RWE Renewables UK Dogger Bank South (West) Limited

RWE Renewables UK Dogger Bank South (East) Limited

Dogger Bank South Offshore Wind Farms

Environmental Statement

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Chapter 12 – Offshore Ornithology

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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.
Dogger Bank South (DBS) Offshore Wind Farms	The collective name for the two Projects, DBS East and DBS West.

Term	Definition
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.
Electrical Switching Platform (ESP)	The Electrical Switching Platform (ESP), if required would be located either within one of the Array Areas (alongside an Offshore Converter Platform (OCP)) or the Export Cable Platform Search Area.
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.
Export Cable Platform Search Area	The Export Cable Platform Search Area is located mid-way along the Offshore Export Cable Corridor and is the area of search for the Electrical Switching Platform (ESP)..
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.

Term	Definition
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.
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 (and potentially the ESP) 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.

Term	Definition
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.
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
CRM	Collision Risk Model
DBS	Dogger Bank South
DCO	Development Consent Order
EIA	Environmental Impact Assessment
ECC	Export Cable Corridor
EPP	Evidence Plan Process
ES	Environmental Statement
ETG	Expert Topic Group
HRA	Habitats Regulations Assessment
JNCC	Joint Nature Conservation Committee
MMO	Marine Management Organisation
PEIR	Preliminary Environmental Information Report
RSPB	Royal Society for the Protection of Birds
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.

2. 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)**;
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- **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. 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. 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.

12.3 Scope

12.3.1 Study Area

5. 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)**).

6. 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.

7. 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

8. The realistic worst case design parameters for likely significant effects scoped into the ES for the offshore ornithology assessment are summarised in **Table 12-1**. 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.

9. In addition to the design parameters set out in **Table 12-1**, 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 12-1 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 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 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 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 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 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 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 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

10. 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.
11. 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.
12. 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)**.
13. The three Development Scenarios to be considered for assessment purposes are outlined in **Table 12-2**.

Table 12-2 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
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

14. 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.

15. 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.

16. 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.

17. 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.

18. 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

19. 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.

20. 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.

21. The operational lifetime of each Project is expected to be 30 years.

12.3.2.4 Decommissioning Scenarios

22. 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

23. 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 12-3**). 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 12-3 Embedded Mitigation Measures

Parameter	Embedded Mitigation Measures	Where commitment is 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: • 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); • 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	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 commitment is secured?
	• 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

24. 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 12-4** together with an indication of the section of this chapter where each is addressed.

Table 12-4 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

NPS Requirement	NPS Reference	ES Section Reference
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 consideration, depending on the location of development.	EN-1 Paragraph 5.4.22	As discussed in **Table 12-3** the Projects' locations and design have given consideration to ornithological receptors. Transboundary effects are considered in section 12.9
EN-3 NPS for Renewable Energy Infrastructure		
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 2.8.91	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 2.8.94	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 (application ref: 7.12.12.1)**.

NPS Requirement	NPS Reference	ES Section Reference
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 2.8.96, 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 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 12.6.1), operation (section 12.6.2) and decommissioning (section 12.6.3).
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 12-3** 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/decommissioning/maintenance vessels and piling; • displacement during the operational phase, resulting in loss of foraging/roosting area; • impacts on bird flight lines (i.e. barrier effect) and associated increased energy use by birds for commuting flights between roosting and foraging areas;	EN-3 Paragraph 2.8.126	These potential impacts have been assessed in section 12.6.
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 2.8.127	Cumulative assessments are based on current advice and do not consider headroom (see section 12.7)
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 2.8.128	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 Licences (Schedules

NPS Requirement	NPS Reference	ES Section Reference
		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 2.8.133, 2.8.134	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 2.8.135	See section 12.4.2

12.4.1.2 Other

25. 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); and
- A wide range of additional guidance has been referred to throughout the assessment as required.

26. 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

27. 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

28. **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.

12.4.3.1 Definitions

29. 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 12-5** and **Table 12-6.**

Table 12-5 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.

30. 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.

31. The definitions of the magnitude levels for ornithology receptors are set out in **Table 12-6**. 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 12-6 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.

Magnitude	**Definition**
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.
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

32. 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 12.7**. Definitions of each level of significance are provided in **Table 12.8**. 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 12-7 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

33. 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 12-8 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.

34. 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.

12.4.4 Cumulative Effects Assessment Methodology

35. 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.

36. 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).

37. Further detail on potential cumulative effects is provided in section 12.7.

12.4.5 Transboundary Effect Assessment Methodology

38. 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.

39. 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

40. 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.

41. 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

42. 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

43. 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.

44. 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 12-9**).

Table 12-9 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
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 Assessment of Nature Conservation Value for Each Bird Species

45. 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.

46. 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 12-10**.

Table 12-10 Summary of Nature Conservation Value of Species Considered at Risk of Impacts.

Species	Conservation status
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 Amber 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 Amber listed, Birds Directive Migratory Species

47. 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 12-11**). 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 12-11**).

48. 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 12-11 Species Specific Seasonal Definitions and Biologically Defined Minimum Population Sizes (In Brackets) Have Been Taken from Furness (2015). 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
Fulmar	Jan-Aug	Apr-Aug	Sep-Oct (957,502)	Nov (568,736	Dec-Mar (957,502)	-
Gannet	Mar-Sep	Apr-Aug	Sep-Nov (456,298)	-	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 (231,957)
Razorbill	Apr-Jul	Apr-Jun	Aug-Oct (591,874)	Nov-Dec (218,622)	Jan-Mar (591,874)	-
Guillemot	Mar-Jul (2,045,078)	Mar-Jun	Jul-Oct	Nov	Dec-Feb	Aug-Feb (1,617,306)
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)	-
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 (829,937)	-	Jan-Apr (627,816)	-
Little gull (Not included in Furness, 2015)	Apr-Jul	May-Jul	-	-	-	Aug-Apr

Species	Breeding	Migration-free breeding	Migration - autumn	Winter	Migration - spring	Nonbreeding
Lesser black-backed gull	Apr-Aug	May-Jul	Aug-Oct (209,007)	Nov-Feb (39,314)	Mar-Apr (197,483)	-
Herring gull	Mar-Aug	May-Jul	Aug-Nov	Dec	Jan-Apr	Sep-Feb (466,511)
Great black-backed gull	Mar-Aug	May-Jul	Aug-Nov	Dec	Jan-Apr	Sep-Mar (91,399)

** 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*

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

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

Species	**Biogeographic population with connectivity to UK waters (adults and immatures)**
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*

50. 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.

51. Demographic rates for each species screened into assessment were taken from Horswill and Robinson (2015) and entered into a matrix population model. This was used to calculate the expected stable proportions in each age class (note, to obtain robust stable age class distributions for less well studied species such as divers it was necessary to adjust the rates in order to obtain a stable population size). Each age class survival rate was multiplied by its stable age proportion and the total for all ages summed to give the weighted average survival rate for all ages. Taking this value from one gives the average mortality rate. The demographic rates and the age class proportions, and average mortality rates calculated from them are presented in **Table 12-13**.

Table 12-13 Average Mortality Across All Age Classes. Average Mortality Calculated Using Age Specific Demographic Rates and Age Class Proportions

Species	Parameter	Survival (age class)						Productivity	Average mortality
		0-1	1-2	2-3	3-4	4-5	Adult		
Gannet	Demographic rate	0.424	0.829	0.891	0.895	-	0.912	0.7	0.191
	Population age ratio	0.191	0.081	0.067	0.06	-	0.6	-	
Guillemot	Demographic rate	0.56	0.792	0.917	0.939	0.939	0.939	0.672	0.14
	Population age ratio	0.168	0.091	0.069	0.062	0.056	0.552	-	
Razorbill	Demographic rate	0.63	0.63	0.895	0.895	-	0.895	0.57	0.174
	Population age ratio	0.159	0.102	0.065	0.059	-	0.613	-	
Puffin	Demographic rate	0.709	0.709	0.709	0.760	0.805	0.906	0.617	0.176
	Population age ratio	0.156	0.113	0.082	0.060	0.047	0.543	-	
Common tern[1]	Demographic rate	0.441	0.441	0.85	-	-	0.883	0.764	0.263
	Population age ratio	0.223	0.103	0.048	-	-	0.626	-	
Kittiwake	Demographic rate	0.79	0.854	0.854	0.854		0.854	0.69	0.156
	Population age ratio	0.155	0.123	0.105	0.089		0.53	-	

Species	Parameter	Survival (age class)						Productivity	Average mortality
		0-1	1-2	2-3	3-4	4-5	Adult		
Lesser black-backed gull	Demographic rate	0.82	0.885	0.885	0.885		0.885	0.53	0.124
	Population age ratio	0.134	0.109	0.095	0.083		0.579	-	
Herring gull	Demographic rate	0.798	0.834	0.834	0.834		0.834	0.92	0.172
	Population age ratio	0.178	0.141	0.117	0.097		0.467		
Great black-backed gull[2]	Demographic rate	0.815	0.815	0.815	0.815		0.885	0.53	0.144
	Population age ratio	0.137	0.112	0.093	0.076		0.581	-	

1 – Common tern have a combined survival rate from 0 – 2 of 0.441, giving an annual rate of 0.66. Note that the rates for common tern have been used for the commic tern assessment where necessary.

2 – Great black-backed gull survival rates were taken from EATL (2016) which made compelling reasons for the representativeness of these rates rather than those in Horswill and Robinson (2015).

52. The seasonal peak abundance within species specific seasons (as defined in **Table 12-11**) recorded individually within the Array Areas are provided in **Table 12-14** (note these abundances do not include birds observed in the 4km buffer around the Array Areas).

53. 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.

54. 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 12-14 Peak abundance estimates (and 95% Confidence Intervals) by Biological Season for Bird Species within the East and West Array Areas Recorded during Baseline Surveys.

Species	Biological Season									
	Spring migration		Breeding (full)		Autumn migration		Winter		Nonbreeding	
	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[1]	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)

Species	Biological Season									
	Spring migration		Breeding (full)		Autumn migration		Winter		Nonbreeding	
	East	West	East	West	East	West	East	West	East	West
Razorbill[1]	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[1]	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)
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)
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)

Species	Biological Season									
	Spring migration		Breeding (full)		Autumn migration		Winter		Nonbreeding	
	East	West	East	West	East	West	East	West	East	West
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)
1. Including unidentified auks apportioned using identified auk ratios and accounting for availability bias										

12.5.3 Future Trends

55. 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.

56. 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.

57. 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.

58. 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).

59. 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).

60. 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.

61. 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.

62. 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).

63. 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.

64. 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.

65. 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.

66. 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

12.6.1 Potential Effects During Construction

12.6.1.1 Impact 1 Direct Disturbance and Displacement from Increased Vessel Activity

12.6.1.1.1 Array Areas

67. 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.

68. Although there is a degree of flexibility in the Project's Design Envelopes regarding construction scenarios, section 12.3.2.2 set out the scenarios and identified that either concurrent or sequential construction of both 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.

69. 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.

70. 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).

71. 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.

72. 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 12.6.1).

73. 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.

74. 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).

75. 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 12.6.2, below).

76. 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)**).

77. 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.

78. 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.

79. 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 12-15**). 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.

80. 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.

81. 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 12-15 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
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.

12.6.1.1.1.1 Gannet

82. 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.

83. 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).

84. Additional mortality of gannet during the breeding season has been assessed in relation to the Flamborough and Filey Coast SPA population. The SPA population at designation was 11,061 pairs, increasing to 13,392 pairs in 2017 (Aitken *et al*., 2017) with 13,125 pairs recorded in 2022 (Clarkson *et al*., 2022). The Clarkson *et al*. (2022) estimate, adjusted to include nonbreeding and immature birds that associate with the colony, has been used as a reference population, being closer in time to baseline surveys. This equates to a total population size during the breeding season of approximately 47,727 (derived as individual adults divided by the adult proportion of 0.55 from Furness, 2015, to provide an all-age class total).

85. The number of individuals from this population expected to die at the baseline mortality rate in the breeding season is 9,116 (47,727 x 0.191, **Table 12-13**).

86. During the nonbreeding seasons the gannet BDMPS populations for the North Sea have been used as the reference populations (in the autumn: 456,298 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 87,153 (456,298 x 0.191), in the spring is 47,442 (248,385 x 0.191), and annually from the biogeographic population is 225,380 (1,180,000 x 0.191).

12.6.1.1.1.1.1 Significance of Effect – DBS East in Isolation

12.6.1.1.1.1.1.1 Breeding Season – construction vessels

87. 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).

88. During the breeding season, the maximum mean peak density in the DBS East Array Area 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 would be expected to be at risk of mortality.

89. Based on the average mortality for the species of 0.191 a total of 9,116 birds would be expected to die each year (see paragraph 85). 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 0.006%, which is below the 1% threshold for detectability.

90. 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**.

12.6.1.1.1.1.1.2 Breeding Season – 50% installed turbines

91. 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 12.6.2.1.1.1.1). Thus, a maximum of three 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 0.191 (**Table 12-13**) a total of 9,116 birds would be expected to die each year (see paragraph 85). The addition of three individuals would increase the mortality rate by 0.03%, which is below the 1% threshold for detectability.

92. 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**.

12.6.1.1.1.1.1.3 Breeding Season – construction vessels and 50% installed turbines

93. The combination of displacement by construction vessels and half of that estimated for operational displacement in the breeding season gives a maximum of 3.56 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.191 (**Table 12-13**) a total of 9,116 birds would be expected to die each year (see paragraph 85). The addition of 3.56 individuals would increase the mortality rate by 0.04%, which is below the 1% threshold for detectability.

94. 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**.

12.6.1.1.1.1.1.4 Autumn Migration – construction vessels

95. During the autumn migration season the maximum mean peak density in the DBS East Array Area 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 birds would be predicted to be at risk of mortality.

96. At the average baseline mortality rate for gannet of 0.191, a total of 87,153 birds would be expected to die in autumn (see paragraph 86). The addition of 0.57 to this would increase the mortality rate by <0.001%, which is below the 1% threshold for detectability.

97. 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**.

12.6.1.1.1.1.1.5 Autumn Migration – 50% installed turbines

98. 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 12.6.2.1.1.1.2). Thus, a maximum of three 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 0.191 (**Table 12-13**) a total of 87,153 birds would be expected to die each year (see paragraph 86). The addition of three individuals would increase the mortality rate by 0.03%, which is below the 1% threshold for detectability.

99. 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**.

12.6.1.1.1.1.1.6 Autumn Migration – construction vessels and 50% installed turbines

100. The combination of displacement by construction vessels and half of that estimated for operational displacement in the autumn migration period gives a maximum of 3.57 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.191 (**Table 12-13**) a total of 87,153 birds would be expected to die each year (see paragraph 86). The addition of 3.57 individuals would increase the mortality rate by 0.004%, which is below the 1% threshold for detectability.

101. 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.**

12.6.1.1.1.1.1.7 Spring Migration – construction vessels

102. During the spring migration season, the maximum mean peak density in the DBS East Array Area 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 a would be expected to be at risk of mortality.

103. Based on the average mortality for the species of 0.191, a total of 47,442 birds would be expected to die in spring (see paragraph 86). 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.

104. 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.

12.6.1.1.1.1.1.8 Spring Migration – 50% installed turbines

105. 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 12.6.2.1.1.1.3). Thus, a maximum of 0.5 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 0.191 (**Table 12-13**) a total of 47,442 birds would be expected to die each year (see paragraph 86). The addition of 0.5 individuals would increase the mortality rate by 0.001%, which is below the 1% threshold for detectability.

106. 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.

12.6.1.1.1.1.1.9 Spring Migration – construction vessels and 50% installed turbines

107. The combination of displacement by construction vessels and half of that estimated for operational displacement in the spring migration period gives a maximum of 0.56 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.191 (**Table 12-13**) a total of 47,442 birds would be expected to die each year (see paragraph 86). The addition of 0.56 individuals would increase the mortality rate by 0.001%, which is below the 1% threshold for detectability.

108. 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**.

12.6.1.1.1.1.1.10 Annual – construction vessels

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

110. At the average baseline mortality rate for gannet of 0.191, a total of 87,153 birds would be expected to die from the largest BDMPS population throughout the year (see paragraph 86). 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.

111. The number of individuals from the biogeographic population expected to die across all seasons is 225,380 (see paragraph 86). 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.

112. 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**.

12.6.1.1.1.1.1.11 Annual – 50% installed turbines

113. 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 12.6.2.1.1.1.4). Thus, a maximum of 6.5 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 0.191 (**Table 12-13**) a total of 87,153 birds would be expected to die each year (see paragraph 86). The addition of 6.5 individuals would increase the mortality rate by 0.007%, which is below the 1% threshold for detectability.

114. The number of individuals from the biogeographic population expected to die across all seasons is 225,380 (see paragraph 86). The addition of a maximum of 6.5 to this increases the mortality rate by 0.003%, which is below the 1% threshold for detectability.

115. 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**.

12.6.1.1.1.1.1.12 Annual – construction vessels and 50% installed turbines

116. 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 7.69 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.191 (**Table 12-13**) a total of 225,380 birds would be expected to die each year (see paragraph 86). The addition of 7.69 individuals would increase the mortality rate by 0.009%, which is below the 1% threshold for detectability.

117. The number of individuals from the biogeographic population expected to die across all seasons is 225,380 (see paragraph 86). The addition of a maximum of 7.69 to this increases the mortality rate by 0.003%, which is below the 1% threshold for detectability.

118. 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**.

12.6.1.1.1.1.2 Significance of Effect – DBS West in Isolation

12.6.1.1.1.1.2.1 Breeding Season – construction vessels

119. During the breeding season, the maximum mean peak density in the DBS West Array Area 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 would be expected to be at risk of mortality.

120. Based on the average mortality for the species of 0.191 a total of 9,116 birds would be expected to die in the breeding season (see paragraph 85). 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 0.006%, which is below the 1% threshold for detectability.

121. 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**.

12.6.1.1.1.1.2.2 Breeding Season – 50% installed turbines

122. 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 12.6.2.1.1.2.1).Thus, a maximum of three 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 0.191 (**Table 12-13**) a total of 9,116 birds would be expected to die each year (see paragraph 85). The addition of three individuals would increase the mortality rate by 0.03%, which is below the 1% threshold for detectability.

123. 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**.

12.6.1.1.1.1.2.3 Breeding Season – construction vessels and 50% installed turbines

124. 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 0.191 (**Table 12-13**) a total of 9,116 birds would be expected to die each year (see paragraph 85). The addition of 3.58 individuals would increase the mortality rate by 0.04%, which is below the 1% threshold for detectability.

125. 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**.

12.6.1.1.1.1.2.4 Autumn Migration – construction vessels

126. During the autumn migration season the maximum mean peak density in the DBS West Array Area 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 (0.57 x 12.56 x 3) could be at risk of displacement, of which 0.58 birds would be predicted to be at risk of mortality.

127. At the average baseline mortality rate for gannet of 0.191 a total of 87,153 birds would be expected to die in autumn (see paragraph 86). 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.

128. 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**.

12.6.1.1.1.1.2.5 Autumn Migration – 50% installed turbines

129. 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 12.6.2.1.1.2.2). Thus, a maximum of three 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 0.191 (**Table 12-13**) a total of 87,153 birds would be expected to die each year (see paragraph 86). The addition of three individuals would increase the mortality rate by 0.03%, which is below the 1% threshold for detectability.

130. 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**.

12.6.1.1.1.1.2.6 Autumn Migration – construction vessels and 50% installed turbines

131. The combination of displacement by construction vessels and half of that estimated for operational displacement in the autumn migration period gives a maximum of 3.58 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.191 (**Table 12-13**) a total of 87,153 birds would be expected to die each year (see paragraph 86). The addition of 3.58 individuals would increase the mortality rate by 0.004%, which is below the 1% threshold for detectability.

132. 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**.

12.6.1.1.1.1.2.7 Spring Migration – construction vessels

133. During the spring migration season, the maximum mean peak density in the DBS West array 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 would be expected to be at risk of mortality.

134. Based on the average mortality for the species of 0.191, a total of 47,442 birds would be expected to die in spring (see paragraph 86). 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.

135. 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**.

12.6.1.1.1.1.2.8 Spring Migration – 50% installed turbines

136. 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 12.6.2.1.1.2.3). Thus, a maximum of 0.5 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 0.191 (**Table 12-13**) a total of 47,442 birds would be expected to die each year (see paragraph 86). The addition of 0.5 individuals would increase the mortality rate by 0.001%, which is below the 1% threshold for detectability.

137. 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**.

12.6.1.1.1.1.2.9 Spring Migration – construction vessels and 50% installed turbines

138. The combination of displacement by construction vessels and half of that estimated for operational displacement in the spring migration period gives a maximum of 0.56 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.191 (**Table 12-13**) a total of 47,442 birds would be expected to die each year (see paragraph 86). The addition of 0.56 individuals would increase the mortality rate by 0.001%, which is below the 1% threshold for detectability.

139. 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**.

12.6.1.1.1.1.2.10 Annual – construction vessels

140. The estimated number of gannets subject to construction disturbance / displacement mortality at DBS West throughout the year is 1.22 individuals.

141. At the average baseline mortality rate for gannet of 0.191, a total of 87,153 birds would be expected to die from the largest BDMPS population throughout the year (see paragraph 86). The addition of a maximum of 1.22 to this would increase the mortality rate by 0.001%, which is below the 1% threshold for detectability.

142. The number of individuals from the biogeographic population expected to die across all seasons is 225,380 (see paragraph 86). The addition of a maximum of 1.22 to this increases the mortality rate by <0.001%, which is below the 1% threshold for detectability.

143. 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**.

12.6.1.1.1.1.2.11 Annual – 50% installed turbines

144. 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 12.6.2.1.1.2.4). Thus, a maximum of seven 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 0.191 (**Table 12-13**) a total of 87,153 birds would be expected to die each year (see paragraph 86). The addition of seven individuals would increase the mortality rate by 0.008, which is below the 1% threshold for detectability.

145. The number of individuals from the biogeographic population expected to die across all seasons is 225,380 (see paragraph 86). The addition of a maximum of 1.19 to this increases the mortality rate by 0.003%, which is below the 1% threshold for detectability.

146. 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**.

12.6.1.1.1.1.2.12 Annual – construction vessels and 50% installed turbines

147. 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 8.22 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.191 (**Table 12-13**) a total of 87,153 birds would be expected to die each year (see paragraph 86). The addition of 8.22 individuals would increase the mortality rate by 0.009%, which is below the 1% threshold for detectability.

148. The number of individuals from the biogeographic population expected to die across all seasons is 225,380 (see paragraph 86). The addition of a maximum of 8.22 to this increases the mortality rate by 0.004%, which is below the 1% threshold for detectability.

149. 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**.

12.6.1.1.1.1.3 Significance of Effect – DBS East and DBS West Together

12.6.1.1.1.1.3.1 Breeding Season – construction vessels

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

151. Based on the average mortality for the species of 0.191, a total of 9,116 birds would be expected to die in the breeding season (see paragraph 85). The addition of 1.14 individuals to this would increase the mortality rate by 0.013%, which is below the 1% threshold for detectability.

152. 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**.

12.6.1.1.1.1.3.2 Breeding Season – 50% installed turbines

153. 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 12.6.2.1.1.3.1). Thus, a maximum of 5.5 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 0.191 (**Table 12-13**) a total of 9,116 birds would be expected to die each year (see paragraph 85). The addition of 5.5 individuals would increase the mortality rate by 0.06%, which is below the 1% threshold for detectability.

154. 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**.

12.6.1.1.1.1.3.3 Breeding Season – construction vessels and 50% installed turbines

155. The combination of displacement by construction vessels and half of that estimated for operational displacement in the breeding season gives a maximum of 6.64 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.191 (**Table 12-13**) a total of 9,116 birds would be expected to die each year (see paragraph 85). The addition of 6.64 individuals would increase the mortality rate by 0.07%, which is below the 1% threshold for detectability.

156. 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**.

12.6.1.1.1.1.3.4 Autumn Migration – construction vessels

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

158. At the average baseline mortality rate for gannet of 0.191, a total of 87,153 birds would be expected to die in autumn (see paragraph 86). 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.

159. 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**.

12.6.1.1.1.1.3.5 Autumn Migration – 50% installed turbines

160. 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 12.6.2.1.1.3.2). Thus, a maximum of 6.5 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 0.191 (**Table 12-13**) a total of 87,153 birds would be expected to die each year (see paragraph 86). The addition of 6.5 individuals would increase the mortality rate by 0.007%, which is below the 1% threshold for detectability.

161. 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**.

12.6.1.1.1.1.3.6 Autumn Migration – construction vessels and 50% installed turbines

162. The combination of displacement by construction vessels and half of that estimated for operational displacement in the autumn migration period gives a maximum of 7.65 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.191 (**Table 12-13**) a total of 87,153 birds would be expected to die each year (see paragraph 86). The addition of 7.65 individuals would increase the mortality rate by 0.009%, which is below the 1% threshold for detectability.

163. 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**.

12.6.1.1.1.1.3.7 Spring Migration – construction vessels

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

165. Based on the average mortality for the species of 0.191, a total of 47,442 birds would be expected to die in spring (see paragraph 86). 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.

166. 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**.

12.6.1.1.1.1.3.8 Spring Migration – 50% installed turbines

167. 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 12.6.2.1.1.3.3). Thus, a maximum of 0.5 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 0.191 (**Table 12-13**) a total of 47,442 birds would be expected to die each year (see paragraph 86). The addition of 0.5 individuals would increase the mortality rate by 0.001%, which is below the 1% threshold for detectability.

168. 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**.

12.6.1.1.1.1.3.9 Spring Migration – construction vessels and 50% installed turbines

169. The combination of displacement by construction vessels and half of that estimated for operational displacement in the spring migration period gives a maximum of 0.62 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.191 (**Table 12-13**) a total of 47,442 birds would be expected to die each year (see paragraph 86). The addition of 0.62 individuals would increase the mortality rate by 0.001%, which is below the 1% threshold for detectability.

170. 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**.

12.6.1.1.1.1.3.10 Annual – construction vessels

171. Throughout the year the number of gannets at risk of mortality due to displacement from construction activity across the Array Areas was up to 2.41 individuals.

172. At the average baseline mortality rate for gannet of 0.191, a total of 87,153 birds would be expected to die from the largest BDMPS population throughout the year (see paragraph 86). The addition of a maximum of 2.41 to this increases the mortality rate by 0.003%, which is below the 1% threshold for detectability.

173. The number of individuals from the biogeographic population expected to die across all seasons is 225,380 (see paragraph 86). The addition of a maximum of 2.41 to this increases the mortality rate by 0.001%, which is below the 1% threshold for detectability.

174. 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**.

175. A table summarising the gannet construction displacement assessment is provided below (**Table 12-16**).

12.6.1.1.1.1.4 Summary of Construction Displacement Assessment - Gannet

Table 12-16 Summary of Gannet Displacement During Construction Assessment for DBS East, DBS West and Combined (Projects). Note that the Project Total is Less Than the Sum of East and West due to Overlap of the Individual 2km Buffers.

Gannet		DBS East	DBS West	Projects
Baseline average annual mortality				0.191
Breeding season	Reference population (subadult component of nonbreeding BDMPS)			47,727
	Density (birds/km²)	1.48	1.55	N/A
	Construction displacement mortality (@1%)	0.56	0.58	1.14
	Mortality due to 50% installed turbines (80% displaced x 1% mortality)	3	3	5.5
	Combined construction mortality	3.56	3.58	6.64
	Overall increase in background mortality (%)	0.04	0.04	0.07
	Significance	Negligible	Negligible	Negligible
Autumn	Reference population (nonbreeding season BDMPS)			456,298
	Density (birds/km²)	1.52	1.54	N/A
	Construction displacement mortality (@1%)	0.57	0.58	1.15
	Mortality due to 50% installed turbines (80% displaced x 1% mortality)	3	3	6.5
	Combined construction mortality	3.57	3.58	7.65
	Overall increase in background mortality (%)	0.004	0.004	0.009
	Significance	Negligible	Negligible	Negligible
Spring	Reference population			248,385
	Density (birds/km²)	0.15	0.17	N/A

Gannet		DBS East	DBS West	Projects
	Construction displacement mortality (@1%)	0.06	0.06	0.12
	Mortality due to 50% installed turbines (80% displaced x 1% mortality)	0.5	0.5	0.5
	Combined construction mortality	0.56	0.56	0.62
	Overall increase in background mortality (%)	0.001	0.001	0.001
	Significance	Negligible	Negligible	Negligible
Annual (BDMPS)	Reference population			456,298
	Density (birds/km^2)	3.15	3.26	N/A
	Construction displacement mortality (@1%)	1.19	1.22	2.41
	Mortality due to 50% installed turbines (80% displaced x 1% mortality)	6.5	7	12
	Combined construction mortality	7.69	8.22	14.41
	Overall increase in background mortality (%)	0.009	0.009	0.017
	Significance	Negligible	Negligible	Negligible
Annual (biogeographic)	Biogeographical population			1,180,000
	Increase in background mortality (%)	0.003	0.004	0.006
	Significance	Negligible	Negligible	Negligible

12.6.1.1.1.1.4.1 Annual – 50% installed turbines

176. 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 the Projects, (section 12.6.2.1.1.3.4). Thus, a maximum of 12 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 0.191 (**Table 12-13**) a total of 87,153 birds would be expected to die each year (see paragraph 86). The addition of 12 individuals would increase the mortality rate by 0.014%, which is below the 1% threshold for detectability.

177. The number of individuals from the biogeographic population expected to die across all seasons is 225,380 (see paragraph 86). The addition of a maximum of 12 to this increases the mortality rate by 0.005%, which is below the 1% threshold for detectability.

178. 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 Projects, the magnitude of annual impact at the Projects is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.6.1.1.1.1.4.2 Annual – construction vessels and 50% installed turbines

179. The combination of displacement by construction vessels and half of that estimated for operational displacement the annual impact at the Projects gives a maximum of 14.41 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.191 (**Table 12-13**) a total of 225,380 birds would be expected to die each year (see paragraph 86). The addition of 14.41 individuals would increase the mortality rate by 0.017%, which is below the 1% threshold for detectability.

180. The number of individuals from the biogeographic population expected to die across all seasons is 225,380 (see paragraph 86). The addition of a maximum of 14.41 to this increases the mortality rate by 0.006%, which is below the 1% threshold for detectability.

181. 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 Projects, the magnitude of annual impact at the Projects is assessed as negligible. As the species is of low sensitivity to displacement, the effect significance is **negligible**.

12.6.1.1.1.2 Auks (Guillemot and Razorbill and Puffin)

182. A review of available evidence for displacement of auks concluded that precautionary rates of displacement and mortality from operational wind farms would be 50% and 1% respectively (MacArthur Green, 2021, submitted for the Norfolk Vanguard assessment). These figures are also considered suitably precautionary for the potential displacement around construction vessels. Thus, the assessment presents estimates using a range from 1% mortality to 10% mortality.

12.6.1.1.1.3 Guillemot

183. 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).

184. 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 (**Table 12-9**).

185. 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).

186. The number of individuals from this population expected to die in the breeding season is 286,311 (2,045,078 x 0.14, **Table 12-13**).

187. During the nonbreeding season the guillemot BDMPS population for the North Sea has been used as the reference population (1,617,306). For 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 in the nonbreeding season are 286,311 (2,045,078 x 0.14) and 577,500 (4,125,000 x 0.14) respectively.

12.6.1.1.1.3.1 Significance of Effect – DBS East in Isolation

12.6.1.1.1.3.1.1 Breeding Season – construction vessels

188. During the breeding season, the maximum mean peak density in the DBS East Array Area was 17.71/km^2. With a precautionary 2km radius of disturbance around each of three acti.ve 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 would be expected to be at risk of mortality.

189. Based on the average mortality for guillemot of 0.14 (Table 12-13), a total of 286,311 birds would be expected to die each year from the breeding season reference population (see paragraph 186). The addition of a maximum of 66.7 birds would increase the mortality rate by 0.02%. which is below the 1% threshold for detectability.

190. 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**.

12.6.1.1.1.3.1.2 Breeding Season – 50% installed turbines

191. 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 12.6.2.1.3.1.1). Thus, a maximum of 5.5 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 0.14 (**Table 12-13**) a total of 286,311 birds would be expected to die each year (see paragraph 186). The addition of 5.5 individuals would increase the mortality rate by 0.06%, which is below the 1% threshold for detectability.

192. 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**.

12.6.1.1.1.3.1.3 Breeding Season – construction vessels and 50% installed turbines

193. The combination of displacement by construction vessels and half of that estimated for operational displacement in the breeding season gives a maximum of 382.7 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.41 (**Table 12-13**) a total of 286,311 birds would be expected to die each year (see paragraph 186). The addition of 382.7 individuals would increase the mortality rate by 0.13%, which is below the 1% threshold for detectability.

194. 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**.

12.6.1.1.1.3.1.4 Nonbreeding – construction vessels

195. 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 would be expected to be at risk of mortality.

196. Based on the average mortality rate for guillemot of 0.14 (**Table 12-13**), a total 226,423 birds would be expected to die each year from the nonbreeding season BDMPS population (see paragraph 187). The addition of a maximum of 92.8 birds to this would increase the mortality rate by 0.04%, which is below the 1% threshold for detectability.

197. 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**.

12.6.1.1.1.3.1.5 Nonbreeding – 50% installed turbines

198. 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 nonbreeding season (section 12.6.2.1.3.1.2). Thus, a maximum of 439.5 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 0.14 (**Table 12-13**) a total of 226,423 birds would be expected to die each year (see paragraph 186). The addition of 439.5 individuals would increase the mortality rate by 0.2%, which is below the 1% threshold for detectability.

199. 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**.

12.6.1.1.1.3.1.6 Nonbreeding – construction vessels and 50% installed turbines

200. The combination of displacement by construction vessels and half of that estimated for operational displacement in the nonbreeding season gives a maximum of 532.3 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.41 (**Table 12-13**) a total of 226,423 birds would be expected to die each year (see paragraph 186). The addition of 532.3 individuals would increase the mortality rate by 0.24%, which is below the 1% threshold for detectability.

201. 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**.

12.6.1.1.1.3.1.7 Annual – construction vessels

202. The estimated number of guillemots subject to construction disturbance and displacement mortality at DBS East throughout the year is up to 159.5 individuals.

203. The number of individuals expected to die from the largest BDMPS population throughout the year is 286,311 (see paragraph 186). The addition of a maximum of 159.5 individuals to this increases the mortality rate by 0.06%, which is below the 1% threshold for detectability.

204. The number of individuals from the biogeographic population expected to die across all seasons is 577,500 (see paragraph 187). The addition of a maximum of 159.5 to this increases the mortality rate by 0.03%, which is below the 1% threshold for detectability.

205. 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**.

12.6.1.1.1.3.1.8 Annual – 50% installed turbines

206. 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 the Projects, (section 12.6.2.1.3.1.3). Thus, a maximum of 755.5 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 0.41 (**Table 12-13**) a total of is 286,311 birds would be expected to die each year (see paragraph 187). The addition of 755.5 individuals would increase the mortality rate by 0.26%, which is below the 1% threshold for detectability.

207. The number of individuals from the biogeographic population expected to die across all seasons is 577,500 (see paragraph 187). The addition of a maximum of 755.5 to this increases the mortality rate by 0.13%, which is below the 1% threshold for detectability.

208. 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**.

12.6.1.1.1.3.1.9 Annual – construction vessels and 50% installed turbines

209. The combination of displacement by construction vessels and half of that estimated for operational displacement the annual impact at the Projects gives a maximum of 915 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.141 (**Table 12-13**) a total of is 286,311 birds would be expected to die each year (see paragraph 187). The addition of 915 individuals would increase the mortality rate by 0.32%, which is below the 1% threshold for detectability.

210. The number of individuals from the biogeographic population expected to die across all seasons is 577,500 (see paragraph 187). The addition of a maximum of 915 to this increases the mortality rate by 0.16%, which is below the 1% threshold for detectability.

211. 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**.

12.6.1.1.1.3.1.10 Significance of Effect – DBS West in Isolation

12.6.1.1.1.3.1.11 Breeding Season – construction vessels

212. 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 would be expected to be at risk of mortality.

213. Based on the average mortality for guillemot of 0.14 (**Table 12-13**), a total of 286,311 birds would be expected to die each year from the breeding season reference population (see paragraph 186). The addition of a maximum of 63.8 birds would increase the mortality rate by 0.02%, which is below the 1% threshold for detectability.

214. 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**.

12.6.1.1.1.3.1.12 Breeding Season – 50% installed turbines

215. 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 12.6.2.1.3.2.1). Thus, a maximum of 5.5 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 0.14 (**Table 12-13**) a total of 286,311 birds would be expected to die each year (see paragraph 186). The addition of 5.5 individuals would increase the mortality rate by 0.06%, which is below the 1% threshold for detectability.

216. 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**.

12.6.1.1.1.3.1.13 Breeding Season – construction vessels and 50% installed turbines

217. The combination of displacement by construction vessels and half of that estimated for operational displacement in the breeding season gives a maximum of 371.3 Based on the average mortality for the species of 0.41 (**Table 12-13**) a total of 286,311 birds would be expected to die each year (see paragraph 186). The addition of 371.3 individuals would increase the mortality rate by 0.13%, which is below the 1% threshold for detectability.

218. 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**.

12.6.1.1.1.3.1.14 Nonbreeding – construction vessels

219. During the nonbreeding season, 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 would be expected to be at risk of mortality.

220. Based on the average mortality rate for guillemot, of 0.14, 226,423 birds would be expected to die each year from the nonbreeding season BDMPS population (see paragraph 187). The addition of 90.7 birds to this would increase the mortality rate by up to 0.04%, which is below the 1% threshold for detectability.

221. 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**.

12.6.1.1.1.3.1.15 Nonbreeding – 50% installed turbines

222. 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 nonbreeding season (section 12.6.2.1.3.2.2). Thus, a maximum of 437.5 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 0.14 (**Table 12-13**) a total of 226,423 birds would be expected to die each year (see paragraph 186). The addition of 437.5 individuals would increase the mortality rate by 0.2%, which is below the 1% threshold for detectability.

223. 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**.

12.6.1.1.1.3.1.16 Nonbreeding – construction vessels and 50% installed turbines

224. The combination of displacement by construction vessels and half of that estimated for operational displacement in the nonbreeding season gives a maximum of 528.2 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.41 (**Table 12-13**) a total of 226,423 birds would be expected to die each year (see paragraph 186). The addition of 528.2 individuals would increase the mortality rate by 0.23%, which is below the 1% threshold for detectability.

225. 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**.

12.6.1.1.1.3.1.17 Annual – construction vessels

226. The estimated number of guillemots subject to construction disturbance and displacement mortality at DBS West throughout the year is up to 154.5.

227. The number of individuals expected to die from the largest BDMPS population throughout the year is 286,311 (see paragraph 186). The addition of a maximum of 154.5 individuals to this increases the mortality rate by 0.05%, which is below the 1% threshold for detectability.

228. The number of individuals from the biogeographic population expected to die across all seasons is 577,500 (see paragraph 187). The addition of a maximum of 154.5 to this increases the mortality rate by 0.03%, which is below the 1% threshold for detectability.

229. 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**.

12.6.1.1.1.3.1.18 Annual – 50% installed turbines

230. 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 the Projects, (section 12.6.2.1.3.2.3. Thus, a maximum of 745 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 0.41 (**Table 12-13**) a total of is 286,311 birds would be expected to die each year (see paragraph 187). The addition of 745 individuals would increase the mortality rate by 0.26%, which is below the 1% threshold for detectability.

231. The number of individuals from the biogeographic population expected to die across all seasons is 577,500 (see paragraph 187). The addition of a maximum of 745 to this increases the mortality rate by 0.13%, which is below the 1% threshold for detectability.

232. 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**.

12.6.1.1.1.3.1.19 Annual – construction vessels and 50% installed turbines

233. The combination of displacement by construction vessels and half of that estimated for operational displacement the annual impact at the Projects gives a maximum of 899.5 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.141 (**Table 12-13**) a total of is 286,311 birds would be expected to die each year (see paragraph 187). The addition of 899.5 individuals would increase the mortality rate by 0.31%, which is below the 1% threshold for detectability.

234. The number of individuals from the biogeographic population expected to die across all seasons is 577,500 (see paragraph 187). The addition of a maximum of 14.41 to this increases the mortality rate by 0.16%, which is below the 1% threshold for detectability.

235. 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**.

12.6.1.1.1.3.2 Significance of Effect – DBS East and DBS West Together

12.6.1.1.1.3.2.1 Breeding Season – construction vessels

236. During the breeding season the number of guillemots at risk of mortality due to displacement from construction vessels across the Array Areas was up to 130.5.

237. Based on the average mortality for guillemot of 0.14 (**Table 12-13**), a total of 286,311 birds would be expected to die each year from the breeding season reference population (see paragraph 186). 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 0.05%, which is below the 1% threshold for detectability.

238. 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**.

12.6.1.1.1.3.2.2 Breeding Season – 50% installed turbines

239. 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 12.6.2.1.3.3.1). Thus, a maximum of 5.5 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 0.14 (**Table 12-13**) a total of 286,311 birds would be expected to die each year (see paragraph 186). The addition of 5.5 individuals would increase the mortality rate by 0.06%, which is below the 1% threshold for detectability.

240. 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**.

12.6.1.1.1.3.2.3 Breeding Season – construction vessels and 50% installed turbines

241. The combination of displacement by construction vessels and half of that estimated for operational displacement in the breeding season gives a maximum of 653 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.41 (**Table 12-13**) a total of 286,311 birds would be expected to die each year (see paragraph 186). The addition of 653 individuals would increase the mortality rate by 0.23%, which is below the 1% threshold for detectability.

242. 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**.

12.6.1.1.1.3.2.4 Nonbreeding – construction vessels

243. During the nonbreeding season the number of guillemots at risk of mortality due to displacement from construction vessels across the Array Areas was up to 183.5.

244. Based on the average mortality rate for guillemot, of 0.14, 226,423 birds would be expected to die each year from the nonbreeding season BDMPS population (see paragraph 187). The addition of 183.5 birds to this would increase the mortality rate by up to 0.08%, which is below the 1% threshold for detectability.

245. 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**.

12.6.1.1.1.3.2.5 Nonbreeding – 50% installed turbines

246. 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 nonbreeding season (section 12.6.2.1.3.3.2). Thus, a maximum of 705 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 0.14 (**Table 12-13**) a total of 226,423 birds would be expected to die each year (see paragraph 186). The addition of 705 individuals would increase the mortality rate by 0.3 which is below the 1% threshold for detectability.

247. 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**.

12.6.1.1.1.3.2.6 Nonbreeding – construction vessels and 50% installed turbines

248. The combination of displacement by construction vessels and half of that estimated for operational displacement in the nonbreeding season gives a maximum of 888.5 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.41 (**Table 12-13**) a total of 226,423 birds would be expected to die each year (see paragraph 186). The addition of 888.5 individuals would increase the mortality rate by 0.4%, which is below the 1% threshold for detectability.

249. 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**.

12.6.1.1.1.3.2.7 Annual – construction vessels

250. Throughout the year the number of guillemots at risk of mortality due to displacement from construction activity across the Array Areas was up to 314.

251. The number of individuals expected to die from the largest BDMPS population throughout the year is 286,311 (see paragraph 186). The addition of a maximum of 314 individuals to this increases the mortality rate by 0.11%, which is below the 1% threshold for detectability.

252. The number of individuals from the biogeographic population expected to die across all seasons is 577,500 (see paragraph 187). The addition of a maximum of 314 to this increases the mortality rate by 0.05%, which is below the 1% threshold for detectability.

253. 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**.

254. A table summarising the guillemot construction displacement assessment is provided below (**Table 12-17**).

12.6.1.1.1.3.3 Summary of Construction Displacement Assessment - Guillemot

Table 12-17 Summary of Guillemot Displacement During Construction Assessment For DBS East, DBS West and Combined (Projects). Note that the Project Total is Less Than the Sum of East and West Due to Overlap of the Individual 2km Buffers.

Guillemot		DBS East	DBS West	Projects
Baseline average annual mortality				0.14
Breeding season	Reference population (subadult component of nonbreeding BDMPS)			2,045,078
	Density (birds/km²)	17.71	16.92	N/A
	Construction displacement mortality (@10%)	66.7	63.8	130.5
	Mortality due to 50% installed turbines (70% displaced x 10% mortality)	316	307.5	522.5
	Combined construction mortality	382.7	371.3	653
	Overall increase in background mortality (%)	0.13	0.13	0.23
	Significance	Minor	Minor	Minor
Non breeding season	Reference population			1,617,306
	Density (birds/km²)	24.62	24.08	N/A
	Construction displacement mortality (@10%)	92.8	90.7	183.5
	Mortality due to 50% installed turbines (70% displaced x 10% mortality)	439.5	437.5	705
	Combined construction mortality	532.3	528.2	888.5
	Overall increase in background mortality (%)	0.24	0.23	0.39
	Significance	Minor	Minor	Minor
Annual (BDMPS)	Reference population			2,045,078
	Density (birds/km²)	42.33	41	N/A

Guillemot		DBS East	DBS West	Projects
	Construction displacement mortality (@10%)	159.5	154.5	314
	Mortality due to 50% installed turbines (70% displaced x 10% mortality)	755.5	745	1227
	Combined construction mortality	915	899.5	1541
	Overall increase in background mortality (%)	0.32	0.31	0.54
	Significance	Minor	Minor	Minor
Annual (bio-geographic)	Biogeographical population			4,125,000
	Increase in background mortality (%)	0.16	0.16	0.27
	Significance	Minor	Minor	Minor

12.6.1.1.1.3.3.1 Annual – 50% installed turbines

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 the Projects, (section 12.6.2.1.3.3.3). Thus, a maximum of 1,227 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 0.41 (**Table 12-13**) a total of is 286,311 birds would be expected to die each year (see paragraph 187). The addition of 1,227 individuals would increase the mortality rate by 0.43%, which is below the 1% threshold for detectability.

256. The number of individuals from the biogeographic population expected to die across all seasons is 577,500 (see paragraph 187). The addition of a maximum of 1,227 to this increases the mortality rate by 0.21%, which is below the 1% threshold for detectability.

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 the Projects is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.6.1.1.1.3.4 Annual – construction vessels and 50% installed turbines

258. The combination of displacement by construction vessels and half of that estimated for operational displacement the annual impact at the Projects gives a maximum of 1,541 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.141 (**Table 12-13**) a total of is 286,311 birds would be expected to die each year (see paragraph 187). The addition of 1,541 individuals would increase the mortality rate by 0.54%, which is below the 1% threshold for detectability.

259. The number of individuals from the biogeographic population expected to die across all seasons is 577,500 (see paragraph 187). The addition of a maximum of 1,541 to this increases the mortality rate by 0.27%, which is below the 1% threshold for detectability.

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 the Projects is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.6.1.1.1.4 Razorbill

261. 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).

262. 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 (**Table 12-9**).

263. It is therefore appropriate to assume that individuals seen during the breeding season are nonbreeding and that they are predominantly sub-adult birds. Since sub-adult seabirds are known to remain in wintering areas, the number of sub-adult birds in the relevant population during the breeding season may be estimated as 43% of the preceding BDMPS population (the proportion of the wintering BDMPS population that is immature, Furness, 2015). This gives a breeding season population of 94,007 (BDMPS for the UK North Sea and Channel, 218,622 x 43%).

264. The number of individuals from this population expected to die in the breeding season is 16,357 (94,007 x 0.174, **Table 12-13**).

265. During the nonbreeding seasons the razorbill BDMPS populations for the North Sea have been used as the reference populations (in the autumn and spring: 591,874 and in the winter: 218,622). For the annual assessment impacts have been considered in relation to the largest of the BDMPS populations (autumn/spring) and also to the biogeographic population (1,707,000; Furness, 2015). The number of individuals from these populations expected to die in the nonbreeding season are for spring and autumn 102,986 (591,874 x 0.174), for winter 38,040 (218,622 x 0.174) and from the biogeographic population 297,018 (1,707,000 x 0.174) respectively.

12.6.1.1.1.4.1 Significance of Effect – DBS East in Isolation

12.6.1.1.1.4.1.1 Breeding Season – construction vessels

266. 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 would be expected to be at risk of mortality.

267. Based on the average mortality for the species of 0.174, a total of 16,357 birds would be expected to die each year from the breeding season reference population (see paragraph 264). The addition of a maximum of 4.1 birds would increase the mortality rate by 0.03%, which is below the 1% threshold for detectability.

268. 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**.

12.6.1.1.1.4.1.2 Breeding Season – 50% installed turbines

269. 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 12.6.2.1.4.1.1). Thus, a maximum of 19.5 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 0.174 (**Table 12-13**) a total of 16,357 birds would be expected to die each year (see paragraph 264). The addition of 19.5 individuals would increase the mortality rate by 0.12%, which is below the 1% threshold for detectability.

270. 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**.

12.6.1.1.1.4.1.3 Breeding Season – construction vessels and 50% installed turbines

271. The combination of displacement by construction vessels and half of that estimated for operational displacement in the breeding season gives a maximum of 23.6 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.174 (**Table 12-13**) a total of 16,357 birds would be expected to die each year (see paragraph 264). The addition of 23.6 individuals would increase the mortality rate by 0.14%, which is below the 1% threshold for detectability.

272. 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**.

12.6.1.1.1.4.1.4 Autumn Migration – construction vessels

273. 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 birds would be predicted to be at risk of mortality.

274. Based on the average mortality for the species of 0.174, a total of 102,986 birds would be expected to die in autumn (see paragraph 265). The addition of 34.6 birds to this would increase the mortality rate by 0.03%, which is below the 1% threshold for detectability.

275. 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**.

12.6.1.1.1.4.1.5 Autumn Migration – 50% installed turbines

276. 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 12.6.2.1.4.1.2). Thus, a maximum of 164 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 0.174 (**Table 12-13**) a total of 102,986 birds would be expected to die each year (see paragraph 265). The addition of 164 individuals would increase the mortality rate by 0.16%, which is below the 1% threshold for detectability.

277. 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**.

12.6.1.1.1.4.1.6 Autumn Migration – construction vessels and 50% installed turbines

278. 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 0.174 (**Table 12-13**) a total of 102,986 birds would be expected to die each year (see paragraph 265). The addition of 198.6 individuals would increase the mortality rate by 0.2%, which is below the 1% threshold for detectability.

279. 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**.

12.6.1.1.1.4.1.7 Winter – construction vessels

280. 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 would be expected to be at risk of mortality.

281. Based on the average mortality for the species of 0.174, a total of 38,040 birds would be expected to die from the winter population (see paragraph 265). The addition of a maximum of 24.9 birds would increase the mortality rate by 0.07%, which is below the 1% threshold for detectability.

282. 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**.

12.6.1.1.1.4.1.8 Winter– 50% installed turbines

283. 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 12.6.2.1.4.1.3). Thus, a maximum of 118 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 0.174 (**Table 12-13**) a total of 38,040 birds would be expected to die each year (see paragraph 265). The addition of 118 individuals would increase the mortality rate by 0.3%, which is below the 1% threshold for detectability.

284. 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**.

12.6.1.1.1.4.1.9 Winter – construction vessels and 50% installed turbines

285. The combination of displacement by construction vessels and half of that estimated for operational displacement in the winter period gives a maximum of 142.9 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.174 (**Table 12-13**) a total of 38,040 birds would be expected to die each year (see paragraph 265). The addition of 142.9 individuals would increase the mortality rate by 0.4%, which is below the 1% threshold for detectability.

286. 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**.

12.6.1.1.1.4.1.10 Spring Migration – construction vessels

287. 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 would be expected to be at risk of mortality.

288. Based on the average mortality for the species of 0.174, a total of 102,986 birds would be expected to die during the spring migration period (see paragraph 265). The addition of a maximum of 26.5 birds would increase the mortality rate by 0.03%, which is below the 1% threshold for detectability.

289. 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**.

12.6.1.1.1.4.1.11 Spring Migration – 50% installed turbines

290. 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 12.6.2.1.4.1.4). Thus, a maximum of 125.5 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 0.174 (**Table 12-13**) a total of 102,986 birds would be expected to die each year (see paragraph 265). The addition of 125.5 individuals would increase the mortality rate by 0.12%, which is below the 1% threshold for detectability.

291. 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**.

12.6.1.1.1.4.1.12 Spring Migration – construction vessels and 50% installed turbines

292. The combination of displacement by construction vessels and half of that estimated for operational displacement in the spring migration period gives a maximum of 152 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.174 (**Table 12-13**) a total of 102,986 birds would be expected to die each year (see paragraph 265). The addition of 152 individuals would increase the mortality rate by 0.15%, which is below the 1% threshold for detectability.

293. 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**.

12.6.1.1.1.4.1.13 Annual – construction vessels

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

295. At the average baseline mortality rate for razorbill of 0.174 (**Table 12-13**), a total of 102,986 birds would be expected to die from the largest BDMPS population throughout the year (see paragraph 265). The addition of a maximum of 90.1 individuals to this increases the mortality rate by 0.09%, which is below the 1% threshold for detectability.

296. The number of individuals from the biogeographic population expected to die across all seasons is 297,018 (see paragraph 265). The addition of a maximum of 90.1 to this increases the mortality rate by 0.03%, which is below the 1% threshold for detectability.

297. 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**.

12.6.1.1.1.4.1.14 Annual – 50% installed turbines

298. 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 12.6.2.1.4.1.5). Thus, a maximum of 427 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 0.174 (**Table 12-13**) a total of is 102,986 birds would be expected to die each year (see paragraph 265). The addition of 427individuals would increase the mortality rate by 0.4%, which is below the 1% threshold for detectability.

299. The number of individuals from the biogeographic population expected to die across all seasons is 297,018 (see paragraph 265). The addition of a maximum of 427 to this increases the mortality rate by 0.14%, which is below the 1% threshold for detectability.

300. 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**.

12.6.1.1.1.4.1.15 Annual – construction vessels and 50% installed turbines

301. 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 517.1 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.174 (**Table 12-13**) a total of is 102,986 birds would be expected to die each year (see paragraph 265). The addition of 517.1 individuals would increase the mortality rate by 0.5%, which is below the 1% threshold for detectability.

302. The number of individuals from the biogeographic population expected to die across all seasons is 297,018 (see paragraph 265). The addition of a maximum of 517.1 to this increases the mortality rate by 0.2%, which is below the 1% threshold for detectability.

303. 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**.

12.6.1.1.1.4.2 Significance of Effect – DBS West in Isolation

12.6.1.1.1.4.2.1 Breeding Season – construction vessels

304. 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 birds would be expected to be at risk of mortality.

305. Based on the average mortality for the species of 0.174, a total of 16,357 birds would be expected to die each year from the breeding season reference population (see paragraph 264).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 0.1%, which is below the 1% threshold for detectability.

306. 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**.

12.6.1.1.1.4.2.2 Breeding Season – 50% installed turbines

307. 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 12.6.2.1.4.2.2). Thus, a maximum of 80 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 0.174 (**Table 12-13**) a total of 16,357 birds would be expected to die each year (see paragraph 264). The addition of 80 individuals would increase the mortality rate by 0.5%, which is below the 1% threshold for detectability.

308. 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**.

12.6.1.1.1.4.2.3 Breeding Season – construction vessels and 50% installed turbines

309. The combination of displacement by construction vessels and half of that estimated for operational displacement in the breeding season gives a maximum of 96.5 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.174 (**Table 12-13**) a total of 16,357 birds would be expected to die each year (see paragraph 264). The addition of 96.5 individuals would increase the mortality rate by 0.6%, which is below the 1% threshold for detectability.

310. 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**.

12.6.1.1.1.4.2.4 Autumn Migration – construction vessels

311. During the autumn migration season the maximum mean peak density in the DBS West Array Area was 9.41 /km2 DBS West. 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 birds would be predicted to be at risk of mortality.

312. Based on the average mortality for the species of 0.174, a total of 102,986 birds would be expected to die in autumn (see paragraph 265). The addition of 35.5 birds to this would increase the mortality rate by 0.03%, which is below the 1% threshold for detectability.

313. 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**.

12.6.1.1.1.4.2.5 Autumn Migration – 50% installed turbines

314. 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 12.6.2.1.4.1.2). Thus, a maximum of 171 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 0.174 (**Table 12-13**) a total of 102,986 birds would be expected to die each year (see paragraph 265). The addition of 171 individuals would increase the mortality rate by 0.17%, which is below the 1% threshold for detectability.

315. 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**.

12.6.1.1.1.4.2.6 Autumn Migration – construction vessels and 50% installed turbines

316. 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 0.174 (**Table 12-13**) a total of 102,986 birds would be expected to die each year (see paragraph 265). The addition of 206.5 individuals would increase the mortality rate by 0.2%, which is below the 1% threshold for detectability.

317. 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**.

12.6.1.1.1.4.2.7 Winter – construction vessels

318. 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 would be expected to be at risk of mortality.

319. Based on the average mortality for the species of 0.174, a total of 38,040 birds would be expected to die in winter (see paragraph 265). The addition of a maximum of 36.8 birds would increase the mortality rate by 0.10%, which is below the 1% threshold for detectability.

320. 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**.

12.6.1.1.1.4.2.8 Winter– 50% installed turbines

321. 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 12.6.2.1.4.2.3). Thus, a maximum of 177.5 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 0.174 (**Table 12-13**) a total of 38,040 birds would be expected to die each year (see paragraph 265). The addition of 177.5 individuals would increase the mortality rate by 0.5%, which is below the 1% threshold for detectability.

322. 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**.

12.6.1.1.1.4.2.9 Winter – construction vessels and 50% installed turbines

323. The combination of displacement by construction vessels and half of that estimated for operational displacement in the winter period gives a maximum of 214.3 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.174 (**Table 12-13**) a total of 38,040 birds would be expected to die each year (see paragraph 265). The addition of 214.3 individuals would increase the mortality rate by 0.6%, which is below the 1% threshold for detectability.

324. 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**.

12.6.1.1.1.4.2.10 Spring Migration – construction vessels

325. 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 (5.34 x 12.56 x 3) could be at risk of displacement, of which up to 32.3 would be expected to be at risk of mortality.

326. Based on the average mortality for the species of 0.174, a total of 102,986 birds would be expected to die each year from the spring migration (see paragraph 265). The addition of a maximum of 32.3 birds would increase the mortality rate by 0.03%, which is below the 1% threshold for detectability.

327. 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**.

12.6.1.1.1.4.2.11 Spring Migration – 50% installed turbines

328. 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 12.6.2.1.4.1.2). Thus, a maximum of 156 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 0.174 (**Table 12-13**) a total of 102,986 birds would be expected to die each year (see paragraph 265). The addition of 156 individuals would increase the mortality rate by 0.15%, which is below the 1% threshold for detectability.

329. 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**.

12.6.1.1.1.4.2.12 Spring Migration – construction vessels and 50% installed turbines

330. The combination of displacement by construction vessels and half of that estimated for operational displacement in the spring migration period gives a maximum of 188.3 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.174 (**Table 12-13**) a total of 102,986 birds would be expected to die each year (see paragraph 265). The addition of 188.3 individuals would increase the mortality rate by 0.2%, which is below the 1% threshold for detectability.

331. 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**.

12.6.1.1.1.4.2.13 Annual – construction vessels

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

333. At the average baseline mortality rate for razorbill of 0.174, a total of 102,986 birds would be expected to die from the largest BDMPS population throughout the year (see paragraph 265). The addition of a maximum of 121.1 individuals to this increases the mortality rate by 0.12%, which is below the 1% threshold for detectability.

334. The number of individuals from the biogeographic population expected to die across all seasons is 297,018 (see paragraph 264). The addition of a maximum of 121.1 to this increases the mortality rate by 0.04%, which is below the 1% threshold for detectability.

335. 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**.

12.6.1.1.1.4.2.14 Annual – 50% installed turbines

336. 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 12.6.2.1.4.2.5). Thus, a maximum of 584 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 0.174 (**Table 12-13**) a total of is 102,986 birds would be expected to die each year (see paragraph 265). The addition of 584 individuals would increase the mortality rate by 0.57%, which is below the 1% threshold for detectability.

337. The number of individuals from the biogeographic population expected to die across all seasons is 297,018 (see paragraph 271). The addition of a maximum of 584 to this increases the mortality rate by 0.20%, which is below the 1% threshold for detectability.

338. 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**.

12.6.1.1.1.4.2.15 Annual – construction vessels and 50% installed turbines

339. 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 705.1 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.174 (**Table 12-13**) a total of is 102,986 birds would be expected to die each year (see paragraph 265). The addition of 705.1 individuals would increase the mortality rate by 0.68%, which is below the 1% threshold for detectability.

340. The number of individuals from the biogeographic population expected to die across all seasons is 297,018 (see paragraph 265). The addition of a maximum of 705.1 to this increases the mortality rate by 0.24%, which is below the 1% threshold for detectability.

341. 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**.

12.6.1.1.1.4.3 Significance of Effect – DBS East and DBS West Together

12.6.1.1.1.4.3.1 Breeding Season – construction vessels

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

343. Based on the average mortality for the species of 0.174, a total of 16,357 birds would be expected to die each year from the breeding season reference population (see paragraph 264). 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 0.13%, which is below the 1% threshold for detectability.

344. 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**.

12.6.1.1.1.4.3.2 Breeding Season – 50% installed turbines

345. 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 12.6.2.1.4.3.1). Thus, a maximum of 99 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 0.174 (**Table 12-13**) a total of 16,357 birds would be expected to die each year (see paragraph 264). The addition of 99 individuals would increase the mortality rate by 0.6%, which is below the 1% threshold for detectability.

346. 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**.

12.6.1.1.1.4.3.3 Breeding Season – construction vessels and 50% installed turbines

347. The combination of displacement by construction vessels and half of that estimated for operational displacement in the breeding season gives a maximum of 119.6 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.174 (**Table 12-13**) a total of 16,357 birds would be expected to die each year (see paragraph 264). The addition of 119.6 individuals would increase the mortality rate by 0.7%, which is below the 1% threshold for detectability.

348. 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**.

12.6.1.1.1.4.3.4 Autumn Migration – construction vessels

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

350. Based on the average mortality for the species of 0.174, a total of 102,986 birds would be expected to die in autumn (see paragraph 265). The addition of 70 birds to this would increase the mortality rate by 0.07%, which is below the 1% threshold for detectability.

351. 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**.

12.6.1.1.1.4.3.5 Autumn Migration – 50% installed turbines

352. 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 12.6.2.1.4.3.2). Thus, a maximum of 222.5 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 0.174 (**Table 12-13**) a total of 102,986 birds would be expected to die each year (see paragraph 265). The addition of 222.5 individuals would increase the mortality rate by 0.2%, which is below the 1% threshold for detectability.

353. 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**.

12.6.1.1.1.4.3.6 Autumn Migration – construction vessels and 50% installed turbines

354. The combination of displacement by construction vessels and half of that estimated for operational displacement in the autumn migration period gives a maximum of 292.6 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.174 (**Table 12-13**) a total of 102,986 birds would be expected to die each year (see paragraph 265). The addition of 292.6 individuals would increase the mortality rate by 0.3%, which is below the 1% threshold for detectability.

355. 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**.

12.6.1.1.1.4.3.7 Winter – construction vessels

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

357. Based on the average mortality for the species of 0.174, a total of 38,040 birds would be expected to die in winter (see paragraph 265). The addition of a maximum of 61.7 birds would increase the mortality rate by 0.16%, which is below the 1% threshold for detectability.

358. 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**.

12.6.1.1.1.4.3.8 Winter– 50% installed turbines

359. 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 12.6.2.1.4.3.3. Thus, a maximum of 204 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 0.174 (**Table 12-13**) a total of 38,040 birds would be expected to die each year (see paragraph 265). The addition of 204 individuals would increase the mortality rate by 0.5%, which is below the 1% threshold for detectability.

360. 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**.

12.6.1.1.1.4.3.9 Winter – construction vessels and 50% installed turbines

361. The combination of displacement by construction vessels and half of that estimated for operational displacement in the winter period gives a maximum of 265.7 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.174 (**Table 12-13**) a total of 38,040 birds would be expected to die each year (see paragraph 265). The addition of 265.7 individuals would increase the mortality rate by 0.7%, which is below the 1% threshold for detectability.

362. 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**.

12.6.1.1.1.4.3.10 Spring Migration – construction vessels

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

364. Based on the average mortality for the species of 0.174, a total of 102,986 birds would be expected to die each year from the spring migration (see paragraph 265). The addition of a maximum of 58.8 birds would increase the mortality rate by 0.05%, which is below the 1% threshold for detectability.

365. 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**.

12.6.1.1.1.4.3.11 Spring Migration – 50% installed turbines

366. 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 12.6.2.1.4.3.4). Thus, a maximum of 220.5 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 0.174 (**Table 12-13**) a total of 102,986 birds would be expected to die each year (see paragraph 265). The addition of 220.5 individuals would increase the mortality rate by 0.2%, which is below the 1% threshold for detectability.

367. 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**.

12.6.1.1.1.4.3.12 Spring Migration – construction vessels and 50% installed turbines

368. The combination of displacement by construction vessels and half of that estimated for operational displacement in the spring migration period gives a maximum of 279.3 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.174 (**Table 12-13**) a total of 102,986 birds would be expected to die each year (see paragraph 265). The addition of 279.3 individuals would increase the mortality rate by 0.3%, which is below the 1% threshold for detectability.

369. 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**.

12.6.1.1.1.4.3.13 Annual – construction vessels

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

371. At the average baseline mortality rate for razorbill of 0.174, a total of 102,986 birds would be expected to die from the largest BDMPS population throughout the year (see paragraph 265). The addition of a maximum of 211.2 individuals to this increases the mortality rate by 0.21%, which is below the 1% threshold for detectability.

372. The number of individuals from the biogeographic population expected to die across all seasons is 297,018 (see paragraph 264). The addition of a maximum of 211.2 to this increases the mortality rate by 0.07%, which is below the 1% threshold for detectability.

373. 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**.

374. A table summarising the razorbill construction displacement assessment is provided below (**Table 12-18**).

12.6.1.1.1.4.4 Summary of Construction Displacement Assessment - Razorbill

Table 12-18 Summary of Razorbill Displacement During Construction Assessment for DBS East, DBS West and Combined (Projects). Note that the Project Total is Less Than the Sum of East and West Due to Overlap of the Individual 2km Buffers.

Razorbill		DBS East	DBS West	Projects
Baseline Average Annual Mortality				0.174
Breeding season	Reference population (subadult component of nonbreeding BDMPS)			94,007
	Density (birds/km^2)	1.09	4.39	N/A
	Construction displacement mortality (@1%)	4.1	16.5	20.6
	Mortality due to 50% installed turbines (70% displaced x 10% mortality)	19.5	80	99
	Combined construction mortality	23.6	96.5	119.6
	Overall increase in background mortality (%)	0.14	0.6	0.7
	Significance	Minor	Minor	Minor
Autumn	Reference population (Nonbreeding season BDMPS)			591,874
	Density (birds/km^2)	9.19	9.41	N/A
	Construction displacement mortality (@1%)	34.6	35.5	70.1
	Mortality due to 50% installed turbines (70% displaced x 10% mortality)	164	171	222.5
	Combined construction mortality	198.6	206.5	292.6
	Overall increase in background mortality (%)	0.2	0.2	0.3
	Significance	Minor	Minor	Minor
Winter	Reference population (nonbreeding season BDMPS)			218,622
	Density (birds/km^2)	6.62	9.76	N/A
	Construction displacement mortality (@1%)	24.9	36.8	61.7

Razorbill		DBS East	DBS West	Projects
	Mortality due to 50% installed turbines (70% displaced x 10% mortality)	118	177.5	204
	Combined construction mortality	142.9	214.3	265.7
	Overall increase in background mortality (%)	0.4	0.56	0.7
	Significance	Minor	Minor	Minor
Spring	Reference population			591,874
	Density (birds/km²)	7.02	8.85	N/A
	Construction displacement mortality (@1%)	26.5	32.3	58.5
	Mortality due to 50% installed turbines (70% displaced x 10% mortality)	125.5	156	220.5
	Combined construction mortality	152	188.3	279.3
	Overall increase in background mortality (%)	0.15	0.2	0.3
	Significance	Minor	Minor	Minor
Annual (BDMPS)	Reference population			591,874
	Density (birds/km²)	23.92	32.14	N/A
	Construction displacement mortality (@1%)	90.1	121.1	211.2
	Mortality due to 50% installed turbines (70% displaced x 10% mortality)	427	584	745.5
	Combined construction mortality	517.1	705.1	956.7
	Increase in background mortality (%)	0.5	0.68	0.93
	Significance	Minor	Minor	Minor
Annual (Biogeographic)	Biogeographical population			1,707,000
	Increase in background mortality (%)	0.2	0.24	0.32
	Significance	Minor	Minor	Minor

12.6.1.1.1.4.4.1 Annual – 50% installed turbines

375. 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 the Projects, (section 12.6.2.1.4.3.5). Thus, a maximum of 745.5 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 0.174 (**Table 12-13**) a total of is 102,986 birds would be expected to die each year (see paragraph 265). The addition of 745.5 individuals would increase the mortality rate by 0.72%, which is below the 1% threshold for detectability.

376. The number of individuals from the biogeographic population expected to die across all seasons is 297,018 (see paragraph 265). The addition of a maximum of 745.5 to this increases the mortality rate by 0.25%, which is below the 1% threshold for detectability.

377. 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 Projects is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.6.1.1.1.4.4.2 Annual – construction vessels and 50% installed turbines

378. The combination of displacement by construction vessels and half of that estimated for operational displacement the annual impact at the Projects gives a maximum of 956.7 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.174 (**Table 12-13**) a total of is 102,986 birds would be expected to die each year (see paragraph 265). The addition of 956.76 individuals would increase the mortality rate by 0.93%, which is below the 1% threshold for detectability.

379. The number of individuals from the biogeographic population expected to die across all seasons is 297,018 (see paragraph 265). The addition of a maximum of 956.7 to this increases the mortality rate by 0.32%, which is below the 1% threshold for detectability.

380. 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 Projects is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.6.1.1.1.5 Puffin

381. 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).

382. 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. However, as the Array Areas are at the upper end of the foraging range, and the numbers seen in breeding season months were generally low (or the birds were absent altogether, e.g. May and June), two reference populations have been considered for the breeding season assessment. The first is derived from the latest FFC SPA breeding adult population estimate of 3,080 individuals (Clarkson *et al*., 2022). If it is assumed these are adult breeding birds, the inclusion of sub-adults associated with the colony based on the adult proportion of 55%, Furness, 2015), the total population associated with the FFC SPA would be 5,600 individuals.

383. The second was advised by Natural England (2023) as a breeding season BDMPS figure of 868,689.

384. In the breeding season, the number of individuals expected to die from the population associated with the FFC SPA is 986 (5,600 x 0.176, **Table 12-13**), while the number of birds expected to die from the breeding season BDMPS population is 152,889 (868,689 x 0.176).

385. During the nonbreeding seasons the puffin BDMPS population for the North Sea, 231,957, is used as the reference population for assessment. For the assessment of annual impacts, two reference populations have been considered; the BDMPS (868,689) and the biogeographic population (11,840,000; Furness, 2015). The number of individuals from these populations expected to die in the nonbreeding season are 40,824 (231,957 x 0.1.76), 152,889 (868,689 x 0.1.76) and 2,083,840 (11,840,000 x 0. 176) respectively.

12.6.1.1.1.5.1 Significance of Effect – DBS East in Isolation

12.6.1.1.1.5.1.1 Breeding Season – construction vessels

386. 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 would be expected to be at risk of mortality.

387. Based on the average mortality for adult puffin of 0.176 (**Table 12-13**), a total of 986 birds from the FFC SPA population would be expected to die in the breeding season (see paragraph 384). The addition of a maximum of 0.5 to this increases the mortality rate by 0.05% which is below the 1% threshold for detectability.

388. Alternatively, a total of 152,889 birds from the breeding season reference population (derived from breeding season BDMPS population, see paragraph 384) would be expected to die in the breeding season. The addition of a maximum of 0.5 to this increases the mortality rate by <0.01% which is below the 1% threshold for detectability.

389. 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**.

12.6.1.1.1.5.1.2 Breeding Season – 50% installed turbines

390. 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 12.6.2.1.5.1.1). Thus, a maximum of two 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 0.176 (**Table 12-13**) a total of 986 birds would be expected to die each year (see paragraph 384). The addition of two individuals would increase the mortality rate by 0.2%, which is below the 1% threshold for detectability.

391. Alternatively, a total of 152,889 birds from the breeding season reference population (derived from breeding season BDMPS population, see paragraph 384) would be expected to die in the breeding season. The addition of a maximum of two to this increases the mortality rate by <0.01% which is below the 1% threshold for detectability.

392. 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**.

12.6.1.1.1.5.1.3 Breeding Season – construction vessels and 50% installed turbines

393. The combination of displacement by construction vessels and half of that estimated for operational displacement in the breeding season gives a maximum of 2.5 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.176 (**Table 12-13**) a total of 986 birds would be expected to die each year (see paragraph 384). The addition of 2.5 individuals would increase the mortality rate by 0.25%, which is below the 1% threshold for detectability.

394. Alternatively, a total of 152,889 birds from the breeding season reference population (derived from breeding season BDMPS population, see paragraph 384) would be expected to die in the breeding season. The addition of a maximum of 2.5 to this increases the mortality rate by <0.01% which is below the 1% threshold for detectability.

395. 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**.

12.6.1.1.1.5.1.4 Nonbreeding – construction vessels

396. During the nonbreeding season the maximum mean peak density in DBS East Array Area was 0.35/km^2. 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 birds would be expected to be at risk of mortality.

397. Based on the average mortality rate for adult puffin of 0.176 (**Table 12-13**), a total of 40,824 birds would be expected to die each year from the nonbreeding season BDMPS population (see paragraph 385). The addition of 1.3 birds to this would increase the mortality rate by up to <0.01%, which is below the 1% threshold for detectability.

398. 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**.

12.6.1.1.1.5.1.5 Nonbreeding – 50% installed turbines

399. 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 nonbreeding season (section 12.6.2.1.5.1.2). Thus, a maximum of 6.5 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 0.176 (**Table 12-13**) a total of 40,824 birds would be expected to die each year (see paragraph 385). The addition of 6.5 individuals would increase the mortality rate by 0.02 which is below the 1% threshold for detectability.

400. 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**.

12.6.1.1.1.5.1.6 Nonbreeding – construction vessels and 50% installed turbines

401. The combination of displacement by construction vessels and half of that estimated for operational displacement in the nonbreeding season gives a maximum of 7.8 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.176 (**Table 12-13**) a total of 40,824 birds would be expected to die each year (see paragraph 385). The addition of 7.8 individuals would increase the mortality rate by 0.02%, which is below the 1% threshold for detectability.

402. 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**.

12.6.1.1.1.5.1.7 Annual – construction vessels

403. The estimated number of puffins subject to construction disturbance and displacement mortality at DBS East throughout the year is up to 1.3 individuals.

404. At the average baseline mortality rate for puffin of 0.176 (**Table 12-13**), a total of 152,889 birds would be expected to die from the largest BDMPS population throughout the year (see paragraph 385). The addition of a maximum of 1.3 individuals to this increases the mortality rate by <0.01%, which is below the 1% threshold for detectability.

405. The number of individuals from the biogeographic population expected to die across all seasons is 2,083,840 (see paragraph 385). The addition of a maximum of 1.3 to this increases the mortality rate by <0.001%, which is below the 1% threshold for detectability.

406. 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**.

12.6.1.1.1.5.1.8 Annual – 50% installed turbines

407. 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 the Projects, (section 12.6.2.1.5.1.3). 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 0.176 (**Table 12-13**) a total of is 152,889 birds would be expected to die each year (see paragraph 384). The addition of 8.5 individuals would increase the mortality rate by 0.01%, which is below the 1% threshold for detectability.

408. The number of individuals from the biogeographic population expected to die across all seasons is 2,083,840 (see paragraph 385). 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.

409. 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 Projects is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.6.1.1.1.5.1.9 Annual – construction vessels and 50% installed turbines

410. The combination of displacement by construction vessels and half of that estimated for operational displacement the annual impact at the Projects 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 0.176 (**Table 12-13**) a total of is 152,889 birds would be expected to die each year (see paragraph 384). The addition of 10.3 individuals would increase the mortality rate by 0.01%, which is below the 1% threshold for detectability.

411. The number of individuals from the biogeographic population expected to die across all seasons is 2,083,840 (see paragraph 385). The addition of a maximum of 10.3 to this increases the mortality rate by <0.001%, which is below the 1% threshold for detectability.

412. 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 Projects is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.6.1.1.1.5.2 Significance of Effect – DBS West in Isolation

12.6.1.1.1.5.2.1 Breeding Season – construction vessels

413. 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.

414. Based on the average mortality for adult puffin of 0.176 (**Table 12-13**), a total of 986 birds individuals from the FFC SPA population expected to die in the breeding season (see paragraph 384). The addition of a maximum of 0.8 to this increases the mortality rate by 0.08%, which is below the 1% threshold for detectability.

415. Alternatively, a total of 152,889 birds from the breeding season reference population (derived from the spring BDMPS, see paragraph 384) would be expected to die in the breeding season. The addition of a maximum of 0.8 to this increases the mortality rate by <0.01% which is below the 1% threshold for detectability.

416. 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**.

12.6.1.1.1.5.2.2 Breeding Season – 50% installed turbines

417. 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 12.6.2.1.5.2.1). Thus, a maximum of four 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 0.176 (**Table 12-13**) a total of 986 birds would be expected to die each year (see paragraph 384). The addition of four individuals would increase the mortality rate by 0.4%, which is below the 1% threshold for detectability.

418. Alternatively, a total of 152,889 birds from the breeding season reference population (derived from breeding season BDMPS population, see paragraph 384) would be expected to die in the breeding season. The addition of a maximum of four to this increases the mortality rate by <0.01% which is below the 1% threshold for detectability.

419. 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**.

12.6.1.1.1.5.2.3 Breeding Season – construction vessels and 50% installed turbines

420. The combination of displacement by construction vessels and half of that estimated for operational displacement in the breeding season gives a maximum of 4.8 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.176 (**Table 12-13**) a total of 986 birds would be expected to die each year (see paragraph 384). The addition of 4.8 individuals would increase the mortality rate by 0.5%, which is below the 1% threshold for detectability.

421. Alternatively, a total of 152,889 birds from the breeding season reference population (derived from breeding season BDMPS population, see paragraph 384) would be expected to die in the breeding season. The addition of a maximum of 4.8 to this increases the mortality rate by <0.01% which is below the 1% threshold for detectability.

422. 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**.

12.6.1.1.1.5.2.4 Nonbreeding – construction vessels

423. 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.

424. Based on the average mortality rate for adult puffin of 0.176 (**Table 12-13**), a total of 40,824 birds would be expected to die each year from the nonbreeding season BDMPS population (see paragraph 385). The addition of 1.4 birds to this would increase the mortality rate by up to <0.01%, which is below the 1% threshold for detectability.

425. 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**.

12.6.1.1.1.5.2.5 Nonbreeding – 50% installed turbines

426. 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 nonbreeding season (section 12.6.2.1.5.2.2). Thus, a maximum of seven 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 0.176 (**Table 12-13**) a total of 40,824 birds would be expected to die each year (see paragraph 385). The addition of seven individuals would increase the mortality rate by 0.02 which is below the 1% threshold for detectability.

427. 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**.

12.6.1.1.1.5.2.6 Nonbreeding – construction vessels and 50% installed turbines

428. The combination of displacement by construction vessels and half of that estimated for operational displacement in the nonbreeding season gives a maximum of 8.4 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.176 (**Table 12-13**) a total of 40,824 birds would be expected to die each year (see paragraph 385). The addition of 8.4 individuals would increase the mortality rate by 0.02%, which is below the 1% threshold for detectability.

429. 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**.

12.6.1.1.1.5.2.7 Annual – construction vessels

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

431. At the average baseline mortality rate for puffin of 0.176 (**Table 12-13**), a total of 152,889 birds would be expected to die from the largest BDMPS population throughout the year (see paragraph 385). The addition of a maximum of 2.2 individuals to this increases the mortality rate by <0.01%, which is below the 1% threshold for detectability.

432. The number of individuals from the biogeographic population expected to die across all seasons is 2,083,840 (see paragraph 385). The addition of a maximum of 2.2 to this increases the mortality rate by <0.001%, which is below the 1% threshold for detectability.

433. 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**.

12.6.1.1.1.5.2.8 Annual – 50% installed turbines

434. 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 the Projects, (section 12.6.2.1.5.2.3. Thus, a maximum of 10.5 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 0.176 (**Table 12-13**) a total of is 152,889 birds would be expected to die each year (see paragraph 384). The addition of 10.5 individuals would increase the mortality rate by 0.01%, which is below the 1% threshold for detectability.

435. The number of individuals from the biogeographic population expected to die across all seasons is 2,083,840 (see paragraph 385). The addition of a maximum of 10.5 to this increases the mortality rate by <0.001%, which is below the 1% threshold for detectability.

436. 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 Projects is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.6.1.1.1.5.2.9 Annual – construction vessels and 50% installed turbines

437. The combination of displacement by construction vessels and half of that estimated for operational displacement the annual impact at the Projects gives a maximum of 12.7 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.176 (**Table 12-13**) a total of is 152,889 birds would be expected to die each year (see paragraph 384). The addition of 12.7 individuals would increase the mortality rate by 0.01%, which is below the 1% threshold for detectability.

438. The number of individuals from the biogeographic population expected to die across all seasons is 2,083,840 (see paragraph 385). The addition of a maximum of 12.7 to this increases the mortality rate by <0.001%, which is below the 1% threshold for detectability.

439. 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 Projects is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.6.1.1.1.5.3 Significance of Effect – DBS East and DBS West Together

12.6.1.1.1.5.3.1 Breeding Season – construction vessels

440. During the breeding season the number of puffins at risk of mortality due to displacement from construction vessels across the Array Areas plus 2km buffer was up to 1.3 birds.

441. Based on the average mortality for adult puffin of 0.176 (**Table 12-13**), a total of 986 birds individuals from the FFC SPA population expected to die in the breeding season (see paragraph 384). The addition of a maximum of 1.3 birds to this increases the mortality rate by 0.13%, which is below the 1% threshold for detectability.

442. Alternatively, a total of 152,889 birds from the breeding season reference population (derived from the spring BDMPS, see paragraph 384) would be expected to die in the breeding season. The addition of a maximum of 1.4 to this increases the mortality rate by <0.01% which is below the 1% threshold for detectability.

443. 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**.

12.6.1.1.1.5.3.2 Breeding Season – 50% installed turbines

444. 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 12.6.2.1.5.3.1). Thus, a maximum of five 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 0.176 (**Table 12-13**) a total of 986 birds would be expected to die each year (see paragraph 384). The addition of five individuals would increase the mortality rate by 0.5%, which is below the 1% threshold for detectability.

445. Alternatively, a total of 152,889 birds from the breeding season reference population (derived from breeding season BDMPS population, see paragraph 384) would be expected to die in the breeding season. The addition of a maximum of five to this increases the mortality rate by <0.01% which is below the 1% threshold for detectability.

446. 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**.

12.6.1.1.1.5.3.3 Breeding Season – construction vessels and 50% installed turbines

447. The combination of displacement by construction vessels and half of that estimated for operational displacement in the breeding season gives a maximum of 6.3 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.176 (**Table 12-13**) a total of 986 birds would be expected to die each year (see paragraph 384). The addition of 6.3 individuals would increase the mortality rate by 0.6%, which is below the 1% threshold for detectability.

448. Alternatively, a total of 152,889 birds from the breeding season reference population (derived from breeding season BDMPS population, see paragraph 384) would be expected to die in the breeding season. The addition of a maximum of 6.3 to this increases the mortality rate by <0.01% which is below the 1% threshold for detectability.

449. 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**.

12.6.1.1.1.5.3.4 Nonbreeding – construction vessels

450. During the breeding season the number of guillemots at risk of mortality due to displacement from construction vessels across the Array Areas was up to 2.7 birds.

451. Based on the average mortality rate for adult puffin of 0.176 (**Table 12-13**), a total of 40,824 birds would be expected to die each year from the nonbreeding season BDMPS population (see paragraph 385). The addition of 2.7 birds to this would increase the mortality rate by up to 0.01%, which is below the 1% threshold for detectability.

452. 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**.

12.6.1.1.1.5.3.5 Nonbreeding – 50% installed turbines

453. 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 nonbreeding season (section 12.6.2.1.5.3.2). Thus, a maximum of 13 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 0.176 (**Table 12-13**) a total of 40,824 birds would be expected to die each year (see paragraph 385). The addition of 13 individuals would increase the mortality rate by 0.3 which is below the 1% threshold for detectability.

454. 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**.

12.6.1.1.1.5.3.6 Nonbreeding – construction vessels and 50% installed turbines

455. The combination of displacement by construction vessels and half of that estimated for operational displacement in the nonbreeding season gives a maximum of 15.7 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.176 (**Table 12-13**) a total of 40,824 birds would be expected to die each year (see paragraph 385). The addition of 15.7 individuals would increase the mortality rate by 0.04%, which is below the 1% threshold for detectability.

456. 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**.

12.6.1.1.1.5.3.7 Annual – construction vessels

457. Throughout the year the number of puffins at risk of mortality due to displacement from construction vessels across the Array Areas was up to 4 birds.

458. At the average baseline mortality rate for puffin of 0.176 (**Table 12-13**), a total of 152,889 birds would be expected to die from the largest BDMPS population throughout the year (see paragraph 385). The addition of a maximum of 4 individuals to this increases the mortality rate by <0.01%, which is below the 1% threshold for detectability.

459. The number of individuals from the biogeographic population expected to die across all seasons is 2,083,840 (see paragraph 385). The addition of a maximum of 4 to this increases the mortality rate by <0.001%, which is below the 1% threshold for detectability.

460. 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**.

461. A table summarising the puffin construction displacement assessment is provided below (**Table 12-19**).

12.6.1.1.1.5.4 Summary of Construction Displacement Assessment - Puffin

Table 12-19 Summary of Puffin Displacement During Construction Assessment for DBS East, DBS West and Combined (Projects). Note that the Project Total is Less Than the Sum of East and West Due to Overlap of the Individual 2km Buffers

<table>
<tr><th colspan="2">Puffin</th><th>DBS East</th><th>DBS West</th><th>Projects</th></tr>
<tr><td colspan="2">Baseline average annual mortality</td><td colspan="3">0.176</td></tr>
<tr><td rowspan="11">Breeding season</td><td>Reference population (FFC SPA only)</td><td colspan="3">5,600</td></tr>
<tr><td>Density (birds/km^2)</td><td>0.12</td><td>0.21</td><td>N/A</td></tr>
<tr><td>Construction displacement mortality (@1%)</td><td>0.5</td><td>0.8</td><td>1.3</td></tr>
<tr><td>Mortality due to 50% installed turbines (70% displaced x 10% mortality)</td><td>2</td><td>4</td><td>5</td></tr>
<tr><td>Combined construction mortality</td><td>20.5</td><td>4.8</td><td>6.3</td></tr>
<tr><td>Overall increase in background mortality (%)</td><td>0.25</td><td>0.5</td><td>0.6</td></tr>
<tr><td>Significance</td><td>Minor</td><td>Minor</td><td>Minor</td></tr>
<tr><td>Reference population (breeding season BDMPS population)</td><td colspan="3">868,689</td></tr>
<tr><td>Increase in background mortality (%)</td><td><0.01</td><td><0.01</td><td><0.01</td></tr>
<tr><td>Significance</td><td>Minor</td><td>Minor</td><td>Minor</td></tr>
<tr><td rowspan="6">Non breed-ing season</td><td>Reference population</td><td colspan="3">231,957</td></tr>
<tr><td>Density (birds/km^2)</td><td>0.35</td><td>0.38</td><td>N/A</td></tr>
<tr><td>Construction displacement mortality (@1%)</td><td>1.3</td><td>1.4</td><td>2.7</td></tr>
<tr><td>Mortality due to 50% installed turbines (70% displaced x 10% mortality)</td><td>6.5</td><td>7</td><td>13</td></tr>
<tr><td>Combined construction mortality</td><td>7.8</td><td>8.4</td><td>15.7</td></tr>
<tr><td>Overall increase in background mortality (%)</td><td>0.02</td><td>0.02</td><td>0.04</td></tr>
</table>

Puffin		DBS East	DBS West	Projects
	Significance	Minor	Minor	Minor
Annual (BDMPS)	Reference population			868,689
	Density (birds/km^2)	0.47	0.59	N/A
	Construction displacement mortality (@1%)	1.8	2.2	4
	Mortality due to 50% installed turbines (70% displaced x 10% mortality)	8.5	10.5	18
	Combined construction mortality	10.3	12.7	22
	Overall increase in background mortality (%)	0.01	0.01	0.01
	Significance	Minor	Minor	Minor
Annual (bio-geographic)	Biogeographical population			11,840,000
	Increase in background mortality (%)	<0.001	<0.001	<0.01
	Significance	Minor	Minor	Minor

12.6.1.1.1.5.4.1 Annual – 50% installed turbines

462. 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 the Projects, (section 12.6.2.1.5.3.3). Thus, a maximum of 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 0.176 (**Table 12-13**) a total of is 152,889 birds would be expected to die each year (see paragraph 384). The addition of 18 individuals would increase the mortality rate by 0.01%, which is below the 1% threshold for detectability.

463. The number of individuals from the biogeographic population expected to die across all seasons is 2,083,840 (see paragraph 385). The addition of a maximum of 18 to this increases the mortality rate by <0.001%, which is below the 1% threshold for detectability.

464. 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 Projects is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.6.1.1.1.5.4.2 Annual – construction vessels and 50% installed turbines

465. The combination of displacement by construction vessels and half of that estimated for operational displacement the annual impact at the Projects gives a maximum of 22 individuals at risk of displacement mortality during each year of construction. Based on the average mortality for the species of 0.176 (**Table 12-13**) a total of is 152,889 birds would be expected to die each year (see paragraph 384). The addition of 22 individuals would increase the mortality rate by 0.01%, which is below the 1% threshold for detectability.

466. The number of individuals from the biogeographic population expected to die across all seasons is 2,083,840 (see paragraph 385). The addition of a maximum of 22 to this increases the mortality rate by <0.001%, which is below the 1% threshold for detectability.

467. 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 Projects is assessed as negligible. As the species is of medium sensitivity to displacement, the effect significance is **minor adverse**.

12.6.1.1.2 Offshore Export Cable Corridor During Cable Installation

468. Up to two years has been allowed for Offshore Export Cable installation for up to four cables laid independently. For each cable 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).

469. 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.

12.6.1.1.2.1 Red-Throated Diver

470. 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.

471. 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.

472. 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.

473. 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 $25.2km^2$ ($2 \times 12.6km^2$). 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).

474. 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.

475. 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.

476. 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.

477. 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.

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

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

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

480. 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.

481. 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).

482. 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).

12.6.2 Potential Effects During Operation

12.6.2.1 Impact 3 Disturbance and Displacement from Offshore Infrastructure

483. 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.

484. 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.

485. 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).

486. 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.

487. 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.

488. 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).

489. 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.

490. 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).

491. It is important to note that 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 May), but instead is the highest of the DBS East plus DBS West values in each month.

492. 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.

493. 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.

494. 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 12-20**), 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.

495. Operational disturbance and displacement screening (**Table 12-20**) presents the general sensitivity to disturbance and displacement for each species.

Table 12-20 Operational Disturbance and Displacement Screening.

Receptor	Sensitivity to Disturbance and Displacement[1]	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.
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.

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

Receptor	Sensitivity to Disturbance and Displacement[1]	Biological Season(s) with peak numbers	Screening Result (IN or OUT)
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 displ.acement.
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)
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)

496. 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 12-13**) have been used.

497. 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.

498. 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.

499. 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)**.

12.6.2.1.1 Gannet

500. 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.

501. 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).

502. 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).

503. 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.

504. Additional mortality of gannet during the breeding season has been assessed in relation to the Flamborough and Filey Coast SPA population. The SPA population at designation was 11,061 pairs, increasing to 13,392 pairs in 2017 (Aitken *et al*. 2017) with 13,125 pairs recorded in 2022 (Clarkson *et al*., 2022). The Clarkson *et al*. (2022) estimate, adjusted to include nonbreeding and immature birds that associate with the colony, has been used as a reference population, being closer in time to baseline surveys. This equates to a total population size during the breeding season of approximately 47,727 (derived as individual adults divided by the adult proportion of 0.55 from Furness, 2015, to provide an all-age class total).

505. The number of individuals from this population expected to die at the baseline mortality rate in the breeding season is 9,116 (47,727 x 0.191, **Table 12-13**).

506. During the nonbreeding seasons the gannet BDMPS populations for the North Sea have been used as the reference populations (in the autumn: 456,298 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 87,153 (456,298 x 0.191), in the spring is 47,442 (248,385 x 0.191), and annually from the biogeographic population is 225,380 (1,180,000 x 0.191).

12.6.2.1.1.1 Significance of Effect – DBS East in Isolation

12.6.2.1.1.1.1 Breeding Season

507. 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 12-21**).

Table 12-21 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

508. Based on the average mortality for the species of 0.191 (**Table 12-13**) a total of 9,116 birds would be expected to die each year (see paragraph 505). The addition of a maximum of six individuals to these would increase the mortality rate by 0.08%, which is below the 1% threshold for detectability.

509. 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**.

12.6.2.1.1.1.2 Autumn Migration

510. 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 6 individuals (**Table 12-22**).

Table 12-22 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

511. At the average baseline mortality rate for gannet of 0.191 (**Table 12-13**) a total of 87,153 birds would be expected to die in autumn (see paragraph 506). The addition of a maximum of six to this increases the mortality rate by 0.01%, which is below the 1% threshold for detectability.

512. 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**.

12.6.2.1.1.1.3 Spring Migration

513. 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 individuals (**Table 12-23)**.

Table 12-23 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

514. Based on the average mortality for the species of 0.191 (**Table 12-13**), a total of 47,442 birds would be expected to die in spring (see paragraph 506). The addition of a maximum of one to this increases the mortality rate by <0.01%, which is below the 1% threshold for detectability.

515. 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**.

12.6.2.1.1.1.4 Annual

516. 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 12-24**).

Table 12-24 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

517. At the average baseline mortality rate for gannet of 0.191 (**Table 12-13**) a total of 87,153 birds would be expected to die from the largest BDMPS population throughout the year (see paragraph 506). The addition of a maximum of 13 to this increases the mortality rate by 0.01%, which is below the 1% threshold for detectability.

518. The number of individuals from the biogeographic population expected to die across all seasons is 225,380 (see paragraph 506). The addition of a maximum of 13 to this increases the mortality rate by 0.01%, which is below the 1% threshold for detectability.

519. 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**.

12.6.2.1.1.2 Significance of Effect – DBS West in Isolation

12.6.2.1.1.2.1 Breeding Season

520. 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 12-25**).

Table 12-25 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

521. Based on the average mortality for the species of 0.191 (**Table 12-13**) a total of 9,116 birds would be expected to die each year (see paragraph 505). The addition of six individuals to these would increase the mortality rate by 0.07%, which is below the 1% threshold for detectability.

522. 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**.

12.6.2.1.1.2.2 Autumn Migration

523. 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 12-26**).

Table 12-26 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

524. At the average baseline mortality rate for gannet of 0.191 (**Table 12-13**), a total of 87,153 birds would be expected to die in autumn (see paragraph 506). The addition of a maximum of six to this increases the mortality rate by 0.01%, which is below the 1% threshold for detectability.

525. 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**.

12.6.2.1.1.2.3 Spring Migration

526. 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 1 individuals (**Table 12-27**).

Table 12-27 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

527. Based on the average mortality for the species of 0.191 (**Table 12-13**), a total of 47,442 birds would be expected to die in spring (see paragraph 506). The addition of a maximum of 1 to this increases the mortality rate by <0.01%, which is below the 1% threshold for detectability.

528. 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**.

12.6.2.1.1.2.4 Annual

529. 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 12-28**).

Table 12-28 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

530. At the average baseline mortality rate for gannet of 0.191 (**Table 12-13**), a total of 87,153 birds would be expected to die from the largest BDMPS population throughout the year (see paragraph 506). The addition of a maximum of 14 to this increases the mortality rate by 0.02%, which is below the 1% threshold for detectability.

531. The number of individuals from the biogeographic population expected to die across all seasons is 225,380 (see paragraph 506). The addition of a maximum of 14 to this increases the mortality rate by 0.01%, which is below the 1% threshold for detectability.

532. 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**.

12.6.2.1.1.3 Significance of Effect – DBS East and DBS West Together

12.6.2.1.1.3.1 Breeding Season

533. During the breeding season, the maximum mean peak abundance in the Array Areas and 2km buffer was 1,335 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 11 individuals (**Table 12-29**).

Table 12-29 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	1	3	4	5	7	8	9	11	12	13
2	3	5	8	11	13	16	19	21	24	27
3	4	8	12	16	20	24	28	32	36	40
4	5	11	16	21	27	32	37	43	48	53
5	7	13	20	27	33	40	47	53	60	67
6	8	16	24	32	40	48	56	64	72	80
7	9	19	28	37	47	56	65	75	84	93
8	11	21	32	43	53	64	75	85	96	107
9	12	24	36	48	60	72	84	96	108	120
10	13	27	40	53	67	80	93	107	120	134
20	27	53	80	107	134	160	187	214	240	267
30	40	80	120	160	200	240	280	320	360	401
50	67	134	200	267	334	401	467	534	601	668

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
75	100	200	300	401	501	601	701	801	901	1001
100	134	267	401	534	668	801	935	1068	1202	1335

534. Based on the average mortality for the species of 0.191 (**Table 12-13**) a total of 9,116 birds would be expected to die each year (see paragraph 505). The addition of 11 individuals to these would increase the mortality rate by 0.12%, which is below the 1% threshold for detectability.

535. 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**.

12.6.2.1.1.3.2 Autumn Migration

536. During the autumn migration period, the 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 12-30**).

Table 12-30 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

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
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

537. At the average baseline mortality rate for gannet of 0.191 (**Table 12-13**), a total of 87,153 birds would be expected to die in autumn (see paragraph 506). The addition of a maximum of 13 to this increases the mortality rate by 0.01%, which is below the 1% threshold for detectability.

538. 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**.

12.6.2.1.1.3.3 Spring Migration

539. During the spring migration period, the maximum mean peak abundance in the Array Areas and 2km buffer was 134 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 1 individual (**Table 12-31**).

Table 12-31 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	1
2	0	1	1	1	1	2	2	2	2	3
3	0	1	1	2	2	2	3	3	4	4
4	1	1	2	2	3	3	4	4	5	5
5	1	1	2	3	3	4	5	5	6	7
6	1	2	2	3	4	5	6	6	7	8
7	1	2	3	4	5	6	7	8	8	9
8	1	2	3	4	5	6	8	9	10	11
9	1	2	4	5	6	7	8	10	11	12
10	1	3	4	5	7	8	9	11	12	13
20	3	5	8	11	13	16	19	21	24	27

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
30	4	8	12	16	20	24	28	32	36	40
50	7	13	20	27	34	40	47	54	60	67
75	10	20	30	40	50	60	70	80	90	101
100	13	27	40	54	67	80	94	107	121	134

540. Based on the average mortality for the species of 0.191 (**Table 12-13**), a total of 47,442 birds would be expected to die in spring (see paragraph 506). The addition of a maximum of 1 to this increases the mortality rate by <0.01%, which is below the 1% threshold for detectability.

541. 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**.

12.6.2.1.1.3.4 Annual

542. Summed across the year the maximum mean peak abundance in the Array Areas and 2km buffer was 3,043 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 24 individuals (**Table 12-32**).

Table 12-32 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	6	9	12	15	18	21	24	27	30
2	6	12	18	24	30	37	43	49	55	61
3	9	18	27	37	46	55	64	73	82	91
4	12	24	37	49	61	73	85	97	110	122
5	15	30	46	61	76	91	107	122	137	152
6	18	37	55	73	91	110	128	146	164	183
7	21	43	64	85	107	128	149	170	192	213
8	24	49	73	97	122	146	170	195	219	243
9	27	55	82	110	137	164	192	219	246	274

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
10	30	61	91	122	152	183	213	243	274	304
20	61	122	183	243	304	365	426	487	548	609
30	91	183	274	365	456	548	639	730	822	913
50	152	304	456	609	761	913	1065	1217	1369	1522
75	228	456	685	913	1141	1369	1598	1826	2054	2282
100	304	609	913	1217	1522	1826	2130	2434	2739	3043

543. At the average baseline mortality rate for gannet of 0.191 (**Table 12-13**), a total of 87,153 birds would be expected to die from the largest BDMPS population throughout the year (see paragraph 506). The addition of a maximum of 24 to this increases the mortality rate by 0.03%, which is below the 1% threshold for detectability.

544. The number of individuals from the biogeographic population expected to die across all seasons is 225,380 (see paragraph 506). The addition of a maximum of 24 to this increases the mortality rate by 0.01%, which is below the 1% threshold for detectability.

545. 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**.

546. A table summarising the gannet operational displacement assessment is provided below (**Table 12-33**).

12.6.2.1.1.4 Summary of Operational Displacement Assessment - Gannet

Table 12-33 Summary of Gannet Operational Displacement Assessment for DBS East, DBS West and Combined (Projects). Note that the Project Total is Less Than the Sum of East and West Due to Overlap of the Individual 2km Buffers.

Gannet		DBS East	DBS West	Projects
Baseline average annual mortality				0.191
Breeding season	Reference population			47,727
	Displacement mortality (@80% x 1%)	6	6	11
	Increase in background mortality (%)	0.07	0.07	0.12
	Significance	Negligible - Minor	Negligible - Minor	Negligible - Minor
Autumn	Reference population			456,298
	Displacement mortality (@80% x 1%)	6	6	13
	Increase in background mortality (%)	0.01	0.01	0.01
	Significance	Negligible - Minor	Negligible - Minor	Negligible - Minor
Spring	Reference population			248,835
	Displacement mortality (@80% x 1%)	1	1	1
	Increase in background mortality (%)	<0.01	<0.01	<0.01
	Significance	Negligible - Minor	Negligible - Minor	Negligible - Minor
Annual (BDMPS)	Reference population			456,298
	Displacement mortality (@80% x 1%)	13	14	24
	Increase in background mortality (%)	0.01	0.02	0.03
	Significance	Negligible - Minor	Negligible - Minor	Negligible - Minor
Annual (biogeo-graphic)	Biogeographical population			1,180,000
	Displacement mortality (@80% x 1%)	13	14	24
	Increase in background mortality (%)	0.01	0.01	0.01
	Significance	Negligible - Minor	Negligible - Minor	Negligible - Minor

12.6.2.1.2 Auks (Guillemot, Razorbill and Puffin)

547. 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).

548. 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).

549. 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.

550. 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.

551. 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. Thus, the assessment presents estimates using 1% mortality and 10%.

552. 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.

553. 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.

554. There are no breeding colonies for guillemot and razorbill within foraging range of the DBS Offshore Wind Farms (guillemot mean maximum range: 73km; razorbill mean maximum foraging range 88km). Puffins have a slightly larger foraging range (mean maximum 137km) which just extends into the Array Areas from the nearest colony. Therefore, for guillemot and razorbill it is reasonable to assume that individuals seen during the breeding season are nonbreeding individuals (e.g. immature birds). For puffin, assessment considers both the breeding population within foraging range and also the nonbreeding birds which may be present.

555. Natural England has advised that the guillemot breeding season reference population appropriate for this assessment is 2,045,078 individuals (Natural England 2023).

556. Since immature seabirds are known to remain in wintering areas, the number of immature razorbill present during the breeding season may be estimated as 43% of the total wintering BDMPS population (Furness, 2015). This gives a breeding season razorbill reference population of 94,007 (BDMPS for the UK North Sea and Channel, 218622 x 43%).

557. Since the Array Areas are within the mean maximum foraging range of puffins (137km) from the breeding colony at the FFC SPA some degree of connectivity is possible. However, as the Array Areas are at the upper end of the foraging range, and the numbers seen in breeding season months were generally low (or the birds were absent altogether, e.g. May and June), two alternative reference populations have been considered for the breeding season assessment. The first is derived from the latest FFC SPA breeding adult population estimate of 3,080 individuals (Clarkson *et al.*, 2022). If it is assumed these are adult breeding birds, accounting for the inclusion of sub-adults associated with the colony based on the adult proportion of 55%, Furness, 2015) gives a total population associated with the FFC of 5,600 individuals.

558. The second breeding season reference population, advised by Natural England (2023) was 868,689.

559. There is only one defined nonbreeding season for guillemot and puffin (for both: August - February) while for razorbill there are three (August - October, November - December and January - March; **Table 12-13**). The number of birds which could potentially be displaced has been estimated for each species using their species-specific relevant seasons.

560. 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.

12.6.2.1.3 Guillemot

12.6.2.1.3.1 Significance of Effect – DBS East in Isolation

12.6.2.1.3.1.1 Breeding Season

561. 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 from the DBS East (and 2km buffer; **Table 12-34**) is between 27 and 632 individuals.

Table 12-34 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

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
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

562. At the average baseline mortality rate for guillemot of 0.14 (**Table 12-13**) the number of individuals expected to die in the breeding season is 286,311 (2,045,078 x 0.14). The addition of a maximum of 632 to this increases the background mortality rate by 0.22%, which is below the 1% threshold for detectability.

563. 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**.

12.6.2.1.3.1.2 Nonbreeding Season

564. 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 from the DBS East (and 2km buffer; **Table 12-35**) is between 38 and 879 individuals.

Table 12-35 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

565. At the average baseline mortality rate for guillemot of 0.14 (**Table 12-13**) the number of individuals expected to die in the nonbreeding period is 226,423 (1,617,306 x 0.14). The addition of a maximum of 879 to this increases the background mortality rate by 0.4%, which is below the 1% threshold for detectability.

566. 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**.

12.6.2.1.3.1.3 Annual

567. Summed across the year the maximum mean peak abundance in the DBS East Array Area and 2km buffer was 21,583 individuals. The estimated number of guillemots subject to mortality combined across all seasons due to displacement from DBS East Array Area (and 2km buffer; **Table 12-36**) is between 65 and 1,511 individuals.

Table 12-36 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	22	43	65	86	108	129	151	173	194	216
2	43	86	129	173	216	259	302	345	388	432
3	65	129	194	259	324	388	453	518	583	647
4	86	173	259	345	432	518	604	691	777	863
5	108	216	324	432	540	647	755	863	971	1079
6	129	259	388	518	647	777	906	1036	1165	1295
7	151	302	453	604	755	906	1058	1209	1360	1511
8	173	345	518	691	863	1036	1209	1381	1554	1727
9	194	388	583	777	971	1165	1360	1554	1748	1942
10	216	432	647	863	1079	1295	1511	1727	1942	2158
20	432	863	1295	1727	2158	2590	3022	3453	3885	4317
30	647	1295	1942	2590	3237	3885	4532	5180	5827	6475
50	1079	2158	3237	4317	5396	6475	7554	8633	9712	10792
75	1619	3237	4856	6475	8094	9712	11331	12950	14569	16187
100	2158	4317	6475	8633	10792	12950	15108	17266	19425	21583

568. At the average baseline mortality rate for guillemot of 0.14 (**Table 12-13**) the number of individuals expected to die from the largest BDMPS population across all seasons is 286,311 (2,045,078 x 0.14). The addition of a maximum of 1,511 to this increases the background mortality rate by 0.53%, which is below the 1% threshold for detectability. The number of individuals from the biogeographic population expected to die across all seasons is 577,500 (4,125,000 x 0.14). The addition of a maximum of 1,511 to this increases the mortality rate by 0.26%. Thus, the increase in background mortality is between 0.26% and 0.53%.

569. This magnitude 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.

570. 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**.

12.6.2.1.3.2 Significance of Effect – DBS West in Isolation

12.6.2.1.3.2.1 Breeding Season

571. 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 from the DBS West (and 2km buffer; **Table 12-37**) is between 26 and 615 individuals.

Table 12-37 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

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
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

572. At the average baseline mortality rate for guillemot of 0.14 (**Table 12-13**) the number of individuals expected to die in the breeding season is 286,311 (2,045,078 x 0.14). The addition of a maximum of 615 to this increases the background mortality rate by 0.21%, which is below the 1% threshold for detectability.

573. 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**.

12.6.2.1.3.2.2 Nonbreeding Season

574. During the nonbreeding season, 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 nonbreeding period due to displacement from the DBS West (and 2km buffer; **Table 12-38**) is between 37 and 875 individuals.

Table 12-38 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	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

Mortality (%)	Displacement (%)									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
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

575. At the average baseline mortality rate for guillemot of 0.14 (**Table 12-13**) the number of individuals expected to die in the nonbreeding period is 226,423 (1,617,306 x 0.14). The addition of a maximum of 875 to this increases the background mortality rate by 0.39%, which is below the 1% threshold for detectability.

576. 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**.

12.6.2.1.3.2.3 Annual

577. Summed across the year the maximum mean peak abundance in the DBS West Array Area and 2km buffer was 21,281 individuals. The estimated number of guillemots subject to mortality combined across all seasons due to displacement from the DBS West (and 2km buffer; **Table 12-39**) is between 64 and 1,490 individuals.

Table 12-39 Displacement Matrix Presenting the Number of Guillemots in the DBS West Array Area (and 2km Buffer) During 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	21	43	64	85	106	128	149	170	192	213
2	43	85	128	170	213	255	298	340	383	426
3	64	128	192	255	319	383	447	511	575	638
4	85	170	255	340	426	511	596	681	766	851
5	106	213	319	426	532	638	745	851	958	1064
6	128	255	383	511	638	766	894	1021	1149	1277
7	149	298	447	596	745	894	1043	1192	1341	1490
8	170	340	511	681	851	1021	1192	1362	1532	1702
9	192	383	575	766	958	1149	1341	1532	1724	1915
10	213	426	638	851	1064	1277	1490	1702	1915	2128
20	426	851	1277	1702	2128	2554	2979	3405	3831	4256
30	638	1277	1915	2554	3192	3831	4469	5107	5746	6384
50	1064	2128	3192	4256	5320	6384	7448	8512	9576	10641
75	1596	3192	4788	6384	7980	9576	11173	12769	14365	15961
100	2128	4256	6384	8512	10641	12769	14897	17025	19153	21281

578. At the average baseline mortality rate for guillemot of 0.14 (**Table 12-13**) the number of individuals expected to die from the largest BDMPS population across all seasons is 286,311 (2,045,078 x 0.14). The addition of a maximum of 1,490 to this increases the background mortality rate by 0.52%, which is below the 1% threshold for detectability. The number of individuals from the biogeographic population expected to die across all seasons is 577,500 (4,125,000 x 0. 140). The addition of a maximum of 1,490 to this increases the mortality rate by 0.26%. Thus, the increase in background mortality is between 0.26% and 0.52%. 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**.

12.6.2.1.3.3 Significance of Effect – DBS East and DBS West Together

12.6.2.1.3.3.1 Breeding Season

579. During the breeding season, the maximum mean peak abundance in the Array Areas and 2km buffer was 14,928 individuals. The estimated number of guillemots subject to mortality during the breeding period due to displacement from the Array Areas (and 2km buffer; **Table 12-40**) is between 45 and 1,045 individuals.

Table 12-40 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	15	30	45	60	75	90	104	119	134	149
2	30	60	90	119	149	179	209	239	269	299
3	45	90	134	179	224	269	313	358	403	448
4	60	119	179	239	299	358	418	478	537	597
5	75	149	224	299	373	448	522	597	672	746
6	90	179	269	358	448	537	627	717	806	896
7	104	209	313	418	522	627	731	836	940	1045
8	119	239	358	478	597	717	836	955	1075	1194
9	134	269	403	537	672	806	940	1075	1209	1344
10	149	299	448	597	746	896	1045	1194	1344	1493
20	299	597	896	1194	1493	1791	2090	2388	2687	2986
30	448	896	1344	1791	2239	2687	3135	3583	4031	4478
50	746	1493	2239	2986	3732	4478	5225	5971	6718	7464
75	1120	2239	3359	4478	5598	6718	7837	8957	10076	11196
100	1493	2986	4478	5971	7464	8957	10450	11942	13435	14928

580. At the average baseline mortality rate for guillemot of 0.14 (**Table 12-13**) the number of individuals expected to die in the breeding season is 286,311 (2,045,078 x 0.14). The addition of a maximum of 1,045 to this increases the background mortality rate by 0.36%, which is below the 1% threshold for detectability.

581. 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**.

12.6.2.1.3.3.2 Nonbreeding Season

582. During the nonbreeding season, the maximum mean peak abundance in the Array Areas and 2km buffer was 20,136 individuals. The estimated number of guillemots subject to mortality during the nonbreeding period due to displacement from the Array Areas (and 2k buffer; **Table 12-41**) is between 60 and 1,410 individuals.

Table 12-41 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	20	40	60	81	101	121	141	161	181	201
2	40	81	121	161	201	242	282	322	362	403
3	60	121	181	242	302	362	423	483	544	604
4	81	161	242	322	403	483	564	644	725	805
5	101	201	302	403	503	604	705	805	906	1007
6	121	242	362	483	604	725	846	967	1087	1208
7	141	282	423	564	705	846	987	1128	1269	1410
8	161	322	483	644	805	967	1128	1289	1450	1611
9	181	362	544	725	906	1087	1269	1450	1631	1812
10	201	403	604	805	1007	1208	1410	1611	1812	2014
20	403	805	1208	1611	2014	2416	2819	3222	3624	4027
30	604	1208	1812	2416	3020	3624	4229	4833	5437	6041
50	1007	2014	3020	4027	5034	6041	7048	8054	9061	10068
75	1510	3020	4531	6041	7551	9061	10571	12082	13592	15102
100	2014	4027	6041	8054	10068	12082	14095	16109	18122	20136

583. At the average baseline mortality rate for guillemot of 0.14 (**Table 12-13**) the number of individuals expected to die in the nonbreeding period is 226,423 (1,617,306 x 0.14). The addition of a maximum of 1,410 to this increases the background mortality rate by 0.62%, which is below the 1% threshold for detectability.

584. 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**.

12.6.2.1.3.3.3 Annual

585. Summed across the year the maximum mean peak abundance in the Array Areas and 2km buffer was 35,064 individuals. The estimated number of guillemots subject to mortality combined across all seasons due to displacement from the Array Areas (and 2km buffer; **Table 12-42**) is between 105 and 2,454 individuals.

Table 12-42 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	35	70	105	140	175	210	245	281	316	351
2	70	140	210	281	351	421	491	561	631	701
3	105	210	316	421	526	631	736	842	947	1052
4	140	281	421	561	701	842	982	1122	1262	1403
5	175	351	526	701	877	1052	1227	1403	1578	1753
6	210	421	631	842	1052	1262	1473	1683	1893	2104
7	245	491	736	982	1227	1473	1718	1964	2209	2454
8	281	561	842	1122	1403	1683	1964	2244	2525	2805
9	316	631	947	1262	1578	1893	2209	2525	2840	3156
10	351	701	1052	1403	1753	2104	2454	2805	3156	3506
20	701	1403	2104	2805	3506	4208	4909	5610	6312	7013
30	1052	2104	3156	4208	5260	6312	7363	8415	9467	10519
50	1753	3506	5260	7013	8766	10519	12272	14026	15779	17532
75	2630	5260	7889	10519	13149	15779	18409	21038	23668	26298

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
100	3506	7013	10519	14026	17532	21038	24545	28051	31558	35064

586. At the average baseline mortality rate for guillemot of 0.14 (**Table 12-13**) the number of individuals expected to die from the largest BDMPS population across all seasons is 286,311 (2,045,078 x 0.14). The addition of a maximum of 2,454 to this increases the background mortality rate by 0.86%, which is below the 1% threshold for detectability. The number of individuals from the biogeographic population expected to die across all seasons is 577,500 (4,125,000 x 0. 140). The addition of a maximum of 2,454 to this increases the mortality rate by 0.42%. Thus, the increase in background mortality is between 0.42% and 0.86%.

587. This magnitude 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.

588. The sensitivity of guillemot to operational displacement is considered to be medium and the magnitude of annual impact at the Array Areas is negligible medium 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**.

589. A table summarising the guillemot operational displacement assessment is provided below (**Table 12-43**).

12.6.2.1.3.4 Summary of Operational Displacement Assessment - Guillemot

Table 12-43 Summary of Guillemot Operational Displacement Assessment for DBS East, DBS West and Combined (Projects). Note that the Projects Total is Less Than the Sum of East and West Due to Overlap of the Individual 2km Buffers.

Guillemot		DBS East	DBS West	Projects
Baseline average annual mortality				0.14
Breeding season	Reference population (breeding BDMPS)			2,045,078
	Displacement mortality (@70% x 10%)	632	615	1045
	Increase in background mortality (%)	0.22	0.21	0.36
	Significance	Minor	Minor	Minor
Non breeding season	Reference population			1,617,306
	Displacement mortality (@70% x 10%)	879	875	1,410
	Increase in background mortality (%)	0.39	0.39	0.62
	Significance	Minor	Minor	Minor
Annual (BDMPS)	Reference population			2,045,078
	Displacement mortality (@70% x 10%)	1,511	1,490	2,454
	Increase in background mortality (%)	0.53	0.52	0.86
	Significance	Minor	Minor	Minor
Annual (biogeo-graphic)	Biogeographical population			4,125,000
	Displacement mortality (@70% x 10%)	1,511	1,490	2,454
	Increase in background mortality (%)	0.26	0.26	0.42
	Significance	Minor	Minor	Minor

12.6.2.1.4 Razorbill

12.6.2.1.4.1 Significance of Effect – DBS East in Isolation

12.6.2.1.4.1.1 Breeding Season

590. 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 from the DBS East (and 2k buffer; **Table 12-44**) is between two and 39 individuals.

Table 12-44 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

591. At the average baseline mortality rate for razorbill of 0.174 (**Table 12-13**) the number of individuals expected to die in the breeding season is 16,357 (94,007 x 0.174). The addition of a maximum of 39 to this increases the background mortality rate by 0.24%, which is below the 1% threshold for detectability.

592. 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**.

12.6.2.1.4.1.2 Autumn Migration

593. 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 from the DBS East (and 2km buffer; **Table 12-45**) is between 14 and 328 individuals.

Table 12-45 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

594. At the average baseline mortality rate for razorbill of 0.174 (**Table 12-13**) the number of individuals expected to die in the autumn migration period is 102,986 (591,874 x 0.174). The addition of a maximum of 328 to this increases the background mortality rate by 0.32%, which is below the 1% threshold for detectability.

595. 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**.

12.6.2.1.4.1.3 Winter

596. 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 from the DBS East (and 2km buffer; **Table 12-46**) is between 10 and 236 individuals.

Table 12-46 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

597. At the average baseline mortality rate for razorbill of 0.174 (**Table 12-13**) the number of individuals expected to die in the winter is 38,040 (218,622 x 0.174). The addition of a maximum of 236 to this increases the background mortality rate by 0.62%, which is below the 1% threshold for detectability.

598. 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**.

12.6.2.1.4.1.4 Spring Migration

599. 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 from the DBS East (and 2km buffer; **Table 12-47**) is between 11 and 251 individuals.

Table 12-47 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

600. At the average baseline mortality rate for razorbill of 0.174 (**Table 12-13**) the number of individuals expected to die in the spring migration season is 102,986 (591,874 x 0.174). The addition of a maximum of 251 to this increases the background mortality rate by 0.24%, which is below the 1% threshold for detectability.

601. 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**.

12.6.2.1.4.1.5 Annual

602. 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 from the DBS East (and 2km buffer; **Table 12-48**) is between 37 and 854 individuals.

Table 12-48 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

603. At the average baseline mortality rate for razorbill of 0.174 (**Table 12-13**) the number of individuals from the largest BDMPS population expected to die across all seasons is 102,986 (591,874 x 0.174). The addition of a maximum of 854 to this increases the background mortality rate by 0.83%, which is below the 1% threshold for detectability.

604. The number of individuals from the biogeographic population expected to die across all seasons is 297,018 (1,707,000 x 0.174). The addition of a maximum of 854 to this increases the mortality rate by 0.29%. Thus, the increase in background mortality is between 0.29% and 0.83%.

605. 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**.

12.6.2.1.4.2 Significance of Effect – DBS West in Isolation

12.6.2.1.4.2.1 Breeding Season

606. 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 from DBS West Array Area (and 2k buffer; **Table 12-49**) is between seven and 160 individuals.

Table 12-49 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
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

607. At the average baseline mortality rate for razorbill of 0.174 (**Table 12-13**) the number of individuals expected to die in the breeding season is 16,357 (94,007 x 0.174). The addition of a maximum of 160 to this increases the background mortality rate by 0.98%, which is below the 1% threshold for detectability.

608. 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**.

12.6.2.1.4.2.2 Autumn Migration

609. 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 from the DBS West (and 2km buffer; **Table 12-50**) is between 15 and 342 individuals.

Table 12-50 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
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

610. At the average baseline mortality rate for razorbill of 0.174 (**Table 12-13**) the number of individuals expected to die in the autumn migration period is 102,986 (591,874 x 0.174). The addition of a maximum of 342 to this increases the background mortality rate by 0.33%, which is below the 1% threshold for detectability.

611. 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**.

12.6.2.1.4.2.3 Winter

612. 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 from the DBS West (and 2km buffer; **Table 12-51**) is between 15 and 355 individuals.

Table 12-51 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

613. At the average baseline mortality rate for razorbill of 0.174 (**Table 12-13**) the number of individuals expected to die in the winter is 38,040 (218,622 x 0.174). The addition of a maximum of 355 to this increases the background mortality rate by 0.93%, which is below the 1% threshold for detectability.

614. 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**.

12.6.2.1.4.2.4 Spring Migration

615. During the spring migration period, the maximum mean peak abundance in the DBS West Array Area and 2km buffer was 2,772 individuals. The estimated number of razorbills subject to mortality during the spring migration period due to displacement from the DBS West (and 2km buffer; **Table 12-52**) is between 13 and 312 individuals.

Table 12-52 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

616. At the average baseline mortality rate for razorbill of 0.174 (**Table 12-13**) the number of individuals expected to die in the spring migration season is 102,986 (591,874 x 0.174). The addition of a maximum of 312 to this increases the background mortality rate by 0.3%, which is below the 1% threshold for detectability.

617. 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**.

12.6.2.1.4.2.5 Annual

618. 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 from the DBS West (and 2km buffer; **Table 12-53**) is between 50 and 1,168 individuals.

Table 12-53 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

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
100	1669	3338	5007	6676	8345	10013	11682	13351	15020	16689

619. At the average baseline mortality rate for razorbill of 0.174 (**Table 12-13**) the number of individuals from the largest BDMPS population expected to die across all seasons is 102,986 (591,874 x 0.174). The addition of a maximum of 1,168 to this increases the background mortality rate by 1.13%, which is above the 1% threshold for detectability. However, this is based on the worst case combination of parameters (70% displaced and 10% mortality). If displacement occurred at rate of 62% (with 10% mortality) or mortality was 8.8% (at 70% displaced), this figure would fall below the 1% threshold of detectability.

620. The number of individuals from the biogeographic population expected to die across all seasons is 297,018 (1,707,000 x 0.174). The addition of a maximum of 1,168 to this increases the mortality rate by 0.39%. Thus, the increase in background mortality is between 0.39% and 1.13%.

621. 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**.

12.6.2.1.4.3 Significance of Effect – DBS East and DBS West Together

12.6.2.1.4.3.1 Breeding Season

622. During the breeding season, the maximum mean peak abundance in the Array Areas and 2km buffer was 2,826 individuals. The estimated number of razorbills subject to mortality during the breeding period due to displacement from the Array Areas (and 2km buffer; **Table 12-54**) is between eight and 198 individuals.

Table 12-54 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	8	11	14	17	20	23	25	28
2	6	11	17	23	28	34	40	45	51	57
3	8	17	25	34	42	51	59	68	76	85
4	11	23	34	45	57	68	79	90	102	113
5	14	28	42	57	71	85	99	113	127	141
6	17	34	51	68	85	102	119	136	153	170
7	20	40	59	79	99	119	138	158	178	198
8	23	45	68	90	113	136	158	181	203	226
9	25	51	76	102	127	153	178	203	229	254
10	28	57	85	113	141	170	198	226	254	283
20	57	113	170	226	283	339	396	452	509	565
30	85	170	254	339	424	509	593	678	763	848
50	141	283	424	565	707	848	989	1130	1272	1413
75	212	424	636	848	1060	1272	1484	1696	1908	2120
100	283	565	848	1130	1413	1696	1978	2261	2543	2826

623. At the average baseline mortality rate for razorbill of 0.174 (**Table 12-13**) the number of individuals expected to die in the breeding season is 16,357 (94,007 x 0.174). The addition of a maximum of 198 to this increases the background mortality rate by 1.21%, which is above the 1% threshold for detectability. However, this is based on the worst case combination of parameters (70% displaced and 10% mortality). If displacement occurred at rate of 50% (with 10% mortality) or mortality was 8% (at 70% displaced), this figure would fall below the 1% of detectability.

624. 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**.

12.6.2.1.4.3.2 Autumn Migration

625. During the autumn migration period, the maximum mean peak abundance in the Array Areas and 2km buffer was 6,350 individuals. The estimated number of razorbills subject to mortality during the autumn migration period due to displacement from the Array Areas (and 2km buffer; **Table 12-55)** is between 19 and 445 individuals.

Table 12-55 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	6	13	19	25	32	38	44	51	57	64
2	13	25	38	51	64	76	89	102	114	127
3	19	38	57	76	95	114	133	152	171	191
4	25	51	76	102	127	152	178	203	229	254
5	32	64	95	127	159	191	222	254	286	318
6	38	76	114	152	191	229	267	305	343	381
7	44	89	133	178	222	267	311	356	400	445
8	51	102	152	203	254	305	356	406	457	508
9	57	114	171	229	286	343	400	457	514	572
10	64	127	191	254	318	381	445	508	572	635
20	127	254	381	508	635	762	889	1016	1143	1270
30	191	381	572	762	953	1143	1334	1524	1715	1905
50	318	635	953	1270	1588	1905	2223	2540	2858	3175
75	476	953	1429	1905	2381	2858	3334	3810	4286	4763
100	635	1270	1905	2540	3175	3810	4445	5080	5715	6350

626. At the average baseline mortality rate for razorbill of 0.174 (**Table 12-13**) the number of individuals expected to die in the autumn migration period is 102,986 (591,874 x 0.174). The addition of a maximum of 445 to this increases the background mortality rate by 0.43%, which is below the 1% threshold for detectability.

627. 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**.

12.6.2.1.4.3.3 Winter

628. During the winter period, the maximum mean peak abundance in the Array Areas and 2km buffer was 5,824 individuals. The estimated number of razorbills subject to mortality during the winter period due to displacement from the Array Areas (and 2km buffer; **Table 12-56**) is between 17 and 408 individuals.

Table 12-56 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	6	12	17	23	29	35	41	47	52	58
2	12	23	35	47	58	70	82	93	105	116
3	17	35	52	70	87	105	122	140	157	175
4	23	47	70	93	116	140	163	186	210	233
5	29	58	87	116	146	175	204	233	262	291
6	35	70	105	140	175	210	245	280	314	349
7	41	82	122	163	204	245	285	326	367	408
8	47	93	140	186	233	280	326	373	419	466
9	52	105	157	210	262	314	367	419	472	524
10	58	116	175	233	291	349	408	466	524	582
20	116	233	349	466	582	699	815	932	1048	1165
30	175	349	524	699	874	1048	1223	1398	1572	1747
50	291	582	874	1165	1456	1747	2038	2330	2621	2912
75	437	874	1310	1747	2184	2621	3058	3494	3931	4368
100	582	1165	1747	2330	2912	3494	4077	4659	5242	5824

629. At the average baseline mortality rate for razorbill of 0.174 (**Table 12-13**) the number of individuals expected to die in the winter is 38,040 (218,622 x 0.174). The addition of a maximum of 408 to this increases the background mortality rate by 1.1%, which is above the 1% threshold for detectability. However, this is based on the worst case combination of parameters (70% displaced and 10% mortality). If displacement occurred at rate of 65% (with 10% mortality) or mortality was 9.3% (at 70% displaced), this figure would fall below the 1% of detectability.

630. 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**.

12.6.2.1.4.3.4 Spring migration

631. During the spring migration period, the maximum mean peak abundance in the Array Areas and 2km buffer was 6,303 individuals. The estimated number of razorbills subject to mortality during the spring migration period due to displacement from the Array Areas (and 2km buffer; **Table 12-57**) is between 19 and 441 individuals.

Table 12-57 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	6	13	19	25	32	38	44	50	57	63
2	13	25	38	50	63	76	88	101	113	126
3	19	38	57	76	95	113	132	151	170	189
4	25	50	76	101	126	151	176	202	227	252
5	32	63	95	126	158	189	221	252	284	315
6	38	76	113	151	189	227	265	303	340	378
7	44	88	132	176	221	265	309	353	397	441
8	50	101	151	202	252	303	353	403	454	504
9	57	113	170	227	284	340	397	454	511	567
10	63	126	189	252	315	378	441	504	567	630
20	126	252	378	504	630	756	882	1008	1135	1261
30	189	378	567	756	945	1135	1324	1513	1702	1891
50	315	630	945	1261	1576	1891	2206	2521	2836	3152
75	473	945	1418	1891	2364	2836	3309	3782	4255	4727
100	630	1261	1891	2521	3152	3782	4412	5042	5673	6303

632. At the average baseline mortality rate for razorbill of 0.174 (**Table 12-13**) the number of individuals expected to die in the spring migration season is 102,986 (591,874 x 0.174). The addition of a maximum of 441 to this increases the background mortality rate by 0.43%, which is below the 1% threshold for detectability.

633. 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**.

12.6.2.1.4.3.5 Annual

634. Summed across the year the maximum mean peak abundance in the Array Areas and 2km buffer was 21,303individuals. The estimated number of razorbills subject to mortality combined across all seasons due to displacement from the Array Areas (and 2km buffer; **Table 12-58**) is between 64 and 1,491 individuals.

Table 12-58 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	21	43	64	85	107	128	149	170	192	213
2	43	85	128	170	213	256	298	341	383	426
3	64	128	192	256	320	383	447	511	575	639
4	85	170	256	341	426	511	596	682	767	852
5	107	213	320	426	533	639	746	852	959	1065
6	128	256	383	511	639	767	895	1023	1150	1278
7	149	298	447	596	746	895	1044	1193	1342	1491
8	170	341	511	682	852	1023	1193	1363	1534	1704
9	192	383	575	767	959	1150	1342	1534	1726	1917
10	213	426	639	852	1065	1278	1491	1704	1917	2130
20	426	852	1278	1704	2130	2556	2982	3408	3835	4261
30	639	1278	1917	2556	3195	3835	4474	5113	5752	6391
50	1065	2130	3195	4261	5326	6391	7456	8521	9586	10652
75	1598	3195	4793	6391	7989	9586	11184	12782	14380	15977
100	2130	4261	6391	8521	10652	12782	14912	17042	19173	21303

635. At the average baseline mortality rate for razorbill of 0.174 (**Table 12-13**) the number of individuals from the largest BDMPS population expected to die across all seasons is 102,986 (591,874 x 0.174). The addition of a maximum of 1,491 to this increases the background mortality rate by 1.45%, which is above the 1% threshold for detectability. However, this is based on the worst case combination of parameters (70% displaced and 10% mortality). If displacement occurred at rate of 48% (with 10% mortality) or mortality was 6.9% (at 70% displaced), this figure would fall below the 1% of detectability.

636. The number of individuals from the biogeographic population expected to die across all seasons is 297,018 (1,707,000 x 0.174). The addition of a maximum of 1,491 to this increases the mortality rate by 0.50%. Thus, assessed at the worst case displacement and mortality rates the increase in background mortality is between 0.50% and 1.45%.

637. While the upper end of this range is above the 1% threshold, this is only achieved through a combination of worst case assumptions (the smaller reference population estimate, the worst case displacement and mortality rates). Even a small reduction in the precaution would reduce this effect to 1%. Therefore the magnitude of impact for razorbill assessed against both the BDMPS population and biogeographic population is considered to be negligible to low.

638. 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**. A table summarising the razorbill operational displacement assessment is provided below (**Table 12-43**).

12.6.2.1.4.4 Summary of Operational Displacement Assessment - Razorbill

Table 12-59 Summary of Razorbill Operational Displacement Assessment for DBS East, DBS West and Combined (Projects). Note that the Project Total is Less Than the Sum of East and West Due to Overlap of the Individual 2km Buffers.

Razorbills		**DBS East**	**DBS West**	**Projects**
Baseline average annual mortality				0.174
Breeding season	Reference population (subadult component of nonbreeding BDMPS)			94,007
	Displacement mortality (@80% x 1%)	39	160	198
	Increase in background mortality (%)	0.24	0.98	1.21*
	Significance	Minor	Minor	Minor
Autumn	Reference population			591,874

Razorbills		DBS East	DBS West	Projects
	Displacement mortality (@70% x 10%)	328	342	445
	Increase in background mortality (%)	0.32	0.33	0.43
	Significance	Minor	Minor	Minor
Winter	Reference population			218,622
	Displacement mortality (@70% x 10%)	236	355	408
	Increase in background mortality (%)	0.62	0.93	1.1*
	Significance	Minor	Minor	Minor
Spring	Reference population			591,874
	Displacement mortality (@70% x 10%)	251	194	441
	Increase in background mortality (%)	0.24	0.19	0.43
	Significance	Minor	Minor	Minor
Annual (BDMPS)	Reference population (Nonbreeding season BDMPS)			591,874
	Displacement mortality (@70% x 10%)	854	1,168	1,491
	Increase in background mortality (%)	0.83	1.13*	1.45*
	Significance	Minor	Minor	Minor
Annual (biogeographic)	Biogeographical population			1,707,000
	Displacement mortality (@70% x 10%)	854	1,168	1,491
	Increase in background mortality (%)	0.29	0.39	0.50
	Significance	Minor	Minor	Minor

** Note that these fall below 1% threshold at slightly lower displacement or mortality rates as discussed in the text.*

12.6.2.1.5 Puffin

12.6.2.1.5.1 Significance of Effect – DBS East in Isolation

12.6.2.1.5.1.1 Breeding Season

639. 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 from the DBS East (and 2km buffer; **Table 12-60**) is up to four individuals.

Table 12-60 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

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
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
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

640. At the average baseline mortality rate for adult puffin of 0.176 (**Table 12-13**) the number of individuals from the FFC SPA population expected to die in the breeding season is 986 (5,600 x 0.176). The addition of a maximum of four to this increases the background mortality rate by 0.41%, which is below the 1% threshold for detectability.

641. At the average baseline mortality rate for adult puffin of 0.176 (**Table 12-13**) the number of individuals from the breeding season BDMPS population expected to die in the breeding season is 152,889 (868,689 x 0.176). The addition of a maximum of four to this increases the background mortality rate by <0.01%, which is below the 1% threshold for detectability. Therefore, the impact is expected to lie between these two values (<0.01% to 0.41).

642. 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**.

12.6.2.1.5.1.2 Nonbreeding Season

643. 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 from the DBS East (and 2km buffer; **Table 12-61**) is between one and 13 individuals.

Table 12-61 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
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

644. At the average baseline mortality rate for puffin of 0.176 (**Table 12-13**) the number of individuals expected to die in the nonbreeding period is 40,824 (231,957 x 0. 176). The addition of a maximum of 13 to this increases the background mortality rate by 0.03%, which is below the 1% threshold for detectability.

645. 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**.

12.6.2.1.5.1.3 Annual

646. 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 from the DBS East (and 2km buffer; **Table 12-62**) is between one and 17 individuals.

Table 12-62 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
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

647. At the average baseline mortality rate for puffin of 0.176 (**Table 12-13**) the number of individuals from the largest BDMPS population expected to die across all seasons is 152,889 (868,689 x 0. 176). The addition of a maximum of 17 to this increases the background mortality rate by 0.01%, which is below the 1% threshold for detectability. The number of individuals from the biogeographic population expected to die across all seasons is 2,083,840 (11,840,000 x 0. 176). The addition of a maximum of 17 to this increases the mortality rate by <0.001%. Thus, the increase in background mortality is between <0.001% and 0.01%. 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**.

12.6.2.1.5.2 Significance of Effect – DBS West in Isolation

12.6.2.1.5.2.1 Breeding Season

648. 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 from the DBS West (and 2km buffer; **Table 12-63**) is between zero and eight individuals.

Table 12-63 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

649. At the average baseline mortality rate for adult puffin of 0.176 (**Table 12-13**) the number of individuals from the FFC SPA population expected to die in the breeding season is 986 (5,600 x 0.176). The addition of a maximum of eight to this increases the background mortality rate by 0.81%, which is below the 1% threshold for detectability.

650. At the average baseline mortality rate for adult puffin of 0.176 (**Table 12-13**) the number of individuals from the breeding season BDMPS population expected to die in the breeding season is 152,889 (868,689 x 0.176). The addition of a maximum of eight to this increases the background mortality rate by 0.01%, which is below the 1% threshold for detectability. Therefore, the impact is expected to lie between these two values (0.01% to 0.81).

651. 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**.

12.6.2.1.5.2.2 Nonbreeding Season

652. 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 from the DBS West (and 2k buffer; **Table 12-64**) is between one and 14 individuals.

Table 12-64 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

653. At the average baseline mortality rate for puffin of 0.176 (**Table 12-13**) the number of individuals expected to die in the nonbreeding period is 40,824 (231,957 x 0. 176). The addition of a maximum of 14 to this increases the background mortality rate by 0.03%, which is below the 1% threshold for detectability.

654. 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**.

12.6.2.1.5.2.3 Annual

655. 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 from the DBS West (and 2km buffer; **Table 12-65**) is between one and 21 individuals.

Table 12-65 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

656. At the average baseline mortality rate for puffin of 0.176 (**Table 12-13**) the number of individuals from the largest BDMPS population expected to die across all seasons is 152,889 (868,689 x 0. 176). The addition of a maximum of 21 to this increases the background mortality rate by 0.01%, which is below the 1% threshold for detectability.

657. The number of individuals from the biogeographic population expected to die across all seasons is 2,083,840 (11,840,000 x 0. 176). The addition of a maximum of 21 to this increases the mortality rate by <0.01%. Thus, the increase in background mortality is between <0.01% and 0.01%.

658. 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**.

12.6.2.1.5.3 Significance of Effect – DBS East and DBS West Together

12.6.2.1.5.3.1 Breeding Season

659. During the breeding season, the maximum mean peak abundance in the Array Areas and 2km buffer was 147 individuals. The estimated number of puffins subject to mortality during the breeding period due to displacement from the Array Areas (and 2km buffers; **Table 12-66**) is between zero and 10 individuals.

Table 12-66 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	0	1	1	1	1	1	1	1
2	0	1	1	1	1	2	2	2	3	3
3	0	1	1	2	2	3	3	4	4	4
4	1	1	2	2	3	4	4	5	5	6
5	1	1	2	3	4	4	5	6	7	7
6	1	2	3	4	4	5	6	7	8	9
7	1	2	3	4	5	6	7	8	9	10
8	1	2	4	5	6	7	8	9	11	12
9	1	3	4	5	7	8	9	11	12	13
10	1	3	4	6	7	9	10	12	13	15
20	3	6	9	12	15	18	21	24	26	29
30	4	9	13	18	22	26	31	35	40	44
50	7	15	22	29	37	44	51	59	66	74
75	11	22	33	44	55	66	77	88	99	110
100	15	29	44	59	74	88	103	118	132	147

660. At the average baseline mortality rate for adult puffin of 0.176 (**Table 12-13**) the number of individuals from the FFC SPA population expected to die in the breeding season is 986 (5,600 x 0.176). The addition of a maximum of 10 to this increases the background mortality rate by 1.01%, which is slightly above the 1% threshold for detectability (however only a small reduction in displacement rate (60%) or mortality rate (9%) will reduce this below the 1% threshold of detectability).

661. At the average baseline mortality rate for adult puffin of 0.176 (**Table 12-13**) the number of individuals from the breeding season BDMPS population expected to die in the breeding season is 152,889 (868,689 x 0.176). The addition of a maximum of 10 to this increases the background mortality rate by 0.01%, which is below the 1% threshold for detectability. Therefore, the impact is expected to lie between these two values (0.01% to 1.01%).

662. 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** to **minor adverse**.

12.6.2.1.5.3.2 Nonbreeding season

663. During the nonbreeding season, the maximum mean peak abundance in the Array Areas and 2km buffer was 373 individuals. The estimated number of puffins subject to mortality during the nonbreeding period due to displacement from the Array Areas (and 2km buffers; **Table 12-67**) is between one and 26 individuals.

Table 12-67 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	1	2	2	3	3	3	4
2	1	1	2	3	4	4	5	6	7	7
3	1	2	3	4	6	7	8	9	10	11
4	1	3	4	6	7	9	10	12	13	15
5	2	4	6	7	9	11	13	15	17	19
6	2	4	7	9	11	13	16	18	20	22
7	3	5	8	10	13	16	18	21	23	26
8	3	6	9	12	15	18	21	24	27	30
9	3	7	10	13	17	20	23	27	30	34
10	4	7	11	15	19	22	26	30	34	37
20	7	15	22	30	37	45	52	60	67	75

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
30	11	22	34	45	56	67	78	90	101	112
50	19	37	56	75	93	112	131	149	168	187
75	28	56	84	112	140	168	196	224	252	280
100	37	75	112	149	187	224	261	298	336	373

664. At the average baseline mortality rate for puffin of 0.176 (**Table 12-13**) the number of individuals expected to die in the nonbreeding period is 40,824 (231,957 x 0. 176). The addition of a maximum of 26 to this increases the background mortality rate by 0.06%, which is below the 1% threshold for detectability.

665. 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**.

12.6.2.1.5.3.3 Annual

666. Summed across the year the maximum mean peak abundance in the Array Areas and 2km buffer was 520 individuals. The estimated number of puffins subject to mortality combined across all seasons due to displacement from the Array Areas (and 2km buffers; **Table 12-68**) is between two and 36 individuals.

Table 12-68 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	1	1	2	2	3	3	4	4	5	5
2	1	2	3	4	5	6	7	8	9	10
3	2	3	5	6	8	9	11	12	14	16
4	2	4	6	8	10	12	15	17	19	21
5	3	5	8	10	13	16	18	21	23	26
6	3	6	9	12	16	19	22	25	28	31
7	4	7	11	15	18	22	25	29	33	36
8	4	8	12	17	21	25	29	33	37	42
9	5	9	14	19	23	28	33	37	42	47
10	5	10	16	21	26	31	36	42	47	52

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
20	10	21	31	42	52	62	73	83	94	104
30	16	31	47	62	78	94	109	125	140	156
50	26	52	78	104	130	156	182	208	234	260
75	39	78	117	156	195	234	273	312	351	390
100	52	104	156	208	260	312	364	416	468	520

667. At the average baseline mortality rate for puffin of 0.176 (**Table 12-13**) the number of individuals from the largest BDMPS population expected to die across all seasons is 152,889 (868,689 x 0. 176). The addition of a maximum of 36 to this increases the background mortality rate by 0.02%, which is below the 1% threshold for detectability.

668. The number of individuals from the biogeographic population expected to die across all seasons is 2,083,840 (11,840,000 x 0. 176). The addition of a maximum of 36 to this increases the mortality rate by <0.01%. Thus, the increase in background mortality is between <0.01% and 0.02%.

669. 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**.

670. A table summarising the puffin operational displacement assessment is provided below (**Table 12-69**).

12.6.2.1.5.4 Summary of Operational Displacement Assessment - Puffin

Table 12-69 Summary of Puffin Operational Displacement Assessment for DBS East, DBS West and Combined (Projects). Note that the Project Total is Less Than the Sum of East and West Due to Overlap of the Individual 2km Buffers.

Puffin		DBS East	DBS West	Projects
Baseline average annual mortality				0.176
Breeding season	Reference population (adults from FFC SPA only)			5,600
	Displacement mortality (@70% x 10%)	4	8	10
	Increase in background mortality (%)	0.41	0.81	1.01
	Significance	Negligible	Negligible	Negligible
	Reference population (subadult component of nonbreeding BDMPS)			868,689

Puffin		DBS East	DBS West	Projects
	Increase in background mortality (%)	<0.01	0.01	0.01
	Significance	Negligible	Negligible	Negligible
Non breeding season	Reference population			231,957
	Displacement mortality (@70% x 10%)	13	14	26
	Increase in background mortality (%)	0.03	0.03	0.06
	Significance	Negligible	Negligible	Negligible
Annual (BDMPS)	Reference population (Nonbreeding season BDMPS)			868,689
	Displacement mortality (@70% x 10%)	17	21	36
	Increase in background mortality (%)	0.01	0.01	0.02
	Significance	Negligible	Negligible	Negligible
Annual (biogeographic)	Biogeographical population			11,840,000
	Displacement mortality (@70% x 10%)	17	21	36
	Increase in background mortality (%)	<0.001	<0.01	<0.01
	Significance	Negligible	Negligible	Negligible

12.6.2.2 Impact 4 Indirect Impacts Through Effects on Habitats and Prey Species During Operation

671. 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.

672. 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.

673. 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 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.

674. 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.

675. 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.

676. 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.

12.6.2.3 Impact 5 Collision Risk

677. 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.

678. Initial screening for species to include in the collision risk assessment is presented in **Table 12-70**. 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 12-70 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**

Receptor	Risk of collisions[1]	Estimated density of birds in flight at the Array Areas	Screening Result (IN or OUT)
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			

679. 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**).

680. 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).

681. 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)**).

682. 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 12-71**); and proportions at collision height (based on the generic dataset in Johnston *et al*. 2014a, 2014b).

Table 12-71 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	99.79*# (±0.0003)	8% (±0.10)
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 advise inclusion of 65-85% (or 70% as a single value) macro-avoidance is included for gannet by adjusting the density values. However, this can also be incorporated by adjusting the avoidance rate as here: total AR of 0.9979 = 1 - ((1 - 0.993) x (1 - 0.7)).*

*# 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)**.*

683. Seasonal mortality predictions (seasons defined in **Table 12-11)** have been compared to the relevant BDMPS populations and the predicted increases in background mortality which could result have been estimated.

684. An overview of annual collision risk estimates for all species is presented in **Table 12-72** 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 12-72 Annual Collision Risk Estimates for the Array Areas Combined (Deterministic Band Model Option 2, Avoidance Rates as per Table 12-11). 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	12.22 (3.97-24.48)	8.67 (2.98-17.1)
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*

685. The annual collision risk estimates presented in **Table 12-72** 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 12-73**.

Table 12-73 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	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)
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)
	East+West	191.14 (96.22-378.38)	79.32 (30.47-143.14)	0 (0-0)	29.48 (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)

686. Impacts during the nonbreeding periods have been assessed in relation to the relevant BDMPS (Furness, 2015). Where there is potential for impacts during the breeding season, these have been assessed in relation to suitable reference populations (defined in each species section below).

12.6.2.3.1.1 Breeding Season Reference Populations for Collision Assessment

12.6.2.3.1.1.1 Gannet

687. The nearest gannet breeding colony to the proposed development is Bempton Cliffs within the Flamborough and Filey Coast SPA. The SPA is 100km from the Projects' Array Areas at the nearest point (**Table 12-9**). This is within the mean maximum foraging range of gannets, estimated as 315km (Woodward *et al*., 2019).

688. Additional mortality of gannet during the breeding season has been assessed in relation to the Flamborough and Filey Coast SPA reference population. The SPA population at designation was 11,061 pairs, increasing to 13,392 pairs in 2017 (Aitken *et al*., 2017) with a small decrease to 13,125 pairs recorded in 2022 (Clarkson *et al*., 2022). These equate to a total population size during the breeding season of approximately 47,727 (calculated as individual adults and multiplied up to include subadult birds, based on the adult proportion of 0.55 from Furness, 2015). The Clarkson *et al*. (2022) estimate has been used as the reference population, being closer in time to baseline surveys.

689. During the nonbreeding seasons the gannet BDMPS populations for the North Sea have been used as the reference populations. 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).

12.6.2.3.1.1.2 Kittiwake

690. The nearest large breeding concentration of kittiwakes to the Projects' Array Areas is the Flamborough and Filey Coast SPA, 100km from the Array Areas at the closest point. The mean maximum foraging range of kittiwake from breeding colonies is estimated at 156km (Woodward *et al*., 2019). Therefore, connectivity with this SPA in the breeding season has been assumed.

691. However, while the RSPB's Future of the Atlantic Marine Environments (FAME) studies have shown some extremely long foraging trips for this species (as reported in various publications such as Fair Isle Bird Observatory annual reports) those extreme values tend to occur at colonies where food supply is extremely poor and breeding success is low (for example Orkney and Shetland). Daunt *et al*. (2002) point out that seabirds, as central place foragers, have an upper limit to their potential foraging range from the colony, set by time constraints. For example, they assess this limit to be 73km for kittiwake based on foraging flight speed and time required to catch food, based on observations of birds from the Isle of May. This means that kittiwakes would be unable to consistently travel more than 73km from the colony and provide enough food to keep chicks alive. Hamer *et al*. (1993) recorded kittiwake foraging ranges exceeding 40km in 1990 when sandeel stock biomass was very low and breeding success at the study colony in Shetland was 0.0 chicks per nest, but <5km in 98% of trips in 1991 when sandeel abundance was higher and breeding success was 0.98 chicks per nest. Kotzerka *et al*. (2010) reported a maximum foraging range of 59km, with a mean range of around 25km for a kittiwake colony in Alaska.

692. Consequently, as well as assessing collisions against the SPA population, the breeding season impact on kittiwake has also been assessed against an alternative reference BDMPS population, as advised by Natural England, of 839,456.

12.6.2.3.1.1.3 Lesser Black-backed Gull

693. There are no breeding colonies for this species within foraging range of the Array Areas. Consequently, the breeding season impact on lesser black-backed gulls has been assessed against a reference population estimated from the observation that immature birds tend to remain in wintering areas. Thus, the number of immature birds in the relevant population during the breeding season can be calculated as 42% (the proportion of sub-adults in the population, see **Table 12-13**) of the nonbreeding BDMPS populations of lesser black-backed gull. This results in a breeding season population of nonbreeding lesser black-backed gull of 16,512 (nonbreeding BDMPS for the UK North Sea and Channel, 39,314 x 42%).

12.6.2.3.1.1.4 Herring Gull

694. There are no herring gull breeding colonies for this species within foraging range of the Array Areas. Consequently, the breeding season impact has been assessed against a reference population estimated from the observation that immature birds tend to remain in wintering areas. Thus, the number of immature birds in the relevant population during the breeding season can be calculated as 53% (the proportion of sub-adults in the population, see **Table 12-13**) of the nonbreeding BDMPS populations of herring gull. This results in a breeding season population of nonbreeding herring gull of 247,251 (nonbreeding BDMPS for the UK North Sea and Channel, 466,511 x 53%).

12.6.2.3.1.1.5 Great Black-backed Gull

695. There are no great black-backed gull breeding colonies within foraging range of the Array Areas. Consequently, the breeding season impact on great black-backed gull has been assessed against a reference population estimated from the observation that immature birds tend to remain in wintering areas. Thus, the number of immature birds in the relevant population during the breeding season can be calculated as 42% (the proportion of sub-adults in the population, see **Table 12-13**) of the nonbreeding BDMPS populations of great black-backed gull (Furness, 2015). This yields a breeding season population of nonbreeding great black-backed gull of 38,388 (nonbreeding BDMPS for the UK North Sea and Channel, 91,399 x 42%).

12.6.2.3.1.2 Nonbreeding Season Reference Populations for Collision Assessment

696. As advised by Natural England, the nonbreeding season reference populations were taken from Furness (2015).

12.6.2.3.1.3 Collision Impacts

697. 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. It has been assumed that all age classes are equally at risk of collisions (i.e. in proportion to their presence in the population), therefore it is necessary to calculate an average baseline mortality rate for all age classes for each species assessed. These were calculated using the different survival rates for each age class and their relative proportions in the population.

698. The first step is to calculate an average survival rate. The demographic rates for each species were taken from reviews of the relevant literature (e.g. Horswill and Robinson, 2015) and recent examples of population modelling (e.g. EATL, 2016). The rates were entered into a matrix population model to calculate the expected proportions in each age class. For each age class, the survival rate was multiplied by its proportion and the total for all ages summed to give the average survival rate for all ages. Taking this value away from one gives the average mortality rate. The demographic rates and the age class proportions, and average mortality rates calculated from them are presented in **Table 12-13**.

699. The percentage increases in background mortality rates of seasonal and annual populations due to predicted collisions with the Projects' wind turbines (presented in **Table 12-73**), summed across DBS East and DBS West, are shown in **Table 12-74** to **Table 12-78** for all species using avoidance rates recommended by Natural England (**Table 12-71**).

700. 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 12-74**), 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**.

701. 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 12-75**), 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**.

702. 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 (

704. Table 12-76), 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**.

705. 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 12-77**), 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**.

706. 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 12-78**), 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 12-74 Predicted Gannet 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**		
Gannet		Mean	Lower c.i.	Upper c.i.
Baseline average annual mortality				0.191
Breeding season	Reference population			47,727
	Seasonal mortality	8.25	2.71	16.09
	Increase in background mortality (%)	0.10	0.03	0.17
Autumn	Reference population			456,298
	Seasonal mortality	3.72	1.12	8.13
	Increase in background mortality (%)	<0.01	<0.01	0.01
Spring	Reference population			248,835
	Seasonal mortality	0.25	0	0.88
	Increase in background mortality (%)	<0.01	0	<0.01
Annual largest BDMPS	Reference population			456,298
	Annual mortality	12.2	3.97	24.48
	Increase in background mortality (%)	0.01	<0.01	0.03
Annual bio-geographic	Reference population			1,180,000
	Annual mortality	12.36	2.74	29.79
	Increase in background mortality (%)	0.01	<0.01	0.01

Table 12-75 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				0.156
Breeding season	Reference population			839,456
	Seasonal mortality	191.14	96.22	378.38
	Increase in background mortality (%)	0.15	0.07	0.29
Autumn	Reference population			829,937
	Seasonal mortality	79.32	30.47	143.14
	Increase in background mortality (%)	0.06	0.02	0.11
Spring	Reference population			627,816
	Seasonal mortality	29.48	16.89	47.35
	Increase in background mortality (%)	0.03	0.02	0.05
Annual largest BDMPS	Reference population			839,456
	Annual mortality	299.94	150.92	540.51
	Increase in background mortality (%)	0.23	0.12	0.41
Annual bio-geographic	Reference population			5,100,000
	Annual mortality	299.94	150.92	540.51
	Increase in background mortality (%)	0.04	0.02	0.07

Table 12-76 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				0.126
Breeding season	Reference population			16,512
	Seasonal mortality	1.21	0	4.37
	Increase in background mortality (%)	0.06	0.00	0.21
Autumn	Reference population			209,007
	Seasonal mortality	0	0	0
	Increase in background mortality (%)	0	0	0
Winter / nonbreeding	Reference population			39,314
	Seasonal mortality	0	0	0
	Increase in background mortality (%)	0	0	0
Spring	Reference population			197,483
	Seasonal mortality	0	0	0
	Increase in background mortality (%)	0	0	0
Annual largest BDMPS	Reference population			209,007
	Annual mortality	1.21	0	4.37
	Increase in background mortality (%)	<0.01	0.00	0.02
Annual bio-geographic	Reference population			854,000
	Annual mortality	1.21	0	4.37
	Increase in background mortality (%)	<0.01	0.00	<0.01

Table 12-77 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				0.172
Breeding season	Reference population			247,251
	Seasonal mortality	0.76	0	2.62
	Increase in background mortality (%)	<0.01	0.00	0.01
Winter / nonbreeding	Reference population			466,511
	Seasonal mortality	1.42	0	3.78
	Increase in background mortality (%)	<0.01	0.00	<0.01
Annual largest BDMPS	Reference population			466,511
	Annual mortality	2.18	0	5.18
	Increase in background mortality (%)	<0.01	0.00	0.01
Annual bio-geographic	Reference population			1,098,000
	Annual mortality	2.18	0	5.18
	Increase in background mortality (%)	<0.01	0.00	<0.01

Table 12-78 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				0.185
Breeding season	Reference population			38,388
	Seasonal mortality	0.92	0	4.42
	Increase in background mortality (%)	0.01	0.00	0.06
Winter / nonbreeding	Reference population			91,399
	Seasonal mortality	3.92	0	9.76
	Increase in background mortality (%)	0.02	0.00	0.06
Annual largest BDMPS	Reference population			91,399
	Annual mortality	4.84	0.74	11.5
	Increase in background mortality (%)	0.03	0.00	0.07
Annual bio-geographic	Reference population			235,000
	Annual mortality	4.84	0.74	11.5
	Increase in background mortality (%)	0.01	0.00	0.03

12.6.2.4 Impact 6 Combined Operational Collision Risk and Displacement

12.6.2.4.1.1 Gannet

707. 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.

708. As noted above (**Table 12-72**), the estimated annual gannet collision mortality associated with the Projects is 12.2 (3.97-24.48). The estimated mortality for gannet displacement is up to 24 birds at a displacement rate of 60-80% and mortality of 1% (Impact 3, **Table 12-32**).

709. Based on the largest Annual BDMPS for the UK North Sea and Channel, of 456,298 (Furness, 2015) and baseline mortality of 0.191 (**Table 12-13**), 87,153 individual gannets would be expected to die each year; the addition of a maximum of 36.2 individuals would represent a 0.04% increase in annual mortality. Based on the annual biogeographic population with connectivity to UK waters of 1,180,000 (Furness, 2015), 225,380 individuals would be expected to die; the addition of a maximum of 36.2 individuals would represent an 0.02% increase in mortality. These magnitudes of increase would not materially alter the background mortality of the population and would be undetectable.

710. 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**.

711. 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.

12.6.3 Potential Effects During Decommissioning

712. 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.

713. 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.

714. 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.

12.6.3.1 Impact 7 Direct Disturbance and Displacement

715. 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.

716. 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 12.6.2.1) to zero, passing through the magnitude levels assessed for construction displacement (section 12.6.1.1). Both of these assessments assessed impacts to be of **negligible** or **minor adverse** significance, and therefore the same conclusions apply to decommissioning.

12.6.3.2 Impact 8 Indirect Impacts Through Effects on Habitats and Prey Species

717. 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.

718. 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.

12.7 Cumulative Effects Assessment

719. 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.

720. 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).

721. 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.

722. 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 ES, the most recent cumulative wind farm totals were for the Dudgeon and Sheringham Extension Projects, Hornsea Project Four and Rampion 2. Hence those assessments have been reviewed and form the basis of the assessment provided here.

12.7.1 Screening for Cumulative Effects

723. The potential impacts arising from the Projects that were screened in for assessment for the project alone have also been considered in **Table 12-79** for the potential for cumulative impacts with other schemes (as defined below).

Table 12-79 Screening for Potential Cumulative Effects.

Impact	Potential for Cumulative impact	Data Confidence[1]	Rationale
Construction			
Impact 1: Direct Disturbance and Displacement	No	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.
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 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	Potential for Cumulative impact	Data Confidence[1]	Rationale
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.

12.7.2 Schemes Considered for Cumulative Impacts

724. 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.

725. 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.

726. 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.

727. 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.

728. The wind farms listed in **Table 12-80** (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 12-80 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

Tier	Scheme Name	Distance to Array Areas (km)
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
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

Tier	Scheme Name	Distance to Array Areas (km)
4	ForthWind Offshore Wind Demonstration Project - phase 1	318
4	North Falls (PEIR)	262
4	Five Estuaries (PEIR)	263
4	Outer Dowsing (PEIR)	81
4	Dogger Bank D	68

729. Dogger Bank D has been considered but scoped out as there is insufficient information to include this in the assessment.

12.7.3 Impact 9 Cumulative Assessment of Operational Displacement

730. The species assessed for project alone operational displacement impacts were gannet, guillemot, razorbill and puffin.

731. 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 12-80** have the potential to contribute to cumulative effects.

12.7.3.1 Gannet

732. The annual total of gannets at risk of displacement from the Projects' Array Areas was estimated as 3,043 individuals (summing the seasonal peak means within the arrays and 2km buffers) for the annual period (**Table 12-32**).

733. **Table 12-81** 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 59,093. When the estimated numbers at risk due to the Projects are included, this would increase to 62,136 birds.

Table 12-81 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

Tier	Wind farm	Breeding season	Autumn migration	Spring migration	Annual
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	-	-	-	-
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

Tier	Wind farm	Breeding season	Autumn migration	Spring migration	Annual
4	ForthWind Offshore Wind Demonstration Project - phase 1	64	26	44	134
4	Rampion 2	111	102	123	336
4	North Falls (PEIR)	68	453	245	766
4	Five Estuaries (PEIR)	233	640	67	940
4	Outer Dowsing (PEIR)	847	169	172	1188
	Total (other schemes)	**27841**	**24862**	**6390**	**59093**
	DBS East	755	776	75	1606
	DBS West	805	798	86	1689
	DBS East and West together	1335	1574	134	3043
	Total (all schemes + DBS East)	**28596**	**25638**	**6465**	**60699**
	Total (all schemes + DBS West)	**28646**	**25660**	**6476**	**60782**
	Total (all schemes + DBS East and West together)	**29176**	**26436**	**6524**	**62136**

734. At displacement rates of 60-80%, 1% mortality of displaced birds, between 373 and 497 gannets would be predicted to die from cumulative displacement (**Table 12-82**).

Table 12-82 Cumulative Annual Displacement Matrix for Gannet.

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	62	124	186	249	311	373	435	497	559	621
2	124	249	373	497	621	746	870	994	1118	1243
3	186	373	559	746	932	1118	1305	1491	1678	1864
4	249	497	746	994	1243	1491	1740	1988	2237	2485
5	311	621	932	1243	1553	1864	2175	2485	2796	3107
6	373	746	1118	1491	1864	2237	2610	2983	3355	3728
7	435	870	1305	1740	2175	2610	3045	3480	3915	4350
8	497	994	1491	1988	2485	2983	3480	3977	4474	4971
9	559	1118	1678	2237	2796	3355	3915	4474	5033	5592
10	621	1243	1864	2485	3107	3728	4350	4971	5592	6214
20	1243	2485	3728	4971	6214	7456	8699	9942	11184	12427

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
30	1864	3728	5592	7456	9320	11184	13049	14913	16777	18641
50	3107	6214	9320	12427	15534	18641	21748	24854	27961	31068
75	4660	9320	13981	18641	23301	27961	32621	37282	41942	46602
100	6214	12427	18641	24854	31068	37282	43495	49709	55922	62136

735. Based on the largest Annual BDMPS of 456,298 (Furness 2015) and baseline mortality of 0.191 (**Table 12-13**), 87,153 individual gannets would be expected to die each year; the addition of a maximum of 497 individuals would represent a 0.57% increase in annual mortality. Based on the annual biogeographic population with connectivity to UK waters of 1,180,000 (Furness 2015), 225,380 individuals would be expected to die; the addition of a maximum of 497 individuals would represent a 0.2% increase in mortality.

736. 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 0.5%, 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.

737. 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**.

12.7.3.2 Guillemot

738. The annual total of guillemots at risk of displacement from the Projects Array Areas is estimated as 35,064 individuals (summing the seasonal peak means within the arrays and 2km buffers) for the annual period (**Table 12-42**).

739. 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 12-83**. 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.

Table 12-83 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
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

Tier	Wind farm	Breeding season	Non-breed-ing season	Annual
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
4	Sheringham and Dudgeon Extension Pro-jects	4924	15982	20906
4	Berwick Bank	74154	44171	11832 5
4	ForthWind Offshore Wind Demonstration Project - phase 1	417	401	818
4	Rampion 2	134	5723	5857
4	North Falls (PEIR)	1103	4497	5600
4	Five Estuaries (PEIR)	1201	3698	4899
4	Outer Dowsing (PEIR)	23173	22248	45421
	Total (other schemes)	**285109**	**304559**	**58966 8**
	DBS East	9031	12552	21583
	DBS West	8783	12498	21281
	DBS East and West together	14928	20136	35064
	Total (all schemes + DBS East)	**294140**	**317111**	**61125 1**
	Total (all schemes + DBS West)	**293892**	**317057**	**61094 9**
	Total (all schemes + DBS East and West together)	**300037**	**324695**	**62473 2**

740. The estimated annual cumulative total of guillemots at risk of displacement from wind farms in the North Sea is 589,668 individuals, which rises to 624,732 individuals when including the Projects (**Table 12-83**).

741. 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 1,874 and 43,731 (**Table 12-84**).

Table 12-84 Cumulative Annual Displacement Matrix for Guillemot.

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
1	625	1249	1874	2499	3124	3748	4373	4998	5623	6247
2	1249	2499	3748	4998	6247	7497	8746	9996	11245	12495
3	1874	3748	5623	7497	9371	11245	13119	14994	16868	18742
4	2499	4998	7497	9996	12495	14994	17492	19991	22490	24989
5	3124	6247	9371	12495	15618	18742	21866	24989	28113	31237
6	3748	7497	11245	14994	18742	22490	26239	29987	33736	37484
7	4373	8746	13119	17492	21866	26239	30612	34985	39358	43731
8	4998	9996	14994	19991	24989	29987	34985	39983	44981	49979
9	5623	11245	16868	22490	28113	33736	39358	44981	50603	56226
10	6247	12495	18742	24989	31237	37484	43731	49979	56226	62473
20	12495	24989	37484	49979	62473	74968	87462	99957	112452	124946
30	18742	37484	56226	74968	93710	112452	131194	149936	168678	187420
50	31237	62473	93710	124946	156183	187420	218656	249893	281129	312366
75	46855	93710	140565	187420	234275	281129	327984	374839	421694	468549
100	62473	124946	187420	249893	312366	374839	437312	499786	562259	624732

742. The largest BDMPS for guillemot in UK North Sea waters is 2,045,078 (Natural England 2023). At the average baseline mortality rate of 0.14 (**Table 12-13**) the number of individuals expected to die in a year is 286,311 (2,045,078 x 0.14). The addition of between 1,874 and 43,731 individuals to this increases the background mortality rate by between 0.65 and 15.3%. Based on the annual biogeographic population with connectivity to UK waters of 4,125,000 (Furness 2015), 577,500 individuals would be expected to die; the addition 1,874 and 43,731 individuals would represent increase between 0.32 % and 7.75% in mortality.

743. 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.

744. 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).

745. 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).

746. 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%.

747. Using these evidence based rates (displacement and mortality of 50% and 1% respectively) would result in a predicted total mortality of 3,124 annually due to cumulative displacement (**Table 12-84**). Assessed against the largest BDMPS 286,311 (2,045,078 x 0.14) would increase the background mortality rate by 1.1% and against the biogeographic population 577,500 (4,125,000 x 1.40) by 0.54%.

748. 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**.

12.7.3.3 Razorbill

749. The annual total of razorbills at risk of displacement from the Projects' Array Areas is estimated as 19,934 individuals across the migration-free breeding, autumn migration, winter, and spring migration periods; **Table 12-58**). Estimates of the number of razorbills at risk of displacement from other offshore wind farms included in the cumulative assessment are given in **Table 12-85**. 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 12-85 Cumulative Numbers of Razorbills at Risk of Displacement from Offshore Wind farms in the North Sea.

Tier	Wind farm	Breeding season	Autumn migration	Non-breeding 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
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

Tier	Wind farm	Breed-ing season	Autumn migration	Non-breeding season	Spring migration	Annual
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
3	Norfolk Vanguard	879	866	839	924	3508
3	Hornsea Project Four	386	4311	455	449	5601
4	Sheringham and Dudgeon Exten-sion Projects	4500	1239	464	1534	7737
4	Berwick Bank	4040	8849	1399	7480	21768
4	ForthWind Off-shore Wind Demonstration Project - phase 1	57	40	58	41	196
4	Rampion 2	32	26	1193	6303	7554
4	North Falls (PEIR)	168	266	2565	1860	4859
4	Five Estuaries (PEIR)	90	284	1046	756	2176
4	Outer Dowsing (PEIR)	5163	2339	2570	5229	15301
-	**Total (other schemes)**	**46560**	**52454**	**33845**	**56183**	**189042**
-	*DBS East*	555	4686	3377	3579	12197
-	*DBS West*	2281	4887	5066	4455	16689
-	*DBS East and West together*	2826	6350	5824	6303	21303
-	***Total (all schemes + DBS East)***	**47115**	**57140**	**37222**	**59762**	**201239**

Tier	Wind farm	Breeding season	Autumn migration	Non-breeding season	Spring migration	Annual
-	***Total (all schemes + DBS West)***	**48841**	**57341**	**38911**	**60638**	**205731**
-	***Total (all schemes + DBS East and West together)***	**49386**	**58804**	**39669**	**62486**	**210345**

750. The estimated annual cumulative total of razorbills at risk of displacement from wind farms in the North Sea is 189,042 individuals, which rises to 210,345 individuals when including the Projects (**Table 12-85**).

751. 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 631 and 14,724 (**Table 12-86**).

Table 12-86 Cumulative Annual Displacement Matrix for Razorbill.

Mortality (%)	Displacement (%)									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	210	421	631	841	1052	1262	1472	1683	1893	2103
2	421	841	1262	1683	2103	2524	2945	3366	3786	4207
3	631	1262	1893	2524	3155	3786	4417	5048	5679	6310
4	841	1683	2524	3366	4207	5048	5890	6731	7572	8414
5	1052	2103	3155	4207	5259	6310	7362	8414	9466	10517
6	1262	2524	3786	5048	6310	7572	8834	10097	11359	12621
7	1472	2945	4417	5890	7362	8834	10307	11779	13252	14724
8	1683	3366	5048	6731	8414	10097	11779	13462	15145	16828
9	1893	3786	5679	7572	9466	11359	13252	15145	17038	18931
10	2103	4207	6310	8414	10517	12621	14724	16828	18931	21035

Mortality (%)	Displacement (%)									
	10	20	30	40	50	60	70	80	90	100
20	4207	8414	12621	16828	21035	25241	29448	33655	37862	42069
30	6310	12621	18931	25241	31552	37862	44172	50483	56793	63104
50	10517	21035	31552	42069	52586	63104	73621	84138	94655	105173
75	15776	31552	47328	63104	78879	94655	110431	126207	141983	157759
100	21035	42069	63104	84138	105173	126207	147242	168276	189311	210345

752. The largest BDMPS for razorbill in UK North Sea waters is 591,874 (Furness 2015). At the average baseline mortality rate of 0.174 (**Table 12-13**) the number of individuals expected to die in a year is 102,986 (591,874 x 0.174). The addition of a maximum of between 631 and 14,724 individuals to this increases the background mortality rate by respectively 0.6% and 14.3%. Based on the annual biogeographic population with connectivity to UK waters of 1,707,000 (Furness 2015), 297,018 individuals would be expected to die; the addition 631 and 14,724 individuals would represent increase between 0.21 and 4.96% in mortality.

753. 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% (see paragraph 746).

754. Using these evidence based rates would result in a predicted total mortality of 1,052 annually due to cumulative displacement (**Table 12-86**). Assessed against the BDMPS 102,986 (591,874 x 0.174) this would increase the background mortality rate by 1.02% and against the biogeographic population 297,018 (1,707,000 x 0174) by 0.35%.

755. 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%.

756. 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**.

12.7.3.4 Puffin

757. The annual total of puffins at risk of displacement from the Projects Array Areas is estimated as 520 individuals for breeding and nonbreeding periods; **Table 12-68**).

758. Estimates of the number of puffins at risk of displacement from other offshore wind farms included in the cumulative assessment are given in **Table 12-87.** 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 12-87 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
1	Rampion	7	0	7
1	Scroby Sands	-	-	
1	Sheringham Shoal	4	26	30
1	Teesside	35	18	53

Tier	Wind farm	Breeding season	Non-breeding season	Annual
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 (PEIR)	-	-	-
4	Five Estuaries (PEIR)	-	-	-
4	Outer Dowsing (PEIR)	884	1167	2051
	Total (other schemes)	**26804**	**25147**	**51951**
	DBS East	63	179	242
	DBS West	109	198	307
	DBS East and West together	147	373	520
	Total (all schemes + DBS East)	**26867**	**25326**	**52193**
	Total (all schemes + DBS West)	**26913**	**25345**	**52258**
	Total (all schemes + DBS East and West together)	**26951**	**25520**	**52471**

759. The estimated annual cumulative total of puffins at risk of displacement from wind farms in the North Sea is 51,951 individuals, which rises to 52,471 individuals when including the Projects (**Table 12-87**).

760. 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 157 and 3,673 (**Table 12-88**).

Table 12-88 Cumulative Annual Displacement Matrix for Puffin.

Mortality (%)	Displacement (%)									
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	52	105	157	210	262	315	367	420	472	525
2	105	210	315	420	525	630	735	840	944	1049
3	157	315	472	630	787	944	1102	1259	1417	1574
4	210	420	630	840	1049	1259	1469	1679	1889	2099
5	262	525	787	1049	1312	1574	1836	2099	2361	2624
6	315	630	944	1259	1574	1889	2204	2519	2833	3148
7	367	735	1102	1469	1836	2204	2571	2938	3306	3673
8	420	840	1259	1679	2099	2519	2938	3358	3778	4198
9	472	944	1417	1889	2361	2833	3306	3778	4250	4722
10	525	1049	1574	2099	2624	3148	3673	4198	4722	5247
20	1049	2099	3148	4198	5247	6297	7346	8395	9445	10494
30	1574	3148	4722	6297	7871	9445	11019	12593	14167	15741
50	2624	5247	7871	10494	13118	15741	18365	20988	23612	26236
75	3935	7871	11806	15741	19677	23612	27547	31483	35418	39353
100	5247	10494	15741	20988	26236	31483	36730	41977	47224	52471

761. The largest BDMPS for puffin in UK North Sea waters is 868,689 (Natural England 2023). At the average baseline mortality rate of 0.176 (**Table 12-13**) the number of individuals expected to die in a year is 152,889 (868,689 x 0.176). The addition of a maximum of between 157 and 3,673 individuals to this increases the background mortality rate by respectively 0.1% and 2.4%. Based on the annual biogeographic population with connectivity to UK waters of 11,840,000 (Furness 2015), 1,977,280 individuals would be expected to die; the addition 157 and 3,673 individuals would represent an increase of between 0.01% and 0.18% in mortality.

762. This is a wide range, so the assessment considers the most realistic value within this range (see paragraph 746).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%.

763. Using these evidence based rates would result in a predicted total mortality of 262 annually due to cumulative displacement (**Table 12-88**). Assessed against the BDMPS 152, 889 (868,689 x 0.176) this would increase the background mortality rate by 0.17% and against the biogeographic population 1,977,280 (11,840,000 x 0.176) by 0.01%.

764. 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%.

765. 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**.

12.7.4 Impact 10 Cumulative Assessment of Operational Collision Risk

766. Cumulative annual collision risk was assessed for gannet, kittiwake, lesser black-backed gull, herring gull and great black-backed gull.

767. It is considered that all of the wind farms identified for inclusion in the cumulative assessment in **Table 12-80** have the potential to contribute to a cumulative effect.

12.7.4.1 Gannet

768. The cumulative gannet collision risk prediction is set out in **Table 12-89**. This collates collision predictions from other wind farms, which may contribute to the cumulative total.

Table 12-89 Cumulative Collision Risk Assessment for Gannet unless otherwise indicated an avoidance rate of 98.9% was used.

Tier	Wind farm	Breeding season	Autumn migration	Spring migration	Annual
1	Beatrice	37.4	48.8	9.5	95.7
1	Beatrice Demonstrator	0.6	0.9	0.7	2.2
1	Blyth Demonstration Project	3.5	2.1	2.8	8.4
1	Dudgeon	22.3	38.9	19.1	80.3
1	East Anglia ONE	3.4	131	6.3	140.7
1	European Offshore Wind Deployment Centre	4.2	5.1	0.1	9.4
1	Galloper	18.1	30.9	12.6	61.6
1	Greater Gabbard	14	8.8	4.8	27.6
1	Gunfleet Sands	-	-	-	-
1	Hornsea Project One	11.5	32	22.5	66
1	Hornsea Project Two	7	14	6	27
1	Humber Gateway	1.9	1.1	1.5	4.5
1	Hywind	5.6	0.8	0.8	7.2
1	Kentish Flats	1.4	0.8	1.1	3.3
1	Kentish Flats Extension	-	-	-	-
1	Kincardine	3	0	0	3
1	Lincs & LID	2.3	1.4	1.9	5.6
1	London Array	2.3	1.4	1.8	5.5
1	Methil	6	0	0	6
1	Moray East	80.6	35.4	8.9	124.9
1	Race Bank	33.7	11.7	4.1	49.5
1	Rampion	36.2	63.5	2.1	101.8
1	Scroby Sands	-	-	-	-
1	Sheringham Shoal	14.1	3.5	0	17.6
1	Teesside	4.9	1.7	0	6.6
1	Thanet	1.1	0	0	1.1
1	Triton Knoll	26.8	64.1	30.1	121
1	Westermost Rough	0.2	0.1	0.2	0.5
2	Dogger Bank A and B	81.1	83.5	54.4	219
2	Moray West	10	2	1	13
2	Neart na Gaoithe	143	47	23	213
2	Seagreen A and B	800.8	49.3	65.8	915.9
3	Dogger Bank C and Sofia	14.8	10.1	10.8	35.7
3	East Anglia One North	12.4	11	1.1	24.5
3	East Anglia Three	6.1	33.3	9.6	49
3	East Anglia Two	12.5	23.1	4	39.6
3	Hornsea Project Three (revised)	10	5	4	19

Tier	Wind farm	Breeding season	Autumn migration	Spring migration	Annual
3	Inch Cape	336.9	29.2	5.2	371.3
3	Norfolk Boreas	14.1	12.7	3.9	30.7
3	Norfolk Vanguard	8.2	18.6	5.3	32.1
3	Hornsea Project Four [1]	14.3	0.3	0.1	14.7
4	Sheringham and Dudgeon Extension Projects	0.4	0.6	0	1
4	Berwick Bank	170	18	3	191
4	ForthWind Offshore Wind Demonstration Project - phase 1 [2]	1	0	0	1
4	Rampion 2 [3]	2.9	1.4	0.6	4.9
4	North Falls (PEIR)	6.6	8.1	4.8	19.5
4	Five Estuaries (PEIR) [4]	2	2.3	0.2	4.5
4	Outer Dowsing (PEIR)	2.9	0.4	0.4	3.7
	Total (other schemes)	**1992.1**	**853.9**	**334.1**	**3180.1**
	DBS East	3.4	1.6	0.1	5.2
	DBS West	4.8	2.1	0.1	7.1
	DBS East and West together	8.2	3.7	0.2	12.3
	Total (all schemes + DBS East)	**1995.5**	**855.5**	**334.2**	**3185.3**
	Total (all schemes + DBS West)	**1996.9**	**856.0**	**334.2**	**3187.2**
	Total (all schemes + DBS East and West together)	**2000.3**	**857.6**	**334.3**	**3192.4**

[1] An avoidance rate of 98.7% was used;

[2] An avoidance rate of 99% was used;

[3] An avoidance rate of 99.3% was used;

[4] An avoidance rate of 99.79% was used.

769. 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 12-71**). 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%. 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.

770. The annual cumulative total estimated collision mortality for existing wind farm schemes is 3,180, which would be reduced to approximately 607 on application of the revised avoidance rates (99.79%; note that some recent wind farms have already applied similarly high avoidance rates, but as these wind farms add comparatively few collisions this does not affect the overall conclusions). To this, the Projects add 12 birds. Based on the largest Annual BDMPS of 456,298 (Furness 2015) and baseline mortality of 0.191 (**Table 12-13**), 87,153 individual gannets would be expected to die each year; the addition of 3,192 collisions (including the Projects) would represent a preliminary 3.6% increase in annual mortality. Based on the annual biogeographic population with connectivity to UK waters of 1,180,000 (Furness 2015), 225,380 individuals would be expected to die; the addition of 3,192 collisions would represent 1.42% increase in mortality.

771. However, using the lower collision mortality range obtained with the current Natural England advised methods, the calculated collision mortality including the Projects would be 619, which would represent a 0.71% increase in annual mortality for the largest BDMPS population. Based on the annual biogeographic population with connectivity to UK waters of 1,180,000 (Furness 2015), 225,380 individuals would be expected to die; the addition of 619 collisions would represent 0.27% increase in mortality.

772. 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%. It is clear from all of the above, that the current cumulative collision total is a considerable over estimate.

773. 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 very unlikely to be significant, and the contribution to the total from the Projects is very small.

774. The cumulative impact on the gannet population due to annual 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**.

12.7.4.2 Kittiwake

775. The cumulative kittiwake collision risk prediction is set out in **Table 12-90.** This collates collision predictions from other wind farms, which may contribute to the cumulative total.

Table 12-90 Cumulative Collision Risk Assessment for Kittiwake unless otherwise indicated an avoidance rate of 98.9% was used.

Tier	Wind farm	Breeding season	Autumn migration	Spring migration	Annual
1	Beatrice	94.7	10.7	39.8	145.2
1	Beatrice Demonstrator	0	2.1	1.7	3.8
1	Blyth Demonstration Project	1.7	2.3	1.4	5.4
1	Dudgeon	-	-	-	-
1	East Anglia ONE	1.8	160.4	46.8	209
1	European Offshore Wind Deployment Centre	11.8	5.8	1.1	18.7
2	Galloper	6.3	27.8	31.8	65.9
1	Greater Gabbard	1.1	15	11.4	27.5
1	Gunfleet Sands	-	-	-	-
1	Hornsea Project One	44	55.9	20.9	120.8
1	Hornsea Project Two	16	9	3	28
1	Humber Gateway	1.9	3.2	1.9	7
1	Hywind	16.6	0.9	0.9	18.4
1	Kentish Flats	0	0.9	0.7	1.6
1	Kentish Flats Extension	0	0	2.7	2.7
1	Kincardine	22	9	1	32
1	Lincs & LID	0.7	1.2	0.7	2.6
1	London Array	1.4	2.3	1.8	5.5
1	Methil	0.4	0	0	0.4
1	Moray East	43.6	2	19.3	64.9
1	Race Bank	1.9	23.9	5.6	31.4
1	Rampion	54.4	37.4	29.7	121.5
1	Scroby Sands	-	-	-	-
1	Sheringham Shoal	-	-	-	-
1	Teesside	38.4	24	2.5	64.9
1	Thanet	0.2	0.5	0.4	1.1
1	Triton Knoll	24.6	139	45.4	209

Tier	Wind farm	Breeding season	Autumn migration	Spring migration	Annual
1	Westermost Rough	0.1	0.2	0.1	0.4
2	Dogger Bank A and B	288.6	135	295.4	719
2	Moray West	79	24	7	110
2	Neart na Gaoithe	32.9	56.1	4.4	93.4
2	Seagreen A and B	153.1	313.1	247.6	713.8
3	Dogger Bank C and Sofia	136.9	90.7	216.9	444.5
3	East Anglia One North	40.4	8.1	3.5	52
3	East Anglia Three	6.1	69	37.6	112.7
3	East Anglia Two	29.5	5.4	7.4	42.3
3	Hornsea Project Three (re-vised)	77	38	8	123
3	Inch Cape	13.1	224.8	63.5	301.4
3	Norfolk Boreas	13.3	32.2	11.9	57.4
3	Norfolk Vanguard	21.8	16.4	19.3	57.5
3	Hornsea Project Four [1]	74.5	13.9	4.6	93
4	Sheringham and Dudgeon Ex-tension Projects	7.2	4.3	0.9	12.4
4	Berwick Bank	617	190	179	986
4	ForthWind Offshore Wind Demonstration Project - phase 1 [2]	-	-	-	-
4	Rampion 2 [3]	1.2	9.8	17.3	28.3
4	North Falls (PEIR)	21	19	12	52
4	Five Estuaries (PEIR) [4]	11.9	7.9	5.5	25.3
4	Outer Dowsing (PEIR)	28.1	18.1	50.4	96.6
	Total (other schemes)	**2036.2**	**1809.3**	**1462.8**	**5308.3**
	DBS East	83.3	41.4	14.6	139.3
	DBS West	107.8	37.9	14.9	160.6
	DBS East and West together	191.1	79.3	29.5	299.9
	Total (all schemes + DBS East)	**2119.5**	**1850.7**	**1477.4**	**5447.6**
	Total (all schemes + DBS West)	**2144.0**	**1847.2**	**1477.7**	**5468.9**
	Total (all schemes + DBS East and West together)	**2227.3**	**1888.6**	**1492.3**	**5608.2**

[1] *Hornsea 4 used an avoidance rate of 98.7%;*

[2] *ForthWind Offshore used an avoidance rate of 99%;*

[3] *Rampion 2 used an avoidance rate of 99.3%;*

[4] *Five Estuaries used an avoidance rate of 99.2%.*

776. 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 99.2% in the latest guidance (**Table 12-71**). 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.

777. The annual cumulative total, not including the Projects, is 5,308, which would be reduced to approximately 3,860 on application of the revised avoidance rate (99.2%). To this, the Projects add a maximum of 299 birds. Based on the largest Annual BDMPS of 839,456 (Natural England 2023) and baseline mortality of 0.156 (**Table 12-13**), 130,955 individual kittiwakes would be expected to die each year. The addition of 5,608 collisions (including the Projects) would represent a 4.3% increase in annual mortality. Based on the annual biogeographic population with connectivity to UK waters of 5,100,000 (Furness 2015), 795,600 individuals would be expected to die. The addition of 5,608 collisions would represent 0.7% increase in mortality.

778. Applying the lower calculated collision mortality (including the Projects, 4,159) would represent a 3.2% increase in annual mortality. Based on the annual biogeographic population with connectivity to UK waters of 5,100,000 (Furness 2015), 795,600 individuals would be expected to die; the addition of 4,159 collisions would represent 0.52% increase in mortality.

779. 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.

780. 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**.

12.7.4.3 Lesser Black-backed Gull

781. The cumulative collision risk prediction for lesser black-backed gull is set out in **Table 12-91**. This collates collision predictions from other wind farms which may contribute to the cumulative total.

Table 12-91 Cumulative Collision Risk Assessment for Lesser black-backed gull unless otherwise indicated an avoidance rate of 99.5% was used.

Tier	Wind farm	Breeding season	Nonbreed-ing season	Annual
1	Beatrice	0	0	0
1	Beatrice Demonstrator	-	-	-
1	Blyth Demonstration Project	0	0	0
1	Dudgeon	7.7	30.6	38.3
1	East Anglia ONE	5.9	33.8	39.7
1	European Offshore Wind Deployment Centre	0	0	0
1	Galloper	27.8	111	138.8
1	Greater Gabbard	12.4	49.6	62
1	Gunfleet Sands	1	0	1
1	Hornsea Project One	4.4	17.4	21.8
1	Hornsea Project Two	2	2	4
1	Humber Gateway	0.3	1.1	1.4
1	Hywind	0	0	0
1	Kentish Flats	-	-	-
1	Kentish Flats Extension	0.3	1.3	1.6
1	Kincardine	0	0	0
1	Lincs & LID	1.7	6.8	8.5
1	London Array	-	-	-
1	Methil	0.5	0	0.5
1	Moray East	0	0	0
1	Race Bank	43.2	10.8	54
1	Rampion	1.6	6.3	7.9
1	Scroby Sands	-	-	-
1	Sheringham Shoal	1.7	6.6	8.3
1	Teesside	0	0	0
1	Thanet	3.2	12.8	16
1	Triton Knoll	7.4	29.6	37
1	Westermost Rough	0.1	0.3	0.4
2	Dogger Bank A and B	2.6	10.4	13
2	Moray West	0	0	0
2	Neart na Gaoithe	0.3	1.2	1.5
2	Seagreen A and B	2.1	8.4	10.5
3	Dogger Bank C and Sofia	2.4	9.6	12

Tier	Wind farm	Breeding season	Nonbreeding season	Annual
3	East Anglia One North	0.9	0.6	1.5
3	East Anglia Three	1.8	8.2	10
3	East Anglia Two	4.2	0.5	4.7
3	Hornsea Project Three (revised)	8	1	9
3	Inch Cape	0	0	0
3	Norfolk Boreas	6.2	8.1	14.3
3	Norfolk Vanguard	8.4	3.6	12
3	Hornsea Project Four [1]	0.3	0.1	0.4
4	Sheringham and Dudgeon Extension Projects	1.9	0.3	2.2
4	Berwick Bank	9	0	9
4	ForthWind Offshore Wind Demonstration Project – phase 1 [2]	0	0	0
4	Rampion 2 [1]	1.5	2.9	4.4
4	North Falls (PEIR)	12	7	19
4	Five Estuaries (PEIR) [1]	35.1	5.5	40.6
4	Outer Dowsing	1.5	2.1	3.7
	Total (other schemes)	**219.4**	**389.5**	**608.9**
	DBS East	0.9	0	0.9
	DBS West	0.3	0	0.3
	DBS East and West together	1.2	0	1.2
	Total (all schemes + DBS East)	**220.3**	**389.5**	**609.8**
	Total (all schemes + DBS West)	**219.7**	**389.5**	**609.2**
	Total (all schemes + DBS East and West together)	**220.6**	**389.5**	**610.1**

[1] An avoidance rate of 99.4% was used.

[2] An avoidance rate of 99% was used.

782. 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 608.9. When the estimated numbers at risk due to the Projects are included (1.2), this would increase to 610.1 collisions.

783. 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 (**Table 12-71**). 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.

784. The annual cumulative total, not including the Projects, is 608.9, which would be increased to approximately 730.7 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 209,007 (Furness 2015) and baseline mortality of 0.126 (**Table 12-13**), 26,335 individual lesser black-backed gulls would be expected to die each year; the addition of 610.1 collisions (including the Projects) would represent a 2.3% increase in annual mortality. Based on the annual biogeographic population with connectivity to UK waters of 854,000 (Furness 2015), 107,604 individuals would be expected to die; the addition of 610.1 collisions would represent 0.57% increase in mortality.

785. Applying the higher calculated collision mortality (including the Projects, 731.9) would represent a 2.8% increase in annual mortality for the BDMPS population. Based on the annual biogeographic population with connectivity to UK waters of 854,000 (Furness 2015), 107,604 individuals would be expected to die; the addition of 731.9 collisions would represent 0.68% increase in mortality.

786. 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.

787. 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.

788. 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**.

12.7.4.4 Herring Gull

789. The cumulative herring gull collision risk prediction is set out in **Table 12-92**. This collates collision predictions from other wind farms which may contribute to the cumulative total.

Table 12-92 Cumulative Collision Risk Assessment for Herring gull unless otherwise indicated an avoidance rate of 99.5% was used.

Tier	Wind farm	Breeding season	Nonbreed-ing season	Annual
1	Beatrice	49.4	197.4	246.8
1	Beatrice Demonstrator	0	-	0
1	Blyth Demonstration Project	0.5	2.2	2.7
1	Dudgeon	-	-	-
1	East Anglia ONE	0	28	28
1	European Offshore Wind Deployment Centre	4.8	-	4.8
1	Galloper	27.2	-	27.2
1	Greater Gabbard	0	-	0
1	Gunfleet Sands		-	
1	Hornsea Project One	2.9	11.6	14.5
1	Hornsea Project Two	23.8		23.8
1	Humber Gateway	0.4	1.1	1.5
1	Hywind	0.6	7.8	8.4
1	Kentish Flats	0	0	0
1	Kentish Flats Extension	0.5	1.7	2.2
1	Kincardine	1	0	1
1	Lincs & LID	0	-	0
1	London Array	-	-	-
1	Methil	5.8	3.7	9.5
1	Moray East	52	-	52
1	Race Bank	0	-	0
1	Rampion	155	-	155
1	Scroby Sands	-	-	-
1	Sheringham Shoal	0		0
1	Teesside	8.7	34.5	43.2
1	Thanet	4.9	19.6	24.5
1	Triton Knoll	0		0
1	Westermost Rough	0.1	0	0.1
2	Dogger Bank A and B	0	-	0
2	Moray West	12	1	13
2	Neart na Gaoithe	5	12.5	17.5
2	Seagreen A and B	10	21	31
3	Dogger Bank C and Sofia	0	-	0
3	East Anglia One North	0	0	0
3	East Anglia Three	0	23	23
3	East Anglia Two	0	0.5	0.5
3	Hornsea Project Three (revised)	1	4	5

Tier	Wind farm	Breeding season	Nonbreed-ing season	Annual
3	Inch Cape	0	13.5	13.5
3	Norfolk Boreas	1.5	5.4	6.9
3	Norfolk Vanguard	0.4	7.1	7.5
3	Hornsea Project Four [1]	0.5	0.3	0.8
4	Sheringham and Dudgeon Extension Projects	0.3	0.0	0.3
4	Berwick Bank	43	7	50
4	ForthWind Offshore Wind Demonstration Project - phase 1 [2]	0	0	0
4	Rampion 2 [1]	34.5	28.1	62.6
4	North Falls (PEIR)	0.5	1.1	1.6
4	Five Estuaries (PEIR) [1]	0.7	1.4	2.1
4	Outer Dowsing (PEIR)	2.7	0.2	3.0
	Total (other schemes)	**449.7**	**433.7**	**883.4**
	DBS East	0	0.6	0.6
	DBS West	0.8	0.8	1.6
	DBS East and West together	0.8	1.4	2.2
	Total (all schemes + DBS East)	**449.7**	**434.3**	**884.0**
	Total (all schemes + DBS West)	**450.5**	**434.5**	**885.0**
	Total (all schemes + DBS East and West together)	**450.5**	**435.1**	**885.6**

[1] An avoidance rate of 99.4% was used;

[2] An avoidance rate of 99% was used.

790. The annual number of herring gull at risk of collision from offshore wind farms in the UK North Sea and Channel BDMPS, which has been calculated as 883.4 When the estimated numbers at risk due to the Projects are included (2.2), this would increase to 885.6 collisions. The existing total is expected to increase when projects, which are not yet determined are included, however the contribution from those projects is not yet finalised and subject to change.

791. 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 (**Table 12-71**). 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.

792. The annual cumulative total, not including the Projects, is 883, which would be increased to approximately 1,060 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 466,511 (Furness 2015) and baseline mortality of 0.172 (**Table 12-13**), 80,240 individual herring gulls would be expected to die each year; the addition of 885.6 collisions (including the Projects) would represent a 1.1% increase in annual mortality. Based on the annual biogeographic population with connectivity to UK waters of 1,098,000 (Furness 2015), 188,856 individuals would be expected to die; the addition of 886.9 collisions would represent 0.47% increase in mortality.

793. Applying the higher calculated collision mortality (including the Projects, 1,062.2) would represent a 1.3% increase in annual mortality of the BDMPS population. Based on the annual biogeographic population with connectivity to UK waters of 1,098,000 (Furness 2015), 188,856 individuals would be expected to die; the addition of 1,063.5 collisions would represent 0.56% increase in mortality.

794. 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.

795. 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.

796. 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**.

12.7.4.5 Great Black-backed Gull

797. The cumulative predicted collision risk for great black-backed gull is set out in **Table 12-93**. This collates collision predictions from other wind farms which may contribute to the cumulative total.

Table 12-93 Cumulative Collision Risk Assessment for Great black-backed gull unless otherwise indicated an avoidance rate of 99.5% was used.

Tier	Wind farm	Breeding season	Nonbreed-ing season	Annual
1	Beatrice	30.2	120.8	151
1	Beatrice Demonstrator	0	0	0
1	Blyth Demonstration Project	1.3	5.1	6.4
1	Dudgeon	0	0	0
1	East Anglia ONE	0	46	46
1	European Offshore Wind De-ployment Centre	0.6	2.4	3
1	Galloper	4.5	18	22.5
1	Greater Gabbard	15	60	75
1	Gunfleet Sands	-	-	-
1	Hornsea Project One	17.2	68.6	85.8
1	Hornsea Project Two	3	20	23
1	Humber Gateway	1.3	5.1	6.4
1	Hywind	0.3	4.5	4.8
1	Kentish Flats	-	-	-
1	Kentish Flats Extension	0.1	0.2	0.3
1	Kincardine	0	0	0
1	Lincs & LID	0	0	0
1	London Array	-	-	-
1	Methil	0.8	0.8	1.6
1	Moray East	9.5	25.5	35
1	Race Bank	0	0	0
1	Rampion	5.2	20.8	26
1	Scroby Sands	-	-	-
1	Sheringham Shoal	0	0	0
1	Teesside	8.7	34.8	43.5
1	Thanet	0.1	0.4	0.5
1	Triton Knoll	24.4	97.6	122
1	Westermost Rough	0.1	0	0.1
2	Dogger Bank A and B	5.8	23.3	29.1
2	Moray West	4	5	9
2	Neart na Gaoithe	0.9	3.6	4.5
2	Seagreen A and B	13.4	53.4	66.8
3	Dogger Bank C and Sofia	6.4	25.5	31.9
3	East Anglia One North	3.7	1.2	4.9
3	East Anglia Three	4.6	34.4	39
3	East Anglia Two	3.5	3.4	6.9
3	Hornsea Project Three (revised)	8	28	36

Tier	Wind farm	Breeding season	Nonbreeding season	Annual
3	Inch Cape	0	36.8	36.8
3	Norfolk Boreas	6.9	28.7	35.6
3	Norfolk Vanguard	4.5	21.5	26
3	Hornsea Project Four [1]	0.5	5.2	5.7
4	Sheringham and Dudgeon Extension Projects	5.7	0.3	6
4	Berwick Bank	-	-	-
4	ForthWind Offshore Wind Demonstration Project - phase 1 [2]	-	-	-
4	Rampion 2 [1]	6.3	13.6	19.9
4	North Falls (PEIR)	0	6	6
4	Five Estuaries (PEIR) [1]	0.7	0.6	1.3
4	Outer Dowsing	0.5	4.2	4.7
	Total (other schemes)	**197.7**	**825.3**	**1023**
	DBS East	0.9	2.8	3.7
	DBS West	0	1.2	1.2
	DBS East and West together	0.9	3.9	4.8
	Total (all schemes + DBS East)	**188.6**	**828.1**	**1026.7**
	Total (all schemes + DBS West)	**197.7**	**826.5**	**1024.2**
	Total (all schemes + DBS East and West together)	**198.6**	**829.2**	**1027.8**

[1] An avoidance rate of 99.4% was used;

[2] An avoidance rate of 99% was used.

798. 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 (4.8), this would increase to 1,027.8 collisions. The existing total is expected to increase when projects, which are not yet determined are included, however the contribution from those projects is not yet finalised and subject to change.

799. 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 (**Table 12-71**). 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.

800. The annual cumulative total, not including the Projects, is 1,023, which would be increased to approximately 1,227.6 on application of the revised avoidance rate. To this the Projects add a maximum of 4.8 birds. Based on the largest Annual BDMPS of 91,399 (Furness 2015) and baseline mortality of 0.185 (**Table 12-13**), 16,909 individual greater black-backed gulls would be expected to die each year; the addition of 1,027.8 collisions (including the Projects) would represent a 6.1% increase in annual mortality. Based on the annual biogeographic population with connectivity to UK waters of 235,000 (Furness 2015), 43,475 individuals would be expected to die; the addition of 1,027.8 collisions would represent 2.3% increase in mortality.

801. Applying the higher calculated collision mortality (including the Projects, 1,232.4) would represent a 7.3% increase in annual mortality of the BDMPS population. Based on the annual biogeographic population with connectivity to UK waters of 235,000 (Furness 2015), 43,475 individuals would be expected to die; the addition of 1,232 collisions would represent 2.8% increase in mortality.

802. 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.

803. 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%.

804. 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.

805. 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.

806. 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**.

12.7.5 Impact 11 Cumulative Assessment of Operational Collision Risk and Displacement

12.7.5.1 Gannet

807. 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.

808. As noted above, the estimated cumulative annual total for gannet collision mortality is 607 (99.79%; paragraph 769 and 770). The estimated cumulative total for gannet displacement is 373 and 497 birds (**Table 12-82**).

809. Based on the largest Annual BDMPS for the UK North Sea and Channel, of 456,298 (Furness 2015) and baseline mortality of 0.191 (**Table 12-13**), 87,153 individual gannets would be expected to die each year; the addition of 980-1,104 individuals would represent a 1.12–1.27% increase in annual mortality. Based on the annual biogeographic population with connectivity to UK waters of 1,180,000 (Furness 2015), 225,380 individuals would be expected to die; the addition of 980-1.104 individuals would represent 0.43-0.49% increase in mortality.

810. The estimated cumulative impacts of collision are an order of magnitude higher than those of displacement, and addition of the precautionary 1% estimated mortality of displaced birds to the collision mortality results in a very small change in the estimated increased in population mortality rates due to collision. 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.

811. 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**.

12.8 Potential Monitoring Requirements

812. 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.

813. 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.

12.9 Transboundary Effects

814. 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 12.7).

815. 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.

816. 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 12.7. Therefore, any potential transboundary effects are expected to be minimal and will not require any additional mitigation.

12.10 Interactions

817. 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 12-94**.

818. No potential interactions between the impacts assessed have been identified.

819. Within **Table 12-95**, a lifetime assessment is undertaken which considers the potential for an effect to affect receptors across all development phases.

Table 12-94 Summary of Potential interactions

<table>
<tr><th colspan="4">Potential Interactions between Impacts</th></tr>
<tr><td colspan="4">Construction</td></tr>
<tr><td></td><td colspan="2">Impact 1: Direct disturbance and displacement from increased vessel activity</td><td>Impact 2: Indirect Impacts Through Effects on Habitats and Prey Species During Construction</td></tr>
<tr><td>Impact 1: Direct disturbance and displacement from increased vessel activity</td><td colspan="2"></td><td>No interaction
Birds that have been displaced cannot be impacted by prey availability effects, which are highly localized to the source of impact.</td></tr>
<tr><td>Impact 2: Indirect Impacts Through Effects on Habitats and Prey Species During Construction</td><td colspan="2">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.</td><td></td></tr>
<tr><td colspan="4">Operation</td></tr>
<tr><td></td><td>Impact 3: Disturbance and displacement from offshore infrastructure</td><td>Impact 4: Indirect Impacts Through Effects on Habitats and Prey Species During Operation</td><td>Impact 5: Collision risk</td></tr>
<tr><td>Impact 3: Disturbance and displacement from offshore infrastructure</td><td></td><td>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.</td><td>No interaction
Birds that are displaced from the wind farm are not at risk of collision (except gannet which has been considered separately).</td></tr>
<tr><td>Impact 4: Indirect Impacts Through Effects on Habitats and Prey Species During Operation</td><td>No interaction
Birds that are subject to reduced prey availability effects, which will only occur within the wind farm, have not been displaced.</td><td></td><td>No interaction
Birds susceptible to indirect effects which occur within the wind farm have not been involved in collisions.</td></tr>
<tr><td>Impact 5: Collision risk</td><td>No interaction
Birds that are at risk of collisions have not been displaced from the wind farm (except gannet which has been considered separately).</td><td>No interaction
Birds involved in collisions would not be susceptible to indirect effects which occur within the wind farm.</td><td></td></tr>
<tr><td colspan="4">Decommissioning</td></tr>
<tr><td colspan="4">It is anticipated that the decommissioning impacts will be similar in nature to those of construction.</td></tr>
</table>

Table 12-95 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.

12.11 Inter-relationships

820. 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 12-96**, which indicates where assessments carried out in other ES chapters have been used to inform the offshore ornithology assessment.

Table 12-96 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	12.6.1.1.2
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	12.6.2.2
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	12.6.3.2

12.12 Summary

821. 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 12-97**.

822. 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**,

823. 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.**

824. 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**,

825. Cumulative effects assessed included displacement and collision risks and were assessed as **negligible** to **moderate adverse.**

Table 12-97 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 Operational Displacement	Gannet, Guillemot, Razorbill, Puffin	Low - Medium	Negligible to Medium	Negligible-Moderate Adverse	N/A	Negligible - Moderate adverse

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Impact 10 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 11 Cumulative Assessment of Operational Collision Risk and Displacement	Gannet	Medium	Negligible	Negligible - Minor adverse	N/A	Negligible - Minor adverse

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