RWE Renewables UK Dogger Bank South (West) Limited

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Dogger Bank South Offshore Wind Farms

Environmental Statement

Volume 7

Chapter 12 – Offshore Ornithology (Revision 4) (Tracked)

June 2025

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Company:	**RWE Renewables UK Dogger Bank South (West) Limited and RWE Renewables UK Dogger Bank South (East) Limited**	Asset:	**Development**
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01	June 2024	Final for DCO Application	MacArthur Green	RWE	RWE
02	November 2024	Revision for Updated NE Guidance and Relevant Representations	MacArthur Green	RWE	RWE
03	April 2025	Submission at Deadline 4	MacArthur Green	RWE	RWE
04	June 2025	Submission at Deadline 6	RHDHV	RWE	RWE

Unrestricted

Revision Change Log			
Rev No.	**Page**	**Section**	**Description**
01	N/A	N/A	Submitted for DCO Application
02	23	12.2.1	Section added describing post-submission consultation and how Relevant Representations have informed revisions to the chapter.
02	58	12.4.3.2	Clarification added regarding sums of DBS East and DBS West in isolation numbers not being equal to the Projects together values.
02	61	12.5.2	Additional section 'Baseline Environment and Representativeness of Survey Data' added in response to Natural England's Relevant Representation [RR-039].
02	72	12.5.3	Table 12-15 updated with chick rearing and moult periods for guillemot as advised by Natural England [RR-039].
02	75	12.5.3	Table 12-17 added detailing the average Mortality Across All Age Classes as advised by Natural England.
02	77	12.5.3	Table 12-18 updated with postbreeding peak abundance estimates for guillemot.
02	83-187	12.7	Potential effects during construction section updated to reflect latest Natural England guidance and Relevant Representations.
02	187 - 290	12.8	Potential effects during operation section updated to reflect latest Natural England guidance and Relevant Representations.
02	293 – 337	12.10	Cumulative Effects Assessment updated to reflect latest Natural England guidance and Relevant Representations.
02	298 - 299	12.10.3	Section 12.10.3, Impact 9 Cumulative Assessment of Construction Effects on Red-throated Diver added.
02	344 - 345	12.15	Table 12-106 added comparing annual displacement mortalities and increase in background mortality stated in the original ES compared and this revision.
02	345 - 347	12.15	Table 12-107 added comparing annual upper 95% confidence interval collision mortalities and increase in background mortality stated in the original ES and this revision.

Revision Change Log			
03	30-51	Table 12.1	Rows added to consultation table summarising further revisions following submissions from Natural England (AS-159).
03	79	Table 12-14	Updates to BoCC classifications in response to OR1.41 of EXQ1.
03	277-344	12.10	Cumulative tables checked and updated as necessary.
03	277-344	12.10	Additional PVA scenarios and results added as appropriate.
04	N/A	N/A	Chapter 12 Offshore Ornithology updated at the request of the Examining Authority within the Rule 17 [PD-018] to accurately reflect the proposed development and contains all the updated information within the chapter as a result of Project Change Request 1 - Offshore & Intertidal Works [AS-141] and commitment to bundling of offshore export cables in pairs.
04	N/A	N/A	Updates to reflect responses received from stakeholders and the Examining Authority during Examination up to Deadline 6.
04	N/A	N/A	Population Viability Numbers amended throughout chapter following NE comments at Deadline 5 [REP5-058].

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Glossary

Term	Definition
Array Areas	The DBS East and DBS West offshore Array Areas, where the wind turbines, offshore platforms and array cables will be located. The Array Areas do not include the Offshore Export Cable Corridor or the Inter-Platform Cable Corridor within which no wind turbines are proposed. Each area is referred to separately as an Array Area.
Array cables	Offshore cables which link the wind turbines to the Offshore Converter Platform(s).
Collision	The act or process of colliding (crashing) between two moving objects.
Collision Risk Model (CRM)	Quantitative means to estimate the number of predicted collisions between seabirds recorded in the Array Areas and rotating wind turbines.
Concurrent Scenario	A potential construction scenario for the Projects where DBS East and DBS West are both constructed at the same time.
Cumulative effects	The combined effect of the Projects in combination with the effects of a number of different (defined cumulative) schemes, on the same single receptor / resource.
Cumulative Effects Assessment (CEA)	The assessment of the combined effect of the Projects in combination with the effects of a number of different (defined cumulative) schemes, on the same single receptor/resource.
Cumulative impact	The combined impact of the Projects in combination with the effects of a number of different (defined cumulative) schemes, on the same single receptor / resource.
Development Consent Order (DCO)	An order made under the Planning Act 2008 granting development consent for one or more Nationally Significant Infrastructure Project (NSIP).
Development Scenario	Description of how the DBS East and/or DBS West Projects would be constructed either in-isolation, sequentially or concurrently.

Term	Definition
Dogger Bank South (DBS) Offshore Wind Farms	The collective name for the two Projects, DBS East and DBS West.
Effect	Term used to express the consequence of an impact. The significance of an effect is determined by correlating the magnitude of the impact with the value, or sensitivity, of the receptor or resource in accordance with defined significance criteria.
Environmental Impact Assessment (EIA)	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the EIA Directive and EIA Regulations, including the publication of an Environmental Statement (ES).
Evidence Plan Process (EPP)	A voluntary consultation process with specialist stakeholders to agree the approach, and information to support, the Environmental Impact Assessment (EIA) and Habitats Regulations Assessment (HRA) for certain topics.
Expert Topic Group (ETG)	A forum for targeted engagement with regulators and interested stakeholders through the EPP.
Habitats Regulations Assessment (HRA)	The process that determines whether or not a plan or project many have an adverse effect on the integrity of a European Site or European Offshore Marine Site.
Impact	Used to describe a change resulting from an activity via the Projects, i.e. increased suspended sediments / increased noise.
In Isolation Scenario	A potential construction scenario for one Project which includes either the DBS East or DBS West array, associated offshore and onshore cabling and only the eastern Onshore Converter Station within the Onshore Substation Zone and only the northern route of the onward cable route to the proposed Birkhill Wood National Grid Substation.
Inter-Platform Cable Corridor	The area where Inter-Platform Cables would route between platforms within the DBS East and DBS West Array Areas, should both Projects be constructed.

Term	Definition
Mean Sea Level	The average level of the sea surface over a defined period (usually a year or longer), taking account of all tidal effects and surge events.
Offshore Development Area	The Offshore Development Area for ES encompasses both the DBS East and West Array Areas, the Inter-Platform Cable Corridor, the Offshore Export Cable Corridor, plus the associated Construction Buffer Zones.
Offshore Export Cable Corridor	This is the area which will contain the Offshore Export Cables between the offshore substation / converter platforms and Transition Joint Bays at the landfall.
Offshore Export Cables	The cables which would bring electricity from the offshore platforms to the Transition Joint Bays (TJBs).
Offshore Ornithology Study Area	Area considered for seabird species with potential connectivity to the Project areas and hence subject to assessment. Comprises the North Sea and breeding colonies located along the British coastline of the North Sea.
Offshore Ornithology Survey Area	The Offshore Ornithology Survey Area comprises the Array Areas plus a 4km buffer.
Projects Design (or Rochdale) Envelope	A concept that ensures the EIA is based on assessing the realistic worst case scenario where flexibility or a range of options is sought as part of the consent application.
Scoping opinion	The report adopted by the Planning Inspectorate on behalf of the Secretary of State.
Scoping report	The report that was produced in order to request a Scoping Opinion from the Secretary of State.
Sequential Scenario	A potential construction scenario for the Projects where DBS East and DBS West are constructed with a lag between the commencement of construction activities. Either Project could be built first.

Term	Definition
The Applicants	The Applicants for the Projects are RWE Renewables UK Dogger Bank South (East) Limited and RWE Renewables UK Dogger Bank South (West) Limited. The Applicants are themselves jointly owned by the RWE Group of companies (51% stake) and Masdar (49% stake).
The Projects	DBS East and DBS West (collectively referred to as the Dogger Bank South Offshore Wind Farms).

Acronyms

Term	Definition
BDMPS	Biologically Defined Minimum Population Scale
BoCC	Birds of Conservation Concern
BTO	British Trust for Ornithology
CEA	Cumulative Effects Assessment
CGR	Counterfactuals of Growth Rate
CPS	Counterfactuals of Population Size
CRM	Collision Risk Model
DAS	Digital Aerial Survey
DBS	Dogger Bank South
DCO	Development Consent Order
DML	Deemed Marine Licence
EIA	Environmental Impact Assessment
EMF	Electro-Magnetic Fields
EPP	Evidence Plan Process
ES	Environmental Statement
ESAS	European Seabirds at Sea
ETG	Expert Topic Group
~~ESP~~	~~Electrical Switching Platform~~
FFC	Flamborough and Filey Coast
HAT	Highest Astronomical Tide

Term	Definition
HPAI	Highly Pathogenic Avian Influenza
HRA	Habitats Regulations Assessment
IPMP	In-Principal Monitoring Plan
JNCC	Joint Nature Conservation Committee
MSL	Mean Sea Level
NPS	National Policy Statements
PEIR	Preliminary Environmental Information Report
PEMP	Pollution Environmental Management Plan
PVA	Population Viability Analyses
RIAA	Report to Inform Appropriate Assessment
RSPB	Royal Society for the Protection of Birds
SEP & DEP	Sheringham & Dudgeon Extensions Projects
SPA	Special Protection Area

12 Offshore Ornithology

12.1 Introduction

1. This chapter of the Environmental Statement (ES) considers the likely significant effects of the Projects on offshore ornithology. The chapter provides an overview of the existing environment for the proposed Offshore Development Area, followed by an assessment of likely significant effects for the construction, operation, and decommissioning phases of the Projects.

~~1.~~2. As detailed in **Chapter 1 Introduction (application ref: 7.1)**, Chapter 12 has been updated to incorporate the changes to the Projects Design Parameters resulting from the **Project Change Request 1 – Offshore and Intertidal Works** [AS-141], commitment to the bundling of Offshore Export Cables, and the incorporation of any associated responses and corrections provided on Offshore Ornithology throughout the Examination process.

~~2.~~3. Additional information to support the offshore ornithology assessment is included in:

- **Volume 7, Appendix 12-1 Offshore Ornithology Consultation Responses (application ref: 7.12.12.1)**;
- **Volume 7, Appendix 12-2 Technical Appendix (application ref: 7.12.12.2)**;
- **Volume 7, Appendix 12-3a Monthly Abundance (All) (application ref: 7.12.12.3)**;
- **Volume 7, Appendix 12-3b Monthly Abundance (Sitting) (application ref: 7.12.12.3)**;
- **Volume 7, Appendix 12-3c Monthly Abundance (Flying) (application ref: 7.12.12.3)**;
- **Volume 7, Appendix 12-4a Monthly Densities (All) (application ref: 7.12.12.4)**;
- **Volume 7, Appendix 12-b4 Monthly Densities (Sitting) (application ref: 7.12.12.4)**;
- **Volume 7, Appendix 12-4c Monthly Densities (Flying) (application ref: 7.12.12.4)**;
- **Volume 7, Appendix 12-5a Seasonal Peak Abundance (All) (application ref: 7.12.12.5)**;
- **Volume 7, Appendix 12-5b Seasonal Peak Abundance (Sitting) (application ref: 7.12.12.5)**;

- **Volume 7, Appendix 12-5c Seasonal Peak Abundance (Flying) (application ref: 7.12.12.5)**;
- **Volume 7, Appendix 12-6a Seasonal Peak Density (All) (application ref: 7.12.12.6)**;
- **Volume 7, Appendix 12-6b Seasonal Peak Density (Sitting) (application ref: 7.12.12.6)**;
- **Volume 7, Appendix 12-6c Seasonal Peak Density (Flying) (application ref: 7.12.12.6)**;
- **Volume 7, Appendix 12-7a Survey Abundances (All) (application ref: 7.12.12.7)**;
- **Volume 7, Appendix 12-7b Survey Abundances (Sitting) (application ref: 7.12.12.7)**;
- **Volume 7, Appendix 12-7c Survey Abundances (Flying) (application ref: 7.12.12.7)**;
- **Volume 7, Appendix 12-8a Survey Densities (All) (application ref: 7.12.12.8)**;
- **Volume 7, Appendix 12-8b Survey Densities (Sitting) (application ref: 7.12.12.8)**;
- **Volume 7, Appendix 12-8c Survey Densities (Flying) (application ref: 7.12.12.8)**;
- **Volume 7, Appendix 12-9 Collision Risk Modelling Inputs and Outputs (application ref: 7.12.12.9)**;
- **Volume 7, Appendix 12-10 Seabird Distribution Figures (application ref: 7.12.12.10)**;
- **Volume 7, Appendix 12-11 Review of Turbines Lighting - Furness 2018 (application ref: 7.12.12.11)**;
- **Volume 7, Appendix 12-12 Seasonal Displacement Matrices Upper Lower C.I. Abundance (application ref: 7.12.12.12)**; and
- **Volume 7, Appendix 12-13 Population Viability Analyses (application ref: 7.12.12.13)**.

12.2 Consultation

~~3.~~4. Consultation with regard to offshore ornithology has been undertaken in line with the general process described in **Volume 7, Chapter 7 Consultation (application ref: 7.7)** and the **Volume 5, Consultation Report (application ref: 5.1)**. The key elements to date include EIA Scoping, formal consultation on the Preliminary Environmental Information Report (PEIR) under section 42 of the Planning Act 2008 and the ongoing Evidence Plan Process (EPP) via the Offshore Ornithology Expert Topic Group (ETG).

~~4.~~5. The feedback received throughout this process has been considered in preparing the ES. This chapter has been updated following consultation in order to produce the final assessment submitted within the Development Consent Order (DCO) application. **Volume 7, Appendix 12-1 Offshore Ornithology Consultation Responses (application ref: 7.12.12.1)** provides a summary of the consultation responses received to date relevant to this topic, and details how the comments have been addressed within this chapter.

12.2.1 Post-Submission Consultation

~~5.~~6. This document provides an updated assessment for offshore ornithology to address requests made in **Natural England's Relevant Representation** [RR-039] and **Appendix G2 - Natural England's Advice on Offshore Ornithology Deadline 2** [AS-159]. These updates also address RSPB **Relevant Representation** [RR-049] where applicable.

~~6.~~7. A comprehensive response to each of Natural England's comments was provided on 29th October 2024 [PDB-006]. Responses to **Appendix G2 - Natural England's Advice on Offshore Ornithology Deadline 2** [AS-159] were provided in **The Applicants' Reponses to Deadline 2 Documents** [REP3-028] at Deadline 3. Comments which also required revision to the assessment are provided in **Table 12-1** and are addressed in this document, with the relevant section of the document identified. Note that only those comments relevant to this assessment are reproduced in **Table 12-1** and addressed in the document. Comments of relevance to the Report to Inform Appropriate Assessment (RIAA)) are provided in an update to the **RIAA Habitats Regulations Assessment (HRA) Part 3 of 4** [document reference: 6.1].

Table 12-1 Natural England Relevant Representation comments of relevance to the EIA and the Applicants' response

NE Ref. No.	NE Comment	Applicants' Response	Section
G1	Deviation from Natural England/SNCB advice Natural England cannot agree with the EIA or HRA conclusions presented due to several aspects of the assessment not being provided in line with SNCB advice given during the EPP and/or our Best Practice Advice	An updated assessment has been provided in this document where appropriate. This has been provided in order to reduce the risk of delays, but critically the changes requested by Natural England do not substantively alter the conclusions of the original application (and in the majority of cases do not materially change those conclusions at all).	N/A – throughout
G2	Methods used to combine impacts of the two arrays. Natural England do not agree that the approach taken by the Applicant to calculate the combined impacts of the Dogger Bank South (DBS) East and West arrays is appropriate or accurately reflects the worst-case scenario.	An update to the East plus West combined assessment is provided in this document, with the combined values derived as Natural England request, rather than as provided in the original submission. However, the Applicants consider the analysis originally presented was robust and that the update has made no material difference to the assessment conclusions.	12.7.1 12.8.1

NE Ref. No.	NE Comment	Applicants' Response	Section
G3	Calculation of impacts on guillemot and razorbill at FFC SPA Natural England do not agree with the approach taken by the Applicant in assessing and apportioning impacts on guillemot and razorbill to Flamborough and Filey Coast Special Protection Area (FFC SPA). Whilst we welcome that the Applicant has considered the need for a bespoke approach to apportioning guillemot in August and September, we consider that the inclusion of these months within an extended breeding season under-represents the impacts. For razorbill, we consider that the use of the Biologically Defined Minimum Population Scale (BDMPS) method for apportioning impacts during the post-breeding migration season also under-represents the impacts.	The Applicants have provided a revised assessment incorporating this new guidance from Natural England.	Assessment with respect to FFC SPA is provided in the updated **RIAA HRA Part 3 of 4** [document reference: 6.1]. In this document, sections 12.7.1 and 12.8.1 provide updated auk assessment for the wider population.
G5	Impacts from several developments that have recently submitted applications or are material considerations in the planning process, have	An updated in-combination assessment is provided in section 12.10, which includes projects for which assessment totals are now available. This includes Outer Dowsing, Five	12.10

NE Ref. No.	NE Comment	Applicants' Response	Section
	been excluded from the in-combination assessments, including: •Outer Dowsing •Five Estuaries •North Falls •Dogger Bank D Whilst we acknowledge that the final submissions of these Projects were likely too close to the DBS submission to allow for full inclusion, information will have been in the public domain from the Preliminary Environmental Information Reports to allow them to be a material consideration. The Applicant has also not included the impacts of projects where compensation has been agreed. Natural England agree that this may be appropriate for impacts on kittiwake, however we advise that impacts from Hornsea Project Four on guillemot should be included due to the current uncertainty regarding the effectiveness of compensation measures for auks.	Estuaries and North Falls as these have submitted their final applications (although it is important to note that some of their estimated impacts are subject to requests for revision by Natural England so these totals are expected to be preliminary until final agreements have been reached between each project and Natural England). Dogger Bank D has not submitted a PEIR at this stage and it is considered unlikely that this will occur within the timescale of the DBS examination. In the updates provided, the Applicants have included impact estimates for projects that have agreed compensation, although the Applicants consider that it is more appropriate to apply a consistent approach for impacts that have agreed compensation (i.e. guillemot compensation should be treated the same as kittiwake compensation in terms of in-combination assessment). The inclusion of these additional projects to the in-combination assessments are not expected to make any material or substantive	

NE Ref. No.	NE Comment	Applicants' Response	Section
		differences to the conclusions presented in the original application.	
G10	The minimum lower blade tip clearance has been provided as 34m to Mean Sea Level (MSL) rather than Highest Astronomical Tide (HAT). We acknowledge the Applicant's reasons for using MSL but consider that HAT provides the true minimum clearance and is also consistent with the parameters presented across other projects.	Mean Sea Level (MSL) has been used as a datum in the ES for the purpose of considering the minimum lower blade tip clearance. The reason for stating blade tip heights with respect to MSL in the Offshore Ornithology assessment is that this is the sea-level datum used for seabird flight heights in the collision risk model. The lower blade clearance relative to HAT is 32.2m (the mean difference between MSL and HAT is 1.8m). The Applicants note that a variety of different datums have been used across recent offshore wind DCOs and the Applicants are not aware of any reason to favour one approach over another and therefore have retained MSL.	N/A
G11 & G15	Natural England does not support the approach taken by the Applicant to combine the impacts of the two arrays for several aspects of the project	While Natural England is correct that the combined totals for the wind farm plus buffers do not always match the sum of the	12.7.1 12.8.1

NE Ref. No.	NE Comment	Applicants' Response	Section
	assessment (e.g. abundance estimates and displacement) as it underrepresents the impacts and does not reflect the worst case scenario. We note that the Applicant has acknowledged that the arrays should be considered as NSIPs in their own right and assessed separately, and that if separate applications were to be submitted their impacts would be calculated separately and summed. However, the Applicant has not followed this approach in their assessment.	individual Array Areas (East and West), this is due to the methods used at PEIR. To estimate the baseline abundances for PEIR, at which time the East and West Array Areas shared a common border, it was necessary to perform calculations on the East plus West datasets combined since summing the buffer areas would result in double-counting of birds recorded in the buffer zones. Although following PEIR the Array Area boundaries were revised such that the 4km buffers no longer overlapped, the approach to abundance calculation was retained for the DCO submission, and this is why there can be differences between the sum of East and West Array Areas and the combined abundances. While the mean estimates can be summed to obtain the combined total as Natural England advise (an updated assessment using this approach is provided in this document), it remains the case that this approach cannot be taken for the measures of uncertainty (SD and confidence intervals)	

NE Ref. No.	NE Comment	Applicants' Response	Section
		as those can only be robustly obtained from a combined bootstrap analysis (i.e. it is not appropriate to sum SDs).	
G13	Representativeness of baseline data Natural England note that there is considerable variation in the abundance and density estimates between survey years for several species, however no assessment of between-year variation has been undertaken and no additional datasets have been considered when characterising the baseline. This is particularly important given that the baseline survey period includes months before and during the recent highly pathogenic avian influenza (HPAI) outbreaks. To aid understanding of any influence of HPAI on the baseline, NE provided the Applicant with our Advice note "Highly Pathogenic Avian Influenza (HPAI) outbreak in seabirds and Natural England advice on impact assessment (specifically relating to offshore wind)"(September 2022) during the	A discussion of these aspects is provided as context for the survey results in this document. In summary, having compared the DBS survey results with those for nearby wind farms it is apparent that there is a very wide range of inter-annual variation across all wind farm sites, and this is a widespread phenomenon in sea bird survey data (Trinder *et al.* 2024). This means there is very little probability of detecting differences due to HPAI, and indeed for some species the numbers on the DBS Array Areas were higher in the second year (i.e. following the occurrence of HPAI in the region) than in the first year. The Applicants therefore consider the baseline site characterisation data to be representative of the seabird presence at the	12.5

NE Ref. No.	NE Comment	Applicants' Response	Section
	Evidence Plan Process and advised that relevant datasets from other developments in the area (e.g. the other Dogger Bank offshore wind farms) or modelled datasets (e.g. MERP (Waggitt *et al.* 20203) or SeaMaST) should be considered when characterising the project baseline. We note that Outer Dowsing OWF recently submitted an application covering a similar baseline period, and in line with NE advice provided an assessment of between-year variation and consideration of baseline data from nearby OWF projects, to assess the representativeness of their baseline data.	Array Areas and provided a robust basis for impact assessment.	
G14	In Chapter 7.12 the Applicant states that "the results of the current seabird census (Seabirds Count) will provide important information" on seabird population trends. However, the results of the most recent seabird census were published in October 2023 (Burnell *et al.* 2023) and have not been used in this assessment when	Discussion of seabird trends has been provided in this document. While there has been concern regarding the potential impacts of HPAI on seabird breeding colonies in recent years, with a few notable exceptions (e.g. great skua on Foula), most seabird populations have been relatively unaffected. Furthermore, there is no	12.5

NE Ref. No.	NE Comment	Applicants' Response	Section
	considering seabird population trends, particularly when interpreting the results of PVAs. We also note that an assessment of the impacts of the recent HPAI outbreaks on seabird populations since the Seabirds Count surveys is now available (Tremlett et al, 2024). We advise that this is a useful reference when considering seabird population trends, which has not been referred to in this assessment.	indication of any HPAI effects in the baseline surveys of the Array Areas, and most SPA populations have either shown no reductions or have already recovered.	
G16	Seasonal peak abundances for the arrays combined The Applicant states in 7.12: "the combined seasonal peak abundance across the DBS East and DBS West sites used for assessment will be lower than the individual site peaks when the peaks on the latter occurred in different months. For example, if the breeding season peak on DBS East was recorded in March and the peak on DBS West in May, the combined peak will not be obtained as the sum of those values (March plus	The Applicants disagree with Natural England on this aspect because the East and West Array Areas were surveyed on the same day on each occasion so it would be inappropriate to sum abundances from different months as Natural England has proposed, as this would introduce a very high probability of double counting across the two Array Areas.	N/A

NE Ref. No.	NE Comment	Applicants' Response	Section
	May), but instead is the highest of the DBS East plus DBS West values in each month". Natural England do not support this approach as it under-represents the impacts of the arrays combined. For example, when following the SNCB approach the sum of the seasonal peak abundances for guillemot in the breeding season for DBS E and DBS W would be 17,813.99, however the seasonal peak abundance presented by the Applicant is 14,927.69 (Table 57, Appendix 7.12.12.5). This will cause the impacts calculated in the displacement assessment to also be underestimated (see G21).		
G18	Decommissioning displacement The Applicant has not included an assessment of displacement impacts for the decommissioning phase. We note that we previously advised the Applicant that this should be included (advice dated 27th February 2024) and that the PINS EIA Scoping response also stated that	Section 12.9 provides the decommissioning assessment which is reasonably assumed to be equivalent to construction effects.	12.9

NE Ref. No.	NE Comment	Applicants' Response	Section
	decommissioning impacts should not be scoped out of the assessment.		
G19	The Applicant has not used Natural England's advised baseline mortality rates or EIA reference populations for several species. We note that these were provided to the Applicant with our post-PEIR advice note "NE and NRW interim advice regarding demographic rates, EIA scale mortality rates and reference populations for use in offshore wind impact assessments (dated 8th March 2024, sent to applicant 13th March 2024)". The use of non-NE-recommended EIA baseline mortality rates and reference populations has resulted in estimates of annual background mortality that differ from those calculated using the Natural England-recommended values for the affected species.	This updated information was received too late to be applied to the assessment for DCO Application submission, but has been used in this update to the assessment as appropriate.	Throughout
G21	Displacement impacts of arrays combined	The Applicants acknowledge that some of the table headings in the appendices incorrectly stated there was an overlap of buffers. This	12.7.1 12.8.1

NE Ref. No.	NE Comment	Applicants' Response	Section
	Natural England note that the displacement assessment impacts for the arrays combined presented by the Applicant do not reflect the sum of the displacement impacts of the arrays summed, due to the method used to calculate seasonal peak abundance for the arrays combined. See G16. Further, the titles of Tables 12.16-12.19, 12.33, 12.43, 12.59 and 12.69 state "that the Project Total is Less Than the Sum of East and West due to Overlap of the Individual 2km Buffers." However, the figures provided in the application show that the 2km buffers do not overlap. We consider that these titles misrepresent the data and the project impacts, as the reason for the project total impacts being lower than the summed impacts is due to the method used to calculate seasonal peak abundances.	was accidently retained from the PEIR submission when the Array Areas were adjacent to one another and hence the buffers did overlap. However, the Applicants disagree that the displacement assessment for the combined DBS East plus DBS West is underestimated, for the reasons set out in response to comment G11 and G15. Nonetheless, an updated assessment has been provided for the DBS East and DBS West summed totals.	
G23	Construction displacement The Applicant has not followed the SNCB Best Practice Guidance for calculating construction	The Applicants dispute this statement since construction effects have been assessed as Natural England advised. An example of the	12.7.1

NE Ref. No.	NE Comment	Applicants' Response	Section
	displacement impacts, which is to halve the operational impacts.	headings for this part of the assessment include: 12.7.1.1.1 Gannet 12.7.1.1.1.1 Significance of effect - DBS East in isolation 12.7.1.1.1.1.1 Breeding season - construction vessels 12.7.1.1.1.1.2 Breeding season - 50% installed turbines 12.7.1.1.1.1.3 Breeding season - construction vessels and 50% installed turbines. The same structure was repeated for all the sites and all the species assessed. It is therefore unclear how Natural England has concluded that the assessment has not followed the SNCB Best practice guidance in considering displacement from half the wind farm and also from construction vessels.	

NE Ref. No.	NE Comment	Applicants' Response	Section
G24	Calculation of seasonal mean peak abundances for guillemot Natural England do not agree with the approach taken for seasonality when assessing impacts on guillemot. The Applicant has only used two seasons (breeding and non-breeding) for guillemot. Natural England advise that August and September should be treated as a separate 'chick rearing and moult' season, with seasonal mean peaks and impacts calculated accordingly. Our detailed advice on the assessment of impacts for guillemot is provided in Annex G1.	The Applicants have used this revised guidance from Natural England to update the assessment as requested.	12.7.1.1.3 12.8.1.1.3
G26	Gannet collision The Applicant has not followed the SNCB advised approach for assessing gannet collision risk. The Applicant has calculated their own, single avoidance rate for Gannet of 99.79%, incorporating Natural England's advised avoidance rate of 99.3% and a macro-avoidance rate of 70%.	While the Applicants consider that they have followed the advice provided by Natural England, since it is a simple matter to calculate collisions for alternative avoidance rates (just multiply the collisions by the old avoidance rate divided by the new avoidance rate) these have been provided. For information the combined avoidance rate (including meso and micro avoidance at	12.8.3.1

NE Ref. No.	NE Comment	Applicants' Response	Section
	Natural England's advice on the application of macro-avoidance rates for gannet collision risk modelling (CRM) remains as per our interim advice note on CRM parameters (July 2022), provided to the Applicant during the EPP. This advises that a range of macro-avoidance rates between 65% and 85%, or a single rate of 70% be applied for gannet, with an avoidance rate of 99.3%. Given the remaining uncertainties around potential sources of variation in macro avoidance and uncertainties over the long-term impacts of HPAI on gannet populations, Natural England believe that this range-based approach is most appropriate.	99.3%) at 65% macro avoidance is 99.755% and for 85% avoidance is 99.895%. These will respectively increase collisions by 16% (x1.16) and decrease them by 50% (x0.5).	
G27	Lack of cumulative assessment for impacts on Red-threated Diver Natural England note that the Applicant has screened out construction impacts of "Direct Disturbance and Displacement" for Red throated diver from the cumulative effects assessment, due to "very low likelihood of temporal and spatial coincidence of disturbance/displacement	Additional assessment of red-throated diver effects due to vessel movements resulting from the Projects cumulatively with other projects has been included in this update.	12.10.3

NE Ref. No.	NE Comment	Applicants' Response	Section
	from other schemes in the area acting on the same populations". Natural England is becoming increasingly concerned in relation to disturbance and/or displacement of red-throated divers from the more persistent presence of OWF-related vessels. In this context, we feel that it is inappropriate to screen out cumulative assessment of these impacts on Red-throated Diver.		
G28	Given the scale of the predicted impacts of the projects on seabird features, further consideration should be given to potential mitigation measures to reduce impacts, such as array reductions, changes to the design and/or layout of arrays or increasing the hub height of turbines. Hotspot modelling of seabird densities and distributions in the study area may help to identify areas where impacts are particularly high, and that might be suitable for changes to array size or layout to mitigate impacts. We	Mitigation relating to air gaps has been applied in accordance with the Round 4 plan level Habitats Regulation Assessment (The Crown Estate, 2022) whereby, to reduce potential collisions with birds in flight (particularly kittiwakes), the clearance of the blades above the water was set at a minimum 34m above MSL. This mitigation measure has been adhered to within the design envelopes of the Projects.	

NE Ref. No.	NE Comment	Applicants' Response	Section
	understand that ornithological data was considered to inform the post-PEIR reductions in the array red line boundaries, and areas of elevated non-breeding guillemot and razorbill were noted. However, this data/mapping was not provided for review and Natural England were not consulted on the reduction process. It is unclear to what extent the ornithological mapping was used to inform the array reductions, and whether further impact reductions could be achieved.	As part of the progression of project design from the Preliminary Environmental Information Report to the application stage the Array Area boundaries were reduced and refined. A number of factors, including bird distribution data, were considered as part of the boundary refinement exercise. Density mapping data based on the site-specific aerial survey data was collated and examined to indicate areas within The Crown Estate lease options that showed higher and lower densities of birds, and this was used alongside other environmental and technical information to enact the boundary change. An outline of the factors considered in the boundary refinement exercise was presented as part of the minutes from the ornithology ETG meeting 6/2/24). The refinements to the Array Area boundaries was, therefore, undertaken to help reduce impacts on important bird populations.	

NE Ref. No.	NE Comment	Applicants' Response	Section
G29	Natural England cannot agree with the EIA conclusions presented due to there being outstanding concerns with several aspects of the assessment, including: • baseline mortality rates and EIA reference populations used (G19) • guillemot seasonality (G24) • gannet collision risk (G26) • approach taken to combining the impacts of the two arrays (G11/G15)	As noted above in the relevant rows of this table: G19 - these revised demographic rates were provided too late for the assessment and an update for these has been included in this document. G24 - the Applicants have updated the assessment in this document taking into account this new advice from Natural England which was provided after the original application was submitted. G26 - the Applicants have provided the additional collision risks for gannet as requested, although these make only a small (non-material) difference to the conclusions reached. G11/G15 - As per the response above the Applicants have explained the reasons for the approach taken and why the assessment is considered robust, nonetheless an update to	12.5.3 12.7.1.1.3 12.8.1.1.3 12.8.3.1 12.7.1 12.8.1

NE Ref. No.	NE Comment	Applicants' Response	Section
		the combined assessment is provided in this document.	
Updates following Natural England's Deadline 2 submission Appendix G2 [AS-159]			
G2	In-combination and cumulative assessments Natural England note that the cumulative and in-combination totals presented for several species do not align with the most recently agreed figures as presented at Sheringham & Dudgeon Extensions Projects (SEP & DEP) (Deadline 8). For several species, the cumulative totals also do not match with the unapportioned in-combination totals presented.	The Applicants have reviewed and updated tables where this has been necessary and ensured the cumulative and in-combination tables match one another. It should be noted however, that the Applicants are not in agreement with all of the totals presented in the SEP and DEP submissions. For example, in review of these tables it was evident that errors had been made in the presentation of lesser black-backed gull for some wind farms (due to mistaken adjustment for avoidance rates that had already been applied). Furthermore, some of the discrepancies highlighted by Natural England were in fact simply due to estimates being presented using different avoidance rate parameters (reflecting changes to statutory guidance)	Section 12.10.5

NE Ref. No.	NE Comment	Applicants' Response	Section
		and there were not in fact any fundamental differences in the estimates for each wind farm. In an effort to help the reader understand how these changes in guidance have affected cumulative totals the Applicants have presented cumulative tables with collision estimates obtained using both previous and current avoidance rates.	
G3	Scenarios for displacement impacts on auks in PVAs. Natural England note that the Population Viability Analyses (PVAs) run for impacts on guillemot and razorbill do not include the full range of displacement and mortality rates, as advised by Natural England. We note that the highest combination of rates included is 70% displacement and 2% mortality. Though we recognise that consent decisions to date have been based on 70% displacement and 2% mortality values, and that 70% and 10% represent an extreme worse-case scenario, the exclusion of the upper end of Natural England's	The PVAs for guillemot and razorbill have been updated with the additional scenarios requested by Natural England. The full results are provided in [an update to **Appendix 12-13 PVA (Revision 2)** [document reference: 7.12.12.13]] which has been submitted at Deadline 4 and summary results included in the relevant sections of the assessment.	Sections 12.10.4, 12.10.5

NE Ref. No.	NE Comment	Applicants' Response	Section
	advised range of displacement and mortality rates (70% and 10%) means that the full range of possible impact levels has not been captured by the PVAs undertaken. Further, we note that a PVA has not been run for FFC SPA razorbill for the proposal alone, nor guillemot at the EIA scale, despite the potential impacts exceeding 1% of baseline mortality.		
R&I ref: G12 RR ref: G22	High densities of auks between the two arrays The spatial distribution figures provided in 7.12.12.10 show that high densities of auks (particularly guillemot and razorbill) were recorded in the area between the two arrays, but outside the 2km buffer. Natural England consider it is likely that birds in this area will be vulnerable to cumulative displacement impacts from the arrays on either side and therefore advised that the Applicant should provide an assessment of cumulative displacement impacts on auks between the arrays.	The Applicants maintain their position that the suggestion from Natural England that the assessment should consider displacement of auks beyond the advised 2km buffer is unprecedented and unwarranted. There is no additional reason why birds in this region would be subject to displacement any more than those located around all other wind farm boundaries (See **The Applicants' Reponses to Deadline 2 Documents** [REP3-028] for additional response on this matter). Furthermore, the Applicants have reviewed the assessments for previous wind farm applications and consider there to be	N/A

NE Ref. No.	NE Comment	Applicants' Response	Section
	We note that this assessment has not been provided, and that the Applicant cites Trinder *et al.* (2024) as evidence that auks are not displaced beyond the 2km buffer. Natural England do not agree that the Trinder *et al.* (2024) paper provides evidence that auks are not displaced by offshore windfarms, as this study focuses on the behaviour of birds within-array (i.e. on the proportion of birds that are not displaced) and does not attempt to quantify a displacement rate for auks with respect to the array and buffer. Natural England highlight the recently published paper by Peschko *et al.* (2024), which demonstrates cumulative displacement impacts on guillemot up to 21km from offshore wind farms. Furthermore, a recent review of the evidence on displacement by offshore wind farms (Lamb *et al.* 2024) found that "effects of offshore wind energy development on marine birds extend well beyond the immediate	numerous previous examples of wind farms constructed alongside each other (i.e. considerably closer than the >=8km for DBS) and for which no such additional consideration of extended displacement was considered necessary. The Applicants maintain that there is no evidence to suggest that if birds are displaced from the Projects that this will have any knock-on effects on areas beyond the 2km buffer of displacement and this is another example of over-precaution in Natural England's approach to assessment.	

NE Ref. No.	NE Comment	Applicants' Response	Section
	surroundings of the wind farms" and recommended that buffer zones of 4km		
R&I ref: G17 RR ref: G27	Cumulative assessment for impacts on red-throated diver Natural England welcome that the Applicant has included a cumulative assessment for impacts on red-throated diver. However, the figures presented in this assessment do not align with the most recently agreed cumulative figures from the SEP&DEP Examination (See Natural England's Response to Deadline 8 [REP8-102]). SEP&DEP presented a cumulative displacement impact for red-throated diver of between 32 and 318 birds, representing an increase in BDMPS baseline mortality of 1.10-10.5%. By contrast, the figures presented by the Applicant suggest a maximum of 6.6 birds. We highlight that it has been Natural England's long-standing position that significant adverse effects at the EIA scale could not be ruled out for this species due to cumulative impacts.	As noted in **The Applicants' Reponses to Deadline 2 Documents** [REP3-028], the Applicants consider that Natural England has mistakenly identified the SEP and DEP assessment of wind farm operational impacts with the Applicants assessment of construction impacts and this accounts for the apparent discrepancy. No further update to the cumulative construction assessment for red-throated diver is therefore required.	N/A

NE Ref. No.	NE Comment	Applicants' Response	Section
R&I ref: G54 & G55	Cumulative and in-combination collision tables. Natural England note that the cumulative impact totals presented in **Chapter 12 Offshore Ornithology (Revision 2)** [AS-058] and the unapportioned in-combination totals presented in **RIAA HRA Part 4 of 4 – Marine Ornithological Features (Revision 3)** [AS-086] do not always match. For example, the cumulative collision impacts presented for Kittiwake in Table 12-99 of [AS-058] are 5510.7, while the unapportioned in-combination totals presented in Table 9-23 of [AS-086] are 4071. Natural England note that we would expect the unapportioned in-combination totals in the RIAA to be the same as the cumulative totals presented in the ES. The cumulative collision totals presented for great black-backed gull and lesser black-backed gull are lower than the cumulative totals presented at SEP & DEP, despite additional impacts from several projects since the SEP&DEP examination, including those of Dogger Bank South. The annual cumulative	The Applicants have reviewed the cumulative and in-combination tables for all species and made updates where necessary. However, much of the apparent discrepancies identified by Natural England are actually due to presentation of estimates derived under previous guidance and how these are updated for current assessments. To make this clearer, where appropriate, the tables now provide estimates derived under previous and current guidance.	Section 12.10.5

NE Ref. No.	NE Comment	Applicants' Response	Section
	collision mortality presented by the Applicant for lesser black-backed gull (Table 12-100) is 597.8. The annual cumulative collision mortality presented at SEP & DEP [REP8-102]4 was 640. The annual cumulative collision mortality presented by the Applicant for great black-backed gull (Table 12-102) is 1023.2. The annual cumulative collision mortality presented at SEP & DEP [REP8-102]4 was 1357.		
R&I ref: G56	Lack of PVAs for cumulative impact assessments The Applicant has not provided PVAs for cumulative EIA impacts, despite several of these amounting to increases in background mortality rates of over 1%, when assessed according to Natural England's advice. For example, cumulative totals presented for guillemot (7.12, para 766) amount to an increase in background mortality rate of 3.08% when applying a displacement rate of 70% and a mortality rate of 2%.	The PVAs have been updated to provide these additional scenarios (see **Appendix 12-13 Population Viability Analyses (Revision 2)** [document reference: 7.13.13.12]). Summary results are included in the cumulative assessment as necessary.	Section 12.10.5

NE Ref. No.	NE Comment	Applicants' Response	Section
R&I ref: G19 RR ref: G29	Whilst substantial progress has been made, outstanding concerns with aspects of the assessment need addressing before Natural England can advise on the EIA conclusions, including: • Discrepancies in cumulative impact figures • Lack of PVAs to assess cumulative impacts resulting in increases in background mortality rates of more than 1% • Lack of assessment of cumulative displacement impacts on auks between the arrays. We highlight that Natural England considers that impacts on the following species are already significant at an EIA scale in the North Sea: gannet, great black-backed gull, guillemot, kittiwake, razorbill, and red-throated diver, and that this proposal will be making an addition to the cumulative totals.	The Applicants have made the various updates as necessary to address this comment (which is a summary of previous ones with responses above).	Cumulative tables and PVA in section 12.10.5

NE Ref. No.	NE Comment	Applicants' Response	Section
Updates following Natural England's Deadline 5 submission Appendix G5 [REP5-058]			
R&I ref: G55 / G59	Deadline 5 status - No Change. We acknowledge that the Applicants have provided updated assessments, however the totals remain lower than expected. Please see Appendix G5 for further details.	The Applicants have thoroughly reviewed their cumulative tables and are confident these are accurate for the wind farms presented and following the latest SNCB guidance. **Great black-backed gull** Natural England state there is a discrepancy between the total they expect (1420, as presented by Outer Dowsing) and the Applicants' total of 1227. This difference is 193. This is accounted for as follows. For the Greater Gabbard wind farm an annual collision estimate of 27 was presented at an avoidance rate of 99.82% (Banks et al	N/A

NE Ref. No.	NE Comment	Applicants' Response	Section
		2006[1]). Adjusting this to the current avoidance rate of 99.4% gives a figure of 90 (as presented by the Applicants in Table 12-109 of **Chapter 12 Offshore Ornithology** [REP4-032]). Unfortunately, Outer Dowsing reproduced a figure of 250 which had been erroneously calculated by DEP and SEP. This error appears to have occurred because DEP and SEP applied an avoidance rate correction (from 99.82% to 99.5%) to collision figures which had already been corrected (i.e. the original collisions were corrected twice). This accounts for 160 of the 193 apparent discrepancy identified by Natural England. For the Inch Cape wind farm there appears to be an error in the annual total column of the	

[1] The Potential Effects on Birds of the Greater Gabbard Offshore Wind Farm Report for February 2004 to April 2006. BTO Research Report No. 440 A.N. Banks, I.M.D. Maclean, N.H.K. Burton, G.E. Austin, N. Carter, D.E. Chamberlain, C. Holt & M.M. Rehfisch British Trust for Ornithology, The Nunnery, Thetford, IP24 2PU S. Pinder, A. Batty, E. Wakefield & P. Gill

NE Ref. No.	NE Comment	Applicants' Response	Section
		Outer Dowsing submission (Table 12.81 of REP4a-011 of the Outer Dowsing submissions[2]). This states that there zero collisions in the breeding season, 44.2 in the nonbreeding season and 219.2 in total. The Applicants have double-checked the original Inch Cape submission and can confirm that the annual total using the current avoidance rate should be the same as the nonbreeding season one (44.2). This difference (175) is clearly more than that remaining between the Applicants total and the one Natural England expected (1420). However the sum of the Outer Dowsing annual total is actually 1595, not 1420 as reported. Correcting for the Greater Gabbard and Inch Cape errors, the Outer Dowsing total is 1260, 33 more than that in the Applicants' table. This is accounted	

[2] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010130/EN010130-001850-6.1.12%20Chapter%2012%20Offshore%20and%20Intertidal%20Ornithology.pdf

NE Ref. No.	NE Comment	Applicants' Response	Section
		for by Outer Dowsing including several additional Scottish wind farms which have been recently submitted (but not consented). Given that it is clear there is considerable scope for mistakes in transcribing and updating cumulative impacts, as illustrated by this detailed investigation undertaken by the Applicants, it is the Applicants' strong recommendation that Natural England should review and collate wind farm impacts for all UK projects and maintain this as new projects are added, in order that this can be made available to future applicants and avoid this situation in future. **Guillemot** Outer Dowsing's guillemot total annual abundance (Table 12.61 of REP4a-011 of	

NE Ref. No.	NE Comment	Applicants' Response	Section
		the Outer Dowsing submissions[3]) was 741,587. This is 108,618 more than the Applicants' equivalent (632,969, REP4-032 Table 12-92). This difference is accounted for by six additional Scottish wind farms (137,022 in total) minus 28,404 for wind farms which Outer Dowsing report as being lower (for the Projects: 35,604 instead of 6,0438; Five Estuaries 4,813 instead of 4,899 and for Outer Dowsing 24,709 instead of 27,653). As for great black-backed gull the Applicants consider these differences to reflect the inevitable situation which arises with an ever increasing list of wind farms, regularly revised guidance on approaches and the increasing risk of errors being made. As above, the	

[3] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010130/EN010130-001850-6.1.12%20Chapter%2012%20Offshore%20and%20Intertidal%20Ornithology.pdf

NE Ref. No.	NE Comment	Applicants' Response	Section
		Applicants consider the solution to this situation is for Natural England to be custodians of the cumulative list of wind farm impacts and to supply this list to applicants. **Razorbill** Outer Dowsing's razorbill total annual abundance (Table 12.67 of REP4a-011 of the Outer Dowsing submissions[4]) was 217,162. This is 2,044 more than the Applicants' equivalent (215,118, REP4-032 Table 12-96). This difference is accounted for by six additional Scottish wind farms (10,768 in total) minus 8,805 for wind farms which Outer Dowsing report as being lower (for the Projects: 21,303 instead of 28,886 and for Outer Dowsing 12,257 instead of 13,479) plus 81 for Forthwind which Outer	

[4] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010130/EN010130-001850-6.1.12%20Chapter%2012%20Offshore%20and%20Intertidal%20Ornithology.pdf

NE Ref. No.	NE Comment	Applicants' Response	Section
		Dowsing mistakenly added twice (i.e. an annual total of 277 instead of 196). As for guillemot and great black-backed gull the Applicants consider these differences to reflect the inevitable situation which arises with an ever increasing list of wind farms, regularly revised guidance on approaches and the increasing risk of errors being made. As above, the Applicants consider the solution to this situation is for Natural England to be custodians of the cumulative list of wind farm impacts and to supply this list to applicants. Overall these differences will make no material difference to the assessments and the conclusions of the PVA will be little affected, therefore the Applicants do not consider there to be any useful purpose served by continuing to update these totals and rerun the PVA each time one of the 50 wind farms in the list releases an update.	

NE Ref. No.	NE Comment	Applicants' Response	Section
R&I ref: G57	Deadline 5 status - Issue Progressed. Whilst updated PVAs have been provided some results are still not as we would expect, and so we advise the Applicant to verify the results of all PVA scenarios run for the assessment.	The Applicants have scrutinised the PVA inputs, outputs and model code and have realised there has been a misunderstanding of the model guidance literature with respect to how mortality is applied to immature age classes. The 'switch' in the model used to set immature mortality to match adult mortality was turned 'on', as per the guidance, however this setting appears to have been over-ridden during model execution due to the presence of default values of zero in the input tables. This led to models being run without impacts being applied to the immature age classes. When this is rectified, the outputs correspond to those in Natural England's comment. The PVA have been re-run and all relevant sections of this chapter and accompanying **Volume 7, Appendix 12-13 Population Viability Analyses (application ref: 7.12.12.13)** report have been updated.	Throughout

12.3 Scope

12.3.1 Study Area

~~7.~~8. The Offshore Ornithology Study Area has been defined on the basis of the potential connectivity between the Projects and seabird populations during the breeding, migration and wintering periods. This encompasses seabird colonies from northern Scotland (including Shetland) to south-east England (e.g. Suffolk) (see **Volume 6, Report to Inform Appropriate Assessment (RIAA) (application ref: 6.1)**).

~~8.~~9. The Offshore Ornithology Survey Area includes the Projects' Array Areas and a 4km buffer (see **Volume 7, Appendix 12-2 Technical Appendix (application ref: 7.12.12.2)**). Monthly aerial surveys across the survey area commenced in March 2021 and were completed in February 2023. The ES is based on all of the data collected during this 24 month period.

~~9.~~10. The data collected during these surveys have been used to identify the species present and their seasonal abundance.

12.3.2 Realistic Worst Case Scenario

12.3.2.1 General Approach

~~10.~~11. The realistic worst case design parameters for likely significant effects scoped into the ES for the offshore ornithology assessment are summarised in **Table 12-2**. These are based on the project parameters described in **Volume 7, Chapter 5 Project Description (application ref: 7.5)**, which provides further details regarding specific activities and their durations.

~~11.~~12. In addition to the design parameters set out in **Table 12-2**, consideration is also given to the different Development Scenarios still under consideration and the possible phasing of the construction as set out in sections 12.3.2.2 to 12.3.2.4.

Table 12-2 Realistic Worst Case Design Parameters for Offshore Ornithology

	Parameter			
	DBS East or DBS West In-Isolation	**DBS West and DBS East Concurrently**	**DBS West and DBS East Sequentially**	**Notes and rationale**
Construction				
Array Areas	Pin piling (four pins per wind turbine) for largest number of wind turbines (up to 100 in either DBS East or DBS West) Up to three simultaneous ~~piling~~ construction vessels operating at same time	Pin piling (four pins per wind turbine) for largest number of wind turbines (up to 200 across the two Projects) Up to three simultaneous construction ~~piling~~ vessels operating at same time	Pin piling (four pins per wind turbine) for largest number of wind turbines (up to 200 across the two Projects) Up to three simultaneous construction ~~piling~~ vessels operating at same time	Assumed a 2km buffer around each construction location (see **Volume 7, Appendix 12-2 Technical Appendix (application ref: 7.12.12.2)**).
Offshore Export Cable Corridor	Two cables – assume each paired within a single cable trench~~assume each laid independently~~. Assessment will be based on a 2km buffer around each independently operating cable laying vessel. ~~Pin piling (eight pins piles) for one Electrical Switching Platform (ESP) along the Offshore Export Cable Corridor.~~	Four cables – assume Offshore Export Cables for each Project paired within a cable trench per Project~~assume each laid independently~~. Assessment will be based on a 2km buffer around each independently operating cable laying vessel. ~~Pin piling (eight pins piles) for one Electrical Switching Platform (ESP) along the Offshore Export Cable Corridor.~~	Four cables – assume Offshore Export Cables for each Project paired within a cable trench per Project~~assume each laid independently~~. Assessment will be based on a 2km buffer around each independently operating cable laying vessel. ~~Pin piling (eight pins piles) for one Electrical Switching Platform (ESP) along the Offshore Export Cable Corridor.~~	(see **Volume 7, Appendix 12-2 Technical Appendix (application ref: 7.12.12.2)**).
Operation				
Array Areas	100 small wind turbines in either DBS East or DBS West for 30 years.	200 small wind turbines (100 in DBS East and 100 in DBS West) for 30 years.	200 small wind turbines (100 in DBS East and 100 in DBS West) for 32 years.	Larger number of smaller wind turbines gives highest collision risk (see **Volume 7, Appendix 12-9 Collision Risk Modelling Inputs and Outputs (application ref: 7.12.12.9)**).
	Complete development of areas within Array Area boundaries (DBS East: 349.1km^2; DBS West: 354.7km^2)	Complete development of areas within Array Area boundaries	Complete development of areas within Array Area boundaries	Greatest area from which birds could be displaced (see **Volume 7, Appendix 12-2 Technical Appendix (application ref: 7.12.12.2)**).
Decommissioning				
No final decision regarding the final decommissioning policy for the offshore project infrastructure including landfall, has yet been made. It is also recognised that legislation and industry best practice change over time. It is likely that offshore project infrastructure will be removed above the seabed and reused or recycled where practicable. The detail and scope of the				

	Parameter			
	DBS East or DBS West In-Isolation	DBS West and DBS East Concurrently	DBS West and DBS East Sequentially	Notes and rationale
decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning and will be agreed with the regulator. It is anticipated that for the worst case scenario, the impacts will be no greater than those identified for the construction phase. A decommissioning plan for the offshore works would be submitted prior to any decommissioning commencing.				

12.3.2.2 Development Scenarios

~~12.~~13. Following Statutory Consultation high voltage alternating current (HVAC) technology (previously assessed in PEIR) was removed from the Projects' Design Envelope (see **Volume 7, Chapter 4 Site Selection and Assessment of Alternatives (application ref: 7.4)** for further information). As a result, only high voltage direct current (HVDC) technology has been taken forward for assessment purposes. The ES considers the following Development Scenarios:

- Either DBS East or DBS West is built In Isolation; or
- DBS East and DBS West are both built either Sequentially or Concurrently.

~~13.~~14. An In Isolation Scenario has been assessed within the ES on the basis that theoretically one Project could be taken forward without the other being built out. If an In Isolation project is taken forward, either DBS East or DBS West may be constructed. As such the onshore / offshore assessment considers both DBS East and DBS West In Isolation.

~~14.~~15. In order to ensure that a robust assessment has been undertaken, all Development Scenarios have been considered to ensure the realistic worst case scenario for each topic has been assessed. A summary is provided here, and further details are provided in **Volume 7, Chapter 5 Project Description (application ref: 7.5)**.

~~15.~~16. The three Development Scenarios to be considered for assessment purposes are outlined in **Table 12-3**.

Table 12-3 Development Scenarios and Construction Durations

Development Scenario	Description	Overall Construction Duration (Years)	Maximum construction Duration Offshore (Years)	Maximum construction Duration Onshore (Years)
In Isolation	Either DBS East or DBS West is built In Isolation	Five	Five	Four

Development Scenario	Description	Overall Construction Duration (Years)	Maximum construction Duration Offshore (Years)	Maximum construction Duration Onshore (Years)
Sequential	DBS East and DBS West are both built sequentially, either Project could commence construction first with staggered / overlapping construction	Seven	A five year period of construction for each project with a lag of up to two years in the start of construction of the second project (excluding landfall duct installation) – reflecting the maximum duration of effects of seven years.	Construction works (i.e. onshore cable civil works, including duct installation) to be completed for both Projects simultaneously in the first four years, with additional works at the landfall, substation zone and cable joint bays in the following two years. Maximum duration of effects of six years.
Concurrent	DBS East and DBS West are both built concurrently reflecting the maximum peak effects	Five	Five	Four

~~16.~~17. Natural England has advised that displacement impacts on offshore ornithological interests during construction should be assessed for the duration of construction (taken here as construction of foundations and installation of turbines) on the basis that the magnitude of displacement impacts during construction are, on average, 50% of those for the constructed wind farm.

~~17.~~18. Therefore, the three construction scenarios considered by the offshore ornithology assessment are:

- Build DBS East or build DBS West in isolation (i.e. only one of the wind farms is constructed). This equates to one wind farm over four years at 50% impact = two wind farm years;
- Build DBS East and DBS West concurrently – reflecting the maximum peak effects (i.e. disturbance occurring on both sites over the same period). This equates to two wind farms over four years at 50% impact = four wind farm years; and
- Build the Projects sequentially with a lag of up to two years – reflecting the maximum duration of effects (i.e. disturbance occurring over a longer period of time due to the lag of two years between construction commencing at either site). This equates to wind farm A over two years plus both wind farms over two years plus wind farm B over two years at 50% impact = four wind farm years.

~~18.~~19. Thus, either concurrent or sequential construction of both wind farms will generate similar effective impact magnitudes and either one represents the worst case with respect to construction displacement.

~~19.~~20. The individual, concurrent and sequential construction scenarios all allow for flexibility to build out the Projects using a phased approach. This will allow the Projects to adapt to National Grid Electricity Transmission Operator's development plans for the onshore grid connection points. Under a phased approach the maximum timescales for individual elements of the construction have been assessed.

~~20.~~21. Any differences between the Projects, or differences that could result from the manner in which the first and the second Projects are built (concurrent or sequential and the length of any gap) are identified and discussed where relevant in section 12.6. For each potential impact, only the worst case construction scenario for the In Isolation Scenario and the Concurrent or Sequential Scenario is presented. The worst case scenario presented for the Concurrent or Sequential Scenario will depend on which of these is the worst case for the potential impact being considered. The justification for what constitutes the worst case is provided, where necessary, in section 12.6.

12.3.2.3 Operation Scenarios

~~21.~~22. Operation scenarios are described in detail in **Volume 7, Chapter 5 Project Description (application ref: 7.5)**. The assessment considers the following scenarios:

- Only DBS East in operation;
- Only DBS West in operation; and
- DBS East and DBS West operating concurrently, with or without a lag of up to two years between each Project commencing operation.

~~22.~~23. If the Projects are built using a phased approach, there would also be a phased approach to starting the operational stage. The worst case scenario for the operational phases for the Projects have been assessed. See section 5.1.1 of **Volume 7, Chapter 5 Project Description (application ref: 7.5)**; for further information on phasing scenarios for the Projects.

~~23.~~24. The operational lifetime of each Project is expected to be 30 years.

12.3.2.4 Decommissioning Scenarios

~~24.~~25. Decommissioning scenarios are described in **Volume 7, Chapter 5 Project Description (application ref: 7.5)**. Decommissioning arrangements will be agreed through the submission of a Decommissioning Programme prior to construction, however for the purpose of this assessment it is assumed that decommissioning of the Projects could be conducted separately, or at the same time.

12.3.3 Embedded Mitigation

~~25.~~26. This section outlines the embedded mitigation relevant to the offshore ornithology assessment, which has been incorporated into the design of the Projects or constitutes standard mitigation measures for this topic (**Table 12-4**). Mitigation is also detailed within the **Volume 8, Commitments Register (application ref: 8.6)** and cross-referenced within this chapter. Where additional mitigation measures are proposed, these are detailed in the impact assessment (section 12.6).

Table 12-4 Embedded Mitigation Measures

Parameter	Embedded Mitigation Measures	Where is commitment secured?
Site Selection	The Crown Estate conducted a detailed site selection exercise, considering a range of sensitivities which included ornithological impacts. The Projects' Array Areas are located at least 100km from the nearest seabird breeding colony at Flamborough and Filey Coast Special Protection Area (FFC SPA) and as such connectivity for most species will be relatively low. The Array Areas have been refined following review of site-specific survey information.	DCO Schedule 1
Minimum blade clearance	There would be a minimum blade tip clearance (air draft height) of at least 34m above MSL. Project parameters would be secured within **Volume 3, Draft DCO (application ref: 3.1)**.	Deemed Marine Licence (DML) 1 & 2 - Condition 2
Vessel traffic	Potential impacts on red throated diver in the Greater Wash SPA during construction, operation and maintenance works will be mitigated through measures such as: • Existing shipping lanes will be utilised for any vessels crossing the Greater Wash SPA and up to 2km beyond the SPA boundary to limit potential disturbance of red-throated diver; • Vessels may deviate from the existing shipping lanes to avoid disturbance of red-throated diver should they be located within the existing shipping lane; • Selecting routes that avoid known aggregations of birds; • Restricting vessel movements to existing navigation routes (where the densities of red-throated divers are typically relatively low);	Pollution Environmental Management Plan (PEMP) DML 1 & 2 - Conditions 15 & 21 DML 3 & 4-Conditions 13 & 19 DML 5 - Conditions 11 & 15

Parameter	Embedded Mitigation Measures	Where is commitment secured?
	• Maintaining direct transit routes (to minimise transit distances through areas used by red-throated diver); • Considering the potential for crew transfer vessels to travel in convoy en route to the wind farm sites and seeking to do so where it is considered practicable; • Avoidance of over-revving of engines (to minimise noise disturbance); and • Briefing of vessel crew on the purpose and implications of these vessel management practices (through, for example, tool-box talks). These measures are set out in **Volume 8, Outline Project Environmental Management Plan (application ref: 8.21).**	

12.4 Assessment Methodology

12.4.1 Policy, Legislation and Guidance

12.4.1.1 National Policy Statements

~~26.~~27. The assessment of potential impacts upon offshore ornithology has been made with specific reference to the relevant National Policy Statements (NPS) including the Overarching NPS for Energy (EN-1), the NPS for Renewable Energy Infrastructure (EN-3) and the NPS for Electricity Networks Infrastructure (EN-5) (DESNZ, 2023a-c). These were published in November 2023 and were designated in January 2024. The specific assessment requirements for offshore ornithology, as detailed in the NPS, are summarised in **Table 12-5** together with an indication of the section of this chapter where each is addressed.

Table 12-5 NPS Assessment Requirements

NPS Requirement	NPS Reference	ES Section Reference
EN-1 NPS for Energy		
Where the development is subject to EIA the applicant should ensure that the ES clearly sets out any effects on internationally, nationally, and locally designated sites of ecological or geological conservation importance (including those outside England), on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity, including irreplaceable habitats.	EN-1 Paragraph 5.4.17	The receptors included in this assessment encompass the categories described.
The design of Energy NSIP proposals will need to consider the movement of mobile / migratory species such as birds, fish and marine and terrestrial mammals and their potential to interact with infrastructure. As energy infrastructure could occur anywhere within England and Wales, both inland and onshore and offshore, the potential to affect mobile and migratory species across the UK and more widely across Europe (transboundary effects) requires	EN-1 Paragraph 5.4.22	As discussed in **Table 12-4** the Projects' locations and design have given consideration to ornithological receptors. Transboundary effects are considered in section 12.12

NPS Requirement	NPS Reference	ES Section Reference
consideration, depending on the location of development.		
EN-3 NPS for Renewable Energy Infrastructure		
In addition, applicants should have regard to the specific ecological and biodiversity considerations that relate to proposed offshore renewable energy infrastructure developments, namely: • Birds (see Section 2.8.240 of this NPS)	EN-3 Paragraph 2.8.98	This chapter specifically covers these receptors.
Applicants must undertake a detailed assessment of the offshore ecological, biodiversity and physical impacts of their proposed development, for all phases of the lifespan of that development, in accordance with the appropriate policy for offshore wind farm EIAs, HRAs and MCZ assessments (See sections 4.3 and 5.4 of EN-1).	EN-3 Paragraph 2.8.1012.8.91	This has been conducted in the following sections of this chapter: • Construction (section 12.7); • Operation (section 12.8); and • Decommissioning (section 12.9).The receptors included in this assessment encompass the categories described
Applicants should consult at an early stage of pre-application with relevant statutory consultees and energy not-for profit organisations/non--governmental organisations as appropriate, on the assessment methodologies, baseline data collection, and potential avoidance, mitigation and compensation options should be undertaken.	EN-3 Paragraph 2.8.1042.8.94	The Applicants have consulted with Natural England on these matters. The record of consultation is provided in **Volume 7, Appendix 12-1 Offshore Ornithology Consultation Responses**

NPS Requirement	NPS Reference	ES Section Reference
		(application ref: 7.12.12.1).
In developing proposals applicants must refer to the most recent best practice advice originally provided by Natural England under the Offshore Wind Enabling Action Programme, and/or their relevant SNCB.	EN-3 Paragraph 2.8.105	The Applicants have used the most recent best practice guidance and other SNCB guidance when developing the Projects.
Any relevant data that has been collected as part of post construction ecological monitoring from existing, operational offshore wind farms should be referred to where appropriate. A range of research programmes are ongoing to investigate impacts of offshore wind farm development, including, but not limited to: BEIS SEA Research Programme, ORJIP, ScotMER, the ORE Catapult and OWEC. Applicants should explain why their decisions on siting, design, and impact mitigation are proportionate and well-targeted, referring to relevant scientific research and literature as appropriate.	EN-3 Paragraph 2.8.106, 107~~2.8.96, 2.8.97~~	Relevant studies whether academic, strategic or project specific are referred to throughout this assessment.
~~In addition, applicants should have regard to the specific ecological and biodiversity considerations that pertain to proposed offshore wind infrastructure developments, namely:~~ ~~Birds~~	~~EN-3 Paragraph 2.11.35~~	~~This chapter specifically covers these receptors~~
Applicants are expected to have regard to guidance issued in respect of Marine Licence requirements and consult at an early stage of pre-application with the MMO or NRW.	EN-3 Paragraph 2.8.108	The Applicants have consulted with the MMO on statutory and non-statutory basis through the EPP since 2021. The

NPS Requirement	NPS Reference	ES Section Reference
		EPP is divided into several ETGs which follow the majority of topics covered by the EIA and HRA. The MMO have been a part of all ETGs relating to offshore topics.
Applicants should have regard to duties in relation to Good Environmental Status (GES) of marine waters under the UK Marine Strategy and MPA target (including any interim target) in England, set under the Environment Act 2021.	EN-3 Paragraph 2.8.109	The ES has considered the international, national, regional and local planning policy and legislative context that is relevant to the impact assessment of the Projects. This includes the Marine Strategy Framework Directive.
~~Applicants must undertake a detailed assessment of the offshore ecological, biodiversity and physical impacts of their proposed development, for all phases of the lifespan of that development, in accordance with the appropriate policy for EIAs, HRAs and MCZ assessments~~	~~EN-3 Paragraph 2.11.36~~	~~This has been conducted in the ES: construction (section 12.7), operation (section 12.8) and decommissioning (section 12.9).~~
~~Applicants should demonstrate that their site selection, project design, and (where relevant) mitigation plans have been determined considering relevant evidence.~~	~~EN-3 Paragraph 2.11.37~~	~~As discussed in **Table 12-4** the Projects' locations and design have given consideration to ornithological receptors, including embedded mitigation~~

NPS Requirement	NPS Reference	ES Section Reference
Offshore wind farms have the potential to impact on birds through: • Collisions with rotating blades; • Direct habitat loss; • Disturbance from construction activities such as the movement of construction/de-commissioning/maintenance vessels and piling; • Displacement during the operational phase, resulting in loss of foraging/roosting area; • Impacts on bird flight lines (i.e. barrier ef-fect) and associated increased energy use by birds for commuting flights between roosting and foraging areas.	EN-3 Paragraph 2.8.1326	These potential impacts have been assessed in section 12.7 - 12.912.6.
Currently, cumulative impact assessments for ornithology are based on the consented Rochdale Envelope parameters of projects, rather than the 'as-built' parameters, which may pose a lower risk to birds.	EN-3 Paragraph 2.8.1327	Cumulative assessments are based on current advice and do not consider headroom (see section 12.10).
The applicant must ensure any draft consents include provisions to define the final 'as built' parameters (which may not then be exceeded). These parameters must be used in future cumulative impact assessments.	EN-3 Paragraph 2.8.1328	Provisions to define and confirm the 'as built' parameters for the Projects' wind turbines following completion of construction so that these can be used in Cumulative Impact Assessments (CIAs) for future developments is included as a condition of the Deemed Marine

NPS Requirement	NPS Reference	ES Section Reference
		Licences (Schedules 10 and 11 of the draft DCO).
Applicants should discuss the scope, effort and methods required for ornithological surveys with the relevant statutory advisor, taking into consideration baseline and monitoring data from operational windfarms. Applicants must undertake Collision Risk Modelling, as well as displacement and population viability assessments for certain species of birds. Applicants are expected to seek advice from SNCBs.	EN-3 Paragraph 2.8.14~~3~~3, 2.8.14~~3~~4	As noted in **Volume 7, Appendix 12-1 Offshore Ornithology Consultation Responses (application ref: 7.12.12.1)**, The Applicants have consulted with Natural England on these matters.
Where necessary, applicants should assess collision risk using survey data collected from the site at the pre-application EIA stage.	EN-3 Paragraph 2.8.14~~3~~5	In order to provide site specific and up to date information on which to base the impact assessment, 24 months of digital aerial survey have been completed. The survey methodology was discussed and agreed with Natural England through the ETG process.~~See section 12.4.2~~
Aviation and navigation lighting should be minimised and/or on demand (as encouraged in EN-1 Section 5.5) to avoid attracting birds, taking into account impacts on safety. Subject to other constraints, wind turbines should be laid out within a site, in a way that minimises collision risk.	EN-3 Paragraph 2.8.240	In accordance with ANO Article 223, lighting intensity would be reduced at and below the horizontal and further reduced when visibility in all directions from every

NPS Requirement	NPS Reference	ES Section Reference
		wind turbine is more than 5km.
Turbine parameters should also be developed to reduce collision risk where the assessment shows there is a significant risk of collision (e.g., altering rotor height)	EN-3 Paragraph 2.8.241	The Projects' locations and design have given consideration to ornithological receptors, as detailed in **Table 12-4**.
Construction vessels and post-construction maintenance vessel traffic associated with offshore wind farms and offshore transmission should, where practicable and compatible with operational requirements and navigational safety, avoid rafting seabirds during sensitive periods and follow agreed navigation routes to and from the site and minimise the number of vessel movements overall.	EN-3 Paragraph 2.8.242	Embedded mitigation for the Projects regarding vessel traffic and offshore ornithology is detailed in **Table 12-4**.
With increasing deployment of offshore wind farms and offshore transmission, environmental impacts upon SACs SPAs, and Ramsar sites and MCZs (individually and as part of a network) may not be addressed by avoidance, reduction, or mitigation alone, therefore compensatory measures (through derogation for SACs SPAs, Ramsar sites, and MCZs may be required at a plan or project level where adverse effects on site integrity and/or on conservation objectives cannot be ruled out. For many receptors, the scale of offshore wind and offshore transmission developments, and potential in-combination effects, means compensation could be required and applicants must refer to the latest Defra compensation guidance when making their assessments.	EN-3 Paragraph 2.8.265, 2.8.266, 2.8.267 and 2.8.269	Details of the HRA process followed by the Projects is contained within the RIAA document. The RIAA has been consulted upon during the pre-application period and all HRA matters discussed with relevant stakeholders through the EPP. The Habitats Derogation Provision of Evidence document outlines the evidence to support Stage 3

NPS Requirement	NPS Reference	ES Section Reference
If, during the pre-application stage, SNCBs indicate that the proposed development is likely adversely to impact a protected site, the applicant should include with their application such information as may reasonably be required to assess potential derogations under the Habitats Regulations or the Marine and Coastal Access Act 2009. This information includes: assessment of alternative solutions, showing the relevant tests on alternatives have been met; a case showing that the relevant tests for IROPI or Measures of Equivalent Environmental Benefit have been met; and appropriate securable environmental compensation, which will ensure no net loss to the MPA network and help ensure that the MPA target (including any interim target) set under the Environment Act 2021 targets can be met.		(Derogation) of the HRA Process. The cumulative residual impacts have been assessed within the RIAA. Following the employment of the mitigation hierarchy, the Habitats Regulations Derogation: Provision of Evidence' document, contains several appendices and annexes which include a suite of compensatory plans. These include the Kittiwake Compensation Plan and the Guillemot and Razorbill Compensation Plan. The Compensation Plan in relation to Razorbill is provided on a 'without prejudice' basis only. Where the Secretary of State concludes that the Projects would result in Adverse Effects on Integrity the Applicants are proposing that the compensatory measures will be secured in the dDCO. The Habitats Regulations

NPS Requirement	NPS Reference	ES Section Reference
		Derogation: Provision of Evidence explains the long list of alternative solutions/ measures considered by the Applicant. These alternatives include: alternative Offshore windfarm locations; Alternative Scale; Alternative Design and Method; Alternative Timing. However, the RIAA confirms that none of these alternative solutions are feasible and so a HRA derogation case has been made and concludes a commitment to compensatory measures.
It is vital that applicants consider the need for compensation as early as possible in the design process, as 'retrofitting' compensatory measures will introduce delays and uncertainty to the consenting process. Applicants are encouraged to include all compensatory measures considered, with reasoning for why they have been discounted. Applicants should work closely at an early stage in the pre-application process with SNCBs, and Defra, in conjunction with the relevant regulators, Local Planning Authorities, National Park Authorities, landowners and other relevant stakeholders to develop a compensation plan for all protected sites adversely affected by the development.	EN-3 Paragraph 2.8.272 to 2.8.275	Through early consultation, the Applicants have worked closely with SNCBs, and Defra, in conjunction with the relevant regulators to develop appropriate compensation proposals. The Habitats Regulations Derogation: Provision of Evidence explains the long list of alternative solutions/ measures considered

NPS Requirement	NPS Reference	ES Section Reference
Before submitting an application, applicants should seek the views of the SNCB and Defra, as to the suitability, securability and effectiveness of the compensation plan to ensure that the overall coherence of the National Site Network for the impacted SAC/SPA/MCZ feature is protected. Consultation should also take place throughout the pre-application phase with key stakeholders (e.g. via the evidence plan process and use of expert topic groups). In cases where such views are provided, the applicant should include a copy of this information with the compensation plan in their application for further consideration by the Examining Authority and Secretary of State.		by the Applicant. These alternatives include: alternative Offshore windfarm locations; Alternative Scale; Alternative Design and Method; Alternative Timing. However, the Habitats Regulations Derogation: Provision of Evidence confirms that none of these alternative solutions are feasible and so a HRA derogation case has been made and concludes a commitment to compensatory measures. In addition to these effects and in relation to HRA, cumulative residual impacts have been assessed within the RIAA. Following the employment of the mitigation hierarchy, the Habitats Regulations Derogation: Provision of Evidence' document, contains several appendices and annexes which include a suite of compensatory plans. These include the Kittiwake Compensation Plan;

NPS Requirement	NPS Reference	ES Section Reference
		and the Guillemot and Razorbill Compensation Plan. The Compensation Plan in relation to Razorbill is provided on a 'without prejudice' basis only. Where the Secretary of State concludes that the Projects would result in Adverse Effects on Integrity the Applicants are proposing that the compensatory measures will be secured in the dDCO.
Not every impact for every project will initially fall within the strategic compensation proposals, so applicants should continue to discuss with SNCBs and Defra the need for site specific or strategic compensation at the earliest opportunity.	EN-3 Paragraph 2.8.282	The Applicants consulted with SNCBs and Defra regarding strategic compensation measures through the pre-application stage of the Projects (as evidenced in the **Consultation Report, Appendix F - Non-statutory consultation and engagement (application ref: 5.7)**) and will continue consultation through the Projects lifetime.

12.4.1.2 Other

~~27.~~28. In addition to the NPS, there are a number of pieces of policy and guidance applicable to the assessment of offshore ornithology. These include:

- CIEEM (2018) presents the most relevant EIA guidance for offshore ornithology assessment. The EIA methodology described in section 12.4.3 and applied in this chapter is based on this guidance;
- Guidance documents for the assessment of OWF impacts on offshore ornithology receptors produced by Natural England (Natural England 2021a, 2021b, 2021c);
- Interim advice on Collision Risk Modelling parameters (Natural England 2022);
- Headroom in Cumulative Offshore Wind Farm Impacts for Seabirds: Legal Issues and Possible Solutions (The Crown Estate and Womble Bond Dickinson 2021);
- NE and NRW interim advice regarding demographic rates, EIA scale mortality rates and reference populations for use in offshore wind impact assessments rates and reference populations for use in offshore wind impact assessments (Natural England, 2024); and
- A wide range of additional guidance has been referred to throughout the assessment as required.

~~28.~~29. Further detail on overarching policy and guidance is provided in **Volume 7, Chapter 3 Policy and Legislative Context (application ref: 7.3)**.

12.4.2 Data and Information Sources

12.4.2.1 Site Specific Surveys

~~29.~~30. In order to provide site specific and up to date information on which to base the impact assessment, 24 months of digital aerial survey have been completed (**Volume 7, Appendix 12-2 Technical Appendix (application ref: 7.12.12.2)**). The survey methodology was discussed and agreed with Natural England through the ETG process.

12.4.3 Impact Assessment Methodology

~~30.~~31. **Volume 7, Chapter 6 EIA Methodology (application ref: 7.6)** provides a summary of the general impact assessment methodology applied. The following sections describe the methods used to assess the likely significant effects on offshore ornithology. It should be noted that the general impact assessment methodology remains unchanged from the original chapter submitted alongside the Projects' DCO Application [APP-103], with the updated Natural England (2024) guidance only amending the parameter values utilised in the assessment itself.

12.4.3.1 Definitions

~~31.~~32. For each potential impact, the assessment identifies receptors sensitive to that impact and implements a systematic approach to understanding the impact pathways and the level of impacts (i.e. magnitude) on given receptors. The definitions of sensitivity and magnitude for the purpose of the offshore ornithology assessment are provided in **Table 12-6** and **Table 12-7**.

Table 12-6 Definition of Sensitivity for Ornithological Receptors

Sensitivity	Definition
High	Bird species has very limited tolerance of sources of impact.
Medium	Bird species has limited tolerance of sources of impact.
Low	Bird species has some tolerance of sources of impact.
Negligible	Bird species is generally tolerant of sources of impact.

~~32.~~33. It should be noted that although sensitivity is a core component of the assessment, conservation value (defined in section 12.5.2) is also taken into account in determining each potential impact's significance. Furthermore, high conservation value (defined below) and high sensitivity are not necessarily linked within a particular impact. A receptor could be categorised as being of high conservation value (e.g. an interest feature of a SPA) but have a low or negligible physical / ecological sensitivity to an effect and vice versa. Determination of potential impact significance takes both of these into consideration. The narrative behind the assessment is important here; the conservation value of an ornithological receptor can be used where relevant as a modifier for the sensitivity (to the effect) already assigned to the receptor.

~~33.~~34. The definitions of the magnitude levels for ornithology receptors are set out in **Table 12-7**. This set of definitions has been determined on the basis of changes to bird populations. Note that the effects assessment also applies to the approach advised by Natural England (Parker *et al.* 2022c), with effects which increase background mortality by less than 1% considered to be undetectable and therefore not significant. It is important to note that the corollary of this approach (i.e. effects that increase background mortality by more than 1%) does not automatically apply, but rather such effects warrant additional consideration, for example using population modelling or the basis for the assumptions applied in the assessment, to determine the likely significance.

Table 12-7 Definition of Magnitude of Impacts

Magnitude	Definition
High	A change in the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site that is predicted to irreversibly alter the population in the short-to-long term and to alter the long-term viability of the population and / or the integrity of the protected site. Recovery from that change predicted to be achieved in the long-term (i.e. more than five years) following cessation of the project activity.
Medium	A change in the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site that occurs in the short and long-term, but which is not predicted to alter the long-term viability of the population and / or the integrity of the protected site. Recovery from that change predicted to be achieved in the medium-term (i.e. no more than five years) following cessation of the project activity.
Low	A change in the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site that is sufficiently small-scale or of short duration to cause no long-term harm to the feature / population. Recovery from that change predicted to be achieved in the short-term (i.e. no more than one year) following cessation of the project activity.
Negligible	Very slight change from the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site. Recovery from that change predicted to be rapid (i.e. no more than circa six months) following cessation of the project related activity.

Magnitude	Definition
No change	No loss of, or gain in, size or extent of distribution of the relevant biogeographic population or the population that is the interest features of a specific protected site.

12.4.3.2 Significance of Effect

~~34.~~35. The assessment of significance of an effect is informed by the sensitivity of the receptor and the magnitude of the impact (see **Volume 7, Chapter 6 EIA Methodology (application ref: 7.6)** for further detail). The determination of significance is guided by the use of an offshore ornithology significance of effect matrix, as shown in **Table 12-8**. Definitions of each level of significance are provided in **Table 12-9**. For the purposes of this assessment, any effect that is of major or moderate significance is considered to be significant in EIA terms, whether this be adverse or beneficial. Any effect that has a significance of minor or negligible is not significant.

Table 12-8 Offshore Ornithology Significance of Effect Matrix

		Adverse Magnitude				Beneficial Magnitude			
		High	**Medium**	**Low**	**Negligible**	**Negligible**	**Low**	**Medium**	**High**
Sensitivity	High	Major	Major	Moderate	Minor	Minor	Moderate	Major	Major
	Medium	Major	Moderate	Minor	Minor	Minor	Minor	Moderate	Major
	Low	Moderate	Minor	Minor	Negligible	Negligible	Minor	Minor	Moderate
	Negligible	Minor	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Minor

~~35.~~36. It is important that the matrix (and indeed the definitions of sensitivity and magnitude) is seen as a framework to aid understanding of how a judgement has been reached from the narrative of each impact assessment and it is not a prescriptive formulaic method. IEEM (2010) guidance and expert judgement has been applied to the assessment of likelihood and ecological significance of a predicted impact.

Table 12-9 Definition of Effect Significance

Significance	Definition
Major	Very large or large change in receptor condition, which is likely to be an important consideration at a regional or district level because it contributes to achieving national, regional or local objectives, or could result in exceedance of statutory objectives and / or breaches of legislation.
Moderate	Intermediate change in receptor condition, which is likely to be an important consideration at a local level.
Minor	Small change in receptor condition, which may be raised as a local issue but is unlikely to be important in the decision making process.
Negligible	No discernible change in receptor condition.
No change	No impact, therefore no change in receptor condition.

~~36.~~37. Note that for the purposes of this Chapter, major and moderate impacts are considered to be significant. In addition, whilst minor impacts are not significant in their own right, it is important to distinguish these from other non-significant impacts as they may contribute to significant impacts cumulatively or through interactions.

~~37.~~38. It should also be noted that there may be some very small apparent differences in summed values in some cases (e.g. when DBS East and DBS West values are summed), which is due to rounding of values and the number of decimal places presented.

12.4.4 Cumulative Effects Assessment Methodology

~~38.~~39. The Cumulative Effects Assessment (CEA) considers other schemes, plans, projects and activities that may result in significant effects in cumulation with the Projects. **Volume 7, Chapter 6 EIA Methodology (application ref: 7.6)** (and accompanying **Volume 7, Appendix 6-2 Offshore Cumulative Assessment (CEA) Methodology (application ref: 7.6.6.2)**) provides further details of the general framework and approach to the CEA.

~~39.~~40. The methodology has also been aligned with the approach to the assessment of cumulative impacts that has been applied by Ministers when consenting offshore wind farms and confirmed in recent consent decisions. It also follows the approach set out in guidance from the Planning Inspectorate (Planning Inspectorate, 2015) and from the renewables industry (RenewableUK, 2013).

~~40.~~41. Further detail on potential cumulative effects is provided in section 12.10.

12.4.5 Transboundary Effect Assessment Methodology

~~41.~~42. The transboundary assessment considers the potential for transboundary effects to occur on offshore ornithology receptors as a result of the Projects; either those that might arise within the Exclusive Economic Zone (EEZ) of European Economic Area (EEA) states or arising on the interests of EEA states e.g. a non UK fishing vessel. **Volume 7, Chapter 6 EIA Methodology (application ref: 7.6)** provides further details of the general framework and approach to the assessment of transboundary effects.

~~42.~~43. For offshore ornithology, the potential for transboundary effects has been identified in relation to potential linkages to non-UK protected sites and sites with large concentrations of breeding, migratory or wintering birds (including the use of available information on tagged birds).

12.4.6 Assumptions and Limitations

~~43.~~44. The cumulative assessment has included the latest information available for projects which are in the later stages of the planning process, but for which the possibility exists that their impacts may be revised. Thus, there could be discrepancies between the estimates for those projects presented here and in their final submissions. While every effort to keep this assessment up to date and to use the latest information will be made this may not be possible.

~~44.~~45. No further overarching assumptions or limitations have been identified that apply to the assessment for offshore ornithology. Where routine assumptions have been made in the course of undertaking the assessment, these are noted throughout.

12.5 Existing Environment

~~45.~~46. This section summarises the baseline ornithological information from the desk-based assessment and the aerial surveys, as detailed in **Volume 7**, **Appendices 12-2** to **12-8 (application ref: 7.12.12.2** to **application ref: 7.12.12.8)**.

12.5.1 Designated sites

~~46.~~47. The offshore ornithology section of the Habitats Regulations Assessment (HRA) will consider Special Protection Areas (SPAs) with the potential for connectivity to the Array Areas. **Volume 6, Appendix A HRA Screening Report (application ref: 6.1.1)** has considered 93 offshore and coastal designated sites within 700km of the Projects. These comprised SPAs and Ramsar sites designated for bird interests. Of these, the HRA screening identified ten sites which are the primary focus for further consideration in relation to potential effects (note that Natural England has advised additional consideration of sites which may have nonbreeding season connectivity. This is addressed in **Volume 6, RIAA (application ref: 6.1)**). All remaining sites were either considered to be beyond connectivity distance or to have no pathway for a potential effect in relation to the Projects.

~~47.~~48. Although the HRA is separate from the EIA, the screening carried out is also considered to be appropriate in terms of identifying potential connectivity for the ornithological impact assessment, so the same ten sites are identified here (**Table 12-10**).

Table 12-10 Designated Sites for Birds with Potential Connectivity to the Proposed Projects.

Site	Designation	Ornithological interest features	Minimum distance to the Array Areas (km)
Flamborough and Filey Coast	SPA	Breeding seabirds	100
Greater Wash	SPA	Nonbreeding seabirds and breeding terns	130 (SPA has small overlap with Offshore Export Cable Corridor)
Northumbria Coast	SPA and Ramsar	Breeding seabirds, wintering and passage waterbirds	165
The Wash	SPA and Ramsar	Breeding seabirds, wintering and passage waterbirds	176
Northumberland Marine	SPA	Breeding seabirds	183
Coquet Island	SPA	Breeding seabirds	194
Farne Islands	SPA	Breeding seabirds	210

Site	Designation	Ornithological interest features	Minimum distance to the Array Areas (km)
Outer Firth of Forth and St Andrews Bay Complex	SPA	Breeding seabirds	250
St Abbs Head to Fast Castle	SPA	Breeding seabirds	252
Forth Islands	SPA	Breeding seabirds	289

12.5.2 Baseline Environment and Representativeness of Survey Data

~~48.~~49. In their Relevant Representation [RR-039], Natural England requested additional consideration of the representativeness of the baseline data since the offshore ornithology survey period overlapped with the beginning of the outbreak of Highly Pathogenic Avian Influenza (HPAI) among UK seabird populations.

~~49.~~50. HPAI virus was identified as a concern within seabird populations during 2022 (Tremlett *et al*. 2024). Natural England (2022a) has advised that the results of at sea surveys conducted during the period of the HPAI outbreak may have been affected and in [RR-039] requested the Applicants provide consideration of this aspect. Natural England (2022a) consider that the impact and influence of HPAI on seabird populations may be present in digital aerial survey (DAS) data from June 2022.

~~50.~~51. The Projects undertook DAS of the Array Areas and 4km buffers from March 2021 to February 2023 (inclusive) with a single survey per month. Therefore, the survey data were divided into 'pre-' (March 2021 - Feb 2022) and 'post' (March 2022 - Feb 2023) HPAI datasets. The data have been compared to the equivalent outputs obtained from Waggitt *et al.* (2019) and wind farms in proximity to the Projects: Hornsea Four, Dogger Bank A and B, and Dogger Bank C and Sofia. Given their location within the same region of the North Sea, it is reasonable to assume these projects may share similar factors affecting seabird activity and distribution.

Table 12-11 Wind farms used in density comparisons with Dogger Bank South.

Wind farm	Distance to DBS East (km)	Distance to DBS West (km)	Survey date range
Hornsea Project Four	42	41	April 2016 – March 2018
Dogger Bank C	56	65	January 2010 – Jun 2012
Sofia	34	38	
Dogger Bank A	8	8	January 2010 – November 2011
Dogger Bank B	24	17	

~~51.~~52. The data were also compared to the Waggitt *et al.* (2019) dataset, which provides a modelled density map of seabirds across the UK North Sea region. The data analysed in this report were gathered from various sources between 1980 and 2018 and collected using boat-based surveys.

~~52.~~53. The species-specific seasonal mean and peak densities for each species considered (gannet, kittiwake, guillemot, razorbill, puffin and great black-backed gull) were collated for comparison with the Projects' DAS data. The data for the other wind farms were extracted from their respective applications. The data from Waggitt *et al.* (2019) was extracted from the distribution maps produced from the report at 10km resolution, created from species distribution models. To obtain comparable densities for the Projects from the Waggitt *et al.* (2019) outputs the data were clipped using GIS and the monthly densities extracted for 10km cells that overlapped with the arrays' 4km boundaries. Seasonal means and peaks were obtained as for the other datasets.

~~53.~~54. The collated seasonal densities for the other sites are provided in **Table 12-12.**

Table 12-12 Mean and peak seasonal densities (birds/km²) reported from other North Sea sites in proximity to the Projects. Blanks (-) indicate non-applicable seasons.

Species & Wind Farm	Spring migration		Migration-free breeding		Autumn migration		Non-breeding	
	Mean density	Peak density	Mean density	Peak density	Mean density	Peak density	Mean density	Peak density
Kittiwake								
Waggitt DBS E	0.48	0.48	0.21	0.33	0.39	0.45	-	-
Waggitt DBS W	0.52	0.53	0.25	0.37	0.44	0.50	-	-
Hornsea Four	1.30	4.35	2.02	3.44	2.69	6.24	-	-
Dogger Bank C	2.08	2.99	2.26	6.34	0.81	1.21	-	-
Sofia	2.65	3.74	3.30	8.67	1.14	1.57	-	-
Dogger Bank A	4.53	5.56	4.49	9.43	1.63	2.08	-	-
Dogger Bank B	5.09	6.24	5.07	10.59	1.86	3.94	-	-
Guillemot								
Waggitt DBS E	-	-	0.54	0.85	0.83	1.01	1.17	1.26
Waggitt DBS W	-	-	0.67	0.99	1.08	1.30	1.40	1.45
Hornsea Four	-	-	8.53	11.40	-	-	15.82	39.45
Dogger Bank C	-	-	4.29	9.40	0.57	0.68	3.93	9.40
Sofia	-	-	6.46	14.11	1.72	2.05	5.72	8.98
Dogger Bank A	-	-	7.30	14.67	3.55	3.87	10.18	14.67
Dogger Bank B	-	-	11.72	19.97	11.08	12.09	13.90	21.58
Razorbill								

Species & Wind Farm	Spring migration		Migration-free breeding		Autumn migration		Non-breeding	
	Mean density	**Peak density**	**Mean density**	**Peak density**	**Mean density**	**Peak density**	**Mean density**	**Peak density**
Waggitt DBS E	0.17	0.21	0.05	0.06	0.13	0.17	0.19	0.19
Waggitt DBS W	0.20	0.23	0.06	0.06	0.17	0.20	0.22	0.22
Hornsea Four	0.33	0.37	0.25	0.39	2.51	4.41	0.63	0.76
Dogger Bank C	2.51	3.60	1.09	3.77	0.40	1.06	1.26	1.53
Sofia	3.67	5.44	1.43	4.90	0.73	1.69	1.77	2.09
Dogger Bank A	5.62	6.34	1.70	6.09	2.12	4.35	2.34	2.88
Dogger Bank B	6.35	7.18	1.91	6.82	2.56	4.94	2.66	3.28
Puffin								
Waggitt DBS E	-	-	0.02	0.02	-	-	0.01	0.01
Waggitt DBS W	-	-	0.03	0.04	-	-	0.01	0.02
Hornsea Four	-	-	0.10	0.25	-	-	0.13	0.48
Dogger Bank C	-	-	0.06	0.13	-	-	0.32	0.57
Sofia	-	-	0.07	0.15	-	-	0.36	0.58
Dogger Bank A	-	-	0.07	0.16	-	-	0.37	0.55
Dogger Bank B	-	-	0.18	0.39	-	-	0.82	1.24
Gannet								
Waggitt DBS E	0.06	0.06	0.12	0.16	0.10	0.12	-	-

Species & Wind Farm	Spring migration		Migration-free breeding		Autumn migration		Non-breeding	
	Mean density	Peak density	Mean density	Peak density	Mean density	Peak density	Mean density	Peak density
Waggitt DBS W	0.07	0.08	0.15	0.22	0.13	0.15	-	-
Hornsea Four	0.18	0.35	0.63	0.80	0.84	1.00	-	-
Dogger Bank C	0.17	0.30	0.37	1.26	0.31	0.49	-	-
Sofia	0.18	0.30	0.47	1.61	0.39	0.64	-	-
Dogger Bank A	0.17	0.24	0.29	0.71	0.82	1.26	-	-
Dogger Bank B	0.19	0.27	0.32	0.79	0.92	1.41	-	-
Great black-backed gull								
Waggitt DBS E	-	-	-	-	-	-	-	-
Waggitt DBS W	-	-	-	-	-	-	-	-
Hornsea Four	-	-	-	-	-	-	-	-
Dogger Bank C	-	-	0.06	0.14	0.11	0.19	-	-
Sofia	-	-	0.06	0.16	0.13	0.22	-	-
Dogger Bank A	-	-	0.05	0.16	0.14	0.29	-	-
Dogger Bank B	-	-	0.05	0.18	0.16	0.34	-	-

~~54.~~55. The range of densities across the six datasets, is reproduced in **Table 12-13** alongside the corresponding densities for the Projects. Wide variation in the densities recorded at the Projects is evident, and in many cases higher seasonal densities were recorded in the second ('post') year of data than the first ('pre').

~~55.~~56. The Projects' densities in both pre- and post- years also typically lie within the range of values from the other datasets and there are no clear patterns, such as consistently lower densities in the post- data than the pre-data. Therefore, there is no indication from these comparisons that HPAI affected the site characterisation survey results for the Projects. Given the highly variable nature of seabird distributions as reported in at sea surveys this is not an unexpected result. This is further to be expected since the colony reporting for the FFC SPA suggests that the breeding populations there have been comparatively little affected by HPAI (Butcher *et al.* 2023).

Table 12-13 Mean and peak seasonal densities (birds/km²) on DBS East, DBS West and the range reported from other North Sea sites in proximity to the Projects. See Table 12-12 for the densities reported on each wind farm and dataset used. Blanks (-) indicate non-applicable seasons

Species & Wind Farm	Spring migration		Migration-free breeding		Autumn migration		Non-breeding	
	Mean density	Peak density	Mean density	Peak density	Mean density	Peak density	Mean density	Peak density
Kittiwake								
DBS – East Pre	1.44	1.97	4.04	16.86	1.41	2.78	-	-
DBS – East Post	3.62	3.8	4.77	10.9	6.11	11.87	-	-
DBS – West Pre	1.57	2.05	2.54	5.91	0.66	0.92	-	-
DBS – West Post	4.05	4.58	6.45	18.3	8.41	12.81	-	-
Range (other data)	0.5 – 5.1	0.5 – 6.2	0.2 – 5.1	0.3 – 10.6	0.4 – 2.7	0.4 – 6.2	-	-
Guillemot								
DBS – East Pre	-	-	5.00	9.33	3.36	3.60	4.41	14.64
DBS – East Post	-	-	4.44	7.34	9.89	18.43	8.36	13.03
DBS – West Pre	-	-	6.31	9.92	2.70	3.31	3.30	7.67
DBS – West Post	-	-	7.09	13.40	16.55	30.83	9.46	19.35

Species & Wind Farm	Spring migration		Migration-free breeding		Autumn migration		Non-breeding	
	Mean density	Peak density	Mean density	Peak density	Mean density	Peak density	Mean density	Peak density
Range (other data)			0.5 – 11.7	0.8 – 20.0	0.8 – 11.1	1.0 – 12.1	1.2 – 15.8	1.3 – 39.4
Razorbill								
DBS – East Pre	2.03	5.07	0.42	1.23	0.36	0.56	1.87	3.54
DBS – East Post	3.33	4.95	0.49	0.71	6.34	12.24	3.59	4.47
DBS – West Pre	1.11	1.49	0.87	2.78	0.23	0.39	0.64	0.93
DBS – West Post	6.39	9.02	0.66	1.23	5.55	9.64	6.50	10.78
Range (other data)	0.2 – 6.3	0.2 – 7.2	0.1 – 1.9	0.1 – 6.8	0.1 – 2.6	0.2 – 4.9	0.2 – 2.7	0.2 – 3.3
Puffin								
DBS – East Pre	-	-	0.02	0.12	-	-	0.10	0.50
DBS – East Post	-	-	0.07	0.20	-	-	0.05	0.10
DBS – West Pre	-	-	0.09	0.35	-	-	0.09	0.47
DBS – West Post	-	-	0.09	0.17	-	-	0.04	0.18
Range (other data)			0.02-0.2	0.02-0.4			0.01-0.8	0.01-1.2
Gannet								
DBS – East Pre	0.01	0.01	0.42	1.21	0.64	1.01	-	-
DBS – East Post	0.15	0.23	0.72	2.31	1.29	1.78	-	-

Species & Wind Farm	Spring migration		Migration-free breeding		Autumn migration		Non-breeding	
	Mean density	Peak density	Mean density	Peak density	Mean density	Peak density	Mean density	Peak density
DBS – West Pre	0.00	0.00	0.48	0.95	0.48	0.55	-	-
DBS – West Post	0.15	0.39	0.74	1.84	1.55	2.12	-	-
Range (other data)	0.1-0.2	0.1-0.3	0.1-0.6	0.2-1.6	0.1-0.9	0.1-1.4		
Great black-backed gull								
DBS – East Pre	-	-	0.00	0.01	0.06	0.25	-	-
DBS – East Post	-	-	0.05	0.27	0.09	0.25	-	-
DBS – West Pre	-	-	0.01	0.05	0.04	0.11	-	-
DBS – West Post	-	-	0.01	0.05	0.07	0.16	-	-
Range (other data)			0.05-0.06	0.14-0.2	0.1-0.2	0.2-0.3		

12.5.3 Assessment of Nature Conservation Value for Each Bird Species

~~56.~~57. Bird abundances have been estimated from the digital aerial surveys of the Projects' Array Areas and species specific buffers (Parker *et al*. 2022c). The bird abundance estimates and how they were derived are presented in detail in the Ornithology Technical Appendix (**Volume 7**, **Appendix 12-2 Technical Appendix (application ref: 7.12.12.2)**). Detail from this report has not been repeated in this chapter to minimise unnecessary repetition.

~~57.~~58. Species assessed for impacts are those which were recorded during surveys and which are considered to be at potential risk either due to their abundance, potential sensitivity to wind farm impacts or due to biological characteristics which make them potentially susceptible (e.g. the species commonly flies at rotor heights). The conservation status of these species is provided in **Table 12-14**.

Table 12-14 Summary of Nature Conservation Value of Species Considered at Risk of Impacts.

Species	Conservation status
Red-throated diver	BoCC Green listed, Birds Directive Migratory Species
Fulmar	BoCC Amber listed, Birds Directive Migratory Species
Gannet	BoCC Amber listed, Birds Directive Migratory Species
Arctic skua	BoCC Red listed, Birds Directive Migratory Species
Great skua	BoCC Amber listed, Birds Directive Migratory Species
Puffin	BoCC Red listed, Birds Directive Migratory Species
Razorbill	BoCC Amber listed, Birds Directive Migratory Species
Common guillemot	BoCC Amber listed, Birds Directive Migratory Species
Common tern	BoCC Amber listed, Birds Directive Migratory Species, Birds Directive Annex 1
Arctic tern	BoCC Red listed, Birds Directive Migratory Species, Birds Directive Annex 1
Kittiwake	BoCC Red listed, Birds Directive Migratory Species
Little gull	BoCC Green listed, Birds Directive Migratory Species
Lesser black-backed gull	BoCC Amber listed, Birds Directive Migratory Species
Herring gull	BoCC Red listed, Birds Directive Migratory Species
Great black-backed gull	BoCC Red listed, Birds Directive Migratory Species

~~58.~~59. Impacts have been assessed in relation to relevant biological seasons, as defined by Furness (2015). For the nonbreeding period, the seasons and relevant population sizes for Biologically Defined Minimum Population Scales (BDMPS) were taken from Furness (2015; **Table 12-15**). For the breeding period, the potential for connectivity to known breeding populations has been considered in relation to species-specific foraging ranges (Woodward *et al*. 2019). Natural England also provided breeding season reference populations for kittiwake, guillemot and puffin (**Table 12-15**) and some of these were further updated by Natural England [RR-039].

~~59.~~60. The seasonal definitions in Furness (2015) include overlapping months in some instances due to variation in the timing of migration for birds which breed at different latitudes (i.e. individuals from breeding sites in the north of the species' range may still be on spring migration when individuals farther south have already commenced breeding). However, as a precautionary assumption, the full breeding season has been applied, with the adjacent nonbreeding months reduced to remove overlaps (i.e. if March was identified as a spring migration month and also a breeding season month, it was assigned only to the latter). The exception to this approach was for migrant seabird species (e.g. terns) which Natural England advised should be assessed with favour given to the migration seasons rather than the breeding season. Hence for these species, the migration free breeding season was applied and overlapping months assigned to pre- and post-breeding periods.

Table 12-15 Species Specific Seasonal Definitions and Biologically Defined Minimum Population Sizes (In Brackets) Have Been Taken from Furness (2015) or Natural England 2024 [RR-039] where updated. Chick rearing and moult periods for guillemot have been added as advised by Natural England [RR-039]). Shaded Cells Indicate the Appropriate Nonbreeding Season Periods Used in the Assessment for Each Species

Species	Breeding	Migration-free breeding	Migration - autumn	Winter	Migration - spring	Nonbreeding	Chick rearing and moult
Fulmar	Jan-Aug	Apr-Aug	Sep-Oct (957,502)	Nov (568,736	Dec-Mar (957,502)	-	-
Gannet	Mar-Sep (400,326)	Apr-Aug	Sep-Nov (456,299)	-	Dec-Mar (248,385)	Mar-Sep	-
Cormorant	Apr-Aug	May-Jul	-	-	-	Sep-Mar (10,460)	-
Shag	Feb-Aug	Mar-July	-	-	-	Sep-Jan (4,346)	-
Arctic skua	May-Jul	Jun-Jul	Aug-Oct (6,427)	-	Apr-May (1,227)	-	-
Great skua	May-Aug	May-Jul	Aug-Oct (19,556)	Nov-Feb (143)	Mar-Apr (8,485)	-	-
Puffin	Apr-Aug (868,689)	May-Jun	Jul-Aug	Sep-Feb	Mar-Apr	Mid-Aug-Mar (231,958)	-
Razorbill	Apr-Jul (158,031)	Apr-Jun	Aug-Oct (591,875)	Nov-Dec (218,621)	Jan-Mar (591,875)	-	-
Guillemot	Mar-Jul (2,045,078)	Mar-Jun	Jul-Oct	Nov	Dec-Feb	Oct-Feb** (1,617,305)	Aug & Sep (1,617,305)
Sandwich tern	Apr-Aug	Jun	Jul-Sep (38,051)	Oct-Feb	Mar-May (38,051)	Sep-Mar	-
Common tern	May-Aug	Jun-mid Jul	Late Jul-Sep (144,911)	-	Apr-May (144,911)	-	-

Species	Breeding	Migration-free breeding	Migration - autumn	Winter	Migration - spring	Nonbreeding	Chick rearing and moult
Arctic tern	May- early Aug	Jun	Jul-early Sep (163,930)	-	Apr-May (163,930)	-	-
Commic tern*	May-Aug	Jun	Jul-Sep (308,841)	-	Apr-May (308,841)	-	-
Kittiwake	Mar-Aug (839,456)	May-Jul	Aug-Dec (829,938)	-	Jan-Apr (627,816)	-	-
Little gull (Not included in Furness, 2015)	Apr-Jul	May-Jul	-	-	-	Aug-Apr	-
Lesser black-backed gull	Apr-Aug (51,233)	May-Jul	Aug-Oct (209,006)	Nov-Feb (39,313)	Mar-Apr (197,482)	-	-
Herring gull	Mar-Aug (324,887)	May-Jul	Aug-Nov	Dec	Jan-Apr	Sep-Feb (466,510)	-
Great black-backed gull	Mar-Aug (25,915)	May-Jul	Aug-Nov	Dec	Jan-Apr	Sep-Mar (91,398)	-

** Commic tern' is used to include common terns and Arctic terns, for instances where these species were not readily identified to species level from the survey data*

** Guillemot nonbreeding season has been reduced to October to February following the addition of a post-breeding period in August and September as per Natural England advice [RR-039]

~~60.~~61. In addition to BDMPS populations, the biogeographic populations have also been considered in the assessment where appropriate. These are provided in **Table 12-16**.

Table 12-16 Biogeographic Population Sizes Taken from Furness (2015).

Species	Biogeographic population with connectivity to UK waters (adults and immatures)
Red-throated diver	27,000
Fulmar	8,055,000
Gannet	1,180,000
Cormorant	324,000
Shag	106,000
Arctic skua	229,000
Great skua	73,000
Puffin	11,840,000
Razorbill	1,707,000
Guillemot	4,125,000
Sandwich tern	148,000
Common tern	248,000
Arctic tern	480,000
Commic tern*	628,000
Kittiwake	5,100,000
Great black-backed gull	235,000
Herring gull	1,098,000
Lesser black-backed gull	864,000
Little gull (not included in Furness, 2015)	75,000 #

 # Estimated passage population (Stienen et al., 2007)

** 'Commic tern' is used to include common terns and Arctic terns, for instances where these species were not readily identified to species level from the survey data*

~~61.~~62. The impact of additional mortality due to wind farm effects is assessed in terms of the change in the baseline mortality rate which could result. It has been assumed that all age classes are equally at risk of effects, with each age class affected in proportion to its presence in the population. Therefore, a weighted average baseline mortality rate has been calculated which is appropriate for all age classes for use in assessments, calculated for those species screened in for assessment. These were calculated using the different rates for each age class and their relative proportions in the population.

~~62.~~63. Natural England (2024, and RR-039) provided weighted average mortality rates which were used in this assessment update (see **Table 12-17**).

Table 12-17 Average Mortality Across All Age Classes as advised by Natural England (2024)

Species	Weighted average mortality rate
Red-throated diver	0.2277
Gannet	0.1866
Guillemot	0.1405
Razorbill	0.1302
Puffin	0.1190
Common tern	0.1728
Kittiwake	0.1577
Lesser black-backed gull	0.1237
Herring gull	0.1724
Great black-backed gull	0.0969

~~63.~~64. The seasonal peak abundance within species specific seasons (as defined in **Table 12-15**) recorded individually within the Array Areas are provided in **Table 12-18** (note these abundances do not include birds observed in the 4km buffer around the Array Areas).

~~64.~~65. The method to calculate the seasonal peaks for DBS Array Areas were as follows:

- The population density and abundance for each survey was calculated using design-based estimation methods, with 95% confidence intervals calculated using non-parametric bootstrapping (see **Volume 7, Appendix 12-2 Technical Appendix (application ref: 7.12.12.2)** for further details).
- For the ES, 24 months of data were collected, so these are presented as the abundance for each calendar month calculated as the mean of estimates for each month.

~~65.~~66. The seasonal peak was taken as the highest from the months falling within each season. Some months are included in both the full breeding season and the adjacent nonbreeding seasons. In these cases, the breeding season has taken precedence (i.e. if for a given species March falls in both the spring migration and full breeding season and a peak was recorded in this month it is only presented in the breeding season).

Table 12-18 Peak abundance estimates (and 95% Confidence Intervals) by Biological Season for Bird Species within the East and West Array Areas Recorded during Baseline Surveys. A post-breeding season has been added for guillemot as requested by Natural England [RR-039].

Species	**Biological Season**											
	Spring migration		**Breeding (full)**		**Autumn migration**		**Winter**		**Nonbreeding**		**Post-breeding / chick-rearing**	
	East	**West**	**East**	**West**	**East**	**West**	**East**	**West**	**East**	**West**	**East**	**West**
Red-throated diver	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	-	-
Fulmar	20.45 (0-64.85)	8.55 (0-34.2)	113.15 (16.76-368.98)	188.1 (16.48-485.76)	96.14 (8.3-226.05)	54.95 (8.44-126.91)	50.65 (0-151.96)	37.99 (0-98.56)	96.14 (8.3-226.05)	54.95 (8.44-126.91)	-	-
Gannet	70.76 (0-324.85)	64.13 (0-179.56)	597.8 (337.84-864.5)	570.42 (275.94-907.75)	479.96 (257.4-862.55)	617.24 (177.18-1209.83)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	-	-
Arctic skua	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	4.15 (0-24.91)	4.25 (0-25.52)	0 (0-0)	0 (0-0)	4.15 (0-24.91)	4.25 (0-25.52)	-	-
Great skua	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	4.26 (0-25.53)	4.1 (0-24.62)	4.93 (0-29.57)	4.1 (0-24.62)	4.93 (0-29.57)	-	-
Puffin	25.18 (0-90.65)	34.25 (0-107.64)	50 (0-130.01)	83.62 (0-206.58)	0 (0-0)	0 (0-0)	120.43 (0-355.93)	101.28 (10.15-263.21)	120.43 (0-355.93)	101.28 (10.15-263.21)	-	-
Razorbill	2379.41 (423.06-4972.75)	3068.6 (330.6-7144.05)	341.06 (142.03-625.52)	1687.02 (569.43-3184.59)	3488.69 (0-11538.87)	3689.79 (12.4-18245.08)	2430.95 (1654.89-3154.07)	3329.46 (392.66-7735.54)	3488.69 (0-11538.87)	3689.79 (12.4-18245.08)	-	-
Guillemot	3663.9 (1906.89-5972.19)	7127.07 (1205.56-15589.44)	6698.09 (2564.43-10942.41)	6142.93 (3813.62-9054.17)	5812.28 (930.48-16074.02)	9547.59 (1047.62-23953.7)	8760.2 (6834.3-11021.7)	4367.91 (3240.73-5525.44)	8760.2 (6834.3-11021.7)	9547.59 (1047.62-23953.7)	5812.28 (930.48-16074.02)	9547.59 (1047.62-23953.7)
Arctic tern	0 (0-0)	0 (0-0)	37.47 (0-124.89)	21.27 (0-93.58)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	-	-

Species	Biological Season											
	Spring migration		Breeding (full)		Autumn migration		Winter		Nonbreeding		Post-breeding / chick-rearing	
	East	West	East	West	East	West	East	West	East	West	East	West
Common tern	0 (0-0)	0 (0-0)	4.16 (0-24.98)	8.37 (0-25.25)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	-	-
Kittiwake	947.07 (469.34-1961.18)	1299.06 (271.65-3501.05)	5752.29 (2144.46-9946.21)	4253.42 (0-17216.18)	1669.31 (388.35-3717.29)	3477.95 (68.09-17855.75)	0 (0-0)	0 (0-0)	1669.31 (388.35-3717.29)	3477.95 (68.09-17855.75)	-	-
Little gull	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	4.24 (0-25.45)	-	-
Common gull	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	20.84 (0-83.26)	55.3 (0-204.18)	-	-
Lesser black-backed gull	4.2 (0-25.18)	0 (0-0)	8.33 (0-49.96)	4.2 (0-25.22)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	4.2 (0-25.18)	0 (0-0)	-	-
Herring gull	8.38 (0-50.29)	4.2 (0-25.22)	12.59 (0-50.36)	8.51 (0-42.54)	4.22 (0-25.33)	8.43 (0-33.7)	0 (0-0)	0 (0-0)	8.38 (0-50.29)	8.43 (0-33.7)	-	-
Great black-backed gull	92.19 (16.76-234.67)	16.61 (0-41.21)	42.23 (0-152.03)	8.51 (0-51.05)	4.22 (0-25.33)	16.96 (0-76.34)	4.24 (0-25.43)	29.9 (0-102.44)	92.19 (16.76-234.67)	29.9 (0-102.44)	-	-

12.5.4 Future Trends

~~66.~~67. In the event that the Projects are not developed, an assessment of future conditions for offshore ornithology has been carried out and is described within this section. Key drivers of seabird population size in western Europe are climate change (Sandvik *et al*. 2012; Frederiksen *et al*. 2004, 2013; Burthe *et al*. 2014; Macdonald *et al*. 2015; Furness 2016; JNCC 2016; Pearce-Higgins 2021), and fisheries (Tasker *et al*. 2000; Frederiksen *et al*. 2004; Ratcliffe 2004; Carroll *et al*. 2017; Sydeman *et al*. 2017). Pollutants (including oil, persistent organic pollutants, plastics), alien mammal predators at colonies, disease, and loss of nesting habitat also impact on seabird populations but are generally much less important and often more local factors (Ratcliffe 2004; Votier *et al*. 2005, 2008; JNCC 2016). In 2022 Highly Pathogenic Avian Influenza (HPAI) adversely affected survival and productivity within seabird colonies across the UK, and investigations are underway to determine the long-term effects on species' populations.

~~67.~~68. Trends in seabird numbers in breeding populations are better known, and better understood than trends in numbers at sea within particular areas. Breeding numbers are regularly monitored at many colonies (JNCC 2016), and in the British Isles there have been three comprehensive censuses of breeding seabirds in 1969-70, 1985-88 and 1998-2002 (Mitchell *et al*. 2004) as well as single-species surveys (such as the decadal counts of breeding gannet numbers, Murray *et al*. 2015). In contrast, the European Seabirds at Sea (ESAS) database is incomplete, and few data have been added since 2000, so that current trends in numbers at sea in areas of the North Sea are not so easy to assess.

~~68.~~69. Breeding numbers of many seabird species in the British Isles are declining, especially in the northern North Sea (Foster and Marrs 2012; Macdonald *et al*. 2015; JNCC 2016). The most striking exception is gannet, which continues to increase in abundance (Murray *et al*. 2015), although the rate of increase has been slowing (Murray *et al*. 2015). These trends in British seabird populations seem likely to continue in the short to medium term future, although for gannet, which has notably been susceptible to the effects of HPAI, the long-term impact on the population trend is unclear.

~~69.~~70. Climate change has been identified as one of three key threats to UK seabirds and a key cause of recent declines, along with invasive alien species and by-catch in fisheries (Burthe *et al*. 2014; Macdonald *et al*. 2015; Capuzzo *et al*. 2018; Dias *et al*. 2019, Mitchell *et al*. 2020. Pearce-Higgins 2021). Pearce-Higgins (2021) assessed the impact that climate change has already had on UK bird populations by relating their long-term trends to separately published species' responses to climate change, temperature and rainfall. It was found that of the 20 seabird species found in the UK, 14 are regarded as being at high or medium risk of negative climate change impacts. Documented declines in sandeel populations have led to reduced breeding success in seabirds, and at least partially underpin long-term population declines (Johnston *et al*. 2021).

~~70.~~71. Whilst the results of the current seabird census (Seabirds Count) will provide important information, there is already good evidence that kittiwake, Arctic skua, puffin and fulmar are being affected by climate processes (Frederiksen *et al*. 2004, Burthe *et al*. 2014, Cook *et al*. 2014, Perkins *et al*. 2018). It is therefore highly likely that breeding numbers of most of our seabird species will continue to decline under a scenario with continuing climate change due to increasing levels of greenhouse gases in the atmosphere. Fisheries management is also likely to influence future numbers in seabird populations. The Common Fisheries Policy (CFP) Landings Obligation ('discard ban') will further reduce food supply for scavenging seabirds such as great black-backed gulls, lesser black-backed gulls, herring gulls, fulmars, kittiwakes and gannets (Votier *et al*. 2004; Bicknell *et al*. 2013; Votier *et al*. 2013; Foster *et al*. 2017).

~~71.~~72. Recent changes in fisheries management that aid recovery of predatory fish stock biomass are likely to further reduce food supply for seabirds that feed primarily on small fish such as sandeels, as those small fish are major prey of large predatory fish. Therefore, anticipated future increases in predatory fish abundance resulting from improved management to constrain fishing mortality on those commercially important species at more sustainable levels than in the past are likely to cause further declines in stocks of small pelagic seabird 'food-fish' such as sandeels (Frederiksen *et al*. 2007; Macdonald *et al*. 2015). Lindegren *et al*. (2018) concluded that sandeel stocks in the North Sea, the most important prey fish stock for North Sea seabirds during the breeding season (Furness and Tasker 2000), have been depleted by high levels of targeted fishing effort.

~~72.~~73. These stocks are unlikely to recover fully despite the recent ban on sandeel fisheries in English waters (Defra, 2024), because climate change has altered the North Sea food web to the detriment of productivity of fish populations. As a result, seabird populations are likely to continue to experience food shortages in the North Sea, especially for those species most dependent on sandeels as food.

~~73.~~74. Future decreases in kittiwake breeding numbers are likely to be particularly pronounced, as kittiwakes are very sensitive to climate change (Frederiksen *et al*. 2013; Carroll *et al*. 2015) and to fishery impacts on sandeel stocks near breeding colonies (Frederiksen *et al*. 2004; Carroll *et al*. 2017), and the species will lose the opportunity to feed on fishery discards as the Landings Obligation comes into effect. Gannet numbers may continue to increase for some years, but evidence suggests that this increase is already slowing (Murray *et al*. 2015), and numbers may peak not too far into the future. While the Landings Obligation will reduce discard availability to gannets in European waters, in recent years increasing proportions of adult gannets have wintered in west African waters rather than in UK waters (Kubetzki *et al*. 2009), probably because there are large amounts of fish discarded by west African trawl fisheries and decreasing amounts available in the North Sea (Kubetzki *et al*. 2009; Garthe *et al*. 2012). The flexible behaviour and diet of gannets probably reduces their vulnerability to changes in fishery practices or to climate change impacts on fish communities (Garthe *et al*. 2012).

~~74.~~75. Fulmars, terns, common guillemot, razorbill and puffin appear to be highly vulnerable to climate change, so numbers may decline over the next few decades (Burthe *et al*. 2014). Strong declines in shag numbers are likely to continue as they are adversely affected by climate change, by low abundance of sandeels and especially by stormy and wet weather conditions in winter (Burthe *et al*. 2014; Frederiksen *et al*. 2008). Most of the red-throated divers and common scoters wintering in the southern North Sea originate from breeding areas at high latitudes in Scandinavia and Russia. Numbers of red-throated divers and common scoters wintering in the southern North Sea may possibly decrease in future if warming conditions make the Baltic Sea more favourable as a wintering area for those species so that they do not need to migrate as far as UK waters. There has been a trend of increasing numbers of sea ducks remaining in the Baltic Sea overwinter (Mendel *et al*. 2008; Fox *et al*. 2016; Ost *et al*. 2016) and decreasing numbers coming to the UK (Austin and Rehfisch 2005; Pearce-Higgins and Holt 2013), and that trend is likely to continue, although to an uncertain extent.

~~75.~~76. ESAS data indicate that there has already been a long-term decrease in numbers of great black-backed gulls wintering in the southern North Sea (S. Garthe *et al*. in prep.), and the Landings Obligation will probably result in further decreases in numbers of north Norwegian great black-backed gulls and herring gulls coming to the southern North Sea in winter. It is likely that further redistribution of breeding herring gulls and lesser black-backed gulls will occur into urban environments (Rock and Vaughan 2013), although it is unclear how the balance between terrestrial and marine feeding by these gulls may alter over coming years; that may depend greatly on the consequences of Brexit for UK fisheries and farming. Some of the human impacts on seabirds are amenable to effective mitigation (Ratcliffe *et al*. 2009; Brooke *et al*. 2018), but the scale of efforts to reduce these impacts on seabird populations has been small by comparison with the major influences of climate change and fisheries. This is likely to continue to be the case in future, and the conclusion must be that with the probable exception of gannet, numbers of almost all other seabird species in the UK North Sea region will most likely be on a downward trend over the next few decades, due to population declines, redistributions or a combination of both.

~~76.~~77. For offshore ornithology, the ecological impact assessment is therefore carried out in a context of declining baseline populations of a number of species. Where a species is declining, the assessment takes into account whether a given impact is likely to exacerbate a decline in the relevant reference population and prevent a species from recovery should environmental conditions become more favourable.

~~77.~~78. Climate change has been identified as the strongest influence on future seabird population trends. In this context it is noted that a key component of global strategies to reduce climate change is the development of low-carbon renewable energy developments such as offshore wind.

12.6 Assessment of Significance

12.7 Potential Effects During Construction

12.7.1 Impact 1 Direct Disturbance and Displacement from Increased Vessel Activity

12.7.1.1 Array Areas

~~78.~~79. The Projects have the potential to affect bird populations in the marine environment through disturbance due to activity leading to displacement of birds from construction areas.

~~79.~~80. Although there is a degree of flexibility in the Projects' Design Envelopes regarding construction scenarios, section 12.3.2.2 set out the scenarios and identified that either concurrent or sequential construction of the wind farms would generate similar levels of disturbance overall. Assuming a constructed wind farm generates impacts which are, on average, 50% those of an operational one (as per Natural England guidance) both these scenarios are equivalent to four years of wind farm operation.

~~80.~~81. The construction phase would require the mobilisation of vessels, helicopters and equipment and the installation of foundations, export cables and other infrastructure. These activities have the potential to disturb and displace birds from within and around the Array Areas and Offshore Export Cable Corridor. Causes of potential disturbance would comprise the presence of construction vessels and associated human activity, noise and vibration from construction activities and lighting associated with construction sites. The level of disturbance at each work location would differ dependent on the activities taking place, but there could be vessel movements at any time of day or night over the construction period.

~~81.~~82. Any impacts resulting from disturbance and displacement from construction activities would be short-term, temporary and reversible in nature, lasting only for the duration of construction activity, with birds expected to return to the area once construction activities have ceased. Construction related disturbance and displacement is most likely to affect foraging birds. Furthermore, modelling of the consequences of displacement for fitness of displaced birds suggests that even in the case of breeding seabirds that are displaced on a daily basis, there is likely to be little or no impact on survival unless the offshore windfarm is close to the breeding colony (Searle *et al*. 2014, 2017).

~~82.~~83. Bird species differ in their susceptibility to anthropogenic disturbance and in their responses to noise and visual disturbance stimuli. The principal source of noise during construction would be subsea noise from piling works associated with the installation of foundations for wind turbines and associated offshore substation platforms. While assessed for marine mammals and fish, subsea noise is not considered a risk factor for diving birds and it is thought that birds do not hear well underwater (Dooling and Therrien, 2012). Seabirds and other diving bird species will spend most of their time above or on the water surface, where hearing will detect sound propagated through the air.

~~83.~~84. Anatomical studies of ear structure in diving birds suggest that there are adaptations for protection against the large pressure changes that may occur while diving, which may reduce hearing ability underwater but also protect the ear from damage due to acoustic over-exposure (Dooling and Therrien, 2012). Above water noise disturbance from construction activities is not considered in isolation as a risk factor for birds; but rather, combined with the presence of vessels, man-made structures, and human activity, part of the overall disturbance stimulus that causes birds to avoid boats and other structures – as discussed below (section 12.7).

~~84.~~85. Lighting of construction sites, vessels and other structures at night may potentially be a source of attraction (phototaxis), as opposed to displacement, for birds; however, the areas affected would be very small, and restricted to offshore construction areas which are active at night at a given time.

~~85.~~86. Phototaxis can be a serious hazard for fledglings of some seabird species (notably petrels and shearwaters) but occurs over short distances (hundreds of metres) in response to bright white light close to breeding colonies of these species. It is not seen over large distances or in older (adult and immature) seabirds (**Volume 7**, **Appendix 12-11 Review of Turbines Lighting - Furness 2018 (application ref: 7.12.12.11)**) (Furness, 2018). Construction sites associated with the Offshore Development Area would be far enough removed from any seabird breeding colonies as to render this risk negligible. Phototaxis of nocturnal migrating birds can be a problem, especially in autumn during conditions of poor visibility, but is generally seen where birds are exposed to intense white lighting such as from lighthouses; light from construction sites is likely to be one or two orders of magnitude less powerful than that from lighthouses (**Volume 7, Appendix 12-11 Review of Turbines Lighting - Furness 2018 (application ref: 7.12.12.11)**) (Furness, 2018).

~~86.~~87. Construction would not occur across the whole of the proposed Array Areas simultaneously or every day but will be phased and assumed to occur at up to a maximum of three discrete locations for the purposes of this assessment. Until wind turbines (and other structures) are placed on foundations, the impacts will occur only in the areas where vessels are operating at any given point and not the entire Array Areas. When installation of wind turbines (and other infrastructure) begins, the impact of displacement would be expected to increase incrementally to the same levels as operational impacts (section 12.8, below).

~~87.~~88. It would be very difficult to undertake an assessment of displacement which reflected the gradual increase in the number of turbines. Therefore, to simplify this assessment it has been assumed that the effect is 50% of that for the fully constructed wind farm and lasts for the period of turbine installation (this accords with advice from Natural England, see **Volume 7, Appendix 12-1 Offshore Ornithology Consultation Responses (application ref: 7.12.12.1)**).

~~88.~~89. Considering variation between species in response to disturbance, gulls are not considered susceptible to disturbance, as they are often associated with fishing boats (e.g. Camphuysen, 1995; Hüppop and Wurm, 2000) and have been noted in association with construction vessels at the Greater Gabbard offshore wind farm (GGOWL, 2011) and close to active foundation piling activity at the Egmond aan Zee (OWEZ) wind farm, where they showed no noticeable reactions to the works (Leopold and Camphuysen, 2007); and Irwin *et al*. (2019) found that great black-backed gull distribution within the Outer Thames Estuary SPA showed a slight skew towards shipping lanes in the southern sector. However, at the other end of the spectrum, species such as divers and scoters have been observed to avoid shipping by several kilometres (Mitschke *et al*., 2001 from Exo *et al*. 2003; Garthe and Hüppop, 2004; Schwemmer *et al*., 2011), and Irwin *et al*. (2019) found that red-throated divers clearly showed displacement from shipping lanes within the Outer Thames SPA.

~~89.~~90. There are a number of different measures used to assess bird disturbance and displacement from areas of sea in response to activities associated with an offshore windfarm. Garthe and Hüppop (2004) developed a scoring system for such disturbance factors which they applied to seabird species in German sectors of the North Sea. This was refined by Furness and Wade (2012) and Furness *et al*. (2013) with a focus on seabirds using Scottish offshore waters. The approach uses information in the scientific and 'grey' literature, as well as expert opinion to identify disturbance ratings for individual species, alongside scores for habitat flexibility and conservation importance. These factors were used to define an index value that highlights the sensitivity of a species to disturbance and displacement. As many of these references relate to disturbance from helicopter and vessel activities, these are considered relevant to this assessment.

~~90.~~91. In order to focus the assessment of disturbance and displacement, a screening exercise was undertaken to identify those species most likely to be at risk (**Table 12-19**). Any species recorded only in very small numbers within the Study Area or with a low sensitivity to displacement was screened out of further assessment.

~~91.~~92. The species screened in for assessment were: gannet, guillemot, razorbill and puffin. These were assessed for impacts during the construction period and spatial locations where effects were likely.

~~92.~~93. The increase in mortality rate has been calculated for each Array Area separately (DBS East and DBS West) to estimate effects for each Array Area, with the results summed to obtain the combined impact.

Table 12-19 Construction Disturbance and Displacement Screening

Species	Sensitivity to Disturbance and Displacement[1]	Screening Result (IN or OUT)	Rationale
Red-throated diver	High	OUT	Single individual recorded in one baseline survey during passage migration period. Site is unsuitable habitat as too far from shore.
Fulmar	Low	OUT	Recorded at low densities during baseline surveys and not considered at risk of disturbance

Species	Sensitivity to Disturbance and Displacement[1]	Screening Result (IN or OUT)	Rationale
Gannet	Low	IN	Recorded at moderate densities during baseline surveys and considered to be at risk of disturbance
Arctic skua	Low	OUT	Recorded in very low numbers on baseline surveys and only during passage migration periods
Great skua	Low	OUT	Recorded in very low numbers on baseline surveys and only during passage migration periods
Puffin	Medium	IN	Recorded at moderate densities during baseline surveys and considered to be at risk of disturbance
Razorbill	Medium	IN	Recorded at high densities during baseline surveys and considered to be at risk of disturbance
Guillemot	Medium	IN	Recorded at high densities during baseline surveys and considered to be at risk of disturbance
Arctic tern	Low	OUT	Recorded in very low numbers on baseline surveys and only during passage migration periods
Common tern	Low	OUT	Recorded in very low numbers on baseline surveys and only during passage migration periods
Sandwich tern	Low	OUT	Not recorded during baseline surveys
Kittiwake	Low	OUT	Recorded at moderate densities during baseline surveys but not considered at risk of disturbance

Species	Sensitivity to Disturbance and Displacement[1]	Screening Result (IN or OUT)	Rationale
Little gull	Low	OUT	Recorded at very low densities during baseline surveys and not considered at risk of disturbance
Common gull	Low	OUT	Recorded at very low densities during baseline surveys and not considered at risk of disturbance
Lesser black-backed gull	Low	OUT	Recorded at very low densities during baseline surveys and not considered at risk of disturbance
Herring gull	Low	OUT	Recorded at low densities during baseline surveys and not considered at risk of disturbance
Great black-backed gull	Low	OUT	Recorded at low densities during baseline surveys and not considered at risk of disturbance
[1] With reference to Garthe and Hüppop, 2004; Furness and Wade, 2012; Furness *et al.*, 2013; Wade *et al.*, 2016; Goodship and Furness, 2022.			

12.7.1.1.1 Gannet

~~93.~~94. This section provides the update to section 12.6.1.1.1.1 of the ES.

~~94.~~95. The nearest gannet breeding colony to the Array Areas is the Flamborough and Filey Coast SPA. The SPA is a minimum of 100km from the Projects' Array Areas, and therefore they are within the mean maximum foraging range of gannets, estimated as 315km (Woodward *et al.* 2019). Consequently, breeding season connectivity to this SPA has been assumed. Although the gannets which breed at the Bass Rock, part of the Forth Islands SPA, are also within this distance (c. minimum of 290km to the Projects), Wakefield *et al.* (2013) found very little overlap in colony foraging areas, so connectivity is considered very unlikely during the breeding season.

~~95.~~96. Gannets were recorded in the Array Areas year round, with peak estimated densities within the DBS East Array Area plus 2km buffer in October (1.52/km^2) and in the DBS West Array Area plus 2km buffer in April (1.55/km^2).

~~96.~~97. Natural England has advised that the gannet breeding season BDMPS reference population for the North Sea and Channel appropriate for this assessment is 400,326 individuals [RR-039]. The number of individuals from this population expected to die at the baseline mortality rate (**Table 12-15**) in the breeding season is 74,701 (400,326 x 0.1866).

~~97.~~98. During the nonbreeding seasons the gannet BDMPS populations for the North Sea and Channel have been used as the reference populations (in the autumn: 456,299 and in the spring: 248,385). For the annual assessment. impacts have been considered in relation to the largest of the BDMPS populations (autumn) and also to the biogeographic population (1,180,000; Furness, 2015). The number of individuals from these populations expected to die in the autumn is 85,145 (456,299 x 0.1866), in the spring is 46,349 (248,385 x 0.1866), and annually from the biogeographic population is 220,188 (1,180,000 x 0.1866).

12.7.1.1.1.1 Significance of Effect – DBS East in Isolation

12.7.1.1.1.1.1 Breeding Season – construction vessels

~~98.~~99. For this precautionary assessment it has been assumed that 1% of displaced individuals could be at risk of mortality as a result of displacement by construction vessels (as per Natural England advice for wind farms in similar areas of the North Sea).

~~99.~~100. During the breeding season, the maximum mean peak density in the DBS East Array Area and 2km buffer was 1.48/km^2. With a 2km radius of disturbance around each of three active construction areas (wind turbines or other infrastructure), up to 56 individuals (1.48 x 12.56 x 3) could be at risk of displacement, of which 0.56 (1%) would be expected to be at risk of mortality.

~~100.~~101. Based on the average mortality for the species of 0.1866 a total of 74,701 birds would be expected to die each year. The addition of a maximum of 0.56 birds predicted to be at risk of mortality from construction disturbance and displacement would increase the mortality rate by 0.001%, which is below the 1% threshold for detectability.

~~101.~~102. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.1.2 Breeding Season – 50% installed turbines

~~102.~~103. The impact from half the wind farm during the breeding season has been assumed to be half of that estimated for operational displacement in the breeding season (section 12.8.1.1.1.1.1). Thus, a maximum of 3.02 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1866 a total of 74,701 birds would be expected to die each year. The addition of 3.02 individuals would increase the mortality rate by 0.004%, which is below the 1% threshold for detectability.

~~103.~~104. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season period, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.1.3 Breeding Season – construction vessels and 50% installed turbines

~~104.~~105. The combination of displacement by construction vessels and half of that estimated for operational displacement in the breeding season gives a maximum of 3.58 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1866 a total of 74,701 birds would be expected to die each year. The addition of 3.58 individuals would increase the mortality rate by 0.005%, which is below the 1% threshold for detectability.

~~105.~~106. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season period, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.1.4 Autumn Migration – construction vessels

~~106.~~107. During the autumn migration season the maximum mean peak density in the DBS East Array Area and 2km buffer was 1.52 /km^2. With a precautionary 2km radius of disturbance around each of three construction areas (wind turbines or other infrastructure) up to 57 individual birds (1.52 x 12.56 x 3) could be at risk of displacement, of which 0.57 (1%) birds would be predicted to be at risk of mortality.

~~107.~~108. At the average baseline mortality rate for gannet of 0.1866, a total of 85,145 birds would be expected to die in autumn. The addition of 0.57 to this would increase the mortality rate by 0.001%, which is below the 1% threshold for detectability.

~~108.~~109. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.1.5 Autumn Migration – 50% installed turbines

~~109.~~110. The impact from half the wind farm during the autumn migration period has been assumed to be half of that estimated for operational displacement in the autumn migration period (section 12.8.1.1.1.1.2). Thus, a maximum of 3.10 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1866 a total of 85,145 birds would be expected to die each year. The addition of 3.10 individuals would increase the mortality rate by 0.004%, which is below the 1% threshold for detectability.

~~110.~~111. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.1.6 Autumn Migration – construction vessels and 50% installed turbines

~~111.~~112. The combination of displacement by construction vessels and half of that estimated for operational displacement in the autumn migration period gives a maximum of 3.67 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1866 a total of 85,145 birds would be expected to die each year. The addition of 3.67 individuals would increase the mortality rate by 0.004%, which is below the 1% threshold for detectability.

~~112.~~113. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible.**

12.7.1.1.1.1.7 Spring Migration – construction vessels

~~113.~~114. During the spring migration season, the maximum mean peak density in the DBS East Array Area and 2km buffer was 0.15/km^2. With a precautionary 2km radius of disturbance around each of three construction areas (wind turbines or other infrastructure), up to 6 individual birds (0.15 x 12.56 x 3) could be at risk of displacement, of which 0.06 (1%) a would be expected to be at risk of mortality.

~~114.~~115. Based on the average mortality for the species of 0.1866, a total of 46,349 birds would be expected to die in spring. The addition of a maximum of 0.06 to this would increase the mortality rate by <0.001%, which is below the 1% threshold for detectability.

~~115.~~116. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is negligible.

12.7.1.1.1.1.8 Spring Migration – 50% installed turbines

~~116.~~117. The impact from half the wind farm during the spring migration period has been assumed to be half of that estimated for operational displacement in the spring migration period (section 12.8.1.1.1.1.3). Thus, a maximum of 0.3 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1866 a total of 46,349 birds would be expected to die each year. The addition of 0.3 individuals would increase the mortality rate by 0.001%, which is below the 1% threshold for detectability.

~~117.~~118. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is negligible.

12.7.1.1.1.1.9 Spring Migration – construction vessels and 50% installed turbines

~~118.~~119. The combination of displacement by construction vessels and half of that estimated for operational displacement in the spring migration period gives a maximum of 0.36 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1866 a total of 46,349 birds would be expected to die each year. The addition of 0.36 individuals would increase the mortality rate by 0.001%, which is below the 1% threshold for detectability.

~~119.~~120. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.1.10 Annual – construction vessels

~~120.~~121. The estimated number of gannets subject to construction disturbance / displacement mortality at DBS East throughout the year is 1.19 individuals.

~~121.~~122. At the average baseline mortality rate for gannet of 0.1866, a total of 85,145 birds would be expected to die from the largest BDMPS population throughout the year. The addition of a maximum of 1.19 to this increases the mortality rate by 0.001%, which is below the 1% threshold for detectability.

~~122.~~123. The number of individuals from the biogeographic population expected to die across all seasons is 220,188. The addition of a maximum of 1.19 to this increases the mortality rate by <0.001%, which is below the 1% threshold for detectability.

~~123.~~124. The sensitivity of gannet to construction displacement is considered to be low and the magnitude of annual impact at DBS East is negligible, therefore the annual effect on gannet due to construction displacement at DBS East is assessed as **negligible**.

12.7.1.1.1.1.11 Annual – 50% installed turbines

~~124.~~125. The impact from half the wind farm during the annual impact at DBS East has been assumed to be half of that estimated for operational displacement in the annual impact at DBS East (section 12.8.1.1.1.1.4). Thus, a maximum of 6.42 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1866 a total of 85,145 birds from the largest BDMPS population would be expected to die each year. The addition of 6.42 individuals would increase the mortality rate by 0.008%, which is below the 1% threshold for detectability.

~~125.~~126. The number of individuals from the biogeographic population expected to die across all seasons is 220,188. The addition of a maximum of 6.42 to this increases the mortality rate by 0.003%, which is below the 1% threshold for detectability.

~~126.~~127. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the magnitude of the annual impact at DBS East is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.1.12 Annual – construction vessels and 50% installed turbines

~~127.~~128. The combination of displacement by construction vessels and half of that estimated for operational displacement the annual impact at DBS East gives a maximum of 7.61 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1866 **Table 12-17**a total of 85,145 birds from the largest BDMPS population would be expected to die each year. The addition of 7.61 individuals would increase the mortality rate by 0.009%, which is below the 1% threshold for detectability.

~~128.~~129. The number of individuals from the biogeographic population expected to die across all seasons is 220,188. The addition of a maximum of 7.61 to this increases the mortality rate by 0.003%, which is below the 1% threshold for detectability.

~~129.~~130. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the magnitude of annual impact at DBS East is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.2 Significance of Effect – DBS West in Isolation

12.7.1.1.1.2.1 Breeding Season – construction vessels

~~130.~~131. During the breeding season, the maximum mean peak density in the DBS West Array Area and 2km buffer was 1.55/km^2. With a precautionary 2km radius of disturbance around each of three active construction areas (wind turbines or other infrastructure), up to 58 individuals (1.55 x 12.56 x 3) could be at risk of displacement, of which 0.58 (1%) would be expected to be at risk of mortality.

~~131.~~132. Based on the average mortality for the species of 0.1866 a total of 74,701 birds would be expected to die in the breeding season. The addition of a maximum of 0.58 birds predicted to be at risk of mortality from construction disturbance and displacement to these would increase the mortality rate by 0.001%, which is below the 1% threshold for detectability.

~~132.~~133. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the magnitude of annual impact at DBS West is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.2.2 Breeding Season – 50% installed turbines

~~133.~~134. The impact from half the wind farm during the breeding season has been assumed to be half of that estimated for operational displacement in the breeding season (section 12.8.1.1.1.2.1).Thus, a maximum of 3.22 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1866 a total of 74,701 birds would be expected to die each year. The addition of 3.22 individuals would increase the mortality rate by 0.004%, which is below the 1% threshold for detectability.

~~134.~~135. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season period, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.2.3 Breeding Season – construction vessels and 50% installed turbines

~~135.~~136. The combination of displacement by construction vessels and half of that estimated for operational displacement in the breeding season gives a maximum of 3.80 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1866 a total of 74,701 birds would be expected to die each year. The addition of 3.80 individuals would increase the mortality rate by 0.005%, which is below the 1% threshold for detectability.

~~136.~~137. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season period, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.2.4 Autumn Migration – construction vessels

~~137.~~138. During the autumn migration season the maximum mean peak density in the DBS West Array Area and 2km buffer was 1.54/km^2. With a precautionary 2km radius of disturbance around each of three construction areas (wind turbines or other infrastructure) up to 58 individual birds (1.54 x 12.56 x 3) could be at risk of displacement, of which 0.58 (1%) would be predicted to be at risk of mortality.

~~138.~~139. At the average baseline mortality rate for gannet of 0.1866 a total of 85,145 birds would be expected to die in autumn. The addition of a maximum of 0.58 to this would increase the mortality rate by <0.001%, which is below the 1% threshold for detectability.

~~139.~~140. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.2.5 Autumn Migration – 50% installed turbines

~~140.~~141. The impact from half the wind farm during the autumn migration period has been assumed to be half of that estimated for operational displacement in the autumn migration period (section 12.8.1.1.1.2.2). Thus, a maximum of 3.19 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1866 a total of 85,145 birds would be expected to die each year. The addition of 3.19 individuals would increase the mortality rate by 0.004%, which is below the 1% threshold for detectability.

~~141.~~142. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.2.6 Autumn Migration – construction vessels and 50% installed turbines

~~142.~~143. The combination of displacement by construction vessels and half of that estimated for operational displacement in the autumn migration period gives a maximum of 3.77 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1866 a total of 85,145 birds would be expected to die each year. The addition of 3.77 individuals would increase the mortality rate by 0.004%, which is below the 1% threshold for detectability.

~~143.~~144. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.2.7 Spring Migration – construction vessels

~~144.~~145. During the spring migration season, the maximum mean peak density in the DBS West array and 2km buffer was $0.17/km^2$. With a precautionary 2km radius of disturbance around each of three construction areas (wind turbines or other infrastructure), up to 6 individual birds (0.17 x 12.56 x 3) could be at risk of displacement, of which 0.06 (1%) would be expected to be at risk of mortality.

~~145.~~146. Based on the average mortality for the species of 0.1866, a total of 46,349 birds would be expected to die in spring. The addition of a maximum of 0.06 to this would increase the mortality rate by <0.001%, which is below the 1% threshold for detectability.

~~146.~~147. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.2.8 Spring Migration – 50% installed turbines

~~147.~~148. The impact from half the wind farm during the spring migration period has been assumed to be half of that estimated for operational displacement in the spring migration period (section 12.8.1.1.1.2.3). Thus, a maximum of 0.34 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1866 a total of 46,349 birds would be expected to die each year. The addition of 0.34 individuals would increase the mortality rate by 0.001%, which is below the 1% threshold for detectability.

~~148.~~149. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.2.9 Spring Migration – construction vessels and 50% installed turbines

~~149.~~150. The combination of displacement by construction vessels and half of that estimated for operational displacement in the spring migration period gives a maximum of 0.40 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1866 a total of 46,349 birds would be expected to die each year. The addition of 0.40 individuals would increase the mortality rate by 0.001%, which is below the 1% threshold for detectability.

~~150.~~151. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.2.10 Annual – construction vessels

~~151.~~152. The estimated number of gannets subject to construction disturbance / displacement mortality at DBS West throughout the year is 1.23 individuals.

~~152.~~153. At the average baseline mortality rate for gannet of 0.1866, a total of 85,145 birds would be expected to die from the largest BDMPS population throughout the year. The addition of a maximum of 1.23 to this would increase the mortality rate by 0.001%, which is below the 1% threshold for detectability.

~~153.~~154. The number of individuals from the biogeographic population expected to die across all seasons is 220,188. The addition of a maximum of 1.23 to this increases the mortality rate by <0.001%, which is below the 1% threshold for detectability.

~~154.~~155. The sensitivity of gannet to construction displacement is considered to be low and the magnitude of annual impact at DBS West is negligible, therefore the annual effect on gannet due to construction displacement at DBS West is assessed as **negligible**.

12.7.1.1.1.2.11 Annual – 50% installed turbines

~~155.~~156. The impact from half the wind farm during the annual impact at DBS West, has been assumed to be half of that estimated for operational displacement in the annual impact at DBS West, (section 12.8.1.1.1.2.4). Thus, a maximum of 6.76 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1866 a total of 85,145 birds from the largest BDMPS population would be expected to die each year. The addition of 6.76 individuals would increase the mortality rate by 0.008, which is below the 1% threshold for detectability.

~~156.~~157. The number of individuals from the biogeographic population expected to die across all seasons is 220,188. The addition of a maximum of 6.76 to this increases the mortality rate by 0.008%, which is below the 1% threshold for detectability.

~~157.~~158. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the magnitude of annual impact at DBS West is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.2.12 Annual – construction vessels and 50% installed turbines

~~158.~~159. The combination of displacement by construction vessels and half of that estimated for operational displacement the annual impact at DBS West gives a maximum of 7.99 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1866 a total of 85,145birds from the largest BDMPS population would be expected to die each year. The addition of 7.99 individuals would increase the mortality rate by 0.009%, which is below the 1% threshold for detectability.

~~159.~~160. The number of individuals from the biogeographic population expected to die across all seasons is 220,188. The addition of a maximum 7.99 to this increases the mortality rate by 0.004%, which is below the 1% threshold for detectability.

~~160.~~161. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the magnitude of annual impact at DBS West is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.3 Significance of Effect – DBS East and DBS West Together

12.7.1.1.1.3.1 Breeding Season – construction vessels

~~161.~~162. During the breeding season the combined number of gannets at risk of mortality due to displacement from construction activity across the Array Areas was 1.14 birds.

~~162.~~163. Based on the average mortality for the species of 0.1866, a total of 74,701 birds would be expected to die in the breeding season. The addition of 1.14 individuals to this would increase the mortality rate by 0.002%, which is below the 1% threshold for detectability.

~~163.~~164. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.3.2 Breeding Season – 50% installed turbines

~~164.~~165. The combined impact from half of the Array Areas during the breeding season has been assumed to be half of that estimated for operational displacement in the breeding season (section 12.8.1.1.1.3.1). Thus, a maximum of 6.24 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1886 a total of 74,701 birds would be expected to die each year. The addition of 6.24 individuals would increase the mortality rate by 0.008%, which is below the 1% threshold for detectability.

~~165.~~166. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season period, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.3.3 Breeding Season – construction vessels and 50% installed turbines

~~166.~~167. The combination of displacement by construction vessels and half of that estimated for operational displacement in the breeding season for the Array Areas gives a combined maximum of 7.38 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1866 a total of 74,701 birds would be expected to die each year. The addition of 7.38 individuals would increase the mortality rate by 0.010%, which is below the 1% threshold for detectability.

~~167.~~168. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season period, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.3.4 Autumn Migration – construction vessels

~~168.~~169. During the autumn the combined number of gannets at risk of mortality due to displacement from construction activity across the Array Areas was 1.15 birds.

~~169.~~170. At the average baseline mortality rate for gannet of 0.1866, a total of 85,145 birds would be expected to die in autumn. The addition of a maximum of 1.15 to this increases the mortality rate by 0.001%, which is below the 1% threshold for detectability.

~~170.~~171. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.3.5 Autumn Migration – 50% installed turbines

~~171.~~172. The combined impact from half of the Array Areas during the autumn migration period has been assumed to be half of that estimated for operational displacement in the autumn migration period (section 12.8.1.1.1.3.2). Thus, a maximum of 6.30 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1866 a total of 85,145 birds would be expected to die each year. The addition of 6.30 individuals would increase the mortality rate by 0.007%, which is below the 1% threshold for detectability.

~~172.~~173. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.3.6 Autumn Migration – construction vessels and 50% installed turbines

~~173.~~174. The combination of displacement by construction vessels and half of that estimated for operational displacement in the autumn migration period for the Array Areas gives a combined maximum of 7.45 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1866 a total of 85,145 birds would be expected to die each year. The addition of 7.45 individuals would increase the mortality rate by 0.009%, which is below the 1% threshold for detectability.

~~174.~~175. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.3.7 Spring Migration – construction vessels

~~175.~~176. During the spring season the combined number of gannets at risk of mortality due to displacement from construction activity across the Array Areas was 0.12 birds.

~~176.~~177. Based on the average mortality for the species of 0.1866, a total of 46,349 birds would be expected to die in spring. The addition of a maximum of 0.12 to this increases the mortality rate by <0.001%, which is below the 1% threshold for detectability.

~~177.~~178. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.3.8 Spring Migration – 50% installed turbines

~~178.~~179. The combined impact from half of the Array Areas during the spring migration period has been assumed to be half of that estimated for operational displacement in the spring migration period (section 12.8.1.1.1.3.3). Thus, a maximum of 0.64 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1866 a total of 46,349 birds would be expected to die each year. The addition of 0.64 individuals would increase the mortality rate by 0.001%, which is below the 1% threshold for detectability.

~~179.~~180. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.3.9 Spring Migration – construction vessels and 50% installed turbines

~~180.~~181. The combination of displacement by construction vessels and half of that estimated for operational displacement in the spring migration period for the Array Areas gives a maximum of 0.76 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1866 a total of 46,349 birds would be expected to die each year. The addition of 0.76 individuals would increase the mortality rate by 0.002%, which is below the 1% threshold for detectability.

~~181.~~182. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.3.10 Annual – construction vessels

~~182.~~183. Throughout the year the combined number of gannets at risk of mortality due to displacement from construction activity across the Array Areas was up to 2.42 individuals.

~~183.~~184. At the average baseline mortality rate for gannet of 0.1866, a total of 85,145 birds would be expected to die from the largest BDMPS population throughout the year. The addition of a maximum of 2.42 to this increases the mortality rate by 0.003%, which is below the 1% threshold for detectability.

~~184.~~185. The number of individuals from the biogeographic population expected to die across all seasons is 220,188. The addition of a maximum of 2.42 to this increases the mortality rate by 0.001%, which is below the 1% threshold for detectability.

~~185.~~186. The sensitivity of gannet to construction displacement is considered to be low and the magnitude of annual impact at the Array Areas is negligible, therefore the annual effect on gannet due to construction displacement at the Array Areas is assessed as **negligible**.

12.7.1.1.1.3.11 Annual – 50% installed turbines

~~186.~~187. The combined impact per annum from half the Array Areas, has been assumed to be half of that estimated for operational displacement in the annual impact at Array Areas (section 12.8.1.1.1.3.4). Thus, a maximum of 13.18 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1866 a total of 85,145 birds from the largest BDMPS population would be expected to die each year. The addition of 13.18 individuals would increase the mortality rate by 0.015%, which is below the 1% threshold for detectability.

~~187.~~188. The number of individuals from the biogeographic population expected to die across all seasons is 220,188. The addition of a maximum of 13.18 to this increases the mortality rate by 0.006%, which is below the 1% threshold for detectability.

~~188.~~189. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the annual impact at the Array Areas, the magnitude of annual impact at the Array Areas is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.1.3.12 Annual – construction vessels and 50% installed turbines

~~189.~~190. The combination of displacement by construction vessels and half of that estimated for operational displacement per annum for the Array Areas gives a combined maximum of 15.60 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1866 a total of 85,145 birds from the largest BDMPS population would be expected to die each year. The addition of 15.60 individuals would increase the mortality rate by 0.018%, which is below the 1% threshold for detectability.

~~190.~~191. The number of individuals from the biogeographic population expected to die across all seasons is 220,188. The addition of a maximum of 15.60 to this increases the mortality rate by 0.007%, which is below the 1% threshold for detectability.

~~191.~~192. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the annual impact at the Array Areas, the magnitude of annual impact at the Array Areas is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.7.1.1.2 Summary of Construction Displacement Assessment – Gannet

~~192.~~193. A table summarising the gannet construction displacement assessment is provided below (**Table 12-20**).

Table 12-20 Summary of Gannet Displacement During Construction Assessment for DBS East, DBS West and Combined (Projects)

Gannet		DBS East	DBS West	Projects
Baseline average annual mortality				0.1866
Breeding season	Reference population (subadult component of nonbreeding BDMPS)			400,326
	Density (birds/km^2)	1.48	1.55	3.03
	Construction displacement mortality (@1%)	0.56	0.58	1.14
	Mortality due to 50% installed turbines (80% displaced x 1% mortality)	3.02	3.22	6.24
	Combined construction mortality	3.58	3.80	7.38
	Overall increase in background mortality (%)	0.005	0.005	0.010
	Significance	Negligible	Negligible	Negligible
Autumn	Reference population (nonbreeding season BDMPS)			456,299
	Density (birds/km^2)	1.52	1.54	3.06
	Construction displacement mortality (@1%)	0.57	0.58	1.15
	Mortality due to 50% installed turbines (80% displaced x 1% mortality)	3.10	3.19	6.30
	Combined construction mortality	3.67	3.77	7.45
	Overall increase in background mortality (%)	0.004	0.004	0.009

Gannet		DBS East	DBS West	Projects
	Significance	Negligible	Negligible	Negligible
Spring	Reference population			248,385
	Density (birds/km^2)	0.15	0.17	0.32
	Construction displacement mortality (@1%)	0.06	0.06	0.12
	Mortality due to 50% installed turbines (80% displaced x 1% mortality)	0.30	0.34	0.64
	Combined construction mortality	0.36	0.40	0.76
	Overall increase in background mortality (%)	0.001	0.001	0.002
	Significance	Negligible	Negligible	Negligible
Annual (BDMPS)	Reference population			456,299
	Density (birds/km^2)	3.15	3.26	6.41
	Construction displacement mortality (@1%)	1.19	1.23	2.42
	Mortality due to 50% installed turbines (80% displaced x 1% mortality)	6.42	6.76	13.18
	Combined construction mortality	7.61	7.99	15.60
	Overall increase in background mortality (%)	0.009	0.009	0.018
	Significance	Negligible	Negligible	Negligible
	Biogeographical population			1,180,000

Gannet		DBS East	DBS West	Projects
Annual (biogeographic)	Increase in background mortality (%)	0.003	0.004	0.007
	Significance	Negligible	Negligible	Negligible

12.7.1.1.3 Guillemot

~~193.~~194. Guillemots were recorded in the Array Areas year-round, with estimated peak densities within the DBS East array plus 2km buffer in November (24.62/km^2) and in the DBS West array and 2km buffer in August (24.08/km^2). Guillemots are considered to have a medium sensitivity to disturbance and displacement, based on their sensitivity to ship and helicopter traffic in Garthe and Hüppop (2004), Furness and Wade (2012), Furness *et al.* (2013) and Bradbury *et al.* (2014).

~~194.~~195. The mean maximum foraging range for breeding guillemot is 73km (Woodward *et al*, 2019) which places the Array Areas beyond the range of the nearest breeding colony at Flamborough Head which is 100km from the Array Areas.

~~195.~~196. It is therefore appropriate to assume that individuals seen during the breeding season are nonbreeding and that they are predominantly sub-adult birds. Indeed, the lowest densities in the Array Areas were recorded during the peak breeding months of May and June (<1 bird/km^2). Natural England has advised that the guillemot breeding season reference population appropriate for this assessment is 2,045,078 individuals (see **Volume 7, Appendix 12-1 Offshore Ornithology Consultation Responses (application ref: 7.12.12.1)**) for further details).

~~196.~~197. The number of individuals from this population expected to die in the breeding season is 287,333 (2,045,078 x 0.1405, **Table 12-17**).

~~197.~~198. During the nonbreeding season the guillemot BDMPS population for the North Sea has been used as the reference population (1,617,305). In their Relevant Representation [RR-039] Natural England advised that guillemot impacts at the Projects should include a post-breeding period (August and September). Since these months fall within the nonbreeding season, the nonbreeding season BDMPS population (1,617,305) has been used as a reference regional population. The number of individuals from this population expected to die in both the post-breeding and nonbreeding seasons is therefore 227,231 (1,617,305 x 0.1405).

~~198.~~199. The annual assessment impacts have been considered in relation to both the largest of the BDMPS population and also to the biogeographic population (4,125,000; Furness, 2015). The number of individuals from these populations expected to die is 287,333 (2,045,078 x 0.1405) and 579,563 (4,125,000 x 0.1405) respectively.

12.7.1.1.3.1 Significance of Effect – DBS East in Isolation

12.7.1.1.3.1.1 Breeding Season – construction vessels

~~199.~~200. During the breeding season, the maximum mean peak density in the DBS East Array Area and 2km buffer was 17.71/km^2. With a precautionary 2km radius of disturbance around each of three active construction areas (wind turbines or other infrastructure) up to 667 individuals (17.71 x 12.56 x 3) could be at risk of displacement, of which up to 66.7 (10%) would be expected to be at risk of mortality.

~~200.~~201. Based on the average mortality for guillemot of 0.1405, a total of 287,333 birds would be expected to die each year from the breeding season reference population. The addition of a maximum of 66.7 birds would increase the mortality rate by 0.023%. which is below the 1% threshold for detectability.

~~201.~~202. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.1.2 Breeding Season – 50% installed turbines

~~202.~~203. The impact from half the wind farm during the breeding season has been assumed to be half of that estimated for operational displacement in the breeding season (section 12.8.1.1.3.1.1). Thus, a maximum of 16.1 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1405 a total of 287,333 birds would be expected to die each year. The addition of 16.1 individuals would increase the mortality rate by 0.110%, which is below the 1% threshold for detectability.

~~203.~~204. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.1.3 Breeding Season – construction vessels and 50% installed turbines

~~204.~~205. The combination of displacement by construction vessels and half of that estimated for operational displacement in the breeding season gives a maximum of 382.8 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1405 a total of 287,333 birds would be expected to die each year. The addition of 382.8 individuals would increase the mortality rate by 0.133%, which is below the 1% threshold for detectability.

This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.1.4 Chick Rearing and Moult – construction vessels

~~205.~~206. During the chick rearing and moult period, the maximum mean peak density in the DBS East Array Area was 15.06/km^2. With a precautionary 2km radius of disturbance around each of three active construction areas (wind turbines or other infrastructure), up to 567 individual birds (15.06 x 12.56 x 3) could be at risk of displacement, of which up to 56.7 (10%) would be expected to be at risk of mortality.

~~206.~~207. Based on the average mortality rate for guillemot of 0.1405, a total 227,231 birds would be expected to die each year from the post-breeding season BDMPS population. The addition of a maximum of 56.7 birds to this would increase the mortality rate by 0.025%, which is below the 1% threshold for detectability.

~~207.~~208. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the chick rearing and moult period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.1.5 Chick Rearing and Moult – 50% installed turbines

~~208.~~209. The impact from half the wind farm during the chick rearing and moult period has been assumed to be half of that estimated for operational displacement in the chick rearing and moult period (section 12.8.1.1.3.1.2). Thus, a maximum of 268.7 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1405 a total of 227,231 birds would be expected to die each year. The addition of 268.7 individuals would increase the mortality rate by 0.112%, which is below the 1% threshold for detectability.

~~209.~~210. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the chick rearing and moult period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.1.6 Chick Rearing and Moult – construction vessels and 50% installed turbines

~~210.~~211. The combination of displacement by construction vessels and half of that estimated for operational displacement in the post-breeding season gives a maximum of 325.5 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1405 a total of 227,231 birds would be expected to die each year. The addition of 325.5 individuals would increase the mortality rate by 0.143%, which is below the 1% threshold for detectability.

~~211.~~212. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the chick rearing and moult period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.1.7 Nonbreeding – construction vessels

~~212.~~213. During the nonbreeding season the maximum mean peak density in the DBS East Array Area was 24.62/km^2. With a precautionary 2km radius of disturbance around each of three active construction areas (wind turbines or other infrastructure), up to 928 individual birds (24.62 x 12.56 x 3) could be at risk of displacement, of which up to 92.8 (10%) would be expected to be at risk of mortality.

~~213.~~214. Based on the average mortality rate for guillemot of 0.1405, a total 227,231 birds would be expected to die each year from the nonbreeding season BDMPS population. The addition of a maximum of 92.8 birds to this would increase the mortality rate by 0.041%, which is below the 1% threshold for detectability.

~~214.~~215. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.1.8 Nonbreeding – 50% installed turbines

~~215.~~216. The impact from half the wind farm during the nonbreeding season has been assumed to be half of that estimated for operational displacement in the nonbreeding season (section 12.8.1.1.3.1.3). Thus, a maximum of 439.3 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1405 a total of 227,231 birds would be expected to die each year. The addition of 439.3 individuals would increase the mortality rate by 0.193%, which is below the 1% threshold for detectability.

~~216.~~217. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.1.9 Nonbreeding – construction vessels and 50% installed turbines

~~217.~~218. The combination of displacement by construction vessels and half of that estimated for operational displacement in the nonbreeding season gives a maximum of 532.1 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1405 a total of 227,231 birds would be expected to die each year. The addition of 532.1 individuals would increase the mortality rate by 0.234%, which is below the 1% threshold for detectability.

~~218.~~219. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.1.10 Annual – construction vessels

~~219.~~220. The estimated number of guillemots subject to construction disturbance and displacement mortality at DBS East throughout the year is up to 216.2 individuals.

~~220.~~221. The number of individuals expected to die from the largest BDMPS population throughout the year is 287,333. The addition of a maximum of 216.2 individuals to this increases the mortality rate by 0.075%, which is below the 1% threshold for detectability.

~~221.~~222. The number of individuals from the biogeographic population expected to die across all seasons is 579,563. The addition of a maximum of 216.2 to this increases the mortality rate by 0.037%, which is below the 1% threshold for detectability.

~~222.~~223. The sensitivity of guillemot to construction displacement is considered to be medium and the magnitude of annual impact at DBS East is negligible, therefore the annual effect on guillemot due to construction displacement at DBS East is assessed as **minor adverse**.

12.7.1.1.3.1.11 Annual – 50% installed turbines

~~223.~~224. The impact from half the wind farm during the annual impact at the DBS East, has been assumed to be half of that estimated for operational displacement in the annual impact at DBS East, (section 12.8.1.1.3.1.4). Thus, a maximum of 1,024.1 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1405 a total of is 287,333 birds would be expected to die each year. The addition of 1,024.1 individuals would increase the mortality rate by 0.356%, which is below the 1% threshold for detectability.

~~224.~~225. The number of individuals from the biogeographic population expected to die across all seasons is 579,563. The addition of a maximum of 1,024.1 to this increases the mortality rate by 0.177%, which is below the 1% threshold for detectability.

~~225.~~226. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the magnitude of the annual impact at DBS East is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.1.12 Annual – construction vessels and 50% installed turbines

~~226.~~227. The combination of displacement by construction vessels and half of that estimated for operational displacement the annual impact at DBS East gives a maximum of 1,240.4 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1405 a total of is 287,333 birds would be expected to die each year. The addition of 1,240.4 individuals would increase the mortality rate by 0.432%, which is below the 1% threshold for detectability.

~~227.~~228. The number of individuals from the biogeographic population expected to die across all seasons is 579,563. The addition of a maximum of 1,240.4 to this increases the mortality rate by 0.214%, which is below the 1% threshold for detectability.

~~228.~~229. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the magnitude of the annual impact at DBS East is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.2 Significance of Effect – DBS West in Isolation

12.7.1.1.3.2.1 Breeding Season – construction vessels

~~229.~~230. During the breeding season, the maximum mean peak density in the DBS West Array Area was 16.92/km^2. With a precautionary 2km radius of disturbance around each of three active construction areas (wind turbines or other infrastructure) up to 638 individuals (16.92 x 12.56 x 3) could be at risk of displacement, of which up to 63.8 (10%) would be expected to be at risk of mortality.

~~230.~~231. Based on the average mortality for guillemot of 0.1405, a total of 287,333 birds would be expected to die each year from the breeding season reference population. The addition of a maximum of 63.8 birds would increase the mortality rate by 0.022%, which is below the 1% threshold for detectability.

~~231.~~232. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.2.2 *Breeding Season – 50% installed turbines*

~~232.~~233. The impact from half the wind farm during the breeding season has been assumed to be half of that estimated for operational displacement in the breeding season (section 12.8.1.1.3.2.1). Thus, a maximum of 307.4 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1405 a total of 287,333 birds would be expected to die each year. The addition of 307.4 individuals would increase the mortality rate by 0.107%, which is below the 1% threshold for detectability.

~~233.~~234. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.2.3 *Breeding Season – construction vessels and 50% installed turbines*

~~234.~~235. The combination of displacement by construction vessels and half of that estimated for operational displacement in the breeding season gives a maximum of 371.2 Based on the average mortality for the species of 0.1405 a total of 287,333 birds would be expected to die each year. The addition of 371.2 individuals would increase the mortality rate by 0.1293%, which is below the 1% threshold for detectability.

~~235.~~236. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.2.4 *Chick Rearing and Moult – construction vessels*

~~236.~~237. During the chick rearing and moult period, the maximum mean peak density in the DBS West Array Area was 24.08/km^2. With a precautionary 2km radius of disturbance around each of three active construction areas (wind turbines or other infrastructure), up to 907 individual birds (24.08 x 12.56 x 3) could be at risk of displacement, of which up to 90.7 (10%) would be expected to be at risk of mortality.

~~237.~~238. Based on the average mortality rate for guillemot of 0.1405, a total 227,231 birds would be expected to die each year from the post-breeding season BDMPS population. The addition of a maximum of 90.7 birds to this would increase the mortality rate by 0.040%, which is below the 1% threshold for detectability.

~~238.~~239. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the chick rearing and moult period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.2.5 Chick Rearing and Moult – 50% installed turbines

~~239.~~240. The impact from half the wind farm during the chick rearing and moult period has been assumed to be half of that estimated for operational displacement in the post-breeding season (section 12.8.1.1.3.3.1). Thus, a maximum of 437.4 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1405 a total of 227,231 birds would be expected to die each year. The addition of 437.4 individuals would increase the mortality rate by 0.193%, which is below the 1% threshold for detectability.

~~240.~~241. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the chick rearing and moult period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.2.6 Chick Rearing and Moult – construction vessels and 50% installed turbines

~~241.~~242. The combination of displacement by construction vessels and half of that estimated for operational displacement in the post-breeding season gives a maximum of 528.1 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1405 a total of 227,231 birds would be expected to die each year. The addition of 528.1 individuals would increase the mortality rate by 0.232%, which is below the 1% threshold for detectability.

~~242.~~243. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the chick rearing and moult period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.2.7 Nonbreeding – construction vessels

~~243.~~244. During the nonbreeding season the maximum mean peak density in the DBS West Array Area was 19.06/km². With a precautionary 2km radius of disturbance around each of three active construction areas (wind turbines or other infrastructure), up to 718 individual birds (19.06 x 12.56 x 3) could be at risk of displacement, of which up to 71.8 (10%) would be expected to be risk of mortality.

~~244.~~245. Based on the average mortality rate for guillemot, of 0.1405, 227,231 birds would be expected to die each year from the nonbreeding season BDMPS population. The addition of 71.8 birds to this would increase the mortality rate by up to 0.032%, which is below the 1% threshold for detectability.

~~245.~~246. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.2.8 Nonbreeding – 50% installed turbines

~~246.~~247. The impact from half the wind farm during the nonbreeding season has been assumed to be half of that estimated for operational displacement in the nonbreeding season (section 12.8.1.1.3.3.2). Thus, a maximum of 346.3 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1405 a total of 227,231 birds would be expected to die each year. The addition of 346.3 individuals would increase the mortality rate by 0.152% which is below the 1% threshold for detectability.

~~247.~~248. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.2.9 Nonbreeding – construction vessels and 50% installed turbines

~~248.~~249. The combination of displacement by construction vessels and half of that estimated for operational displacement in the nonbreeding season gives a maximum of 418.2 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1405 a total of 227,231 birds would be expected to die each year. The addition of 418.2 individuals would increase the mortality rate by 0.184%, which is below the 1% threshold for detectability.

~~249.~~250. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.2.10 Annual – construction vessels

~~250.~~251. The estimated number of guillemots subject to construction disturbance and displacement mortality at DBS West throughout the year is up to 226.3.

~~251.~~252. The number of individuals expected to die from the largest BDMPS population throughout the year is 287,333. The addition of a maximum of 226.3 individuals to this increases the mortality rate by 0.079%, which is below the 1% threshold for detectability.

~~252.~~253. The number of individuals from the biogeographic population expected to die across all seasons is 579,563. The addition of a maximum of 226.3 to this increases the mortality rate by 0.039%, which is below the 1% threshold for detectability.

~~253.~~254. The sensitivity of guillemot to construction displacement is considered to be medium and the magnitude of annual impact at DBS West is negligible, therefore the annual effect on guillemot due to construction displacement at DBS West is assessed as **minor adverse**.

12.7.1.1.3.2.11 Annual – 50% installed turbines

~~254.~~255. The impact from half the wind farm during the annual impact at the Projects, has been assumed to be half of that estimated for operational displacement in the annual impact at DBS West, (section 12.8.1.1.3.2.4). Thus, a maximum of 1,091.2 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1405 a total of 287,333 birds from the largest BDMPS population would be expected to die each year. The addition of 1,091.2 individuals would increase the mortality rate by 0.380%, which is below the 1% threshold for detectability.

~~255.~~256. The number of individuals from the biogeographic population expected to die across all seasons is 579,563. The addition of a maximum of 1,091.2 to this increases the mortality rate by 0.188%, which is below the 1% threshold for detectability.

~~256.~~257. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the magnitude of annual impact at DBS West is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.2.12 Annual – construction vessels and 50% installed turbines

~~257.~~258. The combination of displacement by construction vessels and half of that estimated for operational displacement the annual impact at DBS West gives a maximum of 1,317.5 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1405 a total of 287,333 birds from the largest BDMPS population would be expected to die each year. The addition of 1,317.5 individuals would increase the mortality rate by 0.459%, which is below the 1% threshold for detectability.

~~258.~~259. The number of individuals from the biogeographic population expected to die across all seasons is 579,563. The addition of a maximum of 1,317.5 to this increases the mortality rate by 0.227%, which is below the 1% threshold for detectability.

~~259.~~260. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the magnitude of annual impact at DBS West is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.3 Significance of Effect – DBS East and DBS West Together

12.7.1.1.3.3.1 Breeding Season – construction vessels

~~260.~~261. During the breeding season the combined number of guillemots at risk of mortality due to displacement from construction vessels across the Array Areas was up to 130.5 (East: 66.7, West: 63.8).

~~261.~~262. Based on the average mortality for guillemot of 0.1405, a total of 287,333 birds would be expected to die each year from the breeding season reference population. The addition of a maximum of 130.5 birds predicted to be at risk of mortality from construction disturbance and displacement would increase the mortality rate by 0.045%, which is below the 1% threshold for detectability.

~~262.~~263. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.3.2 Breeding Season – 50% installed turbines

~~263.~~264. The combined impact from half of the Array Areas during the breeding season has been assumed to be half of that estimated for operational displacement in the breeding season (section 12.8.1.1.3.3.1). Thus, a maximum of 623.5 (East: 316.1, West: 307.4) individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1405 a total of 287,333 birds would be expected to die each year. The addition of 623.5 individuals would increase the mortality rate by 0.217%, which is below the 1% threshold for detectability.

~~264.~~265. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.3.3 Breeding Season – construction vessels and 50% installed turbines

~~265.~~266. The combination of displacement by construction vessels and half of that estimated for operational displacement in the breeding season for the Array Areas gives a combined maximum of 754.0 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1405 a total of 287,333 birds would be expected to die each year. The addition of 754.0 individuals would increase the mortality rate by 0.262%, which is below the 1% threshold for detectability.

~~266.~~267. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.3.4 Chick Rearing and Moult – construction vessels

~~267.~~268. During the chick rearing and moult period the combined number of guillemots at risk of mortality due to displacement from construction vessels across the Array Areas was up to 147.5 (DBS East: 56.7, DBS West: 90.7).

~~268.~~269. Based on the average mortality for guillemot of 0.1405, a total of 227,231 birds would be expected to die each year from the nonbreeding season reference population. The addition of a maximum of 147.5 birds predicted to be at risk of mortality from construction disturbance and displacement would increase the mortality rate by 0.065%, which is below the 1% threshold for detectability.

~~269.~~270. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the chick rearing and moult period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.3.5 Chick Rearing and Moult – 50% installed turbines

~~270.~~271. The combined impact from half of the Array Areas during the chick rearing and moult period has been assumed to be half of that estimated for operational displacement in the post-breeding season (section 12.8.1.1.3.2). Thus, a maximum of 706.2 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1405, a total of 227,231 birds would be expected to die each. The addition of 706.2 individuals would increase the mortality rate by 0.311%, which is below the 1% threshold for detectability.

~~271.~~272. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the chick rearing and moult period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.3.6 Chick Rearing and Moult – construction vessels and 50% installed turbines

~~272.~~273. The combination of displacement by construction vessels and half of that estimated for operational displacement in the post-breeding season for the Array Areas gives a combined maximum of 853.7 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1405 a total of 227,231 birds would be expected to die each year. The addition of 853.7 individuals would increase the mortality rate by 0.376%, which is below the 1% threshold for detectability.

~~273.~~274. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the chick rearing and moult period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.3.7 Nonbreeding – construction vessels

~~274.~~275. During the nonbreeding season the combined number of guillemots at risk of mortality due to displacement from construction vessels across the Array Areas was up to 164.6 (East: 92.8, West: 71.8).

~~275.~~276. Based on the average mortality rate for guillemot, of 0.1405, 227,231 birds would be expected to die each year from the nonbreeding season BDMPS population. The addition of 164.6 birds to this would increase the mortality rate by up to 0.072%, which is below the 1% threshold for detectability.

~~276.~~277. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.3.8 Nonbreeding – 50% installed turbines

~~277.~~278. The combined impact from half of the Array Areas during the nonbreeding season has been assumed to be half of that estimated for operational displacement in the nonbreeding season (section 12.8.1.1.3.3.3). Thus, a maximum of 785.7 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1405 a total of 227,231 birds would be expected to die each year. The addition of 785.7 individuals would increase the mortality rate by 0.346% which is below the 1% threshold for detectability.

~~278.~~279. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.3.9 Nonbreeding – construction vessels and 50% installed turbines

~~279.~~280. The combination of displacement by construction vessels and half of that estimated for operational displacement in the nonbreeding season for the Array Areas gives a combined maximum of 950.3 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1405 a total of 227,231 birds would be expected to die each year. The addition of 950.3 individuals would increase the mortality rate by 0.418%, which is below the 1% threshold for detectability.

~~280.~~281. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.3.10 Annual – construction vessels

~~281.~~282. Throughout the year the combined number of guillemots at risk of mortality due to displacement from construction activity across the Array Areas was up to 442.6 (East: 216.2, West: 226.3).

~~282.~~283. The number of individuals expected to die from the largest BDMPS population throughout the year is 287,333. The addition of a maximum of 442.6 individuals to this increases the mortality rate by 0.154%, which is below the 1% threshold for detectability.

~~283.~~284. The number of individuals from the biogeographic population expected to die across all seasons is 579,563. The addition of a maximum of 442.6 to this increases the mortality rate by 0.076%, which is below the 1% threshold for detectability.

~~284.~~285. The sensitivity of guillemot to construction displacement is considered to be medium and the magnitude of annual impact at the Array Areas is negligible, therefore the annual effect on guillemot due to construction displacement at the Array Areas is assessed as **minor adverse**.

12.7.1.1.3.3.11 Annual – 50% installed turbines

~~285.~~286. The annual impact per annum from half of the Array Areas, has been assumed to be half of that estimated for operational displacement in the annual impact across the Array Areas (section 12.8.1.1.3.3.4). Thus, a maximum of 2,115.3 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1405, a total of 287,333 birds from the largest BDMPS population would be expected to die each year. The addition of 2,115.3 individuals would increase the mortality rate by 0.736%, which is below the 1% threshold for detectability.

~~286.~~287. The number of individuals from the biogeographic population expected to die across all seasons is 579,563. The addition of a maximum of 2,115.3 to this increases the mortality rate by 0.365%, which is below the 1% threshold for detectability.

~~287.~~288. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the magnitude of annual impact at the Array Areas is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.1.3.3.12 Annual – construction vessels and 50% installed turbines

~~288.~~289. The combination of displacement by construction vessels and half of that estimated for operational displacement per annum for the Array Areas gives a combined maximum of 2,557.9 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1405, a total of 287,333 birds from the largest BDMPS population would be expected to die each year. The addition of 2,557.9 individuals would increase the mortality rate by 0.890%, which is below the 1% threshold for detectability.

~~289.~~290. The number of individuals from the biogeographic population expected to die across all seasons is 579,563. The addition of a maximum of 2,557.9 to this increases the mortality rate by 0.441%, which is below the 1% threshold for detectability.

~~290.~~291. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the magnitude of annual impact at the Array Areas is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

~~291.~~292. A table summarising the guillemot construction displacement assessment is provided below (**Table 12-21**).

12.7.1.1.4 Summary of Construction Displacement Assessment - Guillemot

Table 12-21 Summary of Guillemot Displacement During Construction Assessment For DBS East, DBS West and Combined (Projects).

Guillemot		DBS East	DBS West	Projects
Baseline average annual mortality				0.1405
Breeding season	Reference population			2,045,078
	Density (birds/km²)	17.71	16.92	34.63
	Construction displacement mortality (@10%)	66.7	63.8	130.5
	Mortality due to 50% installed turbines (70% displaced x 10% mortality)	316.1	307.4	623.5
	Combined construction mortality	382.8	371.2	754.0
	Overall increase in background mortality (%)	0.133	0.129	0.262
	Significance	Minor	Minor	Minor
Chick rearing and	Reference population			1,617,305
	Density (birds/km²)	15.06	24.08	39.14

Guillemot		DBS East	DBS West	Projects
moult period	Construction displacement mortality (@10%)	56.7	90.7	147.5
	Mortality due to 50% installed turbines (70% displaced x 10% mortality)	268.7	437.4	706.2
	Combined construction mortality	325.5	528.1	853.7
	Overall increase in background mortality (%)	0.143	0.232	0.376
	Significance	Minor	Minor	Minor
Non breeding season	Reference population	1,617,305		
	Density (birds/km^2)	24.62	19.06	43.68
	Construction displacement mortality (@10%)	92.8	71.8	164.6
	Mortality due to 50% installed turbines (70% displaced x 10% mortality)	439.3	346.3	785.7
	Combined construction mortality	532.1	418.2	950.3
	Overall increase in background mortality (%)	0.234	0.184	0.418

Guillemot		DBS East	DBS West	Projects
	Significance	Minor	Minor	Minor
Annual (BDMPS)	Reference population			2,045,078
	Density (birds/km^2)	57.39	60.06	117.45
	Construction displacement mortality (@10%)	216.2	226.3	442.6
	Mortality due to 50% installed turbines (70% displaced x 10% mortality)	1,024.1	1,091.2	2,115.3
	Combined construction mortality	1,240.4	1,317.5	2,557.9
	Overall increase in background mortality (%)	0.432	0.459	0.890
	Significance	Minor	Minor	Minor
Annual (biogeographic)	Biogeographical population			4,125,000
	Increase in background mortality (%)	0.214	0.227	0.441
	Significance	Minor	Minor	Minor

12.7.1.2 Razorbill

~~292.~~293. Razorbills were recorded in the Array Areas year-round, with estimated peak densities within the DBS East array plus 2km buffer in August (9.19km^2) and in the DBS West array plus 2km buffer in September (9.41/km^2). Razorbills are considered to have a medium sensitivity to disturbance and displacement, based on their sensitivity to ship and helicopter traffic in Garthe and Hüppop (2004), Furness and Wade (2012), Furness *et al*. (2013) and Bradbury *et al*. (2014).

~~293.~~294. The mean maximum foraging range for breeding razorbill is 88.7km (Woodward *et al.* 2019) which places the Array Areas beyond the range of the nearest breeding colony at Flamborough Head which is 100km from the Array Areas.

~~294.~~295. It is therefore appropriate to assume that individuals seen during the breeding season are nonbreeding and that they are predominantly sub-adult birds. Natural England has advised that the razorbill breeding season BDMPS reference population for the North Sea and Channel appropriate for this assessment is 158,031 individuals (Natural England 2024).

~~295.~~296. The number of individuals from this population expected to die at the baseline mortality rate in the breeding season is 20,576 (158,031 x 0.1302, **Table 12-17**).

~~296.~~297. During the nonbreeding seasons the razorbill BDMPS populations for the North Sea and Channel have been used as the reference populations (in the autumn and spring: 591,875 and in the winter: 218,621). For the annual assessment, impacts have been considered in relation to the largest of the BDMPS population (591,875 autumn/spring) and also to the biogeographic population (1,707,000; Furness, 2015). The number of individuals from these populations expected to die in spring and autumn are 77,062 (591,875 x 0.1302 and in winter 28,464 (218,621 x 0.1302) and annually from the biogeographic population 222,251 (1,707,000 x 0.1302).

12.7.1.2.1 Significance of Effect – DBS East in Isolation

12.7.1.2.1.1 Breeding Season – construction vessels

~~297.~~298. During the breeding season, the maximum peak density in the DBS East Array Area was 1.09/km^2. With a precautionary 2km radius of disturbance around each of three active construction areas (wind turbines or other infrastructure), up to 41 individuals (1.09 x 12.56 x 3) could be at risk of displacement, of which up to 4.1 (10%) would be expected to be at risk of mortality.

~~298.~~299. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.1.2 Breeding Season – 50% installed turbines

~~299.~~300. The impact from half the wind farm during the breeding season has been assumed to be half of that estimated for operational displacement in the breeding season (section 12.8.1.1.4.1.1). Thus, a maximum of 19.4 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1302 a total of 20,576 birds would be expected to die each year. The addition of 19.4 individuals would increase the mortality rate by 0.094%, which is below the 1% threshold for detectability.

~~300.~~301. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.1.3 Breeding Season – construction vessels and 50% installed turbines

~~301.~~302. The combination of displacement by construction vessels and half of that estimated for operational displacement in the breeding season gives a maximum of 23.5 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1302 a total of 20,576 birds would be expected to die each year. The addition of 23.5 individuals would increase the mortality rate by 0.114%, which is below the 1% threshold for detectability.

~~302.~~303. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.1.4 Autumn Migration – construction vessels

~~303.~~304. During the autumn migration season the maximum mean peak density in the DBS East Array Area was 9.19/km^2. With a precautionary 2km radius of disturbance around each of three construction areas (wind turbines or other infrastructure) up to 346 individual birds (9.19 x 12.56 x 3) that could be at risk of displacement, of which up to 34.6 (10%) birds would be predicted to be at risk of mortality.

~~304.~~305. Based on the average mortality for the species of 0.1302, a total of 77,062 birds would be expected to die in autumn. The addition of 34.6 birds to this would increase the mortality rate by 0.045%, which is below the 1% threshold for detectability.

~~305.~~306. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.1.5 Autumn Migration – 50% installed turbines

~~306.~~307. The impact from half the wind farm during the autumn migration period has been assumed to be half of that estimated for operational displacement in the autumn migration period (section 12.8.1.1.4.1.2). Thus, a maximum of 164.0 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1302 a total of 77,062 birds would be expected to die each year. The addition of 164.0 individuals would increase the mortality rate by 0.213%, which is below the 1% threshold for detectability.

~~307.~~308. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.1.6 Autumn Migration – construction vessels and 50% installed turbines

~~308.~~309. The combination of displacement by construction vessels and half of that estimated for operational displacement in the autumn migration period gives a maximum of 198.6 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1302 a total of 77,062 birds would be expected to die each year. The addition of 198.6 individuals would increase the mortality rate by 0.258%, which is below the 1% threshold for detectability.

~~309.~~310. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.1.7 Winter – construction vessels

~~310.~~311. During the winter, the maximum mean peak density in the DBS East Array Area was 6.62/km^2. With a precautionary 2km radius of disturbance around each of three construction areas (wind turbines or other infrastructure), up to 249 individual birds (6.62 x 12.56 x 3) could be at risk of displacement, of which up to 24.9 (10%) would be expected to be at risk of mortality.

~~311.~~312. Based on the average mortality for the species of 0.1302, a total of 28,464 birds would be expected to die from the winter population. The addition of a maximum of 24.9 birds would increase the mortality rate by 0.088%, which is below the 1% threshold for detectability.

~~312.~~313. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the winter period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.1.8 Winter– 50% installed turbines

~~313.~~314. The impact from half the wind farm during the winter migration period has been assumed to be half of that estimated for operational displacement in the winter migration period (section 12.8.1.1.4.1.3). Thus, a maximum of 118.2 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1302 a total of 28,464 birds would be expected to die each year. The addition of 118.2 individuals would increase the mortality rate by 0.415%, which is below the 1% threshold for detectability.

~~314.~~315. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the winter period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.1.9 Winter – construction vessels and 50% installed turbines

~~315.~~316. The combination of displacement by construction vessels and half of that estimated for operational displacement in the winter period gives a maximum of 143.1individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1302 a total of 28,464 birds would be expected to die each year. The addition of 143.1 individuals would increase the mortality rate by 0.503%, which is below the 1% threshold for detectability.

~~316.~~317. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the winter period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.1.10 Spring Migration – construction vessels

~~317.~~318. During the spring migration, the maximum mean peak density in the DBS East array was 7.02/km^2. With a precautionary 2km radius of disturbance around each of three construction areas (wind turbines or other infrastructure), up to 265 individual birds (7.02 x 12.56 x 3) could be at risk of displacement, of which up to 26.5 (10%) would be expected to be at risk of mortality.

~~318.~~319. Based on the average mortality for the species of 0.1302, a total of 77,062 birds would be expected to die during the spring migration period. The addition of a maximum of 26.5 birds would increase the mortality rate by 0.034%, which is below the 1% threshold for detectability.

~~319.~~320. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.1.11 Spring Migration – 50% installed turbines

~~320.~~321. The impact from half the wind farm during the spring migration period has been assumed to be half of that estimated for operational displacement in the spring migration period (section 12.8.1.1.4.1.4). Thus, a maximum of 125.3 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1302 a total of 77,062 birds would be expected to die each year. The addition of 125.3 individuals would increase the mortality rate by 0.163%, which is below the 1% threshold for detectability.

~~321.~~322. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.1.12 Spring Migration – construction vessels and 50% installed turbines

~~322.~~323. The combination of displacement by construction vessels and half of that estimated for operational displacement in the spring migration period gives a maximum of 151.8 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1302 a total of 77,062 birds would be expected to die each year. The addition of 151.8 individuals would increase the mortality rate by 0.197%, which is below the 1% threshold for detectability.

~~323.~~324. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.1.13 Annual – construction vessels

~~324.~~325. The estimated number of razorbills subject to construction disturbance and displacement mortality at DBS East throughout the year was up to 90.1 individuals.

~~325.~~326. At the average baseline mortality rate for razorbill of 0.1302, a total of 77,062 birds would be expected to die from the largest BDMPS population throughout the year. The addition of a maximum of 90.1 individuals to this increases the mortality rate by 0.117%, which is below the 1% threshold for detectability.

~~326.~~327. The number of individuals from the biogeographic population expected to die across all seasons is 222,251. The addition of a maximum of 90.1 to this increases the mortality rate by 0.041%, which is below the 1% threshold for detectability.

~~327.~~328. The sensitivity of razorbill to displacement is considered to be medium and the magnitude of annual impact at DBS East is negligible, therefore the annual effect on razorbill due to construction displacement at DBS East is assessed as **minor adverse**.

12.7.1.2.1.14 Annual – 50% installed turbines

~~328.~~329. The impact from half the wind farm during the annual impact at DBS East, has been assumed to be half of that estimated for operational displacement in the annual impact at DBS East, (section 12.8.1.1.4.1.5). Thus, a maximum of 426.9 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1302 a total of is 77,062 birds from the largest BDMPS population would be expected to die each year. The addition of 426.9 individuals would increase the mortality rate by 0.4554%, which is below the 1% threshold for detectability.

~~329.~~330. The number of individuals from the biogeographic population expected to die across all seasons is 222,251. The addition of a maximum of 426.9 to this increases the mortality rate by 0.192%, which is below the 1% threshold for detectability.

~~330.~~331. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the magnitude of annual impact at DBS East is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.1.15 Annual – construction vessels and 50% installed turbines

~~331.~~332. The combination of displacement by construction vessels and half of that estimated for operational displacement the annual impact at DBS East gives a maximum of 517.0 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1302 a total of is 77,062 birds from the largest BDMPS population would be expected to die each year. The addition of 517.0 individuals would increase the mortality rate by 0.671%, which is below the 1% threshold for detectability.

~~332.~~333. The number of individuals from the biogeographic population expected to die across all seasons is 222,251. The addition of a maximum of 517.0 to this increases the mortality rate by 0.233%, which is below the 1% threshold for detectability.

~~333.~~334. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the magnitude of annual impact at DBS East is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.2 Significance of Effect – DBS West in Isolation

12.7.1.2.2.1 Breeding Season – construction vessels

~~334.~~335. During the breeding season, the maximum mean peak density in the DBS West Array Areas was 4.39/km^2. With a precautionary 2km radius of disturbance around each of three active construction areas (wind turbines or other infrastructure), up to 165 individuals (4.39 x 12.56 x 3) could be at risk of displacement, of which up to 16.5 (10%) birds would be expected to be at risk of mortality.

~~335.~~336. Based on the average mortality for the species of 0.1302, a total of 20,576 birds would be expected to die each year from the breeding season reference population. The addition of a maximum of 16.5 birds predicted to be at risk of mortality from construction disturbance and displacement would increase the mortality rate by 0.080%, which is below the 1% threshold for detectability.

~~336.~~337. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.2.2 Breeding Season – 50% installed turbines

~~337.~~338. The impact from half the wind farm during the breeding season has been assumed to be half of that estimated for operational displacement in the breeding season (section 12.8.1.1.4.2.2). Thus, a maximum of 79.8 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1302 a total of 20,576 birds would be expected to die each year. The addition of 79.8 individuals would increase the mortality rate by 0.388%, which is below the 1% threshold for detectability.

~~338.~~339. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.2.3 Breeding Season – construction vessels and 50% installed turbines

~~339.~~340. The combination of displacement by construction vessels and half of that estimated for operational displacement in the breeding season gives a maximum of 96.3 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1302 a total of 20,576 birds would be expected to die each year. The addition of 96.3 individuals would increase the mortality rate by 0.468%, which is below the 1% threshold for detectability.

~~340.~~341. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.2.4 Autumn Migration – construction vessels

~~341.~~342. During the autumn migration season the maximum mean peak density in the DBS West Array Area was 9.41/km^2. With a precautionary 2km radius of disturbance around each of three construction areas (wind turbines or other infrastructure) up to 355 individual birds (9.41 x 12.56 x 3) could be at risk of displacement, of which up to 35.5 (10%) birds would be predicted to be at risk of mortality.

~~342.~~343. Based on the average mortality for the species of 0.1302, a total of 77,062 birds would be expected to die in autumn. The addition of 35.5 birds to this would increase the mortality rate by 0.046%, which is below the 1% threshold for detectability.

~~343.~~344. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.2.5 Autumn Migration – 50% installed turbines

~~344.~~345. The impact from half the wind farm during the autumn migration period has been assumed to be half of that estimated for operational displacement in the autumn migration period (section 12.8.1.1.4.1.2). Thus, a maximum of 171.0 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1302 a total of 77,062 birds would be expected to die each year. The addition of 171.0 individuals would increase the mortality rate by 0.222%, which is below the 1% threshold for detectability.

~~345.~~346. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.2.6 Autumn Migration – construction vessels and 50% installed turbines

~~346.~~347. The combination of displacement by construction vessels and half of that estimated for operational displacement in the autumn migration period gives a maximum of 206.5 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1302 a total of 77,062 birds would be expected to die each year. The addition of 206.5 individuals would increase the mortality rate by 0.268%, which is below the 1% threshold for detectability.

~~347.~~348. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.2.7 Winter – construction vessels

~~348.~~349. During the winter, the maximum mean peak density in the DBS West Array Area was 9.76/km^2. With a precautionary 2km radius of disturbance around each of three construction areas (wind turbines or other infrastructure), up to 368 individual birds (9.76 x 12.56 x 3) could be at risk of displacement, of which up to 36.8 (10%) would be expected to be at risk of mortality.

~~349.~~350. Based on the average mortality for the species of 0.1302, a total of 28,464 birds would be expected to die in winter. The addition of a maximum of 36.8 birds would increase the mortality rate by 0.129%, which is below the 1% threshold for detectability.

~~350.~~351. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the winter period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.2.8 Winter– 50% installed turbines

~~351.~~352. The impact from half the wind farm during the winter migration period has been assumed to be half of that estimated for operational displacement in the winter migration period (section 12.8.1.1.4.2.3). Thus, a maximum of 177.3 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1302 a total of 28,464 birds would be expected to die each year. The addition of 177.3 individuals would increase the mortality rate by 0.623%, which is below the 1% threshold for detectability.

~~352.~~353. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the winter period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.2.9 Winter – construction vessels and 50% installed turbines

~~353.~~354. The combination of displacement by construction vessels and half of that estimated for operational displacement in the winter period gives a maximum of 214.1 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1302 a total of 28,464 birds would be expected to die each year. The addition of 214.1 individuals would increase the mortality rate by 0.752%, which is below the 1% threshold for detectability.

~~354.~~355. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the winter period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.2.10 Spring Migration – construction vessels

~~355.~~356. During the spring migration, the maximum mean peak density in the DBS West Array Area was 8.58/km^2. With a precautionary 2km radius of disturbance around each of three construction areas (wind turbines or other infrastructure), up to 323 individual birds (8.58 x 12.56 x 3) could be at risk of displacement, of which up to 32.3 (10%) would be expected to be at risk of mortality.

~~356.~~357. Based on the average mortality for the species of 0.1302, a total of 77,062 birds would be expected to die each year from the spring migration. The addition of a maximum of 32.3 birds would increase the mortality rate by 0.042%, which is below the 1% threshold for detectability.

~~357.~~358. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.2.11 Spring Migration – 50% installed turbines

~~358.~~359. The impact from half the wind farm during the spring migration period has been assumed to be half of that estimated for operational displacement in the spring migration period (section 12.8.1.1.4.1.2). Thus, a maximum of 155.9 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1302 a total of 77,062 birds would be expected to die each year. The addition of 155.9 individuals would increase the mortality rate by 0.202%, which is below the 1% threshold for detectability.

~~359.~~360. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.2.12 Spring Migration – construction vessels and 50% installed turbines

~~360.~~361. The combination of displacement by construction vessels and half of that estimated for operational displacement in the spring migration period gives a maximum of 188.2 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1302 a total of 77,062 birds would be expected to die each year. The addition of 188.2 individuals would increase the mortality rate by 0.244%, which is below the 1% threshold for detectability.

~~361.~~362. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.2.13 Annual – construction vessels

~~362.~~363. The estimated number of razorbills subject to construction disturbance/displacement mortality at DBS West throughout the year was up to 121.1 individuals.

~~363.~~364. At the average baseline mortality rate for razorbill of 0.1302, a total of 77,062 birds would be expected to die from the largest BDMPS population throughout the year. The addition of a maximum of 121.1 individuals to this increases the mortality rate by 0.157%, which is below the 1% threshold for detectability.

~~364.~~365. The number of individuals from the biogeographic population expected to die across all seasons is 222,251. The addition of a maximum of 121.1 to this increases the mortality rate by 0.054%, which is below the 1% threshold for detectability.

~~365.~~366. The sensitivity of razorbill to displacement is considered to be medium and the magnitude of annual impact at DBS West is negligible, therefore the annual effect on razorbill due to construction displacement at DBS West is assessed as **minor adverse**.

12.7.1.2.2.14 Annual – 50% installed turbines

~~366.~~367. The impact from half the wind farm during the annual impact at DBS West, has been assumed to be half of that estimated for operational displacement in the annual impact at DBS West, (section 12.8.1.1.4.2.5). Thus, a maximum of 584.1 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1302 a total of 77,062 birds from the largest BDMPS population would be expected to die each year. The addition of 584.1 individuals would increase the mortality rate by 0.758%, which is below the 1% threshold for detectability.

~~367.~~368. The number of individuals from the biogeographic population expected to die across all seasons is 222,251. The addition of a maximum of 584.1 to this increases the mortality rate by 0.263%, which is below the 1% threshold for detectability.

~~368.~~369. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the magnitude of annual impact at DBS West is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.2.15 Annual – construction vessels and 50% installed turbines

~~369.~~370. The combination of displacement by construction vessels and half of that estimated for operational displacement the annual impact at DBS West gives a maximum of 705.2 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1302 a total of is 77,062 birds from the largest BDMPS population would be expected to die each year. The addition of 705.2 individuals would increase the mortality rate by 0.915%, which is below the 1% threshold for detectability.

~~370.~~371. The number of individuals from the biogeographic population expected to die across all seasons is 222,251. The addition of a maximum of 705.2 to this increases the mortality rate by 0.317%, which is below the 1% threshold for detectability.

~~371.~~372. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the magnitude of annual impact at DBS West is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.3 Significance of Effect – DBS East and DBS West Together

12.7.1.2.3.1 Breeding Season – construction vessels

~~372.~~373. During the breeding season the combined number of razorbills at risk of mortality due to displacement from construction vessels across the Array Areas was up to 20.6.

~~373.~~374. Based on the average mortality for the species of 0.1302, a total of 20,576 birds would be expected to die each year from the breeding season reference population. The addition of a maximum of 20.6 birds predicted to be at risk of mortality from construction disturbance and displacement would increase the mortality rate by 0.100%, which is below the 1% threshold for detectability.

~~374.~~375. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.3.2 Breeding Season – 50% installed turbines

~~375.~~376. The combined impact from half of the Array Areas during the breeding season has been assumed to be half of that estimated for operational displacement in the breeding season (section 12.8.1.1.4.3.1). Thus, a maximum of 99.3 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1302 a total of 20,576 birds would be expected to die each year. The addition of 99.3 individuals would increase the mortality rate by 0.482%, which is below the 1% threshold for detectability.

~~376.~~377. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.3.3 Breeding Season – construction vessels and 50% installed turbines

~~377.~~378. The combination of displacement by construction vessels and half of that estimated for operational displacement in the breeding season for the Array Areas gives a maximum of 119.9 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1302 a total of 20,576 birds would be expected to die each year. The addition of 119.9 individuals would increase the mortality rate by 0.583%, which is below the 1% threshold for detectability.

~~378.~~379. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.3.4 Autumn Migration – construction vessels

~~379.~~380. During the autumn migration the combined number of razorbills at risk of mortality due to displacement from construction vessels across the Array Areas was up to 70.1 birds.

~~380.~~381. Based on the average mortality for the species of 0.1302, a total of 77,062 birds would be expected to die in autumn. The addition of 70.1 birds to this would increase the mortality rate by 0.091%, which is below the 1% threshold for detectability.

~~381.~~382. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.3.5 Autumn Migration – 50% installed turbines

~~382.~~383. The combined impact from half of the Array Areas during the autumn migration period has been assumed to be half of that estimated for operational displacement in the autumn migration period (section 12.8.1.1.4.3.2). Thus, a maximum of 335.1 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1302 a total of 77,062 birds would be expected to die each year. The addition of 335.1 individuals would increase the mortality rate by 0.435%, which is below the 1% threshold for detectability.

~~383.~~384. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.3.6 Autumn Migration – construction vessels and 50% installed turbines

~~384.~~385. The combination of displacement by construction vessels and half of that estimated for operational displacement in the autumn migration period for the Array Areas gives a combined maximum of 405.1 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1302 a total of 77,062 birds would be expected to die each year. The addition of 405.1 individuals would increase the mortality rate by 0.526%, which is below the 1% threshold for detectability.

~~385.~~386. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.3.7 Winter – construction vessels

~~386.~~387. During the winter the combined number of razorbills at risk of mortality due to displacement from construction vessels across the Array Areas was up to 61.7.

~~387.~~388. Based on the average mortality for the species of 0.1302, a total of 28,464 birds would be expected to die in winter. The addition of a maximum of 61.7 birds would increase the mortality rate by 0.217%, which is below the 1% threshold for detectability.

~~388.~~389. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the winter period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.3.8 Winter– 50% installed turbines

~~389.~~390. The combined impact from half of the Array Areas during the winter migration period has been assumed to be half of that estimated for operational displacement in the winter migration period (section 12.8.1.1.4.3.3). Thus, a maximum of 295.5 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1302 a total of 28,464 birds would be expected to die each year. The addition of 295.5 individuals would increase the mortality rate by 1.038%, which is above the 1% threshold for detectability. However, this is based on the worst case combination of parameters used to estimate operational displacement (70% displaced and 10% mortality, halved for construction effects). If construction displacement mortality was 2% (at 70% displaced), this figure would fall below the 1% threshold of detectability (note that 70% and 2% have been accepted for previous wind farms[5], use of which results in a much lower impact).

~~390.~~391. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the winter period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

[5] Note that 2% mortality was accepted for the Sheringham and Dudgeon Extensions in decision by SoS made after the assessment in the application (APP-103) was completed, hence this was not included at the time

12.7.1.2.3.9 Winter – construction vessels and 50% installed turbines

~~391.~~392. The combination of displacement by construction vessels and half of that estimated for operational displacement in the winter period for the Array Areas gives a combined maximum of 357.2 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1302 a total of 28,464 birds would be expected to die each year. The addition of 357.2 individuals would increase the mortality rate by 1.255%, which is above the 1% threshold for detectability. However, this is based on the worst case combination of parameters used to estimate operational displacement (70% displaced and 10% mortality). If construction displacement mortality was 2% (at 70% displaced), this figure would fall below the 1% threshold of detectability.

~~392.~~393. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the winter period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.3.10 Spring Migration – construction vessels

~~393.~~394. During the spring migration the combined number of razorbills at risk of mortality due to displacement from construction vessels across the Array Areas was up to 58.8.

~~394.~~395. Based on the average mortality for the species of 0.1302, a total of 77,062 birds would be expected to die each year from the spring migration. The addition of a maximum of 58.8 birds would increase the mortality rate by 0.076%, which is below the 1% threshold for detectability.

~~395.~~396. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.3.11 Spring Migration – 50% installed turbines

~~396.~~397. The combined impact from half of the Array Areas during the spring migration period has been assumed to be half of that estimated for operational displacement in the spring migration period (section 12.8.1.1.4.3.4). Thus, a maximum of 281.2 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1302 a total of 77,062 birds would be expected to die each year. The addition of 281.2 individuals would increase the mortality rate by 0.365%, which is below the 1% threshold for detectability.

~~397.~~398. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.3.12 Spring Migration – construction vessels and 50% installed turbines

~~398.~~399. The combination of displacement by construction vessels and half of that estimated for operational displacement in the spring migration period for the Array Areas gives a combined maximum of 340.0 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1302 a total of 77,062 birds would be expected to die each year. The addition of 340.0 individuals would increase the mortality rate by 0.441%, which is below the 1% threshold for detectability.

~~399.~~400. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.3.13 Annual – construction vessels

~~400.~~401. Throughout the year the combined number of razorbills at risk of mortality due to displacement from construction vessels across the Array Areas was up to 211.2 individuals.

~~401.~~402. At the average baseline mortality rate for razorbill of 0.1302, a total of 77,062 birds would be expected to die from the largest BDMPS population throughout the year. The addition of a maximum of 211.2 individuals to this increases the mortality rate by 0.274%, which is below the 1% threshold for detectability.

~~402.~~403. The number of individuals from the biogeographic population expected to die across all seasons is 222,251. The addition of a maximum of 211.2 to this increases the mortality rate by 0.095%, which is below the 1% threshold for detectability.

~~403.~~404. The sensitivity of razorbill to displacement is considered to be medium and the magnitude of annual impact at the Array Areas is negligible, therefore the annual effect on razorbill due to construction displacement at the Array Areas is assessed as minor adverse.

12.7.1.2.3.14 Annual – 50% installed turbines

~~404.~~405. The annual impact per annum from half of the Array Areas, has been assumed to be half of that estimated for operational displacement in the annual impact at the Array Areas (section 12.8.1.1.4.3.5). Thus, a maximum of 1,011.0 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.1302 a total of is 77,062 birds would be expected to die each year. The addition of 1,011.0 individuals would increase the mortality rate by 1.312%, which is above the 1% threshold for detectability. However, this is based on the worst case combination of parameters used to estimate operational displacement (70% displaced and 10% mortality). If construction displacement mortality was 2% (at 70% displaced), this figure would fall below the 1% threshold of detectability.

~~405.~~406. The number of individuals from the biogeographic population expected to die across all seasons is 222,251. The addition of a maximum of 1,011 to this increases the mortality rate by 0.455%, which is below the 1% threshold for detectability.

~~406.~~407. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the magnitude of annual impact at the Array Areas is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.3.15 Annual – construction vessels and 50% installed turbines

~~407.~~408. The combination of displacement by construction vessels and half of that estimated for operational displacement per annum for the Array Areas gives a combined maximum of 1,222.2 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.1302 a total of is 77,062 birds from the largest BDMPS population would be expected to die each year. The addition of 1,222.2 individuals would increase the mortality rate by 1.586%, which is above the 1% threshold for detectability. However, this is based on the worst case combination of parameters used to estimate operational displacement (70% displaced and 10% mortality). If construction displacement mortality was 2% (at 70% displaced), this figure would fall below the 1% threshold of detectability.

~~408.~~409. The number of individuals from the biogeographic population expected to die across all seasons is 222,251. The addition of a maximum of 1,222.2 to this increases the mortality rate by 0.550%, which is below the 1% threshold for detectability.

~~409.~~410. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the magnitude of annual impact at the Array Areas is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.2.4 Summary of Construction Displacement Assessment - Razorbill

~~410.~~411. A table summarising the razorbill construction displacement assessment is provided below (**Table 12-22**).

Table 12-22 Summary of Razorbill Displacement During Construction Assessment for DBS East, DBS West and Combined (Projects)

Razorbill		DBS East	DBS West	Projects
Baseline Average Annual Mortality				0.1302
Breeding season	Reference population (subadult component of nonbreeding BDMPS)			158,031
	Density (birds/km^2)	1.09	4.39	5.48
	Construction displacement mortality (@10%)	4.1	16.5	20.6
	Mortality due to 50% installed turbines (70% displaced x 10% mortality)	19.4	79.8	99.3
	Combined construction mortality	23.5	96.3	119.9
	Overall increase in background mortality (%)	0.114	0.468	0.583
	Significance	Minor	Minor	Minor
Autumn	Reference population (Nonbreeding season BDMPS)			591,875
	Density (birds/km^2)	9.19	9.41	18.6
	Construction displacement mortality (@10%)	34.6	35.5	70.1

Razorbill		DBS East	DBS West	Projects
	Mortality due to 50% installed turbines (70% displaced x 10% mortality)	164.0	171.0	335.1
	Combined construction mortality	198.6	206.5	405.1
	Overall increase in background mortality (%)	0.258	0.268	0.526
	Significance	Minor	Minor	Minor
Winter	Reference population (nonbreeding season BDMPS)			218,621
	Density (birds/km^2)	6.62	9.76	16.38
	Construction displacement mortality (@10%)	24.9	36.8	61.7
	Mortality due to 50% installed turbines (70% displaced x 10% mortality)	118.2	177.3	295.5
	Combined construction mortality	143.1	214.1	357.2
	Overall increase in background mortality (%)	0.503	0.752	1.255
	Significance	Minor	Minor	Minor
Spring	Reference population			591,875

Razorbill		DBS East	DBS West	Projects
	Density (birds/km^2)	7.02	8.58	15.6
	Construction displacement mortality (@10%)	26.5	32.3	58.8
	Mortality due to 50% installed turbines (70% displaced x 10% mortality)	125.3	155.9	281.2
	Combined construction mortality	151.8	188.2	340.0
	Overall increase in background mortality (%)	0.197	0.244	0.441
	Significance	Minor	Minor	Minor
Annual (BDMPS)	Reference population			591,875
	Density (birds/km^2)	23.92	32.14	56.06
	Construction displacement mortality (@10%)	90.1	121.1	211.2
	Mortality due to 50% installed turbines (70% displaced x 10% mortality)	426.9	584.1	1,011.0
	Combined construction mortality	517.0	705.2	1,222.2
	Increase in background mortality (%)	0.671	0.915	1.586

Razorbill		DBS East	DBS West	Projects
	Significance	Minor	Minor	Minor
Annual (Biogeographic)	Biogeographical population			1,707,000
	Increase in background mortality (%)	0.233	0.317	0.550
	Significance	Minor	Minor	Minor

12.7.1.3 Puffin

~~411.~~412. Puffins were recorded in the Array Areas with a spring and autumn focus (March, April and July to October). Estimated densities peaked within the DBS East array plus 2km buffer in October (0.35/km^2) and in the DBS West array plus 2km buffer in October (0.38/km^2). Puffins are considered to have a medium sensitivity to disturbance and displacement, based on their sensitivity to ship and helicopter traffic in Garthe and Hüppop (2004), Furness and Wade (2012), Furness *et al*. (2013) and Bradbury *et al*. (2014).

~~412.~~413. The Array Areas are within the mean maximum foraging range of puffins (137km) from the breeding colony at the FFC SPA, therefore indicating some degree of connectivity is possible. Natural England has advised that the puffin breeding season BDMPS reference population for the North Sea and Channel appropriate for this assessment is 868,689 individuals (Natural England 2024). The number of individuals from this population expected to die at the baseline mortality rate in the breeding season is 103,374 (868,689 x 0.119).

~~413.~~414. During the nonbreeding season, the puffin BDMPS population for the North Sea and Channel, 231,958, was used as the reference population for assessment. For the assessment of annual impacts, two reference populations have been considered; the largest BDMPS (868,689) and the biogeographic population (11,840,000; Furness, 2015). The number of individuals from these populations expected to die are 27,603 (231,958 x 0.119), 103,374 (868,689 x 0.119) and 1,408,960 (11,840,000 x 0.119) respectively.

12.7.1.3.1 Significance of Effect – DBS East in Isolation

12.7.1.3.1.1 Breeding Season – construction vessels

~~414.~~415. During the breeding season, the maximum mean peak density in the DBS East Array Area was 0.12/km^2. With a precautionary 2km radius of disturbance around each of three active construction areas (wind turbines or other infrastructure) up to 5 individuals (0.12 x 12.56 x 3) could be at risk of displacement, of which 0.5 (10%) would be expected to be at risk of mortality.

~~415.~~416. Based on the average mortality for adult puffin of 0.119, a total of 103,374 birds would be expected to die in the breeding season. The addition of a maximum of 0.5 to this increases the mortality rate by <0.001% which is below the 1% threshold for detectability.

~~416.~~417. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.3.1.2 Breeding Season – 50% installed turbines

~~417.~~418. The impact from half the wind farm during the breeding season has been assumed to be half of that estimated for operational displacement in the breeding season (section 12.8.1.1.5.1.1). Thus, a maximum of 2.2 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction.

~~418.~~419. Based on the average mortality for the species of 0.119, a total of 103,374 birds from the breeding season BDMPS population would be expected to die in the breeding season. The addition of a maximum of 2.2 to this increases the mortality rate by <0.002% which is below the 1% threshold for detectability.

~~419.~~420. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.3.1.3 Breeding Season – construction vessels and 50% installed turbines

~~420.~~421. The combination of displacement by construction vessels and half of that estimated for operational displacement in the breeding season gives a maximum of 2.7 individuals at risk of displacement mortality during each year of construction.

~~421.~~422. Based on the average mortality for the species of 0.0.119 a total of 103.374 birds from the breeding season BDMPS population would be expected to die in the breeding season. The addition of a maximum of 2.7 to this increases the mortality rate by 0.003% which is below the 1% threshold for detectability.

~~422.~~423. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.3.1.4 Nonbreeding – construction vessels

~~423.~~424. During the nonbreeding season the maximum mean peak density in DBS East Array Area was 0.35/km². With a precautionary 2km radius of disturbance around each of three active construction areas (wind turbines or other infrastructure), up to 13 individual birds (0.35 x 12.56 x 3) could be at risk of displacement, of which up to 1.3 (10%) birds would be expected to be at risk of mortality.

~~424.~~425. Based on the average mortality rate for adult puffin of 0.119, a total of 27,603 birds would be expected to die each year from the nonbreeding season BDMPS population. The addition of 1.3 birds to this would increase the mortality rate by up to <0.005%, which is below the 1% threshold for detectability.

~~425.~~426. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.3.1.5 Nonbreeding – 50% installed turbines

~~426.~~427. The impact from half the wind farm during the nonbreeding season has been assumed to be half of that estimated for operational displacement in the nonbreeding season (section 12.8.1.1.5.1.2). Thus, a maximum of 6.3 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.119 a total of 27,603 birds would be expected to die each year. The addition of 6.3 individuals would increase the mortality rate by 0.023 which is below the 1% threshold for detectability.

~~427.~~428. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.3.1.6 Nonbreeding – construction vessels and 50% installed turbines

~~428.~~429. The combination of displacement by construction vessels and half of that estimated for operational displacement in the nonbreeding season gives a maximum of 7.6 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.119 a total of 27,603 birds would be expected to die each year. The addition of 7.6 individuals would increase the mortality rate by 0.027%, which is below the 1% threshold for detectability.

~~429.~~430. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.3.1.7 Annual – construction vessels

~~430.~~431. The estimated number of puffins subject to construction disturbance and displacement mortality at DBS East throughout the year is up to 1.8 individuals.

~~431.~~432. At the average baseline mortality rate for puffin of 0.119, a total of 103,374 birds would be expected to die from the largest BDMPS population throughout the year. The addition of a maximum of 1.8 individuals to this increases the mortality rate by <0.01%, which is below the 1% threshold for detectability.

~~432.~~433. The number of individuals from the biogeographic population expected to die across all seasons is 1,408,960. The addition of a maximum of 1.8 to this increases the mortality rate by <0.001%, which is below the 1% threshold for detectability.

~~433.~~434. The sensitivity of puffin to construction displacement is considered to be medium and the magnitude of annual impact at DBS East is negligible, therefore the annual effect on puffin due to construction displacement at DBS East is assessed as **minor adverse**.

12.7.1.3.1.8 Annual – 50% installed turbines

~~434.~~435. The impact from half the wind farm during the annual impact at DBS East, has been assumed to be half of that estimated for operational displacement in the annual impact at DBS East, (section 12.8.1.1.5.1.3). Thus, a maximum of 8.5 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.119 a total of is 103,374 birds would be expected to die each year. The addition of 8.5 individuals would increase the mortality rate by 0.008%, which is below the 1% threshold for detectability.

~~435.~~436. The number of individuals from the biogeographic population expected to die across all seasons is 1,408,960. The addition of a maximum of 8.5 to this increases the mortality rate by <0.001%, which is below the 1% threshold for detectability.

~~436.~~437. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the magnitude of annual impact at DBS East is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.3.1.9 Annual – construction vessels and 50% installed turbines

~~437.~~438. The combination of displacement by construction vessels and half of that estimated for operational displacement the annual impact at DBS East gives a maximum of 10.3 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.119 a total of is 103,374 birds would be expected to die each year. The addition of 10.3 individuals would increase the mortality rate by 0.010%, which is below the 1% threshold for detectability.

~~438.~~439. The number of individuals from the biogeographic population expected to die across all seasons is 1,408,960. The addition of a maximum of 10.3 to this increases the mortality rate by <0.01%, which is below the 1% threshold for detectability.

~~439.~~440. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the magnitude of annual impact at DBS East is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.3.2 Significance of Effect – DBS West in Isolation

12.7.1.3.2.1 Breeding Season – construction vessels

~~440.~~441. During the breeding season, the maximum mean peak density in the DBS West Array Area was 0.21/km^2. With a precautionary 2km radius of disturbance around each of three active construction areas (wind turbines or other infrastructure) up to 8 individuals (0.21 x 12.56 x 3) could be at risk of displacement, of which 0.8 would be expected to be at risk of mortality.

Based on the average mortality for adult puffin of 0.119, a total of 103,374 birds from the BDMPS population would be expected to die in the breeding season. The addition of a maximum of 0.8 to this increases the mortality rate by 0.001%, which is below the 1% threshold for detectability.

~~441.~~442. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.3.2.2 Breeding Season – 50% installed turbines

~~442.~~443. The impact from half the wind farm during the breeding season has been assumed to be half of that estimated for operational displacement in the breeding season (section 12.8.1.1.5.2.1). Thus, a maximum of 3.8 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction.

~~443.~~444. Based on the average mortality for the species of 0.119, a total of 103,374 birds from the BDMPS population would be expected to die in the breeding season. The addition of a maximum of 3.8 to this increases the mortality rate by <0.004% which is below the 1% threshold for detectability.

~~444.~~445. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.3.2.3 Breeding Season – construction vessels and 50% installed turbines

~~445.~~446. The combination of displacement by construction vessels and half of that estimated for operational displacement in the breeding season gives a maximum of 4.6 individuals at risk of displacement mortality during each year of construction.

~~446.~~447. Based on the average mortality for the species of 0.119 a total of 103,374 birds from the BDMPS population would be expected to die in the breeding season. The addition of a maximum of 4.6 to this increases the mortality rate by 0.004% which is below the 1% threshold for detectability.

~~447.~~448. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.3.2.4 Nonbreeding – construction vessels

~~448.~~449. During the nonbreeding season the maximum mean peak density in DBS West Array Area was 0.38/km^2. With a precautionary 2km radius of disturbance around each of three active construction areas (wind turbines or other infrastructure), up to 14 individual birds (0.38 x 12.56 x 3) could be at risk of displacement, of which up to 1.4 birds would be expected to be at risk of mortality.

~~449.~~450. Based on the average mortality rate for adult puffin of 0.119, a total of 27,603 birds would be expected to die each year from the nonbreeding season BDMPS population. The addition of 1.4 birds to this would increase the mortality rate by up to <0.005%, which is below the 1% threshold for detectability.

~~450.~~451. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.3.2.5 Nonbreeding – 50% installed turbines

~~451.~~452. The impact from half the wind farm during the nonbreeding season has been assumed to be half of that estimated for operational displacement in the nonbreeding season (section 12.8.1.1.5.2.2). Thus, a maximum of 6.9 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.119 a total of 27,603 birds would be expected to die each year. The addition of 6.9 individuals would increase the mortality rate by 0.025 which is below the 1% threshold for detectability.

~~452.~~453. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.3.2.6 Nonbreeding – construction vessels and 50% installed turbines

~~453.~~454. The combination of displacement by construction vessels and half of that estimated for operational displacement in the nonbreeding season gives a maximum of 8.3 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.119 a total of 27,603 birds would be expected to die each year. The addition of 8.3 individuals would increase the mortality rate by 0.030%, which is below the 1% threshold for detectability.

~~454.~~455. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.3.2.7 Annual – construction vessels

~~455.~~456. The estimated number of puffins subject to construction disturbance and displacement mortality at DBS West throughout the year is up to 2.2 individuals.

~~456.~~457. At the average baseline mortality rate for puffin of 0.119, a total of 103,374 birds would be expected to die from the largest BDMPS population throughout the year. The addition of a maximum of 2.2 individuals to this increases the mortality rate by <0.002%, which is below the 1% threshold for detectability.

~~457.~~458. The number of individuals from the biogeographic population expected to die across all seasons is 1,408,960. The addition of a maximum of 2.2 to this increases the mortality rate by <0.002%, which is below the 1% threshold for detectability.

~~458.~~459. The sensitivity of puffin to displacement is considered to be medium and the magnitude of annual impact at DBS West is negligible, therefore the annual effect on puffin due to construction displacement at DBS West is assessed as **minor adverse**.

12.7.1.3.2.8 Annual – 50% installed turbines

~~459.~~460. The impact from half the wind farm during the annual impact at DBS West, has been assumed to be half of that estimated for operational displacement in the annual impact at DBS West, (section 12.8.1.1.5.2.3). Thus, a maximum of 10.7 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.119 a total of is 103,374 birds would be expected to die each year. The addition of 10.7 individuals would increase the mortality rate by 0.010%, which is below the 1% threshold for detectability.

~~460.~~461. The number of individuals from the biogeographic population expected to die across all seasons is 1,408,960. The addition of a maximum of 10.7 to this increases the mortality rate by <0.001%, which is below the 1% threshold for detectability.

~~461.~~462. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the magnitude of annual impact at DBS West is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.3.2.9 Annual – construction vessels and 50% installed turbines

~~462.~~463. The combination of displacement by construction vessels and half of that estimated for operational displacement the annual impact at DBS West gives a maximum of 12.9 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.119 a total of is 103,374 birds would be expected to die each year. The addition of 12.9 individuals would increase the mortality rate by 0.01%, which is below the 1% threshold for detectability.

~~463.~~464. The number of individuals from the biogeographic population expected to die across all seasons is 1,408,960. The addition of a maximum of 12.9 to this increases the mortality rate by <0.001%, which is below the 1% threshold for detectability.

~~464.~~465. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the magnitude of annual impact at DBS West is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.3.3 Significance of Effect – DBS East and DBS West Together

12.7.1.3.3.1 Breeding Season – construction vessels

~~465.~~466. During the breeding season the combined number of puffins at risk of mortality due to displacement from construction vessels across the Array Areas was up to 1.2 birds.

~~466.~~467. Based on the average mortality for adult puffin of 0.119, a total of 103,374 birds from the breeding BDMPS population would be expected to die in the breeding season. The addition of a maximum of 1.2 to this increases the mortality rate by 0.001%, which is below the 1% threshold for detectability.

~~467.~~468. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.3.3.2 Breeding Season – 50% installed turbines

~~468.~~469. The combined impact from half of the Array Areas during the breeding season has been assumed to be half of that estimated for operational displacement in the breeding season (section 12.8.1.1.5.3.1). Thus, a maximum of six individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction.

~~469.~~470. Based on the average mortality for the species of 0.119 a total of 103,374 birds from the breeding season BDMPS population would be expected to die in the breeding season. The addition of a maximum of six to this increases the mortality rate by <0.006% which is below the 1% threshold for detectability.

~~470.~~471. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.3.3.3 Breeding Season – construction vessels and 50% installed turbines

~~471.~~472. The combination of displacement by construction vessels and half of that estimated for operational displacement in the breeding season for the Array Areas gives a combined maximum of 7.2 individuals at risk of displacement mortality during each year of construction.

~~472.~~473. Based on the average mortality for the species of 0.119 a total of 103,374 birds from the breeding season BDMPS population would be expected to die in the breeding season The addition of a maximum of 7.2 to this increases the mortality rate by 0.007%, which is below the 1% threshold for detectability.

~~473.~~474. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.3.3.4 Nonbreeding – construction vessels

~~474.~~475. During the nonbreeding season the combined number of puffins at risk of mortality due to displacement from construction vessels across the Array Areas was up to 2.8 birds.

~~475.~~476. Based on the average mortality rate for adult puffin of 0.119, a total of 27,603 birds would be expected to die each year from the nonbreeding season BDMPS population. The addition of 2.8 birds to this would increase the mortality rate by up to 0.010%, which is below the 1% threshold for detectability.

~~476.~~477. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance **is minor adverse**.

12.7.1.3.3.5 Nonbreeding – 50% installed turbines

~~477.~~478. The combined impact from half of the Array Areas during the nonbreeding season has been assumed to be half of that estimated for operational displacement in the nonbreeding season (section 12.8.1.1.5.3.2). Thus, a maximum of 13.2 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.119 a total of 27,603 birds would be expected to die each year. The addition of 13.2 individuals would increase the mortality rate by 0.048% which is below the 1% threshold for detectability.

~~478.~~479. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during nonbreeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance **is minor adverse**.

12.7.1.3.3.6 Nonbreeding – construction vessels and 50% installed turbines

~~479.~~480. The combination of displacement by construction vessels and half of that estimated for operational displacement in the nonbreeding season for the Array Areas gives a maximum of 16.0 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.119 a total of 27,603 birds would be expected to die each year. The addition of 16.0 individuals would increase the mortality rate by 0.058%, which is below the 1% threshold for detectability.

~~480.~~481. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.3.3.7 Annual – construction vessels

~~481.~~482. Throughout the year the combined number of puffins at risk of mortality due to displacement from construction vessels across the Array Areas was up to 4.0 birds.

~~482.~~483. At the average baseline mortality rate for puffin of 0.119, a total of 103,374 birds would be expected to die from the largest BDMPS population throughout the year. The addition of a maximum of four individuals to this increases the mortality rate by <0.004%, which is below the 1% threshold for detectability.

~~483.~~484. The number of individuals from the biogeographic population expected to die across all seasons is 1,408,960. The addition of a maximum of four to this increases the mortality rate by <0.001%, which is below the 1% threshold for detectability.

~~484.~~485. The sensitivity of puffin to construction displacement is considered to be medium and the magnitude of annual impact at the Array Areas is negligible, therefore the annual effect on puffin due to construction displacement at the Array Areas is assessed as **minor adverse**.

12.7.1.3.3.8 Annual – 50% installed turbines

~~485.~~486. The annual impact per annum from half of the Array Areas during the annual impact at the Array Areas has been assumed to be half of that estimated for operational displacement in the annual impact at the Array Areas, (section 12.8.1.1.5.3.3). Thus, a maximum of 19.2 individuals could be at risk of displacement mortality from constructed turbines during the four year period of construction. Based on the average mortality for the species of 0.119 a total of is 103,374 birds from the largest BDMPS would be expected to die each year. The addition of 19.2 individuals would increase the mortality rate by 0.019%, which is below the 1% threshold for detectability.

~~486.~~487. The number of individuals from the biogeographic population expected to die across all seasons is 1,408,960. The addition of a maximum of 19.2 to this increases the mortality rate by 0.001%, which is below the 1% threshold for detectability.

~~487.~~488. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the magnitude of annual impact at the Array Areas is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.3.3.9 Annual – construction vessels and 50% installed turbines

~~488.~~489. The combination of displacement by construction vessels and half of that estimated for operational displacement per annum the Array Areas gives a combined maximum of 23.2 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.119 a total of is 103,374 birds from the largest BDMPS would be expected to die each year. The addition of 23.2 individuals would increase the mortality rate by 0.022%, which is below the 1% threshold for detectability.

~~489.~~490. The number of individuals from the biogeographic population expected to die across all seasons is 1,408,960. The addition of a maximum of 23.2 to this increases the mortality rate by <0.001%, which is below the 1% threshold for detectability.

~~490.~~491. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the magnitude of annual impact at the Array Areas is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.7.1.3.4 Summary of Construction Displacement Assessment - Puffin

~~491.~~492. A table summarising the puffin construction displacement assessment is provided below (**Table 12-23**).

Table 12-23 Summary of Puffin Displacement During Construction Assessment for DBS East, DBS West and Combined (Projects)

Puffin		DBS East	DBS West	Projects
Baseline average annual mortality				0.1190
Breeding season	Reference population			868,689
	Density (birds/km²)	0.12	0.21	0.33
	Construction displacement mortality (@10%)	0.5	0.8	1.3
	Mortality due to 50% installed turbines (70% displaced x 10% mortality)	2.2	3.8	6.0
	Combined construction mortality	2.7	4.6	7.2
	Overall increase in background mortality (%)	0.003	0.004	0.007
	Significance	Minor	Minor	Minor
Non breeding season	Reference population			231,958
	Density (birds/km²)	0.35	0.38	0.73
	Construction displacement mortality (@10%)	1.3	1.4	2.8
	Mortality due to 50% installed turbines (70% displaced x 10% mortality)	6.3	6.9	13.2
	Combined construction mortality	7.6	8.3	15.9
	Overall increase in background mortality (%)	0.027	0.030	0.058
	Significance	Minor	Minor	Minor

Puffin		DBS East	DBS West	Projects
Annual (BDMPS)	Reference population			868,689
	Density (birds/km^2)	0.47	0.59	1.06
	Construction displacement mortality (@10%)	1.8	2.2	4.0
	Mortality due to 50% installed turbines (70% displaced x 10% mortality)	8.5	10.7	19.2
	Combined construction mortality	10.3	12.9	23.2
	Overall increase in background mortality (%)	0.010	0.013	0.022
	Significance	Minor	Minor	Minor
Annual (biogeographic)	Biogeographical population			11,840,000
	Increase in background mortality (%)	<0.01	<0.01	<0.01
	Significance	Minor	Minor	Minor

12.7.1.4 Offshore Export Cable Corridor During Cable Installation

~~492.~~493. Up to two years has been allowed for Offshore Export Cable installation for up to four cables laid ~~independently~~in pairs. For each pair of cables this would involve a single cable installation vessel travelling at a slow speed along the cable route with one support vessel. There is potential for seabirds to be displaced by these vessels, within a precautionary radius of up to 2km. For most of the cable route the presence of these vessels would have a minimal impact on the species present, however as the cable route approaches the coast it will pass through the northern end of the Greater Wash SPA which is designated for red-throated diver, common scoter, little gull, common tern, little tern and Sandwich tern. Of these species, the tern breeding colonies are all located further south than the cable route (even allowing for foraging distances), little gull were not recorded in that part of the SPA (Natural England and JNCC 2016) and common scoter were recorded at very low levels through the SPA, apart from in the vicinity of the Wash. The only species recorded at higher levels in the northern part of the SPA was red-throated diver, and indeed it was this species for which this section of the SPA was defined (Natural England and JNCC 2016).

~~493.~~494. Therefore, there is potential that red-throated diver may be displaced by the cable laying vessels as it crosses the SPA if this takes place during the nonbreeding season.

12.7.1.4.1 Red-Throated Diver

12.7.1.4.1.1 Offshore Export Cable Installation

~~494.~~495. There is potential for disturbance and displacement of nonbreeding red-throated divers resulting from the presence of construction vessels installing the offshore cables when they are laid through the Greater Wash SPA. However, cable laying vessels are static for large periods of time and move only short distances as cable installation takes place. Offshore cable installation activity is also a relatively low noise emitting operation.

~~495.~~496. The magnitude of disturbance to red-throated diver from construction vessels has been estimated on a worst case basis. This assumes that there would be 100% displacement of birds within a 2km buffer surrounding the source, in this case around a maximum of two cable laying vessels (one main cable vessel and one support vessel). This 100% displacement from vessels is consistent with Garthe and Hüppop (2004) and Schwemmer *et al*. (2011) since they suggested that all red-throated divers present fly away from approaching vessels at a distance of often more than 1km.

~~496.~~497. In order to calculate the number of red-throated divers that would potentially be at risk of displacement from the Offshore Export Cable Corridor during the cable laying process, the density of red-throated divers in the SPA along the section crossed by the Offshore Export Cable Corridor was estimated. This was derived from a review of the Greater Wash SPA proposal details (Natural England and JNCC, 2016). This indicated that the peak density of birds in the SPA crossed by the cable corridor was between 0.68 and 0.87 per km^2.

~~497.~~498. The worst case area from which birds could be displaced was defined as a circle with a 2km radius around each cable laying vessel, which is 25.2km^2 (2 x 12.6km^2). If 100% displacement is assumed to occur within this area, then a peak of between 17 and 22 divers could be displaced at any given time. This would lead to a 0.7% increase in diver density in the remaining areas of the SPA assuming that displaced birds all remain within the SPA. As the vessels move it is assumed that displaced birds return and therefore any individual will be subjected to a brief period of impact. It is considered reasonable to assume that birds will return following passage of the vessel since the cable laying vessels would move at an approximate speed of 400m per hour if surface laying, 300m per hour for ploughing and 80m per hour if trenching (**Volume 7, Chapter 5 Project Description (application ref: 7.5)**). This represents a maximum speed of 7m per minute. For context, a modest tidal flow rate for the region would be in the region of 1m per second (60m per minute). The tide would therefore be flowing about nine times faster than the cable laying vessel. Consequently, for the purposes of this assessment it has been assumed that the estimated number displaced at any one time represents the total number displaced over the course of a single winter (i.e. rather than many individuals for a short duration each, the same individuals for the duration of a single winter).

~~498.~~499. Definitive mortality rates associated with displacement for red-throated divers, or for any other seabird species, are not known and precautionary estimates have to be used. There is no evidence that birds displaced from wind farms suffer any mortality as a consequence of displacement; any mortality due to displacement would be most likely a result of increased density in areas outside the affected area, resulting in increased competition for food where density was elevated (Dierschke *et al*., 2017). Such impacts are most likely to be negligible, and below levels that could be quantified, as the available evidence suggests that red-throated divers are unlikely to be affected by density-dependent competition for resources during the nonbreeding period (Dierschke *et al*., 2017). Impacts of displacement are also likely to be context-dependent. In years when food supply has been severely depleted, as for example by unsustainably high fishing mortality of sandeel stocks as has occurred several times in recent decades (ICES, 2013), displacement of sandeel-dependent seabirds from optimal habitat may increase mortality. In years when food supply is good, displacement is unlikely to have any negative effect on seabird populations. Red-throated divers may feed on sandeels, but take a wide diversity of small fish prey, so would be buffered to an extent from fluctuations in abundance of individual fish species.

~~499.~~500. For recent wind farm assessments Natural England has advised that an unconfirmed 10% mortality rate should be used for birds displaced by cable laying vessels. This magnitude of impact is not supported in the literature and given that this would equate to more than half the natural adult annual mortality (16%) from a single occasion of disturbance (as described above), it is highly improbable that such an effect would occur. To put this in context it is worth considering that disturbance from vessels in the southern North Sea has been ongoing for decades and designated shipping lanes are located throughout the areas where this species is present. With this in mind, additional mortality of 10% of the population due to single instances of vessel disturbance during the course of the winter, as proposed by Natural England, would reduce a population of 1,407 (i.e. the Greater Wash SPA population) to fewer than 100 within 10 years (alternatively the SPA population would need to have been 16 times larger 10 years prior to the SPA designation surveys in order to have been reduced to 1,407). Neither of these scenarios is supported by the evidence.

~~500.~~501. A review of available evidence for red-throated diver displacement was submitted for the Norfolk Vanguard assessment (MacArthur Green, 2019a) and this concluded that there would be little or no effect of displacement on diver survival. Consequently, a maximum, and hence precautionary, displacement caused mortality rate of 1% was identified as appropriate for this assessment.

~~501.~~502. At this level of additional mortality, only a maximum of 0.2 individuals would be expected to die across the entire winter period (September to April) as a result of any potential displacement effects from the offshore cable installation activities, which would be restricted to a maximum of nonbreeding seasons. This highly precautionary assessment will generate an effect of negligible magnitude.

~~502.~~503. The Offshore Export Cable laying works are temporary and localised in nature, therefore the magnitude of effect has been determined as negligible. As the species is of high sensitivity to disturbance, the impact significance is **minor adverse**.

504. As the impact is no greater than **minor adverse** no additional mitigation is required.

12.7.1.4.1.2 Subtidal Exit Pit Installation

505. In addition to the Offshore Export Cable laying works detailed in section 12.7.1.4.1.1, up to six subtidal exit pits may be installed in the nearshore area of the Offshore Export Cable Corridor. Works on the exit pits could take place over three separate construction periods, the first for horizontal directional drill (HDD) exit pit preparation, a second period for HDD duct installation and a third period for cable pull-in. It is estimated that HDD exit pit preparation and HDD duct installation would at most extend over an indicative 6–8 month period, with cable pull activities taking place over an indicative 4-6 month period. It should be noted that vessels would not be present for the entirety of the two defined time periods, with any final construction timelines being dependent on the finalised construction approach and equipment selected. In addition, cable pull activities would not occur directly following the installation of the subtidal exit pits, with all works taking place within a 3-year period.

506. During installation activities for the subtidal exit pits and cable pull, installation vessels would remain effectively stationary. Assuming for 100% displacement of birds within 2km of construction activity, this would effectively result in a stationary 12.56km² area of disturbance around each construction site, encompassing approximately 0.35% of the total area of the Greater Wash SPA per construction site.

507. Figure 12-1 and Figure 12-2 show the density of red-throated diver recorded in the previous 2016 JNCC survey (JNCC and Natural England, 2016) in relation to the Offshore Export Cable Corridor and the indicative location of where the subtidal exit pits may be located. As shown in this figure, the indicative subtidal exit pit construction area is outside the area surveyed for red-throated diver in the previous 2016 JNCC survey area, with this area assumed to reflect the species' distribution within the SPA.

508. The subtidal exit pit works are temporary and localised in nature, therefore the magnitude of effect has been determined as negligible. As the species is of high sensitivity to disturbance, the impact significance is **minor adverse**.

509. As the impact is no greater than **minor adverse** no additional mitigation is required.

12.7.2 Impact 2 Indirect Impacts Through Effects on Habitats and Prey Species During Construction

~~503.~~510. Indirect disturbance and displacement of birds may occur during the construction phase if there are impacts on prey species and the habitats of prey species. These indirect effects include those resulting from the production of underwater noise (e.g. during piling) and the generation of suspended sediments (e.g. during preparation of the seabed for foundations) that may alter the behaviour or availability of bird prey species. Underwater noise may cause fish and mobile invertebrates to avoid the construction area and also affect their physiology and behaviour. Suspended sediments may cause fish and mobile invertebrates to avoid the construction area and may smother and hide immobile benthic prey. These mechanisms may result in less prey being available within the construction area to foraging seabirds. Such potential effects on benthic invertebrates and fish have been assessed in **Volume 7, Chapter 9 Benthic and Intertidal Ecology (application ref: 7.9)** and **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)** and the conclusions of those assessments inform this assessment of indirect effects on birds.

~~504.~~511. With regard to noise impacts on fish, **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)** discusses the potential impacts upon fish relevant to ornithology as prey species. For species such as herring, sprat and sandeel, which are the main prey items of seabirds such as gannet and auks, unmitigated underwater noise effects (physical injury or behavioural changes) during construction are considered to be minor adverse for herring (group 3, most sensitive species), sandeel and sprat (group 1, least sensitive species). With a minor effect on fish, it is concluded that the magnitude of effect on seabirds, for which the DBS Array Areas represent only a small part of their possible foraging range, will be negligible. Therefore, the indirect significance, even for high sensitivity seabirds, of impacts on fish during the construction phase is, at most, **minor adverse**. This conclusion applies irrespective of the alternative construction scenarios (one or two projects, constructed concurrently or sequentially).

~~505.~~512. With regard to changes to the seabed and to suspended sediment levels, **Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)** and **Volume 7, Chapter 9 Benthic and Intertidal Ecology (application ref: 7.9)** discusses the nature of any likely significant effects on the seabed and benthic habitats. The impact on benthic habitats is predicted to be of local spatial extent (i.e. restricted to discrete areas within the Array Areas in the vicinity of the construction location), short-term duration (as it is limited to the duration of construction activities), intermittent and with high reversibility. The consequent indirect effect on benthic habitats is considered to be minor. With a minor effect on benthic habitats which support fish that are bird prey species, it is concluded that the magnitude of effect on seabirds, for which the DBS Array Areas represent only a small part of their possible foraging range, will be negligible. Therefore, the indirect significance, even for high sensitivity seabirds, of impacts on benthic habitats during the construction phase is, at most, minor adverse. This conclusion applies irrespective of the alternative construction scenarios (one or two Projects, constructed concurrently or sequentially).

12.8 Potential Effects During Operation

12.8.1 Impact 3 Disturbance and Displacement from Offshore Infrastructure

~~506.~~513. The presence of wind turbines has the potential to directly disturb and displace birds from within and around the Array Area. This is assessed as effective habitat loss, as it has the potential to reduce the area available to birds for feeding, loafing and moulting. Vessel activity and the lighting of wind turbines and associated ancillary structures could also attract (or repel) certain species of birds and affect migratory behaviour on a local scale.

~~507.~~514. Seabird species vary in their reactions to the presence of operational infrastructure (e.g. wind turbines, offshore project substations and met masts) and to the maintenance activities that are associated with them (particularly ship and helicopter traffic), with Garthe and Hüppop (2004) presenting a scoring system for such disturbance factors, which is used widely in offshore wind farm EIAs. There is limited evidence as to the disturbance and displacement effects of the operational infrastructure in the long term. However, Dierschke *et al*. (2016) reviewed all available evidence from operational offshore wind farms on the extent of displacement or attraction of seabirds in relation to these structures. They found strong avoidance of operational offshore wind farms by red-throated diver, black-throated diver and gannet. They found weak avoidance by long-tailed duck, common scoter, fulmar, Manx shearwater, razorbill, guillemot, little gull and Sandwich tern. They found no evidence of any consistent response by eider, kittiwake, common tern and Arctic tern, and evidence of weak attraction to operating offshore wind farms for common gull, black-headed gull, great black-backed gull, herring gull and lesser black-backed gull, and strong attraction for shags and cormorants. Dierschke *et al*. (2016) suggested that strong avoidance would lead to some habitat loss for those species, while attracted birds appear to benefit from increases in food abundance within operational offshore wind farms.

~~508.~~515. Post-construction monitoring over two breeding seasons of the Beatrice wind farm in Scotland has found little indication that guillemots and razorbills avoid wind turbines, with spatial distributions within the wind farm no different from those that might be expected by chance (MacArthur Green, 2023).

~~509.~~516. The Statutory Nature Conservation Bodies (SNCBs) issued a joint Interim Displacement Guidance Note (JNCC, 2017), which provides recommendations for presenting information to enable the assessment of displacement effects in relation to offshore wind farm developments. This guidance note has been used in the assessment provided below.

~~510.~~517. There are a number of different measures used to determine bird displacement from areas of sea in response to activities associated with an offshore wind farm. Furness *et al*. (2013), for example, use disturbance ratings for particular species, alongside scores for habitat flexibility and conservation importance to define an index value that highlights the sensitivity to disturbance and displacement. These authors also recognise that displacement may contribute to individual birds experiencing fitness consequences, which at an extreme level could lead to the mortality of individuals.

~~511.~~518. Both the presence of the infrastructure and the operational activities associated with the Projects have the potential to directly disturb birds. These activities could potentially displace birds from important areas for feeding, moulting and loafing. Reduced access to some areas could result, at the extreme, in changes to feeding and other behavioural activities resulting in a loss of fitness and a reduction in survival chances. This would be unlikely for seabirds that have large areas of alternative habitat available but would be more likely to affect seabirds with highly specialised habitat requirements that are limited in availability (Furness *et al*., 2013; Bradbury *et al*., 2014).

~~512.~~519. The methodology presented in JNCC (2017) recommends a matrix is presented for each key species showing bird losses at differing rates of displacement and mortality. This assessment uses the range of predicted losses, in association with the scientific evidence available from post-construction monitoring studies, to quantify the level of displacement and the potential losses as a consequence of the proposed project. These losses are then placed in the context of the relevant population (e.g. SPA, BDMPS or biogeographic) to determine the magnitude of impact.

~~513.~~520. The population estimate used for each species to assess the displacement effects was the relevant seasonal peak (i.e. the highest value for the months within each season). The seasonal peaks were calculated as follows; first the density for each calendar month was calculated, then the highest value from the months within each season extracted. As per JNCC (2017), for divers, the assessment used all data recorded within the 4km buffer, for all other species the assessment used all data recorded within the 2km buffer (although it should be noted that the evidence reviews in MacArthur Green (2021) indicate that these buffer distances are highly precautionary for both divers and auks).

~~514.~~521. It is important to note that the combined seasonal peak abundance across the DBS East and DBS West Array Areas used for assessment will be lower than the individual site peaks when the peaks on the latter occurred in different months. This is because the surveys for DBS East and DBS West were conducted on the same day, and as a consequence it would result in double counting if seasonal peaks recorded at each Array Area in different months were summed. For example, if the breeding season peak on DBS East was recorded in March and the peak on DBS West in May, the combined peak will not be obtained as the sum of those values (March plus May), but instead is the highest of the DBS East plus DBS West values in each month.

~~515.~~522. Birds are considered to be most at risk from operational disturbance and displacement effects when they are resident (e.g. during the breeding season or wintering season). The small risk of impact to migrating birds is better considered in terms of barrier effects. However, JNCC (2017) suggests that migration periods should also be assessed using the matrix approach and this has been undertaken where appropriate. This also applies to a suggestion from the Netherlands Government to take account of auk migration routes from the UK to areas in Dutch waters used during the moult (e.g. the Frisian Front). Thus, the displacement assessment is considered to incorporate these migratory movements without the need for any further assessment.

~~516.~~523. Following installation of the offshore cable, the required operational and maintenance activities (in relation to the cable) may have short-term and localised disturbance and displacement impacts on birds. However, disturbance from operational cable activities (e.g. maintenance) would be temporary and localised, and is unlikely to result in detectable effects at either the local or regional population level. Therefore, no impact due to cable operation and maintenance is predicted. The focus of this section is therefore on the disturbance and displacement of birds due to the presence and operation of wind turbines, other offshore infrastructure and any maintenance operations associated with these structures.

~~517.~~524. In order to focus the assessment of disturbance and displacement, a screening exercise was undertaken to identify those species most likely to be at risk (**Table 12-24**), focussing on the main species described in the Ornithology Technical Report (**Volume 7, Appendix 12-2 Technical Appendix (application ref: 7.12.12.2)**). The species identified as at risk were then assessed within the biological seasons within which effects were potentially likely to occur. Any species with a low sensitivity to displacement or recorded only in very small numbers within the DBS Array Areas during the breeding and wintering seasons, were screened out of further assessment.

~~518.~~525. Operational disturbance and displacement screening (**Table 12-24**) presents the general sensitivity to disturbance and displacement for each species.

Table 12-24 Operational Disturbance and Displacement Screening.

Receptor	Sensitivity to Disturbance and Displacement[6]	Biological Season(s) with peak numbers	Screening Result (IN or OUT)
Red-throated diver	High	Breeding (although considered to be a record of a late migrant)	Screened OUT due to very low numbers recorded (1 individual) and sub-optimal location.
Great northern diver	High	Breeding (although considered to be a record of a late migrant)	Screened OUT due to very low numbers recorded (1 individual) and sub-optimal location.
Fulmar	Considered Low in some studies, but possibly high according to Dierschke *et al.* (2016)	Moderate numbers throughout the year	Screened OUT as the species has a maximum habitat flexibility score of 1 in Furness & Wade (2012), suggesting species utilises a wide range of habitats over a large area.

[6] Garthe and Hüppop, 2004; Furness and Wade, 2012, Wade *et al.*, 2016, Dierschke *et al.*, 2016

Receptor	Sensitivity to Disturbance and Displacement[6]	Biological Season(s) with peak numbers	Screening Result (IN or OUT)
Gannet	Considered Low in some studies, but possibly high according to Dierschke *et al.* (2016). Low to Medium applied in the assessment	Breeding and autumn migration	Screened IN for breeding, autumn and spring migration seasons, as has a high macro avoidance rate.
Guillemot	Medium	Nonbreeding	Screened IN as present in moderate to high numbers all year round and due to medium sensitivity to disturbance and displacement.
Razorbill	Medium	Migration and nonbreeding seasons	Screened IN as present in moderate to high numbers all year round and due to medium sensitivity to disturbance and displacement.
Puffin	Low	Winter	Screened IN as present in moderate numbers, particularly in migration periods and due to medium sensitivity to disturbance and displacement.
Kittiwake	Low	Breeding	Screened OUT as migration numbers low relative to BDMPS and not known to avoid wind turbines (low macro avoidance rate)

Receptor	Sensitivity to Disturbance and Displacement[6]	Biological Season(s) with peak numbers	Screening Result (IN or OUT)
Lesser black-backed gull	Low	Breeding	Screened OUT as present in low numbers in all seasons and not known to avoid wind turbines (low macro avoidance rate)
Herring gull	Low	Breeding	Screened OUT as present in low numbers in all seasons and not known to avoid wind turbines (low macro avoidance rate)
Great black-backed gull	Low	Nonbreeding	Screened OUT as present in relatively low numbers in all seasons and not known to avoid wind turbines (low macro avoidance rate)

~~519.~~526. The impact of mortality caused by displacement on a population has been assessed in terms of the change in the baseline mortality rate which could result. It has been assumed that all age classes are equally at risk of displacement (i.e. in proportion to their presence in the population), therefore the average mortality rates calculated above (**Table 12-17**) have been used.

~~520.~~527. For assessment a worst case assumption has been made that birds will be at risk of displacement from the complete extent of the Array Areas plus species specific buffers. This will over-estimate impacts since it is highly unlikely that the entire area within the Array Areas will contain wind turbines, and even if it did then the inter-wind turbine separation distance would be such that birds would be very likely to use areas between wind turbines. Therefore, the estimated number of birds at risk of an effect is highly precautionary, since it corresponds to a much larger area than will ultimately be developed (possibly more than twice the final wind farm size). There is evidence to suggest that the density of wind turbines influences the magnitude of displacement (Leopold *et al*., 2011). Indeed, since the cause of operational displacement is bird responses to the wind turbines, it is logical to infer that a wind farm with a lower wind turbine density will cause lower displacement levels than one with a higher density of wind turbines.

~~521.~~528. Natural England guidance (Parker *et al*. 2022c) is that displacement effects estimated in different seasons should be combined to provide an annual effect for assessment which should then be assessed in relation to the largest of the component BDMPS populations, and also the biogeographic population. Natural England has acknowledged that summing impacts in this manner almost certainly over-estimates the number of individuals at risk through double counting (i.e. some individuals may potentially be present in more than one season) and assessing against the BDMPS almost certainly under-estimates the population from which they are drawn (which must be at least this size and is likely to be considerably larger as a consequence of turnover of individuals). However, at the present time there is no agreed alternative method for undertaking assessment of annual displacement and therefore the above approach is presented, albeit with the caveat that the results are anticipated to be highly precautionary.

~~522.~~529. The displacement matrices presented in the following species sections use the mean abundance in each season. Natural England (2023) requested additional matrices using the upper and lower 95% confidence intervals. These have been provided in **Volume 7, Appendix 12-12 Seasonal Displacement Matrices Upper Lower C.I. Abundance (application ref: 7.12.12.12)**.

12.8.1.1.1 Gannet

~~523.~~530. Gannets show a low level of sensitivity to ship and helicopter traffic (Garthe and Hüppop, 2004; Furness and Wade, 2012) however, a detailed study (Krijgsveld *et al*., 2011) using radar and visual observations to monitor the post-construction effects of the Windpark Egmond aan Zee OWEZ established that 64% of gannets avoided entering the wind farm (macro-avoidance) and a similar result (80% macro avoidance) was also observed during a study at the Thanet wind farm (Skov *et al*., 2018). Leopold *et al*. (2013) reported that most gannets avoided Dutch offshore wind farms and did not forage within these. Dierschke *et al*. (2016) concluded that gannets show high avoidance of offshore wind farms despite showing little avoidance of ships.

~~524.~~531. The displacement matrices have been populated with data for gannets recorded during the breeding, autumn and spring migration periods within the DBS East and DBS West Array Areas and the two combined including a 2km buffer, in line with guidance (JNCC, 2017). It should be noted that the inclusion of birds within the 2km buffer to determine the total number of birds subject to displacement is precautionary since in reality the avoidance rate is likely to fall with distance from the Array Area, as demonstrated in a study of gannet distribution in relation to the Greater Gabbard wind farm (APEM, 2014).

~~525.~~532. For the purpose of this assessment, percentage displacement rates between 10 and 100% at 10% increments have been combined with mortality between 1 and 100% at varying increments. The highlighted cells in the matrices indicate displacement rates of 60% to 80% (as the OWEZ and Thanet data suggest the actual rate lies between these two figures based on macro-avoidance; Leopold *et al*., 2013; Skov *et al*., 2018) and the most likely mortality rate, which is assumed to be no more than 1% (as they score highly for habitat flexibility; Furness and Wade, 2012). A high score in habitat flexibility is given to species that use a wide range of habitats over a large area, and usually with a relatively wide range of foods (Furness and Wade, 2012).

~~526.~~533. The nearest gannet breeding colony to the Projects is the Flamborough and Filey Coast SPA. The SPA is a minimum of 100km from the Projects' Array Areas, and therefore they are within the mean maximum foraging range of gannets, estimated as 315km (Woodward *et al*. 2019). Consequently, breeding season connectivity to this SPA has been assumed.

~~527.~~534. Natural England has advised that the gannet breeding season BDMPS reference population for the North Sea and Channel appropriate for this assessment is 400,326 individuals (Natural England, 2024).

~~528.~~535. The number of individuals from this population expected to die at the baseline mortality rate in the breeding season is 74,701 (400,326 x 0.1866).

~~529.~~536. During the nonbreeding seasons the gannet BDMPS populations for the North Sea and Channel have been used as the reference populations (in the autumn: 456,299 and in the spring: 248,385). For the annual assessment, impacts have been considered in relation to the largest of the BDMPS populations (autumn) and also to the biogeographic population (1,180,000; Furness, 2015). The number of individuals from these populations expected to die in the autumn is 85,145 (456,299 x 0.1866), in the spring is 46,349 (248,385 x 0.1866), and annually from the biogeographic population is 220,188 (1,180,000 x 0.1866).

12.8.1.1.1.1 Significance of Effect – DBS East in Isolation

12.8.1.1.1.1.1 Breeding Season

~~530.~~537. During the breeding season, the maximum mean peak abundance in the DBS East Array Area and 2km buffer was 755 individuals. Within the range of 60-80% displacement and 1% mortality, the maximum number of individual gannets which could potentially suffer mortality as a consequence of displacement from the DBS East Array Area (and 2km buffer) during the breeding season has been estimated as six individuals (**Table 12-25**).

Table 12-25 Displacement Matrix Presenting the Number of Gannets in the DBS East Array Area (and 2km Buffer) During the Breeding Season That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	1	2	2	3	4	5	5	6	7	8
2	2	3	5	6	8	9	11	12	14	15
3	2	5	7	9	11	14	16	18	20	23
4	3	6	9	12	15	18	21	24	27	30
5	4	8	11	15	19	23	26	30	34	38
6	5	9	14	18	23	27	32	36	41	45
7	5	11	16	21	26	32	37	42	48	53
8	6	12	18	24	30	36	42	48	54	60
9	7	14	20	27	34	41	48	54	61	68
10	8	15	23	30	38	45	53	60	68	76
20	15	30	45	60	76	91	106	121	136	151
30	23	45	68	91	113	136	159	181	204	227
50	38	76	113	151	189	227	264	302	340	378
75	57	113	170	227	283	340	396	453	510	566
100	76	151	227	302	378	453	529	604	680	755

~~531.~~538. Based on the average mortality for the species of 0.1866 a total of 74,701 birds would be expected to die each year. The addition of a maximum of six individuals to these would increase the mortality rate by 0.008%, which is below the 1% threshold for detectability.

~~532.~~539. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season period, the magnitude of impact is assessed as negligible. As the species is of low to medium sensitivity to displacement, the effect significance is **negligible** to **minor adverse**.

12.8.1.1.1.1.2 Autumn Migration

~~533.~~540. During the autumn migration period, the maximum mean peak abundance in the DBS East Array Area and 2km buffer was 776 individuals. Within the range of 60-80% displacement and 1% mortality, the maximum number of individual gannets which could potentially suffer mortality as a consequence of displacement from the DBS East Array Area (and 2km buffer) during the autumn migration period has been estimated as six individuals (**Table 12-26**).

Table 12-26 Displacement Matrix Presenting the Number of Gannets in the DBS East Array Area (and 2km Buffer) During the Autumn Migration Season That May Be Subject to Mortality (Highlighted).

Mortality (%)	**Displacement (%)**									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	1	2	2	3	4	5	5	6	7	8
2	2	3	5	6	8	9	11	12	14	16
3	2	5	7	9	12	14	16	19	21	23
4	3	6	9	12	16	19	22	25	28	31
5	4	8	12	16	19	23	27	31	35	39
6	5	9	14	19	23	28	33	37	42	47
7	5	11	16	22	27	33	38	43	49	54
8	6	12	19	25	31	37	43	50	56	62
9	7	14	21	28	35	42	49	56	63	70
10	8	16	23	31	39	47	54	62	70	78
20	16	31	47	62	78	93	109	124	140	155
30	23	47	70	93	116	140	163	186	210	233
50	39	78	116	155	194	233	272	310	349	388
75	58	116	175	233	291	349	407	466	524	582
100	78	155	233	310	388	466	543	621	698	776

~~534.~~541. At the average baseline mortality rate for gannet of 0.1866) a total of 85,145 birds would be expected to die in autumn. The addition of a maximum of six to this increases the mortality rate by 0.007%, which is below the 1% threshold for detectability.

~~535.~~542. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of impact is assessed as negligible. As the species is of low to medium sensitivity to displacement, the effect significance is **negligible** to **minor adverse**.

12.8.1.1.1.1.3 Spring Migration

~~536.~~543. During the spring migration period, the maximum mean peak abundance in the DBS East Array Area and 2km buffer was 75 individuals. Within the range of 60-80% displacement and 1% mortality, the maximum number of individual gannets which could potentially suffer mortality as a consequence of displacement from the DBS East Array Area (and 2km buffer) during the spring migration period has been estimated as one individual (**Table 12-27**).

Table 12-27 Displacement Matrix Presenting the Number of Gannets in the DBS East Array Area (and 2km Buffer) During the Spring Migration Season That May Be Subject to Mortality (Highlighted)

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	0	0	0	0	0	0	1	1	1	1
2	0	0	0	1	1	1	1	1	1	2
3	0	0	1	1	1	1	2	2	2	2
4	0	1	1	1	2	2	2	2	3	3
5	0	1	1	2	2	2	3	3	3	4
6	0	1	1	2	2	3	3	4	4	5
7	1	1	2	2	3	3	4	4	5	5
8	1	1	2	2	3	4	4	5	5	6
9	1	1	2	3	3	4	5	5	6	7
10	1	2	2	3	4	5	5	6	7	8
20	2	3	5	6	8	9	11	12	14	15
30	2	5	7	9	11	14	16	18	20	23
50	4	8	11	15	19	23	26	30	34	38
75	6	11	17	23	28	34	39	45	51	56
100	8	15	23	30	38	45	53	60	68	75

~~537.~~544. Based on the average mortality for the species of 0.1866 a total of 46,349 birds would be expected to die in spring. The addition of a maximum of one to this increases the mortality rate by 0.001%, which is below the 1% threshold for detectability.

~~538.~~545. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of impact is assessed as negligible. As the species is of low to medium sensitivity to displacement, the effect significance is **negligible** to **minor adverse**.

12.8.1.1.1.1.4 Annual

~~539.~~546. Summed across the year the maximum mean peak abundance in the DBS East Array Area and 2km buffer was 1,606 individuals. Within the range of 60-80% displacement and 1% mortality, the maximum number of individual gannets which could potentially suffer mortality as a consequence of displacement from the DBS East Array Area (and 2km buffer) during the breeding, autumn migration and spring migration periods combined (i.e. annually) has been estimated as 13 individuals (**Table 12-28**).

Table 12-28 Displacement Matrix Presenting the Number of Gannets in the DBS East Array Area (and 2km Buffer) Combined Across the Breeding and Nonbreeding Seasons That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	2	3	5	6	8	10	11	13	14	16
2	3	6	10	13	16	19	22	26	29	32
3	5	10	14	19	24	29	34	39	43	48
4	6	13	19	26	32	39	45	51	58	64
5	8	16	24	32	40	48	56	64	72	80
6	10	19	29	39	48	58	67	77	87	96
7	11	22	34	45	56	67	79	90	101	112
8	13	26	39	51	64	77	90	103	116	128
9	14	29	43	58	72	87	101	116	130	145
10	16	32	48	64	80	96	112	128	145	161
20	32	64	96	128	161	193	225	257	289	321
30	48	96	145	193	241	289	337	385	434	482
50	80	161	241	321	402	482	562	642	723	803
75	120	241	361	482	602	723	843	964	1084	1205
100	161	321	482	642	803	964	1124	1285	1445	1606

~~540.~~547. At the average baseline mortality rate for gannet of 0.1866 a total of 85,145 birds would be expected to die from the largest BDMPS population throughout the year. The addition of a maximum of 13 to this increases the mortality rate by 0.015%, which is below the 1% threshold for detectability.

~~541.~~548. The number of individuals from the biogeographic population expected to die across all seasons is220,188. The addition of a maximum of 13 to this increases the mortality rate by 0.006%, which is below the 1% threshold for detectability.

~~542.~~549. The sensitivity of gannet to operational displacement is considered to be low to medium and the magnitude of annual impact at DBS East is negligible, therefore the annual effect on gannet due to operational displacement at DBS East is assessed as **negligible** to **minor adverse**.

12.8.1.1.1.2 Significance of Effect – DBS West in Isolation

12.8.1.1.1.2.1 Breeding Season

~~543.~~550. During the breeding season, the maximum mean peak abundance in the DBS West Array Area and 2km buffer was 805 individuals. Within the range of 60-80% displacement and 1% mortality, the maximum number of individual gannets which could potentially suffer mortality as a consequence of displacement from the DBS West Array Area (and 2km buffer) during the breeding season has been estimated as six individuals (**Table 12-29**).

Table 12-29 Displacement Matrix Presenting the Number of Gannets in the DBS West Array Area (And 2km Buffer) During the Breeding Season That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	1	2	2	3	4	5	6	6	7	8
2	2	3	5	6	8	10	11	13	14	16
3	2	5	7	10	12	14	17	19	22	24
4	3	6	10	13	16	19	23	26	29	32
5	4	8	12	16	20	24	28	32	36	40
6	5	10	14	19	24	29	34	39	43	48
7	6	11	17	23	28	34	39	45	51	56
8	6	13	19	26	32	39	45	52	58	64
9	7	14	22	29	36	43	51	58	65	72
10	8	16	24	32	40	48	56	64	72	81
20	16	32	48	64	81	97	113	129	145	161
30	24	48	72	97	121	145	169	193	217	242
50	40	81	121	161	201	242	282	322	362	403
75	60	121	181	242	302	362	423	483	543	604
100	81	161	242	322	403	483	564	644	725	805

~~544.~~551. Based on the average mortality for the species of 0.1866 a total of 74,701 birds would be expected to die each year. The addition of six individuals to these would increase the mortality rate by 0.009%, which is below the 1% threshold for detectability.

545.552. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season period, the magnitude of impact is assessed as negligible. As the species is of low to medium sensitivity to displacement, the effect significance is **negligible** to **minor adverse**.

12.8.1.1.1.2.2 Autumn Migration

546.553. During the autumn migration period, the maximum mean peak abundance in the DBS West Array Area and 2km buffer was 798 individuals. Within the range of 60-80% displacement and 1% mortality, the maximum number of individual gannets which could potentially suffer mortality as a consequence of displacement from the DBS West Array Area (and 2km buffer) during the autumn migration period has been estimated as six individuals (**Table 12-30**).

Table 12-30 Displacement Matrix Presenting the Number of Gannets in the DBS West Array Area (and 2km Buffer) During the Autumn Migration Season That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	1	2	2	3	4	5	6	6	7	8
2	2	3	5	6	8	10	11	13	14	16
3	2	5	7	10	12	14	17	19	22	24
4	3	6	10	13	16	19	22	26	29	32
5	4	8	12	16	20	24	28	32	36	40
6	5	10	14	19	24	29	34	38	43	48
7	6	11	17	22	28	34	39	45	50	56
8	6	13	19	26	32	38	45	51	57	64
9	7	14	22	29	36	43	50	57	65	72
10	8	16	24	32	40	48	56	64	72	80
20	16	32	48	64	80	96	112	128	144	160
30	24	48	72	96	120	144	168	192	215	239
50	40	80	120	160	200	239	279	319	359	399
75	60	120	180	239	299	359	419	479	539	599
100	80	160	239	319	399	479	559	638	718	798

547.554. At the average baseline mortality rate for gannet of 0.1866 a total of 85,145 birds would be expected to die in autumn. The addition of a maximum of six to this increases the mortality rate by 0.007%, which is below the 1% threshold for detectability.

~~548.~~555. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of impact is assessed as negligible. As the species is of low to medium sensitivity to displacement, the effect significance is **negligible** to **minor adverse**.

12.8.1.1.1.2.3 Spring Migration

~~549.~~556. During the spring migration period, the maximum mean peak abundance in the DBS West Array Area and 2km buffer was 86 individuals. Within the range of 60-80% displacement and 1% mortality, the maximum number of individual gannets which could potentially suffer mortality as a consequence of displacement from the DBS West Array Area (and 2km buffer) during the spring migration period has been estimated as one individual (**Table 12-31**).

Table 12-31 Displacement Matrix Presenting the Number of Gannets in the DBS West Array Area (and 2km Buffer) During the Spring Migration Season That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	0	0	0	0	0	1	1	1	1	1
2	0	0	1	1	1	1	1	1	2	2
3	0	1	1	1	1	2	2	2	2	3
4	0	1	1	1	2	2	2	3	3	3
5	0	1	1	2	2	3	3	3	4	4
6	1	1	2	2	3	3	4	4	5	5
7	1	1	2	2	3	4	4	5	5	6
8	1	1	2	3	3	4	5	6	6	7
9	1	2	2	3	4	5	5	6	7	8
10	1	2	3	3	4	5	6	7	8	9
20	2	3	5	7	9	10	12	14	15	17
30	3	5	8	10	13	15	18	21	23	26
50	4	9	13	17	22	26	30	34	39	43
75	6	13	19	26	32	39	45	52	58	65
100	9	17	26	34	43	52	60	69	77	86

~~550.~~557. Based on the average mortality for the species of 0.1866 a total of 46,349 birds would be expected to die in spring. The addition of a maximum of one to this increases the mortality rate by 0.001%, which is below the 1% threshold for detectability.

~~551.~~558. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of impact is assessed as negligible. As the species is of low to medium sensitivity to displacement, the effect significance is **negligible** to **minor adverse**.

12.8.1.1.1.2.4 Annual

~~552.~~559. Summed across the year the maximum mean peak abundance in the DBS West Array Area and 2km buffer was 1,689 individuals. Within the range of 60-80% displacement and 1% mortality, the maximum number of individual gannets which could potentially suffer mortality as a consequence of displacement from the DBS West Array Area (and 2km buffer) during the breeding, autumn migration and spring migration periods combined has been estimated as 14 individuals (**Table 12-32**).

Table 12-32 Displacement Matrix Presenting the Number of Gannets in the DBS West Array Area (and 2km Buffer) Combined Across the Breeding and Nonbreeding Seasons That May Be Subject to Mortality (Highlighted).

Mortality (%)	**Displacement (%)**									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	2	3	5	7	8	10	12	14	15	17
2	3	7	10	14	17	20	24	27	30	34
3	5	10	15	20	25	30	35	41	46	51
4	7	14	20	27	34	41	47	54	61	68
5	8	17	25	34	42	51	59	68	76	84
6	10	20	30	41	51	61	71	81	91	101
7	12	24	35	47	59	71	83	95	106	118
8	14	27	41	54	68	81	95	108	122	135
9	15	30	46	61	76	91	106	122	137	152
10	17	34	51	68	84	101	118	135	152	169
20	34	68	101	135	169	203	236	270	304	338
30	51	101	152	203	253	304	355	405	456	507
50	84	169	253	338	422	507	591	676	760	845
75	127	253	380	507	633	760	887	1013	1140	1267
100	169	338	507	676	845	1013	1182	1351	1520	1689

~~553.~~560. At the average baseline mortality rate for gannet of 0.1866 a total of 85,145 birds would be expected to die from the largest BDMPS population throughout the year. The addition of a maximum of 14 to this increases the mortality rate by 0.016%, which is below the 1% threshold for detectability.

~~554.~~561. The number of individuals from the biogeographic population expected to die across all seasons is 220,188. The addition of a maximum of 14 to this increases the mortality rate by 0.006%, which is below the 1% threshold for detectability.

~~555.~~562. The sensitivity of gannet to operational displacement is considered to be low to medium and the magnitude of annual impact at DBS East is negligible, therefore the annual effect on gannet due to operational displacement at DBS East is assessed as **negligible** to **minor adverse**.

12.8.1.1.1.3 Significance of Effect – DBS East and DBS West Together

12.8.1.1.1.3.1 Breeding Season

~~556.~~563. During the breeding season, the combined maximum mean peak abundance in the Array Areas and 2km buffer was 1,560 individuals. Within the range of 60-80% displacement and 1% mortality, the maximum number of individual gannets which could potentially suffer mortality as a consequence of displacement from the Array Areas (and 2km buffer) during the breeding season has been estimated as 12 individuals (**Table 12-33**).

Table 12-33 Displacement Matrix Presenting the Number of Gannets in the Array Areas (and 2km Buffer) During the Breeding Season That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	2	3	5	6	8	9	11	12	14	16
2	3	6	9	12	16	19	22	25	28	31
3	5	9	14	19	23	28	33	37	42	47
4	6	12	19	25	31	37	44	50	56	62
5	8	16	23	31	39	47	55	62	70	78
6	9	19	28	37	47	56	66	75	84	94
7	11	22	33	44	55	66	76	87	98	109
8	12	25	37	50	62	75	87	100	112	125
9	14	28	42	56	70	84	98	112	126	140
10	16	31	47	62	78	94	109	125	140	156
20	31	62	94	125	156	187	218	250	281	312
30	47	94	140	187	234	281	328	374	421	468
50	78	156	234	312	390	468	546	624	702	780
75	117	234	351	468	585	702	819	936	1053	1170
100	156	312	468	624	780	936	1092	1248	1404	1560

~~557.~~564. Based on the average mortality for the species of 0.1866 a total of 74,701 birds would be expected to die each year. The addition of a combined maximum of 12 individuals to this would increase the mortality rate by 0.017%, which is below the 1% threshold for detectability.

~~558.~~565. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season period, the magnitude of impact is assessed as negligible. As the species is of low to medium sensitivity to displacement, the effect significance is **negligible** to **minor adverse**.

12.8.1.1.1.3.2 Autumn Migration

~~559.~~566. During the autumn migration period, the combined maximum mean peak abundance in the Array Areas and 2km buffer was 1,574 individuals. Within the range of 60-80% displacement and 1% mortality, the maximum number of individual gannets which could potentially suffer mortality as a consequence of displacement from the Array Areas (and 2km buffer) during the autumn migration period has been estimated as 13 individuals (**Table 12-34**).

Table 12-34 Displacement Matrix Presenting the Number of Gannets in the Array Areas (and 2km Buffer) During the Autumn Migration Season That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	2	3	5	6	8	9	11	13	14	16
2	3	6	9	13	16	19	22	25	28	31
3	5	9	14	19	24	28	33	38	42	47
4	6	13	19	25	31	38	44	50	57	63
5	8	16	24	31	39	47	55	63	71	79
6	9	19	28	38	47	57	66	76	85	94
7	11	22	33	44	55	66	77	88	99	110
8	13	25	38	50	63	76	88	101	113	126
9	14	28	42	57	71	85	99	113	127	142
10	16	31	47	63	79	94	110	126	142	157
20	31	63	94	126	157	189	220	252	283	315
30	47	94	142	189	236	283	331	378	425	472
50	79	157	236	315	394	472	551	630	708	787
75	118	236	354	472	590	708	826	944	1062	1181
100	157	315	472	630	787	944	1102	1259	1417	1574

~~560.~~567. At the average baseline mortality rate for gannet of 0.1866 a total of 85,145 birds would be expected to die in autumn. The addition of a combined maximum of 13 to this increases the mortality rate by 0.015%, which is below the 1% threshold for detectability.

~~561.~~568. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of impact is assessed as negligible. As the species is of low to medium sensitivity to displacement, the effect significance is **negligible** to **minor adverse**.

12.8.1.1.1.3.3 Spring Migration

~~562.~~569. During the spring migration period, the combined maximum mean peak abundance in the Array Areas and 2km buffer was 161 individuals. Within the range of 60-80% displacement and 1% mortality, the maximum number of individual gannets which could potentially suffer mortality as a consequence of displacement from the Array Areas (and 2km buffer) during the spring migration period has been estimated as one individual (**Table 12-35**).

Table 12-35 Displacement Matrix Presenting the Number of Gannets in the Array Areas (and 2km Buffer) During the Spring Migration Season That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	0	0	0	1	1	1	1	1	1	2
2	0	1	1	1	2	2	2	3	3	3
3	0	1	1	2	2	3	3	4	4	5
4	1	1	2	3	3	4	5	5	6	6
5	1	2	2	3	4	5	6	6	7	8
6	1	2	3	4	5	6	7	8	9	10
7	1	2	3	5	6	7	8	9	10	11
8	1	3	4	5	6	8	9	10	12	13
9	1	3	4	6	7	9	10	12	13	14
10	2	3	5	6	8	10	11	13	14	16
20	3	6	10	13	16	19	23	26	29	32
30	5	10	14	19	24	29	34	39	43	48
50	8	16	24	32	40	48	56	64	72	81
75	12	24	36	48	60	72	85	97	109	121
100	16	32	48	64	81	97	113	129	145	161

~~563.~~570. Based on the average mortality for the species of 0.1866, a total of 46,349 birds would be expected to die in spring. The addition of a combined maximum of one individual to this increases the mortality rate by 0.003%, which is below the 1% threshold for detectability.

~~564.~~571. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of impact is assessed as negligible. As the species is of low to medium sensitivity to displacement, the effect significance is **negligible** to **minor adverse**.

12.8.1.1.1.3.4 Annual

~~565.~~572. Summed across the year the combined maximum mean peak abundance in the Array Areas and 2km buffer was 3,295 individuals Within the range of 60-80% displacement and 1% mortality, the maximum number of individual gannets which could potentially suffer mortality as a consequence of displacement from the Array Areas (and 2km buffer) during the breeding, autumn migration and spring migration periods combined has been estimated as 26 individuals (**Table 12-36**).

Table 12-36 Displacement Matrix Presenting the Number of Gannets in the Array Areas (and 2km Buffer) Combined Across the Breeding and Nonbreeding Seasons That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	3	7	10	13	16	20	23	26	30	33
2	7	13	20	26	33	40	46	53	59	66
3	10	20	30	40	49	59	69	79	89	99
4	13	26	40	53	66	79	92	105	119	132
5	16	33	49	66	82	99	115	132	148	165
6	20	40	59	79	99	119	138	158	178	198
7	23	46	69	92	115	138	161	185	208	231
8	26	53	79	105	132	158	185	211	237	264
9	30	59	89	119	148	178	208	237	267	297
10	33	66	99	132	165	198	231	264	297	330
20	66	132	198	264	330	395	461	527	593	659
30	99	198	297	395	494	593	692	791	890	989
50	165	330	494	659	824	989	1153	1318	1483	1648
75	247	494	741	989	1236	1483	1730	1977	2224	2471
100	330	659	989	1318	1648	1977	2307	2636	2966	3295

~~566.~~573. At the average baseline mortality rate for gannet of 0.1866, a total of 85,145 birds would be expected to die from the largest BDMPS population throughout the year. The addition of a combined maximum of 26 to this increases the mortality rate by 0.031%, which is below the 1% threshold for detectability.

~~567.~~574. The number of individuals from the biogeographic population expected to die across all seasons is 220,188. The addition of a maximum of 26 to this increases the mortality rate by 0.012%, which is below the 1% threshold for detectability.

~~568.~~575. The sensitivity of gannet to operational displacement is considered to be low to medium and the magnitude of annual impact at DBS East is negligible, therefore the annual effect on gannet due to operational displacement at DBS East is assessed as **negligible** to **minor adverse**.

12.8.1.1.1.4 Summary of Operational Displacement Assessment – Gannet

~~569.~~576. A table summarising the gannet operational displacement assessment is provided below (**Table 12-37**).

Table 12-37 Summary of Gannet Operational Displacement Assessment for DBS East, DBS West and Combined (Projects).

Gannet		DBS East	DBS West	Projects
Baseline average annual mortality				0.1866
Breeding season	Reference population			400,236
	Displacement mortality (@80% x 1%)	6	6	12
	Increase in background mortality (%)	0.008	0.009	0.017
	Significance	Negligible - Minor	Negligible - Minor	Negligible - Minor
Autumn	Reference population			456,299
	Displacement mortality (@80% x 1%)	6	6	13
	Increase in background mortality (%)	0.007	0.007	0.015
	Significance	Negligible - Minor	Negligible - Minor	Negligible - Minor
Spring	Reference population			248,835
	Displacement mortality (@80% x 1%)	1	1	1
	Increase in background mortality (%)	0.001	0.001	0.003
	Significance	Negligible - Minor	Negligible - Minor	Negligible - Minor
Annual (BDMPS)	Reference population			456,299
	Displacement mortality (@80% x 1%)	13	14	26

Gannet		DBS East	DBS West	Projects
	Increase in background mortality (%)	0.015	0.016	0.031
	Significance	Negligible - Minor	Negligible - Minor	Negligible - Minor
Annual (biogeo-graphic)	Biogeographical population			1,180,000
	Displacement mortality (@80% x 1%)	13	14	26
	Increase in background mortality (%)	0.006	0.006	0.012
	Significance	Negligible - Minor	Negligible - Minor	Negligible - Minor

12.8.1.1.2 Auks (Guillemot, Razorbill and Puffin)

~~570.~~577. Razorbill, guillemot and puffin are considered to have a medium (or low for puffin) sensitivity to disturbance and displacement, based on their sensitivity to ship and helicopter traffic in Garthe and Hüppop (2004), Langston (2010), an interpretation of the Furness and Wade (2012) species concern index value in the context of disturbance and/or displacement from a habitat, and the meta-analysis of avoidance and attraction responses of seabirds to offshore wind farms by Dierschke *et al*. (2016).

~~571.~~578. Available pre- and post-construction monitoring data have yielded variable results but indicate that auks may be displaced to some extent by some wind farms, but this is partial, and apparently negligible in some Array Areas (Dierschke *et al*., 2016).

~~572.~~579. Common guillemots were displaced at Blighbank (Vanermen *et al*., 2012), were displaced only in a minority of surveys at two Dutch wind farms (OWEZ and PAWP; Leopold *et al*., 2011; Krijgsveld *et al*., 2011), but were not significantly displaced at Horns Rev (although the data suggest that slight displacement was probably occurring; Petersen *et al*., 2006) or Thornton Bank (Vanermen *et al*., 2012). Razorbills were displaced in one out of six surveys at two Dutch wind farms (OWEZ and PAWP; Leopold *et al*., 2011, Krijgsveld *et al*., 2011), but not at Horns Rev (Petersen *et al*., 2006), Thornton Bank or Blighbank (Vanermen *et al*., 2012). There is less direct evidence for puffin as this species has not typically been recorded in the monitoring of earlier installed wind farms in the southern North Sea. However, given the similarities of these auk species it is considered reasonable to apply a similar approach as that used for guillemot and razorbill.

~~573.~~580. For recent wind farm assessments Natural England has advised that the mortality rate may be up to 10% for auks displaced from wind farms. This magnitude of impact is not supported in the literature. For, example this would equate to a doubling of natural adult annual mortality for razorbill (10.5%; Horswill and Robinson, 2015) and puffin (9.4% Horswill and Robinson, 2015) and more than double that for guillemot (6%; Horswill and Robinson, 2015). Such high mortality rates for displacement are considered to be highly conservative and improbable in reality.

~~574.~~581. A review of available evidence for auk displacement was submitted for the Norfolk Vanguard assessment (MacArthur Green, 2021) and this concluded that precautionary rates of displacement and mortality from operational wind farms would be 50% and 1% respectively. These figures are also considered suitably precautionary for the potential displacement around construction vessels.

~~575.~~582. Following statutory guidance (Joint SNCB Note, 2017), the abundance estimates for the most relevant biological periods have each been placed into individual displacement matrices. Each displacement matrix contains the abundance of each auk species within the DBS Array Areas and the 2km buffer.

~~576.~~583. Each matrix displays displacement rates and mortality rates for each species, with the species-specific recommended rates highlighted in each case. At the upper end these extend to 70% displaced and to 10% mortality, representing a highly precautionary worst case scenario as advised by Natural England. Mortality due to displacement might arise if displacement increased competition for resources in the remaining areas of auk habitat outside the wind farm. However, it should be recognised that the mortality rate due to displacement may well be 0% since the increase in density of birds outside the wind farm area will be negligible (because the rest of the available habitat is vast in comparison) and is very unlikely to be as high as these precautionary values.

~~577.~~584. Recent Natural England advice to offshore wind farm developers[7] has highlighted that consideration should also be given to rates of 70% displaced and 2% mortality. Thus, the assessment presents estimates using the full range of displacement and mortality rates and discusses the predicted effects in relation to combinations of 70% displaced with 2% mortality and 10% mortality, on the basis these represent precautionary upper limits on displacement impacts.

~~578.~~585. Mortality of auks during the breeding season has been assessed in relation to the species specific BDMPS reference populations provided by Natural England (2024) for the North Sea and Channel: guillemot (2,045,078 individuals), razorbill (158,031 individuals) and puffin (868,689 individuals).

~~579.~~586. The number of individuals from these auk species expected to die at the baseline mortality rates in the breeding season are, for guillemot 287,333 (2,045,078 x 0.1405), for razorbill 20,576 (158,031 x 0.1302) and for puffin 103,374 (868,689 x 0.119).

~~580.~~587. During the nonbreeding seasons, the species specific BDMPS populations for the North Sea and Channel have been used as the reference populations. Furness (2015) only defined one nonbreeding season for guillemot and puffin (for both: August - February) while for razorbill there are three (August - October, November - December and January - March; **Table 12-15**). However, for guillemot, in their Relevant Representations [RR-039] Natural England have advised the Applicants to separately assess impacts in the chick rearing and moult period (August and September), with the nonbreeding season adjusted to October to February. The number of birds which could potentially be displaced has been estimated for each species using their species-specific relevant seasons. For the annual assessment, impacts have been considered in relation to the largest of the BDMPS populations and also to the biogeographic population (Furness, 2015).

[7] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010109/EN010109-002129-Natural%20England%20-%20Other-%20EN010109%20441148%20SEP%20DEP%20Appendix%20B3%20-%20Natural%20England%E2%80%99s%20Offshore%20Ornithology%20Position%20(Revision%202)%20Deadline%208.pdf

~~581.~~588. For each auk species the abundance estimates used in the assessment include unidentified auks assigned to each species using the identified proportions and adjustment for availability bias.

12.8.1.1.3 Guillemot

12.8.1.1.3.1 Significance of Effect – DBS East in Isolation

12.8.1.1.3.1.1 Breeding Season

~~582.~~589. During the breeding season, the maximum mean peak abundance in the DBS East Array Area and 2km buffer was 9,031 individuals. The estimated number of guillemots subject to mortality during the breeding period due to displacement at 30-70% displaced and 1-10% mortality from DBS East (and 2km buffer; **Table 12-38**) is between 27 and 632 individuals, with 126 at 70% displaced and 2% mortality.

Table 12-38 Displacement Matrix Presenting the Number of Guillemots in the DBS East Array Area (and 2km Buffer) During the Breeding Season That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	9	18	27	36	45	54	63	72	81	90
2	18	36	54	72	90	108	126	144	163	181
3	27	54	81	108	135	163	190	217	244	271
4	36	72	108	144	181	217	253	289	325	361
5	45	90	135	181	226	271	316	361	406	452
6	54	108	163	217	271	325	379	433	488	542
7	63	126	190	253	316	379	443	506	569	632
8	72	144	217	289	361	433	506	578	650	722
9	81	163	244	325	406	488	569	650	732	813
10	90	181	271	361	452	542	632	722	813	903
20	181	361	542	722	903	1084	1264	1445	1626	1806
30	271	542	813	1084	1355	1626	1897	2167	2438	2709
50	452	903	1355	1806	2258	2709	3161	3612	4064	4516
75	677	1355	2032	2709	3387	4064	4741	5419	6096	6773
100	903	1806	2709	3612	4516	5419	6322	7225	8128	9031

~~583.~~590. At the average baseline mortality rate for guillemot of 0.1405 the number of individuals expected to die in the breeding season is 287,333 (2,045,078 x 0.1405). The addition of a maximum of 632 (70% x 10%) to this increases the background mortality rate by 0.220%, or of 126 (70% x 2%) to this would increase the mortality rate by 0.044%, both of which are below the 1% threshold for detectability.

~~584.~~591. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.8.1.1.3.1.2 Chick Rearing and Moult

~~585.~~592. During the chick rearing and moult period, the maximum mean peak abundance in the DBS East Array Area and 2km buffer was 7,678 individuals. The estimated number of guillemots subject to mortality during the chick rearing and moult period due to displacement at 30-70% displaced and 1-10% mortality from DBS East (and 2km buffer; **Table 12-39**) is between 23 and 537 individuals, with 107 at 70% displaced and 2% mortality.

Table 12-39 Displacement Matrix Presenting the Number of Guillemots in the DBS East Array Area (and 2km Buffer) During the Chick Rearing and Moult Period That May Be Subject to Mortality (Highlighted)

Mortality (%)	**Displacement (%)**									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	8	15	23	31	38	46	54	61	69	77
2	15	31	46	61	77	92	107	123	138	154
3	23	46	69	92	115	138	161	184	207	230
4	31	61	92	123	154	184	215	246	276	307
5	38	77	115	154	192	230	269	307	346	384
6	46	92	138	184	230	276	322	369	415	461
7	54	107	161	215	269	322	376	430	484	537
8	61	123	184	246	307	369	430	491	553	614
9	69	138	207	276	346	415	484	553	622	691
10	77	154	230	307	384	461	537	614	691	768
20	154	307	461	614	768	921	1075	1228	1382	1536
30	230	461	691	921	1152	1382	1612	1843	2073	2303
50	384	768	1152	1536	1920	2303	2687	3071	3455	3839
75	576	1152	1728	2303	2879	3455	4031	4607	5183	5759
100	768	1536	2303	3071	3839	4607	5375	6142	6910	7678

~~586.~~593. At the average baseline mortality rate for guillemot of 0.1405 the number of individuals expected to die in the chick rearing and moult period is 227,231 (1,617,305 x 0.1405). The addition of a maximum of 537 (70% x 10%) to this increases the background mortality rate by 0.237%, or of 107 (70% x 2%) to this would increase the mortality rate by 0.047%, both of which are below the 1% threshold for detectability.

~~587.~~594. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the chick rearing and moult period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse.**

12.8.1.1.3.1.3 Nonbreeding Season

~~588.~~595. During the nonbreeding season, the maximum mean peak abundance in the DBS East Array Area and 2km buffer was 12,552 individuals. The estimated number of guillemots subject to mortality during the nonbreeding period due to displacement at 30-70% displaced and 1-10% mortality from DBS East (and 2km buffer) is between 38 and 879 individuals, with 176 at 70% displaced and 2% mortality.

Table 12-40 Displacement Matrix Presenting the Number of Guillemots in the DBS East Array Area (and 2km Buffer) During the Nonbreeding Season That May Be Subject to Mortality (Highlighted).

Mortality (%)	**Displacement (%)**									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	13	25	38	50	63	75	88	100	113	126
2	25	50	75	100	126	151	176	201	226	251
3	38	75	113	151	188	226	264	301	339	377
4	50	100	151	201	251	301	351	402	452	502
5	63	126	188	251	314	377	439	502	565	628
6	75	151	226	301	377	452	527	602	678	753
7	88	176	264	351	439	527	615	703	791	879
8	100	201	301	402	502	602	703	803	904	1004
9	113	226	339	452	565	678	791	904	1017	1130
10	126	251	377	502	628	753	879	1004	1130	1255
20	251	502	753	1004	1255	1506	1757	2008	2259	2510
30	377	753	1130	1506	1883	2259	2636	3012	3389	3766
50	628	1255	1883	2510	3138	3766	4393	5021	5648	6276
75	941	1883	2824	3766	4707	5648	6590	7531	8473	9414
100	1255	2510	3766	5021	6276	7531	8786	10042	11297	12552

~~589.~~596. At the average baseline mortality rate for guillemot of 0.1405 the number of individuals expected to die in the nonbreeding period is 227,231 (1,617,305 x 0.1405). The addition of a maximum of 879 (70% x 10%) to this increases the background mortality rate by 0.387%, or of 176 (70% x 2%) to this increases the background mortality rate by 0.077%, both of which are below the 1% threshold for detectability.

~~590.~~597. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.8.1.1.3.1.4 Annual

~~591.~~598. Summed across the year the maximum mean peak abundance in the DBS East Array Area and 2km buffer was 29,260 individuals. The estimated number of guillemots subject to mortality combined across all seasons due to displacement at 30-70% displaced and 1-10% mortality from DBS East Array Area (and 2km buffer; **Table 12-41**) is between 88 and 2,048 individuals, with 410 at 70% displaced and 2% mortality.

Table 12-41 Displacement Matrix Presenting the Number of Guillemots in the DBS East Array Area (and 2km Buffer) Combined Across the Breeding and Nonbreeding Seasons That May Be Subject to Mortality (Highlighted).

Mortality (%)	**Displacement (%)**									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	29	59	88	117	146	176	205	234	263	293
2	59	117	176	234	293	351	410	468	527	585
3	88	176	263	351	439	527	614	702	790	878
4	117	234	351	468	585	702	819	936	1053	1170
5	146	293	439	585	732	878	1024	1170	1317	1463
6	176	351	527	702	878	1053	1229	1404	1580	1756
7	205	410	614	819	1024	1229	1434	1639	1843	2048
8	234	468	702	936	1170	1404	1639	1873	2107	2341
9	263	527	790	1053	1317	1580	1843	2107	2370	2633
10	293	585	878	1170	1463	1756	2048	2341	2633	2926
20	585	1170	1756	2341	2926	3511	4096	4682	5267	5852
30	878	1756	2633	3511	4389	5267	6145	7022	7900	8778

Mortality (%)	**Displacement (%)**									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
50	1463	2926	4389	5852	7315	8778	10241	11704	13167	14630
75	2195	4389	6584	8778	10973	13167	15362	17556	19751	21945
100	2926	5852	8778	11704	14630	17556	20482	23408	26334	29260

~~592.~~599. At the average baseline mortality rate for guillemot of 0.1405 the number of individuals expected to die from the largest BDMPS population across all seasons is 287,333 (2,045,078 x 0.1405). The addition of a maximum of 2,048 (70% x 10%) to this increases the background mortality rate by 0.713%, or of 410 (70% x 2%) to this would increase the mortality rate by 0.143%, both of which are below the 1% threshold for detectability.

~~593.~~600. The number of individuals from the biogeographic population expected to die across all seasons is 579,563 (4,125,000 x 0.1405). The addition of a maximum of 2,048 (70% x 10%) to this increases the mortality rate by 0.353%, or of 410 (70% x 2%) to this would increase the mortality rate by 0.071%, both of which are below the 1% threshold for detectability.

~~594.~~601. These magnitudes of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, across the annual period the magnitude of impact is assessed as negligible.

~~595.~~602. The sensitivity of guillemot to operational displacement is considered to be medium and the magnitude of annual impact at DBS East is negligible when assessed against either the largest BDMPS or the biogeographic population. Therefore, the significance of the annual effect on guillemot due to operational displacement at DBS East is assessed as **minor adverse**.

12.8.1.1.3.2 Significance of Effect – DBS West in Isolation

12.8.1.1.3.2.1 Breeding Season

~~596.~~603. During the breeding season, the maximum mean peak abundance in the DBS West Array Area and 2km buffer was 8,783 individuals. The estimated number of guillemots subject to mortality during the breeding period due to displacement at 30-70% displaced and 1-10% mortality from DBS West (and 2km buffer; **Table 12-42**) is between 26 and 615 individuals, with 123 at 70% displaced and 2% mortality.

Table 12-42 Displacement Matrix Presenting the Number of Guillemots in the DBS West Array Area (and 2km Buffer) During the Breeding Season That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	9	18	26	35	44	53	61	70	79	88
2	18	35	53	70	88	105	123	141	158	176
3	26	53	79	105	132	158	184	211	237	263
4	35	70	105	141	176	211	246	281	316	351
5	44	88	132	176	220	263	307	351	395	439
6	53	105	158	211	263	316	369	422	474	527
7	61	123	184	246	307	369	430	492	553	615
8	70	141	211	281	351	422	492	562	632	703
9	79	158	237	316	395	474	553	632	711	790
10	88	176	263	351	439	527	615	703	790	878
20	176	351	527	703	878	1054	1230	1405	1581	1757
30	263	527	790	1054	1317	1581	1844	2108	2371	2635
50	439	878	1317	1757	2196	2635	3074	3513	3952	4392
75	659	1317	1976	2635	3294	3952	4611	5270	5929	6587
100	878	1757	2635	3513	4392	5270	6148	7026	7905	8783

~~597.~~604. At the average baseline mortality rate for guillemot of 0.1405 the number of individuals expected to die in the breeding season is 287,333 (2,045,078 x 0.1405). The addition of a maximum of 615 (70% x 10%) to this increases the background mortality rate by 0.214%, or of 123 (70% x 2%) to this would increase the mortality rate by 0.043%, both of which are below the 1% threshold for detectability.

~~598.~~605. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.8.1.1.3.2.2 Chick rearing and Moult

~~599.~~606. During the chick rearing and moult period, the maximum mean peak abundance in the DBS West Array Area and 2km buffer was 12,498 individuals. The estimated number of guillemots subject to mortality during the chick rearing and moult period due to displacement at 30-70% displaced and 1-10% mortality from DBS West (and 2km buffer; **Table 12-43**) is between 37 and 875 individuals, with 175 at 70% displaced and 2% mortality.

Table 12-43 Displacement Matrix Presenting the Number of Guillemots in the DBS West Array Area (and 2km Buffer) During the Chick Rearing and Moult Period That May Be Subject to Mortality (Highlighted).

Mortality (%)	**Displacement (%)**									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	12	25	37	50	62	75	87	100	112	125
2	25	50	75	100	125	150	175	200	225	250
3	37	75	112	150	187	225	262	300	337	375
4	50	100	150	200	250	300	350	400	450	500
5	62	125	187	250	312	375	437	500	562	625
6	75	150	225	300	375	450	525	600	675	750
7	87	175	262	350	437	525	612	700	787	875
8	100	200	300	400	500	600	700	800	900	1000
9	112	225	337	450	562	675	787	900	1012	1125
10	125	250	375	500	625	750	875	1000	1125	1250
20	250	500	750	1000	1250	1500	1750	2000	2250	2500
30	375	750	1125	1500	1875	2250	2625	3000	3374	3749
50	625	1250	1875	2500	3125	3749	4374	4999	5624	6249
75	937	1875	2812	3749	4687	5624	6561	7499	8436	9374
100	1250	2500	3749	4999	6249	7499	8749	9998	11248	12498

~~600.~~607. At the average baseline mortality rate for guillemot of 0.1405) the number of individuals expected to die in the chick rearing and moult period is 227,231 (1,617,305 x 0.1405). The addition of a maximum of 875 (70% x 10%) to this increases the background mortality rate by 0.385%, or of 175 (70% x 2%) to this would increase the mortality rate by 0.077%, both of which are below the 1% threshold for detectability.

~~601.~~608. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the chick rearing and moult season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.8.1.1.3.2.3 Nonbreeding season

~~602.~~609. During the nonbreeding season, the maximum mean peak abundance in the DBS West Array Area and 2km buffer was 9,895 individuals. The estimated number of guillemots subject to mortality during the nonbreeding period due to displacement at 30-70% displaced and 1-10% mortality from DBS West (and 2km buffer; **Table 12-44**) is between 30 and 693 individuals, with 139 at 70% displaced and 2% mortality.

Table 12-44 Displacement Matrix Presenting the Number of Guillemots in the DBS West Array Area (and 2km Buffer) During the Nonbreeding Season That May Be Subject to Mortality (Highlighted)

Mortality (%)	**Displacement (%)**									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	0	20	30	40	49	59	69	79	89	99
2	20	40	59	79	99	119	139	158	178	198
3	30	59	89	119	148	178	208	237	267	297
4	40	79	119	158	198	237	277	317	356	396
5	49	99	148	198	247	297	346	396	445	495
6	59	119	178	237	297	356	416	475	534	594
7	69	139	208	277	346	416	485	554	623	693
8	79	158	237	317	396	475	554	633	712	792
9	89	178	267	356	445	534	623	712	801	891
10	99	198	297	396	495	594	693	792	891	990
20	198	396	594	792	990	1187	1385	1583	1781	1979
30	297	594	891	1187	1484	1781	2078	2375	2672	2969
50	495	990	1484	1979	2474	2969	3463	3958	4453	4948
75	742	1484	2226	2969	3711	4453	5195	5937	6679	7421
100	990	1979	2969	3958	4948	5937	6927	7916	8906	9895

~~603.~~610. At the average baseline mortality rate for guillemot of 0.1405 the number of individuals expected to die in the nonbreeding period is 227,231 (1,617,305 x 0.1405). The addition of a maximum of 693 (70% x 10%) to this increases the background mortality rate by 0.305%, or of 139 (70% x 2%) to this increases the background mortality rate by 0.061%, both of which are which is below the 1% threshold for detectability.

~~604.~~611. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse.**

12.8.1.1.3.2.4 Annual

~~605.~~612. Summed across the year the maximum mean peak abundance in the DBS West Array Area and 2km buffer was 31,177 individuals. The estimated number of guillemots subject to mortality combined across all seasons due to displacement at 30-70% displaced and 1-10% mortality from DBS West (and 2km buffer; **Table 12-45**) is between 94 and 2,182 individuals, with 436 at 70% displaced and 2% mortality.

Table 12-45 Displacement Matrix Presenting the Number of Guillemots in the DBS West Array Area (and 2km Buffer) During the Breeding Season, Chick Rearing and Moult Period and Nonbreeding Season That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	0	62	94	125	156	187	218	249	281	312
2	62	125	187	249	312	374	436	499	561	624
3	94	187	281	374	468	561	655	748	842	935
4	125	249	374	499	624	748	873	998	1122	1247
5	156	312	468	624	779	935	1091	1247	1403	1559
6	187	374	561	748	935	1122	1309	1496	1684	1871
7	218	436	655	873	1091	1309	1528	1746	1964	2182
8	249	499	748	998	1247	1496	1746	1995	2245	2494
9	281	561	842	1122	1403	1684	1964	2245	2525	2806
10	312	624	935	1247	1559	1871	2182	2494	2806	3118
20	624	1247	1871	2494	3118	3741	4365	4988	5612	6235
30	935	1871	2806	3741	4677	5612	6547	7482	8418	9353

Mortality (%)	Displacement (%)									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
50	1559	3118	4677	6235	7794	9353	10912	12471	14030	15589
75	2338	4677	7015	9353	11691	14030	16368	18706	21044	23383
100	3118	6235	9353	12471	15589	18706	21824	24942	28059	31177

~~606.~~613. At the average baseline mortality rate for guillemot of 0.1405 the number of individuals expected to die from the largest BDMPS population across all seasons is 287,333 (2,045,078 x 0.1405). The addition of a maximum of 2,182 (70% x 10%) to this increases the background mortality rate by 0.760%, or of 436 (70% x 2%) to this would increase the mortality rate by 0.152%, both of which are below the 1% threshold for detectability.

~~607.~~614. The number of individuals from the biogeographic population expected to die across all seasons is 579,563 (4,125,000 x 0. 1405). The addition of a maximum of 2,182 (70% x 10%) to this increases the mortality rate by 0.377%, or of 436 (70% x 2%) to this would increase the mortality by 0.075, both of which are below the 1% threshold for detectability.

~~608.~~615. The sensitivity of guillemot to operational displacement is considered to be medium and the magnitude of annual impact at DBS West is negligible, therefore the annual effect on guillemot due to operational displacement at DBS West is assessed as **minor adverse**.

12.8.1.1.3.3 Significance of Effect – DBS East and DBS West Together

12.8.1.1.3.3.1 Breeding Season

~~609.~~616. During the breeding season, the combined maximum mean peak abundance in the Array Areas and 2km buffer was 17,814 individuals. The estimated number of guillemots subject to mortality during the breeding period due to displacement at 30-70% displaced and 1-10% mortality from the Array Areas (and 2km buffer; **Table 12-46**) is between 53 and 1,247 individuals, with 249 at 70% displaced and 2% mortality.

Table 12-46 Displacement Matrix Presenting the Number of Guillemots in the Array Areas (and 2km Buffer) During the Breeding Season That May Be Subject to Mortality (Highlighted).

Mortality (%)	**Displacement (%)**									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	18	36	53	71	89	107	125	143	160	178
2	36	71	107	143	178	214	249	285	321	356
3	53	107	160	214	267	321	374	428	481	534
4	71	143	214	285	356	428	499	570	641	713
5	89	178	267	356	445	534	623	713	802	891
6	107	214	321	428	534	641	748	855	962	1069
7	125	249	374	499	623	748	873	998	1122	1247
8	143	285	428	570	713	855	998	1140	1283	1425
9	160	321	481	641	802	962	1122	1283	1443	1603
10	178	356	534	713	891	1069	1247	1425	1603	1781
20	356	713	1069	1425	1781	2138	2494	2850	3207	3563
30	534	1069	1603	2138	2672	3207	3741	4275	4810	5344
50	891	1781	2672	3563	4454	5344	6235	7126	8016	8907
75	1336	2672	4008	5344	6680	8016	9352	10688	12024	13361
100	1781	3563	5344	7126	8907	10688	12470	14251	16033	17814

~~610.~~617. At the average baseline mortality rate for guillemot of 0.1405 the number of individuals expected to die in the breeding season is 287,333 (2,045,078 x 0.1405). The addition of a combined maximum of 1,247 (70% x 10%) to this increases the background mortality rate by 0.434%, or of 249 (70% x 2%) to this would increase the mortality rate by 0.087%, both of which are below the 1% threshold for detectability.

~~611.~~618. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.8.1.1.3.3.2 Chick Rearing and Moult

~~612.~~619. During the chick rearing and moult period, the combined maximum mean peak abundance in the Array Areas and 2km buffer was 20,176 individuals. The estimated number of guillemots subject to mortality during the chick rearing and moult period due to displacement at 30-70% displaced and 1-10% mortality from the Array Areas (and 2km buffer; **Table 12-47**) is between 61 and 1,412 individuals, with 282 at 70% displaced and 2% mortality.

Table 12-47 Displacement Matrix Presenting the Number of Guillemots in the Array Areas (and 2km Buffer) During the Chick Rearing and Moult Period That May Be Subject to Mortality (Highlighted).

Mortality (%)	**Displacement (%)**									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	20	40	61	81	101	121	141	161	182	202
2	40	81	121	161	202	242	282	323	363	404
3	61	121	182	242	303	363	424	484	545	605
4	81	161	242	323	404	484	565	646	726	807
5	101	202	303	404	504	605	706	807	908	1009
6	121	242	363	484	605	726	847	968	1090	1211
7	141	282	424	565	706	847	989	1130	1271	1412
8	161	323	484	646	807	968	1130	1291	1453	1614
9	182	363	545	726	908	1090	1271	1453	1634	1816
10	202	404	605	807	1009	1211	1412	1614	1816	2018
20	404	807	1211	1614	2018	2421	2825	3228	3632	4035
30	605	1211	1816	2421	3026	3632	4237	4842	5448	6053
50	1009	2018	3026	4035	5044	6053	7062	8070	9079	10088
75	1513	3026	4540	6053	7566	9079	10592	12106	13619	15132
100	2018	4035	6053	8070	10088	12106	14123	16141	18158	20176

~~613.~~620. At the average baseline mortality rate for guillemot of 0.1405 the number of individuals expected to die in the chick rearing and moult period is 227,231 (1,617,305 x 0.1405). The addition of a combined maximum of 1,412 (70% x 10%) to this increases the background mortality rate by 0.622%, or of 282 (70% x 2%) to this would increase the mortality rate by 0.124%, both of which are below the 1% threshold for detectability.

~~614.~~621. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the chick rearing and moult period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.8.1.1.3.3.3 Nonbreeding Season

~~615.~~622. During the nonbreeding season, the combined maximum mean peak abundance in the Array Areas and 2km buffer was 22,447 individuals. The estimated number of guillemots subject to mortality during the nonbreeding period due to displacement at 30-70% displaced and 1-10% mortality from the Array Areas (and 2km buffer; **Table 12-48**) is between 67 and 1,571 individuals, with 314 at 70% displaced and 2% mortality.

Table 12-48 Displacement Matrix Presenting the Number of Guillemots in the Array Areas (and 2km Buffer) During the Nonbreeding Season That May Be Subject to Mortality (Highlighted)

Mortality (%)	**Displacement (%)**									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	0	45	67	90	112	135	157	180	202	224
2	45	90	135	180	224	269	314	359	404	449
3	67	135	202	269	337	404	471	539	606	673
4	90	180	269	359	449	539	629	718	808	898
5	112	224	337	449	561	673	786	898	1010	1122
6	135	269	404	539	673	808	943	1077	1212	1347
7	157	314	471	629	786	943	1100	1257	1414	1571
8	180	359	539	718	898	1077	1257	1437	1616	1796
9	202	404	606	808	1010	1212	1414	1616	1818	2020
10	224	449	673	898	1122	1347	1571	1796	2020	2245
20	449	898	1347	1796	2245	2694	3143	3592	4040	4489
30	673	1347	2020	2694	3367	4040	4714	5387	6061	6734
50	1122	2245	3367	4489	5612	6734	7856	8979	10101	11224
75	1684	3367	5051	6734	8418	10101	11785	13468	15152	16835
100	2245	4489	6734	8979	11224	13468	15713	17958	20202	22447

~~616.~~623. At the average baseline mortality rate for guillemot of 0.1405 the number of individuals expected to die in the nonbreeding period is 227,231 (1,617,305 x 0.1405). The addition of a combined maximum of 1,571 (70% x 10%) individuals to this increases the background mortality rate by 0.692%, or of 314 (70% x 2%) to this increases the background mortality rate by 0.138%, both of which are below the 1% threshold for detectability.

~~617.~~624. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.8.1.1.3.3.4 Annual

~~618.~~625. Summed across the year the combined maximum mean peak abundance in the Array Areas and 2km buffer was 60,438 individuals. The estimated number of guillemots subject to mortality combined across all seasons due to displacement at 30-70% displaced and 1-10% mortality from the Array Areas (and 2km buffer; **Table 12-49**) is between 181 and 4,231 individuals, with 846 at 70% displaced and 2% mortality.

Table 12-49 Displacement Matrix Presenting the Number of Guillemot in the Array Areas (and 2km Buffer) Combined Across the Breeding and Nonbreeding Seasons That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	60	121	181	242	302	363	423	484	544	604
2	121	242	363	484	604	725	846	967	1088	1209
3	181	363	544	725	907	1088	1269	1451	1632	1813
4	242	484	725	967	1209	1451	1692	1934	2176	2418
5	302	604	907	1209	1511	1813	2115	2418	2720	3022
6	363	725	1088	1451	1813	2176	2538	2901	3264	3626
7	423	846	1269	1692	2115	2538	2961	3385	3808	4231
8	484	967	1451	1934	2418	2901	3385	3868	4352	4835
9	544	1088	1632	2176	2720	3264	3808	4352	4895	5439
10	604	1209	1813	2418	3022	3626	4231	4835	5439	6044
20	1209	2418	3626	4835	6044	7253	8461	9670	10879	12088
30	1813	3626	5439	7253	9066	10879	12692	14505	16318	18131
50	3022	6044	9066	12088	15110	18131	21153	24175	27197	30219
75	4533	9066	13599	18131	22664	27197	31730	36263	40796	45329
100	6044	12088	18131	24175	30219	36263	42307	48350	54394	60438

~~619.~~626. At the average baseline mortality rate for guillemot of 0.1405 the number of individuals expected to die from the largest BDMPS population across all seasons is 287,333 (2,045,078 x 0.1405). The addition of a combined maximum of 4,231 (70% x 10%) individuals to this increases the background mortality rate by 1.472%, or of 846 (70% x 2%) to this would increase the mortality rate by 0.294%. While the worst case estimate is above the 1% threshold for detectability, using the Natural England advised rates for other wind farms[7] (70% x 2%) is below this level. Indeed, even if displacement occurred at rate of 47% (with 10% mortality) or mortality was 6.7% (at 70% displaced), this figure would be below the 1% of detectability.

~~620.~~627. The number of individuals from the biogeographic population expected to die across all seasons is 579,563 (4,125,000 x 0. 1405). The addition of a maximum of 4,231 (70% x 10%) to this increases the mortality rate by 0.73%, or of 846 (70% x 2%) to this would increase the mortality rate by 0.146%, both of which are below the 1% threshold for detectability.

~~621.~~628. Therefore, the magnitude of impact for guillemot assessed against both the BDMPS population and biogeographic population is considered to be negligible to low.

~~622.~~629. The sensitivity of guillemot to operational displacement is considered to be medium and the magnitude of annual impact at the Array Areas is negligible to low when assessed against either the largest BDMPS or the biogeographic population. Therefore, the significance of the annual effect on guillemot due to operational displacement at the Array Areas is assessed as **minor adverse**.

~~623.~~630. A table summarising the guillemot operational displacement assessment is provided below (**Table 12-50**).

12.8.1.1.3.4 Summary of Operational Displacement Assessment - Guillemot

Table 12-50 Summary of Guillemot Operational Displacement Assessment for DBS East, DBS West and Combined (Projects).

Guillemot		DBS East	DBS West	Projects
Baseline average annual mortality				0.1405
Breeding season	Reference population (breeding BDMPS)			2,045,078
	Displacement mortality (@70% x 2%)	126	123	249
	Increase in background mortality (%)	0.044	0.043	0.087
	Significance	Minor	Minor	Minor

Guillemot		DBS East	DBS West	Projects
Chick rearing and moult	Reference population (breeding BDMPS)			1,617,305
	Displacement mortality (@70% x 2%)	107	175	282
	Increase in background mortality (%)	0.047	0.077	0.124
	Significance	Minor	Minor	Minor
Non breeding season	Reference population			1,617,305
	Displacement mortality (@70% x 2%)	176	139	314
	Increase in background mortality (%)	0.077	0.061	0.138
	Significance	Minor	Minor	Minor
Annual (BDMPS)	Reference population			2,045,078
	Displacement mortality (@70% x 2%)	410	436	846
	Increase in background mortality (%)	0.143	0.152	0.294
	Significance	Minor	Minor	Minor
Annual (biogeo-graphic)	Biogeographical population			4,125,000
	Displacement mortality (@70% x 2%)	410	436	846
	Increase in background mortality (%)	0.071	0.075	0.146
	Significance	Minor	Minor	Minor

12.8.1.1.4 Razorbill

12.8.1.1.4.1 Significance of Effect – DBS East in Isolation

12.8.1.1.4.1.1 Breeding Season

~~624.~~631. During the breeding season, the maximum mean peak abundance in the DBS East Array Area and 2km buffer was 555 individuals. The estimated number of razorbills subject to mortality during the breeding period due to displacement at 30-70% displaced and 1-10% mortality from DBS East (and 2km buffer; **Table 12-51**) is between two and 39 individuals, with eight at 70% displaced and 2% mortality.

Table 12-51 Displacement Matrix Presenting the Number of Razorbills in the DBS East Array Area (and 2km Buffer) During the Breeding Season That May Be Subject to Mortality (Highlighted).

Mortality (%)	**Displacement (%)**									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	1	1	2	2	3	3	4	4	5	6
2	1	2	3	4	6	7	8	9	10	11
3	2	3	5	7	8	10	12	13	15	17
4	2	4	7	9	11	13	16	18	20	22
5	3	6	8	11	14	17	19	22	25	28
6	3	7	10	13	17	20	23	27	30	33
7	4	8	12	16	19	23	27	31	35	39
8	4	9	13	18	22	27	31	36	40	44
9	5	10	15	20	25	30	35	40	45	50
10	6	11	17	22	28	33	39	44	50	56
20	11	22	33	44	56	67	78	89	100	111
30	17	33	50	67	83	100	117	133	150	167
50	28	56	83	111	139	167	194	222	250	278
75	42	83	125	167	208	250	291	333	375	416
100	56	111	167	222	278	333	389	444	500	555

~~625.~~632. At the average baseline mortality rate for razorbill of 0.1302 the number of individuals expected to die in the breeding season is 20,576 (158,031 x 0.1302). The addition of a maximum of 39 (70% x 10%) to this increases the background mortality rate by 0.189%, or of 8 (70% x 2%) to this would increase the mortality rate by 0.038%, both of which are below the 1% threshold for detectability.

~~626.~~633. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.8.1.1.4.1.2 Autumn Migration

~~627.~~634. During the autumn migration period, the maximum mean peak abundance in the DBS East Array Area and 2km buffer was 4,686 individuals. The estimated number of razorbills subject to mortality during the autumn migration period due to displacement at 30-70% displaced and 1-10% mortality from DBS East (and 2km buffer; **Table 12-52**) is between 14 and 328 individuals, with 66 at 70% displaced and 2% mortality.

Table 12-52 Displacement Matrix Presenting the Number of Razorbills in the DBS East Array Area (and 2km buffer) During Autumn Migration That May Be Subject to Mortality (Highlighted).

Mortality (%)	**Displacement (%)**									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	5	9	14	19	23	28	33	37	42	47
2	9	19	28	37	47	56	66	75	84	94
3	14	28	42	56	70	84	98	112	127	141
4	19	37	56	75	94	112	131	150	169	187
5	23	47	70	94	117	141	164	187	211	234
6	28	56	84	112	141	169	197	225	253	281
7	33	66	98	131	164	197	230	262	295	328
8	37	75	112	150	187	225	262	300	337	375
9	42	84	127	169	211	253	295	337	380	422
10	47	94	141	187	234	281	328	375	422	469
20	94	187	281	375	469	562	656	750	843	937
30	141	281	422	562	703	843	984	1125	1265	1406
50	234	469	703	937	1172	1406	1640	1874	2109	2343
75	351	703	1054	1406	1757	2109	2460	2812	3163	3515
100	469	937	1406	1874	2343	2812	3280	3749	4217	4686

~~628.~~635. At the average baseline mortality rate for razorbill of0.1302 the number of individuals expected to die in the autumn migration period is 77,062 (591,875 x 0.1302). The addition of a maximum of 328 (70% x 10%) to this increases the background mortality rate by 0.426%, or of 66 (70% x 2%) to this would increase the mortality rate by 0.085%, both of which are below the 1% threshold for detectability.

~~629.~~636. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.8.1.1.4.1.3 Winter

~~630.~~637. During the winter period, the maximum mean peak abundance in the DBS East Array Area and 2km buffer was 3,377 individuals. The estimated number of razorbills subject to mortality during the winter period due to displacement at 30-70% displaced and 1-10% mortality from DBS East (and 2km buffer; **Table 12-53**) is between 10 and 236 individuals, with 47 at 70% displaced and 2% mortality.

Table 12-53 Displacement Matrix Presenting the Number of Razorbills in the DBS East Array Area (and 2km Buffer) During the Winter Period That May Be Subject to Mortality (Highlighted).

Mortality (%)	**Displacement (%)**									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	3	7	10	14	17	20	24	27	30	34
2	7	14	20	27	34	41	47	54	61	68
3	10	20	30	41	51	61	71	81	91	101
4	14	27	41	54	68	81	95	108	122	135
5	17	34	51	68	84	101	118	135	152	169
6	20	41	61	81	101	122	142	162	182	203
7	24	47	71	95	118	142	165	189	213	236
8	27	54	81	108	135	162	189	216	243	270
9	30	61	91	122	152	182	213	243	274	304
10	34	68	101	135	169	203	236	270	304	338
20	68	135	203	270	338	405	473	540	608	675
30	101	203	304	405	507	608	709	810	912	1013
50	169	338	507	675	844	1013	1182	1351	1520	1689
75	253	507	760	1013	1266	1520	1773	2026	2279	2533
100	338	675	1013	1351	1689	2026	2364	2702	3039	3377

~~631.~~638. At the average baseline mortality rate for razorbill of 0.1302 the number of individuals expected to die in the winter is 28,464 (218,621 x 0.1302). The addition of a maximum of 236 (70% x 10%) to this increases the background mortality rate by 0.830%, or of 47 (70% x 2%) to this increases the background mortality rate by 0.166%, both of which are below the 1% threshold for detectability.

~~632.~~639. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the winter period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.8.1.1.4.1.4 Spring Migration

~~633.~~640. During spring migration period, the maximum mean peak abundance in the DBS East Array Area and 2km buffer was 3,579 individuals. The estimated number of razorbills subject to mortality during the spring migration period due to displacement at 30-70% displaced and 1-10% mortality from DBS East (and 2km buffer; **Table 12-54**) is between 11 and 251 individuals, with 50 at 70% displaced and 2% mortality.

Table 12-54 Displacement Matrix Presenting the Number of Razorbills in the DBS East Array Area (and 2km Buffer) During Spring Migration That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	4	7	11	14	18	21	25	29	32	36
2	7	14	21	29	36	43	50	57	64	72
3	11	21	32	43	54	64	75	86	97	107
4	14	29	43	57	72	86	100	115	129	143
5	18	36	54	72	89	107	125	143	161	179
6	21	43	64	86	107	129	150	172	193	215
7	25	50	75	100	125	150	175	200	225	251
8	29	57	86	115	143	172	200	229	258	286
9	32	64	97	129	161	193	225	258	290	322
10	36	72	107	143	179	215	251	286	322	358
20	72	143	215	286	358	429	501	573	644	716
30	107	215	322	429	537	644	752	859	966	1074
50	179	358	537	716	895	1074	1253	1432	1611	1790
75	268	537	805	1074	1342	1611	1879	2147	2416	2684
100	358	716	1074	1432	1790	2147	2505	2863	3221	3579

~~634.~~641. At the average baseline mortality rate for razorbill of 0.1302 the number of individuals expected to die in the spring migration season is 77,062 (591,875 x 0.1302). The addition of a maximum of 251 (70% x 10%) to this increases the background mortality rate by 0.325%, or of 50 (70% x 2%) to this would increase the mortality rate by 0.065%, both of which are below the 1% threshold for detectability.

~~635.~~642. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.8.1.1.4.1.5 Annual

~~636.~~643. Summed across the year the maximum mean peak abundance in the DBS East Array Area and 2km buffer was 12,197 individuals. The estimated number of razorbills subject to mortality combined across all seasons due to displacement at 30-70% displaced and 1-10% mortality from DBS East (and 2km buffer; **Table 12-55**) is between 37 and 854 individuals, with 171 at 70% displaced and 2% mortality.

Table 12-55 Displacement Matrix Presenting the Number of Razorbills in the DBS East Array Area (and 2km Buffer) Combined Across the Breeding, Autumn Migration, Winter and Spring Migration Periods That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	12	24	37	49	61	73	85	98	110	122
2	24	49	73	98	122	146	171	195	220	244
3	37	73	110	146	183	220	256	293	329	366
4	49	98	146	195	244	293	342	390	439	488
5	61	122	183	244	305	366	427	488	549	610
6	73	146	220	293	366	439	512	585	659	732
7	85	171	256	342	427	512	598	683	768	854
8	98	195	293	390	488	585	683	781	878	976
9	110	220	329	439	549	659	768	878	988	1098
10	122	244	366	488	610	732	854	976	1098	1220
20	244	488	732	976	1220	1464	1708	1952	2195	2439
30	366	732	1098	1464	1830	2195	2561	2927	3293	3659
50	610	1220	1830	2439	3049	3659	4269	4879	5489	6099
75	915	1830	2744	3659	4574	5489	6403	7318	8233	9148
100	1220	2439	3659	4879	6099	7318	8538	9758	10977	12197

~~637.~~644. At the average baseline mortality rate for razorbill of 0.1302 the number of individuals from the largest BDMPS population expected to die across all seasons is 77,062 (591,875 x 0.1302). The addition of a maximum of 854 (70% x 10%) to this increases the background mortality rate by 1.108%, or of 171 (70% x 2%) to this would increase the mortality rate by 0.222%. While the worst case estimate is above the 1% threshold for detectability, using the Natural England advised rates for other wind farms[7] (70% x 2%) the impact is below this level. Indeed, even if displacement occurred at rate of 63% (with 10% mortality) or mortality was 9% (at 70% displaced), this figure would be below the 1% threshold of detectability.

~~638.~~645. The number of individuals from the biogeographic population expected to die across all seasons is 222,251 (1,707,000 x 0.1302). The addition of a maximum of 854 (70% x 10%) to this increases the mortality rate by 0.384%, or of 171 (70% x 2%) to this would increase the mortality rate by 0.077%, both of which are below the 1% threshold for detectability.

~~639.~~646. Therefore, the magnitude of impact for razorbill assessed against both the BDMPS population and biogeographic population is considered to be negligible to low.

~~640.~~647. The sensitivity of razorbill to operational displacement is considered to be medium and the magnitude of annual impact at DBS East is negligible, therefore the annual significance of effect on razorbill due to operational displacement at DBS East is assessed as **minor adverse**.

12.8.1.1.4.2 Significance of Effect – DBS West in Isolation

12.8.1.1.4.2.1 Breeding Season

~~641.~~648. During the breeding season, the maximum mean peak abundance in the DBS West Array Area and 2km buffer was 2,281 individuals. The estimated number of razorbills subject to mortality during the breeding period due to displacement at 30-70% displaced and 1-10% mortality from DBS West (and 2km buffer; **Table 12-56**) is between seven and 160 individuals, with 32 at 70% displaced and 2% mortality.

Table 12-56 Displacement Matrix Presenting the Number of Razorbills in the DBS West Array Area (and 2km Buffer) During the Breeding Season That May Be Subject to Mortality (Highlighted).

Mortality (%)	**Displacement (%)**									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	2	5	7	9	11	14	16	18	21	23
2	5	9	14	18	23	27	32	36	41	46
3	7	14	21	27	34	41	48	55	62	68
4	9	18	27	36	46	55	64	73	82	91
5	11	23	34	46	57	68	80	91	103	114

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
6	14	27	41	55	68	82	96	109	123	137
7	16	32	48	64	80	96	112	128	144	160
8	18	36	55	73	91	109	128	146	164	182
9	21	41	62	82	103	123	144	164	185	205
10	23	46	68	91	114	137	160	182	205	228
20	46	91	137	182	228	274	319	365	411	456
30	68	137	205	274	342	411	479	547	616	684
50	114	228	342	456	570	684	798	912	1026	1141
75	171	342	513	684	855	1026	1198	1369	1540	1711
100	228	456	684	912	1141	1369	1597	1825	2053	2281

~~642.~~649. At the average baseline mortality rate for razorbill of 0.1302 the number of individuals expected to die in the breeding season is 20,576 (158,031 x 0.1302). The addition of a maximum of 160 (70 x 10%) to this increases the background mortality rate by 0.776%, or of 32 (70% x 2%) to this would increase the mortality rate by 0.155%, both of which are below the 1% threshold for detectability.

~~643.~~650. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.8.1.1.4.2.2 Autumn Migration

~~644.~~651. During the autumn migration period, the maximum mean peak abundance in the DBS West Array Area and 2km buffer was 4,887 individuals. The estimated number of razorbills subject to mortality during the autumn migration period due to displacement at 30-70% displaced and 1-10% mortality from DBS West (and 2km buffer; **Table 12-57**) is between 15 and 342 individuals, with 68 at 70% displaced and 2% mortality.

Table 12-57 Displacement Matrix Presenting the Number of Razorbills in the DBS West Array Area (and 2km Buffer) During Autumn Migration That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	5	10	15	20	24	29	34	39	44	49
2	10	20	29	39	49	59	68	78	88	98
3	15	29	44	59	73	88	103	117	132	147

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
4	20	39	59	78	98	117	137	156	176	195
5	24	49	73	98	122	147	171	195	220	244
6	29	59	88	117	147	176	205	235	264	293
7	34	68	103	137	171	205	239	274	308	342
8	39	78	117	156	195	235	274	313	352	391
9	44	88	132	176	220	264	308	352	396	440
10	49	98	147	195	244	293	342	391	440	489
20	98	195	293	391	489	586	684	782	880	977
30	147	293	440	586	733	880	1026	1173	1319	1466
50	244	489	733	977	1222	1466	1710	1955	2199	2444
75	367	733	1100	1466	1833	2199	2566	2932	3299	3665
100	489	977	1466	1955	2444	2932	3421	3910	4398	4887

~~645.~~652. At the average baseline mortality rate for razorbill of 0.1302 the number of individuals expected to die in the autumn migration period is 77,062 (591,875 x 0.1302). The addition of a maximum of 342 to this increases the background mortality rate by 0.444%, or of 68 (70% x 2%) to this would increase the mortality rate by 0.089%, both of which are below the 1% threshold for detectability.

~~646.~~653. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.8.1.1.4.2.3 Winter

~~647.~~654. During the winter period, the maximum mean peak abundance in the DBS West Array Area and 2km buffer was 5,066 individuals. The estimated number of razorbills subject to mortality during the winter period due to displacement at 30-70% displaced and 1-10% mortality from DBS West (and 2km buffer; **Table 12-58**) is between 15 and 355 individuals, with 71 at 70% displaced and 2% mortality.

Table 12-58 Displacement Matrix Presenting the Number of Razorbills in the DBS West Array Area (and 2km Buffer) During the Winter Period That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	5	10	15	20	25	30	35	41	46	51
2	10	20	30	41	51	61	71	81	91	101
3	15	30	46	61	76	91	106	122	137	152
4	20	41	61	81	101	122	142	162	182	203
5	25	51	76	101	127	152	177	203	228	253
6	30	61	91	122	152	182	213	243	274	304
7	35	71	106	142	177	213	248	284	319	355
8	41	81	122	162	203	243	284	324	365	405
9	46	91	137	182	228	274	319	365	410	456
10	51	101	152	203	253	304	355	405	456	507
20	101	203	304	405	507	608	709	811	912	1013
30	152	304	456	608	760	912	1064	1216	1368	1520
50	253	507	760	1013	1267	1520	1773	2026	2280	2533
75	380	760	1140	1520	1900	2280	2660	3040	3420	3800
100	507	1013	1520	2026	2533	3040	3546	4053	4559	5066

~~648.~~655. At the average baseline mortality rate for razorbill of 0.1302 the number of individuals expected to die in the winter is 28,464 (218,621 x 0.1302). The addition of a maximum of 355 (70% x 10%) to this increases the background mortality rate by 1.246%, or of 71 (70% x 2%) to this increases the background mortality rate by 0.249%. While the worst case estimate is above the 1% threshold for detectability, using the Natural England advised rates for other wind farms[7] (70% x 2%) the impact is below this level. Indeed, even if displacement occurred at rate of 56% (with 10% mortality) or mortality was 8% (at 70% displaced), this figure would be below the 1% threshold of detectability.

~~649.~~656. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the winter period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.8.1.1.4.2.4 Spring Migration

~~650.~~657. During the spring migration period, the maximum mean peak abundance in the DBS West Array Area and 2km buffer was 4,455 individuals. The estimated number of razorbills subject to mortality during the spring migration period due to displacement at 30-70% displaced and 1-10% mortality from DBS West (and 2km buffer; **Table 12-59**) is between 13 and 312 individuals, with 62 at 70% displaced and 2% mortality.

Table 12-59 Displacement Matrix Presenting the Number of Razorbill in the DBS West Array Area (and 2km Buffer) During Spring Migration That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	4	9	13	18	22	27	31	36	40	45
2	9	18	27	36	45	53	62	71	80	89
3	13	27	40	53	67	80	94	107	120	134
4	18	36	53	71	89	107	125	143	160	178
5	22	45	67	89	111	134	156	178	200	223
6	27	53	80	107	134	160	187	214	241	267
7	31	62	94	125	156	187	218	249	281	312
8	36	71	107	143	178	214	249	285	321	356
9	40	80	120	160	200	241	281	321	361	401
10	45	89	134	178	223	267	312	356	401	446
20	89	178	267	356	446	535	624	713	802	891
30	134	267	401	535	668	802	936	1069	1203	1337
50	223	446	668	891	1114	1337	1559	1782	2005	2228
75	334	668	1002	1337	1671	2005	2339	2673	3007	3341
100	446	891	1337	1782	2228	2673	3119	3564	4010	4455

~~651.~~658. At the average baseline mortality rate for razorbill of 0.1302 the number of individuals expected to die in the spring migration season is 77,062 (591,875 x 0.1302). The addition of a maximum of 312 to this increases the background mortality rate by 0.405%, or of 62 (70% x 2%) to this would increase the mortality rate by 0.081%, both of which are below the 1% threshold for detectability.

~~652.~~659. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.8.1.1.4.2.5 Annual

~~653.~~660. Summed across the year the maximum mean peak abundance in the DBS West Array Area and 2km buffer was 16,689 individuals. The estimated number of razorbills subject to mortality combined across all seasons due to displacement at 30-70% displaced and 1-10% mortality from the DBS West (and 2km buffer; **Table 12-60**) is between 50 and 1,168 individuals, with 234 at 70% displaced and 2% mortality.

Table 12-60 Displacement Matrix Presenting the Number of Razorbill in the DBS West Array Area (and 2km Buffer) Combined Across the Breeding, Autumn Migration, Winter and Spring Migration Periods That May Be Subject to Mortality (highlighted).

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	17	33	50	67	83	100	117	134	150	167
2	33	67	100	134	167	200	234	267	300	334
3	50	100	150	200	250	300	350	401	451	501
4	67	134	200	267	334	401	467	534	601	668
5	83	167	250	334	417	501	584	668	751	834
6	100	200	300	401	501	601	701	801	901	1001
7	117	234	350	467	584	701	818	935	1051	1168
8	134	267	401	534	668	801	935	1068	1202	1335
9	150	300	451	601	751	901	1051	1202	1352	1502
10	167	334	501	668	834	1001	1168	1335	1502	1669
20	334	668	1001	1335	1669	2003	2336	2670	3004	3338
30	501	1001	1502	2003	2503	3004	3505	4005	4506	5007
50	834	1669	2503	3338	4172	5007	5841	6676	7510	8345
75	1252	2503	3755	5007	6258	7510	8762	10013	11265	12517
100	1669	3338	5007	6676	8345	10013	11682	13351	15020	16689

~~654.~~661. At the average baseline mortality rate for razorbill of 0.1302 the number of individuals from the largest BDMPS population expected to die across all seasons is 77,062 (591,875 x 0.1302). The addition of a maximum of 1,168 (70% x 10%) to this increases the background mortality rate by 1.516%, or of 234 (70% x 2%) to this would increase the mortality rate by 0.303%. While the worst case estimate is above the 1% threshold for detectability, using the Natural England advised rates for other wind farms[7] (70% x 2%) the impact is below this level. Indeed, even if displacement occurred at rate of 46% (with 10% mortality) or mortality was 6.5% (at 70% displaced), this figure would fall below the 1% threshold of detectability.

~~655.~~662. The number of individuals from the biogeographic population expected to die across all seasons is 222,251 (1,707,000 x 0.1302). The addition of a maximum of 1,168 (70 x 10%) to this increases the mortality rate by 0.526%, or of 234 (70% x 2%) to this would increase the mortality rate by 0.105%, both of which are below the 1% threshold for detectability.

~~656.~~663. The sensitivity of razorbill to operational displacement is considered to be medium and the magnitude of annual impact at DBS West is negligible, therefore the significance of the annual effect on razorbill due to operational displacement at DBS West is assessed as **minor adverse**.

12.8.1.1.4.3 Significance of Effect – DBS East and DBS West Together

12.8.1.1.4.3.1 Breeding Season

~~657.~~664. During the breeding season, the combined maximum mean peak abundance in the Array Areas and 2km buffer was 2,836 individuals. The estimated number of razorbills subject to mortality during the breeding period due to displacement at 30-70% displaced and 1-10% mortality from the Array Areas (and 2km buffer; **Table 12-61**) is between nine and 199 individuals, with 40 at 70% displaced and 2% mortality.

Table 12-61 Displacement Matrix Presenting the Number of Razorbills in the Array Areas (and 2km Buffer) During the Breeding Season That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	3	6	9	11	14	17	20	23	26	28
2	6	11	17	23	28	34	40	45	51	57
3	9	17	26	34	43	51	60	68	77	85
4	11	23	34	45	57	68	79	91	102	113
5	14	28	43	57	71	85	99	113	128	142
6	17	34	51	68	85	102	119	136	153	170
7	20	40	60	79	99	119	139	159	179	199
8	23	45	68	91	113	136	159	182	204	227
9	26	51	77	102	128	153	179	204	230	255
10	28	57	85	113	142	170	199	227	255	284
20	57	113	170	227	284	340	397	454	510	567
30	85	170	255	340	425	510	596	681	766	851
50	142	284	425	567	709	851	993	1134	1276	1418
75	213	425	638	851	1064	1276	1489	1702	1914	2127
100	284	567	851	1134	1418	1702	1985	2269	2552	2836

~~658.~~665. At the average baseline mortality rate for razorbill of 0.1302 the number of individuals expected to die in the breeding season is 20,576 (158,031 x 0.1302). The addition of a combined maximum of 199 (70 x 10%) individuals to this increases the background mortality rate by 0.965%, or of 40 (70% x 2%) to this would increase the mortality rate by 0.193%, both of which are below the 1% threshold for detectability.

~~659.~~666. Therefore, the magnitude of increase in mortality would be very unlikely to materially alter the background mortality of the population and would almost certainly be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible to low. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.8.1.1.4.3.2 Autumn Migration

~~660.~~667. During the autumn migration period, the combined maximum mean peak abundance in the Array Areas and 2km buffer was 9,573 individuals. The estimated number of razorbills subject to mortality during the autumn migration period due to displacement at 30-70% displaced and 1-10% mortality from the Array Areas (and 2km buffer; **Table 12-62)** is between 29 and 670 individuals, with 134 at 70% displaced and 2% mortality.

Table 12-62 Displacement Matrix Presenting the Number of Razorbill in the Array Areas (and 2km Buffer) During Autumn Migration That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	10	19	29	38	48	57	67	77	86	96
2	19	38	57	77	96	115	134	153	172	191
3	29	57	86	115	144	172	201	230	258	287
4	38	77	115	153	191	230	268	306	345	383
5	48	96	144	191	239	287	335	383	431	479
6	57	115	172	230	287	345	402	460	517	574
7	67	134	201	268	335	402	469	536	603	670
8	77	153	230	306	383	460	536	613	689	766
9	86	172	258	345	431	517	603	689	775	862
10	96	191	287	383	479	574	670	766	862	957
20	191	383	574	766	957	1149	1340	1532	1723	1915
30	287	574	862	1149	1436	1723	2010	2298	2585	2872
50	479	957	1436	1915	2393	2872	3351	3829	4308	4787
75	718	1436	2154	2872	3590	4308	5026	5744	6462	7180
100	957	1915	2872	3829	4787	5744	6701	7658	8616	9573

~~661.~~668. At the average baseline mortality rate for razorbill of 0.1302 the number of individuals expected to die in the autumn migration period is 77,062 (591,875 x 0.1302). The addition of a combined maximum of 670 (70% x 10%) individuals to this increases the background mortality rate by 0.870%, or of 134 (70% x 2%) to this would increase the mortality rate by 0.174%, both of which are below the 1% threshold for detectability.

~~662.~~669. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.8.1.1.4.3.3 Winter

~~663.~~670. During the winter period, the combined maximum mean peak abundance in the Array Areas and 2km buffer was 8,443 individuals. The estimated number of razorbills subject to mortality during the winter period due to displacement at 30-70% displaced and 1-10% mortality from the Array Areas (and 2km buffer; **Table 12-63**) is between 25 and 591 individuals, with 118 at 70% displaced and 2% mortality.

Table 12-63 Displacement Matrix Presenting the Number of Razorbill in the Array Areas (and 2km Buffer) During the Winter Period That May Be Subject to Mortality (Highlighted).

Mortality (%)	**Displacement (%)**									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	8	17	25	34	42	51	59	68	76	84
2	17	34	51	68	84	101	118	135	152	169
3	25	51	76	101	127	152	177	203	228	253
4	34	68	101	135	169	203	236	270	304	338
5	42	84	127	169	211	253	296	338	380	422
6	51	101	152	203	253	304	355	405	456	507
7	59	118	177	236	296	355	414	473	532	591
8	68	135	203	270	338	405	473	540	608	675
9	76	152	228	304	380	456	532	608	684	760
10	84	169	253	338	422	507	591	675	760	844
20	169	338	507	675	844	1013	1182	1351	1520	1689
30	253	507	760	1013	1266	1520	1773	2026	2280	2533
50	422	844	1266	1689	2111	2533	2955	3377	3799	4222
75	633	1266	1900	2533	3166	3799	4433	5066	5699	6332
100	844	1689	2533	3377	4222	5066	5910	6754	7599	8443

~~664.~~671. At the average baseline mortality rate for razorbill of 0.1302 the number of individuals expected to die in the winter is 28,464 (218,621 x 0.1302). The addition of a combined maximum of 591 (70% x 10%) individuals to this increases the background mortality rate by 2.076%, or of 118 (70% x 2%) to this increases the background mortality rate by 0.415%. While the worst case estimate is above the 1% threshold for detectability, using the Natural England advised rates for other wind farms[7] (70% x 2%) the impact is below this level. Indeed, even if displacement occurred at rate of 33% (with 10% mortality) or mortality was 4.8% (at 70% displaced), this figure would be below the 1% of detectability.

~~665.~~672. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the winter period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.8.1.1.4.3.4 Spring migration

~~666.~~673. During the spring migration period, the combined maximum mean peak abundance in the Array Areas and 2km buffer was 8,033 individuals. The estimated number of razorbills subject to mortality during the spring migration period due to displacement at 30-70% displaced and 1-10% mortality from the Array Areas (and 2km buffer;) is between 24 and 562 individuals, with 112 at 70% displaced and 2% mortality.

Table 12-64 Displacement Matrix Presenting the Number of Razorbill in the Array Areas (and 2km Buffer) During Spring Migration That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	8	16	24	32	40	48	56	64	72	80
2	16	32	48	64	80	96	112	129	145	161
3	24	48	72	96	121	145	169	193	217	241
4	32	64	96	129	161	193	225	257	289	321
5	40	80	121	161	201	241	281	321	362	402
6	48	96	145	193	241	289	337	386	434	482
7	56	112	169	225	281	337	394	450	506	562
8	64	129	193	257	321	386	450	514	578	643
9	72	145	217	289	362	434	506	578	651	723
10	80	161	241	321	402	482	562	643	723	803
20	161	321	482	643	803	964	1125	1285	1446	1607

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
30	241	482	723	964	1205	1446	1687	1928	2169	2410
50	402	803	1205	1607	2009	2410	2812	3214	3615	4017
75	603	1205	1808	2410	3013	3615	4218	4820	5423	6026
100	803	1607	2410	3214	4017	4820	5624	6427	7231	8033

~~667.~~674. At the average baseline mortality rate for razorbill of 0.1302 the number of individuals expected to die in the spring migration season is 77,062 (591,875 x 0.1302). The addition of a combined maximum of 562 (70% x 10%) individuals to this increases the background mortality rate by 0.730%, or of 112 (70% x 2%) to this would increase the mortality rate by 0.146%, both of which are below the 1% threshold for detectability.

~~668.~~675. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of impact is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.8.1.1.4.3.5 Annual

~~669.~~676. Summed across the year the combined maximum mean peak abundance in the Array Areas and 2km buffer was 28,886 individuals. The estimated number of razorbills subject to mortality combined across all seasons due to displacement at 30-70% displaced and 1-10% mortality from the Array Areas (and 2km buffer; **Table 12-65**) is between 87 and 2,022 individuals, with 404 at 70% displaced and 2% mortality.

Table 12-65 Displacement Matrix Presenting the Number of Razorbill in the Array Areas (and 2km buffer) Combined Across the Breeding, Autumn Migration, Winter and Spring Migration Periods That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	29	58	87	116	144	173	202	231	260	289
2	58	116	173	231	289	347	404	462	520	578
3	87	173	260	347	433	520	607	693	780	867
4	116	231	347	462	578	693	809	924	1040	1155
5	144	289	433	578	722	867	1011	1155	1300	1444
6	173	347	520	693	867	1040	1213	1387	1560	1733
7	202	404	607	809	1011	1213	1415	1618	1820	2022

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
8	231	462	693	924	1155	1387	1618	1849	2080	2311
9	260	520	780	1040	1300	1560	1820	2080	2340	2600
10	289	578	867	1155	1444	1733	2022	2311	2600	2889
20	578	1155	1733	2311	2889	3466	4044	4622	5199	5777
30	867	1733	2600	3466	4333	5199	6066	6933	7799	8666
50	1444	2889	4333	5777	7222	8666	10110	11554	12999	14443
75	2166	4333	6499	8666	10832	12999	15165	17332	19498	21665
100	2889	5777	8666	11554	14443	17332	20220	23109	25997	28886

~~670.~~677. At the average baseline mortality rate for razorbill of 0.1302 the number of individuals from the largest BDMPS population expected to die across all seasons is 77,062 (591,875 x 0.1302). The addition of a combined maximum of 2,022 (70% x 10%) individuals to this increases the background mortality rate by 2.624%, or of 404 (70% x 2%) to this would increase the mortality rate by 0.525%. While the worst case estimate is above the 1% threshold for detectability, using the Natural England advised rates for other wind farms[7] (70% x 2%) the impact is below this level. Indeed, even if mortality was 3.8% (at 70% displaced), this figure would be below the 1% of detectability.

~~671.~~678. The number of individuals from the biogeographic population expected to die across all seasons is 222,251 (1,707,000 x 0.1302). The addition of a maximum of 2,022 (70% x 10%) to this increases the mortality rate by 0.91%, or of 404 (70% x 2%) to this would increase the mortality rate by 0.182%, both of which are below the 1% threshold for detectability.

~~672.~~679. The sensitivity of razorbill to operational displacement is considered to be medium and the magnitude of annual impact at the Array Areas is negligible to low. Therefore the significance of the annual effect on razorbill due to operational displacement at the Array Areas is assessed as **minor adverse**.

~~673.~~680. A table summarising the razorbill operational displacement assessment is provided below (**Table 12-66**).

12.8.1.1.4.4 Summary of Operational Displacement Assessment - Razorbill

Table 12-66 Summary of Razorbill Operational Displacement Assessment for DBS East, DBS West and Combined (Projects).

Razorbills		DBS East	DBS West	Projects
Baseline average annual mortality				0.1302
Breeding season	Reference population (subadult component of nonbreeding BDMPS)			158,031
	Displacement mortality (@70% x 2%)	8	32	40
	Increase in background mortality (%)	0.038	0.155	0.193
	Significance	Minor	Minor	Minor
Autumn	Reference population			591,875
	Displacement mortality (@70% x 2%)	66	68	134
	Increase in background mortality (%)	0.085	0.089	0.174
	Significance	Minor	Minor	Minor
Winter	Reference population			218,621
	Displacement mortality (@70% x 2%)	47	71	118
	Increase in background mortality (%)	0.166	0.249	0.415
	Significance	Minor	Minor	Minor
Spring	Reference population			591,875
	Displacement mortality (@70% x 2%)	50	62	112
	Increase in background mortality (%)	0.065	0.081	0.146
	Significance	Minor	Minor	Minor
Annual (BDMPS)	Reference population (Nonbreeding season BDMPS)			591,875
	Displacement mortality (@70% x 2%)	171	234	404

Razorbills		DBS East	DBS West	Projects
	Increase in background mortality (%)	0.222	0.303	0.525
	Significance	Minor	Minor	Minor
Annual (biogeographic)	Biogeographical population	1,707,000		
	Displacement mortality (@70% x 10%)	171	234	404
	Increase in background mortality (%)	0.077	0.105	0.182
	Significance	Minor	Minor	Minor

12.8.1.1.5 Puffin

12.8.1.1.5.1 Significance of Effect – DBS East in Isolation

12.8.1.1.5.1.1 Breeding Season

~~674.~~681. During the breeding season, the maximum mean peak abundance in the DBS East Array Area and 2km buffer was 63 individuals. The estimated number of puffins subject to mortality during the breeding period due to displacement at 30-70% displaced and 1-10% mortality from DBS East (and 2km buffer; **Table 12-67**) is between zero and four individuals, with 1 at 70% displaced and 2% mortality.

Table 12-67 Displacement Matrix Presenting the Number of Puffins in the DBS East Array Area (and 2km Buffer) During the Breeding Season That May Be Subject to Mortality (Highlighted).

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

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
50	3	6	9	13	16	19	22	25	28	32
75	5	9	14	19	24	28	33	38	43	47
100	6	13	19	25	32	38	44	50	57	63

~~675.~~682. At the average baseline mortality rate for adult puffin of 0.119 the number of individuals expected to die in the breeding season is 103,374 (868,689 x 0.119). The addition of a maximum of 4 (70% x 10%) to this increases the background mortality rate by 0.004%, or of 1 (70% x 2%) to this would increase the mortality rate by 0.001%, both of which are below the 1% threshold for detectability.

~~676.~~683. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.8.1.1.5.1.2 Nonbreeding Season

~~677.~~684. During the nonbreeding season, the maximum mean peak abundance in the DBS East Array Area and 2km buffer was 179 individuals. The estimated number of puffins subject to mortality during the nonbreeding period due to displacement at 30-70% displaced and 1-10% mortality from DBS East (and 2km buffer; **Table 12-68**) is between 1 and 13 individuals, with three at 70% displaced and 2% mortality.

Table 12-68 Displacement Matrix Presenting the Number of Puffins in the DBS East Array Area (and 2km Buffer) During the Nonbreeding Season That May Be Subject to Mortality (Highlighted).

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

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
20	4	7	11	14	18	21	25	29	32	36
30	5	11	16	21	27	32	38	43	48	54
50	9	18	27	36	45	54	63	72	81	90
75	13	27	40	54	67	81	94	107	121	134
100	18	36	54	72	90	107	125	143	161	179

~~678.~~685. At the average baseline mortality rate for puffin of 0.119 the number of individuals expected to die in the nonbreeding period is 27,603 (231,958 x 0. 119). The addition of a maximum of 13 (70% x 10%) to this increases the background mortality rate by 0.045%, or of 3 (70% x 2%) to this would increase the mortality rate by 0.009%, both of which are below the 1% threshold for detectability.

~~679.~~686. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.8.1.1.5.1.3 Annual

~~680.~~687. Summed across the year the maximum mean peak abundance in the DBS East Array Area and 2km buffer was 242 individuals. The estimated number of puffins subject to mortality combined across all seasons due to displacement at 30-70% displaced and 1-10% mortality from the DBS East (and 2km buffer; **Table 12-69**) is between 1 and 17 individuals, with three at 70% displaced and 2% mortality.

Table 12-69 Displacement Matrix Presenting the Number of Puffins in the DBS East Array Area (and 2km Buffer) Combined Across the Breeding and Nonbreeding Seasons That May Be Subject to Mortality (Highlighted).

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

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
8	2	4	6	8	10	12	14	15	17	19
9	2	4	7	9	11	13	15	17	20	22
10	2	5	7	10	12	15	17	19	22	24
20	5	10	15	19	24	29	34	39	44	48
30	7	15	22	29	36	44	51	58	65	73
50	12	24	36	48	61	73	85	97	109	121
75	18	36	54	73	91	109	127	145	163	182
100	24	48	73	97	121	145	169	194	218	242

~~681.~~688. At the average baseline mortality rate for puffin of 0.119 the number of individuals from the largest BDMPS population expected to die across all seasons is 103,374 (868,689 x 0. 119). The addition of a maximum of 17 (70% x 10%) to this increases the background mortality rate by 0.016%, or of 3 (70% x 2%) to this increases the background mortality rate by 0.003%, both of which are below the 1% threshold for detectability.

~~682.~~689. The number of individuals from the biogeographic population expected to die across all seasons is 1,408,960 (11,840,000 x 0. 119). The addition of a maximum of 17 (70% x 10%) to this increases the mortality rate by 0.001%, or of 3 (70% x 2%) to this increases the background mortality rate by <0.001%, both of which are below the 1% threshold for detectability.

~~683.~~690. The sensitivity of puffin to operational displacement is considered to be low and the magnitude of annual impact at DBS East is negligible, therefore the annual effect on puffin due to operational displacement at DBS East is assessed as **negligible**.

12.8.1.1.5.2 Significance of Effect – DBS West in Isolation

12.8.1.1.5.2.1 Breeding Season

~~684.~~691. During the breeding season, the maximum mean peak abundance in the DBS West Array Area and 2km buffer was 109 individuals. The estimated number of puffins subject to mortality during the breeding period due to displacement at 30-70% displaced and 1-10% mortality from DBS West (and 2km buffer; **Table 12-70**) is between zero and eight individuals, with 2 at 70% displaced and 2% mortality.

Table 12-70 Displacement Matrix Presenting the Number of Puffins in the DBS West Array Area (and 2km Buffer) During the Breeding Season That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	0	0	0	0	1	1	1	1	1	1
2	0	0	1	1	1	1	2	2	2	2
3	0	1	1	1	2	2	2	3	3	3
4	0	1	1	2	2	3	3	3	4	4
5	1	1	2	2	3	3	4	4	5	5
6	1	1	2	3	3	4	5	5	6	7
7	1	2	2	3	4	5	5	6	7	8
8	1	2	3	3	4	5	6	7	8	9
9	1	2	3	4	5	6	7	8	9	10
10	1	2	3	4	5	7	8	9	10	11
20	2	4	7	9	11	13	15	17	20	22
30	3	7	10	13	16	20	23	26	29	33
50	5	11	16	22	27	33	38	44	49	55
75	8	16	25	33	41	49	57	65	74	82
100	11	22	33	44	55	65	76	87	98	109

~~685.~~692. At the average baseline mortality rate for adult puffin of 0.119 the number of individuals expected to die in the breeding season is 103,374 (868,689 x 0.119). The addition of a maximum of eight (70 x 10%) to this increases the background mortality rate by 0.007%, or of 2 (70% x 2%) to this would increase the mortality rate by 0.001%, both of which are below the 1% threshold for detectability.

~~686.~~693. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.8.1.1.5.2.2 Nonbreeding Season

~~687.~~694. During the nonbreeding season, the maximum mean peak abundance in the DBS West Array Area and 2km buffer was 198 individuals. The estimated number of puffins subject to mortality during the nonbreeding period due to displacement at 30-70% displaced and 1-10% mortality from DBS West (and 2km buffer; **Table 12-71**) is between 1 and 14 individuals, with three at 70% displaced and 2% mortality.

Table 12-71 Displacement Matrix Presenting the Number of Puffins in the DBS West Array Area (and 2km Buffer) During the Nonbreeding Season That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	0	0	1	1	1	1	1	2	2	2
2	0	1	1	2	2	2	3	3	4	4
3	1	1	2	2	3	4	4	5	5	6
4	1	2	2	3	4	5	6	6	7	8
5	1	2	3	4	5	6	7	8	9	10
6	1	2	4	5	6	7	8	10	11	12
7	1	3	4	6	7	8	10	11	12	14
8	2	3	5	6	8	10	11	13	14	16
9	2	4	5	7	9	11	12	14	16	18
10	2	4	6	8	10	12	14	16	18	20
20	4	8	12	16	20	24	28	32	36	40
30	6	12	18	24	30	36	42	48	53	59
50	10	20	30	40	50	59	69	79	89	99
75	15	30	45	59	74	89	104	119	134	149
100	20	40	59	79	99	119	139	158	178	198

~~688.~~695. At the average baseline mortality rate for puffin of 0.119 the number of individuals expected to die in the nonbreeding period is 27,603 (231,958 x 0.119). The addition of a maximum of 14 (70% x 10%) to this increases the background mortality rate by 0.050%, or of 3 (70% x 2%) to this would increase the mortality rate by 0.010%, both of which are below the 1% threshold for detectability.

~~689.~~696. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.8.1.1.5.2.3 Annual

~~690.~~697. Summed across the year the maximum mean peak abundance in the DBS West Array Area and 2km buffer was 307 individuals. The estimated number of puffins subject to mortality combined across all seasons due to displacement at 30-70% displaced and 1-10% mortality from DBS West (and 2km buffer; **Table 12-72**) is between one and 21 individuals, with four at 70% displaced and 2% mortality.

Table 12-72 Displacement Matrix Presenting the Number of Puffins in the DBS West Array Area (and 2km Buffer) Across the Breeding and Nonbreeding Season That May Be Subject To Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	0	1	1	1	2	2	2	2	3	3
2	1	1	2	2	3	4	4	5	6	6
3	1	2	3	4	5	6	6	7	8	9
4	1	2	4	5	6	7	9	10	11	12
5	2	3	5	6	8	9	11	12	14	15
6	2	4	6	7	9	11	13	15	17	18
7	2	4	6	9	11	13	15	17	19	21
8	2	5	7	10	12	15	17	20	22	25
9	3	6	8	11	14	17	19	22	25	28
10	3	6	9	12	15	18	21	25	28	31
20	6	12	18	25	31	37	43	49	55	61
30	9	18	28	37	46	55	64	74	83	92
50	15	31	46	61	77	92	107	123	138	154
75	23	46	69	92	115	138	161	184	207	230
100	31	61	92	123	154	184	215	246	276	307

~~691.~~698. At the average baseline mortality rate for puffin of 0.119 the number of individuals from the largest BDMPS population expected to die across all seasons 103,374 (868,689 x 0.119). The addition of a maximum of 21 (70% x 10%) to this increases the background mortality rate by 0.021%, or of four (70% x 2%) to this increases the background mortality rate by 0.004%, both of which are below the 1% threshold for detectability.

~~692.~~699. The number of individuals from the biogeographic population expected to die across all seasons is 1,408,960 (11,840,000 x 0. 1190). The addition of a maximum of 21 (70% x 10%) to this increases the mortality rate by 0.002%, or of 4 (70% x 2%) to this increases the background mortality rate by <0.001%, both of which are below the 1% threshold for detectability.

~~693.~~700. The sensitivity of puffin to operational displacement is considered to be low and the magnitude of annual impact at DBS West is negligible, therefore the annual effect on puffin due to operational displacement at DBS West is assessed as **negligible**.

12.8.1.1.5.3 Significance of Effect – DBS East and DBS West Together

12.8.1.1.5.3.1 Breeding Season

~~694.~~701. During the breeding season, the combined maximum mean peak abundance in the Array Areas and 2km buffer was 172 individuals. The estimated number of puffins subject to mortality during the breeding period due to displacement at 30-70% displaced and 1-10% mortality from the Array Areas (and 2km buffers; **Table 12-73**) is between one and 12 individuals, with two at 70% displaced and 2% mortality.

Table 12-73 Displacement Matrix Presenting the Number of Puffins in the Array Areas (and 2km Buffer) During the Breeding Season That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	0	0	1	1	1	1	1	1	2	2
2	0	1	1	1	2	2	2	3	3	3
3	1	1	2	2	3	3	4	4	5	5
4	1	1	2	3	3	4	5	6	6	7
5	1	2	3	3	4	5	6	7	8	9
6	1	2	3	4	5	6	7	8	9	10
7	1	2	4	5	6	7	8	10	11	12
8	1	3	4	6	7	8	10	11	12	14
9	2	3	5	6	8	9	11	12	14	15
10	2	3	5	7	9	10	12	14	15	17
20	3	7	10	14	17	21	24	28	31	34
30	5	10	15	21	26	31	36	41	46	52
50	9	17	26	34	43	52	60	69	77	86
75	13	26	39	52	65	77	90	103	116	129
100	17	34	52	69	86	103	120	138	155	172

~~695.~~702. At the average baseline mortality rate for adult puffin of 0.119 the number of individuals expected to die in the breeding season is 103,374 (868,689 x 0.119). The addition of a combined maximum of 12 (70% x 10%) individuals to this increases the background mortality rate by 0.012%, or the addition of two (70% x 2%) to this increases the background mortality rate by 0.002%, both of which are below the 1% threshold for detectability.

~~696.~~703. The sensitivity of puffin to operational displacement is considered to be low and the magnitude of effect in the breeding season at the Array Areas is negligible to low. Therefore, the significance of the breeding season effect on puffin due to operational displacement at the Array Areas is assessed as **negligible**.

12.8.1.1.5.3.2 Nonbreeding season

~~697.~~704. During the nonbreeding season, the combined maximum mean peak abundance in the Array Areas and 2km buffer was 377 individuals. The estimated number of puffins subject to mortality during the nonbreeding period due to displacement at 30-70% displaced and 1-10% mortality from the Array Areas (and 2km buffers; **Table 12-74**) is between one and 26 individuals, with five at 70% displaced and 2% mortality.

Table 12-74 Displacement Matrix Presenting the Number of Puffins in the Array Areas (and 2km Buffer) During the Nonbreeding Season That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	0	1	1	2	2	2	3	3	3	4
2	1	2	2	3	4	5	5	6	7	8
3	1	2	3	5	6	7	8	9	10	11
4	2	3	5	6	8	9	11	12	14	15
5	2	4	6	8	9	11	13	15	17	19
6	2	5	7	9	11	14	16	18	20	23
7	3	5	8	11	13	16	18	21	24	26
8	3	6	9	12	15	18	21	24	27	30
9	3	7	10	14	17	20	24	27	31	34
10	4	8	11	15	19	23	26	30	34	38
20	8	15	23	30	38	45	53	60	68	75
30	11	23	34	45	57	68	79	90	102	113
50	19	38	57	75	94	113	132	151	170	189
75	28	57	85	113	141	170	198	226	254	283
100	38	75	113	151	189	226	264	302	339	377

~~698.~~705. At the average baseline mortality rate for puffin of 0.119 the number of individuals expected to die in the nonbreeding period is 27,603 (231,958 x 0. 119). The addition of a combined maximum of 26 (70% x 10%) individuals to this increases the background mortality rate by 0.096%, or of 5 (70% x 2%) to this would increase the mortality rate by 0.019%, both of which are below the 1% threshold for detectability.

~~699.~~706. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of impact is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.8.1.1.5.3.3 Annual

~~700.~~707. Summed across the year the combined maximum mean peak abundance in the Array Areas and 2km buffer was 549 individuals. The estimated number of puffins subject to mortality combined across all seasons due to displacement at 30-70% displaced and 1-10% mortality from the Array Areas (and 2km buffers; **Table 12-75**) is between two and 38 individuals, with eight at 70% displaced and 2% mortality.

Table 12-75 Displacement Matrix Presenting the Number of Puffins in the Array Areas (and 2km Buffer) Combined Across the Breeding and Nonbreeding Seasons That May Be Subject to Mortality (Highlighted).

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	0	1	2	2	3	3	4	4	5	5
2	1	2	3	4	5	7	8	9	10	11
3	2	3	5	7	8	10	12	13	15	16
4	2	4	7	9	11	13	15	18	20	22
5	3	5	8	11	14	16	19	22	25	27
6	3	7	10	13	16	20	23	26	30	33
7	4	8	12	15	19	23	27	31	35	38
8	4	9	13	18	22	26	31	35	40	44
9	5	10	15	20	25	30	35	40	44	49
10	5	11	16	22	27	33	38	44	49	55
20	11	22	33	44	55	66	77	88	99	110
30	16	33	49	66	82	99	115	132	148	165
50	27	55	82	110	137	165	192	220	247	275
75	41	82	124	165	206	247	288	329	371	412
100	55	110	165	220	275	329	384	439	494	549

~~701.~~708. At the average baseline mortality rate for puffin of 0.119 the number of individuals from the largest BDMPS population expected to die across all seasons is 103,374 (868,689 x 0.119). The addition of a combined maximum of 38 (70% x 10%) individuals to this increases the background mortality rate by 0.037%, or of 8 (70% x 2%) to this increases the background mortality rate by 0.007%, both of which are below the 1% threshold for detectability.

~~702.~~709. The number of individuals from the biogeographic population expected to die across all seasons is 1,408,960 (11,840,000 x 0.119). The addition of a maximum of 38 (70% x 10%) to this increases the mortality rate by 0.003%, or of eight (70% x 2%) to this increases the background mortality rate by 0.001%, both of which are below the 1% threshold for detectability.

~~703.~~710. The sensitivity of puffin to displacement is considered to be low and the magnitude of annual impact at the Array Areas is negligible, therefore the annual effect on puffin due to operational displacement at the Array Areas is assessed as **negligible**.

~~704.~~711. A table summarising the puffin operational displacement assessment is provided below (**Table 12-76**).

12.8.1.1.5.4 Summary of Operational Displacement Assessment - Puffin

Table 12-76 Summary of Puffin Operational Displacement Assessment for DBS East, DBS West and Combined (Projects).

Puffin		**DBS East**	**DBS West**	**Projects**
Baseline average annual mortality				0.119
Breeding season	Reference population			868,689
	Displacement mortality (@70% x 2%)	1	2	2
	Increase in background mortality (%)	0.001	0.001	0.002
	Significance	Negligible	Negligible	Negligible
Non breeding season	Reference population			231,958
	Displacement mortality (@70% x 2%)	3	3	5
	Increase in background mortality (%)	0.009	0.010	0.019
	Significance	Negligible	Negligible	Negligible

Puffin		**DBS East**	**DBS West**	**Projects**
Annual (BDMPS)	Reference population (Nonbreeding season BDMPS)	868,689		
	Displacement mortality (@70% x 2%)	3	4	8
	Increase in background mortality (%)	0.003	0.004	0.007
	Significance	Negligible	Negligible	Negligible
Annual (biogeographic)	Biogeographical population	11,840,000		
	Displacement mortality (@70% x 2%)	3	4	8
	Increase in background mortality (%)	<0.001	<0.001	0.001
	Significance	Negligible	Negligible	Negligible

12.8.2 Impact 4 Indirect Impacts Through Effects on Habitats and Prey Species During Operation

~~705.~~712. Indirect disturbance and displacement of birds may occur during the operational phase of the Projects if there are impacts on prey species and the habitats of prey species. These indirect effects include those resulting from the production of underwater noise (e.g. the turning of the wind turbines), electro-magnetic fields (EMF) and the generation of suspended sediments (e.g. due to scour or maintenance activities) that may alter the behaviour or availability of bird prey species.

~~706.~~713. Underwater noise and EMF may cause fish and mobile invertebrates to avoid the operational area and also affect their physiology and behaviour. Suspended sediments may cause fish and mobile invertebrates to avoid the operational area and may smother and hide immobile benthic prey. These mechanisms could result in less prey being available within the operational area to foraging seabirds. Changes in fish and invertebrate communities due to changes in presence of hard substrate (resulting in colonisation by epifauna) may also occur, and changes in fishing activity could influence the communities present.

~~707.~~714. With regard to noise impacts on fish, **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)** discusses the potential impacts upon fish relevant to ornithology as prey species. With regard to behavioural changes related to underwater noise impacts on fish during the operation of the Projects, **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)** concludes that the effects on fish and shellfish species to operational noise is considered to be of minor adverse significance. With a non-significant effect on fish that are bird prey species, it is concluded that the indirect effects on seabirds occurring in or around the Array Areas and Offshore Export Cable Corridor during the operational phase would result in no more than low magnitude effects for species of no more than medium sensitivity and would thus result in effects of **minor adverse** significance. This would be the case irrespective of whether just one of DBS East or DBS West is built, or both.

~~708.~~715. With regard to changes to the seabed and to suspended sediment levels, **Volume 7, Chapter 9 Benthic and Intertidal Ecology (application ref: 7.9)** discusses the nature of any change and impact. It identifies that changes in physical processes and temporary habitat disturbance would be of negligible significance. With negligible effects on benthic habitats and species, it is concluded that the indirect impact on seabirds occurring in or around the Array Areas and Offshore Export Cable Corridor during the operational phase would result in no more than negligible magnitude effects for species of no more than medium sensitivity and would thus result in a **negligible** to **minor adverse** effect. This would be the case irrespective of whether just one of DBS East or DBS West is built, or both.

~~709.~~716. With regard to EMF effects, these are identified as very localised (<10m; Gill *et al.* 2005) with the majority of cables being buried to up to 1m depth, further reducing the effect of EMF. The magnitude of impact is considered negligible on benthic communities, and so it is concluded that the indirect effect on seabirds occurring in or around the Array Areas and Offshore Export Cable Corridor during the operational phase would result in no more than negligible magnitude effects for species of no more than medium sensitivity and would thus result in a **negligible** effect.

~~710.~~717. Very little is known about potential long-term changes in invertebrate and fish communities due to colonisation of hard substrate and changes in fishing pressures associated with offshore wind farms. Whilst the impact of the colonisation of introduced hard substrate is seen as a minor adverse effect in terms of benthic ecology (as it is a change from the baseline conditions), the consequences for seabirds may be positive or negative locally (i.e. this may increase or decrease local prey abundance and availability) but are predicted to be of negligible magnitude and **negligible** significance (either beneficially or adversely) in EIA terms.

12.8.3 Impact 5 Collision Risk

~~711.~~718. There is a potential risk of collision with the wind turbine rotors and associated infrastructure resulting in injury or fatality to birds which fly through the Array Areas whilst foraging for food or commuting between breeding sites and foraging areas.

~~712.~~719. Initial screening for species to include in the collision risk assessment is presented in **Table 12-77**. Species where risk of collision was assessed as very low were screened out (e.g. low flying species such as auks). Species where risk of collision was assessed as low were screened out if their abundance in flight was very low or low (e.g. species associated with nearshore waters such as terns). To be precautionary, all species where the risk of collision was assessed as medium or high were screened in, even if their abundance in flight was very low.

Table 12-77 Collision Risk Screening. Species Were Screened in on the Basis of Columns Two and Three.

Receptor	Risk of collisions[1]	Estimated density of birds in flight at the Array Areas	Screening Result (IN or OUT)
Fulmar	Low	High	**IN**
Gannet	Medium	Medium	**IN**
Arctic skua	Medium	Very low	**IN**
Great skua	Medium	Very low	**IN**
Puffin	Very low	Low	**OUT**
Razorbill	Very low	High	**OUT**
Common guillemot	Very low	High	**OUT**
Common tern	Medium	Very low	**IN**
Arctic tern	Medium	Very low	**IN**
Kittiwake	Medium	High	**IN**
Little gull	Medium	Very low	**IN**
Common gull	Medium	Very low	**IN**
Lesser black-backed gull	High	Low	**IN**
Herring gull	High	Low	**IN**
Great black-backed gull	High	Low	**IN**
[1]Garthe and Hüppop, 2004; Furness and Wade, 2012, Wade *et al.*, 2016			

~~713.~~720. Collision Risk Modelling (CRM) has been used in this assessment to estimate the risk to birds associated with the Projects' Array Areas. CRM, using the Band model (Band, 2012) has been used to produce predictions of mortality for particular species across biological seasons and annually. The approach to CRM is summarised here and further details are provided in **Volume 7, Appendix 12-9 Collision Risk Modelling Inputs and Outputs (application ref: 7.12.12.9**).

~~714.~~721. The assessment is based on collision risk for each key seabird species from the Band CRM Option 2. This option uses generic estimates of flight height for each species based on the percentage of birds flying at Potential Collision Height (PCH) derived from data from a number of offshore wind farms, presented in Johnston *et al*. (2014a, 2014b).

~~715.~~722. Modelling was undertaken based on the two indicative wind turbine maximum design scenarios described in **Volume 7, Chapter 5 Project Description (application ref: 7.5)**, i.e. the 200 small wind turbines scenario (turbine parameter set 1, **Volume 7, Appendix 12-9 Collision Risk Modelling Inputs and Outputs (application ref: 7.12.12.9**) and the 113 large wind turbines scenario (turbine parameter set 2, **Volume 7, Appendix 12-9 Collision Risk Modelling Inputs and Outputs (application ref: 7.12.12.9)**).

~~716.~~723. CRM has been run using the stochastic Band model (Band, 2012; Caneco *et al*. 2022), incorporating uncertainty in flight densities, flight height, bird dimensions (wingspan, body length, flight speed), avoidance rates and nocturnal activity. Input parameters used for the CRM were those advised by Natural England (**Table 12-78**); and proportions at collision height (based on the generic dataset in Johnston *et al*. 2014a, 2014b).

Table 12-78 Parameters Used in CRM

Species	Avoidance Rate (± SD)	Nocturnal activity factor % (± SD)
Arctic skua	99.0	0%
Great skua	99.0	0%
Common gull / Little gull	99.5 (±0.0002)	50%
Fulmar	99.0	75%
Gannet (@ 70% macro-avoidance)	99.79*# (±0.0003)	8% (±0.10)

Species	Avoidance Rate (± SD)	Nocturnal activity factor % (± SD)
Gannet (@ 65% macro-avoidance)	99.755 (±0.0003)	
Gannet (@ 85% macro-avoidance)	99.895 (±0.0003)	
Great black-backed gull	99.4 (±0.0004)	37.5% (±0.0637)
Herring gull	99.4 (±0.0004)	37.5% (±0.0637)
Kittiwake	99.3 (±0.0003)	37.5% (±0.0637)
Lesser black-backed gull	99.4 (±0.0004)	37.5% (±0.0637)
Arctic tern	99.0	0
Common tern	99.0	0

**Natural England [RR-039] requested gannet collisions be presented across the range of macro avoidance from 65% to 85% in addition to the central value of 70%.*

*# RSPB requested gannet collision estimates using their preferred avoidance rate of 99.3%. These are presented in **Volume 7, Appendix 12-9 Collision Risk Modelling Inputs and Outputs (application ref: 7.12.12.9)**.*

~~717.~~724. Seasonal mortality predictions (seasons defined in **Table 12-15**) have been compared to the relevant BDMPS populations and the predicted increases in background mortality which could result have been estimated.

~~718.~~725. An overview of annual collision risk estimates for all species is presented in **Table 12-79** for the Small and Large wind turbine scenarios. Species initially screened in but for which very low collisions were predicted (i.e. <=3) were screened out of further assessment as there was no justification for further analysis (Arctic skua, great skua, fulmar, common gull, little gull, Arctic tern, common tern and commic tern). The exceptions to this screening on the basis of low collision estimates were the large gulls which are considered for the Projects alone in order to be included in the cumulative section, in line with recent offshore wind farm assessments.

Table 12-79 Annual Collision Risk Estimates for the Array Areas Combined (Deterministic Band Model Option 2, Avoidance Rates as per Table 12-78). Values are the Mean Number of Birds and 95% Confidence Intervals. For Species Screened in for Assessment, the 200 Small Turbine Scenario Gave the Highest Collision Risks.

Species	200 Small wind turbine scenario	114 Large wind turbine scenario
Arctic skua	0.02 (0-0.10)	0.01 (0-0.09)
Great skua	0.13 (0-0.74)	0.10 (0-0.57)
Fulmar	1.5 (0-5.62)	1.15 (0-4.31)
Gannet (@ 70% macro-avoidance)	12.22 (3.97-24.48)	8.67 (2.98-17.1)
Gannet (@ 65% macro-avoidance)	14.26 (4.63-28.56)	10.11 (3.48-19.95)
Gannet (@ 85% macro-avoidance)	6.11 (1.99-12.24)	4.34 (1.49-8.55)
Kittiwake	299.94 (150.92-540.51)	222.07 (110.04-396.99)
Lesser black-backed gull	1.21 (0-4.37)	0.87 (0-3.05)
Herring gull	2.18 (0-5.18)	1.52 (0-3.57)
Great black-backed gull	4.84 (0.74-11.5)	3.35 (0.5-8.16)
Common gull	2.52 (0-7.84)	1.88 (0-5.76)
Little gull	0	0
Arctic tern	0.41 (0-2.23)	0.30 (0-1.61)
Common tern	0.09 (0-0.3)	0.07 (0-0.22)
Commic tern*	1.25 (0.1-3.76)	0.94 (0.1-2.77)

** 'Commic tern' is used to include common terns and Arctic terns, for instances where these species were not readily identified to species level from the survey data*

~~719.~~726. The annual collision risk estimates presented in **Table 12-79** were used to identify the worst-case scenario for each species scoped in. For all species, the worst-case design was the more numerous small wind turbine scenario. The species considered further in relation to worst case collision risks are gannet, kittiwake, lesser black-backed gull, great black-backed gull and herring gull. The seasonal collision estimates for these species are presented in **Table 12-80**. Impacts have been assessed in relation to the relevant BDMPS (Natural England [RR-039]).

Table 12-80 Seasonal Collision Risk Estimates for the Worst Case Scenario Wind Turbine (1). Values are the Mean Number of Predicted Collisions and 95% Confidence Intervals Derived From 5,000 stochastic simulations.

Species	Array Area	Breeding season	Autumn migration	Nonbreeding / Winter	Spring Migration	Annual
Gannet (@70% macro avoidance)	East	3.44 (0.76-7.78)	1.61 (0.34-3.81)	0 (0-0)	0.11 (0-0.55)	5.16 (1.15-11.44)
	West	4.81 (1.02-11.39)	2.11 (0.31-5.92)	0 (0-0)	0.14 (0-0.63)	7.06 (1.37-17.77)
	East+West	8.25 (2.71-16.09)	3.72 (1.12-8.13)	0 (0-0)	0.25 (0-0.88)	12.22 (3.97-24.48)
Gannet (@65% macro avoidance)	East	4.01 (0.89-9.08)	1.88 (0.40-4.44)	0 (0-0)	0.13 (0-0.64)	6.02 (1.34-13.35)
	West	5.61 (1.19-13.29)	2.46 (0.36-6.91)	0 (0-0)	0.16 (0-0.73)	8.24 (1.60-20.73)
	East+West	9.62 (3.16-18.77)	4.34 (1.31-9.48)	0 (0-0)	0.29 (0-1.03)	14.26 (4.63-28.56)
	East	1.72 (0.38-3.89)	0.81 (0.17-1.91)	0 (0-0)	0.06 (0-0.28)	2.58 (0.58-5.72)

Species	Array Area	Breeding season	Autumn migration	Nonbreeding / Winter	Spring Migration	Annual
Gannet (@85% macro avoidance)	West	2.41 (0.51-5.70)	1.06 (0.16-2.96)	0 (0-0)	0.07 (0-0.32)	3.53 (0.69-8.89)
	East+West	4.13 (1.36-8.05)	1.87 (0.56-4.07)	0 (0-0)	0.13 (0-0.44)	6.11 (1.99-12.24)
Great black-backed gull	East	0.92 (0-4.42)	0.33 (0-2.05)	2.76 (0-7.66)	2.43 (0-7.35)	3.68 (0.58-9.83)
	West	0 (0-0)	0.82 (0-3.81)	1.16 (0-4.92)	0.34 (0-1.99)	1.16 (0-4.92)
	East+West	0.92 (0-4.42)	1.15 (0-4.43)	3.92 (0-9.76)	2.77 (0-7.95)	4.84 (0.74-11.5)
Herring gull	East	0 (0-0)	0.29 (0-1.79)	0.57 (0-2.08)	0.28 (0-1.78)	0.57 (0-2.08)
	West	0.76 (0-2.62)	0.55 (0-2.72)	0.85 (0-2.81)	0.3 (0-1.82)	1.61 (0-4.22)
	East+West	0.76 (0-2.62)	0.84 (0-3.26)	1.42 (0-3.78)	0.58 (0-2.43)	2.18 (0-5.18)
Kittiwake	East	83.31 (42.28-168.51)	41.39 (14.65-82.93)	0 (0-0)	14.59 (6.83-28.02)	139.3 (66.87-261.27)
	West	107.83 (36.94-280.76)	37.92 (9.54-81.91)	0 (0-0)	14.88 (7.07-26.47)	160.64 (55.88-372.05)

Species	Array Area	Breeding season	Autumn migration	Nonbreeding / Winter	Spring Migration	Annual
	East+West	191.14 (96.22-378.38)	79.31 (30.47-143.14)	0 (0-0)	29.47 (16.89-47.35)	299.94 (150.92-540.51)
Lesser black-backed gull	East	0.93 (0-3.82)	0 (0-0)	0 (0-0)	0 (0-0)	0.93 (0-3.82)
	West	0.28 (0-1.7)	0 (0-0)	0 (0-0)	0 (0-0)	0.28 (0-1.7)
	East+West	1.21 (0-4.37)	0 (0-0)	0 (0-0)	0 (0-0)	1.21 (0-4.37)

12.8.3.1 Collision Impacts

~~720.~~727. The impacts of mortality caused by collisions on the populations are assessed in terms of the change in the baseline mortality rate which could result. The baseline mortality rates used in the collision risk impact assessment are those recommended by Natural England in their updated guidance (**Table 12-17**).

~~721.~~728. The percentage increases in background mortality rates of seasonal and annual populations due to predicted collisions with the Projects' wind turbines (presented in **Table 12-80**), summed across DBS East and DBS West, are shown in **Table 12-81** to **Table 12-87** for all species using avoidance rates recommended by Natural England (**Table 12-78**).

~~722.~~729. The sensitivity of gannet to collision risk is considered to be medium and collision estimates in all seasons, considered separately on DBS East and DBS West and together, generated increases in background mortality of less than 1% for either BDMPS or biogeographic populations (**Table 12-81, Table 12-82** and **Table 12-83**), resulting in impact magnitudes assessed as negligible. Therefore, the significance of the effect of collisions on gannet at the Array Areas is assessed as **minor adverse**.

~~723.~~730. The sensitivity of kittiwake to collision risk is considered to be medium and the collision estimates in all seasons, considered separately on DBS East and DBS West and together, generated increases in background mortality of less than 1% for either BDMPS or biogeographic populations (**Table 12-84**), resulting in impact magnitudes assessed as negligible. Therefore, the significance of the effect of collisions on kittiwake at the Array Areas is assessed as **minor adverse**.

~~724.~~731. The sensitivity of lesser black-backed gull to collision risk is considered to be high and the collision estimates in all seasons, considered separately on DBS East and DBS West and together, generated increases in background mortality of less than 1% for either BDMPS or biogeographic populations (**Table 12-85**), resulting in impact magnitudes assessed as negligible. Therefore, the significance of the effect of collisions on lesser black-backed gull at the Array Areas is assessed as **minor adverse**.

~~725.~~732. The sensitivity of herring gull to collision risk is considered to be high and the collision estimates in all seasons, considered separately on DBS East and DBS West and together, generated increases in background mortality of less than 1% for either BDMPS or biogeographic populations (**Table 12-86**), resulting in impact magnitudes assessed as negligible. Therefore, the significance of the effect of collisions on herring gull at the Array Areas is assessed as **minor adverse**.

~~726.~~733. The sensitivity of great black-backed gull to collision risk is considered to be high and the collision estimates in all seasons, considered separately on DBS East and DBS West and together, generated increases in background mortality of less than 1% for either BDMPS or biogeographic populations (**Table 12-87**), resulting in impact magnitudes assessed as negligible. Therefore, the significance of the effect of collisions on great black-backed gull at the Array Areas is assessed as **minor adverse**.

Table 12-81Predicted Gannet Collisions at 70% macro-avoidance at DBS East and DBS West combined and Percentage Increases in the Background Mortality Rate of Seasonal and Annual Populations for the Worst Case Wind Turbine Scenario (1). Note that the Annual Mortalities Have Been Assessed Against Both the Biogeographic Populations and the Largest BDMPS in Order to Indicate the Range of Likely Effects

Species		**Collisions**		
Gannet		Mean	Lower c.i.	Upper c.i.
Baseline average annual mortality				0.1866
Breeding season	Reference population			400,326
	Seasonal mortality	8.25	2.71	16.09
	Increase in background mortality (%)	0.011	0.004	0.022
Autumn	Reference population			456,299
	Seasonal mortality	3.72	1.12	8.13
	Increase in background mortality (%)	0.004	0.001	0.010
Spring	Reference population			248,385
	Seasonal mortality	0.25	0	0.88
	Increase in background mortality (%)	0.001	0.000	0.002
Annual largest BDMPS	Reference population			456,299
	Annual mortality	12.22	3.97	24.48
	Increase in background mortality (%)	0.014	0.005	0.029
Annual bio-geographic	Reference population			1,180,000
	Annual mortality	12.22	3.97	24.48
	Increase in background mortality (%)	0.006	0.002	0.011

Table 12-82 Predicted Gannet Collisions at 65% macro-avoidance at DBS East and DBS West combined and Percentage Increases in the Background Mortality Rate of Seasonal and Annual Populations for the Worst Case Wind Turbine Scenario (1). Note that the Annual Mortalities Have Been Assessed Against Both the Biogeographic Populations and the Largest BDMPS in Order to Indicate the Range of Likely Effects

Species		**Collisions**		
Gannet		Mean	Lower c.i.	Upper c.i.
Baseline average annual mortality				0.1866
Breeding season	Reference population			400,326
	Seasonal mortality	9.62	3.16	18.77
	Increase in background mortality (%)	0.013	0.004	0.025
Autumn	Reference population			456,299
	Seasonal mortality	4.34	1.31	9.48
	Increase in background mortality (%)	0.005	0.002	0.011
Spring	Reference population			248,385
	Seasonal mortality	0.29	0	1.03
	Increase in background mortality (%)	0.001	0	0.002
Annual largest BDMPS	Reference population			456,299
	Annual mortality	14.26	4.63	28.56
	Increase in background mortality (%)	0.017	0.005	0.034
Annual bio-geographic	Reference population			1,180,000
	Annual mortality	14.26	4.63	28.56
	Increase in background mortality (%)	0.006	0.002	0.013

Table 12-83 Predicted Gannet Collisions at 85% macro-avoidance at DBS East and DBS West combined and Percentage Increases in the Background Mortality Rate of Seasonal and Annual Populations for the Worst Case Wind Turbine Scenario (1). Note that the Annual Mortalities Have Been Assessed Against Both the Biogeographic Populations and the Largest BDMPS in Order to Indicate the Range of Likely Effects

Species		**Collisions**		
Gannet		Mean	Lower c.i.	Upper c.i.
Baseline average annual mortality				0.1866
Breeding season	Reference population			400,326
	Seasonal mortality	4.13	1.36	8.08
	Increase in background mortality (%)	0.006	0.002	0.011
Autumn	Reference population			456,299
	Seasonal mortality	1.86	0.56	4.07
	Increase in background mortality (%)	0.002	0.001	0.005
Spring	Reference population			248,835
	Seasonal mortality	0.13	0	0.44
	Increase in background mortality (%)	<0.001	0	0.001
Annual largest BDMPS	Reference population			456,299
	Annual mortality	6.11	1.99	12.24
	Increase in background mortality (%)	0.007	0.002	0.014
Annual bio-geographic	Reference population			1,180,000
	Annual mortality	6.11	1.99	12.24
	Increase in background mortality (%)	0.003	0.001	0.006

Table 12-84 Predicted Kittiwake Collisions at DBS East and DBS West combined and Percentage Increases in the Background Mortality Rate of Seasonal and Annual Populations for the Worst Case Wind Turbine Scenario (1). Note that the Annual Mortalities Have Been Assessed Against Both the Biogeographic Populations and the Largest BDMPS in Order to Indicate the Range of Likely Effects

Species		**Collisions**		
Kittiwake		Mean	Lower c.i.	Upper c.i.
Baseline average annual mortality				0.1577
Breeding season	Reference population			839,456
	Seasonal mortality	191.14	96.22	378.38
	Increase in background mortality (%)	0.144	0.073	0.286
Autumn	Reference population			829,938
	Seasonal mortality	79.32	30.47	143.14
	Increase in background mortality (%)	0.061	0.023	0.109
Spring	Reference population			627,816
	Seasonal mortality	29.48	16.89	47.35
	Increase in background mortality (%)	0.030	0.017	0.048
Annual largest BDMPS	Reference population			839,456
	Annual mortality	299.94	150.92	540.51
	Increase in background mortality (%)	0.227	0.114	0.408
Annual bio-geographic	Reference population			5,100,000
	Annual mortality	299.94	150.92	540.51
	Increase in background mortality (%)	0.037	0.019	0.067

Table 12-85 Predicted Lesser Black-Backed Gull Collisions at DBS East and DBS West combined and Percentage Increases in the Background Mortality Rate of Seasonal and Annual Populations for the Worst Case Wind Turbine Scenario (1). Note that the Annual Mortalities Have Been Assessed Against Both the Biogeographic Populations and the Largest BDMPS in Order to Indicate the Range of Likely Effects

Species		**Collisions**		
Lesser Black-backed Gull		Mean	Lower c.i.	Upper c.i.
Baseline average annual mortality				0.1237
Breeding season	Reference population			51,233
	Seasonal mortality	1.21	0	4.37
	Increase in background mortality (%)	0.0019	0.000	0.069
Autumn	Reference population			209,006
	Seasonal mortality	0	0	0
	Increase in background mortality (%)	0	0	0
Winter / nonbreeding	Reference population			39,313
	Seasonal mortality	0	0	0
	Increase in background mortality (%)	0	0	0
Spring	Reference population			197,482
	Seasonal mortality	0	0	0
	Increase in background mortality (%)	0	0	0
Annual largest BDMPS	Reference population			209,006
	Annual mortality	1.21	0	4.37
	Increase in background mortality (%)	0.005	0.000	0.017
Annual bio-geographic	Reference population			864,000
	Annual mortality	1.21	0	4.37
	Increase in background mortality (%)	0.001	0.000	0.004

Table 12-86 Predicted Herring Gull Collisions at DBS East and DBS West combined and Percentage Increases in the Background Mortality Rate of Seasonal and Annual Populations for the Worst Case Wind Turbine Scenario (1). Note that the Annual Mortalities Have Been Assessed Against Both the Biogeographic Populations and the Largest BDMPS in Order to Indicate the Range of Likely Effects

Species		**Collisions**		
Herring gull		Mean	Lower c.i.	Upper c.i.
Baseline average annual mortality				0.1724
Breeding season	Reference population			324,887
	Seasonal mortality	0.76	0	2.62
	Increase in background mortality (%)	0.001	0.000	0.005
Winter / nonbreeding	Reference population			466,510
	Seasonal mortality	1.42	0	3.78
	Increase in background mortality (%)	0.002	0.000	0.005
Annual largest BDMPS	Reference population			466,510
	Annual mortality	2.18	0	5.18
	Increase in background mortality (%)	0.003	0.000	0.006
Annual bio-geographic	Reference population			1,098,000
	Annual mortality	2.18	0	5.18
	Increase in background mortality (%)	0.001	0.000	0.003

Table 12-87 Predicted Great Black-Backed Gull Collisions at DBS East and DBS West combined and Percentage Increases in the Background Mortality Rate of Seasonal and Annual Populations for the Worst Case Wind Turbine Scenario (1). Note that the Annual Mortalities Have Been Assessed Against Both the Biogeographic Populations and the Largest BDMPS in Order to Indicate the Range of Likely Effects

Species		**Collisions**		
Great black-backed gull		Mean	Lower c.i.	Upper c.i.
Baseline average annual mortality				0.0969
Breeding season	Reference population			25,915
	Seasonal mortality	0.92	0	4.42
	Increase in background mortality (%)	0.037	0.000	0.176
Winter / nonbreeding	Reference population			91,398
	Seasonal mortality	3.92	0	9.76
	Increase in background mortality (%)	0.044	0.000	0.110
Annual largest BDMPS	Reference population			91,398
	Annual mortality	4.84	0.74	11.5
	Increase in background mortality (%)	0.055	0.008	0.130
Annual bio-geographic	Reference population			235,000
	Annual mortality	4.84	0.74	11.5
	Increase in background mortality (%)	0.021	0.003	0.051

12.8.4 Impact 6 Combined Operational Collision Risk and Displacement

12.8.4.1 Gannet

~~727.~~734. Being the only species that has been scoped in for collision and displacement impacts from the Projects, it is possible that these impacts could combine to adversely affect gannet populations. Obviously, they would not act on the same individuals, as birds which do not enter a windfarm cannot be subject to mortality from collision, and vice versa. Avoidance rates for offshore wind farms, used in Collision Risk Modelling, take account of macro-avoidance (where birds avoid entering a wind farm), meso-avoidance (avoidance of the rotor swept zone within a windfarm), and micro-avoidance (avoiding wind turbine blades). Thus, birds which exhibit macro-avoidance could be subject to mortality from displacement.

~~728.~~735. As noted above (**Table 12-82**), the estimated annual gannet collision mortality at a worst case macro-avoidance rate of 65% for associated with the Projects is 14.26 (4.63-28.56). The estimated mortality for gannet displacement is up to 27 birds at a displacement rate of 80% and mortality of 1% (**Table 12-37**).

~~729.~~736. Based on the largest Annual BDMPS for the UK North Sea and Channel, of 456,299 (Natural England [RR-039]) and baseline mortality of 0.1866, 85,145 individual gannets would be expected to die each year; the addition of a maximum of 41.26 (14.26+27) individuals would represent a 0.048% increase in annual mortality. Based on the annual biogeographic population with connectivity to UK waters of 1,180,000 (Furness, 2015), 220,188 individuals would be expected to die; the addition of a maximum of 41.26 individuals would represent a 0.0187% increase in mortality. These magnitudes of increase would not materially alter the background mortality of the population and would be undetectable.

~~730.~~737. The sensitivity of gannet to combined displacement and collision risk is considered to be medium and the magnitude of annual impact at the Projects is negligible when assessed against the BDMPS population and negligible when assessed against the biogeographic population. Therefore, the significance of the annual effect on gannet due to combined displacement and collision risk from the Projects is assessed as **minor adverse**.

~~731.~~738. The same conclusion can also be made with respect to the potential individual effects from DBS East and DBS West, since these would necessarily be of lower magnitude.

12.9 Potential Effects During Decommissioning

~~732.~~739. There are two potential impacts that may affect bird populations during the decommissioning phase of the Projects that have been screened in. These are:

- Impact 7: Direct disturbance and displacement; and
- Impact 8: Indirect impacts through effects on habitats and prey species.

~~733.~~740. Any impacts generated during the decommissioning phase of the Projects are expected to be similar, or of reduced magnitude, to those generated during the construction phase, as certain activities such as piling would not be required. This is because it would generally involve a reverse of the construction phase through the removal of some structures and materials installed.

~~734.~~741. It is anticipated that any future activities would be programmed in close consultation with the relevant statutory marine and nature conservation bodies, to allow any future guidance and best practice to be incorporated to minimise any potential impacts.

12.9.1 Impact 7 Direct Disturbance and Displacement

~~735.~~742. Disturbance and displacement may occur due to the presence of working vessels and crews and the movement, noise and light associated with these. Such activities have already been assessed for relevant bird species in the construction section above and have been found to be of negligible to minor negative magnitude. Any impacts generated during the decommissioning phase of the Projects are expected to be similar, but likely of reduced magnitude compared to those generated during the construction phase; therefore, the magnitude of impact is predicted to be negligible. The resultant effect on a range of species of low to medium sensitivity to disturbance is of **negligible** to **minor adverse** significance.

~~736.~~743. Disturbance and displacement may also occur due to the presence of the wind turbines themselves, albeit to a decreasing extent as turbines are removed from the sites. Thus during decommissioning the magnitudes of disturbance and displacement due to wind turbines would decline from those assessed for operational displacement (section 12.8.1) to zero, passing through the magnitude levels assessed for construction displacement (section 12.7.1). Both of these assessments assessed impacts to be of **negligible** or **minor adverse** significance, and therefore the same conclusions apply to decommissioning.

12.9.2 Impact 8 Indirect Impacts Through Effects on Habitats and Prey Species

~~737.~~744. Indirect impacts such as displacement of seabird prey species are likely to occur as structures are removed. Such activities have already been assessed for relevant bird species in the construction section above and have been found to be of negligible magnitude.

~~738.~~745. Any impacts generated during the decommissioning phase of the Projects are expected to be similar, but likely of reduced magnitude compared to those generated during the construction phase; therefore, the magnitude of impact is predicted to be negligible. The resultant effect on a range of species of low to high sensitivity to disturbance is of **negligible** to **minor adverse** significance.

12.10 Cumulative Effects Assessment

~~739.~~746. Cumulative effects can be defined as incremental effects on that same receptor from other proposed and reasonably foreseeable schemes and developments in combination with the Projects. This includes all schemes that result in a comparative effect that is not intrinsically considered as part of the existing environment and is not limited to offshore wind schemes.

~~740.~~747. The Cumulative Effects Assessment for offshore ornithology has been undertaken in accordance with the approach that has been applied by the Secretary of State when consenting offshore wind farms and confirmed in recent consent decisions. It has also followed the approach set out in guidance from the Planning Inspectorate (Planning Inspectorate, 2015) and from the renewables industry (RenewableUK, 2013 and The Crown Estate, 2019) and Natural England (Parker *et al*. 2022).

~~741.~~748. Wherever possible the cumulative assessment is quantitative (i.e. where data in an appropriate format have been obtained). However, the level of data available and the ease with which impacts can be combined across the wind farms is variable, reflecting the availability of relevant data for older schemes and the approach to assessment taken. Where this has not been possible (e.g. for older schemes), a qualitative assessment has been undertaken.

~~742.~~749. The effects for the Projects have been added to the totals from the published cumulative assessment for the most recently agreed and / or consented wind farms. At the time of producing the original ES, the most recent cumulative wind farm totals were for the Dudgeon and Sheringham Extension Projects, Hornsea Project Four and Rampion 2, but for this update North Falls, Five Estuaries and Outer Dowsing have also submitted their applications. Hence those assessments have been reviewed and form the basis of the assessment provided here.

12.10.1 Screening for Cumulative Effects

~~743.~~750. The potential impacts arising from the Projects that were screened in for assessment for the project alone have also been considered in **Table 12-88** for the potential for cumulative impacts with other schemes (as defined below).

Table 12-88 Screening for Potential Cumulative Effects.

Impact	Potential for Cumulative impact	Data Confidence[1]	Rationale
Construction			
Impact 1: Direct Disturbance and Displacement	No (except red-throated diver)	High	There is a very low likelihood of temporal and spatial coincidence of disturbance / displacement from other schemes in the area acting on the same populations. However, Natural England [RR-039] requested consideration of potential cumulative construction effects on red-throated diver. This has now been added.
Impact 2: Indirect Impacts Through Effects on Habitats and Prey Species	No	Low	The likelihood that there would be a cumulative impact is low because the contribution from the Projects is small and it is dependent on a temporal and spatial co-incidence of disturbance / displacement from other schemes.
Operation			
Impact 3: Direct Disturbance and Displacement	Yes	High	There is a sufficient likelihood of a cumulative impact to justify a detailed, quantitative cumulative impact assessment.
Impact 4: Indirect Impacts Through Effects on Habitats and Prey Species	No	Low	The likelihood that there would be a cumulative impact is low because the contribution from the Projects is small.

Impact	Potential for Cumulative impact	Data Confidence[1]	Rationale
Impact 5: Collision Risk	Yes	High	There is a sufficient likelihood of a cumulative impact to justify a detailed, quantitative cumulative impact assessment.
Impact 6: Combined Operational Collision Risk and Displacement	Yes	Medium	There is a sufficient likelihood of a cumulative impact to justify quantitative cumulative impact assessment.
Decommissioning			
Impact 7: Direct Disturbance and Displacement	No	Low	The likelihood that there would be a cumulative impact is low because the contribution from the Projects is small and it is dependent on a temporal and spatial co-incidence of disturbance / displacement from other schemes.
Impact 8: Indirect Impacts Through Effects on Habitats and Prey Species	No	Low	The likelihood that there would be a cumulative impact is low because the contribution from the Projects is small and it is dependent on a temporal and spatial co-incidence of disturbance / displacement from other schemes.
[1] Indicates the degree of confidence; medium / low reflects lower confidence in older assessments which used variable methods.			

12.10.2 Schemes Considered for Cumulative Impacts

~~744.~~751. The schemes selected as relevant to the assessment of impacts to offshore ornithology are based upon an initial screening exercise undertaken on a long list. Each scheme has been considered and scoped in or out on the basis of effect-receptor pathway, data confidence and the temporal and spatial scales involved.

~~745.~~752. In addition, other offshore wind farms, the classes of schemes that could potentially be considered for the cumulative assessment of offshore ornithological receptors include:

- Marine aggregate extraction;
- Oil and gas exploration and extraction;
- Sub-sea cables and pipelines; and
- Commercial shipping.

~~746.~~753. With respect to these activities, the cumulative assessment takes into account the fact that birds are expected to already be habituated to long-term, on-going activities and therefore these may be considered to be part of the baseline conditions, and therefore it is important to avoid double-counting or exaggeration of potential impacts. On this basis it is not expected that the Projects will contribute to cumulative effects with the activities in the above list, and therefore these have been scoped out and the cumulative assessment is focused on offshore wind farms.

~~747.~~754. The identification of offshore wind farms to include in the cumulative assessment of offshore ornithological receptors has been based on:

- Approved schemes;
- Constructed schemes;
- Approved but as yet unconstructed schemes; and
- Schemes for which an application has been submitted, determination is currently under consideration and which may be consented before the proposed Projects.

~~748.~~755. The wind farms listed in **Table 12-89** (which are those located in the North Sea or English Channel and are therefore functionally within the same area of potential effect as the Projects) have been assigned to four tiers as follows:

- Tier 1: Schemes that are built and operational;
- Tier 2: Schemes under construction;
- Tier 3: Consented schemes; and
- Tier 4: Application submitted or in planning.

Table 12-89 Schemes Considered Within the Offshore Ornithology Cumulative Effect Assessment.

Tier	**Scheme** Name	**Distance to** Array Areas (km)
1	Beatrice	460
1	Beatrice Demonstrator	460
1	Blyth Demonstration Project	174
1	Dudgeon	122
1	East Anglia ONE	230
1	European Offshore Wind Deployment Centre	346
1	Galloper	263
1	Greater Gabbard	265
1	Gunfleet Sands	294
1	Hornsea Project One	44
1	Hornsea Project Two	41
1	Humber Gateway	120
1	Hywind	349
1	Kentish Flats	335
1	Kentish Flats Extension	326
1	Kincardine	327
1	Lincs	154
1	London Array	297
1	Lynn and Inner Dowsing (LID)	164
1	Methil	320
1	Moray East	450
1	Race Bank	134
1	Rampion	431
1	Scroby Sands	189
1	Sheringham Shoal	143
1	Teesside	155
1	Thanet	323
1	Triton Knoll	114
1	Westermost Rough	112
2	Dogger Bank A & B	8
2	Moray West	456
2	Neart na Gaoithe	277
2	Seagreen A and B	269
3	Dogger Bank C and Sofia	35

Tier	**Scheme** Name	**Distance to** Array Areas (km)
3	East Anglia One North	216
3	East Anglia Three	188
3	East Anglia Two	230
3	Hornsea Project Three – revised	45
3	Inch Cape	288
3	Norfolk Boreas	143
3	Norfolk Vanguard	153
3	Hornsea Project Four	41
4	Berwick Bank	229
4	Sheringham and Dudgeon Extension Projects	116
4	Rampion 2	437
4	ForthWind Offshore Wind Demonstration Project - phase 1	318
4	North Falls	262
4	Five Estuaries	263
4	Outer Dowsing	81
4	Dogger Bank D	68

~~749.~~756. Dogger Bank D has been included, but is scoped out as there is insufficient information to include this in the assessment.

12.10.3 Impact 9 Cumulative Assessment of Construction Effects on Red-throated Diver

~~750.~~757. Natural England [RR-039] advised that cumulative disturbance and displacement impacts should be considered for red-throated diver. As discussed in section 12.7.1.4.1, the estimated magnitude of impact on red-throated divers in the Greater Wash SPA as a result of construction vessel disturbance from the Projects alone was 0.2 mortalities per year.

~~751.~~758. Outer Dowsing Wind Farm presented a cumulative estimate for wind farms in the southern North Sea which predicted that up to 64 red-throated divers could be at risk of construction displacement mortality, based on a 10% mortality rate[8] . However, a mortality rate of 1% is considered to be suitably precautionary for this species, hence a cumulative mortality of 6.6 (including the Projects' impact of 0.2) would be appropriate. The BDMPS population was estimated to be 13,276 and the biogeographic population was estimated to be 27,000 (Furness 2015). The increases in background mortality (at a baseline rate of 0.2277) for these two populations from the addition of 6.6 would be 0.218% and 0.107% respectively.

~~752.~~759. These increases in mortality due to construction displacement would be undetectable and are assessed as negligible. As the species is of high sensitivity to disturbance, the impact significance is **minor adverse.**

~~753.~~760. Natural England [RR-039] stated an additional concern in relation to disturbance and displacement of red-throated divers from '*the more persistent presence of offshore wind farm related vessels*'. Natural England also advised that appropriate mitigation (should an impact be identified) would be to use existing shipping lanes until 2km beyond the edge of the Greater Wash SPA. Given the existing levels of shipping within the relevant region of the Greater Wash SPA (see **Volume 7, Figure 12-3~~1~~ Existing Shipping Traffic Through the Greater Wash SPA (application ref: 7.12.1)**) it is clear that the addition of a small number of additional vessel movements through the SPA in relation to the Projects will not make any meaningful difference to the levels of disturbance already occurring. Nonetheless, the Applicants are prepared to commit to Natural England's request to use existing shipping lanes whilst crossing the SPA and as far as 2km beyond the SPA boundary for vessel movements which are transiting the SPA, as well as standard practice mitigation for this species (e.g. avoiding flocks of divers, etc.). The embedded mitigation measures detailed in **Table 12-4** have been updated to include this commitment.

[8] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010130/EN010130-000354-6.1.12%20Chapter%2012%20Offshore%20and%20Intertidal%20Ornithology.pdf

12.10.4 Impact 10 Cumulative Assessment of Operational Displacement

~~754.~~761. The species assessed for project alone operational displacement impacts were gannet, guillemot, razorbill and puffin.

~~755.~~762. A review of the BDMPS regions for each species indicated that for gannet, guillemot, razorbill and puffin all the wind farms identified for inclusion in the cumulative assessment in **Table 12-89** have the potential to contribute to cumulative effects.

12.10.4.1 Gannet

~~756.~~763. The annual total of gannets at risk of displacement from the Projects' Array Areas was estimated as 3,295 individuals (summing the seasonal peak means within the arrays and 2km buffers) for the annual period (**Table 12-36**).

~~757.~~764. **Table 12-90** provides the annual number of birds at risk of displacement from offshore wind farms in the UK North Sea and Channel BDMPS, which has been calculated as 59,007. When the estimated numbers at risk due to the Projects are included, this would increase to 62,302 birds.

Table 12-90 Cumulative Numbers of Gannets at Risk of Displacement from Offshore Wind farms in the North Sea.

Tier	Wind farm	Breeding season	Autumn migration	Spring migration	Annual
1	Beatrice	151	0	0	151
1	Beatrice Demonstrator	-	-	-	-
1	Blyth Demonstration Project	-	-	-	-
1	Dudgeon	53	25	11	89
1	East Anglia ONE	161	3638	76	3875
1	European Offshore Wind Deployment Centre	35	5	0	40
1	Galloper	360	907	276	1543
1	Greater Gabbard	252	69	105	426
1	Gunfleet Sands	0	12	9	21
1	Hornsea Project One	671	694	250	1615
1	Hornsea Project Two	457	1140	124	1721
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 & LID	-	-	-	-
1	London Array	-	-	-	-

Tier	Wind farm	Breeding season	Autumn migration	Spring migration	Annual
1	Methil	23	0	0	23
1	Moray East	564	292	27	883
1	Race Bank	92	32	29	153
1	Rampion	0	590	0	590
1	Scroby Sands	-	-	-	-
1	Sheringham Shoal	47	31	2	80
1	Teesside	1	0	0	1
1	Thanet	-	-	-	-
1	Triton Knoll	211	15	24	250
1	Westermost Rough	-	-	-	-
2	Dogger Bank A and B	1155	2048	394	3597
2	Moray West	2827	439	144	3410
2	Neart na Gaoithe	1987	552	281	2820
2	Seagreen A and B	2956	664	332	3952
3	Dogger Bank C and Sofia	2250	887	464	3601
3	East Anglia One North	149	468	44	661
3	East Anglia Three	412	1269	524	2205
3	East Anglia Two	192	891	192	1275
3	Hornsea Project Three (revised)	1333	984	524	2841
3	Inch Cape	2398	703	212	3313
3	Norfolk Boreas	1229	1723	526	3478
3	Norfolk Vanguard	271	2453	437	3161
3	Hornsea Project Four	976	790	401	2167
4	Sheringham and Dudgeon Extension Projects	440	638	58	1136
4	Berwick Bank	4735	1500	269	6504
4	ForthWind Offshore Wind Demonstration Project - phase 1	64	26	44	134
4	Rampion 2	111	102	123	336
4	North Falls (ES)	69	287	290	646
4	Five Estuaries (ES)	233	640	67	940
4	Outer Dowsing (ES)	635	496	91	1222
	Total (other schemes)	**27630**	**25023**	**6354**	**59007**
	DBS East	755	776	75	1606
	DBS West	805	798	86	1689
	DBS East and West together	1560	1574	161	3295
	Total (all schemes + DBS East)	**28385**	**25799**	**6429**	**60613**

Tier	Wind farm	Breeding season	Autumn migration	Spring migration	Annual
	Total (all schemes + DBS West)	**28435**	**25821**	**6440**	**60696**
	Total (all schemes + DBS East and West together)	**29190**	**26597**	**6515**	**62302**

~~758.~~765. At displacement rates of 60-80% and 1% mortality of displaced birds, between 374 and 498 gannets would be predicted to die from cumulative displacement (**Table 12-91**).

Table 12-91 Cumulative Annual Displacement Matrix for Gannet.

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	62	125	187	249	312	374	436	498	561	623
2	125	249	374	498	623	748	872	997	1121	1246
3	187	374	561	748	935	1121	1308	1495	1682	1869
4	249	498	748	997	1246	1495	1744	1994	2243	2492
5	312	623	935	1246	1558	1869	2181	2492	2804	3115
6	374	748	1121	1495	1869	2243	2617	2990	3364	3738
7	436	872	1308	1744	2181	2617	3053	3489	3925	4361
8	498	997	1495	1994	2492	2990	3489	3987	4486	4984
9	561	1121	1682	2243	2804	3364	3925	4486	5046	5607
10	623	1246	1869	2492	3115	3738	4361	4984	5607	6230
20	1246	2492	3738	4984	6230	7476	8722	9968	11214	12460
30	1869	3738	5607	7476	9345	11214	13083	14952	16822	18691
50	3115	6230	9345	12460	15576	18691	21806	24921	28036	31151
75	4673	9345	14018	18691	23363	28036	32709	37381	42054	46727
100	6230	12460	18691	24921	31151	37381	43611	49842	56072	62302

~~759.~~766. Based on the largest Annual BDMPS of 456,299 and baseline mortality of 0.1866, 85,145 individual gannets would be expected to die each year; the addition of a maximum of 498 (80% displaced 1% mortality) individuals would represent a 0.586% increase in annual mortality. Based on the annual biogeographic population with connectivity to UK waters of 1,180,000 (Furness 2015), 220,188 individuals would be expected to die; the addition of a maximum of 498 individuals would represent a 0.227% increase in mortality.

~~760.~~767. Thus, precautionary estimates of the number of gannets which might die as a result of cumulative displacement from offshore wind farms in the UK North Sea and Channel BDMPS represent a change in mortality rate of no more than 0.586%, which would not be detectable at the population level. In reality, given the wide-ranging behaviour of gannets and their flexibility in foraging behaviour, displacement from offshore wind farms is considered unlikely to cause any increase in the population mortality rate.

~~761.~~768. The magnitude of cumulative displacement for gannet is considered to be negligible and the impact significance of cumulative displacement on a receptor of low to medium sensitivity is **negligible** to **minor adverse**.

12.10.4.2 Guillemot

~~762.~~769. The annual total of guillemots at risk of displacement from the Projects' Array Areas is estimated as 60,438 individuals (summing the seasonal peak means within the arrays and 2km buffers) for the annual period (**Table 12-49**).

~~763.~~770. The estimates of the total numbers of guillemots at risk of displacement from other offshore wind farms in the North Sea are included in **Table 12-92**. These totals omit wind farms for which no data are available (as indicated in the table), but they are also likely to over-estimate the numbers present due to the precautionary use of seasonal peak numbers at each site rather than average numbers, which is likely to lead to double counting as birds move through the North Sea. ~~Values updated from the original ES are highlighted in yellow.~~

Table 12-92 Cumulative Numbers of Guillemots at Risk of Displacement from Offshore Wind farms in the North Sea.

Tier	Wind farm	Breeding season	Non-breeding season	Annual
1	Beatrice	13610	2755	16365
1	Beatrice Demonstrator	-	-	-
1	Blyth Demonstration Project	1220	1321	2541

Tier	Wind farm	Breeding season	Non-breeding season	Annual
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	9836	8097	17933
1	Hornsea Project Two	7735	13164	20899
1	Humber Gateway	99	138	237
1	Hywind	249	2136	2385
1	Kentish Flats	0	3	3
1	Kentish Flats Extension	0	4	4
1	Kincardine	632	0	632
1	Lincs & LID	582	814	1396
1	London Array	192	377	569
1	Methil	25	0	25
1	Moray East	9820	547	10367
1	Race Bank	361	708	1069
1	Rampion	10887	15536	26423
1	Scroby Sands	-	-	-
1	Sheringham Shoal	390	715	1105
1	Teesside	267	901	1168
1	Thanet	18	124	142
1	Triton Knoll	425	746	1171
1	Westermost Rough	347	486	833
2	Dogger Bank A and B	14886	16763	31649
2	Moray West	24426	38174	62600
2	Neart na Gaoithe	1755	3761	5516
2	Seagreen A and B	24724	8800	33524
3	Dogger Bank C and Sofia	8494	5969	14463
3	East Anglia One North	4183	1888	6071
3	East Anglia Three	1744	2859	4603
3	East Anglia Two	2077	1675	3752
3	Hornsea Project Three (revised)	13374	17772	31146
3	Inch Cape	4371	3177	7548
3	Norfolk Boreas	7767	13777	21544
3	Norfolk Vanguard	4320	4776	9096
3	Hornsea Project Four	9382	36965	46347

Tier	Wind farm	Breeding season	Non-breeding season	Annual
4	Sheringham and Dudgeon Extension Projects	4934	15972	20906
4	Berwick Bank	74154	44171	118325
4	ForthWind Offshore Wind Demonstration Project - phase 1	417	401	818
4	Rampion 2	134	5723	5857
4	North Falls (ES)	866	5365	6231
4	Five Estuaries (ES)	1201	3698	4899
4	Outer Dowsing (ES)	16445	11208	27653
	Total (other schemes)	**278154**	**294377**	**572531**
	DBS East	9031	20230	29261
	DBS West	8783	22393	31177
	DBS East and West together	17814	42623	60438
	Total (all schemes + DBS East)	**287185**	**314607**	**601792**
	Total (all schemes + DBS West)	**286937**	**316770**	**603708**
	Total (all schemes + DBS East and West together)	**295968**	**337000**	**632969**

~~764.~~771. The estimated annual cumulative total of guillemots at risk of displacement from wind farms in the North Sea is 572,531 individuals, which rises to 632,969 individuals when including the Projects (**Table 12-92**).

~~765.~~772. Considering a range of displacement of 30 to 70%, and mortality of displaced individuals from 1 to 10%, the estimated number of guillemots subject to mortality from displacement throughout the year is between 1,899 and 44,308 (**Table 12-93**), and at 70% displaced and 2% mortality would be 8,862.

Table 12-93 Cumulative Annual Displacement Matrix for Guillemot.

Mortality (%)	**Displacement (%)**									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	633	1266	1899	2532	3165	3798	4431	5064	5697	6330
2	1266	2532	3798	5064	6330	7596	8862	10127	11393	12659
3	1899	3798	5697	7596	9495	11393	13292	15191	17090	18989

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
4	2532	5064	7596	10127	12659	15191	17723	20255	22787	25319
5	3165	6330	9495	12659	15824	18989	22154	25319	28484	31648
6	3798	7596	11393	15191	18989	22787	26585	30382	34180	37978
7	4431	8862	13292	17723	22154	26585	31015	35446	39877	44308
8	5064	10127	15191	20255	25319	30382	35446	40510	45574	50637
9	5697	11393	17090	22787	28484	34180	39877	45574	51270	56967
10	6330	12659	18989	25319	31648	37978	44308	50637	56967	63297
20	12659	25319	37978	50637	63297	75956	88616	101275	113934	126594
30	18989	37978	56967	75956	94945	113934	132923	151912	170901	189890
50	31648	63297	94945	126594	158242	189890	221539	253187	284836	316484
75	47473	94945	142418	189890	237363	284836	332308	379781	427253	474726
100	63297	126594	189890	253187	316484	379781	443078	506374	569671	632968

~~766.~~773. The largest BDMPS for guillemot in UK North Sea and Channel waters is 2,045,078 (as advised by Natural England in their response to the Projects PEIR, see **Volume 7, Appendix 12-1 Offshore Ornithology Consultation Responses (application ref: 7.12.12.1)** for further information). At the average baseline mortality rate of 0.1405 the number of individuals expected to die in a year is 287,333 (2,045,078 x 0.1405). The addition of between 1,899 (30% x 1%) and 44,308 (70% x 10%) individuals to this increases the background mortality rate by between 0.66% and 15.42%, while 8,862 (70% x 2%) would increase the background mortality by 3.08%.

~~767.~~774. Based on the annual biogeographic population with connectivity to UK waters of 4,125,000 (Furness 2015), 579,563 individuals would be expected to die; the addition of between 1,899 (30% x 1%) and 44,308 (70% x 10%) individuals would increase this rate by 0.32% and 7.65%, while 8,862 (70% x 2%) would increase the background mortality by 1.53%.

~~768.~~775. As the increases in background mortality assessed against the BDMPS and biogeographic populations exceeded 1% the Natural England commissioned PVA tool was used to examine the effect of the estimated cumulative mortality on the guillemot populations. The complete input parameters, settings and results are provided in **Appendix 12-13 – Population Viability Analyses (Revision 2**) [document reference: 7.12.12.13]. The counterfactuals of growth rate (CGR) and population size (CPS) are presented in **Table 12-94.**

Table 12-94 PVA results for cumulative displacement impacts on the guillemot BDMPS population after 30 years.

PVA run scenario	Annual mortality	Decrease in adult survival rate	Mean CGR (95% c.i.)	Mean CPS (95% c.i.)
Cumulative displacement (50% x 1%)	3,165	0.001547	0.9983 (0.9982-0.9983)~~0.9990 (0.9989-0.9991)~~	0.9474 (0.9446-0.9503)~~0.9689 (0.9658-0.9719)~~
Cumulative displacement (70% x 2%)	8,862	0.004333	0.9951 (0.995-0.9952)~~0.9972 (0.9970-0.9973)~~	0.8594 (0.8566-0.8622)~~0.9153 (0.9116-0.9188)~~
Cumulative displacement (70% x 10%)	44,308	0.021665	0.9756 (0.9754-0.9758)~~0.9859 (0.9854-0.9863)~~	0.4653 (0.4617-0.4688)~~0.6438 (0.6348-0.6518)~~

~~769.~~776. After a period of 30 years, cumulative displacement at up to 70% displaced and 2% mortality reduced the BDMPS population growth rate by up to 0.49~~28~~% (0.9951~~72~~) and reduced the BDMPS population size compared to the baseline by up to 14.1~~8.5~~% (0.8594~~9153~~).

Table 12-95 PVA results for cumulative displacement impacts on the guillemot biogeographic population after 30 years.

PVA run scenario	Annual mortality	Decrease in adult survival rate	Mean CGR (95% c.i.)	Mean CPS (95% c.i.)
Cumulative displacement (50% x 1%)	3,165	0.000767	0.9991 (0.9991-0.9992)~~0.9995 (0.9994-0.9995)~~	0.9736 (0.9715-0.9756)~~0.9844 (0.9823-0.9866)~~
Cumulative displacement (70% x 2%)	8,862	0.002148	0.9976 (0.9975-0.9976)~~0.9986 (0.9985-0.9987)~~	0.9277 (0.9256-0.9298)~~0.9571 (0.9548-0.9594)~~
Cumulative displacement (70% x 10%)	44,308	0.010741	0.9879 (0.9878-0.988)~~0.9930 (0.9927-0.9932)~~	0.6859 (0.6831-0.6886)~~0.8033 (0.7978-0.8084)~~

~~770.~~777. After a period of 30 years, cumulative displacement at up to 70% displaced and 2% mortality reduced the biogeographic population growth rate by up to 0.2~~1~~4% (0.997~~8~~6) and reduced the biogeographic population size compared to the baseline by up to 7~~4~~.3% (0.9277~~571~~).

~~771.~~778. This is a wide range of potential impacts, therefore further consideration has been given below to the evidence for displacement impacts in auks and the most likely realistic values within this range.

~~772.~~779. Reviews of post-construction monitoring of auks at offshore wind farms have found evidence of avoidance behaviour, although avoidance was incomplete and variable between sites and was considered overall to be less than an average of 50% reduction in density compared to pre-construction data; it was also considered that auks might habituate to the presence of operational wind farms and there is some indication that displacement may decrease with wider spacing between turbines (Norfolk Vanguard Ltd 2019, Dierschke *et al*. 2016). This is particularly relevant since many of the reported studies have been conducted in older wind farms where turbines were separated by much smaller distances (e.g. 500-600m) than in current wind farm designs (>=1km separation).

~~773.~~780. Post-construction monitoring over two breeding seasons of the Beatrice wind farm in Scotland has found little indication that guillemots and razorbills avoid wind turbines, with spatial distributions within the wind farm no different from those that might be expected by chance (Trinder *et al*., 2024).

~~774.~~781. A detailed review of the potential effects of displacement from offshore wind farms on auks (Norfolk Vanguard Ltd 2019) acknowledged that, while the impact of displacement of razorbills and guillemots by offshore wind farms is uncertain, the existing information indicates that 'natural' annual mortality of adults of these species (including due to impacts of existing human activities) is very low (10% and 6% per annum respectively), and that displacement of razorbills and guillemots by offshore wind farms is likely to be incomplete, may reduce with habituation, and offshore wind farms may in the long-term increase food availability to guillemots and razorbills through providing enhanced habitat for fish populations. This suggests that impacts of displacement from offshore wind farms are unlikely to represent levels of mortality anywhere near to the 6% or 10% total annual mortality that occurs due to the combination of many natural factors plus existing human activities. This evidence-based review recommended a displacement rate of 50% for auks within an offshore wind farm and 30% within a 1km buffer, to be combined with what was considered a highly precautionary maximum mortality rate of 1%.

~~775.~~782. Using these rates (displacement and mortality of 50% and 1% respectively), derived from a thorough review of evidence, would result in a predicted total mortality of 3,165 annually due to cumulative displacement. Assessed against the largest BDMPS 287,333 (2,045,078 x 0.1405) would increase the background mortality rate by 1.101% and against the biogeographic population 579,563 (4,125,000 x 1.405) by 0.546%.

~~776.~~783. On the basis of these impact sizes, combined with the various additive sources of precaution in this assessment, indicates there is a very high likelihood that cumulative displacement would be at most around 1%. The magnitude of cumulative displacement for guillemots is assessed as low to medium. Therefore, as the species is of medium sensitivity to disturbance, the cumulative effect significance would be **minor to moderate adverse**. There is no change to the conclusion from the original ES.

12.10.4.3 Razorbill

~~777.~~784. This section provides the update to section 12.7.3.3 of the original ES.

~~778.~~785. The annual total of razorbills at risk of displacement from the Projects' Array Areas is estimated as 28,886 individuals across the migration-free breeding, autumn migration, winter, and spring migration periods; **Table 12-65**).

~~779.~~786. Estimates of the number of razorbills at risk of displacement from other offshore wind farms included in the cumulative assessment are given in **Table 12-96**. The cumulative totals omit wind farms for which no data are available (as indicated in table), but they are also likely to over-estimate the numbers present due to the precautionary use of seasonal peak numbers at each site rather than average numbers, which is likely to lead to double counting as birds move through the North Sea. ~~Values updated from the original ES are highlighted in yellow.~~

Table 12-96 Cumulative Numbers of Razorbills at Risk of Displacement from Offshore Wind farms in the North Sea.

Tier	Wind farm	Breeding season	Autumn migration	Nonbreeding season	Spring migration	Annual
1	Beatrice	873	833	555	833	3094
1	Beatrice Demonstrator	-	-	-	-	-
1	Blyth Demonstration Project	121	91	61	91	364
1	Dudgeon	256	346	745	346	1693
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

Tier	Wind farm	Breeding season	Autumn migration	Nonbreeding season	Spring migration	Annual
1	Gunfleet Sands	0	0	30	0	30
1	Hornsea Project One	1109	4812	1518	1803	9242
1	Hornsea Project Two	2511	4221	720	1668	9120
1	Humber Gateway	27	20	13	20	80
1	Hywind	30	719	10	-	759
1	Kentish Flats	-	-	-	-	-
1	Kentish Flats Extension	-	-	-	-	-
1	Kincardine	22	-	-	-	22
1	Lincs & LID	45	34	22	34	135
1	London Array	14	20	14	20	68
1	Methil	4	0	0	0	4
1	Moray East	2423	1103	30	168	3724
1	Race Bank	28	42	28	42	140
1	Rampion	630	66	1244	3327	5267
1	Scroby Sands	-	-	-	-	-
1	Sheringham Shoal	106	1343	211	30	1690
1	Teesside	16	61	2	20	99
1	Thanet	3	0	14	21	38
1	Triton Knoll	40	254	855	117	1266
1	Westermost Rough	91	121	152	91	455
2	Dogger Bank A and B	2788	3673	3871	9268	19600
2	Moray West	2808	3544	184	3585	10121
2	Neart na Gaoithe	331	5492	508	-	6331
2	Seagreen A and B	9574	0	2375	0	11949
3	Dogger Bank C and Sofia	1987	902	2385	4872	10146
3	East Anglia One North	403	85	54	207	749
3	East Anglia Three	1807	1122	1499	1524	5952
3	East Anglia Two	281	44	136	230	691
3	Hornsea Project Three (revised)	630	2020	3649	2105	8404
3	Inch Cape	1436	2870	651	-	4957
3	Norfolk Boreas	630	263	1065	345	2303

Tier	Wind farm	Breeding season	Autumn migration	Nonbreeding season	Spring migration	Annual
3	Norfolk Vanguard	879	866	839	924	3508
3	Hornsea Project Four	386	4311	455	449	5601
4	Sheringham and Dudgeon Extension Projects	4500	1239	464	1531	7734
4	Berwick Bank	4040	8849	1399	7480	21768
4	ForthWind Offshore Wind Demonstration Project - phase 1	57	40	58	41	196
4	Rampion 2	32	26	1193	6303	7554
4	North Falls (ES)	104	248	1781	1741	3874
4	Five Estuaries (ES)	90	284	1046	756	2176
4	Outer Dowsing (ES)	3596	2390	1956	5537	13479
-	**Total (other schemes)**	**44929**	**52487**	**32447**	**56369**	**186232**
-	*DBS East*	555	4686	3377	3579	12197
-	*DBS West*	2281	4887	5066	4455	16689
-	*DBS East and West together*	2836	9573	8443	8034	28886
-	***Total (all schemes + DBS East)***	**45484**	**57173**	**35824**	**59948**	**198429**
-	***Total (all schemes + DBS West)***	**47210**	**57374**	**37513**	**60824**	**202921**
-	***Total (all schemes + DBS East and West together)***	**47765**	**62060**	**40890**	**64403**	**215118**

~~780.~~787. The estimated annual cumulative total of razorbills at risk of displacement from wind farms in the North Sea is 186,232 individuals, which rises to 215,118 individuals when including the Projects (**Table 12-96**).

~~781.~~788. Considering a range of displacement of 30-70%, and mortality of displaced individuals from 1-10%, based on advice from Natural England, the estimated number of razorbills subject to mortality from displacement throughout the year is between 645 and 15,058 (**Table 12-97**), and at 70% displaced and 2% mortality would be 3,012.

Table 12-97 Cumulative Annual Displacement Matrix for Razorbill.

Mortality (%)	**Displacement (%)**									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	215	430	645	860	1076	1291	1506	1721	1936	2151
2	430	860	1291	1721	2151	2581	3012	3442	3872	4302
3	645	1291	1936	2581	3227	3872	4517	5163	5808	6454
4	860	1721	2581	3442	4302	5163	6023	6884	7744	8605
5	1076	2151	3227	4302	5378	6454	7529	8605	9680	10756
6	1291	2581	3872	5163	6454	7744	9035	10326	11616	12907
7	1506	3012	4517	6023	7529	9035	10541	12047	13552	15058
8	1721	3442	5163	6884	8605	10326	12047	13768	15488	17209
9	1936	3872	5808	7744	9680	11616	13552	15488	17425	19361
10	2151	4302	6454	8605	10756	12907	15058	17209	19361	21512
20	4302	8605	12907	17209	21512	25814	30117	34419	38721	43024
30	6454	12907	19361	25814	32268	38721	45175	51628	58082	64535
50	10756	21512	32268	43024	53780	64535	75291	86047	96803	107559
75	16134	32268	48402	64535	80669	96803	112937	129071	145205	161339
100	21512	43024	64535	86047	107559	129071	150583	172094	193606	215118

~~782.~~789. The largest BDMPS for razorbill in UK North Sea waters is 591,875 (Furness 2015). At the average baseline mortality rate of 0.1302 the number of individuals expected to die in a year is 77,062 (591,875 x 0.1302). The addition of between 645 (30% X 1%) and 15,058 (70% X 10%) individuals to this increases the background mortality rate by respectively 0.837% and 19.541%, while 3,012 (70% x 2%) would increase the background mortality by 3.908%.

~~783.~~790. Based on the annual biogeographic population with connectivity to UK waters of 1,707,000 (Furness 2015), 222,251 individuals would be expected to die; the addition 645 (30% x 1%) and 15,058 (70% x 10%) individuals would represent increase between 0.290 and 6.775%, while 3,012 (70% x 2%) would increase the background mortality by 1.355%.

~~784.~~791. This is a wide range, so the assessment considers the most realistic value within this range. Recommendations of an evidence-based review (Norfolk Vanguard 2019) are for a displacement rate of 50% for auks within an offshore wind farm and 30% within a 1km buffer, both combined with a highly precautionary maximum mortality of 1%.

~~785.~~792. Using these rates (displacement and mortality of 50% and 1% respectively), derived from a thorough review of evidence would result in a predicted total mortality of 1,076 annually due to cumulative displacement. Assessed against the BDMPS 77,062 (591,875 x 0.1302) this would increase the background mortality rate by 1.395% and against the biogeographic population 222,251 (1,707,000 x 0.1302) by 0.484%.

~~786.~~793. As the increases in background mortality assessed against the BDMPS and biogeographic populations exceeded 1% the Natural England commissioned PVA tool was used to examine the effect of the estimated cumulative mortality on the guillemot populations. The complete input parameters and settings and results are provided **Appendix 12-13 – Population Viability Analyses (Revision 2)** [document reference: 7.12.12.13]. The counterfactuals of growth rate (CGR) and population size (CPS) are presented in **Table 12-98** and **Table 12-99**.

Table 12-98 PVA results for cumulative displacement impacts on the razorbill BDMPS population after 30 years.

PVA run scenario	Annual mortality	Decrease in adult survival rate	Mean CGR (95% c.i.)	Mean CPS (95% c.i.)
Cumulative displacement (50% x 1%)	1,076	0.001818	0.9979 (0.9977-0.9981)~~0.9988 (0.9986-0.9990)~~	0.9376 (0.93-0.9449)~~0.9639 (0.9563-0.9715)~~
Cumulative displacement (70% x 2%)	3,012	0.005089	0.9942 (0.9939-0.9944)~~0.9967 (0.9965-0.9969)~~	0.8345 (0.8274-0.8412)~~0.9022 (0.8949-0.9098)~~

PVA run scenario	Annual mortality	Decrease in adult survival rate	Mean CGR (95% c.i.)	Mean CPS (95% c.i.)
Cumulative displacement (70% x 10%)	15,058	0.025441	0.9709 (0.9703-0.9714)~~0.9836 (0.9832-0.9841)~~	0.4005 (0.3925-0.4076)~~0.5994 (0.5903-0.6087)~~

~~787.~~794. After a period of 30 years, cumulative displacement at up to 70% displaced and 2% mortality reduced the BDMPS population growth rate by up to 0.58~~33~~% (0.9942~~67~~) and reduced the BDMPS population size compared to the baseline by up to 16.6~~9.8~~% (0.8345~~9022~~).

Table 12-99 PVA results for cumulative displacement impacts on the razorbill biogeographic population after 30 years.

PVA run scenario	Annual mortality	Decrease in adult survival rate	Mean CGR (95% c.i.)	Mean CPS (95% c.i.)
Cumulative displacement (50% x 1%)	1,076	0.000630	0.9993 (0.9992-0.9994)~~0.9996 (0.9995-0.9997)~~	0.9779 (0.9734-0.9825)~~0.9873 (0.9828-0.9918)~~
Cumulative displacement (70% x 2%)	3,012	0.001764	0.9980 (0.9979-0.9981)~~0.9988 (0.9987-0.9990)~~	0.9393 (0.9347-0.9437)~~0.9649 (0.9604-0.9693)~~
Cumulative displacement (70% x 10%)	15,058	0.008821	0.9899 (0.9897-0.9901)~~0.9943 (0.9941-0.9945)~~	0.7303 (0.7246-0.7356)~~0.8368 (0.8317-0.8420)~~

~~788.~~795. After a period of 30 years, cumulative displacement at up to 70% displaced and 2% mortality reduced the biogeographic population growth rate by up to 0.12% (0.998~~8~~0) and reduced the biogeographic population size compared to the baseline by up to 6.1~~3.5~~% (0.9~~6~~393)~~49)~~.

~~789.~~796. Reviews of post-construction monitoring of auks at offshore wind farms have found evidence of avoidance behaviour, although avoidance was incomplete and variable between sites and was considered overall to be less than an average of 50% reduction in density compared to pre-construction data; it was also considered that auks might habituate to the presence of operational wind farms and there is some indication that displacement may decrease with wider spacing between turbines (Norfolk Vanguard Ltd 2019, Dierschke *et al*. 2016). This is particularly relevant since many of the reported studies have been conducted in older wind farms where turbines were separated by much smaller distances (e.g. 500-600m) than in current wind farm designs (>=1km separation).

~~790.~~797. Post-construction monitoring over two breeding seasons of the Beatrice wind farm in Scotland has found little indication that guillemots and razorbills avoid wind turbines, with spatial distributions within the wind farm no different from those that might be expected by chance (Trinder *et al.*, 2024). On the basis of these impact sizes, combined with the various additive sources of precaution in this assessment, indicates there is a very high likelihood that cumulative displacement would be less than 1%.

~~791.~~798. A detailed review of the potential effects of displacement from offshore wind farms on auks (Norfolk Vanguard Ltd 2019) acknowledged that, while the impact of displacement of razorbills and guillemots by offshore wind farms is uncertain, the existing information indicates that 'natural' annual mortality of adults of these species (including due to impacts of existing human activities) is very low (10% and 6% per annum respectively), and that displacement of razorbills and guillemots by offshore wind farms is likely to be incomplete, may reduce with habituation, and offshore wind farms may in the long-term increase food availability to guillemots and razorbills through providing enhanced habitat for fish populations. This suggests that impacts of displacement from offshore wind farms are unlikely to represent levels of mortality anywhere near to the 6% or 10% total annual mortality that occurs due to the combination of many natural factors plus existing human activities. This evidence-based review recommended a displacement rate of 50% for auks within an offshore wind farm and 30% within a 1km buffer, to be combined with what was considered a highly precautionary maximum mortality rate of 1%.

~~792.~~799. The magnitude of cumulative displacement for razorbills is assessed as low. Therefore, as the species is of medium sensitivity to disturbance, the cumulative effect significance would be **minor adverse**.

12.10.4.4 Puffin

~~793.~~800. The annual total of puffins at risk of displacement from the Projects Array Areas is estimated as 549 individuals for breeding and nonbreeding periods; **Table 12-75**).

~~794.~~801. Estimates of the number of puffins at risk of displacement from other offshore wind farms included in the cumulative assessment are given in **Table 12-100**. The cumulative totals omit wind farms for which no data are available (as indicated in table), but they are also likely to over-estimate the numbers present due to the precautionary use of seasonal peak numbers at each site rather than average numbers, which is likely to lead to double counting as birds move through the North Sea.

Table 12-100 Cumulative Numbers of Puffins at Risk of Displacement from Offshore Wind farms in the North Sea.

Tier	Wind farm	Breeding season	Non-breeding season	Annual
1	Beatrice	2858	2435	5293
1	Beatrice Demonstrator	-	-	
1	Blyth Demonstration Project	235	123	358
1	Dudgeon	1	3	4
1	East Anglia ONE	16	32	48
1	European Offshore Wind Deployment Centre	42	82	124
1	Galloper	1115	3966	5081
1	Greater Gabbard	0	1	1
1	Gunfleet Sands	-	-	
1	Hornsea Project One	1070	1257	2327
1	Hornsea Project Two	468	2039	2507
1	Humber Gateway	15	10	25
1	Hywind	119	85	204
1	Kentish Flats	-	-	
1	Kentish Flats Extension	3	6	9
1	Kincardine	19	0	19
1	Lincs & LID	3	6	9
1	London Array	0	1	1
1	Methil	8	0	8
1	Moray East	2795	656	3451
1	Race Bank	1	10	11

Tier	Wind farm	Breeding season	Non-breeding season	Annual
1	Rampion	7	0	7
1	Scroby Sands	-	-	
1	Sheringham Shoal	4	26	30
1	Teesside	35	18	53
1	Thanet	0	0	0
1	Triton Knoll	23	71	94
1	Westermost Rough	61	35	96
2	Dogger Bank A and B	0	1	1
2	Moray West	2562	2103	4665
2	Neart na Gaoithe	6154	5389	11543
3	Seagreen A and B	139	1038	1177
3	Dogger Bank C and Sofia	104	930	1034
3	East Anglia One North	-	-	
3	East Anglia Three	181	307	488
3	East Anglia Two	15	0	15
3	Hornsea Project Three (revised)	253	127	380
3	Inch Cape	2956	2688	5644
3	Norfolk Boreas	0	23	23
3	Norfolk Vanguard	67	112	179
3	Hornsea Project Four	78	373	451
4	Sheringham and Dudgeon Extension Projects	0	28	28
4	Berwick Bank	4513	-	4513
4	ForthWind Offshore Wind Demonstration Project - phase 1	-	-	-
4	Rampion 2	-	-	-
4	North Falls (ES)	0	3	3
4	Five Estuaries (ES)	-	-	-
4	Outer Dowsing (ES)	784	645	1429
	Total (other schemes)	26704	24628	51332
	DBS East	63	179	242
	DBS West	109	198	307
	DBS East and West together	172	377	549
	Total (all schemes + DBS East)	26767	24807	51574
	Total (all schemes + DBS West)	26813	24826	51639
	Total (all schemes + DBS East and West together)	26876	25005	51881

~~795.~~802. The estimated annual cumulative total of puffins at risk of displacement from wind farms in the North Sea is 51,332 individuals, which rises to 51,881 individuals when including the Projects.

~~796.~~803. Considering a range of displacement of 30-70%, and mortality of displaced individuals from 1-10%, based on advice from Natural England, the estimated number of puffins subject to mortality from displacement throughout the year is between 156 and 3,632 (**Table 12-101**), and at 70% displaced and 2% mortality would be 726.

Table 12-101 Cumulative Annual Displacement Matrix for Puffin.

Mortality (%)	**Displacement (%)**									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	52	104	156	208	259	311	363	415	467	519
2	104	208	311	415	519	623	726	830	934	1038
3	156	311	467	623	778	934	1090	1245	1401	1556
4	208	415	623	830	1038	1245	1453	1660	1868	2075
5	259	519	778	1038	1297	1556	1816	2075	2335	2594
6	311	623	934	1245	1556	1868	2179	2490	2802	3113
7	363	726	1090	1453	1816	2179	2542	2905	3269	3632
8	415	830	1245	1660	2075	2490	2905	3320	3735	4150
9	467	934	1401	1868	2335	2802	3269	3735	4202	4669
10	519	1038	1556	2075	2594	3113	3632	4150	4669	5188
20	1038	2075	3113	4150	5188	6226	7263	8301	9339	10376
30	1556	3113	4669	6226	7782	9339	10895	12451	14008	15564
50	2594	5188	7782	10376	12970	15564	18158	20752	23346	25941
75	3891	7782	11673	15564	19455	23346	27238	31129	35020	38911
100	5188	10376	15564	20752	25941	31129	36317	41505	46693	51881

~~797.~~804. The largest BDMPS for puffin in UK North Sea waters is 868,689 (as advised by Natural England in their response to the Projects PEIR, see **Volume 7, Appendix 12-1 Offshore Ornithology Consultation Responses (application ref: 7.12.12.1)** for further information). At the average baseline mortality rate of 0.119 the number of individuals expected to die in a year is 103,374 (868,689 x 0.119). The addition of between 156 (30% x 1%) and 3,632 (70% x 10%) individuals to this increases the background mortality rate by respectively 0.151% and 3.513%, while 726 (70% x 2%) would increase the background mortality by 0.703%.

~~798.~~805. Based on the annual biogeographic population with connectivity to UK waters of 11,840,000 (Furness 2015), 1,408,960 individuals would be expected to die; the addition 156 (30% x 1%) and 3,632 (70% x 10%) individuals would represent an increase of between 0.011% and 0.258%, while 726 (70% x 2%) would increase the background mortality by 0.052%.

~~799.~~806. This is a wide range, so the assessment considers the most realistic value within this range. Recommendations of an evidence-based review (Norfolk Vanguard 2019) are for a displacement rate of 50% for auks (although this review focussed on guillemot and razorbill, it is considered that puffin will exhibit similar responses) within an offshore wind farm and 30% within a 1km buffer, both combined with a highly precautionary maximum mortality of 1%.

~~800.~~807. Using these rates (displacement and mortality of 50% and 1% respectively), derived from a thorough review of evidence would result in a predicted total mortality of 259 annually due to cumulative displacement. Assessed against the BDMPS 103,374 (868,689 x 0.1190) this would increase the background mortality rate by 0.251% and against the biogeographic population 1,408,960 (11,840,000 x 0.1190) by 0.018%.

~~801.~~808. On the basis of these impact sizes, combined with the various additive sources of precaution in this assessment, indicates there is a very high likelihood that cumulative displacement would be less than 1%.

~~802.~~809. The magnitude of cumulative displacement for puffins is assessed as low. Therefore, as the species is of low sensitivity to disturbance, the cumulative effect significance would be **minor adverse**. There is no change to the conclusion from the ES.

12.10.5 Impact 11 Cumulative Assessment of Operational Collision Risk

~~803.~~810. This section provides the update to section 12.7.4.1 of the original ES.

~~804.~~811. Cumulative annual collision risk was assessed for gannet, kittiwake, lesser black-backed gull, herring gull and great black-backed gull.

~~805.~~812. It is considered that all of the wind farms identified for inclusion in the cumulative assessment in **Table 12-89** have the potential to contribute to a cumulative effect.

12.10.5.1 Gannet

~~806.~~813. The cumulative gannet collision risk prediction is set out in **Table 12-102**. This collates collision predictions from other wind farms, which may contribute to the cumulative total. ~~Values updated from the original ES are highlighted in yellow.~~

Table 12-102 Cumulative Collision Risk Assessment for Gannet at the previous avoidance rate (98.9%, apart from more recent projects which have followed the latest Natural England guidance of 99.2% and macro avoidance of 70%) and also updated to latest guidance rates for all projects.

Tier	Wind farm	98.9% Avoidance rate, no macro avoidance (*unless otherwise noted)				99.2% Avoidance rate and 70% macro avoidance			
		Breeding season	Autumn migration	Spring migration	Annual	Breeding season	Autumn migration	Spring migration	Annual
1	Beatrice	37.4	48.8	9.5	95.7	8.2	10.6	2.1	20.9
1	Beatrice Demonstrator	0.6	0.9	0.7	2.2	0.1	0.2	0.2	0.5
1	Blyth Demonstration Project	3.5	2.1	2.8	8.4	0.8	0.5	0.6	1.8
1	Dudgeon	22.3	38.9	19.1	80.3	4.9	8.5	4.2	17.5
1	East Anglia ONE	3.4	131	6.3	140.7	0.7	28.6	1.4	30.7
1	European Offshore Wind Deployment Centre	4.2	5.1	0.1	9.4	0.9	1.1	0.0	2.1
1	Galloper	18.1	30.9	12.6	61.6	3.9	6.7	2.7	13.4
1	Greater Gabbard	14	8.8	4.8	27.6	3.1	1.9	1.0	6.0
1	Gunfleet Sands	-	-	-	-	-	-	-	-
1	Hornsea Project One	11.5	32	22.5	66	2.5	7.0	4.9	14.4
1	Hornsea Project Two	7	14	6	27	1.5	3.1	1.3	5.9
1	Humber Gateway	1.9	1.1	1.5	4.5	0.4	0.2	0.3	1.0
1	Hywind	5.6	0.8	0.8	7.2	1.2	0.2	0.2	1.6
1	Kentish Flats	1.4	0.8	1.1	3.3	0.3	0.2	0.2	0.7
1	Kentish Flats Extension	-	-	-	-	-	-	-	-

Tier	Wind farm	98.9% Avoidance rate, no macro avoidance (*unless otherwise noted)				99.2% Avoidance rate and 70% macro avoidance			
		Breeding season	Autumn migration	Spring migration	Annual	Breeding season	Autumn migration	Spring migration	Annual
1	Kincardine	3	0	0	3	0.7	0.0	0.0	0.7
1	Lincs & LID	2.3	1.4	1.9	5.6	0.5	0.3	0.4	1.2
1	London Array	2.3	1.4	1.8	5.5	0.5	0.3	0.4	1.2
1	Methil	6	0	0	6	1.3	0.0	0.0	1.3
1	Moray East	80.6	35.4	8.9	124.9	17.6	7.7	1.9	27.3
1	Race Bank	33.7	11.7	4.1	49.5	7.4	2.6	0.9	10.8
1	Rampion	36.2	63.5	2.1	101.8	7.9	13.9	0.5	22.2
1	Scroby Sands	-	-	-	-	-	-	-	-
1	Sheringham Shoal	14.1	3.5	0	17.6	3.1	0.8	0.0	3.8
1	Teesside	4.9	1.7	0	6.6	1.1	0.4	0.0	1.4
1	Thanet	1.1	0	0	1.1	0.2	0.0	0.0	0.2
1	Triton Knoll	26.8	64.1	30.1	121	5.8	14.0	6.6	26.4
1	Westermost Rough	0.2	0.1	0.2	0.5	0.0	0.0	0.0	0.1
2	Dogger Bank A and B	81.1	83.5	54.4	219	17.7	18.2	11.9	47.8
2	Moray West	10	2	1	13	2.2	0.4	0.2	2.8
2	Neart na Gaoithe	143	47	23	213	31.2	10.3	5.0	46.5
2	Seagreen A and B	800.8	49.3	65.8	915.9	174.7	10.8	14.4	199.8
3	Dogger Bank C and Sofia	14.8	10.1	10.8	35.7	3.2	2.2	2.4	7.8
3	East Anglia One North	12.4	11	1.1	24.5	2.7	2.4	0.2	5.3

Tier	Wind farm	98.9% Avoidance rate, no macro avoidance (*unless otherwise noted)				99.2% Avoidance rate and 70% macro avoidance			
		Breeding season	Autumn migration	Spring migration	Annual	Breeding season	Autumn migration	Spring migration	Annual
3	East Anglia Three	6.1	33.3	9.6	49	1.3	7.3	2.1	10.7
3	East Anglia Two	12.5	23.1	4	39.6	2.7	5.0	0.9	8.6
3	Hornsea Project Three (revised)	10	5	4	19	2.2	1.1	0.9	4.1
3	Inch Cape	336.9	29.2	5.2	371.3	73.5	6.4	1.1	81.0
3	Norfolk Boreas	14.1	12.7	3.9	30.7	3.1	2.8	0.9	6.7
3	Norfolk Vanguard	8.2	18.6	5.3	32.1	1.8	4.1	1.2	7.0
3	Hornsea Project Four	15.6	5	1.4	22	3.4	1.1	0.3	4.8
4	Sheringham and Dudgeon Extension Projects	0.4	0.6	0	1	0.4	0.6	0.0	1.0
4	Berwick Bank	170	18	3	191	37.1	3.9	0.7	41.7
4	ForthWind Offshore Wind Demonstration Project - phase 1	1	0	0	1	0.1	0.0	0.0	0.1
4	Rampion 2*	2.9	1.4	0.6	4.9	2.9	1.4	0.6	4.9
4	North Falls (ES)*	0.6	0.9	0.6	2.1	0.6	0.9	0.6	2.1
4	Five Estuaries (ES)*	2.4	2.7	0.3	5.4	2.4	2.7	0.3	5.4
4	Outer Dowsing (ES)*	2.9	0.4	0.4	3.7	2.9	0.4	0.4	3.7
	Total (other schemes)	1987.8	851.8	331.3	3170.9	440.8	190.5	73.8	705.1
	*DBS East**	3.4	1.6	0.1	5.1	3.4	1.6	0.1	5.1

Tier	Wind farm	98.9% Avoidance rate, no macro avoidance (*unless otherwise noted)				99.2% Avoidance rate and 70% macro avoidance			
		Breeding season	Autumn migration	Spring migration	Annual	Breeding season	Autumn migration	Spring migration	Annual
	*DBS West**	4.9	2.1	0.1	7.1	4.9	2.1	0.1	7.1
	DBS East and West together	8.3	3.7	0.2	12.2	8.3	3.7	0.2	12.2
	Total (all schemes + DBS East)	1991.2	853.4	331.4	3176.0	444.2	192.1	73.9	710.2
	Total (all schemes + DBS West)	1992.7	853.9	331.4	3178.0	445.7	192.6	73.9	712.2
	Total (all schemes + DBS East and West together)	1996.1	855.5	331.5	3183.1	449.1	194.2	74.0	717.3

~~807.~~814. The estimates for other wind farms were calculated under previous Natural England guidance on parameter rates to use. Specifically, these have used an avoidance rate of 98.9%, which generates collision risks approximately 4 to 10 times higher than that obtained using the latest advised rates of 99.72% to 99.88% (99.79%), which incorporates 65% to 85% (70%) macro avoidance (**Table 12-78**). Expressed as the collision rate (rather than the avoidance rate), this means that collisions predicted with the 98.9% avoidance rate are reduced from 1.1% to 0.2% (i.e. a five-fold reduction). The nocturnal activity rates used will also typically have been higher for older wind farms in most instances, further increasing the precaution in collision estimates for previous schemes.

~~808.~~815. The annual cumulative total estimated collision mortality for existing wind farm schemes under the latest guidance 705 (3,171 under the old guidance). To this, the Projects add 12 birds, taking the total to 717.

~~809.~~816. Based on the largest Annual BDMPS of 456,299 (Furness 2015) and baseline mortality of 0.1866, 85,145 individual gannets would be expected to die each year; the addition of 717 collisions (including the Projects) would represent a 0.84% increase in annual mortality. Based on the annual biogeographic population with connectivity to UK waters of 1,180,000 (Furness 2015), 220,188 individuals would be expected to die; the addition of 717 collisions would represent 0.32% increase in mortality.

~~810.~~817. Furthermore, many of the collision estimates for older wind farms were calculated for designs with higher numbers of wind turbines (and total rotor swept areas) than have been installed (or are currently planned). These design changes almost always result in reduced collision risks. A method for updating collision estimates for changes in windfarm design such as this was presented in MacArthur Green (2017). This uses ratios of consented and as-built turbine parameters to robustly adjust the collision risk mortality estimates for a consented wind farm. Updating the collision estimates for wind farms in the North Sea using the built wind farm designs rather than the consented worst-case designs reduces the cumulative annual mortality by around 7%. Thus the current cumulative collision total is likely a considerable overestimate of the real level of impact.

~~811.~~818. In conclusion, based on the above information and realistic reductions in predicted collision rates due to (i) post-consent windfarm design revisions; (ii) the increase in avoidance rate and (iii) the reduction in nocturnal activity factor, the cumulative impact on the gannet population due to collisions is considered to be not significant, and the contribution to the total from the Projects is very small.

~~812.~~819. The cumulative impact on the gannet population due to collisions year round is considered to be negligible when assessed using the most recent avoidance rate. Gannets are considered to be of low to medium sensitivity to collision mortality and the effect significance is therefore **negligible** to **minor adverse**. There is no change to the conclusion from the ES.

12.10.5.2 Kittiwake

~~813.~~820. This section provides the update to section 12.7.4.2 of the original ES.

~~814.~~821. The cumulative kittiwake collision risk prediction is set out in **Table 12-103**. This collates collision predictions from other wind farms, which may contribute to the cumulative total. ~~Values updated from the original ES are highlighted in yellow.~~

Table 12-103 Cumulative Collision Risk Assessment for Kittiwake at the previous avoidance rate (98.9%, apart from more recent projects which have followed the latest Natural England guidance of 99.23%) and also updated to latest guidance rates for all projects..

Tier	Wind farm	98.9% Avoidance rate (*unless otherwise noted)				99.23% Avoidance rate			
		Breeding season	Autumn migration	Spring migration	Annual	Breeding season	Autumn migration	Spring migration	Annual
1	Beatrice	94.7	10.7	39.8	145.2	66.3	7.5	27.9	101.6
1	Beatrice Demonstrator	0	2.1	1.7	3.8	0	1.5	1.2	2.7
1	Blyth Demonstration Project	1.7	2.3	1.4	5.4	1.2	1.6	1	3.8
1	Dudgeon	-	-	-	-	-	-	-	-
1	East Anglia ONE	1.8	160.4	46.8	209	1.3	112.3	32.8	146.3
1	European Offshore Wind Deployment Centre	11.8	5.8	1.1	18.7	8.3	4.1	0.8	13.1
2	Galloper	6.3	27.8	31.8	65.9	4.4	19.5	22.3	46.1
1	Greater Gabbard	1.1	15	11.4	27.5	0.8	10.5	8	19.3
1	Gunfleet Sands	-	-	-	-	-	-	-	-
1	Hornsea Project One	44	55.9	20.9	120.8	30.8	39.1	14.6	84.6
1	Hornsea Project Two	16	9	3	28	11.2	6.3	2.1	19.6
1	Humber Gateway	1.9	3.2	1.9	7	1.3	2.2	1.3	4.9
1	Hywind	16.6	0.9	0.9	18.4	11.6	0.6	0.6	12.9
1	Kentish Flats	0	0.9	0.7	1.6	0	0.6	0.5	1.1
1	Kentish Flats Extension	0	0	2.7	2.7	0	0	1.9	1.9
1	Kincardine	22	9	1	32	15.4	6.3	0.7	22.4

Tier	Wind farm	98.9% Avoidance rate (*unless otherwise noted)				99.23% Avoidance rate			
		Breeding season	Autumn migration	Spring migration	Annual	Breeding season	Autumn migration	Spring migration	Annual
1	Lincs & LID	0.7	1.2	0.7	2.6	0.5	0.8	0.5	1.8
1	London Array	1.4	2.3	1.8	5.5	1	1.6	1.3	3.9
1	Methil	0.4	0	0	0.4	0.3	0	0	0.3
1	Moray East	43.6	2	19.3	64.9	30.5	1.4	13.5	45.4
1	Race Bank	1.9	23.9	5.6	31.4	1.3	16.7	3.9	22
1	Rampion	54.4	37.4	29.7	121.5	38.1	26.2	20.8	85.1
1	Scroby Sands	-	-	-	-	-	-	-	-
1	Sheringham Shoal	-	-	-	-	-	-	-	-
1	Teesside	38.4	24	2.5	64.9	26.9	16.8	1.8	45.4
1	Thanet	0.2	0.5	0.4	1.1	0.1	0.4	0.3	0.8
1	Triton Knoll	24.6	139	45.4	209	17.2	97.3	31.8	146.3
1	Westermost Rough	0.1	0.2	0.1	0.4	0.1	0.1	0.1	0.3
2	Dogger Bank A and B	288.6	135	295.4	719	202	94.5	206.8	503.3
2	Moray West	79	24	7	110	55.3	16.8	4.9	77
2	Neart na Gaoithe	32.9	56.1	4.4	93.4	23	39.3	3.1	65.4
2	Seagreen A and B	153.1	313.1	247.6	713.8	107.2	219.2	173.3	499.7
3	Dogger Bank C and Sofia	136.9	90.7	216.9	444.5	95.8	63.5	151.8	311.2
3	East Anglia One North	40.4	8.1	3.5	52	28.3	5.7	2.5	36.4
3	East Anglia Three	6.1	69	37.6	112.7	4.3	48.3	26.3	78.9

Tier	Wind farm	98.9% Avoidance rate (*unless otherwise noted)				99.23% Avoidance rate			
		Breeding season	Autumn migration	Spring migration	Annual	Breeding season	Autumn migration	Spring migration	Annual
3	East Anglia Two	29.5	5.4	7.4	42.3	20.7	3.8	5.2	29.6
3	Hornsea Project Three (revised)	77	38	8	123	53.9	26.6	5.6	86.1
3	Inch Cape	13.1	224.8	63.5	301.4	9.2	157.4	44.5	211
3	Norfolk Boreas	13.3	32.2	11.9	57.4	9.3	22.5	8.3	40.2
3	Norfolk Vanguard	21.8	16.4	19.3	57.5	15.3	11.5	13.5	40.3
3	Hornsea Project Four	74.5	13.9	4.6	93	52.2	9.7	3.2	65.1
4	Sheringham and Dudgeon Extension Projects	9.9	5.8	1.3	15	6.9	4.1	0.9	10.5
4	Berwick Bank	617	190	179	986	431.9	133	125.3	690.2
4	ForthWind Offshore Wind Demonstration Project - phase 1	-	-	-	-	-	-	-	-
4	Rampion 2 *	1.2	9.8	17.3	28.3	1.2	9.8	17.3	28.3
4	North Falls (ES)*	8.8	3.6	7.8	20.2	8.8	3.6	7.8	20.2
4	Five Estuaries (ES)*	11.9	7.9	5.5	25.3	11.9	7.9	5.5	25.3
4	Outer Dowsing (ES)*	25.5	2.8	2.6	30.9	25.5	2.8	2.6	30.9
	Total (other schemes)	2024.1	1780.1	1411.2	5213.4	1431.3	1253.4	998.1	3681.2
	*DBS East**	83.3	41.4	14.6	139.3	83	41	15	139
	*DBS West**	107.8	37.9	14.9	160.6	108	38	15	161
	*DBS East and West together**	191.1	79.3	29.5	299.9	191	79	30	300

Tier	Wind farm	98.9% Avoidance rate (*unless otherwise noted)				99.23% Avoidance rate			
		Breeding season	Autumn migration	Spring migration	Annual	Breeding season	Autumn migration	Spring migration	Annual
	Total (all schemes + DBS East)	2107.4	1821.5	1425.8	5352.7	1514.3	1294.4	1013.1	3820.2
	Total (all schemes + DBS West)	2131.9	1818.0	1426.1	5374.0	1539.3	1291.4	1013.1	3842.2
	Total (all schemes + DBS East and West together)	2215.2	1859.4	1440.7	5513.3	1622.3	1332.4	1028.1	3981.2

~~815.~~822. The estimates for other wind farms were calculated under previous Natural England guidance on the parameter rates to use. Specifically, these have used an avoidance rate of 98.9% rather than the rate of 99.23% in the latest guidance used in this assessment. Expressed as the collision rate (rather than the avoidance rate), this means that the predicted collision risk is reduced from 1.1% to 0.8%, and estimates for older wind farms are 37.5% higher than those obtained using the latest advice.

~~816.~~823. The annual cumulative total using the older avoidance rate for wind farms prior to Rampion 2 and not including the Projects, is 5,213, which is reduced to 3,681 on application of the revised avoidance rate (99.23%). To this latter value, the Projects add a maximum of 300 birds. Based on the largest Annual BDMPS of 839,456 (as advised by Natural England in their response to the Projects PEIR, see **Volume 7, Appendix 12-1 Offshore Ornithology Consultation Responses (application ref: 7.12.12.1)** for further information) and baseline mortality of 0.1577, 132,382 individual kittiwakes would be expected to die each year. The addition of 3,981 collisions (including the Projects) would represent a 3.0% increase in annual mortality. Based on the annual biogeographic population with connectivity to UK waters of 5,100,000 (Furness 2015), 804,720 individuals would be expected to die. The addition of 3,981 collisions would represent 0.49% increase in mortality.

~~817.~~824. As the increase in background mortality assessed against the BDMPS population exceeded 1% the Natural England commissioned PVA tool was used to examine the effect of the estimated cumulative mortality on the kittiwake BDMPS population. The complete input parameters and settings and results are provided in **Appendix 12-13 – Population Viability Analyses (Revision 2)** [document reference: 7.12.12.13]. The counterfactuals of growth rate (CGR) and population size (CPS) are presented in Table 12-104.

Table 12-104 PVA results for cumulative combined displacement and collisions impacts on the kittiwake BDMPS population after 30 years.

PVA run scenario	Annual mortality	Decrease in adult survival rate	Mean CGR (95% c.i.)	Mean CPS (95% c.i.)
Cumulative collisions	3,981	0.04465	0.9471~~713~~ (0.9455~~699~~-0.9484~~726~~)	0.1853~~4053~~ (0.1759~~3878~~-0.1935~~4227~~)

~~818.~~825. After a period of 30 years, cumulative collisions reduced the BDMPS population growth rate by up to 5.3~~2.9~~% (0.9471~~713~~) and reduced the BDMPS population size compared to the baseline by up to 81~~59~~% (0.1853~~4053~~).Reviews of nocturnal activity in seabirds have led Natural England to advise that rates between 25% and 50% are appropriate for kittiwake (whilst still retaining precaution) for assessment of collisions. These lower rates have been applied to more recent wind farm assessments (i.e. over the last year), but previously the higher rate of 50% will have been used in most cases. Retrospective application of lower nocturnal activity rates for older wind farms would reduce the cumulative collision estimate, potentially by a significant amount (due to variations in daylength over the annual cycle at different latitudes this cannot be simply calculated but reductions are likely to be in the order of approximately 10%). This further emphasises the precautionary nature of the current assessment.

~~819.~~826. The cumulative impact on the kittiwake population due to collisions year round is considered to be of low to medium magnitude, and the relative contribution of the proposed Projects to this cumulative total is very small. Kittiwakes are considered to be of low to medium sensitivity to collision mortality and the effect significance is therefore **minor** to **moderate adverse**. There is no change to the conclusion from the ES.

12.10.5.3 Lesser Black-backed Gull

~~820.~~827. This section provides the update to section 12.7.4.3 of the ES.

~~821.~~828. The cumulative collision risk prediction for lesser black-backed gull is set out in **Table 12-105**. This collates collision predictions from other wind farms which may contribute to the cumulative total. ~~Values updated from the original ES are highlighted in yellow.~~

Table 12-105 Cumulative Collision Risk Assessment for Lesser black-backed gull at the previous avoidance rate (99.5%, apart from more recent projects which have followed the latest Natural England guidance of 99.4%) and also updated to latest guidance rates for all projects..

Tier	Wind farm	Previous avoidance rate (99.5%) unless noted *			Updated avoidance rate (99.4%)		
		Breeding season	Nonbreeding season	Annual	Breeding season	Nonbreeding season	Annual
1	Beatrice	0	0	0	0	0	0
1	Beatrice Demonstrator	-	-	-	-	-	-
1	Blyth Demonstration Project	0	0	0	0	0	0
1	Dudgeon	7.7	30.6	38.3	9.2	36.7	46
1	East Anglia ONE	5.9	33.8	39.7	7.1	40.6	47.6
1	European Offshore Wind Deployment Centre	0	0	0	0	0	0
1	Galloper	27.8	111	138.8	33.4	133.2	166.6
1	Greater Gabbard	12.4	49.6	62	14.9	59.5	74.4
1	Gunfleet Sands	1	0	1	1.2	0	1.2
1	Hornsea Project One	4.4	17.4	21.8	5.3	20.9	26.2
1	Hornsea Project Two	2	2	4	2.4	2.4	4.8
1	Humber Gateway	0.3	1.1	1.4	0.4	1.3	1.7
1	Hywind	0	0	0	0	0	0
1	Kentish Flats	-	-	-	-	-	-
1	Kentish Flats Extension	0.3	1.3	1.6	0.4	1.6	1.9

Tier	Wind farm	Previous avoidance rate (99.5%) unless noted *			Updated avoidance rate (99.4%)		
		Breeding season	Nonbreeding season	Annual	Breeding season	Nonbreeding season	Annual
1	Kincardine	0	0	0	0	0	0
1	Lincs & LID	1.7	6.8	8.5	2	8.2	10.2
1	London Array	-	-	-	-	-	-
1	Methil	0.5	0	0.5	0.6	0	0.6
1	Moray East	0	0	0	0	0	0
1	Race Bank	43.2	10.8	54	51.8	13	64.8
1	Rampion	1.6	6.3	7.9	1.9	7.6	9.5
1	Scroby Sands	-	-	-	-	-	-
1	Sheringham Shoal	1.7	6.6	8.3	2	7.9	10
1	Teesside	0	0	0	0	0	0
1	Thanet	3.2	12.8	16	3.8	15.4	19.2
1	Triton Knoll	7.4	29.6	37	8.9	35.5	44.4
1	Westermost Rough	0.1	0.3	0.4	0.1	0.4	0.5
2	Dogger Bank A and B	2.6	10.4	13	3.1	12.5	15.6
2	Moray West	0	0	0	0	0	0
2	Neart na Gaoithe	0.3	1.2	1.5	0.4	1.4	1.8
2	Seagreen A and B	2.1	8.4	10.5	2.5	10.1	12.6
3	Dogger Bank C and Sofia	2.4	9.6	12	2.9	11.5	14.4
3	East Anglia One North	0.9	0.6	1.5	1.1	0.7	1.8

Tier	Wind farm	Previous avoidance rate (99.5%) unless noted *			Updated avoidance rate (99.4%)		
		Breeding season	Nonbreeding season	Annual	Breeding season	Nonbreeding season	Annual
3	East Anglia Three	1.8	8.2	10	2.2	9.8	12
3	East Anglia Two	4.2	0.5	4.7	5	0.6	5.6
3	Hornsea Project Three (revised)	8	1	9	9.6	1.2	10.8
3	Inch Cape	0	0	0	0	0	0
3	Norfolk Boreas	6.2	8.1	14.3	7.4	9.7	17.2
3	Norfolk Vanguard	8.4	3.6	12	10.1	4.3	14.4
3	Hornsea Project Four	0.3	0.1	0.4	0.4	0.1	0.5
4	Sheringham and Dudgeon Extension Projects*	1.9	0.3	2.2	2.3	0.4	2.6
4	Berwick Bank	9	0	9	10.8	0	10.8
4	ForthWind Offshore Wind Demonstration Project – phase 1	0	0	0	0	0	0
4	Rampion 2*	1.5	2.9	4.4	1.5	2.9	4.4
4	North Falls (ES)*	6.5	2	8.6	6.5	2.0	8.6
4	Five Estuaries (ES)*	35.1	5.5	40.6	35.1	5.5	40.6
4	Outer Dowsing (ES) *	1.5	0.2	1.7	1.5	0.2	1.7
	Total (other schemes)	213.9	382.6	596.6	247.8	457.1	705
	*DBS East**	0.9	0	0.9	0.9	0	0.9
	*DBS West**	0.3	0	0.3	0.3	0	0.3

Tier	Wind farm	Previous avoidance rate (99.5%) unless noted *			Updated avoidance rate (99.4%)		
		Breeding season	Nonbreeding season	Annual	Breeding season	Nonbreeding season	Annual
	DBS East and West together	1.2	0	1.2	1.2	0	1.2
	Total (all schemes + DBS East)	214.8	382.6	597.5	248.7	457.1	705.9
	Total (all schemes + DBS West)	214.2	382.6	596.9	248.1	457.1	705.3
	Total (all schemes + DBS East and West together)	215.1	382.6	597.8	249.0	457.1	706.2

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~~822.~~829. The annual number of lesser black-backed gull at risk of collision from offshore wind farms in the UK North Sea and Channel BDMPS has been calculated as 597. When the estimated numbers at risk due to the Projects are included (1.2), this would increase to 597.8 collisions.

~~823.~~830. The estimates for other wind farms were calculated under previous Natural England guidance on the parameter rates to use. Specifically, these have used an avoidance rate of 99.5% rather than the rate of 99.4% in the latest guidance used in this assessment. Expressed as the collision rate (rather than the avoidance rate), this means that the predicted collision risk is increased from 0.5% to 0.6%, and that the older estimates for other wind farms are 20% lower than those obtained using the latest advice.

~~824.~~831. The annual cumulative total, not including the Projects, is 596.6, which increases to 705 on application of the revised avoidance rate. To this, the Projects add a maximum of 1.2 birds. Based on the largest Annual BDMPS of 209,006 (Furness 2015) and baseline mortality of 0.1237, 25,854 individual lesser black-backed gulls would be expected to die each year; the addition of 706 collisions (including the Projects) would represent a 2.7% increase in annual mortality. Based on the annual biogeographic population with connectivity to UK waters of 864,000 (Furness 2015), 106,877 individuals would be expected to die; the addition of 706 collisions would represent 0.66% increase in mortality.

~~825.~~832. As the increase in background mortality assessed against the BDMPS population exceeded 1% the Natural England commissioned PVA tool was used to examine the effect of the estimated cumulative mortality on the lesser black-backed gull BDMPS population. The complete input parameters and settings and results are provided in **Appendix 12-13 – Population Viability Analyses (Revision 2)** [document reference: 7.12.12.13]. The counterfactuals of growth rate (CGR) and population size (CPS) are presented in **Table 12-106**.

Table 12-106 PVA results for cumulative combined displacement and collisions impacts on the lesser black-backed gull BDMPS population after 30 years.

PVA run scenario	Annual mortality	Decrease in adult survival rate	Mean CGR (95% c.i.)	Mean CPS (95% c.i.)
Cumulative collisions	706	0.003378	0.99961~~76~~ (0.99956~~9~~-0.99967~~82~~)	0.88739~~9274~~ (0.86949~~9072~~-0.9058~~465~~)

~~826.~~833. After a period of 30 years, cumulative collisions reduced the BDMPS population growth rate by up to 0.39~~24~~% (0.9961~~76~~) and reduced the BDMPS population size compared to the baseline by up to 11.~~7.~~3% (0.88739~~274~~).

~~827.~~834. Reviews of nocturnal activity in seabirds have led Natural England to advise that rates between 25% and 50% are appropriate for lesser black-backed gull (whilst still retaining precaution) for assessment of collisions. These lower rates have been applied to more recent wind farm assessments (i.e. over the last year), but previously the higher rate of 50% will have been used. Retrospective application of lower nocturnal activity rates for older wind farms would reduce the cumulative collision estimate by a similar amount.

~~828.~~835. Applying reductions for lowered nocturnal activity to predictions for older wind farms would reduce the cumulative collision estimate further emphasising the precautionary nature of the current assessment.

~~829.~~836. The cumulative impact on the lesser black-backed gulls population due to collisions year round is considered to be of low magnitude, and the relative contribution of the proposed Projects to this cumulative total is very small. Lesser black-backed gulls are considered to be of low to medium sensitivity to collision mortality and the effect significance is therefore **minor adverse**. There is no change to the conclusion from the ES.

12.10.5.4 Herring Gull

~~830.~~837. This section provides the update to section 12.7.4.4 of the ES.

~~831.~~838. The cumulative herring gull collision risk prediction is set out in **Table 12-107**. This collates collision predictions from other wind farms which may contribute to the cumulative total. ~~Values updated from the original ES are highlighted in yellow.~~

Table 12-107 Cumulative Collision Risk Assessment for herring gull at the previous avoidance rate (99.5%, apart from more recent projects which have followed the latest Natural England guidance of 99.4%) and also updated to latest guidance rates for all projects.

Tier	Wind farm	Previous avoidance rate (99.5%) unless noted *			Updated avoidance rate (99.4%)		
		Breeding season	Nonbreeding season	Annual	Breeding season	Nonbreeding season	Annual
1	Beatrice	49.4	197.4	246.8	59.3	236.9	296.2
1	Beatrice Demonstrator	0	-	0	0	-	0
1	Blyth Demonstration Project	0.5	2.2	2.7	0.6	2.6	3.2
1	Dudgeon	-	-	-	-	-	-
1	East Anglia ONE	0	28	28	0	33.6	33.6
1	European Offshore Wind Deployment Centre	4.8	-	4.8	5.8	-	5.8
1	Galloper	27.2	-	27.2	32.6	-	32.6
1	Greater Gabbard	0	-	0	0	-	0
1	Gunfleet Sands		-		-	-	-
1	Hornsea Project One	2.9	11.6	14.5	3.5	13.9	17.4
1	Hornsea Project Two	23.8		23.8	28.6	0	28.6
1	Humber Gateway	0.4	1.1	1.5	0.5	1.3	1.8
1	Hywind	0.6	7.8	8.4	0.7	9.4	10.1
1	Kentish Flats	0	0	0	0	0	0
1	Kentish Flats Extension	0.5	1.7	2.2	0.6	2	2.6
1	Kincardine	1	0	1	1.2	0	1.2
1	Lincs & LID	0	-	0	0	-	0

Tier	Wind farm	Previous avoidance rate (99.5%) unless noted *			Updated avoidance rate (99.4%)		
		Breeding season	Nonbreeding season	Annual	Breeding season	Nonbreeding season	Annual
1	London Array	-	-	-	-	-	-
1	Methil	5.8	3.7	9.5	7	4.4	11.4
1	Moray East	52	-	52	62.4	-	62.4
1	Race Bank	0	-	0	0	-	0
1	Rampion	155	-	155	186	-	186
1	Scroby Sands	-	-	-	-	-	-
1	Sheringham Shoal	0		0	0	0	0
1	Teesside	8.7	34.5	43.2	10.4	41.4	51.8
1	Thanet	4.9	19.6	24.5	5.9	23.5	29.4
1	Triton Knoll	0		0	0	0	0
1	Westermost Rough	0.1	0	0.1	0.1	0	0.1
2	Dogger Bank A and B	0	-	0	0	-	0
2	Moray West	12	1	13	14.4	1.2	15.6
2	Neart na Gaoithe	5	12.5	17.5	6	15	21
2	Seagreen A and B	10	21	31	12	25.2	37.2
3	Dogger Bank C and Sofia	0	-	0	0	-	0
3	East Anglia One North	0	0	0	0	0	0
3	East Anglia Three	0	23	23	0	27.6	27.6
3	East Anglia Two	0	0.5	0.5	0	0.6	0.6

Tier	Wind farm	Previous avoidance rate (99.5%) unless noted *			Updated avoidance rate (99.4%)		
		Breeding season	Nonbreeding season	Annual	Breeding season	Nonbreeding season	Annual
3	Hornsea Project Three (revised)	1	4	5	1.2	4.8	6
3	Inch Cape	0	13.5	13.5	0	16.2	16.2
3	Norfolk Boreas	1.5	5.4	6.9	1.8	6.5	8.3
3	Norfolk Vanguard	0.4	7.1	7.5	0.5	8.5	9
3	Hornsea Project Four	0.5	0.3	0.8	0.6	0.4	1
4	Sheringham and Dudgeon Extension Projects	0.3	0.0	0.3	0.4	0	0.4
4	Berwick Bank	43	7	50	51.6	8.4	60
4	ForthWind	0	0	0	0	0	0
4	Rampion 2*	34.5	28.1	62.6	34.5	28.1	62.6
4	North Falls (ES)*	0.7	0	0.7	0.7	0	0.7
4	Five Estuaries (ES)*	0.7	1.4	2.1	0.7	1.4	2.1
4	Outer Dowsing (ES)*	1.5	0.7	2.2	1.5	0.7	2.2
	Total (other schemes)	448.7	433.1	881.8	531.1	513.6	1044.7
	*DBS East**	0	0.6	0.6	0	0.6	0.6
	*DBS West**	0.8	0.8	1.6	0.8	0.8	1.6
	*DBS East and West together**	0.8	1.4	2.2	0.8	1.4	2.2
	Total (all schemes + DBS East)	448.7	433.7	882.4	531.1	514.2	1045.3
	Total (all schemes + DBS West)	449.5	433.9	883.4	531.9	514.4	1046.3

Tier	Wind farm	Previous avoidance rate (99.5%) unless noted *			Updated avoidance rate (99.4%)		
		Breeding season	Nonbreeding season	Annual	Breeding season	Nonbreeding season	Annual
	Total (all schemes + DBS East and West together)	449.5	434.5	884.0	531.9	515	1046.9

~~832.~~839. The annual number of herring gull at risk of collision from offshore wind farms in the UK North Sea and Channel BDMPS has been calculated as 881.8. When the estimated numbers at risk due to the Projects are included (2.2), this would increase to 884 collisions.

~~833.~~840. The estimates for other wind farms were calculated under previous Natural England guidance on the parameter rates to use. Specifically, these have used an avoidance rate of 99.5% rather than the rate of 99.4% in the latest guidance used in this assessment. Expressed as the collision rate (rather than the avoidance rate), this means that the predicted collision risk is increased from 0.5% to 0.6%, and that the older estimates for other wind farms are 20% lower than those obtained using the latest advice.

~~834.~~841. The annual cumulative total, not including the Projects, is 881.8, which would be increased to 1,045 on application of the revised avoidance rate. To this the Projects add a maximum of 2.2 birds. Based on the largest Annual BDMPS of 466,510 (Furness 2015) and baseline mortality of 0.1724, 80,426 individual herring gulls would be expected to die each year; the addition of 1,047 collisions (including the Projects) would represent a 1.3% increase in annual mortality. Based on the annual biogeographic population with connectivity to UK waters of 1,098,000 (Furness 2015), 189,295 individuals would be expected to die; the addition of 1,047 collisions would represent 0.55% increase in mortality.

~~835.~~842. As the increase in background mortality assessed against the BDMPS population exceeded 1% the Natural England commissioned PVA tool was used to examine the effect of the estimated cumulative mortality on the herring gull BDMPS population. The complete input parameters and settings and results are provided in **Appendix 12-13 – Population Viability Analyses (Revision 2)** [document reference: 7.12.12.13]. The counterfactuals of growth rate (CGR) and population size (CPS) are presented in **Table 12-108**.

Table 12-108 PVA results for cumulative combined displacement and collisions impacts on the herring gull BDMPS population after 30 years.

PVA run scenario	Annual mortality	Decrease in adult survival rate	Mean CGR (95% c.i.)	Mean CPS (95% c.i.)
Cumulative collisions	1,047	0.002244	0.9973~~85~~ (0.9966~~78~~- 0.9979~~91~~)	0.9191~~541~~ (0.8991~~9322~~- 0.9393~~753~~)

~~836.~~843. After a period of 30 years, cumulative collisions reduced the BDMPS population growth rate by up to 0.27~~15~~% (0.997~~385~~) and reduced the BDMPS population size compared to the baseline by up to 8.1~~4.6~~% (0.9191~~541~~).

~~837.~~844. Reviews of nocturnal activity in seabirds have led Natural England to advise that rates between 25% and 50% are appropriate for herring gull (whilst still retaining precaution) for assessment of collisions. These lower rates have been applied to more recent wind farm assessments (i.e. over the last year), but previously the higher rate of 50% will have been used. Retrospective application of lower nocturnal activity rates for older wind farms would reduce the cumulative collision estimate by a similar amount.

~~838.~~845. Applying reductions for lowered nocturnal activity to predictions for older wind farms would reduce the cumulative collision estimate further emphasising the precautionary nature of the current assessment.

~~839.~~846. In conclusion, the cumulative impact on herring gull due to year round collisions includes precaution and is considered to be of negligible magnitude; and the relative contribution of the proposed Projects to this cumulative total is very small. Herring gulls are considered to be of low to medium sensitivity to collision mortality and the effect significance is therefore **minor adverse**. There is no change to the conclusion from the ES.

12.10.5.5 Great Black-backed Gull

~~840.~~847. This section provides the update to section 12.7.4.5 of the ES.

~~841.~~848. The cumulative predicted collision risk for great black-backed gull is set out in **Table 12-109**. This collates collision predictions from other wind farms which may contribute to the cumulative total. ~~Values updated from the original ES are highlighted in yellow.~~

Table 12-109 Cumulative Collision Risk Assessment for Great black-backed gull at the previous avoidance rate (99.5%, apart from more recent projects which have followed the latest Natural England guidance of 99.4%) and also updated to latest guidance rates for all projects.

Tier	Wind farm	Previous avoidance rate (99.5%) unless noted *			Updated avoidance rate (99.4%)		
		Breeding season	Nonbreeding season	Annual	Breeding season	Nonbreeding season	Annual
1	Beatrice	30.2	120.8	151	36.2	145	181.2
1	Beatrice Demonstrator	0	0	0	0	0	0
1	Blyth Demonstration Project	1.3	5.1	6.4	1.6	6.1	7.7
1	Dudgeon	0	0	0	0	0	0
1	East Anglia ONE	0	46	46	0	55.2	55.2
1	European Offshore Wind Deployment Centre	0.6	2.4	3	0.7	2.9	3.6
1	Galloper	4.5	18	22.5	5.4	21.6	27
1	Greater Gabbard	15	60	75	18	72	90
1	Gunfleet Sands	-	-	-	-	-	-
1	Hornsea Project One	17.2	68.6	85.8	20.6	82.3	103
1	Hornsea Project Two	3	20	23	3.6	24	27.6
1	Humber Gateway	1.3	5.1	6.4	1.6	6.1	7.7
1	Hywind	0.3	4.5	4.8	0.4	5.4	5.8
1	Kentish Flats	-	-	-	-	-	-
1	Kentish Flats Extension	0.1	0.2	0.3	0.1	0.2	0.4

Tier	Wind farm	Previous avoidance rate (99.5%) unless noted *			Updated avoidance rate (99.4%)		
		Breeding season	Nonbreeding season	Annual	Breeding season	Nonbreeding season	Annual
1	Kincardine	0	0	0	0	0	0
1	Lincs & LID	0	0	0	0	0	0
1	London Array	-	-	-	-	-	-
1	Methil	0.8	0.8	1.6	1	1	1.9
1	Moray East	9.5	25.5	35	11.4	30.6	42
1	Race Bank	0	0	0	0	0	0
1	Rampion	5.2	20.8	26	6.2	25	31.2
1	Scroby Sands	-	-	-	-	-	-
1	Sheringham Shoal	0	0	0	0	0	0
1	Teesside	8.7	34.8	43.5	10.4	41.8	52.2
1	Thanet	0.1	0.4	0.5	0.1	0.5	0.6
1	Triton Knoll	24.4	97.6	122	29.3	117.1	146.4
1	Westermost Rough	0.1	0	0.1	0.1	0	0.1
2	Dogger Bank A and B	5.8	23.3	29.1	7	28	34.9
2	Moray West	4	5	9	4.8	6	10.8
2	Neart na Gaoithe	0.9	3.6	4.5	1.1	4.3	5.4
2	Seagreen A and B	13.4	53.4	66.8	16.1	64.1	80.2
3	Dogger Bank C and Sofia	6.4	25.5	31.9	7.7	30.6	38.3
3	East Anglia One North	3.7	1.2	4.9	4.4	1.4	5.9

Tier	Wind farm	Previous avoidance rate (99.5%) unless noted *			Updated avoidance rate (99.4%)		
		Breeding season	Nonbreeding season	Annual	Breeding season	Nonbreeding season	Annual
3	East Anglia Three	4.6	34.4	39	5.5	41.3	46.8
3	East Anglia Two	3.5	3.4	6.9	4.2	4.1	8.3
3	Hornsea Project Three (revised)	8	28	36	9.6	33.6	43.2
3	Inch Cape	0	36.8	36.8	0	44.2	44.2
3	Norfolk Boreas	6.9	28.7	35.6	8.3	34.4	42.7
3	Norfolk Vanguard	4.5	21.5	26	5.4	25.8	31.2
3	Hornsea Project Four	0.8	8.8	9.6	1	10.6	11.5
4	Sheringham and Dudgeon Extension Projects	5.7	0.3	6	6.8	0.4	7.2
4	Berwick Bank	-	-	-	-	-	-
4	ForthWind Offshore Wind Demonstration Project - phase 1	-	-	-	-	-	-
4	Rampion 2*	6.3	13.6	19.9	6.3	13.6	19.9
4	North Falls (ES)*	0	3	3	0	3	3
4	Five Estuaries (ES)*	0.7	0.6	1.3	0.7	0.6	1.8
4	Outer Dowsing (ES)*	3.0	0.7	3.7	3	0.7	3.7
	Total (other schemes)	200.5	822.4	1023.4	238.6	983.5	1222.6
	*DBS East**	0.9	2.8	3.7	0.9	2.8	3.7
	*DBS West**	0	1.2	1.2	0	1.2	1.2
	*DBS East and West together**	0.9	4	4.9	0.9	4	4.9

Tier	Wind farm	Previous avoidance rate (99.5%) unless noted *			Updated avoidance rate (99.4%)		
		Breeding season	Nonbreeding season	Annual	Breeding season	Nonbreeding season	Annual
	Total (all schemes + DBS East)	201.4	825.2	1027.1	239.5	986.3	1226.3
	Total (all schemes + DBS West)	200.5	823.6	1024.6	238.6	984.7	1223.8
	Total (all schemes + DBS East and West together)	201.4	826.4	1028.3	239.5	987.5	1227.5

~~842.~~849. The annual number of great black-backed gull at risk of collision from offshore wind farms in the UK North Sea and Channel BDMPS has been calculated as 1,023. When the estimated numbers at risk due to the Projects are included (4.9), this would increase to 1,028 collisions.

~~843.~~850. The estimates for other wind farms were calculated under previous Natural England guidance on the parameter rates to use. Specifically, these have used an avoidance rate of 99.5% rather than the rate of 99.4% in the latest guidance used in this assessment. Expressed as the collision rate (rather than the avoidance rate), this means that the predicted collision risk is increased from 0.5% to 0.6%, and that the older estimates for other wind farms are 20% lower than those obtained using the latest advice. The nocturnal activity rates used will also have been higher in most instances, further increasing the collision estimates for previous projects.

~~844.~~851. The annual cumulative total, not including the Projects, is 1,023, which would be increased to 1,222 on application of the revised avoidance rate. To this the Projects add a maximum of 4.9 birds. Based on the largest Annual BDMPS of 91,398 (Furness 2015) and baseline mortality of 0.0969, 8,856 individual great black-backed gulls would be expected to die each year; the addition of 1,227 collisions (including the Projects) would represent a 13.8% increase in annual mortality. Based on the annual biogeographic population with connectivity to UK waters of 235,000 (Furness 2015), 22,772 individuals would be expected to die; the addition of 1,227 collisions would represent 5.4% increase in mortality.

~~845.~~852. Based on findings from population viability analyses for bird species, it would be considered that increases in mortality rates of less than 1% would be undetectable in terms of changes in population size, whereas above 1% there could be detectable effects.

~~846.~~853. As the increase in background mortality assessed against the BDMPS population exceeded 1% the Natural England commissioned PVA tool was used to examine the effect of the estimated cumulative mortality on the great black-backed gull BDMPS and biogeographic populations. The complete input parameters and settings and results are provided in **Appendix 12-13 – Population Viability Analyses (Revision 2)** [document reference: 7.12.12.13]. The counterfactuals of growth rate (CGR) and population size (CPS) are presented in **Table 12-110** and **Table 12-111**.

Table 12-110 PVA results for cumulative combined displacement and collisions impacts on the great black-backed gull BDMPS population after 30 years.

PVA run scenario	Annual mortality	Decrease in adult survival rate	Mean CGR (95% c.i.)	Mean CPS (95% c.i.)
Cumulative collisions	1,222	0.013370	0.9856~~931~~ (0.9854~~927~~-0.9858~~935~~)	0.6383~~8080~~ (0.6321~~7962~~-0.6446~~8195~~)

~~847.~~854. After a period of 30 years, cumulative collisions reduced the BDMPS population growth rate by up to 1.4~~0.69~~% (0.9856~~931~~) and reduced the BDMPS population size compared to the baseline by up to 36.2~~19.2~~% (0.6383~~8080~~).

Table 12-111 PVA results for cumulative combined displacement and collisions impacts on the great black-backed gull biogeographic population after 30 years.

PVA run scenario	Annual mortality	Decrease in adult survival rate	Mean CGR (95% c.i.)	Mean CPS (95% c.i.)
Cumulative collisions	1,222	0.005200	0.9944~~73~~ (0.9943~~71~~-0.9945~~75~~)	0.8404~~9203~~ (0.8355~~9136~~-0.8454~~9267~~)

~~848.~~855. After a period of 30 years, cumulative collisions reduced the biogeographic population growth rate by up to 0.56~~27~~% (0.9944~~73~~) and reduced the biogeographic population size compared to the baseline by up to 16~~8~~.0% (0.8404)~~9203)~~.

~~849.~~856. As with lesser black-backed gull described above, the avoidance rate for great black-backed gull has reduced from 99.5% to 99.4% on the advice from Natural England, leading to an increase in collision rates for projects by around 20% if they have used that previous avoidance rate. This is likely to be offset by implementation of a lower nocturnal activity factor from 50% to 25%.

~~850.~~857. Reviews of nocturnal activity in seabirds have led Natural England to advise that rates between 25% and 50% are appropriate for great black-backed gull (whilst still retaining precaution) for assessment of collisions. These lower rates have been applied to more recent wind farm assessments (i.e. over the last year), but previously the higher rate of 50% will have been used. Retrospective application of lower nocturnal activity rates for older wind farms would reduce the cumulative collision estimate by a similar amount.

~~851.~~858. Applying reductions for lowered nocturnal activity to predictions for older wind farms would reduce the cumulative collision estimate further emphasising the precautionary nature of the current assessment.

~~852.~~859. In conclusion, the cumulative impact on the great black-backed gull population due to predicted year-round collisions is considered to be of low to medium magnitude and great black-backed gull is considered to be of low to medium sensitivity, therefore the effect significance is **minor** to **moderate adverse**. There is no change to the conclusion from the ES.

12.10.6 Impact 12 Cumulative Assessment of Operational Collision Risk and Displacement

12.10.6.1 Gannet

~~853.~~860. This section provides the update to section 12.7.5 of the original ES.

~~854.~~861. As a species which has been scoped in for collision and displacement from offshore wind farms, it is possible that the impacts of cumulative collision risk and cumulative displacement could combine to adversely affect gannet populations. Obviously, they would not act on the same individuals, as birds which do not enter a windfarm cannot be subject to mortality from collision, and vice versa. Avoidance rates for offshore wind farms, used in collision risk monitoring, take account of macro-avoidance (where birds avoid entering a windfarm), meso-avoidance (avoidance of the rotor swept zone within a windfarm), and micro-avoidance (avoiding wind turbine blades). Thus, birds which exhibit macro-avoidance could be subject to mortality from displacement.

~~855.~~862. As noted above, the estimated cumulative annual total for gannet collision mortality is 717 (at an overall avoidance rate of 99.79%). The estimated cumulative total for gannet displacement is between 374 (60% x 1%) and 498 (80% x 1%) (**Table 12-91**).

~~856.~~863. Based on the largest Annual BDMPS for the UK North Sea and Channel, of 456,299 (Furness 2015) and baseline mortality of 0.1866, 85,145 individual gannets would be expected to die each year; the addition of 1,091-1,215 individuals would represent a 1.28%–1.42% increase in annual mortality. Based on the annual biogeographic population with connectivity to UK waters of 1,180,000 (Furness 2015), 220,188 individuals would be expected to die; the addition of 1,091-1,215 individuals would represent 0.49%-0.55% increase in mortality.

~~857.~~864. As the increase in background mortality assessed against the BDMPS population exceeded 1% the Natural England commissioned PVA tool was used to examine the effect of the estimated cumulative mortality on the gannet BDMPS population. The complete input parameters and settings and results are provided in **Appendix 12-13 – Population Viability Analyses (Revision 2)** [document reference: 7.12.12.13]. The counterfactuals of growth rate (CGR) and population size (CPS) are presented in **Table 12-112**.

Table 12-112 PVA results for cumulative combined displacement and collisions impacts on the gannet BDMPS population after 30 years.

PVA run scenario	Annual mortality	Decrease in adult survival rate	Mean CGR (95% c.i.)	Mean CPS (95% c.i.)
Cumulative displacement (60% x 1%) + collisions	1,091	0.002391	0.9972~~83~~ (0.99669~~81~~-0.9974~~85~~)	0.9153~~487~~ (0.9071~~406~~-0.9235~~573~~)
Cumulative displacement (80% x 1%) + collisions	1,215	0.002663	0.9968~~81~~ (0.99666~~79~~-0.9971~~83~~)	0.9062~~432~~ (0.8983~~9349~~-0.9144~~515~~)

~~858.~~865. After a period of 30 years, cumulative displacement and collisions reduced the BDMPS population growth rate by up to 0.32~~19~~% (0.9968~~81~~) and reduced the BDMPS population size compared to the baseline by up to 9.1~~5.7~~% (0.9062~~432~~).As discussed in the cumulative assessment sections above, it is considered that the mortality of displaced gannets would in reality be at or very close to zero, and there would therefore be no increase in the mortality rate increases estimated for cumulative collision risk.

~~859.~~866. The British gannet population has grown at an average annual rate of at least 2% since the beginning of the 20th century (Burnell *et al.* 2023), therefore a maximum precautionary decline in this of 0.2% would not result in a noticeable deterioration in the species' population status.

~~860.~~867. Thus, the combined impact of cumulative displacement and collision risk would be of low magnitude (as for the assessment of cumulative collision risk alone). Gannets are considered to be of low to medium sensitivity to collision mortality and the effect significance is therefore **negligible** to **minor adverse**. There is no change to the conclusion from the ES.

12.11 Potential Monitoring Requirements

~~861.~~868. Monitoring requirements are described in **Volume 8, In-Principal Monitoring Plan (IPMP) (application ref: 8.23)** submitted alongside the DCO application and further developed and agreed with stakeholders prior to construction based on the IPMP and taking account of the final detailed design of the Projects.

~~862.~~869. It is important that monitoring studies should be designed to address both site specific concerns and also contribute to the wider understanding of offshore wind farm effects on seabirds. Since the monitoring should therefore build on existing and planned monitoring, it is too early to define what the focus should be, but it is likely to reflect the impacts discussed in this assessment, namely displacement and collision risks.

12.12 Transboundary Effects

~~863.~~870. Collisions and displacement of offshore ornithology receptors will also be predicted to occur at offshore wind farms located outside UK territorial waters. This means that potential transboundary impacts are greater than that quantitatively assessed in the CEA presented above (section 12.10).

~~864.~~871. It is considered that the spatial scale and hence seabird reference populations sizes against which transboundary assessment would be conducted are considerably larger than those against which UK cumulative impacts have been assessed. However, robust information on the sizes of these populations is not available. A further complication is that the methods used to assess potential offshore wind farm impacts varies by country, and the outputs of impact assessments are not directly comparable. As a result, quantitative transboundary impact assessment is not possible. A limited attempt at quantifying this was attempted recently as part of the Strategic Environmental Assessment North Seas Energy (SEANSE) project (DHI, 2020a, 2020b). It provides a useful indicator of the level of potential impacts on offshore ornithology receptors beyond UK waters, and suggests that in the majority of cases, impacts on offshore ornithology receptors are largest in UK waters. However, there are a range of limitations that make the approach taken in the SEANSE project unsuitable for quantitative impact assessment purposes.

~~865.~~872. However, overall the increase in the reference populations that would result from the expansion of the area of search is anticipated to exceed the increase in impacts from the inclusion of non-UK offshore wind farms, with the result that the magnitude of transboundary cumulative impacts would be reduced below those assessed for each species presented in section 12.10. Therefore, any potential transboundary effects are expected to be minimal and will not require any additional mitigation.

12.13 Interactions

~~866.~~873. This section considers the potential for the impacts on offshore ornithology receptors that have been identified and assessed in this ES chapter to interact with one other. These are presented in a matrix to simplify presentation in **Table 12-113**.

~~867.~~874. No potential interactions between the impacts assessed have been identified.

~~868.~~875. Within **Table 12-114**, a lifetime assessment is undertaken which considers the potential for an effect to affect receptors across all development phases.

Table 12-113 Summary of Potential interactions

Potential Interactions between Impacts			
Construction			
	Impact 1: Direct disturbance and displacement from increased vessel activity	Impact 2: Indirect Impacts Through Effects on Habitats and Prey Species During Construction	
Impact 1: Direct disturbance and displacement from increased vessel activity		No interaction Birds that have been displaced cannot be impacted by prey availability effects, which are highly localized to the source of impact.	
Impact 2: Indirect Impacts Through Effects on Habitats and Prey Species During Construction	No interaction Birds that are subject to prey availability effects, which are highly localized to the source of impact, can only be present if they have not been displaced by construction activities.		
Operation			
	Impact 3: Disturbance and displacement from offshore infrastructure	Impact 4: Indirect Impacts Through Effects on Habitats and Prey Species During Operation	Impact 5: Collision risk
Impact 3: Disturbance and displacement from offshore infrastructure		No interaction Birds that are displaced from the wind farm would not be subject to prey availability effects as these will only occur within the wind farm.	No interaction Birds that are displaced from the wind farm are not at risk of collision (except gannet which has been considered separately).
Impact 4: Indirect Impacts Through Effects on Habitats and Prey Species During Operation	No interaction Birds that are subject to reduced prey availability effects, which will only occur within the wind farm, have not been displaced.		No interaction Birds susceptible to indirect effects which occur within the wind farm have not been involved in collisions.
Impact 5: Collision risk	No interaction Birds that are at risk of collisions have not been displaced from the wind farm (except gannet which has been considered separately).	No interaction Birds involved in collisions would not be susceptible to indirect effects which occur within the wind farm.	
Decommissioning			
It is anticipated that the decommissioning impacts will be similar in nature to those of construction.			

Table 12-114 Potential Interactions Between Impacts on Offshore Ornithology

Receptor	Highest Level Significance			Phase Assessment	Lifetime Assessment
	Construction	Operational	Decommissioning		
All species	Minor Adverse	Minor Adverse	Minor Adverse	**No greater than individually assessed impact** Seabird impacts have been considered against each phase with respect to each species' respective ecology and consequent risks. With the exception of gannet, each species assessed is considered to only be at risk of individual impacts, either displacement (low flying species which dive to feed) or collision (higher flying species which forage on the wing). Thus, for the former (e.g. auks) and the latter (e.g. gulls) there is very little interaction in terms of risks. The only species considered to be at risk of both displacement and collisions (gannet) has been explicitly assessed for the combination of those potential impacts. Therefore potential interactions have already been assessed and no further combinations are predicted.	**No greater than individually assessed impact** There is potential for disturbance and displacement due to construction activities, including the construction of wind turbines and other infrastructure (offshore electrical platforms, construction operation and maintenance platforms and meteorological mast) and associated vessel traffic. However, construction will not occur across the whole of the Array Areas simultaneously or every day but will be phased, with activity focused on particular wind turbine, offshore platform or cable locations at any time. At such time as wind turbines (and other infrastructure) are installed onto foundations the impact of displacement would increase incrementally to the same levels as operational impacts. Effectively therefore the construction impacts simply extend the duration of the operational impacts. It is therefore considered that over the Projects' lifetime these impacts would not combine and represent an increase in the significance level.

12.14 Inter-relationships

~~869.~~876. The construction, operation and decommissioning of the Projects has the potential to result in a range of effects on offshore ornithology receptors, and these may be inter-related with other receptor groups. With respect to the impacts assessed for offshore ornithology receptors in this ES chapter, only indirect effects on habitats and prey are considered to be relevant. The potential inter-relationships are summarised in **Table 12-115**, which indicates where assessments carried out in other ES chapters have been used to inform the offshore ornithology assessment.

Table 12-115 Summary of Potential inter-relationships

Impact	Related topic	Basis for consideration	Section where addressed
Construction			
Impact 2: Indirect impacts through effects on habitats and prey species during construction	**Volume 7, Chapter 9 Benthic and Intertidal Ecology (application ref: 7.9)** **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**	Potential impacts on benthic and intertidal ecology and on fish and shellfish ecology during construction could affect prey resource for offshore ornithology receptors	12.7.1.3.3.8
Operation			
Impact 4: Indirect impacts through effects on habitats and prey species during operation	**Volume 7, Chapter 9 Benthic and Intertidal Ecology (application ref: 7.9)** **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**	Potential impacts on benthic and intertidal ecology and on fish and shellfish ecology during operation could affect prey resource for offshore ornithology receptors	12.8.2
Decommissioning			

Impact	Related topic	Basis for consideration	Section where addressed
Impact 8: Indirect impacts through effects on habitats and prey species	As per construction	As per construction	12.9.2

12.15 Summary

~~870.~~877. This chapter has provided a characterisation of the existing environment for offshore ornithology based on both existing and Array Area specific survey data which has established that there are potential risks to seabirds from cumulative displacement and collisions risk. The impact assessment is summarised in **Table 12-118**. This document also provides updated assessment for offshore ornithology to address requests made by in Natural England's Relevant Representation [RR-039]. There are no changes to any of the conclusions from the original ES submitted.

~~871.~~878. Construction effects assessed included those due to additional vessel movements, cable installation and the presence of 50% of the wind turbines and have been assessed as **negligible** to **minor adverse**,

~~872.~~879. Operation effects assessed included displacement from the Array Areas, collision risk with turbines and indirect effects mediated via fish prey species or benthic communities. These were assessed as **negligible** to **minor adverse.**

~~873.~~880. It is in the operation effects that the clearest changes to the assessment, following this update, were expressed. To illustrate the differences between the original and updated assessments, **Table 12-116** and

~~874.~~881. **Table** 12-117 summarise the annual impacts on species assessed for the two main effects of concern (i.e. displacement and collision risk). The largest (and only material) difference is for guillemot and razorbill displacement, although if the displacement mortality accepted by the Secretary of State for the Sheringham and Dudgeon Extensions assessment (i.e. 2%) is applied these numbers actually fall.

Table 12-116 Comparison of annual displacement mortalities and increase in background mortality from the Original ES and this update

Species / Population	ES		Update		Notes
	Mortality (no. individuals)	**Increase in background mortality (%)**	**Mortality (no. individuals)**	**Increase in background mortality (%)**	
Gannet	See Table 12-33 of Original ES		See **Table 12-37**		
Annual (BDMPS)	24	0.03	26	0.031	
Annual (biogeographic)	24	0.01	26	0.012	
Guillemot	See Table 12-43 of Original ES		See **Table 12-50**		
Annual (BDMPS)	2454	0.85	846 (4,231)	0.294 (1.472)	*70%/10% values in parentheses*
Annual (biogeographic)	2454	0.42	846 (4,231)	0.146 (0.73)	*70%/10% values in parentheses*
Razorbill	See Table 12-59 of Original ES		See **Table 12-66**		
Annual (BDMPS)	1491	1.45	404 (2,022)	0.525 (2.624)	*70%/10% values in parentheses*
Annual (biogeographic)	1491	0.5	404 (2,022)	0.182 (0.91)	*70%/10% values in parentheses*
Puffin	See Table 12-69 of Original ES		See **Table 12-76**		

Species / Population	ES		Update		Notes
Annual (BDMPS)	36	0.02	8	0.007	
Annual (biogeographic)	36	<0.01	8	0.001	

Table 12-117 Comparison of annual upper 95% confidence interval collision mortalities and increase in background mortality from the original ES and this update

Species / Population	ES		Update		Notes
	Mortality (no. individuals, upper 95% c.i.)	**Increase in background mortality (%)**	**Mortality (no. individuals, upper 95% c.i.)**	**Increase in background mortality (%)**	
Gannet (@ 70% macro-avoidance)	See Table 12-74 of Original ES		See **Table 12-81**		
Annual (BDMPS)	24.48	0.03	24.48	0.029	Updates for baseline mortality, reference populations
Annual (biogeographic)	24.48	0.01	24.48	0.011	
Gannet (@ 65% macro-avoidance)	n/a		See **Table 12-82**		
Annual (BDMPS)	n/a	n/a	28.56	0.034	Now included at stakeholder request
Annual (biogeographic)	n/a	n/a	28.56	0.013	
Gannet (@ 85% macro-avoidance)	n/a		See **Table 12-83**		

Species / Population	ES		Update		Notes
	Mortality (no. individuals, upper 95% c.i.)	Increase in background mortality (%)	Mortality (no. individuals, upper 95% c.i.)	Increase in background mortality (%)	
Annual (BDMPS)	n/a	n/a	12.24	0.014	Now included at stakeholder request
Annual (biogeographic)	n/a	n/a	12.24	0.006	
Kittiwake	See Table 12-75 of Original ES		See **Table 12-84**		
Annual (BDMPS)	540.51	0.41	540.51	0.408	No updates required
Annual (biogeographic)	540.51	0.07	540.51	0.067	
Lesser black-backed gull	See Table 12-76 of Original ES		See **Table 12-85**		
Annual (BDMPS)	4.37	0.02	4.37	0.017	Updates for baseline mortality, reference populations
Annual (biogeographic)	4.37	<0.01	4.37	0.004	
Herring gull	See Table 12-77 of Original ES		See **Table 12-86**		
Annual (BDMPS)	5.18	0.01	5.18	0.006	Updates for reference populations
Annual (biogeographic)	5.18	<0.01	5.18	0.003	
Great black-backed gull	See Table 12-78 of Original ES		See **Table 12-87**		

Species / Population	ES		Update		Notes
	Mortality (no. individuals, upper 95% c.i.)	**Increase in background mortality (%)**	**Mortality (no. individuals, upper 95% c.i.)**	**Increase in background mortality (%)**	
Annual (BDMPS)	11.5	0.07	11.5	0.13	Updates for baseline mortality, reference populations
Annual (biogeographic)	11.5	0.03	11.5	0.051	

~~875.~~882. Decommissioning effects assessed included those due to additional vessel movements, cable installation and the presence of 50% of the wind turbines and have been assessed as **negligible** to **minor adverse**.

~~876.~~883. Cumulative effects assessed included displacement and collision risks and were assessed as **negligible** to **moderate adverse.** An additional impact, cumulative disturbance and displacement impacts was considered for red-throated diver, with the impact assessed as **minor adverse**. Additional mitigation commitments have been proposed with regard to this impact.

Table 12-118 Summary of Potential Likely Significant Effects on Offshore Ornithology

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Impact 1: Direct disturbance and displacement from increased vessel activity	Gannet, Guillemot, Razorbill, Puffin	Low-Medium	Negligible	Negligible-Minor Adverse	N/A	Negligible-Minor Adverse
Impact 2: Indirect impacts through effects on habitats and prey species	Seabirds	Low-High	Negligible	Negligible-Minor Adverse	N/A	Negligible-Minor Adverse
Impact 3: Disturbance and displacement from offshore infrastructure	Gannet, Guillemot, Razorbill, Puffin	Low-Medium	Negligible-Low	Negligible–Minor Adverse	N/A	Negligible–Minor Adverse
Impact 4: Indirect impacts through effects on habitats and prey species	Seabirds	Low	Negligible	Negligible	N/A	Negligible
Impact 5: Collision Risk	Fulmar, Gannet, Arctic skua, Great skua, Kittiwake, Little gull, Common gull, Lesser black-backed gull, Herring gull, Great black-backed gull	Low - High	Negligible	Negligible-Minor Adverse	N/A	Negligible-Minor Adverse
Impact 6: Combined operational collision risk and displacement	Gannet	Medium	Negligible	Minor Adverse	N/A	Minor Adverse
Decommissioning						
Impact 7: Direct disturbance and displacement	Gannet, Guillemot, Razorbill, Puffin	Low-Medium	Negligible	Negligible-Minor Adverse	N/A	Negligible-Minor Adverse
Impact 8: Indirect impacts through effects on habitats and prey species	Seabirds	Low-High	Negligible	Negligible-Minor Adverse	N/A	Negligible-Minor Adverse
Cumulative						
Impact 9 Cumulative Assessment of Construction Displacement	Red-throated diver	High	Negligible	Minor Adverse	Best practice vessel operation, use of existing shipping lanes whilst transiting the Greater Wash SPA	Minor adverse

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Impact 10 Cumulative Assessment of Operational Displacement	Gannet, Guillemot, Razorbill, Puffin	Low - Medium	Negligible to Medium	Negligible-Moderate Adverse	N/A	Negligible - Moderate adverse
Impact 11 Cumulative Assessment of Operational Collision Risk	Gannet, Kittiwake, Lesser black-backed gull, Herring gull and Great black-backed gull	Low - Medium	Negligible to Medium	Negligible-Moderate Adverse	N/A	Negligible-Moderate Adverse
Impact 12 Cumulative Assessment of Operational Collision Risk and Displacement	Gannet	Medium	Negligible	Negligible - Minor adverse	N/A	Negligible - Minor adverse

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