023a). The guidelines promote the use of a displacement matrix approach (i.e. representing proportions of seabirds potentially displaced or mortalities as a result of an offshore wind farm development). Both JNCC *et al*. (2022) and NatureScot (2023a) detail that any effects from disturbance and displacement are expected to be spatially limited to the offshore wind farm footprint and within close proximity (birds are impacted by displacement up to 2 kilometres (km) from the wind farm footprint for most species, with displacement up to 4km considered for divers and seaducks (and in some cases up to 10km) due to being the most sensitive species groups to disturbance from sound, boat and helicopter traffic).

1.1.1.6 The displacement assessment for Morven North makes use of the displacement matrix approach alongside the SeabORD application (Searle *et al*., 2018) as recommended by NatureScot in pre-application consultation (see Volume 1, Chapter 5: Consultation, of the Environmental Impact Assessment (EIA) Report). The methodology and outputs from SeabORD modelling are provided in Volume 3, Annex 11.5: Offshore Ornithology Displacement Modelling Report (SeabORD).

1.2 Aim of the report

1.2.1.1 This report presents the method and results of the matrix table approach to seabird displacement assessment resulting from Morven North during the construction, operations and maintenance, and

decommissioning phases. The analyses incorporate those species identified as Valued Ornithological Receptors (VORs) in Volume 3, Annex 11.1: Offshore Ornithology Baseline Characterisation Report that are vulnerable to displacement effects.

2 Methodology

2.1 Species for consideration

2.1.1.1 The full process applied to identify VORs that may be affected by impacts associated with Morven North is documented in Volume 3, Annex 11.1: Offshore Ornithology Baseline Characterisation Report. VORs that are potentially affected by displacement are those:

- Known to be vulnerable to displacement impacts (based on Wade *et al*., 2016; Bradbury *et al*., 2014) (Table 2.1) (i.e. a score of moderate or higher) with the uncertainty level associated with the vulnerability scores also taken into account;
- Where the population of the species observed at the Morven North Offshore Ornithology Study Area (as defined in Volume 3, Annex 11.1: Offshore Ornithology Baseline Characterisation Report) is considered to be of importance, when compared against a relevant population scale thresholds (regional, national or international) as described in Volume 3, Annex 11.1: Offshore Ornithology Baseline Characterisation Report.
- Where an SNCB recommends the consideration of a species in the assessment of displacement from offshore wind farms

2.1.1.2 Table 2.1 identifies those VORs for which displacement analysis is required based on the above criteria.

Table 2.1: Identification of VORs for which analysis of displacement for Morven North is required

VOR	Vulnerability to displacement impacts	Uncertainty level associated with vulnerability rating	Importance of population at Morven North	Displacement analysis required (Yes/No)
Kittiwake (*Rissa tridactyla*)	Low	Very Low	Local	Yes – low vulnerability, very low associated uncertainty, species recorded in locally important numbers at Morven North. However, NatureScot recommend the inclusion of this species in displacement assessments.
Little gull (*Hydrocoloeus minutus*)	Very Low	N/A	Negligible	No – very low vulnerability, species not recorded in baseline surveys
Great black-backed gull (*Larus marinus*)	Low	Very Low	Local	No – low vulnerability, very low associated uncertainty, species recorded in locally important numbers at Morven North
Herring gull (*Larus argentatus*)	Low	Very Low	Local	No – low vulnerability, very low associated uncertainty, species recorded in locally important numbers at Morven North
Sandwich tern (*Thalasseus sandvicensis*)	Low	Low	Local	No – low vulnerability and species not recorded during baseline surveys
Little tern (*Sternula albifrons*)	Low	Moderate	Negligible	No – low vulnerability and species not recorded during baseline surveys
Roseate tern (*Sterna dougallii*)	Low	High	Negligible	No – low vulnerability and species not recorded during baseline surveys
Common tern (*Sterna hirundo*)	Low	Low	Negligible	No – low vulnerability, and species not recorded in relevant study area during baseline surveys
Arctic tern (*Sterna paradisaea*)	Low	Moderate	National	No – low vulnerability and although species recorded in nationally important numbers occurrence is considered to represent passage birds as there are no breeding colonies within foraging range

VOR	Vulnerability to displacement impacts	Uncertainty level associated with vulnerability rating	Importance of population at Morven North	Displacement analysis required (Yes/No)
Great skua (*Stercorarius skua*)	Very Low	High	Local	No – low vulnerability and species occurrence at Morven North limited
Arctic skua (*Stercorarius parasiticus*)	Very Low	Very High	Negligible	No – low vulnerability, and species not recorded in relevant study area during baseline surveys
Common guillemot (*Uria aalge*)	High	Very Low	National	Yes – high vulnerability, species recorded in nationally important numbers at Morven North. NatureScot also recommend the inclusion of this species in displacement assessments.
Razorbill (*Alca torda*)	High	Very Low	National	Yes – high vulnerability, species recorded in nationally important numbers at Morven North. NatureScot also recommend the inclusion of this species in displacement assessments.
Puffin (*Fratercula arctica*)	Moderate	Moderate	Regional	Yes – moderate vulnerability, species recorded in regionally important numbers at Morven North. NatureScot also recommend the inclusion of this species in displacement assessments.
European storm petrel (*Hydrobates pelagicus*)	Very Low	Very High	Regional	No – very low vulnerability, species recorded in only one baseline survey
Leach's petrel (*Oceanodroma leucorhoa*)	Very Low	Very High	Negligible	No – very low vulnerability and species not recorded during baseline surveys
Fulmar (*Fulmarus glacialis*)	Very Low	High	Local	No – very low vulnerability although note uncertainty is high. Species also has a high habitat flexibility. Species only recorded in locally important numbers at Morven North. However, NatureScot have recommended the inclusion of this species in displacement assessments (11 July 2025).

VOR	Vulnerability to displacement impacts	Uncertainty level associated with vulnerability rating	Importance of population at Morven North	Displacement analysis required (Yes/No)
Manx shearwater (*Puffinus puffinus*)	Very Low	Very High	Local	No – vulnerability is very low, although the associated uncertainty is very high. The species was only recorded in four baseline surveys
Gannet (*Morus bassanus*)	High	Very Low	Local	Yes – high vulnerability, recorded in majority of baseline surveys. NatureScot also recommend the inclusion of this species in displacement assessments.

2.1.1.3 The following species were selected for displacement analysis:

- Kittiwake (included on the advice of NatureScot);
- Guillemot (high vulnerability, national population importance);
- Razorbill (high vulnerability, national population importance);
- Puffin (moderate vulnerability, regional population importance);
- Fulmar (included on the advice of NatureScot);
- Gannet (high vulnerability and although only of local population importance, species recorded in the majority of surveys).

2.2 Abundance estimates and seasonality

2.2.1.1 Digital aerial surveys of the Morven North and Morven South Offshore Wind Array Project (hereafter 'Morven South') were undertaken between January 2021 and September 2023. Further information on the aerial surveys undertaken for Morven North and the methodologies used to derive population estimates is provided in the Volume 3, Annex 11.1: Offshore Ornithology Baseline Characterisation Report. During pre-application consultation with NatureScot (see Volume 1, Chapter 5: Consultation, of the Morven North EIA Report) it was advised that due to the planned application date for Morven North (Quarter 2, 2026), only data from October 2021 to September 2023 (representing the standard 24 months of baseline data) should be used for baseline characterisation to avoid data being older than the five year data cut-off at the point of application (NatureScot, 2023b). Whilst this temporal extent corresponds with the seasonal extents for gannet it foreshortens the non-breeding seasons defined for other species. Morven Offshore Wind Limited (MvOWL, hereafter referred to as "the Applicant") has therefore agreed with NatureScot through additional targeted consultation (April 2025) and consultation meetings (28 May 2025) that data prior to October 2021 can be used to allow for the consideration of two complete seasonal extents for each species (see Volume 1, Chapter 5: Consultation). This therefore leads to a dataset with a temporal extent of July 2021 to September 2023 providing two full seasonal extents for each species identified in Section 2.1.

2.2.1.2 Seasons have been defined based on NatureScot advice (breeding season) (NatureScot, 2020) with non-breeding seasons split, where necessary, based on the seasonal extents defined in Furness (2015) with priority given to the breeding season where overlaps exist (Table 2.2). Where the seasonal extents presented in NatureScot (2020) begin or end within a month, the middle of the month was used as the cut off for inclusion in either the breeding or relevant non-breeding season. Months were assigned to a season based on the day that the site-specific survey from which abundance estimates were calculated was flown. Timings of each survey can be found in Volume 3, Annex 11.1: Offshore Ornithology Baseline Characterisation Report.

2.2.1.3 In the case of guillemot and razorbill, further advice has been sought from NatureScot regarding seasonality, and the inclusion of alternative seasons for use in displacement analyses for these species (see Volume 1, Chapter 5: Consultation). This advice, and full descriptions and justifications of changes to the seasonal extents used for these two species can be found in Appendix B. It was agreed that peak abundances of both guillemot and razorbill in the Morven North Boundary occurring late in the breeding season likely represents post-breeding dispersal of birds from breeding colonies. This aligns with the phenology provided in Furness (2015), which describes modal dispersal from breeding colonies as taking place in July and colonies being deserted by August. It also aligns with fledging data from the Isle of May from 2021 to 2023, where chicks fledge between late June and early August (see Volume 3, Annex 11.1: Offshore Ornithology Baseline Characterisation Report).

2.2.1.4 In the case of guillemot, NatureScot advised during a consultation meeting undertaken on 28 May 2025 that July and August should be included in a post-breeding season, where the abundance estimates were higher than those recorded in surrounding months. In the case of Morven North, a post-breeding season comprising July and August 2022 and July 2023 has been defined. Justification for the inclusion of these months in the post-breeding season is provided in Appendix B.

2.2.1.5 In the case of razorbill, NatureScot has advised that the post-breeding season should be extended to include the months in which peak abundance was recorded during the digital aerial surveys; in this case, this means including July and August in the post-breeding season rather than the breeding season.

Table 2.2: Seasonal definitions as the basis for assessment, from NatureScot (2020) and Furness (2015) and after additional advice from NatureScot taking into account the date each baseline survey was flown

Species	Pre-breeding season/spring migration	Breeding season	Post breeding season/autumn migration	Non-breeding/winter season
Kittiwake	January to April 2022 and 2023	May to August 2022 and 2023	September to December 2021 and 2022	n/a
Gannet	December to March 2021/22 and 2022/23	April to September 2022 and 2023	October to November 2021 and 2022	n/a
Guillemot	n/a	April to June 2022 and 2023	July and August 2022 and July 2023	August 2021 to March 2022 and September 2022 to March 2023
Razorbill	January to March 2022 and 2023	April to June 2022 and 2023	July to October 2021 and 2022	November to December 2021 and 2022
Puffin	n/a	April to August 2022 and 2023	n/a	September to March 2021/22 and 2022/23
Fulmar	December to March 2021/22 and 2022/23	April to September 2022 and 2023	October 2021 and 2022	November 2021 and 2022

2.2.1.6 Population estimates for each species for relevant months have been calculated using data relevant to Morven North plus an appropriate buffer as recommended in JNCC *et al*. (2022) and NatureScot (2023a). For those species identified in Section 2.1, a 2km buffer is considered appropriate to inform assessment of displacement. No species for which a 4km displacement buffer (or 10km buffer in some cases) around the wind farm would typically be applied (i.e. those with a Very High vulnerability to displacement (e.g. common scoter and red-throated diver)) were selected for inclusion in the analyses presented in this Annex due to these species being absent during aerial surveys of Morven North.

2.2.1.7 Model-based estimates using the Marine Renewables Strategic Environmental Assessment (MRSea) package were produced to predict bird numbers across the survey area alongside 95% confidence intervals (CIs) to provide a level of uncertainty. Design based estimates for bird numbers and densities in each month were also generated and compared to the MRSea estimates. This provides additional validation of the MRSea outputs and provides estimates for months where low raw abundances prevented the use of the MRSea model, if required. A full description of the methodology applied for both of these abundance estimation approaches is provided in Volume 3, Annex 11.1: Offshore Ornithology Baseline Characterisation Report.

2.2.1.8 The primary data that informs the basis for the assessment of displacement effects are seasonal mean-peak population estimates including seabirds both on the water and in flight within Morven

North plus a 2km buffer. The monthly data used to calculate these populations are presented in Appendix A. Seasonal mean-peak population estimates of each species were calculated using the defined seasons identified in Table 2.2 to provide the number of seabirds at risk of displacement impacts (Table 2.3). The use of a mean-peak population allows for consideration of inter-annual variability (JNCC *et al.*, 2022).

Table 2.3: Mean peak abundances for use in the assessment for each bio-season from model-based abundance estimation

Species	Pre-breeding season/spring migration	Breeding season	Post breeding season/autumn migration	Non-breeding/winter season
Kittiwake	135	2,480	410	n/a
Gannet	40	796	349	n/a
Guillemot	n/a	4,126	23,080	6,447
Razorbill	96	270	5,591	453
Puffin	n/a	550	n/a	1,215
Fulmar	330	2,879	239	515

2.3 Displacement and mortality rates

2.3.1.1 Displacement matrices are presented in Section 3 for each species and associated seasons. Potential displacement impacts for each species are presented based on a wide range of potential displacement (0 to 100%) and mortality rates (0 to 100%) following SNCB guidance (JNCC *et al.*, 2022). In addition, the displacement and mortality rates identified following the guidance in NatureScot (2023a) and those considered by the Applicant based on the evidence presented in Section 4 are highlighted. The displacement and mortality rates defined based on guidance in NatureScot (2023a) and for fulmar only, subsequent advice provided by NatureScot to the Applicant (11th July 2025), are summarised in Table 2.4.

Table 2.4: Displacement and mortality rates applied for each species

Species	Displacement rate (%)		Mortality rate (%)		
	NatureScot	Applicant	NatureScot		Applicant
			Breeding season	Non-breeding season	All seasons
Kittiwake	30	30	1 and 3	1 and 3	1
Guillemot	60	50	3 and 5	1 and 3	1
Razorbill	60	50	3 and 5	1 and 3	1
Puffin	60	50	3 and 5	1 and 3	1
Gannet	70	70	1 and 3	1 and 3	1
Fulmar	20	10	1 and 3	1 and 3	1

3 Results

3.1.1.1 Displacement matrices for all species and associated seasons are presented in the following species-specific sections. In all matrices cells that are filled with yellow represent the displacement mortality when the displacement and mortality rates recommended by the Applicant are applied. Cells with purple borders represent the displacement mortality when the displacement and mortality rates recommended by NatureScot are applied.

3.2 Kittiwake

3.2.1.1 Displacement matrices for kittiwake in the pre-breeding, breeding and post-breeding seasons are presented in Table 3.1, Table 3.2 and Table 3.3, respectively.

Table 3.1: Predicted kittiwake mortality for Morven North plus 2km buffer during the pre-breeding season

Kittiwake (pre-breeding)		Mortality rate (%)												
		1	**3**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Displacement rate (%)	**10**	0	0	1	1	3	4	5	7	8	9	11	12	13
	20	0	1	1	3	5	8	11	13	16	19	22	24	27
	30	0	1	2	4	8	12	16	20	24	28	32	36	40
	40	1	2	3	5	11	16	22	27	32	38	43	48	54
	50	1	2	3	7	13	20	27	34	40	47	54	61	67
	60	1	2	4	8	16	24	32	40	48	57	65	73	81
	70	1	3	5	9	19	28	38	47	57	66	75	85	94
	80	1	3	5	11	22	32	43	54	65	75	86	97	108
	90	1	4	6	12	24	36	48	61	73	85	97	109	121
	100	1	4	7	13	27	40	54	67	81	94	108	121	135

Table 3.2: Predicted kittiwake mortality for Morven North plus 2km buffer during the breeding season

Kittiwake (breeding)		Mortality rate (%)												
		1	3	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	2	7	12	25	50	74	99	124	149	174	198	223	248
	20	5	15	25	50	99	149	198	248	298	347	397	446	496
	30	7	22	37	74	149	223	298	372	446	521	595	670	744
	40	10	30	50	99	198	298	397	496	595	694	794	893	992
	50	12	37	62	124	248	372	496	620	744	868	992	1,116	1,240
	60	15	45	74	149	298	446	595	744	893	1,042	1,191	1,339	1,488
	70	17	52	87	174	347	521	694	868	1,042	1,215	1,389	1,563	1,736
	80	20	60	99	198	397	595	794	992	1,191	1,389	1,587	1,786	1,984
	90	22	67	112	223	446	670	893	1,116	1,339	1,563	1,786	2,009	2,232
	100	25	74	124	248	496	744	992	1,240	1,488	1,736	1,984	2,232	2,480

Table 3.3: Predicted kittiwake mortality for Morven North plus 2km buffer during the post-breeding season

Kittiwake (post-breeding)		Mortality rate (%)												
		1	3	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	1	2	4	8	12	16	21	25	29	33	37	41
	20	1	2	4	8	16	25	33	41	49	57	66	74	82
	30	1	4	6	12	25	37	49	62	74	86	98	111	123
	40	2	5	8	16	33	49	66	82	98	115	131	148	164
	50	2	6	10	21	41	62	82	103	123	144	164	185	205
	60	2	7	12	25	49	74	98	123	148	172	197	221	246
	70	3	9	14	29	57	86	115	144	172	201	230	258	287
	80	3	10	16	33	66	98	131	164	197	230	262	295	328
	90	4	11	18	37	74	111	148	185	221	258	295	332	369
	100	4	12	21	41	82	123	164	205	246	287	328	369	410

3.3 Gannet

3.3.1.1 Displacement matrices for gannet in the pre-breeding, breeding and post-breeding seasons are presented in Table 3.4, Table 3.5 and Table 3.6, respectively.

Table 3.4: Predicted gannet mortality for Morven North plus 2km buffer during the pre-breeding season

Gannet (pre-breeding)		Mortality rate (%)												
		1	3	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	0	1	1	2	2	2	3	3	4	4
	20	0	0	0	1	2	2	3	4	5	6	6	7	8
	30	0	0	1	1	2	4	5	6	7	8	9	11	12
	40	0	0	1	2	3	5	6	8	9	11	13	14	16
	50	0	1	1	2	4	6	8	10	12	14	16	18	20
	60	0	1	1	2	5	7	9	12	14	17	19	21	24
	70	0	1	1	3	6	8	11	14	17	19	22	25	28
	80	0	1	2	3	6	9	13	16	19	22	25	28	32
	90	0	1	2	4	7	11	14	18	21	25	28	32	36
	100	0	1	2	4	8	12	16	20	24	28	32	36	40

Table 3.5: Predicted gannet mortality for Morven North plus 2km buffer during the breeding season

Gannet (breeding)		Mortality rate (%)												
		1	3	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	1	2	4	8	16	24	32	40	48	56	64	72	80
	20	2	5	8	16	32	48	64	80	96	111	127	143	159
	30	2	7	12	24	48	72	96	119	143	167	191	215	239
	40	3	10	16	32	64	96	127	159	191	223	255	287	319
	50	4	12	20	40	80	119	159	199	239	279	319	358	398
	60	5	14	24	48	96	143	191	239	287	334	382	430	478
	70	6	17	28	56	111	167	223	279	334	390	446	502	557
	80	6	19	32	64	127	191	255	319	382	446	510	573	637
	90	7	22	36	72	143	215	287	358	430	502	573	645	717
	100	8	24	40	80	159	239	319	398	478	557	637	717	796

Table 3.6: Predicted gannet mortality for Morven North plus 2km buffer during the post-breeding season

Gannet (post-breeding)		Mortality rate (%)												
		1	3	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	1	2	3	7	10	14	17	21	24	28	31	35
	20	1	2	3	7	14	21	28	35	42	49	56	63	70
	30	1	3	5	10	21	31	42	52	63	73	84	94	105
	40	1	4	7	14	28	42	56	70	84	98	112	126	139
	50	2	5	9	17	35	52	70	87	105	122	139	157	174
	60	2	6	10	21	42	63	84	105	126	146	167	188	209
	70	2	7	12	24	49	73	98	122	146	171	195	220	244
	80	3	8	14	28	56	84	112	139	167	195	223	251	279
	90	3	9	16	31	63	94	126	157	188	220	251	282	314
	100	3	10	17	35	70	105	139	174	209	244	279	314	349

3.4 Guillemot

3.4.1.1 Displacement matrices for guillemot in the breeding and non-breeding seasons are presented in Table 3.7 and Table 3.9, respectively. Displacement matrices for the additional post-breeding season introduced after advice from NatureScot are presented in Table 3.8.

Table 3.7: Predicted guillemot mortality for Morven North plus 2km buffer during the breeding season

Guillemot (breeding)		Mortality rate (%)												
		1	**3**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Displacement rate (%)	**10**	4	12	21	41	83	124	165	206	248	289	330	371	413
	20	8	25	41	83	165	248	330	413	495	578	660	743	825
	30	12	37	62	124	248	371	495	619	743	866	990	1,114	1,238
	40	17	50	83	165	330	495	660	825	990	1,155	1,320	1,485	1,650
	50	21	62	103	206	413	619	825	1,031	1,238	1,444	1,650	1,856	2,063
	60	25	74	124	248	495	743	990	1,238	1,485	1,733	1,980	2,228	2,475
	70	29	87	144	289	578	866	1,155	1,444	1,733	2,022	2,310	2,599	2,888
	80	33	99	165	330	660	990	1,320	1,650	1,980	2,310	2,640	2,970	3,300
	90	37	111	186	371	743	1,114	1,485	1,856	2,228	2,599	2,970	3,342	3,713
	100	41	124	206	413	825	1,238	1,650	2,063	2,475	2,888	3,300	3,713	4,126

Table 3.8: Predicted guillemot mortality for Morven North plus 2km buffer during the post-breeding season

Guillemot (post-breeding)		Mortality rate (%)												
		1	3	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	23	69	115	231	462	692	923	1,154	1,385	1,616	1,846	2,077	2,308
	20	46	138	231	462	923	1,385	1,846	2,308	2,770	3,231	3,693	4,154	4,616
	30	69	208	346	692	1,385	2,077	2,770	3,462	4,154	4,847	5,539	6,232	6,924
	40	92	277	462	923	1,846	2,770	3,693	4,616	5,539	6,462	7,386	8,309	9,232
	50	115	346	577	1,154	2,308	3,462	4,616	5,770	6,924	8,078	9,232	10,386	11,540
	60	138	415	692	1,385	2,770	4,154	5,539	6,924	8,309	9,694	11,078	12,463	13,848
	70	162	485	808	1,616	3,231	4,847	6,462	8,078	9,694	11,309	12,925	14,540	16,156
	80	185	554	923	1,846	3,693	5,539	7,386	9,232	11,078	12,925	14,771	16,617	18,464
	90	208	623	1,039	2,077	4,154	6,232	8,309	10,386	12,463	14,540	16,617	18,695	20,772
	100	231	692	1,154	2,308	4,616	6,924	9,232	11,540	13,848	16,156	18,464	20,772	23,080

Table 3.9: Predicted guillemot mortality for Morven North plus 2km buffer during the non-breeding season

Guillemot (non-breeding)		Mortality rate (%)												
		1	3	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	6	19	32	64	129	193	258	322	387	451	516	580	645
	20	13	39	64	129	258	387	516	645	774	903	1,032	1,161	1,289
	30	19	58	97	193	387	580	774	967	1,161	1,354	1,547	1,741	1,934
	40	26	77	129	258	516	774	1,032	1,289	1,547	1,805	2,063	2,321	2,579
	50	32	97	161	322	645	967	1,289	1,612	1,934	2,257	2,579	2,901	3,224
	60	39	116	193	387	774	1,161	1,547	1,934	2,321	2,708	3,095	3,482	3,868
	70	45	135	226	451	903	1,354	1,805	2,257	2,708	3,159	3,610	4,062	4,513
	80	52	155	258	516	1,032	1,547	2,063	2,579	3,095	3,610	4,126	4,642	5,158
	90	58	174	290	580	1,161	1,741	2,321	2,901	3,482	4,062	4,642	5,222	5,803
	100	64	193	322	645	1,289	1,934	2,579	3,224	3,868	4,513	5,158	5,803	6,447

3.5 Razorbill

3.5.1.1 Displacement matrices for razorbill in the pre-breeding, breeding, post-breeding and non-breeding seasons are presented in Table 3.10, Table 3.11, Table 3.12 and Table 3.13, respectively.

Table 3.10: Predicted razorbill mortality for Morven North plus 2km buffer during the pre-breeding season

Razorbill (post-breeding)		Mortality rate (%)												
		1	3	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	1	1	2	3	4	5	7	8	9	10	11
	20	0	1	1	2	4	7	9	11	13	15	18	20	22
	30	0	1	2	3	7	10	13	16	20	23	26	30	33
	40	0	1	2	4	9	13	18	22	26	31	35	39	44
	50	1	2	3	5	11	16	22	27	33	38	44	49	55
	60	1	2	3	7	13	20	26	33	39	46	53	59	66
	70	1	2	4	8	15	23	31	38	46	54	61	69	77
	80	1	3	4	9	18	26	35	44	53	61	70	79	88
	90	1	3	5	10	20	30	39	49	59	69	79	89	99
	100	1	3	5	11	22	33	44	55	66	77	88	99	109

Table 3.11: Predicted razorbill mortality for Morven North plus 2km buffer during the breeding season

Razorbill (breeding)		Mortality rate (%)												
		1	3	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	1	2	3	6	9	13	16	19	22	25	28	32
	20	1	2	3	6	13	19	25	32	38	44	51	57	63
	30	1	3	5	9	19	28	38	47	57	66	76	85	95
	40	1	4	6	13	25	38	51	63	76	88	101	114	126
	50	2	5	8	16	32	47	63	79	95	111	126	142	158
	60	2	6	9	19	38	57	76	95	114	133	152	171	190

Razorbill (breeding)		Mortality rate (%)												
		1	3	5	10	20	30	40	50	60	70	80	90	100
	70	2	7	11	22	44	66	88	111	133	155	177	199	221
	80	3	8	13	25	51	76	101	126	152	177	202	227	253
	90	3	9	14	28	57	85	114	142	171	199	227	256	284
	100	3	9	16	32	63	95	126	158	190	221	253	284	316

Table 3.12: Predicted razorbill mortality for Morven North plus 2km buffer during the post-breeding season

Razorbill (post-breeding)		Mortality rate (%)												
		1	3	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	7	20	33	65	131	196	261	327	392	457	523	588	653
	20	13	39	65	131	261	392	523	653	784	915	1,045	1,176	1,307
	30	20	59	98	196	392	588	784	980	1,176	1,372	1,568	1,764	1,960
	40	26	78	131	261	523	784	1,045	1,307	1,568	1,829	2,091	2,352	2,613
	50	33	98	163	327	653	980	1,307	1,633	1,960	2,287	2,613	2,940	3,267
	60	39	118	196	392	784	1,176	1,568	1,960	2,352	2,744	3,136	3,528	3,920
	70	46	137	229	457	915	1,372	1,829	2,287	2,744	3,202	3,659	4,116	4,574
	80	52	157	261	523	1,045	1,568	2,091	2,613	3,136	3,659	4,182	4,704	5,227
	90	59	176	294	588	1,176	1,764	2,352	2,940	3,528	4,116	4,704	5,292	5,880
	100	65	196	327	653	1,307	1,960	2,613	3,267	3,920	4,574	5,227	5,880	6,534

Table 3.13: Predicted razorbill mortality for Morven North plus 2km buffer during the non-breeding season

Razorbill (non-breeding)		Mortality rate (%)												
		1	3	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	1	2	3	5	11	16	21	26	32	37	42	48	53
	20	1	3	5	11	21	32	42	53	64	74	85	95	106
	30	2	5	8	16	32	48	64	79	95	111	127	143	159
	40	2	6	11	21	42	64	85	106	127	148	169	191	212
	50	3	8	13	26	53	79	106	132	159	185	212	238	265
	60	3	10	16	32	64	95	127	159	191	222	254	286	318
	70	4	11	19	37	74	111	148	185	222	259	297	334	371
	80	4	13	21	42	85	127	169	212	254	297	339	381	424
	90	5	14	24	48	95	143	191	238	286	334	381	429	477
	100	5	16	26	53	106	159	212	265	318	371	424	477	530

3.6 Puffin

3.6.1.1 Displacement matrices for puffin in the breeding and non-breeding seasons are presented in Table 3.14 and Table 3.15, respectively.

Table 3.14: Predicted puffin mortality for Morven North plus 2km buffer during the breeding season

Puffin (breeding)		Mortality rate (%)												
		1	3	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	1	2	3	6	13	19	25	31	38	44	50	56	63
	20	1	4	6	13	25	38	50	63	75	88	100	113	125
	30	2	6	9	19	38	56	75	94	113	131	150	169	188
	40	3	8	13	25	50	75	100	125	150	175	200	225	250
	50	3	9	16	31	63	94	125	156	188	219	250	281	313
	60	4	11	19	38	75	113	150	188	225	263	300	338	375

Puffin (breeding)		Mortality rate (%)												
		1	3	5	10	20	30	40	50	60	70	80	90	100
	70	4	13	22	44	88	131	175	219	263	306	350	394	438
	80	5	15	25	50	100	150	200	250	300	350	400	450	500
	90	6	17	28	56	113	169	225	281	338	394	450	506	563
	100	6	19	31	63	125	188	250	313	375	438	500	563	625

Table 3.15: Predicted puffin mortality for Morven North plus 2km buffer during the non-breeding season

Puffin (non-breeding)		Mortality rate (%)												
		1	3	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	1	4	7	14	28	42	55	69	83	97	111	125	139
	20	3	8	14	28	55	83	111	139	166	194	222	249	277
	30	4	12	21	42	83	125	166	208	249	291	332	374	416
	40	6	17	28	55	111	166	222	277	332	388	443	499	554
	50	7	21	35	69	139	208	277	346	416	485	554	623	693
	60	8	25	42	83	166	249	332	416	499	582	665	748	831
	70	10	29	48	97	194	291	388	485	582	679	776	873	970
	80	11	33	55	111	222	332	443	554	665	776	886	997	1108
	90	12	37	62	125	249	374	499	623	748	873	997	1122	1247
	100	14	42	69	139	277	416	554	693	831	970	1108	1247	1385

3.7 Fulmar

3.7.1.1 Displacement matrices for fulmar in the pre-breeding, breeding, post-breeding and non-breeding seasons are presented in Table 3.17, Table 3.18 and Table 3.19 respectively.

Table 3.16: Predicted fulmar mortality for Morven North plus 2km buffer during the pre-breeding season

Fulmar (non-breeding)		Mortality rate (%)												
		1	**3**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Displacement rate (%)	**1**	0	0	0	0	1	1	1	2	2	2	3	3	3
	2	0	0	0	1	1	2	3	3	4	5	5	6	7
	5	0	0	1	2	3	5	7	8	10	12	13	15	17
	10	0	1	2	3	7	10	13	17	20	23	26	30	33
	20	1	2	3	7	13	20	26	33	40	46	53	59	66
	30	1	3	5	10	20	30	40	50	59	69	79	89	99
	40	1	4	7	13	26	40	53	66	79	92	106	119	132
	50	2	5	8	17	33	50	66	83	99	116	132	149	165
	60	2	6	10	20	40	59	79	99	119	139	159	178	198
	70	2	7	12	23	46	69	92	116	139	162	185	208	231
	80	3	8	13	26	53	79	106	132	159	185	211	238	264
	90	3	9	15	30	59	89	119	149	178	208	238	268	297
	100	3	10	17	33	66	99	132	165	198	231	264	297	330

Table 3.17: Predicted fulmar mortality for Morven North plus 2km buffer during the breeding season

Fulmar (breeding)		Mortality rate (%)												
		1	3	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	1	0	1	1	3	6	9	12	14	17	20	23	26	29
	2	1	2	3	6	12	17	23	29	35	40	46	52	58
	5	1	4	7	14	29	43	58	72	86	101	115	130	144
	10	3	9	14	29	58	86	115	144	173	202	230	259	288
	20	6	17	29	58	115	173	230	288	345	403	461	518	576
	30	9	26	43	86	173	259	345	432	518	605	691	777	864
	40	12	35	58	115	230	345	461	576	691	806	921	1,036	1,152
	50	14	43	72	144	288	432	576	720	864	1,008	1,152	1,295	1,439
	60	17	52	86	173	345	518	691	864	1,036	1,209	1,382	1,555	1,727
	70	20	60	101	202	403	605	806	1,008	1,209	1,411	1,612	1,814	2,015
	80	23	69	115	230	461	691	921	1,152	1,382	1,612	1,842	2,073	2,303
	90	26	78	130	259	518	777	1,036	1,295	1,555	1,814	2,073	2,332	2,591
	100	29	86	144	288	576	864	1,152	1,439	1,727	2,015	2,303	2,591	2,879

Table 3.18: Predicted fulmar mortality for Morven North plus 2km buffer during the post-breeding season

Fulmar (post-breeding)		Mortality rate (%)												
		1	3	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	1	0	0	0	0	0	1	1	1	1	2	2	2	2
	2	0	0	0	0	1	1	2	2	3	3	4	4	5
	5	0	0	1	1	2	4	5	6	7	8	10	11	12
	10	0	1	1	2	5	7	10	12	14	17	19	22	24
	20	0	1	2	5	10	14	19	24	29	33	38	43	48
	30	1	2	4	7	14	22	29	36	43	50	57	65	72

Fulmar (post-breeding)		Mortality rate (%)												
		1	3	5	10	20	30	40	50	60	70	80	90	100
	40	1	3	5	10	19	29	38	48	57	67	77	86	96
	50	1	4	6	12	24	36	48	60	72	84	96	108	120
	60	1	4	7	14	29	43	57	72	86	100	115	129	144
	70	2	5	8	17	33	50	67	84	100	117	134	151	167
	80	2	6	10	19	38	57	77	96	115	134	153	172	191
	90	2	6	11	22	43	65	86	108	129	151	172	194	215
	100	2	7	12	24	48	72	96	120	144	167	191	215	239

Table 3.19: Predicted fulmar mortality for Morven North plus 2km buffer during the non-breeding season

Fulmar (non-breeding)		Mortality rate (%)												
		1	3	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	1	0	0	0	1	1	2	2	3	3	4	4	5	5
	2	0	0	1	1	2	3	4	5	6	7	8	9	10
	5	0	1	1	3	5	8	10	13	15	18	21	23	26
	10	1	2	3	5	10	15	21	26	31	36	41	46	51
	20	1	3	5	10	21	31	41	51	62	72	82	93	103
	30	2	5	8	15	31	46	62	77	93	108	124	139	154
	40	2	6	10	21	41	62	82	103	124	144	165	185	206
	50	3	8	13	26	51	77	103	129	154	180	206	232	257
	60	3	9	15	31	62	93	124	154	185	216	247	278	309
	70	4	11	18	36	72	108	144	180	216	252	288	324	360
	80	4	12	21	41	82	124	165	206	247	288	329	371	412
	90	5	14	23	46	93	139	185	232	278	324	371	417	463
	100	5	15	26	51	103	154	206	257	309	360	412	463	515

4 Discussion

4.1 Evidence-based displacement and mortality rates

4.1.1.1 Since displacement sensitivity varies between species, the displacement rates and associated mortality rates used to assess the effects of displacement from Morven North for the Applicant's position have been derived from previous studies, guidance documents and advice received by SNCBs.

4.1.1.2 There is limited empirical evidence on which mortality rate to use when assessing the impacts of displacement of offshore wind farms, however, the current SNCBs guidance, based on expert opinion, is to consider a mortality rate of up to 10% (JNCC *et al*., 2022). Van Kooten *et al*. (2019) studied the effects of displacement on seabirds using energy-budget models for two scenarios using habitat utilization maps and a fixed 10% mortality rate. The evidence from this study suggests that a 1% mortality rate for displaced birds is more appropriate than the potentially over-precautionary 10% mortality rate. Similarly, Searle *et al*., (2014; 2018) used time and energy budget models to investigate the effects of displacement and barrier effects on breeding populations of seabirds, including auks during the chick rearing period. The study reported changes in time and energy budgets which could impact future survival of auks, however the simulations concluded that the displacement effects were unlikely to result in a mortality rate increase of over 0.5%. Therefore, in line with the advice from the JNCC *et al*. (2022), a 1% to 10% mortality of displaced individuals is presented for all species in this assessment, although the Applicant considers that 1% mortality rate to be the more likely impact based on the studies discussed above.

4.1.2 Kittiwake

4.1.2.1 Kittiwake are considered to have a moderate habitat flexibility and low vulnerability to displacement (Wade *et al*., 2016). However, NatureScot recommend that displacement effects are considered for kittiwake (NatureScot, 2023a).

4.1.2.2 Studies regarding the displacement at Egmond aan Zee Offshore Wind Farm (Leopold *et al*., 2011), Bligh Bank Offshore Wind Farm and Thorntonbank Offshore Wind Farm (Vanermen, 2013). Horns Rev Offshore Wind Farm, Princess Amalia Windpark (Furness, 2013) reported no significant displacement of kittiwake. A study by Peschko (2020) used a long-term dataset covering 14 years before and 3 years after the construction of offshore wind farms in the southern North Sea to assess the displacement of kittiwake. They found a 45% decrease in density during the breeding season.

4.1.2.3 NatureScot advise a 30% displacement rate and 1% to 3% mortality rate for kittiwake in both the breeding and non-breeding season (Nature Scot, 2023) and when following joint SNCB guidance (JNCC *et al*., 2022) a 10% to 30% displacement rate range would be used. To assess the effects of displacement from Morven North on the kittiwake population in the area, a displacement rate of 30% is recommended by the Applicant with this corresponding with the displacement rate recommended by NatureScot. The Applicant recommends the use of a 1% mortality rate which aligns with one of the mortality rates recommended by NatureScot (1% and 3%).

4.1.3 Guillemot, razorbill and puffin

4.1.3.1 To assess the effects of displacement from Morven North on the guillemot, razorbill and puffin populations in the area, a displacement rate of 50% is recommended by the Applicant. This is slightly lower than the rate recommended by NatureScot (60%). The Applicant recommends the use of a 1% mortality rate in all seasons whereas NatureScot recommend the use of 3% and 5% in the breeding season and 1 and 3% in non-breeding seasons.

4.1.3.2 Evidence shows that auk species have a moderate vulnerability to displacement from structures and vessel and helicopter traffic (Wade *et al*., 2016). Furthermore, displacement impacts from post-consent monitoring studies (from 13 different European offshore windfarm sites) have been collated

and reviewed by Dierschke *et al*., (2016), which found auk species to show 'weak displacement' overall, but results were highly variable. Similarly, a recent review submitted by Hornsea Four Offshore Wind Farm (APEM, 2022) summarises all current post consent-monitoring studies undertaken to date within the UK waters and provides an extensive study and analysis of the empirical data from offshore wind farms. This review found that auk displacement varies considerably across different sites, with displacement rates ranging from +112% to -75%. However, this review concluded that a displacement rate of 50% and mortality rate of 1% was appropriate for use in relation to displacement assessments being undertaken for the Hornsea Four offshore wind farm. The review suggests that in areas of high abundance, displacement is limited and postulates that this may be due to higher importance of the underlying habitat to birds meaning birds are more likely to tolerate the presence of structures in the area. For areas with low abundance, displacement rates were increased and the review postulates that this may be that birds are able to forage in other areas as competition between birds is reduced. Although greater than 50% displacement was observed at five developments in the study, all had very low auk abundance within the study area. Where auk abundance was greater, <50% displacement was recorded. Therefore, considering the abundance of auks at Morven North, a 50% displacement rate is considered appropriate for Morven North.

4.1.3.3 A recent study on displacement at the Beatrice offshore wind farm utilising an approach investigating the distribution of seabirds in relation to turbine locations suggested that auk species did not avoid turbines (MacArthur Green, 2023). The abundance of both guillemot and razorbill increased significantly from the pre-construction period into the post-construction period. This would suggest that these species are not displaced by offshore wind farms and that the use of a 50% displacement rate, as suggested by APEM (2022) is highly precautionary.

4.1.3.4 Based on the review of the relevant literature, a displacement rate of 50% has been deemed appropriate for auk species. This rate is considered to be highly precautionary as a study of offshore wind farms in the German North Sea found reduced displacement rates (~20%) of guillemots during the breeding season compared to the non-breeding season (Peschko *et al*., 2020) and the most recent studies have shown no displacement of auks (MacArthur Green, 2023). This is an important consideration as the mean displacement rates derived from the Dierschke *et al*. (2016) review were primarily from data collected in the non-breeding season. Therefore, by applying a single displacement rate of 50% across all seasons ensures a precautionary rate is used for the assessment.

4.1.3.5 Furthermore, evidence suggests that although auk species are somewhat sensitive to displacement, the effects are short-term, and studies indicate auk habituation to offshore windfarms. For example, a study at Thanet Offshore Windfarm found auk species became habituated in the post-construction period. The density of guillemot and razorbill decreased in the construction and first year of post-construction when compared to the pre-construction period and whilst the densities in subsequent post-construction years were lower than recorded during the pre-construction period, these differences were not significant (Percival, 2013). Further evidence is emerging through additional post-construction monitoring of offshore windfarms, for instance, there are reports of auk numbers increasing and observations of foraging behaviour within wind farm areas (Leopold and Verdaat, 2018). This suggests the displacement rates of auk species within Morven North will reduce over time.

4.1.4 Gannet

4.1.4.1 To assess the effects of displacement from Morven North on the gannet population in the area, a displacement rate of 70% is recommended by the Applicant. This corresponds with the displacement rate recommended by NatureScot. The Applicant recommends the use of a 1% mortality rate which aligns with one of the mortality rates recommended by NatureScot (1% and 3%).

4.1.4.2 Whilst evidence suggests that gannet show a limited vulnerability to disturbance from ship and helicopter traffic (Wade *et al*., 2016), the species avoidance rates to offshore wind farms can be high. Natural England recently reviewed nine studies that reported on gannet avoidance rates using a

variation of survey methods (Pavat *et al*., 2023). The avoidance rates reported range from 61.7% to 100%. Another review by APEM (2022) looked at studies across 25 offshore wind farms, over different seasons, and reported displacement rates of 40% to 60% during the breeding season, and 60% to 80% during the non-breeding season. In light of literature the use of a displacement rate of 70% has been deemed appropriate.

4.1.4.3 Based on expert judgement a mortality rate of 1% is considered appropriate. This decision is supported by additional evidence that suggests that gannet have a large mean-maximum (315km) and maximum (709km) foraging range (Woodward *et al*., 2019) and feed on a diverse range of prey items and thus displaced birds will have access to suitable alternative foraging opportunities despite the potential reduced foraging activities within Morven North.

4.1.5 Fulmar

4.1.5.1 Evidence has been interpreted to show that fulmar show a very low vulnerability to displacement from structures and vessel and helicopter traffic, though the uncertainty level associated with the vulnerability rating was high (Wade *et al*., 2016). A recent meta-analysis of 39 studies by Lamb *et al*. (2024) highlights this uncertainty, the synthetic analysis showing that less frequently observed species like fulmar exhibit few significant displacement events, yet when effects are detected, they tend to be strongly negative. This would suggest displacement may be underestimated in these species.

4.1.5.2 To assess the effects of displacement from Morven North on the fulmar population in the area, a displacement rate of 10% is recommended by the Applicant. This is slightly lower than the rate recommended by NatureScot (20%) when recommending the inclusion of this species in displacement assessments (11 July 2025). The Applicant recommends the use of a 1% mortality rate which aligns with one of the mortality rates recommended by NatureScot (1% and 3%).

5 References

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Appendix A Bird data for displacement assessment

Table A.1: Kittiwake abundance estimates (all behaviours) within Morven North plus 2km buffer

Year	Abundance metric	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Model-based abundance estimates													
Year 1	Mean	654	229	66	7	26	199	137	136	460	1,570	1,328	92
	Upper confidence	854	315	103	34	57	274	207	208	570	1,906	1,642	152
	Lower confidence	497	179	36	2	0	149	92	99	375	1,265	1,084	61
Year 2	Mean	17	44	83	166	37	24	52	70	243	385	3,391	16
	Upper confidence	43	92	180	220	98	49	142	121	365	489	4,037	134
	Lower confidence	0	22	60	120	21	12	34	42	180	306	2,714	7

Table A.2: Gannet abundance estimates (all behaviours) within Morven North plus 2km buffer

Year	Abundance metric	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Model-based abundance estimates													
Year 1	Mean	607	64	22	0	31	17	46	542	1,144	270	217	54
	Upper confidence	716	107	49	0	68	50	82	649	1,429	354	305	122
	Lower confidence	516	36	0	0	0	0	22	461	913	190	165	35

Year	Abundance metric	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Year 2	Mean	90	55	14	0	16	48	76	251	351	449	225	185
	Upper confidence	161	100	36	0	41	134	152	325	452	555	302	257
	Lower confidence	62	33	5	0	0	31	51	199	279	371	172	137

Table A.3: Guillemot abundance estimates (all behaviours) within Morven North plus 2km buffer

Year	Abundance metric	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Model-based abundance estimates													
Year 1	Mean	1,021	10,676	829	2,115	2,146	374	1,034	3,438	980	3,897	3,025	17,152
	Upper confidence	1,210	11,518	983	2,375	2,519	496	1,217	3,710	1,284	4,192	3,281	18,165
	Lower confidence	842	9,758	672	1,879	1,869	287	879	3,128	759	3,590	2,754	15,987
Year 2	Mean	15,971	852	2,218	1,676	1,351	239	2,120	1,215	823	4,354	2,369	29,008
	Upper confidence	17,478	1,033	2,482	1,920	1,575	369	2,653	1,408	1,198	4,674	2,610	31,197
	Lower confidence	14,292	725	1,956	1,439	1,143	173	1,705	1,016	588	4,020	2,134	26,616

Table A.4: Razorbill abundance estimates (all behaviours) within Morven North plus 2km buffer

Year	Abundance metric	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Model-based abundance estimates													
Year 1	Mean	9,490	123	812	56	138	405	95	51	111	109	389	45
	Upper confidence	10,267	228	997	127	208	625	169	114	260	189	499	116
	Lower confidence	8,664	88	693	27	81	312	52	24	82	72	314	21
Year 2	Mean	1,497	3,578	823	199	654	74	105	108	99	36	194	243
	Upper confidence	1,685	4,129	983	302	820	205	186	180	200	116	284	357
	Lower confidence	1,299	3,032	686	135	525	42	59	62	67	0	141	186

Table A.5: Puffin abundance estimates (all behaviours) within Morven North plus 2km buffer

Year	Abundance metric	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Model-based abundance estimates													
Year 1	Mean	2,293	60	18	53	0	12	0	40	82	22	46	782
	Upper confidence	2,517	124	45	136	0	35	0	73	183	57	110	923
	Lower confidence	2,056	33	0	29	0	0	0	9	56	9	21	653
Year 2	Mean	320	26	0	35	9	477	90	58	468	306	51	0
	Upper confidence	412	65	0	76	29	613	176	101	605	419	119	0

Year	Abundance metric	Sep		Oct		Nov		Dec		Jan		Feb		Mar		Apr	May	Jun	Jul	Aug
	Lower confidence	243	10	0	17	0	376	65	32	383	253	24	0							

Table A.6: Fulmar abundance estimates (all behaviours) within Morven North plus 2km buffer

Year	Abundance metric	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Model-based abundance estimates													
Year 1	Mean	439	884	471	61	268	49	58	60	5,382	21	23	63
	Upper confidence	540	1,013	590	105	345	116	109	123	11,107	50	94	117
	Lower confidence	360	757	397	34	195	29	33	41	3,100	11	12	37
Year 2	Mean	39	146	190	166	107	172	0	375	48	61	263	318
	Upper confidence	116	231	262	248	180	240	0	476	157	105	342	409
	Lower confidence	24	108	140	119	75	124	0	302	33	36	201	248

Appendix B Calculation process for guillemot and razorbill mean-peak population estimates

5.1.1.1 The approach to defining the seasonal extents for guillemot and razorbill to enable the calculation of seasonal mean-peak population estimates is based on advice received from NatureScot during pre-application consultation. This advice, which is also included in Volume 1, Chapter 5: Consultation, of the Morven North EIA Report is summarised here.

5.1.1.2 In January 2025, the Applicant requested advice from NatureScot in relation to the age of the data to be used to support the assessments required for Morven North. The Applicant had collected baseline data between January 2021 and September 2023 and with a proposed application date of Q2 2026 was aware that data towards the start of this period would be beyond the five year cut-off usually applied to baseline data. NatureScot advised that in order to the application being informed by data beyond the five year cut-off that the assessment should utilise data between October 2021 and September 2023, thus providing a dataset covering the required minimum of two years.

5.1.1.3 In March 2025, the Applicant requested further advice from NatureScot in relation to the use of data between October 2021 and September 2023. Whilst this time period corresponded with the seasonal extents for gannet it foreshortened the non-breeding seasons defined for other species. The Applicant proposed that data from before October 2021 be used to ensure two full seasons for each species could be used within displacement analyses. The Applicant has therefore agreed with NatureScot through additional targeted consultation (April 2025) and consultation meetings (28th May 2025) that data prior to October 2021 can be used to allow for the consideration of two complete seasonal extents for each species (see Volume 1, Chapter 5: Consultation). This therefore leads to a dataset with a temporal extent of July 2021 to September 2023 providing two full seasonal extents for each species identified in Section 2.1.

5.1.1.4 During pre-application consultation the Applicant had identified increased populations of guillemot and razorbill in months towards the end of the breeding season/start of the non-breeding season, when compared to surrounding months. In March 2025, the Applicant presented evidence that these increased populations were likely due to the post-breeding dispersal of the two species from nearby colonies and requested NatureScot's advice in relation to the treatment of these months in displacement analyses for the two species. In April 2025 and May 2025, NatureScot provided advice stating that July and August be incorporated into a new post-breeding season for guillemot and the existing post-breeding season for razorbill where it was evident that the populations were different to surrounding months.

5.1.1.5 Table B.1 identifies the seasons defined for guillemot and the justification behind the seasonal extents based on the advice provided by NatureScot. An explanation as to how this advice applies to individual months is provided in Table B.1. The data presented in Table B.1 can also be found in Appendix 4, Table 12.5 of Volume 3, Annex 11.1: Offshore Ornithology Baseline Characterisation Report.

Table B.1: Seasonal extents defined for guillemot

Season	Extent	Justification
Breeding	April to June 2022 and 2023	As population estimates in July 2022 are higher than preceding breeding season months, July 2022 is included in the post-breeding season leaving April, May and June to form the breeding season.

Season	Extent	Justification
Post-breeding	July to October 2021 and 2022	July included in post-breeding season based on NatureScot's advice, remaining post-breeding season extent based on seasonal extents provided in Furness (2015).

5.1.1.6 Table B.2 identifies the seasons defined for razorbill and the justification behind the seasonal extents based on the advice provided by NatureScot. An explanation as to how this advice applies to individual months is provided in Table B.2. The data presented in Table B.2 can also be found in Appendix 4, Table 12.8 of Volume 3, Annex 11.1: Offshore Ornithology Baseline Characterisation Report.

Table B.2: Seasonal extents defined for razorbill

Season	Extent	Justification
Breeding	April to June 2022 and 2023	As population estimates in July 2022 are higher than preceding breeding season months, July 2022 is included in the post-breeding season leaving April, May and June to form the breeding season.
Post-breeding	July to October 2021 and 2022	July included in post-breeding season based on NatureScot's advice, remaining post-breeding season extent based on seasonal extents provided in Furness (2015).
Non-breeding	November to December 2021 and 2022	Based on seasonal extents provided in Furness (2015).
Pre-breeding	January to March 2022 and 2023	Based on seasonal extents provided in Furness (2015).

Table B.3: Calculation process used to calculate mean-peak population estimates for guillemot based on NatureScot's advice

Month	Population estimate (no. of birds)	Season	Justification
June 2021	17504	Not used	Not used. Data in 2022 and 2023 has been given priority in order to ensure data is within the five year cut-off. Data presented to show where population estimates began to decline indicating the start of the non-breeding season in 2021.
July 2021	31248	Not used	
August 2021	1021	Non-breeding	Population estimate lower than July and considered to be unaffected by post-breeding dispersal, considered to be a non-breeding month following the seasonal definitions in NatureScot (2020).
September 2021	10676	Non-breeding	Included in the non-breeding season based on the seasonal definitions in NatureScot (2020).
October 2021	829	Non-breeding	
November 2021	2115	Non-breeding	
December 2021	2146	Non-breeding	
January 2022	374	Non-breeding	
February 2022	1034	Non-breeding	
March 2022	3438	Non-breeding	
April 2022	980	Breeding	Included in the breeding season based on the seasonal definitions in NatureScot (2020).
May 2022	3897	Breeding	
June 2022	3025	Breeding	
July 2022	17152	Post-breeding	

Month	Population estimate (no. of birds)	Season	Justification
August 2022	15971	Post-breeding	Population estimate significantly higher than preceding breeding season months in this year, assigned to the post-breeding season following NatureScot pre-application advice.
September 2022	852	Non-breeding	Included in the non-breeding season based on the seasonal definitions in NatureScot (2020).
October 2021	2218	Non-breeding	
November 2022	1676	Non-breeding	
December 2022	1351	Non-breeding	
January 2023	239	Non-breeding	
February 2023	2120	Non-breeding	
March 2023	1215	Non-breeding	
April 2023	823	Breeding	Included in the breeding season based on the seasonal definitions in NatureScot (2020).
May 2023	4354	Breeding	
June 2023	2369	Breeding	
July 2023	29008	Post-breeding	Population estimate significantly higher than other breeding season months in this year, assigned to the post-breeding season following NatureScot pre-application advice.
August 2023	282	Not used	Population estimate lower than previous month in same year and therefore would be assigned to the non-breeding season however, two complete non-breeding seasons have already been identified and this month does not form part of a complete non-breeding season. This population estimate is not used.

Month	Population estimate (no. of birds)	Season	Justification
September 2023	170	Not used	This month does not form part of a complete non-breeding season. This population estimate is not used.

Table B.4: Calculation process used to calculate mean-peak population estimates for razorbill

Month	Population estimate (no. of birds)	Season	Justification
June 2021	1019	Not used	Not used. Data in 2022 and 2023 has been given priority in order to ensure data is within the five year cut-off. Data presented to provide a comparison between breeding seasons months and July 2021 to determine if July should be included in the post-breeding season.
July 2021	9490	Post-breeding	Population estimate is higher than preceding breeding season month and therefore it is included in the post-breeding season based on NatureScot's pre-application advice.
August 2021	123	Post-breeding	Included in the post-breeding season based on the seasonal definitions in Furness (2015).
September 2021	812	Post-breeding	
October 2021	56	Post-breeding	
November 2021	138	Non-breeding	Included in the non-breeding season based on the seasonal definitions in Furness (2015).
December 2021	405	Non-breeding	
January 2022	95	Pre-breeding	Included in the pre-breeding season based on the seasonal definitions in Furness (2015).
February 2022	51	Pre-breeding	
March 2022	111	Pre-breeding	
April 2022	109	Breeding	Included in the breeding season based on the seasonal definitions in NatureScot (2020).
May 2022	389	Breeding	
June 2022	45	Breeding	

Month	Population estimate (no. of birds)	Season	Justification
July 2022	1497	Post-breeding	Population estimate is higher than preceding breeding season month and therefore it is included in the post-breeding season based on NatureScot's pre-application advice.
August 2022	3578	Post-breeding	Included in the post-breeding season based on the seasonal definitions in Furness (2015).
September 2022	823	Post-breeding	
October 2021	199	Post-breeding	
November 2022	654	Non-breeding	Included in the non-breeding season based on the seasonal definitions in Furness (2015).
December 2022	74	Non-breeding	
January 2023	105	Pre-breeding	Included in the pre-breeding season based on the seasonal definitions in Furness (2015).
February 2023	108	Pre-breeding	
March 2023	99	Pre-breeding	
April 2023	36	Breeding	Included in the breeding season based on the seasonal definitions in NatureScot (2020).
May 2023	194	Breeding	
June 2023	243	Breeding	
July 2023	6277	Not used	Population is higher than preceding breeding season months in this year. This month would therefore be incorporated into the post-breeding season, however, two post-breeding seasons have already been defined and the post-breeding season in this year is incomplete. This population estimate is therefore not used.
August 2023	0	Not used	This month does not form part of a complete post-breeding season. This population estimate is not used.
September 2023	46	Not used	