Outer Dowsing Offshore Wind

Preliminary Environmental Information Report

Volume 1, Chapter 12: Intertidal and Offshore Ornithology

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Abbreviations

Acronym	Expanded name
AoS	Area of Search
BDMPS	Biologically Defined Minimum Population Scales
BTO	British Trust for Ornithology
CCUS	Carbon Capture Utilisation and Storage
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 Route
EEA	European Economic Area
EEC	European Economic Community
EIA	Environmental Impact Assessment
EPP	Evidence Plan Process
ES	Environmental Statement
ETG	Expert Topic Group
EU	European Union
FFC	Flamborough & Filey Coast
HAT	Highest Astronomical Tide
HRA	Habitats Regulation Assessment
IOF	Important Ornithological Feature
JNCC	Joint Nature Conservation Committee
MDS	Maximum Design Scenario
MHWS	Marine High-Water Springs
MLWS	Marine Low-Water Springs
MSS	Marine Scotland Science
NEWS	Non-Estuarine Waterbird Surveys
O&M	Operation and maintenance
OWEZ	Offshore Windpark Egmond aan Zee
OWF	Offshore Wind farm
PCH	Proportion at Collision Height
PEIR	Preliminary Environmental Information Report
pSPA	Potential Special Protection Area
PVA	Population Viability Analysis
RSPB	Royal Society for the Protection of Birds
sCRM	Stochastic Collision Risk Modelling
SD	Standard Deviation
SMP	Seabird Monitoring Programme
SNCB	Statutory Nature Conservation Body
SoS	Secretary of State

Acronym	Expanded name
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
WEBS	Wetland Bird Survey
WTG	Wind Turbine Generator
WWT	Wildfowl & Wetlands Trust
ZOIs	Zones of Influence

Terminology

Term	Definition
Array area	The area offshore within the PEIR Boundary 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.
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).

Term	Definition
EIA Directive	European Union Directive 2011/92/EU of 13 December 2011 (as amended in 2014 by Directive 2014/52/EU)
EIA Regulations	Infrastructure Planning (Environmental Impact Assessment) Regulations 2017
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 (ODOW)	The Project.
Offshore Export Cable Corridor (ECC)	The Offshore Export Cable Corridor (Offshore ECC) is the area within the Preliminary Environmental Information Report (PEIR) Boundary within which the export cable running from the array to landfall will be situated.
Onshore Infrastructure	The combined name for all onshore infrastructure associated with the

Term	Definition
Pre-construction and post-construction	The phases of the Project before and after construction takes place.
Preliminary Environmental Information Report (PEIR)	The PEIR is written in the style of a draft Environmental Statement (ES) and provides information to support and inform the statutory consultation process in the pre-application phase. Following that consultation, the PEIR documentation will be updated to produce the Project's ES that will accompany the application for the Development Consent Order (DCO).
PEIR Boundary	The PEIR Boundary is outlined in Figure 3.1 of Volume 1, Chapter 3: Project Description and comprises the extent of the land and/or seabed for which the PEIR assessments are based upon.
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. Not all prescribed bodies and interests will be statutory consultees (see non-statutory consultee definition).
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 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)
Wind turbine generator (WTG)	All the components of a wind turbine, including the tower, nacelle, and rotor.

12 Intertidal and Offshore Ornithology

12.1 Introduction

12.1.1 This chapter of the Preliminary Environmental Information Report (PEIR) presents the results to date 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.

12.1.2 GTR4 Limited (trading as Outer Dowsing Offshore Wind) hereafter referred to as the 'Applicant', is proposing to develop the Project. The Project 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 (wind farm), export cables to landfall, and connection to the electricity transmission network (see Volume 1, Chapter 3: Project Description for full details).

12.1.3 This chapter should be read alongside the following chapters:

- Volume 1, Chapter 10: Fish and Shellfish Ecology (in terms of key prey resources available to birds); and
- Volume 1, Chapter 9: Benthic and intertidal ecology (in terms of relevant habitat and key prey resources available to birds); and
- Volume 1, Chapter 22: Onshore ornithology.

12.1.4 Additionally, the following annexes have been compiled to support the information provided within this chapter:

- Volume 2, Appendix 12.1: Intertidal and Offshore Ornithology Technical Baseline;
- Volume 2, Appendix 12.2: Collision Risk Modelling Assessment Appendix; and
- Volume 2, Appendix 12.3: Displacement Assessment Appendix.

12.2 Statutory and Policy Context

12.2.1 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.

12.2.2 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:

- The Overarching National Policy Statement (NPS) for Energy (NPS EN-1; Department for Energy and Climate Change (DECC), 2011a);
- Draft revised Overarching NPS for Energy (EN-1) (Department for Energy Security and Net Zero (DESNZ), 2023a);

- The National Policy Statement for Renewable Energy Infrastructure (NPS EN-3, DECC, 2011b;
- Draft National Policy Statement for Renewable Energy Infrastructure (EN-3) (DESNZ, 2023b);
- NPS for Electricity Networks Infrastructure (EN-5) (DECC, 2011c); and
- Draft NPS for Electricity Networks Infrastructure (EN-5) (DESNZ, 2023c).

12.2.3 Specific assessment requirements within these documents which are relevant to this PEIR chapter are presented in Table 12.1.

12.2.4 A number of international and national laws regarding the protection of wildlife and the marine environment also need to be considered, including:

- European Commission ('EC') Directive 2009/147/EC (codified version of 79/409/EC) on the Conservation of Wild Birds (the 'Birds Directive');
- EC Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (known as the 'Habitats Directive'); and
- Ramsar Convention on Wetlands of International Importance 1971.

12.2.5 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 12 nm.

12.2.6 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 12 nm throughout the UK.

12.2.7 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.

Table 12.1: NPS requirements for assessment

Legislation/Policy	Key Provisions	Section where comment addressed
The Overarching National Policy Statement (NPS) for Energy (NPS EN-1) (Department for Energy and Climate	EN-1 Paragraph 5.3.3 - 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	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
Change (DECC), 2011a)	habitats and other species identified as being of principal importance for the conservation of biodiversity."	
	EN-1 Paragraph 5.3.4 states that the Applicant is required to show how the proposed project has taken advantage of opportunities to conserve and enhance biodiversity conservation interests.	Sections 12.4 - 12.5.
	EN-1 Paragraph 5.3.6 states that the decision maker "should take account of the context of the challenge of climate change: failure to address this challenge will result in significant adverse impacts to biodiversity" and states "The benefits of nationally significant low carbon energy infrastructure development may include benefits for biodiversity and geological conservation interests"	The Project will make a significant contribution to the generation of renewable energy.
	EN-1 Paragraph 5.3.18 – states that EIAs should include effects on and opportunities to enhance and mitigate for biodiversity as an integral part of the proposed development.	Section 12.5.
Draft revised Overarching NPS for Energy (EN-1) (DESNZ, 2023a)	Draft NPS EN-1 Paragraph 5.4.48 intimates 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 RIAA, though consideration to relevant designated sites is given in Section 12.4.
	Draft NPS EN-1 Paragraph 5.4.17 mirrors 2011 EN-1 section 5.3.3 referred to above.	Sections 12.4 - 12.5.
	Draft NPS EN-1 Paragraph 5.4.19 mirrors 2011 EN-1 section 5.3.4 referred to above.	Section 12.5.
	Draft NPS EN-1 Paragraph 5.4.35 mirrors 2011 EN-1 section 5.3.18 referred to above.	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
	Draft NPS EN1 Paragraph 5.4.2 mirrors 2011 EN-1 paragraph 5.3.6 referred to above.	The Project will make a significant contribution to the generation of renewable energy.
The National Policy Statement for Renewable Energy Infrastructure (NPS EN-3, DECC, 2011b)	EN-3 Paragraph 2.6.64 - states that the "assessment of offshore ecology and biodiversity should be undertaken by the applicant for all stages of the lifespan of the proposed offshore wind farm and in accordance with the appropriate policy for offshore wind farm EIAs."	Sections 12.7 - 12.8.
	EN-3 Paragraph 2.6.65 – states that "Consultation on the assessment methodologies should be undertaken at early stages with the statutory consultees as appropriate."	The assessment approach as been agreed through discussions with Natural England and other interested parties through the Evidence Plan Process (Section 12.1.1).
	EN-3 Paragraph 2.6.66 - states that the "Any relevant data that has been collected as part of post-construction ecological monitoring from existing, operational offshore wind farms should be referred to where appropriate."	Evidence from operational OWFs is referred to throughout the PEIR.
	EN-3 Paragraph 2.6.67 states that the "assessment should include the potential of the scheme to have both positive and negative effects on marine ecology and biodiversity".	The potential impacts are discussed throughout the PEIR, predominantly in Sections 12.7 - 12.8.
	EN-3 Paragraphs 2.6.70 & 2.6.71 on mitigation. "Mitigation may be possible in the form of careful design of the development itself and the construction techniques employed. Ecological monitoring is likely to be appropriate during the construction and operational phases to identify the actual impact so that, where appropriate, adverse effects can then be mitigated and to enable further useful information to be published relevant to future projects."	Embedded mitigation in relation to Intertidal and Offshore Ornithology is set out in Section 12.5.
	EN-3 Paragraphs 2.6.78 – 2.6.80 – Intertidal impacts.	Intertidal specific policies have been considered;

Legislation/Policy	Key Provisions	Section where comment addressed
		however any potential impacts will be assessed post-PEIR.
	EN-3 Paragraph 2.6.101 – 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 foraging/roosting area; and ▪ impacts on bird flight lines (i.e. barrier effect) and associated increased energy use by birds for commuting flights between roosting and foraging areas."	The potential impacts are discussed throughout the PEIR, predominantly in Sections 12.7 - 12.8.
	EN-3 Paragraph 2.6.102 - states that "the scope, effort and methods required for ornithological surveys should have been discussed with the relevant statutory advisor."	Natural England were consulted prior to and during the process.
	EN-3 Paragraph 2.6.103 – states that "relevant data from operational offshore wind farms should be referred to in the applicant's assessment."	Evidence from relevant OWFs is referred to throughout the PEIR. Predominantly in section 12.8.
	EN-3 Paragraph 2.6.104 - states that "it may be appropriate for the assessment to include collision risk modelling for certain species of bird."	Section 12.8.
Draft National Policy Statement for Renewable Energy Infrastructure (EN-3) (DESNZ, 2023b)	Draft NPS EN-3 Paragraph 3.8.149 mirrors 2011 EN-1 section 2.6.101 referred to above.	The potential impacts are discussed throughout the PEIR, predominantly in Sections 12.7 - 12.8.
	EN-3 Paragraph 3.8.157 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 SNCBs."	Collision and displacement assessments are undertaken for relevant species in sections 12.7 - 12.8. PVA is not undertaken within this PEIR, though consideration

Legislation/Policy	Key Provisions	Section where comment addressed
		is given to the potential for PVA analysis post-PEIR in sections 12.7 - 12.8.
	EN-3 Paragraph 3.8.257 “Applicants should undertake a review of up-to-date research and all potential mitigation options presented. 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 12.5.
	EN-3 Paragraph 3.8.258 “Turbine parameters should 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 12.5, the minimum air gap has been raised from 22m to 30m HAT to reduce the impacts of collision on birds.

12.2.8 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. To this end, Annex I of the Directive identifies 11 high level qualitative descriptors for determining GES. Descriptors considered relevant the assessment of offshore and intertidal ornithology for the Project are presented in Table 12.2.

12.2.9 Alongside these documents, several other guidance documents are considered relevant, including:

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

Table 12.2: Summary of the Marine Strategy Framework Directive's (MSFD) 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 has been described and considered within the assessment for the Project alone and cumulatively (Sections 12.7 - 12.8).
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 an cumulatively (Sections 12.7 - 12.8), and in the description of inter-relationships (Section 12.11).
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 12.7 - 12.8).
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 12.7 - 12.8).

12.3 Consultation

12.3.1 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) Expert Technical Group (ETG) meetings (Section 12.1.1) and the EIA Scoping Report (Outer Dowsing Offshore Wind, 2022). An overview of the Project consultation process is presented within Volume 1, Chapter 6: Consultation Process.

12.3.2 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 PEIR.

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 (The Inspectorate, 9 September 2022)	The Inspectorate does not support the scoping out of these matters. 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 within the displacement assessment Sections 12.7, 12.8, and 12.8.
Scoping Opinion (The Inspectorate, 9 September 2022)	The Inspectorate does not support the scoping out of disturbance and displacement within the ECC during O&M. The 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 Inspectorate suggests the ES should assess impacts on Important Ornithological Features (IOFs) from disturbance and displacement during O&M, where significant effects are likely to occur; any assumptions made in the assessment should be clearly set out.	Impacts on IOFs from disturbance and displacement have been scoped into the assessment. This is assessed in Sections 12.7, 12.8, and 12.8.
Scoping Opinion (The Inspectorate, 9 September 2022)	With regards to effects on prey species, the inspectorate notes that the scoping Report assessment relies on the data and impact assessments including 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	Barrier effects and effects on prey have been scoped into the assessment. This is assessed in Sections 12.7, 12.8, and 12.8..

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
	inspectorate does not agree to scope these effects out of assessment. The 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.	
Scoping Opinion (The Inspectorate, 9 September 2022)	The 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 2, Appendix 12.1: Ornithology Technical Baseline.
Scoping Opinion (The Inspectorate, 9 September 2022)	The Inspectorate advises that effort is made to agree via the EPP the extent of study 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 the baseline has been established and the outcomes of consultation undertaken in relation to these matters.	Through the EPP, consultation on the survey methodology and study area has been undertaken. Details can be found in Section 12.4 and Volume 2, Appendix 12.1: Ornithology Technical Baseline.
Scoping Opinion (The Inspectorate, 9 September 2022)	The 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.	Through the EPP consultation on the intertidal survey methodology has been undertaken. Details can be found in Appendix 22.3: Winter Bird Survey Report.
Scoping Opinion – Impact assessment Methodology (The inspectorate, 9 September 2022)	The Inspectorate notes that the ES should also assess any likely significant effects to the North Norfolk Coast 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.

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
Scoping Opinion – Mitigation measures (The Inspectorate, 9 September 2022)	The 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. This is addressed in Sections 12.4 and 12.5
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 will be included as key IOF. Common tern and little gull will be 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 12.8.
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 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 12.7, 12.8, and 12.8.

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 has been addressed in Section 12.7.
Scoping Opinion (Natural England, 9 September 2022)	Natural England do not have sufficient confidence in the estimation of heights of individual seabirds using 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 (%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 will be considered within the assessments and consultation undertaken to discuss suitable methodology, addressed in Section 12.8 and Volume 2, 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 CRM methods and parameters. 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.	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 and Compensation ETG (Natural England, 27th March 2023). Natural England have also been consulted regarding displacement, CRM, and assessment

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
		methodology, including key matters such as the projects approach to seasonality.
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 12.7, 12.8, and 12.9.
Scoping Opinion (Natural England, 9 September 2022)	Natural England raises concern about the additional displacement from turbines 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 home port that avoids high concentrations of red throated diver. Natural England highlighted concerns in relation to disturbance and/or displacement of red-throated divers features from the more persistent presence of offshore wind farm 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. ANE 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 advice has been noted and taken into consideration in Sections 12.5, 12.7 and 12.8.

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
	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.	
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 12.5 and 12.7.
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.	Consultation will continue to ensure that this method remains appropriate.
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 RTD species. However Natural England note that initial survey outputs may identify the need for further data collection or analysis, therefore	Continued consultation about the methodology and results will be undertaken with Natural England.

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)	RSPB confirmed the migratory CRM within the Band model has not been used for a while and that Marine Scotland Science commissioned BTO to update the sCRM for migratory species and this would be considered the most appropriate method.	The Project envisage using the new mCRM tool from NatureScot for migratory collision risk assessment post-PEIR. Discussions with RSPB will continue to make sure this remains an appropriate method.
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. RSPB confirmed agreement with the Project's proposed approach.	Once the 2-year report has been completed this will be reassessed and consulted with RSPB. The Project has included assessments on great black-backed gull, herring gull and sandwich tern at PEIR, these can be found in Sections 12.8 and 12.8.
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.	The Project has included assessments on GBBG, HG and ST at PEIR. Fulmar has been screened

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
	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.	out for collision risk. Information regarding this can be found in section Sections 12.5, 12.8 and 12.8..
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. Details This has been included within the Part 7, Appendix 7.4: Apportioning methodology.
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 species are likely to be subject to PVA, so stakeholders can consider this.	This has been included for relevant species conclusions within the assessments in Sections 12.8 and 12.8.
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 12.8.
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	This advice has been noted and will be taken into consideration for the assessment. Information can be found in Section 12.8 and Volume 2, Appendix 12.2: Collision Risk Modelling Assessment Appendix.

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
	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.	
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 gannets, using interim avoidance rate guidance for collision risk and published Natural England advice for the displacement analysis. The Project intends to adjust the avoidance rates to include macro avoidance post CRM. Natural England agree that the approach is suitable.	This has been included within the assessments in Section 12.8 and Volume 2, Appendix 12.2: Collision Risk Modelling Assessment Appendix.
Offshore Ornithology and Derogation and Compensation ETG (Natural England, 28 November 2022)	The project proposes that non like for like compensation may be appropriate for predator control. Natural England noted that they may be open to some contribution of non-like-for-like to the necessary quantum of compensation, but it would be dependent on the species and overall measure and proportions.	Consultation will continue on potential non like for like measures.
Offshore Ornithology and Derogation and Compensation ETG (Natural England, 28 November 2022)	Regarding apportioning, Natural England is of the opinion that even for FFC, some kittiwake could be attributed to non-SPA colonies. Natural England confirmed to have impact from compensated project be considered as zero.	This is noted and will be taken into consideration for the assessments in Sections 12.8 and 12.8.
Offshore Ornithology and Derogation and Compensation ETG (Natural England, 28 November 2022)	The project proposes that Sandwich tern are screened in for collision but not for displacement. Natural England agree with the project that Sandwich tern are screened in for collision but not for displacement	This methodology has been agreed and is assessed in Sections 12.8 and 12.8
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 LSE or if screened in and concluded as no AEoI.	Clear justification has been provided in Section 12.8. A similar justification will be provided for Manx shearwater in Section 12.8.

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
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 at PEIR.
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 12.8 and Volume 2, Appendix 12.2: Collision Risk Modelling Assessment Appendix.
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.	The full range of WTG options and minimum tips heights (30 and 40m) are presented in an Annex to Volume 2, Appendix 12.2: Collision Risk Modelling Assessment Appendix. The MDS scenario is the focus of the assessment within this Intertidal and Offshore Ornithology Chapter and within the Draft RIAA.
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 2, Appendix 12.3: Displacement Assessment Appendix).
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 18-months of available DAS data was used within the assessments at PEIR: Volume 2,

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
		Appendix 12.1: Intertidal and Offshore Ornithology Technical Baseline; Volume 2, Appendix 12.2: Collision Risk Modelling Appendix; Volume 2, Appendix 12.3: Displacement Assessment Appendix.

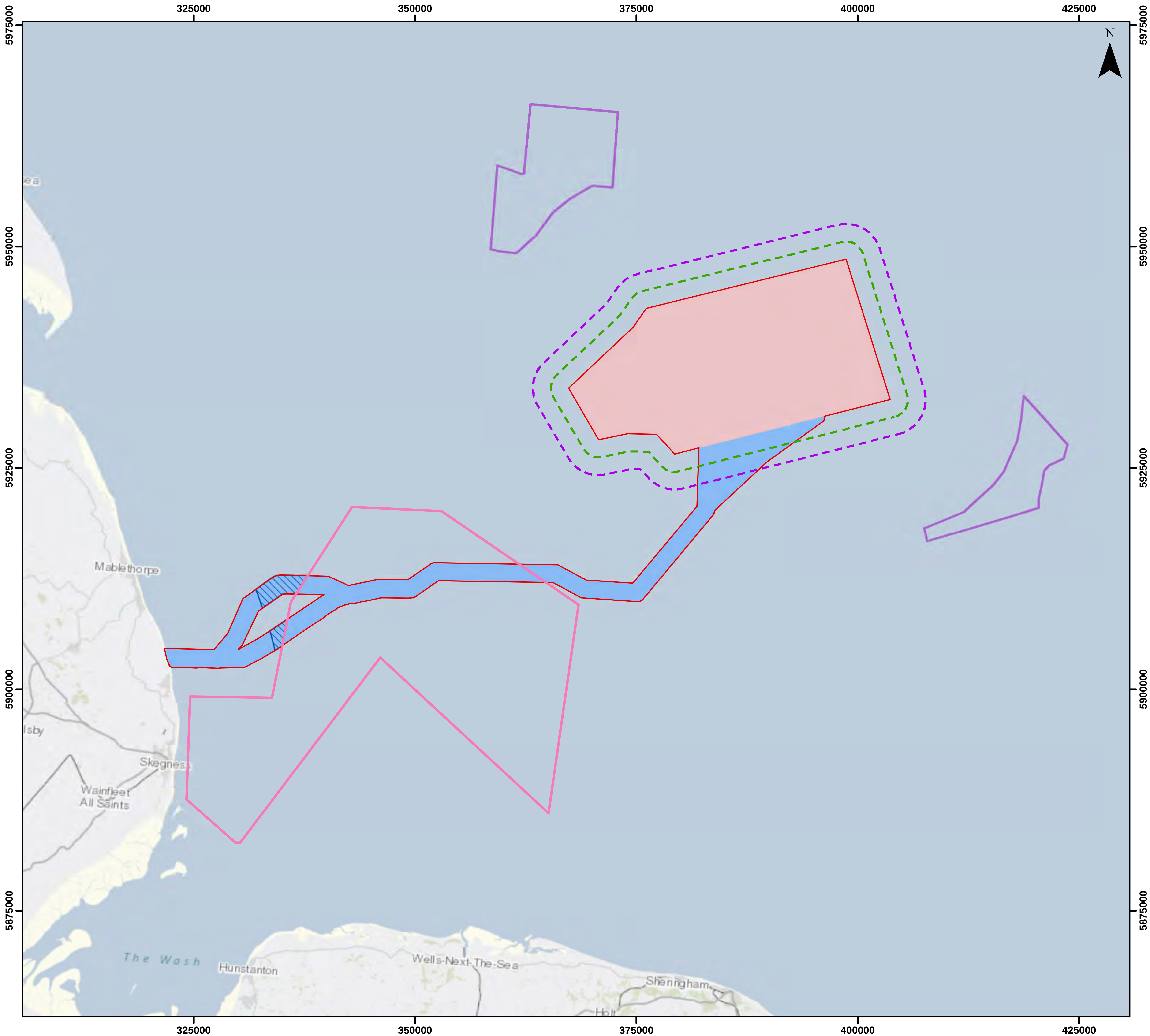
12.3.3 As identified in Volume 1, Chapter 4: Site Selection and Consideration of Alternatives and Volume 1, Chapter 3: Project Description, the Project design envelope has been refined and will be refined further prior to DCO submission. This process will take account of stakeholder consultation feedback.

12.4 Baseline Environment

Study Area

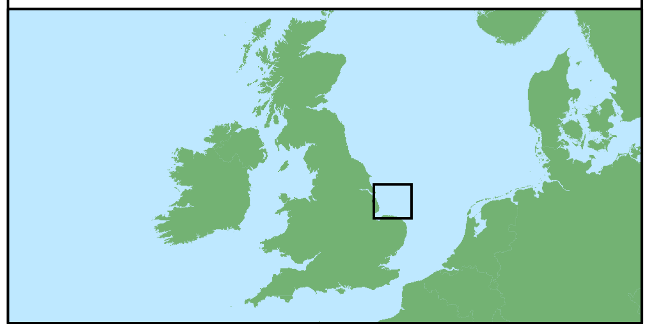
12.4.1 The Project is located in the southern North Sea, with WTGs positioned at their closest point approximately 54km east of the Lincolnshire coast and 57km north of the Norfolk coast (Figure 12.1). The currently proposed array area covers 500km^2. The Applicant intends to reduce the size of the array area from 500km^2 to an area of 300km^2 prior to consent. 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 array area with a 4km buffer, the offshore ECC and the cable landfall area (Figure 12.1). The study area will be reviewed and amended in response to the refinement of the array area, the identification of any additional impact pathways and in response, where appropriate, to feedback from the statutory preapplication consultation informed by this PEIR and further ongoing stakeholder consultation thereafter.

12.4.2 The intertidal area and related assessments consider IOFs using the habitat between mean high-water springs (MHWS) and mean low-water springs (MLWS), while recognising that some IOFs may nest or roost on the shore above the MHWS.



Legend

- Offshore PEIR Boundary
- Array Area
- Offshore Export Cable Corridor
- ORCP Search Area
- Artificial Nesting Structure Search Area
- Biogenic Reef Restoration Search Area
- 2km Buffer from Array Area
- 4km Buffer from Array Area



Coordinate System: WGS 1984 UTM Zone 31N

0 10 20 km

Scale: 1:400,000

Preliminary Environmental Information Report

Ornithological Study Area for the Project

Figure 12.1

OUTER DOWSING OFFSHORE WIND

Date: 09/05/2023
Produced By: BPHB
Revision: 0.1

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Data Sources

12.4.3 The key sources of data, presented in Table 12.4 have been used as the basis for the PEIR baseline characterisation.

12.4.4 It is important to note that at this stage, the information sources, guidelines, assessment methods and reports applied throughout this chapter may be supplemented and/or updated where appropriate for assessments at the ES stage. Furthermore, the ornithological evidence base is constantly expanding with new information becoming available regularly. The Project will stay abreast of new evidence and will consider its usage where appropriate, as necessary.

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	Commenced 2021	Digital aerial surveys conducted by HiDef Digital Aerial Surveying Ltd. on a monthly basis between March 2021 and February 2023, with two surveys per month between March and August 2022. For the purpose of this PEIR, 18 months of survey data (March 2021 – August 2022) have been assessed, with details presented in the Technical Baseline report (Volume 1, Appendix 12.1: Ornithology Technical Baseline).	Array area plus 4km buffer. A total of 22 transects with 1.5km spacing totalling 16.7% coverage using two cameras.
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 includes the intertidal area and immediate onshore area of the landfall.
Kittiwake census on offshore structures	July 2022	Ornithological census of 19 offshore oil and gas platforms in the southern North Sea 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 array area. For further information see Part 7, Document 7.4: Offshore Artificial Nesting Structures Ecological Evidence & Roadmap.	Covered all oil and gas platforms within 20km of The Project Array Area.
Publicly available datasets			
Existing offshore wind farm 'grey literature'	Various dates	Information obtained from various offshore wind farm 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.

Source	Date	Summary	Coverage of study 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).	Coverage of 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			
Potential impacts of offshore	Various dates	Peer reviewed scientific literature regarding the potential impacts from OWF e.g. (Garthe and Hüppop, 2004; Drewitt and Langston, 2006; Stienen *et*	Generic information applicable to Project IOFs.

Source	Date	Summary	Coverage of study area
wind farms on birds		*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);	
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. Mitchell *et al.*, 2004; 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.

Existing Environment

12.4.5 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 PEIR.

12.4.6 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 wind farm 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.

12.4.7 During the breeding season, the southern North Sea region provides foraging, loafing and preening 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 reside in more inshore waters, while auks are found further offshore. The southern North Sea is also subject to pronounced passages of birds during spring and autumn with species such as gannets, skuas, gulls, terns and auks travelling to and from mainland Europe and further afield (Stienen *et al.*, 2007). It is also subject to migratory movements of non-seabirds moving from the UK to mainland Europe or further afield such as waders, wildfowl, passerines and non-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 breeding coastal colonies; and (iii) on post-breeding dispersal, migration and pre-breeding return.

12.4.8 HiDef Digital Aerial Surveying Ltd. have undertaken two years of digital aerial surveys (DAS) for the Project, with surveys commencing in March 2021 and completing in February 2023. These provide the most detailed and up-to-date site-specific data on offshore ornithology. At the time of preparing this PEIR, species counts from the first 18 months of aerial footage (March 2021 – August 2022) are available for the Project. The surveys comprised a single survey per month from March 2021 – February 2022, with two surveys per month undertaken between March 2022 – August 2022. These seabird population data have been summarised for the array area, 2km buffer and the 4km buffer in the Technical Baseline report (Volume 2, Appendix 12.1: Ornithology Technical Baseline) to provide an initial insight into key species likely to be present at the Project area based on the initial 18 months of survey effort.

12.4.9 A list of key species recorded within DAS data, and therefore most likely to be considered IOFs, are 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 2, Appendix 12.1: Ornithology Technical Baseline.

Table 12.5: Species conservation value table for current key IOFs

Species	Nature Conservation Value
Red-throated diver	Birds of Conservation Concern (BoCC) (Eaton *et al.*, 2015) Green listed, Birds Directive Migratory Species, Birds Directive Annex I, International Union for Conservation of Nature (IUCN) Red List 'Least Concern'
Common scoter	BoCC Red listed, Birds Directive Migratory Species, IUCN Red List 'Least Concern' status
Gannet	BoCC Amber listed, Birds Directive Migratory Species, IUCN Red List 'Least Concern' status
Kittiwake	BoCC Red listed, Birds Directive Migratory Species, IUCN Red List 'Vulnerable' status
Herring gull	BoCC Red listed, Birds Directive Migratory Species, IUCN Red List 'Least Concern' status
Lesser black-backed gull	BoCC Amber listed, Birds Directive Migratory Species, IUCN Red List 'Least Concern' status
Great black-backed gull	BoCC Amber listed, Birds Directive Migratory Species, IUCN Red List 'Least Concern' status
Little gull	BoCC Green listed, Birds Directive Migratory Species, IUCN Red List 'Least Concern' status
Sandwich tern	BoCC Amber listed, Birds Directive Annex I, Migratory Species, IUCN Red List 'Least Concern' status
Common tern	BoCC Amber listed, Birds Directive Migratory Species, IUCN Red List 'Least Concern' status
Guillemot	BoCC Amber listed, Birds Directive Migratory Species, IUCN Red List 'Least Concern' status
Razorbill	BoCC Amber listed, Birds Directive Migratory Species, IUCN Red List 'Least Concern' status
Puffin	BoCC Red listed, Birds Directive Migratory Species, IUCN Red List 'Vulnerable' status

12.4.10 Several bird species are also likely to be reliant on the intertidal habitats of the east coast that lie 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.

12.4.11 For this PEIR, a review of the BTO NEWS survey data covering the area of interest in the vicinity of the offshore export cable landfall, are summarised in Table 12.6. Although the survey area covers a larger region than the surrounding coastline, it provides an indication of bird species present within the intertidal area over a prolonged period to identify what the potential key species are for assessment purposes.

Table 12.6: Population estimates from BTO NEWS survey data collected during the winter (December, January and February) of 2015/16 for intertidal species along the full Lincolnshire coast using methodologies set out in Austin *et al.* (2017). Nationally important populations make up greater than 1% of the UK population

Species	Count	Population Estimate	Nationally important (>1%)
Bar-tailed Godwit	5	5 (0-15)	No
Black-headed Gull	577	539 (266-810)	No
Common Gull	450	414 (161-668)	No
Common Scoter	80	80 (0-160)	No
Cormorant	55	54 (2-126)	No
Curlew	96	96 (0-288)	No
Dunlin	1	1 (0-3)	No
Great Black-backed Gull	80	76 (44-107)	No
Great Crested Grebe	1	1 (0-3)	No
Great Northern Diver	1	1 (0-3)	No
Herring Gull	752	686 (356-1,249)	No
Lesser Black-backed Gull	7	6 (1-11)	No
Mallard	38	37 (0-79)	No
Mediterranean Gull	1	1 (0-3)	No
Mute Swan	41	41 (0-123)	No
Oystercatcher	69	68 (4-169)	No
Redshank	19	19 (0-57)	No
Red-throated Diver	6	5 (2-11)	No
Ringed Plover	23	18 (2-48)	No
Sanderling	132	124 (51-238)	No
Turnstone	6	6 (0-18)	No

Designated Sites

12.4.12 The impact assessment will consider potential connectivity of the Project with statutory designated sites for nature conservation, which have birds listed as qualifying features. Four classes of statutory designated sites will be considered: SPAs, pSPAs, Ramsar sites and SSSIs. 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).

12.4.13 The ECC directly overlaps with the Greater Wash SPA which has offshore ornithological designations for breeding terns and overwintering 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 seabird relevant designated sites and offshore wind farms 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.

12.4.14 Full consideration of connectivity of European and Internationally designated sites (SPAs and Ramsar sites) will be provided in a separate Habitats Regulation Assessment (HRA) Report to Inform Appropriate Assessment (Part 7, Document 7.1), which will cover in more detail matters associated with the National Site Network and will also be discussed with relevant stakeholders throughout the pre-application phase, as the HRA is developed in parallel with the EIA process.

12.4.15 For the EIA specifically, a review of SSSIs (often overlapping in extent with SPAs and Ramsar sites) will be undertaken to consider potential connectivity with the Project.

12.4.16 The key sites identified in relation to ornithological interest are as follows.

- **The Flamborough and Filey Coast (FFC) SPA** is approximately 8,040 ha in area, encompassing terrestrial, coastal and marine habitats supporting breeding seabirds both when they are nesting and when using the nearshore sea surface (extending out to approximately 2km) for activities such as displaying, washing and preening. The interest features of this site are breeding gannet, razorbill, guillemot and kittiwake and a breeding seabird assemblage of those four species and fulmar as main components with cormorant, shag, herring gull and puffin also part of the breeding seabird assemblage (Natural England, 2014). The FFC SPA is approximately 95km to the north-west of the array area. All of the interest feature species have been recorded within the array area during the breeding season, except great cormorant, *Phalacrocorax carbo.*
- **The Greater Wash SPA** is approximately 353,580 ha in area, encompassing coastal and marine habitats and extending along the east coast of England between Bridlington Bay in the north and Great Yarmouth in the south. The boundary on the landward side is at mean high water and the seaward boundary is approximately 14 nautical miles from the shore at its furthest extent. The interest features of this site are non-breeding red-throated diver, non-breeding common scoter, non-breeding little gull, breeding Sandwich tern, breeding common tern and breeding little tern. The array area is outside of the SPA and beyond the mean-maximum foraging range during the breeding season for little tern but within the mean-maximum foraging range for common tern and sandwich tern that are interest features. Red-throated diver, little gull, Sandwich tern and common tern have been recorded within the array area and the Offshore ECC directly overlaps with the Greater Wash SPA.

- **The Wash SPA** covers 62,200 ha and forms part of the larger Wash and North Norfolk Coast Special Area, encompassing extensive wetland and coastal habitats. It is designated for 21 species of waterbird which pass through in high numbers each year and breeding common tern and little tern. The boundary of the SPA is approximately 58km to the west of the array area and 16.4km south of the Offshore ECC.
- **Humber Estuary SPA** covers 37,630ha in area, encompassing extensive wetland and coastal habitats. It is designated for 23 species of waterbird which pass through in high numbers (c. 154,000) each year. The boundary of the SPA is approximate 58km to the west of the array area and, at its southern extent, overlaps the Offshore ECC.
- **North Norfolk Coast SPA** covers 40km of low-lying barrier coast between Holme and Weybourne on the east coast of England. The SPA is comprised of a range of habitats including saline lagoons, shingle and sand dunes, saltmarshes, intertidal sands and muds, and areas of freshwater grazing reedbeds and marsh. The boundary of the SPA is approximately 56.3km to the south-east of the array area.
- **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. The SSSI is approximately 95km to the north-west of the array area and 73.1km north of the Offshore ECC.
- **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 gulls 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.

Future Baseline

12.4.17 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 will also be 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.

12.4.18 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 effects on seabirds will similarly increase in both frequency and magnitude.

12.4.19 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 gulls, lesser black-backed gulls, herring gulls, fulmars, kittiwakes and gannets, 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). This impact will impact species differently. 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 are considered unlikely to recover fully even if fishing effort was reduced, 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. However, it should be noted that consultation is currently underway relating to potential sandeel fisheries management measures in the North Sea (Defra, 2023).

12.4.20 It is acknowledged that the short, medium and long-term impacts of the 2022 HPAI outbreak 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 2, Appendix 12.1: 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).

12.4.21 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.

12.4.22 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 wind farms.

Biological Seasons, Populations and Demographics for Offshore Ornithology Receptors

12.4.23 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 PEIR, separate bio-seasons are defined and recognised to establish the importance of the study area for different seabird species across different time periods. The BDMPS bio-seasons are based on Furness (2015), and hereafter referred to as 'bio-seasons'.

12.4.24 Within this PEIR, 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 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 to breeding grounds;
- Migration-free breeding: when birds are 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 over-wintering in an area; and
- 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.
- Breeding: extended bio-season from modal arrival of breeding birds to the colony to modal departure from the colony.

12.4.25 The bio-seasons and non-breeding season reference populations (UK North Sea and English Channel) applied to species assessed within this PEIR 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 off Cramp and Simmons (1983) and expert judgement based on data presented in Volume 2, Appendix 12.1: Ornithology Technical Baseline.

12.4.26 The migration-free bio-season was deemed most appropriate for gannet, kittiwake and Sandwich tern because the data suggested that it was more biologically relevant.

12.4.27 Kittiwake abundance within the array area was high in March and April as individuals were migrating back to colonies along the east-coast of the UK. These birds are unlikely to be breeding birds from FFC SPA, but returning to colonies further north in Scotland where there are considerable populations. This is evidenced by the reduced abundance of kittiwake within the array area during the migration-free breeding season when a larger proportion of birds will have been nesting birds at FFC SPA.

12.4.28 Similarly with gannet, there are several very large colonies to the north of the array area, including Bass Rock, and therefore in excess of 100,000 gannets will be migrating northwards through the southern North Sea to return to colonies throughout the return migration period. Consequently, it is considered likely that a high proportion of gannets within the array area during March and April are from colonies north of FFC SPA. Despite this, the Project has taken the precautionary approach of apportioning 100% of gannets to FFC SPA during the breeding season. Therefore, it was considered appropriate and precautionary to use the migration-free breeding season for this species.

Table 12.7: Bio-seasons and associated UK North Sea (and English Channel) BDMPS population estimates 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
Guillemot	-	-	-	-	Mar-Jul	Aug-Feb (1,617,306)
Razorbill	Apr-Jul	Aug-Oct (591,874)	Jan-Mar (591,874)	Nov-Dec (218,622)	-	-
Puffin	-	-	-	-	Apr-Jul	Aug-Mar (231,957)
RTD	May-Aug	Sep-Nov (13,277)	Feb-Apr (13,277)	Dec-Jan (10,177)	-	-
Gannet	Apr-Aug	Sep-Nov (456,298)	Dec-Mar (248,385)	-	-	-
Kittiwake	May-Jul	Aug-Dec (829,937)	Jan-Apr (627,816)	-	-	-
Little gull[1]	-	July to October (30,500)	-	-	May-Jun	Jul-April (30,500)
Herring gull	-	-	-	-	Mar-Aug	Sep-Feb (466,511)
GBBG	-	-	-	-	Apr-Aug	Sep-Mar (91,399)

[1] Bio-season based off Cramp & Simmons (1983) and expert judgement, and Population estimate based on research by APEM (2020) presented in Orsted (2021a) as this was not provided in Furness (2015). As per Volume 2 Annex 12.1: Ornithology Technical Baseline, the non-breeding season was extended into July to incorporate birds recorded in this month which are highly likely to be undertaking post-breeding migration.

Species	Migration-free breeding	Post-breeding migration	Return migration	Migration-free winter	Breeding	Non-breeding
LBBG	May-Jul	Aug-Oct (209,007)	Mar-Apr (197,483)	Nov-Feb (39,314)	Apr-Aug	Sep-Mar
Sandwich tern	Jun	Jul-Sep (38,051)	Mar-May (38,051)	-	-	-
Common tern	Jun	Jul-Sep (144,911)	Apr-May (144,911)	-	-	-
Arctic tern	Jun	Jul-Sep (163,930)	Apr-May (163,930)	-	-	-

12.4.29 As advised in recent Natural England guidance (Parker *et al.* 2022), the regional population of each species during the breeding season was based on the number of birds recorded at colonies within foraging range of the Project. This was based on the mean-maximum plus one standard deviation (SD) foraging range for each species provided in Woodward *et al.* (2019). The number of breeding adults at relevant colonies was taken from the JNCC Seabird Monitoring Programme (SMP) database (JNCC, 2020). In addition to these 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 regionally may be considered to be the proportion of these birds within the relevant bio-season preceding the breeding bio-season. Therefore, the relevant proportion of these birds is estimable from the population age ratio data presented in Table 12.9. This value was used for each species to calculate the number of birds present within the bio-season preceding the breeding season (i.e. return migration or non-breeding). The total regional population in the breeding season was calculated as the total of the known number of breeding individuals and the estimated number of juveniles and immatures.

12.4.30 For great black-backed gull, there are no known breeding colonies within the published mean-maximum foraging (MMF) range (73km) (Woodward *et al.*, 2019) from which birds could originate. The population for the breeding season is therefore considered to consist of only the non-breeding component of the non-breeding BDMPS population.

12.4.31 Red-throated divers recorded within the array area during the breeding season are not considered to be breeding individuals because there are very few breeding pairs in the UK. It was assumed that these were migratory birds, 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) (Section 12.1.1). See paragraph 12.8.74 for more detail.

Table 12.8: Regional breeding season populations (calculated from the number of individuals at colonies within MMF +1SD of the ODOW OWF and additional juveniles and immature birds)

Species	Population of breeding adults within foraging range of the Project	Return migration BDMPS for the UK North Sea and Channel	Proportion of juvenile and immature individuals (%)	Number of juvenile and immature individuals	Total regional baseline population during the breeding season
Guillemot	121,754	1,617,306*	0.504	815,122	936,876
Razorbill	40,506	591,874	0.409	242,076	282,582
Puffin	4,316	231,957*	0.448	103,917	108,233
Gannet	186,974	248,385	0.453	112,518	299,492
Kittiwake	121,928	627,816	0.465	291,934	413,862
Herring gull	3,152	466,511*	0.533	248,650	251,802
GBBG	-	91,399*	0.603	55,114	55,114
LBBG	8,964	197,483	0.421	83,140	92,104
Sandwich tern	14,588	38,051	0.39	14,840	29,428

*non-breeding BDMPS used instead of return migration.

12.4.32 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		
Red-throated diver	Demographic rate	0.600	0.620	-	-	-	-	0.840	0.571	0.235
	Population age ratio	0.179	0.145	-	-	-	-	0.676		
Common scoter	Demographic rate	0.749	0.749	-	-	-	-	0.783	1.838	0.234
	Population age ratio	0.344	0.221	-	-	-	-	0.434		
Gannet	Demographic rate	0.424	0.829	0.891	0.895	0.895	-	0.919	0.700	0.187
	Population age ratio	0.191	0.081	0.067	0.060	0.054	-	0.547		
Kittiwake	Demographic rate	0.79	0.854	0.854	0.854	-	-	0.854	0.690	0.156
	Population age ratio	0.153	0.121	0.103	0.088	-	-	0.535		
Great black-backed gull[2]	Demographic rate	0.798	0.816	0.816	0.816	0.816	-	0.885	0.890	0.160
	Population age ratio	0.153	0.141	0.115	0.094	0.076	-	0.397		
Lesser black-backed gull	Demographic rate	0.82	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		
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		
Common tern	Demographic rate	0.441	0.441	0.850	-	-	-	0.883	0.764	0.268
	Population age ratio	0.235	0.104	0.046	-	-	-	0.615		
Guillemot	Demographic rate	0.56	0.792	0.917	0.917	0.939	0.939	0.939	0.672	0.138
	Population age ratio	0.16	0.09	0.071	0.065	0.061	0.057	0.496		
Razorbill	Demographic rate	0.63	0.63	0.63	0.895	0.895	-	0.895	0.570	0.193
	Population age ratio	0.163	0.103	0.065	0.041	0.037	-	0.591		

[2] Great black-backed gull mortality rate was calculated using herring gull juvenile survival rate (0.798) for juveniles and the calculated survival rate taken from the herring gull juvenile and adult for great black-backed gull sub-adults. Great black-backed gull productivity was taken from the latest SMP report (JNCC, 2020) providing an average UK productivity between 1991 to 2018 of 0.890.

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	0.709	0.76	0.805	-	0.906	0.617	0.175
	Population age ratio	0.158	0.112	0.079	0.056	0.043	-	0.552		
Sandwich tern	Demographic rate	0.358	0.741	0.741	0.741	-	-	0.898	0.702	0.241
	Population age ratio	0.2	0.063	0.063	0.063	-	-	0.61		
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		
Little gull	Demographic rate	-	-	-	-	-	-	0.8	-	0.2
	Population age ratio	-	-	-	-	-	-			

12.5 Basis of Assessment

Scope of the Assessment

Impacts Scoped in for Assessment

12.5.1 The following impacts have been scoped into this assessment following Natural England's best practice advice (Parker *et al.,* 2022):

- Construction:
  - Impact 1: Disturbance and displacement: Offshore ECC;
  - Impact 2: Disturbance and displacement: Array area[3]; 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[3];
  - 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 and offshore ECC.
- Decommissioning:
  - Impact 8: Disturbance and displacement: Array area;
  - Impact 9: Disturbance and displacement: Offshore ECC; and
  - Impact 10: Indirect impacts on IOFs due to impacts on prey species habitat loss.

Impacts Scoped out of Assessment

12.5.2 In line with the Scoping Opinion (The Inspectorate, 2022), 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;
- O&M phase:
  - Disturbance and displacement: Intertidal ECC;
  - Lit structures; and
- Decommissioning phase:

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

- Disturbance and displacement: Intertidal ECC;

Barrier Effects

12.5.3 During all phases of the Project, the presence of turbines (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 are highly unlikely to be making daily commutes past and around the wind farm. As such, the potential for impacts resulting from barrier effects is highly unlikely at the location of the Project.

12.5.4 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.

12.5.5 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 (Section 12.1.1). 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 (Construction and O&M Phase)

12.5.6 The Project has agreed to no open cut cable installation, so no intertidal works are planned during construction. 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 intertidal area or nearshore Offshore ECC during the operational phase, best practice measures will be adopted, thereby minimising disturbance during key times for intertidal birds.

Lit Structures

12.5.7 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. Whereas the attractant of birds may increase the likelihood of collision and have displacement-level impacts due to alterations in flight path.

12.5.8 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).

12.5.9 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).

12.5.10 On migration, there could be potential for impacts if large numbers of birds pass through the site in a single event, 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.

Maximum Design Scenario (MDS)

12.5.11 The following section 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.	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 and displacement: 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); ▪ 8 anchored 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
	▪ 93 helicopter return trips. OSS and Accommodation Platform Installation: ▪ Up to 2 installation vessels (Jack Up 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 and Offshore 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 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

Potential effect	Maximum design scenario assessed	Justification
		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 and Intertidal Ecology.
O&M		
Impact 4: Disturbance and displacement: Array area.	Array Area: ▪ WTG deployment across the full array area (500km^2). WTGs: ▪ Up to 93 WTGs; ▪ Minimum height of lowest blade tip above MSL: 30 m; ▪ Minimum rotor blade diameter: 242 m; and ▪ Maximum rotor blade diameter: 340 m. O&M: ▪ 1,339 vessel return trips to wind turbines per year; ▪ 409 vessel return trips to wind turbine 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 2,216 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. Assessment of extent/varying displacement from array area and a buffer is species specific due to their 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: Array area.	Array Area: ▪ WTG deployment across the full array area ($500km^2$) area. WTGs: ▪ Up to 93 WTGs; ▪ Minimum height of lowest blade tip above MSL: 30m; and ▪ Maximum rotor blade diameter: 340m.	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: Array area.	Array Area: ▪ WTG deployment across the full array area ($500km^2$) area. WTGs: ▪ Up to 93 WTGs; ▪ Minimum height of lowest blade tip above MSL: 30m; and ▪ Maximum rotor blade diameter: 340m.	No assessment provided at PEIR. Assessment will be presented within the ES.
Impact 7: Indirect impacts on IOFs due to impacts on prey species habitat loss: Array area 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 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)

Potential effect	Maximum design scenario assessed	Justification
		and Volume 1, Chapter 9: Benthic 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.	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.	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 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 and Intertidal Ecology.

Embedded Mitigation

12.5.12 Mitigation measures that were 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	ODOW Array site selection, chosen to avoid overlap with designated sites to protect: benthic & intertidal, fish and shellfish, marine mammals, ornithology and commercial fisheries habitat features.
Minimum tip height	The design of the Project includes an air gap of 30m relative to MSL.
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.

12.6 Assessment Methodology

12.6.1 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.

12.6.2 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).

12.6.3 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.

12.6.4 The sensitivity 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 sensitive to disturbance given its propensity to exploit food resources made available by people and to nest on buildings 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 sensitivity of receptors is defined in Table 12.12.

Table 12.12: Definitions of Sensitivity 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.

12.6.5 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 wind farm have been drawn, or for which no SPAs are designated.

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

12.6.7 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.

12.6.8 The potential significance of the effect upon ornithological receptors is determined by correlating 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 12.15 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

Sensitivity of receptor		Magnitude of impact: *Negligible*	*Minor*	*Moderate*	*Major*
	Negligible	Negligible (Not significant)	Negligible (Not significant)	Minor (Not significant)	Minor (Not significant)
	Minor	Negligible (Not significant)	Minor (Not significant)	Minor (Not significant)	Moderate (Significant)
	Moderate	Minor (Not significant)	Minor (Not significant)	Moderate (Significant)	Major (Significant)
	Major	Minor (Not significant)	Moderate (Significant)	Major (Significant)	Major (Significant)

12.6.9 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, both adverse or beneficial, which are likely to be important considerations at a regional or district level because the 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.

12.7 Impact Assessment: Construction Phase

12.7.1 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 bases of impact assessments.

Disturbance and Displacement

12.7.2 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 yet not operational, and may present a similar displacement stimulus as is described for the O&M phase.

12.7.3 This section will consider both displacement within the array area and within the offshore ECC for relevant species.

12.7.4 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.

12.7.5 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 Wind Farm (GGOWL, 2011) and close to active foundation piling activity at the Egmond aan Zee (OWEZ) wind farm, where they showed no noticeable reactions to the works (Leopold and Camphuysen, 2007).

12.7.6 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 (Section 12.1.1). 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 2, Chapter 12.1: Offshore and Intertidal Ornithology Technical Baseline.

12.7.7 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. 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)
Arctic skua	Minor	Low	Low	Out
Arctic tern	Minor	Low	Low	Out
Black-headed gull	Minor	Low to Medium	Low	Out
Common gull	Minor	Medium	Low	Out
Common scoter*	Major	Low	Low	In
Common tern	Minor	Low	Medium	Out
Fulmar	Minor	Medium	Low	Out
Gannet	Minor to Moderate	High	Medium	In
Great black-backed gull	Negligible	Medium	Medium	Out
Great northern diver	Major	Low	Low	Out
Great skua	Minor	Low	Low	Out
Guillemot	Moderate	High	High	In
Herring gull	Negligible	Medium	Medium	Out
Kittiwake	Minor	High	High	Out
Lesser black-backed gull	Negligible	Medium	Medium	Out
Little auk	Moderate	Low	Low	Out
Little gull	Moderate	Low to Medium	Low	Out
Manx shearwater	Moderate	Low	Low	Out
Oystercatcher	Unknown	Low	Low	Out
Puffin	Moderate	High	Medium to High	In
Razorbill	Moderate	High	High	In
Red-throated diver	Major	Medium	Low to Medium	In
Sandwich tern	Minor	Low to Medium	Low to Medium	Out
Shag	Negligible	Low	Low	Out

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

12.7.8 Based on the screening process outlined above, guillemot, razorbill, puffin and red-throated diver have been screened in owing to their sensitivity to disturbance and displacement and/or their high frequency and/or 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.

12.7.9 Notably, gannet has been screened in for assessment of displacement in the array area despite showing low to medium sensitivity to displacement. This is 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.

12.7.10 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 (Section 12.1.1). 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 one standard deviation (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.

12.7.11 This section will also consider species at risk of displacement within the offshore ECC, 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 for 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.

12.7.12 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 and Offshore ECC, where vessels and construction activities are present; and
- Construction activities are temporally restricted (over a maximum of 48 months).

12.7.13 The potential impacts on screened in species is assessed against the MDS outlined in Table 12.10. It should be noted that a large proportion of the ECC was not covered within baseline digital aerial surveys, and therefore data provided by Lawson *et al*. (2016) has been used to assess the densities and distributions of red-throated diver and common scoter within in the Greater Wash SPA. This dataset is almost 15 years old and therefore may not be fully representative of the densities of birds within the Offshore ECC area at this time, however it is a robust dataset collected over multiple years of survey and the best source of data available at this time.

12.7.14 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 gannets next to operating vs non-operating turbines. 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 turbines are present.

12.7.15 Therefore, 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. This approach is biologically realistic based on the limited available evidence, while still providing a sufficiently precautionary approach. For full justification of rates used, reference should be made to the assessment of the operational phase (Section 12.8). 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%.

12.7.16 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.

12.7.17 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

12.7.18 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 12.6$km^{2,}$ 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, and it is extremely unlikely that more than one cable-laying vessel would be working on the cable-route simultaneously and present within the Greater Wash SPA.

12.7.19 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 0.236 (Table 12.9) the baseline mortality for this population is 814 individuals per annum.

12.7.20 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 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.

12.7.21 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.

12.7.22 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.**

Red-throated Diver

Potential Magnitude of Impact – Offshore ECC

12.7.23 In addition to the information presented in the O&M section (Section 12.8), red-throated diver are considered to be particularly sensitive to human activities which may be occurring during the construction phase, notably 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).

12.7.24 Birds are reported to commonly 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 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).

12.7.25 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. Based on a 2km buffer around each of three construction 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 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.

12.7.26 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.

12.7.27 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.

12.7.28 The annual BDMPS population is defined as 13,277 individuals and, using the average baseline mortality rate of 0.233 (Table 12.9), the natural predicted mortality is 3,120 individuals per annum. The addition of less than one (0.2) mortality would increase baseline mortality by 0.003%.

12.7.29 The annual bio-geographic population is defined as 27,000 individuals. Using the average baseline mortality rate of 0.233 (Table 12.9), the natural predicted mortality is 6,345 individuals per annum. The addition of less than one (0.2) mortality would increase baseline mortality by 0.002%.

12.7.30 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.

Potential Magnitude of Impact – Array Area

12.7.31 A mortality rate of 1% and a displacement rate of 50% were chosen for assessment of 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 non-breeding season populations (presented in Table 12.7) 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.

12.7.32 During the return migration bio-season, the mean peak abundance for red-throated diver, is 217 (217.3) individuals within the array area plus 4km buffer. Using a displacement rate range of 50% and a mortality rate 1% results in one (1.1) red-throated diver being subject to mortality during the return migration bio-season per annum. The regional population in the return migration bio-season is defined as 13,277 individuals and, using the average baseline mortality rate of 0.235 (Table 12.9), the natural predicted mortality in the return migration bio-season is 3,120 individuals per annum. The addition of one (1.1) predicted mortality per annum would increase baseline mortality by 0.035%.

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

12.7.34 During the migration-free breeding bio-season, the mean peak abundance for red-throated diver, is 16 (16.0) individuals within the array area plus 4km buffer. Using a displacement rate range of 50% and a mortality rate 1% results in less than one (0.1) red-throated diver 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 13,277 individuals and, using the average baseline mortality rate of 0.235 (Table 12.9), the natural predicted mortality in the migration-free breeding bio-season is 3,120 individuals per annum. The addition of less than one predicted mortality per annum would increase baseline mortality by 0.003%.

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

12.7.36 During the post-breeding migration bio-season, the mean peak abundance for red-throated diver, is 25 (25.0) individuals within the array area plus 4km buffer. Using a displacement rate range of 50% and a mortality rate 1% results in less than one (0.1) red-throated diver 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 13,277 individuals and, using the average baseline mortality rate of 0.235 (Table 12.9), the natural predicted mortality in the post-breeding migration bio-season is 3,120 individuals per annum. The addition of less than one predicted mortalities per annum would increase baseline mortality by 0.004%.

12.7.37 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.

12.7.38 During the migration-free winter bio-season, the mean peak abundance for red-throated diver, is 24 (24.0) 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 (0.1) red-throated diver being subject to mortality per annum. The regional population in the migration-free winter bio-season is defined as 10,177 individuals and, using the average baseline mortality rate of 0.235 (Table 12.9), the natural predicted mortality in the migration-free winter bio-season is 2,392 individuals per annum. The addition of less than one predicted mortality per annum would increase baseline mortality by 0.005%.

12.7.39 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.

12.7.40 Across all bio-seasons combined, the total mean peak abundance for red-throated diver is 282 (282.3) individuals. The predicted maximum number of red-throated diver subject to mortality due to displacement from the Project is one (1.4) individual per annum, based on a displacement rate of 50% and a mortality rate of 1%. Using the largest UK North Sea and English Channel BDMPS of 13,277 individuals (Furness, 2015) and using the average baseline mortality rate of 0.235 (Table 12.9), the natural predicted mortality across all seasons is 3,120 per annum. The addition of one predicted mortality would increase the baseline mortality rate by 0.045%. When considering displacement impacts at the wider biogeographic population scale, then of the 27,000 population the natural annual mortality rate would be 6,343 individuals per annum. The addition of one predicted mortality would increase the biogeographic baseline mortality rate by 0.022%.

12.7.41 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.

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
Return migration (Feb-Apr)	217	13,277	3,120	1.1	1.0 – 10.9	0.035	0.031 – 0.348
Migration-free breeding (May-Sep)	16	13,277	3,120	0.1	0.1 – 0.8	0.003	0.003 – 0.026
Post-breeding migration (Sep-Nov)	25	13,277	3,120	0.1	0.1 – 1.3	0.004	0.004 – 0.040
Migration-free winter (Dec-Jan)	24	10,177	2,392	0.1	0.1 – 1.2	0.005	0.005 – 0.050
Annual (BDMPS)	282	13,277	3,120	1.4	1.3 – 14.1	0.045	0.045 – 0.452
Annual (biogeographic)	282	27,000	6,345	1.4	1.3 – 14.1	0.022	0.022 – 0.222

Guillemot

Potential Magnitude of Impact

12.7.42 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 12.8.25). 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 (presented in Table 12.7) 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.

12.7.43 During the breeding bio-season, the mean peak abundance for guillemot is 23,173 (23,172.5) individuals within the array area plus 2km buffer. Using a displacement rate of 25% and a mortality rate of 1% results in 58 (57.9) guillemot being subject to mortality during the breeding season per annum. The regional population in the breeding bio-season is defined as 936,876 individuals and, using the average baseline mortality rate of 0.138 (Table 12.9), the natural predicted mortality in the breeding bio-season is 129,289 individuals per annum. The addition of 58 (57.9) predicted mortalities per annum would increase baseline mortality by 0.045%

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

12.7.45 During the non-breeding bio-season, the mean peak abundance for guillemot is 22,248 (22,248.0) individuals within the array area plus 2km buffer. Using a displacement rate of 25% and a mortality rate of 1% results in 56 (55.6) guillemots being subject to mortality during the non-breeding season per annum. The regional population in the non-breeding bio-season is defined as 1,617,306 individuals and, using the average baseline mortality rate of 0.138 (Table 12.9), the natural predicted mortality in the non-breeding bio-season is 223,188 individuals per annum. The addition of 56 predicted mortalities per annum would increase baseline mortality by 0.025%

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

12.7.47 Across all bio-seasons combined, the total mean peak abundance for guillemot is 45,421 (45,420.8) individuals. The predicted maximum number of guillemot subject to mortality due to displacement from the Project is 114 (113.5) 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 1,617,.306 individuals (Furness, 2015) and using the average baseline mortality rate of 0.138 (Table 12.9), the natural predicted mortality across all seasons is 223,188 per annum. The addition of 114 predicted mortalities would increase the baseline mortality rate by 0.051%. When considering displacement impacts at the wider biogeographic population scale, then of the 4,125,000 population the natural annual mortality rate would be 569,250 individuals per annum. The addition of 114 predicted mortalities would increase the biogeographic baseline mortality rate by 0.020%.

12.7.48 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.

Table 12.19: Bio-season displacement estimates for guillemot 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	15-35% displacement, 1-10% mortality	25% displacement, 1% mortality	15-35% displacement, 1-10% mortality
Breeding (Mar-Jul)	23,173	936,876	129,289	57.9	34.8 – 811.1	0.045	0.027 – 0.627
Non-breeding (Aug-Feb)	22,248	1,617,306	223,188	55.6	33.4 – 778.7	0.025	0.015 – 0.349
Annual (BDMPS)	45,421	1,617,306	223,188	113.6	68.1 – 1589.7	0.051	0.031 – 0.712
Annual (biogeographic)	45,421	4,125,000	569,250	113.6	68.1 – 1589.7	0.020	0.012 – 0.279

Razorbill

Potential Magnitude of Impact

12.7.49 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 12.8.25). Based on the range of displacement and mortality rates suggested by SNCBs, an additional range is presented in Table 12.20 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 (presented in Table 12.7) 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.

12.7.50 During the return migration bio-season, the mean peak abundance for razorbill is 5,229 (5,229.0) individuals within the array area plus 2km buffer. Using a displacement rate of 25% and a mortality rate 1% results in 13 (13.1) 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 591,874 individuals and, using the average baseline mortality rate of 0.193 (Table 12.9), the natural predicted mortality in the breeding bio-season is 114,232 individuals per annum. The addition of 13 predicted mortalities per annum would increase baseline mortality by 0.011%

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

12.7.52 During the migration-free breeding bio-season, the mean peak abundance for razorbill is 5,163 (5,163.0) individuals within the array area plus 2km buffer. Using a displacement rate of 25% and a mortality rate 1% results in 13 (12.9) razorbill 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 282,582 individuals and, using the average baseline mortality rate of 0.193 (Table 12.9), the natural predicted mortality in the migration-free breeding bio-season is 54,538 individuals per annum. The addition of 13 predicted mortalities per annum would increase baseline mortality by 0.024%

12.7.53 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.

12.7.54 During the post-breeding migration bio-season, the mean peak abundance for razorbill is 2,339 (2,339.0) individuals within the array area plus 2km buffer. Using a displacement rate of 25% and a mortality rate 1% results in six (5.8) 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 591,874 individuals and, using the average baseline mortality rate of 0.193 (Table 12.9), the natural predicted mortality in the post-breeding migration bio-season is 114,232 individuals per annum. The addition of six predicted mortalities per annum would increase baseline mortality by 0.005%

12.7.55 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.

12.7.56 During the migration-free winter bio-season, the mean peak abundance for razorbill is 2,570 (2,570.0) individuals within the array area plus 2km buffer. Using a displacement rate range of 25% and a mortality rate 1% results in six (6.4) 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 218,622 individuals and, using the average baseline mortality rate of 0.193 (Table 12.9), the natural predicted mortality in the migration-free winter bio-season is 42,194 individuals per annum. The addition of six predicted mortalities per annum would increase baseline mortality by 0.015%

12.7.57 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.

12.7.58 Across all bio-seasons combined, the total mean peak abundance for razorbill is 15,301 (15,301.0) individuals. The predicted maximum number of razorbill subject to mortality due to displacement from the Project is 38 (38.3) 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 591,874 individuals (Furness, 2015) and using the average baseline mortality rate of 0.193 (Table 12.9), the natural predicted mortality across all seasons is 114,232 per annum. The addition of 38 predicted mortalities would increase the baseline mortality rate by 0.033%. When considering displacement impacts at the wider biogeographic population scale, then of the 1,707,000 population the natural annual mortality rate would be 329,451 individuals per annum. The addition of 38 predicted mortalities would increase the biogeographic baseline mortality rate by 0.012%.

12.7.59 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.

Table 12.20: 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	15-35% displacement, 1-10% mortality	25% displacement, 1% mortality	15-35% displacement, 1-10% mortality
Return migration (Jan-Mar)	5,229	591,874	114,232	13.1	7.8 – 183.0	0.011	0.007 – 0.160
Migration-free breeding (Apr-Jul)	5,163	282,582	54,538	12.9	7.7 – 180.7	0.024	0.014 – 0.331
Post-breeding migration (Aug-Oct)	2,339	591,874	114,232	5.8	3.5 – 81.9	0.005	0.003 – 0.072
Migration-free winter (Nov-Dec)	2,570	218,622	42,194	6.4	3.9 – 45.0	0.015	0.009 – 0.107
Annual (BDMPS)	15,301	591,874	114,232	38.3	23.0 – 490.6	0.033	0.020 – 0.429
Annual (biogeographic)	15,301	1,707,000	329,451	38.3	23.0 – 490.6	0.012	0.007 – 0.149

Puffin

Potential Magnitude of Impact

12.7.60 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 12.8.25). Based on the range of displacement and mortality rates suggested by SNCBs, an additional range is presented in Table 12.21 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 (presented in Table 12.7) 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.

12.7.61 During the breeding bio-season, the mean peak abundance for puffin is 884 (883.8) individuals within the array area plus 2km buffer. Using a displacement rate of 25% and a mortality rate 1% results in two (2.2) puffin being subject to mortality during the breeding bio-season per annum. The regional population in the breeding bio-season is defined as 108,233 individuals and, using the average baseline mortality rate of 0.175 (Table 12.9), the natural predicted mortality in the breeding bio-season is 18,941 individuals per annum. The addition of two predicted mortalities per annum would increase baseline mortality by 0.012%.

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

12.7.63 During the non-breeding bio-season, the mean peak abundance for puffin is 1,167 individuals within the array area plus 2km buffer. Using a displacement rate of 25% and a mortality rate 1% results in three (2.9) 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 231,957 individuals and, using the average baseline mortality rate of 0.175 (Table 12.9), the natural predicted mortality in the non-breeding bio-season is 40,592 individuals per annum. The addition of three predicted mortalities per annum would increase baseline mortality by 0.007%.

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

12.7.65 Across all bio-seasons combined, the total mean peak abundance for puffin is 2,051 (2,050.8) individuals. The predicted maximum number of puffin subject to mortality due to displacement from the Project is five (5.1) 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 231,957 individuals (Furness, 2015) and using the average baseline mortality rate of 0.175 (Table 12.9), the natural predicted mortality across all seasons is 40,592 per annum. The addition of five predicted mortalities would increase the baseline mortality rate by 0.013%. When considering displacement impacts at the wider biogeographic population scale, then of the 11,840,000 population the natural annual mortality rate would be 2,072,000 individuals per annum. The addition of five predicted mortalities would increase the biogeographic baseline mortality rate by 0.000%.

12.7.66 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.

Table 12.21: Bio-season 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	15-35% displacement, 1-10% mortality	25% displacement, 1% mortality	15-35% displacement, 1-10% mortality
Breeding (Apr-Jul)	884	108,233	18,941	2.2	1.3 – 30.9	0.012	0.007 – 0.163
Non-breeding (Aug-Mar)	1167	231,957	40,592	2.9	1.8 – 40.8	0.007	0.004 – 0.101
Annual (BDMPS)	2051	231,957	40,592	5.1	3.1 – 71.8	0.013	0.008 – 0.177
Annual (biogeographic)	2051	11,840,000	2,072,000	5.1	3.1 – 71.8	0.000	0.000 – 0.003

Gannet

Potential Magnitude of Impact

12.7.67 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 12.8.58). Based on the range of displacement and mortality rates suggested by SNCBs, an additional range is presented in Table 12.22 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 (presented in Table 12.7) 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.

12.7.68 During the return migration bio-season, the mean peak abundance for gannet is 172 (171.5) individuals within the array area plus 2km buffer. Using a displacement rate of 35% and a mortality rate 1% results in less than one (0.6) 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 0.187 (Table 12.9), the natural predicted mortality in the return migration bio-season is 46,448 individuals per annum. The addition of less than one predicted mortality per annum would increase baseline mortality by 0.001%.

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

12.7.70 During the migration-free breeding bio-season, the mean peak abundance for gannet is 847 (846.8) individuals within the array area plus 2km buffer. Using a displacement rate of 35% and a mortality rate 1% results in three (3.0) gannets 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 299,492 individuals and, using the average baseline mortality rate of 0.187 (Table 12.9), the natural predicted mortality in the migration-free breeding bio-season is 56,005 individuals per annum. The addition of three mortalities per annum would increase baseline mortality by 0.005%.

12.7.71 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.

12.7.72 During the post-breeding migration bio-season, the mean peak abundance for gannet is 169 (169.0) individuals within the array area plus 2km buffer. Using a displacement rate of 35% and a mortality rate 1% results in less than one (0.6) gannet being subject to mortality per annum. The regional population in the post-breeding migration bio-season is defined as 456,298 individuals and, using the average baseline mortality rate of 0.187 (Table 12.9), the natural predicted mortality in the post-breeding migration bio-season is 85,328 individuals per annum. The addition of less than one predicted mortality per annum would increase baseline mortality by 0.001%.

12.7.73 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.

12.7.74 Across all bio-seasons combined, the total mean peak abundance for gannet is 1,187 (1,187.3) individuals. The predicted maximum number of gannets subject to mortality due to displacement from the Project is four (4.2) 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 456,298 individuals (Furness, 2015) and using the average baseline mortality rate of 0.187 (Table 12.9), the natural predicted mortality across all seasons is 85,328 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 220,660 individuals per annum. The addition of four predicted mortalities would increase the biogeographic baseline mortality rate by 0.002%.

12.7.75 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.

Table 12.22: 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)	172	248,385	46,448	0.6	0.5 – 0.7	0.001	0.001 – 0.001
Migration-free breeding (Apr-Aug)	847	299,492	56,005	3.0	2.5 – 3.4	0.005	0.005 – 0.006
Post-breeding migration (Sep-Nov)	169	456,298	85,328	0.6	0.5 – 0.7	0.001	0.001 – 0.001
Annual (BDMPS)	1187	456,298	85,328	4.2	3.6 – 4.7	0.005	0.004 – 0.006
Annual (biogeographic)	1187	1,180,000	220,660	4.2	3.6 – 4.7	0.002	0.002 – 0.002

Indirect Impacts Due to Impacts on Prey

12.7.76 During construction of the Project, potential effects on the availability of prey species may indirectly have effects on offshore ornithology. 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 2, Chapter 9: Benthic and Intertidal Ecology.

12.7.77 The main prey items of seabirds such as gannets 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 2, 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.

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.

12.8 Impact Assessment: O&M Phase

12.8.1 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 bases of impact assessments.

Disturbance and Displacement

12.8.2 The presence of turbines and other infrastructure within the array area has the potential to directly disturb and displace seabirds that would normally reside within and around the area of sea where the Project is proposed. This may result in a reduced area in which those seabirds can forage, loaf and/or moult, behaviours that currently occur within and around. Displacement may contribute to individual birds experiencing fitness consequences, which at an extreme level could lead to the mortality of some individuals.

12.8.3 Seabird species vary in their response to the presence of operational infrastructure associated with OWFs, such as turbines and also 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.

12.8.4 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.

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

12.8.6 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 repeated here.

12.8.7 The five species that were screened in for assessment for disturbance and displacement within the array area are gannet, guillemot, razorbill, puffin, and red-throated diver. Kittiwake, Sandwich tern, fulmar and Manx shearwater were not considered for displacement as justified in Paragraph 12.7.10 of the construction phase.

Red-Throated Diver

Displacement Rate Evidence Base

12.8.8 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 12.7) on susceptibility to disturbance from ship and helicopter traffic.

12.8.9 A detailed review of observed red-throated diver displacement rates and distance of effect was undertaken by Norfolk Vanguard Ltd (2019), with findings showing high variability in both the displacement rate (94– 50%) and distance of effect observed out from an array area (0-12km). Norfolk Vanguard suggested that the reason for such varying scales of displacement effects could be due to the differences in ecological and anthropogenic conditions between the OWF sites. For example, for OWF sites where optimal habitat is limited, birds might show lower displacement distances due to habitat suitability constraints. It is also suggested that the visibility of offshore structures and other anthropogenic influences could also lead to greater displacement effects.

12.8.10 An update to the review presented by Norfolk Vanguard Ltd (2019) 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).

12.8.11 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

12.8.12 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 in areas outside the affected area due to factors such as increased competition for food. However, these impacts are expected to be negligible, with literature reviews undertaken Norfolk Vanguard Ltd (2019b) and MacArthur Green and Royal HaskoningDHV (2021) identified clear evidence that red-throated diver populations are not constrained by resources in wintering grounds, but 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. They 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.

12.8.13 SNCB guidance (MIG-Birds, 2022) suggests a mortality rate of up to 10% for the assessment of red-throated divers. 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 the assessment with a range of up to 10% also presented.

Potential Magnitude of Impact

12.8.14 A mortality rate of 1% and a displacement rate of 50% 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 12.23.

The magnitude of this impact is assessed against BDMPS non-breeding season populations (presented in Table 12.7) 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.

12.8.15 During the return migration bio-season, the mean peak abundance for red-throated diver is 217 (217.3) individuals within the array area plus 4km buffer. Using a displacement rate range of 100% and a mortality rate 1% results in two (2.2) red-throated diver being subject to mortality during the return migration bio-season per annum. The regional population in the return migration bio-season is defined as 13,277 individuals and, using the average baseline mortality rate of 0.235 (Table 12.9), the natural predicted mortality in the return migration bio-season is 3,120 individuals per annum. The addition of two (2.2) mortalities per annum would increase baseline mortality by 0.070%.

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

12.8.17 During the migration-free breeding bio-season, the mean peak abundance for red-throated diver is 16 (16.0) individuals within the array area plus 4km buffer. Using a displacement rate range of 100% and a mortality rate 1% results in less than one (0.2) red-throated diver 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 13,277 individuals and, using the average baseline mortality rate of 0.235 (Table 12.9), the natural predicted mortality in the migration-free breeding bio-season is 3,120 individuals per annum. The addition of less than one mortality per annum would increase baseline mortality by 0.005%.

12.8.18 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.

12.8.19 During the post-breeding migration bio-season, the mean peak abundance for red-throated diver is 25 (25.0) individuals within the array area plus 4km buffer. Using a displacement rate range of 100% and a mortality rate 1% results in less than one (0.3) red-throated diver 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 13,277 individuals and, using the average baseline mortality rate of 0.235 (Table 12.9), the natural predicted mortality in the post-breeding migration bio-season is 3,120 individuals per annum. The addition of less than one mortality per annum would increase baseline mortality by 0.008%.

12.8.20 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.

12.8.21 During the migration-free winter bio-season, the mean peak abundance for red-throated diver is 24 (24.0) individuals within the array area plus 4km buffer. Using a displacement rate range of 100% and a mortality rate 1% results in less than one (0.2) red-throated diver 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 10,177 individuals and, using the average baseline mortality rate of 0.235 (Table 12.9), the natural predicted mortality in the migration-free winter bio-season is 2,392 individuals per annum. The addition of less than one mortality per annum would increase baseline mortality by 0.010%.

12.8.22 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.

12.8.23 Across all bio-seasons combined, the total mean peak abundance for red-throated diver is 282 (282.3) individuals. The predicted maximum number of red-throated divers subject to mortality due to displacement from the Project is three (2.8) individuals per annum. An annual displacement matrix for red-throated diver within the array area plus a 4km buffer is also presented in Table 12.30 below. Using the largest UK North Sea and English Channel BDMPS of 13,277 individuals (Furness, 2015) and using the average baseline mortality rate of 0.235 (Table 12.9), the natural predicted mortality across all seasons is 3,120 per annum. The addition of three predicted mortalities would increase the baseline mortality rate by 0.090%. When considering displacement impacts at the wider biogeographic population scale, then of the 27,000 population the natural annual mortality rate would be 6,345 individuals per annum. The addition of three predicted mortalities would increase the biogeographic baseline mortality rate by 0.044%.

12.8.24 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.

Table 12.23: 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
Return migration (Feb-Apr)	217	13,277	3,120	2.2	2.0 – 21.7	0.070	0.063 – 0.696
Migration-free breeding (May-Sep)	16	13,277	3,120	0.2	0.1 – 1.6	0.005	0.005 – 0.051
Post-breeding migration (Sep-Nov)	25	13,277	3,120	0.3	0.2 – 2.5	0.008	0.007 – 0.080
Migration-free winter (Dec-Jan)	24	10,177	2,392	0.2	0.2 – 2.4	0.010	0.009 – 0.100
Annual (BDMPS)	282	13,277	3,120	2.8	2.5 – 28.2	0.090	0.081 – 0.905
Annual (biogeographic)	282	27,000	6,345	2.8	2.5 – 28.2	0.044	0.040 – 0.445

Table 12.24: 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

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	1	1	3	6	8	11	14	17	20	23	25	28
20	1	1	3	6	11	17	23	28	34	39	45	51	56
30	1	2	4	8	17	25	34	42	51	59	68	76	85
40	1	2	6	11	23	34	45	56	68	79	90	102	113
50	1	3	7	14	28	42	56	71	85	99	113	127	141
60	2	3	8	17	34	51	68	85	102	118	135	152	169
70	2	4	10	20	39	59	79	99	118	138	158	178	197
80	2	5	11	23	45	68	90	113	135	158	180	203	226
90	3	5	13	25	51	76	102	127	152	178	203	228	254
100	3	6	14	28	56	85	113	141	169	197	226	254	282

Auk Species

12.8.25 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).

12.8.26 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 off 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 sites were 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.

12.8.27 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.

12.8.28 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 wind farm itself (Leopold and Verdaat, 2018). This would suggest that displacement rates are expected to diminish over the operational life of OWFs.

12.8.29 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.

12.8.30 Considering mortality, current expert opinion has advised the use of a range of 1-10% mortality for guillemots 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 (Peschk *et al.*, 2020).

12.8.31 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.

12.8.32 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

12.8.33 A mortality rate of 1% and a displacement rate of 50%, were selected for assessment of guillemot. 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 12.25. The magnitude of this impact is assessed against BDMPS non-breeding season populations (presented in Table 12.7) 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.

12.8.34 During the breeding bio-season, the mean peak abundance for guillemot is 23,173 (23,172.8) individuals within the array area plus 2km buffer. Using a displacement rate of 50% and a mortality rate 1% results in 116 (115.9) guillemots being subject to mortality during the breeding bio-season per annum. The regional population in the breeding bio-season is defined as 936,876 individuals and, using the average baseline mortality rate of 0.138 (Table 12.9), the natural predicted mortality in the breeding bio-season is 129,289 individuals per annum. The addition of 116 mortalities per annum would increase baseline mortality by 0.090%.

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

12.8.36 During the non-breeding bio-season, the mean peak abundance for guillemot is 22,248 (22,248.0) individuals within the array area plus 2km buffer. Using a displacement rate of 70% and a mortality rate 1% results in 111 (111.2) guillemots being subject to mortality during the non-breeding bio-season per annum. The regional population in the non-breeding bio-season is defined as 1,617,306 individuals and, using the average baseline mortality rate of 0.138 (Table 12.9), the natural predicted mortality in the non-breeding bio-season is 223,188 individuals per annum. The addition of 111 mortalities per annum would increase baseline mortality by 0.050%.

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

12.8.38 Across all bio-seasons, the combined total mean peak abundance for guillemot is 45,421 (45,420.8) individuals. The predicted maximum number of guillemots subject to mortality due to displacement from the Project is 227 (227.1) 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 12.26 below. Using the largest UK North Sea and English Channel BDMPS of 1,617,306 individuals (Furness, 2015) and using the average baseline mortality rate of 0.138 (Table 12.9), the natural predicted mortality across all seasons is 223,188 per annum. The addition of 227 predicted mortalities would increase the baseline mortality rate by 0.102%. When considering displacement impacts at the wider biogeographic population scale, then of the 4,125,000 population the natural annual mortality rate would be 569,250 individuals per annum. The addition of 227 predicted mortalities would increase the biogeographic baseline mortality rate by 0.040%.

12.8.39 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.

Table 12.25: Bio-season displacement estimates for guillemot 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	30-70% displacement, 1-10% mortality	50% displacement, 1% mortality	30-70% displacement, 1-10% mortality
Breeding (Mar-Jul)	23,173	936,876	129,289	115.9	69.5 – 1,622.1	0.090	0.054 – 1.255
Non-breeding (Aug-Feb)	22,248	1,617,306	223,188	111.2	66.7 – 1,557.2	0.050	0.030 – 0.698
Annual (BDMPS)	45,421	1,617,306	223,188	227.1	136.3 – 3,179.5	0.102	0.061 – 1.425
Annual (biogeographic)	45,421	4,125,000	569,250	227.1	136.3 – 3,179.5	0.040	0.024 – 0.559

Table 12.26: Annual displacement matrix for guillemot 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

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	45	91	227	454	908	1,363	1,817	2,271	2,725	3,179	3,634	4,088	4,542
20	91	182	454	908	1,817	2,725	3,634	4,542	5,451	6,359	7,267	8,176	9,084
30	136	273	681	1,363	2,725	4,088	5,451	6,813	8,176	9,538	10,901	12,264	13,626
40	182	363	908	1,817	3,634	5,451	7,267	9,084	10,901	12,718	14,535	16,352	18,168
50	227	454	1,136	2,271	4,542	6,813	9,084	11,355	13,626	15,897	18,168	20,439	22,711
60	273	545	1,363	2,725	5,451	8,176	10,901	13,626	16,352	19,077	21,802	24,527	27,253
70	318	636	1,590	3,179	6,359	9,538	12,718	15,897	19,077	22,256	25,436	28,615	31,795
80	363	727	1,817	3,634	7,267	10,901	14,535	18,168	21,802	25,436	29,069	32,703	36,337
90	409	818	2,044	4,088	8,176	12,264	16,352	20,439	24,527	28,615	32,703	36,791	40,879
100	454	908	2,271	4,542	9,084	13,626	18,168	22,711	27,253	31,795	36,337	40,879	45,421

Razorbill

Potential Magnitude of Impact

12.8.40 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 12.27. The magnitude of this impact is assessed against BDMPS non-breeding season populations (presented in Table 12.7) 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.

12.8.41 During the return migration bio-season, the mean peak abundance for razorbill is 5,229 (5,229.0) individuals within the array area plus 2km buffer. Using a displacement rate range of 50% and a mortality rate 1% results in 26 (26.1) 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 591,874 individuals and, using the average baseline mortality rate of 0.193 (Table 12.9), the natural predicted mortality in the return migration bio-season is 114,232 individuals per annum. The addition of 26 mortalities per annum would increase baseline mortality by 0.023%.

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

12.8.43 During the migration-free breeding bio-season, the mean peak abundance for razorbill is 5,163 (5,163.0) individuals within the array area plus 2km buffer. Using a displacement rate range of 50% and a mortality rate 1% results in 26 (25.8) razorbills 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 282,582 individuals and, using the average baseline mortality rate of 0.193 (Table 12.9), the natural predicted mortality in the migration-free breeding bio-season is 54,538 individuals per annum. The addition of 26 mortalities per annum would increase baseline mortality by 0.047%.

12.8.44 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.

12.8.45 During the post-breeding migration bio-season, the mean peak abundance for razorbill is 2,339 (2,339.0) individuals within the array area plus 2km buffer. Using a displacement rate range of 50% and a mortality rate 1% results in 12 (11.7) 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 591,874 individuals and, using the average baseline mortality rate of 0.193 (Table 12.9), the natural predicted mortality in the post-breeding migration bio-season is 114,232 individuals per annum. The addition of 12 mortalities per annum would increase baseline mortality by 0.010%.

12.8.46 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.

12.8.47 During the migration-free winter bio-season, the mean peak abundance for razorbill is 2,570 (2,570.0) individuals within the array area plus 2km buffer. Using a displacement rate range of 50% and a mortality rate 1% results in 13 (12.9) 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 218,622 individuals and, using the average baseline mortality rate of 0.193 (Table 12.9), the natural predicted mortality in the migration-free winter bio-season is 42,194 individuals per annum. The addition of 13 mortalities per annum would increase baseline mortality by 0.030%.

12.8.48 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.

12.8.49 Across all bio-seasons combined, the total mean peak abundance for razorbill is 15,301 (15,301.0) individuals. The predicted maximum number of razorbills subject to mortality due to displacement from the Project is 77 (76.5) 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 12.28 below. Using the largest UK North Sea and English Channel BDMPS of 591,874 individuals (Furness, 2015) and using the average baseline mortality rate of 0.193 (Table 12.9), the natural predicted mortality across all seasons is 114,232 per annum. The addition of 77 predicted mortalities would increase the baseline mortality rate by 0.067%. When considering displacement impacts at the wider biogeographic population scale, then of the 1,707,000 population the natural annual mortality rate would be 329,451 individuals per annum. The addition of 77 predicted mortalities would increase the biogeographic baseline mortality rate by 0.023%.

12.8.50 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.

Table 12.27: 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	30-70% displacement, 1-10% mortality	50% displacement, 1% mortality	30-70% displacement, 1-10% mortality
Return migration (Jan-Mar)	5,229	591,874	114,232	26.1	15.7 – 366.0	0.023	0.014 – 0.320
Migration-free breeding (Apr-Jul)	5,163	282,582	54,538	25.8	15.5 – 361.4	0.047	0.028 – 0.663
Post-breeding migration (Aug-Oct)	2,339	591,874	114,232	11.7	7.0 – 163.7	0.010	0.006 – 0.143
Migration-free winter (Nov-Dec)	2,570	218,622	42,194	12.9	7.7 – 90.0	0.030	0.018 – 0.213
Annual (BDMPS)	15,301	591,874	114,232	76.5	45.9 – 981.1	0.067	0.040 – 0.859
Annual (biogeographic)	15,301	1,707,000	329,451	76.5	45.9 – 981.1	0.023	0.014 – 0.298

Table 12.28: 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 and the darker shade of blue representing the Applicant's approach value

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	15	31	77	153	306	459	612	765	918	1,071	1,224	1,377	1,530
20	31	61	153	306	612	918	1,224	1,530	1,836	2,142	2,448	2,754	3,060
30	46	92	230	459	918	1,377	1,836	2,295	2,754	3,213	3,672	4,131	4,590
40	61	122	306	612	1,224	1,836	2,448	3,060	3,672	4,284	4,896	5,508	6,120
50	77	153	383	765	1,530	2,295	3,060	3,825	4,590	5,355	6,120	6,885	7,651
60	92	184	459	918	1,836	2,754	3,672	4,590	5,508	6,426	7,344	8,263	9,181
70	107	214	536	1,071	2,142	3,213	4,284	5,355	6,426	7,497	8,569	9,640	10,711
80	122	245	612	1,224	2,448	3,672	4,896	6,120	7,344	8,569	9,793	11,017	12,241
90	138	275	689	1,377	2,754	4,131	5,508	6,885	8,263	9,640	11,017	12,394	13,771
100	153	306	765	1,530	3,060	4,590	6,120	7,651	9,181	10,711	12,241	13,771	15,301

Puffin

Potential Magnitude of Impact

12.8.51 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 12.31. The magnitude of this impact is assessed against BDMPS non-breeding season populations (presented in Table 12.7) 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.

12.8.52 During the breeding bio-season, the mean peak abundance for puffins is 884 (883.8) individuals within the array area plus 2km buffer. Using a displacement rate range of 50% and a mortality rate 1% results in four (4.4) puffins being subject to mortality during the breeding bio-season per annum. The regional population in the breeding bio-season is defined as 108,233 individuals and, using the average baseline mortality rate of 0.175 (Table 12.9), the natural predicted mortality in the breeding bio-season is 18,941 individuals per annum. The addition of four mortalities per annum would increase baseline mortality by 0.023%.

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

12.8.54 During the non-breeding bio-season, the mean peak abundance for puffins is 1,167 (1,167.0) individuals within the array area plus 2km buffer. Using a displacement rate range of 50% and a mortality rate 1% results in six (5.8) 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 231,957 individuals and, using the average baseline mortality rate of 0.175 (Table 12.9), the natural predicted mortality in the non-breeding bio-season is 40,592 individuals per annum. The addition of six mortalities per annum would increase baseline mortality by 0.014%.

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

12.8.56 Across all bio-seasons combined, the total mean peak abundance for puffin is 2,051 (2,050.8) individuals. The predicted maximum number of puffins subject to mortality due to displacement from the Project is 10 (10.3) 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 12.30 below. Using the largest UK North Sea and English Channel BDMPS of 231,957 individuals (Furness, 2015) and using the average baseline mortality rate of 0.175 (Table 12.9), the natural predicted mortality across all seasons is 45,592 per annum. The addition of 10 predicted mortalities would increase the baseline mortality rate by 0.025%. When considering displacement impacts at the wider biogeographic population scale, then of the 11,840,000 population the natural annual mortality rate would be 2,072,000 individuals per annum. The addition of 10 predicted mortalities would increase the biogeographic baseline mortality rate by 0.0005%.

12.8.57 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.

Table 12.29: 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	30-70% displacement, 1-10% mortality	50% displacement, 1% mortality	30-70% displacement, 1-10% mortality
Breeding (Apr-Jul)	884	108,233	18,941	4.4	2.7 – 61.9	0.023	0.014 – 0.327
Non-breeding (Aug-Mar)	1,167	231,957	40,592	5.8	3.5 – 81.7	0.014	0.009 – 0.210
Annual (BDMPS)	2,051	231,957	40,592	10.3	6.2 – 143.6	0.025	0.015 – 0.354
Annual (biogeographic)	2,051	11,840,000	2,072,000	10.3	6.2 – 143.6	0.001	0.000 – 0.007

Table 12.30: 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

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	2	4	10	21	41	62	82	103	123	144	164	185	205
20	4	8	21	41	82	123	164	205	246	287	328	369	410
30	6	12	31	62	123	185	246	308	369	431	492	554	615
40	8	16	41	82	164	246	328	410	492	574	656	738	820
50	10	21	51	103	205	308	410	513	615	718	820	923	1,026
60	12	25	62	123	246	369	492	615	738	861	984	1,108	1,231
70	14	29	72	144	287	431	574	718	861	1,005	1,149	1,292	1,436
80	16	33	82	164	328	492	656	820	984	1,149	1,313	1,477	1,641
90	18	37	92	185	369	554	738	923	1,108	1,292	1,477	1,661	1,846
100	21	41	103	205	410	615	820	1,026	1,231	1,436	1,641	1,846	2,051

Gannet

12.8.58 Gannets 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 gannets avoided entering the wind farm (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 gannets would avoid flying into areas with operational WTGs (macro-avoidance), with the estimated macro-avoidance being 95%.

12.8.59 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.

12.8.60 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 in mortality as a result of displacement impacts from the Project.

Potential Magnitude of Impact

12.8.61 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 12.31. The magnitude of this impact is assessed against BDMPS non-breeding season populations (presented in Table 12.7) 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.

12.8.62 During the return migration bio-season, the mean peak abundance for gannet is 172 (171.5) individuals within the array area plus 2km buffer. Using a displacement rate range of 70% and a mortality rate 1% results in one (1.2) 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 0.187 (Table 12.9), the natural predicted mortality in the return migration bio-season is 46,448 individuals per annum. The addition of one mortality per annum would increase baseline mortality by 0.003%.

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

12.8.64 During the migration-free breeding bio-season, the mean peak abundance for gannet is 847 (846.8) individuals within the array area plus 2km buffer. Using a displacement rate range of 70% and a mortality rate 1% results in six (5.9) gannets 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 299,492 individuals and, using the average baseline mortality rate of 0.187 (Table 12.9), the natural predicted mortality in the migration-free breeding bio-season is 56,005 individuals per annum. The addition of six mortalities per annum would increase baseline mortality by 0.011%

12.8.65 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.

12.8.66 During the post-breeding migration bio-season, the mean peak abundance for gannet is 169 (169.0) individuals within the array area plus 2km buffer. Using a displacement rate range of 70% and a mortality rate 1% results in one (1.2) 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 456,298 individuals and, using the average baseline mortality rate of 0.187 (Table 12.9), the natural predicted mortality in the post-breeding migration bio-season is 85,328 individuals per annum. The addition of one predicted mortality per annum would increase baseline mortality by 0.001%

12.8.67 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.

12.8.68 Across all bio-seasons combined, the total mean peak abundance for gannet is 1,187 (1,187.3) individuals. The predicted maximum number of gannets subject to mortality due to displacement from the Project is eight (8.3) 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 12.32Table 12.26 below. Using the largest UK North Sea and English Channel BDMPS of 456,298 individuals (Furness, 2015) and using the average baseline mortality rate of 0.187 (Table 12.9), the natural predicted mortality across all seasons is 85,328 per annum. The addition of eight predicted mortalities would increase the baseline mortality rate by 0.010%. When considering displacement impacts at the wider biogeographic population scale, then of the 1,180,000 population the natural annual mortality rate would be 220,660 individuals per annum. The addition of eight predicted mortalities would increase the biogeographic baseline mortality rate by 0.004%.

12.8.69 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.

Table 12.31: 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
Return migration (Dec-Mar)	172	248,385	46,448	1.2	1.0 – 1.4	0.003	0.002 – 0.003
Migration-free breeding (Apr-Aug)	847	299,492	56,005	5.9	5.1 – 6.8	0.011	0.009 – 0.012
Post-breeding migration (Sep-Nov)	169	456,298	85,328	1.2	1.0 – 1.4	0.001	0.001 – 0.002
Annual (BDMPS)	1,187	456,298	85,328	8.3	7.1 – 8.3	0.010	0.008 – 0.011
Annual (biogeographic)	1,187	1,180,000	220,660	8.3	7.1 – 8.3	0.004	0.003 – 0.004

Table 12.32: 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

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	2	6	12	24	36	47	59	71	83	95	107	119
20	2	5	12	24	47	71	95	119	142	166	190	214	237
30	4	7	18	36	71	107	142	178	214	249	285	320	356
40	5	9	24	47	95	142	190	237	285	332	380	427	475
50	6	12	30	59	119	178	237	297	356	415	475	534	594
60	7	14	36	71	142	214	285	356	427	499	570	641	712
70	8	17	42	83	166	249	332	415	499	582	665	748	831
80	9	19	47	95	190	285	380	475	570	665	760	855	950
90	11	21	53	107	214	320	427	534	641	748	855	961	1,068
100	12	24	59	119	237	356	475	594	712	831	950	1,068	1,187

Collision Risk: Array Area

Overview

12.8.70 There is potential risk to birds from offshore wind farms 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.

12.8.71 Collision risk modelling (CRM) has been carried out for the Project, with detailed methods and results presented in Volume 2, Appendix 12.2: Collision Risk Modelling Assessment Annex, to provide information for seabird species of interest identified as potentially at risk and of interest for impact assessment.

12.8.72 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 turbines, 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 12.33 below.

Table 12.33: 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)
Arctic skua	Moderate	Low	Low	Out
Arctic tern	Minor	Low	Low	Out
Black-headed gull	Moderate	Low to Medium	Low	Out
Common gull	Moderate	Medium	Low	In
Common scoter	Minor	Low	Low	Out
Common tern	Minor	Low	Medium	In
Fulmar	Minor	Medium	Low	Out
Gannet	Moderate	High	Medium	In
Great black-backed gull	Major	Medium	Medium	In
Great northern diver	Minor	Low	Low	Out
Great skua	Moderate	Low	Low	Out
Guillemot	Minor	High	High	Out
Herring gull	Major	Medium	Medium	In
Kittiwake	Moderate	High	High	In
Lesser black-backed gull	Major	Medium	Medium	In

Receptor	Sensitivity to collision*	Relative frequency in the array area	Relative abundance in the array area	Screening result (in or out)
Little auk	Minor	Low	Low	Out
Little gull	Minor	Low to Medium	Low	In
Manx shearwater	Minor	Low	Low	Out
Oystercatcher	Minor	Low	Low	Out
Puffin	Minor	High	Medium to High	Out
Razorbill	Minor	High	High	Out
Red-throated diver	Minor	Medium	Low to Medium	Out
Sandwich tern	Minor	Low to Medium	Low to Medium	In
Shag	Minor	Low	Low	Out

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

12.8.73 Following screening, six species were included in CRM analysis: gannet, kittiwake, herring gull, great black-backed gull, lesser black-backed gull and sandwich tern.

12.8.74 Notably common tern and little gull were almost exclusively recorded in migration seasons only (as presented in Volume 2, Appendix 12.1: Ornithology Technical Baseline), and therefore these species will be assessed in a migratory CRM assessment that will be completed following the statutory consultation supported by the production for this PEIR and will be presented as part of the ES to accompany the DCO application; no further consideration will be given to these species in this PEIR chapter, as agreed through the EPP (Section 12.1.1).

12.8.75 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.

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

12.8.77 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 12.34 below, though a full overview of CRM input parameters and results is provided in (Volume 2, Appendix 12.2: Collision Risk Modelling Assessment Annex).

12.8.78 It should be noted that, based on available evidence, these parameters are precautionary. Regarding avoidance rates, research funded by ORJIP (Offshore Renewables Joint Industry Programme), 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).

12.8.79 Additionally, a recent report undertaken at Aberdeen Offshore Wind Farm Limited (AOWFL, 2023) at the European Offshore Wind Development Centre (EOWC) 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 turbine 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.

12.8.80 Considering flight speeds, a review undertaken for Norfolk Boreas Offshore Wind Farm (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 PEIR 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 12.34: Seabird parameters used in the CRM assessment

Species	Avoidance rate (± SD)	Nocturnal activity factor (± SD)	Flight speed (m/s) (± SD)
Common 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)
Great black-backed gull	0.994 (± 0.0004)	0.375 (± 0.0637)	13.7 (± 1.2)

Species	Avoidance rate (± SD)	Nocturnal activity factor (± SD)	Flight speed (m/s) (± SD)
Herring gull	0.994 (± 0.0004)	0.375 (± 0.0637)	12.8 (± 1.8)
Kittiwake	0.993 (±0.0003)	0.375 (± 0.0637)	13.1 (± 0.4)
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)

12.8.81 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). The use of a range of macro-avoidance rates between 65% to 85%, and a single rate of 70% are used in the analysis and presented below.

Results

12.8.82 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 12.35 below for screened in species. A full overview of these results is provided in Volume 2, Appendix 12.2: Collision Risk Modelling Assessment Annex.

12.8.83 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 (presented in Table 12.7) 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.

Table 12.35: 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	0.7	3.8	14.7	31.2	12.0	6.3	9.8	7.6	6.6	0.7	1.2	2.0	**96.6**
	2.5% CI	0.3	2.3	6.2	16.3	2.4	1.2	2.4	2.7	3.3	0.3	0.7	1.1	**39.3**
	97.5% CI	1.1	5.4	25.2	48.1	22.9	12.0	18.8	13.0	10.5	1.3	1.8	3.1	**163.1**
Gannet[4]	Mean	0.1	0.2	1.2	3.8	2.2	0.7	1.9	1.0	0.3	0.6	0.3	0.0	**12.2**
	2.5% CI	0.0	0.0	0.2	0.8	0.2	0.1	0.2	0.2	0.1	0.1	0.1	0.0	**1.9**
	97.5% CI	0.2	0.4	3.0	8.9	6.0	1.9	5.3	2.2	0.6	1.5	0.8	0.0	**30.7**
Herring gull	Mean	0.2	0.0	0.4	0.4	0.3	1.2	0.5	0.0	0.0	0.0	0.0	0.0	**3.0**
	2.5% CI	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	**0.2**
	97.5% CI	0.6	0.0	1.0	0.9	0.9	2.8	1.3	0.0	0.0	0.0	0.0	0.0	**7.6**
Great black-backed gull	Mean	0.3	0.0	0.5	0.0	0.2	0.1	0.0	0.2	1.2	0.4	1.2	0.6	**4.7**
	2.5% CI	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.2	0.2	**1.0**
	97.5% CI	0.6	0.0	1.3	0.0	0.4	0.3	0.0	0.6	2.2	0.9	2.7	1.0	**10.1**
Lesser black-backed gull	Mean	0.0	0.0	0.2	0.7	0.2	0.7	0.5	0.8	0.0	0.2	0.2	0.0	**3.7**
	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	**0.3**
	97.5% CI	0.0	0.0	0.7	1.9	0.6	2.1	1.4	2.4	0.0	0.7	0.6	0.0	**10.3**
Sandwich tern	Mean	0.0	0.0	0.0	0.2	0.8	0.4	0.0	0.0	0.1	0.0	0.0	0.0	**1.5**
	2.5% CI	0.0	0.0	0.0	0.0	0.1	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	0.7	2.4	1.3	0.1	0.0	0.3	0.0	0.0	0.0	**4.7**

[4] Gannet collisions not corrected for macro-avoidance within this table.

Kittiwake

Potential Magnitude of Impact

12.8.84 The monthly estimated mortality rates are presented in Table 12.35, which vary from a minimum mean of less than one individuals in January and October to a maximum mean of 31 (31.2) individuals in April. On an annual basis, the estimated mortality rate for collision risk from the Project is 97 (96.6) individuals, which is further broken down into relevant bio-seasons in Table 12.36.

Table 12.36: 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	
Return migration (Dec-Mar)	50.4	627,816	97,939	0.051
Migration-free breeding (Apr-Aug)	28.1	413,862	64,563	0.044
Post-breeding migration (Sep-Nov)	18.1	829,937	129,470	0.014
Annual (BDMPS)	96.6	829,937	129,470	0.075
Annual (biogeographic)	96.6	5,100,000	795,600	0.012

12.8.85 During the return migration bio-season, 50 (50.4) kittiwakes may be subject to collision mortality. The regional population in the return migration bio-season is defined as 622,816 individuals and using an average baseline mortality rate of 0.156 (Table 12.9), the natural predicted mortality in the return migration bio-season is 97,939 individuals per annum. The addition of 50 predicted mortalities during the return migration bio-season would increase the baseline mortality rate by 0.051%.

12.8.86 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.

12.8.87 During the migration-free breeding bio-season, 28 (28.1) kittiwakes may be subject to mortality. The regional population in the migration-free breeding bio-season is defined as 413,862 individuals and using an average baseline mortality rate of 0.156 (Table 12.9), the natural predicted mortality in the migration-free breeding bio-season is 64,563 individuals per annum. The addition of 28 predicted mortalities during the migration-free breeding bio-season would increase the baseline mortality rate by 0.044%.

12.8.88 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.

12.8.89 During the post-breeding migration bio-season, 18 (18.1) kittiwakes may be subject to mortality. The regional population in the return migration bio-season is defined as 829,937 individuals and using an average baseline mortality rate of 0.156 (Table 12.9), the natural predicted mortality in the post-breeding migration bio-season is 129,479 individuals per annum. The addition of 18 predicted mortalities during the post-breeding migration bio-season would increase the baseline mortality rate by 0.014%.

12.8.90 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.

12.8.91 The annual total of kittiwakes subject to mortality due to collision is estimated to be 97 (96.6) individuals. Using the largest BDMPS population of 829,937 with an average baseline mortality of 0.157 (Table 12.9), the natural predicted mortality is 129,479 per annum. The addition of 97 individuals would increase the baseline mortality rate by 0.075%. 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 795,600 individuals per annum. The addition of 97 predicted mortalities would increase baseline mortality by 0.012%.

12.8.92 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.

Great Black-Backed Gull

Potential Magnitude of Impact

12.8.93 The monthly estimated mortality rates are presented in Table 12.35, which vary from a minimum mean of zero individuals in February and July to a maximum of one (1.3) individual in November. On an annual basis, the estimated mortality rate for collision risk from the Project is approximately five (4.7) individuals, which is further broken down into relevant bio-seasons in Table 12.39.

Table 12.37: 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	
Breeding (Apr-Aug)	0.5	55,114	8,818	0.006
Non-breeding (Sep-Mar)	4.2	91,399	14,624	0.029
Annual (BDMPS)	4.7	91,399	14,624	0.032
Annual (biogeographic)	4.7	235,000	37,600	0.013

12.8.94 During the breeding bio-season, less than one (0.5) great black-backed gull may be subject to collision mortality. The regional population in the breeding bio-season is defined as 55,114 individuals and using an average baseline mortality rate of 0.160 (Table 12.9), the natural predicted mortality in the breeding bio-season is 8,818 individuals per annum. The addition of less than one predicted mortality during the breeding bio-season would increase the baseline mortality rate by 0.006%.

12.8.95 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.

12.8.96 During the non-breeding bio-season, four (4.2) great black-backed gulls may be subject to collision mortality. The regional population in the non-breeding bio-season is defined as 91,399 individuals and using an average baseline mortality rate of 0.160 (Table 12.9), the natural predicted mortality in the breeding bio-season is 14,624 individuals per annum. The addition of four predicted mortalities during the non-breeding bio-season would increase the baseline mortality rate by 0.029%.

12.8.97 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.

12.8.98 The annual total of great black-backed gulls subject to mortality due to collision is estimated to be five (4.7) individuals. Using the largest BDMPS population of 91,399 individuals with an average baseline mortality of 0.160 (Table 12.9), the natural predicted mortality is 14,624 individuals per annum. The addition of five predicted mortalities would increase the baseline mortality rate by 0.032%. 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 37,600 individuals per annum. The addition of five predicted mortalities would increase baseline mortality by 0.013%.

12.8.99 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.

Lesser Black-Backed Gull

Potential Magnitude of Impact

12.8.100 The monthly estimated mortality rates are presented in Table 12.35, which vary from a minimum mean of zero individuals across four months to a maximum of one (0.8) individual in August. On an annual basis, the estimated mortality rate for collision risk from the Project is four (3.7) individuals, which is further broken down into relevant bio-seasons in Table 12.38.

Table 12.38: 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	
Return migration (Mar-Apr)	0.9	197,483	24,488	0.004
Migration-free breeding (May-Jul)	1.5	92,104	11,421	0.013
Post-breeding migration (Aug-Oct)	1.0	209,007	25,917	0.004
Migration-free winter (Nov-Feb)	0.2	39,314	4,875	0.005
Annual (BDMPS)	3.7	209,007	25,917	0.014
Annual (biogeographic)	3.7	864,000	107,136	0.003

12.8.101 During the return migration bio-season, less than one (0.9) 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 0.124 (Table 12.9), the natural predicted mortality in the return migration bio-season is 24,488 individuals per annum. The addition of less than one predicted mortality during the return migration bio-season would increase the baseline mortality rate by 0.004%.

12.8.102 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.

12.8.103 During the migration-free breeding bio-season, two (1.5) lesser black-backed gulls may be subject to collision mortality. The regional population in the migration-free breeding bio-season is defined as 92,104 individuals and using an average baseline mortality rate of 0.124 (Table 12.9), the natural predicted mortality in the migration-free breeding bio-season is 11,421 individuals per annum. The addition of two predicted mortalities during the migration-free breeding bio-season would increase the baseline mortality rate by 0.013%.

12.8.104 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.

12.8.105 During the post-breeding migration bio-season, one (1.0) lesser black-backed gull may be subject to collision mortality. The regional population in the post-breeding migration bio-season is defined as 209,007 individuals and using an average baseline mortality rate of 0.124 (Table 12.9), the natural predicted mortality in the post-breeding migration bio-season is 25,917 individuals per annum. The addition of one predicted mortality during the post-breeding migration bio-season would increase the baseline mortality rate by 0.004%.

12.8.106 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.

12.8.107 During the migration-free winter bio-season, less than one (0.2) 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 0.124 (Table 12.9), the natural predicted mortality in the migration-free winter bio-season is 4,875 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 0.005%.

12.8.108 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.

12.8.109 The annual total of lesser black-backed gulls subject to mortality due to collision is estimated to be four (3.7) individuals. Using the largest BDMPS population of 209,007 individuals with an average baseline mortality of 0.124 (Table 12.9), the natural predicted mortality is 25,917 individuals per annum. The addition of four 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 864,000 across all seasons is 107,136 per annum. The addition of four predicted mortalities would increase baseline mortality by 0.003%.

12.8.110 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.

Herring Gull

Potential Magnitude of Impact

12.8.111 The monthly estimated mortality rates are presented in Table 12.35, which vary from a minimum of zero individuals across six 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 (3.0) individuals, which is further broken down into relevant bio-seasons in Table 12.39.

Table 12.39: 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	
Breeding (Mar-Aug)	2.7	251,802	43,310	0.006
Non-breeding (Sep-Feb)	0.2	466,511	80,240	0.0003
Annual (BDMPS)	3.0	466,511	80,240	0.004
Annual (biogeographic)	3.0	1,098,000	188,856	0.002

12.8.112 During the breeding bio-season, three (2.7) herring gulls may be subject to collision mortality. The regional population in the breeding bio-season is defined as 251,802 individuals and using an average baseline mortality rate of 0.172 (Table 12.9), the natural predicted mortality in the breeding bio-season is 43,310 individuals per annum. The addition of three predicted mortalities during the breeding bio-season would increase the baseline mortality rate by 0.006%.

12.8.113 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.

12.8.114 During the non-breeding season, less than one (0.2) herring gull may be subject to mortality. The regional population in the non-breeding bio-season is defined as 466,511 individuals and using an average baseline mortality rate of 0.172 (Table 12.9), the natural predicted mortality in the breeding bio-season is 80,240 individuals per annum. The addition of less than one predicted mortality during the non-breeding bio-season would increase the baseline mortality rate by 0.0003%.

12.8.115 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.

12.8.116 The annual total of herring gulls subject to mortality due to collision is estimated to be three (3.0) individuals. Using the largest BSMPS population of 466,511 with an average baseline mortality of 0.172 (Table 12.9), the natural predicted mortality is 80,240 individuals per annum. The addition of three individuals 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 188,856 individuals per annum. The addition of three individuals would increase baseline mortality by 0.002%.

12.8.117 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.

Sandwich Tern

Potential Magnitude of Impact

12.8.118 The monthly estimated mortality rates are presented in Table 12.35, which vary from a minimum mean of zero individuals across seven months to a maximum mean of one (0.8) individual in May. On an annual basis, the estimated mortality rate for collision risk from the Project is two (1.5) individuals, which is further broken down into relevant bio-seasons in Table 12.40.

Table 12.40: Bio-season collision risk estimates for sandwich tern for the Project

Bio-season (months)	Collisions	Regional baseline populations and baseline mortality rates (individuals per annum)		Increase in baseline mortality (%)
		Population	Baseline mortality	
Return migration (Mar-May)	1.0	38,051	9,170	0.011
Migration-free breeding (Jun)	0.4	29,428	7,092	0.006
Post-breeding migration (Jul – Sep)	0.1	38,051	9,170	0.001
Annual (BDMPS)	1.5	38,051	9,170	0.016
Annual (biogeographic)	1.5	148,000	35,668	0.004

12.8.119 During the return migration bio-season, one (1.0) sandwich tern may be subject to mortality. The regional population in the return migration bio-season is defined as 38,051 individuals and using an average baseline mortality rate of 0.241 (Table 12.9), the natural predicted mortality in the return migration bio-season is 9,170 individuals per annum. The addition of one predicted mortality during the return migration bio-season would increase the baseline mortality rate by 0.011%.

12.8.120 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.

12.8.121 During the migration-free 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 29,428 individuals and using an average baseline mortality rate of 0.241 (Table 12.9), the natural predicted mortality in the migration-free breeding bio-season is 7,092 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 0.006%.

12.8.122 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.

12.8.123 During the post-breeding migration bio-season, less than one (0.1) sandwich tern may be subject to mortality. The regional population in the post-breeding migration bio-season is defined as 38,051 individuals and using an average baseline mortality rate of 0.241 (Table 12.9), the natural predicted mortality in the post-breeding migration bio-season is 9,170 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 0.001 %.

12.8.124 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.

12.8.125 The annual total of sandwich terns subject to mortality due to collision is estimated to be two (1.5) individuals. Using the largest BDMPS population of 38,051 with an average baseline mortality of 0.241 (Table 12.9), the natural predicted mortality is 9,170 per annum. The addition of two predicted mortalities would increase the baseline mortality rate by 0.016%. 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 35,668 individuals per annum. The addition of two (1.5) predicted mortalities would increase baseline mortality by 0.004%.

12.8.126 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.

Gannet

Potential Magnitude of Impact

12.8.127 The monthly estimated mortality rates are presented in Table 12.35, which vary from a minimum mean of zero individuals in December to a maximum mean of four (3.8) individuals in April. On an annual basis, the estimated mortality rate for collision risk from the Project is 12 (12.2) individuals. This is reduced to four (3.7) individuals in total after adjusting for 70% macro-avoidance, which is further broken down into relevant bio-seasons in Table 12.41. Results are based on 70% macro-avoidance, with an additional range of 65% to 85% macro-avoidance presented in text. However, results from 70% macro-avoidance will form the main basis of this assessment.

Table 12.41: Bio-season collision risk estimates for gannet for the Project

Bio-season (months)	Mean collisions (range based on 65% to 85% macro-avoidance)	Regional baseline populations and baseline mortality rates (individuals per annum)		% Increase in baseline mortality (range based on 65% to 85% macro-avoidance)
		Population	Baseline mortality	
Return migration (Dec-Mar)	0.4 (0.2 – 0.5)	248,385	46,448	0.001 (0.000 – 0.001)
Migration-free breeding (Apr-Aug)	2.9 (1.4 – 3.4)	299,492	56,005	0.005 (0.003 – 0.006)
Post-breeding migration (Sep-Nov)	0.4 (0.2 – 0.4)	456,298	85,328	0.0004 (0.000 – 0.001)
Annual (BDMPS)	3.7 (1.8 – 4.3)	456,298	85,328	0.004 (0.002 – 0.004)
Annual (biogeographic)	3.7 (1.8 – 4.3)	1,180,000	220,660	0.002 (0.001 – 0.002)

12.8.128 During the return migration bio-season, less than one (0.4) 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 0.187 (Table 12.9), the natural predicted mortality in the return migration bio-season is 46,448 individuals per annum. The addition of less than one predicted mortality during the return migration bio-season would increase the baseline mortality rate by 0.001%.

12.8.129 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.

12.8.130 During the migration-free breeding bio-season, three (2.9) gannet may be subject to mortality. The regional population in the migration-free breeding bio-season is defined as 299,242 individuals and using an average baseline mortality rate of 0.187 (Table 12.9), the natural predicted mortality in the migration-free breeding bio-season is 56,005 individuals per annum. The addition of three predicted mortalities during the migration-free breeding bio-season would increase the baseline mortality rate by 0.005%.

12.8.131 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.

12.8.132 During the post-breeding migration bio-season, less than one (0.4) gannets may be subject to mortality. The regional population in the post-breeding migration bio-season is defined as 456,298 individuals and using an average baseline mortality rate of 0.187 (Table 12.9), the natural predicted mortality in the post-breeding migration bio-season is 85,328 individuals per annum. The addition of less than one predicted mortalities would increase the baseline mortality rate by 0.0004%.

12.8.133 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.

12.8.134 The annual total of gannets subject to mortality due to collision is estimated to be four (3.7) individuals. Using the largest BDMPS population of 456,298 with an average baseline mortality of 0.187 (Table 12.9), the natural predicted mortality is 85,328 per annum. The addition of four individuals 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 1,180,000 individuals across all seasons is 220,660 individuals per annum. The addition of four predicted mortalities would increase baseline mortality by 0.002%.

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.

Combined Operational Disturbance and Collision Risk – Gannet

12.8.135 Due to gannet being scoped in for both displacement and collision risk assessments during the O&M phase, there is potential for these two impacts to cumulatively 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.

12.8.136 It is recognised that assessing both displacement and collision risk for gannet together amounts to double counting birds, since birds subject to displacement would not be subject to potential collision, as they are already assumed to have avoided the array area. Similarly, birds which are estimated to be subject to collision mortality are not also able to be subject to displacement. However, a combined approach is undertaken for this assessment as a precautionary approach and based on recommendations from SNCB guidance (Parker *et al.,* 2022).

Potential Magnitude of Impact

12.8.137 As presented in Table 12.31 the total displacement consequent mortality is estimated as eight (8.3) birds, based on a displacement rate of 70% and a mortality rate of 1%. The collision consequent mortality is estimated as four (3.7) birds, as presented in Table 12.41. The combined potential mortality is therefore estimated as 12 (12.0) birds.

12.8.138 Considering the largest BDMPS population of 456,298 individuals with a baseline mortality of 85,328 individuals per annum, the addition of 12 predicted mortalities would result in a 0.014% increase in baseline mortality. Considering the biogeographic population of 1,180,000 individuals, with a baseline mortality of 220,660 individuals, the addition of 12 predicted mortalities would increase baseline mortality by 0.005%.

12.8.139 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.

Migratory Collision Risk: Array Area

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

12.8.141 Migratory birds moving through the Project array area may not be reliably detected using digital aerial surveys or other standard survey methods. Recording their numbers is extremely complex, owing to their movements through the area in short pulses, in poor weather, at night (when no surveys take place), or at high altitudes. Migratory collision risk assessment will be presented within the final EIA presented in the ES to accompany DCO application. The approach to modelling will be agreed through the EPP.

12.8.142 For the purpose of this PEIR, 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.

12.8.143 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

12.8.144 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 wind farm, 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 wind farm 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 12.42.

Hornsea Project Two

12.8.145 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 wind farm, 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 12.42.

Hornsea Three

12.8.146 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 wind farm (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 12.42.

Norfolk Vanguard

12.8.147 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 wind farm (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 wind farm 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 12.42.

Hornsea Project Four

12.8.148 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 wind farm, 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 12.42.

Table 12.42: 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
Arctic skua	0	10	0	0	0.00	No Change/Negligible	Negligible or Minor Adverse
Great skua	1	1	0	0	0.00	No Change/Negligible	Negligible or Minor Adverse
Little gull	10	1	1	0	0.03	No Change/Negligible	Negligible or Minor Adverse
Common tern	0	9	1	0	0.20	No Change/Negligible	Negligible or Minor adverse
Arctic tern	0	50	0	0	0.04	No Change/Negligible	Negligible or Minor adverse
Berwick's swan	0	0	4	0	0.12	Negligible	Negligible or Minor adverse
Taiga bean goose	0	0	0	n/a	0.00	Negligible	Negligible or Minor adverse
Dark-bellied brent goose	1	0	23	1	n/a	Negligible	Negligible or Minor adverse
Shelduck	4	0	2	n/a	0.97	Negligible	Negligible or Minor adverse
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

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
Pintail	n/a	n/a	n/a	1	n/a	Negligible	Negligible
Shoveler	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
Marsh harrier	n/a	n/a	n/a	0	n/a	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
Ringed plover	n/a	n/a	n/a	1	0.63	Negligible	Negligible
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
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
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
Bar-tailed godwit	2	0	2	2	1.63	Negligible	Negligible or Minor adverse
Curlew	n/a	n/a	n/a	10	4.32	Negligible	Negligible
Redshank	n/a	n/a	n/a	22	4.09	Negligible	Negligible
Turnstone	n/a	n/a	n/a	2	0.79	Negligible	Negligible
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

*for little gull, common tern, sandwich tern, arctic tern, roseate tern, arctic skua and great skua, BO2 CRM outputs were provided for Hornsea Four.

Potential Magnitude of Impact

12.8.149 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.

12.8.150 Consequently, 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. However, as a precautionary approach, a migratory CRM assessment will be undertaken following the statutory consultation supported by this PEIR and presented in the ES to accompany the final DCO application, considering all qualifying migratory species at SPAs within 100km of the Project array area.

Indirect Impacts Due to Impacts on Prey

12.8.151 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 2, Chapter 9: Benthic and Intertidal Ecology.

12.8.152 The main prey items of seabirds such as gannets 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 2, Chapter 9: Benthic 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).

12.8.153 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.

12.9 Impact Assessment: Decommissioning

12.9.1 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 impact assessments.

Disturbance and Displacement: Array Area

12.9.2 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.

12.9.3 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.

Indirect Impacts Due to Impacts on Prey

12.9.4 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**.**

12.10 Cumulative Impact Assessment

Overview and Methodology

12.10.1 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.

12.10.2 To determine the potential impacts arising from the Project in combination with other projects, a screening exercise was undertaken, and is presented in Table 12.43 below.

Table 12.43: Screening for potential cumulative effects

Impact	Screening outcome	Rationale
Construction phase		
Disturbance and displacement (Offshore ECC)	In	Potential for temporal and spatial coincidence of disturbance/displacement from other plans or projects in the area acting on the same populations.
Disturbance and displacement (array area)	Out	Displacement of all assessed 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 overlap with the construction phases of other projects.
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

Impact	Screening outcome	Rationale
		co-incidence of disturbance/displacement from other plans or projects.
O&M phase		
Disturbance and displacement (array area)	In	There is a sufficient likelihood of a cumulative impact to justify a detailed, quantitative cumulative impact assessment.
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.
Collision risk	In	There is a sufficient likelihood of a cumulative impact to justify a detailed, quantitative cumulative impact assessment.
Combined O&M collision risk and displacement	In	There is a sufficient likelihood of a cumulative impact to justify quantitative cumulative impact assessment.
Decommissioning phase		
Disturbance and displacement (ECC)	Out	Displacement of all assessed seabirds during the construction phase, and by extension 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.
Disturbance and displacement (array area)	Out	The likelihood that there would be a cumulative impact is low because the contribution from the proposed project is small and it is dependent on a temporal and spatial co-incidence of disturbance/displacement from other plans or proposed projects.
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.

12.10.3 All impacts for ornithological receptors identified in Table 12.43 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 the impact assessment concluding an (insignificant) extremely low impact (0.01 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.

Projects Considered for Cumulative Impacts

12.10.4 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 2, Appendix 5.1: Offshore Cumulative Impact Assessment) screened in a number of projects and plans as presented in Table 12.45.

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

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

12.10.6 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) 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 a cumulative 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.

12.10.7 Therefore, to avoid double-counting or exaggerating potential cumulative impacts, the above project types, excluding offshore wind farms, are scoped out and the cumulative assessment focuses only on offshore wind farms. 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 area currently available on potential impacts to offshore ornithology and as such this project has also been screened out from further consideration.

12.10.8 All offshore wind farms at all stages of development have been considered within the screening for cumulative effects.

12.10.9 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 12.44.

Table 12.44: 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

12.10.10 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 2, Appendix 5.1: Offshore Cumulative Impact Assessment).

12.10.11 Planned and operational projects were screened out of further consideration for potential cumulative effects on offshore and intertidal ornithology 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; and

- There are no data available or there is low confidence in the data.

12.10.12 The projects screened into the cumulative impact assessment and their allocated tiers (and sub-tiers) are presented in Table 12.45. 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 2, Appendix 5.1: Offshore Cumulative Impact Assessment.

Table 12.45: 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	Operational	444.9	458.8	1a	Potential temporal overlap of operation with the Project
Forthwind Demonstration Project (Methil)	Operational	387.7	387.3	1a	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
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

Project	Status	Distance to the Project array area (km)	Distance to the Project offshore ECC (km)	Tier	Reason for inclusion
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
Lincs	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
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

Project	Status	Distance to the Project array area (km)	Distance to the Project offshore ECC (km)	Tier	Reason for inclusion
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
Westermost Rough	Operational	59.5	53.9	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
Triton Knoll	Operational	7.7	5.5	1a	Potential temporal overlap of operation with the Project
Moray East	Operational	553.2	568.0	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 wind farm	Under construction	375.5	385.8	1b	Potential temporal overlap of operation with the Project
Dogger Bank A	Under construction	114.4	132.1	1c	Potential temporal overlap of operation with the Project
Dogger Bank B	Under construction	132.8	150.7	1c	Potential temporal overlap of operation with the Project
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

Project	Status	Distance to the Project array area (km)	Distance to the Project offshore ECC (km)	Tier	Reason for inclusion
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	1c	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
Sheringham Shoal Extension Project	ES submitted 09/2022	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	ES submitted 09/2022	13.5	0.0	1d	Potential temporal overlap of operation with the Project
Rampion 2	PEIR submitted	321.6	285.2	2	Potential temporal overlap of operation with the Project
Five Estuaries (Galloper Extension)*	In planning	175.5	162.5	2	Potential temporal overlap of operation with the Project
North Falls (Greater Gabbard Extension)*	In planning	169.9	155.1	2	Potential temporal overlap of operation with the Project
Dogger Bank South (East)	Pre-planning	81.2	98.7	2	Potential temporal overlap of operation with the Project
Dogger Bank South (West)	Pre-planning	94.6	112.5	2	Potential temporal overlap of operation with the Project
ScotWind Projects (multiple)	Pre-planning	Multiple	Multiple	2 or 3a	Potential temporal overlap of operation with the Project

12.10.13 The cumulative MDS for the Project is outlined in Table 12.46, 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 12.46: Cumulative MDS

Impact	Maximum Design Scenario	Justification
Construction		
Impact 1: Disturbance and displacement: Offshore ECC.	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, with quantitative data not yet publicly available.	Maximum potential for interactive effects from construction activities associated with and the construction of 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.
O&M phase		
Impact 2: 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, with quantitative data not yet publicly available. Tier 3: - Tier 3 projects identified, with quantitative data not yet publicly available.	Maximum potential for interactive effects from maintenance activities associated with and the operational effects of 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 3: Collision risk: Array area. Gannet, kittiwake, great black-backed gull, herring gull, lesser black-backed gull, and Sandwich tern.	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 maintenance activities associated with and the operational effects of 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.

Cumulative Impact Assessment: Disturbance and Displacement (Construction Phase)

12.10.14 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 12.43, this section only considers cumulative effects on red-throated divers during the construction of the Offshore ECC, with all other species/impacts relating to disturbance and displacement screened out.

Red-Throated Diver

12.10.15 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 12.47 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.

Table 12.47: 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
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	2
Total (other projects)	**0 - 43**	**-**	**-**
The Project	0 - 3	1-10% mortality	-
Total (all projects)	**1 - 46**	**-**	-

12.10.16 In total, up to 43 red-throated divers are currently predicted to be at risk of cumulative displacement-consequent mortality, rising to 46 when including the worst-case scenario from the Project (based on 100% displacement, and 10% mortality).

12.10.17 Considering the largest Southwest North Sea BDMPS population of 13,277 individuals, and a baseline mortality of 3,120 individuals per annum, the addition of 46 individuals would represent a 1.474% increase in baseline mortality. Considering the biogeographic population of 27,000 individuals and a baseline mortality of 6,345 individuals, the addition of 46 individuals would represent a 0.725% increase in baseline mortality.

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

- A review undertaken by Norfolk Vanguard Ltd (2019) found that the top range of 100% and 10% recommended by SNCs 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;
- Assessments for OWFs have assumed that displacement occurs to the same extend across the entire OWF and 4km buffer, whereas in reality it is expected that the degree of displacement will decline with distance from wind farm boundaries, and may be as low as zero by 2km;
- 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%);
- 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 turbines across the two wind farm sites and the consequent reduction in developed area or increase in wind turbine 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; and
- It is probable that the South-west North Sea BDMPS for spring and autumn migration (13,277) is an underestimate. Based on the most recent population count taken from the JNCC SMP[5] database, 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 46 individuals would represent a 0.032% to 1.474% increase in baseline mortality.

[5] https://app.bto.org/seabirds/public/index.jsp

12.10.19 On this basis, it is considered more realistic (and still precautionary) to base the assessment on a displacement rate of 90% 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 4.6 individuals, resulting in an increase in baseline mortality 0.147% at the South-west North Sea BDMPS scale, and a 0.072% increase in baseline mortality at the biogeographic scale.

12.10.20 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.

Cumulative Impact Assessment: Disturbance and Displacement (O&M Phase)

12.10.21 As a result of the operational and maintenance activities associated with the Project and other projects (Table 12.45), 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 impact estimates.

12.10.22 The presence of turbines 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).

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

Red-Throated Diver

12.10.24 As outlined in Section 12.8, 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.

12.10.25 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 wind farms 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).

12.10.26 Mortality estimates from the above projects are presented in Table 12.48 below for the full range of displacement estimates (90% displacement and 1% mortality, to 100% displacement and 10% mortality), with the addition of Hornsea Project Four, Dudgeon Offshore Extension Project and Sheringham Shoal Extension Project which have submitted DCO applications since the submission of the Norfolk Vanguard review.

Table 12.48: Cumulative displacement mortality estimates for red-throated diver from Tier 1 and 2 projects

Project	Post-breeding migration	Migration-free winter	Return migration	Annual total	Tier
Wider region (Norfolk Vanguard Ltd, 2019a)	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
Norfolk Boreas	0 – 1	1 – 15	5 – 62	6 – 78	1c
East Anglia ONE North	0 – 1	1 – 3	3 – 17	4 – 21	1c
East Anglia TWO	0	0 – 2	2 – 25	3 – 28	1c
Hornsea Project 4	0	0	0	0	1d
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	Not assessed				2
Total (other projects)	**3.2 – 34**	**6.4 – 73**	**19.4 – 194**	**35 – 358**	**-**
The Project	0.2 – 2.5	0.2 – 2.4	2.0 – 21.7	2.5 – 28.2	-
Total (all projects)	**3.4 – 36.5**	**6.6 – 75.4**	**21.4 – 215.7**	**37.5 – 386.2**	**-**

12.10.27 The potential 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 13,277 individuals whilst the wider bio-geographic population is 27,000 individuals. Using the average mortality rate of 0.235 (Table 12.9), the background mortality for these population scales are 3,120 and 6,345 individuals per annum, respectively.

12.10.28 The predicted cumulative displacement mortality for red-throated divers based on 90% to 100% displacement, and 1% to 10% mortality, is estimated as 38 (37.5) – 386 (386.2) individuals.

12.10.29 At the UK Southwest North Sea BDMPS scale, the potential cumulative loss of 38 to 386 individuals represents a 1.202% to 12.378% increase in baseline mortality. At the biogeographic scale, this addition of 38 to 386 individuals represents a 0.591% to 6.087% increase in baseline mortality.

12.10.30 It is noted that the cumulative assessment for red-throated diver is considered to be over-precautionary due to several reasons laid out in section 12.10.18. A more realistic scenario is considered to be the use of 100% displacement, and 1% mortality, which would result in an annual total of 38 (38.6) predicted displacement consequent mortalities. This would result in a 1.237% and 0.608% increase in baseline mortality at the BDMPS and biogeographic populations respectively.

12.10.31 As there is the potential for an increase in baseline mortality at the UK Southwest North Sea BDMPS scale of >1%, further assessment of the impacts will be considered in the form of a PVA to inform the final EIA that will be reported in the ES to accompany the DCO application.

Gannet

12.10.32 As outlined in Section 12.8, gannets show a low level of sensitivity to maintenance activities from ship and helicopter traffic as well as to operational WTGs. Additionally, gannets 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. However, a cumulative assessment has been carried out on this species.

12.10.33 Table 12.49 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.

Table 12.49: 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
Beatrice	151	0	0	151	1a
Beatrice demonstrator	-	-	-	0	1a
Blyth Demonstration Site	-	-	-	-	1a
Dudgeon	53	25	11	89	1a
East Anglia One	161	3,638	76	3,875	1a
European Offshore Wind Development Centre (EOWDC)	35	5	0	40	1a
Galloper	360	907	276	1,543	1a
Greater Gabbard	252	69	105	426	1a
Gunfleet Sands	0	12	9	21	1a
Hornsea Project One	671	694	250	1,615	1a
Humber Gateway	-	-	-	-	1a
Hywind	10	0	4	14	1a
Kentish Flats	-	-	-	-	1a
Kentish Flats Extension	0	13	0	13	1a
Kincardine	120	0	0	120	1a
Lincs	-	-	-	-	1a
London Array	-	-	-	-	1a
Lynn and Inner Dowsing	-	-	-	-	1a
Methil	23	0	0	23	1a
Race Bank	92	32	29	153	1a
Rampion	0	590	0	590	1a
Scroby Sands	-	-	-	-	1a
Sheringham Shoal	47	31	2	80	1a
Teesside	1	0	0	1	1a
Thanet	-	-	-	-	1a
Westermost Rough	-	-	-	-	1a
Hornsea Project Two	457	1,140	124	1,721	1a
Triton Knoll	211	15	24	250	1a
Moray East	564	292	27	883	1a
Neart na Gaoithe	1,987	552	281	2,820	1b
Seagreen Offshore Wind Farm	2,956	664	332	3,952	1b
Dogger A and B	1155	2,048	394	3,597	1c
Dogger Bank C and Sofia (formally Dogger Bank Teesside A and B)	2250	887	464	3,601	1c
East Anglia Three	412	1,269	524	2,205	1c
Hornsea Three	1,333	984	524	2,841	1c

Project	Breeding	Post-breeding migration	Return migration	Annual total	Tier
Inch Cape	2,398	703	212	3,313	1c
Moray West	2,827	439	144	3,410	1c
East Anglia ONE North	149	468	44	661	1c
East Anglia TWO	192	891	192	1,275	1c
Norfolk Boreas	1,229	1,723	526	3,478	1c
Norfolk Vanguard	271	2,453	437	3,161	1c
Hornsea Four	976	790	401	2,167	1d
Dudgeon Extension Project	417	343	47	807	1d
Sheringham Shoal Extension Project	23	295	11	328	1d
Rampion 2	98	78	45	221	2
Total (other projects)	**21,881**	**22,050**	**5,515**	**49,445**	-
The Project	847	169	172	1187	-
All Projects Totals	**22,513**	**25,793**	**5,603**	**53,909**	-

Potential Magnitude of Impact

12.10.34 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 456,298 (adults and immatures), whilst the wider bio-geographic population is 1,180,000 individuals (adults and immatures). Using the average mortality rate of 0.187 (Table 12.9), the background mortality for these population scales are 85,328 and 220,660 individuals per annum, respectively.

12.10.35 The predicted cumulative mortality from displacement is estimated based on a displacement rate of 70% and a mortality rate of 1%, though a range of 60% to 80% displacement is also presented in Table 12.50 in line with SNCB guidance (MIG-Birds, 2022). Results are also presented in a displacement matrix in Table 12.51 below.

12.10.36 Across all OWF projects presented in Table 12.45, the annual cumulative total of gannets at risk of displacement is calculated to be 53,909. When applying a 70% displacement rate and a 1% mortality rate, the annual cumulative loss is estimated as 354 (354.1) individuals.

12.10.37 At the UK North Sea and English Channel BDMPS scale, the potential cumulative loss of 354 gannets represents a 0.415% increase in baseline mortality. At the biogeographic scale, this additional mortality would increase baseline mortality by 0.160%.

12.10.38 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.

Table 12.50: 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	60-80% displacement, 1% mortality	70% displacement, 1% mortality	60-80% displacement, 1% mortality
Return migration (Dec-Mar)	5,749	248,385	46,448	40.2	34.5 – 46.0	0.087	0.074 – 0.099
Migration-free breeding (Apr-Aug)	22,674	299,492	56,005	158.7	136.0 – 181.4	0.283	0.243 – 0.324
Post-breeding migration (Sep-Nov)	22,169	456,298	85,328	155.2	133.0 – 177.4	0.182	0.156 – 0.208
Annual (BDMPS)	50,591	456,298	85,328	354.1	303.6 – 404.7	0.415	0.356 – 0.474
Annual (biogeographic)	50,591	1,180,000	220,660	354.1	303.6 – 404.7	0.160	0.138 – 0.183

Table 12.51: 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

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	51	101	253	506	1,012	1,518	2,024	2,530	3,035	3,541	4,047	4,553	5,059
20	101	202	506	1,012	2,024	3,035	4,047	5,059	6,071	7,083	8,095	9,106	10,118
30	152	304	759	1,518	3,035	4,553	6,071	7,589	9,106	10,624	12,142	13,660	15,177
40	202	405	1,012	2,024	4,047	6,071	8,095	10,118	12,142	14,165	16,189	18,213	20,236
50	253	506	1,265	2,530	5,059	7,589	10,118	12,648	15,177	17,707	20,236	22,766	25,296
60	304	607	1,518	3,035	6,071	9,106	12,142	15,177	18,213	21,248	24,284	27,319	30,355
70	354	708	1,771	3,541	7,083	10,624	14,165	17,707	21,248	24,790	28,331	31,872	35,414
80	405	809	2,024	4,047	8,095	12,142	16,189	20,236	24,284	28,331	32,378	36,426	40,473
90	455	911	2,277	4,553	9,106	13,660	18,213	22,766	27,319	31,872	36,426	40,979	45,532
100	506	1,012	2,530	5,059	10,118	15,177	20,236	25,296	30,355	35,414	40,473	45,532	50,591

Guillemot

12.10.39 As outlined in Section 12.8, guillemots show a medium level of sensitivity to maintenance activities from, for example, ship and helicopter traffic as well as to operational WTGs.

12.10.40 Table 12.52 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.

12.10.41 It should be noted that 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 12.52 represents ~28% 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 12.52: Cumulative bio-season and total abundance estimates for guillemot from all Tier 1 and 2 projects

Project	Breeding	Non-breeding	Annual total	Tier
Beatrice	13,610	2,755	16,365	1a
Blyth Demonstration Site	1,220	1,321	2,541	1a
Dudgeon	334	542	876	1a
East Anglia One	274	640	914	1a
EOWDC	547	225	772	1a
Galloper	305	593	898	1a
Greater Gabbard	345	548	893	1a
Gunfleet Sands	0	363	363	1a
Hornsea Project One	9,836	8,097	17,933	1a
Humber Gateway	99	138	237	1a
Hywind	249	2,136	2,385	1a
Kentish Flats	0	3	3	1a
Kentish Flats Extension	0	4	4	1a
Lincs, Lynn and Inner Dowsing	582	814	1,396	1a
Kincardine	632	0	632	1a
London Array	192	377	569	1a
Methil	25	0	25	1a
Race Bank	361	708	1,069	1a
Rampion	10,887	15,536	26,423	1a
Scroby Sands	-	-	-	1a
Sheringham Shoal	390	715	1,105	1a
Teesside	267	901	1,168	1a
Thanet	18	124	142	1a
Westermost Rough	347	486	833	1a
Hornsea Project Two	7,735	13,164	20,899	1a
Triton Knoll	425	746	1,171	1a

Project	Breeding	Non-breeding	Annual total	Tier
Moray East	9,820	547	10,367	1a
Dogger Bank A	5,407	6,142	11,549	1b
Dogger Bank B	9,479	10,621	20,100	1b
Dogger Bank C	3,283	2,268	5,551	1b
Seagreen Alpha	13,606	4,688	18,294	1b
Seagreen Bravo	11,118	4,112	15,230	1b
Sofia	5,211	3,701	8,912	1b
East Anglia Three	1,744	2,859	4,603	1c
Hornsea Three	13,374	17,772	31,146	1c
Inch Cape	4,371	3,177	7,548	1c
Moray West	24,426	38,174	62,600	1c
Neart na Gaoithe	1,755	3,761	5,516	1c
East Anglia ONE North	4,183	1,888	6,071	1c
East Anglia TWO	2,077	1,675	3,752	1c
Norfolk Boreas	7,767	13,777	21,544	1c
Norfolk Vanguard	4,320	4,776	9,096	1c
Hornsea Four	9,382	20,326	29,708	1d
Dudgeon Extension Project	3,839	14,887	18,726	1d
Sheringham Shoal Extension Project	1085	1095	2,180	1d
Rampion 2	185	13,020	13,205	2
Total (other projects)	**185,112**	**220,202**	**405,314**	-
the Project	23,173	22,248	45,421	-
All Projects Totals	**208,285**	**242,450**	**450,735**	**-**

Potential Magnitude of Impact

12.10.42 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 guillemot BDMPS for the UK North Sea and English Channel is 1,617,306 individuals, whilst the wider bio-geographic population is 4,125,000 individuals. Using the average mortality rate of 0.138 (Table 12.9), the background mortality for these population scales are 223,188 and 569,250 individuals per annum, respectively.

12.10.43 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 10% is also presented in Table 12.53 in line with SNCB guidance (MIG-Birds, 2022). Results are also presented in a displacement matrix in Table 12.54.

12.10.44 Across all OWF projects presented in Table 12.45, the annual cumulative total of guillemots at risk of displacement is calculated to be 450,735. When applying a 50% displacement rate and a 1% mortality rate, the annual cumulative loss is estimated as 2,254 (2,254.7) individuals.

12.10.45 At the UK North Sea and English Channel BDMPS scale, the potential cumulative loss of 2,254 guillemots represents a 1.010% increase in baseline mortality. At the biogeographic scale, this additional mortality would increase baseline mortality by 0.396%.

12.10.46 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. PVA will be undertaken post-PEIR, to further assess the cumulative effect of disturbance and displacement on guillemots during the O&M phase.

Table 12.53: Cumulative seasonal and annual displacement impacts on guillemot (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, 1-10% mortality	50% displacement, 1% mortality	30-70% displacement, 1-10% mortality
Breeding (Mar - Jul)	208,285	936,876	129,289	1,041.4	624.9 – 14,579.9	0.806	0.483 – 11.277
Non-breeding (Aug - Feb)	242,450	1,617,306	223,188	1,212.3	727.4 – 16,971.5	0.543	0.326 – 7.604
Annual (BDMPS)	450,735	1,617,306	223,188	2,253.7	1,352.2 - 31,551.4	1.010	0.606 – 14.137
Annual (biogeographic)	450,735	4,125,000	569,250	2,253.7	1,352.2 – 28,372.0	0.396	0.238 – 4.984

Table 12.54: Cumulative annual displacement matrix for guillemot 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

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	451	901	2,254	4,507	9,015	13,522	18,029	22,537	27,044	31,551	36,059	40,566	45,074
20	901	1,803	4,507	9,015	18,029	27,044	36,059	45,074	54,088	63,103	72,118	81,132	90,147
30	1,352	2,704	6,761	13,522	27,044	40,566	54,088	67,610	81,132	94,654	108,176	121,698	135,221
40	1,803	3,606	9,015	18,029	36,059	54,088	72,118	90,147	108,176	126,206	144,235	162,265	180,294
50	2,254	4,507	11,268	22,537	45,074	67,610	90,147	112,684	135,221	157,757	180,294	202,831	225,368
60	2,704	5,409	13,522	27,044	54,088	81,132	108,176	135,221	162,265	189,309	216,353	243,397	270,441
70	3,155	6,310	15,776	31,551	63,103	94,654	126,206	157,757	189,309	220,860	252,412	283,963	315,515
80	3,606	7,212	18,029	36,059	72,118	108,176	144,235	180,294	216,353	252,412	288,470	324,529	360,588
90	4,057	8,113	20,283	40,566	81,132	121,698	162,265	202,831	243,397	283,963	324,529	365,095	405,662
100	4,507	9,015	22,537	45,074	90,147	135,221	180,294	225,368	270,441	315,515	360,588	405,662	450,735

Razorbill

12.10.47 As outlined in Section 12.8, razorbill show a medium level of sensitivity to maintenance activities from, for example, ship and helicopter traffic as well as to operational WTGs.

12.10.48 For the cumulative assessment, the collective total number of birds estimated within the array area and 2km buffers are 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 12.52 represents approximately 26% 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 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.

12.10.49 Based on the justification provided in Section 12.8, a precautionary displacement rate of 50% and mortality rate of 1% is used for assessment.

Table 12.55: 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
Beatrice	873	833	555	833	3,094	1a
Blyth Demonstration Site	121	91	61	91	364	1a
Dudgeon	256	346	745	346	1,693	1a
East Anglia One	16	26	155	336	533	1a
EOWDC	161	64	7	26	258	1a
Galloper	44	43	106	394	587	1a
Greater Gabbard	0	0	387	84	471	1a
Gunfleet Sands	0	0	30	0	30	1a
Hornsea Project One	1,109	4,812	1,518	1,803	9,242	1a
Humber Gateway	27	20	13	20	80	1a
Hywind 2 Demonstration	30	719	10		759	1a
Kentish Flats	-	-	-	-	-	1a
Kentish Flats Extension	-	-	-	-	-	1a
Kincardine	22	0	0	0	22	1a
Lincs, Lynn and Inner Dowsing	45	34	22	34	134	1a
London Array	14	20	14	20	68	1a
Methil	4	0	0	0	4	1a
Race Bank	28	42	28	42	140	1a
Rampion	630	66	1,244	3,327	5,267	1a
Scroby Sands	-	-	-	-	-	1a
Sheringham Shoal	106	1,343	211	30	1,690	1a

Project	Breeding	Post-breeding migration	Non-migratory wintering	Return migration	Annual total	Tier
Teesside	16	61	2	20	99	1a
Thanet	3	0	14	21	37	1a
Westermost Rough	91	121	152	91	455	1a
Hornsea Project Two	2,511	4,221	720	1,668	9,119	1a
Triton Knoll	40	254	855	117	1,266	1a
Moray East	2,423	1,103	30	168	3,724	1a
Dogger Bank A	1,250	1,576	1,728	4,149	8,703	1b
Dogger Bank B	1,538	2,097	2,143	5,119	10,897	1b
Dogger Bank C	834	310	959	1,919	4,022	1b
Sofia	1,153	592	1,426	2,953	6,125	1b
Seagreen Alpha	5,876	0	1,103	0	6,979	1b
Seagreen Bravo	3,698	0	1,272	0	4,970	1b
East Anglia Three	1,807	1,122	1,499	1,524	5,952	1c
Hornsea Three	630	2,020	3,649	2,105	8,404	1c
Inch Cape	1,436	2,870	651	-	4,957	1c
Moray West	2,808	3,544	184	3,585	10,121	1c
Neart na Gaoithe	331	5,492	508	-	6,331	1c
East Anglia ONE North	403	85	54	207	749	1c
East Anglia TWO	281	44	136	230	692	1c
Norfolk Boreas	630	263	1,065	345	2,303	1c
Norfolk Vanguard	879	866	839	924	3,508	1c
Hornsea Four	386	4,311	455	449	5,600	1d
Dudgeon Extension Project	3741	923	320	848	5,829	1d
Sheringham Shoal Extension Project	759	316	144	686	1,905	1d
Rampion 2	44	18	22	2130	2,214	2
Total (other projects)	**37,054**	**40,668**	**25,036**	**36,644**	**139,397**	**-**
the Project	5,163	2,339	2,570	5,229	15,301	-
Total (all projects)	**42,217**	**43,007**	**27,606**	**41,873**	**154,703**	**-**

Potential Magnitude of Impact

12.10.50 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 591,232 individuals, whilst the wider bio-geographic population is 1,707,000 individuals. Using the average mortality rate of 0.193 (Table 12.9), the background mortality for these population scales are 114,232 and 329,451 individuals per annum, respectively.

12.10.51 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 12.56 in line with SNCB guidance (MIG-Birds, 2022). Results are also presented in a displacement matrix in Table 12.57.

12.10.52 Across all OWF projects presented in Table 12.55, the annual cumulative total of razorbills at risk of displacement is calculated to be 154,703. When applying a displacement rate of 50% and a 1% mortality rate, the annual cumulative loss is estimated as 774 (773.5) individuals.

12.10.53 At the UK North Sea and English Channel BDMPS scale, the potential cumulative loss of 774 razorbills represents a 0.677% increase in baseline mortality. At the biogeographic scale, this additional mortality would increase baseline mortality by 0.235%.

12.10.54 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, which is not significant in EIA terms**, based on the matrix approach defined in Table 12.15.

Table 12.56: 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, 1-10% mortality	50% displacement, 1% mortality	30-70% displacement, 1-10% mortality
Return migration (Jan - Mar)	41,873	591,874	114,232	209.4	125.6 – 2,931.1	0.183	0.110 – 2.566
Migration-free breeding (Apr - Jul)	42,217	282,582	54,538	211.1	126.7 – 2,955.2	0.387	0.232 – 5.419
Post-breeding migration (Aug - Oct)	43,007	591874	114231.7	215.0	129.0 – 3,010.5	0.188	0.113 – 2.635
Migration-free winter (Nov - Dec)	27,606	218622	42194.05	138.0	82.8 – 1,932.4	0.327	0.196 – 4.580
Annual (BDMPS)	154,703	591,874	114,232	773.5	464.1 – 10,829.2	0.677	0.406 – 9.480
Annual (biogeographic)	154,703	1,707,000	329,451	773.5	464.1 – 10,829.2	0.235	0.141 – 3.287

Table 12.57: 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

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	155	309	774	1,547	3,094	4,641	6,188	7,735	9,282	10,829	12,376	13,923	15,470
20	309	619	1,547	3,094	6,188	9,282	12,376	15,470	18,564	21,658	24,752	27,847	30,941
30	464	928	2,321	4,641	9,282	13,923	18,564	23,205	27,847	32,488	37,129	41,770	46,411
40	619	1,238	3,094	6,188	12,376	18,564	24,752	30,941	37,129	43,317	49,505	55,693	61,881
50	774	1,547	3,868	7,735	15,470	23,205	30,941	38,676	46,411	54,146	61,881	69,616	77,352
60	928	1,856	4,641	9,282	18,564	27,847	37,129	46,411	55,693	64,975	74,257	83,540	92,822
70	1,083	2,166	5,415	10,829	21,658	32,488	43,317	54,146	64,975	75,804	86,634	97,463	108,292
80	1,238	2,475	6,188	12,376	24,752	37,129	49,505	61,881	74,257	86,634	99,010	111,386	123,762
90	1,392	2,785	6,962	13,923	27,847	41,770	55,693	69,616	83,540	97,463	111,386	125,309	139,233
100	1,547	3,094	7,735	15,470	30,941	46,411	61,881	77,352	92,822	108,292	123,762	139,233	154,703

Puffin

12.10.55 As outlined in Section 12.8, puffin show a medium level of sensitivity to maintenance activities from, for example, ship and helicopter traffic as well as to operational WTGs.

12.10.56 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 12.58 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 12.58: Cumulative bio-season and total abundance estimates for puffin from all Tier 1 and 2 projects

Project	Breeding	Non-breeding	Annual total	Tier
Beatrice	2,858	2,435	5,293	1a
Blyth Demonstration Site	235	123	358	1a
Dudgeon	1	3	4	1a
East Anglia One	16	32	48	1a
EOWDC	42	82	124	1a
Galloper	0	1	1	1a
Greater Gabbard	0	1	1	1a
Gunfleet Sands	-	-	-	1a
Hornsea Project One	1,070	1,257	2,327	1a
Humber Gateway	15	10	25	1a
Hywind	119	85	204	1a
Kentish Flats	-	-	-	1a
Kentish Flats Extension	3	6	9	1a
Kincardine	19	0	19	1a
Lincs, Lynn and Inner Dowsing	3	6	9	1a
London Array	0	1	1	1a
Methil	8	0	8	1a
Race Bank	1	10	11	1a
Rampion	7	0	7	1a
Scroby Sands	-	-	-	1a
Sheringham Shoal	4	26	30	1a
Teesside	35	18	53	1a
Thanet	0	0	0	1a
Westermost Rough	61	35	96	1a
Hornsea Project Two	468	2,039	2,507	1a
Triton Knoll	23	71	94	1a
Moray East	2,795	656	3,451	1a
Dogger Bank A	37	295	332	1b
Dogger Bank B	102	743	845	1b

Project	Breeding	Non-breeding	Annual total	Tier
Dogger Bank C	34	273	307	1b
Sofia	35	329	364	1b
Seagreen Alpha	2,572	1,526	4,098	12.10.571b
Seagreen Bravo	3,582	3,863	7,445	1b
East Anglia Three	181	307	488	1c
Hornsea Three	253	67	320	1c
Inch Cape	2,956	2,688	5,644	1c
Moray West	1,115	3,966	5,081	1c
Neart na Gaoithe	2,562	2,103	4,665	1c
East Anglia One North	-	-	-	1c
East Anglia Two	15	0	15	1c
Norfolk Boreas	0	23	23	1c
Norfolk Vanguard	67	112	179	1c
Hornsea Four	203	442	644	1d
Dudgeon Extension Project	0	17	17	1d
Sheringham Shoal Extension Project	0	11	11	1d
Rampion 2	6	0	6	2
Total (other projects)	**21,503**	**23,662**	**45,164**	-
the Project	884	1,167	2,051	-
All Projects Totals	**22,387**	**24,829**	**47,215**	**-**

Potential Magnitude of Impact

12.10.58 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 231,957 individuals, whilst the wider bio-geographic population is 11,840,000 individuals. Using the average mortality rate of 0.175 (Table 12.9), the background mortality for these population scales are 40,592 and 2,072,000 individuals per annum, respectively.

12.10.59 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 12.59 in line with SNCB guidance (MIG-Birds, 2022). Results are also presented in a displacement matrix in Table 12.60.

12.10.60 Across all OWF projects presented in Table 12.58, the annual cumulative total of puffins at risk of displacement is calculated to be 47,215. When applying a displacement rate of 50% and a 1% mortality rate, the annual cumulative loss is estimated as 236 (236.1) individuals.

12.10.61 At the UK North Sea and English Channel BDMPS scale, the potential cumulative loss of 236 puffins represents a 0.582% increase in baseline mortality. At the biogeographic scale, this additional mortality would increase baseline mortality by 0.011%.

12.10.62 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 .

Table 12.59: 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, 1-10% mortality	50% displacement, 1% mortality	30-70% displacement, 1-10% mortality
Breeding (Mar - Jul)	22,387	108,233	18,941	111.9	67.2 – 1,567.1	0.591	0.355 – 8.274
Non-breeding (Aug - Feb)	24,829	231,957	40,592	124.1	74.5 – 1,738.0	0.306	0.183 – 4.282
Annual (BDMPS)	47,215	231,957	40,592	236.1	141.6 – 3,305.1	0.582	0.349 – 8.142
Annual (biogeographic)	47,215	11,840,000	2,072,000	236.1	141.6 – 3,305.1	0.011	0.007 – 0.160

Table 12.60: 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

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	47	94	236	472	944	1,416	1,889	2,361	2,833	3,305	3,777	4,249	4,722
20	94	189	472	944	1,889	2,833	3,777	4,722	5,666	6,610	7,554	8,499	9,443
30	142	283	708	1,416	2,833	4,249	5,666	7,082	8,499	9,915	11,332	12,748	14,165
40	189	378	944	1,889	3,777	5,666	7,554	9,443	11,332	13,220	15,109	16,997	18,886
50	236	472	1,180	2,361	4,722	7,082	9,443	11,804	14,165	16,525	18,886	21,247	23,608
60	283	567	1,416	2,833	5,666	8,499	11,332	14,165	16,997	19,830	22,663	25,496	28,329
70	331	661	1,653	3,305	6,610	9,915	13,220	16,525	19,830	23,135	26,440	29,745	33,051
80	378	755	1,889	3,777	7,554	11,332	15,109	18,886	22,663	26,440	30,218	33,995	37,772
90	425	850	2,125	4,249	8,499	12,748	16,997	21,247	25,496	29,745	33,995	38,244	42,494
100	472	944	2,361	4,722	9,443	14,165	18,886	23,608	28,329	33,051	37,772	42,494	47,215

Cumulative Impact Assessment: Collision (O&M Phase)

12.10.63 As a result of the operational activities associated with the Project and other projects (Table 12.10), there is potential for cumulative collision risk to birds through collision with turbines 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.

12.10.64 Within this cumulative impact assessment, only projects identified in Table 12.44 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 available at PEIR).

12.10.65 CRM has been carried out for the Project (Section 12.8) 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 12.8, all species assessed for project alone impacts due to collision were assessed for cumulative impacts.

12.10.66 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 turbines (equated 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 12.8); 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 are 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 is predicted to lead to a reduction in collisions.

Kittiwake

12.10.67 As outlined in Section 12.8, kittiwakes show a medium level of sensitivity to collision with WTGs.

12.10.68 Table 12.61 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.

Table 12.61: 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
Beatrice	94.7	10.7	39.8	145.2	1a
Blyth Demonstration Site	1.7	2.3	1.4	5.4	1a
Dudgeon	-	-	-	-	1a
East Anglia One	1.8	160.4	46.8	209	1a
EOWDC	11.8	5.8	1.1	18.7	1a
Galloper	6.3	27.8	31.8	65.9	1a
Greater Gabbard	1.1	15	11.4	27.5	1a
Gunfleet Sands	-	-	-	-	1a
Hornsea Project One	44	55.9	20.9	120.8	1a
Humber Gateway	1.9	3.2	1.9	7	1a
Hywind	16.6	0.9	0.9	18.3	1a
Kentish Flats	0	0.9	0.7	1.6	1a
Kentish Flats Extension	0	0	2.7	2.7	1a
Kincardine	22	9	1	32	1a
Lincs, Lynn and Inner Dowsing	0.7	0.7	1.2	2.6	1a
London Array	1.4	2.3	1.8	5.5	1a
Methil	0.4	0	0	0.4	1a
Race Bank	1.9	23.9	5.6	31.4	1a
Rampion	54.4	37.4	29.7	121.5	1a
Scroby Sands	-	-	-	-	1a
Sheringham Shoal	-	-	-	-	1a
Teesside	38.4	24	2.5	64.9	1a
Thanet	0.2	0.5	0.4	1.1	1a
Westermost Rough	0.1	0.2	0.1	0.5	1a
Hornsea Project Two	16	9	3	28	1a
Triton Knoll	24.6	139	45.4	209	1a
Moray East	43.6	2	19.3	64.9	1a

Project	Breeding	Post-breeding migration	Return migration	Annual total	Tier
Seagreen Offshore Wind Farm	153.1	313.1	247.6	713.8	1b
Dogger Bank A and B	288.6	135	295.4	719	1b
Dogger Bank C and Sofia	136.9	90.7	216.9	444.5	1b
East Anglia Three	6.1	69	37.6	112.7	1c
Hornsea Three	77	38	8	123	1c
Inch Cape	13.1	224.8	63.5	301.4	1c
Moray West	79	24	7	109	1c
Neart na Gaoithe	32.9	56.1	4.4	93.4	1c
East Anglia ONE North	40.4	8.1	3.5	52	1c
East Anglia TWO	29.5	5.4	7.4	42.3	1c
Norfolk Boreas	13.3	32.2	11.9	57.5	1c
Norfolk Vanguard	21.8	16.4	19.3	57.5	1c
Hornsea Four	35.4	31.7	13.5	80.6	1d
Dudgeon Extension Project	9.1	4.64	1.3	15.04	1d
Sheringham Shoal Extension Project	0.83	1.2	0	2.03	1d
Rampion 2	1.74	1.62	7.26	10.63	2
Total (other projects)	**1322.3**	**1585.4**	**1215.2**	**4123.0**	-
The Project	28.1	18.1	50.4	96.6	-
All Projects Totals	**1350.44**	**1603.52**	**1265.56**	**4219.6**	**-**

Potential Magnitude of Impact

12.10.69 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 829,937 individuals, whilst the wider bio-geographic population is 5,100,000 individuals. When considering the average mortality rate of 0.156 (Table 12.9) the background mortality for these two population scales are 129,470 and 795,600 individuals per annum, respectively.

12.10.70 The potential cumulative loss of 4,219 (4,219.6) kittiwakes would represent an increase of 3.259% 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 0.530%. Given the increase in baseline mortality of over 1% at the BDMPS scale, further consideration is given below in relation to kittiwake risk.

12.10.71 Firstly, it should be noted that the majority of data presented in Table 12.61 are based on the previously recommended avoidance rate of 98.9%, not reflecting the most recent Natural England interim CRM guidance (Natural England, 2022a) which recommends a higher rate of 99.2%. Incorporation of this rate would reduce the cumulative total by an estimated 27.2%, which would bring the annual total to approximately 3,098 annual mortalities.

12.10.72 Additionally, a review of nocturnal activity in kittiwakes (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 37.5% nocturnal activity alongside a SD that incorporates variation from 25% - 50% nocturnal activity. Applying the use of a 37.5% (or 25% in the basic Band model) nocturnal activity factor to other projects presented in Table 12.61 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 wind farm latitude owing to variation in day and night length.

12.10.73 Additional consideration to the potential impacts on kittiwakes is based on evidence presented by both East Anglia Three (EATL, 2016) and Norfolk Boreas (Vattenfall, 2019), which showed that when accounting for an additional annual mortality of 4,000 individuals, the density dependant model predicted that the population would be 3.6% to 4.4% smaller than that predicted in the absence of such additional mortality after 25 years. Across a 25-year period, it is considered that such changes are highly unlikely to be detectable against a background of natural changes which have fluctuated between positive and negative changes over the last 50 years.

12.10.74 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.

Great Black-Backed Gull

12.10.75 As outlined in Section 12.8, great black-backed gulls show a medium level of sensitivity to collision with WTGs.

12.10.76 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. Additionally, not all projects provide a seasonal breakdown of collision impacts. Previous advice from Natural England, has suggested an 80:20 split between the non-breeding and breeding seasons for lesser black-backed gull, and therefore for sites where a seasonal split is not presented, this was considered also appropriate for great black-backed gull, in line with previous assessments.

Table 12.62: 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
Beatrice Demonstrator	0	0	0	1a
Greater Gabbard	15	60	75	1a
Gunfleet Sands	-	-	-	1a
Kentish Flats	-	-	-	1a
Kentish Flats Extension	0.1	0.2	0.3	1a
Lincs	0	0	0	1a
London Array	-	-	-	1a
Lynn and Inner Dowsing	0	0	0	1a
Scroby Sands	-	-	-	1a
Sheringham Shoal	0	0	0	1a
Teesside	8.7	34.8	43.6	1a
Thanet	0.1	0.4	0.5	1a
Humber Gateway	1.3	5.1	6.3	1a
Westermost Rough	0	0	0.1	1a
Hywind	0.3	4.5	4.8	1a
Kincardine	0	0	0	1a
Beatrice	30.2	120.8	151	1a
Dudgeon	0	0	0	1a
Galloper	4.5	18	22.5	1a
Race Bank	0	0	0	1a
Rampion	5.2	20.8	26	1a
Hornsea Project One	17.2	68.6	85.8	1a
Blyth Demonstration Project	1.3	5.1	6.3	1a
Triton Knoll	24.4	97.6	122	1a
Hornsea Project Two	3	20	23	1a
Dogger Bank A and B	5.8	23.3	29.1	1b
East Anglia ONE	0	46	46	1b
European Offshore Wind Deployment Centre	0.6	2.4	3	1b
Dogger Bank C and Sofia	6.4	25.5	31.9	1b
Seagreen Offshore Wind Farm	13.4	53.4	66.8	1b
Inch Cape	0	36.8	36.8	1c
Methil	0.8	0.8	1.6	1c
Moray Firth (EDA)	9.5	25.5	35	1c
Neart na Gaoithe	0.9	3.6	4.5	1c
East Anglia THREE	4.6	34.4	39	1c

Project	Breeding	Non-breeding	Annual total	Tier
Hornsea Project Three (revised)	8	28	36	1c
Norfolk Vanguard	4.5	21.5	26	1c
Moray West	4	5	9	1c
Norfolk Boreas	6.9	28.7	35.6	1c
East Anglia TWO	3.5	3.4	6.9	1c
East Anglia ONE North	3.7	1.2	5	1c
Hornsea 4	0.4	4	4.4	1d
Dudgeon Offshore Extension Project	1.1	0.2	1.3	1d
Sheringham Shoal Extension Project	3.7	0	3.7	1d
Rampion 2	0.9	3.1	4	2
Total (without ODOW)	**190**	**802.7**	**992.8**	**-**
The Project	0.5	4.2	4.7	-
Total (all projects)	**190.5**	**806.9**	**997.5**	**-**

Potential Magnitude of Impact

12.10.77 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 91,399 individuals, whilst the wider bio-geographic population is 235,000 individuals. When considering the average mortality rate of 0.160 (Table 12.9) the background mortality for these two population scales are 14,624 and 37,600 individuals per annum, respectively.

12.10.78 The potential cumulative loss of 998 (997.5) great black-backed gulls would represent an increase of 6.821% 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 2.643%. Given the increase in baseline mortality of over 1% at the BDMPS scale, further consideration is given below in relation to great black-backed gull risk.

12.10.79 For the projects presented in Table 12.64, it should be noted that unlike for gannet and kittiwake, the recent Natural England interim CRM guidance (Natural England, 2022a) recommends a lower avoidance rate for great black-backed gull of 99.4% than the previously used 99.5%, which would result in an increase of predicted collisions (~17% increase per project). However, the project assessments are also based on a nocturnal activity factor of 50%, which is considered over-precautionary. 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, which would be expected to cancel out any additional mortalities resulting from alterations in avoidance rates. Additionally, the contribution of the Project alone is five mortalities, representing a 0.032% and 0.013% increase in baseline mortality at both the

BDMPS and biogeographic scales respectively. Therefore, it is considered that the Project is not making a material contribution to the cumulative collision mortality total.

12.10.80 This conclusion is further supported through population modelling undertaken to inform the East Anglia Three assessment of great black-backed gull (EATL, 2016). The study presented four versions of the model using two different sets of demographic rates and using scenarios with and without density dependant regulation of reproduction. Comparison of the historical population trend with the outputs from these four versions indicated that the density dependent scenarios generated population predictions that were more closely aligned to the population trend. The density dependent models were also less sensitive to which set of demographic rates was used, and were therefore considered to provide a more reliable predictive tool.

12.10.81 Based on the density dependant model, the application of an additional annual mortality of 1,000 great black-backed gull mortalities to the BDMPS resulted in impacted populations after 25 years which were 6.8% to 8.9% smaller than those predicted in the absence of the cumulative collision impact. The equivalent density independent predictions generated population reductions of 22.6% to 23.0%. Based on this assessment, Natural England concluded a significant cumulative effect could not be ruled out, though the contribution of 39 mortalities from East Anglia THREE was so small that it made no material contribution. By comparison, the Project contributes only five annual mortalities, and therefore the same conclusion of 'no material contribution' is drawn for this Project.

12.10.82 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. However, PVA will be conducted to inform the final EIA which will be presented in the ES to accompany the DCO application.

Lesser Black-Backed Gull

12.10.83 As outlined in Section 12.8, lesser black-backed gulls show a high level of sensitivity to collision with WTGs.

12.10.84 Table 12.63 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. Additionally, not all projects provide a seasonal breakdown of collision impacts. Previous advice from Natural England has suggested an 80:20 split between the non-breeding and breeding seasons for lesser black-backed gull, and therefore for sites where a seasonal split is not presented, this method was considered appropriate.

Table 12.63: 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
Beatrice Demonstrator	-	-	-	1a
Greater Gabbard	12.4	49.6	62	1a
Gunfleet Sands	1	0	1	1a

Project	Breeding	Non-breeding	Annual total	Tier
Kentish Flats	-	-	-	1a
Kentish Flats Extension	0.3	1.3	1.6	1a
Lincs	1.7	6.8	8.5	1a
London Array	-	-	-	1a
Lynn and Inner Dowsing	-	-	-	1a
Scroby Sands	-.	-	-	1a
Sheringham Shoal	1.7	6.6	8.3	1a
Teesside	0	0	0	1a
Thanet	3.2	12.8	16	1a
Humber Gateway	0.3	1.1	1.4	1a
Westermost Rough	0.1	0.3	0.4	1a
Hywind	0	0	0	1a
Kincardine	0	0	0	1a
Beatrice	0	0	0	1a
Dudgeon	7.7	30.6	38.3	1a
Galloper	27.8	111	138.8	1a
Race Bank	43.2	10.8	54	1a
Rampion	1.6	6.3	7.9	1a
Hornsea Project One	4.4	17.4	21.8	1a
Blyth Demonstration Project	0	0	0	1a
Dogger Bank A and B	2.6	10.4	13	1a
Hornsea Project Two	2	2	4	1a
Triton Knoll	7.4	29.6	37	1a
East Anglia ONE	5.9	33.8	39.7	1b
European Offshore Wind Deployment Centre	0	0	0	1b
Seagreen Offshore Wind Farm	2.1	8.4	10.5	1b
Dogger Bank C and Sofia	2.4	9.6	12	1b
Inch Cape	0	0	0	1c
Methil	0.5	0	0.5	1c
Moray Firth (EDA)	0	0	0	1c
Neart na Gaoithe	0.3	1.2	1.5	1c
East Anglia THREE	1.8	8.2	10	1c
Hornsea Project Three (revised)	8	1	9	1c
Norfolk Vanguard	8.4	3.6	12	1c
Moray West	0	0	0	1c
Norfolk Boreas	6.2	8.1	14.3	1c
East Anglia TWO	4.2	0.5	4.7	1c
East Anglia ONE North	0.9	0.6	1.5	1c

Project	Breeding	Non-breeding	Annual total	Tier
Hornsea 4	0.3	0.1	0.4	1d
Dudgeon Offshore Extension Project	1	0.3	1.3	1d
Sheringham Shoal Extension Project	0.5	0	0.5	1d
Rampion 2	0.6	1.2	1.8	2
Total (other projects)	**160.5**	**373.2**	**533.7**	-
the Project	1.5	2.1	3.7	-
All Projects Totals	**162.0**	**375.3**	**537.4**	-

Potential Magnitude of Impact

12.10.85 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 209,007 individuals, whilst the wider bio-geographic population is 864,000 individuals. When considering the average mortality rate of 0.124 (Table 12.9) the background mortality for these two population scales are 25,917 and 107,136 individuals per annum, respectively.

12.10.86 The potential cumulative loss of 537 (537.4) lesser black-backed gulls would represent an increase of 2.074% 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 0.502%. Given the increase in baseline mortality of over 1% at the BDMPS scale, further consideration is given below in relation to lesser black-backed gull risk.

12.10.87 For the projects presented in Table 12.63 it should be noted that unlike for gannet and kittiwake, the recent Natural England interim CRM guidance (Natural England, 2022a) recommends a lower avoidance rate for lesser black-backed gull of 99.4% than the previously used 99.5%, which would result in an increase of predicted collisions (~17% increase per project). However, the projects are also based on a nocturnal activity factor of 50%, which is considered over-precautionary. 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, which would be expected to cancel out any additional mortalities resulting from alterations in avoidance rates.

12.10.88 Additionally, collision estimates from many wind farms presented above which are now operational are calculated for designs with higher numbers of wind turbines than have actually been installed (or are planned). MacArthur Green (2017) have presented a method for updating collision estimates based on this, with estimates for lesser black-backed gull expected to be reduced by around 28% (Appendix 12.3 of East Anglia TWO EIA submission). Therefore, the predicted 537 mortalities are expected to be a considerable overestimate.

12.10.89 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

12.10.90 As outlined in Section 12.8, herring gulls show a major level of sensitivity to collision with WTGs.

12.10.91 Table 12.64 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.

Table 12.64: 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
Beatrice Demonstrator	0	0	0	1a
Greater Gabbard	0	0	0	1a
Gunfleet Sands	-	-	-	1a
Kentish Flats	0	0	0	1a
Kentish Flats Extension	0.5	1.7	2.2	1a
Lincs	0	0	0	1a
London Array	-	-	-	1a
Lynn and Inner Dowsing	0	0	0	1a
Scroby Sands	-	-	-	1a
Sheringham Shoal	0		0	1a
Teesside	8.7	34.5	43.2	1a
Thanet	4.9	19.6	24.5	1a
Humber Gateway	0.4	1.1	1.5	1a
Westermost Rough	0.1	0	0.1	1a
Hywind	0.6	7.8	8.4	1a
Kincardine	1	0	1	1a
Beatrice	49.4	197.4	246.8	1a
Dudgeon	-	-	-	1a
Galloper	27.2	0	27.2	1a
Race Bank	0	0	0	1a
Rampion	155	0	155	1a
Hornsea Project One	2.9	11.6	14.5	1a
Blyth Demonstration Project	0.5	2.2	2.7	1a
Dogger Bank A and B	0	0	0	1a
Triton Knoll	0	0	0	1a

Project	Breeding	Non-breeding	Annual total	Tier
Hornsea Project Two	23.8	0	23.8	1a
East Anglia ONE	0	28	28	1a
European Offshore Wind Deployment Centre	4.8	0	4.8	1a
Seagreen Alpha and Bravo	10	21	31	1b
Dogger Bank C and Sofia	0	0	0	1b
Inch Cape	0	13.5	13.5	1c
Methil	5.8	3.7	9.5	1c
Moray Firth (EDA)	52	0	52	1c
Neart na Gaoithe	5	12.5	17.5	1c
East Anglia THREE	0	23	23	1c
Hornsea Project Three (revised)	1	4	5	1c
Norfolk Vanguard	0.4	7.1	7.5	1c
Moray West	12	1	13	1c
Norfolk Boreas	1.5	5.4	6.9	1c
East Anglia TWO	0	0.5	0.5	1c
East Anglia ONE North	0	0	0	1c
Hornsea 4	0.5	0.3	0.8	1d
Dudgeon Offshore Extension Project	0.25	0	0.25	1d
Sheringham Shoal Extension Project	0	0	0	1d
Rampion 2	24.1	5.5	29.6	2
Total (other projects)	**392.4**	**401.4**	**793.8**	-
The Project	2.7	0.2	3	-
All Projects Totals	**395.1**	**401.6**	**796.8**	-

Potential Magnitude of Impact

12.10.92 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 466,511 individuals, whilst the wider bio-geographic population is 1,098,000 individuals. When considering the average mortality rate of 0.172 (Table 12.9) the background mortality for these two population scales are 80,240 and 188,856 individuals per annum, respectively.

12.10.93 The potential cumulative loss of 797 (796.8) herring gulls would represent an increase of 0.993% 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 0.422%. Since the impact is less than a 1% increase in baseline mortality, the impact is considered undetectable relative to natural changes in population size. However, given the predicted mortality is close to a 1% increase, further consideration is given below.

12.10.94 For the projects presented in Table 12.64, it should be noted that unlike for gannet and kittiwake, the recent Natural England interim CRM guidance (Natural England, 2022a) recommends a lower avoidance rate for herring gull of 99.4% than the previously used 99.5%, which would result in an increase of predicted collisions (~17% increase per project). However, the projects are also based on a nocturnal activity factor of 50%, which is considered over-precautionary. 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, which would be expected to cancel out any additional mortalities resulting from alterations in avoidance rates. 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.

12.10.95 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.

Sandwich Tern

12.10.96 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).

12.10.97 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:

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

12.10.98 Adjusted rates are presented in Table 12.65 below.

12.10.99 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 terns.

Table 12.65: Summary of cumulative O&M phase collision predictions for Sandwich terns based on consented turbine parameters (Scenario A) and as-built turbine 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	-	1.5
Total (all projects)	**-**	**81.3**
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	-	1.5
Total (all projects)	**-**	**45.6**

Potential Magnitude of Impact

12.10.100 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.

12.10.101 Based on the CRM results using the consented OWF designs (Scenario A; Table 12.65), 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%

12.10.102 Considering the CRM results using the more realistic as-built OWF designs (Scenario A; Table 12.65), 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.

12.10.103 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

12.10.104 As outlined in Section 12.8, gannets show a medium level of sensitivity to collision with WTGs.

12.10.105 Table 12.66 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 wind farms are impacted by displacement and continue to be at risk of collision.

Table 12.66: Cumulative bio-season and annual collision mortality estimates for gannet from all Tier 1 and 2 projects

Project	Breeding	Post-breeding migration	Return migration	Annual total	Tier
Beatrice	37.4	48.8	9.5	95.7	1a
Blyth Demonstration Site	3.5	2.1	2.8	8.4	1a
Dudgeon	22.3	38.9	19.1	80.3	1a
East Anglia One	3.4	131.0	6.3	140.7	1a
EOWDC	4.2	5.1	0.1	9.3	1a
Galloper	18.1	30.9	12.6	61.6	1a
Greater Gabbard	14	8.8	4.8	27.5	1a
Gunfleet Sands	-	-	-	-	1a
Hornsea Project One	11.5	32	22.5	66	1a

Project	Breeding	Post-breeding migration	Return migration	Annual total	Tier
Humber Gateway	1.9	1.1	1.5	4.5	1a
Hywind 2 Demonstration	5.6	0.8	0.8	7.2	1a
Kentish Flats	1.4	0.8	1.1	3.3	1a
Kentish Flats Extension	-	-	-	0	1a
Kincardine	3	0	0	3	1a
Lincs, Lynn and Inner Dowsing	2.3	1.4	1.9	5.6	1a
London Array	2.3	1.4	1.8	5.5	1a
Methil	6	0	0	6	1a
Race Bank	33.7	11.7	4.1	49.5	1a
Rampion	36.2	63.5	2.1	101.8	1a
Scroby Sands	-	-	-	-	1a
Sheringham Shoal	14.1	3.5	0	17.6	1a
Teesside	4.9	1.7	0	6.7	1a
Thanet	1.1	0	0	1.1	1a
Westermost Rough	0.2	0.1	0.2	0.5	1a
Hornsea Project Two	7	14	6	27	1a
Triton Knoll	26.8	64.1	30.1	121	1a
Moray East	80.6	35.4	8.9	124.9	1a
Seagreen Alpha and Bravo	800.8	49.3	65.8	915.9	1b
Dogger Bank A and B	81.1	83.5	54.4	219	1b
Dogger Bank C and Sofia	14.8	10.1	10.8	35.7	1b
East Anglia Three	5.2	28.4	8.2	41.8	1c
Hornsea Three	3	2	2	6	1c
Inch Cape	336.9	29.2	5.2	371.3	1c
Moray West	10	2	1	12	1c
Neart na Gaoithe	143	47	23	213	1c
East Anglia ONE North	12.4	11	1.1	24.5	1c
East Anglia TWO	12.5	23.1	4	39.6	1c
Norfolk Boreas	14.1	12.7	3.9	30.7	1c
Norfolk Vanguard	8.2	18.6	5.3	32.1	1c
Hornsea Four	13.4	4.9	1.8	20.2	1d
Dudgeon Extension Project	1.8	2.8	0.2	4.8	1d
Sheringham Shoal Extension Project	0.3	0.7	0	1	1d
Rampion 2	9.7	4	1.4	15.1	2
Total (other projects)	**1,814.7**	**834.7**	**328.4**	**2,977.9**	-
The Project	2.9	0.4	0.4	3.7	-
All Projects Totals	**1,817.6**	**835.1**	**328.8**	**2,981.6**	**-**

Potential Magnitude of Impact

12.10.106 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 456,298 individuals whilst the wider bio-geographic population is 1,180,000 individuals. Using the average mortality rate of 0.187 (Table 12.9), the background mortality for these population scales are 85,328 and 220,660 individuals per annum, respectively.

12.10.107 The predicted annual cumulative collision mortality is 2,982 (2,981.6), of which the Project contributes four (3.7) birds. At the UK North Sea and English Channel BDMPS scale, the potential cumulative loss of 2,982 birds represents a 3.494% in baseline mortality. At the biogeographic scale, this additional mortality would increase baseline mortality by 1.351%.

12.10.108 It should be noted that Natural England's interim CRM guidance (Natural England, 2022a) advises that gannet avoidance rate should be 99.2%, as opposed to the previously used rate of 98.9%. Consequently, data presented for other OWFs are considered to over-estimate cumulative collisions. Advice from Natural England suggests reducing the density of gannets in flight going into the CRM, either by a representative range of macro-avoidance rates of between 65% - 85% or by selecting a single rate of 70%. Applying the single macro-avoidance rate of 70% to projects presented in Table 12.66 would reduce the annual cumulative collision mortality to 893 (893.4) individuals, with the addition of four (3.7) individuals from the Project increasing this to 897 (897.1) individuals. Based on this value, the impact on the BDMPS population would be reduced to a 1.051% increase in baseline mortality, and the impact on the biogeographic population reduced to a 0.407% increase in baseline mortality. Applying a macro-avoidance rate range of 65% to 85% would reduce the annual predicted cumulative collision mortality to 450 (450.4) – 1,046.

12.10.109 The Natural England interim CRM guidance (Natural England, 2022a) also advises the use of a nocturnal activity factor for gannet of 8% as opposed to the previously used 25%. To calculate the changes this makes for each wind farm included in the cumulative assessment would require calculation of a mortality adjustment rate for each month at each wind farm, 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.

12.10.110 Additionally, collision estimates from many wind farms presented above which are now operational are calculated for designs with higher numbers of wind turbines 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).

12.10.111 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 wind farm 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.

Cumulative Impact Assessment: Combined Collision Risk and Displacement (O&M Phase)

Gannet

12.10.112 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 wind farm cannot then be subject to collision mortality from the same site).

12.10.113 As presented in Section 12.8, the annual cumulative mortality estimate resulting from displacement is 354 (based on 70% displacement and 1% mortality), and for collision the mortality estimate is. 2,982 individuals. This results in a combined annual mortality of 3,336 individuals.

12.10.114 Based on the largest UK North Sea and English Channel BDMPS of 456,298 and a baseline mortality of 85,328 individuals per annum, the addition of 3,336 mortalities per annum would result in a 3.910% increase in baseline mortality. Based on the biogeographic population of 1,180,000 individuals and a baseline mortality of 220,660, the addition of 3,336 additional mortalities would result in a 1.512% increase in baseline mortality.

12.10.115 While the cumulative impact is above the threshold of a 1% increase in baseline mortality at both the BDMPS and biogeographic scales, it is 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 macro-avoidance and nocturnal activity rates and revisions to wind farm parameters post-consent. In addition, the UK gannet population has increased considerably over the last approximately 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 SMP database (JNCC, 2020). Considering these increases, the cumulative impacts resulting from the Project are highly unlikely to impact the trend of the increasing regional gannet population.

12.10.116 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 Inter-Relationships

12.11.1 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.

12.11.2 Identified inter-relationships are summarised in Table 12.67, which indicates where assessments carried out in other PEIR chapters have been used to inform the offshore ornithology assessment.

Table 12.67: 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 and Intertidal Ecology	Section 12.7	Potential impacts on fish, shellfish and benthic ecology during construction, O&M and decommissioning could affect prey resource for offshore ornithological receptors

12.11.3 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.

12.12 Transboundary Effects

12.12.1 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.

12.12.2 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 reduction in impact as opposed to an increase.

12.13 Conclusions

12.13.1 A summary of potential impacts assessed within this PEIR, alongside any mitigation and residual effects, is presented in Table 12.68 and Table 12.69 below.

Table 12.68: 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	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	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.	Minimum tip height raised to 30m 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	To be confirmed post-PEIR	Minimum tip height raised to 30m HAT from 22m	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 12.69: 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
Operation and maintenance			
Impact 4: Disturbance and displacement: Array area	Minor significance of effect for gannet, guillemot, razorbill and puffin. Impact for red-throated diver to be determined following PVA post-PEIR	None proposed beyond existing commitments	Not significant (Red-throated diver to be confirmed post-PEIR)
Impact 5: Collision risk: Array area	Negligible significance of effect for Sandwich tern Minor significance of effect for all other species.	Minimum tip height raised to 30m HAT from 22m	Not significant
Impact 6: Collision risk to migratory birds: Array area	To be confirmed post-PEIR	Minimum tip height raised to 30m HAT from 22m	Not significant
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	Not significant
Decommissioning			
As with construction			

12.14 References

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