NORTH FALLS

Offshore Wind Farm

ENVIRONMENTAL STATEMENT

Appendix 13.3 Supplementary Information for the Offshore Ornithology Cumulative Effects Assessment

NORTH FALLS

Offshore Wind Farm

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Contents

Tables

Glossary of Acronyms

AR	Avoidance Rate (Collision Risk Modelling)
BDMPS	Biologically Defined Minimum Population Scales
CEA	Cumulative Effects Assessment
CRM	Collision Risk Modelling
DCO	Development Consent Order
DEP	Dudgeon Extension Projects
EIA	Environmental Impact Assessment
ES	Environmental Statement
HRA	Habitats Regulations Assessment
MA	Macro-avoidance
OWF	Offshore Wind Farm
PEIR	Preliminary Environmental Information Report
RIAA	Report to Inform Appropriate Assessment
SeaMAST	The Seabird Mapping and Sensitivity Tool
SEP	Sherringham Shoal Extension Project
SNCB	Statutory Nature Conservation Body
SPA	Special Protection Area
WTG	Wind Turbine Generator

Glossary of Terminology

Array area	The offshore wind farm area, within which the wind turbine generators, array cables, platform interconnector cable, offshore substation platform(s) and/or offshore converter platform will be located.
Array cables	Cables which link the wind turbine generators with each other, the offshore substation platform(s) and/or the offshore converter platform.
Landfall	The location where the offshore export cables come ashore at Kirby Brook.
Migration free breeding season	The breeding season for migratory seabird species is defined as a wider breeding season and a narrower window known as the migration free breeding season. In a given species, the timing of breeding will vary depending on the location of the breeding area; with the start of breeding usually later in more northerly locations. Thus, while birds at some colonies are beginning to nest, others may still be migrating to breeding sites. A core or migration free breeding season is defined as the period when all or the majority of breeding adults of a given species are present at breeding colonies.
Offshore convertor Platform	Should an offshore connection to a third party HVDC cable be selected, an offshore converter platform would be required. This is a fixed structure located within the array area, containing HVAC and HVDC electrical equipment to aggregate the power from the wind turbine generators, increase the voltage to a more suitable level for export and convert the HVAC power generated by the wind turbine generators into HVDC power for export to shore via a third party HVDC cable.
Offshore export cables	The cables which bring electricity from the array area to the landfall.
The Applicant	North Falls Offshore Wind Farm Limited (NFOW).
The Project or 'North Falls'	North Falls Offshore Wind Farm, including all onshore and offshore infrastructure.
Wind turbine generator	Power generating device that is driven by the kinetic energy of the wind

1 Introduction

1. This Appendix presents the information that underpins the quantitative element of the cumulative effects assessment (CEA) for Environmental Statement (ES) Chapter 13 Offshore Ornithology (Document Reference: 3.1.15) and the in combination assessment for the Report to Inform Appropriate Assessment (RIAA). A large number of offshore wind farm (OWF) projects require consideration in the CEA of offshore ornithology receptors. This is largely due to the wide-ranging nature of many of the receptors included in the assessment.

2. There is considerable complexity associated with the evolution of OWF project envelopes and changes to collision risk and displacement estimates over time (for example as a project progresses through Development Consent Order (DCO) Examination). In general, this assessment uses the consented designs for OWFs unless otherwise stated, and the latest available estimates for OWFs which are not yet consented. A number of OWFs have been built out with designs that have lower predicted collision risk than the worst case at consent. Thus, using the consented parameters, as recommended by Natural England on the basis that this is a legally secured design, results in a substantial degree of precaution being included in the predicted impacts of collision risk. It has been estimated that the use of consented rather than as-built OWF parameters may lead to the overestimation of collision rates by up to 40% (MacArthur Green, 2017; The Crown Estate and Womble Bond Dickinson, 2021). Notes are included in the species tables below to identify OWFs where there were considerable changes in the as-built layout compared with the worst-case consented design. For Scottish OWFs the values for the as-built designs, if different from consented designs (and if available), are used, as these are accepted by Marine Scotland and NatureScot.

3. For each species scoped in for the CEA, tabulated estimates of collision risk mortality and the number of birds at risk of displacement are provided in Section 2 and Section 3 respectively. These numbers are provided as seasonal and annual totals and include all age classes of birds. An explanation of the biologically relevant seasons used for each offshore ornithology receptor is provided in ES Chapter 13 Offshore Ornithology (Document Reference: 3.1.15).

4. For red-throated diver, the outputs from an alternative approach (Section 3.4.2) to CEA for displacement are presented alongside the "standard" approach (Section 3.4.1). This uses modelled at-sea density estimates from the Seabird Mapping and Sensitivity Tool (SeaMAST) project (Bradbury *et al.*, 2014). The reason for this is that the "standard" approach was not considered comprehensive due to a lack of data from many OWF assessments and the differing time periods over which baseline data for individual OWFs was collected.

5. The key source of information for the majority of the OWFs included in this CEA was the assessment carried out for the Sheringham Shoal and Dudgeon Extension Projects (SEP/DEP). For collision risk the latest values are taken from The Deadline 3 Collision Risk Modelling (CRM) updates (Royal HaskoningDHV, 2023); for displacement the values are based on Appendix 11.2 of the Environmental Statement (Royal HaskoningDHV 2022). The SEP/DEP assessment was in turn principally informed by the post-Examination

update of the cumulative and in-combination collision risk and displacement assessment produced for the East Anglia ONE North and East Anglia TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021). The Preliminary Environmental Information Report (PEIR) cumulative appendix for SEP/DEP (Royal HaskoningDHV, 2021) is also referenced where the data are still current, as it includes source references for OWF information which were not included in the subsequent ES or examination updates.

6.   Key revisions that have been made to this CEA when compared with the SEP/DEP ES and examination updates are the addition of impacts from the following OWFs: Berwick Bank, Green Volt, Rampion 2 and West of Orkney (for which marine licence applications have been submitted); and Dogger Bank South and Outer Dowsing (for which PEIRs are in the public domain).

7.   Sources of data for all OWFs included in the CEA are referenced in the tables below.

8.   The cut off for inclusion of other OWFs into the CEA was the end of January 2024. This means that updates are not included for OWFs for which PEIRs became available or the ES was submitted beyond this date.

9.   In the species tables, OWFs are assigned to tiers as suggested by Natural England (2022a). These are shown in Note that since the ES and RIAA for North Falls was drafted, Green Volt and Sheringham Shoal and Dudgeon Extension Projects - have been consented; and the ESs for three OWFs for which only PEIR was available at the time of drafting, Dogger Bank South, Five Estuaries and Outer Dowsing, have now become publicly available. Tiers have been updated in the tables below. It is understood that no changes to the cumulative values for the two consented sites have been made. Changes may have been made to the cumulative values for the other three OWFs, however the tables below and in the North Falls Offshore ornithology sections of the ES Chapter 13 Offshore Ornithology (Document Reference: 3.1.15) and RIAA Part 1-6 (Document Reference: 7.1.1 to 7.1.6) have not been updated to include the ES rather than the PEIR values for Dogger Bank South, Five Estuaries and Outer Dowsing. This is because the cut off date for including data for other OWFs in the North Falls ES was the end of March 2024.

10.   Table 1.1. Quantitative information is available for OWFs in tiers 1 to 5, which have been included in the assessment. OWFs in tiers 6 and 7 cannot be quantitatively considered with respect to the offshore ornithology assessment since no information at the required level of detail is publicly available (i.e. baseline seabird densities, CRM and displacement assessment results).

11.   Note that since the ES and RIAA for North Falls was drafted, Green Volt and Sheringham Shoal and Dudgeon Extension Projects - have been consented; and the ESs for three OWFs for which only PEIR was available at the time of drafting, Dogger Bank South, Five Estuaries and Outer Dowsing, have now become publicly available. Tiers have been updated in the tables below. It is understood that no changes to the cumulative values for the two consented sites have been made. Changes may have been made to the cumulative values for the other three OWFs, however the tables below and in the North Falls Offshore ornithology sections of the ES Chapter 13 Offshore Ornithology (Document Reference: 3.1.15) and RIAA Part 1-6 (Document Reference: 7.1.1 to 7.1.6) have not been updated to include the ES rather than the PEIR values for Dogger

Bank South, Five Estuaries and Outer Dowsing. This is because the cut off date for including data for other OWFs in the North Falls ES was the end of March 2024.

Table 1.1 Tiers for OWFs included in CEA

Tier	Status
1	Built and operational projects
2	Projects under construction
3	Consented but not yet under construction
4	Application submitted and not yet determined
5	PEIR produced and available
6	In planning and submission of assessment expected (e.g. identified in Planning Inspectorate list of projects)
7	Identified in relevant strategic plans or programmes

2   Cumulative Collision Risk

2.1   Gannet

12.   Predicted seasonal and annual numbers of gannet collisions for OWFs included in the cumulative assessment are given in Table 2.1. This table includes predictions for consented designs, where an OWF has been consented, and the latest available predictions for OWFs which have not been consented.

13.   A review of bird species avoidance rates for use in CRM for OWFs is ongoing and interim guidance has been issued (Natural England 2022b, 2023). As a result of this it is recommended that the within wind farm avoidance rate for collision risk modelling is increased from 0.989 to 0.9924 (±0.0001) for the deterministic Band (2012) model, and 0.9928 (±0.0003) for the stochastic (MacGregor *et al*., 2018) model; and the nocturnal activity factor for this species is reduced from 0.1-0.2 to 0.08 (±0.10). In addition, there is clear evidence that gannets display behavioral responses beyond the perimeter of an OWF, and most individuals avoid entering the turbine array ('macro-avoidance') (Pavat *et al.,* 2023). Natural England (2022b) recommends that densities from baseline surveys within OWF array areas should be reduced by a mean of 70% (or a range of 65-85%), to account for this macro-avoidance. Taken together, the application of 70% macro-avoidance and increase in avoidance rates reduce collision risk predictions for gannet by 52% and 54% for the deterministic and stochastic CRM models respectively.

14.   The collision risk predictions in Table 2.1 are based on the parameters as consented or as most recently published, and details of the CRM model, flight height option and avoidance rate which was used are included. In relation to flight height, Option 1 indicates that flight height data from baseline surveys for a given OWF was used for modelling (usually where baseline surveys were carried out from boats), and Option 2 that the industry standard dataset for flight height (Johnston *et al*., 2014a,b) was used (usually where digital aerial surveys were carried out).

15.   To reflect the most recent Natural England advice and increase parity between collision risk estimates from OWFs included in the CEA, collision predictions in Table 2.2 have been adjusted for 70% macro-avoidance and updated avoidance rates (no adjustment for nocturnal activity factor was made). Where not included in the original CRM prediction, adjustments for macro-avoidance were applied first, multiplying the consented/latest predicted collisions (Table 2.1) by (1-0.7). Avoidance rate adjustments were applied subsequently using the formula $C_a = (C_o/(1-A_o) \times (1-A_a))$, where C_a is the adjusted collision prediction, C_o the prediction before adjustment for avoidance rate (incorporating the macro-avoidance adjustment if applied), A_o the original avoidance rate and A_a the most recently advised avoidance rate. Where the original collision risk was estimated using the Band (2012) or an earlier Band model, the avoidance rate was adjusted to 0.9924; where the original collision risk was estimated using the stochastic CRM, the avoidance rate was adjusted to 0.9928. For example, for Beatrice OWF, the collision risk predicted for the consented design was 37.4 individuals per annum during the breeding season (Table 2.1). Adjusted for macro-avoidance this gives 37.4 x (1-0.7) = 11.2 collisions; and adjusted for avoidance rate (11.2/ (1-0.989) x (1-0.9924) = 7.8 collisions (Table

2.2). In a few cases, the avoidance rate for the consented design of an OWF was unknown (Table 2.1), in which case adjustments for macro-avoidance were applied, but not for avoidance rate.

16. Beatrice is an example of an OWF where the built-out design is likely to have a lower collision risk that the worst-case scenario consented design, the former comprising 84 turbines and the latter 277 (Table 2.1). Thus, even the adjusted total is likely to be a precautionary estimate of collision risk.

Table 2.1 Predicted gannet collisions at OWFs included in the cumulative assessment: consented or most recently published parameters.

Tier	OWF	Predicted gannet collisions				Original CRM model parameters			Source and notes
		Breeding	Autumn	Spring	Annual	Iteration	Option[1]	Avoidance Rate	
1	Beatrice	37.4	48.8	9.5	95.7	Band *et al.* (2007)	1	0.989	Royal HaskoningDHV (2023, 2021). Calculated for 277 turbines; 84 were installed.
1	Beatrice (demonstrator)	0.6	0.9	0.7	2.2	Unknown	Unknown	Unknown	Royal HaskoningDHV (2023, 2021).
1	Blyth Demonstration	3.5	2.1	2.8	8.4	Band *et al.* (2007)	1	0.989	Royal HaskoningDHV (2023, 2021).
1	Dudgeon	22.3	38.9	19.1	80.3	Band (2000)	1	0.989	Royal HaskoningDHV (2023, 2021). Calculated for 168 x 3MW turbines; 67 x 6MW were installed.
1	East Anglia ONE	3.4	131.0	6.3	140.7	Band (2012)	1	0.989	Royal HaskoningDHV (2023, 2021). Consented with 240 turbines; 102 x 7MW were installed
1	EOWDC (Aberdeen)	4.2	5.1	0.1	9.4	Band (2012)	2	0.989	Royal HaskoningDHV (2023, 2021).
1	Galloper	18.1	30.9	12.6	61.6	Band *et al.* (2007)	1	0.989	Royal HaskoningDHV (2023, 2021). Calculated for 140 turbines; 56 x 6.3MW were installed.
1	Greater Gabbard	14.0	8.8	4.8	27.6	Band (2000)	1	0.989	Royal HaskoningDHV (2023, 2021).
1	Gunfleet Sands	-	-	-	-	-	-	-	Royal HaskoningDHV (2023), GE Wind Energy (2002), RPS Group (2005).
1	Hornsea Project One	11.5	32.0	22.5	66.0	Band (2012)	2	0.989	Royal HaskoningDHV (2023, 2021).
1	Hornsea Project Two	7.0	14.0	6.0	27.0	Band (2012)	2	0.989	Royal HaskoningDHV (2023, 2021).
1	Humber Gateway	1.9	1.1	1.5	4.5	Unknown	1	0.989	Royal HaskoningDHV (2023, 2021).

Tier	OWF	Predicted gannet collisions				Original CRM model parameters			Source and notes
		Breeding	Autumn	Spring	Annual	Iteration	Option[1]	Avoidance Rate	
1	Hywind	5.6	0.8	0.8	7.2	Band (2012)	1	0.989	Royal HaskoningDHV (2023, 2021).
1	Kentish Flats	1.4	0.8	1.1	3.3	Band (2012)	1	0.989	Royal HaskoningDHV (2023. Unclear if this may also include collision risk for the extension project. MacArthur Green and RHDHV (2019) database attributes these values to Kentish Flats Extension and gives no collision risk value for Kentish Flats. Royal HaskoningDHV (2021) attributes values to Kentish Flats and Extension.
1	Kentish Flats Extension	-	-	-	-	-	-	-	Royal HaskoningDHV (2023). May be included in figures for Kentish Flats, see above.
1	Kincardine	3.0	0.0	0.0	3.0	Band (2012)	1	0.989	Royal HaskoningDHV (2023, 2021).
1	Lincs	2.1	1.3	1.7	5.1	Band (2000)	1	0.989	Royal HaskoningDHV (2023, 2021).
1	London Array	2.3	1.4	1.8	5.5	Band (2000)	1	0.989	Royal HaskoningDHV (2023, 2021).
1	Lynn and Inner Dowsing	0.2	0.1	0.2	0.5	Unknown			Royal HaskoningDHV (2023, 2021).
1	Methil	6.0	0.0	0.0	6.0	Unknown			Royal HaskoningDHV (2023, 2021).
1	Moray East	80.6	35.4	8.9	124.9	Band (2012)	1	0.989	Royal HaskoningDHV (2023, 2021).
1	Race Bank	33.7	11.7	4.1	49.5	Band (2000)	1	0.989	Royal HaskoningDHV (2023, 2021). Calculated for 206 turbines; 91 x 6MW installed.
1	Rampion	36.2	63.5	2.1	101.8	Band (2012)	1	0.989	Royal HaskoningDHV (2023, 2021). Calculated for 175 x 4MW turbines; 116 x

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Tier	OWF	Predicted gannet collisions				Original CRM model parameters			Source and notes
		Breeding	Autumn	Spring	Annual	Iteration	Option[1]	Avoidance Rate	
									3.4MW installed. 2011 draft of Band (2012) was used.
1	Scroby Sands	-	-	-	-		-		Royal HaskoningDHV (2023). No CRM in original ES (PowerGen renewables 2001).
1	Sheringham Shoal	14.1	3.5	0.0	17.6	Band (2000)	1	0.989	Royal HaskoningDHV (2023, 2021). Calculated for 108 x 3MW turbines; 88 x 3.6MW installed.
1	Teesside	4.9	1.7	0.0	6.7	Band (2000)	1	0.989	Royal HaskoningDHV (2023, 2021).
1	Thanet	1.1	0.0	0.0	1.1	Band (2000)	1	0.989	Royal HaskoningDHV (2023, 2021).
1	Triton Knoll	26.8	64.1	30.1	121.0	Band (2012)	1	0.989	Royal HaskoningDHV (2023, 2021). Consented with 288 turbines, 90 installed.
1	Westermost Rough	0.2	0.1	0.2	0.5	Band *et al.* (2007)	1	0.989	Royal HaskoningDHV (2021).
2	Dogger Bank A and B (Formerly Creyke Beck A and B)	81.1	83.5	54.4	219.0	Band 2012	1	0.989	Royal HaskoningDHV (2023, 2021).
2	Dogger Bank C and Sofia (Formerly Teeside A and B)	14.8	10.1	10.8	35.7	Band (2012)	2	0.989	Royal HaskoningDHV (2023).
2	Moray West	10.0	2.0	1.0	13.0	Band (2012)	2	0.989	Royal HaskoningDHV (2023, 2021).
2	Neart na Gaoithe	88.7	7.0	6.9	102.6	Band (2012)	2	0.989	EDF Renewables (2019).
2	Seagreen Alpha and Bravo	295.8	14.2	7.1	317.0	Band (2012)	2	0.989	Seagreen (2022). This gives only an annual total, seasonal totals derived by apportioning monthly collisions from monthly predictions in Seagreen (2020).

Tier	OWF	Predicted gannet collisions				Original CRM model parameters			Source and notes
		Breeding	Autumn	Spring	Annual	Iteration	Option[1]	Avoidance Rate	
3	East Anglia ONE North	12.4	11.0	1.1	24.5	Band (2012)	2	0.989	Royal HaskoningDHV (2023, 2021).
3	East Anglia THREE	6.1	33.3	9.6	49.0	Band (2012)	1	0.989	Royal HaskoningDHV (2023). Consented with 172 turbines, amended to 121 in 2020 (Non-Material Change; MacArthur Green and Royal HaskoningDHV 2020).
3	East Anglia TWO	12.5	23.1	4.0	39.6	Band (2012)	2	0.989	Royal HaskoningDHV (2023).
3	Green Volt	15.1	0.6	1.7	17.5	McGregor *et al.* (2018)	2	0.993	APEM (2023a), SNCB approach.
3	Hornsea Project Three	10.0	5.0	4.0	19.0	Band (2012)	1	0.989	Royal HaskoningDHV (2023).
3	Hornsea Project Four	15.8	5.2	1.3	22.3	Band (2012)	2	0.989	Royal HaskoningDHV (2023), APEM and GoBe (2022) Natural England approach.
3	Inch Cape	108	5	4	117	Band (2012)	2	0.989	ICOL (2018).
3	Norfolk Boreas	14.1	12.7	3.9	30.7	Band (2012)	2	0.989	Royal HaskoningDHV (2023, 2021).
3	Norfolk Vanguard	8.2	18.6	5.3	32.1	Band (2012)	2	0.989	Royal HaskoningDHV (2023, 2021).
3	Sheringham and Dudgeon Extension Projects	0.4	0.6	0.0	1.1	Band (2012)	2 + 70% MA	0.992	Royal HaskoningDHV (2023).
4	Berwick Bank	138	13	2	153	Band (2012)	2	0.989	Pelagica and Cork Ecology (2022), HiDef (2022a), Developer Approach[
4	Dogger Bank South	8.0	2.9	0.0	10.9	Band (2012)	2 + 70% MA	0.992	RWE (2023). Worst-case scenario (200 WTGs). Gannet collisions are presented at avoidance rates of 0.992 (no macro-avoidance), 0.972 (macro-avoidance at

Tier	OWF	Predicted gannet collisions				Original CRM model parameters			Source and notes
		Breeding	Autumn	Spring	Annual	Iteration	Option[1]	Avoidance Rate	
									65%) and 0.9988 (macro-avoidance at 85%). Values here adjusted to 70% macro-avoidance to match other OWFs
4	Five Estuaries	2.4	2.68	0.28	5.36	Band (2012)	2 + 65% MA	0.992	GoBe (2023c). Gannet collisions are presented at avoidance rates of 0.972 (combined AR 0.992 and macro-avoidance at 0.65 – as presented here) and 0.9988 (combined AR 0.992 and macro-avoidance at 85% - not included in this table)
4	Outer Dowsing	2.9	0.4	0.4	3.7	McGregor *et al.* (2018)	2 + 70% MA	0.993	GoBe (2023b)
4	Rampion 2	2.9	1.4	0.6	4.9	McGregor *et al.* (2018)	2 + 70% MA	0.993	GoBe (2023a), APEM (2023b)
4	West of Orkney	38.7	7.6	1.1	47.5	McGregor *et al.* (2018)	2	0.993	MacArthur Green (2023a)
	North Falls	0.6	0.9	0.6	2.1	McGregor *et al.* (2018)	2 + 70% MA	0.9928	Appendix 13.2, Document Reference: 3.3.13
	TOTALS	1229	759	257	2245				
- = CRM estimate understood not to be provided in the ES for a given OWF (based on Royal HaskoningDHV (2023). 1. MA= macro-avoidance.									

Table 2.2 Predicted gannet collisions at OWFs included in the cumulative assessment: adjusted for macro-avoidance (MA) and avoidance rate (AR)

Tier	OWF	Predicted gannet collisions with 70% MA				Predicted collisions, 70% MA and adjusted AR			
		Breeding	Autumn	Spring	Annual	Breeding	Autumn	Spring	Annual
1	Beatrice	11.2	14.6	2.9	28.7	7.8	10.1	2.0	19.8
1	Beatrice (demonstrator)	0.2	0.3	0.2	0.7	0.2	0.3	0.2	0.7
1	Blyth Demonstration	1.1	0.6	0.8	2.5	0.7	0.4	0.6	1.7
1	Dudgeon	6.7	11.7	5.7	24.1	4.6	8.1	4.0	16.6
1	East Anglia ONE	1.0	39.3	1.9	42.2	0.7	27.2	1.3	29.2
1	EOWDC (Aberdeen)	1.3	1.5	0.0	2.8	0.9	1.1	0.0	1.9
1	Galloper	5.4	9.3	3.8	18.5	3.8	6.4	2.6	12.8
1	Greater Gabbard	4.2	2.6	1.4	8.3	2.9	1.8	1.0	5.7
1	Gunfleet Sands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	Hornsea Project One	3.5	9.6	6.8	19.8	2.4	6.6	4.7	13.7
1	Hornsea Project Two	2.1	4.2	1.8	8.1	1.5	2.9	1.2	5.6
1	Humber Gateway	0.6	0.3	0.5	1.4	0.4	0.2	0.3	0.9
1	Hywind	1.7	0.2	0.2	2.2	1.2	0.2	0.2	1.5
1	Kentish Flats	0.4	0.2	0.3	1.0	0.3	0.2	0.2	0.7
1	Kentish Flats Extension	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	Kincardine	0.9	0.0	0.0	0.9	0.6	0.0	0.0	0.6
1	Lincs	0.6	0.4	0.5	1.5	0.4	0.3	0.4	1.1
1	London Array	0.7	0.4	0.5	1.7	0.5	0.3	0.4	1.1
1	Lynn and Inner Dowsing	0.1	0.0	0.1	0.2	0.1	0.0	0.1	0.2
1	Methil	1.8	0.0	0.0	1.8	1.8	0.0	0.0	1.8
1	Moray East	24.2	10.6	2.7	37.5	16.7	7.3	1.8	25.9
1	Race Bank	10.1	3.5	1.2	14.9	7.0	2.4	0.8	10.3

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Tier	OWF	Predicted gannet collisions with 70% MA				Predicted collisions, 70% MA and adjusted AR			
		Breeding	Autumn	Spring	Annual	Breeding	Autumn	Spring	Annual
1	Rampion	10.9	19.1	0.6	30.5	7.5	13.2	0.4	21.1
1	Scroby Sands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	Sheringham Shoal	4.2	1.1	0.0	5.3	2.9	0.7	0.0	3.6
1	Teesside	1.5	0.5	0.0	2.0	1.0	0.4	0.0	1.4
1	Thanet	0.3	0.0	0.0	0.3	0.2	0.0	0.0	0.2
1	Triton Knoll	8.0	19.2	9.0	36.3	5.6	13.3	6.2	25.1
1	Westermost Rough	0.1	0.0	0.1	0.2	0.0	0.0	0.0	0.1
2	Dogger Bank A and B (Formerly Creyke Beck A and B)	24.3	25.1	16.3	65.7	16.8	17.3	11.3	45.4
2	Dogger Bank C and Sofia (Formerly Teeside A and B)	4.4	3.0	3.2	10.7	3.1	2.1	2.2	7.4
2	Moray West	3.0	0.6	0.3	3.9	2.1	0.4	0.2	2.7
2	Neart na Gaoithe	26.6	2.1	2.1	30.8	18.4	1.5	1.4	21.3
2	Seagreen Alpha and Bravo	88.7	4.2	2.1	95.1	61.3	2.9	1.5	65.7
3	East Anglia ONE North	3.7	3.3	0.3	7.4	2.6	2.3	0.2	5.1
3	East Anglia THREE	1.7	9.3	2.7	13.7	1.2	6.4	1.9	9.5
3	East Anglia TWO	3.8	6.9	1.2	11.9	2.6	4.8	0.8	8.2
3	Hornsea Project Three	3.0	1.5	1.2	5.7	2.1	1.0	0.8	3.9
3	Hornsea Project Four	4.7	1.6	0.4	6.7	3.3	1.1	0.3	4.6
3	Green Volt	4.5	0.2	0.5	5.2	4.7	0.2	0.5	5.4
3	Inch Cape	32.4	1.5	1.2	35.1	22.4	1.0	0.8	24.3
3	Norfolk Boreas	4.2	3.8	1.2	9.2	2.9	2.6	0.8	6.4
3	Norfolk Vanguard	2.5	5.6	1.6	9.6	1.7	3.9	1.1	6.7

Tier	OWF	Predicted gannet collisions with 70% MA				Predicted collisions, 70% MA and adjusted AR			
		Breeding	Autumn	Spring	Annual	Breeding	Autumn	Spring	Annual
4	Berwick Bank	41.4	3.9	0.6	45.9	28.6	2.7	0.4	31.7
4	Dogger Bank South	8.0	2.9	0.0	10.9	7.6	2.8	0.0	10.4
4	Five Estuaries	0.6	0.7	0.1	1.4	0.6	0.7	0.1	1.4
4	Outer Dowsing	2.9	0.4	0.4	3.7	3.0	0.4	0.4	3.8
4	Rampion 2	2.9	1.4	0.6	4.9	3.0	1.4	0.6	5.0
4	West of Orkney	11.6	2.3	0.3	14.2	11.9	2.4	0.3	14.6
	North Falls	0.6	0.9	0.6	2.1	0.6	0.9	0.6	2.1
	TOTALS	381	234	78	693	274	165	55	494

Appendix 13.3 Supplementary Information for the Offshore Ornithology Cumulative Effects Assessment

2.2 Kittiwake

17. Predicted seasonal and annual numbers of kittiwake collisions for OWFs included in the cumulative assessment are given in Table 2.3. This table includes predictions for consented designs, where an OWF has been consented, and the latest available predictions for OWFs which have not been consented.

18. A review of bird species avoidance rates for use in CRM for OWFs is ongoing and interim guidance has been issued (Natural England 2022b, 2023). For kittiwake this recommends that the avoidance rate is increased from 0.989 to 0.9924 (±0.0001) for the deterministic Band (2012) model (a 31% decrease in predicted collisions); and 0.9928 (±0.0003) for the stochastic (MacGregor *et al.*, 2018) model (a 35% decrease in predicted collisions).

19. The collision risk predictions for OWFs in Table 2.3 are based on the parameters as consented or as most recently published, and details of the CRM model, flight height option and avoidance rate which was used are included. In relation to flight height, Option 1 indicates that flight height data from baseline surveys for a given OWF was used for modelling (usually where baseline surveys were carried out from boats), and Option 2 that the industry standard dataset for flight height (Johnston *et al.*, 2014a,b) was used (usually where digital aerial surveys were carried out).

20. To reflect the most recent Natural England advice and increase parity between collision risk estimates from OWFs included in the CEA, the collision predictions in Table 2.4 have been adjusted for the updated avoidance rates. This was done using the formula $C_a = (C_o/(1-A_o) \times (1-A_a))$, where C_a is the adjusted collision prediction, C_o the prediction before adjustment for avoidance rate, C_o the prediction before adjustment for avoidance rate (incorporating the macro-avoidance adjustment if applied), A_o the original avoidance rate and A_a the most recently advised avoidance rate. Where the original collision risk was estimated using the Band (2012) or an earlier Band model, the avoidance rate was adjusted to 0.9924; where the original collision risk was estimated using the stochastic CRM, the avoidance rate was adjusted to 0.9928. For example, for Beatrice OWF, the collision risk predicted for the consented design was 94.7 individuals per annum during the breeding season (Table 2.3); adjusted for avoidance rate this gives $(94.7/(1-0.989) \times (1-0.9924)) = 65.4$ collisions (Table 2.4). In a few cases, the avoidance rate for the consented design of an OWF was unknown (Table 2.3), in which case no avoidance rate adjustments were applied.

Table 2.3 Predicted kittiwake collisions at OWFs included in the cumulative assessment, original consented or most recently published value.

Tier	OWF	Predicted kittiwake collisions				Original CRM model parameters			Source and notes
		Breeding	Autumn	Spring	Annual	Iteration	Option	Avoidance Rate	
1	Beatrice	94.7	10.7	39.8	145.2	Band *et al.* (2007)	1	0.989	Royal HaskoningDHV (2023, 2021). Calculated for 140 turbines; 84 were installed.
1	Beatrice (demonstrator)	0	2.1	1.7	3.8	Band (2000)	1	0.992	Royal HaskoningDHV (2023, 2021).
1	Blyth Demonstration	1.7	2.3	1.4	5.4	Band *et al.* (2007)	1	0.989	Royal HaskoningDHV (2023, 2021).
1	Dudgeon	0	0	0	0	Band (2000)	1	0.989	Royal HaskoningDHV (2023, 2021).
1	East Anglia ONE	1.8	160.4	46.8	209.0	Band (2012)	1	0.989	Royal HaskoningDHV (2023, 2021). Calculated for 240 turbines, 102 were installed.
1	EOWDC (Aberdeen)	11.8	5.8	1.1	18.7	Band (2012)	2	0.989	Royal HaskoningDHV (2023, 2021).
1	Galloper	6.3	27.8	31.8	65.9	Band *et al.* (2007)	1	0.989	Royal HaskoningDHV (2023, 2021). Calculated for 140 turbines, 56 installed.
1	Greater Gabbard	1.1	15.0	11.4	27.5	Band (2000)	1	0.989	Royal HaskoningDHV (2023, 2021).
1	Gunfleet Sands	-	-	-	-	Unknown	Unknown	Unknown	Royal HaskoningDHV (2023, 2021).
1	Hornsea Project One	44.0	55.9	20.9	120.8	Band (2012)	2	0.989	Royal HaskoningDHV (2023, 2021).
1	Hornsea Project Two	16.0	9.0	3.0	28.0	Band (2012)	1	0.989	Royal HaskoningDHV (2023, 2021).
1	Humber Gateway	2.6	3.2	1.9	7.6	Unknown	1	0.989	Royal HaskoningDHV (2021).
1	Hywind	16.6	0.9	0.9	18.3	Band (2012)	1	0.989	Royal HaskoningDHV (2023, 2021).

Tier	OWF	Predicted kittiwake collisions				Original CRM model parameters			Source and notes
		Breeding	Autumn	Spring	Annual	Iteration	Option	Avoidance Rate	
1	Kentish Flats	0.0	0.9	0.7	1.6	Band (2000)	1	0.989	Royal HaskoningDHV (2023).
1	Kentish Flats Extension	0.0	0.0	2.7	2.7	Unknown	Unknown	Unknown	Royal HaskoningDHV (2023).
1	Kincardine	22.0	9.0	1.0	32.0	Band (2012)	1	0.989	Royal HaskoningDHV (2023, 2021).
1	Lincs	0.9	1.2	0.7	2.8	Band (2000)	1	0.989	Royal HaskoningDHV (2021).
1	London Array	1.4	2.3	1.8	5.5	Band (2000)	1	0.989	Royal HaskoningDHV (2023, 2021).
1	Lynn and Inner Dowsing	-	-	-	-	Unknown	Unknown	Unknown	Royal HaskoningDHV (2023).
1	Methil	0.4	0.0	0.0	0.4	Unknown	Unknown	Unknown	Royal HaskoningDHV (2023).
1	Moray East	43.6	2.0	19.3	64.9	Band (2012)	1	0.989	Royal HaskoningDHV (2023, 2021).
1	Race Bank	1.9	23.9	5.6	31.4	Band (2000)	1	0.989	Royal HaskoningDHV (2023, 2021). Calculated for 206 turbines, 91 installed.
1	Rampion	54.4	37.4	29.7	121.5	Band (2012)	1	0.989	Royal HaskoningDHV (2023, 2021). Calculated for 175 turbines, 116 installed. Draft 2011 version of Band (2012) used.
1	Scroby Sands	-	-	-	-	n/a	n/a	n/a	Royal HaskoningDHV (2023). No CRM carried out for original ES (Powergen Renewables 2001).
1	Sheringham Shoal	-	-	-	-	Unknown	Unknown	Unknown	Royal HaskoningDHV (2023).
1	Teesside	38.4	24.0	2.5	64.9	Band (2000)	1	0.989	Royal HaskoningDHV (2023, 2021).
1	Thanet	0.2	0.5	0.4	1.1	Band (2000)	1	0.989	Royal HaskoningDHV (2023).

Tier	OWF	Predicted kittiwake collisions				Original CRM model parameters			Source and notes
		Breeding	Autumn	Spring	Annual	Iteration	Option	Avoidance Rate	
1	Triton Knoll	24.6	139.0	45.4	209.0	Band (2012)	1	0.989	Royal HaskoningDHV (2023, 2021). Calculated for 288 turbines, 90 installed.
1	Westermost Rough	0.2	0.2	0.1	0.5	Band et al. (2007)	1	0.989	Royal HaskoningDHV (2021).
2	Dogger Bank A and B (Formerly Creyke Beck A and B)	288.6	135.0	295.4	719.0	Band (2012)	2	0.989	Royal HaskoningDHV (2023, 2021), Dogger Bank Wind Farms (2018).
2	Dogger Bank C and Sofia (Formerly Teeside A and B)	136.9	90.7	216.9	444.5	Band (2012)	2	0.989	Royal HaskoningDHV (2023, 2021).
2	Moray West	79.0	24.0	7.0	110.0	Band (2012)	2	0.989	Royal HaskoningDHV (2023).
2	Neart na Gaoithe	8.5	16.8	1.7	26.9	Band (2012)	2	0.989	EDF Renewable (2019).
2	Seagreen Alpha and Bravo	171.1	142.3	33.6	347.0	Band (2012)	2	0.989	Seagreen (2022). This gives only an annual total, seasonal totals derived by apportioning monthly collisions from monthly predictions in Seagreen (2020).
3	East Anglia ONE North	40.4	8.1	3.5	52.0	Band (2012)	2	0.989	Royal HaskoningDHV (2023).
3	East Anglia THREE	6.1	69	37.6	112.7	Band (2012)	1	0.989	Royal HaskoningDHV (2023), MacArthur Green (2016). Consented with 172 turbines, amended to 121 in 2020 (Non-Material Change; MacArthur Green and Royal HaskoningDHV 2020).
3	East Anglia TWO	29.5	5.4	7.4	42.3	Band (2012)	2	0.989	Royal HaskoningDHV (2023).

Tier	OWF	Predicted kittiwake collisions				Original CRM model parameters			Source and notes
		Breeding	Autumn	Spring	Annual	Iteration	Option	Avoidance Rate	
3	Green Volt	7.0	5.5	1.3	13.9	McGregor *et al.* (2018)	2	0.993	APEM (2023a), SNCB approach.
3	Hornsea Project Four	74.5	13.9	4.6	93.0	Band (2012)	2	0.989	Royal HaskoningDHV (2023), APEM and GoBe (2022) Natural England approach.
3	Hornsea Project Three	77.0	38.0	8.0	123.0	Band (2012)	2	0.989	Royal HaskoningDHV (2023).
3	Inch Cape	40	26	6	72	Band (2012)	2	0.989	Inch Cape (2018).
3	Norfolk Boreas	13.3	32.2	11.9	57.5	Band (2012)	2	0.989	Royal HaskoningDHV (2023, 2021).
3	Norfolk Vanguard	21.8	16.4	19.3	57.5	Band (2012)	2	0.989	Royal HaskoningDHV (2023, 2021).
3	Sheringham and Dudgeon Extension Projects	7.2	4.3	0.9	12.4	Band (2012)	2	0.992	Royal HaskoningDHV (2023).
4	Berwick Bank	426	155	104	685	Band (2012)	2	0.989	Pelagica and Cork Ecology (2022), HiDef (2022a), Developer Approach[
3	Dogger Bank South	173.1	50.4	31.1	254.6	Band (2012)	2	0.992	RWE (2023). Worst-case scenario (200 WTGs, NAF 50%).
3	Five Estuaries	14.8	10.3	7.2	32.2	Band (2012)	2	0.992	GoBe (2023c)
3	Outer Dowsing	28.1	18.1	50.4	96.6	McGregor *et al.* (2018)	2	0.993	GoBe (2023b).
4	Rampion 2	1.2	9.8	17.3	28.3	McGregor *et al.* (2018)	2	0.993	GoBe (2023a), APEM (2023b).

Tier	OWF	Predicted kittiwake collisions				Original CRM model parameters			Source and notes
		Breeding	Autumn	Spring	Annual	Iteration	Option	Avoidance Rate	
4	West of Orkney	33.4	15.3	4.2	53.0	McGregor *et al.* (2018)	2	0.993	MacArthur Green (2023a)
	North Falls	8.8	3.6	7.8	20.2	McGregor *et al.* (2018)	2	0.9928	Appendix 13.2, Document Reference: 3.3.13
	TOTALS	2071	1424	1148	4622				
- = CRM estimate understood not to be provided in the ES for a given OWF (based on Royal HaskoningDHV (2023)									

Table 2.4 Predicted kittiwake collisions at OWFs included in the cumulative assessment, adjusted for latest guidance on avoidance rate

Tier	OWF	Predicted kittiwake collisions (AR 0.9924, Band 2012 or earlier versions of the Band model; AR 0.9928, McGregor *et al.,* 2018)			
		Breeding	Autumn	Spring	Annual
1	Beatrice	65.4	7.4	27.5	100.3
1	Beatrice (demonstrator)	0.0	2.0	1.6	3.6
1	Blyth Demonstration	1.2	1.6	1.0	3.7
1	Dudgeon	0.0	0.0	0.0	0.0
1	East Anglia ONE	1.2	110.8	32.3	144.4
1	EOWDC (Aberdeen OWF)	8.2	4.0	0.8	12.9
1	Galloper	4.4	19.2	22.0	45.5
1	Greater Gabbard	0.8	10.4	7.9	19.0
1	Gunfleet Sands	0	0	0	0
1	Hornsea Project One	30.4	38.6	14.4	83.5
1	Hornsea Project Two	11.1	6.2	2.1	19.3

Tier	OWF	Predicted kittiwake collisions (AR 0.9924, Band 2012 or earlier versions of the Band model; AR 0.9928, McGregor *et al.,* 2018)			
		Breeding	Autumn	Spring	Annual
1	Humber Gateway	1.8	2.2	1.3	5.3
1	Hywind	11.5	0.6	0.6	12.6
1	Kentish Flats	0.0	0.6	0.5	1.1
1	Kentish Flats Extension	0	0	2.7	2.7
1	Kincardine	15.2	6.2	0.7	22.1
1	Lincs	0.6	0.8	0.5	1.9
1	London Array	1.0	1.6	1.2	3.8
1	Lynn and Inner Dowsing	0	0	0	0
1	Methil	0.4	0	0	0.4
1	Moray East	30.1	1.4	13.3	44.8
1	Race Bank	1.3	16.5	3.9	21.7
1	Rampion	37.6	25.8	20.5	83.9
1	Scroby Sands	0	0	0	0
1	Sheringham Shoal	0	0	0	0
1	Teesside	26.5	16.6	1.7	44.8
1	Thanet	0.1	0.3	0.3	0.8
1	Triton Knoll	17.0	96.0	31.4	144.4
1	Westermost Rough	0.1	0.1	0.1	0.3
2	Dogger Bank A and B	199.4	93.3	204.1	496.8
2	Dogger Bank C and Sofia	94.6	62.7	149.9	307.1
2	Moray West	54.6	16.6	4.8	76.0
2	Neart na Gaoithe	5.9	11.6	1.2	18.6

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Tier	OWF	Predicted kittiwake collisions (AR 0.9924, Band 2012 or earlier versions of the Band model; AR 0.9928, McGregor *et al.,* 2018)			
		Breeding	Autumn	Spring	Annual
2	Seagreen Alpha and Bravo	118.2	98.3	23.2	239.7
3	East Anglia ONE North	27.9	5.6	2.4	35.9
3	East Anglia THREE	4.2	47.7	26.0	63.8
3	East Anglia TWO	20.4	3.7	5.1	29.2
3	Green Volt	7.2	5.7	1.3	14.3
3	Hornsea Project Four	51.5	9.6	3.2	64.3
3	Hornsea Project Three	53.2	26.3	5.5	85.0
3	Inch Cape	27.6	18.0	4.1	49.7
3	Norfolk Boreas	9.2	22.2	8.2	39.7
3	Norfolk Vanguard	15.1	11.3	13.3	39.7
3	Sheringham and Dudgeon Extension Projects	6.8	4.1	0.9	11.8
4	Berwick Bank	294.3	107.1	71.9	473.3
4	Dogger Bank South	164.4	47.9	29.5	241.9
4	Five Estuaries	16.0	11.2	7.8	35.0
4	Outer Dowsing	28.9	18.6	51.8	99.4
4	Rampion 2	1.2	10.1	17.8	29.1
4	West of Orkney	34.4	15.8	4.4	54.5
	North Falls	8.8	3.6	7.8	20.2
	TOTALS	**1510**	**1020**	**833**	**3348**

2.3 Lesser black-backed gull

21. Predicted seasonal and annual numbers of lesser black-backed gull collisions for OWFs included in the cumulative assessment are given in Table 2.5.

22. A review of bird species avoidance rates for use in CRM for OWFs is ongoing and interim guidance has been issued (Natural England 2022b, 2023). For lesser black-backed gull this recommends that the avoidance rate is reduced from 0.995 to 0.9936 (±0.0001) for the deterministic Band (2012) model (a 28% increase in predicted collisions); and 0.9939 (±0.0004) for the stochastic (MacGregor *et al.*, 2018) model (a 22% increase in predicted collisions).

23. The collision risk predictions for OWFs in Table 2.5 are based on the parameters as consented or as most recently published, and details of the CRM model, flight height option and avoidance rate which was used are included. In relation to flight height, Option 1 indicates that flight height data from baseline surveys for a given OWF was used for modelling (usually where baseline surveys were carried out from boats), and Option 2 that the industry standard dataset for flight height (Johnston *et al.*, 2014a,b) was used (usually where digital aerial surveys were carried out).

24. To reflect the most recent Natural England advice and increase parity between collision risk estimates from OWFs included in the CEA, the collision predictions in Table 2.6 have been adjusted for the updated avoidance rates. This was done using the formula Ca = (Co/(1-Ao) x (1-Aa)), where Ca is the adjusted collision prediction, Co the prediction before adjustment for avoidance rate, Ao the original avoidance rate and Aa the most recently advised avoidance rate. Where the original collision risk was estimated using the Band (2012) or an earlier Band model, the avoidance rate was adjusted to 0.9936; where the original collision risk was estimated using the stochastic CRM, the avoidance rate was adjusted to 0.9939. For example, for East Anglia ONE OWF, the collision risk predicted for the consented design was 5.9 individuals per annum during the breeding season (Table 2.5); adjusted for avoidance rate this gives (5.9/ (1-0.995) x (1-0.9936) = 7.6 collisions (Table 2.6). In a few cases, the avoidance rate for the consented design of an OWF was unknown (Table 2.5), in which case no avoidance rate adjustments were applied.

Table 2.5 Predicted lesser black-backed gull collisions at OWFs included in the cumulative assessment, original consented or most recent value

Tier	OWF	Predicted LBBG collisions			Original CRM model parameters			Source and notes
		Breeding	Non-breeding	Annual	Iteration	Option[1]	Avoidance Rate	
1	Beatrice	0	0	0	n/a	n/a	n/a	Royal HaskoningDHV (2023)
1	Beatrice (demonstrator)	-	-	-	Unknown	Unknown	Unknown	Royal HaskoningDHV (2023, 2021).
1	Blyth Demonstration	0	0	0	n/a	n/a	n/a	Royal HaskoningDHV (2023).
1	Dudgeon	7.7	30.6	38.3	Band (2000)	1	0.995	Royal HaskoningDHV (2023). Calculated for 168 x 3MW turbines; 67 x 6MW were installed.
1	East Anglia ONE	5.9	33.8	39.7	Band (2012)	1	0.995	Royal HaskoningDHV (2023, 2021). Consented with 240 turbines; 102 x 7MW were installed
1	EOWDC (Aberdeen)	0	0	0	n/a	n/a	n/a	Royal HaskoningDHV (2023).
1	Galloper	27.8	111.0	138.8	Band et al. (2007)	1	0.995	Royal HaskoningDHV (2023, 2021). Calculated for 140 turbines; 56 x 6.3MW were installed.
1	Greater Gabbard	12.4	49.6	62.0	Band (2000)	1	0.995	Royal HaskoningDHV (2023, 2021).
1	Gunfleet Sands	1.0	0	1.0	Unknown	Unknown	0.990	Royal HaskoningDHV (2023).
1	Hornsea Project One	4.4	17.4	21.8	Band (2012)	1	0.995	Royal HaskoningDHV (2023, 2021). Calculated for 332 turbines, 174 x 7MW installed
1	Hornsea Project Two	2.0	2.0	4.0	Band (2012)	1	0.995	Royal HaskoningDHV (2023, 2021).
1	Humber Gateway	0.3	1.1	1.4	Unknown	1	0.995	Royal HaskoningDHV (2023, 2021).
1	Hywind	0	0	0	n/a	n/a	n/a	Royal HaskoningDHV (2023).
1	Kentish Flats	0.3	1.3	1.6	Band et al. 2007	1	0.995	Royal HaskoningDHV (2023). Same values as extension below. MacArthur Green and RHDHV (2019) database attributes these

Tier	OWF	Predicted LBBG collisions			Original CRM model parameters			Source and notes
		Breeding	Non-breeding	Annual	Iteration	Option[1]	Avoidance Rate	
								values to Kentish Flats Extension and gives no collision risk value for Kentish Flats.
1	Kentish Flats Extension	0.3	1.3	1.6	Unknown	Unknown	Unknown	Royal HaskoningDHV (2023). See above.
1	Kincardine	0	0	0	n/a	n/a	n/a	Royal HaskoningDHV (2023, 2021).
1	Lincs	1.7	6.8	8.5	Band (2000)	1	0.995	Royal HaskoningDHV (2023).
1	London Array	-	-	-	Unknown	Unknown	Unknown	Royal HaskoningDHV (2023).
1	Lynn and Inner Dowsing	-	-	-	Unknown	Unknown	Unknown	Royal HaskoningDHV (2023).
1	Methil	0.5	0	0.5	Unknown	Unknown	Unknown	Royal HaskoningDHV (2023, 2021).
1	Moray East	0	0	0	n/a	n/a	n/a	Royal HaskoningDHV (2023).
1	Race Bank	43.2	10.8	54.0	Band (2000)	1	0.995	Royal HaskoningDHV (2023, 2021). Calculated for 206 turbines; 91 x 6MW installed.
1	Rampion	1.6	6.3	7.9	Band (2012)	1	0.995	Royal HaskoningDHV (2023, 2021). Calculated for 175 x 4MW turbines; 116 x 3.4MW installed. 2011 draft of Band (2012) was used.
1	Scroby Sands	-	-	-	n/a	n/a	n/a	Royal HaskoningDHV (2023). No CRM in original ES (PowerGen Renewables 2001).
1	Sheringham Shoal	1.7	6.6	8.3	Band (2000)	1	0.995	Royal HaskoningDHV (2023). Calculated for 108 x 3MW turbines; 88 x 3.6MW installed.
1	Teesside	0	0	0	n/a	n/a	n/a	Royal HaskoningDHV (2023).
1	Thanet	3.2	12.8	16.0	Band (2000)	1	0.995	Royal HaskoningDHV (2023, 2021).
1	Triton Knoll	7.4	29.6	37.0	Band (2012)	1	0.995	Royal HaskoningDHV (2023, 2021). Consented with 288 turbines, 90 installed.

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Tier	OWF	Predicted LBBG collisions			Original CRM model parameters			Source and notes
		Breeding	Non-breeding	Annual	Iteration	Option[1]	Avoidance Rate	
1	Westermost Rough	0.1	0.3	0.4	Band *et al.* (2007)	1	0.995	Royal HaskoningDHV (2023, 2021).
2	Dogger Bank A and B (Formerly Creyke Beck A and B)	2.6	10.4	13.0	Band (2012)	1	0.995	Royal HaskoningDHV (2023, 2021).
2	Dogger Bank C and Sofia (Formerly Teeside A and B)	2.4	9.6	12.0	Band (2012)	2	0.995	Royal HaskoningDHV (2023, 2021).
2	Moray West	-	-	-	n/a	n/a	n/a	Royal HaskoningDHV (2023), Moray Offshore Wind Farm (West) Ltd (2018).
2	Neart na Gaoithe	1	0	1	Band (2012)	2	0.995	Cork Ecology (2018).
2	Seagreen Alpha and Bravo	2.1	8.4	10.5	Band (2012)	1	0.995	Royal HaskoningDHV (2023, 2021).
3	East Anglia ONE North	0.9	0.6	1.5	Band (2012)	2	0.995	Royal HaskoningDHV (2023, 2021).
3	East Anglia THREE	1.8	8.2	10.0	Band (2012)	1	0.995	Royal HaskoningDHV (2023, 2021). Consented with 172 turbines, amended to 121 in 2020 (Non-Material Change; MacArthur Green and Royal HaskoningDHV 2020).
3	East Anglia TWO	4.2	0.5	4.7	Band (2012)	2	0.995	Royal HaskoningDHV (2023, 2021).
3	Green Volt	0	0	0	n/a	n/a	n/a	APEM (2023c).
3	Hornsea Project Three	8.0	1.0	9.0	Band (2012)	2	0.995	Royal HaskoningDHV (2023).

Appendix 13.3 Supplementary Information for the Offshore Ornithology Cumulative Effects Assessment

Tier	OWF	Predicted LBBG collisions			Original CRM model parameters			Source and notes
		Breeding	Non-breeding	Annual	Iteration	Option[1]	Avoidance Rate	
3	Hornsea Project Four	0.9	0	0.9	MacGregor *et al.* (2018)	2	0.995	APEM (2021), SNCB approach (stochastic CRM appears to have been run deterministically).
3	Inch Cape	0	0	0	n/a	n/a	n/a	Royal HaskoningDHV (2023)
3	Norfolk Boreas	6.2	8.1	14.3	Band (2012)	2	0.995	Royal HaskoningDHV (2023, 2021).
3	Norfolk Vanguard	8.4	3.6	12.0	Band (2012)	2	0.995	Royal HaskoningDHV (2023, 2021).
3	Sheringham and Dudgeon Extension Projects	1.9	0.3	2.2	Band (2012)	2	0.994	Royal HaskoningDHV (2023).
4	Berwick Bank	6	0	6	Band (2012)	2	0.995	Pelagica and Cork Ecology (2022), HiDef (2022a), Developer Approach
4	Dogger Bank South	0.5	0	0.5	Band (2012)	2	0.994	RWE (2023, MacArthur Green (2023). .
4	Five Estuaries	35.8	5.7	41.5	Band (2012)	2	0.994	Gobe (2023c)
4	Outer Dowsing	3.0	0.7	3.7	McGregor *et al.* (2018)	2	0.994	GoBe (2023b)
4	Rampion 2	3.1	1.2	4.4	McGregor *et al.* (2018)	2	0.994	APEM (2023b, Gobe 2023a)
4	West of Orkney	0	0	0	n/a	n/a	n/a	MacArthur Green (2023a)
	North Falls	6.5	2.0	8.6	McGregor *et al.* (2018)	2	0.9939	Appendix 13.2, Document Reference: 3.3.13
	TOTALS	**217**	**382**	**598**				

Tier	OWF	Predicted LBBG collisions			Original CRM model parameters			Source and notes
		Breeding	Non-breeding	Annual	Iteration	Option[1]	Avoidance Rate	
- = No estimate provided in the ES for a given OWF (based on Royal HaskoningDHV 2023), for sites where this has been checked it was because no or very few LBBGs were recorded during baseline surveys so collision risk modelling was not undertaken for this species, thus collision risk would be very close to or equal to zero.								

Table 2.6 Predicted lesser black-backed gull collisions at OWFs included in the cumulative assessment, adjusted for latest guidance on avoidance rate

Tier	OWF	Predicted lesser black-backed gull collisions (AR 0.9936 for Band (2012) (or earlier versions of Band model) and 0.9939 for MacGregor *et al.,* (2018))		
		Breeding	Non-breeding	Annual
1	Beatrice	0	0	0
1	Beatrice (demonstrator)	0	0	0
1	Blyth Demonstration	0	0	0
1	Dudgeon	9.9	39.2	49.0
1	East Anglia ONE	7.6	43.3	50.8
1	EOWDC (Aberdeen OWF)	0	0	0
1	Galloper	35.6	142.1	177.7
1	Greater Gabbard	15.9	63.5	79.4
1	Gunfleet Sands	1.0	0.0	1.0
1	Hornsea Project One	5.6	22.3	27.9
1	Hornsea Project Two	2.6	2.6	5.1
1	Humber Gateway	0.4	1.4	1.8
1	Hywind	0.0	0.0	0.0
1	Kentish Flats	0.4	1.7	2.0
1	Kentish Flats Extension	0.3	1.3	1.6
1	Kincardine	0	0	0
1	Lincs	2.2	8.7	10.9
1	London Array	0	0	0
1	Lynn and Inner Dowsing	0	0	0
1	Methil	0.5	0.0	0.5
1	Moray East	0	0	0

Tier	OWF	Predicted lesser black-backed gull collisions (AR 0.9936 for Band (2012) (or earlier versions of Band model) and 0.9939 for MacGregor *et al.,* (2018))		
		Breeding	Non-breeding	Annual
1	Race Bank	55.3	13.8	69.1
1	Rampion	2.0	8.1	10.1
1	Scroby Sands	0	0	0
1	Sheringham Shoal	2.2	8.4	10.6
1	Teesside	0	0	0
1	Thanet	4.1	16.4	20.5
1	Triton Knoll	9.5	37.9	47.4
1	Westermost Rough	0.1	0.4	0.5
2	Dogger Bank A and B	3.3	13.3	16.6
2	Dogger Bank C and Sofia	3.1	12.3	15.4
2	Moray West	0	0	0
2	Neart na Gaoithe	0.3	1.2	1.5
2	Seagreen Alpha and Bravo	2.1	8.4	10.5
3	East Anglia ONE North	1.3	0.0	1.3
3	East Anglia THREE	2.7	10.8	13.4
3	East Anglia TWO	1.2	0.8	1.9
3	Green Volt	0	0	0
3	Hornsea Project Three	2.3	10.5	12.8
3	Hornsea Project Four	5.4	0.6	6.0
3	Inch Cape	10.2	1.3	11.5
3	Norfolk Boreas	7.9	10.4	18.3
3	Norfolk Vanguard	10.8	4.6	15.4

Appendix 13.3 Supplementary Information for the Offshore Ornithology Cumulative Effects Assessment

Tier	OWF	Predicted lesser black-backed gull collisions (AR 0.9936 for Band (2012) (or earlier versions of Band model) and 0.9939 for MacGregor *et al.,* (2018))		
		Breeding	Non-breeding	Annual
3	Sheringham and Dudgeon Extension Projects	2.0	0.3	2.3
4	Berwick Bank	7.7	0.0	7.7
4	Dogger Bank South	0.5	0.0	0.5
4	Five Estuaries	38.1	6.1	44.2
4	Outer Dowsing	3.0	0.7	3.7
4	Rampion 2	3.2	1.3	4.4
4	West of Orkney	0	0	0
	North Falls	6.5	2.0	8.6
	TOTALS	**265**	**486**	**751**

2.4 Great black-backed gull

25. Predicted seasonal and annual numbers of great black-backed gull collisions for OWFs included in the cumulative assessment are given in Table 2.7.

26. A review of bird species avoidance rates for use in CRM for OWFs is ongoing and interim guidance has been issued (Natural England 2022b, 2023). For great black-backed gull this recommends that the avoidance rate is reduced from 0.995 to 0.9936 (±0.0001) for the deterministic Band (2012) model (a 28% increase in predicted collisions); and 0.9939 (±0.0004) for the stochastic (MacGregor et al., 2018) model (a 22% increase in predicted collisions).

27. The collision risk predictions for OWFs in Table 2.7 are based on the parameters as consented or as most recently published, and details of the CRM model, flight height option and avoidance rate which was used are included. In relation to flight height, Option 1 indicates that flight height data from baseline surveys for a given OWF was used for modelling (usually where baseline surveys were carried out from boats), and Option 2 that the industry standard dataset for flight height (Johnston et al., 2014a,b) was used (usually where digital aerial surveys were carried out).

28. To reflect the most recent Natural England advice and increase parity between collision risk estimates from OWFs included in the CEA, the collision predictions in Table 2.8 have been adjusted for the updated avoidance rates. This was done using the formula Ca = (Co/(1-Ao) x (1-Aa)), where Ca is the adjusted collision prediction, Co the prediction before adjustment for avoidance rate, Ao the original avoidance rate and Aa the most recently advised avoidance rate. Where the original collision risk was estimated using the Band (2012) or an earlier Band model, the avoidance rate was adjusted to 0.9936; where the original collision risk was estimated using the stochastic CRM, the avoidance rate was adjusted to 0.9939. For example, for Beatrice OWF, the collision risk predicted for the consented design was 30.2 individuals per annum during the breeding season Table 2.7); adjusted for avoidance rate this gives (30.2/ (1-0.995) x (1-0.9936)) = 38.7 collisions (Table 2.8). In a few cases, the avoidance rate for the consented design of an OWF was unknown (Table 2.7), in which case no avoidance rate adjustments were applied.

Table 2.7 Predicted great black-backed gull collisions at OWFs included in the cumulative assessment

Tier	OWF	Predicted GBBG collisions			Original CRM model parameters			Source and notes
		Breeding	Non-breeding	Annual	Iteration	Option[1]	Avoidance Rate	
1	Beatrice	30.2	120.8	151.0	Band *et al.* (2007)	1	0.995	Royal HaskoningDHV (2023, 2021). Calculated for 140 turbines; 84 were installed.
1	Beatrice (demonstrator)	0	0	0	n/a	n/a	n/a	Royal HaskoningDHV (2023, 2021).
1	Blyth Demonstration	1.3	5.1	6.3	Band *et al.* (2007)	1	0.995	Royal HaskoningDHV (2023, 2021).
1	Dudgeon	0	0	0	n/a	n/a	n/a	Royal HaskoningDHV (2023, 2021).
1	East Anglia ONE	0	46.0	46.0	Band (2012)	1	0.995	Royal HaskoningDHV (2023, 2021). Consented with 240 turbines; 102 x 7MW were installed
1	EOWDC (Aberdeen)	0.6	2.4	3	Band (2012)	2	0.995	Royal HaskoningDHV (2023, 2021).
1	Galloper	4.5	18	22.5	Band *et al.* (2007)	1	0.995	Royal HaskoningDHV (2023, 2021). Calculated for 140 turbines; 56 x 6.3MW were installed.
1	Greater Gabbard	15.0	60.0	75.0	Band (2000)	1	0.9982	Royal HaskoningDHV (2023, 2021).
1	Gunfleet Sands	-	-	-	Unknown	Unknown	Unknown	Royal HaskoningDHV (2023, 2021).
1	Hornsea Project One	17.2	68.6	85.8	Band (2012)	1	0.995	Royal HaskoningDHV (2023, 2021). Calculated for 332 turbines, 174 x 7MW installed
1	Hornsea Project Two	3.0	20.0	23.0	Band (2012)	1	0.995	Royal HaskoningDHV (2023, 2021).
1	Humber Gateway	1.3	5.1	6.3	Unknown	1	0.995	Royal HaskoningDHV (2023, 2021).
1	Hywind	0.3	4.5	4.8	Band (2012)	1	0.995	Royal HaskoningDHV (2023).

Tier	OWF	Predicted GBBG collisions			Original CRM model parameters			Source and notes
		Breeding	Non-breeding	Annual	Iteration	Option[1]	Avoidance Rate	
1	Kentish Flats	-	-	-	Band *et al.* 2007	1	0.995	Royal HaskoningDHV (2023).
1	Kentish Flats Extension	0.1	0.2	0.3	Unknown	Unknown	Unknown	Royal HaskoningDHV (2023)
1	Kincardine	0	0	0	n/a	n/a	n/a	Royal HaskoningDHV (2023, 2021).
1	Lincs	0	0	0	Unknown	Unknown	Unknown	Royal HaskoningDHV (2023, 2021).
1	London Array	-	-	-	Unknown	Unknown	Unknown	Royal HaskoningDHV (2023).
1	Lynn and Inner Dowsing	0	0	0	Unknown	Unknown	Unknown	Royal HaskoningDHV (2023, 2021).
1	Methil	0.8	0.8	1.6	Unknown	Unknown	Unknown	Royal HaskoningDHV (2023, 2021).
1	Moray East	9.5	25.5	35.0	Band (2012)	1	0.995	Royal HaskoningDHV (2023, 2021).
1	Race Bank	0	0	0	n/a	n/a	n/a	Royal HaskoningDHV (2023, 2021).
1	Rampion	5.2	20.8	26.0	Band (2012)	1	0.995	Royal HaskoningDHV (2023, 2021). Calculated for 175 x 4MW turbines; 116 x 3.4MW installed. 2011 draft of Band (2012) was used.
1	Scroby Sands	-	-	-	n/a	n/a	n/a	Royal HaskoningDHV (2023). No CRM in original ES (PowerGen Renewables 2001).
1	Sheringham Shoal	0	0	0	Unknown	Unknown	Unknown	Royal HaskoningDHV (2023).
1	Teesside	8.7	34.8	43.6	Band (2000)	1	0.995	Royal HaskoningDHV (2023). Calculated for 30 turbines, 27 were installed.
1	Thanet	0.1	0.4	0.5	Band (2000)	1	0.995	Royal HaskoningDHV (2023, 2021).
1	Triton Knoll	24.4	97.6	122.0	Band (2012)	1	0.995	Royal HaskoningDHV (2023, 2021). Consented with 288 turbines, 90 installed.
1	Westermost Rough	0.0	0.0	0.1	Band *et al.* (2007)	1	0.995	Royal HaskoningDHV (2023, 2021).

Tier	OWF	Predicted GBBG collisions			Original CRM model parameters			Source and notes
		Breeding	Non-breeding	Annual	Iteration	Option[1]	Avoidance Rate	
2	Dogger Bank A and B (Formerly Creyke Beck A and B)	5.8	23.3	29.1	Band (2012)	1	0.995	Royal HaskoningDHV (2023, 2021).
2	Dogger Bank C and Sofia (Formerly Teeside A and B)	6.4	25.5	31.9	Band (2012)	2	0.995	Royal HaskoningDHV (2023, 2021).
2	Moray West	4.0	5.0	9.0	Band (2012)	2	0.995	Royal HaskoningDHV (2023), Moray Offshore Wind Farm (West) Ltd (2018).
2	Neart na Gaoithe	0.0	3.0	3.0	Band (2012)	2	0.995	Cork Ecology (2018).
2	Seagreen Alpha and Bravo	13.4	53.4	66.8	Band (2012)	1	0.995	Royal HaskoningDHV (2023, 2021).
3	East Anglia ONE North	3.7	1.2	5.0	Band (2012)	2	0.995	Royal HaskoningDHV (2023, 2021).
3	East Anglia THREE	4.6	34.4	39.0	Band (2012)	1	0.995	Royal HaskoningDHV (2023, 2021). Consented with 172 turbines, amended to 121 in 2020 (Non-Material Change; MacArthur Green and Royal HaskoningDHV 2020).
3	East Anglia TWO	3.5	3.4	6.9	Band (2012)	2	0.995	Royal HaskoningDHV (2023, 2021).
3	Green Volt	0.1	6.9	7.0	MacGregor *et al.* (2018)	2	0.994	APEM (2023a).
3	Hornsea Project Three	8.0	28.0	36.0	Band (2012)	2	0.995	Royal HaskoningDHV (2023).
3	Hornsea Project Four	0.8	8.8	9.6	MacGregor *et al.* (2018)	2	0.995	Royal HaskoningDHV (2023), APEM and GoBe (2022) Natural England Approach. sCRM run deterministically.

Tier	OWF	Predicted GBBG collisions			Original CRM model parameters			Source and notes
		Breeding	Non-breeding	Annual	Iteration	Option[1]	Avoidance Rate	
3	Inch Cape	0	36.8	36.8	Band (2012)	1	0.995	Royal HaskoningDHV (2023). Calculated for 2014 consent for 213 turbines, now superseded by 2019 consent for a maximum of 72 turbines.
3	Norfolk Boreas	6.9	28.7	35.6	Band (2012)	2	0.995	Royal HaskoningDHV (2023, 2021).
3	Norfolk Vanguard	4.5	21.5	26.0	Band (2012)	2	0.995	Royal HaskoningDHV (2023, 2021).
3	Sheringham and Dudgeon Extension Projects	0.8	8.8	9.6	Band (2012)	2	0.994	Royal HaskoningDHV (2023).
4	Berwick Bank	-	-	-	n/a	n/a	n/a	Recorded rarely and at low density in Array Area HiDef (2022b).
4	Dogger Bank South	1.2	4.8	6.0	Band (2012)	2	0.994	RWE (2023, MacArthur Green (2023b).
4	Five Estuaries	1.3	2.1	3.3	Band (2012)	2	0.994	Gobe (2023c)
4	Outer Dowsing	3.0	0.7	3.7	McGregor et al. (2018)	2	0.994	GoBe (2023b)
4	Rampion 2	6.3	13.6	19.8	McGregor et al. (2018)	2	0.994	APEM (2023b, Gobe 2023a)
4	West of Orkney	1.5	11.6	13.2	MacGregor et al. (2018)	2	0.994	MacArthur Green (2023a)
	North Falls	0	3.0	3.0	McGregor et al. (2018)	2	0.9939	Appendix 13.2, Document Reference: 3.3.13

Tier	OWF	Predicted GBBG collisions			Original CRM model parameters			Source and notes
		Breeding	Non-breeding	Annual	Iteration	Option[1]	Avoidance Rate	
TOTALS		198	855	1053				

- = No estimate provided in the ES for a given OWF (based on Royal HaskoningDHV 2023), for sites where this has been checked it was because no or very few GBBGs were recorded during baseline surveys so collision risk modelling was not undertaken for this species, thus collision risk would be very close to or equal to zero.

Table 2.8 Predicted great black-backed gull collisions at OWFs included in the cumulative assessment, adjusted for latest guidance on avoidance rate

Tier	OWF	Predicted great black-backed gull collisions (AR 0.9936 for Band (2012) (or earlier versions of Band model) and 0.9939 for MacGregor *et al.* (2018))		
		Breeding	Non-breeding	Annual
1	Beatrice	38.7	154.6	193.3
1	Beatrice (demonstrator)	0.0	0.0	0.0
1	Blyth Demonstration	1.7	6.5	8.1
1	Dudgeon	0.0	0.0	0.0
1	East Anglia ONE	0.0	58.9	58.9
1	EOWDC (Aberdeen OWF)	0.8	3.1	3.8
1	Galloper	5.8	23.0	28.8
1	Greater Gabbard	53.3	213.3	266.7
1	Gunfleet Sands	0	0	0
1	Hornsea Project One	22.0	87.8	109.8
1	Hornsea Project Two	3.8	25.6	29.4
1	Humber Gateway	1.7	6.5	8.1
1	Hywind	0.4	5.8	6.1
1	Kentish Flats	0.0	0.0	0.0

Tier	OWF	Predicted great black-backed gull collisions (AR 0.9936 for Band (2012) (or earlier versions of Band model) and 0.9939 for MacGregor *et al.* (2018))		
		Breeding	Non-breeding	Annual
1	Kentish Flats Extension	0.1	0.2	0.3
1	Kincardine	0	0	0
1	Lincs	0	0	0
1	London Array	0	0	0
1	Lynn and Inner Dowsing	0	0	0
1	Methil	0.8	0.8	1.6
1	Moray Firth East	12.2	32.6	44.8
1	Race Bank	0.0	0.0	0.0
1	Rampion	6.7	26.6	33.3
1	Scroby Sands	0	0	0
1	Sheringham Shoal	0	0	0
1	Teesside	11.1	44.5	55.8
1	Thanet	0.1	0.5	0.6
1	Triton Knoll	31.2	124.9	156.2
1	Westermost Rough	0.0	0.0	0.1
2	Dogger Bank A and B	7.4	29.8	37.2
2	Dogger Bank C and Sofia	8.2	32.6	40.8
2	Moray West	5.1	6.4	11.5
2	Neart na Gaoithe	0.0	3.8	3.8
2	Seagreen Alpha and Bravo	17.2	68.4	85.5
3	East Anglia ONE North	4.7	1.5	6.4
3	East Anglia THREE	5.9	44.0	49.9

Tier	OWF	Predicted great black-backed gull collisions (AR 0.9936 for Band (2012) (or earlier versions of Band model) and 0.9939 for MacGregor *et al.* (2018))		
		Breeding	Non-breeding	Annual
3	East Anglia TWO	4.5	4.4	8.8
3	Green Volt	0.1	7.0	7.1
3	Hornsea Project Three	10.2	35.8	46.1
3	Hornsea Project Four	1.0	10.7	11.7
3	Inch Cape	0.0	47.1	47.1
3	Norfolk Boreas	8.8	36.7	45.6
3	Norfolk Vanguard	5.8	27.5	33.3
3	Sheringham and Dudgeon Extension Projects	0.9	9.4	10.2
4	Berwick Bank	0.0	0.0	0.0
4	Dogger Bank South	1.3	5.1	6.4
4	Five Estuaries	1.3	2.2	3.5
4	Outer Dowsing	3.0	0.7	3.7
4	Rampion 2	6.4	13.8	20.1
4	West of Orkney	1.6	11.8	13.4
	North Falls	0.0	3.0	3.0
	TOTALS	**284**	**1,217**	**1,501**

3 Cumulative Displacement

3.1 Gannet

29. The predicted seasonal and annual numbers of gannet at risk of displacement from OWFs included in the cumulative assessment are given in Table 3.1. These are seasonal peak mean populations taken from OWF ES's. The standard area for assessment of gannet displacement is the OWF array area plus a 2km buffer (SNCBs 2017); abundance estimates for this standard area are not available for all OWFs so the buffer area for which data was presented is different for some OWFs included in the table.

Table 3.1 Predicted numbers of gannet at risk of displacement from OWFs included in the cumulative assessment

Tier	OWF	Breeding	Autumn	Spring	Annual	Source
1	Beatrice	151	0	0	151	Royal HaskoningDHV (2022)
1	Beatrice (demonstrator)	No estimate available				Royal HaskoningDHV (2022)
1	Blyth Demonstration	No estimate available				Royal HaskoningDHV (2022)
1	Dudgeon	53	25	11	89	Royal HaskoningDHV (2022)
1	East Anglia ONE	161	3,638	76	3,875	Royal HaskoningDHV (2022)
1	EOWDC (Aberdeen OWF)	35	5	0	40	Royal HaskoningDHV (2022)
1	Galloper	360	907	276	1,543	Royal HaskoningDHV (2022)
1	Greater Gabbard	252	69	105	426	Royal HaskoningDHV (2022)
1	Gunfleet Sands	0	12	9	21	Royal HaskoningDHV (2022)
1	Hornsea Project One	671	694	250	1,615	Royal HaskoningDHV (2022)
1	Hornsea Project Two	457	1,140	124	1,721	Royal HaskoningDHV (2022)
1	Humber Gateway	No estimate available				Royal HaskoningDHV (2022)
1	Hywind	10	0	4	14	Royal HaskoningDHV (2022)
1	Kentish Flats	No estimate available				Royal HaskoningDHV (2022)
1	Kentish Flats Extension	0	13	0	13	Royal HaskoningDHV (2022)
1	Kincardine	120	0	0	120	Royal HaskoningDHV (2022)
1	Lincs, Lynn and Inner Dowsing	No estimate available				Royal HaskoningDHV (2022), Royal HaskoningDHV (2019a)

Tier	OWF	Breeding	Autumn	Spring	Annual	Source
1	London Array	No estimate available				Royal HaskoningDHV (2022)
1	Methil	23	0	0	23	Royal HaskoningDHV (2022)
1	Moray Firth East	564	292	27	883	Royal HaskoningDHV (2022)
1	Race Bank	92	32	29	153	Royal HaskoningDHV (2022)
1	Rampion	0	590	0	590	Royal HaskoningDHV (2022)
1	Scroby Sands	No estimate available				Royal HaskoningDHV (2022)
1	Sheringham Shoal	47	31	2	80	Royal HaskoningDHV (2022)
1	Teesside	1	0	0	1	Royal HaskoningDHV (2022)
1	Thanet	No estimate available				Royal HaskoningDHV (2022)
1	Triton Knoll	211	15	24	250	Royal HaskoningDHV (2022)
1	Westermost Rough	No estimate available				Royal HaskoningDHV (2022)
2	Dogger Bank (formerly Creyke Beck) A and B	1,155	2,048	394	3,597	Royal HaskoningDHV (2022)
2	Dogger Bank C and Sofia (formerly Teeside A and B)	2,250	887	464	3,601	Royal HaskoningDHV (2022)
2	Moray West	2,827	439	144	3,410	Royal HaskoningDHV (2022)
2	Neart na Gaoithe	1,987	552	281	2,820	Royal HaskoningDHV (2022)
2	Seagreen Alpha and Bravo	2,956	664	332	3,952	Royal HaskoningDHV (2022)
3	East Anglia ONE North	149	468	44	661	Royal HaskoningDHV (2022)
3	East Anglia THREE	412	1,269	524	2,205	Royal HaskoningDHV (2022)
3	East Anglia TWO	192	891	192	1,275	Royal HaskoningDHV (2022)
3	Green Volt	120	16	49	185	APEM (2023c)
3	Hornsea Project Three	1,333	984	524	2,841	Royal HaskoningDHV (2022)
3	Hornsea Project Four	976	790	401	2,167	APEM and GoBe (2022)
3	Inch Cape	2,398	703	212	3,313	Royal HaskoningDHV (2022)
3	Norfolk Boreas	1,229	1,723	526	3,478	Royal HaskoningDHV (2022)

Tier	OWF	Breeding	Autumn	Spring	Annual	Source
3	Norfolk Vanguard	271	2,453	437	3,161	Royal HaskoningDHV (2022)
3	Sheringham and Dudgeon Extension Projects	440	638	58	1,136	Royal HaskoningDHV (2022)
4	Berwick Bank	4,735	1,500	269	6,504	Pelagica and Cork Ecology (2022)
4	Dogger Bank South	1,038	1,020	17	2,075	RWE (2023)
4	Five Estuaries	233	640	67	940	GoBe (2023c)
4	Outer Dowsing	847	169	172	1,187	GoBe (2023b)
4	Rampion 2	111	102	123	336	GoBe (2023a)
4	West of Orkney	958	1,171	77	2,206	MacArthur Green (2023a)
	North Falls	69	287	290	646	Appendix 13.2, Document Reference: 3.3.13
TOTALS Tier 1-5		29,894	26,877	6,535	63,304	
Tier 1-3		21,343	21,334	5,412	48,089	
Where it is stated no estimate is available, it is understood that there was no estimate in the ES for a given OWF (based on Royal HaskoningDHV 2022)						

3.2 Guillemot

30. The predicted seasonal and annual numbers of guillemots at risk of displacement from OWFs included in the cumulative assessment are given in Table 3.2. These are seasonal peak mean populations taken from OWF ES's. The standard area for assessment of guillemot displacement is the OWF array area plus a 2km buffer (SNCB 2017); abundance estimates for this standard area are not available for all OWFs so the buffer area for which data was presented is different for some OWFs included in the table.

Table 3.2 Predicted numbers of guillemots at risk of displacement from OWFs included in the cumulative assessment

Tier	OWF	Number of guillemots at risk of displacement			Source
		Breeding	Non-breeding	Annual	
1	Beatrice	13,610	2,755	16,365	Royal HaskoningDHV (2022)
1	Beatrice (demonstrator)	No estimate available			Royal HaskoningDHV (2022)
1	Blyth Demonstration	1,220	1,321	2,541	Royal HaskoningDHV (2022)
1	Dudgeon	334	542	876	Royal HaskoningDHV (2022)
1	East Anglia ONE	274	640	914	Royal HaskoningDHV (2022)
1	EOWDC (Aberdeen)	547	225	772	Royal HaskoningDHV (2022)
1	Galloper	305	593	898	Royal HaskoningDHV (2022)
1	Greater Gabbard	345	548	893	Royal HaskoningDHV (2022)
1	Gunfleet Sands	0	363	363	Royal HaskoningDHV (2022)
1	Hornsea Project One	9,836	8,097	17,933	Royal HaskoningDHV (2022)

Tier	OWF	Number of guillemots at risk of displacement			Source
		Breeding	Non-breeding	Annual	
1	Hornsea Project Two	7,735	13,164	20,899	Royal HaskoningDHV (2022)
1	Humber Gateway	99	138	237	Royal HaskoningDHV (2022)
1	Hywind	249	2,136	2,385	Royal HaskoningDHV (2022)
1	Kentish Flats	0	3	3	Royal HaskoningDHV (2022)
1	Kentish Flats Extension	0	4	4	Royal HaskoningDHV (2022)
1	Kincardine	632	0	632	Royal HaskoningDHV (2022)
1	Lincs, Lynn and Inner Dowsing	582	814	1,396	Royal HaskoningDHV (2022)
1	London Array	192	377	569	Royal HaskoningDHV (2022)
1	Methil	25	0	25	Royal HaskoningDHV (2022)
1	Moray Firth East	9,820	547	10,367	Royal HaskoningDHV (2022)
1	Race Bank	361	708	1,069	Royal HaskoningDHV (2022)
1	Rampion	10,887	15,536	26,423	Royal HaskoningDHV (2022)
1	Scroby Sands	No estimate available			Royal HaskoningDHV (2022)
1	Sheringham Shoal	390	715	1,105	Royal HaskoningDHV (2022)
1	Teesside	267	901	1,168	Royal HaskoningDHV (2022)
1	Thanet	18	124	142	Royal HaskoningDHV (2022)
1	Triton Knoll	425	746	1,171	Royal HaskoningDHV (2022)
1	Westermost Rough	347	486	833	Royal HaskoningDHV (2022)
2	Dogger Bank A (formerly Creyke Beck A)	5,407	6,142	11,549	Royal HaskoningDHV (2022)
2	Dogger Bank B (formerly Creyke Beck B)	9,479	10,621	20,100	Royal HaskoningDHV (2022)
2	Dogger Bank C (formerly Teesside A)	3,283	2,268	5,551	Royal HaskoningDHV (2022)
2	Moray West	24,426	38,174	62,600	Royal HaskoningDHV (2022)
2	Neart na Gaoithe	1,755	3,761	5,516	Royal HaskoningDHV (2022)
2	Seagreen (Forth) Alpha	13,606	4,688	18,294	Royal HaskoningDHV (2022)
2	Seagreen (Forth) Bravo	11,118	4,112	15,230	Royal HaskoningDHV (2022)
2	Sofia (formerly Teesside B)	5,211	3,701	8,912	Royal HaskoningDHV (2022)
3	East Anglia ONE North	4,183	1,888	6,071	Royal HaskoningDHV (2022)
3	East Anglia THREE	1,744	2,859	4,603	Royal HaskoningDHV (2022)
3	East Anglia TWO	2,077	1,675	3,752	Royal HaskoningDHV (2022)
3	Green Volt	4,429	16,105	20,534	APEM (2023c)
3	Hornsea Project Three	13,374	17,772	31,146	Royal HaskoningDHV (2022)
3	Hornsea Project Four	9,382	36,965	46,347	APEM and GoBe (2022, Natural England approach)
3	Inch Cape	4,371	3,177	7,548	Royal HaskoningDHV (2022)

Tier	OWF	Number of guillemots at risk of displacement			Source
		Breeding	Non-breeding	Annual	
3	Norfolk Boreas	7,767	13,777	21,544	Royal HaskoningDHV (2022)
3	Norfolk Vanguard	4,320	4,776	9,096	Royal HaskoningDHV (2022)
3	Sheringham and Dudgeon Extension Projects	4,934	15,972	20,906	Royal HaskoningDHV (2022)
4	Berwick Bank	44,171	74,154	118,325	Pelagica and Cork Ecology (2022)
4	Dogger Bank South	31,587	25,342	56,929	RWE (2023)
4	Five Estuaries	1,201	3,698	4,899	GoBe (2023c)
4	Outer Dowsing	23,173	22,248	45,421	GoBe (2023b)
4	Rampion 2	134	5,723	5,857	GoBe (2023a)
4	West of Orkney	4,861	4,275	9,136	MacArthur Green (2023c)
	North Falls	866	5,365	6,231	Appendix 13.3, Document Reference: 3.3.14
TOTALS		288,631	369,681	658,312	

3.3 Razorbill

31. The predicted seasonal and annual numbers of razorbills at risk of displacement from OWFs included in the cumulative assessment are given in Table 3.3. These are seasonal peak mean populations taken from OWF ES's. The standard area for assessment of razorbill displacement is the OWF array area plus a 2km buffer (SNCBs 2017); abundance estimates for this standard area are not available for all OWFs so the buffer area for which data was presented is different for some OWFs included in the table.

Table 3.3 Predicted numbers of razorbills at risk of displacement from OWFs included in the cumulative assessment

Tier	OWF	Breeding	Autumn	Winter	Spring	Annual	Source
1	Beatrice	873	833	555	833	3,094	Royal HaskoningDHV (2022)
1	Beatrice (demonstrator)	No estimate available					Royal HaskoningDHV (2022)
1	Blyth Demonstration	121	91	61	91	364	Royal HaskoningDHV (2022)
1	Dudgeon	256	346	745	346	1,694	Royal HaskoningDHV (2022)
1	East Anglia ONE	16	26	155	336	533	Royal HaskoningDHV (2022)
1	EOWDC (Aberdeen OWF)	161	64	7	26	258	Royal HaskoningDHV (2022)
1	Galloper	44	43	106	394	587	Royal HaskoningDHV (2022)
1	Greater Gabbard	0	0	387	84	471	Royal HaskoningDHV (2022)
1	Gunfleet Sands	0	0	30	0	30	Royal HaskoningDHV (2022)
1	Hornsea Project One	1,109	4,812	1,518	1,803	9,242	Royal HaskoningDHV (2022)
1	Hornsea Project Two	2,511	4,221	720	1,668	9,119	Royal HaskoningDHV (2022)
1	Humber Gateway	27	20	13	20	80	Royal HaskoningDHV (2022)
1	Hywind	30	719	10	0	759	Royal HaskoningDHV (2022)
1	Kentish Flats	No estimate available					Royal HaskoningDHV (2022)
1	Kentish Flats Extension	No estimate available					Royal HaskoningDHV (2022)
1	Kincardine	22	0	0	0	22	Royal HaskoningDHV (2022)
1	Lincs and LID	45	34	22	34	134	Royal HaskoningDHV (2022)
1	London Array	14	20	14	20	68	Royal HaskoningDHV (2022)
1	Methil	4	0	0	0	4	Royal HaskoningDHV (2022)
1	Moray Firth East	2,423	1,103	30	168	3,724	Royal HaskoningDHV (2022)
1	Race Bank	28	42	28	42	140	Royal HaskoningDHV (2022)
1	Rampion	630	66	1,244	3,327	5,267	Royal HaskoningDHV (2022)

Tier	OWF	Breeding	Autumn	Winter	Spring	Annual	Source
1	Scroby Sands	No estimate available					Royal HaskoningDHV (2022)
1	Sheringham Shoal	106	1,343	211	30	1,690	Royal HaskoningDHV (2022)
1	Teesside	16	61	2	20	99	Royal HaskoningDHV (2022)
1	Thanet	3	0	14	21	37	Royal HaskoningDHV (2022)
1	Triton Knoll	40	254	855	117	1,265	Royal HaskoningDHV (2022)
1	Westermost Rough	91	121	152	91	455	Royal HaskoningDHV (2022)
2	Dogger Bank A (formerly Creyke Beck A)	1,250	1,576	1,728	4,149	8,703	Royal HaskoningDHV (2022)
2	Dogger Bank B (formerly Creyke Beck B)	1,538	2,097	2,143	5,119	10,897	Royal HaskoningDHV (2022)
2	Dogger Bank C (formerly Teesside A)	834	310	959	1,919	4,022	Royal HaskoningDHV (2022)
2	Moray West	2,808	3,544	184	3,585	10,121	Royal HaskoningDHV (2022)
2	Neart na Gaoithe	331	5,492	508	0	6,331	Royal HaskoningDHV (2022)
2	Seagreen Alpha and Bravo	9,574	891	594	891	11,950	Royal HaskoningDHV (2022)
2	Sofia (formerly Dogger Bank Teesside B)	1,153	592	1,426	2,953	6,125	Royal HaskoningDHV (2022)
3	East Anglia ONE North	403	85	54	207	749	Royal HaskoningDHV (2022)
3	East Anglia THREE	1,807	1,122	1,499	1,524	5,952	Royal HaskoningDHV (2022)
3	East Anglia TWO	281	44	136	230	691	Royal HaskoningDHV (2022)
3	Green Volt	457	56	15	28	556	APEM (2022)
3	Hornsea Project Three	630	2,020	3,649	2,105	8,404	Royal HaskoningDHV (2022)
3	Hornsea Project Four	386	4,311	455	449	5,601	APEM and GoBe (2022)
3	Inch Cape	1,436	2,870	651	0	4,957	Royal HaskoningDHV (2022)
3	Norfolk Boreas	630	263	1,065	345	2,303	Royal HaskoningDHV (2022)
3	Norfolk Vanguard	879	866	839	924	3,508	Royal HaskoningDHV (2022)
3	Sheringham and Dudgeon Extension Projects	1,239	4,500	1,531	464	7,734	Royal HaskoningDHV (2023b)

Tier	OWF	Breeding	Autumn	Winter	Spring	Annual	Source
4	Berwick Bank	4,040	8,849	1,399	7,480	21,768	Pelagica and Cork Ecology (2022)
4	Dogger Bank South	5,313	1,238	4,117	8,628	19,296	RWE (2023)
4	Five Estuaries	90	284	1,046	756	2,177	Gobe (2023c)
4	Outer Dowsing	5.163	2,339	2,570	5,229	15,301	GoBe (2023b)
4	Rampion 2	32	26	1,193	6,303	7,554	GoBe (2023a)
4	West of Orkney	141	167	19	132	459	MacArthur Green (2023a)
	North Falls	104	248	1,781	1,741	3,874	Appendix 13.3, Document Reference: 3.3.14
	TOTALS	**49,090**	**57,118**	**38,221**	**63,741**	**208,169**	

3.4 Red-throated diver

3.4.1 Standard assessment

32.   The standard approach to CEA for displacement from OWFs is to sum the seasonal/annual numbers of birds of a given species at risk of displacement, or the predicted seasonal/annual mortality as a result of displacement, for each OWF project within the area of search which has been screened into the assessment. If the number of birds at risk of displacement is summed then a displacement matrix (% of birds estimated to be displaced and % of displaced birds predicted to die as a result of displacement, SNCBs 2017) can be applied to the cumulative total to predict the cumulative predicted mortality from displacement.

33.   For North Falls, red-throated divers were only present during the non-breeding season and the area of search for cumulative displacement of red-throated diver is the UK North Sea BDMPS (the largest non-breeding season BDMPS, Furness 2015). This is consistent with advice from Natural England on the scope of the cumulative assessment for red-throated divers at North Falls.

34.   Within the UK North Sea, information on the number of red-throated divers at risk of displacement and/or the number of individuals predicted to die from displacement is not available for all OWFs. This is because assessments for some projects have not considered red-throated diver displacement at all, or have assessed effects in a qualitative manner. This includes projects where few or no red-throated divers were recorded during baseline surveys, for example projects which are distant from the coast (as red-throated divers overwintering in the UK generally occur in nearshore waters, Dierschke *et al.,* 2017). The latter applies to all OWFs in Scottish North Sea waters.

35.   The red-throated diver assessments that have been carried out for OWFs in the English North Sea are summarised in Table 3.4 and Table 3.5 below. Table 3.4 includes sites where no assessment, a qualitative assessment or a basic quantitative assessment was presented; Table 3.5 includes OWFs where a seasonal assessment was provided and gives predicted displacement mortality at 90-100% displacement and 1-10% mortality within the OWF and a buffer (which varied between 0-4km depending on the available data). For the purposes of Environmental Impact Assessment (EIA), Natural England recommended that red-throated diver displacement at North Falls should be considered as 100% within the OWF and a 4km buffer, and 1-10% mortality of displacement birds (which accords with the SNCBs (2017) guidance note on displacement). These displacement mortality predictions from North Falls have been summed with those for other OWFs. Thus, the displacement mortality predictions for OWFs presented in Table 3.5 do not strictly compare like with like, as there are variations in the buffer area considered and the percentage of birds predicted to be displaced (90-100%). However, these are considered to be the best available data at the time of writing for the standard approach to CEA for red-throated diver, given the variability in approach and information presented in Environmental Statements for OWFs in the southern North Sea (which in turn reflects the development of data collection and assessment

methodology over time, and the increasing amount of empirical information that has become available on the responses of red-throated divers to OWFs).

Table 3.4 Red-throated diver assessments for OWFs in the southern North Sea – sites with no or basic assessment (source: MacArthur Green 2019)

Wind farm	Tier	Assessment method	Estimated mortalities from displacement
Blyth Demonstrator	1	Not assessed	No number presented
Dudgeon	1	Not assessed	No number presented
Galloper	1	Quantitative	1-14
Greater Gabbard	1	Quantitative	4-40
Gunfleet Sands	1	Qualitative	'very small'
Hornsea Project One	1	Not assessed	No number presented
Hornsea Project Two	1	Not assessed	No number presented
Hornsea Project Three	1	Not assessed	No number presented
Humber Gateway	1	Not assessed	No number presented
Kentish Flats	1	Qualitative	No number presented
Kentish Flats Extension	1	Qualitative	No number presented
Lincs	1	Qualitative	No number presented
London Array	1	Qualitative	No number presented
Lynn & Inner Dowsing	1	Qualitative	No number presented
Race Bank	1	Not assessed	No number presented
Scroby Sands	1	None	No number presented
Sheringham Shoal	1	None	No number presented
Teeside	1	Not assessed	No number presented
Thanet	1	Quantitative	<1-2
Triton Knoll	1	Not assessed	No number presented
Westernmost Rough	1	Not assessed	No number presented
Dogger Bank A and B (formerly Creyke Beck A and B)	2	Not assessed	No number presented
Dogger Bank C and Sofia (formerly Teeside A and B)	2	Not assessed	No number presented

Table 3.5 Estimated cumulative displacement mortality at OWFs in the southern North Sea, at 90-100% displacement within the Wind farm site and a 4km buffer, and 1-10% mortality of displaced birds.

Wind farm (tier)	Number of birds predicted to die from displacement (90-100% displacement, 1-10% mortality of displaced birds)				Source
	Autumn migration	Winter	Spring Migration	Annual	
Projects listed in (1-3)	-	-	-	6 – 56	MacArthur Green 2019
East Anglia ONE (3)	0.4 - 5	1 – 10	1.4 - 15	2.8 – 30	MacArthur Green 2019
East Anglia ONE North* (3)	-	-	-	0.1 - 1	MacArthur Green & Royal HaskoningDHV 2022)
East Anglia THREE (3)	0.4 - 5	0.2 – 2	2 - 20	2.6 – 27	MacArthur Green 2019
East Anglia TWO (3)	0	0 – 2	2 - 25	3 – 28	Royal HaskoningDHV 2019b
Hornsea Project Four (3)	0	0	0	0	APEM 2022
Norfolk Vanguard (3)	0.4 - 8	3.2 – 39	3 - 32	6.6 – 79	MacArthur Green 2019
Norfolk Boreas (3)	0 - 1	1 - 15	5 - 62	6 – 78	MacArthur Green 2019
Sheringham and Dudgeon Extension Projects (3)	2 - 14	0 – 2	2 - 23	4 – 39	Royal HaskoningDHV 2022
Five Estuaries (4)	0	0 – 2	0 – 4	0 - 6	GoBe (2023c)
Outer Dowsing (4)	0.3 – 2.5	0.2 – 2.4	2.2 – 21.7	2.8 – 28.2	GoBe (2023b)
North Falls	0	0 - 2	1 - 7	1 - 9	ES Chapter 13 Offshore Ornithology (Document Reference: 3.1.15)
Totals				35 - 381	

* Based on the effective size of the consented boundary for East Anglia ONE North. The western extent of the boundary presented for DCO examination was 2km away from the Outer Thames Estuary SPA at the nearest point. The Project was consented with an exclusion zone such that turbines could not be installed within 8km of the SPA boundary. Thus the number of red-throated divers predicted to die from displacement will have been reduced compared with estimates presented in the ES. Revised seasonal or annual abundance estimates of red-throated divers for East Anglia ONE North appear taking account of the exclusion zone appear not to be publicly available, so the seasonal numbers cannot be presented. Revision 5 of offshore ornithology without prejudice compensation measures for the Project (MacArthur Green and Royal HaskoningDHV 2022) provides estimates of the number of individuals displaced for the consented project of between 0 – 10.3, based respectively on a model of red-throated diver displacement developed by the applicant, and a straight-line approach recommended by Natural England, assuming a linear gradient in red-throated diver displacement from 100~% at the OWF, to 0% at 10km. It is assumed this range estimates the number of individuals to be displaced annually, so that at 10% mortality of displaced individuals 0 – 1.0 red-throated divers would be predicted to die, and at 1% mortality 0.1 individuals.

3.4.2 SeaMAST

36.   The Seabird Mapping and Sensitivity Tool (SeaMAST) (Bradbury *et al.*, 2014) provides a common dataset covering the majority of English offshore waters, describing seabird densities in 3x3km squares based on both boat-based and visual aerial surveys. Both of these survey methods may under-estimate the number of red-throated divers present compared with Digital Aerial Surveys, thus this dataset was used to assess the potential relative contribution of UK OWFs in the southern North Sea to displacement of red-throated divers during the non-breeding season, rather than provide robust estimates of the numbers of birds present in individual OWFs and 4km buffers.

37.   Whilst recent evidence indicates that displacement effects of operational OWFs exceed 4km (SNCBs 2022), Natural England advice for the North Falls EIA was to assess displacement for the OWF and a 4km buffer; to incorporate larger buffers with the SeaMAST data would cause complications due to extensive overlap of buffers at one OWF with buffers from other OWFs.

38.   The "BDMPS_Non_Breeding_Boat_Plus_Aerial_D" SeaMAST dataset was selected to describe red-throated diver densities during the non-breeding season (henceforth referred to as "the SeaMAST dataset"). This dataset provides estimated seabird non-breeding season densities (sitting and flying birds summed) from a density surface model (DSM) of Wildfowl and Wetlands Trust (WWT) visual aerial survey data collected between 2001 - 2011, and JNCC European Seabirds At Sea (ESAS) boat-based survey data collected between 1979 - 2011.

39.   The non-breeding season as defined for the SeaMAST data set covers the months September to February. September to February corresponds to the red-throated diver non-breeding season based on the full breeding season of March to August as defined by Furness (2015). The red-throated diver non-breeding season is further subdivided by Furness (2015) into post-breeding or autumn migration (September to November), migration-free winter season (December to January) and return or spring migration (February to April). During the two migration seasons, the north-western and south-western North Sea areas are considered to hold a single population of red-throated divers. During the migration-free winter season, it is considered that the north-western and south-western North Sea area populations are separate (Furness, 2015).

40.   Thus, the SeaMAST data provided a single estimate of red-throated diver numbers during the non-breeding season (i.e. it was not possible to obtain separate estimates for the autumn migration, winter and spring migration periods). In addition, given the geographical coverage, no estimates were available for OWFs in the Scottish North Sea, although as stated previously, few or no red-throated divers were recorded at all of these sites, so they do not contribute to a cumulative displacement effect during the spring and autumn migration periods of the non-breeding season.

41.   The SeaMAST dataset is a collation of available data, which at the time was not collected for the purpose of a wider regional analysis. Thus, across some areas, survey effort may have occurred disproportionally over particular months or seasons depending on the original purpose of the surveys.

42. OWF boundaries were obtained from the Crown Estate, with any known changes accounted for prior to data processing. All 3x3 km grid squares that had been allocated the value "-99", indicating a low confidence in the density generated by the DSM for that square, were excluded from the analysis. This led to a number of OWFs in English waters being excluded from the analysis as no abundance data were available. These were Dudgeon Extension Project, Dudgeon, Hornsea Projects One, Two and Three, Dogger Bank A, B, C and Sofia, Teesside A, Triton Knoll, and Outer Dowsing.

43. Estimates of red-throated diver abundance in OWFs and 4km buffers based on SeaMAST data are given in Table 3.6. To calculate the number of red-throated divers occurring within a given area, the red-throated diver density for each grid square was converted to an abundance by multiplying density by area. Where a given polygon overlapped with more than one 3x3 square (which was usually the case) the estimated abundances for each square or part-square were summed. For areas inside OWFs, the SeaMAST dataset encompassing the area of interest was clipped to the boundary of each OWF. When repeating the exercise for the 4km OWF buffers, where there were instances of overlap between the buffers, and sometimes other OWFs, a system was devised to allocate red-throated divers to a particular OWF based on the tiered system for CEA based on advice from UK SNCBs. For overlapping OWFs and buffers occurring within tiers 1 and/or 2, buffers were amalgamated into a single polygon. Where a similar situation occurred for OWFs in tier 3 or above, OWF red line boundaries were prioritised over buffers. For overlapping buffers within the same tier, the abundance of red-throated divers within the overlapping area was calculated and split equally between the two buffers (site-specific details in Table 3.6). The reference population size used here for the non-breeding season was 19,978 based on the SeaMAST dataset (calculated as the sum of abundances from each grid square, excluding squares with a low confidence in the density).

Table 3.6 Estimated abundance of red-throated divers in OWFs in the English North Sea from SeaMAST data

Tier	OWF	Wind farm site		4km buffer		Wind farm + 4km buffer		Notes
		No. birds	% of ref population	No. birds	% of ref population	No. birds	% of ref population	
1	Blyth Demonstration	0.0	0.00	0.5	0.00	0.6	0.00	Site consists of three polygons; 4km buffers amalgamated
1	Dudgeon	-	-	-	-	-	-	Beyond extent of viable SeaMAST data - not included
1	East Anglia ONE	5.8	0.03	16.1	0.08	21.9	0.11	4km buffer overlap with East Anglia ONE North; East Anglia ONE buffer prioritised
1	Greater Gabbard and Galloper	35.4	0.18	77.9	0.39	113.3	0.57	4km buffer overlap with East Anglia TWO; Greater Gabbard/Galloper prioritised
1	Gunfleet Sands	54.0	0.27	487.2	2.44	541.2	2.71	
1	Hornsea Project One	-	-	-	-	-	-	Beyond extent of viable SeaMAST data - not included
1	Hornsea Project Two	-	-	-	-	-	-	Beyond extent of viable SeaMAST data - not included
1	Humber Gateway	0.1	0.00	0.7	0.00	0.8	0.00	
1	Kentish Flats	48.6	0.24	343.7	1.72	392.3	1.96	
1	Lincs, Lynn and Inner Dowsing	3.1	0.02	18.4	0.09	21.5	0.11	
1	London Array	337.4	1.69	1165.1	5.83	1502.6	7.52	
1	Race Bank	0.7	0.00	2.7	0.01	3.4	0.02	North-eastern edge of buffer not covered by SeaMAST data
1	Scroby Sands	9.7	0.05	80.0	0.40	89.6	0.45	
1	Sheringham Shoal	0.1	0.00	0.6	0.00	0.7	0.00	Northern section of OWF and buffer not covered by SeaMAST data
1	Teesside	0.0	0.00	0.8	0.00	0.9	0.00	
1	Thanet	5.7	0.03	34.8	0.17	40.5	0.20	

Tier	OWF	Wind farm site		4km buffer		Wind farm + 4km buffer		Notes
		No. birds	% of ref population	No. birds	% of ref population	No. birds	% of ref population	
1	Triton Knoll	-	-	-	-	-	-	Beyond extent of viable SeaMAST data - not included
1	Westermost Rough	0.1	0.00	0.8	0.00	0.9	0.00	North-eastern edge of buffer not covered by SeaMAST data
2	Dogger Bank A and B (formerly Creyke Beck A and B)	-	-	-	-	-	-	Beyond extent of viable SeaMAST data - not included
2	Dogger bank C and Sofia (formerly Dogger bank Teeside A and B)	-	-	-	-	-	-	Beyond extent of viable SeaMAST data - not included
3	Dudgeon Extension Project	-	-	-	-	-	-	Beyond extent of viable SeaMAST data - not included
3	East Anglia ONE North	31.7	0.16	89.1	0.45	120.8	0.60	Consented boundary, 4km buffer overlap with East Anglia ONE; East Anglia ONE buffer prioritised
3.	East Anglia THREE	5.9	0.03	13.2	0.07	19.1	0.10	4km buffer overlap with Norfolk Vanguard East; East Anglia THREE buffer prioritised
3	East Anglia TWO	19.0	0.10	71.4	0.36	90.4	0.45	4km buffer overlap with Greater Gabbard/Galloper; Greater Gabbard/Galloper prioritised
3	Hornsea Project Three	-	-	-	-	-	-	Beyond extent of viable SeaMAST data - not included
3	Hornsea Project Four	-	-	-	-	-	-	Beyond extent of viable SeaMAST data - not included
3	Norfolk Boreas	2.9	0.01	3.5	0.02	4.6	0.02	Northern and eastern sections of OWF and 4km buffer beyond extent of viable SeaMAST data; 4km buffer overlap with Norfolk Vanguard East (4km buffers amalgamated)

Tier	OWF	Wind farm site		4km buffer		Wind farm + 4km buffer		Notes
		No. birds	% of ref population	No. birds	% of ref population	No. birds	% of ref population	
3	Norfolk Vanguard	9.4	0.05	13.5	0.07	24.6	0.12	Eastern section of OWF and 4km buffer beyond extent of viable SeaMAST data; 4km buffer overlap with Norfolk Boreas and East Anglia THREE (East Anglia THREE prioritised, Norfolk Vanguard East and Boreas 4km buffer amalgamated)
3	Sheringham Shoal Extension Project	0.0	0.00	0.6	0.00	0.6	0.00	OWF and 4km overlap with Sheringham Shoal OWF. Sheringham Shoal prioritised.
4	Dogger Bank South	-	-	-	-	-	-	Beyond extent of viable SeaMAST data - not included
4	Five Estuaries	1.9	0.01	3.1	0.02	5.0	0.03	4km buffer overlap with 4km buffers of EA2, Greater Gabbard and Galloper
4	Outer Dowsing	-	-	-	-	-	-	Beyond extent of viable SeaMAST data - not included
	North Falls	5.5	0.03	45.8	0.23	51.3	0.26	OWF and 4km buffer overlap with 4km buffers of Greater Gabbard and Galloper
	TOTALS	**577**	**2.89**	**2469.5**	**12.36**	**3046.6**	**15.25**	

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North Falls Offshore Wind Farm Limited

A joint venture company owned equally by SSE Renewables and RWE.

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