Natura Impact Statement

NISA
North Irish Sea Array

Volume 2: Appendices

Appendix 17
Offshore and Intertidal Ornithology Displacement Analysis

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North Irish Sea Array Windfarm Ltd

Offshore Ornithology Displacement Analysis

North Irish Sea Array Offshore Windfarm

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Revision	Date	Status	Author:	Checked by:	Approved by:
1.0	May 2024	Final	FL/JM	JM	CC

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1 Introduction

1.1 Project Background

1.1.1 This document has been prepared by Arup and GoBe Consultants Limited (GoBe) on behalf of North Irish Sea Array Limited (NISA Ltd) to accompany Volume 3, Chapter 15: Offshore and Intertidal Ornithology (hereafter referred to as the 'Offshore and Intertidal Ornithology Chapter').

1.1.2 The North Irish Sea Array Offshore Wind Farm (OWF) (hereafter the 'proposed development') is proposed for construction 11.3 km off the east coast of Ireland (at their nearest points to the mainland). The proposed development will consist of offshore wind turbines generators (WTG), an offshore substation platform (OSP) , inter-array cables, export cables taking power to an onshore converter station. The area considered in the context of offshore ornithological receptors includes the entire array area, covering 89 km^2, an asymmetric 4 km buffer surrounding the array area, and the offshore Export Cable Corridor (ECC) covering a further 67.9 km^2.

1.1.3 During the breeding season, the Irish Sea region provides foraging, loafing and preening habitat for a range of seabirds, including (but not limited to) northern gannet, *Morus bassanus*, various gull species, and several species of auks and terns. An overview of key species present within and in close proximity to the proposed development is presented in Volume 9, Appendix 15.1: Offshore Ornithology Baseline Characterisation (hereafter referred to as the 'Technical Baseline').

1.2 Displacement Analysis

1.2.1 WTGs directly disturb and displace vulnerable seabirds that would normally reside within and around the proposed development array area and ECC. Different seabird species show varying degrees of avoidance to anthropogenic structures and activities. For species which are vulnerable to displacement (i.e., show a higher degree of avoidance of anthropogenic structures and activities), this indirect habitat loss reduces the area available for those seabirds to forage, loaf and / or moult in the way that they are currently able to within and around the proposed development area.

1.2.2 Displacement impacts may arise from the presence of WTGs during the operation and maintenance phase. However, there is also the potential for the construction and decommissioning of WTGs, OSP, and cable laying to directly disturb and displace seabirds (predominantly through the presence of vessels), though potential impacts are more restricted spatially and temporally during those phases of the development.

1.2.3 The presence of WTGs may also result in barrier effects to seabirds, whereby birds will avoid flying through the development, potentially reducing access to feeding areas, or driving them to increase energy expenditure by diverting around WTGs. Though sometimes considered a separate impact to displacement, any impacts resulting from barrier effects are accounted for within the displacement assessment (as is standard across English and Scottish projects, and as agreed appropriate through consultation with other east coast phase 1 Irish OWF projects[1].

Species of Interest

1.2.4 The assessment considers two main aspects; the assessment of displacement due to the presence of offshore infrastructure in the array area, and the assessment of displacement due to increased vessel disturbance in the offshore ECC.

1.2.5 Species of interest in the array area were identified for the displacement assessment based on their abundance in the proposed development array area plus relevant buffer from digital aerial survey (DAS) data, and their sensitivity to displacement impacts as presented in the Offshore and Intertidal Ornithology Chapter The following five species were identified as needing consideration for the displacement assessment:

- Common guillemot, *Uria aalge*;
- Razorbill, *Alca torda*;
- Atlantic puffin, *Fratercula arctica*;
- Manx shearwater *Puffinus puffinus*; and
- Northern gannet.

1.2.6 Species of interest in the offshore ECC were identified based on their abundance in available aerial survey data from Jessop et al. (2018), with three species identified as needing consideration for the displacement assessment:

- Common scoter *Melanitta nigra*;
- Red-throated diver *Gavia stellata*; and
- Great northern diver *Gavia immer*.

1.2.7 As outlined in the Offshore and Intertidal Ornithology Chapter, Jessop et al. (2018) did not distinguish between diver species, and therefore these were apportioned to red-throated diver and great northern diver based on the proportions of each species in the regional population in Furness (2015). Similarly, for any scoter species which were not identified to species level, it was assumed these were all common scoter as a precautionary measure.

[1] Namely Oriel Windfarm, Dublin Array Offshore Wind Farm Project, Codling Wind Park and Arklow Bank Wind Park 2.

2 Methodology

2.1 Guidance

2.1.1 The methodology for assessing displacement and barrier effects is based on available evidence, UK Statutory Nature Conservation Body (SNCB) guidance and consultation with other Phase 1 Irish projects (see agreed methodology in Irish Phase 1 Methodology Statement). This included a review of available Irish Guidance and best practice along with wider offshore renewable industry best-practice. Consideration of SNCB guidance (SNCBs, 2022) was heavily relied upon, given that this represents the closest established industry guidance and heavily supported by substantive and robust research and evidence. This guidance has also already been used to inform displacement assessments of several other recently consented OWF projects in the Irish Sea (for example Awel-y-Mor).

2.1.2 Displacement in the context of OWFs refers to 'a reduced number of birds occurring within or immediately adjacent to an OWF' (Furness et al. 2013). Within this displacement assessment, both flying and sitting birds were considered as this represents a precautionary approach, with the inclusion of sitting birds providing an assessment for individuals potentially displaced as a result of the proposed development, and the inclusion of flying birds providing an assessment of any potential barrier effects to birds moving through the study area. This approach is recommended by guidance from UK SNCBs (SNCBs, 2022), and supported by the most recent NatureScot guidance (NatureScot, 2023), whereby the displacement approach is considered to account for all distributional responses (i.e., displacement effects and barrier effects).

2.2 DAS Surveys

2.2.1 Across the 29-months of DAS data collection, 26 bird species were recorded. For each recorded species, abundance and density estimates were calculated within the array area, array area plus 2km buffer and array area plus 4km buffer. For seabird species that are susceptible to displacement from OWFs, the displacement effects may not only be limited to the array area but also extend to the surrounding area, or buffer zone. Guidance from SNCBs in UK OWFs (SNCBs, 2022) has recommended the use of a 2 km buffer for displacement assessments for the majority of species, with a 4 km buffer recommended for divers and sea ducks. This approach has also been adopted for the displacement assessment for the proposed development.

2.3 Sensitivity to Displacement

2.3.1 Different species exhibit different sensitivity to displacement, with sensitivity based on their susceptibility to disturbance impacts, and their degree of habitat specialization (i.e., their ability to forage elsewhere if they are displaced) (Bradbury et al. 2014; Furness et al. 2013). Species were considered for the displacement assessment if they were considered to be vulnerable to displacement impacts and were recorded in moderate abundances/frequency within DAS surveys. A full outline of the species screening process is provided in the Offshore and Intertidal Ornithology Chapter.

2.4 Bio-seasons

2.4.1 The displacement assessment was undertaken based on bio-season mean peak abundances, calculated as the highest monthly abundance averaged across three years of data in each bio-season. This approach has also been recommended by SNCBs for displacement assessments in UK waters and was agreed appropriate in the Phase One Irish Projects Methodology Note. Given it is highly unlikely that this peak abundance is maintained throughout the whole bio-season, especially the non-breeding bio-season where birds disperse more widely (often outside of Irish waters), this approach is considered highly precautionary. There are no robust bio-seasons defined for Irish seabirds. Consequently, the bio-seasons identified within Furness et al. (2015) were used to guide the bio-season definitions due to the proximity of the Irish projects to species in England and Wales, which are likely to have similar biological traits. Within Furness et al., (2015), some species have both a migration-free breeding season and an extended breeding season defined. As a precautionary approach, the full breeding season was used for relevant species as this may result in a higher mean peak abundance during the breeding season when impacts are greater because they are apportioned to a smaller population size. Bio-seasons for the key species are presented in Table 2-1 below.

2.4.2 The one exception to this is guillemot, which the Furness approach to bio-seasons is not considered the most ecologically relevant for the proposed development. Though Furness (2015) suggest a breeding season of May to July, site-specific DAS data collected for the proposed development and available literature (e.g., Dunn et al. 2020) indicate that birds at the early and late stages of this period are not under the same energy constraints as in the core breeding season. Additionally, birds present in July are highly likely to be a result of post-breeding dispersal (as opposed to being breeding birds). Therefore, a more ecologically relevant guillemot breeding season of April to June is presented throughout the assessment alongside the standard bio-seasons defined by Furness (2015). These two approaches are termed the 'Project Approach' and 'Furness Approach', respectively. A full justification of this approach is provided in the Technical Baseline.

Table 2-1 – Bio-seasons used for seabird species in the displacement assessment.

Species	Autumn migration	Spring season	Migration-free winter	Breeding season	Non-breeding
Common scoter	-	-	-	-	Sep-Apr
Guillemot (project approach)	-	-	-	Apr-Jun	Jul-Mar
Guillemot (Furness approach)	-	-	-	Mar-Jul	Aug-Feb
Razorbill	Aug-Oct	Jan-Mar	Nov-Dec	Apr-Jul	-
Puffin	-	-	-	Apr-Jul	Aug-Mar
Red-throated diver	Sep-Nov	Feb-Apr	Dec-Jan	Mar-Aug	Sep-Apr

Great northern diver	-	-	-	-	Sep-May
Gannet	Sep-Nov	Dec-Feb	-	Mar-Sep	-

2.5 The Matrix Approach

2.5.1 A 'Matrix Approach' is used to present the full range of potential displacement from 0% to 100% of mean seasonal peak abundances observed during baseline surveys, with this approach having been agreed with UK SNCBs for other recent projects. Matrices are presented in tables for the Array Area plus two km buffer at 10% intervals.

2.5.2 Mortality of displaced birds is also presented using the same approach, using 0-100% mortality of displaced birds in 10% increments. At the lower range of this scale it is also considered appropriate to use a finer gradation of percentage increments, for example 1% intervals between 0% and 5%. The potential reduction in productivity of breeding birds was not considered during the assessment owing to a lack of empirical evidence on the consequences of displacement of breeding seabirds; this approach is also supported by UK SNCBs. However, despite a lack of evidence on productivity impacts, mortality rates used are considered to be appropriately precautionary to account for the combined impacts from both mortality and potential productivity.

2.5.3 Guidance also recommends that mean seasonal peak abundance should be used to produce two seasonal matrices covering breeding and non-breeding seasons as minimum. Post-breeding season matrices should also be provided for species where appropriate (for example gannet and razorbill).

2.5.4 When undertaking displacement assessment across multiple seasons, the predicted mortalities should be summed across the bio-seasons where the relevant geographical range and population scale remain the same, or where the assessment involves apportioning back to an SPA colony. Through this process, an annual mortality estimate can be obtained. The default position is to assess the summed annual mortality against the largest population scale in the annual cycle for EIAR. Where the population scale varies with each season, an alternative approach may need to be taken, which assess the impacts against each of the seasonal populations, in turn.

2.5.5 The impacts of displacement were assessed based on mean seasonal peak monthly abundance within the array area, plus a 2km buffer for all species assessed.

2.6 Disturbance and displacement in the offshore ECC

2.6.1 To assess displacement impacts to divers and seaducks in the ECC, data from Jessop et al. (2018) was used, which encompasses fine-scale aerial data on the distribution and abundance of seabirds in the western Irish Sea. On investigation it was found that the Jessop aerial survey data had a 2.3% coverage of the ECC. To increase coverage, and therefore the representativeness of density estimates in the ECC, data from a 4km buffer surrounding the ECC was collated, which increased the total coverage to 10.5%. The density within survey transects across this whole area was then scaled up, assuming an equal distribution of birds throughout, and used as a proxy for the density within just the ECC (i.e. the area over which divers and seaducks may be prone to vessel disturbance). As a survey was only undertaken in the Autumn bio-season, not the spring, the number of birds was assumed to be equal across these two bio-seasons.

2.6.2 For the assessment of displacement impacts within the ECC, the assessment considers the impacts of one cable-laying vessel cluster, with a 2.5km disturbance buffer. Based on a 2.5km disturbance buffer around the vessel cluster, the area from which birds could be displaced was calculated to be 28.3km^2. This is considered a precautionary approach, since vessels disturbance is unlikely to impact birds 2.5km away.

2.6.3 The abundance/density of relevant birds in the ECC, and number at risk of disturbance and displacement based on this methodology is presented in Table 2-2 below. All three species are considered in the non-breeding bio-seasons only. No scoter species were recorded in the breeding season during the survey, and sufficiently low divers were recorded such that no impact pathway is considered to be present in the breeding season (see Offshore and Intertidal Ornithology Chapter for further justification).

Table 2-2: Number of relevant birds at risk of displacement impacts in the offshore ECC based on

Species	Density of birds across the ECC (birds per km^2)		Number of birds at risk of displacement impacts (based on a disturbance area of 28.3km^2)	
	Autumn/Spring	Winter	Autumn/Spring	Winter
Common scoter	-	3.0	-	86.2
Red-throated diver	0.9	0.4	24.9	10.3
Great northern diver	-	0.1	1.7	1.7

3 Results (array area)

3.1 Guillemot

3.1.1 Confidence intervals for mean peak bio-season counts for guillemot are presented in Table 3-1, and the full range of potential impacts based on the matrix approach in Table 3-2 to Table 3-5.

Table 3-1: Mean peak bio-season counts for guillemot in the array area plus 2km buffer, with upper and lower 95% confidence intervals.

Bio-season	Mean peak count	Lower 95% CI	Upper 95% CI
Project approach			
Breeding (Apr-Jun)	1,813	1,258	2,385
Non-breeding (Jul-Mar)	29,765	21,092	38,338
Furness approach			
Breeding (Mar-Jul)	13,703	8,940	18,414
Non-breeding (Aug-Feb)	29,765	21,092	38,338

Table 3-2 - Guillemot breeding season displacement matrix (array area plus two km buffer) – Project approach

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	2	4	9	18	36	54	73	91	109	127	145	163	181
20	4	7	18	36	73	109	145	181	218	254	290	326	363
30	5	11	27	54	109	163	218	272	326	381	435	490	544
40	7	15	36	73	145	218	290	363	435	508	580	653	725
50	9	18	45	91	181	272	363	453	544	635	725	816	907
60	11	22	54	109	218	326	435	544	653	761	870	979	1,088
70	13	25	63	127	254	381	508	635	761	888	1,015	1,142	1,269
80	15	29	73	145	290	435	580	725	870	1,015	1,160	1,305	1,450
90	16	33	82	163	326	490	653	816	979	1,142	1,305	1,469	1,632
100	18	36	91	181	363	544	725	907	1,088	1,269	1,450	1,632	1,813

Table 3-3 – Guillemot non-breeding season displacement matrix (array area plus two km buffer) – Project approach

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	30	60	149	298	595	893	1,191	1,488	1,786	2,084	2,381	2,679	2,977
20	60	119	298	595	1,191	1,786	2,381	2,977	3,572	4,167	4,762	5,358	5,953
30	89	179	446	893	1,786	2,679	3,572	4,465	5,358	6,251	7,144	8,037	8,930
40	119	238	595	1,191	2,381	3,572	4,762	5,953	7,144	8,334	9,525	10,715	11,906
50	149	298	744	1,488	2,977	4,465	5,953	7,441	8,930	10,418	11,906	13,394	14,883
60	179	357	893	1,786	3,572	5,358	7,144	8,930	10,715	12,501	14,287	16,073	17,859
70	208	417	1,042	2,084	4,167	6,251	8,334	10,418	12,501	14,585	16,668	18,752	20,836
80	238	476	1,191	2,381	4,762	7,144	9,525	11,906	14,287	16,668	19,050	21,431	23,812
90	268	536	1,339	2,679	5,358	8,037	10,715	13,394	16,073	18,752	21,431	24,110	26,789
100	298	595	1,488	2,977	5,953	8,930	11,906	14,883	17,859	20,836	23,812	26,789	29,765

Table 3-4 - Guillemot breeding season displacement matrix (array area plus two km buffer) – Furness approach

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	14	27	69	137	274	411	548	685	822	959	1,096	1,233	1,370
20	27	55	137	274	548	822	1,096	1,370	1,644	1,918	2,193	2,467	2,741
30	41	82	206	411	822	1,233	1,644	2,055	2,467	2,878	3,289	3,700	4,111
40	55	110	274	548	1,096	1,644	2,193	2,741	3,289	3,837	4,385	4,933	5,481
50	69	137	343	685	1,370	2,055	2,741	3,426	4,111	4,796	5,481	6,166	6,852
60	82	164	411	822	1,644	2,467	3,289	4,111	4,933	5,755	6,578	7,400	8,222
70	96	192	480	959	1,918	2,878	3,837	4,796	5,755	6,715	7,674	8,633	9,592
80	110	219	548	1,096	2,193	3,289	4,385	5,481	6,578	7,674	8,770	9,866	10,963
90	123	247	617	1,233	2,467	3,700	4,933	6,166	7,400	8,633	9,866	11,100	12,333
100	137	274	685	1,370	2,741	4,111	5,481	6,852	8,222	9,592	10,963	12,333	13,703

Table 3-5 – Guillemot non-breeding season displacement matrix (array area plus two km buffer) – Furness approach

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	30	60	149	298	595	893	1,191	1,488	1,786	2,084	2,381	2,679	2,977
20	60	119	298	595	1,191	1,786	2,381	2,977	3,572	4,167	4,762	5,358	5,953
30	89	179	446	893	1,786	2,679	3,572	4,465	5,358	6,251	7,144	8,037	8,930
40	119	238	595	1,191	2,381	3,572	4,762	5,953	7,144	8,334	9,525	10,715	11,906
50	149	298	744	1,488	2,977	4,465	5,953	7,441	8,930	10,418	11,906	13,394	14,883
60	179	357	893	1,786	3,572	5,358	7,144	8,930	10,715	12,501	14,287	16,073	17,859
70	208	417	1,042	2,084	4,167	6,251	8,334	10,418	12,501	14,585	16,668	18,752	20,836
80	238	476	1,191	2,381	4,762	7,144	9,525	11,906	14,287	16,668	19,050	21,431	23,812
90	268	536	1,339	2,679	5,358	8,037	10,715	13,394	16,073	18,752	21,431	24,110	26,789
100	298	595	1,488	2,977	5,953	8,930	11,906	14,883	17,859	20,836	23,812	26,789	29,765

3.2 Razorbill

3.2.1 Confidence intervals for mean peak bio-season counts for razorbill are presented in Table 3-6, and the full range of potential impacts based on the matrix approach in Table 3-7 to Table 3-10.

Table 3-6: Mean peak bio-season counts for razorbill in the array area plus 2km buffer, with upper and lower 95% confidence intervals.

Bio-season	Mean peak count	Lower 95% CI	Upper 95% CI
Spring (Jan-Mar)	483	236	796
Breeding (Apr-Jul)	168	83	263
Autumn (Aug-Oct)	3,371	1,484	5,385
Winter (Nov-Dec)	2,079	1,230	2,930

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Table 3-7 – Razorbill spring migration season displacement matrix (array area plus two km buffer).

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	1	2	5	10	14	19	24	29	34	39	43	48
20	1	2	5	10	19	29	39	48	58	68	77	87	97
30	1	3	7	14	29	43	58	72	87	101	116	130	145
40	2	4	10	19	39	58	77	97	116	135	155	174	193
50	2	5	12	24	48	72	97	121	145	169	193	217	242
60	3	6	14	29	58	87	116	145	174	203	232	261	290
70	3	7	17	34	68	101	135	169	203	237	271	304	338
80	4	8	19	39	77	116	155	193	232	271	309	348	387
90	4	9	22	43	87	130	174	217	261	304	348	391	435
100	5	10	24	48	97	145	193	242	290	338	387	435	483

Table 3-8 – Razorbill breeding season displacement matrix (array area plus two km buffer)

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	1	2	3	5	7	8	10	12	13	15	17
20	0	1	2	3	7	10	13	17	20	24	27	30	34
30	1	1	3	5	10	15	20	25	30	35	40	45	50
40	1	1	3	7	13	20	27	34	40	47	54	60	67
50	1	2	4	8	17	25	34	42	50	59	67	76	84
60	1	2	5	10	20	30	40	50	60	71	81	91	101
70	1	2	6	12	24	35	47	59	71	82	94	106	118
80	1	3	7	13	27	40	54	67	81	94	108	121	134
90	2	3	8	15	30	45	60	76	91	106	121	136	151
100	2	3	8	17	34	50	67	84	101	118	134	151	168

Table 3-9 – Razorbill post-breeding migration season displacement matrix (array area plus two km buffer).

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	3	7	17	34	67	101	135	169	202	236	270	303	337
20	7	13	34	67	135	202	270	337	405	472	539	607	674
30	10	20	51	101	202	303	405	506	607	708	809	910	1,011
40	13	27	67	135	270	405	539	674	809	944	1,079	1,214	1,348
50	17	34	84	169	337	506	674	843	1,011	1,180	1,348	1,517	1,685
60	20	40	101	202	405	607	809	1,011	1,214	1,416	1,618	1,820	2,023
70	24	47	118	236	472	708	944	1,180	1,416	1,652	1,888	2,124	2,360
80	27	54	135	270	539	809	1,079	1,348	1,618	1,888	2,157	2,427	2,697
90	30	61	152	303	607	910	1,214	1,517	1,820	2,124	2,427	2,730	3,034
100	34	67	169	337	674	1,011	1,348	1,685	2,023	2,360	2,697	3,034	3,371

Table 3-10 – Razorbill migration-free winter season displacement matrix (array area plus two km buffer).

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	2	4	10	21	42	62	83	104	125	146	166	187	208
20	4	8	21	42	83	125	166	208	249	291	333	374	416
30	6	12	31	62	125	187	249	312	374	437	499	561	624
40	8	17	42	83	166	249	333	416	499	582	665	748	832
50	10	21	52	104	208	312	416	520	624	728	832	935	1,039
60	12	25	62	125	249	374	499	624	748	873	998	1,123	1,247
70	15	29	73	146	291	437	582	728	873	1,019	1,164	1,310	1,455
80	17	33	83	166	333	499	665	832	998	1,164	1,330	1,497	1,663
90	19	37	94	187	374	561	748	935	1,123	1,310	1,497	1,684	1,871
100	21	42	104	208	416	624	832	1,039	1,247	1,455	1,663	1,871	2,079

3.3 Puffin

3.3.1 Confidence intervals for mean peak bio-season counts for puffin are presented in Table 3-11, and the full range of potential impacts based on the matrix approach in Table 3-12 to Table 3-13.

Table 3-11: Mean peak bio-season counts for puffin in the array area plus 2km buffer, with upper and lower 95% confidence intervals.

Bio-season	Mean peak count	Lower 95% CI	Upper 95% CI
Breeding (Mar-Jul)	12	3	26
Non-breeding (Aug-Feb)	10	2	27

Table 3-12 – Puffin breeding season displacement matrix (array area plus two km buffer).

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

Table 3-13 – Puffin nonbreeding season displacement matrix (array area plus two km buffer)

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

3.4 Manx shearwater

3.4.1 Confidence intervals for mean peak bio-season counts for Manx shearwater are presented in Table 3-14, and the full range of potential impacts based on the matrix approach in Table 3-14 to Table 3-17.

Table 3-14: Mean peak bio-season counts for Manx shearwater in the array area plus 2km buffer, with upper and lower 95% confidence intervals.

Bio-season	Mean peak count	Lower 95% CI	Upper 95% CI
Spring (Jan-Mar)	0	0	0
Breeding (Apr-Jul)	3,525	2,935	5,527
Autumn (Aug-Oct)	1,019	718	1,550

Table 3-15: Manx shearwater spring migration season displacement matrix (array area plus two km buffer).

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

Table 3-16: Manx shearwater breeding season displacement matrix (array area plus two km buffer).

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	4	7	18	35	71	106	141	176	212	247	282	317	353
20	7	14	35	71	141	212	282	353	423	494	564	635	705
30	11	21	53	106	212	317	423	529	635	740	846	952	1,058
40	14	28	71	141	282	423	564	705	846	987	1,128	1,269	1,410
50	18	35	88	176	353	529	705	881	1,058	1,234	1,410	1,586	1,763
60	21	42	106	212	423	635	846	1,058	1,269	1,481	1,692	1,904	2,115
70	25	49	123	247	494	740	987	1,234	1,481	1,727	1,974	2,221	2,468
80	28	56	141	282	564	846	1,128	1,410	1,692	1,974	2,256	2,538	2,820
90	32	63	159	317	635	952	1,269	1,586	1,904	2,221	2,538	2,855	3,173
100	35	71	176	353	705	1,058	1,410	1,763	2,115	2,468	2,820	3,173	3,525

Table 3-17: Manx shearwater autumn migration season displacement matrix (array area plus two km buffer).

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	2	5	10	20	31	41	51	61	71	82	92	102
20	2	4	10	20	41	61	82	102	122	143	163	183	204
30	3	6	15	31	61	92	122	153	183	214	245	275	306
40	4	8	20	41	82	122	163	204	245	285	326	367	408
50	5	10	25	51	102	153	204	255	306	357	408	459	510
60	6	12	31	61	122	183	245	306	367	428	489	550	611
70	7	14	36	71	143	214	285	357	428	499	571	642	713
80	8	16	41	82	163	245	326	408	489	571	652	734	815
90	9	18	46	92	183	275	367	459	550	642	734	825	917
100	10	20	51	102	204	306	408	510	611	713	815	917	1,019

3.5 Gannet

3.5.1 Confidence intervals for mean peak bio-season counts for gannet are presented in Table 3-18, and the full range of potential impacts based on the matrix approach in Table 3-19 to Table 3-21.

Table 3-18: Mean peak bio-season counts for gannet in the array area plus 2km buffer, with upper and lower 95% confidence intervals.

Bio-season	Mean peak count	Lower 95% CI	Upper 95% CI
Spring (Jan-Mar)	13	3	30
Breeding (Apr-Jul)	304	189	437
Autumn (Aug-Oct)	265	122	432

Table 3-19 - Gannet return migration season displacement matrix (array area plus two km buffer).

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

Table 3-20 – Gannet breeding season displacement matrix (array area plus two km buffer).

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	1	2	3	6	9	12	15	18	21	24	27	30
20	1	1	3	6	12	18	24	30	36	43	49	55	61
30	1	2	5	9	18	27	36	46	55	64	73	82	91
40	1	2	6	12	24	36	49	61	73	85	97	109	122
50	2	3	8	15	30	46	61	76	91	106	122	137	152
60	2	4	9	18	36	55	73	91	109	128	146	164	182
70	2	4	11	21	43	64	85	106	128	149	170	192	213
80	2	5	12	24	49	73	97	122	146	170	195	219	243
90	3	5	14	27	55	82	109	137	164	192	219	246	274
100	3	6	15	30	61	91	122	152	182	213	243	274	304

Table 3-21: Gannet post-breeding migration season displacement matrix (array area plus two km buffer).

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	1	1	3	5	8	11	13	16	19	21	24	27
20	1	1	3	5	11	16	21	27	32	37	42	48	53
30	1	2	4	8	16	24	32	40	48	56	64	72	80
40	1	2	5	11	21	32	42	53	64	74	85	95	106
50	1	3	7	13	27	40	53	66	80	93	106	119	133
60	2	3	8	16	32	48	64	80	95	111	127	143	159
70	2	4	9	19	37	56	74	93	111	130	148	167	186
80	2	4	11	21	42	64	85	106	127	148	170	191	212
90	2	5	12	24	48	72	95	119	143	167	191	215	239
100	3	5	13	27	53	80	106	133	159	186	212	239	265

4 Results (ECC)

4.1 Common scoter

Table 4-1: Common scoter non-breeding season displacement matrix (ECC).

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	1	2	3	3	4	5	6	7	8	9
20	0	0	1	2	3	5	7	9	10	12	14	16	17
30	0	1	1	3	5	8	10	13	16	18	21	23	26
40	0	1	2	3	7	10	14	17	21	24	28	31	34
50	0	1	2	4	9	13	17	22	26	30	34	39	43
60	1	1	3	5	10	16	21	26	31	36	41	47	52
70	1	1	3	6	12	18	24	30	36	42	48	54	60
80	1	1	3	7	14	21	28	34	41	48	55	62	69
90	1	2	4	8	16	23	31	39	47	54	62	70	78
100	1	2	4	9	17	26	34	43	52	60	69	78	86

4.2 Red-throated diver

Table 4-2: Red-throated diver spring migration season displacement matrix (ECC).

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

Table 4-3: Red-throated diver autumn migration season displacement matrix (ECC).

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

X

Table 4-4: Red-throated diver migration-free winter season displacement matrix (ECC).

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

4.3 Great northern diver

Table 4-5: Great northern diver non-breeding season displacement matrix (ECC).

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

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