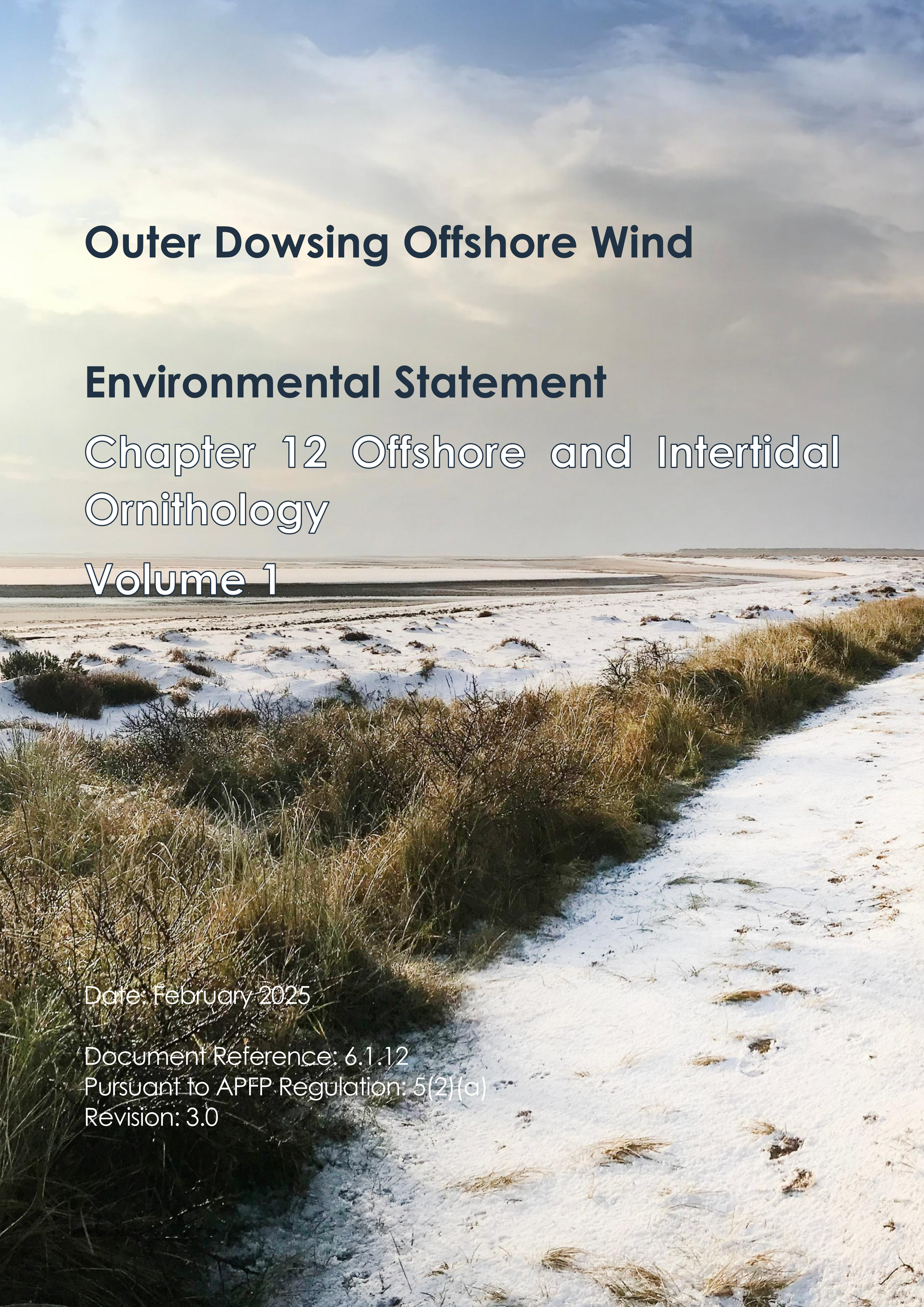

Outer Dowsing Offshore Wind

Environmental Statement

Chapter 12 Offshore and Intertidal Ornithology

Volume 1

Date: February 2025

Document Reference: 6.1.12
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<tr><td colspan="2">Project:</td><td colspan="2">Whole Windfarm</td><td colspan="2">Sub Project/Package:</td><td>Whole Asset</td></tr>
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Change Log

- Examination Update: updates to reflect, where relevant: clarifications to date in Examination; correcting errata; additional commitments made through Examination; and changes to status of or addition of cumulative projects

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Acronyms & Definitions

Abbreviations / Acronyms

Abbreviation / Acronym	Description
AEoI	Adverse eEffect on Integrity
AfL	Agreement for Lease
ANS	Artificial Nesting Structure
AoS	Area of Search
BDMPS	Biologically Defined Minimum Population Scales
BTO	British Trust for Ornithology
CCUS	Carbon Capture Utilisation and Storage
CFP	Common Fisheries Policy
CGR	Counterfactual of Population Growth
CI	Confidence Interval
CPS	Counterfactual of Population Size
CRM	Collision Risk Modelling
CIEEM	Chartered Institute of Ecology and Environmental Management
DAS	Digital Aerial Survey
DCO	Development Consent Order
DESNZ	Department for Energy Security and Net Zero, formerly Department of Business, Energy and Industrial Strategy (BEIS), which was previously Department of Energy & Climate Change (DECC).
ECC	Export Cable Corridor
EEA	European Economic Area
EIA	Environmental Impact Assessment
EOWDC	European Offshore Wind Development Centre
EPP	Evidence Plan Process
ES	Environmental Statement
ETG	Expert Topic Group
EU	European Union
FFC	Flamborough & Filey Coast
GBBG	Great Black-Backed Gull
GBS	Gravit Based Structure
GES	Good Environmental Status
HDD	Horizontal Directional Drilling
HPAI	Highly Pathogenic Avian Influenza
HRA	Habitats Regulation Assessment
IOC	International Ornithological Congress
IOF	Important Ornithological Feature
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
JUV	Jack-Up Vessel
LBBG	Lesser Black-Backed Gull
LSE	Likely Significant Effect
MAT	Migration Assessment Tool

Abbreviation / Acronym	Description
MCRM	Migratory Collision Risk Model
MDS	Maximum Design Scenario
MHWS	Meanarine High-Water Springs
MLWS	Mean Marine Low-Water Springs
MSFD	Marine Strategy Framework Directive
MSL	Mean Sea Level
MSS	Marine Scotland Science
NE	Natural England
NEWS	Non-Estuarine Waterbird Surveys
NPS	National Policy Statement
NSIP	Nationally Significant Infrastructure Project
O&M	Operation and Maintenance
ORBA	Offshore Restricted Build Area
ORCP	Offshore Reactive Compensation Platform
ORJIP	Offshore Renewables Joint Industry Programme
OSS	Offshore Substation
OWEZ	Offshore Windpark Egmond aan Zee
OWF	Offshore Windfarm
PCH	Potential Collision Height
PEIR	Preliminary Environmental Information Report
pSPA	Potential Special Protection Area
PVA	Population Viability Analysis
RIAA	Report to Inform Appropriate Assessment
RSPB	Royal Society for the Protection of Birds
RTDs	Red-Throated Diver Species
sCRM	Stochastic Collision Risk Modelling
SD	Standard Deviation
SEP and DEP	Sheringham and Dudedggeon Extension Projects
SMP	Seabird Monitoring Programme
SNCB	Statutory Nature Conservation Body
SoS	Secretary of State
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
ST	Sandwich Tern
TCE	The Crown Estate
WEBS	Wetland Bird Survey
WTG	Wind Turbine Generator
WWT	Wildfowl & Wetlands Trust
ZOI	Zone of Influence

Terminology

Term	Definition
The Applicant	GTR4 Limited (a joint venture between Corio Generation (and its affiliates), TotalEnergies and Gulf Energy Development), trading as Outer Dowsing Offshore Wind
AfL array area	The area of the seabed awarded to GT R4 Ltd. Through an Agreement for Lease (AfL) for the development of an offshore windfarm, as part of The Crown Estate's Offshore Wind Leasing Round 4.
Array area	The area offshore within the Order Limits within which the generating stations (including wind turbine generators (WTG) and inter array cables), offshore accommodation platforms, offshore transformer substations and associated cabling are positioned, including the ORBA.
Barrier effect	Barrier effect is experienced by bird species which intend to forage beyond or migrate past the array but due to avoidance behaviour, have to navigate around the array. Barrier effect is often not discernible from displacement behaviour.
Baseline	The status of the environment at the time of assessment without the development in place.
Cumulative effects	The combined effect of the Project acting cumulatively with the effects of a number of different projects on the same single receptor/resource.
Cumulative impact	Impacts that result from changes caused by other past, present or reasonably foreseeable actions together with the Project.
Project Design Envelope	A description of the range of possible elements that make up the Project's design options under consideration, as set out in detail in the project description. This envelope is used to define the Project for Environmental Impact Assessment (EIA) purposes when the exact engineering parameters are not yet known. This is also often referred to as the "Rochdale Envelope" approach.
Development Consent Order (DCO)	An order made under the Planning Act 2008 granting development consent for a Nationally Significant Infrastructure Project (NSIP) from the Secretary of State (SoS) for Department for Energy Security and Net Zero (DESNZ).
Effect	Term used to express the consequence of an impact. The significance of an effect is determined by correlating the magnitude of an impact with the sensitivity of a receptor, in accordance with defined significance criteria.
Environmental Impact Assessment (EIA)	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the Environmental Impact Assessment (EIA) Regulations, including the publication of an Environmental Statement (ES).
EIA Regulations	The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017

Term	Definition
Environmental Statement (ES)	The suite of documents that detail the processes and results of the Environmental Impact Assessment (EIA).
Habitats Regulations Assessment (HRA)	Habitats Regulations Assessment. A process which helps determine likely significant effects and (where appropriate) assesses adverse impacts on the integrity of European conservation sites and Ramsar sites. The process consists of up to four stages of assessment: screening, appropriate assessment, assessment of alternative solutions and assessment of imperative reasons of over-riding public interest (IROPI) and compensatory measures.
Impact	An impact to the receiving environment is defined as any change to its baseline condition, either adverse or beneficial.
Intertidal	Area where the ocean meets the land between high and low tides.
Landfall	The location at the land-sea interface where the offshore export cable will come ashore.
Maximum Design Scenario	The maximum design parameters of the combined project assets that result in the greatest potential for change in relation to each impact assessed
Mitigation	Mitigation measures, or commitments, are commitments made by the Project to reduce and/or eliminate the potential for significant effects to arise as a result of the Project. Mitigation measures can be embedded (part of the project design) or secondarily added to reduce impacts in the case of potentially significant effects.
National Policy Statement (NPS)	A document setting out national policy against which proposals for Nationally Significant Infrastructure Projects (NSIPs) will be assessed and decided upon
Non-statutory consultee	Organisations that the Applicant may be required to (under Section 42 of the 2008 Act) or may otherwise choose to engage during the pre-application phases (if, for example, there are planning policy reasons to do so) who are not designated in law but are likely to have an interest in a proposed development.
Outer Dowsing Offshore Wind (the Project)	The Project.
Offshore Export Cable Corridor (ECC)	The Offshore Export Cable Corridor (Offshore ECC) is the area within the Order Limits within which the export cable running from the array to landfall will be situated.
Offshore Restricted Build Area (ORBA)	The area within the array area, where no wind turbine generator, offshore transformer substation or offshore accommodation platform shall be erected.
Offshore Reactive Compensation Platform (ORCP)	A structure attached to the seabed by means of a foundation, with one or more decks (including bird deterrents) housing electrical reactors and switchgear for the purpose of the efficient transfer of power in the course of HVAC transmission by providing reactive compensation
Onshore Infrastructure	The combined name for all onshore infrastructure associated with the Project from landfall to grid connection.
Pre-construction and post-construction	The phases of the Project before and after construction takes place.

Term	Definition
Receptor	A distinct part of the environment on which effects could occur and can be the subject of specific assessments. Examples of receptors include species (or groups) of animals or plants, people (often categorised further such as 'residential' or those using areas for amenity or recreation), watercourses etc.
Rochdale Envelope	Provides flexibility in design options where details of the whole project are not available when the application is submitted, while ensuring the impacts of the final development are fully assessed during the Environmental Impact Assessment (EIA).
Statutory consultee	Organisations that are required to be consulted by the Applicant, the Local Planning Authorities and/or The Inspectorate during the pre-application and/or examination phases, and who also have a statutory responsibility in some form that may be relevant to the Project and the DCO application. This includes those bodies and interests prescribed under Section 42 of the Planning Act 2008.
Study area	Area(s) within which environmental impact may occur – to be defined on a receptor-by-receptor basis by the relevant technical specialist.
The Applicant	GTR4 Limited (a joint venture between Corio Generation (and its affiliates), TotalEnergies and Gulf Energy Development), trading as Outer Dowsing Offshore Wind
The Planning Inspectorate	The agency responsible for operating the planning process for Nationally Significant Infrastructure Projects (NSIPs).
The Project	Outer Dowsing Offshore Wind including proposed onshore and offshore infrastructure.
Transboundary impacts	Transboundary effects arise when impacts from the development within one European Economic Area (EEA) state affects the environment of another EEA state(s).
Vessel cluster	A group of vessels within a confined area performing a joint task
Wind turbine generator (WTG)	All the components of a wind turbine, including the tower, nacelle, and rotor.

Reference Documentation

Document Number	Title	Most Recent Examination Reference

5.1	Consultation Report	AS1-034
6.1.3	Chapter 3: Project Description	V2 Submitted at Deadline 5
6.1.4	Chapter 4: Site Selection and Consideration of Alternatives	V2 Submitted at Deadline 5
6.1.6	Technical Consultation	V2 Submitted at Deadline 5
6.1.9	Chapter 9: Benthic Subtidal and Intertidal Ecology	V2 Submitted at Deadline 5
6.1.10	Chapter 10: Fish and Shellfish Ecology	V2 Submitted at Deadline 5
6.1.22	Chapter 22: Onshore Ornithology	V2 Submitted at Deadline 5
6.2.12	Offshore and Intertidal Ornithology Figures	APP-100
6.2.12.1	Offshore and intertidal Ornithology Study Area	APP-100
6.2.12.2	Disturbance impacts of the ORCP	APP-100
6.3.6.1	Appendix 6.1: Evidence Plan Process Consultation	APP-149
6.3.12.1	Appendix 12.1: Intertidal and Offshore Ornithology Technical Baseline	AS1-064
6.3.12.2	Appendix 12.2: Collision Risk Modelling Assessment Appendix	APP-163
6.3.12.3	Appendix 12.3 : Displacement Assessment Appendix	APP-164
6.3.12.4	Appendix 12.4: Population Viability Analysis	APP-165
6.3.12.5	Appendix 12.5: Migratory Collision Risk Modelling Appendix	APP-166
7.4	Apportioning methodology	REP4-041
8.20	Outline Vessel Management Plan	PD1-064

12 Intertidal and Offshore Ornithology

12.1 Introduction

1. This chapter of the Environmental Statement (ES) presents the results of the Environmental Impact Assessment (EIA) for the potential impacts of Outer Dowsing Offshore Wind ('the Project') on Intertidal and Offshore Ornithology. Specifically, this chapter considers the potential impact of the Project seaward of Mean High-Water Springs (MHWS) during the construction, operation and maintenance (O&M), and decommissioning phases.
2. GT R4 Limited (trading as Outer Dowsing Offshore Wind) hereafter referred to as the 'Applicant', is proposing to develop the Project. The Project array will be located approximately 54km from the Lincolnshire coastline in the southern North Sea. The Project will include both offshore and onshore infrastructure including an offshore generating station (windfarm), export cables to landfall, Offshore Reactive Compensation Platforms (ORCPs), onshore cables, connection to the electricity transmission network, ancillary and associated development, and areas for the delivery of up to two Artificial Nesting Structures (ANS) and the creation of a biogenic reef (if these compensation measures are deemed to be required by the Secretary of State) (see Volume 1, Chapter 3: Project Description for full details). All bird names are in English Vernacular and follow the latest International Ornithological Congress (IOC) order and spelling. Relevant scientific names can be found in Annex 1.
3. This chapter should be read alongside the following chapters presented in Volume 1:
   - Chapter 10 – Fish and Shellfish Ecology (document reference 6.1.10) (in terms of key prey resources available to birds); and
   - Chapter 9 – Benthic Subtidal and Intertidal Ecology (document reference 6.1.9) (in terms of relevant habitat and key prey resources available to birds); and
   - Chapter 22 – Onshore Ornithology (document reference 6.1.22).
4. Additionally, the following appendices have been compiled (presented in Volume 3) to support the information provided within this chapter:
   - Appendix 12.1: Intertidal and Offshore Ornithology Technical Baseline (document reference 6.3.12.1);
   - Appendix 12.2: Collision Risk Modelling Assessment Appendix (document reference 6.3.12.2);
   - Appendix 12.3 : Displacement Assessment Appendix (document reference 6.3.12.3); and
   - Appendix 12.5: Migratory Collision Risk Modelling Appendix (document reference 6.3.12.5).

12.2 Statutory and Policy Context

5. The assessment of impacts on ornithological receptors has considered current legislation, policy and guidance relevant to offshore ornithology. Full details are presented in Volume 1, Chapter 2: Need, Policy and Legislative Context.

6. Relevant National Policy Statements (NPS) are considered of particular importance for the assessment, being principal decision-making documents for Nationally Significant Infrastructure Projects (NSIPs). Documents of relevance to ornithological receptors for the Project are considered to be:
   - Overarching NPS for Energy (EN-1) (Department for Energy Security and Net Zero (DESNZ), 2023a);
   - National Policy Statement for Renewable Energy Infrastructure (EN-3) (DESNZ, 2023b);
   - National Policy Statement for Electricity Networks Infrastructure (EN-5) (DESNZ, 2023c).
7. Specific assessment requirements within these documents which are relevant to this ES chapter are presented in Table 12.1.
8. International and national laws regarding the protection of wildlife and the marine environment also need to be considered, such as the Ramsar Convention on Wetlands of International Importance 1971.
9. The Conservation of Habitats and Species Regulations 2017 (as amended) (known as the 'Habitats Regulations') transfer functions from the European Commission to the appropriate authorities in England and Wales, with all the processes or terms unchanged. The 2017 Habitats Regulations transpose aspects of the Birds Directive and the Habitats Directive into national law, covering all environments out to 12nm.
10. The Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended) (known as the 'Offshore Marine Regulations') provide similar provisions to the 2017 Habitats Regulations in the offshore environment beyond 12nm throughout the UK.
11. The Conservation of Habitats and Species Regulations 2017 (as amended) transposed aspects of the Birds Directive and the Habitats Directive into national law, covering all environments out to 12nm.
12. The Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended) provides similar provisions in the offshore environment beyond 12nm, throughout the UK. These Regulations are together referred to in this chapter as the Habitats Regulations. Following the UK's exit from the European Union (EU), the Habitats Regulations have been amended, mainly to transfer functions from the European Commission to the appropriate authorities in England and Wales, but with most processes and terms otherwise largely unchanged.
13. The Wildlife and Countryside Act 1981 operates in conjunction with the Habitats Regulations and is the principal mechanism for the legislative protection of wildlife in the UK. The Wildlife and Countryside Act 1981 has also been amended following withdrawal from the European Union so that species of wild birds found in or regularly visiting either the UK or the European territory of a Member State will continue to be protected on land and down to MLWS (Mean Low Water Springs).

Table 12.1: NPS requirements for assessment

Legislation/Policy	Key Provisions	Section where comment addressed
Overarching NPS for Energy (EN-1) (DESNZ, 2023a)	NPS EN-1 Paragraph 5.4.48 states that "the SoS (Secretary of State) should ensure that appropriate weight is attached to designated sites of international, national and local importance; protected species; habitats and other species of principal importance for the conservation of biodiversity; and to biodiversity and geological interests within the wider environment."	The potential for effects on designated sites is considered in detail in the Report to Inform Appropriate Assessment (RIAA), though consideration to relevant designated sites is given in Section 12.4.
	NPS EN-1 Paragraph 5.4.17 states that "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, on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity."	Sections 12.4 – 12.6.
	NPS EN-1 Paragraph 5.4.19 states that the Applicant is required to show how the proposed project has taken advantage of opportunities to conserve and enhance biodiversity conservation interests.	Section 12.6.
	NPS EN-1 Paragraph 5.4.35 states that "Applicants should include appropriate avoidance, mitigation, compensation and enhancement measures as an integral part of the proposed development. In particular, the applicant should demonstrate that: • during construction, they will seek to ensure that activities will be confined to the minimum areas required for the works • the timing of construction has been planned to avoid or limit disturbance during construction and operation best practice will be followed to ensure that risk of disturbance or damage to species or habitats is minimised, including as a consequence of transport access arrangements	Section 12.4, with a more detailed assessment undertaken in the Report to Inform Appropriate Assessment (Document no. 7).

Legislation/Policy	Key Provisions	Section where comment addressed
	• habitats will, where practicable, be restored after construction works have finished • opportunities will be taken to enhance existing habitats rather than replace them, and where practicable, create new habitats of value within the site landscaping proposals. Where habitat creation is required as mitigation, compensation, or enhancement, the location and quality will be of key importance. In this regard habitat creation should be focused on areas where the most ecological and ecosystems benefits can be realised. • mitigations required as a result of legal protection of habitats or species will be complied with."	
	NPS EN1 Paragraph 5.4.2 states that "The aim is to halt overall biodiversity loss in England by 2030 and then reverse loss by 2042, support healthy well-functioning ecosystems and establish coherent ecological networks, with more and better places for nature for the benefit of wildlife and people. This aim needs to be viewed in the context of the challenge presented by climate change. Healthy, naturally functioning ecosystems and coherent ecological networks will be more resilient and adaptable to climate change effects. Failure to address this challenge will result in significant adverse impact on biodiversity and the ecosystem services it provides."	The Project will make a significant contribution to the generation of renewable energy.
National Policy Statement for Renewable Energy Infrastructure (EN-3) (DESNZ, 2023b)	NPS EN-3 Paragraph 2.8.136 explains that "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 vessels and piling; ▪ displacement during the operational phase, resulting in loss of	The potential impacts are discussed throughout the ES, predominantly in Sections 12.8 – 12.9.

Legislation/Policy	Key Provisions	Section where comment addressed
	foraging/roosting area; andimpacts 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 2.8.144 states that "Applicants must undertake collision risk modelling, as well as displacement and population viability assessments for certain species of birds. Advice can be sought from Statutory Nature Conservation Body (SNCBs)."	Collision and displacement assessments are undertaken for relevant species in sections 12.8 – 12.9. Population Viability Analysis (PVA) is undertaken in section 1.10.2.
	EN-3 Paragraphs 2.8.239 and 2.8.240 "Applicants should undertake a review of up-to-date research and all potential mitigation options presented as part of the application, having consulted the relevant Joint Nature Conservation Committee (JNCC) mitigation guidelines" "Aviation and navigation lighting should be minimised and/or on demand (as encouraged in EN-1 Section 5.5) to avoid attracting birds, taking into account impacts on safety. Subject to other constraints, wind turbines should be laid out within a site, in a way that minimises collision risk."	Embedded mitigation in relation to Intertidal and Offshore Ornithology is set out in Section 12.6.
	EN-3 Paragraph 3.8.258 "Turbine parameters should also be developed to reduce collision risk where the assessment shows there is significant risk of collision (e.g. altering rotor height)."	As outlined in section 12.6, the minimum air gap has been raised from 22m to 40m mean sea level (MSL) to reduce the impacts of collision on birds.

14. Guidance provided within the Marine Strategy Framework Directive (MSFD), which was implemented in the UK by the Marine Strategy Regulations SI 2010/1627, has also been considered. The overarching goal of the MSFD was to achieve 'Good Environmental Status' (GES) by 2020 across Europe's marine environment. After exiting the EU, the UK remains committed to achieving GES through the UK Marine Strategy Part One. Descriptors considered relevant to the assessment of offshore and intertidal ornithology for the Project are presented in Table 12.2.
15. Alongside these documents, several other guidance documents are considered relevant, including, but not limited to the following:

- EIA guidance for offshore ornithology receptors provided by the Chartered Institute of Ecology and Environmental Management (CIEEM) (2022);
- SNCB guidance documents for the assessment of offshore windfarm (OWF) impacts on offshore ornithology receptors (Parker *et al.,* 2022; Natural England, 2022a; MIG-Birds, 2022); and
- Headroom in Cumulative Offshore Windfarm Impacts for Seabirds: Legal Issues and Possible Solutions (The Crown Estate and Womble Bond Dickinson, 2021).

Table 12.2: Summary of the UK Marine Strategy high level descriptors of Good Environmental Status considered relevant to the assessment of Offshore and Intertidal Ornithology for the Project

MSFD High level descriptor	Section where comment addressed
Biological Diversity – Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.	Effects on biological diversity with respect to offshore and intertidal birds have been described and considered within the assessment for the Project alone and cumulatively (Sections 12.8 – 12.9).
Elements of marine food webs – All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.	Potential effects are considered within the assessment for the Project alone and cumulatively (Sections 12.8 – 12.9), and in the description of inter-relationships (Section 12.12).
Sea floor integrity – Seafloor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.	The indirect effects as a result of impacts on benthic ecology and on fish and shellfish ecology that may impact ornithological receptors through impacts on prey availability are presented within the assessment for the Project alone and cumulatively (Sections 12.8 – 12.9).
Contaminants – Concentrations of contaminants are at levels not giving rise to pollution effects	The effects of contaminants on ornithological receptors are expected to be negligible and have been scoped out of assessment.
Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment	The effects of underwater noise have been assessed in the context of indirect impacts due to effects on habitats and prey species (Sections 12.8 – 12.9).

12.3 Consultation

16. Consultation is a key part of the Development Consent Order (DCO) application process. Consultation regarding Intertidal and Offshore Ornithology has been conducted through the Evidence Plan Process (EPP) and as part of the EIA scoping process (Outer Dowsing Offshore Wind, 2022) and the Preliminary Environmental Information Report (PEIR) process (Outer Dowsing Offshore Wind, 2023). An overview of the Project's Technical Consultation (document reference 6.1.6) and wider consultation is presented in the Consultation Report (document reference 5.1).
17. A summary of the key issues raised during consultation to date, specific to Intertidal and Offshore Ornithology, is outlined in Table 12.3 below, together with how these issues have been considered in the production of this ES.

Table 12.3: Summary of consultation relating to Intertidal and Offshore Ornithology

Date and consultation phase/type	Consultation and key issues raised	Section where comment addressed
Scoping Opinion Comments		
Scoping Opinion (The Planning Inspectorate, 9 September 2022)	The Planning Inspectorate does not support the scoping out of barrier effects across all phases. The justification that the Scoping Report contains limited information regarding the likely extent of areas at each phase that could form a barrier to movement. Additionally, the Scoping Report does not explain why displacement and barrier effects would not also occur during other phases of the Project. The ES should include information on the sources of impact and the receptors that could be subject to barrier effects during construction, O&M, and decommissioning and assess the likely significance of such effects.	Barrier effects are recognised and accounted for by the inclusion of flying birds within the displacement assessment in Sections 12.8 and 12.9. Therefore, a separate assessment for barrier effects on Important Ornithological Features (IOFs) is not necessary.
Scoping Opinion (The Planning Inspectorate, 9 September 2022)	The Planning Inspectorate does not support the scoping out of disturbance and displacement within the ECC during O&M. The Planning Inspectorate is of the view that the Scoping Report contains limited information regarding the extent and nature of any likely maintenance or repair works in the intertidal and offshore ECC. The Planning Inspectorate suggests the ES should assess impacts on IOFs from disturbance	Impacts on IOFs from disturbance and displacement have been scoped into the assessment. This is assessed in Sections 12.8 and 12.9.

Date and consultation phase/type	Consultation and key issues raised	Section where comment addressed
	and displacement during O&M, where significant effects are likely to occur; any assumptions made in the assessment should be clearly set out.	
Scoping Opinion (The Planning Inspectorate, 9 September 2022)	With regards to effects on prey species, the Planning Inspectorate notes that the scoping Report assessment relies on the data and impact assessments including Marine Physical Processes, Noise, Benthic Subtidal and Intertidal Ecology, and Fish and Shellfish. Noting the Applicant's assertion that the temporal and spatial extent of impacts will be small, this is yet to be evidenced. Therefore, the Planning Inspectorate does not agree to scope these effects out of assessment. The Planning Inspectorate is of the view that the ES should include an assessment of cumulative impacts where significant effects are likely to occur. The ES should also assess the potential for 'minor' effects to combine to produce a cumulative, significant effect.	Barrier effects and effects on prey have been scoped into the assessment. This is assessed in Sections 12.8 and 12.9.
Scoping Opinion (The Planning Inspectorate, 9 September 2022)	The Planning Inspectorate advises the Applicant to make every effort to establish species of bird when analysing surveys for the ES, as many were recorded as 'no ID'.	Effort has been made to reduce the 'no ID' birds within the survey. The apportioning methodology is outlined within Volume 3, Appendix 12.1: Offshore and Intertidal Ornithology Technical Baseline.
Scoping Opinion (The Planning Inspectorate, 9 September 2022)	The Planning Inspectorate advises that effort is made to agree via the EPP the extent of study	Consultation on the survey methodology and study area has been undertaken through the EPP.

Date and consultation phase/type	Consultation and key issues raised	Section where comment addressed
	area, the methodologies for data collection, characterisation of the baseline and key species for focus, and the assumptions made around connectivity of the populations within the study area to designated sites. The ES should fully explain how this has been established and the outcomes of consultation undertaken in relation to these matters.	Details can be found in Section 12.4 and Volume 3, Appendix 12.1: Offshore and Intertidal Ornithology Technical Baseline.
Scoping Opinion (The Planning Inspectorate, 9 September 2022)	The Planning Inspectorate recommends the Applicant seek to agree the surveys with relevant consultation bodies, such as NE, and other relevant stakeholders as part of the EPP with regards to the detail about the number, frequency, extent, or proposed methodology for the intertidal surveys.	Consultation on the intertidal survey methodology has been undertaken through the EPP. Details can be found in Appendix 22.3: Winter Bird Survey Report.
Scoping Opinion – Impact assessment Methodology (The Planning Inspectorate, 9 September 2022)	The Planning Inspectorate notes that the ES should also assess any likely significant effects to the North Norfolk Coast Special Protection Area (SPA) based on the proximity of the Proposed Development and the presence of breeding Sandwich tern at the SPA.	The North Norfolk Coast SPA is scoped into the assessments in Part 7, Document 7.1 – Report to Inform Appropriate Assessment.
Scoping Opinion – Mitigation measures (The Planning Inspectorate, 9 September 2022)	The Planning Inspectorate considers that seasonal timing of construction and O&M vessel movements should be considered as a potential measure within the ES. The ES should clearly identify the mechanism for securing and delivering such mitigation, where relied upon for the impact assessment.	Seasonality has been considered in the assessments and assumptions clearly stated. This is addressed in Sections 12.4 and 12.6.

Date and consultation phase/type	Consultation and key issues raised	Section where comment addressed
Scoping Opinion – Survey methodology (Natural England, 9 September 2022)	Natural England advises the Applicant to request that every effort be made to identify birds to at least species group and this data presented when analysing surveys for the ES, as many were recorded as 'no ID'.	Effort has been made to reduce the 'no ID' birds within the survey.
Scoping Opinion – Survey methodology (Natural England, 9 September 2022)	Natural England note that common tern, common gull, and little gull are not included as key IOFs. Natural England advises the inclusion of common tern, common gull, and little gull in the list of IOFs. Natural England welcome the applicant's willingness to add other IOFs as more survey data becomes available.	Common tern, common gull, and little gull have been included as key IOFs. Common tern and little gull have been assessed using migratory collision risk. Common gull were recorded in low numbers in the array area and were screened out for collision risk. Details can be found in Sections 12.4 and 12.9.
Scoping Opinion (Natural England, 9 September 2022)	Natural England note that breeding Sandwich tern are a feature of the NNC spa, therefore NE advises that the Applicant includes North Norfolk Coast SPA in the list of key designated sites for ornithology.	The North Norfolk Coast SPA is scoped into the assessments. This is assessed in Document 7 – Report to Inform Appropriate Assessment.
Scoping Opinion (Natural England, 9 September 2022)	Natural England raised concerns that the key species of focus for EIA and Habitats Regulation Assessment (HRA) are ambiguous. Natural England advise a full list of proposed key species is used. Natural England advise that puffin, Sandwich tern, common tern, great black-backed gull, common gull, and little gull included for consideration as key species at this stage.	Puffin, Sandwich tern, common tern, great black-backed gull, common gull, and little gull have been included for consideration as key species. These have been addressed in Sections 12.8 and 12.9.

Date and consultation phase/type	Consultation and key issues raised	Section where comment addressed
	Justification being that these species have potential connectivity of the project areas with relevant designated sites where these species are features.	
Scoping Opinion (Natural England, 9 September 2022)	Natural England note that common scoter is also a potentially sensitive feature of the Greater Wash SPA and advise that it is included for consideration as a key species for the ECC.	Common scoter has been included for consideration as a key species within the ECC. This species has been addressed in Section 12.8.
Scoping Opinion (Natural England, 9 September 2022)	Natural England do not have sufficient confidence in the estimation of heights of individual seabirds using digital aerial survey (DAS) techniques, due largely to insufficient validation of the methodologies. Natural England advise that assessments of collision risk should present the proportions of birds at potential collision risk height (% Potential Collision Height (PCH)) for a project's turbine specifications based on both the 'generic' and the site-specific data. Natural England advise working with all round 4 developers to improve the knowledge base on flight height and to encourage further engagement.	This is considered within the assessments and consultation undertaken to discuss suitable methodologies; addressed in Section 12.9 and Volume 3, Appendix 12.2: Collision Risk Modelling Assessment Appendix.
Scoping Opinion (Natural England, 9 September 2022)	Natural England welcome the applicant's commitment to further engagement as a stakeholder on collision risk modelling (CRM) methods and parameters.	Natural England have subsequently been consulted during the EPP. The approach to bio-seasons was provided for comment within the minutes for Offshore Ornithology and Derogation

Date and consultation phase/type	Consultation and key issues raised	Section where comment addressed
	Natural England request to be consulted on the approach to seasonality and bio-seasons for all species assessed. Natural England requests that the 'air gap' between the sea surface and the rotor swept area is such that collision risk is reduced as much as is possible.	and Compensation expert topic group (ETG) (Natural England, 27th March 2023). Natural England have also been consulted regarding displacement, CRM, and assessment methodology, including key matters such as the project's approach to seasonality. The Project has committed to a minimum air gap of 40m relative to MSL.
Scoping Opinion (Natural England, 9 September 2022)	Natural England do not agree with the projects statement that 'A range of potential impacts on intertidal and offshore ornithology have been identified which may occur during the construction, O&M, and decommissioning phases of the Project'. Natural England note that advice on construction phase displacement effects is to treat it as 50% of operational phase displacement effects for the years in which the construction occurs.	The advice has been noted and taken into consideration in Sections 12.8, 12.9, and 12.10.
Scoping Opinion (Natural England, 9 September 2022)	Natural England raises concern about the additional displacement from wind turbine generator (WTGs) on the distribution of red-throated divers within the Greater Wash SPA, as well as from associated activities. Natural England advises that construction and operational maintenance vessels follow a route from their base port that avoids high concentrations of red throated diver.	The advice has been noted and taken into consideration in Sections 12.6, 12.8, and 12.9.

Date and consultation phase/type	Consultation and key issues raised	Section where comment addressed
	Natural England highlighted concerns in relation to disturbance and/or displacement of red-throated divers features from the more persistent presence of offshore windfarm and oil and gas related vessel activity which could make a meaningful contribution to in-combination effects to the Greater Wash SPA and indeed the adjacent Outer Thames Estuary SPA depending on the transit route. Natural England (NE) advise appropriate consideration of both seasonal timing of construction and O&M works and vessel transit route is included within the application. Natural England advises that where possible, any construction and O&M activities avoid the months of November to March inclusive. Vessel transit routes outside of existing navigation routes through the Greater Wash SPA and Outer Thames Estuary, depending on the port of origin, should also be avoided during these winter months. Natural England advises as minimum use of best practice measures between 1st November and 31st March to mitigate and therefore minimise disturbance to red-throated diver namely: Selecting routes (when transiting to site) that avoid aggregations of red-throated diver and common scoter, where practicable.	

Date and consultation phase/type	Consultation and key issues raised	Section where comment addressed
Scoping Opinion (Natural England, 9 September 2022)	Natural England hold the opinion that whilst the landfall area of search still includes waterbird SPAs like the Humber, it is premature to scope out intertidal cable operations and maintenance at this stage.	Intertidal cable operations and maintenance have been scoped into assessments. This is addressed in Sections 12.6 and 12.8.
Scoping Opinion (Natural England, 9 September 2022)	Natural England agree that 22 transects with 16.7% coverage is likely to be sufficient for baseline characterisation. However, Natural England note that should the analysis of the survey data show that coverage is insufficient, it may be necessary to increase this coverage by further analysing the survey data from the two additional DAS survey cameras. Natural England welcomes the inclusion of 24 months of survey data, of monthly surveys year-round and two surveys per month during the period between March and August 2022.	This is noted. The Applicant has further supplemented the analysis with 6 months of additional data covering the 2023 breeding season to give a total of 30 months of survey data and 36 data points. The data have been used to provide an additional breeding season to the population estimates used in displacement analyses and the numbers of birds feeding into CRM. The use of these data in the assessment has been discussed with Natural England via the EPP, as detailed in Volume 3, Appendix 6.1: Evidence Plan Process Consultation (document reference 6.3.6.1).
Scoping Opinion (Natural England, 9 September 2022)	Natural England welcome the inclusion of 24 months of survey data, of monthly surveys year-round and two surveys per month during the period between March and August 2022. Natural England agree with the use of a 4km buffer for non-Red Throated Diver species (RTDs). However Natural England note that initial survey outputs may identify the need for further data collection or analysis, therefore	Methods of analysis are described in Sections 1.7 and 1.8, and in Appendices 12.1, 12.2, 12.3, and 12.4 (document references 6.3.12.1 – 6.3.12.4).

Date and consultation phase/type	Consultation and key issues raised	Section where comment addressed
	expect this to be a key topic for discussion as part of the evidence plan process. Natural England note a lack of detail regarding the methods of analysis of the survey data or how abundance and density estimates will be made. Natural England cannot therefore provide comments on these methods at this stage, and would welcome and encourage early engagement with the applicant on these methods. Natural England also advise the use of model-based estimates, evidence of the suitability of any novel modelling method and that design-based outputs are presented alongside model-based outputs, along with distribution maps of the raw survey data.	
Offshore Ornithology Expert Topic Group (ETG) (RSPB, 29 September 2022)	Royal Society for the Protection of Birds (RSPB) confirmed the migratory CRM within the Band model has not been used for a while and that Marine Scotland Science commissioned the British Trust for Ornithology (BTO) to update the sCRM for migratory species and this would be considered the most appropriate method.	The Project has used the Migropath tool from APEM for migratory collision risk assessment to inform the ES, with agreement from Natural England.
Offshore Ornithology ETG (RSPB, 29 September 2022)	The Project propose not assessing great black-backed gull, herring gull, Sandwich tern or fulmar for collision risk within the PEIR. This will be reassessed once the full two-year DAS data is obtained.	The Project has included assessments on great black-backed gull (GBBG), herring gull (HG) and Sandwich tern (ST) at ES, these can be found in Section 12.9.

Date and consultation phase/type	Consultation and key issues raised	Section where comment addressed
	RSPB confirmed agreement with the Project's proposed approach.	
Offshore Ornithology ETG (Natural England, 29 September 2022)	The Project propose not assessing great black-backed gull, herring gull, Sandwich tern or fulmar for collision risk within the PEIR. This will be reassessed once the full two-year DAS data is obtained. Natural England advice that information on large gulls is needed to populate ongoing in combination assessments, and therefore CRM should be carried out unless agreed otherwise. Natural England welcome the proposed reassessment following 2 years data collection, however, may not be able to provide useful comments at PEIR due to only one year of data being presented.	The Project has included assessments on GBBG, HG and ST at ES. Fulmar has been screened out for collision risk. Information regarding this can be found in section Sections 12.6 and 12.9.
Offshore Ornithology ETG (Natural England, 29 September 2022)	For apportioning, the project proposes to use the best practice interim guidance from NatureScot (2018). Natural England advises that the apportioning assessment should also draw on and reflect the findings of any colony-specific tracking data.	The Project has used the NatureScot methodology and colony-specific tracking data to inform apportioning. This has been included within the Appendix 7.4: Apportioning methodology (document reference 7.4).
Offshore Ornithology ETG (Natural England, 29 September 2022)	The Project do not intend to include population viability analysis (PVA) as part of the analysis at PEIR. Natural England advise that it might be useful for the PEIR to take an initial view on which	This has been included for relevant species conclusions within the assessments in Section 12.9.

Date and consultation phase/type	Consultation and key issues raised	Section where comment addressed
	species are likely to be subject to PVA, so stakeholders can consider this.	
Offshore Ornithology and Derogation and Compensation ETG (Natural England, 28 November 2022)	The Project propose that little gull and common tern should only be considered for migratory collision risk. Natural England confirm they are happy for little gull and common tern to only be considered for migratory collision risk.	Information regarding this can be found in Section 12.9.
Offshore Ornithology and Derogation and Compensation ETG (Natural England, 28 November 2022)	The project proposes it will retrospectively apply the new avoidance rates to previous projects for the cumulative impact assessment in the future, though at this stage new avoidance rates have only been applied for the Project alone impacts. Natural England now support the use of the stochastic CRM (sCRM, McGregor *et al.*, 2018) as per the draft updated Collision Risk Modelling parameters. With regards to applying variance within the flight height distributions, Natural England advise the project to use the default option within the application, which uses the Johnston (2014) bootstrap samples to draw from in the simulation.	This advice has been noted. Information can be found in Section 12.9 and Volume 3, Appendix 12.2: Collision Risk Modelling Assessment Appendix (document reference 6.3.12.2).
Offshore Ornithology and Derogation and Compensation ETG (Natural England, 28 November 2022)	The project states that the most appropriate guidance is being used for assessments on gannet, using interim avoidance rate guidance for collision risk and published Natural England advice for the displacement analysis. The	This has been included within the assessments in Section 12.9 and Volume 3, Appendix 12.2: Collision Risk Modelling Assessment Appendix (document reference 6.3.12.2).

Date and consultation phase/type	Consultation and key issues raised	Section where comment addressed
	Project intends to adjust the avoidance rates to include macro avoidance post CRM. Natural England agree that the approach is suitable.	
Offshore Ornithology and Derogation and Compensation ETG (Natural England, 28 November 2022)	The project proposes that Sandwich tern is screened in for collision but not for displacement. Natural England agree with the project that Sandwich tern is screened in for collision but not for displacement	This methodology has been agreed and is assessed in Section 12.9.
Offshore Ornithology and Derogation and Compensation ETG (Natural England, 28 November 2022)	The project proposes that Fulmar are screened out of assessments. Natural England advises that justifications for screening out Fulmar should be clear, whether screened out as no likely significant effect (LSE) or if screened in and concluded as no AEoI (Adverse Effect to Integrity).	Clear justification has been provided in Section 12.9. A similar justification has been provided for Manx shearwater in Section 12.9.
Offshore Ornithology and Derogation and Compensation ETG (Natural England, 28 November 2022)	Natural England confirmed that kittiwake should not be considered for displacement impacts.	Kittiwake is only assessed for collision risk within the ES.
Offshore Ornithology and Derogation and Compensation ETG (Natural England, 27th March 2023)	Interim guidance from Natural England (Natural England, 2022) on avoidance rates to be used. This document also includes guidance on suggested nocturnal activity factors, flights speeds.	This has been included within the assessments in Section 12.9 and Volume 3, Appendix 12.2: Collision Risk Modelling Assessment Appendix (document 6.3.12.2).
Offshore Ornithology and Derogation and Compensation ETG (Natural England, 27th March 2023)	Confirmed that the CRM results for a range of WTG options will be presented at PEIR for both 30m and 40m MSL.	For ES, the Project has commitment to an air gap of 40m above MSL. The CRM results are presented in an Annex to Volume 3, Appendix 12.2: Collision

Date and consultation phase/type	Consultation and key issues raised	Section where comment addressed
		Risk Modelling Assessment Appendix (document 6.3.12.2).
Offshore Ornithology and Derogation and Compensation ETG (Natural England, 27th March 2023)	Natural England confirmed that the Lawson *et al.,* 2016 dataset for red-throated diver and common scoter densities within the Greater Wash SPA is still the most appropriate dataset to use in PEIR. However, there may be an update to this report by ES submission.	Data extracted from Lawson *et al.,* 2016 has been used to inform the displacement assessment for red-throated diver and common scoter within the ECC (Volume 3, Appendix 12.3: Displacement Assessment Appendix) (document 6.3.12.3).
Outer Dowsing/ Natural England Avian Influenza Workshop (Natural England, 29th March 2023)	Natural England requested to review all DAS survey data to date within the technical baseline but confirmed that all the data from DAS could be used at PEIR.	All 30-months of available DAS data were used within the assessments at ES: Volume 3, Appendix 12.1: Intertidal and Offshore Ornithology Technical Baseline; Volume 3, Appendix 12.2: Collision Risk Modelling Appendix; Volume 3, Appendix 12.3: Displacement Assessment Appendix (document 6.3.12.1, 6.3.12.2, and 6.3.12.3 respectively). Natural England are aware that these data have been used for these assessments.
Offshore Ornithology and Derogation and Compensation ETG (Natural England, 20th November 2023)	The Project sought guidance on Natural England's preferred approach to CRM, including the most appropriate tool to use for modelling, macro-avoidance and avoidance rates, and the use of bootstrapped densities.	The Applicant has presented results from the Applicant's approach, and where different, from Natural England's preferred approach as well.
Offshore Ornithology and Derogation and Compensation workshop (Natural England and The Planning Inspectorate), 9th January 2024)	The applicant sought clarification from Natural England on the use of the migratory collision risk model (MCRM) tool. Natural England advised that as the MCRM tool is based on the Stochlab CRM tool, which is still under review, they cannot endorse the use of	The Migropath tool has been used to model migratory collision risk, as described in section 12.4.

Date and consultation phase/type	Consultation and key issues raised	Section where comment addressed
	the MCRM tool alone for migratory collision risk.	
Offshore Ornithology and Derogation and Compensation workshop (Natural England and The Planning Inspectorate), 9th January 2024)	The Applicant sought guidance from Natural England on the populations to use as context for impact assessment. The Applicant has supplied their suggested populations to Natural England	Natural England have provided preferred reference populations, and populations used in impact assessment are in line with those provided by Natural England (Table 12.8).
Offshore Ornithology and Derogation and Compensation workshop (Natural England and The Planning Inspectorate), 9th January 2024)	The Applicant sought guidance on Natural England's preferred demographic rates. Natural England noted that the planned update to Horswill and Robinson (2015) will not be available prior to submission. It was advised that the applicant should use demographic rates accepted by Natural England at a recently submitted project, e.g. Sheringham and Dudgeon Extension Projects (SEP and DEP).	The demographic rates agreed with Natural England for SEP and DEP were used where appropriate. However, it was necessary to calculate average mortalities for some species where there was a lack of clarity in the numbers produced by SEP and DEP (Table 12.9).
Offshore Ornithology and Derogation and Compensation workshop (Natural England and The Planning Inspectorate), 9th January 2024)	The Applicant sought guidance on Natural England's advice on cumulative numbers. It was advised that the applicant should use numbers accepted by Natural England for SEP and DEP (Deadline 8).	The SEP and DEP (Deadline 8) numbers were used where appropriate, though for more recent projects not included in this source, they were also added.
Offshore Ornithology and Derogation and Compensation workshop (Natural England and The Planning Inspectorate), 9th January 2024)	The Applicant sought guidance on thresholds for 'no material contribution' to additions to baseline mortality. For context, the Applicant has provided some impacts it considers to make 'no material contribution' Natural England have advised that due to complexities with population trends and conservation status,	This is noted by the Applicant.

Date and consultation phase/type	Consultation and key issues raised	Section where comment addressed
	simple thresholds for conclusion of 'no material contribution' are not provided.	
Offshore Ornithology Assessment methodology (Natural England, 3rd September 2024)	ORBA site-selection. The Applicant confirmed that a reduction in environmental impacts, specifically displacement of auks, was the driver to identify areas for the ORBA. The Applicant identified hotspots and areas of high density to allow for the greatest impact reduction.	Discussed in section 12.8.1 and section 12.9.1 of this document.
Offshore Ornithology Assessment methodology (Natural England, 17th January 2025)	Discussion primarily focused on resolving assessment methodology and discussing views on the possible impact to red-throated diver during operation.	Discussed in section 12.8.1 and section 12.9.1 of this document.

18. As identified in Volume 1, Chapter 4 – Site Selection and Consideration of Alternatives (document reference 6.1.4) and Volume 1, Chapter 3 – Project Description (document reference 6.1.3), the Project Design Envelope has been refined and finalised. This process has taken account of stakeholder consultation feedback.

12.4 Baseline Environment

12.4.1 Study Area

19. The Project is located in the southern North Sea, with WTGs positioned at their closest point approximately 54km east of the Lincolnshire coast and 57km north of the Norfolk coast (Figure 12.1). The proposed array area covers 436km^2. The intertidal and offshore ornithology study area for the Project is defined as the offshore part of the ECC together with the Zones of Influence (ZoIs) and is based on an area which is considered to represent a realistic maximum spatial extent of potential impacts to Important Ornithological Features (IOFs). The study area for the offshore and intertidal ornithology assessment includes the agreement for lease (AfL) array area with a 4km buffer, the offshore ECC and the cable landfall area, as well as the areas for the provision of ANSs, ORCPs and biogenic reef (Figure 12.1). There was no DAS data collection from ANS areas, or locations for ORCPs as impacts were considered likely to be negligible. The study area has been reviewed and amended in response to the refinement of the array area, and stakeholder consultation.
20. The intertidal area and related assessments consider IOFs using the habitat between MHWS and MLWS while recognising that some IOFs may nest or roost on the shore above the MHWS.

12.4.2 Data Sources

21. The key sources of data presented in Table 12.4 have been used as the basis for the ES baseline characterisation.

Table 12.4: Key sources of information for intertidal and offshore ornithology

Source	Date	Summary	Coverage of study area
Existing project survey data			
Digital aerial survey data	2021 – 2023	Digital aerial surveys conducted by HiDef Digital Aerial Surveying Ltd. On a monthly basis between March 2021 and August 2023, with two surveys per month between March and August 2022. Details presented in the Technical Baseline report (Volume 3, Appendix 12.1: Offshore and Intertidal Ornithology Technical Baseline).	AfL array area plus 4km buffer. A total of 22 transects with 1.5km spacing totalling 16.7% coverage using two cameras. It should be noted that the ornithology study area encompasses the final array area plus a 4km buffer. Therefore the data presented in this report is primarily based on this reduced area, not the full AfL area plus 4km buffer, unless otherwise stated.
Intertidal bird surveys	2022/23	Intertidal bird surveys have taken place at the selected landfall site. For further information see Appendix 22.3: Winter Bird Survey Report 2022/2023.	Data cover the intertidal area and immediate onshore area of the landfall.
Kittiwake census on offshore structures	July 2022 and 2023	Ornithological census of 19 offshore oil and gas platforms within 20 km of the project AfL array area was carried out by RSK Biocensus, commissioned by the Applicant. The primary aim of the census was to quantify the number of birds breeding on offshore structures in proximity to the Project AfL array area. For further information see Annex D of Volume 3, Appendix 12.1: Offshore and Intertidal Ornithology Technical Baseline	All oil and gas platforms within 20km of The Project AfL Array Area.
Publicly available datasets			

Source	Date	Summary	Coverage of study area
Existing offshore windfarm 'grey literature'	Various dates	Information obtained from various offshore windfarm Environmental Statements (e.g. Hornsea 1, 2, 3 and 4, Triton Knoll, Sheringham Shoal, Dudgeon, Race Bank etc.).	Includes data in the ECC as well as context across the broader region for the array area.
Designated sites	Various dates	Information of Special Protection Areas (SPAs) and other designations relevant to Important Ornithological Features (IOFs) with potential connectivity to the Project. Key source of information will be Natural England designated sites portal.	Country wide information on designated sites.
British Trust for Ornithology (BTO) Non-Estuarine Waterbird Surveys (NEWS)	1984 – 2016	NEWS provides recordings focused on intertidal habitats along the UK coastline. These were conducted in 1984/1985, 1997/98, 2006/07 and 2015/16.	Covers part of the nearshore ECC.
BTO Wetland Bird Survey (WeBS)	Annual Reports	Annual survey reports of wetland waterbirds. Most recent being Frost *et al.*, (2020).	UK intertidal and wetland zones. Source contains information which can be drawn upon at a project-specific scale, or a wider regional scale.
National Bird Atlas (Balmer *et al.*, 2013)	2007-2011	Results of five years of breeding season and wintering surveys across the UK at a 10km resolution.	The ECC overlaps with 20km squares.
Local/County bird reports and atlases	Annual Reports	County atlases covering breeding and non-breeding birds within the surrounding east coast counties. Annual publications produced by local birdwatching groups which summarise sightings and surveys results for East Lincolnshire and the wider north-east coast region.	Coverage across region at various intertidal and wetland and coastal areas.
Wildfowl and Wetlands Trust – Aerial surveys of waterbirds in the UK	2004-2009	Aerial surveys of waterbirds around the UK.	Coverage of inshore waters relevant to the Project from survey grids GW4, GW8, GW9, and GW10.
Literature			

Source	Date	Summary	Coverage of study area
Potential impacts of offshore windfarms on birds	Various dates	Peer reviewed scientific literature regarding the potential impacts from OWF e.g. (Garthe and Hüppop, 2004; Drewitt and Langston, 2006; Stienen *et al.*, 2007; Speakman *et al.*, 2009; Langston, 2010; Band, 2012; Cook et al., 2012; Furness and Wade, 2012; Wright et al., 2012; Furness et al., 2013; Johnston *et al.*, 2014a,b; Cook *et al.*, 2014; Dierschke *et al.*, 2016; SNCB, 2017 (updated 2022); Cook *et al.,* 2018; Jarrett *et al.*, 2018; Leopold and Verdaat, 2018; Mendel *et al.*, 2019; Goodale and Milman, 2020);	Generic information applicable to Project IOFs.
Bird distribution	Various dates	Publicly available reports of seabird distribution e.g. Stone *et al.*, 1995; Brown and Grice, 2005; Kober *et al.*, 2010; Waggitt *et al.*, 2019; Cleasby *et al.*, 2020; Bradbury *et al.*, 2014; Davies *et al.*, 2021.	UK wide coverage with information that can be drawn upon at a project-specific scale or a wider regional scale.
Bird breeding ecology	Various dates	Information on the breeding ecology of various bird species e.g. Cramp and Simmons, 1977-94; Del Hoyo *et al.*, 1992-2011; Robinson, 2005.	Generic information applicable to Project IOFs.
Bird population estimates and demographic rates	Various dates	Data on seabird populations and demographic rates for use in assessments e.g. Burnell *et al* 2023; BirdLife International, 2004; Holling *et al.*, 2011; Frost *et al.*, 2019; Musgrove *et al.*, 2013; Furness, 2015; Horswill *et al.*, 2017, JNCC, 2020.	These sources contain information which can be drawn upon at a project-specific scale, or a wider regional scale.
Bird migration and foraging movements	Various dates	Bird movements during breeding season foraging trips and migration e.g. Wernham *et al.*, 2002; Thaxter *et al.*, 2012; Wright *et al.*, 2012; Furness *et al.*, 2018; Woodward *et al.*, 2019; Wakefield *et al.*, 2017; Wakefield *et al.*, 2013; RSPB FAME and STAR tracking data.	These sources contain information which can be drawn upon at a project-specific scale, or a wider regional scale.
OWF Assessment guidance	Various dates	Publications on OWF best practice for assessments e.g. Parker *et al.,* 2022; MIG-Birds, 2022; Natural England, 2022a; CIEEM, 2019.	These sources contain guidance relevant to the ornithological assessments undertaken in coastal waters off England.

12.4.3 Existing Environment

22. Following an initial desk-based review of the data sources identified in Table 12.4 the distribution, abundance, conservation status, biological seasons, behaviour, and characteristics of birds in the offshore and intertidal environment have been used to characterise the study area for the purposes of this ES.
23. Previous literature and surveys demonstrate that the southern North Sea provides an important habitat for numerous bird species throughout the year. The results from previous offshore windfarm baseline surveys (e.g. Hornsea Projects 1, 2, 3, and 4 and the Dudgeon and Sheringham Shoal Extension Projects); evaluations conducted for their Environmental Statements and monitoring reports; extensive ornithological surveys (e.g. Stone *et al*., 1995); bird tracking studies (e.g. Frederiksen *et al*., 2012; Woodward *et al*., 2019); biogeographic population reviews (e.g. Stienen *et al*., 2007; Furness, 2015); and the analysis of population distribution (e.g. Bradbury *et al*., 2014; Wakefield *et al*., 2017) provide evidence for this.
24. During the breeding season, the southern North Sea region provides habitat for a range of seabirds, including (but not limited to) gannet, *Morus bassanus*, kittiwake, *Rissa tridactyla*, and various species of auk. During the non-breeding season, the region supports numerous species; divers and seaducks generally reside in more inshore waters, while auks are found further offshore. The southern North Sea also hosts a pronounced passage of birds during spring and autumn with species such as gannet, skuas, gulls, terns, and auks travelling between breeding and non-breeding areas (Stienen *et al*., 2007). It is also subject to migratory movements of terrestrial birds moving from the UK to and from mainland Europe or further afield such as waders, wildfowl, and passerines. Due to the mix of birds present, it is probable that the proposed array area and offshore ECC is used at different times of the year by birds (i) overwintering in the area; (ii) foraging from nearby coastal breeding colonies; and (iii) on post-breeding dispersal and pre-breeding return migration.
25. HiDef Digital Aerial Surveying Ltd. Have undertaken 30 months of digital aerial surveys (DAS) for the Project, with surveys commencing in March 2021 and completed in August 2023, with two surveys per month between March and September 2022. These surveys provide the most detailed and up-to-date site-specific data on birds within the project area. These seabird population data have been summarised for the AfL array area, 2km buffer and the 4km buffer in the Technical Baseline report (Volume 3, Appendix 12.1: Offshore and Intertidal Ornithology Technical Baseline) to provide an initial insight into key species likely to be present at the Project. A list of key species recorded during DAS, and therefore most likely to be considered IOFs, is presented in Table 12.5 along with their relevant nature conservation value. A full list of species recorded during the DAS and detailed information on their frequency and abundances is available in Volume 3, Appendix 12.1: Offshore and Intertidal Ornithology Technical Baseline.

26. ANS areas and locations of ORCP are offshore and as such may host a similar suite of species as the array area, but species sensitive to displacement are most likely to be impacted. One ORCP will be located within the Greater Wash SPA, which lists red-throated diver and common scoter as features. Impacts will be assessed for the C&D phase and anticipated impacts (from displacement/disturbance resulting from vessel traffic) will be small due to low numbers of vessel clusters used, low numbers of birds anticipated (each structure will be within a 10 km buffer from other OWF projects and as such, numbers of birds are expected to be low as a result), and the lack of overlap between the construction period for these structures and for the array. Monitoring of ANS will not contribute impact as monitoring will be carried out in the breeding season, during which the most sensitive species will be on breeding grounds and not using the area.

Table 12.5: Species conservation value for current key IOFs

Species	Nature Conservation Value
Common scoter	BoCC5 Red listed, Birds Directive Migratory Species, International Union for Conservation of Nature (IUCN) Red List 'Least Concern' status
Kittiwake	BoCC5 Red listed, Birds Directive Migratory Species, IUCN Red List 'Vulnerable' status
Great black-backed gull	BoCC5 Amber listed, Birds Directive Migratory Species, IUCN Red List 'Least Concern' status
Herring gull	BoCC5 Red listed, Birds Directive Migratory Species, IUCN Red List 'Least Concern' status
Lesser black-backed gull	BoCC5 Amber listed, Birds Directive Migratory Species, IUCN Red List 'Least Concern' status
Little gull	BoCC5 Green listed, Birds Directive Migratory Species, IUCN Red List 'Least Concern' status
Sandwich tern	BoCC5 Amber listed, Birds Directive Annex I, Migratory Species, IUCN Red List 'Least Concern' status
Common tern	BoCC5 Amber listed, Birds Directive Migratory Species, IUCN Red List 'Least Concern' status
Guillemot	BoCC5 Amber listed, Birds Directive Migratory Species, IUCN Red List 'Least Concern' status
Razorbill	BoCC5 Amber listed, Birds Directive Migratory Species, IUCN Red List 'Least Concern' status
Puffin	BoCC5 Red listed, Birds Directive Migratory Species, IUCN Red List 'Vulnerable' status
Red-throated diver	Birds of Conservation Concern Five (BoCC5) (Stanbury *et al.*, 2021) Green listed, Birds Directive Migratory Species, Birds Directive Annex I, International Union for Conservation of Nature (IUCN) Red List 'Least Concern'
Gannet	BoCC5 Amber listed, Birds Directive Migratory Species, IUCN Red List 'Least Concern' status

27. Several bird species are also likely to be reliant on the intertidal habitats in the vicinity of the cable landfall and the nearshore parts of the ECC. The intertidal environment of the Lincolnshire coast is dominated by mobile, sandy beaches backed by low, soft cliffs and sand dunes and is an area of active erosion. The Lincolnshire coast is bounded by the Humber Estuary to the north and The Wash to the south. Intertidal areas of both the Wash and Humber are important habitat for wading birds. However, the coastline between the two lacks any significant areas of intertidal estuary or muddy habitats. As a result, habitat and food resources for intertidal birds are limited and the populations of birds using the coast is known to be relatively low in comparison to other intertidal locations from the BTO NEWS survey data. Intertidal bird surveys have taken place throughout the winter of 2022/2023 at the selected landfall site.

28. For this ES, a review of the BTO NEWS survey data covering the area of interest in the vicinity of the offshore export cable landfall is summarised in Table 12.6. Although the survey area covers a larger region than the surrounding coastline, the data provide an indication of bird species present within the intertidal area over a prolonged period and enable the identification of the potential key species to be included within the assessment.

Table 12.6: Population estimates from BTO winter NEWS survey 2015/16. See Austin *et al.* (2017).

Species	Count	Population estimate	Nationally important (>1%)
Mute swan	41	41 (0-123)	No
Mallard	38	37 (0-79)	No
Common scoter	80	80 (0-160)	No
Great crested grebe	1	1 (0-3)	No
Oystercatcher	69	68 (4-169)	No
Ringed plover	23	18 (2-48)	No
Curlew	96	96 (0-288)	No
Bar-tailed godwit	5	5 (0-15)	No
Turnstone	6	6 (0-18)	No
Sanderling	132	124 (51-238)	No
Dunlin	1	1 (0-3)	No
Redshank	19	19 (0-57)	No
Black-headed gull	577	539 (266-810)	No
Common gull	450	414 (161-668)	No
Mediterranean gull	1	1 (0-3)	No
Great black-backed gull	80	76 (44-107)	No
Herring gull	752	686 (356-1,249)	No
Lesser black-backed gull	7	6 (1-11)	No
Red-throated diver	6	5 (2-11)	No
Great northern diver	1	1 (0-3)	No
Cormorant	55	54 (2-126)	No

Designated Sites

29. The impact assessment has considered potential connectivity of the Project with those statutory designated sites for nature conservation which have birds listed as qualifying features. Four classes of statutory designated sites have been considered: SPAs, potential Special Protection Areas (pSPAs), Ramsar sites and Sites of Special Scientific Interest (SSSI). Sites which may have qualifying features with connectivity to the Project include those designated for breeding seabirds, wintering birds and those for terrestrial, coastal or marine bird interests (typically migratory and/or non-breeding aggregations).
30. The ECC directly overlaps with the Greater Wash SPA which is designated for breeding terns and wintering red-throated diver and common scoter. Additionally, as breeding and migratory seabirds can travel significant distances it is necessary to consider designated sites beyond the study area. The extent of connectivity between relevant designated sites and offshore windfarms during the breeding season is largely a function of distance and species-specific foraging ranges (i.e. those identified in the review by Woodward *et al.* (2019). Outside the breeding season patterns of migration are used to infer the origins of species recorded. Terrestrial/coastal sites designated for migrant species outside the breeding season may therefore be connected on the grounds of passage movements through the site.
31. Full consideration of connectivity of European and Internationally designated sites (SPAs and Ramsar sites) is provided in a separate HRA Report to Inform Appropriate Assessment (Part 7, Document 7.1), and covers in more detail matters associated with the National Site Network. The RIAA has been discussed with relevant stakeholders throughout the pre-application phase, with the HRA developed in parallel with the EIA process.
32. For the EIA specifically, a review of SSSIs (often overlapping in extent with SPAs and Ramsar sites) has been undertaken to consider potential connectivity with the Project.
33. The key sites identified in relation to ornithological interest (based on proximity to the Project and designated features) are as follows:

- **The Flamborough and Filey Coast (FFC) SPA** ;
- **The Greater Wash;**
- **The Wash SPA;**
- **Humber Estuary SPA; and**
- **North Norfolk Coast SPA.**
- **Flamborough Head Site of Special Scientific Interest** (SSSI) is approximately 318ha in area, encompassing terrestrial and coastal habitats. The area of the SSSI extends beyond the area of the FFC SPA as its interest features include grassland habitats and geological features but it does not extend beyond mean low water. The notified bird interest features are breeding fulmar, gannet, kittiwake, guillemot, razorbill and puffin.
- **Hornsea Mere** SSSI and SPA is a terrestrial wetland site noted for its large concentration of little gull that use this site in the late summer to wash and preen. These little gull will feed in the offshore environment and are an interest feature of the Greater Wash SPA. Little gull is not an interest feature of the Hornsea Mere SSSI nor the Hornsea Mere SPA.

12.4.4 Future Baseline

34. The current baseline description above provides an accurate reflection of the current state of the existing environment. However, the assessment of impacts on offshore ornithology has also been carried out taking account of the range of pressures which are currently having an effect, and will continue to have an effect, on ornithological receptors in the North Sea and beyond.

35. Key anthropogenic pressures driving variation in seabird population sizes are considered prey availability, bycatch, invasive alien species, disturbance and displacement, collision risk and pollution (Dias *et al*., 2019; Mitchell *et al*., 2020; Royal HaskoningDHV, 2019). However, the most significant driver of population change is considered to be climate change, which is impacting seabirds both directly through impacts such as mortality or reduced breeding success due to extreme weather events, and indirectly such as through impacts on prey availability. Considering currently reported direct impacts, it is apparent that seabirds are susceptible to substantial population-level impacts arising from poor weather and extreme weather events (Daunt *et al*. 2017; Daunt and Mitchell, 2013; Jenouvrier, 2013; Mitchell *et al*. 2020; Morley *et al*., 2016; Newell *et al*., 2015). Indirect impacts are also reported, with seabirds reported struggling to find sufficient food for chicks as breeding season temperatures rise (Brander *et al*. 2016), alongside a range of reported interactions between prey availability and climate change (Lindegren *et al*., 2018; MacDonald *et al*., 2019, 2018, 2015; Régnier *et al*., 2019; Sandvik *et al*., 2012, 2005; Wright *et al*., 2018). Notably the impacts will vary spatially, for example prey recruitment in some areas may be less impacted (ClimeFish, 2019; Frederiksen *et al*. 2005). However, impacts are generally expected to increase in severity with increased incidences of warming and extreme weather predicted in climate models (Palmer *et al*. 2018), and therefore it is expected that impacts on seabirds will similarly increase in both frequency and magnitude.

36. Anthropogenic impacts on ornithological receptors vary greatly by geographic region. For example, the Common Fisheries Policy (CFP) Landings Obligation will reduce food supply for scavenging birds such as great black-backed gull, lesser black-backed gull, herring gull, fulmar, kittiwake and gannet, with impacts expected to be greater in areas where food supply is already limited (Votier *et al*., 2004; Bicknell *et al*., 2013; Votier *et al*., 2013; Foster *et al.* 2017). Additionally, in the North Sea, the most important prey fish stock for seabirds during the breeding season is sandeel (Furness and Tasker 2000). However, the North Sea stocks of this species have been significantly depleted by high levels of fishing, and in spite of the recent closure of the North Sea fishery are considered unlikely to recover fully because climate change has altered the North Sea food web to the detriment of productivity of fish populations (Dulvy *et al*., 2008; Hiddink *et al*., 2015). Seabirds in the North Sea are therefore expected to see continued food shortages and consequent population impacts, especially those that rely more heavily on sandeels, although the severity of these shortages are likely to be somewhat reduced by the closure of the sandeel fishery.

37. It is acknowledged that the short, medium and long-term impacts of recent highly pathogenic avian influenza (HPAI) outbreaks on seabird colony abundance and vital rates (productivity and survival) are unclear, though impacts are expected to be present from ~June 2022 onwards (Natural England, 2022b). However, based on abundance data presented within Volume 3, Appendix 12.1: Offshore and Intertidal Ornithology Technical Baseline, there are currently no clear impacts on the number of birds recorded. For example, in the summer months of 2022 where two surveys per month were undertaken, the variation between the data from the two surveys within the same month was often greater than that between the same month across two years. To ensure full consideration is given to the potential impacts of HPAI, the Applicant has been in consultation with Natural England and has agreed that there is no justification for excluding data at this stage (Section 12.3).
38. With the earliest expected date for the start of the offshore construction of the Project being 2026, with an expected operational life of approximately 35 years, there exists potential for the baseline environment to evolve between the time of assessment and the point of impact. However, any large-scale changes in baseline in relation to offshore ornithology usually occur over an extended period, and therefore the baseline is not anticipated to have fundamentally changed from its current state at the point in time when impacts occur.
39. Considering information presented in this section, the impact assessment will be carried out in a context of declining baseline populations for a number of species, taking into account whether a given impact is likely to exacerbate a decline and prevent a species from recovery should environmental conditions become more favourable. Though it is also noted that climate change has been identified as the strongest influence on future seabird population trends (Dias *et al.* 2019; Mitchell *et al.* 2020), and a key component of global strategies to combat climate change is the development of low-carbon renewable energy developments such as offshore windfarms.

12.5 Description of the Changes from the Assessment Scenarios in the Original ES Submission

40. The introduction of the ORBA is a positive design solution with one of its aims to reduce the Project's ornithological impacts to guillemot (which subsequently had reduction in potential impacts for other displacement risk species within the array area).
41. The location and size of the ORBA was decided using various factors. MRSea based analysis was used to generate estimates of distribution and abundance, underpinned by observations of guillemot recorded in the DAS imagery (Scott-Hayward *et al.,* 2014). This produced month by month density distribution mapping for the period March 2021 to August 2023 that identified hotspots within the Array area plus 2 km buffer.
42. There was some commonality in the hotspots between the 2021 and 2022 surveys with denser concentrations of guillemots recorded in the north and east of the area of interest (Fig 3.1 – 3.4 MRSea Technical Appendix 15.9G) particularly within the months of April and August both in 2021 and 2022.

43. The MRSea data (document reference15.9G) strongly agreed with the design-based density estimates, which also show a general pattern of higher densities of guillemot and razorbill to the north of the array area (see Figures 12.33 - 12.35 and 12.39 - 12.41 of the Offshore Restricted Build Area and Revision to the Offshore Export Cable Corridor Ornithology Baseline Summary (document reference 15.9D)).
44. The introduction and size of the ORBA has been made possible through continued engagement with the relevant oil and gas operators who have interests which overlap with the Project, i.e. due to the presence of oil and gas platforms within or adjacent to the array area. Since the Application, the Applicant has been able to agree the principles for co-existence between the Project and access arrangements to the Malory platform with Perenco, specifically for helicopter transfers to and from this platform. Confidence in the likely final protective provisions for this operator within the DCO for the Project has therefore allowed further engineering work to be undertaken to support additional mitigation of the impact to auk species through a reduction in the area within which WTGs and OPs may be placed.
45. The introduction of the ORBA has resulted in a reduction in the summed mean seasonal peak abundance of guillemot from 27,653.3 birds in the array area plus 2 km buffer (Appendix 12.1 Offshore and Intertidal Ornithology Technical Baseline (AS1-064)) to a summed mean seasonal peak abundance of 23,586 guillemot in the array area minus the ORBA plus 2 km buffer (Appendix 15.9D).
46. The introduction of the ORBA also results in a reduction of the area within which WTGs and OPs will be installed, and as a consequence, the density of WTGs within this area has increased. Therefore, re-modelling of both collision risk modelling (CRM) and displacement effects is required. A reassessment of effects from these impacts combined (i.e. for gannet) is also required to review the previous conclusions.
47. The proposed introduction of the ORBA reduces the area in which WTGs and OPs will be placed. The modification to the offshore ECC removes consideration of the northern ORCP area (and cabling through the northern route of the ECC). Although there is no change to the species identified within the baseline, the densities and abundances of species within the area subject to the impacts of displacement and collision risk during the operational phase has changed. An updated Offshore and Intertidal Ornithology Technical Baseline has therefore also been provided (document reference 15.9D).
48. The densities and abundances within the array area minus the ORBA, have been updated and used within the accompanying modelling, which includes:

- Displacement modelling (technical reporting and results in full presented in Appendix 15.9F); and;
- CRM (technical reporting, input parameters, and results in full presented in Appendix 15.9E).

49. The Applicant has received a Relevant Representation (RR) (RR-045) from Natural England which provides clarifications regarding the methodology to be used to set out "Natural England's Approach" to the impacts within the ES. The approach to the assessments largely remains the same as was presented within the ES (AS1-040). For example, the sensitivity scores of all species assessed remains the same (AS1-040). However, the updates requested by Natural England, including confirmation of guillemot bio-seasons, have been included within this report and associated appendices 15.9D and 15.9F. Additionally, the modelling used herein has been updated to incorporate the new guidance on Demographic rates issued to Round 4 Developers in March 2024 and Interim CRM guidance published by the JNCC and Natural England on 15th August 2024 (JNCC *et al*., 2024).

50. The introduction of the ORBA and the modifications to the offshore ECC do not change those species previously considered as scoped out of the assessment. As both changes are effectively a reduction in area, there is no requirement to consider other impact pathways or new species within the assessment. Due to their nature, Impact 3: Indirect impacts on IOFs due to effects on prey species and Impact 8: Habitat loss- Array area and Offshore ECC do not need to be reconsidered because they were assessed fully within the ES Chapter.

12.5.1 Biological Seasons, Populations and Demographics for Offshore Ornithology Receptors

51. The abundance and behaviour of ornithological receptors will vary across the calendar year depending on the biological seasons (bio-seasons) that apply to different species. In this ES, separate bio-seasons are defined to establish the importance of the study area for different seabird species across different time periods. The biologically defined minimum population scales (BDMPS) bio-seasons are based on Furness (2015), and hereafter referred to as 'bio-seasons', in accordance with guidance in Parker *et al.* (2022).

52. Within this ES, six bio-seasons are defined: return migration, migration-free breeding, post-breeding migration, migration-free winter, non-breeding, and breeding. These bio-seasons can be applied on a monthly basis to different periods within the annual cycle for most seabird species, though not all five are applicable for all species depending on the species-specific biology and life-history:

- Return migration: when birds are migrating from non-breeding to breeding grounds;
- Migration-free breeding: when birds are only attending colonies, nesting and provisioning young;
- Post-breeding migration: when birds are either migrating to wintering areas or dispersing from colonies;
- Migration-free winter: when non-breeding birds are only over-wintering in an area;
- Non-breeding: extended bio-season from modal departure from the colony at the end of breeding to modal return to the colony the following year; and
- Breeding: extended bio-season from modal arrival of breeding birds to the colony to modal departure from the colony.

53. The bio-seasons and non-breeding season reference populations (UK North Sea and English Channel) applied to species assessed within this ES are outlined in Table 12.7, with bio-seasons and population estimates based on Furness (2015) unless stated otherwise. Notably, bio-seasons for little gull were based on Cramp and Simmons (1983) and expert judgement based on data presented in Volume 3, Appendix 12.1: Offshore and Intertidal Ornithology Technical Baseline. Breeding bio-season populations are presented in Table 12.8.

54. As a precautionary approach, the full breeding bio-season was used (as opposed to the migration-free breeding bio-season) for all species. Where non-breeding bio-season months overlapped with the breeding season, these were assigned to the breeding season.

Table 12.7: Bio-seasons used for assessment of key species for the Project based on Furness (2015).

Species	Migration-free breeding	Post-breeding migration	Return migration	Migration-free winter	Breeding	Non-breeding
Kittiwake	May-Jul	Sep-Dec	Jan-Feb	-	Mar-Aug	-
GBBG	-	-	-	-	Apr-Aug	Sep-Mar
Herring gull	-	-	-	-	Mar-Aug	Sep-Feb
Lesser Black-Backed Gull (LBBG)	May-Jul	Sep-Oct	Mar	Nov-Feb	Apr-Aug	-
Little gull[1]	-	Jul – Oct	-	-	May-Jun	Jul-April
Sandwich tern	Jun	Sep	Mar-Apr	-	May-Aug	-
Common tern	Jun	Sep	Apr	-	May-Aug	-
Arctic tern	Jun	Sep	Apr	-	May-Aug	-
Guillemot	-	-	-	-	Mar-Jul	Aug-Feb
Razorbill	Apr-Jun	Aug-Oct	Jan-Mar	Nov-Dec	Apr-Jul	-
Puffin	-	-	-	-	Apr-Jul	Aug-Mar
RTD	-	-	-	-	May – Aug	Sept – Apr
Gannet	Apr-Aug	Sep-Nov	Dec-Mar	-	-	-

55. As advised in recent Natural England guidance (Parker et al., 2022), and during consultation (Section 12.3) the regional population of each species during the breeding season was calculated by summing the breeding population located within the relevant regional BDMPS defined in Furness (2015) that the project sits within plus non-breeders and immature birds. In the case of Outer Dowsing this is generally the UK North Sea or UK North Sea and Channel BDMPS.

56. In addition to breeding birds, there will be additional juvenile and immature birds present during the breeding season. As a proportion of juvenile and immature birds are considered to remain within their wintering areas (whether connected to regional breeding colonies or not), the number of individuals present was calculated by adjusting the breeding individuals by the ratio of adults to immatures provided in Furness (2015). The defined seasonal populations are presented in Table 12.8.

57. Red-throated divers recorded within the array area during the breeding season are not considered to be breeding individuals because the Project is substantially beyond the mean max foraging range (plus 1 standard deviation (SD)) of any breeding birds. It was assumed that these were migratory birds, non-breeders or sabbaticals, and therefore the migration BDMPS was used for the assessment of birds in the breeding season. For little gull and common tern, no value is provided since these species are assessed on migration only, as agreed during the Evidence Plan Process (EPP) (Paragraph 1). See Consultation 12.3 for more detail.

Table 12.8: Regional bio-season populations (calculated from or defined by Furness *et al.,* (2015) plus additional juveniles and immature birds.

Species	Breeding season BDMPS	Autumn/post-breeding BDMPS	Winter/non-breeding BDMPS	Spring/pre-breeding BDMPS
Kittiwake	839,456	829,938	-	627,814
Great black-backed gull	25,917	-	91,398	-
Herring gull	324,887	-	466,510	-
Lesser black-backed gull	51,233	209,006	39,313	197,482
Sandwich tern	31,629	38,050	-	38,050
Common tern	28,753	144,900	-	144,900
Guillemot	2,045,078	-	1,617,305	-
Razorbill	158,031	591,875	218,621	591,875
Puffin	868,689	-	231,958	-
Red-throated diver	-	13,276	-	13,276
Gannet	400,326	456,299	-	248,385

58. When defining populations for EIA scale impacts Natural England currently recommend using the largest appropriate spatial scale during the non-breeding season, when birds are generally expected to represent a mix from the included colonies.

59. To assess the potential impact of the Project to seabird populations, the additional mortality was assessed against the baseline mortality rate for each species within each recognised bio-season. The average mortality across all age classes for each species is presented in Table 12.9. The method presented assumes that the risk of possible impacts of the proposed development is equal across all age classes, and as such the baseline mortality is a weighted average based on all age classes. To calculate the expected stable proportions in each age class for each species, demographic data from Horswill and Robinson (2015) were used. Each age class survival rate was then multiplied by its stable age proportion and the total for all ages summed to give the weighted average survival rate converted to an average mortality rate.

Table 12.9: 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	5-6	Adult		
Common scoter	Demographic rate	0.749	0.783	0.783	-	-	-	0.783	1.838	0.228
	Population age ratio	0.268	0.198	0.140	-	-	-	0.395		
Kittiwake	Demographic rate	0.790	0.854	0.854	0.854	-	-	0.854	0.690	0.158
	Population age ratio	0.155	0.123	0.105	0.089	-	-	0.530		
Great black-backed gull	Demographic rate	0.815	0.815	0.815	0.815	-	-	0.885	0.530	0.097
	Population age ratio	0.137	0.112	0.935	0.076	-	-	0.581		
Herring gull	Demographic rate	0.798	0.834	0.834	0.834	-	-	0.834	0.920	0.172
	Population age ratio	0.178	0.141	0.117	0.097	-	-	0.467		
Lesser black-backed gull	Demographic rate	0.820	0.885	0.885	0.885	-	-	0.885	0.530	0.124
	Population age ratio	0.134	0.109	0.095	0.083	-	-	0.579		
Little gull	Demographic rate	0.800	0.800	-	-	-	-	0.800	0.625	0.200
	Population age ratio	0.175	0.145	-	-	-	-	0.680		
Sandwich tern	Demographic rate	0.358	0.741	0.741	0.741	-	-	0.898	0.702	0.245
	Population age ratio	0.200	0.063	0.063	0.063	-	-	0.610		
Common tern	Demographic rate	0.441	0.441	0.850	-	-	-	0.883	0.764	0.173
	Population age ratio	0.233	0.103	0.048	-	-	-	0.626		
Guillemot	Demographic rate	0.560	0.792	0.917	0.939	0.939	-	0.939	0.672	0.141
	Population age ratio	0.168	0.091	0.069	0.062	0.056	-	0.496		
Razorbill	Demographic rate	0.630	0.63	0.895	0.895	-	-	0.895	0.570	0.130
	Population age ratio	0.159	0.102	0.065	0.059	-	-	0.613		

Species	Parameter	Survival (age class)							Productivity	Average mortality
		0-1	1-2	2-3	3-4	4-5	5-6	Adult		
Puffin	Demographic rate	0.709	0.709	0.760	0.805	-	-	0.906	0.617	0.119
	Population age ratio	0.162	0.115	0.082	0.063	-	-	0.577		
Red-throated diver	Demographic rate	0.600	0.620	-	-	-	-	0.840	0.571	0.228
	Population age ratio	0.179	0.145	-	-	-	-	0.676		
Gannet	Demographic rate	0.424	0.829	0.891	0.895	-	-	0.912	0.700	0.187
	Population age ratio	0.191	0.081	0.067	0.060	-	-	0.600		

12.6 Basis of Assessment

12.6.1 Scope of the Assessment

Impacts Scoped in for Assessment

60. The following impacts have been scoped into this assessment following Natural England's best practice advice (Parker *et al*., 2022). Impacts that have been scoped out are presented in paragraph 61:

- Construction:
  - Impact 1: Disturbance and displacement: Offshore ECC and ORCPs;
  - Impact 2: Disturbance and displacement: Array area[1]; and
  - Impact 3: Indirect impacts on IOFs due to effects on prey species habitat loss: Array area and Offshore ECC.
- O&M:
  - Impact 4: Disturbance and displacement: Array area[1], Offshore ECC and ORCPs;
  - Impact 5: Collision risk: Array area;
  - Impact 6: Collision risk to migratory birds: Array area; and
  - Impact 7: Indirect impacts on IOFs due to impacts on prey species habitat loss: Array area, ORCP and offshore ECC.
- Decommissioning:
  - Impact 8: Disturbance and displacement: Array area;
  - Impact 9: Disturbance and displacement: Offshore ECC and ORCPs; and
  - Impact 10: Indirect impacts on IOFs due to impacts on prey species habitat loss.

Impacts Scoped out of Assessment

61. In line with the Scoping Opinion (The Planning Inspectorate, 2022)[2], and based on the receiving environment, expected parameters of the Project (Volume 1, Chapter 3: Project Description), and expected scale of impact/potential for a pathway for effect on the environment, the following impacts have been scoped out of the assessment:

- Construction phase:
  - Disturbance and displacement: Intertidal ECC, ANS and biogenic reefs;
- O&M phase:

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[1] Consideration of barrier effects is incorporated within this impact.

[2] It is noted that the ANS and biogenic reef were not included within the scoping report, and therefore not commented on within the Scoping Opinion.

- Disturbance and displacement: Intertidal ECC, ANS and biogenic reefs;
- Lit structures; and
- Decommissioning phase:
  - Disturbance and displacement: Intertidal ECC, ANS and biogenic reefs.

Barrier effects

62. During all phases of the Project, the presence of WTG (both operational and during construction/decommissioning) could create a barrier to the movement of flying seabirds. However, with the Project being located >50km offshore it is considered highly likely to be outside of the core foraging range of most seabird species. Therefore, individual birds of most species are highly unlikely to be making daily commutes past and around the windfarm. As such, the potential for impacts resulting from barrier effects is highly unlikely at the location of the Project.
63. Any impacts resulting from barrier effects are quantified within the displacement assessment. Both flying birds and birds on the water are considered in this displacement assessment as recommended by SNCBs in their latest guidance (MIG-Birds, 2022), and from Natural England (Parker *et al*., 2022). The inclusion of sitting birds within the analysis provides for an assessment of those potentially displaced from an area of sea they reside, whilst the inclusion of flying birds provides for an assessment of potential barrier effects to birds moving through the area of interest.
64. These documents outline the methodology for determining impacts from displacement and barrier effects, with the approach agreed through the EPP consultation and Scoping Opinion as the most appropriate method to assess these impacts. Considering the displacement assessment for the Project has considered both sitting and flying birds, it is considered that any impacts relating to barrier effects have therefore been recognised and accounted for within the assessment, with no further consideration needed as a result of barrier effects as an impact alone.

Disturbance and displacement: intertidal ECC, ANS areas and biogenic reefs (Construction and O&M phase)

65. The Project has committed to HDD at landfall, so no intertidal works are planned during construction. The horizontal directional drilling (HDD) exit pits will be a design target of 500m below MLWS and therefore not considered to result in any pathway of effect to the intertidal. Consequently, the main disturbance impact at landfall will be from vessel disturbance at the exit pit, and therefore it has been assessed as part of the consideration of impacts from activities within the offshore ECC.

66. Eight species were detected in excess of 50 times during intertidal surveys. These included several gull species including black-headed gull (174), common gull (308) and herring gull (68). Gull species have a low risk to displacement impacts (Bradbury *et al.,* 2014), and are often found aggregating around vessels as opposed to being displaced by them. Common gull, herring gull and black-headed gull, the most commonly recorded gull species, have large foraging ranges and therefore displacement from a restricted area will not result in any measurable impacts to these species.
67. Common scoter are particularly sensitive to vessel disturbance and were detected in moderate numbers (140 observations) over the 14 intertidal vantage point surveys. However, the risk to common scoter is considered to be low because works undertaken at the exit pit will be highly localised and carried out over a short time period. Any vessel disturbance is considered to be sufficiently covered within the ECC (which includes the ORCP) displacement assessment, which accounts for vessel activity using common scoter densities in the ECC from Lawson *et al*. (2016) during the full construction period.
68. Four wader species were also observed in moderate numbers during intertidal vantage point surveys including wigeon (533), golden plover (57), curlew (60) and sanderling (84), none of which are considered to be vulnerable to displacement impacts (Bradbury *et al.,* 2014).
69. Likewise, during the O&M phase it is considered unlikely that regular maintenance would be taking place in the intertidal ECC and therefore disturbance will be minimal. When any activity is present in the nearshore Offshore ECC during the operational phase, best practice measures will be adopted (as set out within the Outline Vessel Management Plan (document reference 8.20)), thereby minimising disturbance during key times for intertidal birds and is therefore **negligible**.
70. For the ANS and biogenic reef areas, disturbance and displacement impacts are considered to be minimal due to the low level of vessel traffic associated with their construction (a single vessel cluster). Impacts during the O&M phase are based on the passage of maintenance vessels, with impacts anticipated to be infrequent and reversable. Presence of the most sensitive species (i.e. common scoter and red-throated diver) will be restricted to the non-breeding season, so there will be no impacts from vessels carrying out monitoring of seabirds on ANS in the breeding season. Potential disturbance is therefore **negligible**.

Lit structures

71. The presence of illuminated structures has the potential to impact birds, acting both as a deterrent to some species and an attractant to others. When deterred, this drives a change in flight directions and acts in line with effects resulting from displacement. An attractant effect may increase the likelihood of bird collisions and result in displacement-level impacts due to alterations in flight path.
72. Of the seabird species likely to be present in the largest numbers (fulmar, gannet, kittiwake, and auk species), most birds are unlikely to be active at night, either returning to colonies overnight or roosting on the sea surface (Wade *et al*., 2016).

73. A tracking study by Furness *et al*. (2018) reported that gannet flight and diving activity was minimal during the night. Gulls are likely to have low to moderate levels of nocturnal activity, being visual foragers that are known to be attracted to lit fishing vessels and well-lit oil and gas platforms that attract fish to the surface waters (Burke *et al*., 2012). However, Kotzerka *et al*. (2010) reported that kittiwake foraging trips mainly occurred during daylight and birds were mostly inactive during the night and therefore at lower risk. Fulmar and Manx shearwater is given a relatively high nocturnal activity rate, however very few flights are likely to be at collision risk height (Wade *et al*., 2016).
74. On migration, there could be potential for impacts if large numbers of birds pass through the site, leading to disorientation or collisions. However, there is insufficient evidence from current literature or any existing UK OWFs to suggest mass collision events occur because of aviation and navigation lighting at UK OWFs. Evidence from Welcker *et al*. (2017) and Kerlinger *et al*. (2010) found nocturnal migrants do not have a higher risk of collision with wind energy facilities than diurnally active species, nor do mortality rates increase at OWFs with lighting compared to those without. Furthermore, studies have shown that nocturnal flight is altered to counteract the risk of WTG collision as birds tend to fly down the centre of corridors, further away from the structures (Dirksen *et al*., 2000; Desholm and Kahlert, 2005). Therefore, the potential magnitude of impact from lighting is considered to be **negligible.**

12.6.2 Maximum Design Scenario (MDS)

75. The following section (Table 12.10:) identifies the MDS in environmental terms, defined by the Project Design Envelope.

Table 12.10: Maximum design scenario for Intertidal and Offshore Ornithology for the Project alone

Potential effect	Maximum design scenario assessed	Justification
Construction phase		
Impact 1: Disturbance and displacement: Offshore ECC and ORCPs.	Construction Vessels within ECC: ▪ 3 cable laying vessels (20 return trips); ▪ 3 cable jointing vessels (16 return trips); ▪ 3 cable burial vessels (16 return tips); ▪ 16 support vessels (1,070 return trips); ▪ 16 helicopter return trips; and ▪ Single phase of offshore construction over approximately four years.	The assumption is that vessels would be in situ from start to finish, so any disturbance events would be throughout entire period.
Impact 2: Disturbance, displacement and barrier effects: Array area.	Construction Vessels/Helicopters within Array Area: ▪ Up to 10 construction vessels in a 5km^2 area at any one time; ▪ Single phase of offshore construction over approximately 4 years. WTG Installation: ▪ Up to 2 installation vessels (Jack-Up Vessels (JUV) or anchored) (47 return trips); ▪ Up to 18 support vessels (1376 return trips); ▪ Up to 10 transport vessels (140 return trips); and ▪ Up to 176 helicopter return trips. WTG Foundation Installation: ▪ 3 installation vessels (40 return trips); ▪ 10 support vessels (50 return trips); ▪ 8 transport/feeder vessels (including tugs) (372 return trips);	The maximum estimated number of development areas within the array area with vessels operating concurrently would cause the greatest disturbance to birds on site.

Potential effect	Maximum design scenario assessed	Justification
	▪ 8 anchored transport/feeder vessels (including tugs) (372 return trips); ▪ 93 helicopter return trips. Offshore Substation (OSS) and Accommodation Platform Installation: ▪ Up to 2 installation vessels (JUV or anchored) (24 return trips); ▪ Up to 12 support vessels (96 return trips); ▪ Up to 4 transport vessels (48 return trips); and ▪ Up to 40 helicopter return trips. OSS and Accommodation Platform Foundation Installation: ▪ 2 installation vessels, (16 return trips); ▪ 12 support vessels (48 return trips); ▪ 4 transport/feeder vessels (including tugs) (32 return trips); ▪ 28 helicopter return trips. Array and Interlink Cable Installation: ▪ 3 main cable laying vessels (22 return trips); ▪ 2 main cable burial vessels (16 return trips); ▪ 14 support vessels (1022 return trips); and ▪ 22 helicopter return trips.	
Impact 3: Indirect impacts on IOFs due to effects on prey species habitat loss: Array area, Offshore ECC and ORCP.	See MDS for Fish and Shellfish Ecology assessment (Volume 1, Chapter 10 – Fish and Shellfish Ecology) and for the Benthic and Intertidal Ecology assessment (Volume 1, Chapter 9 – Benthic Subtidal and Intertidal Ecology).	Indirect effects on birds could occur through changes to any of the species and habitats considered within the Fish and Shellfish Ecology or Benthic and Intertidal Ecology assessments.

Potential effect	Maximum design scenario assessed	Justification
		The maximum indirect impact on birds would result from the maximum direct impact on fish, shellfish and benthic species and habitats. The maximum design scenario is therefore as per justifications in Volume 1, Chapter 10 – Fish and Shellfish Ecology and Volume 1, Chapter 9 – Benthic Subtidal and Intertidal Ecology.
O&M		
Impact 4: Disturbance and displacement: Array area, Offshore ECC and ORCPs.	Array Area: ▪ WTG deployment across the full array area (365km^2). WTGs: ▪ Up to 100 WTGs; O&M: ▪ 1,339 vessel return trips to WTGs per year; ▪ 409 vessel return trips to WTG foundations per year; ▪ 55 vessel return trips to offshore platforms (structural scope) per year; ▪ 115 vessel return trips to offshore platforms (electrical scope) per year; ▪ 388 crew transfer shifts per year; ▪ A total of 2,480 total vessel return trips per year. The same number is considered for helicopter return trips per year; and	Displacement would be assumed from the entire array area that contains WTGs and other associated structures, which maximises the potential for disturbance and displacement. Displacement is also assessed from presence of ORCP Assessment of the extent/varying displacement from the array area and a buffer is species specific due to sensitivity levels.

Potential effect	Maximum design scenario assessed	Justification
	▪ Vessels include: CTVs, service operation vessels, supply vessels, cable and remedial protection vessels, and JUVs.	
Impact 5: Collision risk: WTG area.	WTG Area: ▪ WTG deployment across the full array area (365km^2) area. WTGs: ▪ 100 WTGs; ▪ Minimum height of lowest blade tip above MSL: 40m; and ▪ Rotor blade diameter: 236m.	This represents the maximum number of the largest WTGs, which represents the greatest total swept area to be considered for collision risk.
Impact 6: Collision risk to migratory birds: WTG area.	WTG Area: ▪ WTG deployment across the full array area (365km^2) area. WTGs: ▪ Up to 100 WTGs; ▪ Maximum rotor blade diameter: 236m.	This represents the maximum number of the largest WTGs, which represents the greatest total swept area to be considered for collision risk.
Impact 7: Indirect impacts on IOFs due to impacts on prey species habitat loss: Array area, ORCP and ECC.	See MDS for Fish and Shellfish Ecology assessment (Volume 1, Chapter 10 - Fish and Shellfish Ecology) and for the Benthic and Intertidal Ecology assessment (Volume 1, Chapter 9 – Benthic Subtidal and Intertidal Ecology).	Indirect effects on birds could occur through changes to any of the species and habitats considered within the Fish and Shellfish Ecology or Benthic and Intertidal Ecology assessments. The maximum indirect impact on birds would result from the maximum direct impact on fish, shellfish and benthic species and habitats. The maximum design scenario is therefore as per justifications in Volume 1, Chapter 10 - Fish and Shellfish

Potential effect	Maximum design scenario assessed	Justification
		Ecology) and Volume 1, Chapter 9 – Benthic Subtidal and Intertidal Ecology.
Decommissioning phase		
Impact 8: Disturbance and displacement: Array area.	MDS is identical (or less) to that of the construction phase.	MDS is identical (or less) to that of the construction phase.
Impact 9: Disturbance and displacement: Offshore ECC and ORCPs.	MDS is identical (or less) to that of the construction phase.	MDS is identical (or less) to that of the construction phase.
Impact 10: Indirect impacts on IOFs due to impacts on prey species habitat loss: ECC and ORCPs.	See MDS for Fish and Shellfish Ecology assessment (Volume 1, Chapter 10 - Fish and Shellfish Ecology) and for the Benthic and Intertidal Ecology assessment (Volume 1, Chapter 9 – Benthic Subtidal and Intertidal Ecology).	Indirect effects on birds could occur through changes to any of the species and habitats considered within the Fish and Shellfish Ecology or Benthic and Intertidal Ecology assessments. The maximum indirect impact on birds would result from the maximum direct impact on fish, shellfish and benthic species and habitats. The maximum design scenario is therefore as per justifications in Volume 1, Chapter 10 - Fish and Shellfish Ecology) and Volume 1, Chapter 9 - Benthic Subtidal and Intertidal Ecology.

12.6.3 Embedded Mitigation

76. Mitigation measures that have been identified and adopted as part of the evolution of the Project design (embedded into the Project design) and that are relevant to Intertidal and Offshore Ornithology are listed in Table 12.11:. Only mitigation measures that would apply specifically to Intertidal and Offshore Ornithology issues associated with the study area are described.

Table 12.11: Embedded mitigation relating to Intertidal and Offshore Ornithology

Parameter	Mitigation measures embedded into the Project design
Site selection	The Order Limits selection was made following a series of constraints analyses, with the AfL array area, ORCP area, the array area, ANS and benthic compensation areas and Offshore ECC route selected to ensure the impacts on sensitive environmental receptors are minimised. As detailed in the Site Selection and Consideration of Alternatives chapter (Volume 1, Chapter 4 (document reference 6.1.4), the array area reduction from the 500km^2 AfL array area to the 436 km^2 ES array area took into account the densities of bird species across the array, in particular areas of high density for auks.
Minimum tip height	The design of the Project includes an air gap of 40m relative to MSL, being above the minimum air gap (22 m relative to MHWS (MCA, 2021)). Increasing the minimum tip height reduces the number of bird collisions.
Best practice protocol	Best practice protocol will be utilised during construction, operation and maintenance and decommissioning works to minimise disturbance of offshore ornithological receptors, especially red-throated divers and common scoter, through the following: ▪ Where possible, minimising vessel traffic during the most sensitive time in October to March; ▪ Where possible, restricting vessel movement to existing navigation routes; ▪ Where possible, maintaining direct transit routes, minimising transit distances through areas used by key species; ▪ Avoidance of rafting birds when necessary to go outside of navigational routes, and where possible avoid disturbance to areas with consistently high diver density; ▪ Avoidance of over-revving engines to minimise noise disturbance; and ▪ Briefing of vessel crew on the purpose and implications of these vessel management practices.
Seasonal restriction for construction within the Greater Wash SPA	The Project has committed to avoid construction activities within the Greater Wash SPA during the period 1st November – 31st March (inclusive) of any year.

12.7 Assessment Methodology

77. The criteria for determining the significance of effects is a two-stage process that involves defining the sensitivity of the receptors and the magnitude of the impacts. This section describes the criteria applied in this chapter to assign values to the sensitivity of receptors and the magnitude of potential impacts.
78. These criteria have been adapted to implement a specific methodology for offshore and intertidal ornithology. However, the general principles of determining potential impact significance from level of sensitivity of individual receptors and magnitude of effect are aligned with the key guidance on ecological impact assessments from CIEEM (2022) and the PD 6900:2015 Environmental impact assessment for offshore renewable energy projects - Guide (British Standards Institute 2015).
79. The assessment approach therefore follows the conceptual source-pathway-receptor model. This model identifies any likely environmental impacts on ornithology receptors resulting from the proposed construction, operation and decommissioning of the Project's offshore and intertidal infrastructure. This process enables an easy-to-follow assessment route between identified impact sources and potentially sensitive receptors, ensuring a transparent impact assessment. The parameters of this model are defined as follows:
    - Source – the origin of a potential impact (noting that one source may have several pathways and receptors), e.g. an activity such as cable installation and a resultant effect such as re-suspension of sediments.
    - Pathway – the means by which the effect of the activity could impact a receptor, e.g. for the example above, re-suspended sediment could settle and smother the seabed.
    - Receptor – the element of the receiving environment that is impacted, e.g. for the above example, bird prey species living on or in the seabed are unavailable to foraging birds.
80. The vulnerability of a receptor is one of the core components of the assessment of potential impacts and their effects on ornithological receptors. The conservation value of each receptor is also taken into account when coming to a reasoned judgement on the definition of the overall sensitivity of any receptor to any potential impact or effect. In that reasoned judgement account must be taken on a species-by-species basis noting that any particular species with a high conservation value may not be sensitive to a specific effect and vice versa. An example of this is herring gull that is an interest feature of some SPAs and has a conservation concern listing of 'Red' because of recent population declines but cannot be judged to be vulnerable to disturbance given its propensity to exploit a wide range of food resources and to utilise man-made resources even while considerable efforts are made to deter them. This reasoned judgement is an important part of the overall narrative used to determine the potential impact significance and can be used where relevant as a mechanism for modifying the sensitivity of an effect assigned to a specific receptor. The vulnerability of receptors is defined in Table 12.12:.

Table 12.12: Definitions of vulnerability levels of ornithological receptors

Receptor sensitivity/importance	Definition
Major	Bird species has very limited tolerance of sources of disturbance such as noise, light, vessel movements, and the sight of people.
Moderate	Bird species has limited tolerance of sources of disturbance such as noise, light, vessel movements, and the sight of people.
Minor	Bird species has some tolerance of sources of disturbance such as noise, light, vessel movements, and the sight of people.
Negligible	Bird species is generally tolerant of sources of disturbance such as noise, light, vessel movements, and the sight of people.

81. The population from which individuals are predicted to originate also contributes to the conservation value of ornithological receptors. Conservation value levels assigned to birds reflects the current understanding of movements of the relevant species, with site-based protection (e.g. SPAs) generally limited to specific time-periods (e.g. the breeding season). Conservation value can therefore vary throughout the year, depending on the relative sizes of the number of individuals predicted to be at risk of impact and the population from which they are estimated to be drawn. The conservation value assigned to a species will correspond to the degree of connectivity predicted between the proposed OWF, and protected populations. In Table 12.13: below, the criteria for defining conservation value are presented, with values assigned to species likely to vary throughout the year.

Table 12.13: Conservation value level definitions for ornithological receptors

Sensitivity	Definition used in this chapter
High	A species for which individuals at risk can be clearly connected to a particular SPA or is found in numbers of international importance within the Project array area.
Medium	A species for which individuals at risk are probably drawn from particular SPA populations or found in numbers of national importance within the Project array area, although other colonies (both SPA and non-SPA) may also contribute to individuals observed in the offshore and intertidal ornithology study area.
Low	A species for which it is not possible to identify in the SPAs and may be found in regionally or locally important numbers from which individuals on the windfarm have been drawn, or for which no SPAs are designated.

82. The overall sensitivity of ornithological receptors in the assessment is determined from expert judgement (CIEEM, 2019), based on both the vulnerability (Table 12.12:) and conservation value (Table 12.13:) of each receptor.

83. Impacts on receptors are also judged based on their magnitude, referring to the scale of an impact; this is determined on a quantitative basis where possible. The impact magnitude may relate, for example, to the area of habitat lost to the development footprint in the case of a habitat feature or predicted loss of individuals in the case of a population of a species of bird. Four levels are used to determine impact magnitude, detailed in Table 12.14: below.

Table 12.14: Impact magnitude definitions for an ornithological receptor

Magnitude	Description/reason
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 development 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 development activity.
Low	A change in the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site that is sufficiently small-scale or of short duration to cause no long-term harm to the feature/population. Recovery from that change predicted to be achieved in the short-term (i.e. no more than one year) following cessation of the development 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 development activity.

84. The potential significance of the effect upon ornithological receptors is determined by considering the magnitude of the impact (Table 12.14:) and the sensitivity of the receptor (Table 12.12:). The method used to determine effect significance is presented in Table below, and definitions of each level of significance in Table 12.16:. For the purposes of this assessment, any effects determined to have a significance level of 'minor' or less are deemed to be not significant in terms of the EIA Regulations.

Table 12.15: Matrix to determine effect significance

		Magnitude of impact			
		Negligible	*Low*	*Medium*	*High*
Sensitivity of receptor	*Negligible*	Negligible (Not significant)	Negligible (Not significant)	Minor (Not significant)	Minor (Not significant)
	Low	Negligible (Not significant)	Minor (Not significant)	Minor (Not significant)	Moderate (Significant)
	Medium	Minor (Not significant)	Minor (Not significant)	Moderate (Significant)	Major (Significant)
	High	Minor (Not significant)	Moderate (Significant)	Major (Significant)	Major (Significant)

85. The latest CIEEM guidance (CIEEM, 2022) suggests that, in addition to the matrix approach, conclusions should also incorporate expert judgement throughout the process. CIEEM also now suggests that some form of consideration should be provided in the confidence of assessments for each species/impact. This may be strong where evidence is agreed in terms of impact levels or when robust survey data is used within the assessments. Confidence in the assessment is deemed lower where, for example, there is less data or evidence underpinning the assessments.

Table 12.16: Definition of Impact Significance.

Impact Significance	Definition
Major	Very large or large change in receptor condition, either adverse or beneficial, which are likely to be important considerations at a regional or district level because they contribute 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 are likely to be important considerations at a local level.
Minor	Small change in receptor condition, which may be raised as local issues but are unlikely to be important in the decision-making process.
Negligible	No discernible change in receptor condition.

12.8 Impact Assessment: Construction phase

86. The impacts of the offshore construction of the Project have been assessed on offshore and intertidal ornithology. The impacts resulting from the construction of the Project are presented in Table 12.10:, along with the MDS which formed the basis of these impact assessment.

12.8.1 Disturbance and Displacement

87. During the construction phase of the Project, disturbance and subsequent potential displacement of seabirds may be caused by a range of drivers, including vessel movements (both major construction vessels and smaller crew transfer or support vessels), general WTG construction activities, and the physical presence of partially or wholly constructed but not operational WTGs or other installed infrastructure, though it is acknowledged that these are likely to be both spatially and temporally limited. As the construction phase progresses, more WTGs will be erected in the array area and the spatial scale will increase until a point when the entire array area is constructed, but not yet operational, and may present a similar displacement stimulus as is described for the O&M phase.
88. This section will consider both displacement within the array area and within the offshore ECC (which contain the ORCPs) for relevant species.
89. Displacement of individual birds from an area could theoretically, at an extreme level, lead to the mortality of individuals (Searle *et al*., 2018), though this is considered unlikely during the construction phase of an OWF as disturbing activities are spatially and temporally restricted.
90. The susceptibility of seabirds to displacement from construction activities varies between species. An overview of this variation is provided by Dierschke *et al.,* (2016), noting inter-species variation in both avoidance and attraction towards OWFs. Notably, guillemot, razorbill, puffin, common scoter and red-throated diver have all shown to exhibit behavioural responses to OWF construction activities and may be displaced as a consequence. Fulmar, gannet and gulls are not considered susceptible to disturbance since they are often associated with fishing boats (e.g. Camphuysen, 1995; Hüppop and Wurm, 2000), and have also been noted in association with both construction vessels at the Greater Gabbard Offshore Windfarm (GGOWL, 2011) and close to active foundation piling activity at the Egmond aan Zee (OWEZ) windfarm, where they showed no noticeable reactions to the works (Leopold and Camphuysen, 2007).

91. In order to identify species present within the Project array area and 4km buffer that may be susceptible to displacement and requiring further assessment, a screening process was undertaken. Species screened in/out are presented in Table 12.17:. These species have been agreed with stakeholders through the EPP (Table 12.3). The relative frequency and abundances for each species used in the screening process were assigned qualitatively through assessment of the baseline survey data. Generally, low frequency refers to species present within the study area on only one or slightly more than one occasion during the survey programme. Medium frequency was used to describe species routinely present in the aerial survey study area during a particular season, or with patchy abundance across multiple seasons, whilst the high frequency descriptor was reserved for species recorded on most or all surveys. The abundance descriptors were used to describe numbers of birds relative to the background population from which they likely originated. Modelled abundance and frequencies for each species can be found in Volume 3, Chapter 12.1: Offshore and Intertidal Ornithology Technical Baseline.

92. Species which were only recorded in low numbers and/or frequencies within the Project array area and 4km buffer or had a low sensitivity to disturbance and displacement were screened out of further assessment, with agreement from Natural England. For species screened into further assessment, matrix-based assessments of displacement were carried out.

Table 12.17: Screening of seabird species recorded within the Project array area and 4km buffer for risk of disturbance and displacement during the construction phase

Receptor	Sensitivity to disturbance and displacement **	Relative frequency in the array area and 4km buffer	Relative abundance in the array area and 4km buffer	Screening result (in or out)
Common scoter*	Major	Low	Low	In
Oystercatcher	Unknown	Low	Low	Out
Kittiwake	Minor	High	High	Out
Great black-backed gull	Negligible	Medium	Medium	Out
Herring gull	Negligible	Medium	Medium	Out
Lesser black-backed gull	Negligible	Medium	Medium	Out
Common gull	Minor	Medium	Low	Out
Little gull	Moderate	Low to Medium	Low	Out
Black-headed gull	Minor	Low to Medium	Low	Out
Sandwich tern	Minor	Low to Medium	Low to Medium	Out
Common tern	Minor	Low	Medium	Out
Arctic tern	Minor	Low	Low	Out

Receptor	Sensitivity to disturbance and displacement **	Relative frequency in the array area and 4km buffer	Relative abundance in the array area and 4km buffer	Screening result (in or out)
Arctic skua	Minor	Low	Low	Out
Great skua	Minor	Low	Low	Out
Guillemot	Moderate	High	High	In
Razorbill	Moderate	High	High	In
Puffin	Moderate	High	Medium to High	In
Little auk	Moderate	Low	Low	Out
Red-throated diver	Major	Medium	Low to Medium	In
Great northern diver	Major	Low	Low	Out
Manx shearwater	Moderate	Low	Low	Out
Fulmar	Minor	Medium	Low	Out
Gannet	Minor to Moderate	High	Medium	In
Shag	Negligible	Low	Low	Out

*Included for assessment in the ECC only. **Bradbury *et al*. (2014); Dierschke *et al*. (2016).

93. Based on the screening process outlined above, guillemot, razorbill, puffin and red-throated diver have been screened in for the array area owing to their sensitivity to disturbance and displacement and/or their abundance in the Project survey area. Therefore, these species are considered further in relation to impacts from disturbance and displacement during the construction phase of the Project.

94. Notably, gannet has been screened in for assessment of displacement in the array area despite showing low to medium sensitivity to displacement. This has been done on a precautionary basis as this species may be influenced by construction activities, and in order to provide Natural England and the RSPB with confidence that any potential effects on gannet during the construction phase are considered in a quantitative manner.

95. It is acknowledged that while kittiwake is considered for displacement risk in assessments for Scottish sites based on recent guidance (NatureScot, 2023), it is not considered at risk of displacement based on advice provided by Natural England through the EPP process. Additionally, although the sensitivity of fulmar and Manx shearwater to displacement is considered variable (i.e. low in Bradbury *et al*. (2014), but higher in Diserschke *et al*. (2016)), their large foraging range and habitat flexibility score (as defined by Woodward *et al*. (2019) and Furness *et al*. (2013)) suggest this species will not be impacted by displacement impacts resulting from the Project. Finally, although Sandwich tern has been considered at risk of displacement for other projects, the Project is located at the extent of the mean max foraging range plus 1 SD of this species from the North Norfolk Coast SPA, and therefore any impacts resulting from displacement are considered minimal. These species are, therefore, not considered further in relation to displacement effects during the construction phase.

96. This section also considers species at risk of displacement within the offshore ECC (containing the ORCP areas), since the Project ECC has an area of approximately 151.2km^2 which directly overlaps with the Greater Wash SPA. The Greater Wash SPA hosts two designated species which are considered sensitive to disturbance and displacement from vessel activity: red-throated diver and common scoter. Both of these species have been shown to be sensitive to vessels at a distance of up to 1km (Schwemmer *et al*., 2011; Bradbury *et al*., 2014). Red-throated diver is therefore considered in relation to potential impacts resulting from displacement in both the array area and in the Offshore ECC. Additionally, while common scoter was not recorded during the digital aerial surveys within the array area, they were screened in for disturbance within the Offshore ECC as a precautionary approach, owing to their high sensitivity to disturbance and displacement and the importance of the Greater Wash SPA for this species. This approach was agreed through the EPP (Section 12.3).

97. Risk of displacement from construction activities associated with the ORCPs is considered within the ECC assessment. Impacts are anticipated to result from vessel disturbance, with disturbance minimised due to the construction periods for these structures and the Array not overlapping. Many species considered for displacement are not sensitive to vessel disturbance (for example guillemot, razorbill and puffin), so displacement risk is confined to common scoter and red-throated diver. Impacts from displacement related to ORCP construction will be restricted to very low levels of vessel traffic (a single vessel cluster for the construction of the ORCPs), so impacts in areas where bird numbers are anticipated to be low already (as structures will be located within 10km buffers of other OWF projects) are anticipated to be very low indeed.

98. Following the screening process, an assessment of displacement has been carried out for the Project. The assessment has been based on the following set of scenarios and assumptions that recognise that construction activities will be both temporally and spatially restricted:

- Construction activities being undertaken within only a small portion of the array area and Offshore ECC at any one time;

- Potential displacement will only occur in the array area, ORCP and Offshore ECC, where vessels and construction activities are present; and
- Construction activities are temporally restricted (over a maximum of 48 months).

99. The potential impacts on screened in species are assessed against the MDS outlined in Table 12.10:. It should be noted that a large proportion of the ECC or ORCP areas was not covered within baseline digital aerial surveys, and therefore data provided by Lawson *et al*. (2016) have been used to assess the densities and distributions of red-throated diver and common scoter within in the Greater Wash SPA. This is a robust dataset collected over multiple years of survey and the best source of data available at this time.

100. There are few studies which have provided definitive empirical displacement rates for the construction phase of OWF developments. Krijgsveld *et al.,* (2011) demonstrated higher flight paths of gannet next to operating vs non-operating WTGs. Displacement rates for auks during construction have been shown to be either significantly lower or comparable to the O&M phase (Royal Haskoning, 2013; Vallejo *et al*., 2017). These studies suggest that although the level of disturbance from construction activities can be high it is focussed around a spatially restricted area within the development. Therefore, displacement rates for the entire site reflect reduced displacement within the site away from construction areas including areas where built non-operational WTGs are present.

101. For the assessment of displacement in the array area during the construction phase, displacement rates used were half of those used in the O&M phase based on SNCB guidance (MIG-Birds, 2022). This approach is biologically realistic based on the limited available evidence, while still providing a sufficiently precautionary approach. For a full justification of rates used, reference should be made to the assessment of the operational phase (Section 12.9). For gannet, guillemot, razorbill and puffin, displacement effects are considered within the array area and a 2km buffer, based on Natural England guidance (MIG-Birds, 2022). For red-throated diver, effects are considered within the array area and a 4km buffer. The level of displacement used during the construction phase for the species assessed is provided below:

- For gannet, a displacement rate of 35% is presented as the Applicant's approach, with a range of 30-40% also presented;
- For auk species (guillemot, razorbill and puffin), a displacement rate of 25% is presented as the Applicant's approach, with a range of 15-35% also presented; and
- For red-throated diver a displacement rate of 50% is presented, as well as a range of 45-50%.

102. For the assessment of displacement in the offshore ECC, displacement rates for red-throated diver and common scoter were not halved, with rates instead based on the full rates recommended by current guidance (MIG-Birds, 2022):

- For red-throated diver, a displacement rate of 100% is presented as the Applicants approach with a range of 90-100% also presented; and
- For common scoter, there are no rates specifically recommended for this species, however as a precautionary approach the same rates used for red-throated diver were applied.

103. A mortality rate of 1% is presented for all species as the Applicant's approach, however a range of 1-10% is also presented for auk species, and red-throated diver (and consequently also for common scoter) as recommended by SNCB guidance (MIG-Birds, 2022).

Common Scoter

Potential Magnitude of Effect – Offshore ECC and ORCPs

104. Based on data by Lawson *et al*. (2016), an average density of 0.004 and a maximum density of 0.029 common scoters per km^2 are estimated to be present within the Project ECC. Based on a 2km buffer around each of the three cable-laying vessels, the area disturbed per vessel was calculated to be 12.6km^2, resulting in a total worst-case area of 37.7km^2 from which birds could be displaced. This is considered a precautionary approach, since vessels are unlikely to be spaced 2km apart at a given time. ORCP construction is likely to be restricted to single vessel clusters, at different periods from cable laying, so disturbance from these activities is anticipated to be small scale, short term and temporary.

105. Since a regional BDMPS population for common scoter is not included in Furness (2015), the predicted impacts are assessed against the Greater Wash SPA citation count of 3,449 individuals, which is considered a precautionary approach since this represents only a proportion of the birds which may potentially have connectivity to the Project. Based on a mortality rate of 0.226 (Table 12.9) the baseline mortality for this population is 769.8 individuals per annum.

106. Based on the average density of 0.004 birds per km^2, and the total disturbance of area of 37.7km^2, less than one (0.1) common scoters are at risk of displacement. Of these, the total displacement consequent mortality is estimated at less than one (<0.001) individual, based on 100% displacement and 1% mortality. Considering a displacement range of 90% to 100% and a mortality range of 1% to 10%, the total displacement and consequent mortality is estimated as 0.001 to 0.01 birds. This would represent a <0.01% increase even at the worst-case scenario of 100% displacement and 10% mortality, and therefore the impact is considered negligible.

107. Even using the over-precautionary maximum density of 0.7 birds per km^2, this increases to a mortality estimate of only 0.01 individuals, based on 100% displacement and 1% mortality, or a range of 0.01 – 0.1 birds based on 90% displacement and 1% mortality, and 100% displacement and 10% mortality respectively, representing a 0.001% – 0.012% increase in baseline mortality. This further precautionary assessment is therefore also assessed as a negligible magnitude. However, the use of the average density is considered more biologically relevant while still being precautionary, and therefore this will form the main basis of the assessment. Additionally, densities of birds in the ECC and ORCP areas are anticipated to be lower than the densities described by Lawson *et al*. (2016), where these areas are now located within 10 km buffers of other OWF projects (e.g. Lincs OWF) which were not operational at the time the Lawson *et al*. (2016) dataset was collected. As such, displacement impacts from these activities are expected to be lower than those described for the ECC.

108. This level of change is considered to be of negligible magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall, as it represents no discernible change to baseline mortality. Given a magnitude change of negligible, and a sensitivity to disturbance and displacement of major, the significance of effect is therefore concluded to be **minor adverse, which is not significant in EIA terms.**

109. Confidence in the conclusions of this assessment is high, as the scale of the impact is very small, site-specific (albeit older) data are used, the assessment is precautionary due to the assumptions made regarding vessel traffic, precautionary maximum densities are used, and impacts are presented within the context of the Greater Wash SPA population, rather than a larger BDMPS population.

110. Since the submission of the ES, the Project have committed to avoid construction activities within the Greater Wash SPA during 1st November to 31st March (inclusive). This reduces the risk of any potential displacement activities from the ECC and ORCPs, and therefore there is no potential pathway for effect on common scoter.

Red-throated Diver

Potential Magnitude of Impact – Offshore ECC and ORCPs

111. In addition to the information presented in the O&M section (Section 12.9), red-throated diver are considered to be particularly sensitive to human activities which may be occurring during the construction phase, notably disturbance effects of vessel and helicopter traffic and the presence of WTGs (Garthe and Hüppop, 2004; Schwemmer *et al*., 2011; Furness and Wade, 2012; Furness *et al*., 2013; Bradbury *et al*., 2014).

112. Birds are reported to avoid areas associated with shipping (e.g. Bellebaum *et al*., 2006; Irwin *et al*., 2019; Jarrett *et al*., 2018; Schwemmer *et al*., 2011), with birds recorded flushing due to the presence of ships, when up to 2km from the vessels (Fliessback *et al.,* 2019), though the majority are expected to flush at 1km or less (Bellebaum *et al*., 2006; Jarrett *et al.,* 2018; Topping and Petersen, 2011). As a precautionary approach, 100% displacement up to 2km from each of the three cable laying vessels is considered in this assessment, with a range of 90% to 100% also presented in line with SNCB guidance (MIG-Birds, 2022).

113. Based on data on red-throated diver densities presented by Lawson *et al*. (2016), an average density of 0.2 birds/km^2 and a maximum density of 0.7 birds/km^2 are estimated to be present within the Offshore ECC (noting the ORCPs are within the ECC boundary). Based on a 2km buffer around each of three construction vessels, the area disturbed per vessel was calculated to be 12.6km^2. A worst-case scenario is based on three construction vessels operating at one time, resulting in a total worst-case area of 37.7km^2 from which birds could be displaced. This is considered a precautionary approach, since in reality vessels are unlikely to be spaced 2km apart at a given time, and there is also likely to be less than three vessels present at a time. ORCP construction is likely to be restricted to single vessel clusters, at different periods from cable laying, so disturbance from these activities is anticipated to be small scale, short term and temporary.

114. Based on the average density of 0.2 birds, and the total disturbance of area of 37.7km^2, a total of 9 (8.8) red-throated divers are at risk of displacement. Of these, the total displacement consequent mortality is estimated at less than one (0.1) individual, based on 100% displacement and 1% mortality. Considering a displacement range of 90% to 100% and a mortality range of 1% to 10%, the total displacement consequent mortality is estimated as 0.1 to 0.9 birds.

115. Based on the maximum density of 0.7 birds, this increases to a mortality estimate of 0.3 individuals, based on 100% displacement and 1% mortality, or a range of 0.2 – 2.6 birds based on 90% displacement and 1% mortality, and 100% displacement and 10% mortality respectively. However, the use of the average density is considered more biologically relevant while still being precautionary, and therefore this will form the main basis of the assessment. Additionally, densities of birds in the ECC and ORCP areas are anticipated to be lower than the densities described by Lawson *et al*. (2016), where these areas are now located within 10 km buffers of other OWF projects (e.g. Lincs OWF) which were not operational at the time the Lawson *et al*. (2016) dataset was collected. As such, displacement impacts from these activities are expected to be lower than those described for the ECC.

116. The annual BDMPS population is defined as 13,277 individuals and, using the average baseline mortality rate of 0.228 (Table 12.9), the natural predicted mortality is 3,027 individuals per annum. The addition of less than one (0.2) mortality would increase baseline mortality by 0.006%.

117. The annual bio-geographic population is defined as 27,000 individuals. Using the average baseline mortality rate of 0.228 (Table 12.9) the natural predicted mortality is 6,156 individuals per annum. The addition of less than one (0.2) mortality would increase baseline mortality by 0.003%.

118. This level of change is considered to be of negligible magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall, as it represents no discernible change to baseline mortality. Given a magnitude change of negligible, and a sensitivity to disturbance and displacement of major, the effect significance is considered **minor adverse, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:. However, due to the impact being well under a single bird, an effect significance of **negligible** can be assumed here.

119. Confidence in the conclusions of this assessment is high due to precautionary displacement parameters used, the site-specific data, and the use of a maximum density to calculate impacts.

120. Since the submission of the ES, the Project have committed to avoiding construction activities within the Greater Wash SPA during 1st November to 31st March (inclusive). This reduces the risk of any potential displacement activities from the ECC and ORCPs, and therefore there is not potential pathway for effect for red-throated diver.

Potential magnitude of impact – array area

121. A mortality rate of 1% and a displacement rate of 50% were chosen for assessment of construction displacement and disturbance impacts on red-throated diver within the array area, based on rates being half of those assessed for the O&M phase. Based on the range of displacement and mortality rates suggested by SNCBs, an additional range is presented in Table 12.18: using a mortality rate of 1% to 10% and displacement rate of 45% to 50%. However, the Applicant's approach of using a 1% mortality rate and 50% displacement for the construction phase will form the focus of the impact assessment. The magnitude of this impact is assessed against BDMPS and biogeographic populations (presented in Table 12.8) and relative to the baseline mortality values, which are based on age specific demographic rates and age class proportions presented in Table 12.9.

122. During the non-breeding bio-season, the mean peak abundance for red-throated diver is 180 (180.0) individuals within the array area plus 4km buffer. Using a displacement rate range of 50% and a mortality rate 1% results in less than 1 (0.90) red-throated diver being subject to mortality per annum. The regional population in the non-breeding bio-season is defined as 13,276 individuals and, using the average baseline mortality rate of 0.228 (Table 12.9), the natural predicted mortality in the migration-free winter bio-season is 3,023 individuals per annum. The addition of less than one predicted mortality per annum would increase baseline mortality by 0.030%.

123. This level of change is considered to be of negligible magnitude during the non-breeding bio-season, representing no discernible change to baseline mortality.

124. When considering displacement impacts at the wider biogeographic population scale, then of the 27,000 population the natural annual mortality rate would be 6,148 individuals per annum. The addition of less than one predicted mortality would increase the biogeographic baseline mortality rate by 0.015%.

125. Over the range of displacement and mortality scenarios assessed, the addition to baseline mortality remains below 1%, and can therefore be considered to make no material difference to the baseline mortality of the species.

126. This level of change is considered to be of negligible (not significant) magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall, as it represents no discernible change to baseline mortality. Given a magnitude change of negligible, and a sensitivity to disturbance and displacement of major (Bradbury *et al*., 2014), the significance of effect is therefore concluded to be **minor adverse, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:. However, due to the impact being under a single bird, an effect significance of **negligible** can be assumed here.

127. Confidence in the conclusions of this assessment is high due to precautionary displacement parameters used, the site-specific data, the low level of impact and the use of a maximum density to calculate impacts.

Table 12.18: Bio-season displacement estimates for red-throated diver for the Project (construction phase)

Bio-season (months)	Seasonal abundance (array area plus 4km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during construction phase.		Increase in baseline mortality (%) during construction phase.	
		Population	Baseline mortality	50% displacement, 1% mortality	45-50% displacement, 1-10% mortality	50% displacement, 1% mortality	45-50% displacement, 1-10% mortality
Non-breeding (Oct – Apr)	180	13,276	3,023	0.90	0.81 – 9.00	0.030	0.027 – 0.298
Annual (BDMPS)	180	13,276	3,023	0.90	0.81 – 9.00	0.030	0.027 – 0.298
Annual (biogeographic)	180	27,000	6,148	0.90	0.81 – 9.00	0.015	0.013 – 0.146

Guillemot

Potential magnitude of impact – array area

128. A mortality rate of 1% and a displacement rate of 25% were chosen for assessment of guillemot, based on rates being half of those assessed for the O&M phase (paragraph 92). Based on the range of displacement and mortality rates suggested by SNCBs, an additional range is presented in Table 12.19: using a mortality rate of 1% to 10% and displacement rate of 15% to 35%. However, the Applicant's approach of using a 1% mortality rate and 25% displacement for the construction phase will form the main focus of the impact assessment. The magnitude of this impact is assessed against BDMPS non-breeding season populations and breeding season populations (presented in Table 12.8) and relative to the baseline mortality values, which are based on age specific demographic rates and age class proportions presented in Table 12.9.

129. The Applicant's approach and Natural England's preferred approach both use model-based abundance estimates for the assessment within text, however the design-based abundance estimates are presented in Table 12.21 and Table 12.22.

Applicant's Approach

130. During the breeding bio-season, the mean peak abundance for guillemot is 11,364 individuals within the array area plus 2km buffer. Using a displacement rate of 25% and a mortality rate of 1% results in 28 (28.4) guillemot being subject to mortality during the breeding season per annum. The regional population in the breeding bio-season is defined as 2,045,078 individuals and, using the average baseline mortality rate of 0.14 (Table 12.19:), the natural predicted mortality in the breeding bio-season is 287,333 individuals per annum. The addition of 28 predicted mortalities per annum would increase baseline mortality by 0.010%.

131. This level of change is considered to be of negligible magnitude during the breeding bio-season, representing no discernible change to baseline mortality.

132. During the non-breeding bio-season, the mean peak abundance for guillemot is 9,066 individuals within the array area plus 2km buffer. Using a displacement rate of 25% and a mortality rate of 1% results in 23 (22.7) guillemot being subject to mortality during the non-breeding season per annum. The regional population in the non-breeding bio-season is defined as 1,617,305 individuals and, using the average baseline mortality rate of 0.14, the natural predicted mortality in the non-breeding bio-season is 227,231 individuals per annum. The addition of 23 predicted mortalities per annum would increase baseline mortality by 0.010%

133. This level of change is considered to be of negligible magnitude during the non-breeding bio-season, representing no discernible change to baseline mortality.

134. Across all bio-seasons combined, the total mean peak abundance for guillemot is 20,430 individuals. The predicted maximum number of guillemot subject to mortality due to displacement from the Project is 51 (51.1) individuals per annum, based on a displacement rate of 25% and a mortality rate of 1%. Using the largest UK North Sea and English Channel BDMPS of 2,045,078 individuals (Furness, 2015) and the average baseline mortality rate of 0.14, the natural predicted mortality across all seasons is 287,333 per annum. The addition of 51 predicted mortalities would increase the baseline mortality rate by 0.018%. When considering displacement impacts at the wider biogeographic population scale, then of the 4,125,000 population the natural annual mortality rate would be 579,563 individuals per annum. The addition of 51 predicted mortalities would increase the biogeographic baseline mortality rate by 0.009%.

Natural England's Approach

135. During the breeding bio-season, the mean peak abundance for guillemot is 11,364 individuals within the array area plus 2 km buffer. Using a displacement rate of 35% and a mortality rate of 2% results in 80 (79.5) guillemot being subject to mortality during the breeding season per annum. The regional population in the breeding bio-season is defined as 2,045,078 individuals and, using the average baseline mortality rate of 0.14 (Table 12.20), the natural predicted mortality in the breeding bio-season is 287,333 individuals per annum. The addition of 79.5 predicted mortalities per annum would increase baseline mortality by 0.028%.

136. This level of change is considered to be of negligible magnitude during the breeding bio-season, representing no discernible change to baseline mortality.

137. During the post-breeding bio-season, the mean peak abundance for guillemot is 9,066 individuals within the array area plus 2 km buffer. Using a displacement rate of 35% and a mortality rate of 2% results in 64 (63.5) guillemot being subject to mortality during the non-breeding season per annum. The regional population in the non-breeding bio-season is defined as 2,045,078 individuals and, using the average baseline mortality rate of 0.14, the natural predicted mortality in the non-breeding bio-season is 287,333 individuals per annum. The addition of 64 predicted mortalities per annum would increase baseline mortality by 0.022%.

138. This level of change is considered to be of negligible magnitude during the non-breeding bio-season, representing no discernible change to baseline mortality.

139. During the non-breeding bio-season, the mean peak abundance for guillemot is 4,279 individuals within the array area plus 2 km buffer. Using a displacement rate of 35% and a mortality rate of 2% results in 30 (29.9) guillemot being subject to mortality during the non-breeding season per annum. The regional population in the non-breeding bio-season is defined as 1,617,305 individuals and, using the average baseline mortality rate of 0.14, the natural predicted mortality in the non-breeding bio-season is 227,231 individuals per annum. The addition of 30 predicted mortalities per annum would increase baseline mortality by 0.013%.

140. This level of change is considered to be of negligible magnitude during the non-breeding bio-season, representing no discernible change to baseline mortality.

141. Across all bio-seasons combined, the total mean peak abundance for guillemot is 24,709 individuals. The predicted maximum number of guillemot subject to mortality due to displacement from the Project is 173 (173.0) individuals per annum, based on a displacement rate of 35% and a mortality rate of 2%. Using the largest UK North Sea and English Channel BDMPS of 2,045,078 individuals (Furness, 2015) and the average baseline mortality rate of 0.14, the natural predicted mortality across all seasons is 287,333 per annum. The addition of 173 predicted mortalities would increase the baseline mortality rate by 0.060%. When considering displacement impacts at the wider biogeographic population scale, then of the 4,125,000 population the natural annual mortality rate would be 579,563 individuals per annum. The addition of 173 predicted mortalities would increase the biogeographic baseline mortality rate by 0.030%.

142. Over the range of displacement and mortality scenarios assessed, the addition to baseline mortality remains well below 1% and can, therefore, be considered to make no material difference to the baseline mortality of this species.

143. This level of change is considered to be of negligible magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall, as it represents no discernible change to baseline mortality. Given a magnitude change of negligible, and a sensitivity to disturbance and displacement of moderate, the significance of effect is therefore concluded to be **minor adverse, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.16:.

144. Confidence in the conclusions of this assessment is high due to the site-specific data used in the assessment, the precautionary displacement and mortality rates used, and the temporary nature of the displacement at this phase.

Table 12.19: Bio-season displacement estimates for guillemot for the Project using model-based abundance estimates (Applicant's Approach) (construction phase)

Bio-season (months)	Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during construction phase.			Increase in baseline mortality (%) during construction phase.		
		Population	Baseline mortality	25% displacement, 1% mortality	35% displacement, 2% mortality	15-35% displacement, 1-10% mortality	25% displacement, 1% mortality	35% displacement, 2% mortality	15-35% displacement, 1-10% mortality
Breeding (Mar-Jul)	11,364	2,045,078	287,333	28.4	79.5	17.0 - 397.7	0.010	0.028	0.006 - 0.138
Non-breeding (Aug-Feb)	9,066	1,617,305	227,231	22.7	63.5	13.6 - 317.3	0.010	0.028	0.006 - 0.140
Annual (BDMPS)	20,430	2,045,078	287,333	51.1	143.0	30.6 - 715.1	0.018	0.050	0.011 - 0.249
Annual (biogeographic)	20,430	4,125,000	579,563	51.1	143.0	30.6 - 715.1	0.009	0.025	0.005 - 0.123

Table 12.20: Bio-season displacement estimates for guillemot for the Project using model-based abundance estimates (Natural England's Approach) (construction phase)

Bio-season (months)	Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during construction phase.			Increase in baseline mortality (%) during construction phase.		
		Population	Baseline mortality	25% displacement, 1% mortality	35% displacement, 2% mortality	15-35% displacement, 1-10% mortality	25% displacement, 1% mortality	35% displacement, 2% mortality	15-35% displacement, 1-10% mortality
Full Breeding (Mar-July)	11,364	2,045,078	287,333	28.4	79.5	17.0 - 397.7	0.010	0.028	0.006 - 0.138
Post-breeding (Aug-Sep)	9,066	2,045,078	287,333	22.7	63.5	13.6 - 317.3	0.008	0.022	0.005 - 0.110
Nonbreeding (Aug-Feb)	4,279	1,617,305	227,231	10.7	29.9	6.4 - 149.7	0.005	0.013	0.003 - 0.066
Annual (BDMPS)	24,709	2,045,078	287,333	61.8	173.0	37.1 - 864.8	0.021	0.060	0.013 - 0.301
Annual (biogeographic)	24,709	4,125,000	579,563	61.8	173.0	37.1 - 864.8	0.011	0.030	0.006 - 0.149

Table 12.21: Bio-season displacement estimates for guillemot for the Project using design-based abundance estimates (Applicant's Approach) (construction phase)

Bio-season (months)	Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during construction phase.			Increase in baseline mortality (%) during construction phase.		
		Population	Baseline mortality	25% displacement, 1% mortality	35% displacement, 2% mortality	15-35% displacement, 1-10% mortality	25% displacement, 1% mortality	35% displacement, 2% mortality	15-35% displacement, 1-10% mortality
Breeding (Mar-Jul)	14,371	2,045,078	287,333	35.9	100.6	21.6 - 503.0	0.013	0.035	0.008 - 0.175
Non-breeding (Aug-Feb)	9,215	1,617,305	227,231	23.0	64.5	13.8 - 322.5	0.010	0.028	0.006 - 0.142
Annual (BDMPS)	23,586	2,045,078	287,333	59.0	165.1	35.4 - 825.5	0.021	0.057	0.012 - 0.287
Annual (biogeographic)	23,586	4,125,000	579,563	59.0	165.1	35.4 - 825.5	0.010	0.028	0.006 - 0.142

Table 12.22: Bio-season displacement estimates for guillemot for the Project using design-based abundance estimates (Natural England's Approach) (construction phase).

Bio-season (months)	Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during construction phase.			Increase in baseline mortality (%) during construction phase.		
		Population	Baseline mortality	25% displacement, 1% mortality	35% displacement, 2% mortality	15-35% displacement, 1-10% mortality	25% displacement, 1% mortality	35% displacement, 2% mortality	15-35% displacement, 1-10% mortality
Full Breeding (Mar-July)	14,371	2,045,078	287,333	35.9	100.6	21.6 - 503.0	0.013	0.035	0.008 - 0.175
Post-breeding (Aug-Sep)	9,215	2,045,078	287,333	23.0	64.5	13.8 - 322.5	0.008	0.022	0.005 - 0.112
Nonbreeding (Aug-Feb)	4,349	1,617,305	227,231	10.9	30.4	6.5 - 152.2	0.005	0.013	0.003 - 0.067
Annual (BDMPS)	27,935	2,045,078	287,333	69.8	195.5	41.9 - 977.7	0.024	0.068	0.015 - 0.340
Annual (biogeographic)	27,935	4,125,000	579,563	69.8	195.5	41.9 - 977.7	0.012	0.034	0.007 - 0.169

Razorbill

Potential magnitude of impact – array area

145. A mortality rate of 1% and a displacement rate of 25% were chosen for assessment of razorbill, based on rates being half of those assessed for the O&M phase (paragraph 101). Based on the range of displacement and mortality rates suggested by SNCBs, an additional range is presented in Table 12.23: using a mortality rate of 1% to 10% and displacement rate of 15% to 35%. However, the Applicant's approach of using a 1% mortality rate and 25% displacement for the construction phase will form the main focus of the impact assessment. The magnitude of this impact is assessed against BDMPS non-breeding season populations and breeding season populations (presented in Table 12.8) and relative to the baseline mortality values, which are based on age specific demographic rates and age class proportions presented in Table 12.9.

146. During the return migration bio-season, the mean peak abundance for razorbill is 5,134 individuals within the array area plus 2km buffer. Using a displacement rate of 25% and a mortality rate 1% results in 13 (12.8) razorbill being subject to mortality during the return. migration bio-season per annum. The regional population in the return migration bio-season is defined as 591,875 individuals and, using the average baseline mortality rate of 0.13 (Table 12.9), the natural predicted mortality in the breeding bio-season is 77,062 individuals per annum. The addition of 13 predicted mortalities per annum would increase baseline mortality by 0.017%. Based on the Natural England preferred approach, using a displacement rate range of 35% and a mortality rate 2% results in 36 (35.9) razorbills being subject to mortality during the return migration bio-season per annum. This would increase baseline mortality by 0.047%.

147. This level of change is considered to be of negligible magnitude during the return migration bio-season, representing no discernible change to baseline mortality.

148. During the breeding bio-season, the mean peak abundance for razorbill is 3,159 individuals within the array area plus 2km buffer. Using a displacement rate of 25% and a mortality rate 1% results in eight (7.9) razorbill being subject to mortality during the breeding bio-season per annum. The regional population in the breeding bio-season is defined as 158,031 individuals and, using the average baseline mortality rate of 0.13, the natural predicted mortality in the breeding bio-season is 20,576 individuals per annum. The addition of eight predicted mortalities per annum would increase baseline mortality by 0.038%. Based on the Natural England preferred approach, using a displacement rate range of 35% and a mortality rate 2% results in 22 (22.1) razorbills being subject to mortality during the breeding bio-season per annum. This would increase baseline mortality by 0.107%.

149. This level of change is considered to be of negligible magnitude during the breeding bio-season, representing no discernible change to baseline mortality.

150. During the post-breeding migration bio-season, the mean peak abundance for razorbill is 2,185 individuals within the array area plus 2km buffer. Using a displacement rate of 25% and a mortality rate 1% results in six (5.5) razorbill being subject to mortality during the post-breeding migration bio-season per annum. The regional population in the post-breeding migration bio-season is defined as 591,875 individuals and, using the average baseline mortality rate of 0.13 (Table 12.9), the natural predicted mortality in the post-breeding migration bio-season is 77,062 individuals per annum. The addition of six predicted mortalities per annum would increase baseline mortality by 0.007%. Based on the Natural England preferred approach, using a displacement rate range of 35% and a mortality rate 2% results in 15 (15.3) razorbills being subject to mortality during the post-breeding migration bio-season per annum. This would increase baseline mortality by 0.020%.

151. This level of change is considered to be of negligible magnitude during the post-breeding migration bio-season, representing no discernible change to baseline mortality.

152. During the migration-free winter bio-season, the mean peak abundance for razorbill is 1,779 individuals within the array area plus 2km buffer. Using a displacement rate range of 25% and a mortality rate 1% results in four (4.4) razorbill being subject to mortality during the migration-free winter bio-season per annum. The regional population in the migration-free winter bio-season is defined as 218,621 individuals and, using the average baseline mortality rate of 0.13, the natural predicted mortality in the migration-free winter bio-season is 28,464 individuals per annum. The addition of four predicted mortalities per annum would increase baseline mortality by 0.016%. Based on the Natural England preferred approach, using a displacement rate range of 35% and a mortality rate 2% results in 13 (12.5) razorbills being subject to mortality during the migration-free winter bio-season per annum. This would increase baseline mortality by 0.044%.

153. This level of change is considered to be of negligible magnitude during the migration-free winter bio-season, representing no discernible change to baseline mortality.

154. Across all bio-seasons combined, the total mean peak abundance for razorbill is 12,257 displacement from the Project is 31 (30.6) individuals per annum, based on a displacement rate of 25% and a mortality rate of 1%. Using the largest UK North Sea and English Channel BDMPS of 591,875 individuals (Furness, 2015) and using the average baseline mortality rate of 0.13, the natural predicted mortality across all seasons is 77,062 per annum. The addition of 31 predicted mortalities would increase the baseline mortality rate by 0.040%. When considering displacement impacts at the wider biogeographic population scale, then of the 1,707,000 population the natural annual mortality rate would be 222,251 individuals per annum. The addition of 31 predicted mortalities would increase the biogeographic baseline mortality rate by 0.014% (Table 12.15:). Based on the Natural England preferred approach, using a displacement rate range of 35% and a mortality rate 2% results in 86 (85.8) razorbills being subject to mortality across all bio-seasons per annum. This would increase the BDMPS baseline mortality by 0.111% and the biogeographic baseline mortality rate by 0.039%.

155. Over the range of displacement and mortality scenarios assessed the addition to baseline mortality remains well below 1% and can, therefore, be considered to make no material difference to the baseline mortality of this species.

156. This level of change is considered to be of negligible magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall, as it represents no discernible change to baseline mortality. Given a magnitude change of negligible, and a sensitivity to disturbance and displacement of moderate, the significance of effect is therefore concluded to be **minor adverse, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

157. Confidence in the conclusions of this assessment is high due to the site-specific data used in the assessment, the precautionary displacement and mortality rates used, and the temporary nature of the displacement at this phase.

Table 12.23: Bio-season displacement estimates for razorbill for the Project (construction phase)

Bio-season (months)	Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during construction phase.			Increase in baseline mortality (%) during construction phase.		
		Population	Baseline mortality	25% displacement, 1% mortality	35% displacement, 2% mortality	15-35% displacement, 1-10% mortality	25% displacement, 1% mortality	35% displacement, 2% mortality	15-35% displacement, 1-10% mortality
Return migration (Jan-Mar)	5,134	591,875	77,062	12.8	35.9	7.7 - 179.7	0.017	0.047	0.010 - 0.233
Breding (Apr-Jul)	3,159	158,031	20,576	7.9	22.1	4.7 - 110.6	0.038	0.107	0.023 - 0.537
Post-breeding migration (Aug- Oct)	2,185	591,875	77,062	5.5	15.3	3.3 - 76.5	0.007	0.020	0.004 - 0.099
Migration-free winter (Nov-Dec)	1,779	218,621	28,464	4.4	12.5	2.7 - 62.3	0.016	0.044	0.009 - 0.219
Annual (BDMPS)	12,257	591,875	77,062	30.6	85.8	18.4 - 429.0	0.040	0.111	0.024 - 0.557
Annual (biogeographic)	12,257	1,707,000	222,251	30.6	85.8	18.4 - 429.0	0.014	0.039	0.008 - 0.193

Puffin

Potential magnitude of impact – array area

158. A mortality rate of 1% and a displacement rate of 25% were chosen for assessment of puffin, based on rates being half of those assessed for the O&M phase (paragraph 92). Based on the range of displacement and mortality rates suggested by SNCBs, an additional range is presented in Table 12.24: using a mortality rate of 1% to 10% and displacement rate of 15% to 35%. However, the Applicant's approach of using a 1% mortality rate and 25% displacement for the construction phase will form the main focus of the impact assessment. The magnitude of this impact is assessed against BDMPS non-breeding season populations and breeding season populations (presented in Table 12.8) and relative to the baseline mortality values, which are based on age specific demographic rates and age class proportions presented in Table 12.9.

159. During the breeding bio-season, the mean peak abundance for puffin is 666 individuals within the array area plus 2km buffer. Using a displacement rate of 25% and a mortality rate 1% results in two (1.7) puffin being subject to mortality during the breeding bio-season per annum. The regional population in the breeding bio-season is defined as 868,689 individuals and, using the average baseline mortality rate of 0.12 (Table 12.9), the natural predicted mortality in the breeding bio-season is 103,374 individuals per annum. The addition of two predicted mortalities per annum would increase baseline mortality by 0.002%. Based on the Natural England preferred approach, using a displacement rate range of 35% and a mortality rate 2% results in five (4.7) puffin being subject to mortality during the breeding bio-season per annum. This would increase baseline mortality by 0.005%.

160. This level of change is considered to be of negligible magnitude during the breeding bio-season, representing no discernible change to baseline mortality.

161. During the non-breeding bio-season, the mean peak abundance for puffin is 414 individuals within the array area plus 2km buffer. Using a displacement rate of 25% and a mortality rate 1% results in one (1.0) puffins being subject to mortality during the non-breeding bio-season per annum. The regional population in the non-breeding bio-season is defined as 231,958 individuals and, using the average baseline mortality rate of 0.12, the natural predicted mortality in the non-breeding bio-season is 27,603 individuals per annum. The addition of one predicted mortalities per annum would increase baseline mortality by 0.004%. Based on the Natural England preferred approach, using a displacement rate range of 35% and a mortality rate 2% results in three (2.9) puffin being subject to mortality during the non-breeding bio-season per annum. This would increase baseline mortality by 0.010%.

162. This level of change is considered to be of negligible magnitude during the non-breeding bio-season, representing no discernible change to baseline mortality.

163. Across all bio-seasons combined, the total mean peak abundance for puffin is 1,080 individuals. The predicted maximum number of puffin subject to mortality due to displacement from the Project is three (2.7) individuals per annum, based on a displacement rate of 25% and a mortality rate of 1%. Using the largest UK North Sea and English Channel BDMPS of 868,689 individuals (Furness, 2015) and using the average baseline mortality rate of 0.12, the natural predicted mortality across all seasons is 103,374 per annum. The addition of four predicted mortalities would increase the baseline mortality rate by 0.003%. When considering displacement impacts at the wider biogeographic population scale, then of the 11,840,000 population the natural annual mortality rate would be 1,408,960 individuals per annum. The addition of three predicted mortalities would increase the biogeographic baseline mortality rate by less than 0.001%. Based on the Natural England preferred approach, using a displacement rate range of 35% and a mortality rate 2% results in eight (7.6) puffin being subject to mortality across all bio-seasons per annum. This would increase the BDMPS baseline mortality by 0.007% and the biogeographic baseline mortality rate by 0.001%.

164. Over the range of displacement and mortality scenarios assessed, the addition to baseline mortality remains well below 1% and can, therefore, be considered to make no material difference to the baseline mortality of this species.

165. This level of change is considered to be of negligible magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall, as it represents no discernible change to baseline mortality. Given a magnitude change of negligible, and a sensitivity to disturbance and displacement of moderate, the significance of effect is therefore concluded to be **minor adverse, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

166. Confidence in the conclusions of this assessment is high due to the site-specific data used in the assessment, the precautionary displacement and mortality rates used, the low levels of predicted impact, and the temporary nature of the displacement at this phase.

Table 12.24: Bio-season mean displacement estimates for puffin for the Project (construction phase).

Bio-season (months)	Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during construction phase.			Increase in baseline mortality (%) during construction phase.		
		Population	Baseline mortality	25% displacement, 1% mortality	35% displacement, 2% mortality	15-35% displacement, 1-10% mortality	25% displacement, 1% mortality	35% displacement, 2% mortality	15-35% displacement, 1-10% mortality
Breeding (Apr-Jul)	666	868,689	103,374	1.7	4.7	1.0 – 23.3	0.002	0.005	0.001 - 0.023
Non-breeding (Aug-Mar)	414	231,958	27,603	1.0	2.9	0.6 – 14.5	0.004	0.010	0.002 - 0.052
Annual (BDMPS)	1,080	868,689	103,374	2.7	7.6	1.6 – 37.8	0.003	0.007	0.002 - 0.037
Annual (biogeographic)	1,080	11,840,000	1,408,960	2.7	7.6	1.6 – 37.8	0.000	0.001	0.000 - 0.003

Gannet

Potential magnitude of impact – array area

167. A mortality rate of 1% and a displacement rate of 35%, were selected for assessment of gannet, based on rates being half of those assessed for the O&M phase (Paragraph 262). Based on the range of displacement and mortality rates suggested by SNCBs, an additional range is presented in Table 12.25: using a mortality rate of 1% and displacement rate of 30% to 40%. However, the Applicant's approach of using a 1% mortality rate and 35% displacement for the construction phase will form the main focus of the impact assessment. The magnitude of this impact is assessed against BDMPS non-breeding season populations and breeding season populations (presented in Table 12.8) and relative to the baseline mortality values, which are based on age-specific demographic rates and age class proportions presented in Table 12.9.

168. During the return migration bio-season, the mean peak abundance for gannet is 69 individuals within the array area plus 2km buffer. Using a displacement rate of 35% and a mortality rate 1% results in less than one (0.2) gannet being subject to mortality during the return migration bio-season per annum. The regional population in the return migration bio-season is defined as 248,385 individuals and, using the average baseline mortality rate of 0.19 (Table 12.9), the natural predicted mortality in the return migration bio-season is 46,349 individuals per annum. The addition of less than one predicted mortality per annum would increase baseline mortality by 0.001%.

169. This level of change is considered to be of negligible magnitude during the return migration bio-season, representing no discernible change to baseline mortality.

170. During the breeding bio-season, the mean peak abundance for gannet is 554 individuals within the array area plus 2km buffer. Using a displacement rate of 35% and a mortality rate 1% results in two (1.9) gannet being subject to mortality during the migration-free breeding bio-season per annum. The regional population in the migration-free breeding bio-season is defined as 400,326 individuals and, using the average baseline mortality rate of 0.19, the natural predicted mortality in the migration-free breeding bio-season is 74,701 individuals per annum. The addition of two mortalities per annum would increase baseline mortality by 0.003%.

171. This level of change is considered to be of negligible magnitude during the migration-free breeding bio-season, representing no discernible change to baseline mortality.

172. During the post-breeding migration bio-season, the mean peak abundance for gannet is 496 individuals within the array area plus 2km buffer. Using a displacement rate of 35% and a mortality rate 1% results in two (1.7) gannet being subject to mortality per annum. The regional population in the post-breeding migration bio-season is defined as 456,299 individuals and, using the average baseline mortality rate of 0.19 (Table 12.9), the natural predicted mortality in the post-breeding migration bio-season is 85,145 individuals per annum. The addition of two predicted mortality per annum would increase baseline mortality by 0.002%.

173. This level of change is considered to be of negligible magnitude during the post-breeding migration bio-season, representing no discernible change to baseline mortality.

174. Across all bio-seasons combined, the total mean peak abundance for gannet is 1,119 individuals. The predicted maximum number of gannet subject to mortality due to displacement from the Project is four (3.9) individuals per annum, based on a displacement rate of 35% and a mortality rate of 1%. Using the largest UK North Sea and English Channel BDMPS of 456,299 individuals (Furness, 2015) and using the average baseline mortality rate of 0.19, the natural predicted mortality across all seasons is 85,145 per annum. The addition of four predicted mortalities would increase the baseline mortality rate by 0.005%. When considering displacement impacts at the wider biogeographic population scale, then of the 1,180,000 population the natural annual mortality rate would be 220,188 individuals per annum. The addition of four predicted mortalities would increase the biogeographic baseline mortality rate by 0.002%.

175. Over the range of displacement and mortality scenarios assessed, the addition to baseline mortality remains well below 1% and can, therefore, be considered to make no material difference to the baseline mortality of this species.

176. This level of change is of negligible magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall, as it represents no discernible change to baseline mortality. Given a magnitude change of negligible, and a sensitivity to disturbance and displacement of minor to moderate, the significance of effect is therefore concluded to be **minor adverse, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

177. Confidence in the conclusions of this assessment is high due to the site-specific data used in the assessment, the precautionary displacement and mortality rates used, the low levels of predicted impact, and the temporary nature of the displacement at this phase.

Table 12.25: Bio-season displacement estimates for gannet for the Project (construction phase).

Bio-season (months)	Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during construction phase.		Increase in baseline mortality (%) during construction phase.	
		Population	Baseline mortality	35% displacement, 1% mortality	30-40% displacement, 1% mortality	35% displacement, 1% mortality	30-40% displacement, 1% mortality
Return migration (Dec-Mar)	69	248,385	46,349	0.2	0.2 - 0.3	0.001	0.000 - 0.001
Migration-free breeding (Apr-Aug)	554	400,326	74,701	1.9	1.7 - 2.2	0.003	0.002 - 0.003
Post-breeding migration (Sep-Nov)	496	456,299	85,145	1.7	1.5 - 2.0	0.002	0.002 - 0.002
Annual (BDMPS)	1,119	456,299	85,145	3.9	3.4 - 4.5	0.005	0.004 - 0.005
Annual (biogeographic)	1,119	1,180,000	220,188	3.9	3.4 - 4.5	0.002	0.002 - 0.002

12.8.2 Indirect impacts due to impacts on prey

178. During construction of the Project, potential impacts on the availability of prey species may indirectly have effects on offshore birds. Increases in underwater anthropogenic noise resulting from, for example, piling activity may result in mobile prey species avoiding the construction area. Additionally, suspended sediments from construction activity in the array or along the Offshore ECC may result in fish and mobile invertebrates avoiding affected areas and may smother immobile benthic prey. The resulting increase in turbidity of the water column may also make it harder for seabirds to see their prey. These impacts could therefore result in a reduction in prey available to foraging seabirds within the construction area. The potential impacts on benthic invertebrates and fish have been assessed in Volume 1, Chapter 10 – Fish and Shellfish Ecology and Volume 1, Chapter 9 – Benthic Subtidal and Intertidal Ecology.

179. The main prey items of seabirds such as gannet and auks are species such as sandeels, herring and sprat. Impacts on these species may arise from underwater noise impacts and due to changes to the seabed and to increases in suspended sediment levels (also covered in Volume 1, Chapter 10 – Fish and Shellfish Ecology). Impacts arising from noise and suspended sediment and deposition during the construction phase are assessed to be minor (not significant) for all fish groups and therefore no impacts of note are expected.

180. Given the conclusion that the impacts arising from the construction of the Project will give rise to limited effects on prey species, the significance of effect on ornithological receptors is concluded to be **negligible, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

12.9 Impact Assessment: O&M phase

181. The impacts of the offshore O&M of the Project have been assessed on offshore and intertidal ornithology. The impacts resulting from the O&M of the Project are presented in Table 12.10:, along with the MDS which formed the basis of these impact assessments.

12.9.1 Disturbance and displacement

182. The presence of WTGs and other infrastructure within the array area has the potential to directly disturb and displace seabirds that use this area. This may result in a reduced area in which those seabirds can forage, loaf or moult. Displacement may increase individual birds' energetic requirements, which at an extreme or repeated level could lead to the mortality of some individuals.

183. Seabird species vary in their response to the presence of infrastructure associated with OWFs, and also to the vessel activity related to maintenance activities. Since OWFs are a new feature in the marine environment there is currently limited evidence as to the long-term effects of disturbance and displacement by operational infrastructure.

184. The joint interim displacement advice note (MIG-Birds, 2022) provides the latest advice for UK development applications on how to consider, assess and present information and potential consequences of seabird displacement from OWFs. This guidance note has been considered in preparing the following assessment.

185. Some species are more susceptible than others to disturbance from OWF operation, which may lead to displacement. Dierschke *et al*. (2016) noted both displacement and avoidance to varying degrees by some seabird species while others were attracted to OWFs.

186. A screening process was undertaken to identify those species of birds present within the Project survey area that may be at most risk of displacement. For the O&M phase, the screening process matched that completed for construction and decommissioning, with the omission of common scoter, since this species was only assessed for disturbance and displacement within the Offshore ECC during the construction phase (Table 12.17:). Considering the screening outcome is identical to the construction and decommissioning, except the exclusion of common scoter, the table has not been re-presented here.

187. The five species that were screened in for assessment for disturbance and displacement within the array area are guillemot, razorbill, puffin, red-throated diver and gannet. Kittiwake, Sandwich tern, fulmar and Manx shearwater were not considered for displacement as justified in Paragraph 95.

Red-throated diver

Displacement rate evidence base

188. Red-throated diver has been identified as being particularly sensitive to human activities in marine areas, including through the disturbance effects of ship and helicopter traffic and the presence of WTGs (Garthe and Hüppop, 2004; Schwemmer *et al*., 2011; Furness and Wade, 2012; Furness *et al*., 2013; Bradbury *et al*., 2014). The below evidence of susceptibility to disturbance from the presence of WTGs is provided in addition to evidence presented in the Offshore ECC displacement assessment (Section 12.8) on susceptibility to disturbance from ship and helicopter traffic.

189. A review of red-throated diver displacement rates was provided for East Anglia ONE North and East Anglia TWO (MacArthur Green and Royal HaskoningDHV, 2021). The study consisted of a modelling analysis using survey data collected in the Outer Thames region between 2002-2018, from before any OWF construction began in the region (prior to 2005), through to completed construction of Kentish Flats, Gunfleet Sands, London Array, Thanet and Greater Gabbard. The model was run separately based on 2013 and 2018 density distributions. Using the 2013 model, the predicted reduction in density as a result of EA1N was predicted to be a maximum of 42.2% within the EA1N array area, with reduced impact in each buffer zone out to a maximum of 8km from the array area, beyond which there was no predicted decrease in density. Using the 2018 density distribution, the model predicted a 44.2% reduction in density within the EA1N array area and no reduction in density beyond 9km from the array area. It was noted that the total number of birds predicted to be displaced (34 based on 2013 data and 9 based on 2018 data) were similar to the numbers estimated using an approach of 100% displacement from the array area plus 4km buffer (40 and 12 birds displaced, based on 2013 and 2018 input data, respectively).

190. For the Project, the Applicant has considered a precautionary approach of 100% displacement, though a range of values between 90% and 100% are also presented based on SNCB guidance (MIG-Birds, 2022).

Mortality rate evidence base

191. There is currently no evidence that red-throated divers suffer mortality because of displacement. Displacement consequent mortality is likely to be a result of increased density of birds being displaced to areas with poorer feeding, or requirements to expend more energy in acquiring food. Red-throated divers typically forage for three to five hours during the non-breeding season, almost exclusively during daylight hours. This suggests that they may have the capacity to adapt to, or accommodate, changes that impact their energetic requirements (Thompson, 2023). However, these impacts are expected to be negligible, with literature reviews undertaken Norfolk Vanguard Ltd (2019b) and MacArthur Green and Royal HaskoningDHV (2021) identifying clear evidence that red-throated diver populations are not constrained by resources in wintering grounds, but rather by available breeding habitat. This would suggest that an increase in density in wintering areas as a result of displacement would not have a negative impact on survival, as there is more than sufficient resource to maintain the current population. The reviews also noted that considering the area of OWFs already constructed, and extensive vessel traffic within the North Sea, if displacement led to a 10% mortality rate, this ought to be evident from an increase in population-level mortality rates, but no such increase has been observed. Both Norfolk Vanguard Ltd (2019b) and MacArthur Green and Royal HaskoningDHV (2021) concluded that based on available evidence, even a 1% mortality rate is likely to be precautionary and presented this as the respective applicants' preferred value.

192. SNCB guidance (MIG-Birds, 2022) suggests a mortality rate of up to 10% for the assessment of red-throated divers when considered displacement and disturbance during the operation of an OWF. Considering the natural mortality of red-throated diver is 16% (Horswill and Robinson, 2015), the value of 10% is considered over-precautionary since it equates to over half the natural annual mortality rate. Therefore, a mortality rate of 1% will form the main basis of this assessment with a range of up to 10% also presented, in line with approaches used by recently submitted projects.

Potential magnitude of impact - Array area

193. This section considers the magnitude of impact on red-throated diver from the presence of WTGs and other infrastructure within the array area.

194. A mortality rate of 1% and a displacement rate of 100% were chosen for assessment of red-throated diver. Based on SNCB guidance (MIG-Birds, 2022), an additional displacement range of 90% to 100% and a mortality rate range of 1% to 10% is presented in Table 12.26:. The magnitude of this impact is assessed against BDMPS and biogeographic populations (presented in Table 12.8) and relative to the baseline mortality values, which are based on age specific demographic rates and age class proportions presented in Table 12.9.

195. During the non-breeding bio-season, the mean peak abundance for red-throated diver is 180 (180.0) individuals within the array area plus 4km buffer. Using a displacement rate range of 100% and a mortality rate 1% results in two (1.80) red-throated diver being subject to mortality during the non-breeding bio-season per annum. The regional population in the non-breeding bio-season is defined as 13,276 individuals and, using the average baseline mortality rate of 0.228, the natural predicted mortality in the migration-free winter bio-season is 3,023 individuals per annum. The addition of two mortalities per annum would increase baseline mortality by 0.060%.

196. This level of change is considered to be of negligible magnitude during the non-breeding bio-season, representing no discernible change to baseline mortality.

197. When considering displacement impacts at the wider biogeographic population scale then, of the 27,000 population, the natural annual mortality rate would be 6,148 individuals per annum. The addition of two (1.80) predicted mortalities would increase the biogeographic baseline mortality rate by 0.029%.

198. Over the range of displacement and mortality scenarios assessed, the addition to baseline mortality remains well below 1% and can, therefore, be considered to make no material difference to the baseline mortality of this species.

199. This level of change is considered to be of negligible magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall, as it represents no discernible change to baseline mortality. Given a magnitude change of negligible, and a sensitivity to disturbance and displacement of major, the significance of effect is therefore concluded to be **minor adverse, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

200. Confidence in the conclusions of this assessment is high due to the site-specific data used in the assessment, the precautionary displacement and mortality rates used, the low levels of predicted impact, and the flexibility within the foraging energy budgets red-throated divers in the non-breeding season.

Table 12.26: Bio-season displacement estimates for red-throated diver for the Project (O&M phase).

Bio-season (months)	Seasonal abundance (array area plus 4km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during O&M phase.		Increase in baseline mortality (%) during construction phase.	
		Population	Baseline mortality	100% displacement, 1% mortality	90-100% displacement, 1-10% mortality	100% displacement, 1% mortality	90-100% displacement, 1-10% mortality
Non-breeding Oct – Apr)	180	13,276	3,023	1.80	1.62 – 18.00	0.060	0.054 – 0.595
Annual (BDMPS)	180	13,276	3,023	1.80	1.62 – 18.00	0.060	0.054 – 0.595
Annual (biogeographic)	180	27,000	6,148	1.80	1.62 –18.00	0.029	0.026 – 0.293

Table 12.27: Annual displacement matrix for red-throated diver within the Project array area plus 4km buffer, values in light blue represent the range-based values advocated by SNCBs and the darker shade of blue representing the Applicant's approach value.

Annual (Array + 4km Buffer)	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	1	2	4	5	7	9	11	13	14	16	18
20	0	1	1	4	7	11	14	18	22	25	29	32	36
30	1	1	2	5	11	16	22	27	32	38	43	49	54
40	1	1	2	7	14	22	29	36	43	50	58	65	72
50	1	2	3	9	18	27	36	45	54	63	72	81	90
60	1	2	3	11	22	32	43	54	65	76	86	97	108
70	1	3	4	13	25	38	50	63	76	88	101	113	126
80	1	3	4	14	29	43	58	72	86	101	115	130	144
90	2	3	5	16	32	49	65	81	97	113	130	146	162
100	2	4	5	18	36	54	72	90	108	126	144	162	180

Potential magnitude of impact - Offshore ECC

201. This section considers the magnitude of impact on red-throated diver from vessel disturbance during O&M within the offshore ECC. Disturbance in the intertidal ECC, ANS and biogenic reef areas were scoped out as described in the ‘Impacts Scoped out of Assessment’ Section.

202. Although red-throated diver is particularly sensitive to human activities such as vessel traffic, during the O&M phase of development, vessels will primarily be using existing, busy shipping lanes and follow vessel best guidance protocol as outlined in the Outline Vessel Management Plan (document reference 8.20). Therefore, impacts from displacement are not predicted to be significantly greater than baseline levels and will be restricted to routine and emergency maintenance activity.

203. The MDS clearly demonstrates that the vessel traffic is considerably lower during O&M compared to construction (Table 12.10:). Therefore, any displacement impacts will be considerably lower than the assessment presented for the construction phase (see Section 12.8)for which the matrix approach concluded an impact to red-throated diver of negligible. It can therefore be concluded that impacts to this species from Offshore ECC disturbance during O&M will be negligible or lower, which is not significant in EIA terms.

Potential magnitude of impact - ORCPs

204. Within their relevant representations, Natural England requested a more detailed assessment of the impacts of the ORCP on red-throated diver, specifically during the O&M phase (RR-045 – F6). Therefore, further detail has been added to the assessment to address these concerns, specifically the uncertainty surrounding the effects of static structures on red-throated diver. Additionally, the Applicant has consulted with Natural England over alternative locations for the ORCP outside the SPA and mitigation in terms of a reduction in size and separation of the ORCPs. The ORCPs had initially been located 6 km from landfall. Following stakeholder feedback during the pre-application process, specifically in relation to feedback from Natural England, the location of the ORCPs was reviewed and they were moved further offshore, 12 km from landfall. The ORCPs could not be moved further east, i.e. beyond the IDRBNR SAC (and also beyond the Greater Wash SPA) without compromising the ability of the project to deliver power to the onshore substation to achieve 1,500 MW export power.

205. Much evidence has been gathered as to the behaviour of red-throated diver in response to OWFs, with the majority of disturbance/displacement from OWFs attributed to the presence of WTG structures which are rotating. However, there is limited peer reviewed studies and analysis of the potential for displacement of red-throated diver from static structures.

206. Based on evidence gathered from the Outer Thames Estuary SPA (also designated for red-throated diver), red-throated divers do not appear to be disturbed or displaced at a consistent distance by anthropogenic structures (Figure 12.2 and Figure 12.3). Figure 12.2 displays the locations of the Sizewell Nuclear Power Station which is along a transect surveyed during the Outer Thames Estuary SPA surveys (Irwin *et al.,* 2019). A number of offshore structures associated with Sizewell Nuclear Power Station (Sizewell Rigs, assumed to be located at the end of the outfall/ intake pipe) are located in the nearshore environment, in proximity to the power plant. As shown in Figure 12.2, red-throated diver were recorded in proximity to these locations, despite the close proximity to the power plant and associated structures. Further evidence is provided from vantage point surveys undertaken to inform the assessment of disturbance and displacement of red-throated diver from Sizewell C Nuclear Power Station which identified red-throated diver within 500 m of the structures. Additionally, the Gunfleet lighthouse is also located within the Outer Thames Estuary SPA (Figure 12.2). Despite this structure being over 20 m in height, a medium to high density of red-throated diver was recorded within a 2 km buffer of the structure.

207. Moreover, three offshore military forts (or groups of forts) are located within the Outer Thames Estuary SPA (Figure 12.3). The middle fort is located within the busy Thames shipping lane (marked by buoys and leading out of the Thames Estuary). The low density of red-throated diver in the area is likely to be due to the shipping lane rather than the fort itself. Figure 12.3 shows a reduction of birds around the most westerly fort where it overlaps the shipping corridor in the north. However, to the south of the fort, medium densities of red-throated divers are recorded along the transect line and well within a 2 km buffer from the structure. Close to the most easterly fort shown on Figure 12.3**Error! Reference source not found.** there is a medium density of red-throated diver, despite also being in close proximity to a shipping lane (marked by buoys).

208. Based on the evidence presented above, it is concluded that the presence of the ORCPs is unlikely to negatively impact the distribution of red-throated. It is also important to note that, with the removal of the northern ORCP area, the ORCPs will be positioned within the southern ORCP area which is closer to the Lincs OWF (**Error! Reference source not found.**). Therefore, there is already a level of baseline disturbance within the area.

209. As such, whilst no measurable displacement effect is predicted from the presence of the ORCPs, were a small-scale effect to occur then it is considered that any displacement from the ORCPs would fall wholly within the existing displacement effects from the Lincs offshore wind farm and would not be additional to ongoing impacts. Moreover, in order to give further comfort to Natural England that there will be no disturbance, the Applicant has proposed reducing the height of the ORCPs from 90 m to 52 m. Based on Natural England's request for detailed assessment of the impacts of the ORCPs on red-throated diver (RR-045 – F6), further consideration is provided below. Additional, during a meeting with the Applicant and Natural England on 17th January 2025, Natural England recommended looking at whether the ORCP is within an area that is already experiencing displacement from surrounding OWFs, and requested the identification of any potentially new areas that would be made unavailable for red-throated diver within the Greater Wash SPA. This is also incorporated into the assessment below.

210. On a precautionary basis, an assessment has been undertaken on the potential displacement mortalities from the ORCPs. Based on a 2 km buffer (considered by the Applicant to include an artificially large degree of precaution based on the review of evidence presented above). Based on data on red-throated diver densities presented by Lawson *et al*. (2016), an average density of 0.4 birds/km^2 are estimated to be present within the ORCP area plus a 2 km buffer. Based on a 2 km buffer around the ORCP area, the area of potential disturbance was calculated to be circa 30.0 km^2.

211. Based on the average density of 0.4 birds/km^2, and the total disturbance of area of circa 30.0 km^2, a total of 13 (12.8) red-throated divers are at potential risk of displacement. Based on a displacement rate of 100% and a mortality rate of 1%, this results in a predicted mortality of less than one (0.1) birds per annum. Considering a displacement range of 90% to 100% and a mortality range of 1% to 10%, the consequent range of potential mortality is estimated between 0.1 to 1.3 birds. It is noted that 10% mortality from the operation of the ORCPs is extremely unlikely given the size of the structures in comparison to the size of an operational OWF, for which 10% is also deemed highly over-precautionary.

212. Using the largest UK North Sea and English Channel BDMPS of 13,276 individuals (Furness, 2015) and the average baseline mortality rate of 0.228, the natural predicted mortality across all seasons is 3,023 per annum. The addition of less than one (0.1) predicted mortalities would increase the baseline mortality rate by 0.004%. When considering displacement impacts at the wider biogeographic population scale then, of the 27,000 population, the natural annual mortality rate would be 6,148 individuals per annum. The addition of less than one (0.1) predicted mortalities would increase the biogeographic baseline mortality rate by 0.002%.

213. Densities of birds in the ORCP area are anticipated to be lower than the densities described by Lawson *et al*. (2016) as these areas are located within 10 km of other operational OWF projects (e.g. Lincs OWF; Figure 12.4) where diver densities have been shown to be reduced (HiDef, 2017). As such, a proportion of the birds occupying areas impacted by the existing OWF and associated buffers will already have been displaced, and therefore potential displacement impacts from the ORCPs are expected to be lower, and therefore negligible, based on a combination of the baseline disturbance from Lincs OWF and the assessment provided above. Additionally, during a meeting between the Applicant and Natural England on 17th January 2025, Natural England stated that the ORCPs are unlikely to increase displacement within the displacement buffer of a windfarm.

Table 12.28: Bio-season displacement estimates for red-throated diver for the Project from the ORCP area (O&M phase).

Bio-season (months)	Seasonal abundance (ORCP area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during O&M phase.		Increase in baseline mortality (%) during construction phase.	
		Population	Baseline mortality	100% displacement, 1% mortality	90-100% displacement, 1-10% mortality	100% displacement, 1% mortality	90-100% displacement, 1-10% mortality
Non-breeding Oct – Apr)	12.8	13,276	3,023	0.13	0.12 – 1.28	0.004	0.004 – 0.042
Annual (BDMPS)	12.8	13,276	3,023	0.13	0.12 – 1.28	0.004	0.004 – 0.042
Annual (biogeographic)	12.8	27,000	6,148	0.13	0.12 – 1.28	0.002	0.002 – 0.021

Auk species

Displacement rate evidence base

214. Auk species (guillemot, razorbill and puffin) show a medium level of sensitivity to ship and helicopter traffic (Garthe and Hüppop, 2004; Furness and Wade, 2012; Langston, 2010; and Bradbury *et al*., 2014). A review by Dierschke *et al*. (2016) has summarised auk displacement responses in relation to OWFs across thirteen European OWF sites, comparing changes in seabird abundance between baseline and post-construction surveys. From the review, the outcomes for auks was 'weak displacement' but highly variable across all OWFs. Since the publication of this review, there have been a number of additional OWF sites which have reported displacement effects on auks (APEM, 2017; Webb *et al*., 2017; Vanermen *et al*., 2019; Peschko *et al*., 2020; MacArthur Green, 2021). Furthermore, previously published datasets from three OWF sites have recently been re-analysed utilising a novel modelling approach, which has resulted in different displacement effects being concluded for some (R-INLA; Zuur, 2018; Leopold *et al*., 2018).

215. More recently, a summary of all current post-consent monitoring studies undertaken to date within the North Sea and UK western waters was submitted for the Hornsea Four OWF (Orsted, 2021b). The review was completed by APEM (APEM, 2022) and provides an extensive analysis of data from multiple OWFs, expanding work undertaken for other studies, such as that submitted by Norfolk Vanguard (2018). The review found auk displacement was highly variable within different study sites, ranging from attraction to no significant effects, to displacement effects. Across the studies analysed, positive displacement effects were observed at one OWF, no significant effect or weak displacement at eight OWFs, three had inferred displacement effects (but not statistically tested), and negative displacement was observed at eight OWFs. From studies which provided a defined displacement rate, rates ranged from +112% to -75%. Notably some study datasets were found to not be using the most appropriate statistical modelling methods for the data collected and coincidently had high displacement rates due to low abundance and high numbers of zero counts, making displacement rate prediction highly problematic given natural spatial and temporal variation in auk abundance and distribution. Consequently, displacement effects reported in these studies are considered to be likely unreliable. From this literature, it is concluded that a displacement rate of up to 50% for the array area and 2km buffer would be the most applicable, and also suitably precautionary for assessment.

216. A displacement rate of 50% as a precautionary approach is further supported by a review of OWF data in the German North Sea, undertaken by Peschko *et al*. (2020). The review indicated that guillemot displacement rates are reduced during the breeding season by approximately 20% compared with the non-breeding season, which is an important consideration given that the mean displacement rates derived from the Dierschke *et al*. (2016) review was predominantly from data collected in the non-breeding season.

217. Studies have also indicated that auks show habituation to OWFs with respect to displacement rates. Recently, this was demonstrated at the Thanet OWF, whereby statistically significant auk displacement was demonstrated, but only in the short term; from year two of post construction monitoring, abundances increased within the OWF, suggesting a level of habituation after one year of operation. Compared with the first year of operation, year two and three displacement rates fell from a range of 75% to 85% in year one, to a low of 31% to 41% (Royal Haskoning, 2013). There is also further emerging evidence as additional post-construction monitoring of OWFs continues, with reports of auk numbers increasing and observations of foraging behaviour within the windfarm itself (Leopold and Verdaat, 2018). This would suggest that displacement rates are expected to diminish over the operational life of OWFs.

218. Post construction monitoring at the Beatrice OWF has shown that although guillemot and razorbill distribution changed between the pre and post construction surveys, there is little evidence to suggest that this is in response to the presence of the windfarm as a whole, and that both species showed no avoidance of individual WTGs, even when active. Modelling of auk distribution was carried out in relation to real WTG distribution, in comparison with randomised WTG locations, on data collected in 2019 and 2021. Each year was analysed independently, and the model took rotor speed into account. The analyses demonstrated that birds within the array area did not avoid active WTGs.

219. Considering the above evidence, an auk displacement rate of 50% within the OWF array area and out to a 2km buffer is considered as strongly evidenced and also sufficiently precautionary. For further evidence and detailed information on displacement rates, specifically related to auks, see Appendix 12.9 (6.3.12.9 Rates of displacement in guillemot and razorbill).

Mortality rate evidence base

220. Considering mortality, current expert opinion has advised the use of a range of 1-10% mortality for guillemot and other auk species (MIG-Birds, 2022). However, it has been advised by environmental consultants working on behalf of a range of developers that 1% or 2% mortality is more appropriate (Norfolk Boreas Limited, 2019; SPR, 2019; Orsted, 2018). In support of this, anecdotal evidence has implied low additional auk mortality as a result of the Helgoland OWF cluster and Butendiek (Peschko *et al*., 2020).

221. In further support of a lower mortality rate, a study by van Kooten *et al*. (2019) demonstrated that a 1% mortality for displaced auks is more appropriate than the overly precautionary 10% rate. They also note that 1% is considered precautionary, considering the study reported a modelled additional non-breeding season mortality rate of 0.1% for a 50% displacement rate and 0.4% for a 100% displacement rate. It should also be noted that due to the large expanse of available habitat outside of the Project array area, the mortality rate due to displacement could be as low as 0% as the increase in density outside of the array area in comparison to the whole of the North Sea would be **negligible**.

222. Based on the above presented evidence, a displacement rate of 50% and a mortality rate of 1% are presented by the Applicant, deemed to be reflective of current available evidence whilst remaining sufficiently precautionary. To reflect the most recent SNCB guidance (MIG-Birds, 2022), a displacement range of 30-70% and a mortality range of 1-10% will also be presented.

Guillemot

Potential magnitude of impact

223. A mortality rate of 1% and a displacement rate of 50%, were selected for the Applicant's approach for the assessment of guillemot, and 2% mortality and 70% displacement rate for Natural England's preferred approach (see review of displacement rates in document reference 19.10). Based on SNCB guidance (MIG-Birds, 2022), an additional displacement range of 30% to 70% and a mortality rate range of 1% to 10% is presented in Table 12.29 and Table 12.30. The magnitude of this impact is assessed against BDMPS non-breeding season populations and breeding season populations (presented in Table 12.8) and relative to the baseline mortality values, which are based on age specific demographic rates and age class proportions presented in Table 12.9. For further evidence and detailed information on the Applicant's position to guillemot bio-season, see Appendix 12.8 (6.3.12.8 Consideration of bio-seasons in the assessment of guillemot).

224. The Applicant's approach and Natural England's preferred approach both use model-based abundance estimates for the assessment within text, however the design-based abundance estimates are presented in Table 12.31 and Table 12.32. The lower and upper confidence intervals (LCI and UCI) have also been presented.

Applicant's Approach

225. During the breeding bio-season, the mean peak abundance for guillemot is 11,364 individuals within the array area plus 2km buffer. Using a displacement rate of 50% and a mortality rate 1% results in 57 (56.8) guillemot being subject to mortality during the breeding bio-season per annum. The regional population in the breeding bio-season is defined as 2,045,078 individuals and, using the average baseline mortality rate of 0.14 (Table 12.9), the natural predicted mortality in the breeding bio-season is 287,333 individuals per annum. The addition of 57 mortalities per annum would increase baseline mortality by 0.020%.

226. This level of change is considered to be of negligible magnitude during the breeding bio-season, representing no discernible change to baseline mortality.

227. During the non-breeding bio-season, the mean peak abundance for guillemot is 9,066 individuals within the array area plus 2km buffer. Using a displacement rate of 50% and a mortality rate 1% results in 45 (45.3) guillemot being subject to mortality during the non-breeding bio-season per annum. The regional population in the non-breeding bio-season is defined as 1,617,305 individuals and, using the average baseline mortality rate of 0.14, the natural predicted mortality in the non-breeding bio-season is 227,231 individuals per annum. The addition of 45 mortalities per annum would increase baseline mortality by 0.020%.

228. This level of change is considered to be of negligible magnitude during the non-breeding bio-season, representing no discernible change to baseline mortality.

229. Across all bio-seasons, the combined total mean peak abundance for guillemot is 20,430 individuals. The predicted maximum number of guillemot subject to mortality due to displacement from the Project is 102 (102.2) individuals per annum, based on a displacement rate of 50% and a mortality rate of 1%. An annual displacement matrix for guillemot within the array area plus a 2km buffer is presented in Table 12.33: below. Using the largest UK North Sea and English Channel BDMPS of 2,045,078 individuals (Furness, 2015) and using the average baseline mortality rate of 0.14, the natural predicted mortality across all seasons is 287,333 per annum. The addition of 102 predicted mortalities would increase the baseline mortality rate by 0.036%. When considering displacement impacts at the wider biogeographic population scale, then of the 4,125,000 population the natural annual mortality rate would be 579,563 individuals per annum. The addition of 102 predicted mortalities would increase the biogeographic baseline mortality rate by 0.018%.

Natural England's Approach

230. During the breeding bio-season, the mean peak abundance for guillemot is 11,364 individuals within the array area plus 2km buffer. Using a displacement rate of 70% and a mortality rate 2% results in 159 (159.1) guillemot being subject to mortality during the breeding bio-season per annum. The regional population in the breeding bio-season is defined as 2,045,078 individuals and, using the average baseline mortality rate of 0.14 (Table 12.9), the natural predicted mortality in the breeding bio-season is 287,333 individuals per annum. The addition of 159 mortalities per annum would increase baseline mortality by 0.055%.

231. This level of change is considered to be of negligible magnitude during the breeding bio-season, representing no discernible change to baseline mortality.

232. During the post-breeding bio-season, the mean peak abundance for guillemot is 9,066 individuals within the array area plus 2km buffer. Using a displacement rate of 70% and a mortality rate 2% results in 127 (126.9) guillemot being subject to mortality during the non-breeding bio-season per annum. The regional population in the non-breeding bio-season is defined as 2,045,078 individuals and, using the average baseline mortality rate of 0.14, the natural predicted mortality in the post-breeding bio-season is 287,333 individuals per annum. The addition of 60 mortalities per annum would increase baseline mortality by 0.044%.

233. This level of change is considered to be of negligible magnitude during the post-breeding bio-season, representing no discernible change to baseline mortality.

234. During the non-breeding bio-season, the mean peak abundance for guillemot is 4,279 individuals within the array area plus 2km buffer. Using a displacement rate of 70% and a mortality rate 2% results in 60 (59.9) guillemot being subject to mortality during the non-breeding bio-season per annum. The regional population in the non-breeding bio-season is defined as 1,617,305 individuals and, using the average baseline mortality rate of 0.14, the natural predicted mortality in the non-breeding bio-season is 227,231 individuals per annum. The addition of 127 mortalities per annum would increase baseline mortality by 0.021%.

235. This level of change is considered to be of negligible magnitude during the non-breeding bio-season, representing no discernible change to baseline mortality.

236. Across all bio-seasons, the combined total mean peak abundance for guillemot is 24,709 individuals. The predicted maximum number of guillemot subject to mortality due to displacement from the Project is 346 (345.9) individuals per annum, based on a displacement rate of 70% and a mortality rate of 2%. An annual displacement matrix for guillemot within the array area plus a 2km buffer is presented in Table 12.34 below. Using the largest UK North Sea and English Channel BDMPS of 2,045,078 individuals (Furness, 2015) and using the average baseline mortality rate of 0.14, the natural predicted mortality across all seasons is 287,333 per annum. The addition of 346 predicted mortalities would increase the baseline mortality rate by 0.120%. When considering displacement impacts at the wider biogeographic population scale, then of the 4,125,000 population the natural annual mortality rate would be 579,563 individuals per annum. The addition of 346 predicted mortalities would increase the biogeographic baseline mortality rate by 0.06%.

237. Over the range of displacement and mortality scenarios assessed, the addition to baseline mortality remains well below 1% and can, therefore, be considered to make no material difference to the baseline mortality of this species.

238. This level of change is considered to be of negligible magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall, as it represents no discernible change to baseline mortality. Given a magnitude change of negligible, and a sensitivity to disturbance and displacement of moderate, the effect significance is considered **minor (not significant)** at worst, based on the matrix approach defined in Table 12.15:.

239. Confidence in the conclusions of this assessment is high due to the precautionary displacement and mortality rates used (see document reference 19.10), the site-specific dataset, and the likelihood of habituation to WTGs over the lifespan of the project.

Table 12.29: Bio-season displacement estimates for guillemot for the Project using model-based abundance estimates (Applicant's Approach). Lower and Upper Confidence intervals are presented (O&M phase).

Bio-season (months)	Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during O&M phase.			Increase in baseline mortality (%) during construction phase.		
		Population	Baseline mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality
Mean									
Breeding (Mar-Jul)	11,364	2,045,078	287,333	56.8	159.1	34.09 - 795.5	0.020	0.055	0.012 - 0.277
Non-breeding (Aug-Feb)	9,066	1,617,305	227,231	45.3	126.9	27.20 - 634.6	0.020	0.056	0.012 - 0.279
Annual (BDMPS)	20,430	2,045,078	287,333	102.2	286.0	61.29 - 1430.1	0.036	0.100	0.021 - 0.498
Annual (biogeographic)	20,430	4,125,000	579,563	102.2	286.0	61.29 - 1430.1	0.018	0.049	0.011 - 0.247
LCI									
Breeding (Mar-Jul)	8,352	2,045,078	287,333	41.8	116.9	25.1 - 584.6	0.015	0.041	0.009 - 0.203
Non-breeding (Aug-Feb)	5,604	1,617,305	227,231	28.0	78.5	16.8 - 392.3	0.012	0.035	0.007 - 0.173

Bio-season (months)	Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during O&M phase.			Increase in baseline mortality (%) during construction phase.		
		Population	Baseline mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality
Annual (BDMPS)	13,956	2,045,078	287,333	69.8	195.4	41.9 - 976.9	0.024	0.068	0.015 - 0.340
Annual (biogeographic)	13,956	4,125,000	579,563	69.8	195.4	41.9 - 976.9	0.012	0.034	0.007 - 0.169
UCI									
Breeding (Mar-Jul)	15,606	2,045,078	287,333	93.3	261.4	56.0 – 1,306.8	0.032	0.091	0.019 - 0.455
Non-breeding (Aug-Feb)	16,011	1,617,305	227,231	60.2	168.6	36.1 - 843.0	0.026	0.074	0.016 - 0.371
Annual (BDMPS)	31,616	2,045,078	287,333	153.6	430.0	92.1 – 2,149.8	0.053	0.150	0.032 - 0.748
Annual (biogeographic)	31,616	4,125,000	579,563	153.6	430.0	92.1 – 2,149.8	0.026	0.074	0.016 - 0.371

Table 12.30: Bio-season displacement estimates for guillemot for the Project using model-based abundance estimates (Natural England's approach). Lower and Upper Confidence intervals are presented (O&M phase).

Bio-season (months)	Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during O&M phase.			Increase in baseline mortality (%) during construction phase.		
		Population	Baseline mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality
Mean									
Breeding (Mar-Jul)	11,364	2,045,078	287,333	56.8	159.1	34.1 - 795.5	0.020	0.055	0.012 - 0.277
Post-breeding (Aug-Sep)	9,066	2,045,078	287,333	45.3	126.9	27.2 - 634.6	0.016	0.044	0.009 - 0.221
Non-breeding (Oct-Feb)	4,279	1,617,305	227,231	21.4	59.9	12.8 - 299.5	0.009	0.021	0.006 - 0.132
Annual (BDMPS)	24,709	2,045,078	287,333	123.5	345.9	74.1 - 1,729.6	0.043	0.120	0.026 - 0.602
Annual (biogeographic)	24,709	4,125,000	579,563	123.5	345.9	74.1 - 1,729.6	0.021	0.060	0.013 - 0.298
LCI									
Breeding (Mar-Jul)	8,352	2,045,078	287,333	41.8	116.9	25.1 - 584.6	0.015	0.041	0.009 - 0.203

Bio-season (months)	Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during O&M phase.			Increase in baseline mortality (%) during construction phase.		
		Population	Baseline mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality
Post-breeding (Aug-Sep)	5,604	2,045,078	287,333	28.0	78.5	16.8 - 392.3	0.010	0.027	0.006 - 0.137
Non-breeding (Oct-Feb)	3,523	1,617,305	227,231	17.6	49.3	10.6 - 246.6	0.008	0.022	0.005 - 0.109
Annual (BDMPS)	17,479	2,045,078	287,333	87.4	244.7	52.4 - 1,223.5	0.030	0.085	0.018 - 0.426
Annual (biogeographic)	17,479	4,125,000	579,563	87.4	244.7	52.4 - 1,223.5	0.015	0.042	0.009 - 0.211
UCI									
Breeding (Mar-Jul)	15,606	2,045,078	287,333	78.0	218.5	46.8 - 1,092	0.020	0.055	0.016 - 0.380
Post-breeding (Aug-Sep)	16,011	2,045,078	287,333	80.1	224.1	48.0 - 1,1120.7	0.016	0.044	0.017- 0.390
Non-breeding (Oct-Feb)	5,226	1,617,305	227,231	26.1	73.2	15.7 – 365.8	0.009	0.026	0.007 - 0.161
Annual (BDMPS)	36,842	2,045,078	287,333	184.2	515.8	110.5 – 2,579.0	0.064	0.180	0.038 - 0.898

Bio-season (months)	Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during O&M phase.			Increase in baseline mortality (%) during construction phase.		
		Population	Baseline mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality
Annual (biogeographic)	36,842	4,125,000	579,563	184.2	515.8	110.5 – 2,579.0	0.032	0.089	0.019 - 0.089

Table 12.31: Bio-season displacement estimates for guillemot for the Project using design-based abundance estimates (Applicant's Approach). Lower and Upper Confidence intervals are presented (O&M phase).

Bio-season (months)	Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during O&M phase.			Increase in baseline mortality (%) during construction phase.		
		Population	Baseline mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality
Mean									
Breeding (Mar-Jul)	14,371	2,045,078	287,333	71.9	201.2	43.1 - 1,006.0	0.025	0.070	0.015 - 0.350
Non-breeding (Aug-Feb)	9,215	1,617,305	227,231	46.1	129.0	27.6 - 645.1	0.020	0.057	0.012 - 0.284
Annual (BDMPS)	23,586	2,045,078	287,333	117.9	330.2	70.8 - 1,651.0	0.041	0.115	0.025 - 0.575
Annual (biogeographic)	23,586	4,125,000	579,563	117.9	330.2	70.8 - 1,651.0	0.020	0.057	0.012 - 0.285
LCI									
Breeding (Mar-Jul)	10,765	2,045,078	287,333	53.8	150.7	32.3 - 753.6	0.019	0.052	0.011 - 0.262
Non-breeding (Aug-Feb)	6,979	1,617,305	227,231	34.9	97.7	20.9 - 488.5	0.015	0.043	0.009 - 0.215

Bio-season (months)	Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during O&M phase.			Increase in baseline mortality (%) during construction phase.		
		Population	Baseline mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality
Annual (BDMPS)	17,744	2,045,078	287,333	88.7	248.4	53.2 – 1,242.1	0.031	0.086	0.019 - 0.432
Annual (biogeographic)	17,744	4,125,000	579,563	88.7	248.4	53.2 – 1,242.1	0.015	0.043	0.009 - 0.214
UCI									
Breeding (Mar-Jul)	18,669	2,045,078	287,333	93.3	261.4	56.0 - 1,306.8	0.032	0.091	0.019 - 0.455
Non-breeding (Aug-Feb)	12,043	1,617,305	227,231	60.2	168.6	36.1 - 843.0	0.026	0.074	0.016 - 0.371
Annual (BDMPS)	30,712	2,045,078	287,333	153.6	430.0	92.1 - 2,149.8	0.053	0.150	0.032 - 0.748
Annual (biogeographic)	30,712	4,125,000	579,563	153.6	430.0	92.1 - 2,149.8	0.026	0.074	0.016 - 0.371

Table 12.32: Bio-season displacement estimates for guillemot for the Project using design-based abundance estimates (Natural England's approach). Lower and Upper Confidence intervals are presented (O&M phase).

Bio-season (months)	Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during O&M phase.			Increase in baseline mortality (%) during construction phase.		
		Population	Baseline mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality
Mean									
Breeding (Mar-Jul)	14,371	2,045,078	287,333	71.9	201.2	43.1 - 1,006.0	0.025	0.070	0.015 - 0.350
Post-breeding (Aug-Sep)	9,215	2,045,078	287,333	46.1	129.0	27.6 - 645.1	0.016	0.045	0.010 - 0.224
Non-breeding (Oct-Feb)	4,349	1,617,305	227,231	21.7	60.9	13.0 - 304.4	0.010	0.027	0.006 - 0.134
Annual (BDMPS)	27,935	2,045,078	287,333	139.7	391.1	83.8 - 1,955.5	0.049	0.136	0.029 - 0.681
Annual (biogeographic)	27,935	4,125,000	579,563	139.7	391.1	83.8 - 1,955.5	0.024	0.067	0.014 - 0.337
LCI									
Breeding (Mar-Jul)	10,765	2,045,078	287,333	53.8	150.7	32.3 - 753.6	0.019	0.052	0.011 - 0.262
Post-breeding (Aug-Sep)	6,979	2,045,078	287,333	34.9	97.7	20.9 - 488.5	0.012	0.034	0.007 - 0.170

Bio-season (months)	Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during O&M phase.			Increase in baseline mortality (%) during construction phase.		
		Population	Baseline mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality
Non-breeding (Oct-Feb)	3,511	1,617,305	227,231	17.6	49.2	10.5 - 245.8	0.008	0.022	0.005 - 0.108
Annual (BDMPS)	21,255	2,045,078	287,333	106.3	297.6	63.8 - 1,487.9	0.037	0.104	0.022 - 0.518
Annual (biogeographic)	21,255	4,125,000	579,563	106.3	297.6	63.8 - 1,487.9	0.018	0.051	0.011 - 0.257
UCI									
Breeding (Mar-Jul)	18,669	2,045,078	287,333	93.3	261.4	56.0 - 1,306.8	0.032	0.091	0.019 - 0.455
Post-breeding (Aug-Sep)	12,043	2,045,078	287,333	60.2	168.6	36.1 - 843.0	0.021	0.059	0.013 - 0.293
Non-breeding (Oct-Feb)	5,311	1,617,305	227,231	26.6	74.4	15.9 - 371.8	0.012	0.033	0.007 - 0.164
Annual (BDMPS)	36,023	2,045,078	287,333	180.1	504.3	108.1 - 2,521.6	0.063	0.176	0.038 - 0.878
Annual (biogeographic)	36,023	4,125,000	579,563	180.1	504.3	108.1 - 2,521.6	0.031	0.087	0.019 - 0.435

Table 12.33: Annual displacement matrix for guillemot within the Project array area plus 2km buffer (Applicant's Approach), values in light blue represent the range-based values advocated by SNCBs and the darker shade of blue representing the Applicant's approach value.

Annual (2km Buffer)	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	20	41	61	204	409	613	817	1,022	1,226	1,430	1,634	1,839	2,043
20	41	82	123	409	817	1,226	1,634	2,043	2,452	2,860	3,269	3,677	4,086
30	61	123	184	613	1,226	1,839	2,452	3,065	3,677	4,290	4,903	5,516	6,129
40	82	163	245	817	1,634	2,452	3,269	4,086	4,903	5,720	6,538	7,355	8,172
50	102	204	306	1,022	2,043	3,065	4,086	5,108	6,129	7,151	8,172	9,194	10,215
60	123	245	368	1,226	2,452	3,677	4,903	6,129	7,355	8,581	9,807	11,032	12,258
70	143	286	429	1,430	2,860	4,290	5,720	7,151	8,581	10,011	11,441	12,871	14,301
80	163	327	490	1,634	3,269	4,903	6,538	8,172	9,807	11,441	13,075	14,710	16,344
90	184	368	552	1,839	3,677	5,516	7,355	9,194	11,032	12,871	14,710	16,549	18,387
100	204	409	613	2,043	4,086	6,129	8,172	10,215	12,258	14,301	16,344	18,387	20,430

Table 12.34: Annual displacement matrix for guillemot within the Project array area plus 2km buffer (Natural England's Approach), values in light blue represent the range-based values advocated by SNCBs and the darker shade of blue representing the Natural England's approach value.

Annual (2km Buffer)	Mortality Rate (%)											
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	25	49	74	247	494	741	988	1,235	1,483	1,730	1,977	2,224	2,471
20	49	99	148	494	988	1,483	1,977	2,471	2,965	3,459	3,953	4,448	4,942
30	74	148	222	741	1,483	2,224	2,965	3,706	4,448	5,189	5,930	6,671	7,413
40	99	198	297	988	1,977	2,965	3,953	4,942	5,930	6,918	7,907	8,895	9,884
50	124	247	371	1,235	2,471	3,706	4,942	6,177	7,413	8,648	9,884	11,119	12,354
60	148	297	445	1,483	2,965	4,448	5,930	7,413	8,895	10,378	11,860	13,343	14,825
70	173	346	519	1,730	3,459	5,189	6,918	8,648	10,378	12,107	13,837	15,567	17,296
80	198	395	593	1,977	3,953	5,930	7,907	9,884	11,860	13,837	15,814	17,790	19,767
90	222	445	667	2,224	4,448	6,671	8,895	11,119	13,343	15,567	17,790	20,014	22,238
100	247	494	741	2,471	4,942	7,413	9,884	12,354	14,825	17,296	19,767	22,238	24,709

Razorbill

Potential magnitude of impact

240. A mortality rate of 1% and a displacement rate of 50%, were selected for assessment of razorbill. Based on SNCB guidance (MIG-Birds, 2022), an additional displacement range of 30% to 70% and a mortality rate range of 1% to 10% is presented in Table 12.35: (see review of displacement rates in document reference 19.10). The magnitude of this impact is assessed against BDMPS non-breeding season populations and breeding season populations (presented in Table 12.8) and relative to the baseline mortality values, which are based on age specific demographic rates and age class proportions presented in Table 12.9.

241. During the return migration bio-season, the mean peak abundance for razorbill is 5,134 individuals within the array area plus 2km buffer. Using a displacement rate range of 50% and a mortality rate 1% results in 26 (25.7) razorbills being subject to mortality during the return migration bio-season per annum. The regional population in the return migration bio-season is defined as 591,875 individuals and, using the average baseline mortality rate of 0.13 (Table 12.9), the natural predicted mortality in the return migration bio-season is 77,062 individuals per annum. The addition of 26 mortalities per annum would increase baseline mortality by 0.033%. Based on the Natural England preferred approach, using a displacement rate range of 70% and a mortality rate 2% results in 72 (71.9) razorbills being subject to mortality during the return migration bio-season per annum. This would increase baseline mortality by 0.093%.

242. This level of change is considered to be of negligible magnitude during the return migration bio-season, representing no discernible change to baseline mortality.

243. During the breeding bio-season, the mean peak abundance for razorbill is 3,159 individuals within the array area plus 2km buffer. Using a displacement rate range of 50% and a mortality rate 1% results in 16 (15.8) razorbills being subject to mortality during the breeding bio-season per annum. The regional population in the breeding bio-season is defined as 158,031 individuals and, using the average baseline mortality rate of 0.13 (Table 12.9), the natural predicted mortality in the breeding bio-season is 20,576 individuals per annum. The addition of 16 mortalities per annum would increase baseline mortality by 0.077%. Based on the Natural England preferred approach, using a displacement rate range of 70% and a mortality rate 2% results in 44 (44.2) razorbills being subject to mortality during the breeding bio-season per annum. This would increase baseline mortality by 0.215%.

244. This level of change is considered to be of negligible magnitude during the breeding bio-season, representing no discernible change to baseline mortality.

245. During the post-breeding migration bio-season, the mean peak abundance for razorbill is 2,185 individuals within the array area plus 2km buffer. Using a displacement rate range of 50% and a mortality rate 1% results in 11 (10.9) razorbills being subject to mortality during the post-breeding migration bio-season per annum. The regional population in the post-breeding migration bio-season is defined as 591,875 individuals and, using the average baseline mortality rate of 0.13 (Table 12.9), the natural predicted mortality in the post-breeding migration bio-season is 77,062 individuals per annum. The addition of 11 mortalities per annum would increase baseline mortality by 0.014%. Based on the Natural England preferred approach, using a displacement rate range of 70% and a mortality rate 2% results in 31 (30.6) razorbills being subject to mortality during the post-breeding migration bio-season per annum. This would increase baseline mortality by 0.04%.

246. This level of change is considered to be of negligible magnitude during the post-breeding migration bio-season, representing no discernible change to baseline mortality.

247. During the migration-free winter bio-season, the mean peak abundance for razorbill is 1,779 individuals within the array area plus 2km buffer. Using a displacement rate range of 50% and a mortality rate 1% results in nine (8.9) razorbills being subject to mortality during the migration-free winter bio-season per annum. The regional population in the migration-free winter bio-season is defined as 218,621 individuals and, using the average baseline mortality rate of 0.13 (Table 12.9), the natural predicted mortality in the migration-free winter bio-season is 28,464 individuals per annum. The addition of nine mortalities per annum would increase baseline mortality by 0.031%. Based on the Natural England preferred approach, using a displacement rate range of 70% and a mortality rate 2% results in 25 (24.9) razorbills being subject to mortality during the migration-free winter bio-season per annum. This would increase baseline mortality by 0.087%.

248. This level of change is considered to be of negligible magnitude during the migration-free winter bio-season, representing no discernible change to baseline mortality.

249. Across all bio-seasons combined, the total mean peak abundance for razorbill is 12,257 individuals. The predicted maximum number of razorbills subject to mortality due to displacement from the Project is 61 (61.3) individuals per annum, based on a displacement rate of 50% and a mortality rate of 1%. An annual displacement matrix for razorbill within the array area plus a 2km buffer is presented in Table 12.36: below. Using the largest UK North Sea and English Channel BDMPS of 591,875 individuals (Furness, 2015) and using the average baseline mortality rate of 0.13 (Table 12.9), the natural predicted mortality across all seasons is 77,062 per annum. The addition of 61 predicted mortalities would increase the baseline mortality rate by 0.080%. When considering displacement impacts at the wider biogeographic population scale, then of the 1,707,000 population the natural annual mortality rate would be 222,251 individuals per annum. The addition of 61 predicted mortalities would increase the biogeographic baseline mortality rate by 0.028%. Based on the Natural England preferred approach, using a displacement rate range of 70% and a mortality rate 2% results in 172 (171.6) razorbills being subject to mortality across all bio-seasons per annum. This would increase the BDMPS baseline mortality by 0.223% and the biogeographic baseline mortality rate by 0.077%.

250. Over the range of displacement and mortality scenarios assessed, the addition to baseline mortality remains well below 1% and can, therefore, be considered to make no material difference to the baseline mortality of this species.

251. This level of change is considered to be of negligible magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall, as it represents no discernible change to baseline mortality. Given a magnitude change of negligible, and a sensitivity to disturbance and displacement of moderate, the significance of effect is therefore concluded to be **minor adverse, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

252. Confidence in the conclusions of this assessment is high due to the precautionary displacement and mortality rates used (see document reference 19.10), the site-specific dataset, and the likelihood of habituation to WTGs over the lifespan of the project.

Table 12.35: Bio-season displacement estimates for razorbill for the Project (O&M phase).

Bio-season (months)	Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during O&M phase.			Increase in baseline mortality (%) during construction phase.		
		Population	Baseline mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality
Mean									
Return migration (Jan-Mar)	5,134	591,875	77,062	25.7	71.9	15.4 - 359.4	0.033	0.093	0.020 - 1.075
Breeding (Apr-Jul)	3,159	158,031	20,576	15.8	44.2	9.5 - 221.1	0.077	0.215	0.046 - 1.075
Post-breeding migration (Aug- Oct)	2,185	591,875	77,062	10.9	30.6	6.6 - 153.0	0.014	0.040	0.009 - 0.198
Migration-free winter (Nov-Dec)	1,779	218,621	28,464	8.9	24.9	5.3 - 124.5	0.031	0.087	0.019 - 0.437
Annual (BDMPS)	12,257	591,875	77,062	61.3	171.6	36.8 - 858.0	0.080	0.223	0.048 - 1.113
Annual (biogeographic)	12,257	1,707,000	222,251	61.3	171.6	36.8 - 858.0	0.028	0.077	0.017 - 0.386
LCI									

Bio-season (months)	Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during O&M phase.			Increase in baseline mortality (%) during construction phase.		
		Population	Baseline mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality
Return migration (Jan-Mar)	3,575	591,875	77,062	17.9	50.1	10.7 - 250.3	0.023	0.065	0.014 - 0.325
Migration-free breeding (Apr-Jul)	1,935	158,031	20,576	9.7	27.1	5.8 - 135.5	0.047	0.132	0.028 - 0.658
Post-breeding migration (Aug- Oct)	932	591,875	77,062	4.7	13.0	2.8 - 65.2	0.006	0.017	0.004 - 0.085
Migration-free winter (Nov-Dec)	1,338	218,621	28,464	6.7	18.7	4.0 - 93.7	0.024	0.066	0.014 - 0.329
Annual (BDMPS)	7,780	591,875	77,062	38.9	108.9	23.3 - 544.6	0.050	0.141	0.030 - 0.707
Annual (biogeographic)	7,780	1,707,000	222,251	38.9	108.9	23.3 - 544.6	0.018	0.049	0.011 - 0.245
UCI									

Bio-season (months)	Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during O&M phase.			Increase in baseline mortality (%) during construction phase.		
		Population	Baseline mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality
Return migration (Jan-Mar)	6,800	591,875	77,062	34.0	95.2	20.4 - 476.0	0.044	0.124	0.026 - 0.618
Breeding (Apr-Jul)	4,712	158,031	20,576	23.6	66.0	14.1 - 329.8	0.115	0.321	0.069 - 1.603
Post-breeding migration (Aug- Oct)	3,847	591,875	77,062	19.2	53.9	11.5 - 269.3	0.025	0.070	0.015 - 0.349
Migration-free winter (Nov-Dec)	2,253	218,621	28,464	11.3	31.5	6.8 - 157.7	0.040	0.111	0.024 - 0.554
Annual (BDMPS)	17,612	591,875	77,062	88.1	246.6	52.8 - 1,232.8	0.114	0.320	0.069 - 1.600
Annual (biogeographic)	17,612	1,707,000	222,251	88.1	246.6	52.8 - 1,232.8	0.040	0.111	0.024 - 0.555

Table 12.36: Annual displacement matrix for razorbill within the Project array area plus 2km buffer, values in light blue represent the range-based values advocated by SNCBs, the darker shade of blue representing the Applicant's approach value and grey representing the Natural England preferred approach.

Return migration (2km Buffer)	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	12	25	37	123	245	368	490	613	735	858	981	1,103	1,226
20	25	49	74	245	490	735	981	1,226	1,471	1,716	1,961	2,206	2,451
30	37	74	110	368	735	1,103	1,471	1,839	2,206	2,574	2,942	3,309	3,677
40	49	98	147	490	981	1,471	1,961	2,451	2,942	3,432	3,922	4,413	4,903
50	61	123	184	613	1,226	1,839	2,451	3,064	3,677	4,290	4,903	5,516	6,129
60	74	147	221	735	1,471	2,206	2,942	3,677	4,413	5,148	5,883	6,619	7,354
70	86	172	257	858	1,716	2,574	3,432	4,290	5,148	6,006	6,864	7,722	8,580
80	98	196	294	981	1,961	2,942	3,922	4,903	5,883	6,864	7,844	8,825	9,806
90	110	221	331	1,103	2,206	3,309	4,413	5,516	6,619	7,722	8,825	9,928	11,031
100	123	245	368	1,226	2,451	3,677	4,903	6,129	7,354	8,580	9,806	11,031	12,257

Puffin

Potential magnitude of impact

253. A mortality rate of 1% and a displacement rate of 50%, were selected for assessment of puffin. Based on SNCB guidance (MIG-Birds, 2022), an additional displacement range of 30% to 70% and a mortality rate range of 1% to 10% is presented in Table 12.39:. The magnitude of this impact is assessed against BDMPS non-breeding season populations and breeding season populations (presented in Table 12.8) and relative to the baseline mortality values, which are based on age specific demographic rates and age class proportions presented in Table 12.9.

254. During the breeding bio-season, the mean peak abundance for puffins is 666 individuals within the array area plus 2km buffer. Using a displacement rate range of 50% and a mortality rate 1% results in three (3.3) puffins being subject to mortality during the breeding bio-season per annum. The regional population in the breeding bio-season is defined as 868,689 individuals and, using the average baseline mortality rate of 0.12 (Table 12.9), the natural predicted mortality in the breeding bio-season is 103,374 individuals per annum. The addition of five mortalities per annum would increase baseline mortality by 0.003%. Based on the Natural England preferred approach, using a displacement rate range of 70% and a mortality rate 2% results in nine (9.3) puffin being subject to mortality during the breeding bio-season per annum. This would increase baseline mortality by 0.009%.

255. This level of change is considered to be of negligible magnitude during the breeding bio-season, representing no discernible change to baseline mortality.

256. During the non-breeding bio-season, the mean peak abundance for puffins is 414 individuals within the array area plus 2km buffer. Using a displacement rate range of 50% and a mortality rate 1% results in two (2.1) puffins being subject to mortality during the non-breeding bio-season per annum. The regional population in the non-breeding bio-season is defined as 231,958 individuals and, using the average baseline mortality rate of 0.12 (Table 12.9), the natural predicted mortality in the non-breeding bio-season is 27,603 individuals per annum. The addition of three mortalities per annum would increase baseline mortality by 0.007%. Based on the Natural England preferred approach, using a displacement rate range of 70% and a mortality rate 2% results in six (5.8) puffin being subject to mortality during the non-breeding bio-season per annum. This would increase baseline mortality by 0.021%.

257. This level of change is considered to be of negligible magnitude during the breeding bio-season, representing no discernible change to baseline mortality.

258. Across all bio-seasons combined, the total mean peak abundance for puffin is 1,080 individuals. The predicted maximum number of puffins subject to mortality due to displacement from the Project is five (5.4) individuals per annum, based on a displacement rate of 50% and a mortality rate of 1%. An annual displacement matrix for puffin within the array area plus a 2km buffer is also presented in Table 12.38: below. Using the largest UK North Sea and English Channel BDMPS of 868,689 individuals (Furness, 2015) and using the average baseline mortality rate of 0.12 (Table 12.9), the natural predicted mortality across all seasons is 103,374 per annum. The addition of five predicted mortalities would increase the baseline mortality rate by 0.005%. When considering displacement impacts at the wider biogeographic population scale, then of the 11,840,000 population the natural annual mortality rate would be 1,408,960 individuals per annum. The addition of eight predicted mortalities would increase the biogeographic baseline mortality rate by less than 0.001%. Based on the Natural England preferred approach, using a displacement rate range of 70% and a mortality rate 2% results in 15 (15.1) puffin being subject to mortality across all bio-seasons per annum. This would increase the BDMPS baseline mortality by 0.015% and the biogeographic baseline mortality rate by 0.001%.

259. Over the range of displacement and mortality scenarios assessed, the addition to baseline mortality remains well below 1% and can, therefore, be considered to make no material difference to the baseline mortality of this species.

260. This level of change is considered to be of negligible magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall, as it represents no discernible change to baseline mortality. Given a magnitude change of negligible, and a sensitivity to disturbance and displacement of moderate, the significance of effect is therefore concluded to be **minor adverse, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

261. Confidence in the conclusions of this assessment is high due to the precautionary displacement and mortality rates used, the site-specific dataset, the very low level of impact predicted. and the possibility of habituation to WTGs over the lifespan of the project.

Table 12.37: Bio-season displacement estimates for puffin for the Project (O&M phase).

Bio-season (months)	Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during O&M phase.			Increase in baseline mortality (%) during construction phase.		
		Population	Baseline mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality
Mean									
Breeding (Apr-Jul)	666	868,689	103,374	3.3	9.3	2.0 – 46.6	0.003	0.009	0.002 – 0.045
Non-breeding (Aug-Mar)	414	231,958	27,603	2.1	5.8	1.2 – 29.0	0.007	0.021	0.004 – 0.105
Annual (BDMPS)	1,080	868,689	103,374	5.4	15.1	3.2 – 75.6	0.005	0.015	0.003 – 0.073
Annual (biogeographic)	1,080	11,840,000	1,408,960	5.4	15.1	3.2 – 75.6	0.000	0.001	0.000 – 0.005
LCI									
Breeding (Apr-Jul)	419	868,689	103,374	2.1	5.9	1.3 - 29.3	0.002	0.006	0.001 - 0.028
Non-breeding (Aug-Mar)	293	231,958	27,603	1.5	4.1	0.9 - 20.5	0.005	0.015	0.003 - 0.074
Annual (BDMPS)	712	868,689	103,374	3.6	10.0	2.1 - 49.8	0.003	0.010	0.002 - 0.048

Bio-season (months)	Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during O&M phase.			Increase in baseline mortality (%) during construction phase.		
		Population	Baseline mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality	50% displacement, 1% mortality	70% displacement, 2% mortality	30-70% displacement, 1-10% mortality
Annual (biogeographic)	712	11,840,000	1,408,960	3.6	10.0	2.1 - 49.8	0.000	0.001	0.000 - 0.004
UCI									
Breeding (Apr-Jul)	960	868,689	103,374	4.8	13.4	2.9 - 67.2	0.005	0.013	0.003 - 0.065
Non-breeding (Aug-Mar)	570	231,958	27,603	2.9	8.0	1.7 - 39.9	0.010	0.029	0.006 - 0.145
Annual (BDMPS)	1,530	868,689	103,374	7.7	21.4	4.6 - 107.1	0.007	0.021	0.004 - 0.104
Annual (biogeographic)	1,530	11,840,000	1,408,960	7.7	21.4	4.6 - 107.1	0.001	0.002	0.000 - 0.008

Table 12.38: Annual displacement matrix for puffin within the Project array area plus 2km buffer, values in light blue represent the range-based values advocated by SNCBs and the darker shade of blue representing the Applicant's approach value and grey representing the Natural England preferred approach.

Annual (2km Buffer)	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	2	3	11	22	32	43	54	65	76	86	97	108
20	2	4	6	22	43	65	86	108	130	151	173	194	216
30	3	6	10	32	65	97	130	162	194	227	259	292	324
40	4	9	13	43	86	130	173	216	259	302	346	389	432
50	5	11	16	54	108	162	216	270	324	378	432	486	540
60	6	13	19	65	130	194	259	324	389	454	518	583	648
70	8	15	23	76	151	227	302	378	454	529	605	680	756
80	9	17	26	86	173	259	346	432	518	605	691	778	864
90	10	19	29	97	194	292	389	486	583	680	778	875	972
100	11	22	32	108	216	324	432	540	648	756	864	972	1,080

Gannet

262. Gannet show a low level of sensitivity to ship and helicopter traffic (Garthe and Hüppop, 2004; Furness and Wade, 2012). A study by Krijgsveld *et al*. (2011) using radar and visual observations to monitor the post-construction effects of the OWEZ established that 64% of gannet avoided entering the windfarm (macro-avoidance). The results of the post-consent monitoring surveys for Thanet OWF found that gannet densities reduced within the site in the third year, but the report did not quantify this (Royal HaskoningDHV, 2013). A more recent study by APEM (APEM, 2014) provided evidence that during their migration most gannet would avoid flying into areas with operational WTGs (macro-avoidance), with the estimated macro-avoidance being 95%.

263. Based on available evidence, a displacement rate of 70% is presented by the Applicant. However, to reflect the most recent SNCB guidance (MIG-Birds 2022), a range of 60-80% is also presented.

264. A mortality rate of 1% was selected based on expert judgement supported by additional evidence that suggests that gannet have a large mean-maximum (315km) and maximum (709km) foraging range (Woodward *et al*., 2019) and feed on a variety of different prey items that provide sufficient alternative foraging opportunities despite the potential loss of habitat within the Project array area and 2km buffer. This is further supported by information provided in Furness *et al*. (2013), which gives gannet a habitat use flexibility score of 1, indicating high flexibility in habitat use, and therefore indicating a low risk of mortality as a result of displacement impacts from the Project.

Potential magnitude of impact

265. A mortality rate of 1% and a displacement rate of 70%, were selected for assessment of gannet. Based on SNCB guidance (MIG-Birds, 2022), an additional displacement range of 60% to 80% is presented in Table 12.39:. The magnitude of this impact is assessed against BDMPS non-breeding season populations (presented in Table 12.17:) and breeding season populations (presented in Table 12.8) and relative to the baseline mortality values, which are based on age specific demographic rates and age class proportions presented in Table 12.9.

266. During the return migration bio-season, the mean peak abundance for gannet is 69 individuals within the array area plus 2km buffer. Using a displacement rate range of 70% and a mortality rate 1% results in one (0.5) gannet being subject to mortality during the return migration bio-season per annum. The regional population in the return migration bio-season is defined as 248,385 individuals and, using the average baseline mortality rate of 0.19 (Table 12.9), the natural predicted mortality in the return migration bio-season is 46,349 individuals per annum. The addition of one mortality per annum would increase baseline mortality by 0.001%.

267. This level of change is considered to be of negligible magnitude during the return migration bio-season, representing no discernible change to baseline mortality.

268. During the breeding bio-season, the mean peak abundance for gannet is 554 individuals within the array area plus 2km buffer. Using a displacement rate range of 70% and a mortality rate 1% results in four (3.9) gannet being subject to mortality during the breeding bio-season per annum. The regional population in the breeding bio-season is defined as 400,326 individuals and, using the average baseline mortality rate of 0.19 (Table 12.9), the natural predicted mortality in the migration-free breeding bio-season is 74,701 individuals per annum. The addition of four mortalities per annum would increase baseline mortality by 0.005%

269. This level of change is considered to be of negligible magnitude during the breeding bio-season, representing no discernible change to baseline mortality.

270. During the post-breeding migration bio-season, the mean peak abundance for gannet is 496 individuals within the array area plus 2km buffer. Using a displacement rate range of 70% and a mortality rate 1% results in four (3.5) gannet being subject to mortality during the post-breeding migration bio-season per annum. The regional population in the post-breeding migration bio-season is defined as 456,299 individuals and, using the average baseline mortality rate of 0.19 (Table 12.9), the natural predicted mortality in the post-breeding migration bio-season is 85,145 individuals per annum. The addition of four predicted mortalities per annum would increase baseline mortality by 0.004%

271. This level of change is considered to be of negligible magnitude during the post-breeding migration bio-season, representing no discernible change to baseline mortality.

272. Across all bio-seasons combined, the total mean peak abundance for gannet is 1,119 individuals. The predicted maximum number of gannet subject to mortality due to displacement from the Project is eight (7.8) individuals per annum, based on a displacement rate of 70% and a mortality rate of 1%. An annual displacement matrix for gannet within the array area plus a 2km buffer is presented in Table 12.40: below. Using the largest UK North Sea and English Channel BDMPS of 456,299 individuals (Furness, 2015) and using the average baseline mortality rate of 0.19 (Table 12.9), the natural predicted mortality across all seasons is 85,145 per annum. The addition of eight predicted mortalities would increase the baseline mortality rate by 0.009%. When considering displacement impacts at the wider biogeographic population scale, then of the 1,180,000 population the natural annual mortality rate would be 220,188 individuals per annum. The addition of eight predicted mortalities would increase the biogeographic baseline mortality rate by 0.004%.

273. Over the range of displacement and mortality scenarios assessed, the addition to baseline mortality remains well below 1% and can, therefore, be considered to make no material difference to the baseline mortality of the species.

274. This level of change is considered to be of negligible magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall, as it represents no discernible change to baseline mortality. Given a magnitude change of negligible, and a sensitivity to disturbance and displacement of minor to moderate, the significance of effect is therefore concluded to be **minor adverse, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

275. Confidence in the conclusions of this assessment is high due to the precautionary displacement and mortality rates used, the use of a site-specific dataset, the small scale of the predicted impact, and the flexibility of potentially displaced gannet to travel to, and forage in new areas.

Table 12.39: Bio-season displacement estimates for gannet for the Project (O&M phase).

Bio-season (months)	Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during O&M phase.		Increase in baseline mortality (%) during construction phase.	
		Population	Baseline mortality	70% displacement, 1% mortality	60-80% displacement, 1% mortality	70% displacement, 1% mortality	60-80% displacement, 1% mortality
Mean							
Return migration (Dec-Mar)	69	248,385	46,349	0.5	0.4 - 0.6	0.001	0.001 - 0.001
Migration-free breeding (Apr-Aug)	554	400,326	74,701	3.9	3.3 - 4.4	0.005	0.004 - 0.006
Post-breeding migration (Sep-Nov)	496	456,299	85,145	3.5	3.0 - 4.0	0.004	0.003 - 0.005
Annual (BDMPS)	1,119	456,299	85,145	7.8	6.7 - 8.9	0.009	0.008 - 0.011
Annual (biogeographic)	1,119	1,180,000	220,188	7.8	6.7 - 8.9	0.004	0.003 - 0.004
LCI							
Return migration (Dec-Mar)	41	248,385	46,349	0.3	0.2 - 0.3	0.001	0.001 - 0.001

Bio-season (months)	Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during O&M phase.		Increase in baseline mortality (%) during construction phase.	
		Population	Baseline mortality	70% displacement, 1% mortality	60-80% displacement, 1% mortality	70% displacement, 1% mortality	60-80% displacement, 1% mortality
Migration-free breeding (Apr-Aug)	316	400,326	74,701	2.2	1.9 - 2.5	0.003	0.003 - 0.003
Post-breeding migration (Sep-Nov)	280	456,299	85,145	2.0	1.7 - 2.2	0.002	0.002 - 0.003
Annual (BDMPS)	637	456,299	85,145	4.5	3.8 - 5.1	0.005	0.004 - 0.006
Annual (biogeographic)	637	1,180,000	220,188	4.5	3.8 - 5.1	0.002	0.002 - 0.002
UCI							
Return migration (Dec-Mar)	103	248,385	46,349	0.7	0.6 - 0.8	0.002	0.001 - 0.002
Migration-free breeding (Apr-Aug)	829	400,326	74,701	5.8	5.0 - 0.0	0.008	0.007 - 0.009
Post-breeding migration (Sep-Nov)	767	456,299	85,145	5.4	4.6 - 6.1	0.006	0.005 - 0.007

Bio-season (months)	Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated mortality level during O&M phase.		Increase in baseline mortality (%) during construction phase.	
		Population	Baseline mortality	70% displacement, 1% mortality	60-80% displacement, 1% mortality	70% displacement, 1% mortality	60-80% displacement, 1% mortality
Annual (BDMPS)	1,699	456,299	85,145	11.9	10.2 - 13.6	0.014	0.012 - 0.016
Annual (biogeographic)	1,699	1,180,000	220,188	11.9	10.2 - 13.6	0.005	0.005 - 0.006

Table 12.40: Annual displacement matrix for gannet within the Project array area plus 2km buffer, values in light blue represent the range-based values advocated by SNCBs and the darker shade of blue representing the Applicant's approach value.

Annual (2km Buffer)	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	2	3	11	22	34	45	56	67	78	89	101	112
20	2	4	7	22	45	67	89	112	134	157	179	201	224
30	3	7	10	34	67	101	134	168	201	235	268	302	336
40	4	9	13	45	89	134	179	224	268	313	358	403	447
50	6	11	17	56	112	168	224	280	336	392	447	503	559
60	7	13	20	67	134	201	268	336	403	470	537	604	671
70	8	16	23	78	157	235	313	392	470	548	626	705	783
80	9	18	27	89	179	268	358	447	537	626	716	805	895
90	10	20	30	101	201	302	403	503	604	705	805	906	1,007
100	11	22	34	112	224	336	447	559	671	783	895	1,007	1,119

12.9.2 Collision risk: array area

Overview

276. There is potential risk to birds from offshore windfarms through collision with WTGs resulting in injury or fatality. This may occur when birds fly through the Project array area whilst foraging for food, commuting between breeding sites and foraging areas, or during migration.

277. Collision risk modelling (CRM) has been carried out for the Project, with detailed methods and results presented in Volume 3, Appendix 12.2: Collision Risk Modelling Assessment, to provide information for seabird species of interest identified as potentially at risk and of interest for impact assessment.

278. To determine which species were of interest for the CRM assessment, a screening exercise was undertaken, considering the abundance and frequency of species recorded flying within the array area, and their vulnerability from collision (identified from published literature, notably Bradbury *et al*., 2014). Species were screened out if they their risk of collision was considered very low, such as fulmar that fly very close to the sea surface and are unlikely to interact with WTGs, and/or if their densities in flight within the array area were low, indicating a low risk of collision. Results of the screening exercise are presented in Table 12.41: below.

Table 12.41: Screening of seabird species recorded within the Project array area and 4km buffer for risk of collision during the O&M phase.

Receptor	Sensitivity to collision*	Relative frequency in the array area	Relative abundance in the array area	Screening result (in or out)
Common scoter	Minor	Low	Low	Out
Oystercatcher	Minor	Low	Low	Out
Kittiwake	Moderate	High	High	In
Great black-backed gull	Major	Medium	Medium	In
Herring gull	Major	Medium	Medium	In
Lesser black-backed gull	Major	Medium	Medium	In
Common gull	Moderate	Medium	Low	Out
Little gull	Minor	Low to Medium	Low	In
Black-headed gull	Moderate	Low to Medium	Low	Out

Receptor	Sensitivity to collision*	Relative frequency in the array area	Relative abundance in the array area	Screening result (in or out)
Sandwich tern	Minor	Low to Medium	Low to Medium	In
Common tern	Minor	Low	Medium	In
Arctic tern	Minor	Low	Low	Out
Arctic skua	Moderate	Low	Low	Out
Great skua	Moderate	Low	Low	Out
Guillemot	Minor	High	High	Out
Razorbill	Minor	High	High	Out
Puffin	Minor	High	Medium to High	Out
Little auk	Minor	Low	Low	Out
Red-throated diver	Minor	Medium	Low to Medium	Out
Great northern diver	Minor	Low	Low	Out
Manx shearwater	Minor	Low	Low	Out
Fulmar	Minor	Medium	Low	Out
Gannet	Moderate	High	Medium	In
Shag	Minor	Low	Low	Out

*Bradbury *et al.,* 2014; Dierschke *et al*., 2016.

279. Following screening, six species were included in CRM analysis: gannet, kittiwake, herring gull, great black-backed gull, lesser black-backed gull, and Sandwich tern. Additionally, as agreed through the evidence plan process, little gull and common tern were assessed using broad front modelling for migratory collision.

280. The CRM assessment was undertaken for each screened in species using the stochastic CRM (sCRM), developed by Marine Scotland (McGregor, 2018). The development and testing of the sCRM was funded by Marine Scotland Science (MSS) and provides the most up-to date version of the CRM originally created by Band (2012) and addresses the uncertainty in developments and other key input parameters as progressed initially by Masden (2015). This method is supported by Natural England in their most recent interim CRM guidance (Natural England, 2022a), with the key difference to the previously used basic band model being the incorporation of uncertainty in input parameters (i.e. WTG parameters, bird densities, bird biometrics and behaviours) and output parameters (i.e. collision estimates) by running at least 1,000 iterations of the model. On each run, the model randomly assigns values for each parameter from a set distribution. This results in a mean collision rate and a variance around the mean presented as 95% confidence intervals.

281. Corrected bootstrap density estimates for birds in flight derived from the Project DAS data were used as an input to the sCRM tool (as opposed to using a mean and standard deviation), with densities pooled from surveys conducted in the same calendar months. For comparison, collision impacts calculated from mean densities and associated SD are provided in Appendix 2 of Volume 3, Chapter 12.2 Collision Risk Modelling (document reference: 6.3.12.2).

282. The assessment is based on Band CRM Option 2, as advocated in recent guidance from Natural England (Parker *et al*., 2022c). This option uses generic estimates of flight height for each species based on the percentage of birds flying at PCH derived from data from a number of offshore windfarm sites, presented in Johnston *et al*. (2014). Modelling was undertaken based on parameters outlined in the MDS (Table 12.10:).

283. CRM accounts for several different species-specific behavioural aspects of the seabirds being assessed, including the height at which birds fly, their ability to avoid moving or static structures and how active they are diurnally and nocturnally. Parameters used were based on the most recent interim guidance from Natural England (Natural England, 2022a), accounting for updates to avoidance rates and nocturnal activity factors provided in this recent guidance. These values are presented in Table 12.42: below, though a full overview of CRM input parameters and results is provided in (Volume 3, Appendix 12.2: Collision Risk Modelling Assessment Annex).

284. It should be noted that, based on available evidence, these parameters are precautionary. Regarding avoidance rates, research funded by the Offshore Renewables Joint Industry Programme (ORJIP), studied birds around Thanet OWF over two years (between 2014 and 2016). The study found that of 12,000 birds recorded during the two-year period, only six birds (all gull species) were reported to have collided with WTGs (Skov *et al*., 2018). Further review undertaken for gannet by both Cook (2018) and APEM (2014) have found that measured gannet avoidance rates are likely higher than the rate used, with APEM reporting an actual avoidance rate as high as 100% during migratory periods (though a rate of 0.995 was suggested as more realistically appropriate).

285. Additionally, a recent report undertaken at Aberdeen Offshore Windfarm Limited (AOWFL, 2023) at the European Offshore Wind Development Centre (EOWDC) found that collision rates of birds are likely to be significantly lower than predicted based on input parameters, implying further precaution of the current methodology used. The two-year study used a combination of radar and video analysis to look at WTG avoidance and found that no collisions or even narrow escapes were recorded in over 10,000 bird videos, highlighting that avoidance rates are likely to be even higher in reality.

286. Considering flight speeds, a review undertaken for Norfolk Boreas Offshore Windfarm (Royal HaskoningDHV, 2020) estimate that the flight speed of 13.1m/sec used for kittiwake is an overestimate, and that a value of 10.8m/s (± 0.9) is more realistic based on a range of monitoring methods. A study undertaken by Skov *et al*. (2018) estimated an even lower value of 8.7m/s (±3.2) to be more appropriate, and also suggested a value of 13.3m/s (±4.2) would be more appropriate for gannet than the currently used 14.9m/s, and a value of 9.8m/s (± 3.6) for large gull species. This data was based on large sample sizes of bird species recorded in Thanet OWF. The assessment presented within this ES has followed the Natural England guidance, however, if these lower flight speeds and lower nocturnal activity factors were used in the models then the collision rates would be lowered considerably (e.g. >30% based on the evidenced lower kittiwake flight speed). As a result, this assessment is considered precautionary.

Table 12.42: Seabird parameters used in the CRM assessment

Species	Avoidance rate (± SD)	Nocturnal activity factor (± SD)	Flight speed (m/s) (± SD)
Kittiwake	0.993 (±0.0003)	0.375 (± 0.0637)	13.1 (± 0.4)
Great black-backed gull	0.994 (± 0.0004)	0.375 (± 0.0637)	13.7 (± 1.2)
Herring gull	0.994 (± 0.0004)	0.375 (± 0.0637)	12.8 (± 1.8)
Lesser black-backed gull	0.994 (± 0.0004)	0.375 (± 0.0637)	13.1 (± 1.9)
Sandwich tern	0.991 (± 0.0004)	0.000 (± 0.0000)	10.3 (± 3.4)
Gannet	0.993 (± 0.0003)	0.080 (± 0.1000)	14.9 (± 0.0)

287. For gannet, predicted collision mortalities are further adjusted based on reported macro-avoidance behaviour displayed in this species, following Natural England interim guidance on CRM (Natural England, 2022a). A single rate of 70% is used in the analysis and presented below.

Results

288. The CRM outputs for each species include a mean estimated collision mortality for each month, along with standard deviations to incorporate uncertainty in the estimates. These results are presented in Table 12.43: below for screened in species. A full overview of these results is provided in Volume 3, Appendix 12.2: Collision Risk Modelling Assessment Annex.

289. Monthly collision estimates are grouped into seasonal mortality estimates for each species, based on bio-seasons presented in Table 12.7. The magnitude of estimated impacts are assessed against BDMPS non-breeding season populations and breeding season populations (presented in Table 12.8) and relative to the baseline mortality values, which are based on age specific demographic rates and age class proportions presented in Table 12.9.

290. Collisions of little gull and common tern have been further considered through migratory CRM analyses and, as such, are not covered further in this section.

Table 12.43: Monthly mean collision estimates (plus 95% confidence intervals) for key seabird species.

Option 2	Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Total**
Kittiwake	Mean	1.1	1.9	5.9	10.0	4.0	2.4	2.0	2.9	1.0	0.4	0.6	1.1	**33.2**
	2.5% CI	0.1	0.6	2.3	3.5	0.4	0.5	0.1	0.3	0.0	0.1	0.2	0.4	**8.3**
	97.5% CI	3.3	3.7	13.6	21.3	13.5	7.0	7.0	9.6	3.1	1.0	1.1	2.1	**86.2**
Great black-backed gull	Mean	1.3	0.0	0.3	0.0	0.0	0.1	0.0	0.4	0.6	0.3	0.6	0.5	**4.0**
	2.5% CI	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**
	97.5% CI	5.4	0.0	0.9	0.0	0.0	0.8	0.0	1.6	2.1	0.9	1.8	1.4	**15.0**
Herring gull	Mean	0.3	0.0	0.3	0.2	0.2	1.2	0.3	0.0	0.0	0.0	0.1	0.3	**2.9**
	2.5% CI	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**
	97.5% CI	1.1	0.0	1.1	1.2	0.9	4.3	1.4	0.0	0.0	0.0	0.5	1.3	**11.8**
Lesser black-backed gull	Mean	0.0	0.0	0.1	0.3	0.1	0.9	0.2	0.5	0.0	0.1	0.1	0.0	**2.4**
	2.5% CI	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**
	97.5% CI	0.0	0.0	0.8	1.4	0.5	3.8	1.0	3.4	0.0	0.6	0.5	0.0	**12.0**
Sandwich tern	Mean	0.0	0.0	0.0	0.1	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	**0.4**
	2.5% CI	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.2**
	97.5% CI	0.0	0.0	0.0	0.4	1.1	0.5	0.0	0.1	0.1	0.0	0.0	0.0	**2.2**
Gannet[3]	Mean	0.0	0.1	0.1	0.4	0.2	0.1	0.1	0.1	0.1	0.1	0.3	0.0	**1.7**
	2.5% CI	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.2**
	97.5% CI	0.3	0.8	1.4	4.2	4.5	1.5	1.9	1.3	1.0	1.5	4.0	0.0	**22.5**

Kittiwake

Potential magnitude of impact

291. The monthly estimated mortality rates are presented in Table 12.43:, which vary from a minimum mean of less than one (0.4) individuals in October to a maximum mean of ten (10.0) individuals in April. On an annual basis, the estimated mortality rate for collision risk from the Project is 33 (33.2) individuals, which is further broken down into relevant bio-seasons in Table 12.44:.

Table 12.44: Bio-season collision risk estimates for kittiwake for the Project.

Bio-season (months)	Mean collisions	Regional baseline populations and baseline mortality rates (individuals per annum)		Increase in baseline mortality (%)
		Population	Baseline mortality	
Mean				
Return migration (Jan-Feb)	2.9	627,814	99,006	0.003
Breeding (Mar-Aug)	27.2	839,456	132,382	0.021
Post-breeding migration (Sep-Dec)	3.0	829,938	130,881	0.002
Annual (BDMPS)	33.2	839,456	132,382	0.025
Annual (biogeographic)	33.2	5,100,000	804,270	0.004
LCI				
Return migration (Jan-Feb)	0.7	627,814	99,006	0.001
Breeding (Mar-Aug)	7.0	839,456	132,382	0.005
Post-breeding migration (Sep-Dec)	0.7	829,938	130,881	0.001
Annual (BDMPS)	8.3	839,456	132,382	0.006
Annual (biogeographic)	8.3	5,100,000	804,270	0.001
UCI				
Return migration (Jan-Feb)	7.0	627,814	99,006	0.007
Breeding (Mar-Aug)	72.0	839,456	132,382	0.054
Post-breeding migration (Sep-Dec)	7.2	829,938	130,881	0.006
Annual (BDMPS)	86.2	839,456	132,382	0.065
Annual (biogeographic)	86.2	5,100,000	804,270	0.011

292. During the return migration bio-season, three (2.9) kittiwake may be subject to collision mortality. The regional population in the return migration bio-season is defined as 627,814 individuals and using an average baseline mortality rate of 0.16 (Table 12.9), the natural predicted mortality in the return migration bio-season is 99,006 individuals per annum. The addition of three predicted mortalities during the return migration bio-season would increase the baseline mortality rate by 0.003%.

293. This level of potential impact is considered to be of negligible magnitude during the return migration bio-season, as it represents no discernible increase to baseline mortality levels due to the small number of estimated collisions.

294. During the breeding bio-season, 27 (27.2) kittiwake may be subject to mortality. The regional population in the breeding bio-season is defined as 839,456 individuals and using an average baseline mortality rate of 0.16, the natural predicted mortality in the breeding bio-season is 132,382 individuals per annum. The addition of 27 predicted mortalities during the migration-free breeding bio-season would increase the baseline mortality rate by 0.021%.

295. This level of potential impact is considered to be of negligible magnitude during the breeding bio-season, as it represents no discernible increase to baseline mortality levels due to the small number of estimated collisions.

296. During the post-breeding migration bio-season, three (3.0) kittiwake may be subject to mortality. The regional population in the return migration bio-season is defined as 829,938 individuals and using an average baseline mortality rate of 0.16, the natural predicted mortality in the post-breeding migration bio-season is 130,881 individuals per annum. The addition of three predicted mortalities during the post-breeding migration bio-season would increase the baseline mortality rate by 0.002%.

297. This level of potential impact is considered to be of negligible magnitude during the post-breeding migration bio-season, as it represents no discernible increase to baseline mortality levels due to the small number of estimated collisions.

298. The annual total of kittiwake subject to mortality due to collision is estimated to be 33 (33.2) individuals. Using the largest BDMPS population of 839,456 with an average baseline mortality of 0.16, the natural predicted mortality is 132,382 per annum. The addition of 33 individuals would increase the baseline mortality rate by 0.025%. When considering the annual potential level of impact at the biogeographic scale, the natural predicted mortality for the biogeographic population of 5,100,000 individuals across all seasons is 804,270 individuals per annum. The addition of 33 predicted mortalities would increase baseline mortality by 0.004%.

299. This level of change is considered to be of negligible magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall, as it represents no discernible change to baseline mortality. Given a magnitude change of negligible, and a sensitivity to collision of moderate, the significance of effect is therefore concluded to be **minor adverse, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

300. Confidence in the conclusions of this assessment is high, due to the precautionary nature of the input parameters for CRM (e.g. the over-estimates of flight speed and nocturnal activity used, the precautionary avoidance rates, and the modelling approach which does not consider any potential displacement effects).

Great black-backed gull

Potential magnitude of impact

301. The monthly estimated mortality rates are presented in Table 12.43:, which vary from a minimum mean of zero (0.0) individuals in February, April, May and July to a maximum of one (1.3) individual in January. On an annual basis, the estimated mortality rate for collision risk from the Project is approximately four (4.0) individuals, which is further broken down into relevant bio-seasons in Table 12.45:.

Table 12.45: Bio-season collision risk estimates for great black-backed gull for the Project.

Bio-season (months)	Mean collisions	Regional baseline populations and baseline mortality rates (individuals per annum)		Increase in baseline mortality (%)
		Population	Baseline mortality	
Mean				
Breeding (Apr-Aug)	0.5	25,917	2,511	0.021
Non-breeding (Sep-Mar)	3.4	91,398	8,856	0.039
Annual (BDMPS)	4.0	91,398	8,856	0.045
Annual (biogeographic)	4.0	235,000	22,772	0.017
LCI				
Breeding (Apr-Aug)	0.0	25,917	2,511	0.000
Non-breeding (Sep-Mar)	0.0	91,398	8,856	0.000
Annual (BDMPS)	0.0	91,398	8,856	0.000
Annual (biogeographic)	0.0	235,000	22,772	0.000
UCI				
Breeding (Apr-Aug)	2.5	25,917	2,511	0.098
Non-breeding (Sep-Mar)	12.6	91,398	8,856	0.142
Annual (BDMPS)	15.0	91,398	8,856	0.170
Annual (biogeographic)	15.0	235,000	22,772	0.066

302. During the breeding bio-season, one (0.5) great black-backed gull may be subject to collision mortality. The regional population in the breeding bio-season is defined as 25,917 individuals and using an average baseline mortality rate of 0.10 (Table 12.9), the natural predicted mortality in the breeding bio-season is 2,511 individuals per annum. The addition of one predicted mortality during the breeding bio-season would increase the baseline mortality rate by 0.021%.

303. This level of potential impact is considered to be of negligible magnitude during the breeding bio-season, as it represents no discernible increase to baseline mortality levels due to the small number of estimated collisions.

304. During the non-breeding bio-season, three (3.4) great black-backed gull may be subject to collision mortality. The regional population in the non-breeding bio-season is defined as 91,398 individuals and using an average baseline mortality rate of 0.10, the natural predicted mortality in the breeding bio-season is 8,856 individuals per annum. The addition of three predicted mortalities during the non-breeding bio-season would increase the baseline mortality rate by 0.039%.

305. This level of potential impact is considered to be of negligible magnitude during the non-breeding bio-season, as it represents no discernible increase to baseline mortality levels due to the small number of estimated collisions.

306. The annual total of great black-backed gull subject to mortality due to collision is estimated to be four (4.0) individuals. Using the largest BDMPS population of 91,398 individuals with an average baseline mortality of 0.10, the natural predicted mortality is 8,856 individuals per annum. The addition of four predicted mortalities would increase the baseline mortality rate by 0.045%. When considering the annual potential level of impact at the biogeographic scale, the natural predicted mortality for the biogeographic population of 235,000 individuals across all seasons is 22,772 individuals per annum. The addition of four predicted mortalities would increase baseline mortality by 0.017%.

307. This level of change is considered to be of negligible magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall, as it represents no discernible change to baseline mortality. Given a magnitude change of negligible, and a sensitivity to collision of major, the significance of effect is therefore concluded to be **minor adverse, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

308. Confidence in the conclusions of this assessment is high, due to the precautionary nature of the input parameters for CRM (e.g. the over-estimates of flight speed and nocturnal activity used, the precautionary avoidance rates, the adaptability of large gulls, and the modelling approach which does not consider any potential displacement effects).

Lesser black-backed gull

Potential magnitude of impact

309. The monthly estimated mortality rates are presented in Table 12.43:, which vary from a minimum mean of zero (0.0) individuals across four months to a maximum of one (0.9) individual in June. On an annual basis, the estimated mortality rate for collision risk from the Project is two (12.4) individuals, which is further broken down into relevant bio-seasons in Table 12.46:.

Table 12.46: Bio-season collision risk estimates for lesser black backed gull for the Project.

Bio-season (months)	Mean collisions	Regional baseline populations and baseline mortality rates (individuals per annum)		Increase in baseline mortality (%)
		Population	Baseline mortality	
Mean				
Return migration (Mar)	0.1	197,483	24,429	0.001
Breeding (Apr-Aug)	2.0	51,233	6,338	0.032
Post-breeding migration (Sep-Dec)	0.1	209,006	25,854	0.001
Migration-free winter (Nov-Feb)	0.1	39,314	4,863	0.002
Annual (BDMPS)	2.4	209,006	25,854	0.009
Annual (biogeographic)	2.4	864,000	106,877	0.002
LCI				
Return migration (Mar)	0.0	197,483	24,429	0.000
Breeding (Apr-Aug)	0.0	51,233	6,338	0.000
Post-breeding migration (Sep-Dec)	0.0	209,006	25,854	0.000
Migration-free winter (Nov-Feb)	0.0	39,314	4,863	0.000
Annual (BDMPS)	0.0	209,006	25,854	0.000
Annual (biogeographic)	0.0	864,000	106,877	0.000
UCI				
Return migration (Mar)	0.5	197,483	24,429	0.002
Breeding (Apr-Aug)	10.2	51,233	6,338	0.161
Post-breeding migration (Sep-Dec)	0.6	209,006	25,854	0.002
Migration-free winter (Nov-Feb)	0.8	39,314	4,863	0.015
Annual (BDMPS)	12.0	209,006	25,854	0.046
Annual (biogeographic)	12.0	864,000	106,877	0.011

310. During the return migration bio-season, less than one (0.1) lesser black-backed gull may be subject to collision mortality. The regional population in the return migration bio-season is defined as 197,483 individuals and using an average baseline mortality rate of 0.12 (Table 12.9), the natural predicted mortality in the return migration bio-season is 24,429 individuals per annum. The addition of less than one predicted mortality during the return migration bio-season would increase the baseline mortality rate by less than 0.001%.

311. This level of potential impact is considered to be of negligible magnitude during the return migration bio-season, as it represents no discernible increase to baseline mortality levels due to the small number of estimated collisions.

312. During the breeding bio-season, two (2.0) lesser black-backed gull may be subject to collision mortality. The regional population in the migration-free breeding bio-season is defined as 51,233 individuals and using an average baseline mortality rate of 0.12, the natural predicted mortality in the breeding bio-season is 6,338 individuals per annum. The addition of two predicted mortalities during the breeding bio-season would increase the baseline mortality rate by 0.032%.

313. This level of potential impact is considered to be of negligible magnitude during the migration-free breeding bio-season, as it represents no discernible increase to baseline mortality levels due to the small number of estimated collisions.

314. During the post-breeding migration bio-season, less than one (0.1) lesser black-backed gull may be subject to collision mortality. The regional population in the post-breeding migration bio-season is defined as 209,006 individuals and using an average baseline mortality rate of 0.12, the natural predicted mortality in the post-breeding migration bio-season is 25,854 individuals per annum. The addition of less than one predicted mortality during the post-breeding migration bio-season would increase the baseline mortality rate by less than 0.001%.

315. This level of potential impact is considered to be of negligible magnitude during the post-breeding migration bio-season, as it represents no discernible increase to baseline mortality levels due to the small number of estimated collisions.

316. During the migration-free winter bio-season, less than one (0.1) lesser black-backed gull may be subject to collision mortality. The regional population in the migration-free winter bio-season is defined as 39,314 individuals and using an average baseline mortality rate of 0.12, the natural predicted mortality in the migration-free winter bio-season is 4,863 individuals per annum. The addition of less than one predicted mortality during the migration-free winter bio-season would increase the baseline mortality rate by 0.002%.

317. This level of potential impact is considered to be of negligible magnitude during the migration-free winter bio-season, as it represents no discernible increase to baseline mortality levels due to the small number of estimated collisions.

318. The annual total of lesser black-backed gull subject to mortality due to collision is estimated to be two (2.4) individuals. Using the largest BDMPS population of 209,006 individuals with an average baseline mortality of 0.12, the natural predicted mortality is 25,854 individuals per annum. The addition of two predicted mortalities would increase the baseline mortality rate by 0.009%. When considering the annual potential level of impact at the biogeographic scale, the natural predicted mortality for the biogeographic population of 864,000 across all seasons is 106,877 per annum. The addition of two predicted mortalities would increase baseline mortality by 0.002%.

319. This level of change is considered to be of negligible magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall, as it represents no discernible change to baseline mortality. Given a magnitude change of negligible, and a sensitivity to collision of major, the significance of effect is therefore concluded to be **minor adverse, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

320. Confidence in the conclusions of this assessment is high, due to the precautionary nature of the input parameters for CRM (e.g. the over-estimates of flight speed and nocturnal activity used, the precautionary avoidance rates, the adaptability of large gulls, and the modelling approach which does not consider any potential displacement effects).

Herring gull

Potential magnitude of impact

321. The monthly estimated mortality rates are presented in Table 12.43:, which vary from a minimum of zero (0.0) individuals across four months to a maximum of one (1.2) individual in June. On an annual basis, the estimated mortality rate for collision risk from the Project is approximately three (2.9) individuals, which is further broken down into relevant bio-seasons in Table 12.47:.

Table 12.47: Bio-season collision risk estimates for herring gull for the Project.

Bio-season (months)	Mean collisions	Regional baseline populations and baseline mortality rates (individuals per annum)		Increase in baseline mortality (%)
		Population	Baseline mortality	
Mean				
Breeding (Mar-Aug)	2.3	324,887	56,011	0.004
Non-breeding (Sep-Feb)	0.7	466,510	80,426	0.001
Annual (BDMPS)	2.9	466,510	80,426	0.004
Annual (biogeographic)	2.9	1,098,000	189,295	0.002
LCI				
Breeding (Mar-Aug)	0.0	324,887	56,011	0.000
Non-breeding (Sep-Feb)	0.0	466,510	80,426	0.000
Annual (BDMPS)	0.0	466,510	80,426	0.000
Annual (biogeographic)	0.0	1,098,000	189,295	0.000
UCI				
Breeding (Mar-Aug)	8.9	324,887	56,011	0.016
Non-breeding (Sep-Feb)	2.9	466,510	80,426	0.004
Annual (BDMPS)	11.8	466,510	80,426	0.015
Annual (biogeographic)	11.8	1,098,000	189,295	0.006

322. During the breeding bio-season, two (2.3) herring gull may be subject to collision mortality. The regional population in the breeding bio-season is defined as 324,887 individuals and using an average baseline mortality rate of 0.17 (Table 12.9), the natural predicted mortality in the breeding bio-season is 56,011 individuals per annum. The addition of three predicted mortalities during the breeding bio-season would increase the baseline mortality rate by 0.004%.

323. This level of potential impact is considered to be of negligible magnitude during the breeding bio-season, as it represents no discernible increase to baseline mortality levels due to the small number of estimated collisions.

324. During the non-breeding season, one (0.7) herring gull may be subject to mortality. The regional population in the non-breeding bio-season is defined as 466,510 individuals and using an average baseline mortality rate of 0.17, the natural predicted mortality in the breeding bio-season is 80,426 individuals per annum. The addition of one predicted mortality during the non-breeding bio-season would increase the baseline mortality rate by 0.001%.

325. This level of potential impact is considered to be of negligible magnitude during the non-breeding bio-season, as it represents no discernible increase to baseline mortality levels due to the small number of estimated collisions.

326. The annual total of herring gull subject to mortality due to collision is estimated to be three (2.9) individuals. Using the largest BDMPS population of 466,510 with an average baseline mortality of 0.17 (Table 12.9), the natural predicted mortality is 80,426 per annum. The addition of three predicted mortalities would increase the baseline mortality rate by 0.004%. When considering the annual potential level of impact at the biogeographic scale, the natural predicted mortality for the biogeographic population of 1,098,000 across all seasons is 189,295 per annum. The addition of three predicted mortalities would increase baseline mortality by 0.002%.

327. This level of change is considered to be of negligible magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall, as it represents no discernible change to baseline mortality. Given a magnitude change of negligible, and a sensitivity to collision of major, the significance of effect is therefore concluded to be **minor adverse, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

328. Confidence in the conclusions of this assessment is high, due to the precautionary nature of the input parameters for CRM (e.g. the over-estimates of flight speed and nocturnal activity used, the precautionary avoidance rates, the adaptability of large gulls, and the modelling approach which does not consider any potential displacement effects).

Sandwich tern

Potential magnitude of impact

329. The monthly estimated mortality rates are presented in Table 12.43:, which vary from a minimum mean of zero individuals across seven months to a maximum mean of less than one (0.3) individual in May. On an annual basis, the estimated mortality rate for collision risk from the Project is less than one (0.4) individual, which is further broken down into relevant bio-seasons in Table 12.48:.

Table 12.48: Bio-season collision risk estimates for Sandwich tern for the Project.

Bio-season (months)	Mean Collisions	Regional baseline populations and baseline mortality rates (individuals per annum)		Increase in baseline mortality (%)
		Population	Baseline mortality	
Mean				
Return migration (Apr)	0.0	38,050	9,307	0.000
Breeding (May - Aug)	0.4	31,629	7,736	0.005
Post-breeding migration (Sep)	0.0	38,050	9,307	0.000
Annual (BDMPS)	0.4	38,050	9,307	0.004
Annual (biogeographic)	0.4	148,000	36,201	0.001
LCI				
Return migration (Apr)	0.0	38,050	9,307	0.000
Breeding (May - Aug)	0.0	31,629	7,736	0.000
Post-breeding migration (Sep)	0.0	38,050	9,307	0.000
Annual (BDMPS)	0.0	38,050	9,307	0.000
Annual (biogeographic)	0.0	148,000	36,201	0.000
UCI				
Return migration (Apr)	0.0	38,050	9,307	0.000
Breeding (May - Aug)	2.1	31,629	7,736	0.028
Post-breeding migration (Sep)	0.1	38,050	9,307	0.001
Annual (BDMPS)	2.2	38,050	9,307	0.024
Annual (biogeographic)	2.2	148,000	36,201	0.006

330. During the return migration bio-season, less than one (0.0) Sandwich tern may be subject to mortality. The regional population in the return migration bio-season is defined as 38,050 individuals and using an average baseline mortality rate of 0.24 (Table 12.9), the natural predicted mortality in the return migration bio-season is 9,307 individuals per annum. The addition of less than one predicted mortality during the return migration bio-season would increase the baseline mortality rate by less than 0.001%.

331. This level of potential impact is considered to be of negligible magnitude during the return migration bio-season, as it represents no discernible increase to baseline mortality levels due to the small number of estimated collisions.

332. During the breeding bio-season, less than one (0.4) Sandwich tern may be subject to mortality. The regional population in the migration-free breeding bio-season is defined as 31,629 individuals and using an average baseline mortality rate of 0.24, the natural predicted mortality in the migration-free breeding bio-season is 7,736 individuals per annum. The addition of less than one predicted mortality during the migration-free breeding bio-season would increase the baseline mortality rate by 0.005%.

333. This level of potential impact is considered to be of negligible magnitude during the migration-free breeding bio-season, as it represents no discernible increase to baseline mortality levels due to the small number of estimated collisions.

334. During the post-breeding migration bio-season, less than one (0.0) Sandwich tern may be subject to mortality. The regional population in the post-breeding migration bio-season is defined as 38,050 individuals and using an average baseline mortality rate of 0.24, the natural predicted mortality in the post-breeding migration bio-season is 9,307 individuals per annum. The addition of less than one predicted mortality during the post-breeding migration bio-season would increase the baseline mortality rate by less than 0.001%.

335. This level of potential impact is considered to be of negligible magnitude during the post-breeding migration bio-season, as it represents no discernible increase to baseline mortality levels due to the small number of estimated collisions.

336. The annual total of Sandwich tern subject to mortality due to collision is estimated to be less than one (0.4) individuals. Using the largest BDMPS population of 38,050 with an average baseline mortality of 0.24, the natural predicted mortality is 9,307 per annum. The addition of less than one predicted mortalities would increase the baseline mortality rate by 0.004%. When considering the annual potential level of impact at the biogeographic scale, the natural predicted mortality for the biogeographic population of 148,000 individuals across all seasons is 36,201 individuals per annum. The addition of less than one predicted mortalities would increase baseline mortality by 0.001%.

337. This level of change is considered to be of negligible magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall, as it represents no discernible change to baseline mortality. Given a magnitude change of negligible, and a sensitivity to collision of minor, the effect significance is considered **negligible, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

338. Confidence in the conclusions of this assessment is high, due to the precautionary nature of the input parameters for CRM (e.g. the over-estimates of flight speed and nocturnal activity used, the precautionary avoidance rates, and the modelling approach which does not consider any potential displacement effects).

Gannet

Potential magnitude of impact

339. The monthly estimated mortality rates are presented in Table 12.43:, which vary from a minimum mean of zero individuals in December to a maximum mean of one (1.3) individuals in April. On an annual basis, the estimated mortality rate for collision risk from the Project is six (5.5) individuals. This is reduced to two (1.7) individuals in total after adjusting for 70% macro-avoidance, which is further broken down into relevant bio-seasons in Table 12.49:. Results are based on 70% macro-avoidance.

Table 12.49: Bio-season collision risk estimates for gannet for the Project.

Bio-season (months)	Mean collisions	Regional baseline populations and baseline mortality rates (individuals per annum)		% Increase in baseline mortality
		Population	Baseline mortality	
Mean				
Return migration (Dec-Feb)	0.1	248,385	46,349	0.000
Breeding (Mar-Sep)	1.2	400,326	74,701	0.002
Post-breeding migration (Oct-Nov)	0.4	456,299	85,145	0.000
Annual (BDMPS)	1.7	456,299	85,145	0.002
Annual (biogeographic)	1.7	1,180,000	220,188	0.001
LCI				
Return migration (Dec-Feb)	0.0	248,385	46,349	0.000
Breeding (Mar-Sep)	0.0	400,326	74,701	0.000
Post-breeding migration (Oct-Nov)	0.0	456,299	85,145	0.000
Annual (BDMPS)	0.1	456,299	85,145	0.000
Annual (biogeographic)	0.1	1,180,000	220,188	0.000
UCI				
Return migration (Dec-Feb)	0.4	248,385	46,349	0.001
Breeding (Mar-Sep)	4.7	400,326	74,701	0.006
Post-breeding migration (Oct-Nov)	1.7	456,299	85,145	0.002
Annual (BDMPS)	6.7	456,299	85,145	0.008
Annual (biogeographic)	6.7	1,180,000	220,188	0.003

340. During the return migration bio-season, less than one (0.1) gannet may be subject to collision mortality. The regional population in the return migration bio-season is defined as 248,385 individuals and using an average baseline mortality rate of 0.19 (Table 12.9), the natural predicted mortality in the return migration bio-season is 46,349 individuals per annum. The addition of less than one predicted mortality during the return migration bio-season would increase the baseline mortality rate by less than 0.001%.

341. This level of potential impact is considered to be of negligible magnitude during the return migration bio-season, as it represents no discernible increase to baseline mortality levels due to the small number of estimated collisions.

342. During the breeding bio-season, one (1.2) gannet may be subject to mortality. The regional population in the breeding bio-season is defined as 400,326 individuals and using an average baseline mortality rate of 0.19, the natural predicted mortality in the breeding bio-season is 74,701 individuals per annum. The addition of one predicted mortality during the breeding bio-season would increase the baseline mortality rate by 0.002%.

343. This level of potential impact is considered to be of negligible magnitude during the migration-free breeding bio-season, as it represents no discernible increase to baseline mortality levels due to the small number of estimated collisions.

344. During the post-breeding migration bio-season, one (0.4) gannet may be subject to mortality. The regional population in the post-breeding migration bio-season is defined as 456,299 individuals and using an average baseline mortality rate of 0.19, the natural predicted mortality in the post-breeding migration bio-season is 85,145 individuals per annum. The addition of one predicted mortalities would increase the baseline mortality rate by less than 0.001%.

345. This level of potential impact is considered to be of negligible magnitude during the migration-free breeding bio-season, as it represents no discernible increase to baseline mortality levels due to the small number of estimated collisions.

346. The annual total of gannet subject to mortality due to collision is estimated to be two (1.7) individuals. Using the largest BDMPS population of 456,299 with an average baseline mortality of 0.19, the natural predicted mortality is 85,145 per annum. The addition of two individuals would increase the baseline mortality rate by 0.002%. When considering the annual potential level of impact at the biogeographic scale, the natural predicted mortality for the biogeographic population of 1,180,000 individuals across all seasons is 220,188 individuals per annum. The addition of wo predicted mortalities would increase baseline mortality by 0.001%.

347. This level of change is considered to be of negligible magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall, as it represents no discernible change to baseline mortality. Given a magnitude change of negligible, and a sensitivity to collision of moderate, the effect significance is considered **minor adverse, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

348. Confidence in the conclusions of this assessment is high, due to the precautionary nature of the input parameters for CRM (e.g. the over-estimates of flight speed and nocturnal activity used, the precautionary avoidance rates, and the modelling approach which does not consider any potential displacement effects).

12.9.3 Combined Operational Disturbance and Collision Risk – Gannet

349. Due to gannet being scoped in for both displacement and collision risk assessments during the O&M phase, there is potential for these two combined impacts to adversely affect gannet populations. The collision and displacement assessments both concluded minor (not significant) effect significance as a result of the Project. However, the combined impact of both collision risk and displacement may be greater than either one acting alone. Further consideration of both impacts acting together is therefore provided.

350. It is recognised that assessing both displacement and collision risk for gannet together amounts to assessing two pathways to mortality for some of the same birds, since displaced birds would not be subject to collision, as they are already assumed to have avoided the array area. Similarly, birds which are subject to collision mortality cannot also have been displaced. However, after applying 70% macro-avoidance to collision risk estimates, a combined approach is considered appropriate and is provided based on recommendations from SNCB guidance (Parker *et al*., 2022c).

Potential magnitude of impact

351. As presented in Table 12.25: the total displacement consequent mortality is estimated as eight (7.8) birds, based on a displacement rate of 70% and a mortality rate of 1%. The collision consequent mortality is estimated as two (1.7) birds, as presented in Table 12.49:. The combined potential mortality is therefore estimated as 10 (9.5) birds.

352. Considering the largest BDMPS population of 456,299 individuals with a baseline mortality of 85,145individuals per annum, the addition of 10 predicted mortalities would result in a 0.011% increase in baseline mortality. Considering the biogeographic population of 1,180,000 individuals, with a baseline mortality of 220,188 individuals, the addition of 10 predicted mortalities would increase baseline mortality by 0.004%.

353. This level of change is considered to be of negligible magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall, as it represents no discernible change to baseline mortality. Given a magnitude change of negligible, and a sensitivity to collision of medium and a sensitivity to displacement of minor to moderate, the significance of effect is therefore concluded to be **minor adverse, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

354. Confidence in the conclusions of this assessment is high due to the precautionary displacement and mortality rates used, the use of a site-specific dataset, the small scale of the predicted impact, the flexibility of potentially displaced gannet to travel to, and forage in new areas, the precautionary nature of the input parameters for CRM (e.g. the over-estimates of flight speed and nocturnal activity used, the precautionary avoidance rates, and the modelling approach which does not consider any potential displacement effects).

12.9.4 Migratory Collision risk: array area

355. In addition to the seabirds considered individually above, there is potential risk to migrant seabirds and waterbirds colliding with WTGs while flying through the array area during the O&M phase.

356. Migratory birds moving through the Project array area may not be reliably detected using digital aerial surveys or other standard survey methods owing to their movements through the area in short pulses, in poor weather, at night (when no surveys take place), or at high altitudes. As such, the project undertook analyses of migratory collision risk using a modelling approach.

357. For the purpose of this ES, a review of potential collision risk was undertaken, considering data presented by other OWFs in the North Sea, including:

- Hornsea Project One;
- Hornsea Project Two;
- Hornsea Three;
- Norfolk Vanguard; and
- Hornsea Project Four.

358. The aim of this review was to identify the potential for significant effects as a result of the operation of the Project, and consequently whether migratory collision risk assessments should be screened in or screened out of the final EIA report. Information used for the basis of this review is predominantly based upon data presented for the Hornsea Four PEIR (Orsted, 2019), updated to reflect the most up to date data based on Hornsea Four's full EIA (Orsted 2021c).

Hornsea Project One

359. The approach to assessing the potential scope and scale of collision risk to migrant seabirds and non-seabirds (waterbirds) taken by Hornsea Project One was to identify which species were most likely to be passing through the proposed windfarm, apply the Migropath model (developed by APEM) and the migratory routes described by Wright *et al*. (2012) to calculate the numbers of these species passing through the proposed windfarm and then apply the Band CRM migrant variant to those numbers to predict potential mortality (SMartWind, 2013). The migratory seabirds and waterbirds that were considered in the assessment and the conclusions drawn on potential impact for each species are presented in Table 12.50:.

Hornsea Project Two

360. The approach to assessing the potential scope and scale of collision risk to migrant non-seabirds (waterbirds) taken by Hornsea Project Two was the same as that for Hornsea Project One with the application of the APEM Migropath model and Band CRM migrant variant (SMartWind, 2015). For migrant seabirds a broad migratory front approach was taken, considering the proportion of the population that might be expected to pass through the proposed windfarm, informed by the migratory routes described by Wright *et al*. (2012) and the population estimates of Furness (2015). The migratory seabirds and waterbirds that were considered in the assessment and the conclusions drawn on potential impact for each species are presented in Table 12.50:.

Hornsea Three

361. The approach to assessing the potential scope and scale of collision risk to migrant seabirds was the same as that for Hornsea Project Two with a broad migratory front approach being taken, considering the proportion of the population that might be expected to pass through the proposed windfarm (Orsted, 2018b). For migrant non-seabirds (waterbirds) the approach taken followed the BTO SOSS Migration Assessment Tool (MAT) model (Wright and Austin, 2012) that is similar to Migropath in that it considers migration routes for specific species that move from the UK coast to continental Europe and vice versa. The migratory seabirds and waterbirds that were considered in the assessment and the conclusions drawn on potential impact for each species are presented in Table 12.50:.

Norfolk Vanguard

362. The approach to assessing the potential scope and scale of collision risk to migrant seabirds and non-seabirds (waterbirds) taken by Norfolk Vanguard was first to scope which species were most likely to be passing through the proposed windfarm (Norfolk Vanguard Ltd, 2018). For migrant seabirds the approach taken followed the migrant corridor, rather than broad front, approach of Wildfowl and Wetlands Trust (WWT) and MacArthur Green (2013) which placed the proposed windfarm beyond the corridor in which migration of the relevant seabird species took place. For migrant non-seabirds (waterbirds) the approach taken followed the BTO SOSS MAT model (Wright and Austin, 2012), an approach that was the same as Hornsea Three. The migratory seabirds and waterbirds that were considered in the assessment and the conclusions drawn on potential impact for each species are presented in Table 12.50:.

Hornsea Project Four

363. The approach to assessing the potential scope and scale of collision risk to migrant non-seabirds (waterbirds) taken by Hornsea Project Four was the same as that for Hornsea Project One and Two with the application of the APEM Migropath model and Band CRM migrant variant (SMartWind, 2015). For migrant seabirds a broad migratory front approach was taken, considering the proportion of the population that might be expected to pass through the proposed windfarm, informed by the migratory routes described by Wright *et al*. (2012) and the population estimates of Furness (2015). For migratory seabirds, BO2 CRM was also undertaken, using the maximum likelihood values in the Johnson *et al*. (2014) flight height spreadsheets, which supplemented the SOSS-02 project (Cook *et al*., 2012). The migratory seabirds and waterbirds that were considered in the assessment and the conclusions drawn on potential impact for each species are presented in Table 12.50:.

Outer Dowsing

364. The approach to assessing the potential scope and scale of collision risk to migrant non-seabirds (waterbirds) taken by Outer Dowsing has been with the application of the APEM Migropath model and Band CRM migrant variant (SMartWind, 2015). Migratory routes, described by Wright *et al*. (2012), were used to calculate the numbers of these species passing through the proposed windfarm, with population estimates taken from Woodward *et al*. (2023). For migrant seabirds a broad migratory front approach was taken, considering the proportion of the population that might be expected to pass through the proposed windfarm, informed by the migratory routes described by Wright *et al*. (2012) and the population estimates of Woodward *et al*. (2023). For migratory seabirds, BO2 CRM was also undertaken, using the maximum likelihood values in the Johnson *et al*. (2014) flight height spreadsheets, which supplemented the SOSS-02 project (Cook *et al*., 2012). The migratory seabirds and waterbirds that were considered in the assessment and the conclusions drawn on potential impact for each species are presented in Table 12.50:.

Table 12.50: Summary of collision risk assessment on migrant seabirds and waterbirds from other North Sea OWF EIA reports.

Species	Hornsea Project One Collisions per annum	Hornsea Project Two Collisions per annum	Hornsea Three Collisions per annum	Norfolk Vanguard Collisions per annum	Hornsea Project Four collisions per annum	Impact magnitude*	Significance of effect
Dark-bellied brent goose	1	0	23	1	n/a	Negligible	Negligible or Minor adverse
Taiga bean goose	0	0	0	n/a	0.00	Negligible	Negligible or Minor adverse
Berwick's swan	0	0	4	0	0.12	Negligible	Negligible or Minor adverse
Shelduck	4	0	2	n/a	0.97	Negligible	Negligible or Minor adverse
Shoveler	n/a	n/a	n/a	1	n/a	Negligible	Negligible
Wigeon	20	0	11	13	6.74	Negligible	Negligible or Minor adverse
Gadwall	n/a	n/a	n/a	1	0.10	Negligible	Negligible
Teal	n/a	n/a	n/a	6	5.99	Negligible	Negligible
Pintail	n/a	n/a	n/a	1	n/a	Negligible	Negligible
Pochard	n/a	n/a	n/a	2	n/a	Negligible	Negligible
Tufted duck	n/a	n/a	n/a	3	n/a	Negligible	Negligible
Common scoter	n/a	n/a	n/a	0	n/a	Negligible	Negligible
Goldeneye	n/a	n/a	n/a	1	0.35	Negligible	Negligible
Oystercatcher	n/a	n/a	n/a	15	7.68	Negligible	Negligible
Avocet	n/a	n/a	n/a	1	n/a	Negligible	Negligible
Lapwing	48	0	25	22	14.89	Negligible	Negligible or Minor adverse

Species	Hornsea Project One Collisions per annum	Hornsea Project Two Collisions per annum	Hornsea Three Collisions per annum	Norfolk Vanguard Collisions per annum	Hornsea Project Four collisions per annum	Impact magnitude*	Significance of effect
Golden plover	16	0	23	21	7.08	Negligible	Negligible or Minor adverse
Grey plover	2	0	2	2	0.71	Negligible	Negligible or Minor adverse
Ringed plover	n/a	n/a	n/a	1	0.63	Negligible	Negligible
Curlew	n/a	n/a	n/a	10	4.32	Negligible	Negligible
Bar-tailed godwit	2	0	2	2	1.63	Negligible	Negligible or Minor adverse
Turnstone	n/a	n/a	n/a	2	0.79	Negligible	Negligible
Knot	12	0	1	12	5.26	Negligible	Negligible or Minor adverse
Sanderling	n/a	n/a	n/a	1	0.59	Negligible	Negligible
Dunlin	10	0	23	27	6.25	Negligible	Negligible or Minor adverse
Redshank	n/a	n/a	n/a	22	4.09	Negligible	Negligible
Little gull	10	1	1	0	0.03	No Change/Negligible	Negligible or Minor Adverse
Sandwich tern	n/a	n/a	n/a	n/a	0.02	Negligible	Negligible
Roseate tern	n/a	n/a	n/a	n/a	n/a	No Change/Negligible	No Change/Negligible
Common tern	0	9	1	0	0.20	No Change/Negligible	Negligible or Minor adverse
Arctic skua	0	10	0	0	0.00	No Change/Negligible	Negligible or Minor Adverse
Arctic tern	0	50	0	0	0.04	No Change/Negligible	Negligible or Minor adverse

Species	Hornsea Project One Collisions per annum	Hornsea Project Two Collisions per annum	Hornsea Three Collisions per annum	Norfolk Vanguard Collisions per annum	Hornsea Project Four collisions per annum	Impact magnitude*	Significance of effect
Great skua	1	1	0	0	0.00	No Change/Negligible	Negligible or Minor Adverse
Marsh harrier	n/a	n/a	n/a	0	n/a	Negligible	Negligible

*for little gull, common tern, Sandwich tern, Arctic tern, roseate tern, Actic skua and great skua, BO2 CRM outputs were provided for Hornsea Four

Magnitude of impact

365. Evidence presented across Hornsea Project One, Hornsea Project Two, Hornsea Project Three, Norfolk Vanguard, and Hornsea Project Four concludes negligible collision risks and no significant effects provide a reliable guide to the potential risks for the Project. The potential for the Project to generate significant collision risks while virtually none were predicted for other OWFs in similar areas of the North Sea is considered to be minimal.

366. The modelled migrant bird collisions for the Project are presented in Table 12.51:. The full details of the approach can be found in Appendix 12.5: Migratory Bird Collision Risk Modelling Volume 3.

Table 12.51: Results of mCRM using Migropath and 'Broad Front' modelling of migrant bird collisions

Species	Avoidance Rate	Annual **Collision Rate BO1**	Annual **Collision Rate BO2**	UK population (IND)	Baseline mortality (IND)	Increase in baseline mortality (%)
Migropath Modelling						
Dark-bellied brent goose	95.00%	1.95	NA	98,500	9,850	0.0198
	98.00%	0.78	NA	98,500	9,850	0.0079
	99.00%	0.39	NA	98,500	9,850	0.0040
	99.50%	0.20	NA	98,500	9,850	0.0020
Pink-footed goose	95.00%	27.10	NA	510,000	87,210	0.0311
	98.00%	10.84	NA	510,000	87,210	0.0124
	99.00%	5.425.4157	NA	510,000	85,500	0.0063
	99.50%	2.7080		510,000	85,500	0.0032
Shelduck	95.00%	3.5564	NA	51,000	7,125	0.0499
	98.00%	1.4230	NA	51,000	7,125	0.0200
	99.00%	0.7116	NA	51,000	7,125	0.0100
	99.50%	0.3558	NA	51,000	7,125	0.0050
Wigeon	95.00%	38.2002	NA	450,000	225,600	0.0169
	98.00%	15.2843	NA	450,000	225,600	0.0068
	99.00%	7.45	NA	450,000	211,500	0.0035
	99.50%	3.73	NA	450,000	211,500	0.0018
Mallard	95.00%	88.02	NA	675,000	251,775	0.0350
	98.00%	35.22	NA	675,000	251,775	0.0140
	99.00%	17.61	NA	675,000	251,775	0.0070
	99.50%	8.81	NA	675,000	251,775	0.0035
Pochard	95.00%	1.91	NA	29,000	13,050	0.0146
	98.00%	0.76	NA	29,000	13,050	0.0058
	99.00%	0.38	NA	29,000	13,050	0.0029

Species	Avoidance Rate	Annual **Collision Rate BO1**	Annual **Collision Rate BO2**	UK population (IND)	Baseline mortality (IND)	Increase in baseline mortality (%)
	99.50%	0.19	NA	29,000	13,050	0.0015
Scaup	95.00%	0.60	NA	6,400	3,328	0.0180
	98.00%	0.24	NA	6,400	3,328	0.0072
	99.00%	0.12	NA	6,400	3,328	0.0036
	99.50%	0.06	NA	6,400	3,328	0.0018
Common scoter	95.00%	16.26	NA	135,000	29,295	0.0555
	98.00%	6.51	NA	135,000	29,295	0.0222
	99.00%	3.25	NA	135,000	29,295	0.0111
	99.50%	1.63	NA	135,000	29,295	0.0056
Goldeneye	95.00%	1.85	NA	21,000	4,788	0.0386
	98.00%	0.74	NA	21,000	4,788	0.0155
	99.00%	0.37	NA	21,000	4,788	0.0077
	99.50%	0.19	NA	21,000	4,788	0.0040
Oystercatcher	95.00%	25.44	NA	305,000	36,600	0.0695
	98.00%	10.18	NA	305,000	36,600	0.0278
	99.00%	5.09	NA	305,000	36,600	0.0139
	99.50%	2.55	NA	305,000	36,600	0.0070
Avocet (Wintering)	95.00%	0.42	NA	8,700	1,914	0.0219
	98.00%	0.17	NA	8,700	1,914	0.0089
	99.00%	0.08	NA	8,700	1,914	0.0042
	99.50%	0.04	NA	8,700	1,914	0.0021
Golden plover	95.00%	41.23	NA	410,000	110,700	0.0372
	98.00%	16.50	NA	410,000	110,700	0.0149
	99.00%	8.25	NA	410,000	110,700	0.0075
	99.50%	4.13	NA	410,000	110,700	0.0037
Ringed plover	95.00%	3.34	NA	42,500	9,690	0.0345
	98.00%	1.34	NA	42,500	9,690	0.0138
	99.00%	0.67	NA	42,500	9,690	0.0069
	99.50%	0.33	NA	42,500	9,690	0.0034
Curlew (Wintering)	95.00%	11.28	NA	125,000	12,625	0.0893
	98.00%	4.52	NA	125,000	12,625	0.0358
	99.00%	2.26	NA	125,000	12,625	0.0179
	99.50%	1.13	NA	125,000	12,625	0.0090
Bar-tailed godwit (Wintering)	95.00%	5.16	NA	53,500	15,248	0.0338
	98.00%	2.07	NA	53,500	15,248	0.0136
	99.00%	1.03	NA	53,500	15,248	0.0068
	99.50%	0.52	NA	53,500	15,248	0.0034
	95.00%	1.07	NA	41,000	2,460	0.0435

Species	Avoidance Rate	Annual **Collision Rate BO1**	Annual **Collision Rate BO2**	UK population (IND)	Baseline mortality (IND)	Increase in baseline mortality (%)
Black-tailed godwit (Icelandic; Wintering)	98.00%	0.43	NA	41,000	2,460	0.0175
	99.00%	0.21	NA	41,000	2,460	0.0085
	99.50%	0.11	NA	41,000	2,460	0.0045
Knot	95.00%	21.11	NA	265,000	42,135	0.0501
	98.00%	8.45	NA	265,000	42,135	0.0201
	99.00%	4.22	NA	265,000	42,135	0.0100
	99.50%	2.11	NA	265,000	42,135	0.0050
Ruff	95.00%	0.06	NA	920	438	0.0137
	98.00%	0.02	NA	920	438	0.0046
	99.00%	0.01	NA	920	438	0.0023
	99.50%	0.01	NA	920	438	0.0023
Sanderling	95.00%	1.49	NA	20,500	3,485	0.0428
	98.00%	0.60	NA	20,500	3,485	0.0172
	99.00%	0.30	NA	20,500	3,485	0.0086
	99.50%	0.15	NA	20,500	3,485	0.0043
Dunlin	95.00%	22.64	NA	350,000	91,000	0.0249
	98.00%	9.06	NA	350,000	91,000	0.0100
	99.00%	4.53	NA	350,000	91,000	0.0050
	99.50%	2.27	NA	350,000	91,000	0.0025
Redshank *robustica*	95.00%	4.08	NA	100,000	26,000	0.0157
	98.00%	1.63	NA	100,000	26,000	0.0063
	99.00%	0.82	NA	100,000	26,000	0.0032
	99.50%	0.41	NA	100,000	26,000	0.0016
Red throated diver	95.00%	0.31	NA	21,500	3,440	0.0090
	98.00%	0.12	NA	21,500	3,440	0.0035
	99.00%	0.06	NA	21,500	3,440	0.0017
	99.50%	0.03	NA	21,500	3,440	0.0009
Bittern	95.00%	0.04	NA	795	239	0.0168
	98.00%	0.01	NA	795	239	0.0042
	99.00%	0.01	NA	795	239	0.0042
	99.50%	0.00	NA	795	239	0.0000
Hen harrier	95.00%	0.09	NA	1,090	207	0.0435
	98.00%	0.04	NA	1,090	207	0.0193
	99.00%	0.02	NA	1,090	207	0.0097
	99.50%	0.01	NA	1,090	207	0.0048
‘Broad Front’ Modelling						
Common tern	95.00%	2.43	0.10	11,838	2,261	0.0044
	98.00%	0.97	0.04	11,838	2,261	0.0018

Species	Avoidance Rate	Annual **Collision Rate BO1**	Annual **Collision Rate BO2**	UK population (IND)	Baseline mortality (IND)	Increase in baseline mortality (%)
	99.00%	0.49	0.0200	11,838	2,261	0.0009
	99.50%	0.24	0.0100	11,838	2,261	0.0004
Little gull	95.00%	0.05	0.0200	50,000	10,000	0.0002
	98.00%	0.02	0.0100	50,000	10,000	0.0001
	99.00%	0.01	0.0000	50,000	10,000	0.0000
	99.20%	0.01	0.0000	50,000	10,000	0.0000

367. Due to the low levels of increase to existing baseline mortalities the significance of effect is concluded to be **negligible, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

368. Confidence in the conclusions of this assessment is high due to the precautionary nature of the input parameters for CRM, and the low levels of migrating non-seabird species recorded during the DAS campaign.

12.9.5 Indirect impacts due to impacts on prey

369. During the O&M phase of the Project, potential effects impacting the availability of prey species may indirectly have effects on offshore ornithology. Increases in underwater anthropogenic noise resulting from the WTGs may result in mobile prey species avoiding the area around the WTGs. Additionally, suspended sediments from maintenance activity may result in fish and mobile invertebrates avoiding the area and may smother and hide immobile benthic prey. The resulting increase in turbidity of the water column may also make it harder for seabirds to see their prey. These impacts could therefore result in a reduction in prey available to foraging seabirds within the construction area. The potential impacts on benthic invertebrates and fish have been assessed in Volume 1, Chapter 10 – Fish and Shellfish Ecology and Volume 1, Chapter 9 – Benthic Subtidal and Intertidal Ecology.

370. The main prey items of seabirds such as gannet and auks are considered to be species such as sandeels, herring and sprat. Impacts on these species may arise from underwater noise impacts and due to changes to the seabed and to suspended sediment levels (also covered in Volume 1, Chapter 9 – Benthic Subtidal and Intertidal Ecology). Impacts arising from noise during the O&M phase are assessed to be minor (not significant) for all fish groups and therefore no impacts of note are expected. Considering impacts arising from suspended sediment concentration, impacts on all species are assessed to be minor (non-significant).

371. Therefore, the significance of effect is therefore concluded to be **negligible, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

12.10 Impact Assessment: Decommissioning

372. The impacts of decommissioning of the Project have been assessed on offshore and intertidal ornithology. The impacts resulting from the construction of the Project are presented in Table 12.10:, along with the MDS which formed the bases of these impact assessments.

12.10.1Disturbance and displacement: array area

373. Decommissioning activities within the array area associated with foundations and WTGs may lead to disturbance and displacement of species within the array area and different degrees of buffers surrounding it. The MDS for decommissioning activities within the Project array area is equal to or less than that for the construction phase, and so for the purpose of this assessment, the impacts are deemed to be similar.

374. Since potential disturbance and displacement effects within the construction phase were deemed to be not significant, no significant effects are expected within the decommissioning phase.

12.10.2Indirect impacts due to impacts on prey

375. During decommissioning phase of the Project, the potential impacts arising from indirect impacts due to impacts on prey are considered to be of similar magnitude of those predicted in the construction phase. Therefore, the significance of effect is therefore concluded to be **negligible, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

12.11 Cumulative Impact Assessment

12.11.1Overview and methodology

376. Cumulative effects refer to the impacts upon a single receptor from the Project combined with the impacts from other proposed and reasonably foreseeable plans and projects. This includes all projects that result in a comparative effect that is not intrinsically considered as part of the existing environment and is not limited to offshore wind projects.

377. To determine the potential impacts arising from the Project in combination with other projects, a screening exercise was undertaken, and is presented in Table 12.52: below.

Table 12.52: Screening for potential cumulative effects.

Impact	Screening outcome	Rationale
Construction phase		
Impact 1: Disturbance and displacement (Offshore ECC & ORCPs)	In	Red-throated diver only. Displacement of all other seabirds during the construction phase of the Project are assessed as negligible at most, spatially restricted and temporary for all species and with very little temporal

Impact	Screening outcome	Rationale
		overlap with the construction phases of other projects. Further explanation provided in Paragraph 392.
Impact 2: Disturbance and displacement (array area)	Out	Cumulative assessment for disturbance and displacement of the array area is provided solely during O&M as the impacts are assessed as half of O&M. O&M therefore provides the worst-case scenario.
Impact 3: Indirect impacts through effects on habitats and prey availability	Out	There is no potential of cumulative impacts since the contribution from the Project is low, and is dependent on a temporal and spatial co-incidence of disturbance/displacement from other plans or projects.
O&M phase		
Impact 4: Disturbance and displacement (Array area)	In	There is a sufficient likelihood of a cumulative impact to justify a detailed, quantitative cumulative impact assessment.
Impact 4: Disturbance and displacement (Offshore ECC and ORCPs)	Out	A cumulative assessment is not required, as O&M vessel traffic will not meaningfully increase beyond existing levels, particularly with the implementation of a Vessel Management Plan (VMP). Vessels will follow established routes where possible, minimising disturbance, and any occasional deviations will result in only short-term displacement, with birds expected to return once vessels pass. Given that the construction-phase assessment found no significant impact on red-throated diver and common scoter, and O&M vessel activity is far lower in scale and duration, there is no realistic pathway for cumulative effects. Furthermore, the ORCPs are static structures located within the buffer zones from existing OWFs. Potential spatial impacts are therefore already considered within the existing baseline and not considered cumulatively.
Impact 5: Collision risk & Combined O&M collision risk and displacement	In	There is a sufficient likelihood of a cumulative impact to justify a detailed, quantitative cumulative impact assessment.
Impact 6: Collision risk to migratory birds: Array area	Out	There is no potential of cumulative impacts since the contribution from the Project is low.

Impact	Screening outcome	Rationale
Impact 7: Indirect impacts through effects on habitats and prey availability	Out	There is no potential of cumulative impacts since the contribution from the Project is low.
Decommissioning phase		
Impact 8: Disturbance and displacement (array area)	Out	Cumulative assessment for disturbance and displacement of the array area is provided solely during O&M as the impacts are assessed as half of O&M. O&M therefore provides the worst-case scenario.
Impact 9: Disturbance and displacement (ECC & ORCPs)	In	Red-throated diver only. Displacement of all other seabirds during the decommissioning phase of the Project are assessed as negligible at most, spatially restricted and temporary for all species and with very little temporal overlap with the construction phases of other projects. Further explanation provided in Paragraph 392
Impact 10: Indirect impacts through effects on habitats and prey availability	Out	There is no potential of cumulative impacts since the contribution from the Project is low, and is dependent on a temporal and spatial co-incidence of disturbance/displacement from other plans or projects.

378. All impacts for ornithological receptors identified in Table 12.52: were considered for cumulative assessment. Where the potential impact magnitude on a species from the Project alone was assessed as both negligible (not significant), and also highly unlikely to make any material contribution to an existing cumulative impact, a full assessment was not undertaken. This was the case for common scoter only, with worst-case scenario impact from the Project concluding an (insignificant) extremely low impact (0.1 birds). While impacts for all other species were concluded to be either negligible or minor adverse, both of which are not significant in EIA terms, they are considered within this section as a precautionary approach.

379. Carbon capture utilisation and storage (CCUS) licences were awarded in September 2023, with several within the vicinity of the Project. In addition to these licences, CCUS activities also require a storage agreement for lease granted by The Crown Estate (TCE), enabling applicants to proceed with a Permit application and a lease if successful. At the time of writing, none have been awarded for the areas licensed in September 2023, including those listed in Table 10.23 and Table 10.24. As such, no information is currently publicly available on the scope or timing of potential works associated with CCUS activities, and there is therefore insufficient data on which to undertake a quantitative or semi-quantitative assessment. As such, no assessment has been made of potential cumulative effects on key seabird receptors with carbon storage licences CS017, CS018, and CS028.

Projects considered for cumulative impacts

380. The projects and plans selected as relevant to the assessment of impacts to Intertidal and Offshore Ornithology are based upon an initial screening exercise undertaken on a long list. Each project, plan or activity has been considered and scoped in or out on the basis of effect-receptor pathway, data confidence and the temporal and spatial scales involved. For the purposes of assessing the impact of the Project on Intertidal and Offshore Ornithology in the region, the cumulative effect assessment technical note submitted through the EIA Evidence Plan (presented in Volume 3, Appendix 5.1: Offshore Cumulative Impact Assessment) screened in a number of projects and plans as presented in Table 12.54:.

381. A number of project types could potentially be considered for the cumulative assessment of offshore ornithological receptors, notably:

- Offshore windfarms;
- Marine aggregate extraction;
- Oil and gas exploration and extraction;
- Sub-sea cables and pipelines; and
- Commercial shipping.

382. Considering these project types, the cumulative assessment takes into account the fact that birds may already be habituated to long-term, on-going activities and therefore these may be considered to be part of the baseline conditions. While other cable laying operations (e.g. interlink cables) or instillation of infrastructure (e.g. ORCPs) could take place at the same time as the installation of cables within the Project Offshore ECC, it is considered unlikely that this would contribute to an inter-related disturbance effect as the duration of cable laying operations within sensitive ornithological areas (such as the Greater Wash SPA) will last no more than a few weeks for any particular project, and the zone of effect is considered comparatively small e.g. 2km radius around cable laying vessels.

383. Therefore, to avoid double-counting or exaggerating potential cumulative impacts, the above project types, excluding offshore windfarms, are scoped out and the cumulative assessment focuses only on offshore windfarms. It is also acknowledged that a further development, the Endurance Carbon Capture Utilisation and Storage (CCUS) project, is proposed 43.2km to the north of the Project array area. However, no data are currently available on potential impacts to offshore ornithology and as such this project has also been screened out from further consideration.

384. All offshore windfarms at all stages of development have been considered within the screening for cumulative effects.

385. For the cumulative effects assessment, it should be noted that some identified developments may not actually be taken forward or fully built out as outlined within their MDS, particularly projects which are 'proposed' or identified in development plans. To account for this, there is a need to factor in consideration of the level of uncertainty of the potential impacts assigned to such developments (i.e. developments not yet approved are less likely to contribute to cumulative impacts than projects under construction). To factor in this uncertainty, a tiered approach was used, assigning 'tiers' and 'sub-tiers' to projects to reflect their current stage within the planning and development process. An explanation of the tiers used is presented in Table 12.53:.

Table 12.53: Description of tiers used to describe the development stage of other developments.

Tier	Sub-Tier	Description of stage of development of project
Tier 1	Tier 1a	Project under operation
	Tier 1b	Project under construction
	Tier 1c	Permitted applications, whether under the Planning Act 2008 or other regimes, but not yet implemented
	Tier 1d	Submitted applications, whether under the Planning Act 2008 or other regimes, but not yet determined
Tier 2	N/A	Projects on the Planning Inspectorate's Programme of Projects where a Scoping Report has been submitted
Tier 3	Tier 3a	Projects on the Planning Inspectorate's Programme of Projects where a Scoping Report has not been submitted
	Tier 3b	Identified in the relevant Development Plan (and emerging Development Plans with appropriate weight being given as they move closer to adoption) recognising that much information on any relevant proposals will be limited
	Tier 3c	Identified in other plans and programmes (as appropriate) which set the framework for future development consents/approvals, where such development is reasonably likely to come forward

386. The plans and projects selected as relevant to the cumulative assessment of impacts to offshore and intertidal ornithology are based on an initial screening exercise undertaken on a long list (see Volume 3, Appendix 5.1: Offshore Cumulative Impact Assessment).

387. Where planned and operational projects were screened out of further consideration for potential cumulative effects on offshore and intertidal ornithology, this was based on there not being a potential impact-receptor-pathway (during construction, O&M, and decommissioning phases) for the following reasons:

- There is no potential impact-receptor-pathway due to the project being outside of the North Sea (and English Channel);
- There is no temporal overlap between projects/activities;
- The project/activity is ongoing and is part of the current baseline; or
- There are no data available or there is low confidence in the data.

388. The projects screened into the cumulative impact assessment and their allocated tiers (and sub-tiers) are presented in Table 12.54:. The operational projects included within the table are included due to their completion/ commissioning subsequent to the data collection process for the Project and as such not included within the baseline characterisation. Note that this table only includes the projects screened into the assessment for offshore and intertidal ornithology based on the criteria outlined above. For the full list of projects considered, including those screened out, please see Volume 3, Appendix 5.1: Offshore Cumulative Impact Assessment.

Table 12.54: Projects considered within the Intertidal and Offshore Ornithology cumulative effect assessment.

Project	Status	Distance to the Project array area (km)	Distance to the Project offshore ECC (km)	Tier	Reason for inclusion
Beatrice	Operational	566.4	579.6	1a	Potential temporal overlap of operation with the Project
Blyth Demonstration Site (Phase 1)	Operational	232.8	233.0	1a	Limited potential temporal overlap of operation with the Project as decommissioning planned for 2024-27, before the Project construction phase scheduled to be completed.
Dudgeon	Operational	19.9	11.1	1a	Potential temporal overlap of operation with the Project
East Anglia ONE	Operational	149.1	144.4	1a	Potential temporal overlap of operation with the Project
European Offshore Wind Development Centre (EOWDC)	Operational	444.9	458.8	1a	Potential temporal overlap of operation with the Project
Forthwind Demonstration Project (Methil)	Consented	387.7	387.3	1c	Potential temporal overlap of operation with the Project
Galloper	Operational	172.6	158.4	1a	Potential temporal overlap of operation with the Project
Greater Gabbard	Operational	173.9	159.3	1a	Potential temporal overlap of operation with the Project

Project	Status	Distance to the Project array area (km)	Distance to the Project offshore ECC (km)	Tier	Reason for inclusion
Gunfleet Sands	Operational	195.9	177.5	1a	Potential temporal overlap of operation with the Project
Hornsea Project One	Operational	21.4	38.2	1a	Potential temporal overlap of operation with the Project
Hornsea Project Two	Operational	17.7	35.5	1a	Potential temporal overlap of operation with the Project
Humber Gateway	Operational	45.5	33.1	1a	Potential temporal overlap of operation with the Project
Hywind Scotland	Operational	455.7	472.5	1a	Potential temporal overlap of operation with the Project
Kentish Flats	Operational	222.6	201.6	1a	Potential temporal overlap of operation with the Project
Kentish Flats Extension	Operational	223.3	201.6	1a	Potential temporal overlap of operation with the Project
Kincardine	Operational	418.1	431.6	1a	Potential temporal overlap of operation with the Project
Lincolnshire Node	Operational	45.2	0.2	1a	Potential temporal overlap of operation with the Project
Lynn	Operational	53.6	10.6	1a	Potential temporal overlap of operation with the Project
Inner Dowsing	Operational	50.3	3.3	1a	Potential temporal overlap of operation with the Project
London Array	Operational	198.3	182.1	1a	Potential temporal overlap of operation with the Project
Methil (Samsung) Demo	Operational	389.1	388.9	1a	Potential temporal overlap of operation with the Project

Project	Status	Distance to the Project array area (km)	Distance to the Project offshore ECC (km)	Tier	Reason for inclusion
Moray East	Operational	553.2	568.0	1b	Potential temporal overlap of operation with the Project
Race Bank	Operational	22.8	0.0	1a	Potential temporal overlap of operation with the Project
Rampion	Operational	321.5	284.8	1a	Potential temporal overlap of operation with the Project
Scroby Sands	Operational	97.6	85.3	1a	Potential temporal overlap of operation with the Project
Sheringham Shoal	Operational	34.0	16.7	1a	Potential temporal overlap of operation with the Project
Teesside	Operational	182.2	177.8	1a	Potential temporal overlap of operation with the Project
Thanet	Operational	225.8	209.7	1a	Potential temporal overlap of operation with the Project
Triton Knoll	Operational	7.7	5.5	1a	Potential temporal overlap of operation with the Project
Westermost Rough	Operational	59.5	53.9	1a	Potential temporal overlap of operation with the Project
Neart na Gaoithe	Under construction	357.0	363.0	1b	Potential temporal overlap of operation with the Project
SeaGreen offshore windfarm	Under construction	375.5	385.8	1b	Potential temporal overlap of operation with the Project
Dogger Bank A	Under construction	114.4	132.1	1b	Potential temporal overlap of operation with the Project
Dogger Bank B	Under construction	132.8	150.7	1b	Potential temporal overlap of operation with the Project

Project	Status	Distance to the Project array area (km)	Distance to the Project offshore ECC (km)	Tier	Reason for inclusion
Dogger Bank C (formerly Dogger Bank Teesside A)	Consented - construction expected 2023-2026	160.1	177.1	1c	Potential temporal overlap of operation with the Project
East Anglia THREE	Consented - construction expected 2023-2026	118.9	122.4	1c	Potential temporal overlap of operation with the Project
Hornsea Three	Consented – construction expected 2024-2030	59.4	70.9	1c	Potential temporal overlap of operation with the Project
Inch Cape	Under construction	374.5	382.8	1c	Potential temporal overlap of operation with the Project
Moray West	Consented – construction expected 2022-2025	555.8	568.7	1c	Potential temporal overlap of operation with the Project
Sofia (formerly Dogger Bank Teesside B)	Under construction	139.4	156.8	1b	Potential temporal overlap of operation with the Project
East Anglia ONE North	Consented - construction expected 2023 – 2026	133.1	127.1	1c	Potential temporal overlap of operation with the Project
East Anglia TWO	Consented - construction expected 2023 – 2026	141.0	131.0	1c	Potential temporal overlap of operation with the Project
Norfolk Boreas	Consented - construction expected 2023 – 2026	94.9	100.5	1c	Potential temporal overlap of operation with the Project
Norfolk Vanguard	Consented – construction expected 2023 – 2025	83.8	86.7	1c	Potential temporal overlap of operation with the Project
Pentland Floating Offshore Wind Demonstrator	Consented- construction expected 2024 – 2026	664.59	612.02	1c	Potential temporal overlap of operation with the Project
Culzean	Consented -cosnstruction expected 2025	393.76	409.21	1c	Potential temporal overlap of operation with the Project
Sheringham Shoal Extension Project	Consented	26.1	8.8	1d	Potential temporal overlap of operation with the Project

Project	Status	Distance to the Project array area (km)	Distance to the Project offshore ECC (km)	Tier	Reason for inclusion
Dudgeon Extension Project	Consented	13.5	0.0	1d	Potential temporal overlap of operation with the Project
Rampion 2	In determination	321.6	285.2	1d	Potential temporal overlap of operation with the Project
Five Estuaries (Galloper Extension)*	In planning	175.5	162.5	1d	Potential temporal overlap of operation with the Project
North Falls (Greater Gabbard Extension)*	In planning	169.9	155.1	1d	Potential temporal overlap of operation with the Project
Dogger Bank South (East)	In planning	81.2	98.7	1d	Potential temporal overlap of operation with the Project
Dogger Bank South (West)	In planning	94.6	112.5	1d	Potential temporal overlap of operation with the Project
Berwick Bank	In planning	317.79	327.08	1d	Potential temporal overlap of operation with the Project
Green Volt	In planning	482.35	497.19	1d	Potential temporal overlap of operation with the Project
West of Orkney	In planning	758.53	712.35	1d	Potential temporal overlap of operation with the Project
Caledonia	In planning	551.36	531	1d	Potential temporal overlap of operation with the Project
Salamander	In planning	465.86	481.12	1d	Potential temporal overlap of operation with the Project
Ossian	In planning	335.04	350.18	1d	Potential temporal overlap of operation with the Project
Dogger Bank D	Pre-planning	117.7	190.1	2	Potential temporal overlap of operation with the Project

Project	Status	Distance to the Project array area (km)	Distance to the Project offshore ECC (km)	Tier	Reason for inclusion
ScotWind Projects (multiple)3	In planning and Pre-planning	Multiple	Multiple	1c to 3a	Potential temporal overlap of operation with the Project

[3] Projects at varying stages of consent. Those with submitted applications have had impacts included for relevant species.

389. The cumulative MDS for the Project is outlined in Table 12.55:, based on the impacts having the potential to result in the greatest cumulative effect on an identified receptor group. The cumulative impact MDS has been selected based on details presented in the project specific MDS (Table 12.10:), alongside publicly available information on other projects and plans.

Table 12.55: Maximum Design Scenario for Cumulative Assessment

Impact	Maximum Design Scenario	Justification
Construction		
Impact 1: Disturbance and displacement (Offshore ECC & ORCPs) Red-throated diver	MDS for the Project, plus the cumulative full development of the following projects within the UK North Sea and English Channel: Tier 1: - Permitted OWFs not yet implemented; and - OWFs with submitted applications not yet determined. Tier 2: - Tier 2 project identified.	Maximum potential for interactive effects from construction activities associated with the construction of the OWFs considered within the UK North Sea and English Channel BDMPS region (where appropriate). This region was chosen as seabirds associated with the Project are expected to come from, or move to, other areas within this region that are also subject to interaction with other projects within this region.
O&M phase		
Impact 4: Disturbance and displacement: Array Area. Gannet and auk species (guillemot, razorbill and puffin).	MDS for the Project, plus the cumulative full development of the following projects within the UK North Sea and English Channel: Tier 1: - Operational OWFs in the North Sea and English Channel (where applicable); - OWFs under construction in the North Sea and English Channel (where applicable); - Permitted OWFs not yet implemented; and - OWFs with submitted applications not yet determined. Tier 2: - Tier 2 project identified Tier 3; and - Tier 3 projects identified.	Maximum potential for interactive effects from operational and maintenance activities associated with the OWFs considered within the UK North Sea and English Channel (where appropriate). This region was chosen as seabirds associated with the Project are expected to come from, or move to, other areas within this region that are also subject to interaction with other projects within this region.

Impact	Maximum Design Scenario	Justification
Impact 5: Collision risk: Array area. Gannet, kittiwake, great black-backed gull, herring gull.	MDS for the Project, plus the cumulative full development of the following projects within the UK North Sea and English Channel: Tier 1: - Operational OWFs in the North Sea and English Channel (where applicable); - OWFs under construction in the North Sea and English Channel (where applicable); - Permitted OWFs not yet implemented; and - OWFs with submitted applications not yet determined. Tier 2: - 1 Tier 2 project identified, with quantitative data not yet publicly available. Tier 3: - 2 tier 3 projects identified, with quantitative data not yet publicly available.	Maximum potential for interactive effects from operational and maintenance activities associated with the OWFs considered within the UK North Sea and English Channel (where appropriate). This region was chosen as seabirds associated with the Project are expected to come from, or move to, other areas within this region that are also subject to interaction with other projects within this region.

Impact	Maximum Design Scenario	Justification
Impact 9: Disturbance and displacement (Offshore ECC & ORCPs) Red-throated diver	MDS for the Project (identical (or less) to that of the construction phase), plus the cumulative full development of the following projects within the UK North Sea and English Channel: Tier 1: - Permitted OWFs not yet implemented; and - OWFs with submitted applications not yet determined. Tier 2: - Tier 2 project identified.	Maximum potential for interactive effects from construction activities (as MDS for decommissioning is less than that for construction) associated with the construction of the OWFs considered within the UK North Sea and English Channel BDMPS region (where appropriate). This region was chosen as seabirds associated with the Project are expected to come from, or move to, other areas within this region that are also subject to interaction with other projects within this region.

Data sources for cumulative impact assessment

390. The data sources that informed the cumulative impacts from the longlisted projects have been included within each results table. For the majority of species, the cumulative numbers agreed by Natural England from the SEP&DEP examination (Royal HaskoningDHV, 2023a & 2023b), were used as a basis to which additional projects and updates were added. The full references are as follows:

- Appropriate Assessment for the Culzean Floating Offshore Wind Turbine Pilot Project. (Marine Directorate, 2024);
- Berwick Bank Wind Farm, Environmental Impact Assessment Report, Volume 2, Chapter 11: Offshore and Intertidal Ornithology. (Pelagica and Cork Ecology, 2022);
- Caledonia Offshore Wind Farm, Volume 7B Proposed Development (Offshore) Appendices. Appendix 6-2 Offshore Ornithology Distributional Responses Technical Report. (GoBe, 2024a);
- Caledonia Offshore Wind Farm, Volume 7B Proposed Development (Offshore) Appendices. Appendix 6-3 Offshore Ornithology Collision Risk Modelling Technical Report. (GoBe, 2024b);
- East Anglia TWO and East Anglia ONE North Offshore Windfarms, Deadline 12 Offshore Ornithology Cumulative and In-Combination Collision and Displacement Update. (MacArthur Green & Royal HaskoningDHV, 2021)
- Five Estuaries Offshore Wind Farm, Environmental Statement, Volume 6, Part 5, Annex 4.8: Collision Risk Modelling Inputs and Outputs. (MacArthur Green, 2024a);
- Forthwind, Offshore Ornithology 6C Technical Appendix Collision Risk Modelling. (HiDef, 2022a);
- Green Volt Offshore Windfarm, Environmental Impact Assessment Report, Volume 2 Technical Appendix 12.8 Supplementary Ornithological Assessment. (APEM, 2023a);
- Hornsea Four, Environmental Statement A2.5. Volume A2 Chapter 5 Offshore and Intertidal Ornithology. (APEM, 2021);
- Hornsea Project Four, Ornithology Environmental Impact Assessment and Habitat Regulations Assessment Annex, Deadline 6 Submission. (APEM, 2022);
- Neart na Gaoithe Offshore Windfarm, Environmental Impact Assessment Report. (GoBe, 2018);
- North Falls, Appendix 13.3 Supplementary Information for the Offshore Ornithology Cumulative Effects Assessment. (SSE Renewables and RWE, 2023);
- North Falls, Environmental Statement, Chapter 13 Offshore Ornithology. (Royal HaskoningDHV. 2024);
- Ossian, Array Environmental Impact Assessment Report, Chapter 11: Offshore Ornithology. (RPS, 2024);

- Outer Dowsing Offshore Wind, Habitats Regulations Assessment for the Offshore Restricted Build Area and Revision to the Offshore Export Cable Corridor (Procedural Deadline 19 September). (GoBe, 2024c);
- Pentland Floating Offshore Wind Farm, Volume 2: Offshore EIAR, Chapter 12: Marine Ornithology. (HiDef, 2022b);
- Pentland Floating Offshore Wind Farm, Volume 3: Appendix A.12.3. Marine Ornithology: Collision Risk Modelling. (HiDef 2022c);
- Rampion 2 Wind Farm, Category 6: Environmental Statement Volume 4, Appendix 12.3: Offshore and intertidal ornithology collision risk modelling. (APEM, 2023b);
- RWE Renewables, UK Dogger Bank South East and West, Dogger Bank South Offshore Wind Farms: Environmental statement, Volume 7, Appendix 12-9 Collision Risk Modelling Outputs. (MacArthur Green, 2024a);
- Salamander Offshore Wind Farm, Offshore Environmental Impact Assessment Report, Volume ER.A.4, Annex 12.3: Collision Risk Modelling Report. (HiDef, 2024);
- Seagreen S36C Application, Environmental Appraisal Report Appendix C, Updated Collision Risk Modelling. (ERM, 2022);
- Sheringham Shoal and Dudgeon Offshore Wind Farm Extension Projects, Gannet and Auk Cumulative Displacement Updates Technical Note. (Royal HaskoningDHV, 2023a);
- Sheringham Shoal and Dudgeon Offshore Wind Farm Extension Projects, Collision Risk Modelling (CRM) Updates (EIA Context) Technical Note (Revision B). Deadline 3 Submission. (Royal HaskoningDHV, 2023b);
- West of Orkney Windfarm, Offshore Ornithology Additional Information. Addendum to the Report to Inform Appropriate Assessment: HRA Stage 2 – SPA Appropriate Assessment. (MacArthur Green, 2024b).

12.11.2 Cumulative Impact Assessment: Disturbance and Displacement (Construction Phase)

391. There is potential for cumulative disturbance and displacement impacts to occur when the construction of the Project temporally overlaps with that of one or more other consented and/or application-stage projects. As outlined in Table 12.56:, this section only considers cumulative effects on red-throated divers during the construction of the Offshore ECC on a precautionary basis.

392. All other species/impacts relating to disturbance and displacement have been screened out of the cumulative assessment. For common scoter, the worst-case scenario impact from the Project is less than one (0.1) mortality per annum and therefore, there is no potential for the Project to contribute materially to any cumulative impact. For auk species and gannet, the impact is also not considered to be relevant at the cumulative level. Impacts during the construction phase are temporary, reversible and spatially limited. In addition, impacts during the construction phase are considered to be at least half compared with the operational phase. Cumulative impacts for the operational phase are considered below (Section 12.11) for these species.

Red-throated diver

393. During the construction phase, there is potential for cumulative construction-related disturbance and displacement impacts arising within project ECCs from a number of Tier 1 and Tier 2 projects, as outlined in Table 12.56: below. The impact assessments for those projects included were largely carried out using a consistent methodology and in common with the methodology used for the Project alone assessment, with an area of 2km around cable-laying vessels being assumed to be subject to displacement. A mortality range of 1% to 10% was mainly considered, but where this was not the case, values have been converted for consistency. Values in the table are those of predicted displacement/disturbance impacts at the construction phase of each relevant project. ECC impacts through displacement and subsequent mortality are considered to be lower than those from the array as the area affected at any one time is small (i.e. a 2 km buffer around the cable laying vessel). As such, no substantial difference to bird distribution arises, and the presence of displacement pressure at any given location is very short-lived.

Table 12.56: Projects and parameters used in the cumulative assessment of red-throated diver.

Project	Predicted mortality range (individuals)	Mortality rate assumptions in ES	Tier
East Anglia THREE	0 - 2	1-10% mortality	1c
Norfolk Vanguard	0 - 9	2 - 4 at 5% mortality, converted to 1-10% mortality	1c
Norfolk Boreas	0 – 9	1-10% mortality	1c
East Anglia ONE North	0 - 10	1-10% mortality	1c
East Anglia TWO	0 - 10	1-10% mortality	1c

Project	Predicted mortality range (individuals)	Mortality rate assumptions in ES	Tier
Hornsea Project 4	0 - 0	No losses even with 100% displacement	1d
Dudgeon Offshore Extension Project	0 - 0	1-10% mortality	1d
Sheringham Shoal Extension Project	0 - 3	1-10% mortality	1d
Rampion 2	0 – 0	Species not assessed	1d
ForthWind Offshore Wind Demonstration Project (Methil)	0 - 0	Species not assessed	1c
West of Orkney	0 - 0	Species not assessed	1d
Dogger Bank South	0 - 0	Species not assessed	1d
North Falls	1 - 18	Species not assessed	1d
Total (other projects)	**1 - 61**	-	-
The Project	0 - 3	1-10% mortality	1d
Total (all projects)	**1 - 64**	-	-

394. In total, up to 61 red-throated divers are currently predicted to be at risk of cumulative displacement-consequent mortality during the construction phase of these OWFs, rising to 64 when including the worst-case scenario from the Project (based on 100% displacement, and 10% mortality).

395. Considering the largest Southwest North Sea BDMPS population of 13,276 individuals, and a baseline mortality of 3,023 individuals per annum, the addition of 64 individuals would represent a 2.117% increase in baseline mortality. Considering the biogeographic population of 27,000 individuals and a baseline mortality of 6,148 individuals, the addition of 64 individuals would represent a 1.040% increase in baseline mortality.

396. It is noted that the cumulative assessment for red-throated diver is considered to be over-precautionary due to several reasons, including:

- The temporary nature of the impact in spatially restricted areas spaced over a large geographic area. Vessel activity will only impact a small number of individuals for a limited period of time, therefore having no expected material differences on seabird densities;
- A review undertaken by Norfolk Vanguard Ltd (2019) found that the top range of 100% and 10% recommended by SNCBs is over precautionary, and that the lower range of 90% displacement and 1% mortality is more appropriate, while still being precautionary. They also recommend that displacement mortality may in reality be less than 1% and as low as zero;
- There is an unknown level of double counting, since some birds will be present within more than one bio-season and could also move between sites;
- The majority of the predicted annual mortality occurs during the autumn and spring migration periods, where the potential consequences of displacement are expected to be much lower in reality, since birds will be present within the area for only a brief duration; and

- It is probable that the South-west North Sea BDMPS for spring and autumn migration (13,276) is an underestimate. Based on the most recent population count, the Greater Wash SPA hosts 22,280 individuals. If this value were used as a minimum estimate for the BDMPS assessment, then the predicted annual cumulative mortality of 1 to 64 individuals would represent a 0.020% to 1.260% increase in baseline mortality.

397. On this basis, it is considered more realistic (and still precautionary) to base the assessment on a displacement rate of 100% and a mortality rate of 1%. This, combined with the additional sources of precaution listed above, would result in a large reduction in the cumulative displacement totals presented as the worst-case scenario to six (6.4) individuals, resulting in an increase in baseline mortality 0.212% at the South-west North Sea BDMPS scale, and a 0.104% increase in baseline mortality at the biogeographic scale.

398. Based on this, the magnitude of the impact is assessed as negligible at the BDMPS and biogeographic scales. Given a magnitude change of negligible, and a sensitivity to disturbance and displacement of high, the significance of the cumulative effect is therefore concluded to be **minor adverse, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

399. Confidence in the conclusions of this assessment is high due to the precautionary displacement and mortality rates used, and the temporary nature of the impact.

12.11.3 Cumulative impact assessment: Disturbance and displacement (O&M phase)

400. As a result of the operational and maintenance activities associated with the Project and other projects (Table 12.55:), there is potential for cumulative displacement. For this cumulative impact assessment, only projects which were defined as being within Tier 1 (sub-tiers 1a to 1d) and Tier 2 were considered because they are the only projects with publicly available ornithological impact estimates. This approach is in line with Planning Inspectorate guidance note 17.

401. The presence of WTGs and other infrastructure or O&M activity has the potential to directly disturb and displace seabirds that would normally reside within and around the area of sea where OWFs are located. This in effect represents indirect habitat loss, which would potentially reduce the area available to those seabirds to forage, loaf, and/or moult that currently occur within and around OWFs and may be susceptible to displacement from such developments. Displacement may contribute to individual birds experiencing fitness consequences, which at an extreme level could lead to the mortality of individuals. Cumulative displacement therefore has the potential to lead to effects on a wider scale, which in this case is defined as the wider non-breeding BDMPS populations of gannet and auk species (adults and immature) within the UK North Sea and English Channel from Furness (2015).

402. Following the screening process, five seabird species of interest (guillemot, razorbill, puffin, red-throated diver, and gannet) were assessed for cumulative displacement.

Red-throated diver

403. As outlined in Section 12.9, red-throated divers show a high level of sensitivity to maintenance activities from, for example, ship and helicopter traffic as well as to the presence of operational WTGs.

404. For red-throated diver, there are a limited number of OWFs in the southern North Sea which have quantitatively assessed the impacts of displacement on this species during the O&M phase. A review of impact assessments for OWFs in the south-west North Sea BDMPS is presented in Norfolk Vanguard Ltd (2019). Within this review, four categories of impact assessments were identified:

- OWFs with no population estimates presented (Dogger Bank A, B, C, and Sofia, and Blyth demonstrator);
- Coastal windfarms with low numbers of over-wintering birds reported (Teesside, Humber Gateway, and Westernmost Rough);
- OWFs with sightings made during months considered to belong to the breeding season (Hornsea projects); and
- OWFs with quantitative numbers of over wintering birds by season (Norfolk Vanguard, Norfolk Boreas).

405. Mortality estimates from the above projects, as provided for Sheringham Shoal and Dudgeon Offshore Windfarm Extension Projects (Royal HaskoningDHV, 2022b) are presented in Table 12.57: below for the full range of displacement scenarios (90% displacement and 1% mortality, to 100% displacement and 10% mortality), with the addition of Rampion 2, ForthWind Offshore Wind Demonstration Project, West of Orkney, Dogger Bank South, North Falls and Five Estuaries for which data has become available since this document.

Table 12.57: Cumulative displacement mortality estimates for red-throated diver from Tier 1 and 2 projects.

Project	Post-breeding migration	Migration-free winter	Return migration	Breeding	Non-breeding	Annual total	Tier
Wider region (Royal HaskoningDHV, 2022b)	N/A	N/A	N/A	-	-	6 – 56	1a
East Anglia ONE	0.4 – 5	1 – 10	1.4 – 15	-	-	2.8 – 30	1a
East Anglia THREE	0.4 – 5	0.2 – 2	2 – 20	-	-	2.6 – 27	1c
Norfolk Vanguard East	0.4 – 5	0.2 – 3	1 – 12	-	-	1.6 – 20	1c
Norfolk Vanguard West	0 – 3	3 – 36	2 – 20	-	-	5 – 59	1c

Project	Post-breeding migration	Migration-free winter	Return migration	Breeding	Non-breeding	Annual total	Tier
Norfolk Boreas	0 – 1	1 – 15	5 – 62	-	-	6 – 78	1c
East Anglia ONE North	0 – 1	1 – 3	3 – 17	-	-	4 – 42	1c
East Anglia TWO	0	0 – 2	2 – 25	-	-	3 – 28	1c
Hornsea Project 4	0	0	0	-	-	0	1c
Dudgeon Offshore Extension Project	1 – 6	0 – 1	1 – 5	-	-	1 – 13	1d
Sheringham Shoal Extension Project	1 – 8	0 – 1	2 – 18	-	-	3 – 26	1d
Rampion 2	0	0	0	0	0	0	1d
ForthWind Offshore Wind Demonstration Project – Phase 1	0	0	0	0	0	0	1c
West of Orkney	0	0	0	0	0	0	1d
Dogger Bank South	0	0	0	0	0	0	1d
North Falls	0 – 1	1 - 6	5 - 49	-	-	6 - 56	1d
Five Estuaries	0 – 0	0 – 2	0 - 3	-	-	0 - 5	1d
Total (other projects)	**3.2 – 35**	**7.4 – 81**	**24.4 – 246**	**0.0 – 0.0**	**0.0 – 0.0**	**41.0 – 440.0**	**-**
The Project	-	-	-		1.6 - 18.0	1.6 - 18.0	1d
Total (all projects)	-	-	-	-	-	**41.6 – 458.0**	**-**

406. The potential overall magnitude of impact is estimated by calculating the increase in baseline mortality when compared against the largest UK Southwest North Sea BDMPS and biogeographic population. The largest red-throated diver BDMPS is 13,276 individuals whilst the wider bio-geographic population is 27,000 individuals. Using the average mortality rate of 0.228 (Table 12.9), the background mortality for these population scales are 3,023 and 6,148 individuals per annum, respectively.

407. The predicted cumulative displacement mortality for red-throated divers based on 90% to 100% displacement, and 1% to 10% mortality, is estimated as 42 (41.6) – 458 (458.0) individuals.

408. At the UK Southwest North Sea BDMPS scale, the potential cumulative loss of 42 to 458 individuals represents a 1.376% to 15.151% increase in baseline mortality. At the biogeographic scale, this addition of 42 to 458 individuals represents a 0.676% to 7.440% increase in baseline mortality. As the population in the south-west North Sea may be increasing (for example the population of the Outer Thames SPA has increased from 6,446 individuals during the period 1989 – 2006/7 to 21,997 (Irwin *et al.*, 2019)) it is likely that the impacts predicted here represent a lower increase in baseline mortality than those calculated above.

409. A more realistic scenario is considered to be the use of 100% displacement, and 1% mortality, which would result in an annual total of 46 (45.8) predicted displacement consequent mortalities. This would result in a 1.515% and 0.744% increase in baseline mortality at the BDMPS and biogeographic populations respectively.

410. However, it is noted that the cumulative assessment for red-throated diver is considered to be over-precautionary due to several reasons laid out below:

- Assessments for OWFs have assumed that displacement occurs to the same extent across the entire OWF and 4km buffer, whereas in reality it is expected that the degree of displacement will decline with distance from windfarm boundaries, and may be as low as zero by 2km;
- The inclusion of total displacement within the 4km buffers from both Norfolk Vanguard East and Norfolk Vanguard West is highly precautionary since no allowance is made for the division of WTGs across the two windfarm sites and the consequent reduction in developed area or increase in WTG spacing;
- The majority of the predicted annual mortality occurs during the autumn and spring migration periods, where the potential consequences of displacement are expected to be much lower in reality, since birds will be present within the area for only a brief duration;
- It is probable that the South-west North Sea BDMPS for spring and autumn migration (13,276) is an underestimate. Based on the most recent population count, the Greater Wash SPA hosts 22,280 individuals. If this value were used as a minimum estimate for the BDMPS assessment, then the predicted annual cumulative mortality of 42 (41.6) – 458 (458.0) individuals would represent a 0.819% to 9.016% increase in baseline mortality (0.902% for 100% displacement, 1% mortality);
- There is an unknown level of double counting, since some birds will be present within more than one bio-season and could also move between sites;

- There is an overlap of the Norfolk Boreas, Norfolk Vanguard East, and East Anglia THREE 4km buffers, resulting in an unaccounted-for level of double counting of birds (approximately 15%); and

411. Based on these elements of precaution, it is considered that the realistic scenario of 100% displacement and 1% mortality, combined with the elements of precaution outlined above, would result in the magnitude of impact at the South-west North Sea BDMPS scale and biogeographic scale being negligible, representing no discernible change to baseline mortality. Given a magnitude change of negligible, and a sensitivity to disturbance and displacement of high, the significance of the effect is therefor considered to be **minor adverse, which is not significant in EIA terms** based on the matrix approach defined in Table 12.15:.

Gannet

412. As outlined in Section 12.9, gannet show a low level of sensitivity to maintenance activities from ship and helicopter traffic as well as to operational WTGs. Additionally, gannet are highly flexible in their foraging requirements, and therefore is it unlikely that the Project will contribute to any significant impacts at the cumulative level. A cumulative assessment has been carried out on this species to demonstrate this.

413. Table 12.58: below presents the bio-season and annual abundance estimates for relevant OWFs in the UK North Sea and Channel BDMPS. This approach has considered birds within the array area and 2km buffer for all projects. Abundances were taken from the Sheringham Shoal and Dudgeon Offshore Windfarm Extension Projects Gannet and Auk cumulative Displacement Updates Technical Note (Royal HaskoningDHV, 2023a). The following amendments were made to these values:

- Inclusion of values from the ForthWind Offshore Wind Demonstration Project, Berwick Bank, North Falls and Five Estuaries;
- Removal of Beatrice Demonstrator as the project will be decommissioned by the time the Project is predicted to be operational; and
- Inclusion of values from the Project.

Table 12.58: Cumulative bio-season and total abundance estimates for gannet from all Tier 1 and 2 projects.

Project	Breeding	Post-breeding migration	Return migration	Annual total	Tier	Source
Beatrice	151	0	0	151	1a	SEP&DEP
Blyth Demonstration Site	-	-	-	0	1a	SEP&DEP
Dudgeon	53	25	11	89	1a	SEP&DEP
East Anglia ONE	161	3,638	76	3,875	1a	SEP&DEP
EOWDC	35	5	0	40	1a	SEP&DEP
Galloper	360	907	276	1,543	1a	SEP&DEP
Greater Gabbard	252	69	105	426	1a	SEP&DEP
Gunfleet Sands	0	12	9	21	1a	SEP&DEP

Project	Breeding	Post-breeding migration	Return migration	Annual total	Tier	Source
Hornsea Project One	671	694	250	1,615	1a	SEP&DEP
Humber Gateway	-	-	-	0	1a	SEP&DEP
Hywind Scotland	10	0	4	14	1a	SEP&DEP
Kentish Flats	-	-	-	0	1a	SEP&DEP
Kentish Flats Extension	0	13	0	13	1a	SEP&DEP
Kincardine	120	0	0	120	1a	SEP&DEP
Lincolnshire Node	-	-	-	0	1a	SEP&DEP
London Array	-	-	-	0	1a	SEP&DEP
Methil (Samsung) Demo	23	0	0	23	1a	SEP&DEP
Race Bank	92	32	29	153	1a	SEP&DEP
Rampion	0	590	0	590	1a	SEP&DEP
Scroby Sands	-	-	-	0	1a	SEP&DEP
Sheringham Shoal	47	31	2	80	1a	SEP&DEP
Teesside	1	0	0	1	1a	SEP&DEP
Thanet	-	-	-	0	1a	SEP&DEP
Westermost Rough	-	-	-	0	1a	SEP&DEP
Hornsea Project Two	457	1,140	124	1,721	1a	SEP&DEP
Moray East	564	292	27	883	1b	SEP&DEP
Neart na Gaoithe	1,987	552	281	2,820	1b	SEP&DEP
Triton Knoll	211	15	24	250	1a	SEP&DEP
SeaGreen Alpha and Bravo	2,956	664	332	3,952	1b	SEP&DEP
Dogger Bank A & B	1,155	2,048	394	3,597	1b	SEP&DEP
Dogger Bank C & Sofia	2,250	887	464	3,601	1b	SEP&DEP
East Anglia THREE	412	1,269	524	2,205	1c	SEP&DEP
Hornsea Three	1,333	984	524	2,841	1c	SEP&DEP
Inch Cape	2,398	703	212	3,313	1c	SEP&DEP
Moray West	2,827	439	144	3,410	1c	SEP&DEP
Norfolk Vanguard	271	2,453	437	3,161	1c	SEP&DEP
Norfolk Boreas	1,229	1,723	526	3,478	1c	SEP&DEP
East Anglia ONE North	149	468	44	661	1c	SEP&DEP
East Anglia TWO	192	891	192	1,275	1c	SEP&DEP
Hornsea Four	976	790	401	2,167	1c	SEP&DEP
ForthWind Offshore Wind Demonstration Project (Methil)	64	26	44	134	1c	Forthwind Displacement Appendix
Sheringham Shoal Extension	23	295	11	329	1d	SEP&DEP
Dudgeon Extension	417	343	47	807	1d	SEP&DEP
Berwick Bank	4,735	1,500	269	6,504	1d	Berwick Bank EIA
Green Volt	120	16	49	185	1c	Green Volt EIA

Project	Breeding	Post-breeding migration	Return migration	Annual total	Tier	Source
Rampion 2	111	102	123	336	1d	Rampion 2 EIA
North Falls	69	287	290	646	1d	North Falls EIA
Five Estuaries	233	640	67	940	1d	Five Estuaries ES
Dogger Bank South	1,335	1,574	134	3,043	1d	Dogger Bank South EIA
Ossian	1,393	775	42	2,210	1d	Ossian EIA
West of Orkney	852	1,368	140	2,359	1d	
Caledonia	909	315	29	1,253	1d	Caledonia OWF Distributional Responses Appendix
Salamander	442	363 (Non-breeding)		805	1d	Salamander Displacement Annex
Total All Projects (without the Project)	26,963	24,709	6,267	57,939	-	
The Project	554	496	69	1,119	1d	
Total (with the Project)	27,517	25,204	6,336	59,058	-	

Potential magnitude of impact

414. The potential overall magnitude of impact is estimated by calculating the increase in baseline mortality when compared against the largest UK North Sea and English Channel BDMPS and biogeographic population. The largest gannet BDMPS for the UK North Sea and English Channel is 456,299 (adults and immatures), whilst the wider bio-geographic population is 1,180,000 individuals (adults and immatures). Using the average mortality rate of 0.19 (Table 12.9), the background mortality for these population scales are 85,145 and 220,188 individuals per annum, respectively.

415. The predicted cumulative mortality from displacement is estimated based on a displacement rate of 70% and a mortality rate of 1% presented in Table 12.59: in line with SNCB guidance (MIG-Birds, 2022). The cumulative annual displacement matrix is presented in Table 12.60:.

Table 12.59: Cumulative seasonal and annual displacement impacts on gannet (O&M phase).

Bio-season (months)	Cumulative Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated cumulative mortality level during O&M phase.	Increase in baseline mortality (%) during O&M phase
		Population	Baseline mortality	70% displacement, 1% mortality	70% displacement, 1% mortality
Return migration (Dec-Mar)	6,336	248,385	46,349	44.4	0.096
Migration-free breeding (Apr-Aug)	27,517	400,326	74,701	192.6	0.258
Post-breeding migration (Sep-Nov)	25,204	456,299	85,145	176.4	0.207
Annual (BDMPS)	59,058	456,299	85,145	413.4	0.486
Annual (biogeographic)	59,058	1,180,000	220,188	413.4	0.188

Table 12.60: Cumulative annual displacement matrix for gannet within the array area and 2km buffer, values in light blue represent the range-based values advocated by SNCBs and the darker shade of blue representing the Applicant's approach value.

Annual (2km Buffer)	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	59	118	295	591	1,181	1,772	2,362	2,953	3,543	4,134	4,725	5,315	5,906
20	118	236	591	1,181	2,362	3,543	4,725	5,906	7,087	8,268	9,449	10,630	11,812
30	177	354	886	1,772	3,543	5,315	7,087	8,859	10,630	12,402	14,174	15,946	17,717
40	236	472	1,181	2,362	4,725	7,087	9,449	11,812	14,174	16,536	18,898	21,261	23,623
50	295	591	1,476	2,953	5,906	8,859	11,812	14,764	17,717	20,670	23,623	26,576	29,529
60	354	709	1,772	3,543	7,087	10,630	14,174	17,717	21,261	24,804	28,348	31,891	35,435
70	413	827	2,067	4,134	8,268	12,402	16,536	20,670	24,804	28,938	33,072	37,206	41,340
80	472	945	2,362	4,725	9,449	14,174	18,898	23,623	28,348	33,072	37,797	42,521	47,246
90	532	1,063	2,658	5,315	10,630	15,946	21,261	26,576	31,891	37,206	42,521	47,837	53,152
100	591	1,181	2,953	5,906	11,812	17,717	23,623	29,529	35,435	41,340	47,246	53,152	59,058

416. Across all OWF projects presented in Table 12.58:, the annual cumulative total of gannet at risk of displacement is calculated to be 59,058. When applying a 70% displacement rate and a 1% mortality rate, the annual cumulative loss is estimated as 413 (413.4) individuals.

417. At the UK North Sea and English Channel BDMPS scale, the potential cumulative loss of 413 gannet represents a 0.486% increase in baseline mortality. At the biogeographic scale, this additional mortality would increase baseline mortality by 0.188%.

418. Over the range of displacement and mortality scenarios assessed, the addition to baseline mortality remains well below 1% and can, therefore, be considered to make no material difference to the baseline mortality of the species.

419. This level of change is considered to be of negligible magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall, as it represents no discernible change to baseline mortality. Given a magnitude change of negligible, and a sensitivity to disturbance and displacement of minor to moderate, the significance of effect is therefore concluded to be **minor adverse, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

Guillemot

420. As outlined in Section 12.9, guillemot show a medium level of sensitivity to maintenance activities from, for example, ship and helicopter traffic as well as to operational WTGs.

421. Table 12.61: below presents the bio-season and annual abundance estimates for relevant OWFs in the UK North Sea and Channel BDMPS (see justification in document reference 19.9). This approach has considered birds within the array area and 2km buffer for all projects. Abundances were taken from the Sheringham Shoal and Dudgeon Offshore Windfarm Extension Projects Gannet and Auk cumulative Displacement Updates Technical Note (Royal HaskoningDHV, 2023a). The following amendments were made to these values:

- Inclusion of values from the ForthWind Offshore Wind Demonstration Project, Berwick Bank, North Falls and Five Estuaries;
- Removal of Beatrice Demonstrator as the project will be decommissioned by the time the Project is predicted to be operational; and
- Inclusion of values from the Project.

422. It should be noted that the total number of birds estimated within the collective array area and 2km buffers is likely to be an overestimate due to each individual assessment considering the mean peak for each bio-season. Consequently, the total abundance presented in Table 12.61: represents ~36% of the entire North Sea and English Channel BDMPS population, whilst the area covered by the combined array area and 2km buffers of all of the OWFs considered within this cumulative displacement assessment would be well under 5% of the corresponding area. The approach undertaken to assess cumulative displacement is therefore considered highly precautionary.

Table 12.61: Cumulative bio-season and total abundance estimates for guillemot from all Tier 1 and 2 projects.

Project	Breeding	Non-breeding	Annual total	Tier	Source
Beatrice	13,610	2,755	16,365	1a	SEP&DEP
Blyth Demonstration Site	1,220	1,321	2,541	1a	SEP&DEP
Dudgeon	334	542	876	1a	SEP&DEP
East Anglia ONE	274	640	914	1a	SEP&DEP
EOWDC	547	225	772	1a	SEP&DEP
Galloper	305	593	898	1a	SEP&DEP
Greater Gabbard	345	548	893	1a	SEP&DEP
Gunfleet Sands	0	363	363	1a	SEP&DEP
Hornsea Project One	9,836	8,097	17,933	1a	SEP&DEP
Humber Gateway	99	138	237	1a	SEP&DEP
Hywind Scotland	249	2,136	2,385	1a	SEP&DEP
Kentish Flats	0	3	3	1a	SEP&DEP
Kentish Flats Extension	0	4	4	1a	SEP&DEP
Kincardine	632	0	632	1a	SEP&DEP
Lincolnshire Node & LID	582	814	1,396	1a	SEP&DEP
London Array	192	377	569	1a	SEP&DEP
Methil (Samsung) Demo	25	0	25	1a	SEP&DEP
Race Bank	361	708	1,069	1a	SEP&DEP
Rampion	10,887	15,536	26,423	1a	SEP&DEP
Scroby Sands	-	-	0	1a	SEP&DEP
Sheringham Shoal	390	715	1,105	1a	SEP&DEP
Teesside	267	901	1,168	1a	SEP&DEP
Thanet	18	124	142	1a	SEP&DEP
Westermost Rough	347	486	833	1a	SEP&DEP
Hornsea Project Two	7,735	13,164	20,899	1b	SEP&DEP
Moray East	9,820	547	10,367	1b	SEP&DEP
Neart na Gaoithe	1,755	3,761	5,516	1b	SEP&DEP
Triton Knoll	425	746	1,171	1b	SEP&DEP
Dogger Bank C	3,283	2,268	5,551	1b	SEP&DEP
Sofia	5,211	3,701	8,912	1b	SEP&DEP
SeaGreen Alpha	13,606	4,688	18,294	1b	SEP&DEP
SeaGreen Bravo	11,118	4,112	15,230	1c	SEP&DEP
Dogger Bank A	5,407	6,142	11,549	1b	SEP&DEP
Dogger Bank B	9,479	10,621	20,100	1b	SEP&DEP
East Anglia THREE	1,744	2,859	4,603	1c	SEP&DEP
Hornsea Three	13,374	17,772	31,146	1c	SEP&DEP
Inch Cape	4,371	3,177	7,548	1c	SEP&DEP
Moray West	24,426	38,174	62,600	1c	SEP&DEP
Norfolk Vanguard	4,320	4,776	9,096	1c	SEP&DEP
Norfolk Boreas	7,767	13,777	21,544	1c	SEP&DEP
East Anglia ONE North	4,183	1,888	6,071	1c	SEP&DEP

Project	Breeding	Non-breeding	Annual total	Tier	Source
East Anglia TWO	2,077	1,675	3,752	1c	SEP&DEP
Hornsea Four (NE approach)	9,382	36,965	46,347	1c	SEP&DEP
ForthWind Offshore Wind Demonstration Project (Methil)	417	401	818	1c	Forthwind Displacement Appendix
Pentland Floating Offshore Wind Demonstrator	1,146	650	1,796	1c	Pentland Floating EIA
Sheringham Shoal Extension	1,085	1,095	2,180	1d	SEP&DEP
Dudgeon Extension	3,839	14,887	18,726	1d	SEP&DEP
Berwick Bank	74,154	44,171	118,325	1d	Berwick Bank EIA
Green Volt	4,429	16,105	20,534	1d	Green Volt EIA
Rampion 2	134	5,723	5,857	1d	Rampion 2 EIA
North Falls	866	5,365	6,231	1d	North Falls EIA
Five Estuaries	1,115	3,698	4,813	1d	Five Estuaries ES
Dogger Bank South	14,928	20,136	35,064	1d	Dogger Bank South EIA
Ossian	27,247	48,340	75,587	1d	Ossian EIA
West of Orkney	7,973	4,393	12,365	1d	
Caledonia	16,092	6,710	22,802	1d	Caledonia OWF Distributional Responses Appendix
Salamander	3,718	220	3,938	1d	Salamander Displacement Annex
Total All Projects (without the Project)	337,146	379,733	716,878		
The Project (Applicant Approach)	11,364	9,066	20,430	1d	
The Project (Natural England Approach)	11,364	9,066 (post-breeding); 4,279 (non-breeding)	24,709	1d	
Total (with the Project (Applicant Approach)	348,510	388,799	737,309	-	

Project	Breeding	Non-breeding	Annual total	Tier	Source
Total (with the Project (Natural England Approach)	348,510	393,078 (388,799; 4,279)	741,587	-	

Potential magnitude of impact

423. The potential overall magnitude of impact is estimated by calculating the increase in baseline mortality when compared against the largest UK North Sea and English Channel BDMPS and biogeographic population. The largest guillemot BDMPS for the UK North Sea and English Channel is 2,045,078 individuals, whilst the wider bio-geographic population is 4,125,000 individuals. Using the average mortality rate of 0.14 (Table 12.9), the background mortality for these population scales are 287,333 and 579,563 individuals per annum, respectively.

424. The predicted cumulative mortality as a result of displacement is estimated based on a displacement rate of 50% and a mortality rate of 1%, though a displacement rate range of 30% to 70% and a mortality rate range of 1% to 2% is also presented in Table 12.62: in line with SNCB guidance (MIG-Birds, 2022) (see review of displacement levels in document reference 19.10). Results are also presented in a displacement matrix in Table 12.64:.

Table 12.62: Cumulative seasonal and annual displacement impacts on guillemot (Applicant's Approach) (O&M phase).

Bio-season (months)	Cumulative Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated cumulative mortality level during O&M phase.		Increase in baseline mortality (%) during O&M phase.	
		Population	Baseline mortality	50% displacement, 1% mortality	30-70% displacement, 1-2% mortality	50% displacement, 1% mortality	30-70% displacement, 1-2% mortality
Breeding (Mar - Jul)	348,510	2,045,078	287,333	1,742.5	1,045.5 – 4,879.1	0.606	0.364 – 1.698
Non-breeding (Aug - Feb)	388,799	1,617,305	227,231	1,944.0	1,166.4 – 5,443.2	0.856	0.513 – 2.395
Annual (BDMPS)	737,309	2,045,078	287,333	3,686.5	2,211.9 – 10,322.3	1.283	0.770 – 3.592
Annual (biogeographic)	737,309	4,125,000	579,563	3,686.5	2,211.9 0 10,322.3	0.636	0.382 – 1.781

Table 12.63: Cumulative seasonal and annual displacement impacts on guillemot (Natural England's Approach) (O&M phase).

Bio-season (months)	Cumulative Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated cumulative mortality level during O&M phase.		Increase in baseline mortality (%) during O&M phase.	
		Population	Baseline mortality	50% displacement, 1% mortality	30-70% displacement, 1-2% mortality	50% displacement, 1% mortality	30-70% displacement, 1-2% mortality
Breeding (Mar - Jul)	348,510	2,045,078	287,333	1,742.5	1,045.5 – 4,879.1	0.606	0.364 – 1.698
Post-breeding (Aug – Sept)	388,799	2,045,078	287,333	1,944.0	1,166.4 – 5,443.2	0.677	0.406 – 1.894
Non-breeding (Aug - Feb)	4,279	1,617,305	227,231	21.4	12.8 – 59.9	0.009	0.006 – 0.026
Annual (BDMPS)	741,587	2,045,078	287,333	3,707.9	2,224.8 – 10,382.2	1.290	0.774 – 3.613
Annual (biogeographic)	741,587	4,125,000	579,563	3,707.9	2,224.8 – 10,382.2	0.640	0.384 – 1.791

Table 12.64: Cumulative annual displacement matrix for guillemot within the array area and 2km buffer (Applicant's Approach), values in light blue represent the range-based values advocated by SNCBs and the darker shade of blue representing the Applicant's approach value.

Annual (2km Buffer)	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	737	1,475	3,687	7,373	14,746	22,119	29,492	36,865	44,239	51,612	58,985	66,358	73,731
20	1,475	2,949	7,373	14,746	29,492	44,239	58,985	73,731	88,477	103,223	117,969	132,716	147,462
30	2,212	4,424	11,060	22,119	44,239	66,358	88,477	110,596	132,716	154,835	176,954	199,073	221,193
40	2,949	5,898	14,746	29,492	58,985	88,477	117,969	147,462	176,954	206,446	235,939	265,431	294,923
50	3,687	7,373	18,433	36,865	73,731	110,596	147,462	184,327	221,193	258,058	294,923	331,789	368,654
60	4,424	8,848	22,119	44,239	88,477	132,716	176,954	221,193	265,431	309,670	353,908	398,147	442,385
70	5,161	10,322	25,806	51,612	103,223	154,835	206,446	258,058	309,670	361,281	412,893	464,505	516,116
80	5,898	11,797	29,492	58,985	117,969	176,954	235,939	294,923	353,908	412,893	471,878	530,862	589,847
90	6,636	13,272	33,179	66,358	132,716	199,073	265,431	331,789	398,147	464,505	530,862	597,220	663,578
100	7,373	14,746	36,865	73,731	147,462	221,193	294,923	368,654	442,385	516,116	589,847	663,578	737,309

Table 12.65: Cumulative annual displacement matrix for guillemot within the array area and 2km buffer (Natural England's Approach), values in light blue represent the range-based values advocated by SNCBs and the darker shade of blue representing the Applicant's approach value.

Annual (2km Buffer)	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	742	1,483	3,708	7,416	14,832	22,248	29,663	37,079	44,495	51,911	59,327	66,743	74,159
20	1,483	2,966	7,416	14,832	29,663	44,495	59,327	74,159	88,990	103,822	118,654	133,486	148,317
30	2,225	4,450	11,124	22,248	44,495	66,743	88,990	111,238	133,486	155,733	177,981	200,229	222,476
40	2,966	5,933	14,832	29,663	59,327	88,990	118,654	148,317	177,981	207,644	237,308	266,971	296,635
50	3,708	7,416	18,540	37,079	74,159	111,238	148,317	185,397	222,476	259,556	296,635	333,714	370,794
60	4,450	8,899	22,248	44,495	88,990	133,486	177,981	222,476	266,971	311,467	355,962	400,457	444,952
70	5,191	10,382	25,956	51,911	103,822	155,733	207,644	259,556	311,467	363,378	415,289	467,200	519,111
80	5,933	11,865	29,663	59,327	118,654	177,981	237,308	296,635	355,962	415,289	474,616	533,943	593,270
90	6,674	13,349	33,371	66,743	133,486	200,229	266,971	333,714	400,457	467,200	533,943	600,686	667,429
100	7,416	14,832	37,079	74,159	148,317	222,476	296,635	370,794	444,952	519,111	593,270	667,429	741,587

425. Using the Applicant Approach, across all OWF projects presented in Table 12.55:, the annual cumulative total of guillemot at risk of displacement is calculated to be 737,309. When applying a 50% displacement rate and a 1% mortality rate, the annual cumulative loss is estimated as 3,687 (3,686.5) individuals.

426. At the UK North Sea and English Channel BDMPS scale, the potential cumulative loss of 3,687 guillemot represents a 1.283% increase in baseline mortality using the Applicant Approach. At the biogeographic scale, this additional mortality would increase baseline mortality by 0.636%. As the predicted impact exceeds a 1% increase in baseline mortality at the BDMPS scale, further consideration is given below in the form of Population Viability Analysis (PVA).

427. Using the Natural England Approach, across all OWF projects presented in Table 12.55:, the annual cumulative total of guillemot at risk of displacement is calculated to be 741,587. When applying a 70% displacement rate and a 2% mortality rate, the annual cumulative loss is estimated as 10,382 (10,382.2) individuals.

428. At the UK North Sea and English Channel BDMPS scale, the potential cumulative loss of 10,382 guillemot represents a 3.613% increase in baseline mortality using the Natural England Approach. At the biogeographic scale, this additional mortality would increase baseline mortality by 1.791%. As the predicted impact exceeds a 1% increase in baseline mortality at the BDMPS scale, further consideration is given below in the form of Population Viability Analysis (PVA).

429. PVA was undertaken on a range of scenarios for both the Project alone and cumulatively with other projects (as presented in Appendix 12.4: Population Viability Analysis [document reference: 6.3.12.4]). For each scenario, counterfactual of population growth (CGR) and counterfactual of population size (CPS) have been presented from the model outputs, measuring the changes in annual growth rate and population size respectively at the end of the impacted period of 35 years relative to a baseline scenario. The impact on adult survival is also presented, calculated as the number of mortalities divided by the relevant population size used in the PVA analysis. PVA results are shown in Table 12.66:.

430. A realistic worst-case scenario is considered to be 70% displacement and 2% mortality, which aligns with recent Natural England preferred approach (e.g. SEP & DEP, Natural England (2023)), results in a reduction in population growth rate of 0.571% and 0.283% at the BDMPS and biogeographic population scales, respectively. These impacts are reduced to 0.203% and 0.101% respectively when considering the applicant’s approach of 50% displacement and 1% mortality.

431. Based on this PVA analysis, even considering the realistic worst-case scenario of 70% displacement and 2% mortality, the resulting reduction in annual population growth rate at both the BDMPS and biogeographic population scales is expected to be indistinguishable from natural fluctuations in the population. Additionally, it should be noted that the displacement assessment undertaken is based on several elements that incorporate a high level of precaution, including:

- The use of mean peak estimates in the displacement assessment results in the unrealistically high estimates of seasonal abundance. This is further exacerbated in the cumulative assessment, which assumes a peak count within all OWFs, regardless of when those peak counts were observed;
- PVA does not incorporate density dependence, resulting in over-precautionary model outputs; and
- The guillemot population is modelled as a closed population, with no emigration or immigration.

432. Within the context of wider UK guillemot population changes (for example, a national decline of 11% between Seabird 2000 and Seabirds Count (a period of approximately 20 years), and an increase of 106% in England and a decrease of 31% in Scotland (Burnell *et al.,* 2023), the changes in populations modelled by PVA from cumulative impacts are considered to be small compared to the natural fluctuations within the population, or changes brought about by other pressures.

433. Density dependence regulates population size by adjusting demographic rates to maintain a population around a carrying capacity. If impacts from OWFs decrease survival rates, the resulting decrease in competition for resources might lead to increased survival and/or productivity in the remaining population, consequently boosting population growth. The importance of density dependence is evident in natural ecosystems, where without it, populations would exhibit exponential growth. However, the mechanisms as to how this operates in seabirds are largely uncertain. Misinterpretation of density dependence in population assessments can result in unreliable predictions. As such, PVA models used in this assessment were density independent, despite ecological evidence suggesting the presence of density dependence in large populations (Horswill *et al.,* 2017). While density-independent models lack the capacity for population recovery once it falls below a certain threshold, they are preferred for impact assessments due to their precautionary nature (Ridge *et al.,* 2019). Please see the PVA Appendix 12.4 for further justification.

434. For more information regarding the all precaution principles used within the HRA assessment, see Appendix 12.7 (6.3.12.7 Levels of precaution in the assessment and compensation calculations for offshore ornithology). To note that despite this is for the purpose for the RIAA, this is relevant in the context of the ES as well.

Table 12.66: PVA results for guillemot impacts on the North Sea BDMPS

PVA Scenario	Annual mortality	Impact on survival	Median CGR	Median CPS
Project alone				
Applicant's Approach				
50% displacement, 1% mortality (BDMPS)	102.2	<0.001	1.000	0.998
70% displacement, 2% mortality (BDMPS)	286.0	<0.001	1.000	0.994
50% displacement, 1% mortality (biogeographic)	102.2	<0.001	1.000	0.999
70% displacement, 2% mortality (biogeographic)	286.0	<0.001	1.000	0.997
Natural England's Approach				
50% displacement, 1% mortality (BDMPS)	123.5	<0.001	1.000	0.998
70% displacement, 2% mortality (BDMPS)	345.9	<0.001	1.000	0.993
50% displacement, 1% mortality (biogeographic)	123.5	<0.001	1.000	0.999
70% displacement, 2% mortality (biogeographic)	345.9	<0.001	1.000	0.997
Project cumulatively				
Applicant's Approach				
50% displacement, 1% mortality (BDMPS)	3,687	<0.001	0.998	0.929

PVA Scenario	Annual mortality	Impact on survival	Median CGR	Median CPS
70% displacement, 2% mortality (BDMPS)	10,322	<0.001	0.994	0.815
50% displacement, 1% mortality (biogeographic)	3,687	<0.001	0.999	0.964
70% displacement, 2% mortality (biogeographic)	10,322	<0.001	0.997	0.903
Natural England's Approach				
50% displacement, 1% mortality (BDMPS)	3,708	<0.001	0.998	0.929
70% displacement, 2% mortality (BDMPS)	10,382	<0.001	0.994	0.814
50% displacement, 1% mortality (biogeographic)	3,708	<0.001	0.999	0.964
70% displacement, 2% mortality (biogeographic)	10,382	<0.001	0.997	0.903

435. This level of change is considered to be of minor magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall as it represents no discernible change to baseline mortality. Given a magnitude change of minor, and a sensitivity to disturbance and displacement of moderate, the significance of effect is therefore concluded to be **minor, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

Razorbill

436. As outlined in Section 12.9, razorbill show a medium level of sensitivity to maintenance activities from, for example, ship and helicopter traffic as well as to operational WTGs.

437. Table 12.67: below presents the bio-season and annual abundance estimates for relevant OWFs in the UK North Sea and Channel BDMPS. This approach has considered birds within the array area and 2km buffer for all projects. Abundances were taken from the Sheringham Shoal and Dudgeon Offshore Windfarm Extension Projects Gannet and Auk Cumulative Displacement Updates Technical Note (Royal HaskoningDHV, 2023). The following amendments were made to these values:

- Inclusion of values from the ForthWind Offshore Wind Demonstration Project, Berwick Bank, North Falls and Five Estuaries;
- Removal of Beatrice Demonstrator as the project will be decommissioned by the time the Project is predicted to be operational; and
- Inclusion of values from the Project.

438. For the cumulative assessment, the collective total number of birds estimated within the array area and 2km buffers is considered to be highly over-inflated due to each individual assessment considering the mean peak for each bio-season. Consequently, the total abundance presented in Table 12.67: represents approximately 37% of the entire North Sea and English Channel BDMPS population. However, the area covered by the combined array area and 2km buffers of all of the OWFs included within this cumulative displacement assessment would be well under 5% of the corresponding area. The approach undertaken to assess cumulative displacement is therefore considered highly precautionary.

439. Based on the justification provided in Section 12.9 and review in document reference 19.10, a precautionary displacement rate of 50% and mortality rate of 1% is used for assessment.

Table 12.67: Cumulative bio-season and total abundance estimates for razorbill from all Tier 1 & 2 projects.

Project	Breeding	Post-breeding migration	Non-migratory wintering	Return migration	Annual total	Tier	Source
Beatrice	873	833	555	833	3,094	1a	SEP&DEP
Blyth Demonstration Site	121	91	61	91	364	1a	SEP&DEP
Dudgeon	256	346	745	346	1,693	1a	SEP&DEP
East Anglia ONE	16	26	155	336	533	1a	SEP&DEP
EOWDC	161	64	7	26	258	1a	SEP&DEP
Galloper	44	43	106	394	587	1a	SEP&DEP
Greater Gabbard	0	0	387	84	471	1a	SEP&DEP
Gunfleet Sands	0	0	30	0	30	1a	SEP&DEP
Hornsea Project One	1,109	4,812	1,518	1,803	9,242	1a	SEP&DEP

Project	Breeding	Post-breeding migration	Non-migratory wintering	Return migration	Annual total	Tier	Source
Humber Gateway	27	20	13	20	80	1a	SEP&DEP
Hywind Scotland	30	719	10		759	1a	SEP&DEP
Kentish Flats and extension	-	-	-	-	0	1a	SEP&DEP
Kincardine	22				22	1a	SEP&DEP
Lincolnshire Node, Lynn and Inner Dowsing	45	34	22	34	135	1a	SEP&DEP
London Array	14	20	14	20	68	1a	SEP&DEP
Methil (Samsung) Demo	4	0	0	0	4	1a	SEP&DEP
Race Bank	28	42	28	42	140	1a	SEP&DEP
Rampion	630	66	1244	3327	5267	1a	SEP&DEP
Scroby Sands	-	-	-	-	0	1a	SEP&DEP
Sheringham Shoal	106	1343	211	30	1690	1a	SEP&DEP
Teesside	16	61	2	20	99	1a	SEP&DEP
Thanet	3	0	14	21	38	1a	SEP&DEP
Westermost Rough	91	121	152	91	455	1a	SEP&DEP
Hornsea Project Two	2511	4221	720	1668	9120	1a	SEP&DEP
Moray East	2,423	1,103	30	168	3,724	1b	SEP&DEP
Neart na Gaoithe	331	5,492	508		6,331	1b	SEP&DEP
Triton Knoll	40	254	855	117	1,266	1a	SEP&DEP
Dogger Bank A	1,250	1,576	1,728	4,149	8,703	1b	SEP&DEP
Dogger Bank B	1,538	2,097	2,143	5,119	10,897	1b	SEP&DEP
SeaGreen Alpha	5876	-	1103	-	6,979	1b	SEP&DEP
SeaGreen Bravo	3,698	-	1,272	-	4,970	1c	SEP&DEP
East Anglia THREE	1807	1,122	1,499	1,524	5,952	1c	SEP&DEP
Hornsea Three	630	2,020	3649	2105	8,404	1c	SEP&DEP
Inch Cape	1,436	2,870	651		4,957	1c	SEP&DEP
Moray West	2808	3,544	184	3585	10,121	1c	SEP&DEP
Norfolk Vanguard	879	866	839	924	3,508	1c	SEP&DEP
Norfolk Boreas	630	263	1,065	345	2,303	1c	SEP&DEP
Sofia	834	310	959	1,919	4,022	1b	SEP&DEP

Project	Breeding	Post-breeding migration	Non-migratory wintering	Return migration	Annual total	Tier	Source
Dogger Bank C	1153	592	1426	2953	6124	1b	SEP&DEP
East Anglia ONE North	403	85	54	207	749	1c	SEP&DEP
East Anglia TWO	281	44	136	230	691	1c	SEP&DEP
ForthWind Offshore Wind Demonstration Project (Methil)	57	81	58	81	277	1c	Forthwind Displacement Appendix
Hornsea Four	386	4,311	455	449	5,601	1c	SEP&DEP
Pentland Floating Offshore Wind Demonstrator	134	16	17	14	181	1c	Pentland Floating EIA
Sheringham Shoal Extension	316	759	686	144	1,905	1d	SEP&DEP
Dudgeon Extension	923	3741	845	320	5829	1d	SEP&DEP
Berwick Bank	4040	8849	1399	7,480	21,768	1d	Berwick Bank EIA
Green Volt	457	58			515	1d	Green Volt EIA
Rampion 2	32	26	1,193	6,303	7,554	2	Rampion 2 EIA
North Falls	104	248	1,781	1,741	3,874	2	North Falls EIA
Five Estuaries	90	284	1,046	756	2,176	2	Five Estuaries ES
Ossian	2,608	1,493	138	224	4,463		Ossian EIA
West of Orkney	141	112	19	132	405		West of Orkney EIA
Caledonia	1,762	1,841	253	530	4,386		Caledonia OWF Distributional Responses Appendix
Salamander	334	484			818		Salamander Displacement Annex
Dogger Bank South	2,826	6,350	5,824	6,303	21,303		Dogger Bank South EIA
Total All Projects (without the Project)	46,334	63,211	37,809	57,008	204,905	-	

Project	Breeding	Post-breeding migration	Non-migratory wintering	Return migration	Annual total	Tier	Source
The Project	3,159	2,185	1,779	5,134	12,257	-	
Total (with the Project)	49,493	65,396	39,588	62,142	217,162	-	

Potential magnitude of impact

440. The potential magnitude of impact is estimated by calculating the increase in baseline mortality when compared against the largest UK North Sea and English Channel BDMPS and biogeographic population. The largest razorbill BDMPS for the UK North Sea and English Channel is 591,875 individuals, whilst the wider bio-geographic population is 1,707,000 individuals. Using the average mortality rate of 0.13 (Table 12.9), the background mortality for these population scales are 77,062 and 222,251 individuals per annum, respectively.

441. The predicted cumulative mortality as a result of displacement is estimated based on a displacement rate of 50% and a mortality rate of 1%, though a range of 30% to 70% displacement is also presented in Table 12.68 in line with SNCB guidance (MIG-Birds, 2022). Results are also presented in a displacement matrix in Table 12.69:.

Table 12.68: Cumulative seasonal and annual displacement impacts on razorbill (O&M phase).

Bio-season (months)	Cumulative Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated cumulative mortality level during O&M phase.		Increase in baseline mortality (%) during O&M phase.	
		Population	Baseline mortality	50% displacement, 1% mortality	30-70% displacement, 1-2% mortality	50% displacement, 1% mortality	30-70% displacement, 1-2% mortality
Return migration (Jan - Mar)	62,142	591,875	77,062	310.7	186.4 – 870.0	0.403	0.242 – 1.129
Breeding (Apr - Jul)	49,493	158,031	20,576	247.5	148.5 – 692.9	1.203	0.722 – 3.368
Post-breeding migration (Aug - Oct)	65,396	591,875	77,062	327.0	196.2 – 915.6	0.424	0.255 – 1.188
Migration-free winter (Nov - Dec)	39,588	218,621	28,464	197.9	118.8 – 554.2	0.695	0.417 – 1.947
Annual (BDMPS)	217,162	591,875	77,062	1,085.8	651.5 – 3,040.3	1.409	0.845 – 3.945
Annual (biogeographic)	217,162	1,707,000	222,251	1,085.8	651.5 – 3,040.3	0.489	0.293 – 1.368

Table 12.69: Cumulative annual displacement matrix for razorbill within the array area and 2km buffer, values in light blue represent the range-based values advocated by SNCBs and the darker shade of blue representing the Applicant's approach value.

Annual (2km Buffer)	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	217	434	651	2,172	4,343	6,515	8,686	10,858	13,030	15,201	17,373	19,545	21,716
20	434	869	1,303	4,343	8,686	13,030	17,373	21,716	26,059	30,403	34,746	39,089	43,432
30	651	1,303	1,954	6,515	13,030	19,545	26,059	32,574	39,089	45,604	52,119	58,634	65,149
40	869	1,737	2,606	8,686	17,373	26,059	34,746	43,432	52,119	60,805	69,492	78,178	86,865
50	1,086	2,172	3,257	10,858	21,716	32,574	43,432	54,291	65,149	76,007	86,865	97,723	108,581
60	1,303	2,606	3,909	13,030	26,059	39,089	52,119	65,149	78,178	91,208	104,238	117,267	130,297
70	1,520	3,040	4,560	15,201	30,403	45,604	60,805	76,007	91,208	106,409	121,611	136,812	152,013
80	1,737	3,475	5,212	17,373	34,746	52,119	69,492	86,865	104,238	121,611	138,984	156,357	173,730
90	1,954	3,909	5,863	19,545	39,089	58,634	78,178	97,723	117,267	136,812	156,357	175,901	195,446
100	2,172	4,343	6,515	21,716	43,432	65,149	86,865	108,581	130,297	152,013	173,730	195,446	217,162

442. Across all OWF projects presented in Table 12.67:, the annual cumulative total of razorbills at risk of displacement is calculated to be 217,162. When applying a displacement rate of 50% and a 1% mortality rate, the annual cumulative loss is estimated as 1,086 (1,085.8) individuals.

443. At the UK North Sea and English Channel BDMPS scale, the potential cumulative loss of 1,086 razorbills represents a 1.409% increase in baseline mortality. At the biogeographic scale, this additional mortality would increase baseline mortality by 0.489%. As the predicted impact exceeds a 1% increase in baseline mortality at the BDMPS scale at the more precautionary higher displacement and mortality ratios, further consideration is given below in the form of PVA analysis.

444. PVA was undertaken on a range of scenarios for both the Project alone and cumulative with other projects (as presented in Appendix 12.4) For each scenario, CGR and CPS have been presented from the model outputs, measuring the changes in annual growth rate and population size respectively at the end of the impacted period of 35 years relative to a baseline scenario. The impact on adult survival is also presented, calculated as the number of mortalities divided by the relevant population size used in the PVA analysis.

445. A more realistic worst-case scenario is considered to be 70% displacement and 2% mortality which results in a reduction in population growth rate of 0.605% and 0.210% at the BDMPS and biogeographic population scales respectively. These impacts are further reduced to 0.216% and 0.075% respectively when considering the applicant's approach of 50% displacement and 1% mortality. Results of the PVA are presented in Table 12.70:.

446. Based on this PVA analysis, even considering the realistic worst-case scenario of 70% displacement and 2% mortality, the resulting reduction in annual population growth rate at both the BDMPS and biogeographic population scales is expected to be indistinguishable from natural fluctuations in the population. Additionally, it should be noted that the displacement assessment undertaken is based on several elements that incorporate a high level of precaution, including:

- The use of mean peak estimates in the displacement assessment results in the unrealistically high estimates of seasonal abundance;
- PVA does not incorporate density dependence, resulting in over-precautionary model outputs; and
- The razorbill population is modelled as a closed population, with no emigration or immigration.

447. Within the context of wider UK razorbill population changes (for example, a national increase of 18% between Seabird 2000 and Seabirds Count (a period of approximately 20 years), and an increase of 240% in England and a decrease of 2% in Scotland (Burnell *et al*., 2023), the changes in populations modelled by PVA from cumulative impacts are considered to be small compared to the natural fluctuations within the population, or changes brought about by other pressures.

448. Density dependence regulates population size by adjusting demographic rates to maintain a population around a carrying capacity. If impacts from OWFs decrease survival rates, the resulting decrease in competition for resources might lead to increased survival and/or productivity in the remaining population, consequently boosting population growth. The importance of density dependence is evident in natural ecosystems, where without it, populations would exhibit exponential growth. However, the mechanisms as to how this operates in seabirds are largely uncertain. Misinterpretation of density dependence in population assessments can result in unreliable predictions. As such, PVA models used in this assessment were density independent, despite ecological evidence suggesting the presence of density dependence in large populations (Horswill *et al*., 2017). While density-independent models lack the capacity for population recovery once it falls below a certain threshold, they are preferred for impact assessments due to their precautionary nature (Ridge *et al.,* 2019). Please see Appendix 12.4 and document reference 19.8 for further justification.

449.

Table 12.70: PVA results for razorbill impacts on the North Sea BDMPS

PVA Scenario	Annual mortality	Impact on survival	Medan CGR	Median CPS
Project alone				
50% displacement, 1% mortality (BDMPS)	61.3	<0.001	1.000	0.996
70% displacement, 2% mortality (BDMPS)	171.6	<0.001	1.000	0.988
50% displacement, 1% mortality (biogeographic)	61.3	<0.001	1.000	0.999
70% displacement, 2% mortality (biogeographic)	171.6	<0.001	1.000	0.996
Project cumulatively				
50% displacement, 1% mortality (BDMPS)	1,0835.8	0.002	0.998	0.925
70% displacement, 2% mortality (BDMPS)	3,040.3	0.005	0.994	0.804

PVA Scenario	Annual mortality	Impact on survival	Medan CGR	Median CPS
50% displacement, 1% mortality (biogeographic)	1,0835.8	<0.001	0.999	0.973
70% displacement, 2% mortality (biogeographic)	3,040.3	0.002	0.998	0.927

450. This level of change is considered to be of minor magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall, as it represents no discernible change to baseline mortality. Given a magnitude change of minor, and a sensitivity to disturbance and displacement of moderate, the significance of effect is therefore concluded to be **minor, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

Puffin

451. As outlined in Section 12.9, puffin show a medium level of sensitivity to maintenance activities from, for example, ship and helicopter traffic as well as to operational WTGs.

452. Table 12.71: below presents the bio-season and annual abundance estimates for relevant OWFs in the UK North Sea and Channel BDMPS. This approach has considered birds within the array area and 2km buffer for all projects. Abundances were taken from the Hornsea Project Four Ornithology EIA & HRA Annex (APEM Ltd and GoBe Consultants 2022). The following amendments were made to these values:

- Inclusion of values from the Pentland Floating Windfarm, Berwick Bank and Green Volt;
- Removal of Beatrice Demonstrator as the project will be decommissioned by the time the Project is predicted to be operational; and
- Inclusion of values from the Project.

453. For the cumulative assessment, a highly unlikely total number of birds is estimated within the collective array area and 2km buffers, due to each individual assessment considering the mean peak for each bio-season. Consequently, the total abundance presented in Table 12.71: represents ~18% of the entire North Sea and English Channel BDMPS population, whilst the area covered by the combined array area and 2km buffers of all of the OWFs considered within this cumulative displacement assessment would be well under 5% of the corresponding area. The approach undertaken to assess cumulative displacement is therefore considered highly precautionary.

Table 12.71: Cumulative bio-season and total abundance estimates for puffin from all Tier 1 and 2 projects.

Project	Breeding	Non-breeding	Annual total	Tier	Source
Beatrice	2,858	2,435	5,293	1a	Hornsea Four Annex
Blyth Demonstration Site	235	123	358	1a	Hornsea Four Annex
Dudgeon	1	3	4	1a	Hornsea Four Annex
EOWDC	42	82	124	1a	Hornsea Four Annex
Galloper	0	1	1	1a	Hornsea Four Annex
Greater Gabbard	0	1	1	1a	Hornsea Four Annex
Gunfleet Sands	-	-	-	1a	Hornsea Four Annex
Humber Gateway	15	10	25	1a	Hornsea Four Annex
Hywind Scotland	119	85	204	1a	Hornsea Four Annex
Kentish Flats	-	-	-	1a	Hornsea Four Annex
Kentish Flats Extension	3	6	9	1a	Hornsea Four Annex
Lincolnshire Node, Lynn and Inner Dowsing	3	6	9	1a	Hornsea Four Annex
London Array	0	1	1	1a	Hornsea Four Annex
Methil (Samsung) Demo	8	0	8	1a	Hornsea Four Annex
Race Bank	1	10	11	1a	Hornsea Four Annex
Rampion	7	0	7	1a	Hornsea Four Annex
Scroby Sands	-	-	-	1a	Hornsea Four Annex
Sheringham Shoal	4	26	30	1a	Hornsea Four Annex
Teesside	35	18	53	1a	Hornsea Four Annex
Thanet	0	0	0	1a	Hornsea Four Annex

Project	Breeding	Non-breeding	Annual total	Tier	Source
Westermost Rough	61	35	96	1a	Hornsea Four Annex
East Anglia ONE	16	32	48	1b	Hornsea Four Annex
Hornsea Project One	1,070	1,257	2,327	1a	Hornsea Four Annex
Hornsea Project Two	468	2,039	2,507	1a	Hornsea Four Annex
Moray East	2,795	656	3,451	1b	Hornsea Four Annex
Triton Knoll	23	71	94	1a	Hornsea Four Annex
Kincardine	19	0	19	1a	Hornsea Four Annex
Dogger Bank A	37	295	332	1b	Hornsea Four Annex
Dogger Bank B	102	743	845	1b	Hornsea Four Annex
Dogger Bank C	34	273	307	1c	Hornsea Four Annex
East Anglia THREE	181	307	488	1c	Hornsea Four Annex
Inch Cape	2,956	2,688	5,644	1c	Hornsea Four Annex
Moray West	1,115	3,966	5,081	1c	Hornsea Four Annex
Neart na Gaoithe	2,562	2,103	4,665	1b	Hornsea Four Annex
Seagreen Alpha	2,572	1,526	4,098	1b	Hornsea Four Annex
Seagreen Bravo	3,582	3,863	7,445	1b	Hornsea Four Annex
Sofia	35	329	364	1b	Hornsea Four Annex
Hornsea Three	253	67	320	1c	Hornsea Four Annex
Norfolk Boreas	0	23	23	1c	Hornsea Four Annex
Norfolk Vanguard	67	112	179	1c	Hornsea Four Annex
East Anglia ONE North	-	-	-	1c	Hornsea Four Annex
East Anglia TWO	15	0	15	1c	Hornsea Four Annex

Project	Breeding	Non-breeding	Annual total	Tier	Source
Hornsea Four	203	442	644	1c	Hornsea Four Annex
Pentland Floating Offshore Wind Demonstrator	1,211	2	1,213	1c	Pentland Floating EIA
ForthWind Offshore Wind Demonstration Project (Methil)	68	24	92	1c	Forthwind Displacement Appendix
Berwick Bank	-	-	4,513	1d	Berwick Bank EIA
Green Volt	250	41	291	1c	Green Volt EIA
Dudgeon Extension Project	0	17	17	1d	Hornsea Four Annex
Sheringham Shoal Extension Project	0	11	11	1d	Hornsea Four Annex
Rampion 2	-	-	-	1d	Rampion 2 EIA
North Falls	-	-	-	1d	North Falls EIA
Five Estuaries	-	-	-	1d	Hornsea Four Annex
Dogger Bank South	147	373	520	1d	Dogger Bank South EIA
Ossian	1,928	1,178	3,106	1d	Ossian EIA
West of Orkney	5,272	2,136	7,408	1d	
Caledonia	2,061	1,336	3,397	1d	Caledonia OWF Distributional Responses Appendix
Salamander	357	-	357	1d	Salamander Displacement Annex
Total All Projects (without the Project)	37,304	28,752	66,055	-	
The Project	666	414	1,080	1d	
Total (with the Project)	37,970	29,166	67,135	-	

Potential magnitude of impact

454. The potential magnitude of impact is estimated by calculating the increase in baseline mortality when compared against the largest UK North Sea and English Channel BDMPS and biogeographic population. The largest puffin BDMPS for the UK North Sea and English Channel is 868,689 individuals, whilst the wider bio-geographic population is 11,840,000 individuals. Using the average mortality rate of 0.12 (Table 12.9), the background mortality for these population scales are 103,374 and 1,408,960 individuals per annum, respectively.

455. The predicted cumulative mortality as a result of displacement is estimated based on a displacement rate of 50% and a mortality rate of 1%, though a range of 30% to 70% displacement is also presented in Table 12.72: in line with SNCB guidance (MIG-Birds, 2022). Results are also presented in a displacement matrix in Table 12.73:.

Table 12.72: Cumulative seasonal and annual displacement impacts on puffin (O&M phase).

Bio-season (months)	Cumulative Seasonal abundance (array area plus 2km buffer)	Regional baseline populations and baseline mortality rates (individuals per annum)		Estimated cumulative mortality level during O&M phase.		Increase in baseline mortality (%) during O&M phase.	
		Population	Baseline mortality	50% displacement, 1% mortality	30-70% displacement, 1-2% mortality	50% displacement, 1% mortality	30-70% displacement, 1-2% mortality
Breeding (Mar - Jul)	37,970	868,689	103,374	189.8	113.9 – 531.6	0.184	0.110 – 0.514
Non-breeding (Aug - Feb)	29,166	231,958	27,603	145.8	87.5 – 408.3	0.528	0.317 – 1.479
Annual (BDMPS)	67,134	868,689	103,374	335.7	201.4 – 939.9	0.325	0.195 – 0.909
Annual (biogeographic)	67,134	11,840,000	1,408,960	335.7	201.4 – 939.9	0.024	0.014 – 0.067

Table 12.73: Cumulative annual displacement matrix for puffin within the array area and 2km buffer, values in light blue represent the range-based values advocated by SNCBs and the darker shade of blue representing the Applicant's approach value.

Annual (2km Buffer)	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	67	134	336	671	1,343	2,014	2,685	3,357	4,028	4,699	5,371	6,042	6,713
20	134	269	671	1,343	2,685	4,028	5,371	6,713	8,056	9,399	10,741	12,084	13,427
30	201	403	1,007	2,014	4,028	6,042	8,056	10,070	12,084	14,098	16,112	18,126	20,140
40	269	537	1,343	2,685	5,371	8,056	10,741	13,427	16,112	18,797	21,483	24,168	26,854
50	336	671	1,678	3,357	6,713	10,070	13,427	16,783	20,140	23,497	26,854	30,210	33,567
60	403	806	2,014	4,028	8,056	12,084	16,112	20,140	24,168	28,196	32,224	36,252	40,280
70	470	940	2,350	4,699	9,399	14,098	18,797	23,497	28,196	32,896	37,595	42,294	46,994
80	537	1,074	2,685	5,371	10,741	16,112	21,483	26,854	32,224	37,595	42,966	48,336	53,707
90	604	1,208	3,021	6,042	12,084	18,126	24,168	30,210	36,252	42,294	48,336	54,378	60,420
100	671	1,343	3,357	6,713	13,427	20,140	26,854	33,567	40,280	46,994	53,707	60,420	67,134

456. Across all OWF projects presented in Table 12.55:, the annual cumulative total of puffins at risk of displacement is calculated to be 67,134. When applying a displacement rate of 50% and a 1% mortality rate, the annual cumulative loss is estimated as 336 (335.7) individuals.

457. At the UK North Sea and English Channel BDMPS scale, the potential cumulative loss of 336 puffins represents a 0.325% increase in baseline mortality. At the biogeographic scale, this additional mortality would increase baseline mortality by 0.024%. Though predicted impacts do not exceed a 1% increase in baseline mortality based on the Applicant's approach, PVA has been carried out as a precautionary approach.

458. PVA was undertaken on a range of scenarios for both the Project alone and cumulatively with other projects (as presented in Appendix 12.4) For each scenario, CGR, and CPS values have been presented from the model outputs, measuring the changes in annual growth rate and population size respectively at the end of the impacted period of 35 years relative to a baseline scenario. The impact on adult survival is also presented, calculated as the number of mortalities divided by the relevant population size used in the PVA analysis. PVA results are presented in Table 12.74:.

459. Based on the BDMPS population, the predicted cumulative impacts would result in a 0.0127% reduction in population growth rate when using the worst-case scenario of 70% displacement and 2% mortality, and a 0.045% reduction considering the Applicant's Approach of 50% displacement and 1% mortality.

460. Even considering the worst-case scenario (70% displacement and 2% mortality) which is not considered ecologically realistic based on available evidence, predicted impacts would be indistinguishable from natural fluctuations in the population.

461. Within the context of wider UK puffin population changes (for example, a national decline of 23% between Seabird 2000 and Seabirds Count (a period of approximately 20 years), and an increase of 50% in England and a decrease of 32% in Scotland (Burnell *et al.,* 2023), the changes in populations modelled by PVA from cumulative impacts are considered to be small compared to the natural fluctuations within the population, or changes brought about by other pressures.

462. Density dependence regulates population size by adjusting demographic rates to maintain a population around a carrying capacity. If impacts from OWFs decrease survival rates, the resulting decrease in competition for resources might lead to increased survival and/or productivity in the remaining population, consequently boosting population growth. The importance of density dependence is evident in natural ecosystems, where without it, populations would exhibit exponential growth. However, the mechanisms as to how this operates in seabirds are largely uncertain. Misinterpretation of density dependence in population assessments can result in unreliable predictions. As such, PVA models used in this assessment were density independent, despite ecological evidence suggesting the presence of density dependence in large populations (Horswill *et al.*, 2017). While density-independent models lack the capacity for population recovery once it falls below a certain threshold, they are preferred for impact assessments due to their precautionary nature (Ridge *et al.,* 2019). Please see Appendix 12.4 for further justification.

Table 12.74: PVA results for puffin impacts on the North Sea BDMPS

PVA Scenario	Annual mortality	Impact on survival	Medan CGR	Median CPS
Project alone				
50% displacement, 1% mortality (BDMPS)	5.4	<0.001	1.000	1.000
70% displacement, 2% mortality (BDMPS)	15.1	<0.001	1.000	0.999
Project cumulatively				
50% displacement, 1% mortality (BDMPS)	335.7	<0.001	1.000	0.984
70% displacement, 2% mortality (BDMPS)	939.9	0.001	0.999	0.955

463. This level of change is considered to be of negligible magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall, as it represents no discernible change to baseline mortality. Given a magnitude change of negligible, and a sensitivity to disturbance and displacement of moderate, the significance of effect is therefore concluded to be **minor adverse, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

12.11.4 Cumulative Impact Assessment: Collision (O&M phase)

464. As a result of the operational activities associated with the Project and other projects Table 12.55:), there is potential for cumulative collision risk to birds through collision with WTGs and associated infrastructure, resulting in injury or fatality. Collision may occur when birds fly through OWFs during foraging trips, migration, and/or commuting trips between breeding sites and foraging areas.

465. Within this cumulative impact assessment, only projects identified in Table 12.58: as being Tier 1 (sub-tiers 1a to 1d) and Tier 2 are considered. The approach taken to assessing cumulative collision risk is a quantitative one, drawing upon the published information produced by the respective project developers. Such published, quantitative information on predicted collisions is not available at an early stage in the development of a project e.g. a project in Tier 3. The result is that the cumulative collision risk assessment addresses projects in Tiers 1 and those in Tier 2 for which publicly available quantitative information is available (for example, projects that have made data available at PEIR).

466. CRM has been carried out for the Project (Section 12.9) for six species of interest which were identified as potentially at risk and of interest for impact assessment (gannet, kittiwake, Sandwich tern, herring gull, great black-backed gull, and lesser black-backed gull). Following the screening process for potential cumulative effects presented in Section 12.9, all species assessed for project alone impacts due to collision were assessed for cumulative impacts.

467. It is noted that the following cumulative collision risk assessments are considered to be highly over precautionary, with an overestimation of predicted collisions driven by a range of factors, including:

- Collision risk estimates are calculated based on consented designs. However, OWFs are rarely constructed as consented, typically comprising a reduced number of larger WTGs (equating to a smaller swept area);
- The CRMs are inherently over-precautionary. Actual collision rates of birds are likely to be significantly lower than predicted based on precaution being applied to each input parameter (evidence presented in Section 12.9); and
- Finally, it must be appreciated that many of the projects within this cumulative impact assessment are likely to be decommissioned during the operational lifetime of the Project, so consideration of their impacts is very much a precautionary estimate with respect to ongoing potential cumulative impacts from collision risk. Even in the event of decommissioned OWFs being replaced by new WTGs, those available to the market in the future would likely include technological advances which would mean the same generating capacity can be produced by fewer, larger WTGs which can be reasonably expected to lead to a reduction in collisions.

Kittiwake

468. As outlined in Section 12.9, kittiwake show a medium level of sensitivity to collision with WTGs.

469.

470. Table 12.75: below presents the bio-season and annual collision mortality estimates for relevant OWFs in the UK North Sea and Channel BDMPS. Collision estimates were taken from the Sheringham Shoal and Dudgeon Offshore Windfarm Extension Projects Collision Risk Modelling (CRM) Updates Technical Note (Royal HaskoningDHV, 2023b), as agreed with Natural England (Offshore Ornithology and Derogation and Compensation Workshop; Table 12.3). Updates to these values have utilised up-to-date avoidance rates to re-calculate impacts for previously submitted projects. As such, the impacts from these projects presented here may differ from those presented at submission. Projects for which impacts have been / are being compensated for due to a conclusion of AEoI of a SPA in the secretary of state's Appropriate Assessment are also included, ensuring that the approach delivers a precautionary assessment of cumulative impact. Updates include:

- Inclusion of revised design collision estimates from Neart na Gaoithe and Inch Cape, and addition of values from Pentland Floating Windfarm, ForthWind Offshore Wind Demonstration Project, Berwick Bank, Green Volt, North Falls, and Five Estuaries;
- Removal of Beatrice Demonstrator as the project will be decommissioned by the time the Project is predicted to be operational; and
- Inclusion of values from the Project.

Table 12.75: Cumulative bio-season and annual collision mortality estimates for kittiwake from all Tier 1 and 2 projects.

Project	Breeding	Post-breeding migration	Return migration	Annual total	Tier	Source
Beatrice	66.3	7.5	27.9	101.6	1a	SEP&DEP
Blyth Demonstration Site	1.2	1.6	1.0	3.8	1a	SEP&DEP
Dudgeon	-	-	-	0.0	1a	SEP&DEP
East Anglia ONE	1.3	112.3	32.8	146.3	1a	SEP&DEP
EOWDC	8.3	4.1	0.8	13.1	1a	SEP&DEP
Galloper	4.4	19.5	22.3	46.1	1a	SEP&DEP
Greater Gabbard	0.8	10.5	8.0	19.3	1a	SEP&DEP
Gunfleet Sands	-	-	-	0.0	1a	SEP&DEP
Hornsea Project One	30.8	39.1	14.6	84.6	1a	SEP&DEP
Humber Gateway	1.3	2.2	1.3	4.9	1a	SEP&DEP
Hywind Scotland	11.6	0.6	0.6	12.9	1a	SEP&DEP
Kentish Flats	0.0	0.6	0.5	1.1	1a	SEP&DEP
Kentish Flats Extension	0.0	0.0	1.9	1.9	1a	SEP&DEP
Kincardine	15.4	6.3	0.7	22.4	1a	SEP&DEP
Lincolnshire Node	0.5	0.8	0.5	1.8	1a	SEP&DEP
London Array	1.0	1.6	1.3	3.9	1a	SEP&DEP
Lynn and Inner Dowsing	-	-	-	0.0	1a	SEP&DEP
Methil (Samsung) Demo	0.3	0.0	0.0	0.3	1a	SEP&DEP
Race Bank	1.3	16.7	3.9	22.0	1a	SEP&DEP
Rampion	38.1	26.2	20.8	85.1	1a	SEP&DEP
Scroby Sands	-	-	-	0.0	1a	SEP&DEP
Sheringham Shoal	-	-	-	0.0	1a	SEP&DEP
Teesside	26.9	16.8	1.8	45.4	1a	SEP&DEP
Thanet	0.1	0.4	0.3	0.8	1a	SEP&DEP

Project	Breeding	Post-breeding migration	Return migration	Annual total	Tier	Source
Westermost Rough	0.1	0.1	0.1	0.3	1a	SEP&DEP
Hornsea Project Two	11.2	6.3	2.1	19.6	1a	SEP&DEP
Moray East	30.5	1.4	13.5	45.4	1b	SEP&DEP
Neart na Gaoithe	10.8	5.1	1.3	17.2	1b	North Falls Appendix
Triton Knoll	17.2	97.3	31.8	146.3	1a	SEP&DEP
Dogger Bank A & B	209.9	98.2	214.8	522.9	1b	SEP&DEP
Dogger Bank C & Sofia	95.8	63.5	151.8	311.2	1b – 1c	SEP&DEP
Seagreen Alpha and Bravo	119.8	99.6	23.5	242.9	1b	North Falls Appendix
East Anglia THREE	4.3	48.3	26.3	78.9	1c	SEP&DEP
Hornsea Three	53.9	26.6	5.6	86.1	1c	SEP&DEP
Inch Cape	4.3	48.3	26.3	78.9	1c	North Falls Appendix
Moray West	55.3	16.8	4.9	77.0	1c	SEP&DEP
Norfolk Vanguard	15.3	11.5	13.5	40.3	1c	SEP&DEP
Norfolk Boreas	9.3	22.5	8.3	40.2	1c	SEP&DEP
East Anglia ONE North	28.3	5.7	2.5	36.4	1c	SEP&DEP
East Anglia TWO	20.7	3.8	5.2	29.6	1c	SEP&DEP
Hornsea Four	48.1	9.0	3.0	60.0	1c	Hornsea Four Annex
Pentland Floating Offshore Wind Demonstrator	4.9	4.9	0.0	9.8	1c	Pentland Floating Appendix
ForthWind Offshore Wind Demonstration Project (Methil)	0.0	0.0	0.0	0.0	1c	Forthwind CRM Appendix
SEP & DEP	7.2	4.3	0.9	12.4	1d	SEP&DEP
Berwick Bank	431.9	133.0	125.3	690.2	1d	Berwick Bank EIA
Green Volt	5.2	5.4	3.3	13.9	1c	Green Volt Additional Information
Rampion 2	1.2	9.8	17.3	28.2	1d	Rampion 2 ES

Project	Breeding	Post-breeding migration	Return migration	Annual total	Tier	Source
North Falls	8.8	3.6	7.8	20.2	1d	North Falls EIA
Five Estuaries	8.5	5.6	3.9	18.0	1d	Five Estuaries CRM Annex
Salamander	14.7	1.4	0.3	16.4	1d	Salamander CRM Annex
Ossian	28.1	5.4	6.2	39.7	1d	Ossian EIA
West of Orkney	17.9	16.3	21.9	56.0	1d	West of Orkney Addendum
Culzean	0.1	0.0	0.0	0.1	1c	Culzean Appropriate Assessment
Caledonia	55.3	7.0	4.8	67.0	1d	Caledonia CRM Appendix
Dogger Bank South	191.1	79.3	29.5	299.9	1d	Dogger Bank South CRM Appendix
Total All Projects (without the Project)	**1,719.0**	**1,108.3**	**897.5**	**3,722.1**		
The Project	27.2	3.0	2.9	33.2	1d	
Total (with the Project)	**1,746.2**	**1,111.3**	**900.4**	**3,755.3**		

Potential magnitude of impact

471. The potential magnitude of impact is estimated by calculating the increase in baseline mortality when compared against the largest UK North Sea and English Channel BDMPS and then separately against the biogeographic population. The largest kittiwake BDMPS for the North Sea and English Channel is 839,456 individuals, whilst the wider bio-geographic population is 5,100,000 individuals. When considering the average mortality rate of 0.16 (Table 12.9) the background mortality for these two population scales is 132,382 and 804,270 individuals per annum, respectively.

472. The potential cumulative loss of 3,755 (3,755.3) kittiwake would represent an increase of 2.837% relative to the baseline mortality rate at the UK North Sea and English Channel BDMPS scale. At the biogeographic scale, this additional mortality would increase baseline mortality by 0.467%. As the predicted impact exceeds a 1% increase in baseline mortality at the BDMPS scale, further consideration is given below in the form of PVA analysis.

473. PVA was undertaken on a range of scenarios for both the Project alone and cumulatively with other projects (as presented in Appendix 12.4). For each scenario, CGR and CPS values have been presented from the model outputs, measuring the changes in annual growth rate and population size respectively at the end of the impacted period of 35 years relative to a baseline scenario. The impact on adult survival is also presented, calculated as the number of mortalities divided by the relevant population size used in the PVA analysis. PVA results are presented in Table 12.76.

474. At the BDMPS population scale, the cumulative mortalities predicted would result in a reduction in population growth of 0.530% relative to a baseline scenario. These predicted levels of change, especially considering the precaution in-built within the assessment, are considered to be sufficiently small that they would be indistinguishable against natural fluctuations in the populations.

475. A key aspect of precaution in the CRM assessment is the use of over-precautionary nocturnal activity rates. A review of nocturnal activity in kittiwake (Furness *et al*., in prep.) has found that the previously used value of 50% is a considerable overestimate, and instead identifies evidence-based rates of 20% during the breeding season and 17% during the non-breeding season. Natural England have acknowledged this element of precaution and have recently advised the use of 40% nocturnal activity alongside a SD that incorporates variation from 25% - 50% nocturnal activity. Applying the use of a 40% (or 25% in the basic Band model) nocturnal activity factor to other projects presented in Table 12.58: would result in a considerable reduction in the annual cumulative collision estimate though the magnitude of reduction will vary depending on the time of year and windfarm latitude owing to variation in day and night length.

476. Within the context of wider UK kittiwake population changes (for example, a national decline of 43% between Seabird 2000 and Seabirds Count (a period of approximately 20 years) and decreases of 4% in England and 57% in Scotland (Burnell *et al* 2023)), the changes in populations modelled by PVA from cumulative impacts are considered to be small compared to the natural fluctuations within the population, or changes brought about by other pressures. One of the most significant factors influencing kittiwake populations is climate-driven shifts in key prey availability, which can have a far greater impact on population trends than the predicted effects of cumulative anthropogenic pressures.

477. Density dependence regulates population size by adjusting demographic rates to maintain a population around a carrying capacity. If impacts from OWFs decrease survival rates, the resulting decrease in competition for resources might lead to increased survival and/or productivity in the remaining population, consequently boosting population growth. The importance of density dependence is evident in natural ecosystems, where without it, populations would exhibit exponential growth. However, the mechanisms as to how this operates in seabirds are largely uncertain. Misinterpretation of density dependence in population assessments can result in unreliable predictions. As such, PVA models used in this assessment were density independent, despite ecological evidence suggesting the presence of density dependence in large populations (Horswill *et al*., 2017). While density-independent models lack the capacity for population recovery once it falls below a certain threshold, they are preferred for impact assessments due to their precautionary nature (Ridge *et al.,* 2019). Please see Appendix 12.4 for further justification.

Table 12.76: PVA results for kittiwake impacts on the North Sea BDMPS

PVA Scenario	Annual mortality	Impact on survival	Medan CGR	Median CPS
Project alone				
BDMPS	33.2	<0.001	1.000	0.998
Project cumulatively				
BDMPS	3,755.3	0.004	0.995	0.826

478. The potential cumulative impact resulting from collision risk to the wider BDMPS population is therefore considered to be of minor magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall. Given a magnitude change of minor, and a sensitivity to collision of moderate, the significance of effect is therefore concluded to be **minor adverse, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:. There is no change to the conclusion from the ES.

Lesser black-backed gull

479. As outlined in Section 12.9, lesser black-backed gull show a high level of sensitivity to collision with WTGs.

480. Table 12.77 below presents the bio-season and annual collision mortality estimates for relevant OWFs in the UK North Sea and Channel BDMPS. Collision estimates were taken from the Sheringham Shoal and Dudgeon Offshore Windfarm Extension Projects Collision Risk Modelling (CRM) Updates Technical Note (Royal HaskoningDHV, 2023b). Up-to-date avoidance rates have been used to calculate impacts for previously submitted projects. As such, impacts presented here may differ from those presented at submission. Projects where impacts from previously submitted projects have been compensated are included here, ensuring that the approach delivers a precautionary assessment of cumulative impact.

481. Updates to these values included:

- Inclusion of values from Pentland Floating Windfarm, ForthWind Offshore Wind Demonstration Project, Berwick Bank, Green Volt, North Falls, and Five Estuaries;
- Removal of Beatrice Demonstrator as the project will be decommissioned by the time the Project is predicted to be operational; and
- Inclusion of values from the Project.

Table 12.77: Cumulative bio-season and annual collision mortality estimates for lesser black-backed gull from all Tier 1 and 2 projects.

Project	Breeding	Non-breeding	Annual total	Tier	Source
Beatrice	0.0	0.0	0.0	1a	SEP&DEP
Blyth Demonstration Site	0.0	0.0	0.0	1a	SEP&DEP
Dudgeon	9.2	36.7	45.9	1a	SEP&DEP
East Anglia ONE	7.1	40.6	47.7	1a	SEP&DEP
EOWDC	0.0	0.0	0.0	1a	SEP&DEP
Galloper	33.4	133.2	166.6	1a	SEP&DEP
Greater Gabbard	14.9	59.5	74.4	1a	SEP&DEP
Gunfleet Sands	0.6	0.0	0.6	1a	SEP&DEP
Hornsea Project One	5.3	20.9	26.2	1a	SEP&DEP
Humber Gateway	0.4	1.3	1.7	1a	SEP&DEP
Hywind Scotland	0.0	0.0	0.0	1a	SEP&DEP
Kentish Flats	-	-	0.0	1a	SEP&DEP
Kentish Flats Extension	0.3	1.3	1.6	1a	SEP&DEP
Kincardine	0.0	0.0	0.0	1a	SEP&DEP
Lincolnshire Node	2.0	8.2	10.2	1a	SEP&DEP
London Array	-	-	0.0	1a	SEP&DEP
Lynn and Inner Dowsing	-	-	0.0	1a	SEP&DEP
Methil	0.5	0.0	0.5	1a	SEP&DEP
Race Bank	51.8	13.0	64.8	1a	SEP&DEP
Rampion	1.9	7.6	9.5	1a	SEP&DEP
Scroby Sands	-	-	0.0	1a	SEP&DEP
Sheringham Shoal	2.0	7.9	9.9	1a	SEP&DEP
Teesside	0.0	0.0	0.0	1a	SEP&DEP
Thanet	3.8	15.4	19.2	1a	SEP&DEP
Westermost Rough	0.1	0.4	0.5	1a	SEP&DEP

Project	Breeding	Non-breeding	Annual total	Tier	Source
Hornsea Project Two	2.4	2.4	4.8	1a	SEP&DEP
Moray East	0.0	0.0	0.0	1b	SEP&DEP
Neart na Gaoithe	1.2	0.0	1.2	1b	Neart na Gaoithe EIAR
Triton Knoll	8.9	35.5	44.4	1a	SEP&DEP
Dogger Bank A & B	3.1	12.5	15.6	1b	SEP&DEP
Dogger Bank C & Sofia	2.9	11.5	14.4	1b	SEP&DEP
Seagreen Alpha and Bravo	2.5	10.1	12.6	1b	Berwick Bank EIA
East Anglia THREE	2.2	9.8	12.0	1c	SEP&DEP
Hornsea Three	9.6	1.2	10.8	1c	SEP&DEP
Inch Cape	0.0	0.0	0.0	1c	SEP&DEP
Moray West	0.0	0.0	0.0	1c	SEP&DEP
Norfolk Vanguard	10.1	4.3	14.4	1c	SEP&DEP
Norfolk Boreas	7.4	9.7	17.1	1c	SEP&DEP
East Anglia ONE North	1.1	0.7	1.8	1c	SEP&DEP
East Anglia TWO	5.0	0.6	5.6	1c	SEP&DEP
Hornsea Four	1.0	0.0	1.0	1c	SEP&DEP
ForthWind Offshore Wind Demonstration Project (Methil)	0.0	0.0	0.0	1c	Forthwind CRM appendix
SEP & DEP	1.9	0.3	2.2	1d	SEP&DEP
Berwick Bank	7.6	0.0	7.6	1d	Berwick Bank EIA
Green Volt	-	-	0.0	1c	Green Volt Additional Information
Rampion 2	1.5	2.8	4.3	1d	Rampion 2 ES
North Falls	6.5	2.0	8.6	1d	North Falls EIA
Five Estuaries	24.0	3.7	27.8	1d	Five Esturaries ES
Salamander	-	-	-	1d	Salamander CRM Annex

Project	Breeding	Non-breeding	Annual total	Tier	Source
Pentland Floating Offshore Windfarm Demonstrator	-	-	-	1c	Pentland EIAR
West of Orkney	-	-	-	1d	West of Orkney Addendum
Culzean	-	-	-	1c	Culzean Appropriate Assessment
Caledonia	-	-	-	1d	Caledonia CRM Appendix
Dogger Bank South	1.2	0.0	1.2	1d	Dogger Bank South CRM Appendix
Ossian	0.0	0.3	0.3	1d	Ossian EIA
Total All Projects (without the Project)	**233.5**	**453.4**	**686.9**	-	
The Project	2.0	0.4	2.4	1d	
Total (with the Project)	**235.5**	**453.8**	**689.3**	**-**	

Potential magnitude of impact

482. The potential magnitude of impact is estimated by calculating the increase in baseline mortality when compared against the largest UK North Sea and English Channel BDMPS and then separately against the biogeographic population. The largest lesser black-backed gull BDMPS for the North Sea and English Channel is 209,006 individuals, whilst the wider bio-geographic population is 864,000 individuals. When considering the average mortality rate of 0.12 (Table 12.9) the background mortality for these two population scales are 25,854 and 106,877 individuals per annum, respectively.

483. The potential cumulative loss of 689 (689.3) lesser black-backed gull would represent an increase of 2.666% relative to the baseline mortality rate at the UK North Sea and English Channel BDMPS scale. At the biogeographic scale this additional mortality would increase baseline mortality by 0.645%. As the predicted impact exceeds a 1% increase in baseline mortality at the BDMPS scale, further consideration is given below in the form of PVA analysis.

484. PVA was undertaken on a range of scenarios for both the Project alone and cumulatively with other projects (as presented in Appendix 12.4) For each scenario, CGR and CPS values have been presented from the model outputs, measuring the changes in annual growth rate and population size respectively at the end of a 35 year period which is the approximate anticipated operational life of the Project, relative to a baseline scenario. The impact on adult survival is also presented, calculated as the number of mortalities divided by the relevant population size used in the PVA analysis. PVA results are presented in Table 12.85:.

485. At the BDMPS population scale, the predicted cumulative impact represents a 0.375% reduction in population growth rate. These impacts are expected to be indistinguishable from natural fluctuations in the population. Additionally, the precautionary nature of the assessment means that the actual impact is considered to be lower than the one predicted here.

486. As with great black-backed gull, a review of nocturnal activity found the use of 25% nocturnal activity to be more appropriate than the previously recommended 50% and currently used 37.5% (EATL, 2015). Applying the use of 25% (or even 37.5%) to other project values would result in a significant reduction in annual cumulative collision estimates.

487. Additionally, collision estimates from many windfarms presented above which are now operational are calculated for designs with higher numbers of WTGs than have actually been installed (or are planned).

488. Within the context of wider UK lesser black-backed gull population changes (for example, a national decline of 49% between Seabird 2000 and Seabirds Count (a period of approximately 20 years), and decreases of 56% in England and 48% in Scotland (Burnell *et al.,* 2023), the changes in populations modelled by PVA from cumulative impacts are considered to be small compared to the natural fluctuations within the population, or changes brought about by other pressures acting on the population.

489. Density dependence regulates population size by adjusting demographic rates to maintain a population around a carrying capacity. If impacts from OWFs decrease survival rates, the resulting decrease in competition for resources might lead to increased survival and/or productivity in the remaining population, consequently boosting population growth. The importance of density dependence is evident in natural ecosystems, where without it, populations would exhibit exponential growth. However, the mechanisms as to how this operates in seabirds are largely uncertain. Misinterpretation of density dependence in population assessments can result in unreliable predictions. As such, PVA models used in this assessment were density independent, despite ecological evidence suggesting the presence of density dependence in large populations (Horswill *et al*., 2017). While density-independent models lack the capacity for population recovery once it falls below a certain threshold, they are preferred for impact assessments due to their precautionary nature (Ridge *et al.,* 2019). Please see Appendix 12.4 for further justification.

Table 12.78: PVA results for lesser black-backed gull impacts on the North Sea BDMPS

PVA Scenario	Annual mortality	Impact on survival	Medan CGR	Median CPS
Project alone				
BDMPS	2.4	<0.001	1.000	1.000
Project cumulatively				
BDMPS	689.3	0.003	0.996	0.873

490. Based on these elements of over-precaution, the magnitude of impact resulting from cumulative collision effects on lesser black-backed gull are considered to be of negligible magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall. Given a magnitude change of negligible, and a sensitivity to collision major, the significance of effect is therefore concluded to be **minor adverse, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

Herring gull

491. As outlined in Section 12.9, herring gull show a major level of sensitivity to collision with WTGs.

492.

493. Table 12.79 below presents the bio-season and annual collision mortality estimates for relevant OWFs in the UK North Sea and Channel BDMPS. Collision estimates were taken from the Five Estuaries PEIR (VE OWFL, 2023). Up-to-date avoidance rates have been used to calculate impacts for previously submitted projects. As such, impacts presented here may differ from those presented at submission. Projects where impacts from previously submitted projects have been compensated are included here, ensuring that the approach delivers a precautionary assessment of cumulative impact.

494. Updates to these values included:

- Inclusion of revised CRM estimates for Neart na Gaoithe and Inch Cape, and inclusion of values from Seagreen Alpha and Bravo, Pentland Floating Windfarm, ForthWind Offshore Wind Demonstration Project, Berwick Bank, Green Volt, North Falls, and Five Estuaries;
- Removal of Beatrice Demonstrator as the project will be decommissioned by the time the Project is predicted to be operational; and
- Inclusion of values from the Project.

Table 12.79: Cumulative bio-season and annual collision mortality estimates for herring gull from all Tier 1 and 2 projects.

Project	Breeding	Non-breeding	Annual total	Tier	Source
Beatrice	59.3	236.9	296.2	1a	Five Estuaries ES
Blyth Demonstration Site	0.6	2.6	3.2	1a	Five Estuaries ES
Dudgeon	-	-	0.0	1a	Five Estuaries ES
East Anglia ONE	0.0	22.8	22.8	1a	Five Estuaries ES
EOWDC	5.8	0.0	5.8	1a	Five Estuaries ES
Galloper	32.6	0.0	32.6	1a	Five Estuaries ES
Greater Gabbard	0.0	0.0	0.0	1a	Five Estuaries ES
Gunfleet Sands	-	-	0.0	1a	Five Estuaries ES
Hornsea Project One	3.5	13.9	17.4	1a	Five Estuaries ES
Humber Gateway	0.5	1.3	1.8	1a	Five Estuaries ES
Hywind Scotland	0.7	9.4	10.1	1a	Five Estuaries ES
Kentish Flats	0.0	0.0	0.0	1a	Five Estuaries ES
Kentish Flats Extension	0.6	2.0	2.6	1a	Five Estuaries ES
Kincardine	1.2	0.0	1.2	1a	Five Estuaries ES
Lincolnshire Node	0.0	0.0	0.0	1a	Five Estuaries ES
London Array	-	-	-	1a	Five Estuaries ES
Lynn and Inner Dowsing	0.0	0.0	0.0	1a	Five Estuaries ES
Methil (Samsung) Demo	7.0	4.4	11.4	1a	Five Estuaries ES
Race Bank	0.0	0.0	0.0	1a	Five Estuaries ES
Rampion	186.0	0.0	186.0	1a	Five Estuaries ES
Scroby Sands	0.0	0.0	0.0	1a	Five Estuaries ES
Sheringham Shoal	0.0	0.0	0.0	1a	Five Estuaries ES
Teesside	10.4	41.4	51.8	1a	Five Estuaries ES
Thanet	5.9	23.5	29.4	1a	Five Estuaries ES
Westermost Rough	0.1	0.0	0.1	1a	Five Estuaries ES

Project	Breeding	Non-breeding	Annual total	Tier	Source
Hornsea Project Two	28.6	0.0	28.6	1a	Five Estuaries ES
Moray East	62.4	0.0	62.4	1b	Five Estuaries ES
Neart na Gaoithe	2.4	4.8	7.2	1b	Five Estuaries ES
Triton Knoll	0.0	0.0	0.0	1a	Five Estuaries ES
Dogger Bank A & B	0.0	0.0	0.0	1b	Five Estuaries ES
Dogger Bank C & Sofia	0.0	0.0	0.0	1b	Five Estuaries ES
Seagreen Alpha and Bravo	6.5	20.0	26.4	1b	Seagreen CRM Appendix
East Anglia THREE	0.0	27.6	27.6	1c	Five Estuaries ES
Hornsea Three	1.2	4.8	6.0	1c	Five Estuaries ES
Inch Cape	1.2	3.6	4.8	1c	North Falls CRM Appendix
Moray West	14.4	1.2	15.6	1c	Five Estuaries ES
Norfolk Vanguard	0.5	8.5	9.0	1c	Five Estuaries ES
Norfolk Boreas	1.8	6.5	8.3	1c	Five Estuaries ES
East Anglia ONE North	0.0	0.0	0.0	1c	Five Estuaries ES
East Anglia TWO	0.0	0.6	0.6	1c	EA2 and EA1N Cumulative and In-combination Report
Hornsea Four	0.6	0.4	1.0	1c	Hornsea Four ES
Pentland Floating Offshore Windfarm Demonstrator	0.0	0.0	0.0	1c	Pentland Floating CRM appendix
ForthWind Offshore Wind Demonstration Project (Methil)	0.0	0.0	0.0	1c	Forthwind CRM appendix
Sheringham Shoal Extension	0.0	0.0	0.0	1d	SEP&DEP
Dudgeon Offshore Extension	0.3	0.0	0.3	1d	SEP&DEP
Berwick Bank	52.0	8.5	60.5	1d	Berwick Bank EIA
Green Volt	0.1	5.8	5.8	1c	Green Volt Additional Information
Rampion 2	34.5	28.1	62.6	1d	Rampion 2 ES

Project	Breeding	Non-breeding	Annual total	Tier	Source
North Falls	0.7	0.0	0.7	1d	North Falls EIA
Five Estuaries	0.4	1.0	1.4	1d	Five Estuaries ES
Salamander				1d	Salamander CRM Annex
Ossian	0.0	2.7	2.7	1d	Ossian EIA
Culzean	-	-	0.0	1c	Culzean Appropriate Assessment
West of Orkney	-	-	0.0	1d	West of Orkney Addendum
Caledonia	0.0	3.1	3.1	1d	Caledonia RM Appendix
Dogger Bank South	0.8	1.4	2.2	1d	Dogger Bank South EIA
Total All Projects (without the Project)	523.3	492.3	1,015.6	-	
the Project	2.3	0.7	2.9	1d	
Total (with the Project)	525.5	493.0	1,018.5	-	

Potential magnitude of impact

495. The potential magnitude of impact is estimated by calculating the increase in baseline mortality when compared against the largest UK North Sea and English Channel BDMPS and then separately against the biogeographic population. The largest herring gull BDMPS for the North Sea and English Channel is 466,510 individuals, whilst the wider bio-geographic population is 1,098,000 individuals. When considering the average mortality rate of 0.17 (Table 12.9) the background mortality for these two population scales are 80,426 and 189,295 individuals per annum, respectively.

496. The potential cumulative loss of 1,019 (1,018.5) herring gull would represent an increase of 1.266% relative to the baseline mortality rate at the UK North Sea and English Channel BDMPS scale. At the biogeographic scale this additional mortality would increase baseline mortality by 0.538%. Given the predicted mortality is over a 1% increase on baseline levels at the BDMPS scale, further consideration is given below in the form of PVA analysis.

497. PVA was undertaken on a range of scenarios for both the Project alone and cumulatively with other projects (as presented in Appendix 12.4). For each scenario, CGR and CPS have been presented from the model outputs, measuring the changes in annual growth rate and population size respectively at the end of the impacted period of 35 years relative to a baseline scenario. The impact on adult survival is also presented, calculated as the number of mortalities divided by the relevant population size used in the PVA analysis. PVA results are presented in Table 12.80 below.

498. At the BDMPS population scale, the predicted cumulative impact represents a 0.264% reduction in population growth rate relative to a baseline scenario. These impacts are expected to be indistinguishable from natural fluctuations in the population. Additionally, the precautionary nature of the assessment means that the actual impact is considered to be lower than the one predicted here.

499. As with lesser black-backed gull, a review of nocturnal activity found the use of 25% nocturnal activity to be more appropriate than the previously recommended 50% and currently used 37.5% (EATL, 2015). Applying the use of 25% to other project values would result in a significant reduction in annual cumulative collision estimates.

500. A review of nocturnal activity in seabirds (EATL, 2015) found that the use of 50% to be an overestimate, with a value of 25% considered more appropriate. This has been recognised and supported by Natural England who recommend the use of both 25% and 50% (when CRM is run deterministically). Applying the use of 25% would result in a significant reduction in annual cumulative collision estimates.

501. Additionally, the contribution of the Project alone is only three mortalities, representing a <0.01% increase in baseline mortality at both the BDMPS and biogeographic scales. Therefore, it is considered that the Project is not making a material contribution to the cumulative collision mortality total.

502. Within the context of wider UK herring gull population changes (for example, a national decline of 44% between Seabird 2000 and Seabirds Count (a period of approximately 20 years) and decreases of 60% in England and 44% in Scotland (Burnell *et al* 2023)), the changes in populations modelled by PVA from cumulative impacts are considered to be small compared to the natural fluctuations within the population, or changes brought about by other pressures.

503. Density dependence regulates population size by adjusting demographic rates to maintain a population around a carrying capacity. If impacts from OWFs decrease survival rates, the resulting decrease in competition for resources might lead to increased survival and/or productivity in the remaining population, consequently boosting population growth. The importance of density dependence is evident in natural ecosystems, where without it, populations would exhibit exponential growth. However, the mechanisms as to how this operates in seabirds are largely uncertain. Misinterpretation of density dependence in population assessments can result in unreliable predictions. As such, PVA models used in this assessment were density independent, despite ecological evidence suggesting the presence of density dependence in large populations (Horswill *et al*., 2017). While density-independent models lack the capacity for population recovery once it falls below a certain threshold, they are preferred for impact assessments due to their precautionary nature (Ridge *et al.,* 2019). Please see Appendix 12.4 for further justification.

Table 12.80: PVA results for herring gull impacts on the North Sea BDMPS.

PVA Scenario	Annual mortality	Impact on survival	Medan CGR	Median CPS
Project alone				
BDMPS	2.9	<0.001	1.000	1.000
Project cumulatively				
BDMPS	1,018.5	0.002	0.997	0.909

504. Based on this, the level of change is considered to be of negligible magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall. Given a magnitude change of negligible, and a sensitivity to collision of major, the significance of effect is therefore concluded to be **minor adverse, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

Great black-backed gull

505. As outlined in Section 12.9, great black-backed gull show a medium level of sensitivity to collision with WTGs.

506. Table 12.81**Error! Reference source not found.** below presents the bio-season and annual collision mortality estimates for relevant OWFs in the UK North Sea and Channel BDMPS. Collision estimates were taken from the Sheringham Shoal and Dudgeon Offshore Windfarm Extension Projects Collision Risk Modelling (CRM) Updates Technical Note (Royal HaskoningDHV, 2023b). Updates to these values included:

- Inclusion of values from Pentland Floating Windfarm, ForthWind Offshore Wind Demonstration Project, Berwick Bank, Green Volt, North Falls, and Five Estuaries;
- Removal of Beatrice Demonstrator as the project will be decommissioned by the time the Project is predicted to be operational; and
- Inclusion of values from the Project.

Table 12.81: Cumulative bio-season and annual collision mortality estimates for great black-backed gull from all Tier 1 and 2 projects.

Project	Breeding	Non-breeding	Annual total	Tier	Source
Beatrice	36.2	145.0	181.2	1a	SEP&DEP
Blyth Demonstration Site	1.6	6.1	7.7	1a	SEP&DEP
Dudgeon	0.0	0.0	0.0	1a	SEP&DEP
East Anglia ONE	0.0	55.2	55.2	1a	SEP&DEP
EOWDC	0.7	2.9	3.6	1a	SEP&DEP
Galloper	5.4	21.6	27.0	1a	SEP&DEP
Greater Gabbard	50.0	200.0	250.0	1a	SEP&DEP
Gunfleet Sands	-	-	0.0	1a	SEP&DEP
Hornsea Project One	20.6	82.3	102.9	1a	SEP&DEP
Humber Gateway	1.6	6.1	7.7	1a	SEP&DEP
Hywind Scotland	0.4	5.4	5.8	1a	SEP&DEP
Kentish Flats	-	-	0.0	1a	SEP&DEP
Kentish Flats Extension	0.1	0.2	0.3	1a	SEP&DEP
Kincardine	0.0	0.0	0.0	1a	SEP&DEP
Lincolnshire Node	0.0	0.0	0.0	1a	SEP&DEP
London Array	-	-	0.0	1a	SEP&DEP
Lynn and Inner Dowsing	0.0	0.0	0.0	1a	SEP&DEP
Methil (Samsung) Demo	0.8	0.8	1.6	1a	SEP&DEP
Race Bank	0.0	0.0	0.0	1a	SEP&DEP
Rampion	6.2	25.0	31.2	1a	SEP&DEP
Scroby Sands	-	-	0.0	1a	SEP&DEP
Sheringham Shoal	0.0	0.0	0.0	1a	SEP&DEP
Teesside	10.4	41.8	52.2	1a	SEP&DEP
Thanet	0.1	0.5	0.6	1a	SEP&DEP
Westermost Rough	0.0	0.0	0.1	1a	SEP&DEP

Project	Breeding	Non-breeding	Annual total	Tier	Source
Hornsea Project Two	3.6	24.0	27.6	1a	SEP&DEP
Moray East	11.4	30.6	42.0	1b	SEP&DEP
Neart na Gaoithe	0.0	3.6	3.6	1b	Neart na Gaoithe EIAR
Triton Knoll	29.3	117.1	146.4	1a	SEP&DEP
Dogger Bank A & B	7.0	28.0	35.0	1b	SEP&DEP
Dogger Bank C & Sofia	7.7	30.6	38.3	1b – 1c	SEP&DEP
Seagreen Alpha and Bravo	16.1	64.1	80.2	1b	SEP&DEP
East Anglia Three	5.5	41.3	46.8	1c	SEP&DEP
Hornsea Three	9.6	33.6	43.2	1c	SEP&DEP
Inch Cape	0.0	44.2	219.2	1c	SEP&DEP
Moray West	4.8	6.0	10.8	1c	SEP&DEP
Norfolk Vanguard	5.4	25.8	31.2	1c	SEP&DEP
Norfolk Boreas	8.3	34.4	42.7	1c	SEP&DEP
East Anglia ONE North	4.4	1.4	5.8	1c	SEP&DEP
East Anglia TWO	4.2	4.1	8.3	1c	SEP&DEP
Hornsea Four	1.0	10.6	11.6	1c	SEP&DEP
ForthWind Offshore Wind Demonstration Project (Methil)	-	-	0.0	1c	Forthwind CRM appendix
Pentland Floating Offshore Wind Demonstrator	0.0	0.0	0.0	1c	Pentland Floating CRM appendix
SEP & DEP	5.7	0.3	6.0	1d	SEP&DEP
Berwick Bank	-	-	0.0	1d	Berwick Bank EIA
Green Volt	0.1	6.9	7.0	1c	Green Volt Additional Information
Rampion 2	6.3	13.6	19.8	1d	Rampion 2 ES
North Falls	0.0	3.0	3.0	1d	North Falls EIA
Five Estuaries	0.7	1.2	1.8	1d	Five Estuaries ES

Project	Breeding	Non-breeding	Annual total	Tier	Source
Salamander	0.0	3.0	3.0	1d	Salamander CRM Annex
Ossian	-	-	0.0	1d	
Culzean	0.1	0.2	0.3	1c	
West of Orkney	0.8	11.1	11.9	1d	
Caledonia	0	14.98	14.98	1d	
Dogger Bank South	0.6	2.7	3.4	1d	Dogger Bank South CRM Appendix
Total All Projects (without the Project)	**266.7**	**1,149.3**	**1,416.0**		
The Project	0.5	3.4	4.0	1d	
Total (with the Project)	**267.2**	**1,152.7**	**1,420.0**		

Potential magnitude of impact

507. The potential magnitude of impact is estimated by calculating the increase in baseline mortality when compared against the largest UK North Sea and English Channel BDMPS and then separately against the biogeographic population. The largest great black-backed gull BDMPS for the North Sea and English Channel is 91,398 individuals, whilst the wider bio-geographic population is 235,000 individuals. When considering the average mortality rate of 0.10 (Table 12.9) the background mortality for these two population scales are 8,856 and 22,772 individuals per annum, respectively.

508. The potential cumulative loss of 1,420 (1,420.0) great black-backed gull would represent an increase of 16.034% relative to the baseline mortality rate at the UK North Sea and English Channel BDMPS scale. At the biogeographic scale this additional mortality would increase baseline mortality by 6.236%. As the predicted impact exceeds a 1% increase in baseline mortality at the BDMPS scale, further consideration is given below in the form of PVA analysis.

509. PVA was undertaken on a range of scenarios for both the Project alone and cumulatively with other projects (as presented in Appendix 12.4). For each scenario, CGR and CPS values have been presented from the model outputs, measuring the changes in annual growth rate and population size respectively at the end of the impacted period of 35 years relative to a baseline scenario. The impact on adult survival is also presented, calculated as the number of mortalities divided by the relevant population size used in the PVA analysis. PVA results are presented in Table 12.82 below**Error! Reference source not found.**.

510. At the BDMPS population scale, the predicted cumulative impacts would result in a 1.671% reduction in population growth rate relative to a baseline scenario, and a 0.650% reduction based on the biogeographic population. Though the comparative reduction in growth rate exceeds 0.5% at both the BDMPS and biogeographic population scales, the resulting impact is not considered significant when accounting for the over-precautionary nature of the assessment.

511. For many of the OWFs included within the cumulative assessment, collisions are based on consented designs which have higher numbers of WTGs (and total rotor swept areas) than have actually been installed (or are planned to be installed), which will considerably reduce the predicted cumulative collisions. Additionally, several of the older operational projects listed are considered to be part of the baseline environment and so should theoretically be excluded from the assessment, though are kept in to represent a precautionary approach.

512. Considering input parameters, as with kittiwake, the nocturnal activity rate used is also highly precautionary, with the use of 25% considered more appropriate than the currently used 0.375, and previously recommended 50% based on a review (EATL, 2015). Meanwhile many of the projects in the cumulative assessment have used a higher value of 50%. Reducing the cumulative collisions to reflect this lower nocturnal activity rate would similarly result in a significant reduction in predicted cumulative collisions.

513. Furthermore, the contribution of the Project to cumulative mortalities is low, with the predicted four (4.0) mortalities representing just 0.28% of the total predicted cumulative mortalities.

514. Within the context of wider UK great black-backed gull population changes (for example, a national decline of 52% between Seabird 2000 and Seabirds Count (a period of approximately 20 years), and decreases of 3% in England and 63% in Scotland (where the majority of the UK's population breeds) (Burnell *et al.,* 2023), the changes in populations modelled by PVA from cumulative impacts are considered to be small compared to the natural fluctuations within the population, or changes brought about by other pressures.

515. Density dependence regulates population size by adjusting demographic rates to maintain a population around a carrying capacity. If impacts from OWFs decrease survival rates, the resulting decrease in competition for resources might lead to increased survival and/or productivity in the remaining population, consequently boosting population growth. The importance of density dependence is evident in natural ecosystems, where without it, populations would exhibit exponential growth. However, the mechanisms as to how this operates in seabirds are largely uncertain. Misinterpretation of density dependence in population assessments can result in unreliable predictions. As such, PVA models used in this assessment were density independent, despite ecological evidence suggesting the presence of density dependence in large populations (Horswill *et al*., 2017). While density-independent models lack the capacity for population recovery once it falls below a certain threshold, they are preferred for impact assessments due to their precautionary nature (Ridge *et al.,* 2019). Please see Appendix 12.4 for further justification.

Table 12.82: PVA results for great black-backed gull impacts on the North Sea BDMPS.

PVA Scenario	Annual mortality	Impact on survival	Medan CGR	Median CPS
Project alone				
BDMPS	4.0	<0.001	1.000	0.998
Biogeographic	4.0	<0.001	1.000	0.999
Project cumulatively				
BDMPS	1,420.0	0.016	0.983	0.545
Biogeographic	1,420.0	0.006	0.994	0.791

516. Consequently, this level of change is considered to be of negligible magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall. Given a magnitude change of negligible, and a sensitivity to collision of major, the significance of effect is therefore concluded to be **minor adverse, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

Sandwich tern

517. For the cumulative assessment of Sandwich tern, previous assessments for OWFs have used methods, notably avoidance rates, which are no longer recommended by Natural England for the estimation of collision risk. This assessment therefore re-calculated collision risk for relevant projects using avoidance rates which are recommended in the most recent Natural England guidance (Natural England, 2022a).

518. Cumulative collision data for relevant projects were extracted from the assessment undertaken for Sheringham Shoal and Dudgeon Offshore Wind Extension Projects (Royal HaskoningDHV, 2022). Project-specific collision estimates based on the previously used avoidance rate of 0.980 were adjusted using the following conversion factor to reflect the updated avoidance rate of 0.991 recommended by Natural England:

$$\frac{(1-0.991)}{(1-0.980)} = 0.45$$

519. Adjusted rates are presented in Table 12.83 below.

520. It is noted that the parameters of projects included in the assessments which have now been built (notably Sheringham Shoal and Dudgeon Offshore Wind Projects, Race Bank, and Triton Knoll) differ to the parameters which were included in the corresponding assessments. Therefore, two scenarios are provided:

- Scenario A, using consented project parameters and representing a worst-case scenario; and
- Scenario B, using the as-built designs (where relevant) and representing the more realistic cumulative impacts on Sandwich tern.

Table 12.83: Cumulative O&M phase collisions for Sandwich tern based on consented (Scenario A) and as built WTG parameters (Scenario B).

Project	Annual collisions (0.980 avoidance)	Annual collisions (0.991 avoidance)
Scenario A (consented project parameters)		
Dudgeon	40.1	18.0
Race Bank	91.5	41.1
Sheringham Shoal	17.3	7.8
Triton Knoll	17.8	8.0
DEP	7.6	3.5
SEP	1.9	0.9
Rampion 2	0.8	0.4
Total (other projects)	**177.0**	**79.8**
the Project		0.4
Total (all projects)	**-**	**80.2**
Scenario B (as-built project parameters)		
Dudgeon	33.3	15.0
Race Bank	30.9	13.9
Sheringham Shoal	17.3	7.8
Triton Knoll	6.1	2.7

DEP	7.6	3.4
SEP	1.9	0.9
Rampion 2	0.8	0.4
Total (other projects)	**97.9**	**44.1**
The Project	-	0.4
Total (all projects)	**-**	**44.5**

Potential magnitude of impact

521. The potential magnitude of impact is estimated by calculating the increase in baseline mortality when compared against the largest UK North Sea and English Channel BDMPS and then separately against the biogeographic population. The largest Sandwich tern BDMPS for the North Sea and English Channel is 38,051 individuals, whilst the wider bio-geographic population is 148,000 individuals. When considering the average mortality rate of 0.241 (Table 12.9) the background mortality for these two population scales are 9,170 and 35,668 individuals per annum, respectively.

522. Based on the CRM results using the consented OWF designs (Scenario A; Table 12.83), and using values based on Natural England's recommended avoidance rate of 0.991, an annual total of 81 (81.3) collision mortalities are predicted, of which the Project contributes less than two individuals. The potential cumulative loss of 81 individuals would represent a 0.886% increase in baseline mortality at the UK North Sea and English Channel BDMPS scale. At the biogeographic scale, this additional mortality would increase baseline mortality by 0.228%

523. Considering the CRM results using the more realistic as-built OWF designs (Scenario A; Table 12.83), the total number of predicted collision mortalities is reduced to 45 (45.6) individuals. This represents a 0.497% increase in baseline at the UK North Sea and English Channel BDMPS scale, and a 0.128% increase in baseline mortality at the biogeographic scale.

524. Based on the worst case-scenario (Scenario A), the predicted level of change is considered to be of negligible magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall, as it represents no discernible change to baseline mortality. Given a magnitude change of negligible, and a sensitivity to collision of minor, the significance of effect is therefore concluded to be **negligible, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

Gannet

525. As outlined in Section 12.9, gannet show a medium level of sensitivity to collision with WTGs.

526. Table 12.84 below presents the bio-season and annual collision mortality estimates for relevant OWFs in the UK North Sea and Channel BDMPS. It should be noted that assessments at other OWFs have been conducted using a range of avoidance rates and alternative collision model options. This makes it challenging to apply a macro-avoidance rate cumulatively, as was done in the Project alone assessment. Consequently, the results have been presented for the full impact from collision and disturbance, which is considered to be highly precautionary, because the birds that are displaced from windfarms are impacted by displacement and continue to be at risk of collision. Collisions have been calculated using the most up-to-date avoidance rates for all projects in Table 12.42:.

Table 12.84: Cumulative bio-season and annual collision mortality estimates for gannet from all Tier 1 and 2 projects.

Project	Migration-free breeding	Post-breeding migration	Return migration	Annual total	Tier	Source
Beatrice	7.9	10.2	2.0	20.1	1a	SEP&DEP
Beatrice demonstrator	0.1	0.2	0.1	0.5		SEP&DEP
Blyth Demonstration Site	0.7	0.4	0.6	1.8	1a	SEP&DEP
Dudgeon	4.7	8.2	4.0	16.9	1a	SEP&DEP
East Anglia ONE	0.7	27.5	1.3	29.5	1a	SEP&DEP
EOWDC	0.9	1.1	0.0	2.0	1a	SEP&DEP
Galloper	3.8	6.5	2.6	12.9	1a	SEP&DEP
Greater Gabbard	2.9	1.8	1.0	5.8	1a	SEP&DEP
Gunfleet Sands	0.0	0.0	0.0	0.0	1a	SEP&DEP
Hornsea Project One	2.4	6.7	4.7	13.9	1a	SEP&DEP
Humber Gateway	0.4	0.2	0.3	0.9	1a	SEP&DEP
Hywind Scotland	1.2	0.2	0.2	1.5	1a	SEP&DEP
Kentish Flats	0.3	0.2	0.2	0.7	1a	SEP&DEP
Kentish Flats Extension	0.0	0.0	0.0	0.0	1a	SEP&DEP
Kincardine	0.6	0.0	0.0	0.6	1a	SEP&DEP
London Array	0.5	0.3	0.4	1.2	1a	SEP&DEP
Lincolnshire Node, Lynn and Inner Dowsing	0.5	0.3	0.4	1.2	1a	SEP&DEP
Methil (Samsung) Demo	1.3	0.0	0.0	1.3	1a	SEP&DEP
Moray East	16.9	7.4	1.9	26.2	1b	SEP&DEP
Race Bank	7.1	2.5	0.9	10.4	1a	SEP&DEP

Project	Migration-free breeding	Post-breeding migration	Return migration	Annual total	Tier	Source
Rampion	7.6	13.3	0.4	21.4	1a	SEP&DEP
Scroby Sands	0.0	0.0	0.0	0.0	1a	SEP&DEP
Sheringham Shoal	3.0	0.7	0.0	3.7	1a	SEP&DEP
Teesside	1.0	0.4	0.0	1.4	1a	SEP&DEP
Thanet	0.2	0.0	0.0	0.2	1a	SEP&DEP
Westermost Rough	0.0	0.0	0.0	0.1	1a	SEP&DEP
Hornsea Project Two	1.5	2.9	1.3	5.7	1a	SEP&DEP
Neart na Gaoithe	18.7	1.5	1.5	21.6	1b	North Falls EIA
Triton Knoll	5.6	13.5	6.3	25.4	1a	SEP&DEP
Dogger Bank A & B	17.0	17.5	11.4	46.0	1b	SEP&DEP
Dogger Bank C & Sofia	3.1	2.1	2.3	7.5	1b	SEP&DEP
Seagreen Alpha and Bravo	1.3	7.0	2.0	10.3	1b	North Falls EIA
East Anglia THREE	2.1	1.1	0.8	4.0	1c	SEP&DEP
Hornsea Three	22.7	1.1	0.8	24.6	1c	SEP&DEP
Inch Cape	2.1	0.4	0.2	2.7	1c	North Falls EIA
Moray West	5.6	13.5	6.3	25.4	1c	SEP&DEP
Norfolk Vanguard	1.7	3.9	1.1	6.7	1c	SEP&DEP
Norfolk Boreas	3.0	2.7	0.8	6.4	1c	SEP&DEP
East Anglia ONE North	2.6	2.3	0.2	5.1	1c	SEP&DEP
East Anglia TWO	2.6	4.9	0.8	8.3	1c	SEP&DEP
Hornsea Four	3.0	1.0	0.3	4.3	1c	Hornsea Four Annex
Pentland Floating Offshore Wind Demonstrator	0.4	0.0	0.0	0.4	1c	Pentland Floating CRM Appendix

Project	Migration-free breeding	Post-breeding migration	Return migration	Annual total	Tier	Source
ForthWind Offshore Wind Demonstration Project (Methil)	0.3	0.0	0.0	0.3	1c	ForthWind CRM Appendix
SEP & DEP	0.4	0.6	0.0	1.1	1d	SEP&DEP
Berwick Bank	35.7	3.8	0.6	40.1	1d	Berwick Bank EIA
Green Volt	4.5	0.1	0.7	5.3	1c	Greenvolt EIA
Rampion 2	2.9	1.4	0.6	4.9	1d	Rampion 2 ES
North Falls	0.6	0.9	0.6	2.1	1d	North Falls EIA
Five Estuaries	1.3	1.5	0.2	3.0	1d	Five Estuaries CRM Annex
Salamander	1.6	0.5	0.2	2.2	1d	Salamander CRM Annex
Ossian	8.5	1.1	0.1	9.7	1d	Ossian EIA
Dogger Bank South	8.3	3.7	0.3	12.2	1d	Dogger Bank South CRM Appendix
West of Orkney	10.6	2.3	0.6	13.5	1d	West of Orkney Addendum
Culzean	0.0	0.0	0.0	0.0	1c	Culzean Appropriate Assessment
Caledonia	3.7	0.6	0.1	4.4	1d	Caledonia CRM Appendix
Total All Projects (without the Project)	**292.6**	**169.5**	**56.5**	**518.6**	-	
The Project	1.2	0.4	0.1	1.7	1d	
Total (with the Project)	**293.8**	**169.9**	**56.6**	**520.3**	**-**	

Potential magnitude of impact

527. The potential magnitude of impact is estimated by calculating the increase in baseline mortality when compared against the largest UK North Sea and English Channel BDMPS and biogeographic population. The largest gannet BDMPS for the UK North Sea and English Channel is 456,299 individuals whilst the wider bio-geographic population is 1,180,000 individuals. Using the average mortality rate of 0.19 (Table 12.9), the background mortality for these population scales are 85,145 and 220,188 individuals per annum, respectively.

528. Applying the single macro-avoidance rate of 70% to projects presented where appropriate in Table 12.84 the annual cumulative collision mortality would be 519 (518.6) individuals, with the addition of two (1.7) individuals from the Project increasing this to 520 (520.3) individuals. Based on this value, the impact on the BDMPS population would be reduced to a 0.611% increase in baseline mortality, and the impact on the biogeographic population reduced to a 0.236% increase in baseline mortality.

529. The Natural England interim CRM guidance (Natural England, 2022a) also advises the use of a nocturnal activity factor for gannet of 14% as opposed to the previously used 25%. To calculate the changes this makes for each windfarm included in the cumulative assessment would require calculation of a mortality adjustment rate for each month at each windfarm, since the duration of night varies with month and latitude (both of which are inputs to the collision model). This has not been undertaken for the current assessment, however the application of this would substantially reduce cumulative totals.

530. Additionally, collision estimates from many windfarms presented above which are now operational are calculated for designs with higher numbers of WTGs than have been installed (or are planned). MacArthur Green (2017) have presented a method for updating collision estimates based on this, with estimates expected to be reduced by around 7% (Appendix 12.3 of East Anglia TWO EIA submission).

531. Based on the realistic reductions in predicted cumulative collision rate owing to (i) inclusion of macro-avoidance in assessments, (ii) reduction in the nocturnal activity factor, and (iii) revisions to post-consent windfarm designs, the annual cumulative collision impact is considered to be of minor magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall. Given a magnitude change of minor, and a sensitivity to collision of moderate, the significance of effect is therefore concluded to be **minor adverse, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

12.11.5 Cumulative impact assessment: Combined collision risk and displacement (O&M phase)

Gannet

532. Since gannet has been assessed for impacts arising from both displacement and collision, a combined cumulative assessment has been undertaken to characterise the risk from these combined impacts at a cumulative level. It should be noted that these impacts are not able to act on the same birds (i.e. birds displaced from a windfarm cannot then be subject to collision mortality from the same site).

533. As presented in Section 12.9, the annual cumulative mortality estimate resulting from displacement is 413 (413.4) (based on 70% displacement and 1% mortality), and for collision the mortality estimate is 520 (520.2) individuals. This results in a combined annual mortality of 934 (933.7) individuals.

534. Based on the largest UK North Sea and English Channel BDMPS of 456,299 and a baseline mortality of 85,145 individuals per annum, the addition of 934 mortalities per annum would result in a 1.097% increase in baseline mortality. Based on the biogeographic population of 1,180,000 individuals and a baseline mortality of 220,188, the addition of 934 additional mortalities would result in a 0.424% increase in baseline mortality.

535. As the cumulative impact exceeds a 1% increase in baseline mortality at the BDMPS population scale, further analysis in the form of PVA has been carried out.

536. PVA was undertaken on a range of scenarios for both the Project alone and cumulatively with other projects (as presented in Appendix 12.4: Population Viability Analysis [document reference: 6.3.12.4]). For each scenario, CGR and CPS values have been presented from the model outputs, measuring the changes in annual growth rate and population size respectively at the end of the impacted period of 35 years relative to a baseline scenario. The impact on adult survival is also presented, calculated as the number of mortalities divided by the relevant population size used in the PVA analysis. PVA results are presented in Table 12.85: below.

537. At the BDMPS population scale, even based on the realistic worst-case scenario of 70% displacement and 1% mortality, the predicted impact would only result in a 0.242% reduction in population growth compared to a baseline scenario.

538. It is also considered that the actual mortality rate will be considerably reduced in reality, based on evidence presented in the cumulative impact assessment above, notably the inclusion of up-to-date nocturnal activity rates and revisions to windfarm parameters post-consent. In addition, the UK gannet population has increased considerably over the last 50 years, more than doubling from 113,006 pairs in 1970 to 293,161 pairs in 2013-15 (JNCC 2021). This trend is also reflected in the Flamborough and Filey Coast SPA, with the population rising from 3,498 pairs in 2002 to 13,392 pairs in 2017 based on data from the JNCC Seabird Monitoring Programme (SMP) database (BTO, 2025). Considering these increases, the cumulative impacts resulting from the Project are highly unlikely to impact the trend of the increasing regional gannet population.

539. Within the context of wider UK gannet population changes (for example, a national increase of 39% between Seabird 2000 and Seabirds Count (a period of approximately 20 years) and increases of 240% in England and 40% in Scotland (Burnell *et al.,* 2023)), the changes in populations modelled by PVA from cumulative impacts are considered to be small compared to the natural fluctuations within the population, or changes brought about by other pressures.

540. Density dependence regulates population size by adjusting demographic rates to maintain a population around a carrying capacity. If impacts from OWFs decrease survival rates, the resulting decrease in competition for resources might lead to increased survival and/or productivity in the remaining population, consequently boosting population growth. The importance of density dependence is evident in natural ecosystems, where without it, populations would exhibit exponential growth. However, the mechanisms as to how this operates in seabirds are largely uncertain. Misinterpretation of density dependence in population assessments can result in unreliable predictions. As such, PVA models used in this assessment were density independent, despite ecological evidence suggesting the presence of density dependence in large populations (Horswill *et al*., 2017). While density-independent models lack the capacity for population recovery once it falls below a certain threshold, they are preferred for impact assessments due to their precautionary nature (Ridge *et al.,* 2019). Please see Appendix 12.4 for further justification.

Table 12.85: PVA results for gannet (combined collision and displacement impacts) on the regional and biogeographic scales.

PVA Scenario	Annual mortality	Impact on survival	Medan CGR	Median CPS
Project alone				
70% displacement, 1% mortality (BDMPS)	9.5	<0.001	1.000	0.999
Project cumulatively				
70% displacement, 1% mortality (BDMPS)	933.7	0.002	0.998	0.916

541. Based on this, the predicted level of change is considered to be of negligible magnitude at the UK North Sea and English Channel BDMPS scale and biogeographic scale overall, as it represents no discernible change to baseline mortality. Given a magnitude change of negligible, and a sensitivity to disturbance and displacement of minor to moderate, and a sensitivity to collision of moderate, the significance of effect is therefore concluded to be **minor adverse, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15:.

12.11.6 Cumulative Impact Assessment: Decommissioning phase

Impacts arising during the decommissioning phase are expected to be equivalent to, or less than, during the construction phase. It is also not possible to predict which projects will temporally overlap with the decommissioning phase at this time. Please refer to the construction phase for further information (Section 12.11.2).

12.12 Inter-Relationships

542. The construction, operation and decommissioning of the Project would cause a range of impacts on offshore ornithological receptors. Impacts to ornithological receptors may be inter-related with impacts on other receptor groups; this is considered to be the case for indirect impacts on habitats and prey species only. For disturbance and displacement, and collision, it is assumed that there is no potential for interaction with other receptor groups.

543. Identified inter-relationships are summarised in Table 12.86, which indicates where assessments carried out in other chapters have been used to inform the offshore ornithology assessment.

Table 12.86: Inter-relationships relevant to the Project.

Impact	Related chapter	Where addressed in this chapter	Rationale
All phases			
Indirect impacts through effects on habitats and prey	▪ Volume 1, Chapter 10 – Fish and Shellfish Ecology ▪ Volume 1, Chapter 9 – Benthic Subtidal and Intertidal Ecology	Section 12.8	Potential impacts on fish, shellfish and benthic ecology during construction, O&M and decommissioning could affect prey resource for offshore ornithological receptors.

544. An assessment on the potential for effects on fish and shellfish ecology receptors was undertaken in Volume 1, Chapter 10: Fish and Shellfish Ecology. The assessment concluded no significant effects from the construction, operation and maintenance and decommissioning of the Project, and therefore no significant effects on prey resource for ornithology receptors are anticipated.

12.13 Transboundary Effects

545. Transboundary effects are defined as those effects upon the receiving environment of a European Economic Area (EEA) state, whether occurring from the Project alone, or cumulatively with other projects in the wider area.

546. While there is potential for collisions and displacement at OWFs outside of UK territorial waters, the spatial scale and therefore the seabird reference populations would be much larger. Therefore, any conclusions drawn from the existing cumulative impact assessment are considered highly unlikely to change, and any potential changes would likely be a relative reduction in scale of impact as opposed to an increase, due to the large size of the reference populations against which impacts would be assessed.

547. Since the BDMPS and biogeographic populations used for impact assessments include transboundary populations (or at least a relevant proportion of them), these impacts are accounted for within the assessment.

12.14 Conclusions

548. A summary of potential impacts assessed within this EIA, alongside any mitigation and residual effects, is presented in Table 12.87 and Table 12.88: below.

Table 12.87: Summary of potential impacts of the Project assessed for offshore and intertidal ornithology.

Description of Impact	Effect	Additional mitigation measures	Residual impact
Construction			
Impact 1: Disturbance and displacement: Offshore ECC and ORCPs	Minor significance for all species (red-throated diver and common scoter)	None proposed beyond existing commitments	No significant adverse residual effects
Impact 2: Disturbance and displacement: Array area	Minor to moderate significance of effect for gannet Moderate significance of effect for guillemot, razorbill and puffin.	None proposed beyond existing commitments	No significant adverse residual effects
Impact 3: Indirect impacts on IOFs due to effects on prey species habitat loss: Array area and Offshore ECC	Negligible significance of effect for all species	None proposed beyond existing commitments	No significant adverse residual effects
Operation and maintenance			
Impact 4: Disturbance and displacement: Array area, Offshore ECC and ORCPs	Minor to moderate significance of effect for gannet and red-throated diver Moderate significance of effect for guillemot, razorbill and puffin.	None proposed beyond existing commitments	No significant adverse residual effects
Impact 5: Collision risk: Array area	Negligible significance of effect for Sandwich tern. Minor significance of effect for all other species.	None proposed beyond existing commitments (e.g. Table 12.11: - Minimum tip height raised to 40m MSL from 22m MHWS.)	No significant adverse residual effects

Description of Impact	Effect	Additional mitigation measures	Residual impact
Impact 6: Collision risk to migratory birds: Array area	Negligible significance of effect for all species	None proposed beyond existing commitments. (e.g. Table 12.11: -Minimum tip height raised to 40m above MSL)	No significant adverse residual effects
Impact 7: Indirect impacts on IOFs due to impacts on prey species habitat loss: Array area.	Negligible significance of effect for all species.	None proposed beyond existing commitments	No significant adverse residual effects
Decommissioning			
As with construction			

Table 12.88: Summary of potential cumulative impacts of the Project assessed for offshore and intertidal ornithology.

Description of effect	Effect	Additional mitigation measures	Residual impact
Construction			
Impact 1: Disturbance and displacement: Offshore ECC	Minor significance of effect for red-throated diver.	None proposed beyond existing commitments	Not significant
Impact 2: Disturbance and displacement: Array area	Minor significance of effect for red-throated diver.	None proposed beyond existing commitments	Not significant
Operation and maintenance			
Impact 5: Disturbance and displacement: Array area	Minor significance of effect for gannet, guillemot, razorbill, puffin and red-throated diver.	None proposed beyond existing commitments	Not significant (Red-throated diver to be confirmed post-PEIR)

Description of effect	Effect	Additional mitigation measures	Residual impact
Impact 6: Collision risk: Array area	Negligible significance of effect for Sandwich tern Minor significance of effect for all other species.	Minimum tip height raised to 40m MSL from 22m	Not significant
Decommissioning			
As with construction			

12.15 References

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13 Annex 1

English names used in the text with relevant scientific names.

English name used in text	Scientific name
Dark-bellied brent goose	*Branta bernicula bernicula*
Pink-footed goose	*Anser brachyrhynchus*
Taiga bean goose	*Anser fabalis*
Shelduck	*Tadorna tadorna*
Mute swan	*Cygnus olor*
Bewick's swan	*Cygnus colombianus*
Shoveler	*Anas clypeata*
Wigeon	*Anas penelope*
Mallard	*Anas platyrhynchos*
Gadwall	*Anas strepera*
Teal	*Anas crecca*
Pintail	*Anas acuta*
Pochard	*Aythya ferina*
Tufted duck	*Aythya fuligula*
Scaup	*Aythya marila*
Common scoter	*Melanitta nigra*
Goldeneye	*Bucephala clanga*
Great crested grebe	*Podiceps cristatus*
Oystercatcher	*Haematopus ostralegus*
Avocet	*Recurvirostra avosetta*
Lapwing	*Vanellus vanellus*
Golden plover	*Pluvialis apricaria*
Grey plover	*pluvialis squatarola*
Ringed plover	*Charadrius hiaticula*
Curlew	*Numenius arquata*
Bar-tailed godwit	*Limosa lapponica*
Black-tailed godwit	*Limosa limosa*
Turnstone	*Arenaria interpres*
Knot	*Calidris canutus*
Ruff	*Calidris pugnax*
Sanderling	*Calidris alba*
Dunlin	*Calidris alpina*
Redshank	*Tringa totanus*
Kittiwake	*Rissa tridactyla*
Black-headed gull	*Criococephalus ridibundus*
Little gull	*Hydrocoleous minutus*
Mediterranean gull	*Larus melanocephalus*

English name used in text	Scientific name
Common gull	*Larus canus*
Great black-backed gull	*Larus marinus*
Herring gull	*Larus argentatus*
Lesser black-backed gull	*Larus fuscus*
Sandwich tern	*Thalasseus sandvicensis*
Little tern	*Sternula albifrons*
Roseate tern	*Sternadougallii*
Common tern	*Sterna hirundo*
Arctic tern	*Sterna paradisaea*
Great skua	*Stercorarius skua*
Arctic skua	*Stercorarius parasiticus*
Guillemot	*Uria aalge*
Razorbill	*Alca torda*
Puffin	*Fratercula arctica*
Little auk	*Alle alle*
Red-throated diver	*Gavia stellata*
Great northern diver	*Gavia immer*
Fulmar	*Fulmarus glacialis*
Manx shearwater	*Puffinus puffinus*
Gannet	*Morus bassanus*
Cormorant	*Phalacrocorax carbo*
Shag	*Phalacrocorax aristotellis*
Bittern	*Botaurus stellaris*
Marsh harrier	*Circus aeruginosus*
Hen harrier	*Circus cyaneus*