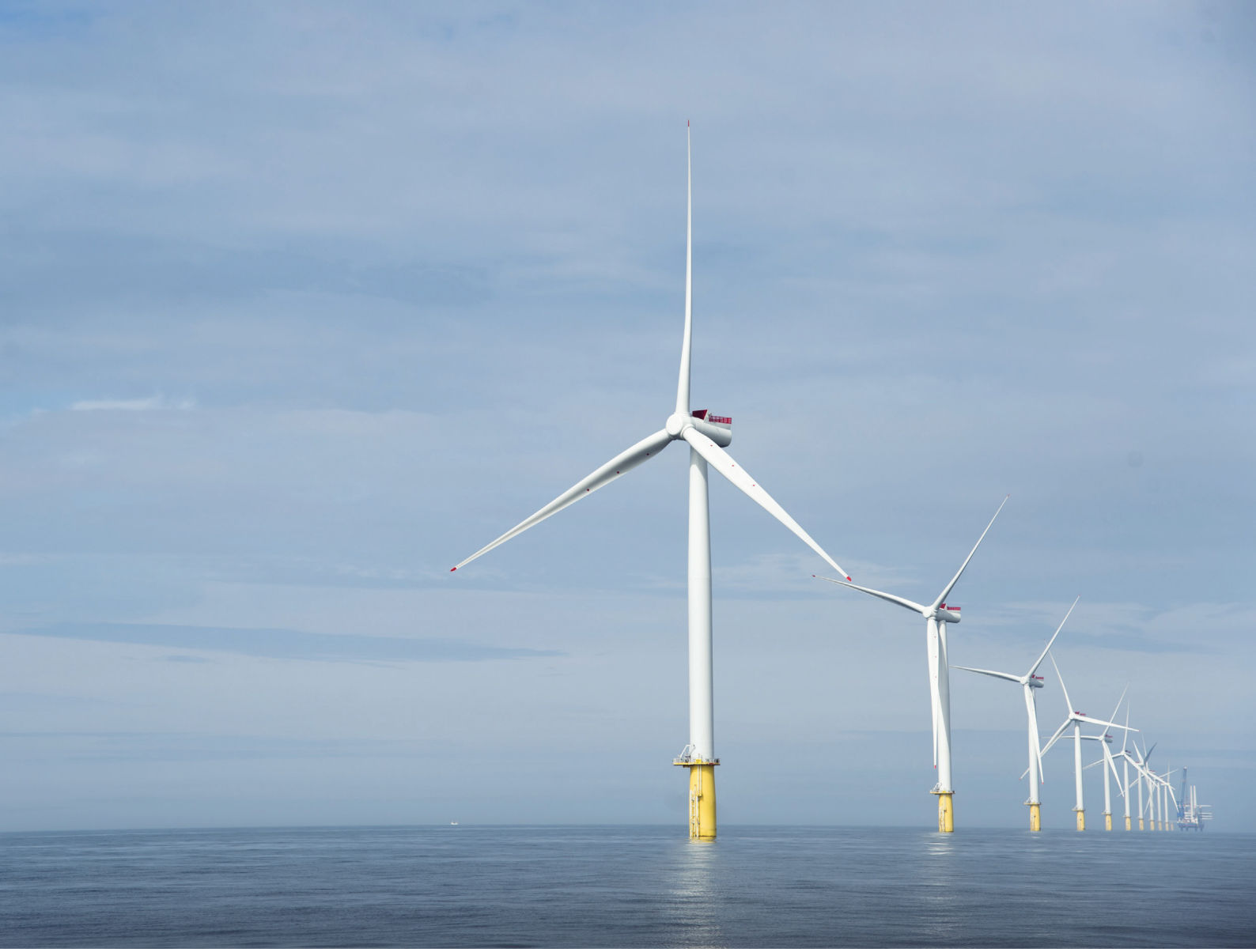

Sheringham Shoal and Dudgeon Offshore Wind Farm Extension Projects

Environmental Statement

Volume 3

Appendix 11.2 - Information to Inform the Offshore Ornithology Cumulative Impact Assessment

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Sarah Chandler, Equinor		August 2022

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Glossary of Acronyms

BDMPS	Biologically Defined Minimum Population Size
CIA	Cumulative Impact Assessment
CRM	Collision Risk Modelling
DCO	Development Consent Order
DEP	Dudgeon Offshore Wind Farm Extension Project
DOW	Dudgeon Offshore Wind Farm
DSM	Density Surface Model
EIA	Environmental Impact Assessment
ES	Environmental Statement
ESAS	European Seabirds at Sea
HAT	Highest Astronomical Tide
JNCC	Joint Nature Conservation Committee
km	Kilometre
MSL	Mean Sea Level
MW	Megawatts
OMP	Ornithological Monitoring Plan
OWF	Offshore Wind Farm
PEIR	Preliminary Environmental Information Report
SeaMAST	Seabird Mapping and Sensitivity Tool
SEP	Sheringham Shoal Offshore Wind Farm Extension Project
SNCB	Statutory Nature Conservation Body
SNS	Southern North Sea
SOW	Sheringham Offshore Wind Farm
SPA	Special Protection Area
UK	United Kingdom
WWT	Wildfowl and Wetlands Trust

Glossary of Terms

Dudgeon Offshore Wind Farm Extension Project (DEP)	The Dudgeon Offshore Wind Farm Extension onshore and offshore sites including all onshore and offshore infrastructure.
DEP offshore site	The Dudgeon Offshore Wind Farm Extension consisting of the DEP wind farm site, interlink cable corridors and offshore export cable corridor (up to mean high water springs).
DEP wind farm site	The offshore area of DEP within which wind turbines, infield cables and offshore substation platform/s will be located and the adjacent Offshore Temporary Works Area. This is also the collective term for the DEP North and South array areas.
Interlink cable corridor	This is the area which will contain the interlink cables between offshore substation platform/s and the adjacent Offshore Temporary Works Area.
Offshore cable corridors	This is the area which will contain the offshore export cables or interlink cables, including the adjacent Offshore Temporary Works Area.
Offshore export cable corridor	This is the area which will contain the offshore export cables between offshore substation platform/s and landfall, including the adjacent Offshore Temporary Works Area.
Offshore export cables	The cables which would bring electricity from the offshore substation platform(s) to the landfall. 220 – 230kV.
Offshore Temporary Works Area	An Offshore Temporary Works Area within the DCO boundary in which vessels are permitted to carry out activities during construction, operation and decommissioning encompassing a 200m buffer around the wind farm sites and a 750m buffer around the offshore cable corridors. No permanent infrastructure would be installed within the Offshore Temporary Works Area.
Sheringham Shoal Offshore Wind Farm Extension Project (SEP)	The Sheringham Shoal Offshore Wind Farm Extension onshore and offshore sites including all onshore and offshore infrastructure.
SEP offshore site	Sheringham Shoal Offshore Wind Farm Extension consisting of the SEP wind farm site and offshore export cable corridor (up to mean high water springs).

SEP wind farm site	The offshore area of SEP within which wind turbines, infield cables and offshore substation platform/s will be located and the adjacent Offshore Temporary Works Area.
The Applicant	Equinor New Energy Limited

11.2 INFORMATION TO INFORM THE OFFSHORE ORNITHOLOGY CUMULATIVE IMPACT ASSESSMENT

11.2.1 Introduction

1. This Appendix provides the information that underpins the quantitative element of the cumulative impact assessment (CIA) for ES **Chapter 11 Offshore Ornithology**. A large number of offshore wind farm (OWF) projects require consideration in the CIA for the Sheringham Shoal Offshore Wind Farm Extension Project (SEP) and Dudgeon Offshore Wind Farm Extension Project (DEP) on 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 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 (with the exception of Sandwich tern, as described below).
3. **Section 11.2.3** and **Section 11.2.4** provide an audit trail for cumulative collision risk and cumulative operational phase displacement assessments respectively. For each species included in the CIA, tabulated estimates of collision risk mortality and the number of birds at risk of displacement by the Projects are provided, together with the source of information. These numbers are provided as seasonal and annual totals as appropriate. An explanation of the biologically relevant seasons used for each offshore ornithology receptor is provided in **Chapter 11 Offshore Ornithology**. For red-throated diver, two approaches are presented. The first utilises data from OWF assessments. The second uses modelled data from the Seabird Mapping and Sensitivity Tool (SeaMAST) project, since the first approach was not considered comprehensive due to a lack of data from many OWF assessments. For Sandwich tern, individual project assessments for other OWFs have been produced for collision risk (since the original assessments used models and input parameters which have seen been superseded), and displacement (since no such assessments were produced by other projects, and recent evidence indicates that this is a potential impact for this species).
4. The source of this information for the majority of species considered was 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), which is the most recent comprehensive CIA considered at a DCO Examination. This includes the numbers for Hornsea Project Four.
5. The cut off for inclusion of other OWFs into the CIA was May 2022. This means that for projects in Examination at that point (i.e. Hornsea Project Four), and those submitted for Examination more recently (i.e. Awel Y Mor), updates to the assessment will be required during the Examination for SEP and DEP.

6. For Sandwich tern, collision risk has been recalculated for all OWFs within the mean maximum foraging range of this species from the North Norfolk Coast Special Protection Area (SPA) (Woodward *et al*., 2019) using the Band Collision Risk Model (CRM) (Band, 2012). The reason that this additional step has been undertaken is that Sandwich tern CRM input parameters have changed extensively since the last OWF in the Greater Wash area was consented. The input parameters used for this assessment are as per the "Realistic Worst Case Scenario" models detailed in **Chapter 11 Offshore Ornithology**. Both consented and as-built OWF designs have been considered, as well as scenarios where existing as-built designs are built out to consented capacity, with either consented or as-built turbine specifications. Displacement rates were not considered by any previous OWF assessment for this species; this has been calculated for Sandwich tern by using flying bird densities (which were all that were available) as an input in the matrix-based approach currently advocated by Natural England (UK SNCBs, 2017).

7. In the species tables, OWFs are assigned to tiers as suggested by Natural England and JNCC in the submission at Deadline 5 for the East Anglia Three Offshore Wind farm (Scottish Power Renewables, 2016), and shown in **Table 1**. This approach is consistent with other recent OWF projects, and has been included in Natural England's recently published guidance on OWF assessments (though the final versions of the guidance were not available during the preparation of the assessment). Quantitative information is available for OWFs in tiers 1 to 4, which have been included in the assessment. Whilst OWFs in tiers 5 and 6 are included in lists of projects to be considered (see **Chapter 5 EIA Methodology**), they cannot be qualitatively considered with respect to the offshore ornithology assessment since no information at the required level of detail is publicly available (e.g. seabird densities, CRM results etc).

Table 1: Tiers for OWFs included in CIA

Tier	Status
1	Built and operational projects
2	Projects under construction
3	Consented
4	Application submitted and not yet determined
5	In planning (scoped or Preliminary Environmental Information Report (PEIR) available), application not yet formally submitted
6	Identified in Planning Inspectorate list of projects

11.2.2 Methods

11.2.2.1 Red-throated Diver CIA

8. Red-throated diver displacement impacts during the operational phase of OWFs have been quantitatively assessed within Environmental Impact Assessments (EIAs) for a small number of OWFs in the southern North Sea. Potential cumulative effects on this species have been investigated using quantitative data from other OWFs where available (i.e. "the standard assessment") (**Section 11.2.4.4.1**). However, given the number of OWFs for which such data was not available, this is not a comprehensive approach to assessment. An alternative approach to estimating potential cumulative displacement risk was required for this species to ensure potential cumulative impacts were not underestimated for OWFs where quantitative displacement assessment for this species had not been previously carried out.

9. The SeaMAST project (Bradbury *et al*., 2014) provides a common dataset covering the majority of English waters, describing modelled seabird densities in 3x3km squares using data collected from boat-based and visual aerial surveys. 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.

10. 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 densities during the non-breeding season (sitting and flying birds summed) from a density surface model (DSM) of Wildfowl and Wetlands Trust (WWT) visual aerial survey data collected between 2001 and 2011, and Joint Nature Conservation Committee (JNCC) European Seabirds At Sea (ESAS) boat-based survey data collected between 1979 and 2011.

11. OWF boundaries were obtained from the Crown Estate, with any known changes accounted for prior to data processing. All 3x3km 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 DEP, Dudgeon Offshore Wind Farm (DOW), Hornsea Projects One, Two and Three, Dogger Bank, Creyke Beck A and B, Sofia, Teesside A and Triton Knoll. As the SeaMAST dataset does not include Scottish Territorial Waters, Scottish OWFs in the North Sea (i.e. Aberdeen (European Offshore Wind Deployment Centre (EOWDC)), Beatrice, Beatrice Demonstrator, Hywind, Kincardine, Methil, Seagreen Alpha and Bravo, Inch Cape and Neart na Gaoithe) were not included in the assessment. This approach is the same as was taken for a very similar analysis for the East Anglia ONE North and TWO OWFs (Royal HaskoningDHV, 2019).

12. The red-throated diver non-breeding season is defined as September to February (Furness, 2015), which was covered by the SeaMAST dataset. The SeaMAST dataset is a collation of data which at the time of its collection was not collected for the purpose of a wider regional analysis. This means that survey effort occurred disproportionally across some areas over particular months or seasons, depending on the original purpose of the surveys. The red-throated diver non-breeding season was further subdivided by Furness (2015) into post-breeding migration (September to November), migration-free winter season (December to January) and return migration (February to April). During the two migration seasons, the northwestern and southwestern North Sea areas are considered to hold a single population of red-throated divers (UK North Sea and Channel Biologically Defined Minimum Population Size (BDMPS)). During the winter season, it is considered that the northwestern and southwestern North Sea area populations are separate (Furness, 2015).

13. To calculate the number of red-throated divers occurring within a given area, the red-throated diver density for each SeaMAST grid square was converted to an abundance by multiplying density by area. For areas inside OWFs, the SeaMAST dataset encompassing the area of interest was clipped to the OWF boundary where there was overlap between 4km OWF buffers and/or other OWFs, red-throated divers were allocated to a particular OWF based on the tiered system for CIA based on advice from UK Statutory Nature Conservation Bodies (SNCBs) (**Table 1**). 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.

14. Whilst more recent evidence indicates that displacement effects of operational OWFs frequently exceed 4km, this approach was not amended primarily because incorporating larger buffers caused considerable complications with overlap of buffers at one OWF with buffers from other OWFs, as well as the OWFs themselves.

15. The SeaMAST dataset is based on survey methods which have a tendency to underestimate the numbers of red-throated divers present. This assessment is not intended to provide robust population estimates at each OWF included, but instead gives a basis for comparison of the relative numbers of birds in each OWF in relation to the estimated population in the reference area.

16. The reference population size used for the non-breeding season was 19,978 based on the SeaMAST dataset.

11.2.2.2 Sandwich Tern CIA

11.2.2.2.1 Density Data

17. Monthly density data of Sandwich terns in flight within DOW (MacArthur Green, 2014), Sheringham Shoal OWF (SOW) (SCIRA Offshore Energy Ltd, 2006), Race Bank OWF (Centrica Energy, 2009) and Triton Knoll OWF (RWE NPower Renewables, 2011) were obtained from a review of available literature (**Table 2)**.

Table 2: Densities of flying Sandwich terns at Greater Wash OWFs used as input parameters into CRM and displacement analysis

Month	Flying bird density (birds/km^2)			
	DOW	SOW	Race Bank	Triton Knoll
January	0	0	0	0
February	0	0	0	0
March	0	0	0.025	0
April	0.635	0.042	0.070	0.013
May	0.847	0.444	0.565	0.081
June	0.367	0.293	0.693	0.040
July	0.017	0.206	0.523	0.02
August	0	0.045	0.280	0.121
September	0	0.046	0.050	0
October	0	0	0	0
November	0	0	0	0
December	0	0	0	0

18. These densities were used as inputs into both CRM and displacement modelling. Whilst density estimates of combined flying and sitting birds are preferred for assessment of displacement, these data were not available for other OWFs in the Greater Wash area. Published literature suggests that Sandwich terns spend the overwhelming majority of their time at sea in flight (Garthe and Hüppop, 2004; Perrow *et al*., 2017). This is supported by the fact that of the 1,710 Sandwich tern observations made during the SEP and DEP baseline surveys, 1,676 (98%) were of birds in flight. As a result, the lack of “all birds” data for other OWFs is not considered to materially affect the assessment.

11.2.2.2.2 Collision Risk

19. CRM was carried out according to the method of Band (2012). The flight height distribution from Harwood (2021) was used as a model input, since it is considered to be the best available evidence for North Norfolk Coast SPA Sandwich tern flight height during the breeding season.

20. As per the advice provided by Natural England, an avoidance rate of 0.980 was used. An additional correction of up to 0.500 macro-avoidance has also been built into the calculations to account for potential operational phase displacement. This range has been selected due to information presented in the DOW Ornithological Monitoring Plan (OMP) (which suggests a range of zero to 0.500 might be appropriate depending on the behaviour associated with a particular area (**Appendix 11.1 Offshore Ornithology Technical Report**)), Cook *et al*. (2014) and Krijgsveld *et al*. (2011) (which suggested a macro-avoidance rate of 0.28 based on three years of radar data, though this rate was not species-specific), and Harwood *et al*. (2018) (which suggested a species-specific macro-avoidance rate of 0.31 to 0.42 based on one year of baseline and three years of operational phase boat-based survey data from SOW). These corrections are applied in increments of 0.10.

21. Nocturnal activity was set at 2%, which is based on evidence from DOW OMP data. Further detail on this is provided in **Appendix 11.1 Offshore Ornithology Technical Report**.

22. The best available evidence for Sandwich tern flight speed is that calculated for North Norfolk Coast SPA breeding Sandwich terns by Fijn and Collier (2020). Natural England have previously indicated that they have concerns over this dataset due to methodologies not being presented in sufficient detail. This has now been provided in **Appendix 11.1 Offshore Ornithology Technical Report**. The mean value calculated by this study was 8.2m/s, and this is what is used in the assessment.

23. The other biometric parameters for Sandwich tern used by the assessment are as presented in **Chapter 11 Offshore Ornithology**.

24. Two sets of parameters for each of the OWFs under consideration were utilised by the CRM. Consented OWF design parameters are presented in **Table 3**. As-built OWF parameters are presented in **Table 4**. Information obtained through Equinor, and from DONG Energy (2015) indicated that a tidal offset of 2m was an appropriate input into the model, given the difference between Mean Sea Level (MSL) and Highest Astronomical Tide (HAT) was between 2m and 3m at SOW, DOW, and Race Bank OWF.

Table 3: Consented turbine parameters for Greater Wash OWFs used in CRM

Site	Number of turbines	Rotation speed (rpm)	Blade pitch (degrees)	Rotor Radius (m)	Hub height (m)[5]	Air Gap (m)[5]	Max blade width (m)
DOW[1]	85	10.59	10	63	85	22	5.45
Race Bank[2]	206	15.90	10	45	67	22	3.40
SOW[3]	88	12.76	10	45	74	22	3.90
Triton Knoll[4]	288	9.47	6	62.5	85	22	4.20

Notes
1 Source for parameters was ECON (2011)
2 Source for parameters was Centrica Energy (2009)
3 Source for parameters was SCIRA Offshore Energy Ltd (2006)
4 Source for parameters was RWE NPower Renewables (2011)
5 Due to uncertainty around tidal parameters used and the frequent absence of hub height information, air gap has been standardised for all OWFs to 22m above HAT, and hub height altered as required. Since 22m above HAT is thought to be the minimum permitted air gap due to navigational requirements, this is considered to be a precautionary assessment.

Table 4: As-built turbine parameters for Greater Wash OWFs used in CRM

Site	Number of turbines	Rotation speed (rpm)	Blade pitch (degrees)	Rotor Radius (m)	Hub height (m)	Air Gap (m)	Max blade width (m)
DOW[1]	67	12.00	10	77	99	22	5.00
Race Bank[2]	91	10.3	15	77	103	26	5.00
SOW[3]	88	12.77	10	52	74	22	3.90
Triton Knoll[4]	90	10.8	5.4	82	105	23	4.20

Notes
1 Source for parameters was Macarthur Green (2014)
2 Source for parameters was DONG Energy (2015)
3 Source for parameters was SCIRA Offshore Energy Ltd (2006)
4 Parameters were updated based on publicly available information on turbine design from Triton Knoll OWF Ltd and Vestas. Some parameters were calculated from other parameters (e.g. hub height and air gap were calculated from the available data on maximum tip height and rotor radius). Where information could not be obtained (e.g. max blade width), this was left the same as for the consented design

25. Whilst the CRM for the as-built scenario (Scenario B) provides the most realistic outputs, these OWF designs are not legally secured (The Crown Estate and Womble Bond Dickinson, 2021), unlike the consented scenario (Scenario A). This means that there is a theoretical, albeit extremely unlikely possibility of additional turbines being added to the design of existing OWFs. As a result, two further sets of CRM outputs for hypothetical OWF designs have been produced, which both assume that the remaining consented nameplate capacity of each OWF is built out. This is presented in **Table 5**.

26. The first scenario (Scenario C) assumes that unbuilt capacity is built out using turbines of the same specification as the consented design. The second assumes that any unbuilt capacity at the consented OWFs is built out using turbines of the same specification as those actually used at the OWF (Scenario D). Both of these scenarios are considered to be improbable, however, the latter is more likely than the former, since it is unlikely that older turbines could be procured. The final set of CRM outputs (Scenario E) is the same as Scenario D but with the assumption that the as-built layout of DOW is legally secured. In this appendix, CRM totals for SEP and DEP are provided from CRMs undertaken using design-based density estimates. **Chapter 11 Offshore Ornithology** provides revised totals based on CRMs produced using model-based density estimates for SEP and DEP.

Table 5: Calculation of "maximum theoretical as-built" CRM correction factors

Site	Number of turbines	Nameplate single turbine capacity (MW)	Nameplate capacity of as-built OWF (MW)	Maximum capacity of OWF at consent (MW)	Design correction factor
DOW	67	6.0	402	560	0.72
Race Bank	91	6.3	573	580	0.99
SOW	88	3.6	317	315	0.99[1]
Triton Knoll	90	9.5	857	1,200	0.71
Notes 1 No correction was applied to SOW					

11.2.2.2.3 Displacement

27. Following guidance from SNCBs (UK SNCBs, 2017), mean peak abundance estimates for Sandwich tern have been used to produce displacement matrices. The spatial extent of this impact is considered to be the OWFs only (i.e. no buffers). This has been selected due to evidence put forward by Perrow *et al*. (2010) that displacement effects for this species are unlikely beyond 1km of an OWF boundary, and Harwood *et al*. (2018) that birds continued to use areas of sea directly adjacent to SOW after the OWF had become operational.

28. Based on information presented in **Section 11.2.2.2.2** and **Chapter 11 Offshore Ornithology**, displacement rates of zero to 0.500 and a mortality rate of 1% is considered appropriate.

29. Displacement matrices are presented for all relevant seasons (i.e. all seasons during which Sandwich terns were recorded at each OWF).

11.2.3 Cumulative Collision Risk

11.2.3.1 Gannet

Table 6: Cumulative collision risk for gannet, consented OWF parameters

Tier	OWF	Estimated collisions			
		Breeding	Autumn migration	Spring migration	Year round
1	Beatrice	37.4	48.8	9.5	95.7
1	Beatrice Demonstrator	0.6	0.9	0.7	2.2
1	Blyth Demonstration Project	3.5	2.1	2.8	8.4
1	Dudgeon	22.3	38.9	19.1	80.3
1	East Anglia ONE	3.4	131	6.3	141
1	European Offshore Wind Deployment Centre	4.2	5.1	0.1	9.3
1	Galloper	18.1	30.9	12.6	61.6
1	Greater Gabbard	14	8.8	4.8	27.5
1	Gunfleet Sands	-	-	-	-
1	Hornsea Project One	11.5	32	22.5	66
1	Humber Gateway	1.9	1.1	1.5	4.5
1	Hywind	5.6	0.8	0.8	7.2
1	Kentish Flats	1.4	0.8	1.1	3.3
1	Kentish Flats Extension	-	-	-	-
1	Kincardine	3	0	0	3
1	Lincs	2.1	1.3	1.7	5
1	London Array	2.3	1.4	1.8	5.5
1	Lynn and Inner Dowsing	0.2	0.1	0.2	0.5
1	Methil	6	0	0	6
1	Moray Firth (EDA)	80.6	35.4	8.9	124.9
1	Race Bank	33.7	11.7	4.1	49.5
1	Rampion	36.2	63.5	2.1	101.8

Tier	OWF	Estimated collisions			
		Breeding	Autumn migration	Spring migration	Year round
1	Scroby Sands	-	-	-	-
1	Sheringham Shoal	14.1	3.5	0	17.6
1	Teesside	4.9	1.7	0	6.7
1	Thanet	1.1	0	0	1.1
1	Westermost Rough	0.2	0.1	0.2	0.5
2	Dogger Bank Creyke Beck Projects A and B	81.1	83.5	54.4	219
2	Firth of Forth Alpha and Bravo	800.8	49.3	65.8	915.9
2	Hornsea Project Two	7	14	6	27
2	Neart na Gaoithe	143	47	23	213
2	Triton Knoll	26.8	64.1	30.1	121
3	Dogger Bank Teesside Projects A and B	14.8	10.1	10.8	35.7
3	East Anglia ONE North	12.4	11	1.1	24.5
3	East Anglia THREE	6.1	33.3	9.6	49
3	East Anglia TWO	12.5	23.1	4	39.6
3	Hornsea Project Three	10	5	4	19
3	Inch Cape	336.9	29.2	5.2	371.3
3	Moray West	10	2	1	13
3	Norfolk Boreas	14.1	12.7	3.9	30.7
3	Norfolk Vanguard	8.2	18.6	5.3	32.1
	TOTAL: TIERS 1-3	**1,792.0**	**822.8**	**325.0**	**2,939.0**
4	Hornsea Project Four (PEIR)	43.3	9.9	8.1	61.3
	TOTAL: TIERS 1-3 plus Hornsea Project Four (PEIR)	**1,835.3**	**832.7**	**333.1**	**3,001.2**
4	DEP (ES Mean)	1.8	2.8	0.2	4.9
4	SEP (ES Mean)	0.2	0.7	0.0	0.9
-	**TOTAL: TIERS 1-4 plus Hornsea Project Four (PEIR), plus SEP and DEP (Mean)**	**1,837.4**	**836.2**	**333.3**	**3,007.0**

11.2.3.2 Kittiwake

Table 7: Cumulative collision risk for kittiwake, consented OWF parameters

Tier	OWF	Estimated collisions			
		Breeding	Autumn migration	Spring migration	Year round
1	Beatrice	94.7	10.7	39.8	145.2
1	Beatrice Demonstrator	0	2.1	1.7	3.8
1	Blyth Demonstration Project	1.7	2.3	1.4	5.4
1	Dudgeon	-	-	-	-
1	East Anglia ONE	1.8	160.4	46.8	209
1	European Offshore Wind Deployment Centre	11.8	5.8	1.1	18.7
1	Galloper	6.3	27.8	31.8	65.9
1	Greater Gabbard	1.1	15	11.4	27.5
1	Gunfleet Sands	-	-	-	-
1	Hornsea Project One	44	55.9	20.9	120.8
1	Humber Gateway	1.9	3.2	1.9	7
1	Hywind	16.6	0.9	0.9	18.3
1	Kentish Flats	0	0.9	0.7	1.6
1	Kentish Flats Extension	0	0	2.7	2.7
1	Kincardine	22	9	1	32
1	Lincs	0.7	1.2	0.7	2.6
1	London Array	1.4	2.3	1.8	5.5
1	Lynn and Inner Dowsing	-	-	-	-
1	Methil	0.4	0	0	0.4
1	Moray Firth (EDA)	43.6	2	19.3	64.9
1	Race Bank	1.9	23.9	5.6	31.4
1	Rampion	54.4	37.4	29.7	121.5
1	Scroby Sands	-	-	-	-
1	Sheringham Shoal	-	-	-	-

Tier	OWF	Estimated collisions			
		Breeding	Autumn migration	Spring migration	Year round
1	Teesside	38.4	24	2.5	64.9
1	Thanet	0.2	0.5	0.4	1.1
1	Westermost Rough	0.1	0.2	0.1	0.5
2	Dogger Bank Creyke Beck Projects A and B	288.6	135	295.4	719
2	Firth of Forth Alpha and Bravo	153.1	313.1	247.6	713.8
2	Hornsea Project Two	16	9	3	28
2	Neart na Gaoithe	32.9	56.1	4.4	93.4
2	Triton Knoll	24.6	139	45.4	209
3	Dogger Bank Teesside Projects A and B	136.9	90.7	216.9	444.5
3	East Anglia ONE North	40.4	8.1	3.5	52
3	East Anglia THREE	6.1	69	37.6	112.7
3	East Anglia TWO	29.5	5.4	7.4	42.3
3	Hornsea Project Three	77	38	8	123
3	Inch Cape	13.1	224.8	63.5	301.4
3	Moray West	79	24	7	110
3	Norfolk Boreas	13.3	32.2	11.9	57.5
3	Norfolk Vanguard	21.8	16.4	19.3	57.5
	TOTAL: TIERS 1-3	**1,275.3**	**1,546.3**	**1,193.1**	**4,014.8**
4	Hornsea Project Four (PEIR)	153.3	34.7	9.9	197.9
	TOTAL: TIERS 1-3 plus Hornsea Project Four (PEIR)	**1,428.6**	**1,581.0**	**1,203.0**	**4,212.7**
4	DEP (ES Mean)	9.1	4.6	1.3	15.0
4	SEP (ES Mean)	0.8	1.2	0	2.0
	TOTAL: TIERS 1-3 plus Hornsea Project Four (PEIR), plus SEP and DEP (Mean)	**1,438.5**	**1,586.8**	**1,204.3**	**4,229.7**

11.2.3.3 Great Black-backed Gull

Table 8: Cumulative collision risk for great black-backed gull, consented OWF parameters

Tier	OWF	Estimated collisions		
		Breeding	Non-breeding	Year round
1	Beatrice	30.2	120.8	151
1	Beatrice Demonstrator	0	0	0
1	Blyth Demonstration Project	1.3	5.1	6.3
1	Dudgeon	0	0	0
1	East Anglia ONE	0	46	46
1	European Offshore Wind Deployment Centre	0.6	2.4	3
1	Galloper	4.5	18	22.5
1	Greater Gabbard	15	60	75
1	Gunfleet Sands	-	-	-
1	Hornsea Project One	17.2	68.6	85.8
1	Humber Gateway	1.3	5.1	6.3
1	Hywind	0.3	4.5	4.8
1	Kentish Flats	-	-	-
1	Kentish Flats Extension	0.1	0.2	0.3
1	Kincardine	0	0	0
1	Lincs	0	0	0
1	London Array	-	-	-
1	Lynn and Inner Dowsing	0	0	0
1	Methil	0.8	0.8	1.6
1	Moray Firth (EDA)	9.5	25.5	35
1	Race Bank	0	0	0
1	Rampion	5.2	20.8	26
1	Scroby Sands	-	-	-
1	Sheringham Shoal	0	0	0
1	Teesside	8.7	34.8	43.6
1	Thanet	0.1	0.4	0.5
1	Westermost Rough	0	0	0.1
2	Dogger Bank Creyke Beck Projects A and B	5.8	23.3	29.1
2	Firth of Forth Alpha and Bravo	13.4	53.4	66.8
2	Hornsea Project Two	3	20	23
2	Neart na Gaoithe	0.9	3.6	4.5
2	Triton Knoll	24.4	97.6	122
3	Dogger Bank Teesside Projects A and B	6.4	25.5	31.9
3	East Anglia ONE North	3.7	1.2	5
3	East Anglia THREE	4.6	34.4	39
3	East Anglia TWO	3.5	3.4	6.9
3	Hornsea Project Three	8	28	36
3	Inch Cape	0	36.8	36.8

Tier	OWF	Estimated collisions		
		Breeding	Non-breeding	Year round
3	Moray West	4	5	9
3	Norfolk Boreas	6.9	28.7	35.6
3	Norfolk Vanguard	4.5	21.5	26
	TOTAL: TIERS 1-3	**183.9**	**795.4**	**979.4**
4	Hornsea Project Four (PEIR)	3.0	13.6	16.6
	TOTAL: TIERS 1-3 plus Hornsea Project Four (PEIR)	**186.9**	**809.0**	**996.0**
4	DEP (ES Mean)	1.1	0.2	1.3
4	SEP (ES Mean)	3.7	0	3.7
	TOTAL: TIERS 1-3 plus Hornsea Project Four (PEIR), plus SEP and DEP (Mean)	**191.7**	**809.2**	**1,001.0**

11.2.3.4 Lesser Black-backed Gull

Table 9: Cumulative collision risk for lesser black-backed gull, consented OWF parameters

Tier	OWF	Estimated collisions		
		Breeding	Non-breeding	Year round
1	Beatrice	0	0	0
1	Beatrice Demonstrator	-	-	-
1	Blyth Demonstration Project	0	0	0
1	Dudgeon	7.7	30.6	38.3
1	East Anglia ONE	5.9	33.8	39.7
1	European Offshore Wind Deployment Centre	0	0	0
1	Galloper	27.8	111	138.8
1	Greater Gabbard	12.4	49.6	62
1	Gunfleet Sands	1	0	1
1	Hornsea Project One	4.4	17.4	21.8
1	Humber Gateway	0.3	1.1	1.4
1	Hywind	0	0	0
1	Kentish Flats	-	-	-
1	Kentish Flats Extension	0.3	1.3	1.6
1	Kincardine	0	0	0
1	Lincs	1.7	6.8	8.5
1	London Array	-	-	-
1	Lynn and Inner Dowsing	-	-	-
1	Methil	0.5	0	0.5
1	Moray Firth (EDA)	0	0	0
1	Race Bank	43.2	10.8	54
1	Rampion	1.6	6.3	7.9
1	Scroby Sands	-	-	-
1	Sheringham Shoal	1.7	6.6	8.3
1	Teesside	0	0	0
1	Thanet	3.2	12.8	16

Tier	OWF	Estimated collisions		
		Breeding	Non-breeding	Year round
1	Triton Knoll	7.4	29.6	37
1	Westermost Rough	0.1	0.3	0.4
2	Dogger Bank Creyke Beck Projects A and B	2.6	10.4	13
2	Firth of Forth Alpha and Bravo	2.1	8.4	10.5
2	Hornsea Project Two	2	2	4
2	Neart na Gaoithe	0.3	1.2	1.5
3	Dogger Bank Teesside Projects A and B	2.4	9.6	12
3	East Anglia ONE North	0.9	0.6	1.5
3	East Anglia THREE	1.8	8.2	10
3	East Anglia TWO	4.2	0.5	4.7
3	Hornsea Project Three	8	1	9
3	Inch Cape	0	0	0
3	Moray West	0	0	0
3	Norfolk Boreas	6.2	8.1	14.3
3	Norfolk Vanguard	8.4	3.6	12
	TOTAL: TIERS 1-3	**158.1**	**371.6**	**529.7**
4	Hornsea Project Four (PEIR)	2.0	0	2.0
	TOTAL: TIERS 1-3 plus Hornsea Project Four (PEIR)	**160.1**	**371.6**	**531.7**
4	DEP (ES Mean)	1.0	0.3	1.3
4	SEP (ES Mean)	0.5	0.0	0.5
	TOTAL: TIERS 1-3 plus Hornsea Project Four (PEIR), plus SEP and DEP (Mean)	**161.6**	**371.9**	**533.5**

11.2.3.5 Sandwich Tern

Table 10: Recalculated Sandwich tern CRM outputs (Option 1) for other Greater Wash OWFs, using consented OWF parameters (Scenario A), and mean CRMs for DEP and SEP based on design-based density estimates

Tier	Site	J	F	M	A	M	J	J	A	S	O	N	D	Total
1	DOW	0	0	0	12.20	19.01	8.48	0.40	0	0	0	0	0	40.09
1	Race Bank	0	0	0.77	2.48	23.46	29.71	22.56	10.86	1.62	0	0	0	91.46
1	SOW	0	0	0	0.58	7.17	4.87	3.45	0.68	0.58	0	0	0	17.33
2	Triton Knoll	0	0	0	0.72	5.39	2.74	1.79	7.20	0	0	0	0	17.84
												TOTAL: TIERS 1-2		**166.73**
4	DEP (ES mean)	0	0	0	1.79	2.98	0.71	1.46	0.40	0.25	0	0	0	7.58
4	SEP (ES mean)	0	0	0	0.02	0.62	0.39	0.72	0.09	0.03	0	0	0	1.88
													TOTAL: TIERS 1-2 plus SEP and DEP	**176.19**

Table 11: Recalculated Sandwich tern CRM outputs (Option 1) for other Greater Wash OWFs, using as-built OWF parameters (Scenario B) , and mean CRMs for DEP and SEP based on design-based density estimates

Tier	Site	J	F	M	A	M	J	J	A	S	O	N	D	Total
1	DOW	0	0	0	10.13	15.79	7.05	0.33	0	0	0	0	0	33.30
1	Race Bank	0	0	0.26	0.84	7.94	10.04	7.63	3.68	0.55	0	0	0	30.95
1	SOW	0	0	0	0.58	7.17	4.87	3.45	0.68	0.58	0	0	0	17.33
2	Triton Knoll	0	0	0	0.24	1.83	0.93	0.61	2.45	0	0	0	0	6.05
												TOTAL: TIERS 1-2		**87.63**
4	DEP (ES mean)	0	0	0	1.79	2.98	0.71	1.46	0.40	0.25	0	0	0	7.58
4	SEP (ES mean)	0	0	0	0.02	0.62	0.39	0.72	0.09	0.03	0	0	0	1.88
													TOTAL: TIERS 1-2 plus SEP and DEP	**97.09**

Table 12: Recalculated Sandwich tern CRM outputs (Option 1) for other Greater Wash OWFs, using as-built OWF parameters, with additional unbuilt capacity built out using consented turbine design (Scenario C) , and mean CRMs for DEP and SEP based on design-based density estimates

Tier	Site	J	F	M	A	M	J	J	A	S	O	N	D	Total
1	DOW	0	0	0	13.55	21.11	9.42	0.44	0	0	0	0	0	44.52
1	Race Bank	0	0	0.27	0.86	8.17	10.35	7.86	3.78	0.56	0	0	0	31.86
1	SOW	0	0	0	0.58	7.17	4.87	3.45	0.68	0.58	0	0	0	17.33
2	Triton Knoll	0	0	0	0.45	3.39	1.73	1.13	4.53	0	0	0	0	11.23
													TOTAL: TIERS 1-2	**104.94**
4	DEP (ES mean)	0	0	0	1.79	2.98	0.71	1.46	0.40	0.25	0	0	0	7.58
4	SEP (ES mean)	0	0	0	0.02	0.62	0.39	0.72	0.09	0.03	0	0	0	1.88
													TOTAL: TIERS 1-2 plus SEP and DEP	**114.40**

Table 13: Recalculated Sandwich tern CRM outputs (Option 1) for other Greater Wash OWFs, using as-built OWF parameters, with additional unbuilt capacity built out using as-built turbine design (Scenario D), and mean CRMs for DEP and SEP based on design-based density estimates

Tier	Site	J	F	M	A	M	J	J	A	S	O	N	D	Total
1	DOW	0	0	0	12.97	20.21	9.02	0.42	0	0	0	0	0	42.62
1	Race Bank	0	0	0.26	0.85	8.02	10.15	7.71	3.71	0.55	0	0	0	31.26
1	SOW	0	0	0	0.58	7.17	4.87	3.45	0.68	0.58	0	0	0	17.33
2	Triton Knoll	0	0	0	0.31	2.36	1.20	0.78	3.15	0	0	0	0	7.81
													TOTAL: TIERS 1-2	**99.02**
4	DEP (ES mean)	0	0	0	1.79	2.98	0.71	1.46	0.40	0.25	0	0	0	7.58
4	SEP (ES mean)	0	0	0	0.02	0.62	0.39	0.72	0.09	0.03	0	0	0	1.88
													TOTAL: TIERS 1-2 plus SEP and DEP	**108.48**

Table 14: Recalculated Sandwich tern CRM outputs (Option 1) for other Greater Wash OWFs, using as-built OWF parameters, with additional unbuilt capacity built out using as-built turbine design except for DOW, which is assumed to be legally secured in its as-built design (Scenario E) , and mean CRMs for DEP and SEP based on design-based density estimates

Tier	Site	J	F	M	A	M	J	J	A	S	O	N	D	Total
1	DOW	0	0	0	10.13	15.79	7.05	0.33	0	0	0	0	0	33.30
1	Race Bank	0	0	0.26	0.85	8.02	10.15	7.71	3.71	0.55	0	0	0	31.26
1	SOW	0	0	0	0.58	7.17	4.87	3.45	0.68	0.58	0	0	0	17.33
2	Triton Knoll	0	0	0	0.31	2.36	1.20	0.78	3.15	0	0	0	0	7.81
													TOTAL: TIERS 1-2	**89.70**
4	DEP (ES mean)	0	0	0	1.79	2.98	0.71	1.46	0.40	0.25	0	0	0	7.58
4	SEP (ES mean)	0	0	0	0.02	0.62	0.39	0.72	0.09	0.03	0	0	0	1.88
													TOTAL: TIERS 1-2 plus SEP and DEP	**99.16**

11.2.4 Cumulative Displacement Risk

11.2.4.1 Gannet

Table 15: Cumulative number of gannets at risk of operational phase OWF displacement

Tier	OWF	Estimated number of birds at risk of displacement			
		Breeding	Autumn migration	Spring migration	Year round
1	Beatrice	151	0	0	151
1	Beatrice Demonstrator	-	-	-	-
1	Blyth Demonstration Project	-	-	-	-
1	Dudgeon	53	25	11	89
1	East Anglia ONE	161	3,638	76	3,875
1	European Offshore Wind Deployment Centre	35	5	0	40
1	Galloper	360	907	276	1,543
1	Greater Gabbard	252	69	105	426
1	Gunfleet Sands	0	12	9	21
1	Hornsea Project One	671	694	250	1,615
1	Humber Gateway	-	-	-	-
1	Hywind	10	0	4	14
1	Kentish Flats	-	-	-	-
1	Kentish Flats Extension	0	13	0	13
1	Kincardine	120	0	0	120
1	Lincs	-	-	-	-
1	London Array	-	-	-	-
1	Methil	23	0	0	23
1	Moray Firth (EDA)	564	292	27	883
1	Race Bank	92	32	29	153
1	Rampion	0	590	0	590
1	Scroby Sands	-	-	-	-

Tier	OWF	Estimated number of birds at risk of displacement			
		Breeding	Autumn migration	Spring migration	Year round
1	Sheringham Shoal	47	31	2	80
1	Teesside	1	0	0	1
1	Thanet	-	-	-	-
1	Westermost Rough	-	-	-	-
2	Dogger Bank Creyke Beck Projects A and B	1,155	2,048	394	3,597
2	Firth of Forth Alpha and Bravo	2,956	664	332	3,952
2	Hornsea Project Two	457	1,140	124	1,721
2	Neart na Gaoithe	1,987	552	281	2,820
2	Triton Knoll	211	15	24	250
3	Dogger Bank Teesside Projects A and B	2,250	887	464	3,601
3	East Anglia ONE North	149	468	44	661
3	East Anglia THREE	412	1,269	524	2,205
3	East Anglia TWO	192	891	192	1,275
3	Hornsea Project Three	1,333	984	524	2,841
3	Inch Cape	2,398	703	212	3,313
3	Moray West	2,827	439	144	3,410
3	Norfolk Boreas	1,229	1,723	526	3,478
3	Norfolk Vanguard	271	2,453	437	3,161
	TOTAL: TIERS 1-3	**20,367**	**20,544**	**5,011**	**45,922**
4	Hornsea Project Four (PEIR)	1,892	1,192	659	3,743
	TOTAL: TIERS 1-3 plus Hornsea Project Four (PEIR)	**22,259**	**21,736**	**5,670**	**49,665**
4	DEP (ES Mean)	417	343	47	807
4	SEP (ES Mean)	23	295	11	28
-	**TOTAL: TIERS 1-4 plus Hornsea Project Four (PEIR), plus SEP and DEP (Mean)**	**22,699**	**22,374**	**5,728**	**50,801**

11.2.4.2 Guillemot

Table 16: Cumulative number of guillemots at risk of operational phase OWF displacement

Tier	OWF	Estimated number of birds at risk of displacement		
		Breeding	Non-breeding	Year round
1	Beatrice	13,610	2,755	16,365
1	Beatrice Demonstrator	No estimate available		
1	Blyth Demonstration Project	1,220	1,321	2,541
1	Dudgeon	334	542	876
1	East Anglia ONE	274	640	914
1	European Offshore Wind Deployment Centre	547	225	772
1	Galloper	305	593	898
1	Greater Gabbard	345	548	893
1	Gunfleet Sands	0	363	363
1	Hornsea Project One	9,836	8,097	17,933
1	Humber Gateway	99	138	237
1	Hywind	249	2,136	2,385
1	Kentish Flats	0	3	3
1	Kentish Flats Extension	0	4	4
1	Kincardine	632	0	632
1	Lincs & LID	582	814	1,396
1	London Array	192	377	569
1	Methil	25	0	25
1	Moray Firth (EDA)	9,820	547	10,367
1	Race Bank	361	708	1,069
1	Rampion	10,887	15,536	26,423
1	Scroby Sands	No estimate available		
1	Sheringham Shoal	390	715	1,105
1	Teesside	267	901	1,168
1	Thanet	18	124	142
1	Westermost Rough	347	486	833
2	Dogger Bank Creyke Beck A	5,407	6,142	11,549
2	Dogger Bank Creyke Beck B	9,479	10,621	20,100
2	Firth of Forth Alpha	13,606	4,688	18,294
2	Firth of Forth Bravo	11,118	4,112	15,230
2	Hornsea Project Two	7,735	13,164	20,899
2	Neart na Gaoithe	1,755	3,761	5,516
2	Triton Knoll	425	746	1,171
3	Dogger Bank Teesside A	3,283	2,268	5,551
3	Dogger Bank Teesside B	5,211	3,701	8,912
3	East Anglia ONE North	4,183	1,888	6,071
3	East Anglia THREE	1,744	2,859	4,603
3	East Anglia TWO	2,077	1,675	3,752

Tier	OWF	Estimated number of birds at risk of displacement		
		Breeding	Non-breeding	Year round
3	Hornsea Project Three	13,374	17,772	31,146
3	Inch Cape	4,371	3,177	7,548
3	Moray West	24,426	38,174	62,600
3	Norfolk Boreas	7,767	13,777	21,544
3	Norfolk Vanguard	4,320	4,776	9,096
	TOTAL: TIERS 1-3	**170,621**	**170,874**	**341,495**
4	Hornsea Project Four (PEIR)	15,245	69,555	84,800
	TOTAL: TIERS 1-3 plus Hornsea Project Four (PEIR)	**185,866**	**240,429**	**426,295**
4	DEP (ES Mean)	3,839	14,887	18,726
4	SEP (ES Mean)	1,085	1,095	2,180
	TOTAL: TIERS 1-3 plus Hornsea Project Four (PEIR), plus SEP and DEP (Mean)	**256,411**	**190,790**	**447,201**

11.2.4.3 Razorbill

Table 17: Cumulative number of razorbills at risk of operational phase OWF displacement

Tier	OWF	Estimated number of birds at risk of displacement				
		Breeding	Autumn migration	Winter	Spring migration	Year round
1	Beatrice	873	833	555	833	3,094
1	Beatrice Demonstrator	No estimate available				
1	Blyth Demonstration Project	121	91	61	91	364
1	Dudgeon	256	346	745	346	1,693
1	East Anglia ONE	16	26	155	336	533
1	European Offshore Wind Deployment Centre	161	64	7	26	258
1	Galloper	44	43	106	394	587
1	Greater Gabbard	0	0	387	84	471
1	Gunfleet Sands	0	0	30	0	30
1	Hornsea Project One	1,109	4,812	1,518	1,803	9,242
1	Humber Gateway	27	20	13	20	80
1	Hywind	30	719	10		759
1	Kentish Flats and Extension	No estimate available				
1	Kincardine	22				22
1	Lincs & LID	45	34	22	34	134
1	London Array	14	20	14	20	68
1	Methil	4	0	0	0	4
1	Moray Firth (EDA)	2,423	1,103	30	168	3,724
1	Race Bank	28	42	28	42	140
1	Rampion	630	66	1,244	3,327	5,267
1	Scroby Sands	No estimate available				
1	Sheringham Shoal	106	1,343	211	30	1,690
1	Teesside	16	61	2	20	99

Tier	OWF	Estimated number of birds at risk of displacement				
		Breeding	Autumn migration	Winter	Spring migration	Year round
1	Thanet	3	0	14	21	37
1	Westermost Rough	91	121	152	91	455
2	Dogger Bank Creyke Beck A	1,250	1,576	1,728	4,149	8,703
2	Dogger Bank Creyke Beck B	1,538	2,097	2,143	5,119	10,897
2	Firth of Forth Alpha	5,876	-	1,103	-	6,979
2	Firth of Forth Bravo	3,698	-	1,272	-	4,970
2	Hornsea Project Two	2,511	4,221	720	1,668	9,119
2	Neart na Gaoithe	331	5,492	508	-	6,331
2	Triton Knoll	40	254	855	117	1,265
3	Dogger Bank Teesside A	834	310	959	1,919	4,022
3	Dogger Bank Teesside B	1,153	592	1,426	2,953	6,125
3	East Anglia ONE North	403	85	54	207	749
3	East Anglia THREE	1,807	1122	1,499	1,524	5,952
3	East Anglia TWO	281	44	136	230	692
3	Hornsea Project Three	630	2,020	3,649	2,105	8,404
3	Inch Cape	1,436	2,870	651	-	4,957
3	Moray West	2,808	3,544	184	3,585	10,121
3	Norfolk Boreas	630	263	1,065	345	2,303
3	Norfolk Vanguard	879	866	839	924	3,508
	TOTAL: TIERS 1-3	**32,124**	**35,100**	**24,095**	**32,531**	**123,848**
4	Hornsea Project Four (PEIR)	580	5,960	685	1,361	8,586
	TOTAL: TIERS 1-3 plus Hornsea Project Four (PEIR)	**32,704**	**41,060**	**24,780**	**33,892**	**132,434**
4	DEP (ES Mean)	3,741	923	320	845	5,829
4	SEP (ES Mean)	759	316	144	686	1,905
-	**TOTAL: TIERS 1-4 plus Hornsea Project Four (PEIR), plus SEP and DEP (Mean)**	**37,204**	**42,299**	**25,244**	**35,423**	**140,170**

11.2.4.4 Red-throated Diver

11.2.4.4.1 Standard Assessment

Table 18: Cumulative number of red-throated divers at risk of operational phase OWF displacement (based on a 4km buffer), using quantitative data from other OWF assessments

Tier	OWF	Predicted mortality, assuming 90% to 100% displacement, 1% to 10% mortality)				Source
		Autumn migration	Winter	Spring migration	Annual	
1 and 2	All other projects in southern North Sea	N/A	N/A	N/A	6 - 56	Royal HaskoningDHV (2019)
1	East Anglia ONE	0.4 - 5	1 - 10	1.4 - 15	2.8 - 30	
3	East Anglia ONE North	0 - 1	1 - 7	3 - 34	4 - 42	
3	East Anglia THREE	0.4 - 5	0.2 – 2	2 - 20	2.6 - 27	
3	East Anglia TWO	0	0 - 2	2 - 25	3 - 28	
3	Norfolk Boreas	0 - 1	1 - 15	5 - 62	6 - 78	
3	Norfolk Vanguard	0.4 - 8	3.2 - 39	3 - 32	6.6 - 79	
4	Hornsea Project Four	0	0	0	0	APEM (2019)
4	DEP	1 - 6	0 - 1	1 - 5	1 - 13	**Chapter 11 Offshore Ornithology**
4	SEP	1 - 8	0 - 1	2 - 18	3 - 26	
	Total	**7 - 33**	**6 - 77**	**19 - 211**	**32 - 321**	

11.2.4.4.2 SeaMAST Data Assessment

Table 19: Cumulative number of red-throated divers at risk of displacement (based on a 4km buffer), according to Bradbury et al. (2014)

Tier	OWF	OWF		4km buffer		OWF and 4km buffer		Notes
		Abundance	% of reference population	Abundance	% of reference population	Abundance	% of reference population	
1	Aberdeen (EOWDC)	-	-	-	-	-	-	Scottish Territorial Waters - not included
1	Beatrice	-	-	-	-	-	-	Scottish Territorial Waters - not included
1	Beatrice Demonstrator	-	-	-	-	-	-	Scottish Territorial Waters - not included
1	Blyth Demonstration	0.044	0	0.534	0.003	0.577	0.003	Site consists of three polygons; 4km buffers amalgamated
1	Dudgeon							Beyond extent of viable SeaMAST data - not included
1	East Anglia ONE	5.752	0.029	16.118	0.081	21.87	0.109	4km buffer overlap with East Anglia ONE North; East Anglia ONE buffer prioritised
1	Greater Gabbard & Galloper	35.404	0.177	77.93	0.39	113.334	0.567	4km buffer overlap with East Anglia TWO; Greater Gabbard/Galloper prioritised
1	Gunfleet Sands	54.038	0.27	487.209	2.439	541.246	2.709	-
1	Hornsea Project One	-	-	-	-	-	-	Beyond extent of viable SeaMAST data - not included
1	Humber Gateway	0.079	0	0.744	0.004	0.823	0.004	-
1	Hywind	-	-	-	-	-	-	Scottish Territorial Waters - not included
1	Kentish Flats	48.552	0.243	343.744	1.721	392.296	1.964	-
1	Kincardine	-	-	-	-	-	-	Scottish Territorial Waters - not included

Tier	OWF	OWF		4km buffer		OWF and 4km buffer		Notes
		Abundance	% of reference population	Abundance	% of reference population	Abundance	% of reference population	
1	Lincs, Lynn and Inner Dowsing	3.075	0.015	18.419	0.092	21.495	0.108	-
1	London Array	337.438	1.689	1165.117	5.832	1502.555	7.521	-
1	Methil	-	-	-	-	-	-	Scottish Territorial Waters - not included
1	Moray Firth East	-	-	-	-	-	-	Scottish Territorial Waters - not included
1	Race Bank	0.672	0.003	2.7	0.014	3.372	0.017	Northeastern edge of buffer not covered by SeaMAST data
1	Scroby Sands	9.661	0.048	79.961	0.4	89.622	0.449	-
1	Sheringham Shoal	0.097	0	0.588	0.003	0.685	0.003	Northern section of OWF and buffer not covered by SeaMAST data
1	Teesside	0.046	0	0.816	0.004	0.863	0.004	-
1	Thanet	5.721	0.029	34.824	0.174	40.545	0.203	-
1	Westermost Rough	0.118	0.001	0.785	0.004	0.903	0.005	Northeastern edge of buffer not covered by SeaMAST data
2	Forth (Seagreen) Alpha and Bravo	-	-	-	-	-	-	Scottish Territorial Waters - not included
2	Hornsea Project Two	-	-	-	-	-	-	Beyond extent of viable SeaMAST data - not included
2	Neart na Gaoithe	-	-	-	-	-	-	Scottish Territorial Waters - not included
2	Triton Knoll	-	-	-	-	-	-	Beyond extent of viable SeaMAST data - not included

Tier	OWF	OWF		4km buffer		OWF and 4km buffer		Notes
		Abundance	% of reference population	Abundance	% of reference population	Abundance	% of reference population	
3	Dogger Bank C (formerly Teesside A) and Sofia (formerly Teesside B)	-	-	-	-	-	-	Beyond extent of viable SeaMAST data - not included
3	Dogger Bank Creyke Beck Projects A and B	-	-	-	-	-	-	Beyond extent of viable SeaMAST data - not included
3	East Anglia ONE North	96.598	0.484	210.292	1.053	306.89	1.536	4km buffer overlap with East Anglia ONE; East Anglia ONE buffer prioritised
3	East Anglia THREE	5.852	0.029	13.222	0.066	19.074	0.095	4km buffer overlap with Norfolk Vanguard East; East Anglia THREE buffer prioritised
3	East Anglia TWO	18.982	0.095	71.439	0.358	90.421	0.453	4km buffer overlap with Greater Gabbard/Galloper; Greater Gabbard/Galloper prioritised
3	Hornsea Project Three	-	-	-	-	-	-	Beyond extent of viable SeaMAST data - not included
3	Inch Cape	-	-	-	-	-	-	Scottish Territorial Waters - not included
3	Moray Firth West	-	-	-	-	-	-	Scottish Territorial Waters - not included
3	Norfolk Boreas	2.9	0.015	3.455	0.017	4.628	0.023	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	OWF		4km buffer		OWF and 4km buffer		Notes
		Abundance	% of reference population	Abundance	% of reference population	Abundance	% of reference population	
3	Norfolk Vanguard	9.388	0.047	13.514	0.068	24.63	0.124	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)
4	Hornsea Project Four	-	-	-	-	-	-	Beyond extent of viable SeaMAST data - not included
4	DEP	-	-	-	-	-	-	Beyond extent of viable SeaMAST data - not included
4	SEP	0.033	0.000	0.576	0.003	0.610	0.003	OWF and 4km overlap with Sheringham Shoal OWF. Sheringham Shoal prioritised.
	TOTALS	**634**	**3.2**	**2,542**	**12.7**	**3,176**	**15.9**	

11.2.4.5 Sandwich Tern

Table 20: Potential displacement (down) and mortality (across) for Sandwich tern at DOW during the breeding season (April to August) and year round (since no birds were observed outside this season), showing the number of birds predicted to die (rounded to the nearest integer) at a given rate of displacement and mortality. Mortality rates used by the assessment are highlighted in red.

	1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
10%	0	0	0	0	0	1	1	2	3	5	6
20%	0	0	0	0	1	1	2	3	6	9	12
30%	0	0	1	1	1	2	3	5	9	14	17
40%	0	0	1	1	1	2	5	7	12	18	23
50%	0	1	1	1	1	3	6	9	14	23	29
60%	0	1	1	1	2	3	7	10	17	28	35
70%	0	1	1	2	2	4	8	12	20	32	40
80%	0	1	1	2	2	5	9	14	23	37	46
90%	1	1	2	2	3	5	10	16	26	42	52
100%	1	1	2	2	3	6	12	17	29	46	58

Table 21: Potential displacement (down) and mortality (across) for Sandwich tern at Race Bank OWF during the breeding season (April to August), showing the number of birds predicted to die (rounded to the nearest integer) at a given rate of displacement and mortality. Mortality rates used by the assessment are highlighted in red.

	1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
10%	0	0	0	1	1	1	3	4	6	10	13
20%	0	1	1	1	1	3	5	8	13	21	26
30%	0	1	1	2	2	4	8	12	19	31	39
40%	1	1	2	2	3	5	10	16	26	42	52
50%	1	1	2	3	3	6	13	19	32	52	65
60%	1	2	2	3	4	8	16	23	39	62	78
70%	1	2	3	4	5	9	18	27	45	73	91
80%	1	2	3	4	5	10	21	31	52	83	104
90%	1	2	4	5	6	12	23	35	58	93	117
100%	1	3	4	5	6	13	26	39	65	104	130

Table 22: Potential displacement (down) and mortality (across) for Sandwich tern at Race Bank OWF during the autumn migration season (September), showing the number of birds predicted to die (rounded to the nearest integer) at a given rate of displacement and mortality. Mortality rates used by the assessment are highlighted in red.

	1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
10%	0	0	0	0	0	0	0	0	0	0	0
20%	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0
40%	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	1
60%	0	0	0	0	0	0	0	0	0	1	1
70%	0	0	0	0	0	0	0	0	0	1	1
80%	0	0	0	0	0	0	0	0	0	1	1
90%	0	0	0	0	0	0	0	0	1	1	1
100%	0	0	0	0	0	0	0	0	1	1	1

Table 23: Potential displacement (down) and mortality (across) for Sandwich tern at Race Bank OWF during the spring migration season (March), showing the number of birds predicted to die (rounded to the nearest integer) at a given rate of displacement and mortality. Mortality rates used by the assessment are highlighted in red.

	1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
10%	0	0	0	0	0	0	0	0	0	0	0
20%	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0
40%	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	1
60%	0	0	0	0	0	0	0	0	0	1	1
70%	0	0	0	0	0	0	0	0	0	1	1
80%	0	0	0	0	0	0	0	0	0	1	1
90%	0	0	0	0	0	0	0	0	1	1	1
100%	0	0	0	0	0	0	0	0	1	1	1

Table 24: Potential displacement (down) and mortality (across) for Sandwich tern at Race Bank OWF year round, showing the number of birds predicted to die (rounded to the nearest integer) at a given rate of displacement and mortality. Mortality rates used by the assessment are highlighted in red.

	1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
10%	0	0	0	1	1	1	3	4	7	11	13
20%	0	1	1	1	1	3	5	8	13	21	27
30%	0	1	1	2	2	4	8	12	20	32	40
40%	1	1	2	2	3	5	11	16	27	42	53
50%	1	1	2	3	3	7	13	20	33	53	66
60%	1	2	2	3	4	8	16	24	40	64	80
70%	1	2	3	4	5	9	19	28	46	74	93
80%	1	2	3	4	5	11	21	32	53	85	106
90%	1	2	4	5	6	12	24	36	60	96	119
100%	1	3	4	5	7	13	27	40	66	106	133

Table 25: Potential displacement (down) and mortality (across) for Sandwich tern at SOW during the breeding season (April to August), showing the number of birds predicted to die (rounded to the nearest integer) at a given rate of displacement and mortality. Mortality rates used by the assessment are highlighted in red.

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

Table 26: Potential displacement (down) and mortality (across) for Sandwich tern at SOW during the autumn migration season (September), showing the number of birds predicted to die (rounded to the nearest integer) at a given rate of displacement and mortality. Mortality rates used by the assessment are highlighted in red.

	1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
10%	0	0	0	0	0	0	0	0	0	0	0
20%	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0
40%	0	0	0	0	0	0	0	0	0	0	1
50%	0	0	0	0	0	0	0	0	0	1	1
60%	0	0	0	0	0	0	0	0	0	1	1
70%	0	0	0	0	0	0	0	0	0	1	1
80%	0	0	0	0	0	0	0	0	1	1	1
90%	0	0	0	0	0	0	0	0	1	1	1
100%	0	0	0	0	0	0	0	0	1	1	1

Table 27: Potential displacement (down) and mortality (across) for Sandwich tern at SOW year round, showing the number of birds predicted to die (rounded to the nearest integer) at a given rate of displacement and mortality. Mortality rates used by the assessment are highlighted in red.

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

Table 28: Potential displacement (down) and mortality (across) for Sandwich tern at Triton Knoll OWF during the breeding season (April to August) and year round (since no birds were observed outside this season), showing the number of birds predicted to die (rounded to the nearest integer) at a given rate of displacement and mortality. Mortality rates used by the assessment are highlighted in red.

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

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