APPENDIX 9

SEABIRD DISPLACEMENT MATRIX REPORT

Table of Contents

1. INTRODUCTION

1.1 Introduction

Individual seabird species react differently to the construction, operation and decommissioning of OWFs. Evidence from post-construction studies (e.g. Dierschke *et al.,* 2016) has shown that some species show avoidance of operational OWFs, and this is considered here as displacement.

The methodology for assessing displacement and barrier effects in this assessment is based on the guidance document prepared by the UK Statutory Nature Conservation Bodies (SNCBs) (SNCBs, 2022a&b). This guidance document outlines how to present assessment information on the extent and potential consequences of seabird displacement from Offshore Wind Farm (OWF) developments, and was first produced in January 2017, with a revised and updated version published in January 2022. This approach has been applied to assess displacement and barrier effects on seabirds for the East Coast Phase 1 projects (GoBe, 2022), and for several recent offshore wind farm projects in the UK and is considered best practice.

Displacement has been defined as 'a reduced number of birds occurring within or immediately adjacent to an offshore wind farm' (Furness *et al.*, 2013). OWFs may also act as barriers to movement for sensitive species, with barrier effects occurring if birds choose to fly around an OWF rather than flying through it. Barrier effects may lead to increased energy expenditure for birds by increasing the distances travelled and the energy required to detour around these barriers (Masden *et al.,* 2009).

As defined in the guidance (SNCBs, 2022a&b), both flying birds and birds on the water are considered in this displacement assessment. In addition, displacement and barrier effects have been considered together in this assessment, as recommended by the guidance (SNCBs, 2022a&b). This is because there is currently not enough evidence to separate out effects from these two impacts, therefore as recommended in the SNCB guidance they are considered together here.

Displacement effects for breeding seabirds are more likely to be observed as changes in productivity as opposed to survival rates (Humphreys *et al.,* 2015). Seabirds experiencing challenging conditions are more likely to abandon the current breeding attempt before compromising their own survival (Furness *et al.*, 2013), although it is likely that stressed birds could go into the wintering period in poor body condition and hence may be susceptible to higher mortality effects as a result.

There is also the potential for displacement effects to have direct consequences for wintering birds if they are displaced from high quality habitat by the presence of an offshore wind farm. In this scenario, birds may have to redistribute to poorer quality habitat which may result in poorer body condition leading to lower over-winter survival rates or potentially reduced breeding success in the subsequent year. However, this scenario may be less likely to occur as outside the breeding season seabirds are able to move greater distances to suitable foraging areas, as they do not have to regularly return to a colony and so displacement effects may be reduced or avoided.

1.2 Methodology

Seabird species that are susceptible to displacement from offshore wind farms may not only be displaced from the development footprint but may also be displaced from the surrounding area (or buffer zone). SNCB guidance recommends that the additional area beyond the development footprint must also be considered in the displacement assessment. For the majority of species, a standard displacement buffer of two km is recommended, with a four km buffer applied for divers and sea ducks (SNCBs, 2022a&b).

Different seabird species have varying sensitivity to displacement effects, and there have been several reviews which have ranked species according to their likely responses to disturbance and displacement (e.g. Furness et al., 2013 and Bradbury et al., 2014). The SNCB guidance contains a table of species ranked according to their sensitivity to disturbance and also the degree of habitat specialization, based on these previous reviews. This table has been reproduced here for the seabird species that were regularly recorded on baseline surveys in the Study area (Table 1-1).

The SNCB guidance recommends as a guide that, any species recorded in the offshore wind farm site or buffer that is ranked as three or more under either category in Table 1-1, should be progressed to the matrix stage unless there is strong empirical evidence to the contrary. For gannet, SNCB guidance states that gannet should be included in the displacement assessment, as there are empirical studies demonstrating they are sensitive to displacement and barrier effects (e.g. Krijgsveld *et al.*, 2011, Vanermen *et al.*, 2013).

Table 1-1 Sensitivity and Habitat Specialisation scores for regularly recorded species in the OAA and buffer (based on Furness et al., 2013 and Bradbury et al., 2014) (2 km buffer unless otherwise stated)

Species	Disturbance Susceptibility	Habitat Specialisation
Red-throated diver	5	4
Great northern diver	5	3
Cormorant	4	3
Eider	3	4
Black guillemot	3	4
Shag	3	3
Guillemot	3	3
Razorbill	3	3
Common tern*	2	3
Arctic tern	2	3
Puffin	2	3
Common gull	2	2
Great black-backed gull	2	2
Kittiwake	2	2
Gannet	2	1
Lesser black-backed gull	2	1
Herring gull	2	1
Fulmar	1	1
Manx shearwater	1	1
European storm petrel	1	1

* Common tern is not listed in the SNCB Guidance species sensitivity table but has been included here with the same scores as Arctic and Sandwich terns

Based on the sensitivity and habitat specialisation scores (Table 1-1), there were nine species to be considered further in the displacement assessment. However, cormorant and black guillemot were only recorded occasionally in the Offshore Array Area (OAA) and surrounding 2 km buffer in very low numbers, with respective monthly peaks of three and one bird. As a result, these species have not been considered further in this displacement assessment, as any displacement effects would not be significant, based on the very low numbers of birds present.

Red throated diver was not assessed for displacement as no red-throated divers were recorded within the OAA or in the OAA plus 4 km buffer within analysed transects flown during baseline surveys (Offshore Ornithology Baseline Report Annex A), therefore it was not possible to assess this species using the matrix approach.

In addition, based on the NPWS response (APBmer, 2023) to the Phase 1 East Coast Developers Methodology document submitted to NPWS in December 2022 (GoBe, 2022), it was decided to include kittiwake and Manx shearwater in the displacement assessment. Although neither species have high rankings for disturbance susceptibility or habitat specialisation as defined in the SNCB guidance (SNCBs, 2022a), both species were assessed for potential displacement effects following the precautionary principle, as recommended in the NPWS response.

Displacement impacts were therefore assessed using the SNCB approach on 11 species; great northern diver, Manx shearwater, shag, gannet, eider, kittiwake, guillemot, razorbill, puffin, common tern and Arctic tern.

The SNCB guidance recommends that the full range of potential displacement (from 0% to 100% of the mean seasonal peak bird numbers recorded on pre-construction baseline surveys) is presented within a 'Matrix Approach', using 10% intervals. These tables should be presented as OAA only and OAA plus appropriate buffer (4 km for great northern diver, 2 km buffer for other species).

Mortality of displaced birds is also required to be presented in the matrix approach, with the presentation of 0-100% mortality of displaced birds, again presented in 10% increments. It is also considered appropriate to have a finer gradation of percentage mortality impacts at the lower range of this scale e.g. 1% intervals between 0% and 5%.

The SNCB guidance also recommends that where appropriate, mean seasonal peak abundance is used to produce, as a minimum, two seasonal matrices covering the breeding and non-breeding seasons. For some species e.g. guillemot and razorbill, it may also be appropriate to present seasonal matrices for the post-breeding season.

Displacement matrices for the relevant seasons for the key species are presented in this appendix. The definition of the breeding and non-breeding seasons for each of these species was based on definitions published by Furness (2015), presented in Chapter 11 of the EIAR. Where appropriate, the non-breeding season has been broken down into autumn and spring migration periods and winter period, as defined in Furness (2015).

Where non-breeding periods overlapped with the breeding season definitions, the non-breeding periods were adjusted to exclude months that were listed in the breeding season. This approach avoids duplicating single monthly estimates which could artificially inflate seasonal abundance estimates and has been used previously in displacement assessments for offshore wind farms in Scotland (e.g. NnGOWL, 2018).

1.2.1 Displacement Matrices

The displacement matrices provide a range of estimated numbers of displaced birds as well as the estimated mortality for each species and season. Each cell in the matrix tables presents seasonal potential bird mortality following displacement from the proposed OAA alone or including a surrounding appropriate buffer.

The shaded outputs in the matrix tables are those considered to be the 'most realistic' displacement and mortality estimates based on available evidence from post-construction studies at operational OWF projects and associated published reviews of displacement effects. These are further detailed in the displacement assessment in Chapter 11 of the EIAR. No adjustments for age classes of birds have been made.

1.2.1.1 Red-throated Diver

For red-throated diver, the SNCB guidance states that where a project is not within 10 km of an SPA designated for red-throated divers in the non-breeding season, then a surrounding buffer of 4 km should be used for the assessment (SNCBs, 2022a). As there are no SPAs designated for red-throated divers within 10 km of the Offshore Ornithology study area, a 4 km buffer has been considered.

No red-throated divers were recorded within the OAA or in the OAA plus 4 km buffer within analysed transects flown during baseline surveys (Offshore Ornithology Baseline Report Annex A), therefore population estimates of red-throated diver were zero birds across all surveys. On this basis, it is considered that there will not be any displacement of red-throated divers in the OAA and 4 km buffer as a result of the Sceirde Rocks project.

1.2.2 Great Northern Diver

For great northern diver, a surrounding buffer of 4 km is recommended in the SNCB advice (SNCBs, 2022), therefore a 4 km buffer has been used in this assessment.

Monthly numbers of great northern divers in the OAA and OAA plus 4 km buffer in Years 1 and 2 are presented in the Offshore Ornithology Baseline Report. Great northern divers do not breed in Ireland, with birds not recorded on baseline surveys between June and October, therefore no breeding season assessment is necessary. Monthly peak estimated numbers in the non-breeding season (October to May) for Years 1 and 2 were averaged to get the mean peak per season (Table 1-2). Where peak numbers occurred in different months within the same season across different years, the peak month was used.

In the non-breeding season (October to May), the mean seasonal peak of great northern divers in the OAA was 11 birds, while in the OAA and 4 km buffer the mean seasonal peak was 53 birds (Table 1-2).

Table 1-2 Seasonal mean peak estimated numbers of great northern divers in the OAA and in the OAA plus 4 km buffer area recorded in the non-breeding season on baseline surveys

	OAA
OAA	11 birds
OAA & 4 km buffer	53 birds

These peak mean estimates were taken as the maximum number of great northern divers in the OAA and the OAA and 4 km buffer for the non-breeding season. These figures were then used in the Displacement matrices produced for this assessment (Table 1-3 to Table 1-4).

Displacement and Mortality Rates

For diver species, a range of displacement rates from 90% to 100% is considered suitable in SNCB guidance (SNCBs, 2022a&b). Displacement rates of 1% to 100% are presented in Table 1-3 and Table 1-4, with the assessment displacement rates of 90% and 100% rows highlighted.

Behaviour-based computer simulation models of waders, geese and sea ducks have demonstrated that displacement can, through changes to the energy budgets of individuals, lead to changes to mortality levels (SNCBs, 2022a&b). However, no such effects were predicted when similar models were applied to wintering divers. This modelling predicted that even in a scenario where there were many OWFs in an area, the increase in population level mortality would be less than 2% (Topping and Petersen 2011).

Based on the above, it is considered unlikely that there will be any mortality resulting from displacement from the OAA and a 4 km buffer, as displaced birds would be able to forage elsewhere off the west coast of Ireland. However, for the purposes of this assessment, it has been assumed that a worst-case scenario of 2% of all displaced great northern divers from the OAA and a 4 km buffer will suffer mortality as a consequence of being displaced.

Mortality rates of 1% to 100% are presented in Table 1-3 and Table 1-4, with the assessment mortality rate of 2% highlighted. Based on displacement rates of 90% and 100%, and a mortality rate of 2%, great northern diver mortality was predicted to be zero birds as a result of displacement within the OAA. For the OAA and a 4 km buffer, great northern diver mortality was predicted to be one bird in the non-breeding season.

Table 1-3 Potential great northern diver mortality following displacement from the OAA in the non-breeding season

		Mortality (%)														
	%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)	10	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	20	0	0	0	0	0	0	0	1	1	1	1	2	2	2	2
	30	0	0	0	0	0	0	1	1	1	2	2	2	3	3	3
	40	0	0	0	0	0	0	1	1	2	2	3	3	4	4	4
	50	0	0	0	0	0	1	1	2	2	3	3	4	4	5	6
	60	0	0	0	0	0	1	1	2	3	3	4	5	5	6	7
	70	0	0	0	0	0	1	2	2	3	4	5	5	6	7	8
	80	0	0	0	0	0	1	2	3	4	4	5	6	7	8	9
	90	0	0	0	0	0	1	2	3	4	5	6	7	8	9	10
	100	0	0	0	0	1	1	2	3	4	6	7	8	9	10	11

Table 1-4 Potential great northern diver mortality following displacement from the OAA and 4 km buffer in the non-breeding season

		Mortality (%)														
	%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)	10	0	0	0	0	0	1	1	2	2	3	3	4	4	5	5
	20	0	0	0	0	1	1	2	3	4	5	6	7	8	10	11
	30	0	0	0	1	1	2	3	5	6	8	10	11	13	14	16
	40	0	0	1	1	1	2	4	6	8	11	13	15	17	19	21
	50	0	1	1	1	1	3	5	8	11	13	16	19	21	24	27
	60	0	1	1	1	2	3	6	10	13	16	19	22	25	29	32
	70	0	1	1	1	2	4	7	11	15	19	22	26	30	33	37
	80	0	1	1	2	2	4	8	13	17	21	25	30	34	38	42
	90	0	**1**	1	2	2	5	10	14	19	24	29	33	38	43	48
	100	1	**1**	2	2	3	5	11	16	21	27	32	37	42	48	53

1.2.3 Manx Shearwater

Monthly numbers of Manx shearwaters in the OAA and OAA plus 2 km buffer in Years 1 and 2 are presented in the Offshore Ornithology Baseline Report. Manx shearwaters are typically absent from Irish waters in the non-breeding season, therefore only the breeding season and the autumn and spring migration periods of the non-breeding season are included in this assessment. Monthly peak estimated numbers in the breeding season and the autumn and spring migration periods for Years 1 and 2 were averaged to get the mean peak per season (Table 1-5). Where peak numbers occurred in different months within the same season across different years, the peak month was used.

In the breeding season (April to August), the mean seasonal peak of Manx shearwaters in the OAA was 437 birds, while in the OAA and 2 km buffer the mean seasonal peak was 6,013 birds. Mean seasonal peaks for the autumn and spring migration periods were much lower (Table 1-5).

Table 1-5 Seasonal peak estimated numbers of Manx shearwaters in the OAA and in the OAA plus 2 km buffer area recorded on baseline surveys

Year	Breeding	Autumn	Spring
OAA	437 birds	0 birds	5 birds
OAA & 2 km buffer	6,013 birds	10 birds	28 birds

These peak mean estimates were taken as the maximum number of Manx shearwaters in the OAA and the OAA and 2 km buffer for the breeding season and autumn and spring migration periods. These figures were then used in the Displacement matrices produced for this assessment (Table 1-6 to Table 1-10).

Displacement and Mortality Rates

Post-construction studies in Europe indicate that Manx shearwaters may be likely to exhibit weak avoidance of offshore wind farms. Dierschke *et al.* (2016) concluded that although Manx shearwaters have been observed inside operating wind farms in the Celtic Sea, there is limited data on this species. Bradbury *et al.*, (2014) ranked Manx shearwater as having “very low” population vulnerability to displacement.

The lack of available evidence of displacement effects was also highlighted in a recent review of the risk of collision and displacement in petrels and shearwaters from offshore wind developments in Scotland (Deakin, *et al.,* 2022). This review concluded that while Manx shearwaters are generally thought to have a low vulnerability to displacement and barrier effects, there is the potential for displacement effects to occur.

Based on the limited available evidence from existing offshore wind farm studies, and published reviews indicating a weak avoidance of offshore wind farms, it has been assumed for this assessment that 30% of Manx shearwaters will be displaced from the array area. Although displacement is considered likely to be less than 30% for Manx shearwaters in the surrounding 2 km buffer area, it has also been assumed that 30% of Manx shearwaters will be displaced from the 2 km buffer area. The 30% displacement row has been highlighted in Table 1-6 to Table 1-10.

Based on the species known very large foraging range and the likely weak avoidance of offshore wind farms, it is considered unlikely that there will be any mortality resulting from displacement from the array area and the 2 km buffer, as displaced birds would be able to forage elsewhere off the west coast of Ireland. However, for the purposes of this assessment, it has been assumed that 1% of all displaced birds from the array area and a 2 km buffer will suffer mortality as a consequence of being displaced.

Mortality rates of 1% to 100% are presented in Table 1-6 to Table 1-10, with the assessment mortality rate of 1% highlighted.

Within the OAA, based on a displacement rate of 30% and a mortality rate of 1%, Manx shearwater mortality was predicted to be one bird as a result of displacement in the breeding season. For the OAA and 2 km buffer, Manx shearwater mortality was predicted to be 18 birds in the breeding season.

In the autumn migration period of the non-breeding season, there were zero birds recorded in the Array area and 2 km buffer in the autumn migration period of the non-breeding season, therefore potential mortality was also zero. Zero mortality was predicted for the OAA and 2 km buffer in the autumn migration period.

In the spring migration period of the non-breeding season, zero mortality was predicted for the Array area and for the Array area and 2 km buffer.

Table 1-6 Potential Manx shearwater mortality following displacement from the OAA in the breeding season

	Mortality (%)														
%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)															
10	0	1	1	2	2	4	9	13	17	22	26	31	35	39	44
20	1	2	3	3	4	9	17	26	35	44	52	61	70	79	87
30	**1**	3	4	5	7	13	26	39	52	66	79	92	105	118	131
40	2	3	5	7	9	17	35	52	70	87	105	122	140	157	175
50	2	4	7	9	11	22	44	66	87	109	131	153	175	197	219
60	3	5	8	10	13	26	52	79	105	131	157	184	210	236	262
70	3	6	9	12	15	31	61	92	122	153	184	214	245	275	306
80	3	7	10	14	17	35	70	105	140	175	210	245	280	315	350
90	4	8	12	16	20	39	79	118	157	197	236	275	315	354	393
100	4	9	13	17	22	44	87	131	175	219	262	306	350	393	437

Table 1-7 Potential Manx shearwater mortality following displacement from the OAA in the spring migration period of the non-breeding season

	Mortality (%)														
%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%) 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
20	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
30	**0**	0	0	0	0	0	0	0	1	1	1	1	1	1	2
40	0	0	0	0	0	0	0	1	1	1	1	1	2	2	2
50	0	0	0	0	0	0	1	1	1	1	2	2	2	2	3
60	0	0	0	0	0	0	1	1	1	2	2	2	2	3	3
70	0	0	0	0	0	0	1	1	1	2	2	2	3	3	4
80	0	0	0	0	0	0	1	1	2	2	2	3	3	4	4
90	0	0	0	0	0	0	1	1	2	2	3	3	4	4	5
100	0	0	0	0	0	1	1	2	2	3	3	4	4	5	5

Table 1-8 Potential Manx shearwater mortality following displacement from the OAA & 2 km buffer in the breeding season

		Mortality (%)														
	%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)	10	6	12	18	24	30	60	120	180	241	301	361	421	481	541	601
	20	12	24	36	48	60	120	241	361	481	601	722	842	962	1,082	1,203
	30	**18**	36	54	72	90	180	361	541	722	902	1,082	1,263	1,443	1,624	1,804
	40	24	48	72	96	120	241	481	722	962	1,203	1,443	1,684	1,924	2,165	2,405
	50	30	60	90	120	150	301	601	902	1,203	1,503	1,804	2,105	2,405	2,706	3,007
	60	36	72	108	144	180	361	722	1,082	1,443	1,804	2,165	2,525	2,886	3,247	3,608
	70	42	84	126	168	210	421	842	1,263	1,684	2,105	2,525	2,946	3,367	3,788	4,209
	80	48	96	144	192	241	481	962	1,443	1,924	2,405	2,886	3,367	3,848	4,329	4,810
	90	54	108	162	216	271	541	1,082	1,624	2,165	2,706	3,247	3,788	4,329	4,871	5,412
	100	60	120	180	241	301	601	1,203	1,804	2,405	3,007	3,608	4,209	4,810	5,412	6,013

Table 1-9 Potential Manx shearwater mortality following displacement from the OAA & 2 km buffer in the autumn migration period of the non-breeding season

	Mortality (%)															
	%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)	10	0	0	0	0	0	0	0	0	1	1	1	1	1	1	2
	20	0	0	0	0	0	0	1	1	1	2	2	2	2	3	3
	30	**0**	0	0	0	0	0	1	1	2	2	3	3	4	4	5
	40	0	0	0	0	0	1	1	2	2	3	4	4	5	5	6
	50	0	0	0	0	0	1	2	2	3	4	5	5	6	7	8
	60	0	0	0	0	0	1	2	3	4	5	5	6	7	8	9
	70	0	0	0	0	1	1	2	3	4	5	6	7	8	9	11
	80	0	0	0	0	1	1	2	4	5	6	7	8	10	11	12
	90	0	0	0	1	1	1	3	4	5	7	8	9	11	12	14
	100	0	0	0	1	1	2	3	5	6	8	9	11	12	14	15

Table 1-10 Potential Manx shearwater mortality following displacement from the OAA & 2 km buffer in the spring migration period of the non-breeding season

	Mortality (%)															
	%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)	10	0	0	0	0	0	0	1	1	1	1	2	2	2	3	3
	20	0	0	0	0	0	1	1	2	2	3	3	4	4	5	6
	30	**0**	0	0	0	0	1	2	3	3	4	5	6	7	8	8
	40	0	0	0	0	1	1	2	3	4	6	7	8	9	10	11
	50	0	0	0	1	1	1	3	4	6	7	8	10	11	13	14
	60	0	0	1	1	1	2	3	5	7	8	10	12	13	15	17
	70	0	0	1	1	1	2	4	6	8	10	12	14	16	18	20
	80	0	0	1	1	1	2	4	7	9	11	13	16	18	20	22
	90	0	1	1	1	1	3	5	8	10	13	15	18	20	23	25
	100	0	1	1	1	1	3	6	8	11	14	17	20	22	25	28

1.2.4 Gannet

Monthly numbers of gannets in the OAA and OAA plus 2 km buffer in Years 1 and 2 are presented in the Offshore Ornithology Baseline Report. Monthly peak estimated numbers in the breeding season (March to September), autumn migration period (October to November) and spring migration period (December to February) for Years 1 and 2 were averaged to get the two-year mean peak per season. Where peak numbers occurred in different months within the same season across different years, the peak month was used.

In the breeding season (March to September), the mean seasonal peak of gannets in the OAA was 21 birds, while the peak mean estimated number of gannets in the OAA plus the 2 km buffer was 73 birds. In the autumn migration period (October and November), zero gannets were recorded in the OAA, while in the OAA and 2 km buffer, the mean seasonal peak was 72 birds. In the spring migration period, mean seasonal peaks were much lower (Table 1-11).

Table 1-11 Seasonal peak estimated numbers of gannets in the OAA and in the OAA plus 2 km buffer area recorded on baseline surveys

Year	Breeding	Autumn	Spring
OAA	21 birds	0 birds	2 birds
OAA & 2 km buffer	73 birds	72 birds	6 birds

These peak mean estimates were taken as the maximum number of gannets in the OAA and the OAA and 2 km buffer for the breeding season and autumn and spring migration periods. These figures were then used in the Displacement matrices produced for this assessment (Table 1-12 to Table 1-16).

Displacement and Mortality Rates

Post-construction studies in Europe indicate that gannets are likely to exhibit a high degree of avoidance of offshore wind farms. A detailed study using radar and visual observations to monitor the post-construction effects of the Windpark Egmond aan Zee (OWEZ) offshore wind farm in the Netherlands established that 64% of gannets avoided entering the wind farm (Krijgsveld *et al.*, 2011). A similar result (80% macro avoidance) was observed during a study at the Thanet wind farm in the UK (Skov *et al.*, 2018). Leopold *et al.* (2013) reported that most gannets avoided Dutch offshore wind farms and did not forage within the turbine areas. Dierschke *et al.* (2016) concluded that gannets show high avoidance of offshore wind farms despite showing little avoidance of ships.

Results from the two years of post-construction studies at the Beatrice OWF site in the Moray Firth agreed with previous studies, with gannets demonstrating a high degree of wind turbine avoidance. Statistical analysis showed that in Year 1, while there was no evidence for an overall change in abundance in the study area, there was a very strong and significant spatial effect, with a decline centred on the wind farm. This spatial modelling backed up the more simplistic observations of gannets avoiding the wind farm derived from post-construction digital aerial survey data (MacArthur Green, 2021). In Year 2, it was not possible to statistically analyse turbine avoidance as virtually no gannets were recorded within the wind farm (MacArthur Green, 2023).

Recent guidance for OWF projects in Scottish waters recommended that a displacement rate of 70% should be used for gannet (NatureScot, 2023). Based on this, and on available evidence from existing offshore wind farm studies, it has been assumed for this assessment that 70% of gannets will be displaced from the OAA. Although displacement is considered likely to be less than 70% for gannets in the surrounding 2 km buffer area, it has also been assumed that 70% of gannets will be displaced from the

2 km buffer area. Displacement rates of 1% to 100% are presented in Table 1-12 to Table 1-16, with the assessment displacement rate of 70% row highlighted.

Recent guidance for OWF projects in Scottish waters recommended that mortality rates of 1% and 3% throughout the year should be used for gannet in displacement assessments (NatureScot, 2023).

Mortality rates of 1% to 100% are therefore presented in Table 1-12 to Table 1-16, with the assessment mortality rates of 1% and 3% highlighted.

Within the OAA, based on a displacement rate of 70% and mortality rates of 1% and 3%, gannet mortality was predicted to be zero birds as a result of displacement in the breeding season and the autumn and spring migration periods.

For the OAA and 2 km buffer, based on a displacement rate of 70% and a mortality rate of 1%, gannet mortality was predicted to be one bird in the breeding season and one bird in the autumn migration period, with zero mortality predicted in the spring migration period.

For the OAA and 2 km buffer, based on a displacement rate of 70% and a mortality rate of 3%, gannet mortality was predicted to be two birds in the breeding season and two birds in the autumn migration period, with zero mortality predicted in the spring migration period.

Table 1-12 Potential gannet mortality following displacement from the OAA in the breeding season

	Mortality (%)														
%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)															
10	0	0	0	0	0	0	0	1	1	1	1	1	2	2	2
20	0	0	0	0	0	0	1	1	2	2	3	3	3	4	4
30	0	0	0	0	0	1	1	2	3	3	4	4	5	6	6
40	0	0	0	0	0	1	2	3	3	4	5	6	7	8	8
50	0	0	0	0	1	1	2	3	4	5	6	7	8	9	11
60	0	0	0	1	1	1	3	4	5	6	8	9	10	11	13
70	**0**	0	**0**	1	1	1	3	4	6	7	9	10	12	13	15
80	0	0	1	1	1	2	3	5	7	8	10	12	13	15	17
90	0	0	1	1	1	2	4	6	8	9	11	13	15	17	19
100	0	0	1	1	1	2	4	6	8	11	13	15	17	19	21

Table 1-13 Potential gannet mortality following displacement from the OAA in the spring migration period of the non-breeding season

		Mortality (%)														
	%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	30	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
	40	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
	50	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	60	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	70	**0**	0	**0**	0	0	0	0	0	1	1	1	1	1	1	1
	80	0	0	0	0	0	0	0	0	1	1	1	1	1	1	2
	90	0	0	0	0	0	0	0	1	1	1	1	1	1	2	2
	100	0	0	0	0	0	0	0	1	1	1	1	1	2	2	2

Table 1-14 Potential gannet mortality following displacement from the OAA & 2 km buffer in the breeding season

	Mortality (%)														
Displacement (%) %	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	0	1	1	2	3	4	4	5	6	7	7
20	0	0	0	1	1	1	3	4	6	7	9	10	12	13	15
30	0	0	1	1	1	2	4	7	9	11	13	15	18	20	22
40	0	1	1	1	1	3	6	9	12	15	18	20	23	26	29
50	0	1	1	1	2	4	7	11	15	18	22	26	29	33	37
60	0	1	1	2	2	4	9	13	18	22	26	31	35	39	44
70	**1**	1	**2**	2	3	5	10	15	20	26	31	36	41	46	51
80	1	1	2	2	3	6	12	18	23	29	35	41	47	53	58
90	1	1	2	3	3	7	13	20	26	33	39	46	53	59	66
100	1	1	2	3	4	7	15	22	29	37	44	51	58	66	73

Table 1-15 Potential gannet mortality following displacement from the OAA & 2 km buffer in the autumn migration period of the non-breeding season

	Mortality (%)															
	%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)	10	0	0	0	0	0	1	1	2	3	4	4	5	6	6	7
	20	0	0	0	1	1	1	3	4	6	7	9	10	12	13	14
	30	0	0	1	1	1	2	4	6	9	11	13	15	17	19	22
	40	0	1	1	1	1	3	6	9	12	14	17	20	23	26	29
	50	0	1	1	1	2	4	7	11	14	18	22	25	29	32	36
	60	0	1	1	2	2	4	9	13	17	22	26	30	35	39	43
	70	**1**	1	**2**	2	3	5	10	15	20	25	30	35	40	45	50
	80	1	1	2	2	3	6	12	17	23	29	35	40	46	52	58
	90	1	1	2	3	3	6	13	19	26	32	39	45	52	58	65
	100	1	1	2	3	4	7	14	22	29	36	43	50	58	65	72

Table 1-16 Potential gannet mortality following displacement from the OAA & 2 km buffer in the spring migration period of the non-breeding season

		Mortality (%)														
	%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
	20	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	30	0	0	0	0	0	0	0	1	1	1	1	1	1	2	2
	40	0	0	0	0	0	0	0	1	1	1	1	2	2	2	2
	50	0	0	0	0	0	0	1	1	1	2	2	2	2	3	3
	60	0	0	0	0	0	0	1	1	1	2	2	3	3	3	4
	70	**0**	0	**0**	0	0	0	1	1	2	2	3	3	3	4	4
	80	0	0	0	0	0	0	1	1	2	2	3	3	4	4	5
	90	0	0	0	0	0	1	1	2	2	3	3	4	4	5	5
	100	0	0	0	0	0	1	1	2	2	3	4	4	5	5	6

1.2.5 Shag

Monthly numbers of shags in the OAA and OAA plus 2 km buffer in Years 1 and 2 are presented in the Offshore Ornithology Baseline Report. Monthly peak estimated numbers in the breeding season and the non-breeding season for Years 1 and 2 were averaged to get the mean peak per season (Table 1-17). Where peak numbers occurred in different months within the same season across different years, the peak month was used.

In the breeding season (February to August), the mean seasonal peak of shags in the OAA was 25 birds, while in the OAA and 4 km buffer the peak mean was 31 birds (Table 1-17).

Table 1-17 Seasonal peak estimated numbers of shags in the OAA and the OAA plus 2 km buffer area recorded on baseline surveys

Year	Breeding	Non-breeding
OAA	25 birds	12 birds
OAA & 2 km buffer	31 birds	29 birds

In the non-breeding season (September to January), the mean seasonal peak of shags in the OAA was 12 birds, while the peak mean estimated number of shags in the OAA plus the 2 km buffer was 29 birds.

These peak mean estimates were taken as the maximum number of shags in the OAA and the OAA and 2 km buffer for the breeding and non-breeding seasons. These figures were then used in the Displacement matrices produced for this assessment (Table 1-18 to Table 1-21).

Displacement and Mortality Rates

The SNCB guidance (2022) states that 'Disturbance Susceptibility' scores based on Bradbury *et al.,* (2014) can be used to determine the appropriate displacement levels on a species-by-species basis.

Recent advice on likely displacement levels from NatureScot for several offshore wind farm projects in Scotland recommended a displacement level of 60% for guillemot and razorbill (e.g. Marine Scotland, 2022a, Marine Scotland, 2022b). Following SNCB advice, this upper limit of 60% displacement could therefore be applied to shags, as shag has the same 'Disturbance Susceptibility' score of 3, based on Bradbury *et al.*, (2014) as guillemot and razorbill. Similarly, JNCC have recommended a displacement level of 40-60% for shags (Busch *et al.,*2015).

Based on these approaches, a 60% displacement effect has been applied for shags in Table 1-18 to Table 1-21. This is considered to be precautionary, given the limited existing evidence of potential attraction to offshore wind farms for this species.

Although, displacement effects are likely to be lower for birds in the 2 km buffer area around the OAA, for this assessment it has also been assumed that 60% of shags will be displaced from the 2 km buffer area.

For this assessment, for shag, displacement rates of 1% to 100% for the OAA and 2 km buffer are presented in Table 1-18 to Table 1-21, with the assessment displacement rates of 60% row highlighted.

The SNCB (2022a) guidance does not recommend a specific mortality level to apply for shags. In addition, there is no published information on an appropriate mortality rate to use for shags, as there are few offshore wind farms where shags have been recorded in high numbers. However, there is limited evidence from post-construction studies that shags may be attracted to offshore wind farms e.g.

at North Hoyle, where there was evidence of a non-significant increase in use of waters around the wind farm recorded on post-construction studies (PMSS, 2007). Shags have also been observed within other operating OWF projects e.g. Bligh Bank, Thorntonbank, Egmond aan Zee and Horns Rev 1 (Dierscke *et al.,* 2016).

Based on the above studies, it is considered that a mortality rate of 1% for shag is suitably precautionary, and therefore, mortality rates of 1% to 100% for the OAA and 2 km are presented in Table 1-18 to Table 1-21, with the assessment mortality rate of 1% highlighted.

Within the OAA, based on a displacement rate of 60% and a mortality rate of 1%, shag mortality was predicted to be zero birds as a result of displacement in the breeding and non-breeding seasons. Similarly, for the OAA and 2 km buffer, shag mortality was predicted to be zero birds in both the breeding and non-breeding season.

Table 1-18 Potential shag mortality following displacement from the OAA in the breeding season

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

Table 1-19 Potential shag mortality following displacement from the OAA in the non-breeding season

		Mortality (%)														
	%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)	10	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	20	0	0	0	0	0	0	0	1	1	1	1	2	2	2	2
	30	0	0	0	0	0	0	1	1	1	2	2	3	3	3	4
	40	0	0	0	0	0	0	1	1	2	2	3	3	4	4	5
	50	0	0	0	0	0	1	1	2	2	3	4	4	5	5	6
	60	**0**	0	0	0	0	1	1	2	3	4	4	5	6	6	7
	70	0	0	0	0	0	1	2	3	3	4	5	6	7	8	8
	80	0	0	0	0	0	1	2	3	4	5	6	7	8	9	10
	90	0	0	0	0	1	1	2	3	4	5	6	8	9	10	11
	100	0	0	0	0	1	1	2	4	5	6	7	8	10	11	12

Table 1-20 Potential shag mortality following displacement from the OAA & 2 km buffer in the breeding season

	Mortality (%)														
%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%) 10	0	0	0	0	0	0	1	1	1	2	2	2	2	3	3
20	0	0	0	0	0	1	1	2	2	3	4	4	5	6	6
30	0	0	0	0	0	1	2	3	4	5	6	7	7	8	9
40	0	0	0	0	1	1	2	4	5	6	7	9	10	11	12
50	0	0	0	1	1	2	3	5	6	8	9	11	12	14	16
60	**0**	0	1	1	1	2	4	6	7	9	11	13	15	17	19
70	0	0	1	1	1	2	4	7	9	11	13	15	17	20	22
80	0	0	1	1	1	2	5	7	10	12	15	17	20	22	25
90	0	1	1	1	1	3	6	8	11	14	17	20	22	25	28
100	0	1	1	1	2	3	6	9	12	16	19	22	25	28	31

Table 1-21 Potential shag mortality following displacement from the OAA & 2 km buffer in the non-breeding season

	Mortality (%)														
Displacement (%)	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	0	0	1	1	1	1	2	2	2	3	3
20	0	0	0	0	0	1	1	2	2	3	3	4	5	5	6
30	0	0	0	0	0	1	2	3	3	4	5	6	7	8	9
40	0	0	0	0	1	1	2	3	5	6	7	8	9	10	12
50	0	0	0	1	1	1	3	4	6	7	9	10	12	13	15
60	**0**	0	1	1	1	2	3	5	7	9	10	12	14	16	17
70	0	0	1	1	1	2	4	6	8	10	12	14	16	18	20
80	0	0	1	1	1	2	5	7	9	12	14	16	19	21	23
90	0	1	1	1	1	3	5	8	10	13	16	18	21	23	26
100	0	1	1	1	1	3	6	9	12	15	17	20	23	26	29

1.2.6 Eider

SNCB displacement guidance states that because seaduck are considered to be sensitive to the presence of wind turbines, a 4 km buffer around an offshore wind farm should be used for the displacement matrix approach (SNCBs, 2022a).

Monthly numbers of eiders in the OAA and OAA plus 4 km buffer in Years 1 and 2 are presented in the Offshore Ornithology Baseline Report. Eiders were only recorded on baseline surveys in March 2022 and March and April 2023, with peak numbers recorded in March of both years. The non-breeding season for eider is defined as September to mid-April (NatureScot, 2020), therefore this displacement assessment is for the non-breeding season. Monthly peak estimated numbers in the OAA in the non-breeding season for Year 1 (30 birds) and Year 2 (99 birds) were averaged to estimate the mean peak. In the non-breeding season, the mean seasonal peak of eiders in the OAA was therefore 65 birds. As these peak counts of eiders were all recorded in the OAA on baseline surveys, with no eiders recorded in the buffer area, then the mean seasonal peak for the OAA and the 4 km buffer area was also 65 birds.

This peak mean estimate was taken as the maximum number of eiders in the OAA and 4 km buffer for the non-breeding season. These figures were then used in the Displacement matrices produced for this assessment (Table 1-22 and Table 1-23).

Displacement and Mortality Rates

The SNCB guidance (2022a&b) states that 'Disturbance Susceptibility' scores based on Bradbury *et al.,* (2014) can be used to determine the appropriate displacement levels on a species-by-species basis.

Recent advice on likely displacement levels from NatureScot for several offshore wind farm projects in Scotland recommended a displacement level of 60% for guillemot and razorbill (e.g. Marine Scotland, 2022a, Marine Scotland, 2022b). Following SNCB advice, this upper limit of 60% displacement could therefore be applied to eider, as eider has the same 'Disturbance Susceptibility' score of 3, based on Bradbury *et al.*, (2014) as guillemot and razorbill.

Using this approach, a 60% displacement effect has been applied for eiders in Table 1-22 and Table 1-23. Although, displacement effects are likely to be lower for birds in the 4 km buffer area around the OAA, due to the increased distance from turbines, for this assessment it has also been assumed that 60% of eiders will be displaced from the 4 km buffer area.

For this assessment, for eider, displacement rates of 1% to 100% for the OAA and 4 km buffer are presented in Table 1-22 and Table 1-23, with the assessment displacement rates of 60% row highlighted.

The SNCB (2022a) guidance does not recommend a specific mortality level to apply for eider. A level of 1% displacement mortality was considered appropriate in the recent displacement assessment for common scoter at Morecambe Offshore Wind Farm in the UK (Royal Haskoning, 2024). Although common scoter are considered to be more sensitive to displacement effects from OWFs than eider (e.g. Bradbury *et al.*, 2014), it is considered precautionary to apply this mortality rate in this assessment .

Based on the above, it is considered that a mortality rate of 1% for eider is suitably precautionary, and therefore, mortality rates of 1% to 100% for the OAA and 4 km are presented in Table 1-22 and Table 1-23, with the assessment mortality rate of 1% highlighted.

Within the OAA, based on a displacement rate of 60% and a mortality rate of 1%, eider mortality was predicted to be zero birds as a result of displacement in the non-breeding season. Similarly, for the OAA and 4 km buffer, eider mortality was predicted to be zero birds in the non-breeding season.

Table 1-22 Potential eider mortality following displacement from the OAA in the non-breeding season

		Mortality (%)														
	%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)	10	0	0	0	0	0	1	1	2	3	3	4	5	5	6	7
	20	0	0	0	1	1	1	3	4	5	7	8	9	10	12	13
	30	0	0	1	1	1	2	4	6	8	10	12	14	16	18	20
	40	0	1	1	1	1	3	5	8	10	13	16	18	21	23	26
	50	0	1	1	1	2	3	7	10	13	16	20	23	26	29	33
	60	**0**	1	1	2	2	4	8	12	16	20	23	27	31	35	39
	70	0	1	1	2	2	5	9	14	18	23	27	32	36	41	46
	80	1	1	2	2	3	5	10	16	21	26	31	36	42	47	52
	90	1	1	2	2	3	6	12	18	23	29	35	41	47	53	59
	100	1	1	2	3	3	7	13	20	26	33	39	46	52	59	65

Table 1-23 Potential eider mortality following displacement from the OAA & 2 km buffer in the non-breeding season

	Mortality (%)														
Displacement (%) %	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	0	1	1	2	3	3	4	5	5	6	7
20	0	0	0	1	1	1	3	4	5	7	8	9	10	12	13
30	0	0	1	1	1	2	4	6	8	10	12	14	16	18	20
40	0	1	1	1	1	3	5	8	10	13	16	18	21	23	26
50	0	1	1	1	2	3	7	10	13	16	20	23	26	29	33
60	**0**	1	1	2	2	4	8	12	16	20	23	27	31	35	39
70	0	1	1	2	2	5	9	14	18	23	27	32	36	41	46
80	1	1	2	2	3	5	10	16	21	26	31	36	42	47	52
90	1	1	2	2	3	6	12	18	23	29	35	41	47	53	59
100	1	1	2	3	3	7	13	20	26	33	39	46	52	59	65

1.2.7 Kittiwake

Monthly numbers of kittiwakes in the OAA and OAA plus 2 km buffer in Years 1 and 2 are presented in the Offshore Ornithology Baseline Report. Monthly peak estimated numbers in the breeding season (March to August), autumn migration period (September to December) and spring migration period (January to February) for Years 1 and 2 were averaged to get the mean seasonal peak. Where peak numbers occurred in different months within the same season across different years, the peak month was used.

In the breeding season, the mean seasonal peak of kittiwakes in the OAA was 47 birds, while the mean seasonal peak of kittiwakes in the OAA plus 2 km buffer was 93 birds (Table 1-24).

Table 1-24 Seasonal peak estimated numbers of kittiwakes in the OAA and in the OAA plus 2 km buffer area recorded on baseline surveys

Year	Breeding	Autumn	Spring
OAA	47 birds	27 birds	50 birds
OAA & 2 km buffer	93 birds	79 birds	144 birds

In the autumn migration period, the mean seasonal peak of kittiwakes in the OAA was 27 birds, while the mean seasonal peak of kittiwakes in the OAA plus 2 km buffer was 79 birds (Table 1-24).

In the spring migration period, the mean seasonal peak of kittiwakes in the OAA was 50 birds, while the mean seasonal peak of kittiwakes in the OAA plus 2 km buffer was 144 birds (Table 1-24).

These peak mean estimates were taken as the maximum number of kittiwakes in the OAA and the OAA and 2 km buffer for the breeding season and autumn and spring migration periods. These figures were then used in the Displacement matrices produced for this assessment (Table 1-25 to Table 1-30).

Displacement and Mortality Rates

There is evidence from other operating offshore wind farm projects that displacement of kittiwakes is not likely to occur to any significant level. A review of post-construction studies of seabirds at offshore wind farms in European waters concluded that kittiwake was one of the species which were hardly affected by offshore wind farms or with attraction and avoidance approximately equal over all studies (Dierschke *et al.*, 2016). Two reviews of vulnerability of Scottish seabirds to offshore wind turbines in the context of disturbance and displacement ranked kittiwake with a score of two, where five was the most vulnerable score and one was the least vulnerable (Furness and Wade, 2012, Furness *et al.*, 2013). Similarly, Bradbury *et al.*, (2014), classified the kittiwake population vulnerability to displacement as very low.

Similarly, in the SNCB (2022a) advice note on displacement, kittiwake is not listed among the priority species for displacement assessment, as it falls below the threshold of disturbance sensitivity used to determine which species should be taken forward for displacement assessment.

Recent guidance for OWF projects in Scottish waters recommended that a displacement rate of 30% should be used for kittiwakes (NatureScot, 2023). Based on this, it has been assumed for this assessment that 30% of kittiwakes will be displaced from the OAA. Although displacement is considered likely to be less than 30% for kittiwakes in the surrounding 2 km buffer area, it has also been assumed that 30% of kittiwakes will be displaced from the 2 km buffer area. Displacement rates of 1% to 100% are presented in Table 1-25 to Table 1-30, with the assessment displacement rate of 30% row highlighted.

Recent guidance for OWF projects in Scottish waters recommended that mortality rates of 1% and 3% throughout the year should be used for kittiwake in displacement assessments (NatureScot, 2023).

Mortality rates of 1% to 100% are therefore presented in Table 1-25 to Table 1-30, with the assessment mortality rates of 1% and 3% highlighted.

However, as presented above, available evidence from post-construction studies and previous reviews indicates that displacement of kittiwakes by offshore wind turbines is not likely to occur to any significant extent. It is therefore considered that 30% displacement with a mortality rate of 1% is suitably precautionary for an assessment of displacement effects from the Offshore Site on kittiwakes.

Within the OAA, based on a displacement rate of 30% and mortality rates of 1% and 3%, kittiwake mortality was predicted to be zero birds as a result of displacement in the breeding season and the autumn and spring migration periods.

For the OAA and 2 km buffer, kittiwake mortality was also predicted to be zero birds in the breeding season and the autumn and spring migration periods based on a displacement rate of 30% and a mortality rate of 1%. Based on a displacement rate of 30% and a mortality rate of 3%, resulted in a predicted mortality of one kittiwake in the breeding season, one in the autumn migration period and one in the spring migration period.

Table 1-25 Potential kittiwake mortality following displacement from the OAA in the breeding season

	Mortality (%)														
%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%) 10	0	0	0	0	0	0	1	1	2	2	3	3	4	4	5
20	0	0	0	0	0	1	2	3	4	5	6	7	8	8	9
30	**0**	0	**0**	1	1	1	3	4	6	7	8	10	11	13	14
40	0	0	1	1	1	2	4	6	8	9	11	13	15	17	19
50	0	0	1	1	1	2	5	7	9	12	14	16	19	21	24
60	0	1	1	1	1	3	6	8	11	14	17	20	23	25	28
70	0	1	1	1	2	3	7	10	13	16	20	23	26	30	33
80	0	1	1	2	2	4	8	11	15	19	23	26	30	34	38
90	0	1	1	2	2	4	8	13	17	21	25	30	34	38	42
100	0	1	1	2	2	5	9	14	19	24	28	33	38	42	47

Table 1-26 Potential kittiwake mortality following displacement from the OAA in the autumn migration period of the non-breeding season

		Mortality (%)														
	%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)	10	0	0	0	0	0	0	1	1	1	1	2	2	2	2	3
	20	0	0	0	0	0	1	1	2	2	3	3	4	4	5	5
	30	**0**	0	**0**	0	0	1	2	2	3	4	5	6	6	7	8
	40	0	0	0	0	1	1	2	3	4	5	6	8	9	10	11
	50	0	0	0	1	1	1	3	4	5	7	8	9	11	12	14
	60	0	0	0	1	1	2	3	5	6	8	10	11	13	15	16
	70	0	0	1	1	1	2	4	6	8	9	11	13	15	17	19
	80	0	0	1	1	1	2	4	6	9	11	13	15	17	19	22
	90	0	0	1	1	1	2	5	7	10	12	15	17	19	22	24
	100	0	1	1	1	1	3	5	8	11	14	16	19	22	24	27

Table 1-27 Potential kittiwake mortality following displacement from the OAA in the spring migration period of the non-breeding season

	Mortality (%)														
%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%) 10	0	0	0	0	0	1	1	2	2	3	3	4	4	5	5
20	0	0	0	0	1	1	2	3	4	5	6	7	8	9	10
30	**0**	0	**0**	1	1	2	3	5	6	8	9	11	12	14	15
40	0	0	1	1	1	2	4	6	8	10	12	14	16	18	20
50	0	1	1	1	1	3	5	8	10	13	15	18	20	23	25
60	0	1	1	1	2	3	6	9	12	15	18	21	24	27	30
70	0	1	1	1	2	4	7	11	14	18	21	25	28	32	35
80	0	1	1	2	2	4	8	12	16	20	24	28	32	36	40
90	0	1	1	2	2	5	9	14	18	23	27	32	36	41	45
100	1	1	2	2	3	5	10	15	20	25	30	35	40	45	50

Table 1-28 Potential kittiwake mortality following displacement from the OAA & 2 km buffer in the breeding season

	Mortality (%)															
	%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)	10	0	0	0	0	0	1	2	3	4	5	6	7	7	8	9
	20	0	0	1	1	1	2	4	6	7	9	11	13	15	17	19
	30	**0**	1	**1**	1	1	3	6	8	11	14	17	20	22	25	28
	40	0	1	1	1	2	4	7	11	15	19	22	26	30	33	37
	50	0	1	1	2	2	5	9	14	19	23	28	33	37	42	47
	60	1	1	2	2	3	6	11	17	22	28	33	39	45	50	56
	70	1	1	2	3	3	7	13	20	26	33	39	46	52	59	65
	80	1	1	2	3	4	7	15	22	30	37	45	52	60	67	74
	90	1	2	3	3	4	8	17	25	33	42	50	59	67	75	84
	100	1	2	3	4	5	9	19	28	37	47	56	65	74	84	93

Table 1-29 Potential kittiwake mortality following displacement from the OAA & 2 km buffer in the autumn migration period of the non-breeding season

	Mortality (%)															
	%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)	10	0	0	0	0	0	1	2	2	3	4	5	6	6	7	8
	20	0	0	0	1	1	2	3	5	6	8	9	11	13	14	16
	30	**0**	0	**1**	1	1	2	5	7	9	12	14	17	19	21	24
	40	0	1	1	1	2	3	6	9	13	16	19	22	25	28	32
	50	0	1	1	2	2	4	8	12	16	20	24	28	32	36	40
	60	0	1	1	2	2	5	9	14	19	24	28	33	38	43	47
	70	1	1	2	2	3	6	11	17	22	28	33	39	44	50	55
	80	1	1	2	3	3	6	13	19	25	32	38	44	51	57	63
	90	1	1	2	3	4	7	14	21	28	36	43	50	57	64	71
	100	1	2	2	3	4	8	16	24	32	40	47	55	63	71	79

Table 1-30 Potential kittiwake mortality following displacement from the OAA & 2 km buffer in the spring migration period of the non-breeding season

	Mortality (%)															
	%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)	10	0	0	0	1	1	1	3	4	6	7	9	10	12	13	14
	20	0	1	1	1	1	3	6	9	12	14	17	20	23	26	29
	30	**0**	1	**1**	2	2	4	9	13	17	22	26	30	35	39	43
	40	1	1	2	2	3	6	12	17	23	29	35	40	46	52	58
	50	1	1	2	3	4	7	14	22	29	36	43	50	58	65	72
	60	1	2	3	3	4	9	17	26	35	43	52	60	69	78	86
	70	1	2	3	4	5	10	20	30	40	50	60	71	81	91	101
	80	1	2	3	5	6	12	23	35	46	58	69	81	92	104	115
	90	1	3	4	5	6	13	26	39	52	65	78	91	104	117	130
	100	1	3	4	6	7	14	29	43	58	72	86	101	115	130	144

1.2.8 Common Tern

Monthly numbers of common terns in the OAA and OAA plus 2 km buffer in Years 1 and 2 are presented in the Offshore Ornithology Baseline Report. Monthly peak estimated numbers in the breeding season (May to August), autumn migration period (September) and spring migration period (April) for Years 1 and 2 were averaged to get the mean seasonal peak. Where peak numbers occurred in different months within the same season across different years, the peak month was used.

In the breeding season, the mean seasonal peak of common terns in the OAA was 15 birds, while the mean seasonal peak of common terns in the OAA plus 2 km buffer was 48 birds (Table 1-31). Common terns were not recorded on baseline surveys in the OAA or the 2 km buffer in the autumn or spring migration periods.

Table 1-31 Seasonal peak estimated numbers of common terns in the OAA and in the OAA plus 2 km buffer area recorded on baseline surveys

Year	Breeding	Autumn	Spring
OAA	15 birds	0 birds	0 birds
OAA & 2 km buffer	48 birds	0 birds	0 birds

These peak mean estimates were taken as the maximum number of common terns in the OAA and the OAA and 2 km buffer for the breeding season and autumn and spring migration periods. These figures were then used in the Displacement matrices produced for this assessment (Table 1-32 and Table 1-33).

Displacement and Mortality Rates

There is considerable uncertainty on the response of terns to OWFs. A number of studies found no evidence of displacement of terns (e.g. Gill *et al.,* 2008, Leopold *et al.,* 2011, Lindeboom *et al.,* 2011), while results indicating displacement have been recorded at Horns Rev I (Petersen *et al.,* 2006), Egmond aan Zee (Leopold *et al.,* 2013) and Alpha Ventus, where the number of tern clusters reduced by about 75% within the wind farm (Welcker and Nehls, 2016). Evidence for attraction of common terns was recorded at Thortonbank OWF (Vanermen *et al.,* 2013). A review of post-construction studies by Dierscke *et al.,* (2016) concluded that for both common and Arctic terns, evidence for attraction and avoidance behaviour were approximately equal between studies, with no strong evidence of either attraction or avoidance.

The SNCB guidance (2022a) states that 'Disturbance Susceptibility' scores based on Bradbury *et al.,* (2014) can be used to determine the appropriate displacement levels on a species-by-species basis. Using this approach, a displacement level of 30% could be applied to common terns, as this species has the same 'Disturbance Susceptibility' score of 3, based on Bradbury *et al.,* (2014) as kittiwake. Advice on likely displacement levels from NatureScot for several offshore wind farm projects off the east coast of Scotland recommended a displacement level of 30% for kittiwake (e.g. Marine Scotland, 2022a and Marine Scotland, 2022b)

Displacement rates of 1% to 100% are presented in Table 1-32 and Table 1-33, with the assessment displacement rate of 30% row highlighted.

Mortality rates of 1% to 100% are presented in Table 1-32 and Table 1-33, with the assessment mortality rate of 1% highlighted.

Within the OAA, based on a displacement rate of 30% and a mortality rate of 1%, common tern mortality was predicted to be zero birds as a result of displacement in the breeding season and the autumn and spring migration periods. For the OAA and 2 km buffer, common tern mortality was also predicted to be zero birds in the breeding season and the autumn and spring migration periods.

Table 1-32 Potential common tern mortality following displacement from the OAA in the breeding season

	Mortality (%)														
%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%) 10	0	0	0	0	0	0	0	0	1	1	1	1	1	1	2
20	0	0	0	0	0	0	1	1	1	2	2	2	2	3	3
30	**0**	0	0	0	0	0	1	1	2	2	3	3	4	4	5
40	0	0	0	0	0	1	1	2	2	3	4	4	5	5	6
50	0	0	0	0	0	1	2	2	3	4	5	5	6	7	8
60	0	0	0	0	0	1	2	3	4	5	5	6	7	8	9
70	0	0	0	0	1	1	2	3	4	5	6	7	8	9	11
80	0	0	0	0	1	1	2	4	5	6	7	8	10	11	12
90	0	0	0	1	1	1	3	4	5	7	8	9	11	12	14
100	0	0	0	1	1	2	3	5	6	8	9	11	12	14	15

Table 1-33 Potential common tern mortality following displacement from the OAA & 2 km buffer in the breeding season

		Mortality (%)														
	%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)	10	0	0	0	0	0	0	1	1	2	2	3	3	4	4	5
	20	0	0	0	0	0	1	2	3	4	5	6	7	8	9	10
	30	**0**	0	0	1	1	1	3	4	6	7	9	10	12	13	14
	40	0	0	1	1	1	2	4	6	8	10	12	13	15	17	19
	50	0	0	1	1	1	2	5	7	10	12	14	17	19	22	24
	60	0	1	1	1	1	3	6	9	12	14	17	20	23	26	29
	70	0	1	1	1	2	3	7	10	13	17	20	24	27	30	34
	80	0	1	1	2	2	4	8	12	15	19	23	27	31	35	38
	90	0	1	1	2	2	4	9	13	17	22	26	30	35	39	43
	100	0	1	1	2	2	5	10	14	19	24	29	34	38	43	48

1.2.9 Arctic Tern

Monthly numbers of Arctic terns in the OAA and OAA plus 2 km buffer in Years 1 and 2 are presented in the Offshore Ornithology Baseline Report. Monthly peak estimated numbers in the breeding season (May to early August), autumn migration period (September) and spring migration period (April) for Years 1 and 2 were averaged to get the mean seasonal peak. Where peak numbers occurred in different months within the same season across different years, the peak month was used.

In the breeding season, the mean seasonal peak of Arctic terns in the OAA was 12 birds, while the mean seasonal peak of Arctic terns in the OAA plus 2 km buffer was 58 birds (Table 1-34). Arctic terns were not recorded on baseline surveys in the OAA or the 2 km buffer in the autumn or spring migration periods.

Table 1-34 Seasonal peak estimated numbers of Arctic terns in the OAA and in the OAA plus 2 km buffer area recorded on baseline surveys

Year	Breeding	Autumn	Spring
OAA	12 birds	0 birds	0 birds
OAA & 2 km buffer	58 birds	0 birds	0 birds

These peak mean estimates were taken as the maximum number of Arctic terns in the OAA and the OAA and 2 km buffer for the breeding season and autumn and spring migration periods. These figures were then used in the Displacement matrices produced for this assessment (Table 1-35 and Table 1-36).

Displacement and Mortality Rates

There is considerable uncertainty on the response of terns to OWFs. A number of studies found no evidence of displacement of terns (e.g. Gill *et al.,* 2008, Leopold *et al.,* 2011, Lindeboom *et al.,* 2011), while results indicating displacement have been recorded at Horns Rev I (Petersen *et al.,* 2006), Egmond aan Zee (Leopold *et al.,* 2013) and Alpha Ventus, where the number of tern clusters reduced by about 75% within the wind farm (Welcker and Nehls, 2016). A review of post-construction studies by Dierscke *et al.,* (2016) concluded that for both common and Arctic terns, evidence for attraction and avoidance behaviour were approximately equal between studies, with no strong evidence of either attraction or avoidance.

The SNCB guidance (2022) states that 'Disturbance Susceptibility' scores based on Bradbury *et al.,* (2014) can be used to determine the appropriate displacement levels on a species-by-species basis. Using this approach, a displacement level of 30% could be applied to Arctic terns, as this species has the same 'Disturbance Susceptibility' score of 3, based on Bradbury *et al.*, (2014) as kittiwake. Advice on likely displacement levels from NatureScot for several offshore wind farm projects off the east coast of Scotland recommended a displacement level of 30% for kittiwake (e.g. Marine Scotland, 2022a and Marine Scotland, 2022b)

Displacement rates of 1% to 100% are presented in Table 1-35 and Table 1-36, with the assessment displacement rate of 30% row highlighted.

Mortality rates of 1% to 100% are presented in Table 1-35 and Table 1-36, with the assessment mortality rate of 1% highlighted.

Within the OAA, based on a displacement rate of 30% and a mortality rate of 1%, Arctic tern mortality was predicted to be zero birds as a result of displacement in the breeding season and the autumn and spring migration periods. For the OAA and 2 km buffer, Arctic tern mortality was also predicted to be zero birds in the breeding season and the autumn and spring migration periods.

Table 1-35 Potential Arctic tern mortality following displacement from the OAA in the breeding season

		Mortality (%)														
	%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)	10	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	20	0	0	0	0	0	0	0	1	1	1	1	2	2	2	2
	30	**0**	0	0	0	0	0	1	1	1	2	2	3	3	3	4
	40	0	0	0	0	0	0	1	1	2	2	3	3	4	4	5
	50	0	0	0	0	0	1	1	2	2	3	4	4	5	5	6
	60	0	0	0	0	0	1	1	2	3	4	4	5	6	6	7
	70	0	0	0	0	0	1	2	3	3	4	5	6	7	8	8
	80	0	0	0	0	0	1	2	3	4	5	6	7	8	9	10
	90	0	0	0	0	1	1	2	3	4	5	6	8	9	10	11
	100	0	0	0	0	1	1	2	4	5	6	7	8	10	11	12

Table 1-36 Potential Arctic tern mortality following displacement from the OAA & 2 km buffer in the breeding season

		Mortality (%)														
	%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)	10	0	0	0	0	0	1	1	2	2	3	3	4	5	5	6
	20	0	0	0	0	1	1	2	3	5	6	7	8	9	10	12
	30	**0**	0	1	1	1	2	3	5	7	9	10	12	14	16	17
	40	0	0	1	1	1	2	5	7	9	12	14	16	19	21	23
	50	0	1	1	1	1	3	6	9	12	15	17	20	23	26	29
	60	0	1	1	1	2	3	7	10	14	17	21	24	28	31	35
	70	0	1	1	2	2	4	8	12	16	20	24	28	32	37	41
	80	0	1	1	2	2	5	9	14	19	23	28	32	37	42	46
	90	1	1	2	2	3	5	10	16	21	26	31	37	42	47	52
	100	1	1	2	2	3	6	12	17	23	29	35	41	46	52	58

1.2.10 Guillemot

Monthly numbers of guillemots in the OAA and OAA plus 2 km buffer in Years 1 and 2 are presented in the Offshore Ornithology Baseline Report. This includes sightings of guillemots/razorbills recorded on baseline surveys that could not be determined to species. These birds have been apportioned to species according to the ratio of identified birds in each month. Further details are presented in the Offshore Ornithology Baseline Report.

Monthly peak estimated numbers in the breeding season (March to July) and the non-breeding season (August to February) for Years 1 and 2 were averaged to get the mean seasonal peak for each season (Table 1-37). Where peak numbers occurred in different months within the same season across different years, the peak month was used.

In the breeding season, the mean seasonal peak of guillemots in the OAA was 377 birds, while the mean seasonal peak of guillemots in the OAA plus 2 km buffer was 3,216 birds.

Table 1-37 Seasonal peak estimated numbers of guillemots in the OAA and the OAA plus 2 km buffer area recorded on baseline surveys

Year	Breeding	Non-breeding
OAA	377 birds	113 birds
OAA & 2 km buffer	3,216 birds	308 birds

In the non-breeding season, the mean seasonal peak of guillemots in the OAA was 113 birds, while the mean seasonal peak of guillemots in the OAA plus 2 km buffer was 308 birds.

These peak mean estimates were taken as the maximum number of guillemots in the OAA and the OAA and 2 km buffer for the breeding and non-breeding seasons. These figures were then used in the Displacement matrices produced for this assessment (Table 1-38 to Table 1-41).

Displacement and Mortality Rates

Recent NatureScot guidance on likely displacement levels for Scottish OWF projects recommended a displacement level of 60% for guillemot (NatureScot, 2023).

For this assessment, for guillemot, displacement rates of 1% to 100% for the OAA and 2 km buffer are presented in Table 1-38 to Table 1-41, with the assessment displacement rates of 50% and 60% rows highlighted.

However, it should be noted that post-construction studies at operational OWFs indicate that the displacement rate of guillemots and razorbills is less than 60%. A recent review of post-construction displacement at OWFs showed that guillemots are not completely displaced from OWFs. The strongest displacement effects were reported for Thorntonbank and Bligh Bank OWFs in Belgian waters, with reductions in density of 68% and 75% for guillemot respectively at these two OWFs (Dierschke *et al.*, 2016).

A more recent review (APEM, 2022) considered that some of the predicted displacement effects on auks reported by Dierschke *et al.,* (2016) may have been over-estimated, as a result of the statistical analyses used. The APEM review based on all OWF post-construction monitoring studies undertaken to date within the North Sea and UK Western Waters found that there was considerable variation in post-construction results from different projects, with one project reporting positive displacement effects, eight projects reporting none or weakly significant displacement effects, three projects inferring displacement effects (but these were not statistically tested) and eight projects reporting negative displacement effects (APEM, 2022).

After examining the analysis methods used in these different studies, the APEM (2022) review concluded that not all predicted displacement effects were equally statistically robust, as there were several projects that reported low or very low auk abundance but which concluded that there were high displacement rates. The review indicated that for projects low auk abundance and corresponding high numbers of zero counts, the prediction of likely displacement rates would be highly problematic, given the natural spatial and temporal variation in auk abundance and distribution. The review concluded that the reported displacement effects for these projects were therefore most likely unreliable.

One example of this is a study at the Prinses Amalia and Egmond aan Zee OWFs off the coast of the Netherlands, where significant displacement effects were previously reported. Independent re-analysis of post-construction data using the statistical package R-INLA did not detect a statistically significant effect (Zuur, 2018). The Zuur study also concluded that previously reported displacement effects at Alpha Ventus, Blighbank, Thorntonbank and Horns Rev OWFs, may also be misleading as there were high numbers of zero observations of guillemots in these datasets. The re-analysis work concluded that the presence of high numbers of zero observations of a species in a dataset is a major challenge for statistical analysis, requiring advanced statistical methods (Zuur, 2018). These studies make up the majority of reported auk displacement rates of up to 75%.

Overall, the APEM review (2022) recommended that results from these post-construction studies with low numbers of auks should be regarded with caution and not presented as strong evidence in support of high displacement effects, following the work undertaken by Zuur (2018).

Post-construction studies at Beatrice OWF in the Moray Firth, Scotland reported that both guillemots and razorbills were more abundant within the wind farm on post-construction surveys compared to pre-construction surveys. Results showed that the overall guillemot and razorbill abundance increased significantly on post-construction surveys, but the spatial component of this relationship was not significant (MacArthur Green, 2021).

Similarly, a post-construction displacement study in the Belgian OWF zone recorded higher densities of razorbills and slightly higher densities of guillemots within the turbine array compared to outside, on a survey conducted in February 2021. Within the turbine area, the peak recorded density of razorbills was 4.59 birds/km^2, compared to 2.36 birds/km^2 outside the turbine area. For guillemot, densities inside the turbine area were slightly higher than outside (1.18 birds/km^2 inside compared to 1.03 birds/km^2 outside) (Vanerman *et al.*, 2021).

The APEM (2022) review recommended that a displacement rate of up to 50% for guillemots and razorbills is suitably precautionary. Although post-construction studies indicate that displacement is likely to be less than 50% for guillemots and razorbills in the surrounding 2 km buffer area (MacArthur Green 2019), for this assessment it has also been assumed that 50% of guillemots will be displaced from the 2 km buffer area.

While both 50% and 60% displacement rates have been used in this assessment, it is considered that applying 50% displacement rate for the array area and 2 km buffer is suitably precautionary, based on available evidence from post-construction studies at operating OWFs in Europe.

The SNCB (2022a) guidance does not recommend a specific mortality level to apply for guillemots or razorbills. However, recent NatureScot guidance on likely displacement mortality levels for Scottish OWF projects recommended using mortality rates of 3% and 5% in the breeding season and 1% and 3% in the non-breeding season for guillemot (NatureScot, 2023). Therefore, mortality rates of 1% to 100% for the OAA and 2 km are presented in Table 1-38 to Table 1-41, with the assessment mortality rates of 3% and 5% highlighted for the breeding season and 1% and 3% highlighted for the non-breeding season. However, it should be noted that it is considered that mortality rates of 3% and 5% in the breeding season for guillemot is overly precautionary, based on available post-construction evidence.

Although studies investigating potential guillemot and razorbill mortality as a result of displacement from offshore wind turbines are limited, results from relevant studies are summarised below. A study conducted by van Kooten *et al.*, (2019) involved assessments for guillemots and razorbills in the non-breeding season and included existing and planned North Sea OWFs as presented in Van der Wal *et al.,* (2018). The analysis consisted of habitat quality maps based on seabird distribution data and determining the cost of habitat loss using an individual based energy-budget model. Displacement rates were set at a realistic maximum of 50% based on Dierschke *et al.,* (2016) or an overly precautionary 100% in order to understand the consequences of complete displacement. Two mortality rates were tested; the first based on the Individual Based Model (IBM), using an energy budget approach to quantify this effect, while the second was based on a precautionary 10% mortality rate. The study estimated an additional non-breeding season mortality rate for displaced guillemots and razorbills of 0.1% for a 50% displacement rate and 0.4% for a 100% displacement rate.

A study on the likely consequences of displacement at the population level concluded that displacement of guillemots and razorbills by OWFs is likely to be incomplete, may reduce with habituation, and that in the long term there may be increased food availability for guillemots and razorbills through providing enhanced habitat for fish populations around OWFs (MacArthur Green 2019). These factors, together with the very low level of natural mortality of adult guillemots and razorbills (approximately 6% and 10% per annum respectively; Horswill and Robinson, 2015), suggest that impacts of displacement from OWFs are unlikely to represent levels of mortality anywhere close to the 6% or 10% total annual mortality that occurs due to the combination of many natural factors plus existing human activities (MacArthur Green 2019).

In addition, there is anecdotal evidence from colony counts of guillemots breeding on Helgoland in the German North Sea close to where OWFs have been operating since 2014. Displacement rates for guillemots were predicted to be 44% in the breeding season and 63% in the non-breeding season (Peschko *et al.,* 2020). However, colony counts of breeding guillemots at the colony have remained largely stable between 2000–2018, indicating that the mortality rate associated with displacement from the offshore wind farms is not higher than 1% (Dierschke *et al.*, 2011; Dierschke *et al.,* 2016).

Within the OAA in the breeding season, based on a displacement rate of 50% and a mortality rate of 1%, guillemot mortality was predicted to be two birds as a result of displacement in the breeding season. Based on a displacement rate of 60% and a mortality rate of 3%, guillemot mortality was predicted to be seven birds. Applying a mortality rate of 5% resulted in a predicted mortality of 11 birds as a result of displacement (Table 1-38).

Within the OAA in the non-breeding season, based on a displacement rate of 50% and a mortality rate of 1%, guillemot mortality was predicted to be one bird as a result of displacement. Based on a displacement rate of 60% and a mortality rate of 1%, guillemot mortality was also predicted to involve one bird. Applying a mortality rate of 3% resulted in a predicted mortality of two guillemots as a result of displacement (Table 1-39).

For the OAA and 2 km buffer in the breeding season, based on a displacement rate of 50% and a mortality rate of 1%, guillemot mortality was predicted to be 16 birds. Based on a displacement rate of 60% and a mortality rate of 3%, guillemot mortality was predicted to be 58. Applying a mortality rate of 5% resulted in a predicted mortality of 96 birds as a result of displacement (Table 1-40).

For the OAA and 2 km buffer in the non-breeding season, based on a displacement rate of 50% and a mortality rate of 1%, guillemot mortality was predicted to be two birds as a result of displacement. Based on a displacement rate of 60% and a mortality rate of 1%, guillemot mortality was also predicted to be two birds. Applying a mortality rate of 3% resulted in a predicted mortality of six guillemots as a result of displacement (Table 1-41).

Table 1-38 Potential guillemot mortality following displacement from the OAA in the breeding season

		Mortality (%)														
	%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)	10	0	1	1	2	2	4	8	11	15	19	23	26	30	34	38
	20	1	2	2	3	4	8	15	23	30	38	45	53	60	68	75
	30	1	2	3	5	6	11	23	34	45	57	68	79	90	102	113
	40	2	3	5	6	8	15	30	45	60	75	90	106	121	136	151
	50	**2**	4	6	8	9	19	38	57	75	94	113	132	151	170	189
	60	2	5	**7**	9	**11**	23	45	68	90	113	136	158	181	204	226
	70	3	5	8	11	13	26	53	79	106	132	158	185	211	238	264
	80	3	6	9	12	15	30	60	90	121	151	181	211	241	271	302
	90	3	7	10	14	17	34	68	102	136	170	204	238	271	305	339
	100	4	8	11	15	19	38	75	113	151	189	226	264	302	339	377

Table 1-39 Potential guillemot mortality following displacement from the OAA in the non-breeding season

	Mortality (%)														
Displacement (%) / %	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	1	1	2	3	5	6	7	8	9	10	11
20	0	0	1	1	1	2	5	7	9	11	14	16	18	20	23
30	0	1	1	1	2	3	7	10	14	17	20	24	27	31	34
40	0	1	1	2	2	5	9	14	18	23	27	32	36	41	45
50	**1**	1	2	2	3	6	11	17	23	28	34	40	45	51	57
60	**1**	1	**2**	3	3	7	14	20	27	34	41	47	54	61	68
70	1	2	2	3	4	8	16	24	32	40	47	55	63	71	79
80	1	2	3	4	5	9	18	27	36	45	54	63	72	81	90
90	1	2	3	4	5	10	20	31	41	51	61	71	81	92	102
100	1	2	3	5	6	11	23	34	45	57	68	79	90	102	113

Table 1-40 Potential guillemot mortality following displacement from the OAA & 2 km buffer in the breeding season

	Mortality (%)														
Displacement (%)	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
10	3	6	10	13	16	32	64	96	129	161	193	225	257	289	322
20	6	13	19	26	32	64	129	193	257	322	386	450	515	579	643
30	10	19	29	39	48	96	193	289	386	482	579	675	772	868	965
40	13	26	39	51	64	129	257	386	515	643	772	900	1,029	1,158	1,286
50	**16**	32	48	64	80	161	322	482	643	804	965	1,126	1,286	1,447	1,608
60	19	39	**58**	77	**96**	193	386	579	772	965	1,158	1,351	1,544	1,737	1,930
70	23	45	68	90	113	225	450	675	900	1,126	1,351	1,576	1,801	2,026	2,251
80	26	51	77	103	129	257	515	772	1,029	1,286	1,544	1,801	2,058	2,316	2,573
90	29	58	87	116	145	289	579	868	1,158	1,447	1,737	2,026	2,316	2,605	2,894
100	32	64	96	129	161	322	643	965	1,286	1,608	1,930	2,251	2,573	2,894	3,216

Table 1-41 Potential guillemot mortality following displacement from the OAA & 2 km buffer in the non-breeding season

	Mortality (%)														
Displacement (%)	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
10	0	1	1	1	2	3	6	9	12	15	18	22	25	28	31
20	1	1	2	2	3	6	12	18	25	31	37	43	49	55	62
30	1	2	3	4	5	9	18	28	37	46	55	65	74	83	92
40	1	2	4	5	6	12	25	37	49	62	74	86	99	111	123
50	**2**	3	5	6	8	15	31	46	62	77	92	108	123	139	154
60	**2**	4	**6**	7	9	18	37	55	74	92	111	129	148	166	185
70	2	4	6	9	11	22	43	65	86	108	129	151	172	194	216
80	2	5	7	10	12	25	49	74	99	123	148	172	197	222	246
90	3	6	8	11	14	28	55	83	111	139	166	194	222	249	277
100	3	6	9	12	15	31	62	92	123	154	185	216	246	277	308

1.2.11 Razorbill

Monthly numbers of razorbills in the OAA and OAA plus 2 km buffer in Years 1 and 2 are presented in the Offshore Ornithology Baseline Report. This includes sightings of guillemots/razorbills recorded on baseline surveys that could not be determined to species. These birds have been apportioned to species according to the ratio of identified birds in each month.

Monthly peak estimated numbers in the breeding season (April to July), the autumn migration period (August to October), the winter period (November and December) and the spring migration period (January to March) of the non-breeding season for Years 1 and 2 were averaged to get the mean seasonal peak (Table 1-42). Where peak numbers occurred in different months within the same season across different years, the peak month was used.

In the breeding season, the mean seasonal peak of razorbills in the OAA was 16 birds, while the mean seasonal peak of razorbills in the OAA plus 2 km buffer was 220 birds (Table 1-42).

Table 1-42 Seasonal peak estimated numbers of razorbill in the OAA and in the OAA plus 2 km buffer area recorded on baseline surveys

Year	Breeding	Autumn	Winter	Spring
OAA	16 birds	3 birds	40 birds	29 birds
OAA & 2 km buffer	220 birds	11 birds	191 birds	79 birds

In the autumn migration period, the mean seasonal peak of razorbills in the OAA was three birds, while the mean seasonal peak of razorbills in the OAA plus 2 km buffer was 11 birds (Table 1-42).

In the winter period, the mean seasonal peak of razorbills in the OAA was 40 birds, while the mean seasonal peak of razorbills in the OAA plus 2 km buffer was 191 birds (Table 1-42).

In the spring migration period, the mean seasonal peak of razorbills in the OAA was 29 birds, while the mean seasonal peak of razorbills in the OAA plus 2 km buffer was 79 birds (Table 1-42).

These peak mean estimates were taken as the maximum number of razorbills in the OAA and the OAA and 2 km buffer for the breeding season and autumn, winter and spring migration periods. These figures were then used in the Displacement matrices produced for this assessment (Table 1-43 to Table 1-50).

Displacement and Mortality Rates

Evidence of displacement and mortality rates from post-construction studies for razorbills are presented in the guillemot species account. As with the approach for guillemot, for this assessment, razorbill displacement rates of 1% to 100% for the OAA and 2 km buffer are presented in Table 1-43 to Table 1-50, with the assessment displacement rate of 50% and 60% and mortality rates of 1%, 3% and 5% highlighted.

In the breeding season, within the OAA, based on displacement rates of 50% and 60%, and mortality rates of 1%, 3% and 5%, razorbill mortality was predicted to be zero birds as a result of displacement (Table 1-43).

In the autumn migration period within the OAA, based on displacement rates of 50% and 60%, and mortality rates of 1% and 3%, razorbill mortality was predicted to be zero birds as a result of displacement (Table 1-44).

In the winter period within the OAA, based on displacement rates of 50% and 60%, and a 1% mortality rate, razorbill mortality was predicted to be zero birds as a result of displacement. Based on a 60% displacement rate and 3% mortality rate, razorbill mortality was predicted to be one bird as a result of displacement (Table 1-45).

In the spring migration period within the OAA, based on displacement rates of 50% and 60%, and a 1% mortality rate, razorbill mortality was predicted to be zero birds as a result of displacement. Based on a 60% displacement rate and 3% mortality rate, razorbill mortality was predicted to involve one razorbill as a result of displacement (Table 1-46).

For the OAA and 2 km buffer, based on a displacement rate of 50% and a mortality rate of 1%, razorbill mortality was predicted to be one bird in the breeding season. Based on a displacement rate of 60% and a mortality rate of 3%, razorbill mortality was predicted to be four birds in the breeding season. Based on a displacement rate of 60% and a mortality rate of 5%, razorbill mortality was predicted to be seven birds in the breeding season (Table 1-47).

For the OAA and 2 km buffer in the autumn migration period, based on displacement rates of 50% and 60%, and mortality rates of 1% and 3%, razorbill mortality was predicted to be zero birds as a result of displacement (Table 1-48).

For the OAA and 2 km buffer in the winter period, based on a displacement rate of 50% and a mortality rate of 1%, razorbill mortality was predicted to be one bird. Based on a displacement rate of 60% and a mortality rate of 1%, razorbill mortality was also predicted to be one bird. Based on a displacement rate of 60% and a mortality rate of 3%, razorbill mortality was predicted to be three birds (Table 1-49).

For the OAA and 2 km buffer in the spring migration period, based on a displacement rate of 50% and a mortality rate of 1%, razorbill mortality was predicted to be zero birds. Based on a displacement rate of 60% and a mortality rate of 1%, razorbill mortality was also predicted to be zero birds. Based on a displacement rate of 60% and a mortality rate of 3%, razorbill mortality was predicted to be one bird (Table 1-50).

Table 1-43 Potential razorbill mortality following displacement from the OAA in the breeding season

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

Table 1-44 Potential razorbill mortality following displacement from the OAA in the autumn migration period of the non-breeding season

	Mortality (%)														
%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%) 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
30	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
40	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
50	**0**	0	0	0	0	0	0	0	1	1	1	1	1	1	2
60	**0**	0	**0**	0	0	0	0	1	1	1	1	1	1	2	2
70	0	0	0	0	0	0	0	1	1	1	1	1	2	2	2
80	0	0	0	0	0	0	0	1	1	1	1	2	2	2	2
90	0	0	0	0	0	0	1	1	1	1	2	2	2	2	3
100	0	0	0	0	0	0	1	1	1	2	2	2	2	3	3

Table 1-45 Potential razorbill mortality following displacement from the OAA in the winter period of the non-breeding season

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

Table 1-46 Potential razorbill mortality following displacement from the OAA in the spring migration period of the non-breeding season

		Mortality (%)														
	%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)	10	0	0	0	0	0	0	1	1	1	1	2	2	2	3	3
	20	0	0	0	0	0	1	1	2	2	3	3	4	5	5	6
	30	0	0	0	0	0	1	2	3	3	4	5	6	7	8	9
	40	0	0	0	0	1	1	2	3	5	6	7	8	9	10	12
	50	**0**	0	0	1	1	1	3	4	6	7	9	10	12	13	15
	60	**0**	0	**1**	1	1	2	3	5	7	9	10	12	14	16	17
	70	0	0	1	1	1	2	4	6	8	10	12	14	16	18	20
	80	0	0	1	1	1	2	5	7	9	12	14	16	19	21	23
	90	0	1	1	1	1	3	5	8	10	13	16	18	21	23	26
	100	0	1	1	1	1	3	6	9	12	15	17	20	23	26	29

Table 1-47 Potential razorbill mortality following displacement from the OAA & 2 km buffer in the breeding season

	Mortality (%)														
%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%) 10	0	0	1	1	1	2	4	7	9	11	13	15	18	20	22
20	0	1	1	2	2	4	9	13	18	22	26	31	35	40	44
30	1	1	2	3	3	7	13	20	26	33	40	46	53	59	66
40	1	2	3	4	4	9	18	26	35	44	53	62	70	79	88
50	**1**	2	3	4	6	11	22	33	44	55	66	77	88	99	110
60	1	3	**4**	5	**7**	13	26	40	53	66	79	92	106	119	132
70	2	3	5	6	8	15	31	46	62	77	92	108	123	139	154
80	2	4	5	7	9	18	35	53	70	88	106	123	141	158	176
90	2	4	6	8	10	20	40	59	79	99	119	139	158	178	198
100	2	4	7	9	11	22	44	66	88	110	132	154	176	198	220

Table 1-48 Potential razorbill mortality following displacement from the OAA & 2 km buffer in the autumn migration period of the non-breeding season

		Mortality (%)														
	%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)	10	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	20	0	0	0	0	0	0	0	1	1	1	1	2	2	2	2
	30	0	0	0	0	0	0	1	1	1	2	2	2	3	3	3
	40	0	0	0	0	0	0	1	1	2	2	3	3	4	4	4
	50	**0**	0	0	0	0	1	1	2	2	3	3	4	4	5	6
	60	**0**	0	**0**	0	0	1	1	2	3	3	4	5	5	6	7
	70	0	0	0	0	0	1	2	2	3	4	5	5	6	7	8
	80	0	0	0	0	0	1	2	3	4	4	5	6	7	8	9
	90	0	0	0	0	0	1	2	3	4	5	6	7	8	9	10
	100	0	0	0	0	1	1	2	3	4	6	7	8	9	10	11

Table 1-49 Potential razorbill mortality following displacement from the OAA & 2 km buffer in the winter period of the non-breeding season

	Mortality (%)															
	%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)	10	0	0	1	1	1	2	4	6	8	10	11	13	15	17	19
	20	0	1	1	2	2	4	8	11	15	19	23	27	31	34	38
	30	1	1	2	2	3	6	11	17	23	29	34	40	46	52	57
	40	1	2	2	3	4	8	15	23	31	38	46	53	61	69	76
	50	**1**	2	3	4	5	10	19	29	38	48	57	67	76	86	96
	60	**1**	2	**3**	5	6	11	23	34	46	57	69	80	92	103	115
	70	1	3	4	5	7	13	27	40	53	67	80	94	107	120	134
	80	2	3	5	6	8	15	31	46	61	76	92	107	122	138	153
	90	2	3	5	7	9	17	34	52	69	86	103	120	138	155	172
	100	2	4	6	8	10	19	38	57	76	96	115	134	153	172	191

Table 1-50 Potential razorbill mortality following displacement from the OAA & 2 km buffer in the spring migration period of the non-breeding season

		Mortality (%)														
	%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)	10	0	0	0	0	0	1	2	2	3	4	5	6	6	7	8
	20	0	0	0	1	1	2	3	5	6	8	9	11	13	14	16
	30	0	0	1	1	1	2	5	7	9	12	14	17	19	21	24
	40	0	1	1	1	2	3	6	9	13	16	19	22	25	28	32
	50	**0**	1	1	2	2	4	8	12	16	20	24	28	32	36	40
	60	**0**	1	**1**	2	2	5	9	14	19	24	28	33	38	43	47
	70	1	1	2	2	3	6	11	17	22	28	33	39	44	50	55
	80	1	1	2	3	3	6	13	19	25	32	38	44	51	57	63
	90	1	1	2	3	4	7	14	21	28	36	43	50	57	64	71
	100	1	2	2	3	4	8	16	24	32	40	47	55	63	71	79

1.2.12 Puffin

Monthly numbers of puffins in the OAA and OAA plus two km buffer in Years 1 and 2 are presented in the Offshore Ornithology Baseline Report. Monthly peak estimated numbers in the breeding season (April to early August) for Years 1 and 2 were averaged to get the mean seasonal peak for the breeding and non-breeding seasons. Where peak numbers occurred in different months within the same season across different years, the peak month was used.

In the breeding season, the two-year peak mean estimated number of puffins in the OAA was 31 birds, while the peak mean estimated number of puffins in the OAA plus 2 km buffer was 76 birds. Peak numbers recorded for the non-breeding season were lower (Table 1-51).

Table 1-51 Seasonal peak estimated numbers of puffins in the OAA and the OAA plus 2 km buffer area recorded on baseline surveys

Year	Breeding	Non-breeding
OAA	31 birds	5 birds
OAA & 2 km buffer	76 birds	9 birds

These peak mean estimates were taken as the maximum number of puffins in the OAA and the OAA and 2 km buffer for the breeding and non-breeding seasons. These figures were then used in the Displacement matrices produced for this assessment (Table 1-52 to Table 1-55).

Displacement and Mortality Rates

Recent NatureScot guidance on likely displacement levels for Scottish OWF projects recommended a displacement level of 60% for puffin (NatureScot, 2023).

However, there is limited evidence of displacement and mortality rates from post-construction studies for puffins, and most studies conclude that displacement and mortality rates for puffins will be similar for the other auk species.

For this assessment, puffin displacement rates of 1% to 100% for the OAA and 2 km buffer are presented in Table 1-52 to Table 1-55, with the assessment displacement rates of 50% and 60% highlighted.

The SNCB (2022a) guidance does not recommend a specific mortality level to apply for puffins. However, recent NatureScot guidance on likely displacement mortality levels for Scottish OWF projects recommended using mortality rates of 3% and 5% in the breeding season and 1% and 3% in the non-breeding season for puffin (NatureScot, 2023). Therefore, mortality rates of 1% to 100% for the OAA and 2 km are presented in Table 1-52 to Table 1-55, with the assessment mortality rates of 3% and 5% highlighted for the breeding season and 1% and 3% highlighted for the non-breeding season. However, it should be noted that it is considered that mortality rates of 3% and 5% in the breeding season for puffin is overly precautionary, based on available post-construction evidence for other auk species, as detailed above.

Within the OAA in the breeding season, based on a displacement rate of 50% and a mortality rate of 1%, puffin mortality as a result of displacement was predicted to be zero. Based on a displacement rate of 60% and a mortality rate of 3%, puffin mortality was predicted to involve one bird. Applying a mortality rate of 5% also resulted in predicted mortality of one puffin as a result of displacement in the breeding season (Table 1-52).

Within the OAA in the non-breeding season, based on a displacement rate of 50% and a mortality rate of 1%, puffin mortality was predicted to be zero birds as a result of displacement. Similarly, based on a displacement rate of 60% and mortality rates of 1% and 3%, puffin mortality was predicted to be zero (Table 1-53).

For the OAA and 2 km buffer in the breeding season, based on a displacement rate of 50% and a mortality rate of 1%, puffin mortality was predicted to be zero birds. Based on a displacement rate of 60% and a mortality rate of 3%, puffin mortality was predicted to involve one bird. Applying a mortality rate of 5% resulted in a predicted mortality of two puffins as a result of displacement (Table 1-54).

For the OAA and 2 km buffer in the non-breeding season, based on a displacement rate of 50% and a mortality rate of 1%, puffin mortality was predicted to be zero birds as a result of displacement. Similarly, based on a displacement rate of 60% and mortality rates of 1% and 3%, puffin mortality was also predicted to be zero birds (Table 1-55).

Table 1-52 Potential puffin mortality following displacement from the OAA in the breeding season

	Mortality (%)														
%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%) 10	0	0	0	0	0	0	1	1	1	2	2	2	2	3	3
20	0	0	0	0	0	1	1	2	2	3	4	4	5	6	6
30	0	0	0	0	0	1	2	3	4	5	6	7	7	8	9
40	0	0	0	0	1	1	2	4	5	6	7	9	10	11	12
50	**0**	0	0	1	1	2	3	5	6	8	9	11	12	14	16
60	0	0	**1**	1	**1**	2	4	6	7	9	11	13	15	17	19
70	0	0	1	1	1	2	4	7	9	11	13	15	17	20	22
80	0	0	1	1	1	2	5	7	10	12	15	17	20	22	25
90	0	1	1	1	1	3	6	8	11	14	17	20	22	25	28
100	0	1	1	1	2	3	6	9	12	16	19	22	25	28	31

Table 1-53 Potential puffin mortality following displacement from the OAA in the non-breeding season

	Mortality (%)														
Displacement (%)	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
20	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
30	0	0	0	0	0	0	0	0	1	1	1	1	1	1	2
40	0	0	0	0	0	0	0	1	1	1	1	1	2	2	2
50	**0**	0	0	0	0	0	1	1	1	1	2	2	2	2	3
60	**0**	0	**0**	0	0	0	1	1	1	2	2	2	2	3	3
70	0	0	0	0	0	0	1	1	1	2	2	2	3	3	4
80	0	0	0	0	0	0	1	1	2	2	2	3	3	4	4
90	0	0	0	0	0	0	1	1	2	2	3	3	4	4	5
100	0	0	0	0	0	1	1	2	2	3	3	4	4	5	5

Table 1-54 Potential puffin mortality following displacement from the OAA & 2 km buffer in the breeding season

	Mortality (%)														
Displacement (%)	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	0	1	2	2	3	4	5	5	6	7	8
20	0	0	0	1	1	2	3	5	6	8	9	11	12	14	15
30	0	0	1	1	1	2	5	7	9	11	14	16	18	21	23
40	0	1	1	1	2	3	6	9	12	15	18	21	24	27	30
50	**0**	1	1	2	2	4	8	11	15	19	23	27	30	34	38
60	0	1	**1**	2	**2**	5	9	14	18	23	27	32	36	41	46
70	1	1	2	2	3	5	11	16	21	27	32	37	43	48	53
80	1	1	2	2	3	6	12	18	24	30	36	43	49	55	61
90	1	1	2	3	3	7	14	21	27	34	41	48	55	62	68
100	1	2	2	3	4	8	15	23	30	38	46	53	61	68	76

Table 1-55 Potential puffin mortality following displacement from the OAA & 2 km buffer in the non-breeding season

	Mortality (%)															
	%	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)	10	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
	20	0	0	0	0	0	0	0	1	1	1	1	1	1	2	2
	30	0	0	0	0	0	0	1	1	1	1	2	2	2	2	3
	40	0	0	0	0	0	0	1	1	1	2	2	3	3	3	4
	50	**0**	0	0	0	0	0	1	1	2	2	3	3	4	4	5
	60	**0**	0	**0**	0	0	1	1	2	2	3	3	4	4	5	5
	70	0	0	0	0	0	1	1	2	3	3	4	4	5	6	6
	80	0	0	0	0	0	1	1	2	3	4	4	5	6	6	7
	90	0	0	0	0	0	1	2	2	3	4	5	6	6	7	8
	100	0	0	0	0	0	1	2	3	4	5	5	6	7	8	9

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