

# Appendix 11-5: Offshore Ornithology Displacement Analysis





# ORIEL WIND FARM PROJECT

## Environmental Impact Assessment Report Appendix 11-5: Offshore Ornithology Displacement Analysis

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## ORIEL WIND FARM PROJECT – OFFSHORE ORNITHOLOGY DISPLACEMENT ANALYSIS

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# 1 INTRODUCTION

## 1.1 Purpose of the report

This technical report has been prepared for the purpose of describing the displacement analysis methodology and results, in support of the assessment of significance of seabirds presented chapter 11: Offshore Ornithology of the Oriel Wind Farm Project EIAR. The displacement analysis has been undertaken by APEM Ltd (hereafter APEM) based on seabird densities and abundances presented in appendix 11-1: Offshore Ornithology Technical Report.

## 1.2 Project background

Oriel Windfarm Limited ('the Applicant') is proposing to develop the Oriel Wind Farm Project, an offshore wind farm (OWF), hereafter referred to as 'the Project'. The offshore wind farm area is located in the Irish Sea, off the coast of County Louth (approximately 22 km east of Dundalk town centre and 18 km east of Blackrock). The closest wind turbine will be approximately 6 km from the closest shore on the Cooley Peninsula. The offshore cable corridor extends approximately 11 km southwest from the wind farm area to the landfall south of Dunany Point. The Project will comprise both offshore and onshore infrastructure including 25 offshore wind turbines generators (WTGs), associated foundations and inter-array cabling, offshore substation, offshore cable within a defined offshore cable corridor, a landfall, onshore cable route and an onshore substation for connection to the electricity transmission network.

## 2 DISPLACEMENT ANALYSIS

The presence of WTGs and other activities associated with an offshore wind farm have the potential to directly displace seabirds that would normally reside within and around the area of sea where the Project is proposed. This effect represents indirect habitat loss, potentially reducing the area available for those seabirds sensitive to disturbance to forage, loaf and / or moult in the way that they are currently able to within and around the offshore wind farm area. There is also the potential for the construction and decommissioning of WTGs, offshore substation and offshore cable laying to directly disturb and displace seabirds.

### 2.1 Displacement matrix approach

There is currently no detailed Irish guidance regarding the method of assessment of displacement of seabirds as a result of offshore wind farms. Guidance for offshore renewable energy projects published by the Department of Communications, Climate Action & Environment (DCCAE) (DCCAE, 2014) includes reference to emerging methods for displacement assessment at the time of its publication, namely JNCC report 551 (Busch *et al.*, 2015). However, at this time such proposed approaches have not been used in other offshore wind farm assessments. This analysis therefore draws on the most recent recommendations of the UK Statutory Nature Conservation Bodies (SNCB, 2022), which promotes a displacement matrix approach.

The methodology presented in SNCB (2022) recommends that a matrix is compiled for each key species for a range of displacement levels (at 10% increments) across a range of likely adult mortality levels (at 0, 1%, 2%, 3%, 4%, 5%, 10% and then 10% increments) in each relevant biological season for that species.

Using available evidence on seabird sensitivity and habitat flexibility, a value, or small range of values of displacement rate and associated mortality levels are selected to provide an estimate of the potential losses. The consequent potential losses to the population as a result of displacement is then assessed for each season against an appropriate population scale. For the breeding season, the appropriate regional population covers the total colony counts within mean-maximum foraging range; for the non-breeding season, the appropriate regional population is based on species specific biologically defined minimum population scales (BDMPS), (Furness, 2015).

This technical report presents the results for the displacement matrices. The estimated losses and potential effect on the seasonal populations are discussed in the assessment presented in chapter 11: Offshore Ornithology of the Oriel Wind Farm Project EIAR.

### 2.2 Species of interest

Species vary in their sensitivity to disturbance and displacement with some species displaying large levels of displacement (e.g. divers, SNCB, 2022), whereas other species have little sensitivity (e.g. Manx shearwater; Bradbury *et al.*, 2014). Within the guidance (SNCB, 2022), only species scoring over three on either the “disturbance susceptibility” or “habitat specialisation” criteria (adapted from Furness *et al.*, 2013 and Bradbury *et al.*, 2014) should be taken forward for assessment of displacement impacts. In addition, the abundance of species within the Offshore Ornithology Study Area needs to be accounted for, and only species deemed to have moderate abundance (see chapter 11: Offshore Ornithology and appendix 11-1: Offshore Ornithology Technical Report) and scoring three or above were included within this assessment.

The following species were identified as the ‘key’ species to include in the displacement assessment due to their sensitivity to disturbance effects and their relative abundance in the offshore ornithology study area:

- Great northern diver (*Gavia immer*);
- Gannet (*Morus bassanus*);
- Guillemot (*Uria aalge*); and
- Razorbill (*Alca torda*).

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This technical report presents the baseline data on the four key species screened in for the assessment of potential disturbance and displacement as a result of the construction, operation, and decommissioning phases of the Project.

### 2.3 Displacement buffers

Different seabird species exhibit different responses to WTGs and offshore wind farms, with consideration of the distance away from offshore wind farms being required out to specific buffer distances. The scale of the potential displacement outside of an offshore wind farm's footprint to account for different buffer distances applied in this report is in response to guidance in the literature. Following the guidance (SNCB, 2022), this report presents displacement matrices for great northern diver within the offshore wind farm area and a 4 km buffer whilst gannet, guillemot and razorbill matrices are for within the offshore wind farm area and a 2 km buffer.

### 2.4 Data sources for displacement matrices

The data contributing to this annex are from 19 months of boat-based surveys undertaken from May 2018 to May 2020 (see appendix 11-1: Offshore Ornithology Technical Report for a complete list of boat-based survey months within this period) and six months of aerial digital surveys completed by APEM from April 2020 to September 2020. The boat-based survey data comprise abundance estimates within the relevant potential impact area (offshore wind farm area plus appropriate buffer) with correction for availability bias applied for guillemot and razorbill. The aerial digital survey data abundance estimates include apportionment for unidentified birds and correction for availability bias applied for guillemot and razorbill.

Displacement matrices are presented for each of the four species (great northern diver, gannet, guillemot and razorbill) including data on different species behaviours. For great northern diver, guillemot and razorbill only "sitting" birds (which includes birds observed diving, landing and taking off) were included from the site-specific survey data in the displacement analysis due to the foraging behaviour of these species being predominately from the water's surface. For gannet all behaviours (flying and sitting) were included.

### 2.5 Data limitations

The data within this report are reliant upon site-specific boat-based and aerial digital surveys undertaken over the offshore ornithology study area for periods of 24 months (with data available for 19 months) and six months, respectively. These data are considered to be the most reliable sources for characterising the baseline environment for offshore ornithology. However, using these data to characterise the abundances for each species within individual bio-seasons or extended bio-seasons (as described in section 2.6 of this report and section 5.5 of appendix 11-1: Offshore Ornithology Technical Report) is subject to interpretation.

Consideration should also be given to missing months from the boat-based survey data over the 24 month period, to the limited temporal coverage within a single year for the aerial digital survey data, migratory movements of birds being subject to variation between species and between years, the age classification of birds within each bio-season and connectivity to breeding colonies. Therefore, these data may be used for the impact assessments accompanying the development application in differing manners, depending upon additional factors considered when assessing the potential impacts and/ or effects of displacement on these species.

### 2.6 Data presentation of displacement by bio-seasons

In order to provide a more visual approach to presenting data on the species considered for displacement within the tables contained in this report, a colour coding has been used to represent different bio-seasons and combined / extended bio-seasons. For each species, the months defining each bio-season are different; the number of bio-seasons also varies between species. Bio-seasons are based on Furness (2015) for all species in this analysis. The bio-seasons used for each species and the constituent months are presented in Table 2-1 below.

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**Table 2-1: Bio-season colour coding.**

Bio-season	Great Northern Diver	Gannet	Guillemot	Razorbill
Return Migration (Green)	N/A	Dec – Mar	N/A	Jan – Mar
Migration-free Breeding (Purple)	N/A	Apr – Aug	N/A	Apr – Jul
Post-breeding Migration (Red)	N/A	Sep – Nov	N/A	Aug – Oct
Migration-free Winter (Blue)	N/A	N/A	N/A	Nov – Dec
Extended Breeding (Pink)	N/A	N/A	Mar – Jul	N/A
Extended Non-breeding (Yellow)	Sep - May	N/A	Aug – Feb	N/A

## 2.7 Bio-season peak and mean peaks

Following the SNCB (2022) guidance, displacement assessment is based on bio-season mean peak abundances. The peak abundance within a bio-season is the highest recorded abundance from surveys within a single bio-season. Mean peak abundance is the mean of peak abundances for each bio-season across a number of years. Note that, as described in section 2.4, the data for this analysis are based on 19 monthly boat-based surveys and six monthly aerial digital surveys.

The bio-season peak and mean peak abundances used for these analyses are presented in Table 2-2 for the boat-based survey data and

**Table 2-3** for the digital aerial survey data. For some of the boat-based and all of the aerial survey data, it was only possible to calculate the peak bio-season abundance due to missing months of second year survey data.



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**Table 2-2: Boat-based bio-season mean peak or peak (indicated by an \*) abundances used for displacement assessment.**

Bio-season	Survey Area	Great Northern Diver	Gannet	Guillemot	Razorbill
Return Migration	Offshore Wind Farm Area	N/A	16	N/A	292*
	Offshore Wind Farm Area plus 2 km buffer	N/A	43	N/A	859*
Migration-free Breeding	Offshore Wind Farm Area	N/A	79	N/A	7
	Offshore Wind Farm Area plus 2 km buffer	N/A	264	N/A	12
Post-breeding Migration	Offshore Wind Farm Area	N/A	113*	N/A	281
	Offshore Wind Farm Area plus 2 km buffer	N/A	336*	N/A	962
Migration-free Winter	Offshore Wind Farm Area	N/A	N/A	N/A	139*
	Offshore Wind Farm Area plus 2 km buffer	N/A	N/A	N/A	512*
Extended Breeding	Offshore Wind Farm Area	N/A	N/A	286	N/A
	Offshore Wind Farm Area plus 2 km buffer	N/A	N/A	820	N/A
Extended Non-breeding	Offshore Wind Farm Area	44	N/A	846	N/A
	Offshore Wind Farm Area plus 2 km buffer	115	N/A	2,670	N/A
	Offshore Ornithology Study Area	281	N/A	N/A	N/A

Table Note: \*Due to insufficient amount of second year data value presented is for the peak first year bio-season abundance only.

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**Table 2-3: Aerial digital bio-season peak abundances used for displacement assessment.**

Bio-season	Survey Area	Great Northern Diver	Gannet	Guillemot	Razorbill
Return Migration	Offshore Wind Farm Area	N/A	N/A	N/A	N/A
	Offshore Wind Farm Area plus 2 km buffer	N/A	N/A	N/A	N/A
Migration-free Breeding	Offshore Wind Farm Area	N/A	135	N/A	154
	Offshore Wind Farm Area plus 2 km buffer	N/A	149	N/A	353
Post-breeding Migration	Offshore Wind Farm Area	N/A	N/A	N/A	265*
	Offshore Wind Farm Area plus 2 km buffer	N/A	N/A	N/A	566*
Migration-free Winter	Offshore Wind Farm Area	N/A	N/A	N/A	N/A
	Offshore Wind Farm Area plus 2 km buffer	N/A	N/A	N/A	N/A
Extended Breeding	Offshore Wind Farm Area	N/A	N/A	594	N/A
	Offshore Wind Farm Area plus 2 km buffer	N/A	N/A	1,594	N/A
Extended Non-breeding	Offshore Wind Farm Area	102**	N/A	1,715*	N/A
	Offshore Wind Farm Area plus 2 km buffer	222**	N/A	4,938*	N/A
	Offshore Wind Farm Area plus 4 km buffer	412**	N/A	N/A	N/A

Table Note: \*Bio-season peak based on only two months (August and September). \*\* Bio-season peak based on only three months (April, May and September).

### 3 RESULTS

The following sections provide the displacement matrices for each of the key species for each relevant bio-season based on the baseline data from the two data platforms: boat-based survey 2018-20 and aerial survey 2020, for the offshore wind farm area and the offshore wind farm area plus the appropriate buffer.

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**3.1 Great northern diver boat-based displacement matrices**

**Table 3-1: Boat-based displacement matrix presenting the mean peak number of great northern divers in the offshore wind farm area only, during the non-breeding bio-season.**

<b>Great northern diver displacement rates (based on non-breeding population of 44 for offshore wind farm area only)</b>																
<b>Displacement (%)</b>	<b>Mortality Rates (%)</b>															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	1	1	2	2	3	3	4	4	4
20	0	0	0	0	0	0	1	2	3	4	4	5	6	7	8	9
30	0	0	0	0	1	1	1	3	4	5	7	8	9	11	12	13
40	0	0	0	1	1	1	2	4	5	7	9	11	12	14	16	18
50	0	0	0	1	1	1	2	4	7	9	11	13	15	18	20	22
60	0	0	1	1	1	1	3	5	8	11	13	16	18	21	24	26
70	0	0	1	1	1	2	3	6	9	12	15	18	22	25	28	31
80	0	0	1	1	1	2	4	7	11	14	18	21	25	28	32	35
90	0	0	1	1	2	2	4	8	12	16	20	24	28	32	36	40
100	0	0	1	1	2	2	4	9	13	18	22	26	31	35	40	44

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**Table 3-2: Boat-based displacement matrix presenting the mean peak number of great northern divers in the offshore wind farm area plus 2 km buffer, during the non-breeding bio-season.**

<b>Great northern diver displacement rates (based on non-breeding population of 115 for offshore wind farm area plus 2 km buffer)</b>																
<b>Displacement (%)</b>	<b>Mortality Rates (%)</b>															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
10	0	0	0	0	0	1	1	2	3	5	6	7	8	9	10	12
20	0	0	0	1	1	1	2	5	7	9	12	14	16	18	21	23
30	0	0	1	1	1	2	3	7	10	14	17	21	24	28	31	35
40	0	0	1	1	2	2	5	9	14	18	23	28	32	37	41	46
50	0	1	1	2	2	3	6	12	17	23	29	35	40	46	52	58
60	0	1	1	2	3	3	7	14	21	28	35	41	48	55	62	69
70	0	1	2	2	3	4	8	16	24	32	40	48	56	64	72	81
80	0	1	2	3	4	5	9	18	28	37	46	55	64	74	83	92
90	0	1	2	3	4	5	10	21	31	41	52	62	72	83	93	104
100	0	1	2	3	5	6	12	23	35	46	58	69	81	92	104	115

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**Table 3-3: Boat-based displacement matrix presenting the mean peak number of great northern divers in the offshore wind farm area plus 4 km buffer, during the non-breeding bio-season.**

<b>Great northern diver displacement rates (based on non-breeding population of 281 for offshore ornithology study area)</b>																
<b>Displacement (%)</b>	<b>Mortality Rates (%)</b>															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3	3
10	0	0	1	1	1	1	3	6	8	11	14	17	20	22	25	28
20	0	1	1	2	2	3	6	11	17	22	28	34	39	45	51	56
30	0	1	2	3	3	4	8	17	25	34	42	51	59	67	76	84
40	0	1	2	3	4	6	11	22	34	45	56	67	79	90	101	112
50	0	1	3	4	6	7	14	28	42	56	70	84	98	112	126	141
60	0	2	3	5	7	8	17	34	51	67	84	101	118	135	152	169
70	0	2	4	6	8	10	20	39	59	79	98	118	138	157	177	197
80	0	2	4	7	9	11	22	45	67	90	112	135	157	180	202	225
90	0	3	5	8	10	13	25	51	76	101	126	152	177	202	228	253
100	0	3	6	8	11	14	28	56	84	112	141	169	197	225	253	281

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**3.2 Great northern diver aerial digital displacement matrices**

**Table 3-4: Aerial digital displacement matrix presenting the peak number of great northern divers in the offshore wind farm area only, during the non-breeding bio-season.**

<b>Great northern diver displacement rates (based on non-breeding population of 102 for offshore wind farm area only)</b>																
<b>Displacement (%)</b>	<b>Mortality Rates (%)</b>															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
10	0	0	0	0	0	1	1	2	3	4	5	6	7	8	9	10
20	0	0	0	1	1	1	2	4	6	8	10	12	14	16	18	20
30	0	0	1	1	1	2	3	6	9	12	15	18	21	24	28	31
40	0	0	1	1	2	2	4	8	12	16	20	24	29	33	37	41
50	0	1	1	2	2	3	5	10	15	20	26	31	36	41	46	51
60	0	1	1	2	2	3	6	12	18	24	31	37	43	49	55	61
70	0	1	1	2	3	4	7	14	21	29	36	43	50	57	64	71
80	0	1	2	2	3	4	8	16	24	33	41	49	57	65	73	82
90	0	1	2	3	4	5	9	18	28	37	46	55	64	73	83	92
100	0	1	2	3	4	5	10	20	31	41	51	61	71	82	92	102

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**Table 3-5: Aerial digital displacement matrix presenting the peak number of great northern divers in the offshore wind farm area plus 2 km buffer, during the non-breeding bio-season.**

<b>Great northern diver displacement rates (based on non-breeding population of 222 for offshore wind farm area plus 2 km buffer)</b>																
<b>Displacement (%)</b>	<b>Mortality Rates (%)</b>															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	1	1	1	1	2	2	2	2
10	0	0	0	1	1	1	2	4	7	9	11	13	16	18	20	22
20	0	0	1	1	2	2	4	9	13	18	22	27	31	36	40	44
30	0	1	1	2	3	3	7	13	20	27	33	40	47	53	60	67
40	0	1	2	3	4	4	9	18	27	36	44	53	62	71	80	89
50	0	1	2	3	4	6	11	22	33	44	56	67	78	89	100	111
60	0	1	3	4	5	7	13	27	40	53	67	80	93	107	120	133
70	0	2	3	5	6	8	16	31	47	62	78	93	109	124	140	155
80	0	2	4	5	7	9	18	36	53	71	89	107	124	142	160	178
90	0	2	4	6	8	10	20	40	60	80	100	120	140	160	180	200
100	0	2	4	7	9	11	22	44	67	89	111	133	155	178	200	222



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**Table 3-6: Aerial digital displacement matrix presenting the peak number of great northern divers in the offshore wind farm area plus 4 km buffer, during the non-breeding bio-season.**

<b>Great northern diver displacement rates (based on non-breeding population of 412 for offshore wind farm area plus 4 km buffer)</b>																
<b>Displacement (%)</b>	<b>Mortality Rates (%)</b>															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1	1	2	2	2	3	3	4	4
10	0	0	1	1	2	2	4	8	12	16	21	25	29	33	37	41
20	0	1	2	2	3	4	8	16	25	33	41	49	58	66	74	82
30	0	1	2	4	5	6	12	25	37	49	62	74	87	99	111	124
40	0	2	3	5	7	8	16	33	49	66	82	99	115	132	148	165
50	0	2	4	6	8	10	21	41	62	82	103	124	144	165	185	206
60	0	2	5	7	10	12	25	49	74	99	124	148	173	198	222	247
70	0	3	6	9	12	14	29	58	87	115	144	173	202	231	260	288
80	0	3	7	10	13	16	33	66	99	132	165	198	231	264	297	330
90	0	4	7	11	15	19	37	74	111	148	185	222	260	297	334	371
100	0	4	8	12	16	21	41	82	124	165	206	247	288	330	371	412

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### 3.3 Gannet boat-based displacement matrices

Table 3-7: Boat-based displacement matrix presenting the mean peak number of gannets in the offshore wind farm area only, during the return migration bio-season.

Gannet displacement rates (based on the return migration population of 16 for offshore wind farm area only)																
Displacement (%)	Mortality Rates (%)															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	2
20	0	0	0	0	0	0	0	1	1	1	2	2	2	3	3	3
30	0	0	0	0	0	0	0	1	1	2	2	3	3	4	4	5
40	0	0	0	0	0	0	1	1	2	3	3	4	4	5	6	6
50	0	0	0	0	0	0	1	2	2	3	4	5	6	6	7	8
60	0	0	0	0	0	0	1	2	3	4	5	6	7	8	9	10
70	0	0	0	0	0	1	1	2	3	4	6	7	8	9	10	11
80	0	0	0	0	1	1	1	3	4	5	6	8	9	10	12	13
90	0	0	0	0	1	1	1	3	4	6	7	9	10	12	13	14
100	0	0	0	0	1	1	2	3	5	6	8	10	11	13	14	16

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**Table 3-8: Boat-based displacement matrix presenting the mean peak number of gannets in the offshore wind farm area plus 2 km buffer, during the return migration bio-season.**

<b>Gannet displacement rates (based on the return migration population of 43 for offshore wind farm area plus 2 km buffer)</b>																
<b>Displacement (%)</b>	<b>Mortality Rates (%)</b>															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	1	1	2	2	3	3	3	4	4
20	0	0	0	0	0	0	1	2	3	3	4	5	6	7	8	9
30	0	0	0	0	1	1	1	3	4	5	6	8	9	10	11	13
40	0	0	0	1	1	1	2	3	5	7	9	10	12	14	15	17
50	0	0	0	1	1	1	2	4	6	9	11	13	15	17	19	21
60	0	0	1	1	1	1	3	5	8	10	13	15	18	20	23	26
70	0	0	1	1	1	1	3	6	9	12	15	18	21	24	27	30
80	0	0	1	1	1	2	3	7	10	14	17	20	24	27	31	34
90	0	0	1	1	2	2	4	8	11	15	19	23	27	31	34	38
100	0	0	1	1	2	2	4	9	13	17	21	26	30	34	38	43

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**Table 3-9: Boat-based displacement matrix presenting the mean peak number of gannets in the offshore wind farm area only, during the migration-free breeding bio-season.**

<b>Gannet displacement rates (based on migration-free breeding population of 79 for offshore wind farm area only)</b>																
<b>Displacement (%)</b>	<b>Mortality Rates (%)</b>															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
10	0	0	0	0	0	0	1	2	2	3	4	5	6	6	7	8
20	0	0	0	0	1	1	2	3	5	6	8	9	11	13	14	16
30	0	0	0	1	1	1	2	5	7	9	12	14	17	19	21	24
40	0	0	1	1	1	2	3	6	9	13	16	19	22	25	28	32
50	0	0	1	1	2	2	4	8	12	16	20	24	28	32	36	40
60	0	0	1	1	2	2	5	9	14	19	24	28	33	38	43	47
70	0	1	1	2	2	3	6	11	17	22	28	33	39	44	50	55
80	0	1	1	2	3	3	6	13	19	25	32	38	44	51	57	63
90	0	1	1	2	3	4	7	14	21	28	36	43	50	57	64	71
100	0	1	2	2	3	4	8	16	24	32	40	47	55	63	71	79

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**Table 3-10: Boat-based displacement matrix presenting the mean peak number of gannets in the offshore wind farm area plus 2 km buffer, during the migration-free breeding bio-season.**

<b>Gannet displacement rates (based on migration-free breeding population of 246 for offshore wind farm area plus 2 km buffer)</b>																
<b>Displacement (%)</b>	<b>Mortality Rates (%)</b>															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	1	1	1	1	2	2	2	2
10	0	0	0	1	1	1	2	5	7	10	12	15	17	20	22	25
20	0	0	1	1	2	2	5	10	15	20	25	29	34	39	44	49
30	0	1	1	2	3	4	7	15	22	29	37	44	52	59	66	74
40	0	1	2	3	4	5	10	20	29	39	49	59	69	79	88	98
50	0	1	2	4	5	6	12	25	37	49	61	74	86	98	110	123
60	0	1	3	4	6	7	15	29	44	59	74	88	103	118	133	147
70	0	2	3	5	7	9	17	34	52	69	86	103	120	137	155	172
80	0	2	4	6	8	10	20	39	59	79	98	118	137	157	177	196
90	0	2	4	7	9	11	22	44	66	88	110	133	155	177	199	221
100	0	2	5	7	10	12	25	49	74	98	123	147	172	196	221	246

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**Table 3-11: Boat-based displacement matrix presenting the peak number of gannets in the offshore wind farm area only, during the post-breeding migration bio-season.**

<b>Gannet displacement rates (based on post-breeding migration population of 113 for offshore wind farm area only)</b>																
<b>Displacement (%)</b>	<b>Mortality Rates (%)</b>															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
10	0	0	0	0	0	1	1	2	3	5	6	7	8	9	10	11
20	0	0	0	1	1	1	2	5	7	9	11	14	16	18	20	23
30	0	0	1	1	1	2	3	7	10	14	17	20	24	27	31	34
40	0	0	1	1	2	2	5	9	14	18	23	27	32	36	41	45
50	0	1	1	2	2	3	6	11	17	23	28	34	40	45	51	57
60	0	1	1	2	3	3	7	14	20	27	34	41	47	54	61	68
70	0	1	2	2	3	4	8	16	24	32	40	47	55	63	71	79
80	0	1	2	3	4	5	9	18	27	36	45	54	63	72	81	90
90	0	1	2	3	4	5	10	20	31	41	51	61	71	81	92	102
100	0	1	2	3	5	6	11	23	34	45	57	68	79	90	102	113

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**Table 3-12: Boat-based displacement matrix presenting the peak number of gannets in the offshore wind farm area plus 2 km buffer, during the post-breeding migration bio-season.**

<b>Gannet displacement rates (based on post-breeding migration population of 336 for offshore wind farm area plus 2 km buffer)</b>																
<b>Displacement (%)</b>	<b>Mortality Rates (%)</b>															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1	1	1	2	2	2	3	3	3
10	0	0	1	1	1	2	3	7	10	13	17	20	24	27	30	34
20	0	1	1	2	3	3	7	13	20	27	34	40	47	54	60	67
30	0	1	2	3	4	5	10	20	30	40	50	60	71	81	91	101
40	0	1	3	4	5	7	13	27	40	54	67	81	94	108	121	134
50	0	2	3	5	7	8	17	34	50	67	84	101	118	134	151	168
60	0	2	4	6	8	10	20	40	60	81	101	121	141	161	181	202
70	0	2	5	7	9	12	24	47	71	94	118	141	165	188	212	235
80	0	3	5	8	11	13	27	54	81	108	134	161	188	215	242	269
90	0	3	6	9	12	15	30	60	91	121	151	181	212	242	272	302
100	0	3	7	10	13	17	34	67	101	134	168	202	235	269	302	336

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### 3.4 Gannet aerial digital displacement matrices

Table 3-13: Aerial digital displacement matrix presenting the peak number of gannets in the offshore wind farm area only, during the migration-free breeding bio-season.

Gannet displacement rates (based on migration-free breeding population of 135 for offshore wind farm area only)																
Displacement (%)	Mortality Rates (%)															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
10	0	0	0	0	1	1	1	3	4	5	7	8	9	11	12	14
20	0	0	1	1	1	1	3	5	8	11	14	16	19	22	24	27
30	0	0	1	1	2	2	4	8	12	16	20	24	28	32	36	41
40	0	1	1	2	2	3	5	11	16	22	27	32	38	43	49	54
50	0	1	1	2	3	3	7	14	20	27	34	41	47	54	61	68
60	0	1	2	2	3	4	8	16	24	32	41	49	57	65	73	81
70	0	1	2	3	4	5	9	19	28	38	47	57	66	76	85	95
80	0	1	2	3	4	5	11	22	32	43	54	65	76	86	97	108
90	0	1	2	4	5	6	12	24	36	49	61	73	85	97	109	122
100	0	1	3	4	5	7	14	27	41	54	68	81	95	108	122	135



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**Table 3-14: Aerial digital displacement matrix presenting the peak number of gannets in the offshore wind farm area plus 2 km buffer, during the migration-free breeding bio-season.**

<b>Gannet displacement rates (based on migration-free breeding population of 149 for offshore wind farm area plus 2 km buffer)</b>																
<b>Displacement (%)</b>	<b>Mortality Rates (%)</b>															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
10	0	0	0	0	1	1	1	3	4	6	7	9	10	12	13	15
20	0	0	1	1	1	1	3	6	9	12	15	18	21	24	27	30
30	0	0	1	1	2	2	4	9	13	18	22	27	31	36	40	45
40	0	1	1	2	2	3	6	12	18	24	30	36	42	48	54	60
50	0	1	1	2	3	4	7	15	22	30	37	45	52	60	67	75
60	0	1	2	3	4	4	9	18	27	36	45	54	63	72	80	89
70	0	1	2	3	4	5	10	21	31	42	52	63	73	83	94	104
80	0	1	2	4	5	6	12	24	36	48	60	72	83	95	107	119
90	0	1	3	4	5	7	13	27	40	54	67	80	94	107	121	134
100	0	1	3	4	6	7	15	30	45	60	75	89	104	119	134	149

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### 3.5 Guillemot boat-based displacement matrices

Table 3-15: Boat-based displacement matrix presenting the mean peak number of guillemots in the offshore wind farm area only, during the breeding bio-season.

Guillemot displacement rates (based on non-breeding population of 286 for offshore wind farm area only)																
Displacement (%)	Mortality Rates (%)															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3	3
10	0	0	1	1	1	1	3	6	9	11	14	17	20	23	26	29
20	0	1	1	2	2	3	6	11	17	23	29	34	40	46	51	57
30	0	1	2	3	3	4	9	17	26	34	43	51	60	69	77	86
40	0	1	2	3	5	6	11	23	34	46	57	69	80	92	103	114
50	0	1	3	4	6	7	14	29	43	57	72	86	100	114	129	143
60	0	2	3	5	7	9	17	34	51	69	86	103	120	137	154	172
70	0	2	4	6	8	10	20	40	60	80	100	120	140	160	180	200
80	0	2	5	7	9	11	23	46	69	92	114	137	160	183	206	229
90	0	3	5	8	10	13	26	51	77	103	129	154	180	206	232	257
100	0	3	6	9	11	14	29	57	86	114	143	172	200	229	257	286

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**Table 3-16: Boat-based displacement matrix presenting the mean peak number of guillemots in the offshore wind farm area plus 2 km buffer, during the breeding bio-season.**

<b>Guillemot displacement rates (based on non-breeding population of 820 for offshore wind farm area plus 2 km buffer)</b>																
<b>Displacement (%)</b>	<b>Mortality Rates (%)</b>															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	1	2	2	3	4	5	6	7	7	8
10	0	1	2	2	3	4	8	16	25	33	41	49	57	66	74	82
20	0	2	3	5	7	8	16	33	49	66	82	98	115	131	148	164
30	0	2	5	7	10	12	25	49	74	98	123	148	172	197	221	246
40	0	3	7	10	13	16	33	66	98	131	164	197	230	262	295	328
50	0	4	8	12	16	21	41	82	123	164	205	246	287	328	369	410
60	0	5	10	15	20	25	49	98	148	197	246	295	344	394	443	492
70	0	6	11	17	23	29	57	115	172	230	287	344	402	459	517	574
80	0	7	13	20	26	33	66	131	197	262	328	394	459	525	590	656
90	0	7	15	22	30	37	74	148	221	295	369	443	517	590	664	738
100	0	8	16	25	33	41	82	164	246	328	410	492	574	656	738	820

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**Table 3-17: Boat-based displacement matrix presenting the mean peak number of guillemots in the offshore wind farm area only, during the non-breeding bio-season.**

Guillemot displacement rates (based on non-breeding population of 846 for offshore wind farm area only)																
Displacement (%)	Mortality Rates (%)															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	1	2	3	3	4	5	6	7	8	8
10	0	1	2	3	3	4	8	17	25	34	42	51	59	68	76	85
20	0	2	3	5	7	8	17	34	51	68	85	101	118	135	152	169
30	0	3	5	8	10	13	25	51	76	101	127	152	178	203	228	254
40	0	3	7	10	14	17	34	68	101	135	169	203	237	271	304	338
50	0	4	8	13	17	21	42	85	127	169	211	254	296	338	380	423
60	0	5	10	15	20	25	51	101	152	203	254	304	355	406	457	507
70	0	6	12	18	24	30	59	118	178	237	296	355	414	473	533	592
80	0	7	14	20	27	34	68	135	203	271	338	406	473	541	609	676
90	0	8	15	23	30	38	76	152	228	304	380	457	533	609	685	761
100	0	8	17	25	34	42	85	169	254	338	423	507	592	676	761	846

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**Table 3-18: Boat-based displacement matrix presenting the mean peak number of guillemots in the offshore wind farm area plus 2 km buffer, during the non-breeding bio-season.**

Guillemot displacement rates (based on non-breeding population of 2,670 for offshore wind farm area plus 2 km buffer)																
Displacement (%)	Mortality Rates (%)															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	1	1	1	1	3	5	8	11	13	16	19	21	24	27
10	0	3	5	8	11	13	27	53	80	107	133	160	187	214	240	267
20	0	5	11	16	21	27	53	107	160	214	267	320	374	427	481	534
30	0	8	16	24	32	40	80	160	240	320	400	481	561	641	721	801
40	0	11	21	32	43	53	107	214	320	427	534	641	747	854	961	1,068
50	0	13	27	40	53	67	133	267	400	534	667	801	934	1,068	1,201	1,335
60	0	16	32	48	64	80	160	320	481	641	801	961	1,121	1,281	1,442	1,602
70	0	19	37	56	75	93	187	374	561	747	934	1,121	1,308	1,495	1,682	1,869
80	0	21	43	64	85	107	214	427	641	854	1,068	1,281	1,495	1,708	1,922	2,136
90	0	24	48	72	96	120	240	481	721	961	1,201	1,442	1,682	1,922	2,162	2,403
100	0	27	53	80	107	133	267	534	801	1,068	1,335	1,602	1,869	2,136	2,403	2,670

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### 3.6 Guillemot aerial digital displacement matrices

Table 3-19: Aerial digital displacement matrix presenting the peak number of guillemots in the offshore wind farm area only, during the breeding bio-season.

Guillemot displacement rates (based on non-breeding population of 594 for offshore wind farm area only)																
Displacement (%)	Mortality Rates (%)															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	1	1	2	2	3	4	4	5	5	6
10	0	1	1	2	2	3	6	12	18	24	30	36	42	48	53	59
20	0	1	2	4	5	6	12	24	36	48	59	71	83	95	107	119
30	0	2	4	5	7	9	18	36	53	71	89	107	125	143	160	178
40	0	2	5	7	10	12	24	48	71	95	119	143	166	190	214	238
50	0	3	6	9	12	15	30	59	89	119	148	178	208	238	267	297
60	0	4	7	11	14	18	36	71	107	143	178	214	249	285	321	356
70	0	4	8	12	17	21	42	83	125	166	208	249	291	333	374	416
80	0	5	10	14	19	24	48	95	143	190	238	285	333	380	428	475
90	0	5	11	16	21	27	53	107	160	214	267	321	374	428	481	534
100	0	6	12	18	24	30	59	119	178	238	297	356	416	475	534	594

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**Table 3-20: Aerial digital displacement matrix presenting peak number of guillemots in the offshore wind farm area plus 2 km buffer, during the breeding bio-season.**

<b>Guillemot displacement rates (based on non-breeding population of 1,594 for offshore wind farm area plus 2 km buffer)</b>																
<b>Displacement (%)</b>	<b>Mortality Rates (%)</b>															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	1	1	2	3	5	6	8	10	11	13	14	16
10	0	2	3	5	6	8	16	32	48	64	80	96	112	128	143	159
20	0	3	6	10	13	16	32	64	96	128	159	191	223	255	287	319
30	0	5	10	14	19	24	48	96	143	191	239	287	335	383	430	478
40	0	6	13	19	26	32	64	128	191	255	319	383	446	510	574	638
50	0	8	16	24	32	40	80	159	239	319	398	478	558	638	717	797
60	0	10	19	29	38	48	96	191	287	383	478	574	669	765	861	956
70	0	11	22	33	45	56	112	223	335	446	558	669	781	893	1,004	1,116
80	0	13	26	38	51	64	128	255	383	510	638	765	893	1,020	1,148	1,275
90	0	14	29	43	57	72	143	287	430	574	717	861	1,004	1,148	1,291	1,434
100	0	16	32	48	64	80	159	319	478	638	797	956	1,116	1,275	1,434	1,594

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**Table 3-21: Aerial digital displacement matrix presenting the peak number of guillemots in the offshore wind farm area only, during the non-breeding bio-season.**

<b>Guillemot displacement rates (based on non-breeding population of 1,715 for offshore wind farm area only)</b>																
<b>Displacement (%)</b>	<b>Mortality Rates (%)</b>															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	1	1	1	2	3	5	7	9	10	12	14	15	17
10	0	2	3	5	7	9	17	34	51	69	86	103	120	137	154	171
20	0	3	7	10	14	17	34	69	103	137	171	206	240	274	309	343
30	0	5	10	15	21	26	51	103	154	206	257	309	360	412	463	514
40	0	7	14	21	27	34	69	137	206	274	343	412	480	549	617	686
50	0	9	17	26	34	43	86	171	257	343	429	514	600	686	772	857
60	0	10	21	31	41	51	103	206	309	412	514	617	720	823	926	1,029
70	0	12	24	36	48	60	120	240	360	480	600	720	840	960	1,080	1,200
80	0	14	27	41	55	69	137	274	412	549	686	823	960	1,097	1,235	1,372
90	0	15	31	46	62	77	154	309	463	617	772	926	1,080	1,235	1,389	1,543
100	0	17	34	51	69	86	171	343	514	686	857	1,029	1,200	1,372	1,543	1,715



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**Table 3-22: Aerial digital displacement matrix presenting the peak number of guillemots in the offshore wind farm area plus 2 km buffer, during the non-breeding bio-season.**

<b>Guillemot displacement rates (based on non-breeding population of 4,938 for offshore wind farm area plus 2 km buffer)</b>																
<b>Displacement (%)</b>	<b>Mortality Rates (%)</b>															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	1	1	2	2	5	10	15	20	25	30	35	40	44	49
10	0	5	10	15	20	25	49	99	148	198	247	296	346	395	444	494
20	0	10	20	30	40	49	99	198	296	395	494	593	691	790	889	988
30	0	15	30	44	59	74	148	296	444	593	741	889	1,037	1,185	1,333	1,482
40	0	20	40	59	79	99	198	395	593	790	988	1,185	1,383	1,580	1,778	1,975
50	0	25	49	74	99	123	247	494	741	988	1,235	1,482	1,728	1,975	2,222	2,469
60	0	30	59	89	119	148	296	593	889	1,185	1,482	1,778	2,074	2,370	2,667	2,963
70	0	35	69	104	138	173	346	691	1,037	1,383	1,728	2,074	2,420	2,766	3,111	3,457
80	0	40	79	119	158	198	395	790	1,185	1,580	1,975	2,370	2,766	3,161	3,556	3,951
90	0	44	89	133	178	222	444	889	1,333	1,778	2,222	2,667	3,111	3,556	4,000	4,445
100	0	49	99	148	198	247	494	988	1,482	1,975	2,469	2,963	3,457	3,951	4,445	4,938

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### 3.7 Razorbill boat-based displacement matrices

Table 3-23: Boat-based displacement matrix presenting the peak number of razorbills in the offshore wind farm area only, during the return migration bio-season.

Razorbill displacement rates (based on the return migration population of 292 for offshore wind farm area only)																
Displacement (%)	Mortality Rates (%)															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3	3
10	0	0	1	1	1	1	3	6	9	12	15	18	20	23	26	29
20	0	1	1	2	2	3	6	12	18	23	29	35	41	47	53	58
30	0	1	2	3	4	4	9	18	26	35	44	53	61	70	79	88
40	0	1	2	4	5	6	12	23	35	47	58	70	82	93	105	117
50	0	1	3	4	6	7	15	29	44	58	73	88	102	117	131	146
60	0	2	4	5	7	9	18	35	53	70	88	105	123	140	158	175
70	0	2	4	6	8	10	20	41	61	82	102	123	143	164	184	204
80	0	2	5	7	9	12	23	47	70	93	117	140	164	187	210	234
90	0	3	5	8	11	13	26	53	79	105	131	158	184	210	237	263
100	0	3	6	9	12	15	29	58	88	117	146	175	204	234	263	292

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**Table 3-24: Boat-based displacement matrix presenting the peak number of razorbills in the offshore wind farm area plus 2 km buffer, during the return migration bio-season.**

<b>Razorbill displacement rates (based on the return migration population of 859 for offshore wind farm area plus 2 km buffer)</b>																
<b>Displacement (%)</b>	<b>Mortality Rates (%)</b>															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	1	2	3	3	4	5	6	7	8	9
10	0	1	2	3	3	4	9	17	26	34	43	52	60	69	77	86
20	0	2	3	5	7	9	17	34	52	69	86	103	120	137	155	172
30	0	3	5	8	10	13	26	52	77	103	129	155	180	206	232	258
40	0	3	7	10	14	17	34	69	103	137	172	206	241	275	309	344
50	0	4	9	13	17	21	43	86	129	172	215	258	301	344	387	430
60	0	5	10	15	21	26	52	103	155	206	258	309	361	412	464	515
70	0	6	12	18	24	30	60	120	180	241	301	361	421	481	541	601
80	0	7	14	21	27	34	69	137	206	275	344	412	481	550	618	687
90	0	8	15	23	31	39	77	155	232	309	387	464	541	618	696	773
100	0	9	17	26	34	43	86	172	258	344	430	515	601	687	773	859

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**Table 3-25: Boat-based displacement matrix presenting the mean peak number of razorbills in the offshore wind farm area only, during the migration-free breeding bio-season.**

<b>Razorbill displacement rates (based on migration-free breeding population of 7 for offshore wind farm area only)</b>																
Displacement (%)	Mortality Rates (%)															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	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	0	1	1	1	1	1	1
30	0	0	0	0	0	0	0	0	0	1	1	1	1	1	2	2
40	0	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3
50	0	0	0	0	0	0	0	0	1	1	1	2	2	2	3	3
60	0	0	0	0	0	0	0	0	1	1	2	2	2	3	3	4
70	0	0	0	0	0	0	0	0	1	1	2	2	3	3	4	5
80	0	0	0	0	0	0	0	1	1	2	2	3	3	4	4	5
90	0	0	0	0	0	0	0	1	1	2	2	3	4	4	5	6
100	0	0	0	0	0	0	0	1	1	2	3	3	4	5	5	6

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**Table 3-26: Boat-based displacement matrix presenting the mean peak number of razorbills in the offshore wind farm area plus 2 km buffer, during the migration-free breeding bio-season.**

<b>Razorbill displacement rates (based on migration-free breeding population of 12 for offshore wind farm area plus 2 km buffer)</b>																
Displacement (%)	Mortality Rates (%)															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
20	0	0	0	0	0	0	0	0	1	1	1	1	2	2	2	2
30	0	0	0	0	0	0	0	1	1	1	2	2	3	3	3	4
40	0	0	0	0	0	0	0	1	1	2	2	3	3	4	4	5
50	0	0	0	0	0	0	1	1	2	2	3	4	4	5	5	6
60	0	0	0	0	0	0	1	1	2	3	4	4	5	6	6	7
70	0	0	0	0	0	0	1	2	3	3	4	5	6	7	8	8
80	0	0	0	0	0	0	1	2	3	4	5	6	7	8	9	10
90	0	0	0	0	0	1	1	2	3	4	5	6	8	9	10	11
100	0	0	0	0	0	1	1	2	4	5	6	7	8	10	11	12

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**Table 3-27: Boat-based displacement matrix presenting the mean peak number of razorbills in the offshore wind farm area only, during the post-breeding migration bio-season.**

<b>Razorbill displacement rates (based on post-breeding migration population of 281 for offshore wind farm area only)</b>																
<b>Displacement (%)</b>	<b>Mortality Rates (%)</b>															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3	3
10	0	0	1	1	1	1	3	6	8	11	14	17	20	22	25	28
20	0	1	1	2	2	3	6	11	17	22	28	34	39	45	51	56
30	0	1	2	3	3	4	8	17	25	34	42	51	59	67	76	84
40	0	1	2	3	4	6	11	22	34	45	56	67	79	90	101	112
50	0	1	3	4	6	7	14	28	42	56	70	84	98	112	126	141
60	0	2	3	5	7	8	17	34	51	67	84	101	118	135	152	169
70	0	2	4	6	8	10	20	39	59	79	98	118	138	157	177	197
80	0	2	4	7	9	11	22	45	67	90	112	135	157	180	202	225
90	0	3	5	8	10	13	25	51	76	101	126	152	177	202	228	253
100	0	3	6	8	11	14	28	56	84	112	141	169	197	225	253	281

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**Table 3-28: Boat-based displacement matrix presenting the mean peak number of razorbills in the offshore wind farm area plus 2 km buffer, during the post-breeding migration bio-season.**

<b>Razorbill displacement rates (based on post-breeding migration population of 962 for offshore wind farm area plus 2 km buffer)</b>																
<b>Displacement (%)</b>	<b>Mortality Rates (%)</b>															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	1	2	3	4	5	6	7	8	9	10
10	0	1	2	3	4	5	10	19	29	38	48	58	67	77	87	96
20	0	2	4	6	8	10	19	38	58	77	96	115	135	154	173	192
30	0	3	6	9	12	14	29	58	87	115	144	173	202	231	260	288
40	0	4	8	12	15	19	38	77	115	154	192	231	269	308	346	385
50	0	5	10	14	19	24	48	96	144	192	240	288	337	385	433	481
60	0	6	12	17	23	29	58	115	173	231	288	346	404	462	519	577
70	0	7	13	20	27	34	67	135	202	269	337	404	471	538	606	673
80	0	8	15	23	31	38	77	154	231	308	385	462	538	615	692	769
90	0	9	17	26	35	43	87	173	260	346	433	519	606	692	779	865
100	0	10	19	29	38	48	96	192	288	385	481	577	673	769	865	962

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**Table 3-29: Boat-based displacement matrix presenting the peak number of razorbills in the offshore wind farm area only, during the migration-free winter bio-season.**

<b>Razorbill displacement rates (based on the migration-free winter population of 139 for offshore wind farm area only)</b>																
<b>Displacement (%)</b>	<b>Mortality Rates (%)</b>															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
10	0	0	0	0	1	1	1	3	4	6	7	8	10	11	13	14
20	0	0	1	1	1	1	3	6	8	11	14	17	19	22	25	28
30	0	0	1	1	2	2	4	8	13	17	21	25	29	33	38	42
40	0	1	1	2	2	3	6	11	17	22	28	33	39	44	50	56
50	0	1	1	2	3	3	7	14	21	28	35	42	49	56	63	70
60	0	1	2	3	3	4	8	17	25	33	42	50	58	67	75	83
70	0	1	2	3	4	5	10	19	29	39	49	58	68	78	88	97
80	0	1	2	3	4	6	11	22	33	44	56	67	78	89	100	111
90	0	1	3	4	5	6	13	25	38	50	63	75	88	100	113	125
100	0	1	3	4	6	7	14	28	42	56	70	83	97	111	125	139



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**Table 3-30: Boat-based displacement matrix presenting the peak number of razorbills in the offshore wind farm area plus 2 km buffer, during the migration-free winter bio-season.**

<b>Razorbill displacement rates (based on the migration-free winter population of 512 for offshore wind farm area plus 2 km buffer)</b>																
<b>Displacement (%)</b>	<b>Mortality Rates (%)</b>															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	1	1	2	2	3	3	4	4	5	5
10	0	1	1	2	2	3	5	10	15	20	26	31	36	41	46	51
20	0	1	2	3	4	5	10	20	31	41	51	61	72	82	92	102
30	0	2	3	5	6	8	15	31	46	61	77	92	108	123	138	154
40	0	2	4	6	8	10	20	41	61	82	102	123	143	164	184	205
50	0	3	5	8	10	13	26	51	77	102	128	154	179	205	230	256
60	0	3	6	9	12	15	31	61	92	123	154	184	215	246	276	307
70	0	4	7	11	14	18	36	72	108	143	179	215	251	287	323	358
80	0	4	8	12	16	20	41	82	123	164	205	246	287	328	369	410
90	0	5	9	14	18	23	46	92	138	184	230	276	323	369	415	461
100	0	5	10	15	20	26	51	102	154	205	256	307	358	410	461	512

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### 3.8 Razorbill aerial digital displacement matrices

Table 3-31: Aerial digital displacement matrix presenting the peak number of razorbills in the offshore wind farm area only, during the migration-free breeding bio-season.

Razorbill displacement rates (based on migration-free breeding population of 154 for offshore wind farm area only)																
Displacement (%)	Mortality Rates (%)															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	2
10	0	0	0	0	1	1	2	3	5	6	8	9	11	12	14	15
20	0	0	1	1	1	2	3	6	9	12	15	19	22	25	28	31
30	0	0	1	1	2	2	5	9	14	19	23	28	32	37	42	46
40	0	1	1	2	2	3	6	12	19	25	31	37	43	49	56	62
50	0	1	2	2	3	4	8	15	23	31	39	46	54	62	69	77
60	0	1	2	3	4	5	9	19	28	37	46	56	65	74	83	93
70	0	1	2	3	4	5	11	22	32	43	54	65	76	86	97	108
80	0	1	2	4	5	6	12	25	37	49	62	74	86	99	111	123
90	0	1	3	4	6	7	14	28	42	56	69	83	97	111	125	139
100	0	2	3	5	6	8	15	31	46	62	77	93	108	123	139	154

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**Table 3-32: Aerial digital displacement matrix presenting the peak number of razorbills in the offshore wind farm area plus 2 km buffer, during the migration-free breeding bio-season.**

<b>Razorbill displacement rates (based on migration-free breeding population of 353 for offshore wind farm area plus 2 km buffer)</b>																
<b>Displacement (%)</b>	<b>Mortality Rates (%)</b>															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1	1	1	2	2	2	3	3	4
10	0	0	1	1	1	2	4	7	11	14	18	21	25	28	32	35
20	0	1	1	2	3	4	7	14	21	28	35	42	49	56	63	71
30	0	1	2	3	4	5	11	21	32	42	53	63	74	85	95	106
40	0	1	3	4	6	7	14	28	42	56	71	85	99	113	127	141
50	0	2	4	5	7	9	18	35	53	71	88	106	123	141	159	176
60	0	2	4	6	8	11	21	42	63	85	106	127	148	169	190	212
70	0	2	5	7	10	12	25	49	74	99	123	148	173	198	222	247
80	0	3	6	8	11	14	28	56	85	113	141	169	198	226	254	282
90	0	3	6	10	13	16	32	63	95	127	159	190	222	254	286	317
100	0	4	7	11	14	18	35	71	106	141	176	212	247	282	317	353

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**Table 3-33: Aerial digital displacement matrix presenting the peak number of razorbills in the offshore wind farm area only, during the post-breeding migration bio-season.**

<b>Razorbill displacement rates (based on post-breeding migration population of 265 for offshore wind farm area only)</b>																
<b>Displacement (%)</b>	<b>Mortality Rates (%)</b>															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1	1	1	1	2	2	2	2	3
10	0	0	1	1	1	1	3	5	8	11	13	16	19	21	24	26
20	0	1	1	2	2	3	5	11	16	21	26	32	37	42	48	53
30	0	1	2	2	3	4	8	16	24	32	40	48	56	63	71	79
40	0	1	2	3	4	5	11	21	32	42	53	63	74	85	95	106
50	0	1	3	4	5	7	13	26	40	53	66	79	93	106	119	132
60	0	2	3	5	6	8	16	32	48	63	79	95	111	127	143	159
70	0	2	4	6	7	9	19	37	56	74	93	111	130	148	167	185
80	0	2	4	6	8	11	21	42	63	85	106	127	148	169	190	212
90	0	2	5	7	10	12	24	48	71	95	119	143	167	190	214	238
100	0	3	5	8	11	13	26	53	79	106	132	159	185	212	238	265

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**Table 3-34: Aerial digital displacement matrix presenting the peak number of razorbills in the offshore wind farm area plus 2 km buffer, during the post-breeding migration bio-season.**

<b>Razorbill displacement rates (based on post-breeding migration population of 566 for offshore wind farm area plus 2 km buffer)</b>																
<b>Displacement (%)</b>	<b>Mortality Rates (%)</b>															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	1	1	2	2	3	3	4	5	5	6
10	0	1	1	2	2	3	6	11	17	23	28	34	40	45	51	57
20	0	1	2	3	5	6	11	23	34	45	57	68	79	91	102	113
30	0	2	3	5	7	8	17	34	51	68	85	102	119	136	153	170
40	0	2	5	7	9	11	23	45	68	91	113	136	158	181	204	226
50	0	3	6	8	11	14	28	57	85	113	141	170	198	226	255	283
60	0	3	7	10	14	17	34	68	102	136	170	204	238	272	306	340
70	0	4	8	12	16	20	40	79	119	158	198	238	277	317	356	396
80	0	5	9	14	18	23	45	91	136	181	226	272	317	362	407	453
90	0	5	10	15	20	25	51	102	153	204	255	306	356	407	458	509
100	0	6	11	17	23	28	57	113	170	226	283	340	396	453	509	566

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