Environmental Impact Assessment Report

NISA

North Irish Sea Array

Volume 3: Offshore Chapters

Chapter 15

Offshore Ornithology

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CIP Copenhagen Infrastructure Partners

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15.1 Introduction

15.1.1 Overview

This chapter of the Environmental Impact Assessment Report (EIAR) presents an assessment of likely significant effects from the North Irish Sea Array (NISA) Offshore Wind Farm (hereafter referred to as the 'proposed development') in relation to offshore and intertidal ornithological receptors during the construction, operation and decommissioning phases.

This chapter sets out the methodology followed (Section 15.2), describes the baseline environment (Section 15.3) and summarises the main characteristics of the proposed development which are of relevance to offshore and intertidal ornithological receptors (Section 15.4), including any embedded mitigation. Potential impacts and relevant receptors are identified, and an assessment of likely significant effects on offshore and intertidal ornithology is undertaken, details of which are provided (Section 15.5).

Additional mitigation measures are proposed to mitigate and monitor these effects if required (Section 15.6) and any residual likely significant effects are then described (Section 15.7). Transboundary effects are considered (Section 15.8), and cumulative effects are considered in Section 15.9 and are summarised in Volume 6, Chapter 38 Cumulative and Inter-Related Effects (hereafter referred to as the 'Cumulative and Inter-Related Effects Chapter'). The chapter then provides a reference section (Section 15.10).

The EIAR also includes the following:

- Detail on the competent experts that have prepared this chapter is provided in Appendix 1.1 in Volume 8
- Detail on the extensive consultation that has been undertaken with a range of stakeholders during the development of the EIAR is set out in Appendix 1.2
- A glossary of terminology, abbreviations and acronyms is provided at the beginning of Volume 2 of the EIAR; and
- A detailed description of the proposed development including construction, operation and decommissioning is provided in Volume 2, Chapter 6: Description of the Proposed Development – Offshore (hereafter referred to as the 'Offshore Description Chapter'), and Volume 2, Chapter 8: Construction Strategy – Offshore (hereafter referred to as the 'Offshore Construction Chapter').

The assessment should be read in conjunction with the following linked EIAR chapters within Volume 3:

- Chapter 12: Benthic Subtidal and Intertidal Ecology (hereafter referred to as the Benthic Ecology Chapter); and
- Chapter 13: Fish and Shellfish Ecology (hereafter referred to as the Fish and Shellfish Chapter).

The chapter should also be read in conjunction with Volume 4, Chapter 23: Biodiversity (hereafter referred to as the Biodiversity Chapter) which provides further information on impacts on ornithological receptors landward of the High Water Mark (HWM), and the Natura Impact Statement (NIS) (North Irish Sea Array Windfarm Ltd, 2024) which provides a specific assessment of the impacts on designated sites for relevant offshore and intertidal ornithological receptors.

This chapter should also be read alongside the following appendices within Volume 9:

- Appendix 15.1: Offshore and Intertidal Ornithology Technical Baseline (hereafter referred to as the Technical Baseline)
- Appendix 15.2: MRSea Modelling for Offshore Ornithology (hereafter referred to as the MRSea Modelling Report)

- Appendix 15.3 Offshore and Intertidal Ornithology Collision Risk Modelling Assessment (CRM; hereafter referred to as the CRM Report)
- Appendix 15.4 Offshore and Intertidal Ornithology Migratory Collision Risk Modelling (hereafter referred to as the Migratory Report)
- Appendix 15.5 Offshore and Intertidal Ornithology Displacement Analysis (hereafter referred to as the Displacement Report)
- Appendix 15.6 Offshore and Intertidal Ornithology Population Viability Analysis (PVA; hereafter referred to as the PVA Report)
- Appendix 15.7 Method Statement – Offshore Wind Ornithology Assessment for East Coast Phase One Projects (hereafter referred to as the Irish Phase One Method Statement)
- Appendix 15.8 NPWS Review of Method Statement; and
- Appendix 15.9: Method Statement Review Consultation and Justification Log.

All figures within this Chapter are provided in Volume 7A.

15.2 Methodology

15.2.1 Introduction

The assessments of offshore and intertidal ornithology are consistent with the EIA methodology presented in Volume 2, Chapter 2: EIAR and Methodology for the preparation of an EIAR (hereafter referred to as the EIAR Methodology Chapter).

15.2.2 Study Area

The offshore and intertidal ornithology study area was initially identified at the proposed development scoping phase as the Maritime Area Consent (MAC) boundary plus 4km buffer, in line with Department of Communications, Climate Action and Environment (DCCAE) (now the Department of the Environment, Climate and Communications; DECC) Guidance (DCCAE, 2017) (Scoping report: Appendix 2.1). This initial study area was used to scope the survey methodologies and inform baseline data gathering. The extent of the digital aerial survey (DAS) that has been undertaken is the MAC Boundary with a 4km buffer but excludes the offshore Export Cable Corridor (ECC) (refer to Section 15.2.5). This baseline data and other sources (refer to Section 15.2.4) have been used to generate abundance and density estimates for each species and this is presented in the Technical Baseline appendix. Regional and/or the biogeographical population data has also been considered. This allows consideration of the mobile nature of the ornithology species when determining potential receptors and their baseline characterisation.

There are four study areas used within this chapter for the purposes of the impact assessment, which are based on a Zone of Influence (ZoI) that is dependent on the results of the baseline data gathering, the nature of the impact, and the sensitivity of the species to that impact. The study areas are presented on Figure 15.1 and are:

- The study area for disturbance and displacement impacts to seabird species (excluding ducks and divers) from activities and infrastructure in the array area, is the array area plus a 2km buffer
- The study area for disturbance and displacement impacts to seaducks and divers from activities and infrastructure within the ECC is limited to the ECC only
- The study area for disturbance and displacement impacts to birds found within the intertidal and nearshore area (assessed qualitatively), is the ECC only; and
- The study area for collision impacts to seabirds is limited to the array area only.

Following review of the baseline data and establishing the ZoI’s, seaducks and divers were scoped out of the displacement and disturbance impact assessment from the array area and so a study area for this is not included within the above (refer to Section 15.5.2.1).

Furthermore, seaducks and divers were the only species assessed for disturbance from the ECC, so a study area for all other species in relation to the ECC is not included within the above (refer to Section 15.5.2.1).

Assessment of offshore activities and impacts on birds found within the intertidal and subtidal zones are presented in this chapter. Onshore activities that may affect birds found within the intertidal area are assessed within Chapter 23 Biodiversity. Where there is the potential for a single offshore ornithology receptor to be impacted by both onshore and offshore activities, this is addressed in this chapter.

15.2.3 Relevant Guidance and Policy

This section outlines guidance and policy specific to offshore and intertidal ornithology, including best practice guidelines. Overarching guidance on EIA is presented in the EIAR Methodology Chapter. Furthermore, policy applicable to the proposed development is detailed in Volume 2, Chapter 3: Legal and Policy Framework.

The EIAR for the proposed development also draws on a number of relevant guidance documents. As a key part of this, east coast Phase one Irish projects (hereafter 'Phase one projects') have developed a methodology statement for ornithological assessments to promote consistency across impact assessments, referred to in this EIAR chapter as the 'Irish Phase One Methodology Statement'. This approach has been welcomed by NPWS and they have given responses to the material provided which have been considered within the impact assessment. A summary of these responses and how they have been considered within the assessment is provided in Appendix 15.9: Method Statement Review Consultation and Justification Log. In addition, the following guidance documents have been used to inform the approach:

- Updated CRM guidance by Natural England (Natural England, 2022) and the JNCC (JNCC, 2023) based on original data by Cook et al. (2012) developed for use on the Band model (Band et al., 2012)
- Recently published guidance from NatureScot for the assessment of offshore wind farm (OWF) impacts on ornithological receptors (NatureScot, 2023a,b,c,d); and
- Updated guidance on assessing displacement impacts (MIG-Birds, 2022).

Further to this, the following guidance documents have been used to inform the ornithological impact assessment:

- Guidance on best practice for baseline data, the evidence plan process and data analysis and presentation provided by Natural England (Parker et al., 2022a,b,c)
- Natural England interim advice on updated Collision Risk Modelling parameters (Natural England, 2022)
- NRW's offshore wind developments online information (NRW, 2023)
- Guidelines on the information to be contained in Environmental Impact Assessment Reports by the Environment Protection Agency (EPA, 2022)
- Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Marine and Coastal published by the Chartered Institute of Ecology and Environmental Management (CIEEM, 2018)
- Assessment methodologies for offshore wind farms (Maclean et al., 2009)
- Guidance on ornithological cumulative impact assessment for offshore wind developers (King et al., 2009)
- Assessing the risk of offshore wind farm development to migratory birds (Wright et al., 2012); and
- Vulnerability of seabirds to offshore wind farms (Furness and Wade, 2012; Furness et al., 2013; Wade et al., 2016; Bradbury et al., 2014).

Alongside these documents, several other international legislative frameworks are considered relevant, including:

- European Commission ('EC') Directive 2009/147/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')
- The European Communities (Birds and Natural Habitats) Regulations 2011- 2021
- The Wildlife Acts 1976 – 2022; and
- Ramsar Convention on Wetlands of International Importance 1971.

Planning policy on renewable energy infrastructure is presented in Volume 2, Chapter 3: Legal and Policy Framework.

The key National Marine Planning Framework (NMPF) policy that is applicable to the assessment of offshore and intertidal ornithology is summarised in Table 15.1. NMPF policies are addressed in their entirety in Appendix 3.1: NMPF Compliance Report.

Table 15.1 Key NMPF policies relevant to the assessment

Policy Name	Policy Description	Where addressed
National Marine Planning Framework (2021)	**Biodiversity Policy 1** Proposals incorporating features that enhance or facilitate species adaptation or migration, or natural native habitat connectivity will be supported, subject to the outcome of statutory environmental assessment processes and subsequent decision by the competent authority, and where they contribute to the policies and objectives of this NMPF. Proposals that may have significant adverse impacts on species adaptation or migration, or on natural native habitat connectivity must demonstrate that they will, in order of preference and in accordance with legal requirements a) avoid, b) minimise, or c) mitigate significant adverse impacts on species adaptation or migration, or on natural native habitat connectivity.	The likely significant effects on migratory species during the operational phase of the proposed development will be reduced where practicable through embedded mitigation (presented in Section 15.4.5) with residual effects on migratory species given full consideration in Sections 15.5 and 15.9.
	Biodiversity Policy 2 Proposals that protect, maintain, restore and enhance the distribution and net extent of important habitats and distribution of important species will be supported, subject to the outcome of statutory environmental assessment processes and subsequent decision by the competent authority, and where they contribute to the policies and objectives of this NMPF. Proposals must avoid significant reduction in the distribution and net extent of important habitats and other habitats that important species depend on, including avoidance of activity that may result in disturbance or displacement of habitats.	The likely significant effects of the construction, operational and maintenance and decommissioning phases of the proposed development is assessed in Section 12.5.including effects on seabirds whilst on migration and access to key habitats.
	Biodiversity Policy 3 Where marine or coastal natural capital assets are recognised by Government: • Proposals must seek to enhance marine or coastal natural assets where possible. • Proposals must demonstrate that they will in order of preference, and in accordance with legal requirements: a) avoid, b) minimise, or c) mitigate significant adverse impacts on marine or coastal natural capital assets, or d) if it is not possible to mitigate significant adverse impacts on marine or coastal natural capital assets proposals must set out the reasons for proceeding.	The likely significant effects on ornithological receptors has been avoided/minimised where practicable through embedded mitigation (presented in Section 15.4.5) with remaining effects given full consideration in Sections 15.5 and 15.9

Policy Name	Policy Description	Where addressed
	Biodiversity Policy 4 Proposals must demonstrate that they will, in order of preference and in accordance with legal requirements: a) avoid, b) minimise, or c) mitigate significant disturbance to, or displacement of, highly mobile species.	The likely significant effects arising from disturbance and displacement are assessed in Section 15.5. Embedded mitigation for the proposed development has been undertaken to minimise likely significant effects, as outlined in Section 15.4.5.

15.2.4 Data Collection and Collation

15.2.5 Site-specific Surveys

A range of data sources were used to characterise the study area in terms of offshore and intertidal ornithology as well as determine potential impacts of OWFs on ornithological receptors. To inform the EIAR, a number of site-specific surveys were undertaken to inform the offshore and intertidal ornithology impact assessment, as outlined in Table 15.2 below. Information on site-specific surveys (both methodology and survey results) is presented in the Technical Baseline.

Table 15.2 Site-specific data considered in the development of the ornithology baseline

Source	Date	Summary	Temporal and spatial coverage
Existing project survey data			
Digital aerial survey (DAS) data	2020-2022	DAS surveys conducted by APEM Ltd. on a monthly basis between May 2020 and October 2022[1], with data used to characterise the baseline environment and form the main basis of the assessment of likely significant effects from the proposed development. Throughout this process, boundary refinements have taken place, with the final array area representing 36% of the boundary that was surveyed during the site specific DAS surveys. The data used to inform this EIAR chapter consists of data within the final defined array area and 4km buffer for the proposed development.	A total of 16 transects with 2.3km spacing totalling 15% coverage of the survey area. The original site-specific DAS survey extent mirrored the array area within the foreshore licence plus a 4km buffer. The DAS survey extent was updated in November 2020 to include the entire MAC boundary (which included the small area beyond 12nm that was not within the original DAS survey extent). The key study area covered by DAS data is the array area plus 2km buffer.
Boat-based survey data	2019 - 2022	Vessel surveys were conducted by in November 2019, January 2020, March 2020, August 2020, June 2021, July 2021, and July 2022. Initial baseline characterisation was undertaken using vessel-based surveys, however these were then succeeded by DAS data collection as the main form of data collection in line with industry standard (e.g., as requested by SNCBs for UK projects). Vessel surveys were consequently used as supplementary data only, as outlined in the Technical Baseline.	Array area within the foreshore licence plus a 4km buffer. Variable transects and coverage.
Landfall surveys	2021 - 2022	Intertidal bird surveys were conducted at the selected landfall site to characterise the baseline environment in terms of ornithological receptors.	Includes the intertidal area and immediate onshore area of the landfall.
Coastal vantagepoint surveys	2019 - 2021	Vantagepoint surveys conducted at two locations to better quantify the movements of migratory species and to supplement DAS data collection	Includes the intertidal area and out to the array area at the north and south edge at each location respectively.

[1] Data was not collected in January 2021 due to adverse weather

15.2.6 Desk-based Review

A detailed desktop study was also undertaken to inform the EIAR, covering a wide variety of published literature, including both peer reviewed scientific literature and the 'grey literature' such as wind farm project submissions and reports. Key desktop sources are outlined in Table 15.3 below.

Table 15.3 Desktop study data considered in the development of the ornithology baseline

Source(s)	Date	Summary	Temporal and spatial coverage
Relevant literature on seabird distribution, population sizes, migration routes and foraging ranges			
JNCC Report No. 267 (Pollock et al. 1997)	1997	European Seabirds at Sea (ESAS) survey data collected between 1980 and 1997 in Irish waters, including a period of intensive surveys between 1994 and 1997, which targeted areas around Ireland with poor survey coverage. Used to provide historic context for the wider Irish Sea.	Offshore waters around Ireland, within and beyond Ireland's continental shelf.
ObSERVE (Jessop et al. 2018)	2018	Visual aerial surveys of the western Irish Sea. Four surveys: summer 2015, winter 2015, summer 2016 and winter 2016.	Offshore waters around Ireland, within and beyond Ireland's continental shelf.
Designated sites	Various dates	Information of Special Protection Areas (SPAs) and other designations relevant to Important Ornithological Features (IOFs) with potential connectivity to the proposed development. Key sources of information are the Natural England, NPWS, NatureScot and NRW designated sites portals.	Country wide information on designated sites.
Seabird Monitoring Programme (SMP) (BTO, 2023)	2015-2020	Online database of seabird colony counts in Ireland and UK – most recent data from Seabirds Count national census 2015-2021. Used to provide SPA reference populations for the EIAR.	Colony counts in Ireland and UK
NPWS Published Report (Cummins et al. 2019)	2019	The Status of Ireland's Breeding Seabirds: Birds Directive Article 12 Reporting 2013 – 2018. Used to provide SPA reference populations for the EIAR.	Ireland
Birdwatch Ireland Irish Wetland Bird Survey (I-WEBS)	Annual Reports	Annual survey reports of wetland waterbirds and intertidal birds throughout the Republic of Ireland.	Coverage of Irish intertidal and wetland zones.
Regional and national bird reports and atlases	Various	Atlases covering breeding and non-breeding birds within relevant areas, e.g. Birds in Ireland (Hutchinson, 2010), North-west European waters (Stone et al., 1995) and in Europe (BirdLife international, 2004).	Coverage across region at various intertidal and wetland and coastal areas.
Review of seabird foraging ranges - Woodward et al., (2019)	2019	British Trust for Ornithology (BTO) report updating foraging ranges of seabirds. These are used to consider connectivity with both designated sites and other OWFs. This report provides an update from previous information on foraging ranges from Thaxter et al., (2012).	Review of foraging ranges covered available information across the globe.
Literature on seabird foraging movements	Various	Various sources on seabird foraging (e.g. tracking data), including the FAME Project (Baer & Newton, 2012) and tern tracking data at Rockabill Island (Perrow et al., 2019)	Various sources in Ireland.
Non-breeding season populations of seabirds in UK waters: Population sizes for Biologically Defined Minimum Population Scales (regional population) – Furness (2015)	2015	Furness 2015 provides regional non-breeding season population sizes for relevant offshore ornithological receptors. Though focussed on UK waters, population sizes in UK Western Waters are considered relevant to Ireland.	Coverage across the UK.

Source(s)	Date	Summary	Temporal and spatial coverage
The status of Ireland's Breeding Seabirds: Birds Directive Article 12 Reporting 2013 – 2018 – Cummins et al (2019)	2019	NPWS commissioned report providing data on breeding seabird population sizes and trends of Ireland's breeding seabird species.	Coverage across Ireland
Literature on migratory bird populations and movements relevant to the proposed development	Various	Various sources on migratory birds and movements, including 'The Migration Atlas: Movements of the birds of Britain and Ireland' (Wernham et al., 2002), and literature on the risk of OWF developments to migratory birds (Wright et al., 2012).	UK and Ireland.
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 the proposed development IOFs.
JNCC review of seabird demographic rates (Horswill and Robinson 2015)	2015	Information on demographic rates of seabirds, used to inform the EIAR assessment.	Predominantly UK based, with data from further afield also considered.
eBird[2] citizen science data	Various dates	Information on bird observations in relevant areas was used to supplement vantagepoint surveys (e.g., data from Clogher Head[3] to compare recorded species distributions)/	UK and Ireland
Relevant literature on the vulnerability of birds to OWFs			
Potential impacts of offshore windfarms on birds	Various dates	Various peer reviewed scientific literature regarding the potential impacts from OWF e.g. (Garthe and Hüppop, 2004; Drewitt and Langston, 2006; Stienen et al., 2007; Speakman et al., 2009; Langston, 2010; Band, 2012; Cook et al., 2012; Furness and Wade, 2012; Wright et al., 2012; Furness et al., 2013; Johnston et al., 2014a,b; Cook et al., 2014; Dierschke et al., 2017; Jarrett et al., 2018; Leopold & Verdaat, 2018; Mendel et al., 2019);	Generic information applicable to the proposed development IOFs.
Potential impacts resulting from highly pathogenic avian influenza (HPAI)	Various	Various literature regarding the impacts of HPAI on seabird species is considered in relation to potential additional impacts on ornithological receptors assessed in this EIAR. These include: Paradell et al., (2023), Lane et al., (2023), Pearce-Higgins et al., 2022). Available information on HPAI from sources such as Birdwatch Ireland and the BTO is also considered wherever relevant.	Ireland and further afield.

15.2.7 Data Limitations

The marine environment is highly variable, both spatially and temporally. The baseline site characterisation for the offshore ornithology impact assessment is based on site-specific data, predominantly 29 months of DAS data collected within the offshore and intertidal ornithology study area. These are considered to provide representative seabird usage for the purposes of impact assessment, with landfall and vantagepoint surveys also used to characterise both the offshore and intertidal ornithology study areas.

[3] https://ebird.org/barchart?r=L7333978&yr=all&m=

Initial data collection for the proposed development involved boat-based data collection, however there are standard limitations to this form of data collection, notably:

- Bias in data collection due to potential disturbance or attraction of seabird species to vessels. For example, species such as divers and scoters which are highly sensitive to displacement impacts may be less evident in boat-based surveys due to this response (Kaiser et al., 2006; Schwemmer et al., 2011; Furness et al., 2013), while other species such as fulmar, gannet and large gulls may be attracted to vessels (Buckland et al., 2012); and
- For DAS data collection, there is a permanent record of birds seen which can be subject to quality assurance, with this generally not possible for visual surveys undertaken on vessels.

To reflect the higher suitability of DAS data collection, this method became the primary form of baseline characterisation data as of May 2020. Though there are also standard limitations to this method, notably that DAS surveys only provide a snapshot survey of a specific day and timeframe which may not be representative of overall density at a site, and the fact that DAS surveys are limited by certain weather conditions (e.g. in January 2020, an aerial survey was not undertaken due to adverse weather), this form of data collection is currently considered industry best practice in the UK (e.g. it is currently used routinely as the primary means of data collection at UK projects). Additionally, to improve the representativeness of data, the proposed development undertook data collection over 29 months (as opposed to the standard minimum of 24-months) which provided a larger dataset and data across a third breeding season to provide greater confidence in seasonal abundance and density data.

The same limitations are also true across vantage point and landfall surveys used to characterise the intertidal and offshore environment (i.e., they provide a snapshot of data and can be impacted by weather). However, the collection of several datasets across this area (i.e., DAS, vantagepoint and landfall) allows cross comparison of key species, reducing any uncertainty due to data limitations.

Across both DAS and vessel surveys, flight height data was collected. However, there are limitations to both data collection methods applied with the calculation of flight heights from DAS data associated with very high levels of uncertainty, and flight height data collection from vessels more prone to human error. This was notable across data collected for the proposed development, with a lack of agreement on flight height data between DAS and vessel data (as outlined in further detail in the Technical Baseline). In addition, the sample size available to produce species-specific flight height distributions for almost all species was very low, reducing the accuracy and confidence in these data. Therefore, site-specific flight height data was not used in the assessment of likely significant effects. The proposed development used generic flight height data from Johnston et al., (2014a,b) within CRMs. This approach is also considered standard industry practice (e.g. recommended for use by both NatureScot and Natural England). Johnston et al., (2014a,b) flight heights are derived from tens of thousands of samples across 32 potential OWF development sites and covering a wide variety of behaviours.

Despite the presented data limitations, the baseline data collected for the proposed development is considered to be of sufficient standard to robustly inform the assessment of likely significant effects on ornithological receptors. The data is comparable to that collected for other relevant projects (both Phase one Irish Projects and UK projects) and complies with general guidance on baseline characterisation from UK Statutory Nature Conservation Bodies (SNCBs) .

As such, confidence in the modelling outputs and the assessments they inform is high. Displacement and mortality rates used for each species are in line with values recommended by UK SNCBs for other OWFs (e.g., Natural England and NatureScot) which are generally considered to be precautionary measures based on available evidence (e.g., post-construction monitoring at the Beatrice OWF; MacArthur Green, 2023). Therefore, any estimated impacts are considered to be overestimated in terms of their potential magnitude. In addition, when considering the baseline data collected for this report, DAS data which forms the main basis of the disturbance and displacement assessment is considered high quality and in line with industry standards, with the assessment based on this data also considered precautionary due to the consideration of seasonal mean peaks (i.e., assuming the peak abundance is true of the whole season, therefore overestimating bird abundance during the assessment).

For the assessment within the ECC, DAS data from Jessop et al., (2018) were used. Confidence in this data is also considered high, with the surveys representing a 10.5% coverage of the ECC plus 4km buffer (in line with the industry standard of 10% coverage).

15.2.7.1 Confidence in the assessment conclusions

Displacement and mortality rates used for each species are in line with values recommended by UK SNCBs for other OWFs (e.g., Natural England and NatureScot) which are considered to be highly precautionary based on available evidence (e.g., post-construction monitoring at the Beatrice OWF; MacArthur Green, 2023). Therefore, the magnitude of impacts presented throughout the assessment are highly likely to be vastly overestimated. For example, the assessment is based on seasonal mean peaks, and therefore assumes the peak abundance is true of the whole season, overestimating bird abundance. In addition, the DAS data which forms the main basis of the disturbance and displacement assessment is considered high quality and in line with industry standards, with three full breeding seasons of data collected for the majority of species.

Confidence in the conclusions for the collision risk assessment is considered high. The assessment was undertaken in line with UK SNCB guidance for other OWF projects (e.g., Natural England and NatureScot), and using parameter values that are considerably more conservative than the latest evidence suggests is reasonable. For example, the assessment used avoidance rates for species groups rather than species specific rates presented in Ozsanlav-Harris et al. (2023). For example, great black backed gull avoidance rate using the species group rates of 0.994

In addition, when considering the baseline data collected for this report, DAS data which forms the main basis of the collision risk assessment is considered high quality and in line with industry standards and as agreed in the Irish Phase one Methodology Statement' .

Confidence in the assessment conclusions for Impact 7 is considered high, with the assessment undertaken based on the best available evidence and also in line with UK SNCB guidance for other OWF projects (e.g., Natural England and NatureScot).

Confidence in the assessment of impacts related to impacts on prey is considered high, with the other chapters which inform this assessment being based on the best available evidence, and best practice methodologies, in assessing potential impacts and drawing conclusions. Therefore, the assessment of these likely significant effects on offshore ornithology receptors is robust.

Confidence in the assessment of impacts of light pollution is considered moderate, noting that evidence is focussed largely on Manx shearwater with less information available for other species (e.g., storm petrel). As outlined below, evidence on likely significant effects due to artificial light is limited, though based on the best available research, the assessment is able to provide a qualitative analysis considering available data and information on specific species ecology.

Confidence in the assessment of impacts due to pollution is considered high. Information relating to likely significant effects of pollutants from OWF developments is limited, and therefore the ability to draw detailed conclusions is limited. However, based on project mitigation, the likelihood of this effect is sufficiently low that there is high confidence in the low likelihood of any effect occurring.

15.2.8 Designated Sites

Article 3(1) of the EIA Directive requires the EIA to identify, describe and assess the direct and indirect significant effects of a project on: '(b) biodiversity, with particular attention to species and habitats protected under Directive 92/43/EEC and Directive 2009/147/EC'. Where European sites (i.e. internationally designated sites) are considered, this chapter summarises the assessments made on the qualifying interests of these sites (with the assessment of likely significant effects on the site itself deferred to the Natura Impact Statement (NIS; North Irish Sea Array Windfarm Ltd, 2024) for the proposed development).

All designated sites with connectivity to the proposed development were identified, if any sites were both an international and national site protected for the same features the national or local conservation concerns have been checked in each case to confirm they are the same and can be assessed together.

Six designated sites have been identified which are considered the most relevant to the offshore and intertidal ornithology EIAR assessment based on their proximity to the proposed development, and the features for which they are designated (noting that these six sites, alongside all other screened SPAs with potential connectivity to the proposed development are fully considered within the NIS). These SPAs correspond with those highlighted in the Site Synopsis for the North-West Irish Sea candidate SPA. Any SPAs outside of the North-West Irish Sea have lower connectivity to the proposed development and therefore the impacts are diluted to a point where they are will not have a significant impact on SPA populations.

SPAs considered within the EIAR include:

- North-West Irish Sea candidate SPA (cSPA)
- Rockabill SPA
- Lambay Island SPA
- Ireland's Eye SPA
- Skerries Island SPA; and
- Boyne Estuary SPA.

The offshore development area is located within the North-West Irish Sea cSPA, which covers an area of 2,333km^2 and is designated for 21 bird species, including four tern species, three auk species, seven gull species, two diver species, fulmar (*Fulmaris glacialis*), Manx shearwater (*Puffinus puffinus*), shag (*Phalacrocorax aristotelis)*, cormorant (*Corvus marinus*) and common scoter (*Melanitta nigra*). All designated species have been considered in the ornithology assessment in Section 15.5. Notable exceptions to this include cormorant and shag which are not considered at risk of collision effects (based on flight height data) or displacement impacts (with evidence of birds even being attracted to OWFs and roosting on the structures) (Bradbury et al. 2014, Dierschke et al. 2016). Furthermore, no cormorants were identified in 29 months of DAS data, and only one shag. Similarly, only one Sandwich tern (*Thalasseus sandvicensis*) was recorded and therefore no likely significant effects on this species are expected.

The Rockabill SPA is also located within close proximity (0.2km) to the array area and is designated for three tern species and purple sandpiper. Consideration to tern species is given through an assessment on collision risk in Section 15.5, with purple sandpiper assessed in the migratory collision risk assessment. Notably purple sandpiper is considered low risk, with no birds recorded during DAS surveys and vantagepoint surveys, and low numbers recorded during landfall surveys (as presented in the Technical Baseline). Although the boundary of Rockabill SPA is located just 0.2km from the proposed development, the island, where purple sandpiper will be over-wintering, is over 3.7km away and therefore beyond the disturbance range for this species of approximately 300m (Goodship & Furness, 2022).

The Lambay Island SPA is located 22.2km from the array area, and is designated for ten species (fulmar, cormorant, shag, greylag goose (*Anser anser*), lesser black-backed gull (*Larus fuscus*), herring gull (*Larus argentatus*), kittiwake (*Rissa tridactyla*), guillemot (*Uria aalge*), razorbill (*Alca torda*) and puffin (*Fratercula arctica*)). With the exception of cormorant and shag which are not considered vulnerable to OWF impacts (as discussed above), and greylag goose which was screened out of the migratory collision risk assessment due to low risk and the mCRM calculations predicting zero percent of the population likely to be at collision risk (Table 15.58), all designated species have been considered in the ornithology assessment in Section 15.5.

The Ireland's Eye SPA is located 33.0km from the array area, and is designated for five species (cormorant, herring gull, kittiwake, guillemot and razorbill). With the exception of cormorant, which is not considered vulnerable to OWF impacts, all designated species have been considered in the ornithology assessment in Section 15.5.

The Skerries Island SPA is located 18.5km from the array area and has breeding season connectivity for herring gull qualifying interest. Shag and cormorant are not considered to be vulnerable to impacts from OWFs and are therefore scoped out of the assessment. Three qualifying wintering waterbird interests from this SPA may pass through the array area twice per annum on migration and are assessed within the ornithology assessment.

The Boyne Estuary SPA is primarily designated for non-seabird species which have limited connectivity to the proposed development. All species are considered to have low vulnerability to OWF impacts. The SPA is beyond the displacement ranges for wintering waterbirds from ECC construction activity. However, some qualifying interests from this SPA may pass through the array area twice per annum on migration. Little tern is the only qualifying seabird species at this SPA and has no breeding season connectivity with the array area due to their small foraging ranges and coastal distribution.

Consideration of SPAs has been incorporated through the value given to each species sensitivity to an impact. Those species that are qualifying interests of SPAs within proximity to the proposed development are given a higher sensitivity score. Maintenance of habitats and species within Natura 2000 sites at favourable conservation condition will contribute to the overall maintenance of favourable conservation status of those habitats and species at a national level.

15.2.9 Methodology for the Assessment of Effects

EIA significance criteria for offshore ornithology follows Environmental Protection Agency (EPA) guidance:

- EPA (2022) Guidelines on the information to be contained in Environmental Impact Assessment Reports.

The specifics of the offshore ornithology assessments were also agreed, where possible, in collaboration between the other Phase one projects. This methodology was presented and consulted on with NPWS (Appendix 15.7).

Overview

The impact assessment for offshore ornithology has followed the methodology presented in the EIAR Methodology chapter, and the methodology as decided across Phase One projects and presented in the Irish Phase One Method Statement'. How advice from NPWS was considered in the assessments is provided in Appendix 15.9: Method Statement Review Consultation and Justification Log.

Impact assessment criteria

The assessment approach follows the conceptual source-pathway-receptor model, which identifies likely environmental impacts on ornithological receptors during all phases of the proposed development. This process provides an easy-to-follow assessment route between 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); and
- 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 individuals).

To determine the significance of potential impacts, a two-stage process is needed to define both the sensitivity of relevant ornithological receptors, and the magnitude of the potential impacts.

15.2.9.1 Sensitivity criteria

The overall sensitivity value of ornithological receptors to potential impact from the proposed development is defined by their vulnerability to the impact in question (based on the tolerance of ornithological receptors to the potential impact, the ability to adapt to the impact, and the ability to recover from the potential impact), and the conservation value/importance of the receptor. The sensitivity and conservation importance are considered together on a species-by-species basis to determine overall sensitivity, as species which have a high conservation value may not be vulnerable to a potential impact and vice versa.

For example, kittiwake is a species listed as a qualifying feature for some SPAs and has a conservation concern listing of 'Red' in Ireland because of recent population declines (Gilbert et al., 2021), but is not considered to be particularly sensitive to human disturbance as there are several examples of individuals nesting on buildings or structures such as oil rigs or bridges. Red-throated diver (*Gavia stellata*) however, is also a species listed as a qualifying feature for some SPAs that is currently 'Amber-listed' in the most recent Birds of Conservation Concern in Ireland (BoCCI) rankings (Gilbert et al., 2021), but is considerably more sensitive to human-related disturbance than kittiwake.

The vulnerability of ornithological receptors is determined through published literature on the behavioural sensitivity of seabirds to OWF impacts (e.g. Bradbury et al., 2014; Diershke et al., 2016), and through expert judgement. Criteria used to determine vulnerability are presented in Table 15.4. The definitions of different levels of conservation importance of ornithological receptors is then presented in Table 15.5, with a matrix approach used to determine overall sensitivity based on these two values (Table 15.6).

Table 15.4 Definition of vulnerability relating to the sensitivity of ornithological receptors

Receptor vulnerability	Definition
High	No/very limited ability to adapt behaviour so that individual survival and reproduction rates are affected. No/very limited tolerance – Impact will cause a change in both individual reproduction and survival rates. No/very limited ability for individuals to recover from any impact on vital rates (reproduction and survival rates).
Medium	Limited ability to adapt behaviour so that individual survival and reproduction rates may be affected. Limited tolerance – Impact may cause a change in both individual reproduction and survival rates. Limited ability for individuals to recover from any impact on vital rates (reproduction and survival rates).
Low	Some ability to adapt behaviour so that individual reproduction rates may be affected but survival rates are unlikely to be affected. Some tolerance – Impact unlikely to cause a change in both individual reproduction and survival rates. Some ability for individuals to recover from any impact on vital rates (reproduction and survival rates).
Negligible	High ability to adapt behaviour so that individual survival and reproduction rates are not affected. High tolerance – Receptors able to tolerate the impact without any impact on individual reproduction and survival rates. Receptor is able to return to previous behavioural states/activities once the impact has ceased.

Table 15.5 Definition of conservation value of ornithological receptors

Conservation value	Definition
High	Receptors considered to have a high level of potential connectivity with internationally designated populations (i.e. overlap with or foraging range connectivity with SPA or Ramsar Sites) and high level conservation designation classifications (BoCCI Red List, IUCN Red List categories of Vulnerable and above, Annex I of the Birds Directive).
Medium	Receptors considered to have some connectivity with internationally designated populations (i.e. foraging range connectivity with SPA and Ramsar Sites, though other non-SPA colonies contribute) or overlap with nationally important population concentrations, and high or moderate conservation designation classifications (BoCCI Amber or Red List, IUCN Red List categories of Near Threatened and above, Annex I of the Birds Directive).
Low	Receptors considered to have limited potential connectivity with internationally designated populations (i.e. distant foraging range connectivity with SPA and Ramsar Sites), proximity to nationally important population concentrations, or overlap with regionally important population concentrations, and/or moderate conservation designation classifications (BoCCI Amber List).

Table 15.6 Matrix to determine overall ornithological receptor sensitivity

		Vulnerability			
		Negligible	**Low**	**Medium**	**High**
Conservation importance	**Negligible**	Negligible	Low	Low	Low
	Low	Low	Low	Medium	Medium
	Medium	Low	Medium	Medium	High
	High	Low	Medium	High	High

15.2.9.2 Magnitude of impact criteria

Potential impacts resulting from the proposed development are then judged based on their magnitude, referring to the scale of a potential impact. This may refer to both a positive impact, or an adverse impact and is determined on a quantitative basis where possible.

The magnitude of potential impacts may differ between ornithological receptors as it relates to the potentially differing ecological sensitivities of those receptors and the potentially differing demographics of impacted populations. For example, when considering a given wind turbine generator (WTG) and array configuration, the location and extent of the rotating blade surface with which birds may collide is the same across all species, though the probability of collisions is influenced by species-specific factors that relate to the likelihood of them colliding with the WTGs (e.g., avoidance rates, flight height distributions, flight speeds etc.).

The magnitude of a potential impact is determined based on EPA guidance (EPA, 2022), and considers the following factors:

- The extent of the impact (i.e. the size of the area, number of sites and/or proportion of the population affected by the impact)
- The duration of the impact
- The frequency at which the impact occurs
- The probability of the impact occurring; and
- The consequence of the impact (taking into account the character of the impact (i.e. beneficial consequence or adverse consequence)).

The criteria for defining different magnitudes of potential impacts are presented in Table 15.7. As with the determination of receptor sensitivity, an element of expert judgement is also used in determining the overall magnitude based on available information on the different criteria used. For example, a potential impact may be identified as high based on its extent (e.g. a widespread shift in distribution) but low or negligible consequence if the population is otherwise unaffected (e.g. no impacts on vital rates). Consequently, each criterion is considered when evaluating the overall magnitude.

Impact magnitude may relate 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 of impact magnitude are used, guided by the definitions in Table 15.7 below.

Where magnitude refers to an increase in baseline mortality, this is relative to the regional and/or biogeographic population scales (as described in Section 15.3). Changes to a populations baseline mortality below 1% are considered to be indistinguishable from natural fluctuations in demographic rates. For example, natural variation in environmental variables influence the baseline mortality of a population over time at an extent that means that small impacts (<1% increase in baseline mortality) will be undetectable. Should the predicted impacts indicate an increase in baseline mortality greater than 1%, further consideration of the significance of the mortality is required to determine if a significant impact can be ruled out, for example through population modelling (Population Viability Analysis (PVA)).

This approach is recommended by Natural England (Parker et al., 2022c) and can incorporate known population trends and density dependence, where it is considered appropriate, to assess the impacts on a population more accurately. Similarly, NatureScot recommend undertaking PVA if the survival rate of an assessed species is adversely affected as a result of the predicted impact (NatureScot, 2023a)

Table 15.7 Magnitude of the impact

Magnitude	Definition
High	**Extent:** A large change in the size or distribution of the relevant biogeographic and/or regional population or interest feature of a designated site. **Duration:** The impact is expected to be long-term, resulting in behavioural changes that last for the lifetime of the proposed development. **Frequency:** The impact is expected to occur constantly throughout a relevant project phase. **Probability:** The impact is highly likely to occur. **Consequence (beneficial):** Impact resulting in a long-term, large-scale increase in the population trajectory at a generational scale. Guide: Predicted increase to baseline population growth rate is above 10%. **Consequence (adverse):** The impact would affect the behaviour and distribution of sufficient numbers of individuals, with sufficient severity, to affect the favourable conservation status and/or the long-term viability of the population at a generational scale. Guide: Predicted increase to baseline mortality rate is above 5%.
Medium	**Extent:** A medium change in the size or distribution of the relevant biogeographic and/or regional population or interest feature of a designated site. **Duration:** The impact is expected to be short-term, resulting in behavioural changes that last up to seven years. **Frequency:** The impact is expected to occur constantly throughout a relevant project phase. **Probability:** The impact is likely to occur. **Consequence (beneficial):** Benefit to the habitat influencing foraging efficiency resulting in increased reproductive potential and increased population health and size. Guide: Predicted increase to baseline population growth rate is above 5%. **Consequence (adverse):** The impact would temporarily (short to long term) cause changes in the behaviour and/or distribution of individuals, though the impact is reversible on cessation of the impact and no long-term impacts on population viability or on the integrity of a designated site are expected. Guide: Predicted increase to baseline mortality rate is above 1%.
Low	**Extent:** A small change in the size or distribution of the relevant biogeographic and/or regional population or interest feature of a designated site. **Duration:** The impact is expected to be temporary, resulting in behavioural changes that last less than a year. **Frequency:** The impact is expected to occur frequently throughout a relevant project phase. **Probability:** The impact is unlikely to occur. **Consequence (beneficial):** Short term (over a limited number of breeding cycles) benefit to the habitat influencing foraging efficiency resulting in increased reproductive potential. Guide: Predicted increase to baseline population growth rate is between 1% and 5%. **Consequence (adverse):** The impact would temporarily (short to long term) cause changes in the behaviour and/or distribution of individuals, though the impact is reversible on cessation of the impact and no medium to long-term impacts on population viability or on the integrity of a designated site are expected. Guide: Predicted increase to baseline mortality rate is above 0.1%.
Negligible	**Extent:** A very small/no change in the size or distribution of the relevant biogeographic and/or regional population or interest feature of a designated site. **Duration:** The impact is expected to be brief, resulting in behavioural changes that last less than a day. **Frequency:** The impact is expected to occur once or infrequently throughout a relevant project phase. **Probability:** The impact is highly unlikely to occur. **Consequence (beneficial):** Very minor benefit to the habitat influencing foraging efficiency of a limited number of individuals. Guide: Predicted increase to baseline population growth rate is less than 1%. **Consequence (adverse):** The impact would be unlikely to impact the population in the short to long term, with any impacts being fully reversible within a short period following cessation of the impact and no predicted impacts in the medium or long-term on the viability of the population or the integrity of a designated site. Guide: Predicted increase to baseline mortality rate is below 0.1%.

15.2.9.3 Defining the significance of effect

The significance of likely significant effects on ornithological receptors from the proposed development is determined by correlating the magnitude of the impact (Table 15.7), with the overall sensitivity of the receptor (Table 15.6). The method used to determine the effect significance is presented in Table 15.8, with definitions of each level of significance presented in Table 15.9.

For the purpose of this assessment, any effects with a significance level of 'significant' or higher have been concluded to be significant in terms of the EIA regulations. Impacts with a significance level of 'moderate', 'slight', 'not significant' and 'imperceptible' are all concluded to be not significant in EIA terms.

Table 15.8 Significance of likely significant effects upon offshore and intertidal ornithology

		Existing Environment - Sensitivity			
		High	**Medium**	**Low**	**Negligible**
Description of Impact Magnitude	**High**	Profound or very significant	Significant	Moderate	Imperceptible
	Medium	Significant	Moderate	Slight	Imperceptible
	Low	Moderate	Slight	Slight	Imperceptible
	Negligible	Not Significant	Imperceptible	Imperceptible	Imperceptible

Table 15.9 Definitions of impact significance

Impact significance	Definition
Profound	An impact which permanently removes all sensitive characteristics.
Very significant	An impact which, by its character, magnitude, duration or intensity, significantly alters most of a sensitive aspect of the environment.
Significant	An impact which, by its character, magnitude, duration or intensity, alters a sensitive aspect of the environment
Moderate	An impact that alters the character of the environment in a manner that is consistent with existing and emerging baseline trends.
Slight	An impact which causes noticeable changes in the character of the environment without affecting its sensitivities.
Not significant	An impact which causes noticeable changes in the character of the environment but without significant consequences.
Imperceptible	An impact capable of measurement but without significant consequences.

It is important that the matrix (and indeed the definitions of sensitivity and magnitude) is seen as a framework to aid understanding of how a judgement has been reached from the narrative of each impact assessment and it is not a prescriptive formulaic method. CIEEM (2018) guidance and expert judgement has been applied to the assessment of likelihood and ecological significance of a predicted impact.

Where relevant, mitigation measures that are incorporated as part of the proposed development design process and/ or can be considered to be industry standard practice (referred to as 'embedded mitigation') are considered throughout the chapter and are reflected in the outcome of the assessment of effects, described in Section 15.4.5. Additional mitigation measures that are not embedded and are considered as part of the residual effects assessment are described separately (Section 15.6).

Screening of impacts

Based on available evidence the impacts considered in the assessments for offshore and intertidal ornithological receptors are presented in Table 15.10.

Table 15.10 Impacts considered in the assessment of offshore and intertidal ornithological receptors

Impact number	Description	Relevant study area
Construction		
Impact 1	Disturbance and displacement from increased vessel activity and other construction activity within the ECC and/or array area for offshore and intertidal ornithological receptors.	Offshore and intertidal
Impact 2	Indirect impacts on ornithological receptors due to effects on prey species habitat loss within the ECC and/or array area.	Offshore and intertidal
Impact 3	Effects arising from the accidental release of pollutants during proposed works.	Offshore and intertidal
Impact 4	Impacts arising from artificial light during construction activity.	Offshore and intertidal
Operation		
Impact 5	Disturbance and displacement from the presence of offshore infrastructure and associated maintenance activity in the array area, including barrier effects.	Offshore and intertidal
Impact 6	Collision risk of seabirds with offshore infrastructure in the array area.	Offshore
Impact 7	Combined collision risk and displacement for species susceptible to both impacts.	Offshore
Impact 8	Migratory collision risk of migratory birds with offshore infrastructure in the array area	Offshore
Impact 9	Indirect impacts on ornithological receptors due to effects on prey species habitat loss within the ECC and/or array area.	Offshore and intertidal
Impact 10	Impacts arising from artificial light during operation and maintenance activity.	Offshore and intertidal
Decommissioning		
Impact 11	Disturbance and displacement from increased vessel activity and other construction activity within the ECC and/or array area.	Offshore and intertidal
Impact 12	Indirect impacts on ornithological receptors due to effects on prey species habitat loss within the ECC and/or array area.	Offshore and intertidal
Impact 13	Effects arising from the accidental release of pollutants during proposed works.	Offshore and intertidal
Impact 14	Impacts arising from artificial light during decommissioning activity.	Offshore and intertidal

An overview of impacts which have been screened out and are not considered further in this EIAR is presented in Table 15.11 below.

Table 15.11 Impacts screened out of assessment for likely significant effects from the proposed development

Impact	Justification for screening out
Construction phase	
Collision risk	During the construction phase the potential for impacts is very low, as turbines will not be rotating and the presence of offshore infrastructure will be limited compared to the operational phase.
Operational phase	
Disturbance and displacement (ECC)	During the operational phase, the presence of vessels within the ECC will be considerably reduced in comparison to the construction phase and therefore the potential for displacement impacts is very low.
Disturbance and displacement for intertidal ornithological receptors	During the operational phase, activity within the intertidal zone will be considerably reduced compared to the construction phase, and therefore the potential for displacement impacts is limited. Additionally, the sensitivity of intertidal receptors to displacement impacts recorded at the landfall location is low, and therefore no realistic impact pathway is present.
Barrier effects	Barrier effects as a standalone impact is not considered further, with any potential impacts appropriately covered within the displacement assessment. A full description is provided below.
Indirect impacts due to accidental release of pollutants	During the operational phase, the likelihood of any pollution impacts is sufficiently low that no impact pathway is considered to be present, with each WTG equipped with sensors to enable early detection of fluids and leaks. Spill kits are located on each WTG to contain any fluids in the unlikely event of pollutant release during the operational phase.

Impact	Justification for screening out
Decommissioning phase	
Collision risk	As with construction phase

Consideration of barrier effects

The presence of WTGs (both operational and during construction/decommissioning) has the potential to create a barrier to the movement of flying seabirds, increasing energy expenditure by causing some species to detour around the OWF(s). There is potential for barrier effects to impact both migratory and resident birds.

For resident birds, potential impacts are already accounted for within the displacement assessment. Within the disturbance and displacement assessment, both flying and sitting birds are considered. The inclusion of sitting birds within the analysis provides for an assessment of those potentially displaced from an area of sea where they reside, whilst the inclusion of flying birds provides for an assessment of potential barrier effects to birds moving through the area of interest. This is also supported by NatureScot guidance (NatureScot 2023c), which states that the displacement assessment is considered to cover all distributional responses (i.e. disturbance and displacement impacts and barrier effects).

Considering impacts to migratory birds, the proposed development is not located in a major flyway for migratory birds (Wright et al., 2012), and most migratory birds are expected to follow the coast more closely (Forrester et al., 2007; WWT, 2014) (the proposed development array area is located over 10km offshore). Additionally, most migrating birds are expected to fly either close to the sea surface, or at heights greater than the greatest turbine blade height, and therefore are highly likely to avoid the rotor swept area of the proposed development as opposed to flying through the rotor blades or having to divert around the array area (Alerstam, 1990). Masen et al. (2009) concluded that the energetic costs of avoidance flight from migrating seaducks were trivial (approximately 500m) compared with the total energetic costs of a 1400km migration.

Even assuming the greatest potential magnitude of impact where a bird may be required to deviate from its flight path when reaching the edge of the proposed development, there is existing evidence that birds are able to learn and adapt their flight paths to foraging sites and therefore after first encountering the proposed development, they would be subsequently able to alter their course and so reduce the potential flight path deviation (Grecian et al., 2018).

Based on the above information, barrier effects as a standalone impact is scoped out of the assessment as it is already sufficiently accounted for within the displacement assessment, and any potential residual effects not considered within this assessment (e.g., assessment of migratory birds) are considered to be of negligible magnitude.

15.3 Baseline Environment

15.3.1 Introduction

As highlighted in Section 15.2.6, the following site-specific surveys were undertaken to inform the baseline environment for offshore and intertidal ornithological receptors:

- 29 months of DAS surveys (May 2020 to October 2022)
- Seven vessel surveys undertaken between November 2019 and July 2022
- Four periods of six coastal vantage-point surveys between September 2019 and May 2021 across two sites; and
- 24 months of landfall surveys (January 2021 to December 2022).

Full details of ornithological surveys and recorded species are presented in the Technical Baseline, with a summary provided in Table 15.12. As outlined in Section 15.2.7, the 29 months of DAS data form the main basis of assessment for offshore ornithological receptors. Vantage-point surveys were also used to inform the inclusion of migratory ornithological receptors in migratory collision risk assessment (Impact 7; Section

15.5), and landfall surveys and publicly available data (notably Jessop et al., 2018) used to form the main basis of the assessment for intertidal receptors.

15.3.2 Offshore Ornithology

For offshore ornithological receptors, the main dataset used to inform assessments is the site-specific DAS data. Across 29 months of DAS surveys, 26 bird species were recorded in the area. Table 15.12 below presents which bird species were recorded across the array area as well as within the 2km and 4km buffers only (as defined in Section 15.2.2). For full detail of species raw counts, density and abundance estimates refer to the Technical Baseline.

Table 15.12 Bird species recorded during digital aerial surveys within the array area, 2km buffer and 4km buffer

Species	Array area	2km buffer	4km buffer
Whimbrel (Numenius phaeopus)			x
Kittiwake	x	x	x
Black-headed gull (Chroicocephalus ridibundus)	x	x	x
Little gull (Hydrocoloeus minutus)			x
Common gull (Larus canus)	x	x	x
Great black-backed gull (Larus marinus)	x	x	x
Herring gull	x	x	x
Lesser black-backed gull	x	x	x
Sandwich tern	x		
Roseate tern (Sterna dougallii)	x	x	x
Common tern (Sterna hirundo)	x	x	x
Arctic tern (Sterna paradisaea)	x	x	x
Commic tern	x	x	x
Great skua (Stercorarius skua)			x
Arctic skua (Stercorarius parasiticus)			x
Guillemot	x	x	x
Razorbill	x	x	x
Black guillemot (Cepphus grylle)	x	x	
Puffin	x	x	x
Red-throated diver			x
Great northern diver (Gavia immer)	x	x	x
Fulmar	x	x	x
Sooty shearwater (Ardenna grisea)	x	x	
Manx shearwater	x	x	x
Gannet (Morus bassanus)	x	x	x
Shag	x		

As outlined in the technical baseline, commic terns refer to terns which were not possible to distinguish between common and Arctic tern. However, for the EIAR assessment, commic terns were apportioned to common and Arctic tern. Species which were recorded as commic tern were assigned to either Arctic tern or common tern based on the ratio of Arctic tern to common tern within the DAS data. Within the array area, a total of 11 common terns were recorded and two Arctic terns. Recorded commic terns were therefore apportioned into species levels according to this ratio (i.e. apportioned common tern abundance = number of recorded common terns + the number of commic terns multiplied by $\frac{11}{13}$) The remaining individuals are apportioned to Arctic tern.

Apportioned numbers are added to those which were recorded at species level (i.e., the total number of common tern is equal to the individuals recorded as common tern, and the number of individuals which were apportioned from those recorded as commic tern).

Project specific DAS data did not cover the ECC, and therefore available aerial survey data from Jessop et al., (2018) is used to characterise this area. Due to the orientation of transects, Jessop aerial survey data had a very low coverage (2.3%) of the ECC. To increase coverage, and therefore the representativeness of density estimates in the ECC, a 4km buffer was applied to the ECC which increased coverage to 10.5%. Therefore, for the purpose of obtaining baseline data, the 4km buffer around the ECC was used. From this, density estimates across the ECC plus 4km buffer were calculated, and resulting abundance estimates were used to represent abundances across the ECC only. Table 15.13 below therefore provides the annual raw count of all species recorded within the ECC plus 4km buffer from the Jessop et al., (2018) aerial survey data.

Table 15.13 Bird species recorded during Jessop et al (2018) digital aerial surveys within the ECC plus a 4km buffer

Species	ECC plus 4km buffer (annual raw count)
Velvet scoter (Melanitta fusca)	1
Common scoter	61
Scoter sp.	12
Kittiwake	40
Black-headed gull	59
Great black-backed gull	4
Herring gull/common gull	114
Lesser black-backed gull/great black-backed gull	14
Lesser black-backed gull	3
Large gull sp.	107
Small gull sp.	6
Little tern	1
Sandwich tern	4
Roseate tern	9
Common tern/Arctic tern	21
Tern sp.	4
Guillemot/Razorbill	834
Diver sp.	25
Fulmar	7
Manx shearwater	3
Gannet	12
Cormorant/shag	147

Seasonal bird abundance

Across the calendar year there will be variation in the abundance and behaviour of ornithological receptors depending on the biological seasons (hereafter ‘bio-seasons’) that apply to different species. In this EIAR chapter, separate bio-seasons are defined and recognised to establish the importance of the study area for different seabird species across different time periods. Where site-specific data supports the regional population bio-seasons (hereafter referred to as ‘bio-seasons’) defined in Furness (2015), they have been used in the assessment. Site-specific DAS data revealed that a different approach to the breeding season and autumn migration (post-breeding) seasons for guillemot was more appropriate. This is explained in more detail below.

Within this EIAR chapter, six bio-seasons are defined: spring migration, migration-free breeding, autumn migration, migration-free winter, full breeding and non-breeding. These bio-seasons can be applied to different periods within the annual cycle for most seabird species, though not all six are applicable for all species depending on the species-specific biology and life-history:

- Spring (return) migration: when birds are migrating to breeding grounds
- Migration-free breeding: when birds are attending colonies, nesting and provisioning young
- Autumn (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
- Non-breeding: extended bio-season from modal departure from the colony at the end of breeding to modal return to the colony the following year; and
- Breeding: extended bio-season from modal arrival of breeding birds to the colony to modal departure from the colony.

It should be noted that the seasonal definitions in Furness (2015) include overlapping months in some instances due to variation in the timing of migration for birds which breed at different latitudes (i.e. individuals from breeding sites in the north of the species' range may still be on spring migration when individuals further south have already commenced breeding). Where months contain overlapping seasons (e.g. breeding and migration), these have been assigned to breeding, since for almost all species, the proposed development is located within species-specific foraging ranges (refer to Woodward et al., 2019) of breeding colonies. Additionally, where species have both a 'migration-free breeding' bio-season and an extended 'breeding' bio-season defined in Furness, the extended 'breeding' season was used as a precautionary approach, with overlapping non-breeding season months assigned to the breeding season. For species not included in Furness (2015), bio-seasons were based on best available evidence.

For guillemot, the Furness approach to bio-seasons is not considered the most ecologically relevant. Though Furness (2015) suggest a breeding season of March to July, project-specific DAS data and available literature (e.g., Dunn *et al.*, 2020, Buckingham *et al.*, 2023) demonstrates that birds at the early and late stages of this period are not under the same energy constraints as in the core breeding season.

The energy budgets of guillemot in March are similar to those across the non-breeding period, and as such it is more appropriate to treat birds in March as non-breeding as opposed to breeding (i.e., there is no demand to return to the colony to relieve the other parent, or to provision the chick during March). Dunn *et al.* (2020) also demonstrated that colony attendance in March and April is lower than in May and through the rest of the breeding season. This can only be a result of adult birds either not attending the colony at all, or birds spending more time away from the colony (as a result of travelling further or staying away for longer). Either option demonstrates that during the early breeding season guillemots are not under the same energetic constraints as when they have eggs or young, and as such are not limited by the mean max foraging ranges that are applicable to the incubation and chick-rearing period. If birds are not limited by mean max foraging ranges then they should not be considered in the same manner as those that are.

Dunn et al. (2022) presents a breeding cycle at the Isle of May, Scotland where incubation begins in early May, and this is likely to be the case at similar latitudes (breeding is later further north, but not at a scale where similar latitudes could have substantially different timings, for example breeding in Iceland is approximately one week later than in the UK (Cramp et al. 1977 – 1994)). Dunn (2022) also demonstrated that energy gain in March and April was relatively consistent with earlier in the year, before reducing substantially through May and June, indicating a radical change in behaviour between these two periods. Therefore, Guillemots may be present at colonies in March and April, but it is considered that their behaviour in March and April is not consistent with their behaviour during incubation and chick rearing in May and June. Therefore, it is concluded that where breeding season assessment is framed around incubation and chich-rearing mean max foraging ranges, March at minimum should not be considered as the breeding season, with April also not considered highly reflective of true breeding season behaviour/constraints.

On the Isle of May, the median fledging date varied between June 20th and July 10th and timings are likely to be similar across similar latitudes. Therefore, aggregations of birds in the offshore development area in July are likely to comprise a larger numbers of birds undergoing post-breeding dispersal (i.e. birds that have finished breeding), compared to those birds still engaged with breeding. If the median fledging date is July 10th, then after this date, the population of birds in the proposed development area will be composed of more post breeding birds than breeding birds. Considering the month as a whole, if after July 10th more birds in the proposed array area are migrating than breeding, it is more appropriate to consider July the non-breeding season than the breeding season, Therefore, a more ecologically relevant breeding season of April to June is used. A full justification of this approach is provided in the Technical Baseline.

The DAS data clearly shows large increases in guillemots using the array area and 2km buffer from July onwards. For example, the mean abundance of guillemots calculated to be present in the core breeding season (May and June) across the three years of DAS data is 1,342 individuals, and this increases to a mean of 11,041 in July. This increase in abundance will be due to guillemots dispersing from colonies in the wider region (including a proportion from local colonies) and continues to increase as birds disperse throughout the region into August and September with mean estimated abundances in the array area and 2km buffer of 22,665 and 29,765, respectively.

Consequently, the removal of march and July from the breeding is considered justified owing to the clear evidence that birds are not constrained by breeding behaviour during this month, with clear evidence presented in site-specific DAS data to support that numbers are inflated in July due to dispersing birds from the wider region as well as local colonies. Therefore, a season of April to June (hereafter the "project approach") is considered most ecologically justified.

The relevant bio-seasons for offshore ornithological receptors which have been included for assessment in Sections 15.5 and 15.9 are presented in Table 15.14 below.

Table 15.14 Bio-seasons for relevant ornithological receptors used in the assessment of likely significant effects, based on Furness (2015)

Species	Autumn migration	Spring migration	Migration-free winter	Breeding	Non-breeding
Common scoter[4]	-	-	-	NA	Sep-Apr
Kittiwake	Sep-Dec	Jan-Feb	-	Mar-Aug	-
Black-headed gull[5]	-	-	-	Apr – Aug	Sep-Mar
Common gull[1]	-	-	-	Apr – Aug	Sep-Apr
Great black-backed gull	-	-	-	Apr-Aug	Sep-Mar
Herring gull	-	-	-	Mar-Aug	Sep-Feb
Lesser black-backed gull	Sep-Oct	Mar	Nov-Feb	Apr-Aug	-
Roseate tern	Sep	Apr	-	May-Aug	-
Common tern	Sep	Apr	-	May-Aug	-
Arctic tern	Sep	Apr	-	May-Aug	-
Guillemot (project approach)	-	-	-	Apr-Jun	Jul-Mar
Guillemot (Furness 2015 approach)	-	-	-	Mar-Jul	Aug-Feb
Razorbill	Aug-Oct	Jan-Mar	Nov-Dec	Apr-Jul	-
Puffin	-	-	-	Apr-Jul	Aug-Mar
Red-throated diver	Sep-Nov	Feb-Apr	Dec-Jan	Mar-Aug	Sep-Apr
Great northern diver	-	-	-	NA	Sep-May

[4] https://www.nature.scot/sites/default/files/2018-11/Guidance%20-%20Suggested%20seasonal%20definitions%20for%20birds%20in%20the%20Scottish%20Marine%20Environment.pdf

[5] Not in Furness (2015), bio-seasons based on Kober et al., (2010)

Species	Autumn migration	Spring migration	Migration-free winter	Breeding	Non-breeding
Fulmar	Sep-Oct	Apr	Nov	Jan-Aug	-
Manx shearwater	Sep-Oct	Mar	-	Apr-Aug	-
Gannet	Oct-Nov	Dec-Feb	-	Mar-Sep	-

The abundance of birds in the survey area has been estimated from site-specific survey data carried out for the proposed development. Two methods were used to estimate the abundance of birds in the array and relevant buffer zone. The abundance for all species was calculated using design-based estimates as laid out in the Technical Baseline. In addition, guillemot and razorbill abundance and distribution within the survey area was predicted using a model-based approach which provides an alternative method of estimating abundance by including environmental information and data to inform the predictions. These two auk species were chosen because they were the most frequently sighted species within the survey area and were observed in varying densities throughout all months of the year, which lends itself to model-based estimates using MRSea[6]. In general, MRSea results predicted lower monthly abundances for both species across the array area (+2km buffer) but more so for guillemot with a reduction in estimated abundance of greater than 30% using the modelled approach. A summary of the mean-peak seasonal abundances of these two auk species based on design-based and model-based abundance estimates are presented in Table 15.15 below.

Table 15.15 Mean-peak bio-seasonal abundance estimates for auks in the array plus 2km buffer calculated using design-based and model-based methodologies. Breeding seasons are described in full in the Technical Baseline

Species	Bio-season	Design-based	Model-based	Percentage difference (%)
Guillemot	Breeding (project)	1,813	1,497	17.4
	Breeding (Furness)	13,703	8,642	36.9
	Non-breeding	29,765	20,791	30.1
	Total	43,468	29,433	32.3
Razorbill	Breeding	168	114	32.3
	Autumn	3,371	2,341	30.6
	Winter	2,079	2,249	-8.2
	Spring	483	389	19.5
	Total	6,101	5,093	16.5

The MRSea modelling also provides robust estimates of habitat usage within the wider survey area (MAC boundary plus 4km buffer). For guillemot and razorbill there are clearly hotspots outside of the array area in the south of the survey area in proximity to Lambay Island, during the breeding season. This is expected, given this is the by far the largest colony on the east-coast and birds are more constrained during this period. Outside of the breeding season auks were more dispersed with no clear hotspots in or around the array area during most survey months.

See the MRSea Modelling Report for further information on the methodology and results. For key ornithological receptors, the seasonal mean peak abundance within species specific seasons were calculated (i.e., the mean of the highest monthly estimates within each season for each year), with full data presented in the Technical Baseline.

[6] Statistical package to model spatial data to predict abundances and spatial distributions; developed by the Centre for Research into Ecological and Environmental Modelling (CREEM) specifically for dealing with data collected for offshore wind farm projects.

Nature conservation value

Species included in the impact assessment are those which were recorded during surveys and which are considered to be at potential risk of impacts from the proposed development either due to their abundance, potential sensitivity to wind farm impacts or due to biological characteristics which make them potentially susceptible (e.g. commonly fly at rotor height). The conservation status of each assessed species is provided in Table 15.16 based on the BoCCI criteria in Gilbert et al. (2021).

Table 15.16 Summary of nature conservation value of species considered at potential risk of impacts

Species	Conservation status
Common scoter	BoCCI Red listed, IUCN Least Concern
Kittiwake	BoCCI Amber listed, IUCN Vulnerable
Black headed gull	BoCCI Amber listed, IUCN Least Concern
Common gull	BoCCI Amber listed, IUCN Least Concern
Great Black-backed gull	BoCCI Amber listed, IUCN Least Concern
Herring gull	BoCCI Amber listed, IUCN Least Concern
Lesser Black-backed gull	BoCCI Amber listed, IUCN Least Concern
Roseate tern	BoCCI Amber listed, Birds Directive Annex 1, IUCN Least Concern
Common tern	BoCCI Amber listed, Birds Directive Annex 1, IUCN Least Concern
Arctic tern	BoCCI Amber listed, Birds Directive Annex 1, IUCN Least Concern
Guillemot	BoCCI Amber listed, IUCN Least Concern
Razorbill	BoCCI Amber listed, IUCN Least Concern
Puffin	BoCCI Amber listed, IUCN Vulnerable
Red-throated diver	BoCCI Amber listed, Birds Directive Annex 1, IUCN Least Concern
Great northern diver	BoCCI Green listed, Birds Directive Annex 1
Fulmar	BoCCI Green listed, IUCN Least Concern
Manx shearwater	BoCCI Amber listed, IUCN Least Concern
Gannet	BoCCI Amber listed, IUCN Least Concern

Reference breeding and non-breeding populations

Reference non-breeding populations at the regional population scale were adapted from data presented in Furness (2015). Within Furness (2015), species-specific regional populations are provided for appropriate regions surrounding Great Britain, with populations incorporating a proportion of the estimated Irish breeding population. For the purpose of this EIAR, populations in Furness (2015) were altered to reflect Irish regional populations to allow a greater weighting towards the Irish component of the regional population than is provided in Furness, and to use the most recent available data from Burnell et al. (2023). For this, the Irish proportion was removed from the regional populations, and replaced with the east and south-east Irish breeding population as defined in Burnell et al., (2023), corrected to include non-adults using season-specific age group proportions from Horswill and Robinson (2015). Full details of the approach are provided in the Technical Baseline.

To calculate breeding bio-season populations, two approaches are available:

- Method 1: Taking colony counts of all colonies within mean maximum foraging range plus one standard deviation (based on Woodward et al., 2019) and adding the number of immatures from the nonbreeding season preceding the breeding season, calculated based on the proportion of immatures from the relevant regional population (using adult proportions from Horswill and Robinson 2015); and
- Method 2: Taking colony counts of all colonies within mean maximum foraging range plus one standard deviation (based on Woodward et al., (2019) and adjusting these based on the number of immatures per adult calculated from Horswill and Robinson (2015).

The first approach (Method 1) is considered more ecologically relevant because it accounts for the breeding adult population, which are constrained by the necessity to tend to a nest (i.e. their foraging range), and the remaining regional population of immature birds and non-breeders that do not have the same constraints during the breeding season. Evidence suggests that large proportion of these birds are likely to remain in the region, and use the area for foraging during the breeding season and therefore should be considered as part of the regional population. Assessments for both populations (using Method 1 and 2) are presented below.

For fulmar, a slightly different approach was undertaken based on knowledge of their behaviour and expert judgement. Fulmar foraging behaviour changes radically between the incubation period and the chick rearing period. During chick rearing, fulmars are constrained by the need to return to the nest to feed young. As such, the average foraging range during this period is substantially reduced in comparison with incubation. Studies of Norwegian birds showed a chick rearing average foraging range of 60km (Weimerskirch et al., 2001). Birds tracked from colonies in Orkney during chick rearing showed median ranges of 6km (males) and 5km (females), compared to median ranges of 475km (males) and 702km (females) during incubation. (Edwards 2015). Fulmar occurrence in the array area is highest during the chick rearing period (defined as July 1 – Aug 20 in Orkney by Edwards) and into September, possibly corresponding with occurrences of locally fledged birds. As fulmar presence is so low in the array area during the incubation period (total of 10 birds across three years in the array area plus 4km buffer), potential impacts will be similarly low. For the chick rearing period, impacts can be assessed against colonies within a precautionary foraging range of 100km.

For species where data was not available in Furness (2015), the best available evidence was used. For common gull and black-headed gull, the Irish population was taken from Stroud et al., (2016). Additionally, for red-throated diver and great northern diver, the Irish component was based on aerial survey data in Jessop et al., (2018) as data was not available in Burnell et al., (2023). A full description is provided in the Technical Baseline.

For each species, a biogeographic population is also provided based on Furness (2015), representing the total number of birds which have connectivity to UK and Irish waters.

Table 15.17 Ornithology reference breeding and non-breeding populations

Species	Regional population						
	Breeding (Method 1)	**Breeding (Method 2)**	**Non-breeding**	**Autumn migration**	**Spring migration**	**Migration-free winter**	**Biogeographic**
Common scoter	-	-	8,616	-	-	-	550,000[7]
Kittiwake	412,374	142,464	-	933,197	713,137	-	5,100,000
Black-headed gull	32,000	-	100,000	-	-	-	4,250,000
Common gull	-	-	67,500	-	-	-	525,000
Great black-backed gull	33,422	2,685	53,406	-	-	-	235,000
Herring gull	119,304	26,459	187,094	-	103,941	186,502	1,098,000

[7] Not in Furness, biogeographic population from Burfield & Bommel (2004)

Species	Regional population						
Lesser black-backed gull	120,320	75,470	-	171,500	171,500	53,368	864,000
Roseate tern	5,911	5,586	-	6,375	6,375	-	2,900
Common tern	34,574	6,949	-	74,000	74,000	-	480,000
Arctic tern	24,532	178	-	72,231	72,231	-	628,000
Guillemot	736,212	190,073	1,332,623	-	-	-	4,125,000
Razorbill	321,633	49,298	-	632,453	632,453	366,961	1,707,000
Puffin	180,693	79,939	300,427	-	-	-	11,840,000
Red-throated diver	-	-	-	12,717	12,717	4,148	27,000
Great northern diver	-	-	871	-	-	-	430,000
Fulmar	441,767	6,249		843,783	843,783	571,956	
Manx shearwater	2,121,049	2,727,371	-	1,585,521	1,585,521	-	2,000,000
Gannet	637,440	632,514	596,525	535,183	643,917	-	1,180,000

Baseline mortality rates

To assess the impacts of wind farms on ornithological receptors, the impact of additional mortality as a result of the proposed development is assessed relative to the baseline mortality rate, as is standard in assessments across other projects (e.g., UK projects) and an agreed method across Phase One projects. It is assumed that the risk of effects is equal across all age classes, with each age class affected in proportion to its presence in the population. Therefore, for all species screened in for assessment, a weighted average baseline mortality rate has been calculated which is appropriate for all age classes. These were calculated using the different mortality rates for each age class and their relative proportions in the population. Only those species for which impacts have been assessed (i.e. those scoped in for specific impacts in Section 15.5) have been included.

Demographic rates for each species were taken from Horswill and Robinson (2015) and entered into a matrix population model. This was used to calculate the expected stable proportions in each age class (note, to obtain robust stable age class distributions for less well studied species such as divers it was necessary to adjust the rates in order to obtain a stable population size). Each age class survival rate was multiplied by its stable age proportion and the total for all ages summed to give the weighted average survival rate for all ages. Taking this value from 1 gives the average mortality rate. The demographic rates, and the age class proportions and average mortality rates calculated from them, are presented in Table 15.18.

For great black-backed gull, the 0-1 survival is not provided in Horswill and Robinson (2015), and therefore the rate is taken from herring gull due to their similar life history strategies. This approach is recommended by Horswill and Robinson (2015), and has been agreed within the Irish Phase one Methodology Statement'. Similarly, information on roseate tern is not provided in Horswill and Robinson (2015), and therefore demographic data is taken from common tern for the same reason.

Table 15.18 Average mortality rates of relevant seabirds across all age classes, calculated using age specific demographic rates and age class proportions

Species	Parameter				Survival (age class)							Productivity	Average mortality
		0-0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	Adult		
Common scoter	Demographic rate	0.749	0.783	0.783	-	-	-	-	-	-	0.783	1.838	0.226
	Population age ratio	0.268	0.198	0.140	-	-	-	-	-	-	0.395		
Kittiwake	Demographic rate	0.790	0.854	0.854	0.854	-	-	-	-	-	0.854	0.690	0.157
	Population age ratio	0.155	0.123	0.105	0.090	-	-	-	-	-	0.527		
Black-headed gull	Demographic rate	0.825	0.825	-	-	-	-	-	-	-	0.825	0.625	0.175
	Population age ratio	0.175	0.145	-	-	-	-	-	-	-	0.680		
Little gull	Demographic rate	0.800	0.800	-	-	-	-	-	-	-	0.800	0.625	0.200
	Population age ratio	0.175	0.145	-	-	-	-	-	-	-	0.680		
Common gull	Demographic rate	0.410	0.710	0.828	-	-	-	-	-	-	0.828	0.543	0.253
	Population age ratio	0.172	0.078	0.061	-	-	-	-	-	-	0.652		
Great black-backed gull8	Demographic rate	0.798	0.930	0.930	0.930	0.930	-	-	-	-	0.930	1.139	0.095
	Population age ratio	0.188	0.134	0.112	0.094	0.078	-	-	-	-	0.394		
Herring gull	Demographic rate	0.834	0.834	0.834	0.834	-	-	-	-		0.834	0.920	0.171
	Population age ratio	0.132	0.111	0.094	0.079	-	-	-	-		0.422		
Lesser black-backed gull	Demographic rate	0.820	0.885	0.885	0.885	0.885	-	-	-	-	0.885	0.530	0.123
	Population age ratio	0.125	0.102	0.090	0.080	0.070	-	-	-	-	0.533		
Roseate tern9	Demographic rate	0.664	0.664	0.850	-	-	-	-	-	-	0.883	0.764	0.191
	Population age ratio	0.197	0.130	0.086	-	-	-	-	-	-	0.588		
Common tern	Demographic rate	0.664	0.664	0.850	-	-	-	-	-	-	0.883	0.764	0.191
	Population age ratio	0.197	0.130	0.086	-	-	-	-	-	-	0.588		
Arctic tern	Demographic rate	0.664	0.837	0.837	0.837	-	-	-	-	-	0.837	0.380	0.183

[8] 0-1 survival based on herring gull

[9] Based on values used for common tern

Species	Parameter	Survival (age class)										Productivity	Average mortality
		0-0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	Adult		
	Population age ratio	0.114	0.082	0.074	0.068	-	-	-	-	-	0.662		
Guillemot	Demographic rate	0.560	0.792	0.917	0.939	0.939	0.939	-	-	-	0.939	0.670	0.135
	Population age ratio	0.160	0.087	0.067	0.060	0.055	0.050	-	-	-	0.522		
Razorbill	Demographic rate	0.794	0.794	0.895	0.895	0.895	-	-	-	-	0.895	0.570	0.129
	Population age ratio	0.135	0.107	0.084	0.075	0.066	-	-	-	-	0.533		
Puffin	Demographic rate	0.709	0.709	0.709	0.760	0.805	-	-	-	-	0.906	0.617	0.176
	Population age ratio	0.156	0.113	0.082	0.060	0.047	-	-	-	-	0.543		
Red-throated diver	Demographic rate	0.600	0.620	0.840	-	-	-	-	-	-	0.840	0.571	0.224
	Population age ratio	0.168	0.108	0.072	-	-	-	-	-	-	0.652		
Great northern diver	Demographic rate	0.770	0.770	0.770	0.870	0.870	0.870	-	-	-	0.870	0.543	0.161
	Population age ratio	0.126	0.101	0.081	0.065	0.059	0.053	-	-	-	0.514		
Manx shearwater	Demographic rate	0.870	0.870	0.870	0.870	0.870	-	-	-	-	0.870	0.697	0.129
	Population age ratio	0.141	0.121	0.104	0.089	0.077	-	-	-	-	0.469		
Fulmar	Demographic rate	0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.861	0.936	0.419	0.103
	Population age ratio	0.095	0.083	0.072	0.062	0.054	0.047	0.041	0.035	0.031	0.48		
Gannet	Demographic rate	0.424	0.829	0.891	0.895	0.919	-	-	-	-	0.919	0.700	0.182
	Population age ratio	0.183	0.077	0.064	0.057	0.051	-	-	-	-	0.568		

15.3.3 Intertidal Ornithology

For intertidal ornithological receptors, the main source of data used to characterise the baseline environment was the landfall surveys, supplemented by publicly available data (e.g. Jessop et al., 2018). Full details of intertidal surveys and relevant data are presented in the Technical Baseline.

Across 24 months of landfall surveys, 64 bird species were observed, with waders and gulls being the most commonly recorded species groups, and common scoter being the most commonly recorded species.

Of the waders, the most commonly recorded species were oystercatcher, curlew, turnstone, and redshank, which were predominantly observed to be foraging within the intertidal area during the winter period.

15.4 Characteristics of the Proposed Development

This section outlines the characteristics of the proposed development that are relevant to the identification and assessment of likely significant effects on offshore and intertidal ornithological receptors during each phase of the proposed development.

Two project options are presented for the proposed development, representing the two options which are being considered for the final design of the proposed development. Both are considered in this EIAR. Further details of how this is incorporated into the assessment of likely significant effects is provided in Section 15.4.6.

Table 15.19 Key characteristics of Project Option 1 and Project Option 2 relevant to offshore and intertidal ornithological receptors

Key Offshore Characteristics	Project Option 1	Project Option 2
Landfall	One landfall site, immediately south of Bremore Point which includes two exit pits offshore	One landfall site, immediately south of Bremore Point, which includes two exit pits offshore
Array area	88.5km2	88.5km2
ECC	36.45km2	36.45km2
Wind Turbine Generator (WTG)	49 WTGs with 250m rotor diameter	35 WTGs with 276m rotor diameter
WTG Foundations	49 12.5m diameter monopiles requiring seabed preparation	35 12.5m diameter monopiles or jacket foundations (three or four leg configurations, with 6m pin piles) requiring seabed preparation
Offshore Substation Platform (OSP) Foundations (array)	One OSP, with either a four-legged jacket foundation with pin piles, or one monopile; or two monopiles	One OSP, with either a four-legged jacket foundation with pin piles, or one monopile; or two monopiles
Cables	Installation of 111km of array cables and installation of two 18km export cables within the ECC	Installation of 91km of array cables and installation of two 18km export cables within the ECC

A presentation of the potential impacts in relation to Project Option 1 and Project Option 2, and the magnitude of those impacts in relation to the size and scale of the proposed development parameters is provided in Section 15.4.6. This enabled the identification of the project option that will result in the greatest magnitude of impact on receptors and will therefore present the greatest potential for a likely significant effect.

To determine the magnitude of the impact level, modelling, calculations and mapping have been undertaken for the project option with the greatest magnitude of impact, for all impacts for each receptor. For collision risk, modelling was undertaken on both project options, with the project option with the greatest magnitude of impact determined on a species-by-species basis.

The significance of effect assessment has then been undertaken for both project options, which considers both receptor sensitivity and the magnitude of the impact and is detailed in Section 15.5. A qualification is provided if the significance of effect is lesser for the option with the lesser magnitude of impact. Given the similarity of the project options in most instances they are the same.

15.4.1 Parameters for assessment

The below activities and infrastructure and key design parameters have been considered within this chapter when determining the potential impacts. Further detail on the offshore elements of the proposed development is provided in the Offshore Description Chapter and Offshore Construction Chapter. These parameters apply to both project options and any differences in values that may require consideration have been identified in Table 15.19.

15.4.2 Construction

During construction the following activities and infrastructure have the potential to impact on offshore and intertidal ornithological receptors:

- Vessels (both in the ECC and array area); and
- Offshore infrastructure (WTGs and associated construction activity, including OSP).

15.4.3 Operational phase

During operation, the following activities and infrastructure have the potential to impact on offshore and intertidal ornithological receptors:

- Offshore infrastructure (WTGs and associated maintenance activity, including OSP).

15.4.4 Decomissioning

The infrastructure that will be decommissioned and methodology for doing so is not currently known but will be agreed prior to the commencement of decommissioning works and will be based upon current best regulations/practices and available technology, as described in the Offshore Description Chapter. For the purposes of this assessment, the following activities and infrastructure have the potential to impact on offshore and intertidal ornithological receptors:

- Vessels (both in the ECC and array area); and
- Offshore infrastructure (WTGs and associated decommissioning activity).

15.4.5 Embedded Mitigation Measures

The following embedded mitigation measures in Table 15.20 have been identified through the design and consultation process and are incorporated as part of the proposed development. The embedded mitigation measures will not be considered again at the residual effect stage.

Table 15.20 Embedded mitigation measures relating to offshore and intertidal ornithological receptors

Measure	Mitigation detail
Refinement and reduction in the offshore development area	Refinements in the offshore development area (as outlined in the Alternatives Chapter) were undertaken to avoid key areas for birds (e.g., avoidance of density hotspots that may indicate key foraging areas where possible, alongside avoidance of breeding colonies and migration corridors where possible). Reducing the extend of the offshore development area also increases distance from Rockabill Island and Lambay Island which leads to a considerable reduction in interaction with bird species that inhabit these SPA colonies. There has been a considerable reduction in the size of the array area from the original MAC boundary. This process considered hotpots of auks, the most abundant species within the survey area, using species heatmaps from raw observations and a modelled approach using MRSea (MRSea Modelling Report). The results of this modelling clearly show high densities of guillemots and razorbills in proximity to Lambay Island during the breeding season. During this time the densities of birds within the array area are comparatively low. Outside of the breeding season there are no clear hotspots throughout the survey area (MAC boundary plus 4km buffer). This process was undertaken for the proposed development, with the array area of the proposed development being reduced by more than 60% from the MAC boundary of 195.9km2 to the refined array area of 88.5km2.
Increase in air draft	The design has increased the WTG air draft, which reduces the collision risk to key vulnerable ornithological receptors by reducing the rotor swept area that is at collision risk height.

Measure	Mitigation detail
	All turbines in Project Option 1 will have minimum air draft of 40m LAT. Turbines in Project Option 2 will have a minimum air draft of 40m LAT except where they are in the aviation restriction zone where the air draft will be 35m LAT. The number of birds at collision risk height at 40m is considerably reduced compared to 22m. For example, the number of common tern flying at collision risk height is reduced by 90.6% between 22m and 40m. Likewise, kittiwake have a reduction of birds at collision risk height of 82.2% between 22m and 40m, and gulls show a reduction of roughly 65%.
Lighting design	Lighting design will avoid lighting levels that exceed those required to comply with navigational safety, aviation, emergency procedures and general activity to reduce the risk of WTG and OSP lighting attracting birds during periods of bad weather or at night. This measure will be provided as part of the Lighting Management Plan (LMP).
Standard pollution and waste management	Each WTG will be equipped with sensors to enable early detection of fluids and leaks. Spill kits will also be located on each WTG to contain any fluids in the unlikely event of pollutant release. Pollution and waste management is considered within Volume 8, Appendix 6.1: Offshore Environmental Management Plan (EMP; hereafter the Offshore EMP).
Assessment of impacts and best practice environmental management	Prior to decommissioning a study of the potential environmental impacts to fish and shellfish receptors from the proposed decommissioning activities would be undertaken, considering the baseline environment at the pre-decommissioning stage. All mitigation measures to be captured would be captured within the Rehabilitation Schedule. Any licences or authorisations that might be required would be identified and obtained prior to decommissioning, including any validation, updating or new submission of an EIAR, as required.

15.4.6 Potential Impacts

The identification of potential impacts has been undertaken by considering the relevant characteristics from both project options (Section 15.4.1) and the potential for a pathway for direct and indirect effects on known receptors (as identified in Section 15.3). Each identified impact relevant to offshore and intertidal ornithology is presented in Table 15.21.

For each impact, the relevant characteristics of Project Option 1 and Project Option 2 are presented to determine the magnitude (size or extent) of the potential impact, defined by the proposed development in the Offshore Description Chapter and in consideration of the WTG Limits of Deviation (LoD[1]), in line with the approach detailed in the EIAR Methodology chapter. A comparison of the project options has then been undertaken for each impact pathway to determine which project option has the greatest magnitude of impact.

Table 15.21 Potential impacts and magnitude of impact per project option. The project option that has the greatest magnitude of impact is identified in blue.

Potential impact	Project Option 1 (49 WTG)	Project Option 2 (35 WTG)	Rationale for the project option with the greatest magnitude of impact
Construction			
1. Disturbance and displacement	ECC area: • ECC area of 36.45km2 Vessel activity (ECC installation): • 1 cable laying vessel; • 1 burial vessel; • 1 support vessel; • 12 work boats/Rigid Inflatable Boat (RIBs); • 1 work boat for subtidal HDD exit pit • 1 small JUV for subtidal HDD exit pit installation; and • 1 guard vessel for HDD and cable installation. • Vessel activity (cable installation – array) • 1 main laying vessel; • 1 burial vessel; • 1 main support vessel; and • 1 main SOV/CTV. Vessel activity (WTG Installation): • 2 installation vessels; • 6 support vessels; • 2 transport vessels; and • 1 support helicopter. Construction duration: • Up to 3 years Array area: • Array area size of 88.5km2	ECC area: ECC area of 36.45km2 Vessel activity (ECC installation): • 1 cable laying vessel; • 1 burial vessel; • 1 support vessel; • 12 work boats/RIBs; • 1 work boat for subtidal HDD exit pit; • 1 small JUV for subtidal HDD exit pit; and • 1 guard vessel for HDD and cable installation. • Vessel activity (cable installation – array) • 1 main laying vessel; • 1 burial vessel; • 1 main support vessel; and • 1 main SOV/CTV. Vessel activity (WTG Installation): • 2 installation vessels; • 6 support vessels; • 2 transport vessels; and • 1 support helicopter. Construction duration: • Up to 3 years Array area: • Array area size of 88.5km2	Both project options have the same magnitude of impact with regard to the number of vessels present for displacement impacts in the ECC, and the size of the array area for displacement due to presence of offshore infrastructure.
2. Indirect impacts due to impacts on prey	See Potential Impacts table for Fish and Shellfish and Benthic Ecology chapters	See Potential Impacts table for Fish and Shellfish and Benthic Ecology chapters	Project Option with greatest Magnitude varies across different impact types on fish and shellfish.
3. Indirect impacts due to accidental pollution	WTGs: 49 Each WTG will contain components that require lubricating oils, hydraulic oils and coolants for	WTGs: 35 Each WTG will contain components that require lubricating oils, hydraulic oils and coolants for	Project Option 1 presents the greatest magnitude of impact with regards to vessel movement during the construction period.

Potential impact	Project Option 1 (49 WTG)	Project Option 2 (35 WTG)	Rationale for the project option with the greatest magnitude of impact
	operations such as grease, synthetic oil, nitrogen, transformer oil, sulphur hexafluoride (SF6) and glycerol. The volume of oils and fluids will vary depending on the WTG design. The OSP will contain diesel for the emergency diesel generators contained in tanks, oil for transformers, deionised water for cooling systems, glycol, lead acid for UPS and batteries, engine oil and SF6. A maximum of 3,008 return vessel trips will occur during construction activities.	operations such as grease, synthetic oil, nitrogen, transformer oil, sulphur hexafluoride (SF6) and glycerol. The volume of oils and fluids will vary depending on the WTG design. The OSP will contain diesel for the emergency diesel generators contained in tanks, oil for transformers, deionised water for cooling systems, glycol, lead acid for UPS and batteries, engine oil and SF6. A maximum of 2,530 return vessel trips will occur during construction activities.	These parameters present the greatest volumes of compounds which could be associated with the proposed development infrastructure.
4. Impacts arising from artificial light	Artificial lighting will be used continuously during HDD drilling activities. During construction, temporary lighting will be used to mark any surface piercing structures and will have a 2.5 second yellow flash visible for at least 2nm with a 360-degree visibility.	Artificial lighting will be used continuously during HDD drilling activities. During construction, temporary lighting will be used to mark any surface piercing structures and will have a 2.5 second yellow flash visible for at least 2nm with a 360-degree visibility.	Project Option 1 is considered to have a greater magnitude of impact due to the higher number of surface piercing structures
Operation			
5. Disturbance and displacement (array area)	Array Array area size of 88.5km2 WTGs: 49 WTGs Vessel activity • 1 JUV; • 1 SOV; • 1 CTV; • 1 lift vessels; • 1 cable vessels; and • 7 aux vessels.	Array Array area size of 88.5km2 WTGs: 35 WTGs Vessel activity • 1 JUV; • 1 SOV; • 1 CTV; • 1 lift vessels; • 1 cable vessels; and • 7 aux vessels.	Both project options have the same magnitude of impact based on the displacement assessment, which is based on the size of the development area which is the same across both options.
6. Collision risk	WTGs: 49 WTGs Air draft 40m (LAT) Rotor diameter 250m Blade width 7m	WTGs: 35 WTGs Air draft 35m (LAT) Rotor diameter 276m Blade width 7.5m	CRM was run for both project options. The project option with the greatest magnitude of impact based on the CRM assessment was predominantly option 1, but considered on a species-by-species basis. Results for both options are presented in the CRM Report.

Potential impact	Project Option 1 (49 WTG)	Project Option 2 (35 WTG)	Rationale for the project option with the greatest magnitude of impact
	Rotor max rotational speed 8.3m/s	Rotor max rotational speed 7.5m/s	
7. Combined collision risk and displacement risk (gannet)	Array area: Array area size of 88.5km2 WTGs: • 49 WTGs • Air draft 40m (LAT) • Rotor diameter 250m • Blade width 7m • Rotor max rotational speed 8.3m/s	Array area: Array area size of 88.5km2 WTGs: • 35 WTGs • Air draft 35m (LAT) • Rotor diameter 276m • Blade width 7.5m • Rotor max rotational speed 7.5m/s	This impact is assessed only for gannet. The CRM was run for both project options 1 and 2, and Project Option 1 having the greatest magnitude of impact for collision impacts (with no differences for displacement impacts)
8. Migratory collision risk	WTGs: • 49 WTGs • Air draft 40m (LAT) • Rotor diameter 250m • Blade width 7m • Rotor max rotational speed 8.3m/s	WTGs: • 35 WTGs • Air draft 35m (LAT) • Rotor diameter 276m • Blade width 7.5m • Rotor max rotational speed 7.5m/s	Project Option 1 is the project option with the greatest magnitude of impact for migratory collision risk
9. Indirect impacts due to impacts on prey	See Potential Impacts table for Fish and Shellfish Chapter	See Potential Impacts table for Fish and Shellfish Chapter	Project Option with greatest magnitude varies across different impact types on fish and shellfish.
10. Impacts arising from artificial light	Artificial lighting will be used continuously in the form of marking lights on selected periphery WTGs. Lighting will be in the form of a synchronised 5 second yellow flashing light with 360 degree visibility and located between 6m and 30m (HAT)	Artificial lighting will be used continuously in the form of marking lights on selected periphery WTGs. Lighting will be in the form of a synchronised 5 second yellow flashing light with 360 degree visibility and located between 6m and 30m (HAT)	Project Option 1 is considered to have a greater magnitude of impact due to the higher number of WTGs, and therefore lights
Decommissioning			
11. Disturbance and displacement in the array area and ECC	The greatest potential for a likely significant effect is identical (or less) to that of the construction phase	The greatest potential for a likely significant effect is identical (or less) to that of the construction phase	Equal magnitude of impact across both options
12. Indirect impacts due to impacts on prey	See Potential Impacts table for Fish and Shellfish and Benthic Ecology	See Potential Impacts table for Fish and Shellfish and Benthic Ecology	Project Option with greatest Magnitude varies across different impact types on fish and shellfish.

Potential impact	Project Option 1 (49 WTG)	Project Option 2 (35 WTG)	Rationale for the project option with the greatest magnitude of impact
13. Indirect impacts due to accidental pollution	The greatest potential for a likely significant effect is identical (or less) to that of the construction phase	The greatest potential for a likely significant effect is identical (or less) to that of the construction phase	Equal magnitude of impact across both project options
14. Impacts arising from artificial light	Artificial lighting will be used continuously during HDD drilling activities. During construction, temporary lighting will be used to mark any surface piercing structures and will have a 2.5 second yellow flash visible for at least 2nm with a 360-degree visibility.	Artificial lighting will be used continuously during HDD drilling activities. During construction, temporary lighting will be used to mark any surface piercing structures and will have a 2.5 second yellow flash visible for at least 2nm with a 360-degree visibility.	Project Option 1 is considered to have a greater magnitude of impact due to the higher number of surface piercing structures

15.5 Potential Effects

The likely significant effects, both beneficial and adverse, on offshore and intertidal ornithology for each stage of the proposed development are considered, specifically, the likely significant effects of the proposed development during its construction, operational and decommissioning phases associated with the offshore development area. The environment in the vicinity of the proposed development is naturally dynamic, and as such will exhibit some level of natural variation and change over time whether the proposed development proceeds or not. Consequently, the identification and assessment of likely significant effects must be done in the context of natural change, both spatial and temporal.

The assessment of likely significant effects on the designated sites listed in Section 15.2.8 is an intrinsic part of the assessment of the regional population of offshore and intertidal ornithology assessed in this section, of which the citation population forms part of. An assessment of the indirect impacts on the offshore and intertidal ornithology receptors designated within these sites including impacts to supporting habitats and water quality is also included in this assessment.

A NIS has been prepared which is a standalone document independent of the findings of this EIAR, In compliance with the EU's Habitats Directive and Birds Directive. The NIS assesses whether the proposed development, individually or in combination with other plans or projects, is likely to have a significant effect on any Natura 2000 sites, in view of the sites' conservation objectives. This considers mitigation measures that will be implemented to ensure that adverse effects on site integrity do not arise, are considered. The conclusion of the NIS assessment was that the proposed development will not adversely affect the integrity of any European site, either alone or in combination with other plans or projects.

15.5.1 Do-Nothing Scenario

A recent review of the top global threats to seabirds identified mammalian invasive non-native species (MINNS), fisheries bycatch, and climate change as the greatest threats (Dias et al., 2019). This is also true of Irish waters in particular, with these threats impacting seabirds within the Irish Sea and further across the UK and Western Europe (Furness, 2016; JNCC, 2021; Tasker et al., 2000; Sydeman et al., 2017). More recently, HPAI has emerged as a key threat to seabirds, with populations first impacted in 2021 and impacts continuing to date. Within Ireland, key risk seabird species are expected to be gulls, gannets, skuas and terns, with the 2023 breeding season seeing particularly negative impacts on black-headed gull and common tern colonies (BTO, 2023). Pollutants (including oil, persistent organic pollutants, plastics), disease, and loss of nesting habitat also impact on seabird populations but are generally much less important and often more localised in their effect (Ratcliffe, 2004; Votier et al., 2005, 2008; JNCC, 2021).

In Ireland, regular monitoring data is available from the BTO SMP database (BTO, 2023) and via NPWS (Cummins et al., 2019). Though many seabird numbers are in decline across the wider British Isles, over the long term (~32 years) it is estimated 68% of species populations have increased, with a more positive trend of 85% of species populations increasing over the short term (~6 years) (Macdonald et al., 2015).

Over the coming years it is expected that climate change will remain one of the strongest influences on seabird populations, which may slow population increases/further ongoing declines in seabird populations. Similarly, fisheries impacts on Irish seabirds are expected to continue/increase, The Common Fisheries Policy (CFP) Landings Obligation, or 'discard ban' is expected to reduce the amount of available food discarded by fishing vessels which currently acts as a food supply for scavenging seabirds including large gull species, fulmars, kittiwakes and gannets (Votier et al., 2004; Bicknell et al., 2013; Votier et al., 2013; Foster et al., 2017). Additionally, ongoing fishing trends within the Irish Sea are expected to cause further declines in food availability for foraging seabirds. Within the region, sprat have shown to be a key resource for seabirds such as kittiwake (in comparison to other regions such as the North Sea where sandeels are proportionally more important) (Chivers et al., 2012). However, sprat fishing within the Irish Sea is currently unregulated, with annual catch continuing to increase beyond scientific advice[10]. Therefore, the availability of key prey items of seabirds is expected to decline within the region.

[10] https://oar.marine.ie/handle/10793/1726

It is not possible to definitively predict future trends in seabird populations in the absence of the proposed development. However, assuming that current impacts (notably climate change and fishing pressure) continue and based on the available information that these impacts are contributing to population declines in seabird species across the globe, it is assumed that a slowing of population growth rates within Ireland can be expected unless these threats are reduced. These changes are expected to occur regardless of the presence of the proposed development. It should also be noted that at this stage there is also uncertainty of projected trends in light of HPAI, with this still being a new threat to seabirds and therefore making it difficult to project long-term impacts.

15.5.2 Construction Phase

This section presents the assessment of impacts arising from the construction phase of the proposed development.

15.5.2.1 Impact 1: Disturbance and displacement

During construction of the proposed development, disturbance and subsequent displacement of seabirds may be caused by a range of drivers, including vessel movements (both construction and personnel), WTG construction activities as well as the physical presence of constructed WTGs, which may cause a displacement response. This impact may be present across both the array area, and in the offshore and intertidal ECC.

As outlined in Table 15.21 the duration of construction is approximately up to 3 years, overlapping with a maximum of four breeding seasons, four winter periods, and up to four migration periods. Notably construction activity will not be undertaken across the whole array area simultaneously or on every day but will be phased, with a maximum of one foundation expected to be piled at any one time. Therefore, the effects will be spatially and temporally limited, occurring only in the vicinity of vessels operating at any given point and not across the entire offshore development area.

The susceptibility of birds to displacement is variable across different species. 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 OWF (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). However, auk and diver species have all been shown to exhibit behavioural responses to OWF activities and may be displaced as a consequence (Dierschke et al., 2017).

The displacement assessment within the array area is undertaken based on DAS data collected for the proposed development. To assess displacement impacts in the ECC, data from Jessop et al., (2018) was used, which encompasses fine-scale aerial data on the distribution and abundance of seabirds in the western Irish Sea. As outlined in Section 15.3, this data had low coverage of the offshore ECC, and therefore data from the ECC plus 4km buffer was used to obtain density estimates and data on species presence, noting that the relevant ECC study area remains the offshore ECC only, with no surrounding buffer.

A screening exercise was undertaken to identify species most likely to be at risk of effects from disturbance and displacement in the array area, presented in Table 15.22 below. The screening exercise considered the relative abundance of species recorded within the proposed development array area and 2km buffer (4km for divers), and their vulnerability to disturbance and displacement. The use of a 2km buffer is standard for most seabirds, with a 4km buffer considered relevant for divers and seaducks. Therefore, within the screening, abundance within the array plus 2km buffer is considered for all species except red-throated diver and great northern diver, for which consideration is given to the array area plus 4km buffer. This approach is consistent across both Natural England and NatureScot guidance. Generally, low frequency refers to species present within the array plus relevant buffer on only one or a low number (based on expert judgement on a case-by-case basis) of occasions during the survey programme. Medium frequency was used to describe species routinely present in the array plus relevant buffer during a particular season, or with patchy abundance across multiple seasons, whilst the high frequency descriptor was reserved for species recorded in the array plus relevant buffer on most or all surveys.

The vulnerability of species to disturbance and displacement in relation to activity during the construction phase (as defined in Table 15.4) is presented for each species in Table 15.22 below, with the vulnerability for each species based on a range of available data sources (e.g. Bradbury et al., 2014; Garthe and Hüppop, 2004; Furness and Wade, 2012, Wade et al., 2016, Dierschke et al., 2016). Species were screened out of the assessment if they had a low vulnerability to disturbance and displacement and/or a low relative abundance/frequency in the array area plus 2km buffer. As a precautionary approach, the following species were an exception to this rule:

- Manx shearwater – although considered to have low sensitivity to displacement impacts, Manx shearwater has been included due to its designation in the North-West-Irish Sea cSPA in which the proposed development is located
- Gannet – although generally considered to have low sensitivity, studies show variable results (e.g., Dierschke et al (2016) suggesting higher vulnerability. However, gannet has a low habitat specialisation (e.g., Bradbury et al 2014) and a large foraging range (Woodward et al 2019) and therefore, though they show high avoidance of OWFs, the consequences in terms of mortality are considered low. Therefore gannet is included with a precautionary vulnerability of medium, and
- Puffin – although puffin were only recorded in low numbers and are considered to be of relatively low sensitivity to displacement impacts, they have also been included as a precautionary approach. This is due to their inclusion in several assessments within the Irish Sea (e.g., Awel y Mor), and due to the recommendation by both Natural England and NatureScot that this species should be included in displacement assessments in English and Scottish projects.

The same screening exercise was carried out for species recorded in the offshore ECC based on aerial survey data from Jessop et al., (2018), presented in Table 15.23 below. As outlined above, density estimates are derived from data the ECC plus a 4km buffer, though the relevant study area is the ECC only (i.e., without a surrounding buffer). Consequently abundance estimates are also calculated and provided within a 4km buffer around the ECC to give a better idea of species abundance and distribution around the ECC, though the study area for assessment of disturbance and displacement remains the ECC only.

Table 15.22 Screening of seabird species recorded within the array area and 2km buffer for risk of disturbance and displacement during the construction phase

Bird species	Vulnerability to disturbance and displacement (based on Bradbury et al., 2014; Dierschke et al., 2016)	Estimated peak abundance in the array area plus 2km buffer[11] (individuals)	Frequency of presence in array area plus 2km buffer12 (months recorded out of 29)	Relative abundance/density in the array area plus 2km buffer12	Screening outcome
Whimbrel	Low	0	1	Low	Out
Kittiwake	Low	1,481	28	High	Out
Black-headed gull	Low	30	2	Low	Out
Little gull	Low	0	0	Low	Out
Common gull	Low	225	10	Low	Out
Great black-backed gull	Negligible	660	20	Medium	Out
Herring gull	Negligible	1,284	24	High	Out
Lesser black-backed gull	Negligible	57	5	Low	Out
Sandwich tern	Low	5	1	Low	Out
Roseate tern	Low	30	2	Low	Out
Common tern	Low	61	2	Low	Out

[11] 4km buffer for divers

Bird species	Vulnerability to disturbance and displacement (based on Bradbury et al., 2014; Dierschke et al., 2016)	Estimated peak abundance in the array area plus 2km buffer[11] (individuals)	Frequency of presence in array area plus 2km buffer12 (months recorded out of 29)	Relative abundance/density in the array area plus 2km buffer12	Screening outcome
Arctic tern	Low	25	1	Low	Out
Great skua	Low	0	0	Low	Out
Arctic skua	Low	0	0	Low	Out
Guillemot	Medium	33,694	29	High	In
Razorbill	Medium	6,274	24	High	In
Black guillemot	Medium	18	2	Low	Out
Puffin	Low to medium	24	7	Low	In
Red-throated diver	High	5	2	Low	Out
Great northern diver	High	30	2	Low	Out
Fulmar	Low	55	5	Low	Out
Sooty shearwater	Low	5	2	Low	Out
Manx shearwater	Low	5,527	16	Medium	In
Gannet	Low to medium	475	22	Medium	In
Shag	Negligible	5	1	Low	Out

Table 15.23 Screening of seabird species recorded within the ECC and 4km buffer for risk of disturbance and displacement during the construction phase

Species	Vulnerability to disturbance and displacement (based on Bradbury et al., 2014; Dierschke et al., 2016)	Relative abundance in ECC plus 4km buffer (annual raw count)	Screening outcome
Velvet scoter	High	Low (1)	Out
Common scoter	High	Medium (61)	In
Scoter sp.	High	Low (12)	In (Apportioned to common scoter)
Kittiwake	Low	Medium (40)	Out
Black-headed gull	Low	Medium (59)	Out
Great black-backed gull	Low	Low (4)	Out
Herring gull/common gull	Low	Medium (114)	Out
Lesser black-backed gull	Low	Low (3)	Out
Lesser black-backed gull/great black-backed gull	Low	Low (14)	Out
Large gull sp.	Low	Medium (107)	Out
Small gull sp.	Low	Low (6)	Out
Sandwich tern	Low	Low (4)	Out
Little tern	Low	Low (1)	Out
Roseate tern	Low	Low (9)	Out
Common tern/Arctic tern	Low	Medium (21)	Out
Tern sp.	Low	Low (4)	Out

Species	Vulnerability to disturbance and displacement (based on Bradbury et al., 2014; Dierschke et al., 2016)	Relative abundance in ECC plus 4km buffer (annual raw count)	Screening outcome
Guillemot/Razorbill	Medium	Medium (834)	Out[12]
Diver sp.	High	Medium (25)	In (red-throated diver / great northern diver)
Fulmar	Low	Low (7)	Out
Manx shearwater	Low	Low (3)	Out
Gannet	Low to medium	Low (12)	Out
Cormorant/shag	Low	Medium (147)	Out

Based on the above screening exercise, guillemot, razorbill, puffin, Manx shearwater and gannet have been screened in for the array area, and red-throated diver, great northern diver and common scoter for the ECC owing to their sensitivity to disturbance and displacement and/or their high frequency and/or abundance in the array area and relevant buffer, with the latter three screened in for assessment in the ECC only.

It is recognised that assessment of these species during the construction phase will result in lower levels of displacement compared with the operational phase. This is due to:

- Construction activities being undertaken predominantly within discrete localised areas of the array area at any one time, meaning that displacement impacts will have a considerably smaller footprint, and therefore act on fewer birds, than during the operational phase
- Only a proportion of the array will be constructed and therefore there will be less infrastructure present to disturb birds during the earlier phases of construction. For example, over the course of construction, assuming that turbines are constructed at a constant rate, on average approximately 50% of the array will have been constructed; and
- Construction activities are temporally limited (over approximately 3 years).

Few studies have provided definitive empirical displacement rates for the construction phase of OWF developments. Studies on auks show that displacement rates are either significantly lower or comparable to the operation phase (Royal HaskoningDHV 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, to reflect available research and to provide a precautionary assessment during the construction phase that reflects the lower levels of displacement compared to the operational phase, displacement rates used are half those used in the operational phase assessment. This accounts for the fact that, on average over the full construction period, approximately half of the array will be constructed. This approach is consistent with what has been undertaken for other projects within the UK (e.g., Natural Resources Wales (NRW) agreed that the Awel y Mor wind farm can use half operational displacement rates in the construction phase; APEM, 2022). Mortality rates used for the construction phase assessment remain the same as those used in the operational phase assessment.

For justification of displacement rates used in the assessment, reference should be made to the operational phase section (Section 15.5.3), with the exception of common scoter, red-throated diver and great northern diver which are only considered within this section.

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[12] Screened out as not identified to species level therefore relative abundance is low when considering apportioning to species level, and the assessment in the array area is considered to appropriately cover any potential displacement risk to both these species.

For the assessment of displacement impacts within the array area, the abundance of birds within the array area plus 2km buffer was used, as justified in the species sections below. For the assessment of displacement impacts within the ECC, the assessment considers the impacts of one vessel cluster, with a surrounding 3km buffer. It is noted that a 2km buffer round vessels is standard use, but a 3km buffer is used here as a precautionary approach, accounting for the fact that vessels may be up to a kilometre apart from each other at a given point. Based on this, the area disturbed from the vessel cluster was calculated to be 28.3km^2, from which birds could be displaced.

Within the displacement assessment, a range of displacement rates and mortality rates are presented in each case (except Manx shearwater where only a single value is considered relevant). In each case, the full range of likely significant effects based on these parameters is presented, though in each case a single evidence-led approach is presented to form the main basis of the assessment, representing parameters deemed most ecologically relevant based on available evidence and expert judgement. For each species, the main approach value selected is consistent with the Phase one projects (as discussed in the Irish Phase one Methodology Statement'), and across other OWF projects in the UK.

As outlined in Section 15.4.6, both Project Option 1 and Project Option 2 have an equal potential for disturbance and displacement impacts, and therefore the magnitude of impact and significance of effect is the same for both project options in this section.

Common scoter

Sensitivity of common scoters

Common scoter are considered to have a high vulnerability to disturbance and displacement impacts (Table 15.22). They have shown to be highly susceptible to disturbance from boat and helicopter traffic (Garthe and Huppop, 2004), with birds showing disturbance responses at distances of over 1km from boats (Kaser et al., 2006; Schwemmer et al., 2011). However, evidence on displacement impacts resulting from permanent infrastructure is more limited. Dierschke et al., (2016) indicates only a weak avoidance behaviour of OWFs for this species (with most impacts resulting from boat and helicopter traffic), while post-consent monitoring at the Gwynt y Mor OWF found limited evidence of displacement impacts on this species (APEM, 2019).

During aerial surveys, no common scoters were recorded in the array or array plus buffers, though it is noted that this species was recorded in relatively high numbers during vantage-point surveys (as presented in the Technical Baseline). They are therefore included for assessment within the ECC only, using available data from Jessop et al., (2018). Within this data, scoter species were recorded only in the non-breeding season and therefore only this period (September to April) is considered within the assessment.

Though not included within the Irish Phase one Methodology Statement' common scoter are considered to have the same disturbance susceptibility and habitat specialisation scores as red-throated diver and great northern diver in Bradbury et al., (2014) and are therefore assessed using the same parameters recommended for this species within the UK Statutory Nature Conservation Body (SNCB) Guidance (MIG-Birds, 2022) which is recommended for use by both Natural England and NatureScot, presenting a range of 90% to 100% displacement and a range of 1% to 10% mortality. A displacement rate of 100% and a mortality rate of 1% are considered the most appropriate approach, with the upper displacement rate of 100% displacement was selected as a precautionary approach due to the high vulnerability of this species to displacement.

On the east coast of Ireland, there are only two SPAs where common scoter is a designated feature. The Raven SPA, which is located beyond the foraging range of this species, and the North-West Irish Sea cSPA within which the proposed development is located and therefore to which individuals are assumed to be connected to. Common scoter are also BoCCI red listed and IUCN Least Concern. They are therefore considered to have a high conservation value (Table 15.5).

Common scoter therefore have a high vulnerability (Table 15.4), and a high conservation value (Table 15.5), with an overall receptor sensitivity assessed as high based on the matrix approach in Table 15.6.

The assessment considers displacement risk in the ECC only because common scoter are generally found within a few kilometres of the coastline and no birds were recorded in the array area during the entire DAS programme.

Magnitude of impact (ECC)
Data collected by Jessop et al., (2018) presented both counts of common scoter, and of scoter species which were not identifiable to species level. As a precautionary approach, this assessment uses the combined count of common scoter and scoter species.

Based on data on common scoter densities presented by Jessop et al., (2018), the peak density of birds present within the ECC in the non-breeding bio-season is 3.0 bird/km^2. Based on a total disturbance area of 28.3m^2 (as described above), a total of 86 (86.2) common scoters are at risk of displacement. Of these, the total displacement consequent mortality is estimated at one (0.9) individual, based on 100% displacement and 1% mortality.

A regional population for common scoter is not provided within Furness (2015). However, Jessop et al., (2018) estimate a peak non-breeding season abundance of abundance of 8,616, with an annual baseline mortality of 1,956 individuals per annum (based on an average mortality rate of 0.226; Table 15.18). The addition of one individual would represent a 0.044% increase in baseline mortality based on 100% displacement and 1% mortality. Considering the biogeographic population of 550,000 and an annual baseline mortality of 124,850 individuals per annum, the addition of one individual would represent a 0.001% increase in baseline mortality based on 100% displacement and 1% mortality. Potential impacts based on a displacement range of 90% to 100% and a mortality range of 1% to 10% are presented in Table 15.24.

The impacts from the proposed development during the non-breeding bio-season at both the regional and biogeographic population scales represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect). This threshold is appropriate based on relevant guidance (e.g., Parker et al 2022c).

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement would be negligible (Table 15.7).

Significance of the effect (ECC)
Overall, it is predicted that the sensitivity of common scoter for both Project Option 1 and Project Option 2 is high and the magnitude of the impact is negligible. The high sensitivity and negligible magnitude of the impact on common scoter results in a not significant effect, which is not significant in EIA terms, based on the matrix approach in Table 15.8.

Table 15.24 Predicted bio-season displacement impacts on common scoter in the ECC from the proposed development during the construction phase

Bio-season (months)	Bio-season mean peak density in the ECC plus 4km buffer (birds/km2)	Population size (individuals)	Estimated mortality (individuals)		Percentage increase in baseline mortality	
			100% displacement, 1% mortality	90% to 100% displacement, 1% to 10% mortality	100% displacement, 1% mortality	90% to 100% displacement, 1% to 10% mortality
Non-breeding (regional population)	3.0	8,616	0.9	0.8 – 8.6	0.044	0.040–0.442
Non-breeding (biogeographic)	3.0	550,000	0.9	0.8 – 8.6	0.001	0.001–0.009

Guillemot

Sensitivity of guillemots

Guillemots are considered to have a medium vulnerability to disturbance and displacement impacts (Table 15.22). A high number of individuals were recorded during surveys, with individuals originating from a mixture of SPA (notably Lambay Island and Ireland's Eye SPA where guillemot is a designated feature) and non-SPA colonies. They are also BoCCI Amber listed and IUCN Least Concern (Table 15.16). They are therefore considered to have a medium conservation value (Table 15.5).

Guillemot therefore have a medium vulnerability (Table 15.4), and a medium conservation value (Table 15.5, with an overall receptor sensitivity assessed as medium based on the matrix approach in Table 15.6.

Guillemots are assessed using a displacement rate of 25% and a mortality rate of 1%, with a range of 15% to 35% displacement and 1% to 5% mortality also presented. Displacement rates used represent half the rates used in the operational phase, with a full justification of rates used provided in that section (Section 15.5.3).

As outlined in Table 15.14, two bio-season approaches are considered for guillemot, with a more ecologically relevant project approach forming the main basis of the assessment, and results based on the general Furness approach used for other species also presented.

The assessment considers displacement risk in the array area only because auks are not particularly sensitive to vessel disturbance (Jarrett et al., 2018), which is the main form of disturbance within the ECC. In addition, the Jessop et al. (2018) dataset shows a low number of birds were observed in the ECC (noting data do not distinguish between guillemot and razorbill).

Magnitude of impact (array area)

The abundance of guillemots within the array area plus 2km buffer was estimated using both design-based and model-based methods. Across all months, model-based methods consistently predicted fewer birds in the array area and 2km buffer. For example, the mean-peak counts during the breeding season (Furness approach) from model-based estimates was 8,642 compared with 13,703 using design-based abundances. This translates to roughly a 37% reduction in the estimated abundance based on the modelled approach. As a precautionary approach, design-based abundance estimates were used in the displacement assessment in this chapter. Nevertheless, this does not mean that the modelled estimates provide a less accurate prediction of the true number and distribution of birds throughout the array plus 2km buffer, and they should be considered in relation to the conclusions provided for guillemot.

During the breeding season, the mean peak abundance for guillemot based on the proposed development approach to bio-seasons is 1,813 individuals within the array area plus 2km buffer. Based on 15% to 35% displacement and 1% to 5% mortality, between three (2.7) and 32 (31.7) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 25% displacement and 1% mortality, the estimated displacement consequent mortality is five (4.5) individuals per annum.

Assuming a breeding bio-season regional population size of 736,212 individuals (Table 15.17) and a baseline mortality of 99,362 individuals per annum (derived from an average mortality rate of 0.135; Table 15.18), the addition of five displacement consequent mortalities would represent a 0.005% increase in baseline mortality. Potential impacts based on 15% to 35% displacement and 1% to 5% mortality, and based on the Furness approach to bio-seasons are presented in Table 15.25 below.

During the non-breeding bio-season, the mean peak abundance for guillemot is 29,765 individuals within the array area plus 2km buffer. Based on 15% to 35% displacement and 1% to 5% mortality, between 45 (44.6) and 104 (104.2) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 25% displacement and 1% mortality, the estimated displacement consequent mortality is 74 (74.4) individuals per annum.

Assuming a non-breeding bio-season regional population size of 1,332,623 individuals (Table 15.17) and a baseline mortality of 179,856 individuals per annum (derived from an average mortality rate of 0.135; Table 15.18), the addition of 74 displacement consequent mortalities would represent a 0.041% increase in baseline mortality. Potential impacts based on 15% to 35% displacement and 1% to 5% mortality are presented in Table 15.25 below.

Across all bio-seasons, the total mean peak abundance of guillemots in the array area plus 2km buffer is 31,578. Based on 15% to 35% displacement and 1% to 5% mortality, between 47 (47.4) and 136 (135.9) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 25% displacement and 1% mortality, the estimated displacement consequent mortality is 79 (78.9) individuals per annum.

Assuming the largest regional population size of 1,332,623 individuals (Table 15.17) and a baseline mortality of 179,856 individuals per annum (derived from an average mortality rate of 0.135; Table 15.18), the addition of 79 displacement consequent mortalities would represent a 0.044% increase in baseline mortality. Considering the biogeographic population size of 4,125,000, with a baseline mortality of 556,727 individuals per annum, the addition of 79 displacement consequent mortalities would represent a 0.014% increase in baseline mortality. Potential impacts based on 15% to 35% displacement and 1% to 5% mortality, and based on the Furness approach to bio-seasons are presented in Table 15.25 below.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent. a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement would be negligible (Table 15.7).

Significance of the effect (array area)

Overall, it is predicted that the sensitivity of guillemot for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on guillemot results in an imperceptible effect, which is not significant in EIA terms, based on the matrix approach in Table 15.8.

Table 15.25 Predicted bio-season displacement impacts on guillemot from the proposed development during the construction phase

Bio-season (months)	Bio-season mean peak abundance in the array plus 2km buffer Estimated mortality (+/- 95% CI)	Population size (individuals)	Estimated mortality (+/- 95% CI)			Percentage increase in baseline mortality (+/- 95% CI)		
			25% displacement, 1% mortality	**15% displacement, 1% mortality**	**35% displacement, 5% mortality**	**25% displacement, 1% mortality**	**15% displacement, 1% mortality**	**35% displacement, 5% mortality**
Furness approach to bio-seasons								
Breeding (method 1)	13,703 (8,940 – 18,414)	736,212	34.3 (22.3 – 46.0)	20.6 (13.4 – 27.6)	239.8 (156.4 – 322.2)	0.034 (0.022 – 0.046)	0.021 (0.013 – 0.028)	0.241 (0.157 – 0.324)
Breeding (method 2)	13,703 (8,940 – 18,414)	190,073	34.3 (22.3 – 46.0)	20.6 (13.4 – 27.6)	239.8 (156.4 – 322.2)	0.134 (0.087 – 0.179)	0.080 (0.052 – 0.108)	0.935 (0.610 – 1.256)
Non-breeding	29,765 (21,092) – 38,338)	1,332,623	74.4 (52.7 – 95.8)	44.6 (31.6 – 57.5)	104.2 (73.8 – 134.2)	0.041 (0.029 – 0.053)	0.025 (0.018 – 0.032)	0.058 (0.041 – 0.075)
Annual (regional population)	43,468 (30,032 – 56,751)	1,332,623	108.7 (75.1 – 141.9)	65.2 (45.0 – 85.1)	344.0 (230.3 – 456.2)	0.060 (0.042 – 0.079)	0.036 (0.025 – 0.047)	0.191 (0.128 – 0.254)
Annual (biogeographic)	43,468 (30,032 – 56,751)	4,125,000	108.7 (75.1 – 141.9)	65.2 (45.0 – 85.1)	344.0 (230.3 – 456.2)	0.020 (0.013 – 0.025)	0.012 (0.008 – 0.015)	0.062 (0.041 – 0.082)
Project approach to bio-seasons								
Breeding (method 1)	1,813 (1,258 – 2,385)	736,212	4.5 (3.1 – 6.0)	2.7 (1.9 – 3.6)	31.7 (22.0 – 41.7)	0.005 (0.003 – 0.006)	0.003 (0.002 – 0.004)	0.032 (0.022 – 0.042)
Breeding (method 2)	1,813 (1,258 – 2,385)	190,073	4.5 (3.1 – 6.0)	2.7 (1.9 – 3.6)	31.7 (22.0 – 41.7)	0.018 (0.012 – 0.023)	0.011 (0.007 – 0.014)	0.124 (0.086 – 0.163)
Non-breeding	29,765 (21,092) – 38,338)	1,332,623	74.4 (52.7 – 95.8)	44.6 (31.6 – 57.5)	104.2 (73.8 – 134.2)	0.041 (0.029 – 0.053)	0.025 (0.018 – 0.032)	0.058 (0.041 – 0.075)
Annual (regional population)	31,578 (22,350 – 40,722)	1,332,623	78.9 (55.9 – 101.8)	47.4 (33.5 – 61.1)	135.9 (95.8 – 175.9)	0.044 (0.031 – 0.057)	0.026 (0.019 – 0.034)	0.076 (0.053 – 0.098)
Annual (biogeographic)	31,578 (22,350 – 40,722)	4,125,000	78.9 (55.9 – 101.8)	47.4 (33.5 – 61.1)	135.9 (95.8 – 175.9)	0.014 (0.010 – 0.018)	0.009 (0.006 – 0.011)	0.024 (0.017 – 0.032)

Razorbill

Sensitivity of razorbills

Razorbills are considered to have a medium vulnerability to disturbance and displacement impacts (Table 15.22). A high number of individuals were recorded during site-specific surveys, with individuals originating from a mixture of SPA (notably Lambay Island and Ireland's Eye SPA where razorbill is a designated feature) and non-SPA colonies. They are also BoCCI Amber listed and IUCN Least Concern (Table 15.16). They are therefore considered to have a medium conservation value (Table 15.5).

Razorbill therefore have a medium vulnerability (Table 15.4), and a medium conservation value (Table 15.5), with an overall receptor sensitivity assessed as medium based on the matrix approach in Table 15.6.

Razorbill are assessed using a displacement rate of 25% and a mortality rate of 1%, with a range of 15% to 35% displacement and 1% to 5% mortality also presented. Displacement rates used represent half the rates used in the operational phase (Section 15.5.3), with a full justification of rates used provided in discussion of the operational phase .

The assessment considers displacement risk in the array area only, with a low number of birds recorded in the ECC (noting the ECC data does not distinguish between guillemot and razorbill).

Magnitude of impact (array area)

The abundance of razorbill within the array area plus 2km buffer was estimated using both design-based and model-based methods. There was variation between months on which method produced the highest abundance. However, the mean peak abundance for the breeding season (and two of the three non-breeding bio-seasons) was lower for the model-based approach (see MRSea Modelling Report). The largest reductions in abundances were in the breeding season and the autumn migration which showed a 30% reduction in the predicted abundance compared with the design-based estimates. Therefore, for precaution design-based abundance estimates were used in the displacement assessment in this chapter (the same approach as used for guillemot and other displacement species). Nevertheless, this does not mean that the modelled estimates provide a less accurate prediction of the true number and distribution of birds throughout the array plus 2km buffer, and they should be considered in relation to the conclusions provided for guillemot.

During the breeding season, the mean peak abundance for razorbill is 168 individuals within the array area plus 2km buffer. Based on 15% to 35% displacement and 1% to 5% mortality, between less than one (0.3) and three (2.9) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 25% displacement and 1% mortality, the estimated displacement consequent mortality is less than one (0.4) individuals per annum.

Assuming a breeding bio-season regional population size of 321,633 individuals (Table 15.17) and a baseline mortality of 41,633 individuals per annum (derived from an average mortality rate of 0.129; Table 15.18), the addition of less than one displacement consequent mortality would represent a 0.001% increase in baseline mortality. Potential impacts based on 15% to 35% displacement and 1% to 5% mortality are presented in Table 15.26 below.

During the autumn migration bio-season, the mean peak abundance for razorbill is 3,371 individuals within the array area plus 2km buffer. Based on 15% to 35% displacement and 1% to 5% mortality, between five (5.1) and 59 (59.0) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 25% displacement and 1% mortality, the estimated displacement consequent mortality is eight (8.4) individuals per annum.

Assuming an autumn migration bio-season regional population size of 632,453 individuals (Table 15.17) and a baseline mortality of 81,866 individuals per annum (derived from an average mortality rate of 0.129; Table 15.18), the addition of eight displacement consequent mortalities would represent a 0.010% increase in baseline mortality. Potential impacts based on 15% to 35% displacement and 1% to 5% mortality are presented in Table 15.26 below.

During the spring migration bio-season, the mean peak abundance for razorbill is 483 individuals within the array area plus 2km buffer. Based on 15% to 35% displacement and 1% to 5% mortality, between one (0.7) and nine (8.5) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 25% displacement and 1% mortality, the estimated displacement consequent mortality is one (1.2) individual per annum.

Assuming a spring migration bio-season regional population size of 632,453 individuals (Table 15.17) and a baseline mortality of 81,866 individuals per annum (derived from an average mortality rate of 0.129; Table 15.18), the addition of one displacement consequent mortality would represent a 0.001% increase in baseline mortality. Potential impacts based on 15% to 35% displacement and 1% to 5% mortality are presented in Table 15.26 below.

During the migration-free winter bio-season, the mean peak abundance for razorbill is 2,079 individuals within the array area plus 2km buffer. Based on 15% to 35% displacement and 1% to 5% mortality, between three (3.1) and 36 (36.4) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 25% displacement and 1% mortality, the estimated displacement consequent mortality is five (5.2) individuals per annum.

Assuming a migration-free winter bio-season regional population size of 366,961 individuals (Table 15.17) and a baseline mortality of 47,500 individuals per annum (derived from an average mortality rate of 0.129; Table 15.18), the addition of five displacement consequent mortalities would represent a 0.011% increase in baseline mortality. Potential impacts based on 15% to 35% displacement and 1% to 5% mortality are presented in Table 15.26 below.

Across all bio-seasons, the total mean peak abundance of razorbill in the array area plus 2km buffer is 6,101. Based on 15% to 35% displacement and 1% to 5% mortality, between nine (9.2) and 107 (106.8) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 25% displacement and 1% mortality, the estimated displacement consequent mortality is 15 (15.3) individuals per annum.

Assuming the largest regional population size of 632,453 individuals (Table 15.17) and a baseline mortality of 81,866 individuals per annum (derived from an average mortality rate of 0.129; Table 15.18), the addition of 15 displacement consequent mortalities would represent a 0.019% increase in baseline mortality. Considering the biogeographic population size of 1,707,000, with a baseline mortality of 220,957 individuals per annum, the addition of 15 displacement consequent mortalities would represent a 0.007% increase in baseline mortality. Potential impacts based on 15% to 35% displacement and 1% to 5% mortality are presented in Table 15.26 below.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement would be negligible (Table 15.7).

Significance of the effect (array area)

Overall, it is predicted that the sensitivity of razorbill for Project Option 1and Project Option 2 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on razorbill results in an imperceptible effect, which is not significant in EIA terms, based on the matrix approach in Table 15.8.

Table 15.26 Predicted bio-season displacement impacts on razorbill from the proposed development during the construction phase

Bio-season (months)	Bio-season mean peak abundance in the array plus 2km buffer (+/- 95% CI)	Population size (individuals)	Estimated mortality (individuals) (+/- 95% CI)			Percentage increase in baseline mortality (+/- 95% CI)		
			25% displacement, 1% mortality	**15% displacement, 1% mortality**	**35% displacement, 5% mortality**	**25% displacement, 1% mortality**	**15% displacement, 1% mortality**	**35% displacement, 5% mortality**
Breeding (method 1)	168 (83 – 263)	321,633	0.4 (0.1 – 0.4)	0.3 (0.1 – 0.4)	2.9 (1.4 – 4.6)	0.001 (0.000 – 0.001)	0.001 (0.000 – 0.001)	0.007 (0.005 – 0.014)
Breeding (method 2)	168 (83 – 263)	49,298	0.4 (0.1 – 0.4)	0.3 (0.1 – 0.4)	2.9 (1.4 – 4.6)	0.007 (0.001 – 0.003)	0.004 (0.001 – 0.003)	0.046 (0.01 – 0.033)
Autumn migration	3,371(1,484 – 5,385)	632,453	8.4 (3.7 – 13.5)	5.1 (2.2 – 8.1)	59.0 (26.0 – 94.2)	0.010 (0.005 – 0.016)	0.006 (0.003 – 0.010)	0.072 (0.032 – 0.115)
Spring migration	2,079 (1,230- 2,930)	632,453	1.2 (0.6 – 2.0)	0.7 (0.4 – 1.2)	8.5 (4.1 – 2.8)	0.001 (0.001 – 0.002)	0.001 (0.000 – 0.001)	0.010 (0.005 – 0.003)
Migration-free winter	483 (236 – 796)	321,633	5.2 (3.1 – 7.3)	3.1 (1.8 – 4.4)	36.4 (4.3 – 10.3)	0.011 (0.006 – 0.015)	0.007 (0.004 – 0.009)	0.077 (0.009 – 0.022)
Annual (regional population)	6,101 (3,032 – 9,374)	632,453	15.3 (7.5 – 23.2)	9.2 (4.5 – 14.1)	106.8 (35.8 – 111.9)	0.019 (0.009 – 0.028)	0.011 (0.006 – 0.017)	0.130 (0.044 – 0.137)
Annual (biogeographic)	6,101 (3,032 – 9,374)	1,707,000	15.3 (7.5 – 23.2)	9.2 (4.5 – 14.1)	106.8 (35.8 – 111.9)	0.007 (0.003 – 0.010)	0.004 (0.002 – 0.006)	0.048 (0.016 – 0.051)

Puffin

Sensitivity of puffins

Puffins are considered to have a low to medium vulnerability to disturbance and displacement impacts (Table 15.22). During surveys, a low number of individuals were recorded. Recorded individuals are assumed to originate from a number of designated and non-designated sites, including Lambay Island SPA where puffin is a designated feature. Puffin are also BoCCI Amber listed and IUCN Vulnerable (Table 15.16). They are therefore considered to have a medium conservation value (Table 15.5).

Puffins therefore have a medium vulnerability (Table 15.4), and a medium conservation value (Table 15.5), with an overall receptor sensitivity assessed as medium based on the matrix approach in Table 15.6.

Puffins are assessed using a displacement rate of 25% and a mortality rate of 1%, with a range of 15% to 35% displacement and 1% to 5% mortality also presented. Displacement rates used represent half the rates used in the operational phase (Section 15.5.3), with a full justification of rates used provided in this section.

This assessment considers displacement risk in the array area only. No birds were recorded in the ECC based on observations by Jessop et al., (2018).

Magnitude of impact (array area)

During the breeding season, the mean peak abundance for puffins is 12 individuals within the array area plus 2km buffer. Based on 15% to 35% displacement and 1% to 5% mortality, between almost zero (0.0) individuals per annum to less than one (0.2) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 25% displacement and 1% mortality, the estimated displacement consequent mortality is almost zero (0.0) individuals per annum.

Assuming a breeding bio-season regional population size of 180,693 individuals (Table 15.17) and a baseline mortality of 31,756 individuals per annum (derived from an average mortality rate of 0.176; Table 15.18), the addition of almost zero displacement consequent mortality would represent a 0.000% increase in baseline mortality. Potential impacts based on 15% to 35% displacement and 1% to 5% mortality are presented in Table 15.27 below.

During the non-breeding season, the mean peak abundance for puffins is 10 individuals within the array area plus 2km buffer. Based on 15% to 35% displacement and 1% to 5% mortality, between almost zero (0.0) and less than one (0.2) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 25% displacement and 1% mortality, the estimated displacement consequent mortality is almost zero (0.0) individuals per annum.

Assuming a non-breeding bio-season regional population size of 300,427 individuals (Table 15.17) and a baseline mortality of 52,799 individuals per annum (derived from an average mortality rate of 0.176; Table 15.18), the addition of almost zero displacement consequent mortalities would represent a 0.000% increase in baseline mortality. Potential impacts based on 15% to 35% displacement and 1% to 5% mortality are presented in Table 15.27 below.

Across all bio-seasons, the total mean peak abundance of puffins in the array area plus 2km buffer is 22. Based on 15% to 35% displacement and 1% to 5% mortality, between less almost zero (0.0) and less than one (0.4) individual are predicted to be at risk of displacement consequent mortality per annum. Based on 25% displacement and 1% mortality, the estimated displacement consequent mortality is less than one (0.1) individual per annum.

Assuming the largest regional population size of 300,427individuals (Table 15.17) and a baseline mortality of 52,799 individuals per annum (derived from an average mortality rate of 0.175; Table 15.18), the addition of less than one displacement consequent mortality would represent a 0.000% increase in baseline mortality. Considering the biogeographic population size of 11,840,000, with a baseline mortality of 2,072,000 individuals per annum, the addition of zero displacement consequent mortalities would represent a 0.000% increase in baseline mortality. Potential impacts based on 15% to 35% displacement and 1% to 5% mortality are presented in Table 15.27 below.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement would be negligible (Table 15.7).

Significance of the effect (array area)

Overall, it is predicted that the sensitivity of puffin for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on puffin results in an imperceptible effect, which is not significant in EIA terms, based on the matrix approach in Table 15.8.

Table 15.27 Predicted bio-season displacement impacts on puffin from the proposed development during the construction phase

Bio-season (months)	Bio-season mean peak abundance in the array plus 2km buffer (+/- 95% CI)	Population size (individuals)	Estimated mortality (+/- 95% CI)			Percentage increase in baseline mortality (+/- 95% CI)		
			25% displacement, 1% mortality	**15% displacement, 1% mortality**	**35% displacement, 5% mortality**	**25% displacement, 1% mortality**	**15% displacement, 1% mortality**	**35% displacement, 5% mortality**
Breeding (method 1)	12 (3 – 26)	180,693	0.0 (0.0 – 0.1)	0.0 (0.0 – 0.0)	0.2 (0.0 – 0.5)	0.000 (0.000 – 0.000)	0.000 (0.000 – 0.000)	0.000 (0.000 – 0.001)
Breeding (method 2)	12 (3 – 26)	79,939	0.0 (0.0 – 0.1)	0.0 (0.0 – 0.0)	0.2 (0.0 – 0.5)	0.000 (0.000 – 0.000)	0.000 (0.000 – 0.000)	0.000 (0.000 – 0.003)
Non-breeding	10 (2 – 27)	300,427	0.0 (0.0 – 0.1)	0.0 (0.0 – 0.0)	0.2 (0.0 – 0.5)	0.000 (0.000 – 0.000)	0.000 (0.000 – 0.000)	0.000 (0.000 – 0.001)
Annual (regional population)	22 (5 – 53)	300,427	0.0 (0.0 – 0.1)	0.0 (0.0 – 0.1)	0.4 (0.1 – 0.9)	0.000 (0.000 – 0.000)	0.000 (0.000 – 0.000)	0.000 (0.000 – 0.002)
Annual (biogeographic)	22 (5 – 53)	11,840,000	0.0 (0.0 – 0.1)	0.0 (0.0 – 0.1)	0.4 (0.1 – 0.9)	0.000 (0.000 – 0.000)	0.000 (0.000 – 0.000)	0.000 (0.000 – 0.000)

Red-throated diver

Sensitivity of red-throated divers

Red-throated divers are considered to have a high vulnerability to disturbance and displacement impacts (Table 15.22). Red-throated divers 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, though the majority are expected to flush at 1km or less (Bellebaum et al., 2006; Jarrett et al., 2018; Topping and Petersen, 2011).

During site-specific aerial surveys only two red-throated divers were recorded, and both were in the 4km buffer only (i.e., no birds in the array area), and therefore a displacement assessment is not undertaken for the array area. In the ECC, aerial survey data from Jessop et al. (2018) recorded 24 diver species, and therefore they are included for assessment with the ECC due to their sensitivity to vessel disturbance.

To reflect their high vulnerability to vessel displacement, a displacement rate of 100% is proposed for the ECC assessment. A range of displacement from 90% to 100% also presented. A mortality rate of 1% is also deemed most realistic for the assessment, with a range of 1% to 5% also presented.

The North-West Irish Sea cSPA is the only SPA designated for red-throated diver with connectivity to the proposed development. Red-throated diver are also BoCCI Amber listed, IUCN Least Concern and Birds Directive Annex 1 (Table 15.16). Overall conservation value could therefore be considered as either medium or high based on these criteria (i.e., high connectivity to an SPA, though relatively low conservation status), though as a precautionary approach, conservation value is considered as high (Table 15.5).

Red-throated diver therefore have a high vulnerability (Table 15.4), and a high conservation value, with overall receptor sensitivity assessed as high based on the matrix approach in Table 15.6.

This assessment considers displacement risk in the ECC only, with only two birds recorded in the array area plus 4km buffer (both in the 4km buffer only).

Magnitude of impact (ECC)

Data collected by Jessop et al., (2018) does not differentiate between diver species within surveys. Recorded diver species were therefore apportioned to species level according to the relevant regional population sizes provided in Furness (2015). Based on the peak non-breeding population size of 300 great northern divers (NW England and Wales regional population; Furness, 2015) and a peak non-breeding population size of 4,673 red-throated divers (UK Western Waters plus Channel regional population; Furness, 2015) it was predicted that 93.6% of divers in Jessop et al., (2018) were red-throated diver and 6.4% were great northern diver. Though there is potential that some divers are black-throated divers, a third diver species which may be present in Ireland, the likelihood of this is considered very low. Black-throated divers are a rare winter visitor in Ireland, and none were recorded across site-specific DAS data, landfall surveys or vantage-point surveys.

Notably, surveys by Jessop et al., (2018) were undertaken within the autumn migration bio-season but not the spring migration bio-season. Densities of red-throated diver within the spring migration bio-season were therefore assumed to be the same as those recorded within the autumn migration bio-season. This is considered ecologically relevant based on available data. For example, Furness (2015) calculate the regional population in UK western waters plus channel to be the same in both the autumn and spring migration seasons, and therefore there is not considered to be a high likelihood of encountering a different number of birds during surveys in the spring compared with the autumn migration bio-season.

Red-throated diver is assessed only across the non-breeding bio-seasons (September – January). Across the breeding season (February to August), only one diver species was recorded within the ECC plus 4km buffer (compared with 17 in the autumn survey, and seven in the winter survey). As this was only recorded as ‘diver species’, after apportioning to red-throated diver and great-northern diver, this would result in an apportioned raw count of less than one individual and equates to a density of less than 0.1 (0.05) red-throated divers per km^2. There is therefore not considered to be an impact pathway for displacement impacts on red-throated diver within the breeding season.

In the spring migration bio-season, the density of birds present within the ECC is 0.9 birds/km^2. Based on a total disturbance area of 28.3km^2, a total of 25 (24.9) red-throated divers are at risk of displacement. Of these, the total displacement consequent mortality is estimated at less than one (0.3) individual, based on 100% displacement and 1% mortality.

Assuming a spring migration regional population size of 12,717 individuals, with an annual baseline mortality of 2,850 individuals per annum (derived from an average mortality rate of 0.224; Table 15.17). The addition of less than one individual would represent a 0.009% increase in baseline mortality based on 100% displacement and 1% mortality. Potential impacts based on a displacement range of 90% to 100% and a mortality range of 1% to 10% are presented in Table 15.28.

In the autumn migration bio-season, the density of birds present within the ECC is 0.9 birds/km^2. Based on a total disturbance area of 28.3km^2, a total of 25 (24.9) red-throated divers are at risk of displacement. Of these, the total displacement consequent mortality is estimated at less than one (0.3) individual, based on 100% displacement and 1% mortality.

Assuming an autumn migration regional population size of 12,717 individuals, with an annual baseline mortality of 2,850 individuals per annum (derived from an average mortality rate of 0.224; Table 15.17). The addition of less than one individual would represent a 0.009% increase in baseline mortality based on 100% displacement and 1% mortality. Potential impacts based on a displacement range of 90% to 100% and a mortality range of 1% to 10% are presented in Table 15.28.

In the migration-free winter bio-season, the density of birds present within the ECC is 0.4 birds/km^2. Based on a total disturbance area of 28.3km^2, a total of ten (10.3) 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.

Assuming a migration-free winter regional population size of 4,148 individuals, with an annual baseline mortality of 929 individuals per annum (derived from an average mortality rate of 0.224; Table 15.17). The addition of less than one individual would represent a 0.011% increase in baseline mortality based on 100% displacement and 1% mortality. Potential impacts based on a displacement range of 90% to 100% and a mortality range of 1% to 10% are presented in Table 15.28.

Across all non-breeding bio-seasons combined the total estimated number of red-throated divers at risk of displacement is 60 (60.1). Of these, the total displacement consequent mortality is estimated at one (0.6) individual, based on 100% displacement and 1% mortality.

Considering the largest regional population of 12,717 individuals, and an annual baseline mortality of 2,850 individuals per annum, the addition of one individual would represent a 0.021% increase in baseline mortality. Based on the biogeographic population of 27,000 individuals, and a baseline mortality of 6,050 individuals per annum, the addition of one individual would represent a 0.0010% increase in baseline mortality. Potential impacts based on a displacement range of 90% to 100% and a mortality range of 1% to 10% are presented in Table 15.28.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement would be negligible (Table 15.7).

Significance of the effect (ECC)

Overall, it is predicted that the sensitivity of red-throated diver for Project Option 1and Project Option 2 is high and the magnitude of the impact is negligible. The high sensitivity and negligible magnitude of the impact on red-throated diver results in a not significant effect, which is not significant in EIA terms, based on the matrix approach in Table 15.8.

Table 15.28 Predicted bio-season displacement impacts on red-throated diver in the ECC from the proposed development during the construction phase

Bio-season (months)	Bio-season mean peak density in the ECC plus 4km buffer (birds/km2)	Population size (individuals)	Estimated mortality (individuals)		Percentage increase in baseline mortality	
			100% displacement, 1% mortality	**90% to 100% displacement, 1% to 5% mortality**	**100% displacement, 1% mortality**	**90% to 100% displacement, 1% to 5% mortality**
Spring migration	0.9	12,717	0.3	0.2–1.3	0.009	0.008–0.044
Autumn migration	0.9	12,717	0.3	0.2–1.3	0.009	0.008–0.044
Migration-free winter	0.4	4,148	0.1	0.1–0.5	0.011	0.010–0.055
Annual (regional population)	2.1	12,717	0.6	0.5–3.0	0.021	0.019–0.106
Annual (biogeographic)	2.1	27,000	0.6	0.5–3.0	0.010	0.009–0.050

Great northern diver

Sensitivity of great northern divers

In comparison to red-throated divers, evidence on the sensitivity of great northern divers is sparse. Some evidence (e.g. Bradbury et al. 2014) indicates that great northern divers are highly vulnerable to disturbance and displacement, while research in Ireland has shown that great northern divers do not show a flush response to boat traffic, even when birds are within 20m of some birds (Gittings et al., 2015). As a precautionary approach, it is assumed the sensitivity of great northern divers is high (Table 15.22).

The North-West Irish Sea cSPA is the only SPA designated for great northern diver with connectivity to the proposed development. Great northern diver are also BoCCI Green listed and Birds Directive Annex 1 (Table 15.16). They are therefore considered to have a medium conservation value (Table 15.5).

To reflect their high vulnerability to displacement, a displacement rate of 100% is proposed for the ECC assessment, with a range of 90% to 100% also presented. For mortality, a rate of 1% is deemed most realistic for the assessment, with a range of 1% to 5% also presented.

Great northern diver therefore has a high vulnerability (Table 15.4), and a medium conservation value (Table 15.5), with an overall receptor sensitivity assessed as high based on the matrix approach in Table 15.6.

This assessment considers displacement risk in the ECC only, with no birds recorded in the array area and 4km buffer.

Magnitude of impact (ECC)

Data collected by Jessop et al., (2018) does not differentiate between diver species within surveys. Recorded diver species were therefore apportioned to species level according to the relevant regional population sizes provided in Furness (2015). Based on the peak non-breeding population size of 300 great northern divers (NW England and Wales regional population; Furness, 2015) and a peak non-breeding population size of 4,673 red-throated divers (UK Western Waters plus Channel regional population; Furness, 2015) it was predicted that 93.6% of divers in Jessop et al., (2018) were red-throated diver and 6.4% were great northern diver. This approach is also considered precautionary as it is assumed all diver species are red-throated divers or great northern divers, as opposed to also apportioning some individuals to black-throated divers which are a rare winter visitor to Ireland. For great northern divers, only one bio-season is considered relevant (the non-breeding bio-season; Table 15.14). Therefore, this assessment considers the peak density of the autumn and winter surveys to represent the full non-breeding season (September – May) density.

Based on data on great northern diver densities presented by Jessop et al., (2018), the apportioned density of birds present within the ECC in the non-breeding bio-season is 0.1 bird/km^2. Based on a total disturbance area of 28.3km^2, a total of two (1.7) great northern divers are at risk of displacement. Of these, the total displacement consequent mortality is estimated at almost zero (0.0) individuals, based on 100% displacement and 1% mortality.

Based on a non-breeding regional population size of 871 individuals, with an annual baseline mortality of 140 individuals per annum (based on an average mortality rate of 0.161; Table 15.18). The addition of almost zero individuals would represent a 0.012% increase in baseline mortality based on 100% displacement and 1% mortality. Considering a biogeographic population of 430,000 individuals and a baseline mortality of 69,179 individuals per annum, the addition of almost zero individuals would represent a 0.000% increase in baseline mortality. Potential impacts based on a displacement range of 90% to 100% and a mortality range of 1% to 5% are presented in Table 15.29.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement would be negligible (Table 15.7).

Significance of the effect (ECC)

Overall, it is predicted that the sensitivity of great northern diver for Project Option 1 and Project Option 2 is high and the magnitude of the impact is negligible. The high sensitivity and negligible magnitude of the impact on great northern diver results in a not significant effect, which is not significant in EIA terms, based on the matrix approach in Table 15.8.

Table 15.29 Predicted bio-season displacement impacts on great northern diver in the ECC from the proposed development during the construction phase

Bio-season (months)	Bio-season mean peak density in the ECC plus 4km buffer (birds/km2)	Population size (individuals)	Estimated mortality (individuals)		Percentage increase in baseline mortality	
			100% displacement, 1% mortality	90% to 100% displacement, 1% to 10% mortality	100% displacement, 1% mortality	90% to 100% displacement, 1% to 5% mortality
Non-breeding (regional population)	0.1	871	0.0	0.0–0.1	0.012	0.011–0.061
Non-breeding (biogeographic)	0.1	430,000	0.0	0.0–0.1	0.000	0.000–0.000

Manx shearwater

Sensitivity of Manx shearwaters

Manx shearwaters are considered to have a low vulnerability to displacement impacts (Table 15.22) (a full justification is presented in the operational phase assessment, Section 15.5.3). Individuals were recorded in medium abundance during site-specific DAS surveys, with a high proportion of these originating from the Skomer, Skokholm and Seas off Pembrokeshire SPA. Manx shearwater are also BoCCI Amber listed and IUCN Least Concern (Table 15.16). Conservation value is therefore considered to be high (Table 15.5). Birds detected on DAS surveys originating from the Skomer, Skokholm and Seas off Pembrokeshire SPA are likely to be foraging in the area or passing through en route between foraging areas and the colonies. As such, it is assumed that any displacement occurring will have minimal impact due to the species large foraging range and ability to easily cover large distances.

Manx shearwaters therefore have a low vulnerability (Table 15.4), and a high conservation value (Table 15.5), with an overall receptor sensitivity assessed as medium based on the matrix approach in Table 15.6.

Manx shearwaters are assessed using a displacement rate of 5% and a mortality rate of 1%. Displacement rates used represent half the rates used in the operational phase (Section 15.5.3), with a full justification of rates used provided in that section.

This assessment considers displacement risk in the array area only, with a low number of birds recorded in the ECC and therefore were scoped out of the assessment.

Magnitude of the impact (array area)

During the breeding bio-season, the mean peak abundance for Manx shearwaters is 3,525 individuals within the array area plus 2km buffer. Based on 5% displacement and 1% mortality, the estimated displacement consequent mortality is two (1.8) individuals per annum.

Based on a breeding bio-season regional population size of 2,727,371 individuals (Table 15.17) and a baseline mortality of 352,185 individuals per annum (based on an average mortality rate of 0.129; Table 15.18) the addition of two displacement consequent mortalities would represent a 0.001% increase in baseline mortality.

During the autumn migration bio-season, the mean peak abundance for Manx shearwaters is 1,019 individuals within the array area plus 2km buffer. Based on 5% displacement and 1% mortality, the estimated displacement consequent mortality is one (0.5) individual per annum.

Based on an autumn migration bio-season regional population size of 1,585,521 individuals (Table 15.17) and a baseline mortality of 204,738 individuals per annum (based on an average mortality rate of 0.129; Table 15.18), the addition of one displacement consequent mortality would represent a 0.000% increase in baseline mortality.

During the spring migration bio-season, no Manx shearwaters were recorded within the array area plus 2km buffer. Based on 5% displacement and 1% mortality, the estimated displacement consequent mortality is zero (0.0) individual per annum.

Based on a spring migration bio-season regional population size of 1,585,521 individuals (Table 15.17) and a baseline mortality of 204,738 individuals per annum (based on an average mortality rate of 0.129; Table 15.18), the addition of zero displacement consequent mortality would represent a 0.000% increase in baseline mortality.

Across all bio-seasons, the total mean peak abundance of Manx shearwaters in the array area plus 2km buffer is 4,544. Based on 5% displacement and 1% mortality, the estimated displacement consequent mortality is two (2.3) individuals per annum.

Based on the largest regional population size of 2,727,371 individuals (Table 15.17) and a baseline mortality of 352,185 individuals per annum (based on an average mortality rate of 0.129; Table 15.18), the addition of two displacement consequent mortalities would represent a 0.001% increase in baseline mortality. Considering the biogeographic population size of 2,000,000 individuals with a baseline mortality of 285,260 individuals per annum, the addition of two displacement consequent mortalities would represent a 0.001% increase in baseline mortality.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement would be negligible (Table 15.7).

Significance of the effect (array area)

Overall, it is predicted that the sensitivity of Manx shearwater for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on Manx shearwater results in an imperceptible effect, which is not significant in EIA terms, based on the matrix approach in Table 15.8.

Table 15.30 Predicted bio-season displacement impacts on Manx shearwater from the proposed development during the construction phase

Bio-season (months)	Bio-season mean peak abundance in the array plus 2km buffer (+/- 95% CI)	Population size (individuals)	Estimated mortality (+/- 95% CI)	Percentage increase in baseline mortality (+/- 95% CI)
			5% displacement, 1% mortality	**5% displacement, 1% mortality**
Breeding (method 1)	3,525 (1,849 – 5,489)	2,121,049	1.8 (0.9 – 2.7)	0.001 (0.000 – 0.001)
Breeding (method 2)	3,525 (1,849 – 5,489)	2,727,371	1.8 (0.9 – 2.7)	0.001 (0.000 – 0.001)
Autumn migration	1,019 (323 – 1,987)	1,585,521	0.5 (0.2 – 1.0)	0.000 (0.000 – 0.000)
Spring migration	0 (0 – 0)	1,585,521	0.0 (0.0 – 0.0)	0.000 (0.000 – 0.000)
Annual total (regional population)	4,544 (2,172 – 7,476)	2,121,049[13]	2.3 (1.1 – 3.7)	0.001 (0.001 – 0.002)
Annual total (biogeographic)	4,544 (2,172 – 7,476)	2,000,000	2.3 (1.1 – 3.7)	0.001 (0.001 – 0.001)

[13] Note, though the breeding (method 2) population is the largest, the breeding (method 1) population is considered more ecologically relevant and is therefore taken forward as the peak regional population for the annual total assessment

Gannet

Sensitivity of gannets

Gannets are considered to have a low to medium vulnerability to displacement impacts (a full justification is presented in operational phase, Section 15.5.3). Individuals were recorded in medium abundance, originating largely from the Lambay Island SPA, Ailsa Craig SPA, and Grassholm SPA, the latter two of which gannet is a designated feature, though notably a high number of immature birds not from these SPAs is also expected within the region. Gannet are also BoCCI Amber listed and IUCN Least Concern (Table 15.16). Based on this, they are considered to have a medium conservation value (Table 15.5).

Gannets therefore have a low to medium vulnerability (Table 15.4), and a medium conservation value (Table 15.5), with an overall receptor sensitivity assessed as medium based on the matrix approach in Table 15.6.

Gannets are assessed using a displacement rate of 35% and a mortality rate of 1%, with a range of 30% to 40% displacement also presented. Displacement rates used represent half the rates used in the operational phase with a full justification of rates used also provided in that section.

This assessment considers displacement risk in the array area only, with low numbers recorded in the ECC.

Magnitude of impact (array area)

During the breeding bio-season, the mean peak abundance for gannets is 304 individuals within the array area plus 2km buffer. Based on 30% to 40% displacement and 1% mortality, between one (0.9) and one (1.2) individual is predicted to be at risk of displacement consequent mortality per annum. Based on 35% displacement and 1% mortality, the estimated displacement consequent mortality is one (1.1) individual per annum.

Based on a breeding bio-season regional population size of 637,440 individuals (Table 15.17) and a baseline mortality of 115,807 individuals per annum (based on an average mortality rate of 0.182; Table 15.18), the addition of one displacement consequent mortality would represent a 0.001% increase in baseline mortality. Potential impacts based on 30% to 40% displacement and 1% mortality are presented in Table 15.31 below.

During the spring migration bio-season, the mean peak abundance for gannets is 13 individuals within the array area plus 2km buffer. Based on 30% to 40% displacement and 1% mortality, between almost zero (0.0) and less than one (0.1) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 35% displacement and 1% mortality, the estimated displacement consequent mortality is almost zero (0.0) individuals per annum.

Based on spring migration bio-season regional population size of 643,917 individuals (Table 15.17) and a baseline mortality of 116,984 individuals per annum (based on an average mortality rate of 0.182; Table 15.18), the addition of almost zero displacement consequent mortalities would represent a 0.000% increase in baseline mortality. Potential impacts based on 30% to 70% displacement and 1% mortality are presented in Table 15.31 below.

During the autumn migration bio-season, the mean peak abundance for gannets is 265 individuals within the array area plus 2km buffer. Based on 30% to 40% displacement and 1% mortality, between one (0.8) and one (1.1) individual are predicted to be at risk of displacement consequent mortality per annum. Based on 35% displacement and 1% mortality, the estimated displacement consequent mortality is one (0.9) individual per annum.

Based on autumn migration bio-season regional population size of 535,183 individuals (Table 15.17) and a baseline mortality of 97,229 individuals per annum (based on an average mortality rate of 0.182; Table 15.18), the addition of one displacement consequent mortalities would represent a 0.001% increase in baseline mortality. Potential impacts based on 30% to 40% displacement and 1% mortality are presented in Table 15.31 below.

Across all bio-seasons, the total mean peak abundance of gannet in the array area plus 2km buffer is 582. Based on 30% to 40% displacement and 1% mortality, between two (1.7) and two (2.3) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 35% displacement and 1% mortality, the estimated displacement consequent mortality is two (2.0) individuals per annum.

Based on the largest regional population size of 643,917 individuals (Table 15.17) and a baseline mortality of 116,984 individuals per annum (based on an average mortality rate of 0.182; Table 15.18), the addition of two displacement consequent mortalities would represent a 0.002% increase in baseline mortality. Considering the biogeographic population size of 1,180,000, with a baseline mortality of 214,377 individuals per annum, the addition of four displacement consequent mortalities would represent a 0.001% increase in baseline mortality. Potential impacts based on 30% to 40% displacement and 1% mortality are presented in Table 15.31 below.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement would be negligible (Table 15.7).

Significance of the effect (array area)

Overall, it is predicted that the sensitivity of gannet for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on gannet results in an imperceptible effect, which is not significant in EIA terms, based on the matrix approach in Table 15.8.

Table 15.31 Predicted bio-season displacement impacts on gannet from the proposed development during the construction phase

Bio-season (months)	Bio-season mean peak abundance in the array plus 2km buffer (+/- 95% CI)	Population size (individuals)	Estimated mortality (individuals) (+/- 95% CI)			Percentage increase in baseline mortality (+/- 95% CI)		
			35% displacement, 1% mortality	**30% displacement, 1% mortality**	**40% displacement, 1% mortality**	**35% displacement, 1% mortality**	**30% displacement, 1% mortality**	**40% displacement, 1% mortality**
Breeding (method 1)	304 (189 – 437)	637,440	1.1 (0.7 – 1.5)	0.9 (0.6 – 1.3)	1.2 (0.8 – 2)	0.001 (0.001 – 0.001)	0.001 (0.000 – 0.001)	0.001 (0.001 – 0.002)
Breeding (method 2)	304 (189 – 437)	632,514	1.1 (0.7 – 1.5)	0.9 (0.6 – 1.3)	1.2 (0.8 – 2)	0.001 (0.001 – 0.001)	0.001 (0 – 0.001)	0.001 (0.001 – 0.002)
Autumn migration	265 (122 – 432)	535,183	0.9 (0.4 – 1.5)	0.8 (0.4 – 1.3)	1.1 (0.5 – 1.7)	0.001 (0.001 – 0.001)	0.001 (0.000 – 0.001)	0.001 (0.001 – 0.002)
Spring migration	13 (3 – 30)	643,917	0.0 (0.0 – 0.1)	0.0 (0.0 – 0.1)	0.1 (0.0 – 0.1)	0.000 (0.000 – 0.000)	0.000	0.000 (0.000 – 0.000)
Annual (regional population)	582 (313 – 899)	643,917	2.0 (1.1 – 3.1)	1.7 (0.9 – 2.7)	2.3 (1.3 – 3.8)	0.002 (0.001 – 0.003)	0.001 (0.001 – 0.002)	0.002 (0.001 – 0.003)
Annual (biogeographic)	582 (313 – 899)	1,180,000	2.0 (1.1 – 3.1)	1.7 (0.9 – 2.7)	2.3 (1.3 – 3.8)	0.001 (0.001 – 0.001)	0.001 (0 – 0.001)	0.001 (0.001 – 0.002)

Disturbance and displacement of intertidal ornithological receptors

During the construction phase, there is potential for disturbance and displacement impacts due to vessel activity, and construction work in the intertidal ECC. The installation method used at landfall is HDD, a trenchless technique which minimises disruption to the structures and environment above, including birds in the intertidal zone. Considering the HDD entry pit will be located landward of the HWM and the exit pits located seaward of the LWM in the subtidal zone, the whole intertidal zone will be avoided. Consequently, the main disturbance impact in the intertidal ECC will be from vessel disturbance at the HDD exit pits and therefore it can be assessed in the same way as the remainder of the offshore ECC. Ornithological receptors present above the HWM are considered in the biodiversity chapter, where impacts from the elements of the proposed development landward of the HWM are assessed.

A range of species were recorded in the intertidal surveys (as outlined in the Technical Baseline). The most common species were waders, gulls, and common scoter.

Gull species are considered to have a low risk to displacement impacts (Bradbury et al., 2014). Both herring gull and black-headed gull, the most commonly recorded gull species, have large foraging ranges and therefore any impacts resulting from displacement from activity in the intertidal ECC are considered unlikely. Additionally, gull species commonly aggregate around vessels as opposed to being displaced by them, and therefore no impact will occur as a result of vessel activity in proximity to the intertidal ECC.

A peak of 3,440 common scoter were recorded during landfall surveys (see Technical Baseline), with individuals consistently present across winter months. Despite their presence at the landfall site, risk to this species is considered to be low because any potential disturbance and displacement impacts will be spatially and temporally limited. As outlined above, works in the intertidal ECC will be undertaken using HDD, which will limit any potential disturbance impacts in the intertidal zone, leaving vessel activity at the HDD exit pit as the main disturbance in the intertidal zone. Works undertaken at the HDD exit pit will be localised and carried out over a short time period with only 24 hours required to complete excavation of the exit pit and transition zone. Meanwhile any vessel disturbance is considered to be sufficiently covered within the offshore ECC displacement assessment, which accounts for vessel activity in the offshore ECC during the full construction period.

Of the wader species identified, oystercatcher, curlew, turnstone and redshank were the most frequently observed. Of these, none are identified in Bradbury et al., (2014) as species vulnerable to disturbance and displacement impacts. Additionally, any potential impacts would be spatially and temporally limited as outlined above.

Sensitivity of intertidal ornithological receptors

Considering the sensitivity of offshore and intertidal receptors to potential disturbance and displacement impacts, this is expected to vary across species, ranging from low (e.g., gull species) to high (e.g., divers and scoters) (Bradbury et al., 2014). Conservation value is also variable, ranging from low (e.g., great black-backed gull) to high (e.g., red-throated diver). Therefore, as a precautionary measure the overall assessment uses a sensitivity of high.

Magnitude of impact

Based on the limited potential for impacts on intertidal ornithological receptors, with works undertaken being temporally and spatially limited, the magnitude of potential impact is expected to be negligible for both Project Option 1 and Project Option 2 (Table 15.7).

Significance of the effect

Overall, it is predicted that the sensitivity of intertidal receptors is up to high and the magnitude of the impact is negligible for both Project Option 1 and Project Option 2. The high sensitivity and negligible magnitude of the impact on intertidal receptors results in a not significant effect at most, which is not significant in EIA terms, based on the matrix approach in Table 15.8.

15.5.2.2 Impact 2: Indirect impacts due to impacts on prey

During the construction phase of the proposed development, there is potential for indirect effects on offshore and intertidal ornithological receptors if any impacts on prey species occur. These effects may arise from the production of underwater noise, and from impacts on prey species habitats (e.g., generation of suspended sediments). Through these impact pathways, prey species may be subject to injury and/or mortality, and the impact pathways may also result in fish and mobile invertebrates avoiding the offshore development area during construction. Additionally, impacts on habitats such as increased suspended sediment may smother key life stages of sandeels and other key prey species as it settles. These impacts may indirectly affect birds by reducing the amount of prey available to them within the impacted area. Full consideration is given to these impacts in the Fish and Shellfish chapter, with the conclusions of these chapters informing the assessment of indirect effects on offshore and intertidal ornithological receptors.

This impact is considered predominantly in relation to offshore ornithology receptors; though there is potential for impacts on prey species in the offshore and intertidal ECC, these will be both spatially and temporally limited.

As outlined in Section 15.4.5, both Project Option 1 and Project Option 2 have an equal potential for indirect impacts due to impacts on prey species, and therefore the magnitude of impact and significance of effect is the same for both project options in this section.

Sensitivity of ornithological receptors

The vulnerability of ornithological receptors to this potential effect varies across species, with some species being generalist foragers, able to feed on a wide variety of food sources (sometimes spanning across both the marine and terrestrial environment (e.g., lesser black-backed gull), whereas some species rely more heavily on a narrower range of food sources such as sandeel and sprat. Additionally, vulnerability is linked to foraging range, with some species (e.g., Manx shearwater) having very large foraging ranges being able to easily forage across other areas, while other species (e.g., Roseate tern) have a smaller foraging range and are more limited in their ability to forage elsewhere.

For relevant ornithological receptors (based on those recorded in sufficient numbers to warrant a potential impact pathway in site-specific DAS data (see Technical Baseline)), an overview of foraging behaviour and vulnerability is presented in Table 15.32 below. Overall vulnerability is determined from expert judgement based on consideration of their diet variability and foraging range. Diet variability is considered to be high if species forage across a wide range of sources (e.g., terrestrial and marine), low if they rely on two or less key sources of food and medium if they are between these two extremes. Information on foraging habitats are based on information presented in the North-West Irish Sea cSPA Conservation Objectives document and sources within. Foraging ranges are based on Woodward et al., (2019), with the key metric being the mean-max foraging range. Foraging ranges were considered large if they exceed 100km, medium if they exceed 50km, and small if they are under 50km.

Table 15.32 Vulnerability of relevant ornithological receptors to indirect prey impacts

Species	Key prey species (North-West Irish Sea cSPA)	Diet variability	Foraging range (High = >100km, Medium = >50km, Low = <50km) (MMF +/- 1SD; Woodward et al., 2019)	Vulnerability (based on expert judgement)
Common scoter	Bivalve molluscs Other various species (e.g. crabs, small fishes, gastropods) (Kaiser et al., 2006)	Medium	9[14]	Medium
Guillemot	Micronektonic prey, 2–25cm in length (mainly 6–10cm), including fish, euphausiids, large copepods, and squid. More diverse diet in non-breeding season. (Ainley et al., 2021)	Medium	Medium (73.2 +/- 80.5)	Medium
Razorbill	Schooling fish (incl. herring and sandeel) Crustaceans Polychaetes (Lavers et al., 2020)	Medium	88.7 +/- 75.9	Medium
Puffin	Small to mid-sized (5 – 15cm) schooling midwater fish including sprat (Sprattus sprattus) sandeel (Ammodytes spp) and herring (Clupea harengus). (Lowther et al., 2020).	Medium	137.1 +/- 128.3	Medium
Red-throated diver	Limited information. Generalist opportunistic feeder, with schooling fish potentially favoured (Kleinschmidt et al., 2019)	Medium	9	Medium
Great northern diver	Largely piscivorous, though frequently eats marine invertebrates (Paruk et al., 2021)	Medium	9 15	Medium
Manx shearwater	Primarily clupeiform fish during chick rearing Squid and other marine invertebrates feature more in non-breeding (Brooke, 1990)	Medium	1,346.8 +/- 1,018.7	Medium
Gannet	Small to mid-sized (2.5 – 30cm) schooling pelagic fish and squid. Key prey items include mackerel and herring)	Medium	315.2 +/- 194.2	Medium
Kittiwake	Primarily piscivorous (sandeels, herring, gadoids) Invertebrates (e.g., ephausids, amphipods) also recorded (Hatch et al., 2020)	Medium	156.1 +/- 144.5	Medium
Black-headed gull	Broad and opportunistic diet (fish and marine invertebrates) (Moskoff et al., 2021)	High	18.5	Low
Common gull	Broad and opportunistic diet (fish and marine invertebrates) (Moskoff et al., 2021)	High	50	Low

[14] Not in Woodward, based on red-throated diver

[15]Not in Woodward, based on red-throated diver

Species	Key prey species (North-West Irish Sea cSPA)	Diet variability	Foraging range (High = >100km, Medium = >50km, Low = <50km) (MMF +/- 1SD; Woodward et al., 2019)	Vulnerability (based on expert judgement)
Great black-backed gull	Generalist predator (fish, marine invertebrates, mammals, insects, waterfowl, and scavenging (urban environment and fisheries discards))	High	73	Low
Herring gull	Generalist an opportunistic feeder (fish, fish offal, bivalves, gastropods, crustaceans, squid, insects, other seabirds, small landbirds, small mammals, terrestrial insects, earthworms, berries, carrion, and a wide variety of human refuse (Weseloh et al., 2020)	High	58.8 +/- 26.8	Low
Lesser black-backed gull	Diverse and opportunistic (small fish, aquatic invertebrates, birds' eggs and chicks, trawler discards, rodents and berries) (Burger et al., 2020).	High	127 +/- 109	Low
Roseate tern	Sandeels (Ammodytes spp), clupeids and, to a lesser extent, gadoids (e.g. Allbrook et al., 2022)	Medium	12.6 +/- 10.6	Medium
Common tern	Sandeels (Ammodytes spp) Clupeidae (herrings) Gadidae (cods, pollocks) (Allbrook et al., 2022).	Medium	18.0 +/- 8.9	Medium
Arctic tern	Largely Piscivorous (small schooling species including from the Clupeidae (herrings), Gadidae (cods, pollocks) and Ammodytidae (sandeels) families) (Hatch et al., 2020)	Medium	25.7 +/- 14.8	Medium
Fulmar	Fisheries discards Sandeels Crustaceans Squid (Phillips et al., 1999)	High	542.3 +/- 657.9	Low

Magnitude of impact

The magnitude of impact resulting from the proposed development on key prey species is presented in Table 15.33 below, based on assessments presented in the Fish and Shellfish chapter.

With respect to the magnitude of this impact relevant to ornithological receptors, the overall significance of the effect on fish and shellfish species is considered (i.e. both the magnitude and sensitivity of fish and shellfish species are considered to assess the magnitude relevant to birds). For instance, where an effect of imperceptible significance is assessed for a species, a negligible magnitude is assessed for birds; where an effect of not significant or slight significance is assessed for a species, a low magnitude is assessed for birds, a significance of moderate as medium magnitude, and significant and profound or very significant significance assessed as high magnitude for birds.

Table 15.33 Magnitude of impact on relevant fish receptor groups from the proposed development

Prey species (relevant receptor groups assessed in Fish and Shellfish chapter)	Impact			
	Temporary increase in SSCs and sediment deposition	**Habitat damage and disturbance**	**Reduction in water and sediment quality**	**Mortality/injury /impacts from noise**
Pelagic VERs (Atlantic mackerel, Atlantic horse mackerel, sprat)	Low	Negligible	Low	Low
Demersal VERs (Atlantic cod, plaice, lemon sole, common sole, common dab, American plaice, witch flounder, whiting, haddock and anglerfish)	Low	Negligible	Low	Low
Sandeels	Low	Low	Low	Low
Herring	Low	Low	Low	Low
Brown crab, European lobster, common whelk, common cockle, King scallop, razor clams	Low	Low	Low	Low

Significance of the effect

The significance of effects on ornithological receptors is presented in Table 15.34 below based on the matrix approach in Table 15.8. The magnitude of impact for Project Option 1 and Project Option 2 was based on a precautionary approach, taking the highest magnitude of impact on any of the prey species consumed by the ornithological receptor in question. This is considered a precautionary approach, as it considers the most impactful scenario out of all prey species, and also assumed the magnitude is directly transferable to birds whereas in reality a low magnitude of impact on one prey receptor would likely not translate into a low magnitude of impact on birds as it may not significantly reduce their food availability still.

Table 15.34 Significance of effects on ornithological receptors due to indirect effects on prey species

Ornithological receptor	Overall sensitivity (vulnerability and conservation importance)	Magnitude of impact on key prey species	Overall impact significance (based on matrix approach)
Common scoter	High	Low	Moderate
Guillemot	Medium	Low	Slight
Razorbill	Medium	Low	Slight
Puffin	Medium	Low	Slight
Red-throated diver	High	Low	Moderate
Great northern diver	High	Low	Moderate
Manx shearwater	High	Low	Moderate
Gannet	Medium	Low	Slight
Kittiwake	High	Low	Moderate
Black-headed gull	Medium	Low	Slight
Common gull	Medium	Low	Slight
Great black-backed gull	Low	Low	Slight
Herring gull	Medium	Low	Slight
Lesser black-backed gull	Medium	Low	Slight
Roseate tern	High	Low	Moderate
Common tern	High	Low	Moderate
Arctic tern	High	Low	Moderate
Fulmar	Low	Low	Slight

Overall, it is predicted that the sensitivity of ornithological receptors for Project Option 1 and Project Option 2 is up to high and the magnitude of the impact is low. The high sensitivity and low magnitude of the impact on ornithological receptors results in a moderate effect at worst, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Notably for all impacts which were assessed as moderate, the magnitude of impact was low and the overall significance was driven by the high conservation value (feeding into overall sensitivity) of the receptor.

15.5.2.3 Impact 3: Indirect impacts due to accidental pollution

During the construction phase of the proposed development there is potential for impacts on ornithological receptors due to accidental pollution, resulting in either direct mortality (e.g., due to ingestion of contaminants), or indirect mortality (e.g., impacts on energy due to pollution impacts, reducing survival probability).

This may result from accidental pollution events of hydrocarbons or other contaminants from vessels and offshore infrastructure, and/or as from surface water run-off of suspended sediment/deposition from the onshore.

The potential for any release of pollutants during the construction phase is, however, considered to be very low. Though each WTG requires components requiring lubricating oils, hydraulic oils and coolants for operations, each WTG will be equipped with sensors to enable early detection of fluids and leaks, with spill kits also located on each WTG to contain any fluids in the unlikely event of pollutant release.

As outlined in Section 15.4.6, Project Option 1 is considered here as the option with the greatest potential for indirect impacts due to pollution.

Sensitivity of ornithological receptors

Information on the sensitivity of ornithological receptors to pollutant release in relation to OWF developments is limited, with this impact generally considered to be low risk and not considered fully within assessments. Birds are also highly mobile and are able to avoid areas of pollution in the case of accidental pollutant release. Therefore, the sensitivity of ornithological receptors is considered to be low.

Magnitude of impact

Given the low likelihood of impacts resulting from pollutants occurring, and the low potential of pollutants to cause impacts on ornithological receptors, the magnitude of impact is considered to be negligible (Table 15.7).

Significance of the effect

Overall, it is predicted that the sensitivity of ornithological receptors is low and the magnitude of the impact for Project Option 1 and Project Option 2 is negligible. The low sensitivity and negligible magnitude of the impact on ornithological receptors results in an imperceptible effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

15.5.2.4 Impact 4: Impacts arising from artificial light

The presence of artificially illuminated structures has the potential to impact birds, acting as both a deterrent to some species and an attractant to other species. For deterred birds, any changes in flight path may increase energy expenditure and act in line with effects resulting from displacement whereas for birds attracted, this may have similar impacts but also potentially increase the risk of collision.

Most species recorded in surveys for the proposed development (fulmar, gannet, kittiwake and auk species) are unlikely to be active at night, with birds either returning to colonies overnight or roosting on the sea surface (Wade et al., 2016). This is supported by tracking studies, with a tracking study by Furness et al., (2018) finding gannet flight and diving activity was minimal during the night, and a study by Kotzerka et al., (2010) reporting kittiwake foraging trips occurred mainly during daylight hours and were mostly inactive at night. The main species which are expected to have higher activity during the night are fulmar, Manx shearwater and European storm petrel.

Considering potential impacts relating to increased energy expenditure, evidence for these impacts occurring are varied, with research largely originating from studies on oil and gas platforms which are more extensively and intensively lit than OWFs (APEM, 2023; Ronconi et al., 2015). Additionally, though species such as Manx shearwater are considered at potential risk due to nocturnal activity, the potential for impacts is still considered low. Though there is some evidence of foraging occurring at night in Scotland (Kane, 2020), Manx shearwater foraging occurs almost exclusively during daylight hours (corresponding to the diurnal diel movements of their primary prey source within the Celtic Se region, clupeid fish (Shoji et al., 2016; Dean, 2012). Nocturnal activity is therefore predominantly associated with birds rafting and then returning to burrows after dusk. Since key foraging trips are not expected to be undertaken during nocturnal hours, potential impacts from artificial light in terms of impacts on energy expenditure are considered to be of negligible magnitude.

Additionally, available research suggests that light-disorientation of Manx shearwaters does not occur at large distances from the light source but is instead related to birds which are within vicinity of the artificial light (Guilford et al., 2019). Research is also largely focussed on maiden flights, with attraction of fledgelings to artificial light predominantly seen in weather conditions involving very poor visibility (Brown et al., 2023; Archer et al., 2015).

In relation to potential increased collision risk due to artificial light for fulmar, Manx shearwater and European storm petrel, these species are expected to remain very low collision risk with a minimal proportion of flights occurring at collision risk height (further details for Manx shearwater and fulmar in relation to this provided in Section 15.5.3). Notably available flight height data is based on data collected during daylight hours, however, Manx shearwater engage in slope-soaring and birds are likely to remain low to the sea surface where the wind shear is strongest regardless of the weather conditions or visibility (Spivey et al., 2014). Therefore, the potential for increased collision risk during nocturnal hours is considered to be negligible.

There is also potential for impacts for migratory birds 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. Available 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. Additionally, studies have shown that birds alter their nocturnal flight to counteract the risk of collision with WTGs as birds tend to fly down the centre of corridors, further away from the structures (Dirksen et al., 2000; Desholm and Kahlert, 2005).

The magnitude of impacts resulting from disorientation and/or collision of ornithological receptors as a result of artificial light is expected to negligible for all receptors. In consideration of the greatest sensitivity of a receptor being high, the significance of effect would be no greater than not significant, which is not significant in EIA terms, based on the matrix approach in Table 15.8.

The proposed offshore marine and aviation lighting and marking is laid out in the Lighting and Marking Plan (LMP)(Appendix 17.4).

15.5.3 Operational Phase

15.5.3.1 Impact 5: Disturbance and displacement (array area)

During the operational phase, vessel and drone activity has the potential to directly impact birds through disturbance, resulting in displacement of birds from the array area (Bradbury et al., 2014; Dierschke et al., 2016; MIG-Birds, 2022). Additionally, the presence of operational infrastructure has the potential to disturb and displace seabirds. This may result in a reduced area in which those seabirds susceptible to displacement, which currently reside within and around the offshore development area, have to forage, loaf and/or moult (Bradbury et al., 2014; Dierschke et al., 2016). Displacement may contribute to individual birds experiencing fitness consequences, which at an extreme level could lead to the mortality of individuals (Bradbury et al., 2014). It is acknowledged that vessel activity is expected to be of reduced magnitude compared to in the construction phase, and the main impacts are expected to be due to the presence of offshore infrastructure.

This section considers impacts in the array area only. During the operational period, the main form of displacement impact is considered to come from the presence of offshore infrastructure in the array area, with vessel activity both in the array area and ECC being lower than in the construction phase. Though there is potential for vessel activity in the ECC or to and from the maintenance port, the magnitude of impact is expected to be relatively low compared with the construction phase due to the lower number of vessels/reduced vessel activity. Since all impacts assessed for construction were not significant with negligible magnitude at worst, the potential for impacts during the operational phase is also considered to be not significant.

Seabird species vary in their response to the presence of operational infrastructure associated with OWFs and related maintenance activity (i.e., ship and helicopter traffic). Some species are known to be more susceptible to displacement than others as a result of OWF operation, with Dierschke et al., (2016) finding varying responses from seabirds from strong avoidance (e.g., red-throated diver) to strong attraction (e.g. shags) to OWFs. It is noted that large gulls and shags are not considered to be at any risk of displacement impacts, with both large gulls and shags often recorded roosting/perching on offshore turbines and large gulls often recorded being attracted to vessel activity (e.g. Vanermen et al., 2019; Somerfeld et al., 2016; Dierschke et al., 2016). The sensitivity of species to disturbance and displacement (as defined in Table 15.6) is presented for each species in Table 15.35 below, with the sensitivity for each species based on a range of available data sources (e.g. Bradbury et al., 2014; Garthe and Hüppop, 2004; Furness and Wade, 2012, Wade et al., 2016, Dierschke et al., 2016). Species with low vulnerability to disturbance and displacement are screened out of the assessment regardless of conservation status and abundance, as there is not considered to be a relevant pathway for impacts to occur on these species in this scenario. Similarly, species which have a low relative abundance are screened out on the basis that the area is not used sufficiently by these species to create an impact pathway.

With OWFs being a relatively new feature in the marine environment, current information as to the long-term impacts of disturbance and displacement by operational infrastructure on seabirds is relatively limited, however some post construction monitoring studies (e.g., at the Beatrice OWF (MacArthur Green, 2023)) are now available and are considered in further detail within this report. However, displacement advice is available from the UK SNCBs who issued a joint Interim Displacement Advice Note (MIG-Birds, 2022) providing recommendations on how to present information to enable the assessment of displacement effects in relation to OWF developments. This guidance has formed the basis of the assessment provided below.

For the assessment of displacement impacts within the array area, the abundance of birds within the array area plus 2km buffer was used, though for divers a 4km buffer was used based on available evidence (e.g. MIG-Birds, 2022).

Table 15.35 Screening of seabird species recorded within the array area and 2km buffer for risk of disturbance and displacement during the operational phase

Bird species	Vulnerability to disturbance and displacement (based on Bradbury et al., 2014; Dierschke et al., 2016)	Estimated peak abundance in the array area plus 2km buffer[16] (individuals)	Frequency of presence in array area plus 2km buffer15 (months recorded out of 29)	Relative abundance/ density in the array area plus 2km buffer	Screening outcome
Whimbrel	Low	0	1	Low	Out
Kittiwake	Low	1,481	28	High	Out
Black-headed gull	Low	30	2	Low	Out
Little gull	Low	0	0	Low	Out
Common gull	Low	225	10	Low	Out
Great black-backed gull	Negligible	660	20	Medium	Out
Herring gull	Negligible	1,284	24	High	Out
Lesser black-backed gull	Negligible	57	5	Low	Out

[16] 4km buffer is most relevant for diver species

Bird species	Vulnerability to disturbance and displacement (based on Bradbury et al., 2014; Dierschke et al., 2016)	Estimated peak abundance in the array area plus 2km buffer[16] (individuals)	Frequency of presence in array area plus 2km buffer15 (months recorded out of 29)	Relative abundance/ density in the array area plus 2km buffer	Screening outcome
Sandwich tern	Low	5	1	Low	Out
Roseate tern	Low	30	2	Low	Out
Common tern	Low	61	2	Low	Out
Arctic tern	Low	25	1	Low	Out
Great skua	Low	0	0	Low	Out
Arctic skua	Low	0	0	Low	Out
Guillemot	Medium	33,694	29	High	In
Razorbill	Medium	6,274	24	High	In
Black guillemot	Medium	18	2	Low	Out
Puffin	Low to medium	24	7	Low	In
Red-throated dive	High	5	2	Low	Out
Great northern diver	High	30	2	Low	Out
Fulmar	Low	55	5	Low	Out
Sooty shearwater	Low	5	2	Low	Out
Manx shearwater	Low	5,527	16	Medium	In
Gannet	Low to medium	475	22	Medium	In
Shag	Low	5	1	Low	Out

As outlined in Section 15.4.6, both Project Option 1 and Project Option 2 have an equal potential for disturbance and displacement impacts (in spite of there being more vessels present in Project Option 1), and therefore the magnitude of impact and significance of effect is the same for both project options in this section.

Auk species (guillemot, razorbill and puffin)

Justification of auk displacement rates

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).

SNCB guidance (MIG-Birds, 2022) in UK windfarms has suggested a displacement range of 30% to 70% should be presented for auk species, with 50% generally presented by Developers as a central value. To date, Natural England have endorsed a precautionary displacement rate of 70%, and NatureScot have endorsed a precautionary displacement rate of 60%.

Considering mortality rates, SNCB guidance (MIG-Birds, 2022) suggests presenting a mortality range of 1% to 10% for auk species, with 1% generally presented by developers as the most appropriate approach. NatureScot (2023) guidance requests a greatest mortality rate for auks of 5% in the breeding season, and 3% in the non-breeding season,

Table 15.36 below presents the displacement and mortality rates used for guillemot and razorbill in recently submitted UK projects. Although the rates recommended by SNCBs and agreed by the Examining Authority (ExA) are larger than those proposed by developers, these recently submitted project rates demonstrate SNCB and the Examining Authority's reluctance to endorse mortality rates above 2%. Secretary of State (SoS) decisions to maintain rates of 70:2 have generally been made prior to the publication of studies that suggest these rates are not representative of real displacement and mortality.

However, based on recent available evidence (outlined below), 70% displacement is likely to be an overestimate, with expected displacement to be lower than 50% and modelled mortality lower than 1%.

Table 15.36 Displacement and mortality rates from recently submitted UK projects.

Project	Applicant position on displacement : mortality rates	SNCB position on displacement : mortality rates	SoS position on displacement : mortality rates
Outer Dowsing	50:1	70:2	Not yet available (no SoS decision provided)
SEP and DEP	50:1	70:2	70:2
Five Estuaries	50:1	70:2	Not yet available (no SoS decision provided)
Hornsea 4	50:1	70:5	70:2
Norfolk projects	50:1	70:2	70:2

Data used to inform auk displacement rates for OWF assessments shows variable results. A review undertaken by Dierschke et al., (2016) found a range of responses (from displacement from OWFs to attraction to OWFs) in auks across 13 European OWFs, though the study concluded that overall, auks show a weak displacement response. More recent work submitted by APEM (2022) considered all post-consent monitoring studies undertaken in the UK and wider work within Europe to date, and similarly found variable responses. However, further analysis revealed that studies finding high displacement rates were often found not to be using the most appropriate statistical modelling methods (e.g., finding high displacement rates due to low abundance and high numbers of zero counts, resulting in reduced reliability of model outcomes), and the outcome from this study was that a displacement rate of 50% was most applicable to auk species, and still sufficiently precautionary. This rate was also supported by a recent review on German North Sea data by Peschko et al., (2020), with this review also finding guillemot displacement rates were reduced by ~20% in the breeding season compared to 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.

Recent post-construction monitoring of the Beatrice OWF found little evidence of any displacement impacts on auk species, and suggested that 30% displacement is likely an over-precautionary approach for guillemot and razorbill, and that 30% is likely an appropriate rate for puffin (MacArthur Green, 2023). These results are also considered relevant for the proposed development, considering the similar distance from shore (13km for Beatrice) and larger size of Beatrice (84 WTGs) which is expected to result in displacement impacts being equal to or larger than that of the proposed development. Surveys in the Belgian North Sea zone initially detected displacement in guillemot and razorbill. However, later surveys with a revised design found no evidence of any strong displacement for guillemot and evidence of attraction for razorbill, but it is unknown whether this was due to habituation or habitat selection. A displacement rate of 44% has been reported from four windfarms in the vicinity of Helgoland (APEM 2022). Taking the evidence above into account, the use of a displacement value of 50% in the assessments for all auk species can be considered a suitably precautionary approach.

There is potential for displacement consequent mortality if displacement increases competition for resources in the remaining habitat outside the wind farm. However, given the large foraging ranges of auk species and the extent of the remaining habitat outside of the array area, it is considered highly unlikely that there will be any significant mortality impacts. Though SNCB guidance (MIG-Birds, 2022) suggests a greatest mortality rate of 10%, this is considered a highly excessive over-estimate of potential impacts. For comparison, a mortality rate of 10% would be equivalent to the natural baseline mortality of razorbill and puffin, and almost double the natural baseline mortality of guillemot (Table 15.18).

Research undertaken on behalf of a range of developers in UK OWFs has concluded that 1% to 2% mortality is an appropriate range (as opposed to 1% to 10%) (Norfolk Vanguard, 2019; SPR, 2019; Orsted, 2018). Further support of this is provided by a study by van Kooten et al., (2019), which found that a mortality rate of 1% itself was precautionary. APEM (2022) predicted mortality rates using simulation models for the Flamborough and Filey Coast SPA from displacement impacts from Hornsea Four.

These models predicted impacts with a maximum of 1%, which was likely to be an overestimate, due to the distance between the SPA and the array area. Recent studies assessing impacts from OWFs a similar distance to that between the Hornsea Four site and the SPA modelled guillemot mortalities of 0.2% (at the Buchan Ness and Collieston Coast SPA) and 2.7% (at the St Abb's Head to Fast Castle SPA). Additionally, in spite of an observed displacement rate of 44% from four windfarms in the vicinity of Helgoland, numbers of birds breeding at local colonies continues to rise, suggesting that the impact from (and as such the mortality rate related to) this displacement effect is not strong. Taking the evidence above into account, the use of a mortality value of 1% in the assessments for all auk species can be considered a suitably precautionary approach.

Based on the above information, a precautionary displacement rate of 50% is presented as the evidence-led approach, which is in line with proposed rates by other projects undertaken in the UK. Though SNCB advised rates for other projects have been higher (70:2), the use of 50% is still considered the most representative range, especially considering information presented in the Beatrice post-construction monitoring report (MacArthur Green, 2023). To reflect the variable responses, a range of 30% to 70% displacement is also presented. Similarly, the evidence outlined above (e.g., APEM 2022) suggests that a 1% mortality rate is most appropriate and sufficiently precautionary. However, a range of up to 5% is also presented for auks (This is also supported by NatureScot (2023) guidance, which requests a greatest mortality rate for auks of 5% in the breeding season, and 3% in the non-breeding season). These values are being used across Phase One projects to provide a consistent approach that is deemed appropriate based on the available evidence, presenting an evidence-led central value and a range based on advice from SNCBs.

Guillemot

Sensitivity of guillemots

Guillemots are considered to have a medium vulnerability to disturbance and displacement impacts (Table 15.22). A high number of individuals were recorded during surveys, with individuals originating from a mixture of SPA (notably Lambay Island and Ireland's Eye SPA where guillemot is a designated feature) and non-SPA colonies. They are also BoCCI Amber listed and IUCN Least Concern (Table 15.16). They are therefore considered to have a medium conservation value (Table 15.5).

Guillemot therefore have a medium vulnerability (Table 15.4), and a medium conservation value (Table 15.5), with an overall receptor sensitivity assessed as medium based on the matrix approach in Table 15.6.

Guillemots are assessed using a displacement rate of 50% and a mortality rate of 1%, with a range of 30% to 70% displacement and 1% to 5% mortality also presented.

As outlined in Table 15.14, two bio-season approaches are considered for guillemot, with a more ecologically relevant project approach forming the main basis of the assessment, and results based on the Furness approach used for other species also presented.

Magnitude of impact

The abundance of guillemots within the array area plus 2km buffer was estimated using both design-based and model-based methods. Across all months, model-based methods consistently predicted fewer birds in the array area and 2km buffer (see MRSea Modelling Report). For example, the mean-peak counts during the breeding season (Furness approach) from model-based estimates was 8,642 compared with 13,703 using design-based abundances. This translates to roughly a 37% reduction in the estimated abundance based on the modelled approach. As a precautionary approach, design-based abundance estimates were used in the displacement assessment in this chapter. Nevertheless, this does not mean that the modelled estimates provide a less accurate prediction of the true number and distribution of birds throughout the array area (plus 2km buffer), and these lower abundances should be considered alongside the conclusions provided for guillemot using the more precautionary approach.

The MRSea results also support the shortened breeding bio-season for guillemot. During 2020 and 2022 the core breeding season when birds are constrained clearly falls within the months of May and June (Appendix 15.2: MRSea Modelling for Offshore Ornithology). By July birds had dispersed more widely across the North-west Irish Sea and beyond. In July 2021, the distribution of guillemots is more constrained compared to the other July surveys, potentially showing a later dispersal of birds from colonies during this year.

During the breeding season, the mean peak abundance for guillemot is 1,813 individuals within the array area plus 2km buffer. Based on 30% to 70% displacement and 1% to 5% mortality, between five (5.4) and 64 (63.5) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 50% displacement and 1% mortality, the estimated displacement consequent mortality is nine (9.1) individuals per annum.

Based on a breeding bio-season regional population size of 736,212 individuals (Table 15.17) and a baseline mortality of 99,362 individuals per annum (based on an average mortality rate of 0.135; Table 15.18), the addition of nine displacement consequent mortalities would represent a 0.009% increase in baseline mortality. Potential impacts based on 30% to 70% displacement and 1% to 5% mortality are presented in Table 15.38 below.

During the non-breeding bio-season, the mean peak abundance for guillemot is 29,765 individuals within the array area plus 2km buffer. Based on 30% to 70% displacement and 1% to 5% mortality, between 89 (89.3) and 1,042 (1,041.8) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 50% displacement and 1% mortality, the estimated displacement consequent mortality is 149 (148.8) individuals per annum.

Based on a non-breeding bio-season regional population size of 1,332,623 individuals (Table 15.17) and a baseline mortality of 179,856 individuals per annum (based on an average mortality rate of 0.135; Table 15.17), the addition of 149 displacement consequent mortalities would represent a 0.083% increase in baseline mortality. Potential impacts based on 30% to 70% displacement and 1% to 5% mortality, and based on the Furness approach to bio-seasons are presented in Table 15.37 below.

Across all bio-seasons, the total mean peak abundance of guillemots in the array area plus 2km buffer is 31,578. Based on 30% to 70% displacement and 1% to 5% mortality, between 95 (94.7) and 1,105 (1,105.2) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 50% displacement and 1% mortality, the estimated displacement consequent mortality is 158 (157.9) individuals per annum. Impacts for the annual total are presented in a displacement matrix in Table 15.37 below.

Based on the largest regional population size of 1,332,623 individuals (Table 15.17) and a baseline mortality of 179,856 individuals per annum (based on an average mortality rate of 0.135; Table 15.18), the addition of 158 displacement consequent mortalities would represent a 0.088% increase in baseline mortality. Considering the biogeographic population size of 4,125,000, with a baseline mortality of 556,727 individuals per annum, the addition of 158 displacement consequent mortalities would represent a 0.028% increase in baseline mortality. Potential impacts based on 30% to 70% displacement and 1% to 5% mortality are presented in Table 15.38 below.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement would be negligible (Table 15.7).

Significance of the effect (array area)

Overall, it is predicted that the sensitivity of guillemot for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on guillemot results in an imperceptible effect, which is not significant in EIA terms, based on the matrix approach in Table 15.8.

Table 15.37 Annual displacement matrix for guillemot within the array area plus 2km buffer, values in light grey represent the range-based values based on best practice the darker shade of grey representing the main approach value

	Mortality Rate (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	32	63	158	316	632	947	1,263	1,579	1,895	2,210	2,526	2,842	3,158
20	63	126	316	632	1,263	1,895	2,526	3,158	3,789	4,421	5,052	5,684	6,316
30	95	189	474	947	1,895	2,842	3,789	4,737	5,684	6,631	7,579	8,526	9,473
40	126	253	632	1,263	2,526	3,789	5,052	6,316	7,579	8,842	10,105	11,368	12,631
50	158	316	789	1,579	3,158	4,737	6,316	7,895	9,473	11,052	12,631	14,210	15,789
60	189	379	947	1,895	3,789	5,684	7,579	9,473	11,368	13,263	15,157	17,052	18,947
70	221	442	1,105	2,210	4,421	6,631	8,842	11,052	13,263	15,473	17,684	19,894	22,105
80	253	505	1,263	2,526	5,052	7,579	10,105	12,631	15,157	17,684	20,210	22,736	25,262
90	284	568	1,421	2,842	5,684	8,526	11,368	14,210	17,052	19,894	22,736	25,578	28,420
100	316	632	1,579	3,158	6,316	9,473	12,631	15,789	18,947	22,105	25,262	28,420	31,578

Table 15.38 Predicted bio-season displacement impacts on guillemot from the proposed development during the operational phase

Bio-season (months)	Bio-season mean peak abundance in the array plus 2km buffer Estimated mortality (+/- 95% CI)	Population size (individuals)	Estimated mortality (+/- 95% CI)			Percentage increase in baseline mortality (+/- 95% CI)		
			50% displacement, 1% mortality	**30% displacement, 1% mortality**	**70% displacement, 5% mortality**	**50% displacement, 1% mortality**	**30% displacement, 1% mortality**	**70% displacement, 5% mortality**
Furness approach to bio-seasons								
Breeding (method 1)	13,703 (8,940 – 18,414)	736,212	68.5 (44.7 – 92.1)	41.1 (26.8 – 55.2)	479.6 (312.9 – 644.5)	0.069 (0.045 – 0.093)	0.041 (0.027 – 0.056)	0.483 (0.315 – 0.649)
Breeding (method 2)	13,703 (8,940 – 18,414)	190,073	68.5 (44.7 – 92.1)	41.1 (26.8 – 55.2)	479.6 (312.9 – 644.5)	0.267 (0.174 – 0.359)	0.160 (0.105 – 0.215)	1.870 (1.22 – 2.512)
Non-breeding	29,765 (21,092) – 38,338)	1,332,623	148.8 (105.5 – 191.7)	89.3 (63.3 – 115)	1,041.8 (738.2 – 1341.8)	0.083 (0.059 – 0.107)	0.050 (0.035 – 0.064)	0.846 (0.584 – 1.104)

Bio-season (months)	Bio-season mean peak abundance in the array plus 2km buffer Estimated mortality (+/- 95% CI)	Population size (individuals)	Estimated mortality (+/- 95% CI)			Percentage increase in baseline mortality (+/- 95% CI)		
			50% displacement, 1% mortality	**30% displacement, 1% mortality**	**70% displacement, 5% mortality**	**50% displacement, 1% mortality**	**30% displacement, 1% mortality**	**70% displacement, 5% mortality**
Annual (regional population)	43,468 (30,032 – 56,751)	1,332,623	217.3 (150.2 – 283.8)	130.4 (90.1 – 170.3)	1,521.4 (1051.1 – 1986.3)	0.121 (0.083 – 0.158)	0.073 (0.05 – 0.095)	0.846 (0.584 – 1.104)
Annual (Biogeographic)	43,468 (30,032 – 56,751)	4,125,000	217.3 (150.2 – 283.8)	130.4 (90.1 – 170.3)	1,521.4 (1051.1 – 1986.3)	0.039 (0.027 – 0.051)	0.023 (0.016 – 0.031)	0.273 (0.189 – 0.357)
Project approach to bio-seasons								
Breeding (method 1)	1,813 (1,258 – 2,385)	736,212	9.1 (6.3 – 11.9)	5.4 (3.8 – 7.2)	63.5 (44 – 83.5)	0.009 (0.006 – 0.012)	0.005 (0.004 – 0.007)	0.064 (0.044 – 0.084)
Breeding (method 2)	1,813 (1,258 – 2,385)	190,073	9.1 (6.3 – 11.9)	5.4 (3.8 – 7.2)	63.5 (44 – 83.5)	0.035 (0.025 – 0.046)	0.021 (0.015 – 0.028)	0.247 (0.172 – 0.325)
Non-breeding	29,765 (21,092) – 38,338)	1,332,623	148.8 (105.5 – 191.7)	89.3 (63.3 – 115)	1,041.8 (738.2 – 1341.8)	0.083 (0.059 – 0.107)	0.050 (0.035 – 0.064)	0.846 (0.584 – 1.104)
Annual (regional population)	31,578 (22,350 – 40,722)	1,332,623	157.9 (111.7 – 203.6)	94.7 (67 – 122.2)	1,105.2 (782.2 – 1425.3)	0.088 (0.062 – 0.113)	0.053 (0.037 – 0.068)	0.615 (0.435 – 0.792)
Annual (Biogeographic)	31,578 (22,350 – 40,722)	4,125,000	157.9 (111.7 – 203.6)	94.7 (67 – 122.2)	1,105.2 (782.2 – 1425.3)	0.028 (0.02 – 0.037)	0.017 (0.012 – 0.022)	0.199 (0.141 – 0.256)

Razorbill

Sensitivity of razorbills

Razorbills are considered to have a medium vulnerability to disturbance and displacement impacts (Table 15.22). A high number of individuals were recorded during site-specific surveys, with individuals originating from a mixture of SPA (notably Lambay Island and Ireland's Eye SPA where razorbill is a designated feature) and non-SPA colonies. They are also BoCCI Amber listed and IUCN Least Concern (Table 15.16). They are therefore considered to have a medium conservation value (Table 15.5).

Razorbill therefore have a medium vulnerability Table 15.4, and a medium conservation value (Table 15.5), with an overall receptor sensitivity assessed as medium based on the matrix approach in Table 15.6.

Razorbill are assessed using a displacement rate of 50% and a mortality rate of 1%, with a range of 30% to 70% displacement and 1% to 5% mortality also presented.

Magnitude of impact

The abundance of razorbill within the array area plus 2km buffer was estimated using both design-based and model-based methods. There was variation between months on which method produced the highest abundance. However, the mean peak abundance for the breeding season (and two of the three non-breeding bio-seasons) was lower for the model-based approach (see MRSea Modelling Report). The largest reductions in abundances were in the breeding season and the autumn migration which showed a 30% reduction in the predicted abundance compared with the design-based estimates. Therefore, for precaution design-based abundance estimates were used in the displacement assessment in this chapter (the same approach as used for guillemot and other displacement species). Nevertheless, this does not mean that the modelled estimates provide a less accurate prediction of the true number and distribution of birds throughout the array plus 2km buffer, and they should be considered in relation to the conclusions provided for guillemot.

During the breeding season, the mean peak abundance for razorbill is 168 individuals within the array area plus 2km buffer. Based on 30% to 70% displacement and 1% to 5% mortality, between one (0.5) and six (5.9) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on% displacement and 1% mortality, the estimated displacement consequent mortality is one (0.8) individual per annum.

Based on a breeding bio-season regional population size of 321,633 individuals (Table 15.17) and a baseline mortality of 41,633 individuals per annum (based on an average mortality rate of 0.129; Table 15.18), the addition of one displacement consequent mortality would represent a 0.002% increase in baseline mortality. Potential impacts based on 30% to 70% displacement and 1% to 5% mortality are presented in Table 15.40 below.

During the autumn migration bio-season, the mean peak abundance for razorbill is 3,371 individuals within the array area plus 2km buffer. Based on 30% to 70% displacement and 1% to 5% mortality, between 10 (10.1) and 118 (118.0) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 50% displacement and 1% mortality, the estimated displacement consequent mortality is 17 (16.9) individuals per annum.

Based on an autumn migration bio-season regional population size of 632,453 individuals (Table 15.17) and a baseline mortality of 81,866 individuals per annum (based on an average mortality rate of 0.129; Table 15.18), the addition of 17 displacement consequent mortalities would represent a 0.021% increase in baseline mortality. Potential impacts based on 30% to 70% displacement and 1% to 5% mortality are presented in Table 15.40 below.

During the spring migration bio-season, the mean peak abundance for razorbill is 483 individuals within the array area plus 2km buffer. Based on 30% to 70% displacement and 1% to 5% mortality, between one (1.4) and 17 (16.9) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 50% displacement and 1% mortality, the estimated displacement consequent mortality is two (2.4) individuals per annum.

Based on a spring migration bio-season regional population size of 632,453 individuals (Table 15.17) and a baseline mortality of 81,866 individuals per annum (based on an average mortality rate of 0.129; Table 15.18), the addition of two displacement consequent mortalities would represent a 0.003% increase in baseline mortality. Potential impacts based on 30% to 70% displacement and 1% to 5% mortality are presented in Table 15.40 below.

During the migration-free winter bio-season, the mean peak abundance for razorbill is 2,079 individuals within the array area plus 2km buffer. Based on 30% to 70% displacement and 1% to 5% mortality, between six (6.2) and 73 (72.8) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 50% displacement and 1% mortality, the estimated displacement consequent mortality is ten (10.4) individuals per annum.

Based on a migration-free winter bio-season regional population size of 366,961 individuals (Table 15.17) and a baseline mortality of 47,500 individuals per annum (based on an average mortality rate of 0.129; Table 15.18), the addition of ten displacement consequent mortalities would represent a 0.022% increase in baseline mortality. Potential impacts based on 30% to 70% displacement and 1% to 5% mortality are presented in Table 15.40 below.

Across all bio-seasons, the total mean peak abundance of razorbill in the array area plus 2km buffer is 6,101. Based on 30% to 70% displacement and 1% to 5% mortality, between 18 (18.3) and 214 (213.8) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 50% displacement and 1% mortality, the estimated displacement consequent mortality is 31 (30.5) individuals per annum. Impacts for the annual total are presented in a displacement matrix in Table 15.40 below.

Based on the largest regional population size of 632,453 individuals (Table 15.17) and a baseline mortality of 81,866 individuals per annum (based on an average mortality rate of 0.129; Table 15.18), the addition of 31 displacement consequent mortalities would represent a 0.037% increase in baseline mortality. Considering the biogeographic population size of 1,707,000, with a baseline mortality of 220,957 individuals per annum, the addition of 31 displacement consequent mortalities would represent a 0.014% increase in baseline mortality. Potential impacts based on 30% to 70% displacement and 1% to 5% mortality are presented in Table 15.40 below.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement would be negligible (Table 15.7).

Significance of the effect (array area)

Overall, it is predicted that the sensitivity of razorbill for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on razorbill results in an imperceptible effect, which is not significant in EIA terms, based on the matrix approach in Table 15.8.

Table 15.39 Annual displacement matrix for razorbill within the array area plus 2km buffer, values in light grey represent the range-based values based on best practice and the darker shade of grey representing the main approach value.

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	6	12	31	61	122	183	244	305	366	427	488	549	610
20	12	24	61	122	244	366	488	610	732	854	976	1,098	1,220
30	18	37	92	183	366	549	732	915	1,098	1,281	1,464	1,647	1,830
40	24	49	122	244	488	732	976	1,220	1,464	1,708	1,952	2,196	2,440
50	31	61	153	305	610	915	1,220	1,525	1,830	2,135	2,440	2,745	3,051
60	37	73	183	366	732	1,098	1,464	1,830	2,196	2,562	2,928	3,295	3,661
70	43	85	214	427	854	1,281	1,708	2,135	2,562	2,989	3,417	3,844	4,271
80	49	98	244	488	976	1,464	1,952	2,440	2,928	3,417	3,905	4,393	4,881
90	55	110	275	549	1,098	1,647	2,196	2,745	3,295	3,844	4,393	4,942	5,491
100	61	122	305	610	1,220	1,830	2,440	3,051	3,661	4,271	4,881	5,491	6,101

Table 15.40 Predicted bio-season displacement impacts on razorbill from the proposed development during the operational phase.

Bio-season (months)	Bio-season mean peak abundance in the array plus 2km buffer (+/- 95% CI)	Population size (individuals)	Estimated mortality (individuals) (+/- 95% CI)			Percentage increase in baseline mortality (+/- 95% CI)		
			50% displacement, 1% mortality	30% displacement, 1% mortality	70% displacement, 5% mortality	50% displacement, 1% mortality	30% displacement, 1% mortality	70% displacement, 5% mortality
Breeding (method 1)	168 (83 – 263)	321,633	0.8 (0.4 – 1.3)	0.5 (0.2 – 0.8)	5.9 (2.9 – 9.2)	0.002 (0.001 – 0.003)	0.001 (0.001 – 0.002)	0.014 (0.007 – 0.022)
Breeding (method 2)	168 (83 – 263)	49,298	0.8 (0.4 – 1.3)	0.5 (0.2 – 0.8)	5.9 (2.9 – 9.2)	0.013 (0.003 – 0.009)	0.008 (0.002 – 0.006)	0.092 (0.045 – 0.066)
Autumn migration	3,371(1,484 – 5,385)	632,453	16.9 (7.4 – 26.9)	10.1 (4.5 – 16.2)	118.0 (51.9 – 188.5)	0.021 (0.009 – 0.033)	0.012 (0.005 – 0.020)	0.144 (0.063 – 0.230)
Spring migration	2,079 (1,230-2,930)	632,453	2.4 (1.2 – 4)	1.4 (0.7 – 2.4)	16.9 (8.3 – 27.9)	0.003 (0.001 – 0.005)	0.002 (0.001 – 0.003)	0.021 (0.010 – 0.034)
Migration-free winter	483 (236 – 796)	366,961	10.4 (6.1 – 14.7)	6.2 (3.7 – 8.8)	72.8 (43.0 – 102.6)	0.022 (0.013 – 0.031)	0.013 (0.008 – 0.019)	0.153 (0.091 – 0.216)

Bio-season (months)	Bio-season mean peak abundance in the array plus 2km buffer (+/- 95% CI)	Population size (individuals)	Estimated mortality (individuals) (+/- 95% CI)			Percentage increase in baseline mortality (+/- 95% CI)		
			50% displacement, 1% mortality	**30% displacement, 1% mortality**	**70% displacement, 5% mortality**	**50% displacement, 1% mortality**	**30% displacement, 1% mortality**	**70% displacement, 5% mortality**
Annual (regional population)	6,101 (3,032 – 9,374)	639,087	30.5 (15.2 – 46.9)	18.3 (9.1 – 28.1)	213.5 (106.1 – 328.1)	0.037 (0.019 – 0.057)	0.022 (0.011 – 0.034)	0.261 (0.130 – 0.401)
Annual (biogeographic)	6,101 (3,032 – 9,374)	1,707,000	30.5 (15.2 – 46.9)	18.3 (9.1 – 28.1)	213.5 (106.1 – 328.1)	0.014 (0.007 – 0.021)	0.008 (0.004 – 0.013)	0.097 (0.048 – 0.148)

Puffin

Sensitivity of puffins

Puffins are considered to have a low to medium vulnerability to disturbance and displacement impacts (Table 15.22). During surveys, a low number of individuals were recorded. Recorded individuals are assumed to originate from a number of designated and non-designated sites, including Lambay Island SPA where puffin is a designated feature. Puffin are also BoCCI Amber listed and IUCN Vulnerable (Table 15.16). They are therefore considered to have a medium conservation value (Table 15.5).

Puffins therefore have a medium vulnerability and recoverability, and a medium conservation value, with an overall receptor sensitivity assessed as medium.

Puffins are assessed using a displacement rate of 50% and a mortality rate of 1%, with a range of 30% to 70% displacement and 1% to 5% mortality also presented.

Magnitude of impact

During the breeding season, the mean peak abundance for puffins is 12 individuals within the array area plus 2km buffer. Based on 30% to 70% displacement and 1% to 5% mortality, between almost zero (0.0) and less than one (0.4) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 50% displacement and 1% mortality, the estimated displacement consequent mortality is less than one (0.1) individuals per annum.

Based on a breeding bio-season regional population size of 180,693 individuals (Table 15.17) and a baseline mortality of 31,756 individuals per annum (based on an average mortality rate of 0.176; Table 15.18), the addition of less than one displacement consequent mortality would represent a 0.000% increase in baseline mortality. Potential impacts based on 30% to 70% displacement and 1% to 5% mortality are presented in Table 15.42 below.

During the non-breeding season, the mean peak abundance for puffins is 10 individuals within the array area plus 2km buffer. Based on 30% to 70% displacement and 1% to 5% mortality, between almost zero (0.0) and less than one (0.3) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 50% displacement and 1% mortality, the estimated displacement consequent mortality is almost zero (0.0) individuals per annum.

Based on a non-breeding bio-season regional population size of 300,427 individuals (Table 15.17) and a baseline mortality of 52,799 individuals per annum (based on an average mortality rate of 0.176; Table 15.18), the addition of almost zero displacement consequent mortalities would represent a 0.000% increase in baseline mortality. Potential impacts based on 30% to 70% displacement and 1% to 5% mortality are presented in Table 15.42 below.

Across all bio-seasons, the total mean peak abundance of puffins in the array area plus 2km buffer is 22. Based on 30% to 70% displacement and 1% to 5% mortality, between less than one (0.1) and one (0.8) individual are predicted to be at risk of displacement consequent mortality per annum. Based on 50% displacement and 1% mortality, the estimated displacement consequent mortality is less than one (0.1) individual per annum. Impacts for the annual total are presented in a displacement matrix in Table 15.41 below.

Based on the largest regional population size of 300,427 individuals (Table 15.17) and a baseline mortality of 52,799 individuals per annum (based on an average mortality rate of 0.176 Table 15.18), the addition of less than one displacement consequent mortalities would represent a 0.000% increase in baseline mortality. Considering the biogeographic population size of 11,840,000, with a baseline mortality of 2,072,000 individuals per annum, the addition of zero displacement consequent mortalities would represent a 0.000% increase in baseline mortality. Potential impacts based on 30% to 70% displacement and 1% to 5% mortality are presented in Table 15.42 below.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement would be negligible (Table 15.7).

Significance of the effect (array area)

Overall, it is predicted that the sensitivity of puffin for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on puffin results in an imperceptible effect, which is not significant in EIA terms, based on the matrix approach in Table 15.8.

Table 15.41: Annual displacement matrix for puffin within the array area plus 2km buffer, values in light grey represent the range-based values based on best practice and the darker shade of grey representing the main approach value

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	0	1	1	1	1	2	2	2	2
20	0	0	0	0	1	1	2	2	3	3	4	4	4
30	0	0	0	1	1	2	3	3	4	5	5	6	7
40	0	0	0	1	2	3	4	4	5	6	7	8	9
50	0	0	1	1	2	3	4	6	7	8	9	10	11
60	0	0	1	1	3	4	5	7	8	9	11	12	13
70	0	0	1	2	3	5	6	8	9	11	12	14	15
80	0	0	1	2	4	5	7	9	11	12	14	16	18
90	0	0	1	2	4	6	8	10	12	14	16	18	20
100	0	0	1	2	4	7	9	11	13	15	18	20	22

Table 15.42 Predicted bio-season displacement impacts on puffin from the proposed development during the operational phase

Bio-season (months)	Bio-season mean peak abundance in the array plus 2km buffer (+/- 95% CI)	Population size (individuals)	Estimated mortality (+/- 95% CI)			Percentage increase in baseline mortality (+/- 95% CI)		
			50% displacement, 1% mortality	**30% displacement , 1% mortality**	**70% displacement, 5% mortality**	**50% displacement, 1% mortality**	**30% displacement, 1% mortality**	**70% displacement, 5% mortality**
Breeding (method 1)	12 (3 – 26)	180,693	0.1 (0 – 0.1)	0.0 (0 – 0.1)	0.4 (0.1 – 0.9)	0.000 (0.000 – 0.000)	0.000 (0.000 – 0.000)	0.000 (0.000 – 0.001)
Breeding (method 2)	12 (3 – 26)	79,939	0.1 (0 – 0.1)	0.0 (0 – 0.1)	0.4 (0.1 – 0.9)	0.000 (0.000 – 0.001)	0.000 (0.000 – 0.001)	0.003 (0.001 – 0.006)
Non-breeding	10 (2 – 27)	300,427	0.0 (0 – 0.1)	0.0 (0 – 0.1)	0.3 (0.1 – 1.0)	0.000 (0.000 – 0.000)	0.000 (0.000 – 0.000)	0.001 (0.000 – 0.002)
Annual (regional population)	22 (5 – 53)	300,427	0.1 (0.0 – 0.3)	0.1 (0.0 – 0.2)	0.8 (0.2 – 1.9)	0.000 (0.000 – 0.001)	0.000 (0.000 – 0.000)	0.001 (0.000 – 0.004)
Annual (biogeographic)	22 (5 – 53)	11,840,000	0.1 (0.0 – 0.3)	0.1 (0.0 – 0.2)	0.8 (0.2 – 1.9)	0.000 (0.000 – 0.000)	0.000 (0.000 – 0.000)	0.000 (0.000 – 0.000)

Manx shearwater

Sensitivity of Manx shearwaters

Manx shearwaters are considered to be at low to very low vulnerability to displacement impacts (Bradbury et al., 2014; Dierschke et al., 2016), though it is also noted that there is uncertainty with their displacement risk (Wade et al., 2016). Guidance on the assessment of Manx shearwater for displacement impacts is limited, however based on information provided in Bradbury et al. (2014), Manx shearwater are assigned the lowest score for both disturbance susceptibility and habitat specialisation, suggesting very low potential displacement sensitivity. They are therefore considered to have a low vulnerability to displacement impacts (Table 15.35). To reflect their low risk a displacement rate of 10% is considered appropriate and sufficiently precautionary. No range-based values are presented for Manx shearwater; this approach is also recommended by UK SNCB guidance (MIG-Birds, 2022).

Manx shearwaters were recorded in medium abundance during surveys, with a high proportion of these originating from the Skomer, Skokholm and Seas off Pembrokeshire SPA, and birds also using the North-West Irish cSPA. Manx shearwater are also BoCCI Amber listed (Table 15.16). Conservation value is therefore considered to be high (Table 15.5).

Manx shearwaters therefore have a low vulnerability (Table 15.4), and a high conservation value (Table 15.5), with an overall receptor sensitivity assessed as medium based on the matrix approach in Table 15.6.

Manx shearwaters are assessed using a displacement rate of 10% and a mortality rate of 1%.

Magnitude of impact

During the breeding bio-season, the mean peak abundance for Manx shearwaters is 3,525 individuals within the array area plus 2km buffer. Based on 10% displacement and 1% mortality, the estimated displacement consequent mortality is four (3.5) individuals per annum.

Based on a breeding bio-season regional population size of 2,121,049 individuals (Table 15.17) and a baseline mortality of 273,891 individuals per annum (based on an average mortality rate of 0.129; Table 15.18), the addition of four displacement consequent mortalities would represent a 0.001% increase in baseline mortality.

During the autumn migration bio-season, the mean peak abundance for Manx shearwaters is 1,019 individuals within the array area plus 2km buffer. Based on 10% displacement and 1% mortality, the estimated displacement consequent mortality is one (1.0) individual per annum.

Based on an autumn migration bio-season regional population size of 1,585,521 individuals (Table 15.17) and a baseline mortality of 204,738 individuals per annum (based on an average mortality rate of 0.129; Table 15.18), the addition of one displacement consequent mortality would represent a 0.000% increase in baseline mortality.

During the spring migration bio-season, no Manx shearwaters were recorded within the array area plus 2km buffer. Based on 10% displacement and 1% mortality, the estimated displacement consequent mortality is zero (0.0) individual per annum.

Based on a spring migration bio-season regional population size of 1,585,521 individuals (Table 15.17) and a baseline mortality of 204,738 individuals per annum (based on an average mortality rate of 0.129; Table 15.18), the addition of zero displacement consequent mortality would represent a 0.000% increase in baseline mortality.

Across all bio-seasons, the total mean peak abundance of Manx shearwaters in the array area plus 2km buffer is 4,544. Based on 10% displacement and 1% mortality, the estimated displacement consequent mortality is five (4.5) individuals per annum. Impacts for the annual total are presented in a displacement matrix in Table 15.43 below.

Based on the largest regional population size of 1,867,732 individuals (Table 15.17) and a baseline mortality of 242,805 individuals per annum (based on an average mortality rate of 0.129; Table 15.18), the addition of five displacement consequent mortalities would represent a 0.001% increase in baseline mortality.

Considering the biogeographic population size of 2,000,000 individuals with a baseline mortality of 285,260 individuals per annum, the addition of five displacement consequent mortalities would represent a 0.000% increase in baseline mortality.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement would be negligible (Table 15.7).

Significance of the effect (array area)

Overall, it is predicted that the sensitivity of Manx shearwater for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on Manx shearwater results in an imperceptible effect, which is not significant in EIA terms, based on the matrix approach in Table 15.8.

Table 15.43 Annual displacement matrix for Manx shearwater within the array area plus 2km buffer, with values in light grey representing the value used in the assessment

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	5	9	23	45	91	136	182	227	273	318	364	409	454
20	9	18	45	91	182	273	364	454	545	636	727	818	909
30	14	27	68	136	273	409	545	682	818	954	1,091	1,227	1,363
40	18	36	91	182	364	545	727	909	1,091	1,272	1,454	1,636	1,818
50	23	45	114	227	454	682	909	1,136	1,363	1,590	1,818	2,045	2,272
60	27	55	136	273	545	818	1,091	1,363	1,636	1,908	2,181	2,454	2,726
70	32	64	159	318	636	954	1,272	1,590	1,908	2,227	2,545	2,863	3,181
80	36	73	182	364	727	1,091	1,454	1,818	2,181	2,545	2,908	3,272	3,635
90	41	82	204	409	818	1,227	1,636	2,045	2,454	2,863	3,272	3,681	4,090
100	45	91	227	454	909	1,363	1,818	2,272	2,726	3,181	3,635	4,090	4,544

Table 15.44 Predicted bio-season displacement impacts on Manx shearwater from the proposed development during the operational phase

Bio-season (months)	Bio-season mean peak abundance in the array plus 2km buffer (+/- 95% CI)	Population size (individuals)	Estimated mortality (+/- 95% CI)	Percentage increase in baseline mortality (+/- 95% CI)
			10% displacement, 1% mortality	**10% displacement, 1% mortality**
Breeding (method 1)	3,525 (1,849 – 5,489)	2,121,049	3.5 (1.8 – 5.5)	0.001 (0.001 – 0.002)
Breeding (method 2)	3,525 (1,849 – 5,489)	2,727,371	3.5 (1.8 – 5.5)	0.001 (0.001 – 0.002)
Autumn migration	1,019 (323 – 1,987)	1,585,521	1.0 (0.3 – 2.0)	0.000 (0.000 – 0.001)
Spring migration	0 (0 – 0)	1,585,521	0.0 (0.0 – 0.0)	0.000 (0.000 – 0.000)
Annual total (regional population)	4,544 (2,172 – 7,476)	2,121,049[17]	4.5 (2.2 – 7.5)	0.001 (0.001 – 0.003)

[17] Note, though the breeding (method 2) population is the largest, the breeding (method 1) population is considered more ecologically relevant and is therefore taken forward as the peak regional population for the annual total assessment

Bio-season (months)	Bio-season mean peak abundance in the array plus 2km buffer (+/- 95% CI)	Population size (individuals)	Estimated mortality (+/- 95% CI)	Percentage increase in baseline mortality (+/- 95% CI)
			10% displacement, 1% mortality	**10% displacement, 1% mortality**
Annual total (biogeographic)	4,544 (3,653 – 7,077)	2,000,000	4.5 (2.2 – 7.5)	0.002 (0.001 – 0.003)

Gannet

Sensitivity of gannets

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. Similar data is available from a study at Thanet wind farm, finding 80% of gannets avoided the OWF (Skov et al., 2018), and from APEM (APEM, 2014) which found the rate to be 95% of gannets on migrations based on data for several OWFs. More recently, a Natural England report (Pavat et al., 2023) illustrated that a mean OWF avoidance rate for gannet was 86% (based on an evidence-based review of nine studies). In guidance used for UK wind farms, a displacement range of 60% to 80% has been suggested for gannet. Based on the above evidence, a rate of 70% is considered the most appropriate while still sufficiently precautionary, though a range of 60% to 80% displacement will also be presented.

Gannets are highly flexible in their habitat use, able to use a wide range of habitats over a large area (Furness and Wade, 2012). They also have a large foraging range (mean-maximum of 315km and maximum of 709km), and feed on a variety of different prey items, meaning they are likely to be able to find sufficient alternative foraging opportunities despite any potential loss of habitat as a result of the proposed development. A precautionary mortality rate of 1% is therefore used in the assessment, noting that actual rates are likely to be lower. This approach is consistent with guidance used for UK wind farms.

Evidence on gannet vulnerability and recoverability to disturbance and displacement is varied (e.g., low in some studies, but possibly high according to Dierschke et al., (2016)). The high macro-avoidance of gannets may imply a higher vulnerability, though this is accounted for in the assessment with a precautionary level of displacement rates (60% to 80%). Overall, vulnerability and recoverability is considered to be low to medium (Table 15.35).

As outlined in Section 15.5.2, gannet have a medium conservation value (Table 15.5), with an overall receptor sensitivity assessed as medium based on the matrix approach in Table 15.6.

Gannets therefore have a low to medium vulnerability (Table 15.4), and a high conservation value (Table 15.5), with an overall receptor sensitivity assessed as medium based on the matrix approach in Table 15.6.

Gannets are assessed using a displacement rate of 70% and a mortality rate of 1%, with a range of 60% to 80% displacement also presented.

Magnitude of impact

During the breeding bio-season, the mean peak abundance for gannets is 304 individuals within the array area plus 2km buffer. Based on 60% to 80% displacement and 1% mortality, between two (1.8) and two (2.4) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 70% displacement and 1% mortality, the estimated displacement consequent mortality is two (2.1) individuals per annum.

Based on a breeding bio-season regional population size of 637,440 individuals (Table 15.17) and a baseline mortality of 115,807 individuals per annum (based on an average mortality rate of 0.182; Table 15.18), the addition of two displacement consequent mortalities would represent a 0.002% increase in baseline mortality. Potential impacts based on 30% to 70% displacement and 1% to 5% mortality are presented in Table 15.46 below.

During the autumn migration bio-season, the mean peak abundance for gannets is 265 individuals within the array area plus 2km buffer. Based on 60% to 80% displacement and 1% mortality, between one (0.8) and two (2.1) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 70% displacement and 1% mortality, the estimated displacement consequent mortality is two (1.9) individuals per annum.

Based on autumn migration bio-season regional population size of 535,183 individuals (Table 15.17) and a baseline mortality of 97,229 individuals per annum (based on an average mortality rate of 0.182; Table 15.18), the addition of two displacement consequent mortalities would represent a 0.002% increase in baseline mortality. Potential impacts based on 60% to 80% displacement and 1% mortality are presented in Table 15.46 below.

During the spring migration bio-season, the mean peak abundance for gannets is 13 individuals within the array area plus 2km buffer. Based on 60% to 80% displacement and 1% mortality, between zero (0.1) and zero (0.1) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 70% displacement and 1% mortality, the estimated displacement consequent mortality is less than one (0.1) individual per annum.

Based on spring migration bio-season regional population size of 643,917 individuals (Table 15.17) and a baseline mortality of 116,984 individuals per annum (based on an average mortality rate of 0.182; Table 15.18), the addition of less than one displacement consequent mortality would represent a 0.000% increase in baseline mortality. Potential impacts based on 60% to 80% displacement and 1% mortality are presented in Table 15.46 below.

Across all bio-seasons, the total mean peak abundance of gannet in the array area plus 2km buffer is 582. Based on 60% to 80% displacement and 1% mortality, between three (2.7) and five (4.7) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 70% displacement and 1% mortality, the estimated displacement consequent mortality is four (4.1) individuals per annum. Impacts for the annual total are presented in a displacement matrix in Table 15.45 below.

Based on the largest regional population size of 643,917 individuals (Table 15.17) and a baseline mortality of 116,984 individuals per annum (based on an average mortality rate of 0.182; Table 15.18), the addition of four displacement consequent mortalities would represent a 0.003% increase in baseline mortality. Considering the biogeographic population size of 1,180,000, with a baseline mortality of 214,377 individuals per annum, the addition of four displacement consequent mortalities would represent a 0.002% increase in baseline mortality. Potential impacts based on 60% to 80% displacement and 1% mortality are presented in Table 15.46 below.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement would be negligible (Table 15.7).

Significance of the effect (array area)

Overall, it is predicted that the sensitivity of gannet for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on gannet results in an imperceptible effect, which is not significant in EIA terms, based on the matrix approach in Table 15.8.

Table 15.45 Annual displacement matrix for gannet within the array area plus 2km buffer, values in light grey represent the range-based values based on best practice and the darker shade of grey representing the main approach value

	Mortality Rate (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	1	1	3	6	12	17	23	29	35	41	47	52	58
20	1	2	6	12	23	35	47	58	70	81	93	105	116
30	2	3	9	17	35	52	70	87	105	122	140	157	175
40	2	5	12	23	47	70	93	116	140	163	186	210	233
50	3	6	15	29	58	87	116	146	175	204	233	262	291
60	3	7	17	35	70	105	140	175	210	244	279	314	349
70	4	8	20	41	81	122	163	204	244	285	326	367	407
80	5	9	23	47	93	140	186	233	279	326	372	419	466
90	5	10	26	52	105	157	210	262	314	367	419	471	524
100	6	12	29	58	116	175	233	291	349	407	466	524	582

Table 15.46 Predicted bio-season displacement impacts on gannet from the proposed development during the operational phase

Bio-season (months)	Bio-season mean peak abundance (array plus 2km buffer)	Population size (individuals)	Estimated mortality (individuals)			Percentage increase in baseline mortality		
			70% displacement, 1% mortality	**60% displacement, 1% mortality**	**80% displacement, 1% mortality**	**70% displacement, 1% mortality**	**60% displacement, 1% mortality**	**80% displacement, 1% mortality**
Breeding (method 1)	304 (189 – 437)	637,440	2.1 (1.3 – 3.1)	1.8 (1.1 – 2.6)	2.4 (1.5 – 3.5)	0.002 (0.001 – 0.003)	0.002 (0.001 – 0.003)	0.002 (0.001 – 0.004)
Breeding (method 2)	304 (189 – 437)	632,514	2.1 (1.3 – 3.1)	1.8 (1.1 – 2.6)	2.4 (1.5 – 3.5)	0.002 (0.001 – 0.022)	0.002 (0.001 – 0.019)	0.002 (0.001 – 0.025)
Autumn migration	265 (122 – 432)	535,183	1.9 (0.9 – 3.0)	0.8 (0.4 – 1.3)	2.1 (1.0 – 3.5)	0.002 (0.001 – 0.003)	0.001 (0 – 0.001)	0.002 (0.001 – 0.004)
Spring migration	13 (3 – 30)	643,917	0.1 (0.0 – 0.2)	0.0 (0.0 – 0.1)	0.1 (0.0 – 0.2)	0.000 (0.000 – 0.000)	0.000 (0.000 – 0.000)	0.000 (0.000 – 0.000)
Annual (regional population)	582 (313 – 899)	643,917	4.1 (2.2 – 6.3)	2.7 (1.5 – 4)	4.7 (2.5 – 7.2)	0.003 (0.002 – 0.005)	0.002 (0.001 – 0.003)	0.004 (0.002 – 0.006)

Bio-season (months)	Bio-season mean peak abundance (array plus 2km buffer)	Population size (individuals)	Estimated mortality (individuals)			Percentage increase in baseline mortality		
			70% displacement, 1% mortality	**60% displacement, 1% mortality**	**80% displacement, 1% mortality**	**70% displacement, 1% mortality**	**60% displacement, 1% mortality**	**80% displacement, 1% mortality**
Annual (Biogeographic)	582 (313 – 899)	1,180,000	4.1 (2.2 – 6.3)	2.7 (1.5 – 4)	4.7 (2.5 – 7.2)	0.002 (0.001 – 0.003)	0.001 (0.001 – 0.002)	0.002 (0.001 – 0.003)

15.5.3.2 Impact 6: Collision risk

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

To evaluate which species should be included in the collision risk assessment, a screening exercise was undertaken, considering all species recorded in flight in the array area. Species were screened in if they were considered susceptible to collision impacts, and if a high abundance of birds in flight were recorded in the array area during site-specific DAS. Species with low vulnerability to collision are screened out of the assessment regardless of conservation status and abundance, as there is not considered to be a pathway for impacts to occur on these species in this scenario. Similarly, species which have a low relative density are screened out on the basis that the area is not used enough by these species to create an impact pathway. Sensitivity values are based on information provided in Garthe and Huppop, (2004), Furness and Wade (2012), Bradbury et al., (2014), and Wade et al., (2016). The outcome of the screening exercise is presented in Table 15.47 below.

Table 15.47 Screening of seabird species recorded within the array area for risk of collision with WTGs during the operational phase

Bird species	Sensitivity to collision with WTGs	Estimated seasonal mean peak density in the array area (birds/km^2)	Frequency of presence in array area (months recorded out of 29)	Relative density/frequency in the array area	Screening outcome
Whimbrel	Low	<0.1	1	Low	Out
Kittiwake	Medium	6.35	28	High	In
Black-headed gull	Medium	<0.1	2	Low	In
Little gull	Medium	<0.1	0	Low	Out
Common gull	Medium	0.57	10	Low	In
Great black-backed gull	High	1.57	20	Medium	In
Herring gull	High	5.11	24	High	In
Lesser black-backed gull	High	0.31	5	Low	In
Sandwich tern	Low	<0.1	1	Low	Out
Roseate tern	Low	<0.1	2	Low	In
Common tern	Low	0.29	2	Low	In
Arctic tern	Low	<0.1	1	Low	In
Great skua	High	<0.1	0	Low	Out
Arctic skua	Medium	<0.1	0	Low	Out
Guillemot	Very low	164.00	27	High	Out
Razorbill	Very low	18.53	24	High	Out
Black guillemot	Low	<0.1	2	Low	Out
Puffin	Very low	0.07	7	Low	Out
Red-throated diver	Low	<0.1	2	Low	Out
Great northern diver	Low	<0.1	2	Low	Out
Fulmar	Low	<0.1	5	Low	In
Sooty shearwater	Low	<0.1	2	Low	Out
Manx shearwater	Low	18.32	16	High	In
Gannet	Medium	1.62	22	Medium	In
Shag	Very low	<0.1	1	Low	Out

Following the screening exercise, 12 species were included in the CRM analysis. It should be noted that despite their low sensitivity to collision impacts, Manx shearwater, fulmar, black-headed gull, common gull, Arctic tern, common tern and roseate tern have been screened in as a precautionary approach owing to their designation at the North-West Irish Sea cSPA. Though little gull is also designated at this site, only 1 individual was recorded in the DAS data and therefore densities are sufficiently low that no impact pathway is expected to be present for this species.

CRM was undertaken stochastically using the sCRM, developed by Marine Scotland (McGregor, 2018), to determine the risk of collision when in flight for each seabird species. 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). The sample-size achieved, and the confidence in site-specific flight height data was low. Therefore, CRM was undertaken using Band Option 2, which uses generic estimates of flight height for each species to estimate the proportion of birds at Collision Height (PCH) (Johnston et al., 2014). Generic flight heights were preferred because they are derived from a very large dataset collected across a range of seasons and behaviours for each species to produce the most robust dataset available on flight height distributions. For more information please refer to the CRM Report.

The CRM assessment accounts for several different species-specific behavioural aspects of the seabirds being assessed. This included their flight heights, their ability to avoid moving or static structures, and how active they are diurnally and nocturnally.

To incorporate variation in CRM model input parameters, the model was run using the mean values and SDs. Input parameters used are provided in the CRM Report.

For the collision risk assessments, the monthly mean density values of birds recorded in flight, calculated from the survey data, were used (the monthly values were derived as the mean of the estimates from each of the two calendar months of survey density data collected across two years of surveys), along with the upper and lower 95% confidence intervals. This method provides an accurate representation of monthly density along with associated certainty in the calculated mean value, and is the standard approach used across UK projects. Full details are provided in the CRM Report.

Avoidance rates and nocturnal activity rates have been agreed within the Irish Phase one Methodology Statement' and are based on the best available published evidence including Furness (2018), Bowgen and Cook (2018) and the latest Natural England interim advice (Natural England, 2022). Further information on rates used is provided in the CRM Report.

Rates used are considered precautionary, with the assessment therefore presenting a scenario with the greatest potential magnitude of impact. For example, a study by APEM (2014) found that avoidance rates shown by gannets were certainly higher than rates recommended by UK SNCBs, and may even be as high as 100% during migratory periods. However, the conclusion from this study was the recommendation of 99.5% avoidance for the autumn migration. Additionally, a Bird Collision Avoidance Study funded by Offshore Renewables Joint Industry Programme (ORJIP) was undertaken to understand seabird behaviour in and around OWFs (Skov et al., 2018). The study reported that only six birds (all gull species) collided with WTGs from over 12,000 birds recorded during the two-year period, providing evidence of the precautionary nature of collision risk modelling for all species of seabirds. 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 actual avoidance rates are likely to be even higher.

Table 15.48 Monthly collision estimates for seabirds for the proposed development based on Band Option 2, with values expressed as the mean and the 95% confidence intervals in brackets

Month	Species											
	Kittiwake	**Black-headed gull**	**Common gull**	**Great black-backed gull**	**Herring gull**	**Lesser black-backed gull**	**Roseate tern**	**Common tern**	**Arctic tern**	**Fulmar**	**Manx shearwater**	**Gannet**
Project Option 1												
Jan	6.4 (0.6–14.3)	0.0 (0.0–0.0)	1.2 (0.1–3.1)	1.6 (0.2–3.6)	11.8 (6.6 – 20.1)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)
Feb	1.0 (0.1–2.3)	0.0 (0.0–0.0)	0.8 (0.1–2.0)	3.4 (0.3–8.6)	2.3 (0.3 – 5.4)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.1 (0.0 – 0.2)
Mar	1.3 (0.1–3.1)	0.0 (0.0–0.0)	0.2 (0.0–0.6)	2.2 (0.2–5.6)	6.0 (0.4 – 15.2)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.2 (0.0 – 0.5)
Apr	0.4 (0.1–0.9)	0.0 (0.0–0.0)	0.2 (0.0–0.4)	0.0 (0.0 0.0)	0.8 (0.1 – 1.9)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.2 (0.0 – 0.6)
May	0.6 (0.0–1.5)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.4 (0.0 – 1.1)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.3 (0.0 – 0.9)
Jun	0.3 (0.0–0.6)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.6 (0.0 – 1.6)	1.5 (0.1 – 4.1)	0.0 (0.0–0.0)	0.1 (0.0–0.4)	0.1 (0.0–0.2)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.3 (0.0 – 0.9)
Jul	2.0 – (0.1–5.5)	0.1 (0.0–0.3)	0.0 (0.0–0.0)	6.5 (0.2-18.6)	8.0 (0.4 – 23.4)	1.3 (0.0 – 4.1)	0.0 (0.0–0.0)	0.2 (0.0–0.5)	0.0 (0.0–0.2)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.3 (0.0 – 1.1)
Aug	0.8 (0.1–1.8)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.7 (0.0–1.8)	0.8 (0.0 – 2.2)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.1)	0.0 (0.0–0.0)	0.4 (0.0 – 1.4)
Sep	1.7 (0.1–5.5)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	1.3 (0.1–3.2)	6.2 (0.3 – 17.2)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.1)	0.0 (0.0–0.0)	2 (0.1 – 6.4)
Oct	1.2 (0.1–2.7)	0.0 (0.0–0.0)	0.1 (0.0–0.4)	0.8 (0.1–2.1)	0.7 (0.0 – 2.0)	0.3 (0.0 – 0.9)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	1.0 (0.0 – 3.4)
Nov	1.2 (0.2–2.9)	0.2 (0.0–0.8)	2.6 (0.1–6.4)	1.6 (0.2–3.8)	4.2 (0.3 – 11.2)	0.2 (0.0 – 0.8)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.1 (0.0 – 0.2)
Dec	2.4 (0.2–5.1)	0.0 (0.0–0.0)	0.3 (0.0–0.8)	7.5 (0.4–21.0)	14.5 (1.2 – 36.2)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)
Annual	19.3 (1.7–45.7)	0.3 (0.0–1.1)	5.4 (0.3–13.7)	26.3 (1.7–70.0)	57.2 (9.8–140.0)	1.8 (0.1–5.8)	0.1 (0.0–0.4)	0.2 (0.0–0.6)	0.0 (0.0–0.2)	0.0 (0.0–0.2)	0.0 (0.0–0.0)	4.7 (0.3–15.8)
Project Option 2												

Month	Species											
	Kittiwake	**Black-headed gull**	**Common gull**	**Great black-backed gull**	**Herring gull**	**Lesser black-backed gull**	**Roseate tern**	**Common tern**	**Arctic tern**	**Fulmar**	**Manx shearwater**	**Gannet**
Jan	6.0 (0.6 – 14)	0.0 (0.0–0.0)	1.1 (0.1–2.6)	1.3 (0.2 – 2.9)	9.8 (5.6 – 16.5)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)
Feb	1.0 (0.1 – 2.2)	0.0 (0.0–0.0)	0.7 (0.1–1.8)	2.8 (0.3 – 6.9)	2.0 (0.2 – 4.7)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.1 (0.0 – 0.2)
Mar	1.2 (0.1 – 2.9)	0.0 (0.0–0.0)	0.2 (0.0–0.5)	1.8 (0.2 – 4.2)	5.0 (0.4 – 13)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.1 (0.0 – 0.5)
Apr	0.4 (0.1 – 0.8)	0.0 (0.0–0.0)	0.1 (0.0–0.4)	0.0 (0.0 – 0.0)	0.6 (0.1 – 1.5)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.2 (0.0 – 0.6)
May	0.6 (0.0 – 1.4)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0 – 0.0)	0.3 (0.0 – 1)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.2 (0.0 – 0.8)
Jun	0.3 (0.0 – 0.6)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.5 (.00 – 1.3)	1.2 (0.1 – 3.3)	0.0 (0.0–0.0)	0.1 (0.0–0.3)	0.1 (0.0–0.2)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.3 (0.0 – 0.9)
Jul	1.8 (0.1 – 4.7)	0.1 (0.0–0.2)	0.0 (0.0–0.0)	5.4 (0.3 – 15.2)	6.7 (0.4 – 17.6)	1.1 (0.1 – 3.5)	0.0 (0.0–0.0)	0.2 (0.0–0.5)	0.0 (0.0–0.1)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.3 (0.0 – 1.0)
Aug	0.8 (0.1 – 1.6)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.6 (0.0 – 1.5)	0.7 (0.0 – 2.1)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.1)	0.0 (0.0–0.0)	0.4 (0.0 – 1.4)
Sep	1.6 (0.1 – 4.1)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	1.1 (0.1 – 2.6)	5.2 (0.2 – 15.1)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.1)	0.0 (0.0–0.0)	1.9 (0.1 – 5.6)
Oct	1.1 (0.1 – 2.5)	0.0 (0.0–0.0)	0.1 (0.0–0.3)	0.7 (0.1 – 1.7)	0.5 (0.0 – 1.5)	0.2 (0.0 – 0.7)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.9 (0.0 – 3.1)
Nov	1.1 (0.1 – 2.6)	0.2 (0.0–0.7)	2.2 (0.1–5.7)	1.3 (0.1 – 2.9)	3.6 (0.2 – 9.7)	0.2 (0.0 – 0.6)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.1 (0.0 – 0.2)
Dec	2.2 (0.3 – 4.6)	0.0 (0.0–0.0)	0.3 (0.0–0.7)	6.1 (0.5 – 15.2)	12.1 (1.1 – 30.4)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)
Annual	17.9 (1.8 – 42.1)	0.5 (0.0–1.6)	4.9 (0.3–12.6)	21.5 (1.7 – 54.5)	47.9 (8.4 – 116.2)	1.5 (0.1 – 4.8)	0.1 (0.0–0.3)	0.2 (0.0–0.7)	0.0 (0.0–0.1)	0.0 (0.0–0.1)	0.0 (0.0–0.0)	4.5 (0.2–14.2)

*Note that presented collision estimates for common and Arctic tern are not apportioned from those identified as commic tern. Commic tern collisions are apportioned to common and Arctic tern at the seasonal level in species sections below.

As outlined in Section 15.4.6, the scenario with the greatest potential magnitude of likely significant effects from both Project Option 1 or Project Option 2 is determined on a species-by-species basis based on CRM results in Table 15.48.

Kittiwake

Sensitivity of kittiwakes

Kittiwakes are considered to have a high vulnerability to collision impacts (Table 15.47). A high number of individuals were recorded during surveys, with considerable connectivity to the Lambay Island SPA expected, of which kittiwake is a designated feature. Kittiwakes are also BoCCI Amber listed and IUCN Vulnerable (Table 15.16). Based on these criteria, kittiwake could be assessed as having either a high or medium conservation value (i.e., high connectivity to a designated site, but relatively low conservation status). However, as a precautionary approach they are given a conservation value of high (Table 15.5).

Kittiwake therefore have high vulnerability (Table 15.4), and a high conservation value (Table 15.5), with an overall receptor sensitivity assessed as high based on the matrix approach in Table 15.6.

Magnitude of impact

During the breeding bio-season, five (5.2) kittiwakes are predicted to be at risk of collision mortality. Based on a breeding bio-season regional population size of 412,374 individuals (Table 15.17) and a baseline mortality of 64,308 individuals per annum (based on an average mortality rate of 0.157; Table 15.18), the addition of five collision mortalities would represent a 0.008% increase in baseline mortality.

During the spring migration bio-season seven (7.4) kittiwakes are predicted to be at risk of collision mortality. Based on a spring migration bio-season regional population size of 717,986 individuals (Table 15.17) and a baseline mortality of 112,724 individuals per annum (based on an average mortality rate of 0.157; Table 15.18), the addition of seven collision mortalities would represent a 0.007% increase in baseline mortality.

During the autumn migration bio-season six (6.5) kittiwakes are predicted to be at risk of collision mortality. Based on an autumn migration bio-season regional population size of 937,798 individuals (Table 15.17) and a baseline mortality of 147,234 individuals per annum (based on an average mortality rate of 0.157; Table 15.18) the addition of six collision mortalities would represent a 0.004% increase in baseline mortality.

Across all bio-seasons, a total of 19 (19.3) kittiwakes are predicted to be at risk of collision mortality. Based on the largest regional population of 937,798 individuals (Table 15.17) and a baseline mortality of 147,234 individuals per annum (based on an average mortality rate of 0.157; Table 15.18), the addition of 19 collision mortalities would represent a 0.013% increase in baseline mortality. Considering the biogeographic population of 5,100,000 individuals (Table 15.17) and a baseline mortality of 800,700 individuals per annum (based on an average mortality rate of 0.157; Table 15.18), the addition of 19 collision mortalities would represent a 0.002% increase in baseline mortality. The full range of results is presented in Table 15.49 below.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from collision risk would be negligible (Table 15.7).

Significance of the effect (array area)

Project Option 1

Overall, it is predicted that the sensitivity of kittiwake for Project Option 1 is high and the magnitude of the impact is negligible. The high sensitivity and negligible magnitude of the impact on kittiwake results in a not significant effect, which is not significant in EIA terms, based on the matrix approach in Table 15.8.

Project Option 2
Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the high sensitivity and negligible magnitude of the impact on kittiwake results in a not significant effect at worst, which is not significant in EIA terms, based on the matrix approach in Table 15.8.

Table 15.49 Predicted bio-season collision impacts on kittiwake from the proposed development during the operational phase

Bio-season (months)	Population size (individuals)	Estimated mortality (individuals) (+/- 95% CI)	Percentage increase in baseline mortality (+/- 95% CI)
Breeding (method 1)	412,374	5.4 (0.5 – 13.4)	0.008 (0.001 – 0.021)
Breeding (method 2)	142,464	5.4 (0.5 – 13.4)	0.024 (0.002 – 0.060)
Autumn migration	933,197	6.5 (0.6 – 15.7)	0.004 (0.000 – 0.011)
Spring migration	713,137	7.4 (0.7 – 16.6)	0.007 (0.001 – 0.015)
Annual (regional population)	933,197	19.3 (1.7 – 45.7)	0.013 (0.001 – 0.031)
Annual (Biogeographic)	5,100,000	19.3 (1.7 – 45.7)	0.002 (0.000 -0.006)

Black-headed gull

Sensitivity of black-headed gull
Black-headed gulls are considered to have a medium vulnerability to collision impacts (Table 15.47). A low number of individuals were recorded during aerial surveys, and with limited connectivity to designated sites other than the North-West Irish Sea cSPA where they are a non-breeding feature. Black-headed gull are also BoCCI Amber listed and IUCN Least Concern (Table 15.16). Conservation status is therefore considered to be medium (Table 15.5).

Black-headed gulls therefore have medium vulnerability, and a medium conservation value, with an overall receptor sensitivity assessed as medium based on the matrix approach in Table 15.6.

Magnitude of impact
Across the 29 months of DAS data collection, a total of five black-headed gulls were recorded within the array area (all of which were flying). Based on the CRM assessment (presented in the CRM Report), a total of less than 0.5 (0.3) collision mortalities are predicted. Based on the very low magnitude of impact predicted, potential collision effects on black-headed gull are not considered further here, with a magnitude of negligible predicted for Project Option 1 and Project Option 2 (Table 15.7).

Significance of the effect

Project Option 1
Overall, it is predicted that the sensitivity of black-headed gull for Project Option 1 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on black-headed gull results in an imperceptible effect, which is not significant in EIA terms, based on the matrix approach in Table 15.8.

Project Option 2
Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the medium sensitivity and negligible magnitude of the impact on black-headed gull results in an imperceptible effect at worst, which is not significant in EIA terms, based on the matrix approach in Table 15.8.

Common gull

Sensitivity of common gull
Common gulls are considered to have a medium vulnerability to collision impacts (Table 15.47). A low number of individuals were recorded during DAS, and with limited connectivity to designated sites other than the North-West Irish Sea cSPA in the non-breeding season only. Common gull are also BoCCI Amber listed and IUCN Least Concern (Table 15.16). Conservation status is therefore considered to be medium.

Common gulls therefore have medium vulnerability (Table 15.4), and a medium conservation value (Table 15.5), with an overall receptor sensitivity assessed as medium based on the matrix approach in Table 15.6.

Magnitude of impact
During the breeding season, no individuals were recorded on DAS surveys in the array area and therefore no impacts are predicted. Common gull is therefore screened out for impacts in the breeding season, and consideration of impacts is only given for the non-breeding season.

During the non-breeding bio-season five (5.4) common gulls are predicted to be at risk of collision mortality. Based on a non-breeding bio-season regional population size of 67,500 individuals (Table 15.17) and a baseline mortality of 17,076 individuals per annum (based on an average mortality rate of 0.253; Table 15.18), the addition of five collision mortalities would represent a 0.032% increase in baseline mortality.

Based on a biogeographic population of 525,000 individuals and a baseline mortality of 132,814 individuals per annum (based on an average mortality rate of 0.253; Table 15.18), the addition of five collision mortalities would represent a 0.004% increase in baseline mortality. The full range of results is presented in Table 15.50 below.

At both the regional population and biogeographic population scales, the impacts from the proposed development across all bio-seasons alone and combined represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from collision risk would be negligible (Table 15.7).

Significance of the effect (array area)

Project Option 1
Overall, it is predicted that the sensitivity of common gull for Project Option 1 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on common gull results in an imperceptible effect, which is not significant in EIA terms, based on the matrix approach in Table 15.8.

Project Option 2
Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the medium sensitivity and negligible magnitude of the impact on common gull results in an imperceptible effect at worst, which is not significant in EIA terms, based on the matrix approach in Table 15.8.

Table 15.50 Predicted bio-season collision impacts on common gull from the proposed development during the operational phase

Bio-season (months)	Population size (individuals)	Estimated mortality (individuals) (+/- 95% CI)	Percentage increase in baseline mortality (+/- 95% CI)
Nonbreeding	67,500	5.4 (0.3– 13.7)	0.032 (0.002 – 0.080)
Annual (biogeographic)	525,000	5.4 (0.3– 13.7)	0.004 (0.000 -0.010)

Great black-backed gull

Sensitivity of great black-backed gull

Great black-backed gulls are considered to have a high vulnerability to collision impacts (Table 15.47). A relatively low number of individuals were recorded during aerial surveys, and with no internationally or nationally designated sites for this species within mean max foraging range of the proposed development. Great black-backed gulls are also BoCCI Amber listed and IUCN Least Concern (Table 15.16). They are therefore considered to have a low conservation value (Table 15.5). However, it is noted that recent research has recommended an increase in IUCN Red List criteria for this species from 'Least Concern' to 'Vulnerable' (Langlois Lopez et al., 2022).

Great black-backed gulls therefore have high vulnerability (Table 15.4), and a low conservation value (Table 15.5) with an overall receptor sensitivity assessed as medium based on the matrix approach in Table 15.6.

Magnitude of impact

During the breeding bio-season ten (10.1) great black-backed gulls are predicted to be at risk of collision mortality. Based on a breeding bio-season regional population size of 33,422 individuals (Table 15.17) and a baseline mortality of 3,169 individuals per annum (based on an average mortality rate of 0.095; Table 15.18), the addition of ten collision mortalities would represent a 0.317% increase in baseline mortality.

During the non-breeding bio-season 16 (16.2) great black-backed gulls are predicted to be at risk of collision mortality. Based on a non-breeding bio-season regional population size of 53,406 individuals (Table 15.17) and a baseline mortality of 5,064 individuals per annum (based on an average mortality rate of 0.095; Table 15.18), the addition of 16 collision mortalities would represent a 0.321% increase in baseline mortality.

Across all bio-seasons, a total of 26 (26.3) great black-backed gulls are predicted to be at risk of collision mortality. Based on the largest regional population of 53,406 individuals (Table 15.17) and a baseline mortality of 5,064 individuals per annum (based on an average mortality rate of 0.095; Table 15.18), the addition of 26 collision mortalities would represent a 0.519% increase in baseline mortality. Considering the biogeographic population of 235,000 individuals (Table 15.17) and a baseline mortality of 22,282 individuals per annum (based on an average mortality rate of 0.095; Table 15.18), the addition of 26 collision mortalities would represent a 0.118% increase in baseline mortality. The full range of impacts is presented in Table 15.51 below.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from collision risk would be low (Table 15.7).

Significance of the effect (array area)

Project Option 1

Overall, it is predicted that the sensitivity of great black-backed gull for Project Option 1 is medium and the magnitude of the impact is low. The medium sensitivity and low magnitude of the impact on great black-backed gull results in a slight effect, which is not significant in EIA terms, based on the matrix approach in Table 15.8.

Project Option 2

Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the medium sensitivity and low magnitude of the impact on great black-backed gull results in a slight effect at worst, which is not significant in EIA terms, based on the matrix approach in Table 15.8.

Table 15.51 Predicted bio-season collision impacts on great black-backed gull from the proposed development during the operational phase

Bio-season (months)	Population size (individuals)	Estimated mortality (individuals) (+/- 95% CI)	Percentage increase in baseline mortality (+/- 95% CI)
Breeding (method 1)	33,422	10.1 (0.5 – 27.6)	0.317 (0.015 – 0.872)
Breeding (method 2)	2,685	10.1 (0.5 – 27.6)	3.949 (0.183 – 10.851)
Non-breeding	53,406	16.2 (1.2 – 42.3)	0.321 (0.025 – 0.836)
Annual (regional population)	53,406	26.3 (1.7 – 70.0)	0.519 (0.034 – 1.382)
Annual (biogeographic)	235,000	26.3 (1.7 – 70.0)	0.118 (0.008 – 0.314)

Herring gull

Sensitivity of herring gull

Herring gulls are considered to have a high vulnerability to collision impacts (Table 15.47). A high number of individuals were recorded during aerial surveys. Though there is connectivity with SPAs where herring gull is a designated feature, including Ireland's Eye SPA and Lambay Island SPA, there are also several non-designated colonies where birds originate from (e.g. Balbriggan Town). Herring gull are BoCCI Amber listed and IUCN Least Concern (Table 15.16). Therefore, the conservation status is considered to be medium (Table 15.5).

Herring gulls therefore have high vulnerability (Table 15.4), and a medium conservation value (Table 15.5), with an overall receptor sensitivity assessed as high based on the matrix approach in Table 15.6.

Magnitude of impact

During the breeding bio-season 18 (17.5) herring gulls are predicted to be at risk of collision mortality. Based on a breeding bio-season regional population size of 119,304 individuals (Table 15.17) and a baseline mortality of 20,405 individuals per annum (based on an average mortality rate of 0.171; Table 15.18), the addition of 18 collision mortalities would represent a 0.086% increase in baseline mortality.

During the non-breeding bio-season 40 (39.7) herring gulls are predicted to be at risk of collision mortality. Based on a non-breeding bio-season regional population size of 187,094 individuals (Table 15.17) and a baseline mortality of 31,999 individuals per annum (based on an average mortality rate of 0.171; Table 15.18), the addition of 40 collision mortalities would represent a 0.124% increase in baseline mortality.

Across all bio-seasons, a total of 57 (57.2) herring gulls are predicted to be at risk of collision mortality. Based on the largest regional population of 187,094 individuals (Table 15.17) and a baseline mortality of 31,999 individuals per annum (based on an average mortality rate of 0.171; Table 15.18), the addition of 57 collision mortalities would represent a 0.179% increase in baseline mortality. Considering the biogeographic population of 1,098,000 individuals (Table 15.17) and a baseline mortality of 187,795 individuals per annum, the addition of 57 collision mortalities would represent a 0.030% increase in baseline mortality. The full range of results is presented in Table 15.52 below.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from collision risk would be low (Table 15.7).

Significance of the effect (array area)

Project Option 1

Overall, it is predicted that the sensitivity of herring gull for Project Option 1 is high and the magnitude of the impact is low. The high sensitivity and low magnitude of the impact on herring gull results in a moderate effect, which is not significant in EIA terms, based on the matrix approach in Table 15.8.

Project Option 2

Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the high sensitivity and low magnitude of the impact on herring gull results in a moderate effect at worst, which is not significant in EIA terms, based on the matrix approach in Table 15.8.

Table 15.52 Predicted bio-season collision impacts on herring gull from the proposed development during the operational phase

Bio-season (months)	Population size (individuals)	Estimated mortality (individuals) (+/- 95% CI)	Percentage increase in baseline mortality (+/- 95% CI)
Breeding (method 1)	119,304	17.5 (1.0 – 47.9)	0.086 (0.005 – 0.235)
Breeding (method 2)	26,459	17.5 (1.0 – 47.9)	0.386 (0.022 – 1.057)
Non-breeding	187,094	39.7 (8.8 – 92.2)	0.124 (0.027 – 0.288)
Annual (regional population)	187,094	57.2 (9.8 – 140.0)	0.179 (0.031 – 0.438)
Annual (biogeographic)	1,098,000	57.2 (9.8 – 140.0)	0.030 (0.005 – 0.075)

Lesser black-backed gull

Sensitivity of lesser black-backed gulls

Lesser black-backed gulls are considered to have a high vulnerability to collision impacts (Table 15.47). During surveys, a low number of individuals were recorded, though a relatively high proportion of these are expected to originate from the Lambay Island SPA, where lesser black-backed gull is a designated feature. Lesser black-backed gulls are also BoCCI Amber listed and IUCN Least Concern (Table 15.16). They are therefore considered to have a medium conservation value (Table 15.5).

Lesser black-backed gull therefore have high vulnerability (Table 15.4), and a medium conservation value (Table 15.5), with an overall receptor sensitivity assessed as high based on the matrix approach in Table 15.6.

Magnitude of impact

During the breeding bio-season one (1.3) lesser black-backed gull is predicted to be at risk of collision mortality. Based on a breeding bio-season regional population size of 120,320 individuals (Table 15.17) and a baseline mortality of 12,198 individuals per annum (based on an average mortality rate of 0.123; Table 15.18), the addition of one collision mortality would represent a 0.009% increase in baseline mortality.

During the spring migration bio-season less than one (0.3) lesser black-backed gull is predicted to be at risk of collision mortality. Based on a spring migration bio-season regional population size of 171,500 individuals (Table 15.17) and a baseline mortality of 21,116 individuals per annum (based on an average mortality rate of 0.123; Table 15.18), the addition of less than one collision mortality would represent a 0.001% increase in baseline mortality.

During the autumn migration bio-season less than one (0.2) lesser black-backed gull is predicted to be at risk of collision mortality. Based on an autumn migration bio-season regional population size of 171,500 individuals (Table 15.17) and a baseline mortality of 21,116 individuals per annum (based on an average mortality rate of 0.123; Table 15.18), the addition of less than one collision mortality would represent a 0.001% increase in baseline mortality.

During the migration-free winter migration bio-season, zero (0.0) lesser black-backed gulls are predicted to be at risk of collision mortality. Based on a migration-free winter bio-season regional population size of 53,368 individuals (Table 15.17) and a baseline mortality of 6,571 individuals per annum (based on an average mortality rate of 0.123; Table 15.18), the addition of zero collision mortalities would represent a 0.000% increase in baseline mortality.

Across all bio-seasons, a total of two (1.8) lesser black-backed gulls are predicted to be at risk of collision mortality. Based on the largest regional population of 171,500 individuals (Table 15.17) and a baseline mortality of 21,116 individuals per annum (based on an average mortality rate of 0.123; Table 15.18), the addition of two collision mortalities would represent a 0.008% increase in baseline mortality.

Considering the biogeographic population of 864,000 individuals (Table 15.17) and a baseline mortality of 106,380 individuals per annum, the addition of two collision mortalities would represent a 0.002% increase in baseline mortality. The full range of results is presented in Table 15.53 below.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from collision risk would be negligible (Table 15.7).

Significance of the effect

Project Option 1

Overall, it is predicted that the sensitivity of lesser black-backed gull for Project Option 1 is high and the magnitude of the impact is negligible. The high sensitivity and negligible magnitude of the impact on lesser black-backed gull results in a not significant effect in EIA terms based on the matrix approach in Table 15.8.

Project Option 2

Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the high sensitivity and negligible magnitude of the impact on lesser black-backed gull results in a not significant effect at worst, based on the matrix approach in Table 15.8.

Table 15.53 Predicted bio-season collision impacts on lesser black-backed gull from the proposed development during the operational phase

Bio-season (months)	Population size (individuals)	Estimated mortality (individuals) (+/- 95% CI)	Percentage increase in baseline mortality (+/- 95% CI)
Breeding (method 1)	120,320	1.3 (0.0 – 4.1)	0.009 (0.000 – 0.028)
Breeding (method 2)	75,470	1.3 (0.0 – 4.1)	0.014 (0.001 – 0.044)
Autumn migration	171,500	0.2 (0.0 – 0.8)	0.001 (0.000 – 0.004)
Spring migration	171,500	0.3 (0.0 – 0.9)	0.001 (0.000 – 0.004)
Migration-free winter	53,368	0.0 (0.0 – 0.0)	0.000 (0.000 – 0.000)
Annual (regional population)	171,500	1.8 (0.1 – 5.8)	0.008 (0.000 – 0.027)
Annual (biogeographic)	864,000	1.8 (0.1 – 5.8)	0.002 (0.000 – 0.010)

Roseate tern

Sensitivity of roseate terns

Roseate terns are considered to have a low vulnerability to collision impacts (Table 15.47). During site-specific DAS surveys, a low number of individuals were recorded, though recorded birds are expected to almost exclusively originate from the Rockabill SPA, representing the only colony with breeding season connectivity to the proposed development where roseate tern is a designated feature (based on foraging ranges provided in Woodward et al., (2019)). Roseate tern are also BoCCI Amber listed, IUCN Least concern and Birds Directive Annex 1 (Table 15.16). Despite their relatively low conservation status, they are considered to have a high conservation value to reflect their high connectivity with the Rockabill SPA (Table 15.5).

Roseate terns therefore have low vulnerability (Table 15.4), and a high conservation value (Table 15.5), with an overall receptor sensitivity assessed as medium based on the matrix approach in Table 15.6.

Magnitude of impact

During the breeding bio-season less than one (0.1) roseate tern is predicted to be at risk of collision mortality. Based on a breeding bio-season regional population size of 5,911 individuals (Table 15.17) and a baseline mortality of 1,126 individuals per annum (based on an average mortality rate of 0.191; Table 15.18), the addition of less than one collision mortality would represent a 0.010% increase in baseline mortality.

During the spring migration bio-season almost zero (0.0) roseate terns are predicted to be at risk of collision mortality. Based on a spring migration bio-season regional population size of 6,375 individuals (Table 15.17) and a baseline mortality of 1,215 individuals per annum (based on an average mortality rate of 0.191; Table 15.18), the addition of almost zero collision mortalities would represent a 0.000% increase in baseline mortality.

During the autumn migration bio-season almost zero (0.0) roseate terns are predicted to be at risk of collision mortality. Based on an autumn migration bio-season regional population size of 6,375 individuals (Table 15.17) and a baseline mortality of 1,215 individuals per annum (based on an average mortality rate of 0.191; Table 15.18), the addition of almost zero collision mortalities would represent a 0.000% increase in baseline mortality.

Across all bio-seasons, a total of less than one (0.1) roseate tern is predicted to be at risk of collision mortality. Based on the largest regional population size of 6,375 individuals (Table 15.17) and a baseline mortality of 1,215 individuals per annum (based on an average mortality rate of 0.191; Table 15.18), the addition of less than one collision mortalities would represent a 0.009% increase in baseline mortality. Considering the biogeographic population of 2,900 individuals (Table 15.17) and a baseline mortality of 553 individuals per annum, the addition of less than one collision mortalities would represent a 0.021% increase in baseline mortality. The full range of impacts is presented in Table 15.54 below.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from collision risk would be negligible (Table 15.7).

Significance of the effect

Project Option 1

Overall, it is predicted that the sensitivity of roseate tern for Project Option 1 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on roseate tern results in an imperceptible effect, which is not significant effect in EIA terms based on the matrix approach in Table 15.8.

Project Option 2

Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the medium sensitivity and negligible magnitude of the impact on roseate tern results in an imperceptible effect at worst, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Table 15.54 Predicted bio-season collision impacts on roseate tern from the proposed development during the operational phase

Bio-season (months)	Population size (individuals)	Estimated mortality (individuals) (+/- 95% CI)	Percentage increase in baseline mortality (+/- 95% CI)
Breeding (method 1)	5,911	0.1 (0.0–0.4)	0.010 (0.002 – 0.031)
Breeding (method 2)	5,586	0.1 (0.0 – 0.4)	0.011 (0.001 – 0.033)
Autumn migration	6,375	0.0 (0.0 – 0.0)	0.000 (0.000 – 0.000)
Spring migration	6,375	0.0 (0.0 – 0.0)	0.000 (0.000 – 0.000)

Bio-season (months)	Population size (individuals)	Estimated mortality (individuals) (+/- 95% CI)	Percentage increase in baseline mortality (+/- 95% CI)
Annual (regional population)	6,375	0.1 (0.0 – 0.4)	0.009 (0.000 – 0.029)
Annual (Biogeographic)	2,900	0.1 (0.0 – 0.4)	0.021 (0.001 – 0.063)

Common tern

Sensitivity of common terns

Common terns are considered to have a low vulnerability to collision impacts (Table 15.47). During surveys, a low number of individuals were recorded, though recorded birds are expected to almost exclusively originate from the Rockabill SPA, representing the only SPA where common tern is a designated feature and has connectivity to the proposed development (based on foraging ranges provided in Woodward et al., (2019). Common terns are also BoCCI Amber listed, IUCN Least Concern, and Birds Directive Annex 1 (Table 15.16). Despite their relatively low conservation status, they are considered to have a high conservation value to reflect their high connectivity with the Rockabill SPA (Table 15.5).

Common terns therefore have low vulnerability (Table 15.4), and a high conservation value (Table 15.5), with an overall receptor sensitivity assessed as medium based on the matrix approach in Table 15.6.

Magnitude of impact

During the breeding bio-season, one (0.7) common tern is predicted to be at risk of collision mortality. Based on a breeding bio-season regional population size of 34,574 individuals (Table 15.17) and a baseline mortality of 6,589 individuals per annum (based on an average mortality rate of 0.191; Table 15.18), the addition of one collision mortality would represent a 0.010% increase in baseline mortality.

During the spring migration bio-season almost zero (0.0) common terns are predicted to be at risk of collision mortality. Based on a spring migration bio-season regional population size of 74,000 individuals (Table 15.17) and a baseline mortality of 14,102 individuals per annum (based on an average mortality rate of 0.191; Table 15.18), the addition of almost zero collision mortalities would represent a 0.000% increase in baseline mortality.

During the autumn migration bio-season almost zero (0.0) common terns are predicted to be at risk of collision mortality. Based on an autumn migration bio-season regional population size of 74,000 individuals (Table 15.17) and a baseline mortality of 14,102 individuals per annum (based on an average mortality rate of 0.191; Table 15.18), the addition of almost zero collision mortalities would represent a 0.000% increase in baseline mortality.

Across all bio-seasons, a total one (0.7) common tern is predicted to be at risk of collision mortality. Based on the largest regional population of 74,000 individuals (Table 15.17) and a baseline mortality of 14,102 individuals per annum (based on an average mortality rate of 0.191; Table 15.18), the addition of one collision mortalities would represent a 0.005% increase in baseline mortality. Considering the biogeographic population of 480,000 individuals (Table 15.17) and a baseline mortality of 91,473 individuals per annum, the addition of one collision mortalities would represent a 0.001% increase in baseline mortality. The full range of impacts is presented in Table 15.55 below.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from collision risk would be negligible (Table 15.7).

Significance of the effect

Project Option 1

Impacts from Project Option 1 are calculated to be equal to or less than those from Project Option 2. Therefore, the medium sensitivity and negligible magnitude of the impact on common tern results in an imperceptible effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Project Option 2

Overall, it is predicted that the sensitivity of common tern for Project Option 1 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on common tern results in an imperceptible effect, which is not significant effect in EIA terms based on the matrix approach in Table 15.8.

Table 15.55 Predicted bio-season collision impacts on common tern from the proposed development during the operational phase

Bio-season (months)	Population size (individuals)	Estimated mortality (individuals) (+/- 95% CI)	Percentage increase in baseline mortality (+/- 95% CI)
Breeding (method 1)	34,574	0.7 (0.0 – 1.9)	0.010 (0.001 – 0.028)
Breeding (method 2)	6,949	0.7 (0.0 – 1.9)	0.051 (0.003 – 0.140)
Autumn migration	74,000	0.0 (0.0 – 0.0)	0.000 (0.000 – 0.000)
Spring migration	74,000	0.0 (0.0 – 0.0)	0.000 (0.000 – 0.000)
Annual (regional population)	74,000	0.7 (0.0 – 1.9)	0.005 (0.000 – 0.013)
Annual (Biogeographic)	480,000	0.7 (0.0 – 1.9)	0.001 (0.000 – 0.002)

Arctic tern

Sensitivity of Arctic terns

Arctic terns are considered to have a low vulnerability to collision impacts (Table 15.47). During surveys, a low number of individuals were recorded, though recorded individuals are expected to almost exclusively originate from the Rockabill SPA, representing the only SPA where Arctic tern is a designated feature and has connectivity to the proposed development (based on foraging ranges provided in Woodward et al., (2019). Arctic terns are also BoCCI Amber listed, IUCN Least Concern and Birds Directive Annex 1 (Table 15.16). Despite their relatively low conservation status, they are considered to have a high conservation value to reflect their high connectivity with the Rockabill SPA (Table 15.5).

Arctic terns therefore have low vulnerability (Table 15.4), and a high conservation value (Table 15.5), with an overall receptor sensitivity assessed as medium based on the matrix approach in Table 15.6.

Magnitude of impact

During the breeding bio-season, less than one (0.1) Arctic tern is predicted to be at risk of collision mortality. Based on a breeding bio-season regional population size of 24,532 individuals (Table 15.17) and a baseline mortality of 4,483 individuals per annum (based on an average mortality rate of 0.183; Table 15.18), the addition of less than one collision mortality would represent a 0.002% increase in baseline mortality.

During the spring migration bio-season almost zero (0.0) Arctic terns are predicted to be at risk of collision mortality. Based on a spring migration bio-season regional population size of 72,231 individuals (Table 15.17) and a baseline mortality of 13,198 individuals per annum (based on an average mortality rate of 0.183; Table 15.18), the addition of almost zero collision mortalities would represent a 0.000% increase in baseline mortality.

During the autumn migration bio-season almost zero (0.0) Arctic terns are predicted to be at risk of collision mortality. Based on an autumn migration bio-season regional population size of 72,231 individuals (Table 15.17) and a baseline mortality of 13,198 individuals per annum (based on an average mortality rate of 0.183; Table 15.18), the addition of almost zero collision mortalities would represent a 0.000% increase in baseline mortality.

Across all bio-seasons, a total less than one (0.1) Arctic tern is predicted to be at risk of collision mortality. Based on the largest regional population of 72,231 individuals (Table 15.17) and a baseline mortality of 13,198 individuals per annum (based on an average mortality rate of 0.183; Table 15.18), the addition of less than one collision mortalities would represent a 0.001% increase in baseline mortality. Considering the biogeographic population of 628,000 individuals (Table 15.17) and a baseline mortality of 114,749 individuals per annum, the addition of less than one collision mortalities would represent a 0.000% increase in baseline mortality.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from collision risk would be negligible (Table 15.7).

Significance of the effect

Project Option 1

Overall, it is predicted that the sensitivity of Arctic tern for Project Option 1 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on Arctic tern results in an imperceptible effect, which is not significant effect in EIA terms based on the matrix approach in Table 15.8.

Project Option 2

Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the medium sensitivity and negligible magnitude of the impact on Arctic tern results in an imperceptible effect at worst, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Table 15.56 Predicted bio-season collision impacts on Arctic tern from the proposed development during the operational phase

Bio-season (months)	Population size (individuals)	Estimated mortality (individuals) (+/- 95% CI)	Percentage increase in baseline mortality (+/- 95% CI)
Breeding (method 1)	24,532	0.1 (0.0 – 0.4)	0.002 (0.000 – 0.008)
Breeding (method 2)	178	0.1 (0.0 – 0.4)	0.329 (0.019 – 1.137)
Autumn migration	72,231	0.0 (0.0 – 0.0)	0.000 (0.000 – 0.000)
Spring migration	72,231	0.0 (0.0 – 0.0)	0.000 (0.000 – 0.000)
Annual (regional population)	72,231	0.1 (0.0 – 0.4)	0.001 (0.000 – 0.003)
Annual (biogeographic)	628,000	0.1 (0.0 – 0.4)	0.000 (0.000 – 0.000)

Fulmar

Sensitivity of fulmars

Fulmars are considered to have a low vulnerability to collision impacts (Table 15.47). During surveys, a low number of individuals were recorded, and individuals are expected to originate from a wide range of both designated and non-designated colonies (with 23 colonies within 100km, an several hundred within foraging range of the proposed development). Fulmar are also BoCCI Green listed and IUCN Least Concern (Table 15.16). They are therefore considered to have a conservation value of low (Table 15.5).

Fulmar therefore have low vulnerability (Table 15.4), and a low conservation value (Table 15.5), with an overall receptor sensitivity assessed as low based on the matrix approach in Table 15.6. Despite this, they are screened in as a precautionary approach due to their designation at the North west Irish Sea cSPA within which the proposed development is located.

Magnitude of impact

Across the 29 months of DAS data collection, a total of six fulmar were recorded within the array area, and of these only two were flying and are therefore considered relevant for potential collision impacts. Based on the CRM assessment (presented in the CRM Report), a total of less than 0.1 (0.05) collision mortalities are predicted across all bio-seasons. Based on the very low magnitude of impact predicted, potential collision effects on fulmar are considered to be of a negligible magnitude across all bio-seasons.

This is further supported by available data, with fulmar considered to be at low risk of collision due to spending limited time at collision risk height (Garthe and Hüppop, 2004, Cook et al., 2012, Fijn et al., 2012, Krijgsveld, 2014, Leopold et al., 2014, Harwood et al., 2018). Based on modelling based on 29,168 vessel-based observations estimates that the proportion of fulmars flying at collision risk height (where the lower limit of the rotor-swept area is 20m above sea level) is 0.002 (95% CI 0.000–0.061; Johnston et al., 2014).

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from collision risk would be negligible (Table 15.7).

Significance of the effect

Project Option 1

Overall, it is predicted that the sensitivity of fulmar for Project Option 1 is low and the magnitude of the impact is negligible. The low sensitivity and negligible magnitude of the impact on fulmar results in an imperceptible effect, which is not significant effect in EIA terms based on the matrix approach in Table 15.8.

Project Option 2

Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the low sensitivity and negligible magnitude of the impact on fulmar results in an imperceptible effect at worst, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Manx shearwater

Sensitivity of Manx shearwaters

Manx shearwater are considered to have a low vulnerability to collision impacts (Table 15.47). As outlined in Section 15.5.2, Manx shearwater have a high conservation value (Table 15.5), with an overall receptor sensitivity assessed as medium based on the matrix approach in Table 15.8.

They are screened in as a precautionary approach due to their designation at the North West Irish Sea SPA within which the proposed development is located.

Magnitude of impact

Based on the CRM assessment (presented in the CRM Report), almost zero (0.0) collision mortalities are predicted. Based on the very low magnitude of impact predicted, potential collision effects on Manx shearwater are not considered further here, with a negligible magnitude predicted across all bio-seasons.

This is further supported by available data, with Manx shearwater considered to be at low risk of collision due to spending limited time at collision risk height (Garthe and Hüppop, 2004, King et al., 2009, Cook et al., 2012, Furness and Wade, 2012, Furness et al., 2013, Bradbury et al., 2014, Certain et al., 2015). Based on modelling based on 6,957 vessel-based observations estimates that the percentage of Manx shearwaters flying at collision risk height (where the lower limit of the rotor-swept area is 20m above sea level) is 0.04% (95% CI <0.01–10.1%; Cook et al., 2012). Similarly, modelling by Johnston and Cook (2016) estimates the proportion of time Manx shearwater fly within the rotor-swept zone is 0.0(95% CI 0.0–0.0) based on boat survey data, and 0.0 (95% CI 0.0–0.02) based on DAS data.

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from collision risk would be negligible (Table 15.7).

Significance of the effect

Project Option 1

Overall, it is predicted that the sensitivity of Manx shearwater for Project Option 1 is medium and the magnitude of the impact is negligible. The low sensitivity and negligible magnitude of the impact on Manx shearwater results in an imperceptible effect, which is not significant effect in EIA terms based on the matrix approach in Table 15.8.

Project Option 2

Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the medium sensitivity and negligible magnitude of the impact on Manx shearwater results in an imperceptible effect at worst, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Gannet

Sensitivity of gannets

Gannets are considered to have a medium vulnerability to collision impacts (Table 15.47). As outlined in Section 15.5.2, gannet have a medium conservation value (Table 15.5), with an overall receptor sensitivity assessed as medium based on the matrix approach in Table 15.6.

Magnitude of impact

For the assessment of gannet, collisions have been reduced by 70% to account for macro-avoidance behaviour, as agreed in the Irish Phase One Methodology Statement' and as is now standard in UK guidance.

During the breeding bio-season, one (1.1) gannet is predicted to be at risk of collision mortality. Based on a breeding bio-season regional population size of 637,440 individuals (Table 15.17) and a baseline mortality of 115,807 individuals per annum (based on an average mortality rate of 0.182; Table 15.17), the addition of one collision mortality would represent a 0.001% increase in baseline mortality.

During the autumn migration bio-season less than one (0.3) gannet is predicted to be at risk of collision mortality. Based on an autumn migration bio-season regional population size of 535,183 individuals (Table 15.17) and a baseline mortality of 97,229 individuals per annum (based on an average mortality rate of 0.182; Table 15.18), the addition of less than one collision mortality would represent a 0.000% increase in baseline mortality.

During the spring migration bio-season almost zero (0.0) gannets are predicted to be at risk of collision mortality. Based on a spring migration bio-season regional population size of 643,917 individuals (Table 15.17) and a baseline mortality of 116,984 individuals per annum (based on an average mortality rate of 0.182; Table 15.18), the addition of almost zero collision mortalities would represent a 0.000% increase in baseline mortality.

Across all bio-seasons, one (1.4) gannet is predicted to be at risk of collision mortality. Based on the largest regional population of 643,917 individuals (Table 15.17) and a baseline mortality of 116,984 individuals per annum (based on an average mortality rate of 0.182; Table 15.18), the addition of one collision mortality would represent a 0.001% increase in baseline mortality. Considering the biogeographic population of 1,180,000 individuals (Table 15.17) and a baseline mortality of 214,33 individuals per annum, the addition of one collision mortality would represent a 0.001% increase in baseline mortality.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from collision risk would be negligible (Table 15.7).

Significance of the effect

Project Option 1

Overall, it is predicted that the sensitivity of gannet for Project Option 1 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on gannet results in an imperceptible effect, which is not significant effect in EIA terms based on the matrix approach in Table 15.8.

Project Option 2

Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the medium sensitivity and negligible magnitude of the impact on gannet results in an imperceptible effect at worst, which is not significant in EIA terms based on the matrix approach in Table 15.8.

15.5.3.3 Impact 7: Combined collision risk and displacement risk (gannet)

For gannet, which has been assessed for both collision and displacement impacts in the operational phase, a combined assessment is needed to fully understand the magnitude of the impacts from the proposed development.

As outlined in Section 15.4.6, Project Option 1 is considered here as the option with the greatest potential for impacts on gannet.

Sensitivity of gannets

As outlined for Impact 5 and Impact 6, gannet have a medium vulnerability to both collision and displacement impacts, with an overall sensitivity of medium.

Magnitude of impact

Results from collision and displacement, and the total combined impacts for gannet in the operational phase for the proposed development alone are presented in Table 15.57 below. Results are presented based on the main approach displacement values, with a range presented for gannet in brackets as carried out within Section 15.5.2.

Table 15.57 Gannet combined displacement and collision impacts

Species	Annual displacement mortality based on 70% displacement and 1% mortality, plus a range of 60% to 80% displacement)	Annual collision mortality	Total combined annual mortalities	Total combined annual impact (regional population)	Total combined annual impact (biogeographic)
Gannet (mean)	4.1 (2.7 – 4.7)	1.4	5.5 (4.1–6.1)	0.005 (0.003 – 0.005)	0.003 (0.002 – 0.003)
Gannet (LCI)	2.2 (1.5 – 2.5)	0.1	2.3 (1.6 – 2.6)	0.002 (0.001 – 0.002)	0.001 (0.001 – 0.001)
Gannet (UCI)	6.3 (4.0 – 7.2)	4.7	11.0 (8.7 – 11.9)	0.009 (0.004 – 0.010)	0.005 (0.002 – 0.006)

One (1.4) collision mortality is predicted as a result of the proposed development, and four (4.1) displacement mortalities. The total combined annal impact is therefore six (5.5).

Based on the largest regional population of 643,917 individuals (Table 15.17), and a baseline mortality of 116,984 individuals per annum (based on an average mortality of 0.182; Table 15.17), the addition of six mortalities would represent a 0.005% increase in baseline mortality. When using the upper and lower displacement values, this impact ranges from a 0.003% to 0.005% increase in baseline mortality. Considering the biogeographic population of 1,180,000 individuals and a baseline mortality of 214,377 individuals per annum, the addition of six mortalities would represent a 0.003% increase in baseline mortality. When using the upper and lower displacement values, this impact ranges from a 0.002% to 0.003% increase in baseline mortality.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from combined collision and displacement impacts would be negligible (Table 15.7).

Significance of the effect

Project Option 1

Overall, it is predicted that the sensitivity of gannet for Project Option 1 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on gannet results in an imperceptible effect, which is not significant effect in EIA terms based on the matrix approach in Table 15.8.

Project Option 2

Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the medium sensitivity and negligible magnitude of the impact on gannet results in an imperceptible effect at worst, which is not significant in EIA terms based on the matrix approach in Table 15.8.

15.5.3.4 Impact 8: Migratory collision risk

In addition to the species assessed under Impact 6, there is also potential collision risk to migratory species which may pass through the array area during autumn and spring migrations.

An assessment of the collision risk to migratory birds has been carried out for the proposed development with detailed methods and results presented in the Migratory Report. In total, 41 migratory species were part of the initial screening process, identified as species at potential at risk from collision during migration. Using the Marine Scotland Avian Migration Collision Risk Model Shiny Application ("mCRM App" HiDef (2022)) (hereafter the 'Shiny App') the mCRM was undertaken for each of the species identified to estimate the number of individuals predicted to pass through the array area each year. Where the number of individuals expected to pass through the array was less than 1% of the Irish population, the species was screened out of further assessment as the greatest impact would be of a negligible magnitude due to the low numbers of birds passing through the array. Based on a negligible magnitude, the greatest significance will be imperceptible regardless of receptor sensitivity, which is not significant in EIA terms. This approach is standard across UK OWF assessments (e.g., as undertaken for the Awel y Mor OWF).

The tool was designed for OWFs in British waters and as such uses UK populations in the calculations. To make it applicable to an OWF in the Irish Sea the defined populations in the tool were altered to reflect a truer representation of the migratory pathways within the region of the array area. To determine appropriate populations and proportions passing the Irish Sea several methods were used, the Irish population used was taken from Burke et al., (2018) and for species with an easterly migration pathway to and from Ireland (e.g. Bewick's swan) the population was set at the Irish population in Burke et al. For species with a northerly or north-westerly migratory route to and from Ireland (e.g. light-bellied brent goose) a precautionary measure was used by adding 25% of the UK population (found in the Shiny App) to the Irish population to include any individuals from the south-western regions of the UK populations overflying the Irish Sea. If the Irish population plus the 25% of the UK population exceeded the flyway population, then the proportion of the population passing through the proposed development was set to one.

Where the all Ireland populations were not provided in Burke et al, the default UK populations in the Shiny App were used with the following caveats applied. For migratory raptor species and snipe it was assumed that a conservative 50% of the UK population may fly over the Irish Sea during the migration period and for corncrake, which migrates north/south from its breeding range in the north-west of the UK that a precautionary 100% of the UK population was assumed to fly over the Irish Sea. The proportion of birds passing through the wind farm footprint was adjusted to meet with the new Irish populations that were calculated and where Irish populations plus the 25% of the UK population exceeded the flyway population the proportion was set to 1. Table 15.58 presents the findings of the screening process. Four species were screened out at this stage due to the number of birds passing through the array being <1% of the Irish population: Icelandic greylag goose, gadwall, bar-tailed godwit and red-throated diver.

Table 15.58 The population estimates passing through the OWF and the proportion of birds at risk of collision for the assessed species

Species	Population estimate	SD	% at collision risk	Screened in/out
Light-bellied brent goose	821	111	2.2	In
Greylag goose	0	0	0	Out
Bewick's swan	1	0	5	In
Shelduck	130	24	1.3	In
Shoveler	35	6	1.5	In
Wigeon	2,165	421	1.2	In
Mallard	377	71	1.3	In
Pintail	93	20	1.4	In
Teal	1,639	344	1.1	In
Goldeneye	204	37	1.5	In
Red-breasted merganser	94	17	1.5	In
Great crested grebe	72	11	2.4	In
Oystercatcher	2,400	396	1.6	In
Lapwing	1,284	227	1.5	In
Golden plover	10,757	2,280	1.2	In
Grey plover	40	8	1.3	In
Ringed plover	589	121	1.1	In
Curlew	873	161	1.2	In
Bar-tailed godwit	47	18	0.3	Out
Black-tailed godwit	2,228	321	2.3	In
Turnstone	1,121	252	1.2	In
Knot	1,307	290	1.2	In
Sanderling	657	140	1.1	In
Dunlin	7,208	1,414	1.3	In
Purple sandpiper	101	17	1.5	In
Redshank	1,837	336	1.4	In

Vantage point surveys were carried out for the proposed development with more detailed methodology and results presented in the Technical Baseline. The vantage point data was used to help assess the species that was inputted into the mCRM tool with the most commonly recorded species being light-bellied brent goose, common scoter, golden plover, oystercatcher, turnstone and dunlin. The peak period for migrating birds during the vantage point surveys was September to November 2019 (plus March 2020).

Sensitivity of migratory birds

The sensitivity of migratory non-seabird species has been less studied in the offshore environment in comparison to seabirds. However, vulnerability to collisions is considered to be generally low, with most migrations occurring on a broad front (i.e., birds flying across a wide area as opposed to channelling through a narrow area) and above rotor height.

The recoverability of migratory bird populations may vary considerably, with some species (e.g. dunlin) having a more favourable conservation status than some larger species with lower reproductive rates (e.g. Eurasian curlew).

Though sensitivity is considered to be low, the sensitivity of all migratory birds is assessed as medium in this EIAR as a precautionary approach.

Magnitude of impact

Following the estimated collision risk to each migratory species being determined (Table 15.59) a range of zero predicted mortalities per annum (e.g. for Bewick's swan) to a maximum 2.6 predicted mortalities per annum (e.g. for wigeon) were estimated for the proposed development. However, when considering the level of impact relative to the baseline mortality rate for each of these species, all were between 0.00% and 0.069%. This level of impact on an annual basis for all species is considered to be of negligible magnitude at most. Therefore, it can be concluded, based on the evidence available, that the proposed development will have an impact of negligible magnitude on migratory birds passing either north-south or east-west on their annual migrations (Table 15.7).

Significance of the effect

Overall, it is predicted that the sensitivity of migratory birds for Project Option 1 and Project Option 2 is medium at worst and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on migratory birds results in an imperceptible effect at worst, which is not significant effect in EIA terms based on the matrix approach in Table 15.8.

Table 15.59 Summary of migratory collision risk assessment on migrant waterbirds from the proposed development

Species	Irish Population (plus proportion of UK)	Adult baseline mortality rate (Robinson 2005, Horswill 2015)	Irish population baseline mortality	Avoidance rates (%)	Annual collision rate (proposed development)	Population baseline mortality rate increase (%)
Light-bellied brent goose	36,500	0.100	3,650	99.90	0.039	0.001
Greylag goose	20,650	0.170	3,511	99.96	0.000	0.000
Bewick's swan	20	0.178	4	98.80	0.000	0.000
Shelduck	10,160	0.114	1,158	98.50	0.120	0.010
Shoveler	2,241	0.420	941	98.50	0.650	0.069
Wigeon	175,730	0.470	82,593	98.50	2.640	0.003
Mallard	28,231	0.373	10,530	98.50	0.786	0.007
Pintail	6,806	0.337	2,294	98.50	0.113	0.005
Teal	144,615	0.470	67,969	98.50	1.919	0.003
Goldeneye	13,196	0.228	3,009	98.50	0.237	0.008
Red-breasted merganser	6,391	0.180*	1,150	98.50	0.118	0.010
Great crested grebe	2,931	0.275	806	99.50	0.042	0.005
Oystercatcher	150,265	0.120	18,032	99.90	0.211	0.001
Lapwing	84,690	0.295	24,984	99.90	0.100	0.000
Golden plover	916,185	0.270	247,370	99.90	0.765	0.000
Grey plover	2,940	0.140	412	99.90	0.002	0.000
Ringed plover	54,500	0.228	12,426	99.90	0.042	0.000
Curlew	70,515	0.101	7,122	99.90	0.079	0.001
Bar-tailed godwit	16,530	0.285	4,711	99.90	0.004	0.000
Black-tailed godwit	93,960	0.060	5,638	99.90	0.103	0.002
Turnstone	96,230	0.140	13,472	99.90	0.093	0.001
Knot	106,270	0.159	16,897	99.90	0.089	0.001
Sanderling	58,421	0.170	9,932	99.90	0.046	0.000
Dunlin	551,212	0.260	143,315	99.90	0.496	0.000

Species	Irish Population (plus proportion of UK)	Adult baseline mortality rate (Robinson 2005, Horswill 2015)	Irish population baseline mortality	Avoidance rates (%)	Annual collision rate (proposed development)	Population baseline mortality rate increase (%)
Purple sandpiper	6,761	0.205	1,386	99.90	0.007	0.001
Redshank	128,800	0.260	33,488	99.90	0.137	0.000

* baseline mortality rate based on goosander

** baseline mortality rate based on redshank

15.5.3.5 Impact 9: Indirect impacts due to impacts on prey

As with the construction phase, there is potential for indirect impacts on ornithological receptors due to impacts on prey species. However, all impacts on key prey species are expected to be of equal or reduced magnitude in the operational phase compared with the construction phase.

During the operational phase, all impacts on key prey species are equal to or less than those presented in the construction phase (Table 15.34). In the construction phase, the greatest receptor sensitivity of high and the low magnitude of the impact on ornithological receptors results in a moderate effect at worst, which is not significant in EIA terms based on the matrix approach in Table 15.8. Therefore, all impacts during the operational phase are concluded to be not significant in EIA terms. As outlined in Section 15.4.6, both Project Option 1 and Project Option 2 have an equal potential for indirect impacts due to impacts on prey, and therefore the magnitude of impact and significance of effect is the same for both project options in this section.

15.5.3.6 Impact 10: Impacts arising from artificial light

As outlined in Section 15.5.2.4, the presence of artificially illuminated structures has the potential to impact birds, acting as both a deterrent to some species and an attractant to other species. For deterred birds, any changes in flight path may increase energy expenditure and act in line with effects resulting from displacement whereas for birds attracted, this may have similar impacts but also potentially increase the risk of collision.

During the operational phase, the presence of artificial light is expected to be of reduced magnitude compared with the construction phase, with light arising predominantly from intermittent lighting on periphery WTGs (as outlined in Table 15.19).

During the construction phase, the potential effects were assessed as imperceptible significance. With the magnitude of impact predicted to be of equal or lower than that of the construction phase, the same conclusion is reached for the operational phase.

15.5.4 Decommissioning

This section presents the assessment of impacts arising from the decommissioning stage of the proposed development. For further details see Volume 9, Appendix 6.2: Rehabilitation Schedule and the Offshore EMP.

15.5.4.1 Impact 11: Disturbance and displacement (array area and ECC)

During the decommissioning phase of the proposed development, there is potential for disturbance and displacement of ornithological receptors within the array area and ECC. As outlined in Table 15.20, the greatest potential magnitude of impact in the decommissioning phase is equal to, or less than that for the construction phase. Likely significant effects are therefore deemed to be similar or less than those assessed in Section 15.5.2.

During the construction phase, all assessed disturbance and displacement effects were deemed to be not significant in EIA terms, and therefore no significant effects are expected within the decommissioning phase.

15.5.4.2 Impact 12: Indirect impacts due to impacts on prey

During the decommissioning phase of the proposed development, there is potential for indirect impacts due to impacts on prey. As outlined in Table 15.20, the greatest potential magnitude of impact in the decommissioning phase is equal to, or less than that for the construction phase. Likely significant effects are therefore deemed to be similar or less than those assessed in Section 15.5.2.

During the construction phase, all assessed disturbance and displacement effects were deemed to be not significant in EIA terms, and therefore no significant effects are expected within the decommissioning phase.

15.5.4.3 Impact 13: Impacts due to accidental pollution

During the decommissioning phase of the proposed development there is potential for impacts on ornithological receptors due to accidental pollution. As outlined in Table 15.20, the greatest potential magnitude of impact in the decommissioning phase is equal to, or less than that for the construction phase. Likely significant effects are therefore deemed to be similar or less than those assessed in Section 15.5.2.

During the construction phase, all assessed pollution effects were deemed to be not significant in EIA terms, and therefore no significant effects are expected within the decommissioning phase.

15.5.4.4 Impact 14: Impacts arising from artificial light

During the decommissioning phase of the proposed development there is potential for impacts on ornithological receptors due to the presence of artificial light. As outlined in Table 15.20, the greatest potential magnitude of impact in the decommissioning phase is equal to, or less than that for the construction phase. Likely significant effects are therefore deemed to be similar or less than those assessed in Section 15.5.2.

During the construction phase, all effects were deemed arising from artificial light to be not significant in EIA terms, and therefore no significant effects are expected within the decommissioning phase.

15.6 Mitigation and Monitoring Measures

15.6.1 Mitigation

Mitigation measures that were identified and adopted as part of the evolution of the proposed development design (embedded into the proposed development design) and that are relevant to offshore ornithology are listed in Table 15.20 and not considered again here. Table 15.60 below identifies additional mitigation measures that are not embedded into the proposed development design.

Table 15.60 Mitigation relating to offshore and intertidal ornithology

Mitigation measure	Description
Construction	
Vessels to avoid birds	Where practicable vessels accessing the offshore development area during construction are to seek to avoid 'rafts' of birds and feeding aggregates to minimise disturbance and displacement. This measure is provided as part of the EVMP.
Use of established navigation routes	Vessel movements will follow, where practicable, existing navigation routes enroute to the array area and offshore export cable, where the densities of divers and seaducks are typically relatively low due to regular vessel presence compared to the wider inshore area. This measure is provided as part of the EVMP.
Avoidance of rafting birds during vessel transit	Avoidance of rafting birds during transiting and within the offshore development area, with particular consideration within the North-west Irish Sea candidate Special Protection Area (cSPA). Vessels will seek to avoid rafting birds and where practicable avoid disturbance to areas with consistently high diver density. This measure is provided as part of the EVMP.
Avoidance of over-revving of engines	Vessels will seek to avoid unnecessary running of engines and idling engines while anchored, in order to minimise noise disturbance. Vessels will shut down engines or maintain low engine power as soon as possible. This measure is provided as part of the EVMP.
Briefing of vessel crew	Vessel crew will be briefed on the purpose and implications of the vessel management practices outlined in the EVMP.
Operation	
Vessels to avoid birds	Where practicable vessels accessing the offshore development area during operation are to seek to avoid 'rafts' of birds and feeding aggregates to minimise disturbance and displacement. This measure is provided as part of the EVMP.
Use of existing navigation routes	Vessel movements will follow, where practicable, existing navigation routes enroute to the array area and offshore export cable, where the densities of divers and seaducks are typically relatively low due to regular vessel presence compared to the wider inshore area. This measure is provided as part of the EVMP.
Avoidance of rafting birds during vessel transit	Avoidance of rafting birds during transiting and within the offshore development area, with particular consideration within the North-west Irish Sea cSPA. Vessels will seek to avoid rafting birds and where practicable seek to avoid disturbance to areas with consistently high diver density. This measure is provided as part of the EVMP.
Avoidance of over-revving of engines	Vessels will seek to avoid unnecessary running of engines and idling engines while anchored, in order to minimise noise disturbance. Vessels will shut down engines or maintain low engine power as soon as possible. This measure is provided as part of the EVMP.
Briefing of vessel crew	Vessel crew will be briefed on the purpose and implications of the vessel management practices outlined in the EVMP.
Reduction of vessel activity in sensitive months	During the operational phase the proposed development will reduce vessel activity in the ECC during the most sensitive months for coastal divers (November to March 1st inclusive), where practicable. This measure is provided as part of the EVMP.

Mitigation measure	Description
Decommissioning	
Vessels to seek to avoid birds	Where practicable vessels accessing the offshore development area during decommissioning are to seek to avoid ‘rafts’ of birds and feeding aggregates to minimis disturbance and displacement. This measure is provided as part of the EVMP.
Use of existing navigation routes	Vessel movements will follow, where practicable, existing navigation routes enroute to the array area and offshore export cable, where the densities of divers and seaducks are typically relatively low due to regular vessel presence compared to the wider inshore area. This measure is provided as part of the EVMP.
Avoidance of rafting birds during vessel transit	Avoidance of rafting birds during transiting and within the offshore development area, with particular consideration within the North-west Irish Sea cSPA. Vessels will seek to avoid rafting birds and where practicable seek to avoid disturbance to areas with consistently high diver density. This measure is provided as part of the EVMP.
Avoidance of over-revving of engines	Vessels will seek to avoid unnecessary running of engines and idling engines while anchored, in order to minimise noise disturbance. Vessels will shut down engines or maintain low engine power as soon as possible. This measure is provided as part of the VMP.
Briefing of vessel crew	Vessel crew will be briefed on the purpose and implications of the vessel management practices outlined in the EVMP.

15.6.2 Monitoring

The proposed development is committed to participating in the 'East Coast Monitoring Group' (ECMG), to discuss and agree potential strategic monitoring initiatives in relation to offshore ornithology. The need for strategic monitoring, and the level of participation by individual projects, will be determined by the conclusions of the EIAR process, in consultation with statutory and technical stakeholders, and with a focus on validation and evidence gathering.

If further monitoring is required for the proposed development on a project alone basis then this will be determined through consultation with relevant stakeholders.

15.7 Residual Effects

This section presents the residual effects of the proposed development once the mitigation outlined in Section 15.6 have been applied.

The impacts presented in Section 15.5 are assessed following embedded mitigation for the proposed development (as outlined in Section 15.4.5), and therefore conclusions from this section are considered to be the residual effects. The exception to this is Impact 1 in relation to vessel activity in the ECC. With the vessel mitigation for the proposed development (as outlined in Section 15.6), the magnitude of this impact will be substantially reduced compared to those assessed in Section 15.5.2.1. Notably for all species except common scoter, red-throated diver and great northern diver, this impact has already been assessed as imperceptible which is the lowest possible significance. For common scoter, red-throated diver and great northern diver the impact was assessed as not-significant, though for all three species the magnitude was assessed as negligible with the slightly higher significance rating driven by their high sensitivity. Therefore, though the magnitude of impact will be reduced, its overall classification cannot be less than negligible, so the overall significance will remain the same.

The residual effects of the project options once mitigation has been applied are summarised in Table 15.61.

Table 15.61 Residual effects relating to offshore and intertidal ornithology

Potential impact	Likely significant effect (pre-mitigation) – Project Option 1	Likely significant effect (pre-mitigation) – Project Option 2	Residual effect – Project Option 1	Residual effect – Project Option 2
Construction				
Impact 1: Disturbance and displacement	Common scoter Not significant Guillemot Imperceptible Razorbill Imperceptible Puffin Imperceptible Red-throated diver Not significant Great northern diver Not significant Manx shearwater Imperceptible Gannet Imperceptible Intertidal ornithological receptors Not significant	Common scoter Not significant Guillemot Imperceptible Razorbill Imperceptible Puffin Imperceptible Red-throated diver Not significant Great northern diver Not significant Manx shearwater Imperceptible Gannet Imperceptible Intertidal ornithological receptors Not significant	Common scoter Not significant Guillemot Imperceptible Razorbill Imperceptible Puffin Imperceptible Red-throated diver Not significant Great northern diver Not significant Manx shearwater Imperceptible Gannet Imperceptible Intertidal ornithological receptors Not significant	Common scoter Not significant Guillemot Imperceptible Razorbill Imperceptible Puffin Imperceptible Red-throated diver Not significant Great northern diver Not significant Manx shearwater Imperceptible Gannet Imperceptible Intertidal ornithological receptors Not significant

Potential impact	Likely significant effect (pre-mitigation) – Project Option 1	Likely significant effect (pre-mitigation) – Project Option 2	Residual effect – Project Option 1	Residual effect – Project Option 2
Impact 2: Indirect impacts due to impacts on prey	Common scoter Moderate Guillemot Slight Razorbill Slight Puffin Slight Red-throated diver Moderate Great northern diver Moderate Manx shearwater Moderate Gannet Slight Kittiwake Moderate Black-headed gull Slight Common gull Slight Great black-backed gull Slight Herring gull Slight Lesser black-backed gull Slight Roseate tern Moderate Common tern Moderate Arctic tern Moderate Fulmar Slight	Common scoter Moderate Guillemot Slight Razorbill Slight Puffin Slight Red-throated diver Moderate Great northern diver Moderate Manx shearwater Moderate Gannet Slight Kittiwake Moderate Black-headed gull Slight Common gull Slight Great black-backed gull Slight Herring gull Slight Lesser black-backed gull Slight Roseate tern Moderate Common tern Moderate Arctic tern Moderate Fulmar Slight	Common scoter Moderate Guillemot Slight Razorbill Slight Puffin Slight Red-throated diver Moderate Great northern diver Moderate Manx shearwater Moderate Gannet Slight Kittiwake Moderate Black-headed gull Slight Common gull Slight Great black-backed gull Slight Herring gull Slight Lesser black-backed gull Slight Roseate tern Moderate Common tern Moderate Arctic tern Moderate Fulmar Slight	Common scoter Moderate Guillemot Slight Razorbill Slight Puffin Slight Red-throated diver Moderate Great northern diver Moderate Manx shearwater Moderate Gannet Slight Kittiwake Moderate Black-headed gull Slight Common gull Slight Great black-backed gull Slight Herring gull Slight Lesser black-backed gull Slight Roseate tern Moderate Common tern Moderate Arctic tern Moderate Fulmar Slight
Impact 3: Indirect impacts due to accidental pollution	All ornithological receptors Imperceptible	All ornithological receptors Imperceptible	All ornithological receptors Imperceptible	All ornithological receptors Imperceptible
Impact 4: Impacts arising from artificial light	All ornithological receptors Not significant	All ornithological receptors Not significant	All ornithological receptors Not significant	All ornithological receptors Not significant
Operation				
Impact 5: Disturbance and displacement (array area)	Guillemot Imperceptible Razorbill Imperceptible Puffin	Guillemot Imperceptible Razorbill Imperceptible Puffin	Guillemot Imperceptible Razorbill Imperceptible Puffin	Guillemot Imperceptible Razorbill Imperceptible Puffin

Potential impact	Likely significant effect (pre-mitigation) – Project Option 1	Likely significant effect (pre-mitigation) – Project Option 2	Residual effect – Project Option 1	Residual effect – Project Option 2
	Imperceptible Manx shearwater Imperceptible Gannet Imperceptible	Imperceptible Manx shearwater Imperceptible Gannet Imperceptible	Imperceptible Manx shearwater Imperceptible Gannet Imperceptible	Imperceptible Manx shearwater Imperceptible Gannet Imperceptible
Impact 6: Collision risk	Kittiwake Not significant Black-headed gull Imperceptible Common gull Imperceptible Great black-backed gull Slight Herring gull Moderate Lesser black-backed gull Not significant Roseate tern Imperceptible Common tern Imperceptible Arctic tern Imperceptible Fulmar Imperceptible Manx shearwater Imperceptible Gannet Imperceptible	Kittiwake Not significant Black-headed gull Imperceptible Common gull Imperceptible Great black-backed gull Slight Herring gull Moderate Lesser black-backed gull Not significant Roseate tern Imperceptible Common tern Imperceptible Arctic tern Imperceptible Fulmar Imperceptible Manx shearwater Imperceptible Gannet Imperceptible	Kittiwake Not significant Black-headed gull Imperceptible Common gull Imperceptible Great black-backed gull Slight Herring gull Moderate Lesser black-backed gull Not significant Roseate tern Imperceptible Common tern Imperceptible Arctic tern Imperceptible Fulmar Imperceptible Manx shearwater Imperceptible Gannet Imperceptible	Kittiwake Not significant Black-headed gull Imperceptible Common gull Imperceptible Great black-backed gull Slight Herring gull Moderate Lesser black-backed gull Not significant Roseate tern Imperceptible Common tern Imperceptible Arctic tern Imperceptible Fulmar Imperceptible Manx shearwater Imperceptible Gannet Imperceptible
Impact 7: Combined collision risk and displacement risk (gannet)	Gannet Imperceptible	Gannet Imperceptible	Gannet Imperceptible	Gannet Imperceptible
Impact 8: Migratory collision risk	Migratory birds Imperceptible	Migratory birds Imperceptible	Migratory birds Imperceptible	Migratory birds Imperceptible
Impact 9: Indirect impacts due to impacts on prey	Equal to or lower than Impact 2	Equal to or lower than Impact 2	Equal to or lower than Impact 2	Equal to or lower than Impact 2
Impact 10: Impacts arising from artificial light	All ornithological receptors Imperceptible	All ornithological receptors Imperceptible	All ornithological receptors Imperceptible	All ornithological receptors Imperceptible
Decommissioning				
Impact 11: Disturbance and displacement (array area and ECC)	Equal to or lower than Impact 1	Equal to or lower than Impact 1	Equal to or lower than Impact 1	Equal to or lower than Impact 1
Impact 12: Indirect impacts due to impacts on prey	Equal to or lower than Impact 2	Equal to or lower than Impact 2	Equal to or lower than Impact 2	Equal to or lower than Impact 2

Potential impact	Likely significant effect (pre-mitigation) – Project Option 1	Likely significant effect (pre-mitigation) – Project Option 2	Residual effect – Project Option 1	Residual effect – Project Option 2
Impact 13: Indirect impacts due to accidental pollution	Equal to or lower than Impact 3	Equal to or lower than Impact 3	Equal to or lower than Impact 3	Equal to or lower than Impact 3
Impact 14: Impacts arising from artificial light	Equal to or lower than Impact 4	Equal to or lower than Impact 4	Equal to or lower than Impact 4	Equal to or lower than Impact 4

15.8 Transboundary Effects

Transboundary effects are defined as those effects upon the receiving environment of other states, whether occurring from the proposed development alone, or cumulatively with other projects in the area. For ornithological receptors which often have wide foraging and migratory ranges, there is therefore potential for these impacts to occur.

The regional populations used within the assessment of likely significant effects (presented in Section 15.3.2) incorporate birds from Ireland, the UK and beyond, and therefore the likely significant effects of the proposed development on birds outside of Irish waters are considered within the assessment.

During the breeding season, connectivity with other sites is determined based on mean-maximum foraging ranges presented in Woodward et al., (2019), representing a standard approach to determining connectivity across Irish and UK projects and as agreed among Phase One projects. Even for species which have particularly large mean-maximum foraging ranges (e.g., Manx shearwater) it is unlikely that these receptors will travel beyond the Irish and Celtic Seas. Therefore, during the breeding season there is limited potential for any impacts from the proposed development on receptors outside of this region. Within the EIAR, regional breeding populations are based on birds in both Irish and the west coast of the UK waters, and therefore potential impacts on relevant UK birds are accounted for within the assessment.

During the non-breeding season, ornithological receptors are able to travel more widely and therefore receptors that disperse widely or undertake migrations have the potential to be impacted by the proposed development even if they originate from SPAs or colonies outside of Ireland and the UK. Impacts on these individuals are considered within the assessments by incorporating the impacts assessed at the larger biogeographic scale, which incorporates all individuals that may have connectivity to the North-East Atlantic and therefore accounts for transboundary impacts. In this case, any likely significant effects would be considered in relation to much larger populations due to the inclusion of more colonies from a wider area.

An overview of potential transboundary effects is provided in Table 15.62 below.

Table 15.62 Potential transboundary effects on ornithological receptors

Likely significant effect	Effect description	Effect significance – Project Option 1	Effect significance – Project Option 2
Disturbance and displacement (including barrier effects)	Likely significant effects resulting from disturbance and displacement due to vessel activity and the presence of offshore infrastructure across the construction, operational and decommissioning phases.	Not significant in EIA terms for all species assessed.	Not significant in EIA terms for all species assessed.
Indirect impacts due to impacts on prey	Likely significant effects seabird species due to impacts on prey availability during the construction, operational and decommissioning phases.	Not significant in EIA terms for all species assessed.	Not significant in EIA terms for all species assessed.

Likely significant effect	Effect description	Effect significance – Project Option 1	Effect significance – Project Option 2
Collision risk	Likely significant effects due to seabird species colliding with offshore infrastructure during the operational phase.	Not significant in EIA terms for all species assessed.	Not significant in EIA terms for all species assessed.
Migratory collision risk	Likely significant effects due to migratory birds colliding with offshore infrastructure during the operational phase.	Not significant in EIA terms for all species assessed.	Not significant in EIA terms for all species assessed.

As outlined in Section 15.8, there is low risk for the proposed development to have transboundary impacts, with potential impacts already largely accounted for within the EIAR assessment. Additionally, for all the impacts identified in Table 15.62, the predicted impacts from the proposed development have all been assessed as not significant in EIA terms, and therefore the contribution of the proposed development to impacts on the environment of other EEA states will not be material.

15.9 Cumulative Effects

15.9.1 Overview

Likely significant cumulative effects of the proposed development in-combination with existing and/or approved projects for offshore and intertidal ornithology have been identified, considered and assessed. The methodology for this cumulative assessment is a three-stage approach which is presented in the Cumulative and Inter-Related Effects Chapter.

The Cumulative and Inter-Related Effects Chapter contains the outcome of Stage 1 Establishing the list of ‘Other Existing and/or Approved Projects’; and Stage 2 ‘Screening of ‘Other Existing and/or Approved Projects’. This section presents Stage 3, an assessment of whether the proposed development in combination with other existing and/or planned projects grouped in tiers, would be likely to have significant cumulative effects.

The assessment specifically considers whether any of the approved developments in the local or wider area have the potential to alter the significance of effects associated with the proposed development. Developments which are already built and operating, and which are not identified in this chapter, are included in the baseline environment or have been screened out as there is no potential to alter the significance of effects.

The assessment of cumulative effects has considered likely significant effects that may arise during construction, operation and decommissioning of the proposed development. Cumulative effects were assessed to a level of detail commensurate with the information that has either been directly shared with the proposed development, or was publicly available at the time of assessment.

Given the location and nature of the proposed development, a tiered approach to establishing the list of other existing and/or approved projects has been undertaken in Stage 1 of the cumulative effects assessment. The tiering of projects is based on project relevance to the proposed development and it is not a hierarchical approach nor based on weighting. Further information on the tiers is provided in Section 15.9.2 and in the Cumulative and Inter-Related Effects Chapter.

The cumulative assessment is based on the information which is publicly available at the time of the assessment. Additionally, Phase One Offshore Wind Farm projects have shared information on project impacts which is included within the cumulative assessment. This was included as a single value for all other Phase One Offshore Wind Farm projects combined to anonymise other projects contributions until they have all submitted an application (e.g., all collision impacts for Phase One Wind Farm projects were added together).

The potential for cumulative impacts will be species-specific as the impacts will be dependent upon the individual sensitivities of each species, where the birds have originated from, and their potential to interact with other windfarms (i.e. on migratory or foraging travel).

15.9.2 Offshore and intertidal ornithology cumulative screening exercise

The existing and/or approved projects selected as relevant to the cumulative effects assessment of impacts to offshore and intertidal ornithology are based on an initial screening exercise undertaken on a long list (see Cumulative and Inter-Related Effects Chapter) based on spatial distance to the proposed development. Consideration of effect-receptor pathways, data confidence and temporal and spatial scales has then allowed the selection of the relevant projects for the offshore and intertidal ornithology cumulative short-list.

Bird species are highly mobile, performing extensive migrations and ranging large distances while foraging. Consequently, bird populations will be affected by impacts arising from multiple (existing and proposed) OWFs within the Irish Sea region.

When assessing likely significant effects for offshore and intertidal ornithology, projects were screened into the assessment based on their ability to impact receptors within the International Council for the Exploration of the Sea (ICES) Celtic Sea Ecoregion, which encompasses the extent of impacts to offshore and intertidal ornithology from the proposed development.

For the full list of projects considered, including those screened out, please see the Cumulative and Inter-Related Effects Chapter and Appendix 38.1.

15.9.3 Projects considered in the cumulative effects assessment

The planned, existing and/or approved projects selected through the screening exercise as potentially relevant to the assessment of impacts to offshore and intertidal ornithology are presented in Table 15.63.

The tiers for the assessment are:

- Tier 1 is limited to the Operation and Maintenance Facility (OMF) for the proposed development. The OMF option being considered involves the adaption and leasing part of an existing port facility at Greenore. Further detail is provided in the Offshore Description Chapter.
- Tier 2 is the east coast Phase One Offshore Wind Farms.
- Tier 3 is all other projects that have been screened in for this topic.

The tiering structure is intended to provide an understanding of the potential for likely significant effects of the proposed development with the construction of its OMF (tier one); followed by a cumulative assessment of the likely significant effect of that scenario combined with the east coast Phase One Offshore Wind Farms (tier two); and lastly the combination of tier one and tier two with all other existing and/or approved projects that have been screened in (tier three).

It should be noted that several OWFs included within the cumulative assessment are operational. Impacts from these projects can be considered less relevant, since they can be considered part of the baseline conditions, and therefore demographic rates and regional population trends are inclusive of these impacts. There is also evidence that birds may become habituated to these impacts over time, thus older OWFs are expected to have a reduced magnitude of impact relative to those predicted from their application. However, operational OWFs remain included within this cumulative assessment as a precautionary approach. Though considered part of the baseline, there remains potential for some impacts to not be fully accounted for. For example, it is unknown whether OWF impacts are accounted for within demographic rates used within the assessment). Demographic rates used from Horswill and Robinson (2015) have been collected over a long time period extending to before the presence of included operational OWFs, and it is unlikely that impacts on these rates are accounted for within the baseline morality. This approach is in line with the approach taken across the majority of UK projects.

Other impacts on birds, for example fisheries bycatch, are not included in the cumulative longlist. These longstanding impacts are considered to be part of the baseline and there is generally inconsistent and unreliable data to quantify any impacts. Therefore, impacts from these industries (such as fisheries) are not included in the longlist.

While other cable laying operations could take place at the same time as the installation of cables for the proposed development ECC and inter-array cables, it is considered unlikely that this would contribute to a cumulative disturbance effect as the duration of cable laying operations within sensitive ornithological areas is assumed to last for 12 months for any particular project, and the zone of effect is considered comparatively small e.g. 2km radius around cable laying vessels. Therefore the cumulative impact from all projects, even if cable laying operations were to coincide, would be negligible.

Within the Irish Sea, impacts resulting from aggregates, oil and gas, cabling projects and commercial shipping are not considered relevant to the assessment of cumulative effects on ornithological receptors. This is due to the following:

- Impacts are already accounted for within the ornithology baseline
- There is no conceptual and/or effect-receptor pathway from these projects/plans
- There is no temporal overlap between projects/plans; and/or
- There is low data confidence or there isn't sufficient data available to undertake an assessment.

In consideration of the above, the only project type considered relevant to the ornithology cumulative effects assessment is offshore wind. The operation and maintenance facility (OMF) is not an OWF and is consequently screened out. This approach is also consistent with other assessments undertaken within the Irish Sea region (e.g., Awel y Mor). The cumulative effects assessment considers all OWFs at all stages of development to which ornithological receptors in the study area may have connectivity to.

Projects which have been screened into the assessment and their relevant tiers are presented in Table 15.63 below.

Table 15.63 Projects and plans considered within the cumulative impact assessment

Development type	Project	Status	Data confidence	Distance to the proposed development		Justification for screening into the cumulative effects assessment
				Array area	ECC	
Tier 1	Operation and Maintenance Facility (OMF)	No projects scoped into offshore and intertidal ornithology cumulative effects assessment. The OMF is proposed to be developed as part of an existing port facility, and therefore no impacts on offshore ornithological receptors are expected. As outlined above, only OWFs are included within the cumulative assessment of potential effects to ornithological receptors, therefore no relevant impact pathway is identified with other plans or projects. Construction of the OMF is not programmed to overlap with the proposed development.				
Tier 2						
Phase one Irish OWF projects	Oriel Wind Park	Pre-consent	Medium – scoping report available at time of writing. A foreshore license has been granted for site investigations (2022-2027). Reference FS007383. Site investigations have been undertaken and EIAR in prep.	16.9km	21.6km	Overlap in construction period, Oriel Wind Park due to construct during 2026-2028
	Dublin Array	Pre-consent	Medium – scoping report available at time of writing. A foreshore license has been granted for site investigations (2022-2027). Reference FS007188. Site investigations have been undertaken and EIAR in prep.	32.9km	37.6km	Overlap in construction period, Dublin Array due to construct during 2028-2032
	Codling Wind Park	Pre-consent	Medium – Scoping Report available at the time of writing. A foreshore license has been granted for site investigations. Reference FS007045	50.9km	56.9km	Overlap in construction period, with Colding Wind Park due to construct during 2027-2028
	Arklow Bank Phase 2	Pre-consent	Medium – scoping report available at time of writing. A foreshore license has been granted for site investigations (2022-2027). Reference FS007339. Site investigations have been undertaken and EIAR in prep.	76.4km	80.0km	Overlap in construction period with Arklow Bank Phase 2 2026-2030
Tier 3						
OWF	Arklow Bank Phase one	Operational	High	88.3	91.3	Arklow Bank Phase one will be operational during the construction phase of the proposed development. Operational OWF projects are

Development type	Project	Status	Data confidence	Distance to the proposed development		Justification for screening into the cumulative effects assessment
				Array area	ECC	
						considered as part of a precautionary approach, despite the habituation of birds to the impacts.
OWF	Morgan	Pre-Consent	High	111.5	119.9	Morgan is expected to be operational during the construction phase of the proposed development. Operational OWF projects are considered as part of a precautionary approach, despite the habituation of birds to the impacts.
OWF	Mona	Pre-Consent	High	117.3	124.8	Mona is expected to be operational during the construction phase of the proposed development. Operational OWF projects are considered as part of a precautionary approach, despite the habituation of birds to the impacts.
OWF	Awel-y-Mor	Consented	High	131.6	139.5	Awel-y-Mor is expected to be operational during the construction phase of the proposed development. Operational OWF projects are considered as part of a precautionary approach, despite the habituation of birds to the impacts.
OWF	Walney Extension 3	Operational	High	133.3	141.8	Walney Extension 3 will be operational during the construction phase of the proposed development. Operational OWF projects are considered as part of a precautionary approach, despite the habituation of birds to the impacts.
OWF	Walney Extension 4	Operational	High	138.6	147.0	Walney Extension 4 will be operational during the construction phase of the proposed development. Operational OWF projects are considered as part of a precautionary approach, despite the habituation of birds to the impacts.
OWF	Morecambe	Operational	High	138.9	146.5	Morecambe will be operational during the construction phase of the proposed development. Operational OWF projects are considered as part of a precautionary approach, despite the habituation of birds to the impacts.
OWF	Gwynt y Mor	Operational	High	143.2	151.2	Gwynt y Mor will be operational during the construction phase of the proposed development. Operational OWF projects are considered as part of a precautionary approach, despite the habituation of birds to the impacts.
OWF	Rhyl Flats	Operational	High	144.5	152.8	Rhyl Flats will be operational during the construction phase of the proposed development. Operational OWF projects are considered as part of a precautionary approach, despite the habituation of birds to the impacts.

Development type	Project	Status	Data confidence	Distance to the proposed development		Justification for screening into the cumulative effects assessment
				Array area	ECC	
OWF	Walney 2	Operational	High	148.3	156.7	Walney 2 will be operational during the construction phase of the proposed development. Operational OWF projects are considered as part of a precautionary approach, despite the habituation of birds to the impacts.
OWF	West of Duddon Sands	Operational	High	153.2	161.5	West of Duddon Sands will be operational during the construction phase of the proposed development. Operational OWF projects are considered as part of a precautionary approach, despite the habituation of birds to the impacts.
OWF	Walney 1	Operational	High	153.7	162.0	Walney 1 will be operational during the construction phase of the proposed development. Operational OWF projects are considered as part of a precautionary approach, despite the habituation of birds to the impacts.
OWF	North Hoyle	Operational	High	157.5	165.5	North Hoyle will be operational during the construction phase of the proposed development. Operational OWF projects are considered as part of a precautionary approach, despite the habituation of birds to the impacts.
OWF	Ormonde	Operational	High	160.7	169.1	Ormonde will be operational during the construction phase of the proposed development. Operational OWF projects are considered as part of a precautionary approach, despite the habituation of birds to the impacts.
OWF	Burbo Bank Extension	Operational	High	163.4	171.1	Burbo Bank Extension will be operational during the construction phase of the proposed development. Operational OWF projects are considered as part of a precautionary approach, despite the habituation of birds to the impacts.
OWF	Barrow	Operational	High	167.7	175.9	Barrow will be operational during the construction phase of the proposed development. Operational OWF projects are considered as part of a precautionary approach, despite the habituation of birds to the impacts.
OWF	Burbo Bank	Operational	High	173.6	181.3	Burbo Bank will be operational during the construction phase of the proposed development. Operational OWF projects are considered as part of a precautionary approach, despite the habituation of birds to the impacts.

Development type	Project	Status	Data confidence	Distance to the proposed development		Justification for screening into the cumulative effects assessment
				Array area	ECC	
OWF	Robin Rigg West	Operational	High	176.7	184.9	Robin Rigg West will be operational during the construction phase of the proposed development. Operational OWF projects are considered as part of a precautionary approach, despite the habituation of birds to the impacts.
OWF	Robin Rigg East	Operational	High	178.8	186.9	Robin Rigg East will be operational during the construction phase of the proposed development. Operational OWF projects are considered as part of a precautionary approach, despite the habituation of birds to the impacts.
OWF	Erebus Floating Wind Demo	Consented	High	235.1	239.6	Erebus is expected to be operational during the construction phase of the proposed development. Operational OWF projects are considered as part of a precautionary approach, despite the habituation of birds to the impacts.
OWF	White Cross	Pre-Consent	High	274.7	280.6	White Cross is expected to be operational during the construction phase of the proposed development. Operational OWF projects are considered as part of a precautionary approach, despite the habituation of birds to the impacts.
OWF	Twin Hub	Operational	High	358.5	362.5	Twin Hub will be operational during the construction phase of the proposed development. Operational OWF projects are considered as part of a precautionary approach, despite the habituation of birds to the impacts.

As outlined in Section 15.9.2, the cumulative effects assessment considers the effects on ornithological receptors from the proposed development alongside those from other relevant OWFs (utilising the tiering system described in the methodology section).

Of the existing projects within the region, many are older developments that did not carry out certain impact assessments (e.g. displacement and/or collision risk) for species such as gannet, fulmar, Manx shearwater and gulls due to limited data at the time on behavioural responses of these species to OWFs. Therefore, information on operational developments have been included only where possible.

For projects in early stages of the planning process and where there is currently insufficient information to incorporate these into a reliable cumulative assessment, these projects have not been included in the assessment and are therefore not featured in the shortlist in Table 15.63.

15.9.4 Project impacts and options included in the assessment

The identification of potential impacts for the cumulative assessment has been undertaken by considering the relevant characteristics from both project options (refer to Section 15.4.1) and the potential for a pathway for them to have direct and indirect effects on known receptors (as identified in Section 15.3) when combined with other projects.

For each impact, the project option with the greatest potential for a likely significant effect has been determined based on the comparison and justification provided in Table 15.21. The impacts considered in the cumulative assessment are presented in Table 15.64. As the residual effects for Project Option 1 and Project Option 2 are the same (as identified in Section 15.7), the cumulative effects assessment presented in this section applies to both options.

The cumulative effects assessment for the proposed development considers the following impacts:

- Disturbance and displacement in the construction phase (array area only)
- Disturbance and displacement in the operational phase (array area only)
- Collision risk in the operational phase; and
- Combined collision risk and displacement risk in the operational phase.

For several impacts assessed for the proposed development alone in Section 15.5, no further consideration is given at the cumulative level. This includes:

- Disturbance and displacement in the ECC (construction phase), as likely significant effects on all receptors were assessed as negligible magnitude at most, with all impacts resulting from the proposed development being spatially and temporally limited
- Indirect impacts due to impacts on prey, since the contribution from the proposed development is low and is dependent on a temporal and spatial co-incidence of impacts on prey from other plans or projects, which is not considered to be a risk; and
- Indirect impacts due to accidental pollution which is also considered negligible following project mitigation, and the same is expected of other OWFs in the Irish/Celtic Sea region. There is therefore not considered any potential for pollution effects at the cumulative level.

As outlined in Section 15.9.1, impacts for other Irish East Coast Phase One projects have been collated for the cumulative assessment and are included as a single combined value where relevant.

Table 15.64 Potential cumulative impacts and tiers for assessment

Potential cumulative impact	Phase	Tiers and Projects	Justification for inclusion in cumulative assessment
1. Disturbance and displacement (array area)	Construction	Tiers 2 - OWFs only	The location and nature of activities involved in the construction, operation and/or decommissioning of the projects has the potential to affect offshore and intertidal ornithology within the Irish Sea region
2. Disturbance and displacement (array area)	Operational	Tier 2 - OWFs only	The location and nature of activities involved in the construction, operation and/or decommissioning of the projects has the potential to affect offshore and intertidal ornithology within the Irish Sea region
3. Collision risk	Operational	Tier 2 - OWFs only	The location and nature of activities involved in the construction, operation and/or decommissioning of the projects has the potential to affect offshore and intertidal ornithology within the Irish Sea region Project option with the greatest potential magnitude for likely significant effects used on a species-by-species basis
4. Combined collision risk and displacement	Operational	Tier 2 - OWFs only	The location and nature of activities involved in the construction, operation and/or decommissioning of the projects has the potential to affect offshore and intertidal ornithology within the Irish Sea region Only assessed for gannet, for which Project Option 1 predicts the highest number of collisions (with no difference across project options for displacement impacts)

15.9.5 Cumulative Impact 1: Disturbance and displacement (construction phase)

During the construction phase, there is potential for cumulative disturbance and displacement effects due to vessel activity and the presence of WTGs/offshore infrastructure. As outlined in Section 15.5.2.1, these impacts are expected to be spatially and temporally limited in comparison to the operational phase, and therefore displacement impacts used are 50% of those used in the operational assessment.

The cumulative assessment considers only projects which will have the potential for construction overlap with the proposed development, notably Awel-y-Mor, Morgan, Mona, Morecambe, Erebus, White Cross, and Phase one projects. The cumulative assessment in the construction phase therefore only considers these projects. It is noted that these projects (with the exception of Awel-y-Mor and Erebus) do not yet have consent or a confirmed route to market, and therefore this approach is highly precautionary by assuming they will all be constructing at the same time. Additionally, as outlined in Table 15.63, current timelines suggest that these projects (with the exception of Phase one projects) will be operational, not constructing during the construction phase of the proposed development, and therefore would not be considered relevant to this assessment (i.e., they would only be relevant in the operational phase assessment for which they are already included). However, since the potential for construction overlap cannot be ruled out, they have been included within this assessment on a precautionary basis.

15.9.5.1 Guillemot

Sensitivity of guillemots

As outlined in Section 15.5, guillemots have an overall sensitivity of medium and are assessed using a displacement rate of 25% and a mortality rate of 1%, with a range of 15% to 35% displacement and 1% to 5% mortality also presented.

As outlined in Table 15.14, two bio-season approaches are considered for guillemot, with a more ecologically relevant project approach forming the main basis of the assessment, and results based on the Furness approach used for other species also presented.

Tier 1

No Tier 1 projects have been scoped into the offshore and intertidal ornithology cumulative effects assessment.

Tier 1 and 2

Magnitude of impact

The estimated annual mean peak abundance of guillemot from relevant projects in the array area plus 2km buffer is presented in Table 15.65 below.

Table 15.65 Guillemot cumulative abundance totals for tier 1 and 2 projects during the construction phase

Project	Annual total cumulative abundance
Phase one projects	49,316
The proposed development (project approach to bio-seasons)	31,578
The proposed development (Furness approach to bio-seasons)	43,468
Total (with the proposed development) – project approach to bio-seasons	80,894
Total (with the proposed development) – Furness approach to bio-seasons	92,784

The cumulative annual total abundance of guillemots is 80,894. Based on 15% to 35% displacement and 1% to 5% mortality, between 121 (121.3) and 1,416 (1,415.6) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 25% displacement and 1% mortality, the estimated displacement consequent mortality is 202 (202.2) individuals per annum, of which the proposed development contributes 79 (78.9) mortalities.

Based on the largest regional population size of 1,332,623 individuals (Table 15.17) and a baseline mortality of 179,856 individuals per annum (based on an average mortality rate of 0.135; Table 15.18), the addition of 202 displacement consequent mortalities would represent a 0.112% increase in baseline mortality. Considering the biogeographic population size of 4,125,000, with a baseline mortality of 556,727 individuals per annum, the addition of 202 displacement consequent mortalities would represent a 0.036% increase in baseline mortality. Likely significant effects based on 15% to 35% displacement and 1% to 5% mortality, and based on the Furness approach to apportioning, are presented in Table 15.68 below.

At both the regional population and biogeographic population scales, the cumulative impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement for tier 1 and 2 projects would be low (Table 15.7).

Table 15.66 Predicted cumulative annual displacement impacts on guillemot from the proposed development during the construction phase for tier 1 and 2 projects

Bio-season (months)	Cumulative mean peak abundance (array plus 2km buffer)	Estimated mortality		Percentage increase in baseline mortality	
		25% displacement, 1% mortality	15% to 35% displacement, 1% to 5% mortality	25% displacement, 1% mortality	15% to 35% displacement, 1% to 5% mortality
Project approach to bio-seasons					
Annual (regional)	80,894	202.2	121.3 – 1,415.6	0.112	0.067 – 0.787
Annual (biogeographic)	80,894	202.2	121.3 – 1,415.6	0.036	0.022 – 0.254
Furness approach to bio-seasons					
Annual (regional)	92,784	232.0	139.2 – 1,623.7	0.129	0.077 – 0.903
Annual (biogeographic)	92,784	232.0	139.2 – 1,623.7	0.042	0.025 – 0.292

It should be noted that the impact estimates within the cumulative assessment were calculated from the more precautionary design-based abundances. If model-based abundance estimates were to be used (see MRSea Modelling Report), then the cumulative mean peak abundance would be reduced by over 14,000 birds, giving rise to far lower estimated mortalities and predicted impacts on the population.

Significance of the effect (array area)

Overall, it is predicted that the sensitivity of guillemot for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is low. The medium sensitivity and low magnitude of the impact on guillemot results in a slight effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Tier 1, 2 and 3 (All tiers)

Magnitude of impact

The estimated annual mean peak abundance of guillemot from relevant projects in the array area plus 2km buffer is presented in Table 15.67 below.

Table 15.67 Guillemot cumulative abundance totals for all tier projects during the construction phase

Project	Annual total cumulative abundance
Awel-y-Mor	4,488
Erebus	35,339

Project	Annual total cumulative abundance
Morgan	8,994
Morecambe	11,697
Mona	11,912
White cross	4,363
Phase one projects	49,316
Total (without the proposed development)	**126,109**
The proposed development (project approach to bio-seasons)	31,578
The proposed development (Furness approach to bio-seasons)	43,468
Total (with the proposed development) – project approach to bio-seasons	**157,687**
Total (with the proposed development) – Furness approach to bio-seasons	**169,577**

The cumulative annual total abundance of guillemots is 157,687. Based on 15% to 35% displacement and 1% to 5% mortality, between 237 (236.5) and 2,760 (2,759.5) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 25% displacement and 1% mortality, the estimated displacement consequent mortality is 394 (394.2) individuals per annum, of which the proposed development contributes 79 (78.9) mortalities.

Based on the largest regional population size of 1,332,623 individuals (Table 15.17) and a baseline mortality of 179,856 individuals per annum (based on an average mortality rate of 0.135; Table 15.18), the addition of 394 displacement consequent mortalities would represent a 0.219% increase in baseline mortality. Considering the biogeographic population size of 4,125,000, with a baseline mortality of 556,727 individuals per annum, the addition of 290 displacement consequent mortalities would represent a 0.071% increase in baseline mortality. Likely significant effects based on 15% to 35% displacement and 1% to 5% mortality, and based on the Furness approach to apportioning, are presented in Table 15.68 below.

At both the regional population and biogeographic population scales, the cumulative impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement for all tier projects would be low (Table 15.7).

Table 15.68 Predicted cumulative annual displacement impacts on guillemot from the proposed development during the construction phase for all tier projects

Bio-season (months)	Cumulative mean peak abundance (array plus 2km buffer)	Estimated mortality		Percentage increase in baseline mortality	
		25% displacement, 1% mortality	**15% to 35% displacement, 1% to 5% mortality**	**25% displacement, 1% mortality**	**15% to 35% displacement, 1% to 5% mortality**
Project approach to bio-seasons					
Annual (regional)	157,687	394.2	236.5 – 2,759.5	0.219	0.132 – 1.534
Annual (biogeographic)	157,687	394.2	236.5 – 2,759.5	0.071	0.042 – 0.496
Furness approach to bio-seasons					
Annual (regional)	169,577	423.9	254.4 – 2,967.6	0.236	0.141 – 1.650
Annual (biogeographic)	169,577	423.9	254.4 – 2,967.6	0.076	0.046 – 0.533

Significance of the effect (array area)
Overall, it is predicted that the sensitivity of guillemot for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is low. The medium sensitivity and low magnitude of the impact on guillemot results in a slight effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

15.9.5.2 Razorbill

Sensitivity of razorbills
As outlined in Section 15.5, razorbills have an overall sensitivity of medium and are assessed using a displacement rate of 25% and a mortality rate of 1%, with a range of 15% to 35% displacement and 1% to 5% mortality also presented.

Tier 1
No Tier 1 projects have been scoped into the offshore and intertidal ornithology cumulative effects assessment.

Tier 1 and 2

Magnitude of impact
The estimated annual mean peak abundance of razorbill from relevant projects in the array area plus 2km buffer is presented in Table 15.69 below.

Table 15.69 Razorbill cumulative abundance totals for tier 1 and 2 projects during the construction phase

Project	Annual total cumulative abundance
Phase one projects	20,980
The proposed development	6,101
Total	**27,081**

The cumulative annual total abundance of razorbills is 27,081 individuals. Based on 15% to 35% displacement and 1% to 5% mortality, between 41 (40.6) and 474 (473.9) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 25% displacement and 1% mortality, the estimated displacement consequent mortality is 68 (67.7) individuals per annum, of which the proposed development contributes 15 (15.2) mortalities.

Based on the largest regional population size of 632,453 individuals (Table 15.17) and a baseline mortality of 81,866 individuals per annum (based on an average mortality rate of 0.129; Table 15.18), the addition of 68 displacement consequent mortalities would represent a 0.083% increase in baseline mortality. Considering the biogeographic population size of 1,707,000, with a baseline mortality of 220,957 individuals per annum, the addition of 95 displacement consequent mortalities would represent a 0.031% increase in baseline mortality. Likely significant effects based on 15% to 35% displacement and 1% to 5% mortality are presented in Table 15.70 below.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement for tier 1 and 2 projects would be low (Table 15.7).

Table 15.70 Predicted cumulative annual displacement impacts on razorbill from the proposed development during the construction phase for tier 1 and 2 projects

Bio-season (months)	Cumulative mean peak abundance (array plus 2km buffer)	Estimated mortality		Percentage increase in baseline mortality	
		25% displacement, 1% mortality	15% to 35% displacement, 1% to 5% mortality	25% displacement, 1% mortality	15% to 35% displacement, 1% to 5% mortality
Annual (regional)	27,081	67.7	40.6 – 473.9	0.083	0.050–0.579
Annual (biogeographic)	27,081	67.7	40.6 – 473.9	0.031	0.018–0.214

It should be noted that the impact estimates within the cumulative assessment were calculated from the more precautionary design-based abundances. If model-based estimates were to be used (see MRSea Modelling Report), then the cumulative mean peak abundance would be over one thousand birds fewer, giving rise to smaller estimated mortalities and predicted impacts on the population.

Significance of the effect

Overall, it is predicted that the sensitivity of razorbill for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is low. The medium sensitivity and low magnitude of the impact on razorbill results in a slight effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Tier 1, 2 and 3 (All tiers)

Magnitude of impact

The estimated annual mean peak abundance of razorbill from relevant projects in the array area plus 2km buffer is presented in Table 15.71 below.

Table 15.71 Razorbill cumulative abundance totals for all tier projects during the construction phase

Project	Annual total cumulative abundance
Awel-y-Mor	692
Erebus	3,867
Morgan	622
Morecambe	1,881
Mona	2,883
White Cross	786
Phase one projects	20,980
Total (without the proposed development)	**31,711**
The proposed development	6,101
Total (with the proposed development)	**37,812**

The cumulative annual total abundance of razorbills is 37,812 individuals. Based on 15% to 35% displacement and 1% to 5% mortality, between 57 (56.7) and 662 (661.7) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 25% displacement and 1% mortality, the estimated displacement consequent mortality is 95 (94.5) individuals per annum, of which the proposed development contributes 15 (15.3) mortalities.

Based on the largest regional population size of 632,453 individuals (Table 15.17) and a baseline mortality of 81,866 individuals per annum (based on an average mortality rate of 0.129; Table 15.18), the addition of 95 displacement consequent mortalities would represent a 0.115% increase in baseline mortality.

Considering the biogeographic population size of 1,707,000, with a baseline mortality of 220,957 individuals per annum, the addition of 95 displacement consequent mortalities would represent a 0.018% increase in baseline mortality. Likely significant effects based on 15% to 35% displacement and 1% to 5% mortality are presented in Table 15.72 below.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement for all tier projects would be low (Table 15.7).

Table 15.72 Predicted cumulative annual displacement impacts on razorbill from the proposed development during the construction phase for all tier projects

Bio-season (months)	Cumulative mean peak abundance (array plus 2km buffer)	Estimated mortality		Percentage increase in baseline mortality	
		25% displacement, 1% mortality	15% to 35% displacement, 1% to 5% mortality	25% displacement, 1% mortality	15% to 35% displacement, 1% to 5% mortality
Annual (regional)	37,812	94.5	56.7 – 661.7	0.115	0.069–0.808
Annual (biogeographic)	37,812	94.5	56.7 – 661.7	0.018	0.011–0.127

Significance of the effect

Overall, it is predicted that the sensitivity of razorbill for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is low. The medium sensitivity and low magnitude of the impact on razorbill results in a slight effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

15.9.5.3 Puffin

Sensitivity of puffins

As outlined in Section 15.5, puffins have an overall sensitivity of medium, and are assessed using a displacement rate of 25% and a mortality rate of 1%, with a range of 15% to 35% displacement and 1% to 5% mortality also presented.

Tier 1

No Tier 1 projects have been scoped into the offshore and intertidal ornithology cumulative effects assessment.

Tier 1 and 2

Magnitude of impact

The estimated annual mean peak abundance of puffin from relevant projects in the array area plus 2km buffer is presented in Table 15.73 below.

Table 15.73 Puffin cumulative abundance totals for tier 1 and 2 projects during the construction phase

Project	Annual total cumulative abundance
Phase one projects	231
The proposed development	22
Total	253

The cumulative annual total abundance of puffins is 253 individuals. Based on 15% to 35% displacement and 1% to 5% mortality, between less than one (0.4) and four (4.4) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 25% displacement and 1% mortality, the estimated displacement consequent mortality is one (0.6) individuals per annum, of which the proposed development contributes less than one (0.1) mortalities.

Based on the largest regional population size of 300,427 individuals (Table 15.17) and a baseline mortality of 52,799 individuals per annum (based on an average mortality rate of 0.176; Table 15.18), the addition of one displacement consequent mortality would represent a 0.001% increase in baseline mortality. Considering the biogeographic population size of 11,840,000, with a baseline mortality of 2,080,856 individuals per annum, the addition of five displacement consequent mortalities would represent a 0.000% increase in baseline mortality. Likely significant effects based on 15% to 35% displacement and 1% to 5% mortality are presented in Table 15.74 below.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement for tier 1 and 2 projects would be low (Table 15.7).

Table 15.74 Predicted cumulative annual displacement impacts on puffin from the proposed development during the construction phase for Phase one and 2 projects

Bio-season (months)	Cumulative mean peak abundance (array plus 2km buffer)	Estimated mortality		Percentage increase in baseline mortality	
		25% displacement, 1% mortality	15% to 35% displacement, 1% to 5% mortality	25% displacement, 1% mortality	15% to 35% displacement, 1% to 5% mortality
Annual (regional)	253	0.6	0.4 – 4.4	0.001	0.001 – 0.008
Annual (biogeographic)	253	0.6	0.4 – 4.4	0.000	0.000 – 0.000

Significance of the effect

Overall, it is predicted that the sensitivity of puffin for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on puffin results in an imperceptible effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Tier 1, 2 and 3 (All tiers)

Magnitude of impact

The estimated annual mean peak abundance of puffin from relevant projects in the array area plus 2km buffer is presented in Table 15.75 below.

Table 15.75 Puffin cumulative abundance totals for all tier projects during the construction phase

Project	Annual total cumulative abundance
Awel-y-Mor	16
Erebus	1,576
Morgan	18
Morecambe	28
Mona	30
White Cross	80
Phase one projects	231

Project	Annual total cumulative abundance
Total (without the proposed development)	**1,979**
The proposed development	22
Total (with the proposed development)	**2,001**

The cumulative annual total abundance of puffins is 2,001 individuals. Based on 15% to 35% displacement and 1% to 5% mortality, between three (3.0) and 35 (35.0) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 25% displacement and 1% mortality, the estimated displacement consequent mortality is five (5.0) individuals per annum, of which the proposed development contributes less than one (0.1) mortalities.

Based on the largest regional population size of 300,427 individuals (Table 15.17) and a baseline mortality of 52,799 individuals per annum (based on an average mortality rate of 0.176; Table 15.18), the addition of five displacement consequent mortalities would represent a 0.009% increase in baseline mortality. Considering the biogeographic population size of 11,840,000, with a baseline mortality of 2,080,856 individuals per annum, the addition of five displacement consequent mortalities would represent a 0.000% increase in baseline mortality. Likely significant effects based on 15% to 35% displacement and 1% to 5% mortality are presented in Table 15.76 below.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement would be negligible (Table 15.7).

Table 15.76 Predicted cumulative annual displacement impacts on puffin from the proposed development during the construction phase for all tier projects

Bio-season (months)	Cumulative mean peak abundance (array plus 2km buffer)	Estimated mortality		Percentage increase in baseline mortality	
		25% displacement, 1% mortality	**15% to 35% displacement, 1% to 5% mortality**	**25% displacement, 1% mortality**	**15% to 35% displacement, 1% to 5% mortality**
Annual (regional)	2,001	5.0	3.0 – 35.0	0.009	0.006–0.066
Annual (biogeographic)	2,001	5.0	3.0 – 35.0	0.000	0.000–0.001

Significance of the effect

Overall, it is predicted that the sensitivity of puffin for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on puffin results in an imperceptible effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Manx shearwater

Sensitivity of Manx shearwaters

As outlined in Section 15.5, Manx shearwater have an overall sensitivity of medium, and are assessed using a displacement rate of 5% and a mortality rate of 1%.

Tier 1

No Tier 1 projects have been scoped into the offshore and intertidal ornithology cumulative effects assessment.

Tier 1 and 2

Magnitude of impact

The estimated annual mean peak abundance of Manx shearwater from relevant projects in the array area plus 2km buffer is presented in Table 15.70 below.

Table 15.77 Manx shearwater cumulative abundance totals for tier 1 and 2 projects during the construction phase

Project	Annual total cumulative abundance
Phase one projects	2,085
The proposed development	4,544
Total	6,629

The cumulative annual total abundance of Manx shearwaters is 6,629 individuals. Based on 5% displacement and 1% mortality, three (3.3) individuals are predicted to be at risk of displacement consequent mortality per annum, of which the proposed development contributes two (2.3) mortalities.

Based on the largest regional population size of 2,121,049 individuals (Table 15.17) and a baseline mortality of 273,891 individuals per annum (based on an average mortality rate of 0.129; Table 15.17), the addition of three displacement consequent mortalities would represent a 0.001% increase in baseline mortality. Considering the biogeographic population size of 2,000,000, with a baseline mortality of 258,260 individuals per annum, the addition of three displacement consequent mortalities would represent a 0.001% increase in baseline mortality.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement for tier 1 and 2 projects would be low (Table 15.7).

Significance of the effect

Overall, it is predicted that the sensitivity of Manx shearwater for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on Manx shearwater results in an imperceptible effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Tiers 1, 2 and 3 (All tiers)

Magnitude of impact

The estimated annual mean peak abundance of Manx shearwater from relevant projects in the array area plus 2km buffer is presented in Table 15.78 below.

Table 15.78 Manx shearwater cumulative abundance totals for all tier projects during the construction phase

Project	Annual total cumulative abundance
Awel-y-Mor	417
Erebus	2,115
Morgan	993
Morecambe	7,583
Mona	2,232
White Cross	12,181
Phase one projects	2,085

Project	Annual total cumulative abundance
Total (without the proposed development)	**27,606**
The proposed development	4,544
Total (with the proposed development)	**32,150**

The cumulative annual total abundance of Manx shearwaters is 32,150 individuals. Based on 5% displacement and 1% to 5% mortality, 16 (16.1) individuals are predicted to be at risk of displacement consequent mortality per annum, of which the proposed development contributes two (2.3) mortalities.

Based on the largest regional population size of 2,121,049 individuals (Table 15.17) and a baseline mortality of 273,891 individuals per annum (based on an average mortality rate of 0.129; Table 15.17), the addition of 16 displacement consequent mortalities would represent a 0.006% increase in baseline mortality. Considering the biogeographic population size of 2,000,000, with a baseline mortality of 258,260 individuals per annum, the addition of 16 displacement consequent mortalities would represent a 0.006% increase in baseline mortality.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement for all tier projects would be low (Table 15.7).

Significance of the effect

Overall, it is predicted that the sensitivity of Manx shearwater for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on Manx shearwater results in an imperceptible effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Gannet

Sensitivity of gannets

As outlined in Section 15.5, gannets have an overall sensitivity of medium, and are assessed using a displacement rate of 35% and a mortality rate of 1%, with a range of 30% to 40% displacement also presented.

Tier 1

No Tier 1 projects have been scoped into the offshore and intertidal ornithology cumulative effects assessment.

Tier 1 and 2

Magnitude of impact

The estimated annual mean peak abundance of razorbill from relevant projects in the array area plus 2km buffer is presented in Table 15.79 below.

Table 15.79 Gannet cumulative abundance totals for tier 1 and 2 projects during the construction phase

Project	Annual total cumulative abundance
Phase one projects	1,894
The proposed development	582
Total	**2,476**

The cumulative annual total abundance of gannets is 2,476 individuals. Based on 30% to 40% displacement and 1% mortality, between seven (7.4) and ten (9.9) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 35% displacement and 1% mortality, the estimated displacement consequent mortality is nine (8.7) individuals per annum, of which the proposed development contributes two (2.0) mortalities.

Based on the largest regional population size of 643,917 individuals (Table 15.17) and a baseline mortality of 116,984 individuals per annum (based on an average mortality rate of 0.186; Table 15.18), the addition of nine displacement consequent mortalities would represent a 0.007% increase in baseline mortality. Considering the biogeographic population size of 1,180,000, with a baseline mortality of 214,377 individuals per annum, the addition of 22 displacement consequent mortalities would represent a 0.004% increase in baseline mortality. Likely significant effects based on 30% to 40% displacement and 1% mortality are presented in Table 15.80 below.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement for tier 1 and 2 projects would be low (Table 15.7).

Table 15.80 Predicted cumulative annual displacement impacts on gannet from the proposed development during the construction phase for tier 1 and 2 projects

Bio-season (months)	Cumulative mean peak abundance (array plus 2km buffer)	Estimated mortality		Percentage increase in baseline mortality	
		35% displacement, 1% mortality	**30% to 40% displacement, 1% mortality**	**35% displacement, 1% mortality**	**30% to 40% displacement, 1% mortality**
Annual (regional)	2,476	8.7	7.4 – 9.9	0.007	0.006 – 0.008
Annual (biogeographic)	2,476	8.7	7.4 – 9.9	0.004	0.003 – 0.005

Significance of the effect

Overall, it is predicted that the sensitivity of gannet for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on gannet results in an imperceptible effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Tier 1 , 2 and 3 (All tiers)

Magnitude of impact

The estimated annual mean peak abundance of gannets from relevant projects in the array area plus 2km buffer is presented in Table 15.81below.

Table 15.81 Gannet cumulative abundance totals for all tier projects during the construction phase

Project	Annual total cumulative abundance
Awel-y-Mor	528
Erebus	658
Morgan	454
Morecambe	912
Mona	693
White Cross	456
Phase one projects	1,894

Project	Annual total cumulative abundance
Total (without the proposed development)	**5,595**
The proposed development	582
Total (with the proposed development)	**6,177**

The cumulative annual total abundance of gannets is 6,177 individuals. Based on 30% to 40% displacement and 1% mortality, between 19 (18.5) and 25 (24.7) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 35% displacement and 1% mortality, the estimated displacement consequent mortality is 22 (21.6) individuals per annum, of which the proposed development contributes two (2.0) mortalities.

Based on the largest regional population size of 643,917 individuals (Table 15.17) and a baseline mortality of 116,984 individuals per annum (based on an average mortality rate of 0.186; Table 15.18), the addition of 22 displacement consequent mortalities would represent a 0.018% increase in baseline mortality. Considering the biogeographic population size of 1,180,000, with a baseline mortality of 214,377 individuals per annum, the addition of 22 displacement consequent mortalities would represent a 0.006% increase in baseline mortality. Likely significant effects based on 30% to 40% displacement and 1% mortality are presented in Table 15.82 below. At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement for all tier projects would be low (Table 15.7).

Table 15.82 Predicted cumulative annual displacement impacts on gannet from the proposed development during the construction phase for all tier projects

Bio-season (months)	Cumulative mean peak abundance (array plus 2km buffer)	Estimated mortality		Percentage increase in baseline mortality	
		35% displacement, 1% mortality	**30% to 40% displacement, 1% mortality**	**35% displacement, 1% mortality**	**30% to 40% displacement, 1% mortality**
Annual (regional)	6,177	21.6	18.5 – 24.7	0.018	0.016 – 0.021
Annual (biogeographic)	6,177	21.6	18.5 – 24.7	0.006	0.005 – 0.007

Significance of the effect

Overall, it is predicted that the sensitivity of gannet for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on gannet results in an imperceptible effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

15.9.6 Cumulative Impact 2: Disturbance and displacement (operational phase)

Due to the presence of WTGs and operational and maintenance activities associated with the proposed development and other projects, there is potential for cumulative disturbance and displacement effects. For the cumulative displacement assessment, only projects within Tiers 1, 2 and 3a were considered, with projects earlier in the planning process lacking publicly available impact estimates. Similarly, for older projects abundance data is often not broken down into seasonal abundances, and therefore the cumulative effects assessment is undertaken using annual totals only.

For the Burbo Bank Extension and Walney Extension, abundance data for the displacement assessment was extracted from the project Environmental Statements (DONG Energy, 2013a, 2013b). It should be noted that abundance data used from these projects is considered highly precautionary since abundance estimates are presented for the array area plus 4km buffer only (as opposed to the array area plus 2km buffer which is considered relevant for the displacement assessment). This results in considerably higher abundance estimates and consequent impacts for these projects than are considered relevant.

Guillemot

Sensitivity of guillemots

As outlined in Section 15.5, guillemots have an overall sensitivity of medium, and are assessed using a displacement rate of 50% and a mortality rate of 1%, with a range of 30% to 70% displacement and 1% to 5% mortality also presented.

As outlined in Table 15.14, two bio-season approaches are considered for guillemot, with a more ecologically relevant project approach forming the main basis of the assessment, and results based on the Furness approach used for other species also presented.

Tier 1

No Tier 1 projects have been scoped into the offshore and intertidal ornithology cumulative effects assessment.

Tier 1 and 2

Magnitude of impact

The estimated annual mean peak abundance of guillemot from relevant projects in the array area plus 2km buffer is presented in Table 15.83 below.

Table 15.83 Guillemot cumulative abundance totals for tier 1 and 2 projects during the operational phase

Project	Annual total cumulative abundance
Phase one projects	49,316
The proposed development (project approach to bio-seasons)	31,578
The proposed development (Furness approach to bio-seasons)	43,468
Total (with the proposed development) – project approach to bio-seasons	80,894
Total (with the proposed development) – Furness approach to bio-seasons	92,784

The cumulative annual total abundance of guillemots is 80,894 individuals. Based on 30% to 70% displacement and 1% to 5% mortality, between 243 (242.7) and 2,831 (2,831.3) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 50% displacement and 1% mortality, the estimated displacement consequent mortality is 405 (404.5) individuals per annum, of which the proposed development contributes 158 (157.9) individuals.

Based on the largest regional population size of 1,332,623 individuals (Table 15.17) and a baseline mortality of 179,856 individuals per annum (based on an average mortality rate of 0.135; Table 15.18), the addition of 405 displacement consequent mortalities would represent a 0.225% increase in baseline mortality. Considering the biogeographic population size of 4,125,000, with a baseline mortality of 556,727 individuals per annum, the addition of 405 displacement consequent mortalities would represent a 0.073% increase in baseline mortality. Likely significant effects based on 30% to 70% displacement and 1% to 5% mortality are presented in Table 15.84 below.

At both the regional population and biogeographic population scales, the cumulative impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement for tier 1 and 2 projects would be low (Table 15.7).

Table 15.84 Predicted cumulative annual displacement impacts on guillemot from the proposed development during the operational phase for tier 1 and 2 projects

Bio-season (months)	Cumulative mean peak abundance (array plus 2km buffer)	Estimated mortality		Percentage increase in baseline mortality	
		50% displacement, 1% mortality	**30% to 70% displacement, 1% to 5% mortality**	**50% displacement, 1% mortality**	**30% to 70% displacement, 1% to 5% mortality**
Project approach to bio-seasons					
Annual (regional)	80,894	404.5	242.7 – 2,831.3	0.225	0.135 – 1.574
Annual (biogeographic)	80,894	404.5	242.7 – 2,831.3	0.073	0.044 – 0.509
Furness approach to bio-seasons					
Annual (regional)	92,784	463.9	278.4 – 3,247.4	0.258	0.155 – 1.806
Annual (biogeographic)	92,784	463.9	278.4 – 3,247.4	0.083	0.050 – 0.583

Significance of the effect

Overall, it is predicted that the sensitivity of guillemot for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is low. The medium sensitivity and low magnitude of the impact on guillemot results in a slight effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Tier 1, 2 and 3 (All tiers)

Magnitude of impact

The estimated annual mean peak abundance of guillemot from relevant projects in the array area plus 2km buffer is presented in Table 15.85 below. It should be noted that for the Burbo Bank Extension and Walney Extension projects, data was only provided within the 4km buffer. The total mean peak abundance is therefore an overestimate of actual mean peak abundance across the projects and is considered a precautionary approach.

Table 15.85 Guillemot cumulative abundance totals for all tier projects

Project	Annual total cumulative abundance
Awel-y-Mor	4,488
Gwynt y Mor	-
Rhyl Flats	-
Burbo Bank Extension	3,448
North Hoyle	-
Walney Extension 3 + 4	6,093
West of Duddon Sands	833
Walney 2	-
Walney 1	-

Project	Annual total cumulative abundance
Burbo Bank	-
Ormonde	238
Barrow	28
Robin Rigg	-
Arklow Bank Phase one	-
Twin Hub	-
Erebus	35,339
Morgan	8,994
Morecambe	11,697
Mona	11,912
White Cross	4,363
Phase one projects	49,316
Total (without the proposed development)	136,749
The proposed development (project approach to bio-seasons)	31,578
The proposed development (Furness approach to bio-seasons)	43,468
Total (with the proposed development) - project approach to bio-seasons	168,327
Total (with the proposed development) - Furness approach to bio-seasons	180,217

It should be noted that the impact estimates within the cumulative assessment were calculated from the more precautionary design-based abundances. If model-based estimates were to be used (see MRSea Modelling Report), then the cumulative mean peak abundance would be over 14,000 birds fewer, giving rise to lower estimated mortalities and predicted impacts on the population.

The cumulative annual total abundance of guillemots is 168,327 individuals. Based on 30% to 70% displacement and 1% to 5% mortality, between 505 (505.0) and 5,891 (5,891.4) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 50% displacement and 1% mortality, the estimated displacement consequent mortality is 842 (841.6) individuals per annum, of which the proposed development contributes 158 (157.9) individuals.

Based on the largest regional population size of 1,332,623 individuals (Table 15.17) and a baseline mortality of 179,856 individuals per annum (based on an average mortality rate of 0.135; Table 15.18), the addition of 842 displacement consequent mortalities would represent a 0.468% increase in baseline mortality. Considering the biogeographic population size of 4,125,000, with a baseline mortality of 556,727 individuals per annum, the addition of 842 displacement consequent mortalities would represent a 0.151% increase in baseline mortality. Likely significant effects based on 30% to 70% displacement and 1% to 5% mortality are presented in Table 15.86 below. Results are also presented in a matrix in Table 15.87.

At both the regional population and biogeographic population scales, the cumulative impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement for all tier projects would be low (Table 15.7).

Significance of the effect

Overall, it is predicted that the sensitivity of guillemot for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is low. The medium sensitivity and low magnitude of the impact on guillemot results in a slight effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Table 15.86 Predicted cumulative annual displacement impacts on guillemot from the proposed development during the operational phase for all tier projects

Bio-season (months)	Cumulative mean peak abundance (array plus 2km buffer)	Estimated mortality		Percentage increase in baseline mortality	
		50% displacement, 1% mortality	**30% to 70% displacement, 1% to 5% mortality**	**50% displacement, 1% mortality**	**30% to 70% displacement, 1% to 5% mortality**
Project approach to bio-seasons					
Annual (regional population)	168,327	841.6	505.0 – 5,891.4	0.468	0.281 – 3.276
Annual (biogeographic)	168,327	841.6	505.0 – 5,891.4	0.151	0.091– 1.058
Furness approach to bio-seasons					
Annual (regional population)	180,217	901.1	540.7 – 6,307.6	0.501	0.301 – 3.507
Annual (biogeographic)	180,217	901.1	540.7 – 6,307.6	0.162	0.097 – 1.133

Table 15.87 Annual cumulative displacement matrix for guillemot within the array area plus 2km buffer, values in light grey represent the range-based values based on best practice and the darker shade of grey representing the main approach value

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	168	337	842	1,683	3,367	5,050	6,733	8,416	10,100	11,783	13,466	15,149	16,833
20	337	673	1,683	3,367	6,733	10,100	13,466	16,833	20,199	23,566	26,932	30,299	33,665
30	505	1,010	2,525	5,050	10,100	15,149	20,199	25,249	30,299	35,349	40,398	45,448	50,498
40	673	1,347	3,367	6,733	13,466	20,199	26,932	33,665	40,398	47,132	53,865	60,598	67,331
50	842	1,683	4,208	8,416	16,833	25,249	33,665	42,082	50,498	58,914	67,331	75,747	84,164
60	1,010	2,020	5,050	10,100	20,199	30,299	40,398	50,498	60,598	70,697	80,797	90,897	100,996
70	1,178	2,357	5,891	11,783	23,566	35,349	47,132	58,914	70,697	82,480	94,263	106,046	117,829
80	1,347	2,693	6,733	13,466	26,932	40,398	53,865	67,331	80,797	94,263	107,729	121,195	134,662
90	1,515	3,030	7,575	15,149	30,299	45,448	60,598	75,747	90,897	106,046	121,195	136,345	151,494
100	1,683	3,367	8,416	16,833	33,665	50,498	67,331	84,164	100,996	117,829	134,662	151,494	168,327

Razorbill

Sensitivity of razorbills

As outlined in Section 15.5, razorbills have an overall sensitivity of medium, and are assessed using a displacement rate of 50% and a mortality rate of 1%, with a range of 30% to 70% displacement and 1% to 5% mortality also presented.

Tier 1

No Tier 1 projects have been scoped into the offshore and intertidal ornithology cumulative effects assessment.

Tier 1 and 2

Magnitude of impact

The estimated annual mean peak abundance of razorbill from relevant projects in the array area plus 2km buffer is presented in Table 15.88 below.

Table 15.88 Razorbill cumulative abundance totals for tier 1 and 2 projects during the operational phase

Project	Annual total cumulative abundance
Phase one projects	20,980
The proposed development	6,101
Total	**27,081**

The cumulative annual total abundance of razorbills is 27,081 individuals. Based on 30% to 70% displacement and 1% to 5% mortality, between 81 (81.2) and 948 (947.8) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 50% displacement and 1% mortality, the estimated displacement consequent mortality is 135 (135.4) individuals per annum, of which the proposed development contributes 31 (30.5) individuals.

Based on the largest regional population size of 632,453 individuals (Table 15.17) and a baseline mortality of 81,866 individuals per annum (based on an average mortality rate of 0.129; Table 15.18), the addition of 135 displacement consequent mortalities would represent a 0.165% increase in baseline mortality. Considering the biogeographic population size of 1,707,000, with a baseline mortality of 220,957 individuals per annum, the addition of 165 displacement consequent mortalities would represent a 0.061% increase in baseline mortality. Likely significant effects based on 30% to 70% displacement and 1% to 5% mortality are presented in Table 15.89 below.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement for tier 1 and 2 projects would be low (Table 15.7).

Table 15.89 Predicted cumulative annual displacement impacts on razorbill from the proposed development during the operational phase for tier 1 and 2 projects

Bio-season (months)	Cumulative mean peak abundance (array plus 2km buffer)	Estimated mortality		Percentage increase in baseline mortality	
		50% displacement, 1% mortality	30% to 70% displacement, 1% to 5% mortality	50% displacement, 1% mortality	30% to 70% displacement, 1% to 5% mortality
Annual (regional)	27,081	135.4	81.2 – 947.8	0.165	0.099 – 1.158
Annual (biogeographic)	27,081	135.4	81.2 – 947.8	0.061	0.037 – 0.429

Significance of the effect

Overall, it is predicted that the sensitivity of razorbill for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is low. The medium sensitivity and low magnitude of the impact on razorbill results in a slight effect, which is not significant in EIA terms based on the matrix approach in Table 15 9.

Tier 1, 2 and 3 (All tiers)

Magnitude of impact

The estimated annual mean peak abundance of razorbills from relevant projects in the array area plus 2km buffer is presented in Table 15.90 below. It should be noted that for the Burbo Bank Extension and Walney Extension projects, data was only provided within the 4km buffer. The total mean peak abundance is therefore an overestimate of actual mean peak abundance across the projects and is considered a precautionary approach.

Table 15.90 Razorbill cumulative abundance totals for all tier projects

Project	Annual total cumulative abundance
Awel-y-Mor	692
Gwynt y Mor	-
Rhyl Flats	-
Burbo Bank Extension	93
North Hoyle	2,354
Walney Extension 3 + 4	9,933
West of Duddon Sands	-
Walney 1 + 2	-
Burbo Bank	-
Ormonde	-
Barrow	-
Robin Rigg	-
Arklow Bank Phase one	-
Twin Hub	-
Erebus	3,867
Morgan	622
Morecambe	1,881
Mona	2,883
White Cross	786
Phase one projects	20,980
Total (without the proposed development)	44,091
The proposed development	6,101
Total (with the proposed development)	50,192

It should be noted that the impact estimates within the cumulative assessment were calculated from the more precautionary design-based abundances. If model-based estimates were to be used (see MRSea Modelling Report), then the cumulative mean peak abundance would be reduced by over one thousand birds, giving rise to smaller estimated mortalities and predicted impacts on the population.

The cumulative annual total abundance of razorbills is 50,192 individuals. Based on 30% to 70% displacement and 1% to 5% mortality, between 151 (150.6) and 1,757 (1,756.7) individuals are predicted to be at risk of displacement consequent mortality per annum.

Based on 50% displacement and 1% mortality, the estimated displacement consequent mortality is 251 (251.0) individuals per annum, of which the proposed development contributes 31 (30.5) individuals..

Based on the largest regional population size of 632,453 individuals (Table 15.17) and a baseline mortality of 81,866 individuals per annum (based on an average mortality rate of 0.129; Table 15.18), the addition of 251 displacement consequent mortalities would represent a 0.307% increase in baseline mortality. Considering the biogeographic population size of 1,707,000, with a baseline mortality of 220,957 individuals per annum, the addition of 251 displacement consequent mortalities would represent a 0.114% increase in baseline mortality. Likely significant effects based on 30% to 70% displacement and 1% to 5% mortality are presented in Table 15.91 below. Results are also presented in a matrix in Table 15.92 .

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement for all tier projects would be low (Table 15.7).

Significance of the effect

Overall, it is predicted that the sensitivity of razorbill for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is low. The medium sensitivity and low magnitude of the impact on razorbill results in a slight effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Table 15.91 Predicted cumulative annual displacement impacts on razorbill from the proposed development during the operational phase for all tier projects

Bio-season (months)	Cumulative mean peak abundance (array plus 2km buffer)	Estimated mortality		Percentage increase in baseline mortality	
		50% displacement, 1% mortality	30% to 70% displacement, 1% to 5% mortality	50% displacement, 1% mortality	30% to 70% displacement, 1% to 5% mortality
Annual (regional population)	50,192	251.0	150.6 – 1,756.7	0.307	0.184 – 2.146
Annual (biogeographic)	50,192	251.0	150.6 – 1,756.7	0.114	0.068 – 0.795

Table 15.92 Annual cumulative displacement matrix for razorbill within the array area plus 2km buffer, values in light grey represent the range-based values based on best practice and the darker shade of grey representing the main approach value

	Mortality Rate (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	50	100	251	502	1,004	1,506	2,008	2,510	3,012	3,513	4,015	4,517	5,019
20	100	201	502	1,004	2,008	3,012	4,015	5,019	6,023	7,027	8,031	9,035	10,038
30	151	301	753	1,506	3,012	4,517	6,023	7,529	9,035	10,540	12,046	13,552	15,058
40	201	402	1,004	2,008	4,015	6,023	8,031	10,038	12,046	14,054	16,061	18,069	20,077
50	251	502	1,255	2,510	5,019	7,529	10,038	12,548	15,058	17,567	20,077	22,586	25,096
60	301	602	1,506	3,012	6,023	9,035	12,046	15,058	18,069	21,081	24,092	27,104	30,115
70	351	703	1,757	3,513	7,027	10,540	14,054	17,567	21,081	24,594	28,108	31,621	35,134
80	402	803	2,008	4,015	8,031	12,046	16,061	20,077	24,092	28,108	32,123	36,138	40,154
90	452	903	2,259	4,517	9,035	13,552	18,069	22,586	27,104	31,621	36,138	40,656	45,173
100	502	1,004	2,510	5,019	10,038	15,058	20,077	25,096	30,115	35,134	40,154	45,173	50,192

Puffin

Sensitivity of puffins

As outlined in Section 15.5, puffins have an overall sensitivity of medium, and are assessed using a displacement rate of 50% and a mortality rate of 1%, with a range of 30% to 70% displacement and 1% to 5% mortality also presented.

Tier 1

No Tier 1 projects have been scoped into the offshore and intertidal ornithology cumulative effects assessment.

Tier 1 and 2

Magnitude of impact

The estimated annual mean peak abundance of razorbill from relevant projects in the array area plus 2km buffer is presented in Table 15.93 below.

Table 15.93 Puffin cumulative abundance totals for tier 1 and 2 projects during the operational phase

Project	Annual total cumulative abundance
Phase one projects	231
The proposed development	22
Total	**253**

The cumulative annual total abundance of puffins is 253. Based on 30% to 70% displacement and 1% to 5% mortality, between one (0.8) and nine (8.9) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 50% displacement and 1% mortality, the estimated displacement consequent mortality is one (1.3) individuals per annum, of which the proposed development contributes less than one (0.1) individual.

Based on the largest regional population size of 300,427 individuals (Table 15.17) and a baseline mortality of 52,799 individuals per annum (based on an average mortality rate of 0.176; Table 15.18), the addition of one displacement consequent mortalities would represent a 0.002% increase in baseline mortality. Considering the biogeographic population size of 11,840,000, with a baseline mortality of 2,080,856 individuals per annum, the addition of one displacement consequent mortality would represent a 0.000% increase in baseline mortality. Likely significant effects based on 30% to 70% displacement and 1% to 5% mortality are presented in Table 15.95 below. Results are also presented in a matrix in Table 15.96 .

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement for tier 1 and 2 projects would be low (Table 15.7).

Significance of the effect

Overall, it is predicted that the sensitivity of puffin for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on puffin results in an imperceptible effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Tier 1,2 and 3 (All tiers)

Magnitude of impact

The estimated annual mean peak abundance of puffins from relevant projects in the array area plus 2km buffer is presented in Table 15.94 below. It should be noted that for the Burbo Bank Extension and Walney Extension projects, data was only provided within the 4km buffer. The total mean peak abundance is therefore an overestimate of actual mean peak abundance across the projects and is considered a precautionary approach.

Table 15.94 Puffin cumulative abundance totals for all tier projects

Project	Annual total cumulative abundance
Awel-y-Mor	16
Gwynt y Mor	-
Rhyl Flats	-
Burbo Bank Extension	493
North Hoyle	-
Walney Extension 3 + 4	561
West of Duddon Sands	-
Walney 1 + 2	-
Burbo Bank	-
Ormonde	-
Barrow	-
Robin Rigg	-
Arklow Bank Phase one	-
Twin Hub	-
Erebus	1,576
Morgan	18
Morecambe	28
Mona	30
White Cross	80
Phase one projects	231
Total (without the proposed development)	**3,033**
The proposed development	22
Total (with the proposed development)	**3,055**

The cumulative annual total abundance of puffins is 3,055. Based on 30% to 70% displacement and 1% to 5% mortality, between nine (9.2) and 107 (106.9) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 50% displacement and 1% mortality, the estimated displacement consequent mortality is 15 (15.3) individuals per annum, of which the proposed development contributes less than one (0.1) individual.

Based on the largest regional population size of 300,427 individuals (Table 15.17) and a baseline mortality of 52,799 individuals per annum (based on an average mortality rate of 0.176; Table 15.18), the addition of 14 displacement consequent mortalities would represent a 0.029% increase in baseline mortality. Considering the biogeographic population size of 11,840,000, with a baseline mortality of 2,080,856 individuals per annum, the addition of 15 displacement consequent mortalities would represent a 0.001% increase in baseline mortality. Likely significant effects based on 30% to 70% displacement and 1% to 5% mortality are presented in Table 15.95 below. Results are also presented in a matrix in Table 15.96 .

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement for all tier projects would be negligible (Table 15.7).

Significance of the effect

Overall, it is predicted that the sensitivity of puffin for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on puffin results in an imperceptible effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Table 15.95 Predicted cumulative annual displacement impacts on puffin from the proposed development during the operational phase for all tier projects

Bio-season (months)	Cumulative mean peak abundance (array plus 2km buffer)	Estimated mortality		Percentage increase in baseline mortality	
		50% displacement, 1% mortality	30% to 70% displacement, 1% to 5% mortality	50% displacement, 1% mortality	30% to 70% displacement, 1% to 5% mortality
Annual (regional population)	3,055	15.3	9.2 – 106.9	0.029	0.017 – 0.203
Annual (biogeographic)	3,055	15.3	9.2 – 106.9	0.001	0.000 – 0.005

Table 15.96 Annual cumulative displacement matrix for puffin within the array area plus 2km buffer, values in light grey represent the range-based values agreed with NPWS and the darker shade of grey representing the main approach value

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	3	6	15	31	61	92	122	153	183	214	244	275	306
20	6	12	31	61	122	183	244	306	367	428	489	550	611
30	9	18	46	92	183	275	367	458	550	642	733	825	917
40	12	24	61	122	244	367	489	611	733	855	978	1,100	1,222
50	15	31	76	153	306	458	611	764	917	1,069	1,222	1,375	1,528
60	18	37	92	183	367	550	733	917	1,100	1,283	1,466	1,650	1,833
70	21	43	107	214	428	642	855	1,069	1,283	1,497	1,711	1,925	2,139
80	24	49	122	244	489	733	978	1,222	1,466	1,711	1,955	2,200	2,444
90	27	55	137	275	550	825	1,100	1,375	1,650	1,925	2,200	2,475	2,750
100	31	61	153	306	611	917	1,222	1,528	1,833	2,139	2,444	2,750	3,055

Manx shearwater

Sensitivity of Manx shearwaters

As outlined in Section 15.5, Manx shearwaters have an overall sensitivity of medium, and are assessed using a displacement rate of 10% and a mortality rate of 1%.

Tier 1

No Tier 1 projects have been scoped into the offshore and intertidal ornithology cumulative effects assessment.

Tier 1 and 2

Magnitude of impact

The estimated annual mean peak abundance of Manx shearwater from relevant projects in the array area plus 2km buffer is presented in Table 15.97 below.

Table 15.97 Manx shearwater cumulative abundance totals for tier 1 and 2 projects during the operational phase

Project	Annual total cumulative abundance
Phase one projects	2,085
The proposed development	4,544
Total	**6,629**

The cumulative annual total abundance of Manx shearwaters is 6,629 individuals. Based on 10% displacement and 1% mortality, the estimated displacement consequent mortality is seven (6.6) individuals per annum, of which the proposed development contributes five (4.5) individuals.

Based on the largest relevant regional population size of 2,121,049 individuals (Table 15.17) and a baseline mortality of 273,891 individuals per annum (based on an average mortality rate of 0.129; Table 15.18), the addition of seven displacement consequent mortalities would represent a 0.002% increase in baseline mortality. Considering the biogeographic population size of 2,000,000, with a baseline mortality of 258,260 individuals per annum, the addition of 38 displacement consequent mortalities would represent a 0.003% increase in baseline mortality. Results are also presented in a matrix in Table 15.99.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent across all bio-seasons alone and combined represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement for tier 1 and 2 projects would be low (Table 15.7).

Significance of the effect

Overall, it is predicted that the sensitivity of Manx shearwater for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on Manx shearwater results in an imperceptible effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Tier 1, 2 and 3 (All tiers)

Magnitude of impact

The estimated annual mean peak abundance of Manx shearwaters from relevant projects in the array area plus 2km buffer is presented in Table 15.98 below. It should be noted that for the Burbo Bank Extension and Walney Extension projects, data was only provided within the 4km buffer.

The total mean peak abundance is therefore an overestimate of actual mean peak abundance across the projects and is considered a precautionary approach.

Table 15.98 Manx shearwater cumulative abundance totals for all tier projects

Project	Annual total cumulative abundance
Awel-y-Mor	417
Gwynt y Mor	-
Rhyl Flats	-
Burbo Bank Extension	2,937
North Hoyle	-
Walney Extension 3 + 4	2,674
West of Duddon Sands	-
Walney 1 + 2	-
Burbo Bank	-
Ormonde	-
Barrow	-
Robin Rigg	-
Arklow Bank Phase one	-
Twin Hub	-
Erebus	2,115
Morgan	993
Morecambe	7,583
Mona	2,232
White Cross	12,181
Phase one projects	2,085
Total (without the proposed development)	**33,217**
The proposed development	4,544
Total (with the proposed development)	**37,761**

The cumulative annual total abundance of Manx shearwaters is 37,761 individuals. Based on 10% displacement and 1% mortality, the estimated displacement consequent mortality is 38 (37.8) individuals per annum, of which the proposed development contributes five (4.5) individuals.

Based on the largest relevant regional population size of 2,121,049 individuals (Table 15.17) and a baseline mortality of 273,891 individuals per annum (based on an average mortality rate of 0.129; Table 15.18), the addition of 38 displacement consequent mortalities would represent a 0.014% increase in baseline mortality. Considering the biogeographic population size of 2,000,000, with a baseline mortality of 258,260 individuals per annum, the addition of 38 displacement consequent mortalities would represent a 0.015% increase in baseline mortality. Results are also presented in a matrix in Table 15.99.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent across all bio-seasons alone and combined represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement for all tier projects would be negligible (Table 15.7).

Significance of the effect

Overall, it is predicted that the sensitivity of Manx shearwater for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on Manx shearwater results in an imperceptible effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Table 15.99 Annual cumulative displacement matrix for Manx shearwater within the array area plus 2km buffer, values in light grey represent the range-based based on best practice and the darker shade of grey representing the main approach value

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	38	76	189	378	755	1,133	1,510	1,888	2,266	2,643	3,021	3,398	3,776
20	76	151	378	755	1,510	2,266	3,021	3,776	4,531	5,287	6,042	6,797	7,552
30	113	227	566	1,133	2,266	3,398	4,531	5,664	6,797	7,930	9,063	10,195	11,328
40	151	302	755	1,510	3,021	4,531	6,042	7,552	9,063	10,573	12,084	13,594	15,104
50	189	378	944	1,888	3,776	5,664	7,552	9,440	11,328	13,216	15,104	16,992	18,881
60	227	453	1,133	2,266	4,531	6,797	9,063	11,328	13,594	15,860	18,125	20,391	22,657
70	264	529	1,322	2,643	5,287	7,930	10,573	13,216	15,860	18,503	21,146	23,789	26,433
80	302	604	1,510	3,021	6,042	9,063	12,084	15,104	18,125	21,146	24,167	27,188	30,209
90	340	680	1,699	3,398	6,797	10,195	13,594	16,992	20,391	23,789	27,188	30,586	33,985
100	378	755	1,888	3,776	7,552	11,328	15,104	18,881	22,657	26,433	30,209	33,985	37,761

Gannet

Sensitivity of gannets

As outlined in Section 15.5, gannets have an overall sensitivity of medium, and are assessed using a displacement rate of 70% and a mortality rate of 1%, with a range of 60% to 80% displacement also presented.

Tier 1

No Tier 1 projects have been scoped into the offshore and intertidal ornithology cumulative effects assessment.

Tier 1 and 2

Magnitude of impact

The estimated annual mean peak abundance of razorbill from relevant projects in the array area plus 2km buffer is presented in Table 15.100 below.

Table 15.100 Gannet cumulative abundance totals for tier 1 and 2 projects during the construction phase

Project	Annual total cumulative abundance
Phase one projects	1,894
The proposed development	582
Total	**2,476**

The cumulative annual total abundance of gannets is 2,476 individuals. Based on 60% to 80% displacement and 1% mortality, between 15 (14.9) and 20 (19.8) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 70% displacement and 1% mortality, the estimated displacement consequent mortality is 17 (17.3) individuals per annum, of which the proposed development contributes four (4.1) individuals.

Based on the largest regional population size of 643,917 individuals (Table 15.17) and a baseline mortality of 116,984 individuals per annum (based on an average mortality rate of 0.182; Table 15.18), the addition of 17 displacement consequent mortalities would represent a 0.015% increase in baseline mortality. Considering the biogeographic population size of 1,180,000, with a baseline mortality of 214,377 individuals per annum, the addition of 17 displacement consequent mortalities would represent a 0.008% increase in baseline mortality. Likely significant effects based on 30% to 70% displacement and 1% to 5% mortality are presented in Table 15.101 below.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement for tier 1 and 2 projects would be low (Table 15.7).

Table 15.101 Predicted cumulative annual displacement impacts on gannet from the proposed development during the operational phase for tier 1 and 2 projects

Bio-season (months)	Cumulative mean peak abundance (array plus 2km buffer)	Estimated mortality		Percentage increase in baseline mortality	
		70% displacement, 1% mortality	**60% to 80% displacement, 1% mortality**	**70% displacement, 1% mortality**	**60% to 80% displacement, 1% mortality**
Annual (regional)	2,476	17.3	14.9 – 19.8	0.015	0.013 – 0.017
Annual (biogeographic)	2,476	17.3	14.9 – 19.8	0.008	0.007 – 0.009

Significance of the effect

Overall, it is predicted that the sensitivity of gannet for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on gannet results in an imperceptible effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Tier 1, 2 and 3 (All tiers)

Magnitude of impact

The estimated annual mean peak abundance of gannets from relevant projects in the array area plus 2km buffer is presented in Table 15.102 below. It should be noted that for the Burbo Bank Extension and Walney Extension projects, data was only provided within the 4km buffer. The total mean peak abundance is therefore an overestimate of actual mean peak abundance across the projects and is considered a precautionary approach.

Table 15.102 Gannet cumulative abundance totals for all tier projects

Project	Annual total cumulative abundance
Awel-y-Mor	528
Gwynt y Mor	-
Rhyl Flats	-
Burbo Bank Extension	429
North Hoyle	-
Walney Extension 3 + 4	1,348
West of Duddon Sands	-
Walney 1 + 2	-
Burbo Bank	-
Ormonde	-
Barrow	-
Robin Rigg	-
Arklow Bank Phase one	-
Twin Hub	-
Erebus	658
Morgan	454
Morecambe	912
Mona	693
White Cross	456
Phase one projects	1,894
Total (without the proposed development)	**7,372**
The proposed development	582
Total (with the proposed development)	**7,954**

The cumulative annual total abundance of gannets is 7,954 individuals. Based on 60% to 80% displacement and 1% mortality, between 48 (47.7) and 64 (63.6) individuals are predicted to be at risk of displacement consequent mortality per annum. Based on 70% displacement and 1% mortality, the estimated displacement consequent mortality is 56 (55.7) individuals per annum, of which the proposed development contributes four (4.1) individuals.

Based on the largest regional population size of 643,917 individuals (Table 15.17) and a baseline mortality of 116,984 individuals per annum (based on an average mortality rate of 0.182; Table 15.18), the addition of 56 displacement consequent mortalities would represent a 0.048% increase in baseline mortality. Considering the biogeographic population size of 1,180,000, with a baseline mortality of 214,377 individuals per annum, the addition of 58 displacement consequent mortalities would represent a 0.026% increase in baseline mortality. Likely significant effects based on 30% to 70% displacement and 1% to 5% mortality are presented in Table 15.103 below. Results are also presented in a matrix in Table 15.104.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from disturbance and displacement for all tier projects would be negligible (Table 15.7).

Significance of the effect

Overall, it is predicted that the sensitivity of gannet for Project Option 1 and Project Option 2 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on gannet results in an imperceptible effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Table 15.103 Predicted cumulative annual displacement impacts on gannet from the proposed development during the operational phase for all project tiers

Bio-season (months)	Cumulative mean peak abundance (array plus 2km buffer)	Estimated mortality		Percentage increase in baseline mortality	
		70% displacement, 1% mortality	60% to 80% displacement, 1% mortality	70% displacement, 1% mortality	60% to 80% displacement, 1% mortality
Annual (regional population)	7,954	55.7	47.7 – 63.6	0.048	0.041 – 0.054
Annual (biogeographic)	7,954	55.7	47.7 – 63.6	0.026	0.022 – 0.030

Table 15.104 Annual cumulative displacement matrix for gannet within the array area plus 2km buffer, values in light grey represent the range-based values based on best practice and the darker shade of grey representing the main approach value

	Mortality Rate (%)												
Displaced (%)	1	2	5	10	20	30	40	50	60	70	80	90	100
10	8	16	40	80	159	239	318	398	477	557	636	716	795
20	16	32	80	159	318	477	636	795	954	1,114	1,273	1,432	1,591
30	24	48	119	239	477	716	954	1,193	1,432	1,670	1,909	2,148	2,386
40	32	64	159	318	636	954	1,273	1,591	1,909	2,227	2,545	2,863	3,182
50	40	80	199	398	795	1,193	1,591	1,989	2,386	2,784	3,182	3,579	3,977
60	48	95	239	477	954	1,432	1,909	2,386	2,863	3,341	3,818	4,295	4,772
70	56	111	278	557	1,114	1,670	2,227	2,784	3,341	3,897	4,454	5,011	5,568
80	64	127	318	636	1,273	1,909	2,545	3,182	3,818	4,454	5,091	5,727	6,363
90	72	143	358	716	1,432	2,148	2,863	3,579	4,295	5,011	5,727	6,443	7,159
100	80	159	398	795	1,591	2,386	3,182	3,977	4,772	5,568	6,363	7,159	7,954

15.9.7 Cumulative Impact 3: Collision risk

During the operation of the proposed development, there is potential for cumulative collision risk to birds with the proposed development and other developments through collision with WTGs and other associated infrastructure, resulting in injury or fatality. This may occur when birds fly through the array area of the proposed development and/or other developments in the area whilst foraging for food, commuting between breeding sites and foraging areas, or during migration.

For the cumulative displacement assessment, only projects within Tiers 1, 2 and 3 were considered. As collision figures for other developments were not always available on a seasonal basis, the cumulative effects assessment has been carried out on an annual basis only.

15.9.7.1 Kittiwake

Sensitivity of kittiwakes

As outlined in Section 15.5, kittiwakes have an overall sensitivity of high.

Tier 1

No Tier 1 projects have been scoped into the offshore and intertidal ornithology cumulative effects assessment.

Tier 1 and 2

Magnitude of impact

The estimated annual mean collisions of kittiwake from tier 1 and 2 projects are presented in Table 15.105 below.

Table 15.105 Kittiwake cumulative collision totals for tier 1 and 2 projects

Project	Annual total cumulative abundance
Phase one projects	347.7
The proposed development	19.3
Total	**367.0**

The predicted annual cumulative total of kittiwakes subject to collision mortality is 367 (367.0) individuals, of which the proposed development contributes 19 (19.3) mortalities. Based on the largest regional population size of 933,197 individuals (Table 15.17) and a baseline mortality of 145,528 individuals per annum (based on an average mortality rate of 0.156; Table 15.18), the addition of 367 collision consequent mortalities would represent a 0.252% increase in baseline mortality. Considering the biogeographic population size of 5,100,000, with a baseline mortality of 795,321 individuals per annum, the addition of 367 collision consequent mortalities would represent a 0.046% increase in baseline mortality.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from collision for tier 1 and 2 projects would be low (Table 15.7).

Significance of the effect

Project Option 1

Overall, it is predicted that the sensitivity of kittiwake for Project Option 1 is high and the magnitude of the impact is low. The high sensitivity and low magnitude of the impact on kittiwake results in a moderate effect, which is not significant in EIA terms based on the matrix approach in Table 15 9.

Project Option 2

Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the high sensitivity and low magnitude of the impact on kittiwake results in a moderate effect at worst, which is not significant in EIA terms based on the matrix approach in Table 15 9.

Tier 1, 2 and 3 (All tiers)

Magnitude of impact

The predicted annual total number of birds subject to collision mortality as a result of the proposed development combined with other developments is presented in Table 15.106 below.

Table 15.106 Kittiwake cumulative collision mortality for all tier projects

Project	Annual total collisions
Awel-y-Mor	53.9
Gwynt y Mor	Unknown
Rhyl Flats	Unknown
Burbo Bank Extension	22.3
North Hoyle	Unknown
Walney Extension 3 + 4	187.6
West of Duddon Sands	Unknown
Walney 1 + 2	Unknown
Burbo Bank	Unknown
Ormonde	2.2
Barrow	Unknown
Robin Rigg	Unknown
Arklow Bank Phase one	Unknown
Twin Hub	10.8
Erebus	58.0
Morgan	39.8
Morecambe	32.0
Mona	37.1
White Cross	21.5
Phase one projects	347.7
Total (without the proposed development)	**812.8**
The proposed development	19.3
Total (with the proposed development)	**832.1**

The predicted annual cumulative total of kittiwakes subject to collision mortality is 832 (832.1) individuals, of which the proposed development contributes 19 (19.3) mortalities. Based on the largest regional population size of 933,197 individuals (Table 15.17) and a baseline mortality of 145,528 individuals per annum (based on an average mortality rate of 0.156; Table 15.18), the addition of 832 collision consequent mortalities would represent a 0.572% increase in baseline mortality. Considering the biogeographic population size of 5,100,000, with a baseline mortality of 795,321 individuals per annum, the addition of 832 collision consequent mortalities would represent a 0.105% increase in baseline mortality.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from collision for all tier projects would be low (Table 15.7).

Significance of the effect

Project Option 1

Overall, it is predicted that the sensitivity of kittiwake for Project Option 1 is high and the magnitude of the impact is low. The high sensitivity and low magnitude of the impact on kittiwake results in a moderate effect, which is not significant in EIA terms based on the matrix approach in Table 15 9.

Project Option 2

Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the high sensitivity and low magnitude of the impact on kittiwake results in a moderate effect at worst, which is not significant in EIA terms based on the matrix approach in Table 15 9.

Common gull

Sensitivity of common gulls

As outlined in Section 15.5, common gulls have an overall sensitivity of medium.

Tier 1

No Tier 1 projects have been scoped into the offshore and intertidal ornithology cumulative effects assessment.

Tier 1 and 2

Magnitude of impact

The estimated annual mean collisions of kittiwake from tier 1 and 2 projects are presented in Table 15.100 below.

Table 15.107 Common gull cumulative mean collisions for tier 1 and 2 projects

Project	Annual total cumulative abundance
Phase one projects	159.6
The proposed development	5.4
Total	**165.0**

The predicted annual cumulative total of common gulls subject to collision mortality is 165 (165.0) individuals, of which the proposed development contributes five (5.4) mortalities. Based on the largest regional population size of 67,500 individuals (Table 15.17) and a baseline mortality of 17,076 individuals per annum (based on an average mortality rate of 0.253; Table 15.18), the addition of 165 consequent mortalities would represent a 0.966% increase in baseline mortality. Considering the biogeographic population size of 525,000, with a baseline mortality of 132,814 individuals per annum, the addition of 165 collision consequent mortalities would represent a 0.124% increase in baseline mortality.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from collision for tier 1 and 2 projects would be low (Table 15.7).

Significance of the effect
Project Option 1

Overall, it is predicted that the sensitivity of common gull for Project Option 1 is medium and the magnitude of the impact is low. The medium sensitivity and low magnitude of the impact on common gull results in an imperceptible effect, which is not significant in EIA terms based on the matrix approach in Table 15 9.

Project Option 2

Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the medium sensitivity and low magnitude of the impact on common gull results in an imperceptible effect at worst, which is not significant in EIA terms based on the matrix approach in Table 15 9.

Tier 1, 2 and 3 (All tiers)

Magnitude of impact
The predicted annual total number of birds subject to collision mortality as a result of the proposed development combined with other developments is presented in Table 15.108 below.

Table 15.108 Common gull cumulative collision mortality for all tier projects

Project	Annual total collisions
Awel-y-Mor	0.1
Gwynt y Mor	Unknown
Rhyl Flats	Unknown
Burbo Bank Extension	Unknown
North Hoyle	Unknown
Walney Extension 3 + 4	Unknown
West of Duddon Sands	Unknown
Walney 1 + 2	Unknown
Burbo Bank	Unknown
Ormonde	Unknown
Barrow	Unknown
Robin Rigg	Unknown
Arklow Bank Phase one	Unknown
Twin Hub	Unknown
Erebus	0.0
Morgan	0.0
Morecambe	3.4
Mona	0.0
White Cross	0.0
Phase one projects	159.6
Total (without the proposed development)	**163.1**
The proposed development	5.4
Total (with the proposed development)	**168.5**

The predicted annual cumulative total of common gulls subject to collision mortality is 169 (168.5) individuals, of which the proposed development contributes five (5.4) mortalities. Based on the largest regional population size of 67,500 individuals (Table 15.17) and a baseline mortality of 17,076 individuals per annum (based on an average mortality rate of 0.253; Table 15.18), the addition of 169 consequent mortalities would represent a 0.987% increase in baseline mortality. Considering the biogeographic population size of 525,000, with a baseline mortality of 132,814 individuals per annum, the addition of 169 collision consequent mortalities would represent a 0.127% increase in baseline mortality.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from collision for all tier projects would be low (Table 15.7).

Significance of the effect

Project Option 1

Overall, it is predicted that the sensitivity of common gull for Project Option 1 is medium and the magnitude of the impact is low. The medium sensitivity and low magnitude of the impact on common gull results in an imperceptible effect, which is not significant in EIA terms based on the matrix approach in Table 15 9.

Project Option 2

Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the medium sensitivity and low magnitude of the impact on common gull results in an imperceptible effect at worst, which is not significant in EIA terms based on the matrix approach in Table 15 9.

15.9.7.2 Great black-backed gull

Sensitivity of great black-backed gulls

As outlined in Section 15.5, great black-backed gulls have an overall sensitivity of medium.

Tier 1

No Tier 1 projects have been scoped into the offshore and intertidal ornithology cumulative effects assessment.

Tier 1 and 2

Magnitude of impact

The estimated annual mean collisions of great black-backed gull from tier 1 and 2 projects are presented in Table 15.109 below.

Table 15.109 Great black-backed gull cumulative collision totals for tier 1 and 2 projects

Project	Annual total cumulative abundance
Phase one projects	70.1
The proposed development	26.3
Total	**96.4**

The predicted annual cumulative total of great black-backed gulls subject to collision mortality is 96 (96.4) individuals, of which the proposed development contributes 26 (26.3) mortalities. Based on the largest regional population size of 54,406 individuals (Table 15.17) and a baseline mortality of 5,064 individuals per annum (based on an average mortality rate of 0.095; Table 15.18), the addition of 96 collision consequent mortalities would represent a 1.903% increase in baseline mortality. Considering the biogeographic population size of 235,000, with a baseline mortality of 22,282 individuals per annum, the addition of 155 collision consequent mortalities would represent a 0.432% increase in baseline mortality. Though the percentage increase in baseline mortality at the regional population level exceeds 1%, further consideration in the form of a PVA analysis is given for all tier projects below.

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from collision risk for tier 1 and 2 projects would be medium. However, based on PVA analysis (outlined for all tiers below) the overall magnitude is considered to be low (Table 15.7).

Significance of the effect

Project Option 1

Overall, it is predicted that the sensitivity of great black-backed gull for Project Option 1 is high and the magnitude of the impact is low. The high sensitivity and low magnitude of the impact on great black-backed gull results in a moderate effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Project Option 2

Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the high sensitivity and low magnitude of the impact on great black-backed gull results in a moderate effect at worst, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Tier 1, 2 and 3 (All tiers)

Magnitude of impact

The predicted annual total number of birds subject to collision mortality as a result of the proposed development combined with other developments is presented in Table 15.110 below.

Table 15.110 Great black-backed gull cumulative collision mortality for all tier projects

Project	Annual total collisions
Awel-y-Mor	4.9
Gwynt y Mor	unknown
Rhyl Flats	unknown
Burbo Bank Extension	unknown
North Hoyle	unknown
Walney Extension 3 + 4	28.2
West of Duddon Sands	unknown
Walney 1 + 2	12.3
Burbo Bank	unknown
Ormonde	0.3
Barrow	unknown
Robin Rigg	unknown
Arklow Bank Phase one	unknown
Twin Hub	unknown
Erebus	1.0
Morgan	2.8

Project	Annual total collisions
Morecambe	1.0
Mona	7.4
White Cross	0.7
Phase one projects	70.1
Total (without the proposed development)	**128.6**
The proposed development	26.3
Total (with the proposed development)	**154.9**

The predicted annual cumulative total of great black-backed gulls subject to collision mortality is 155 (154.9) individuals, of which the proposed development contributes 26 (26.3) mortalities. Based on the largest regional population size of 54,406 individuals (Table 15.17) and a baseline mortality of 5,064 individuals per annum (based on an average mortality rate of 0.095; Table 15.18), the addition of 155 collision consequent mortalities would represent a 3.059% increase in baseline mortality. Considering the biogeographic population size of 235,000, with a baseline mortality of 22,282 individuals per annum, the addition of 155 collision consequent mortalities would represent a 0.695% increase in baseline mortality. As the percentage increase in baseline mortality at the regional population level exceeds 1%, further consideration in the form of a PVA analysis is given below as a precautionary approach. Full details of the PVA analysis are provided in the PVA report.

Results of the PVA are presented in Table 15.111 below. Metrics used for the interpretation of PVA outputs are the CGR and CPS values. Considering the cumulative annual total mortalities of 155 (154.9) individuals per annum, the CGR and CPS are 0.996 and 0.896 respectively. Over the 35-year timeframe, this represents a 0.351% reduction in annual growth rate. This impact is considered to be sufficiently small that they would be indistinguishable from natural fluctuations in the population, regardless of current population trend.

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from collision risk for all tier projects would be medium. However, based on PVA analysis the overall magnitude is considered to be low (Table 15.7).

Significance of the effect

Project Option 1

Overall, it is predicted that the sensitivity of great black-backed gull for Project Option 1 is high and the magnitude of the impact is low. The high sensitivity and low magnitude of the impact on great black-backed gull results in a moderate effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Project Option 2

Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the high sensitivity and low magnitude of the impact on great black-backed gull results in a moderate effect at worst, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Table 15.111 Great black-backed gull PVA results for potential cumulative effects

Scenario	Mortalities (per annum)	Impact on survival (%)	CGR	CPS
Proposed development alone	26.3	<0.001	1.000	0.999
Cumulative	154.9	0.003	0.997	0.902

Herring gull

Sensitivity of herring gulls

As outlined in Section 15.5, herring gulls have an overall sensitivity of high.

Tier 1

No Tier 1 projects have been scoped into the offshore and intertidal ornithology cumulative effects assessment.

Tier 1 and 2

Magnitude of impact

The estimated annual mean collisions of herring gulls from tier 1 and 2 projects are presented in Table 15.112 below.

Table 15.112 herring gull cumulative collision totals for tier 1 and 2 projects

Project	Annual total cumulative abundance
Phase one projects	150.1
The proposed development	57.2
Total	**207.3**

The predicted annual cumulative total of herring gulls subject to collision mortality is 207 (207.3) individuals, of which the proposed development contributes 57 (57.2) mortalities. Based on the largest regional population size of 187,094 individuals (Table 15.17) and a baseline mortality of 31,999 individuals per annum (based on an average mortality rate of 0.171; Table 15.18), the addition of 207 collision consequent mortalities would represent a 0.648% increase in baseline mortality. Considering the biogeographic population size of 1,098,000, with a baseline mortality of 187,795 individuals per annum, the addition of 207 displacement consequent mortalities would represent a 0.110% increase in baseline mortality.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from collision for tier 1 and 2 projects would be low (Table 15.7).

Significance of the effect

Project Option 1

Overall, it is predicted that the sensitivity of herring gull for Project Option 1 is high and the magnitude of the impact is low. The high sensitivity and low magnitude of the impact on herring gull results in a moderate effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Project Option 2

Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the high sensitivity and low magnitude of the impact on herring gull results in a moderate effect at worst, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Tier 1, 2 and 3 (All tiers)

Magnitude of impact

The predicted annual total number of birds subject to collision mortality as a result of the proposed development combined with other developments is presented in Table 15.113 below.

Table 15.113 Herring gull cumulative collision mortality for all tier projects

Project	Annual total collisions
Awel-y-Mor	3.0
Gwynt y Mor	Unknown
Rhyl Flats	Unknown
Burbo Bank Extension	20.3
North Hoyle	Unknown
Walney Extension 3 + 4	54.5
West of Duddon Sands	Unknown
Walney 1 + 2	Unknown
Burbo Bank	Unknown
Ormonde	0.4
Barrow	Unknown
Robin Rigg	Unknown
Arklow Bank Phase one	Unknown
Twin Hub	22.9
Erebus	3.0
Morgan	11.8
Morecambe	3.4
Mona	2.0
White Cross	0.3
Phase one projects	150.1
Total (without the proposed development)	**271.7**
The proposed development	57.2
Total (with the proposed development)	**328.9**

The predicted annual cumulative total of herring gulls subject to collision mortality is 329 (328.9) individuals, of which the proposed development contributes 57 (57.2) mortalities. Based on the largest regional population size of 187,094 individuals (Table 15.17) and a baseline mortality of 31,999 individuals per annum (based on an average mortality rate of 0.171; Table 15.18), the addition of 329 collision consequent mortalities would represent a 1.028% increase in baseline mortality. Considering the biogeographic population size of 1,098,000, with a baseline mortality of 187,795 individuals per annum, the addition of 329 displacement consequent mortalities would represent a 0.175% increase in baseline mortality. As the percentage increase in baseline mortality exceeds 1% at the regional population scale, further consideration is given in the form of PVA.

Results of the PVA are presented in Table 15.114 below. Metrics used for the interpretation of PVA outputs are the CGR and CPS values. Considering the cumulative annual total mortalities of 221 individuals per annum, the CGR and CPS are 0.998 and 0.936 respectively. Over the 35-year timeframe, this represents a 0.213% reduction in annual growth rate. These impacts are considered to be sufficiently small that they would be indistinguishable from natural fluctuations in the population, regardless of current population trend.

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from collision risk for all tier projects would be medium. However, based on PVA analysis the overall magnitude is considered to be low (Table 15.7).

Significance of the effect

Project Option 1

Overall, it is predicted that the sensitivity of herring gull for Project Option 1 is high and the magnitude of the impact is low. The high sensitivity and low magnitude of the impact on herring gull results in a moderate effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Project Option 2

Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the high sensitivity and low magnitude of the impact on herring gull results in a moderate effect at worst, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Table 15.114 PVA results for herring gull for the proposed development alone and cumulatively

Scenario	Mortalities (per annum)	Impact on adult survival (%)	CGR	CPS
Proposed development alone	57.2	<0.001	1.000	0.988
Cumulative	328.0	0.002	0.998	0.936

Lesser black-backed gull

Sensitivity of lesser black-backed gulls

As outlined in Section 15.5, lesser black-backed gulls have an overall sensitivity of high.

Tier 1

No Tier 1 projects have been scoped into the offshore and intertidal ornithology cumulative effects assessment.

Tier 1 and 2

Magnitude of impact

The estimated annual mean collisions of lesser black-backed gull from tier 1 and 2 projects is presented in Table 15.109 below.

Table 15.115 Lesser black-backed gull cumulative collision totals for tier 1 and 2 projects

Project	Annual total cumulative abundance
Phase one projects	4.9
The proposed development	1.8
Total	**6.7**

The predicted annual cumulative total of lesser black-backed gulls subject to collision mortality is seven (6.7) individuals, of which the proposed development contributes two (1.8) mortalities. Based on the largest regional population size of 171,500 individuals (Table 15.17) and a baseline mortality of 21,116 individuals per annum (based on an average mortality rate of 0.123; Table 15.18), the addition of seven collision consequent mortalities would represent a 0.032% increase in baseline mortality. Considering the biogeographic population size of 864,000, with a baseline mortality of 106,380 individuals per annum, the addition of seven collision consequent mortalities would represent a 0.006% increase in baseline mortality.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from collision for tier 1 and 2 projects would be low (Table 15.7).

Significance of the effect

Project Option 1

Overall, it is predicted that the sensitivity of lesser black-backed gull for Project Option 1 is high and the magnitude of the impact is negligible. The high sensitivity and negligible magnitude of the impact on lesser black-backed gull results in a not significant effect in EIA terms based on the matrix approach in Table 15.8.

Project Option 2

Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the medium sensitivity and negligible magnitude of the impact on lesser black-backed gull results in a not significant effect at worst, based on the matrix approach in Table 15 9.

Tier 1, 2 and 3 (All tiers)

Magnitude of impact

The predicted annual total number of birds subject to collision mortality as a result of the proposed development combined with other developments is presented in Table 15.116 below.

Table 15.116 Lesser black-backed gull cumulative collision mortality

Project	Annual total collisions
Awel-y-Mor	0.0
Gwynt y Mor	5.0
Rhyl Flats	1.0
Burbo Bank Extension	52.8
North Hoyle	1.0
Walney Extension 3 + 4	13.0
West of Duddon Sands	52.4
Walney 1 + 2	57.2
Burbo Bank	2.0
Ormonde	22.1
Barrow	unknown
Robin Rigg	unknown
Arklow Bank Phase one	unknown
Twin Hub	5.9
Erebus	6.0
Morgan	1.0
Morecambe	4.4
Mona	1.9
White Cross	0.3
Phase one projects	4.9
Total (without the proposed development)	**230.8**
The proposed development	1.7
Total (with the proposed development)	**232.6**

The predicted annual cumulative total of lesser black-backed gulls subject to collision mortality is 233 (232.6) individuals, of which the proposed development contributes two (1.8) mortalities. Based on the largest regional population size of 171,500 individuals (Table 15.17) and a baseline mortality of 21,116 individuals per annum (based on an average mortality rate of 0.123; Table 15.18), the addition of 233 collision consequent mortalities would represent a 1.102% increase in baseline mortality. Considering the biogeographic population size of 864,000, with a baseline mortality of 106,380 individuals per annum, the addition of 223 displacement consequent mortalities would represent a 0.219% increase in baseline mortality. As the percentage increase in baseline mortality at the regional population level exceeds 1%, further consideration in the form of a PVA analysis is given below. Full details of the PVA analysis are provided in the PVA report.

Results of the PVA are presented in Table 15.117 below. Metrics used for the interpretation of PVA outputs are the CGR and CPS values. Considering the cumulative annual total mortalities of 233 (232.6) individuals per annum, the CGR and CPS are 0.998 and 0.953 respectively. Over the 35-year timeframe, this represents a 0.155% reduction in annual growth rate. This impact is considered to be sufficiently small that they would be indistinguishable from natural fluctuations in the population, regardless of current population trend.

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from collision risk for all tier projects would be medium. However, based on PVA analysis the overall magnitude is considered to be low (Table 15.7).

Significance of the effect

Project Option 1

Overall, it is predicted that the sensitivity of lesser black-backed gull for Project Option 1 is high and the magnitude of the impact is low. The high sensitivity and low magnitude of the impact on lesser black-backed gull results in a moderate effect, which is not significant in EIA terms based on the matrix approach in Table 15 9.

Project Option 2

Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the high sensitivity and low magnitude of the impact on lesser black-backed gull results in a moderate effect at worst, which is not significant in EIA terms based on the matrix approach in Table 15 9.

Table 15.117 PVA results for lesser black-backed gull for the proposed development alone and cumulatively

Scenario	Mortalities (per annum)	Increase in mortality	CGR	CPS
Proposed development alone	1.8	<0.001	1.000	1.000
Cumulative	232.6	0.001	0.998	0.953

Roseate tern

Sensitivity of roseate terns

As outlined in Section 15.5, roseate terns have an overall sensitivity of medium.

Tier 1

No Tier 1 projects have been scoped into the offshore and intertidal ornithology cumulative effects assessment.

Tier 1 and 2

Magnitude of impact

The estimated annual mean collisions of l from tier 1 and 2 projects is presented in Table 15.109 below.

Table 15.118 Roseate tern cumulative collision totals for tier 1 and 2 projects

Project	Annual total cumulative abundance
Phase one projects	0.0
The proposed development	0.1
Total	**0.1**

Across tier 1 and 2 projects, no roseate tern collisions are predicted. Therefore the magnitude of impact is assessed the same for the proposed development alone (negligible magnitude).

Sensitivity of the effect

Project Option 1

Overall, it is predicted that the sensitivity of roseate tern for Project Option 1 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on roseate tern results in an imperceptible effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Project Option 2

Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the medium sensitivity and negligible magnitude of the impact on roseate tern results in a imperceptible effect at worst, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Tier 1, 2 and 3 (All tiers)

Magnitude of impact

The predicted annual total number of birds subject to collision mortality as a result of the proposed development combined with other developments is presented in Table 15.119 below.

Table 15.119 Roseate tern cumulative collision mortality

Project	Annual total collisions
Awel-y-Mor	0.0
Gwynt y Mor	unknown
Rhyl Flats	unknown
Burbo Bank Extension	unknown
North Hoyle	unknown
Walney Extension 3 + 4	unknown
West of Duddon Sands	unknown
Walney 1 + 2	unknown
Burbo Bank	unknown
Ormonde	unknown
Barrow	unknown
Robin Rigg	unknown
Arklow Bank Phase one	unknown
Twin Hub	0.0
Erebus	0.0
Morgan	0.0
Morecambe	0.0

Project	Annual total collisions
Mona	0.0
Total (without the proposed development)	**0.0**
The proposed development	0.1
Total (with the proposed development)	**0.1**

The predicted annual cumulative total of roseate terns subject to collision mortality is less than one (0.1) individual, of which the proposed development contributes less than one (0.1) mortality. Based on the largest regional population size of 171,500 individuals (Table 15.17) and a baseline mortality of 32,682 individuals per annum (based on an average mortality rate of 0.191; Table 15.18), the addition of less than one collision consequent mortality would represent a 0.000% increase in baseline mortality. Considering the biogeographic population size of 2,900, with a baseline mortality of 553 individuals per annum, the addition of less than one collision consequent mortality would represent a 0.018% increase in baseline mortality.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from collision for all tier projects would be negligible (Table 15.7).

Significance of the effect

Project Option 1

Overall, it is predicted that the sensitivity of roseate tern for Project Option 1 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on roseate tern results in an imperceptible effect, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Project Option 2

Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the medium sensitivity and negligible magnitude of the impact on roseate tern results in a imperceptible effect at worst, which is not significant in EIA terms based on the matrix approach in Table 15.8.

Arctic tern

Sensitivity of Arctic terns

As outlined in Section 15.5, Arctic terns have an overall sensitivity of medium.

Tier 1

No Tier 1 projects have been scoped into the offshore and intertidal ornithology cumulative effects assessment.

Tier 1 and 2

Magnitude of impact

The estimated annual mean collisions from tier 1 and 2 projects are presented in Table 15.120 below.

Table 15.120 Arctic tern cumulative collision totals for tier 1 and 2 projects

Project	Annual total cumulative abundance
Phase one projects	0.0
The proposed development	0.1
Total	**0.1**

Across tier 1 and 2 projects, no Arctic tern collisions are predicted. Therefore the magnitude of impact is assessed the same for the proposed development alone (negligible magnitude).

Significance of the effect

Project Option 1

Overall, it is predicted that the sensitivity of Arctic tern for Project Option 1 is medium and the magnitude of the impact is low. The medium sensitivity and negligible magnitude of the impact on Arctic tern results in an imperceptible effect, which is not significant in EIA terms based on the matrix approach in Table 15 9.

Project Option 2

Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the medium sensitivity and negligible magnitude of the impact on Arctic tern results in an imperceptible effect at worst, which is not significant in EIA terms based on the matrix approach in Table 15 9.

Tier 1, 2 and 3 (All tiers)

Magnitude of impact

The predicted annual total number of birds subject to collision mortality as a result of the proposed development combined with other developments is presented in Table 15.121 below.

Table 15.121 Arctic tern cumulative collision mortality

Project	Annual total collisions
Awel-y-Mor	0.5
Gwynt y Mor	unknown
Rhyl Flats	unknown
Burbo Bank Extension	unknown
North Hoyle	unknown
Walney Extension 3 + 4	unknown
West of Duddon Sands	unknown
Walney 1 + 2	unknown
Burbo Bank	unknown
Ormonde	unknown
Barrow	unknown
Robin Rigg	unknown
Arklow Bank Phase one	unknown
Twin Hub	unknown
Erebus	0.0
Morgan	0.0
Morecambe	0.0
Mona	0.0

Project	Annual total collisions
White Cross	0.0
Phase one projects	0.0
Total (without the proposed development)	**0.5**
The proposed development	0.0
Total (with the proposed development)	**0.5**

The predicted annual cumulative total of Arctic terns subject to collision mortality is one (0.5) individual, of which the proposed development contributes almost zero (0.0) mortalities. Based on the largest regional population size of 72,231 individuals (Table 15.17) and a baseline mortality of 13,198 individuals per annum (based on an average mortality rate of 0.183; Table 15.18), the addition of one collision consequent mortality would represent a 0.004% increase in baseline mortality. Considering the biogeographic population size of 628,000, with a baseline mortality of 102,364 individuals per annum, the addition of one collision consequent mortality would represent a 0.000% increase in baseline mortality.

At both the regional population and biogeographic population scales, the cumulative impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from collision for all tier projects would be negligible (Table 15.7).

Significance of the effect

Project Option 1

Overall, it is predicted that the sensitivity of Arctic tern for Project Option 1 is medium and the magnitude of the impact is low. The medium sensitivity and negligible magnitude of the impact on Arctic tern results in an imperceptible effect, which is not significant in EIA terms based on the matrix approach in Table 15 9.

Project Option 2

Impacts from Project Option 2 are calculated to be equal to or less than those from Project Option 1. Therefore, the medium sensitivity and negligible magnitude of the impact on Arctic tern results in an imperceptible effect at worst, which is not significant in EIA terms based on the matrix approach in Table 15 9.

Common tern

Sensitivity of common terns

As outlined in Section 15.5, common terns have an overall sensitivity of medium.

Tier 1

No Tier 1 projects have been scoped into the offshore and intertidal ornithology cumulative effects assessment.

Tier 1 and 2

Magnitude of impact

The estimated annual mean common tern collisions from tier 1 and 2 projects are presented in Table 15.122 below.

Table 15.122 Common tern cumulative collision totals for tier 1 and 2 projects

Project	Annual total cumulative abundance
Phase one projects	13.9
The proposed development	0.7
Total	**14.6**

The predicted annual cumulative total of common terns subject to collision mortality is 15 (14.6) individuals, of which the proposed development contributes one (0.7) mortality. Based on the largest regional population size of 74,000 individuals (Table 15.17) and a baseline mortality of 14,102 individuals per annum (based on an average mortality rate of 0.191; Table 15.18), the addition of 15 collision consequent mortalities would represent a 0.103% increase in baseline mortality. Considering the biogeographic population size of 480,000 with a baseline mortality of 91,473 individuals per annum, the addition of one collision consequent mortality would represent a 0.016% increase in baseline mortality.

Both the regional population and biogeographic population scales, the cumulative impacts from the proposed development across all bio-seasons alone and combined represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from collision for tier 1 and 2 projects would be negligible (Table 15.7).

Significance of the effect

Project Option 1.

Impacts from Project Option 1 are calculated to be equal to or less than those from Project Option 2. Therefore, the medium sensitivity and negligible magnitude of the impact on common tern results in an imperceptible effect at worst, which is not significant in EIA terms based on the matrix approach in Table 15 9.

Project Option 2

Overall, it is predicted that the sensitivity of common tern for Project Option 2 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on common tern results in an imperceptible effect, which is not significant in EIA terms based on the matrix approach in Table 15 9.

Tier 1, 2 and 3 (All tiers)

Magnitude of impact

The predicted annual total number of birds subject to collision mortality as a result of the proposed development combined with other developments is presented in Table 15.123 below.

Table 15.123 Common tern cumulative collision mortality for all tier projects

Project	Annual total collisions
Awel-y-Mor	0.2
Gwynt y Mor	unknown
Rhyl Flats	unknown
Burbo Bank Extension	9.0
North Hoyle	unknown
Walney Extension 3 + 4	unknown
West of Duddon Sands	unknown
Walney 1 + 2	unknown
Burbo Bank	unknown

Project	Annual total collisions
Ormonde	unknown
Barrow	unknown
Robin Rigg	unknown
Arklow Bank Phase one	unknown
Twin Hub	unknown
Erebus	0.0
Morgan	0.0
Morecambe	0.2
Mona	0.0
Phase one projects	13.9
Total (without the proposed development)	**23.3**
The proposed development	0.7
Total (with the proposed development)	**24.0**

The predicted annual cumulative total of common terns subject to collision mortality is 24 (24.0) individuals, of which the proposed development contributes one (0.7) mortality. Based on the largest regional population size of 74,000 individuals (Table 15.17) and a baseline mortality of 14,102 individuals per annum (based on an average mortality rate of 0.191; Table 15.18), the addition of 24 collision consequent mortalities would represent a 0.170% increase in baseline mortality. Considering the biogeographic population size of 480,000 with a baseline mortality of 91,473 individuals per annum, the addition of one collision consequent mortality would represent a 0.026% increase in baseline mortality.

Both the regional population and biogeographic population scales, the cumulative impacts from the proposed development across all bio-seasons alone and combined represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from collision for all tier projects would be negligible (Table 15.7).

Significance of the effect

Project Option 1.

Impacts from Project Option 1 are calculated to be equal to or less than those from Project Option 2. Therefore, the medium sensitivity and negligible magnitude of the impact on common tern results in an imperceptible effect at worst, which is not significant in EIA terms based on the matrix approach in Table 15 9.

Project Option 2

Overall, it is predicted that the sensitivity of common tern for Project Option 2 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on common tern results in an imperceptible effect, which is not significant in EIA terms based on the matrix approach in Table 15 9

.Gannet

Sensitivity of gannets

As outlined in Section 15.5, gannets have an overall sensitivity of medium.

Tier 1

No Tier 1 projects have been scoped into the offshore and intertidal ornithology cumulative effects assessment.

Tier 1 and 2

Magnitude of impact

The estimated annual mean gannet collisions from tier 1 and 2 projects are presented in Table 15.124 below.

Table 15.124 Gannet cumulative collision totals for tier 1 and 2 projects

Project	Annual total cumulative abundance
Phase one projects	17.0
The proposed development	1.4
Total	**18.4**

The predicted annual cumulative total of gannets subject to collision mortality is 18 (18.4) individuals, of which the proposed development contributes one (1.4) mortality. Based on the largest regional population size of 643,917 individuals (Table 15.17) and a baseline mortality of 116,984 individuals per annum (based on an average mortality rate of 0.182; Table 15.18), the addition of 18 collision consequent mortalities would represent a 0.016% increase in baseline mortality. Considering the biogeographic population size of 1,180,000, with a baseline mortality of 214,377 individuals per annum, the addition of 110 displacement consequent mortalities would represent a 0.009% increase in baseline mortality.

At both the regional population and biogeographic population scales, the cumulative impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from collision for tier 1 and 2 projects would be negligible (Table 15.7).

Significance of the effect

Project Option 1

Overall, it is predicted that the sensitivity of gannet for Project Option 1 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on gannet results in an imperceptible effect, which is not significant in EIA terms based on the matrix approach in Table 15 9.

Project Option 2

Impacts from Project Option 2 are **calculated** to be equal to or less than those from Project Option 1. Therefore, the medium sensitivity and negligible magnitude of the impact on gannet results in an imperceptible effect at worst, which is not significant in EIA terms based on the matrix approach in Table 15 9.**Tier 1, 2 and 3 (All tiers)**

Magnitude of impact

The predicted annual total number of birds subject to collision mortality as a result of the proposed development combined with other developments is presented in Table 15.125 below.

Table 15.125 Gannet cumulative collision mortality for all tier projects

Project	Annual total collisions
Awel-y-Mor	20.5
Gwynt y Mor	0.0
Rhyl Flats	0.0

Project	Annual total collisions
Burbo Bank Extension	3.6
North Hoyle	0.0
Walney Extension 3 + 4	37.4
West of Duddon Sands	0.0
Walney 1 + 2	0.0
Burbo Bank	0.0
Ormonde	2.0
Barrow	0.0
Robin Rigg	0.0
Arklow Bank Phase one	0.0
Twin Hub	12.0
Erebus	7.0
Morgan	2.2
Morecambe	1.8
Mona	2.5
Morlas (tidal)	1.0
White Cross	2.0
Phase one projects	17.0
Total (without the proposed development)	**108.9**
The proposed development	1.4
Total (with the proposed development)	**110.3**

The predicted annual cumulative total of gannets subject to collision mortality is 110 (110.3) individuals, of which the proposed development contributes one (1.4) mortality. Based on the largest regional population size of 643,917 individuals (Table 15.17) and a baseline mortality of 116,984 individuals per annum (based on an average mortality rate of 0.182; Table 15.18), the addition of 110 collision consequent mortalities would represent a 0.094% increase in baseline mortality. Considering the biogeographic population size of 1,180,000, with a baseline mortality of 214,377 individuals per annum, the addition of 110 displacement consequent mortalities would represent a 0.051% increase in baseline mortality.

At both the regional population and biogeographic population scales, the cumulative impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from collision for tier 1 and 2 projects would be negligible (Table 15.7).

Significance of the effect

Project Option 1

Overall, it is predicted that the sensitivity of gannet for Project Option 1 is medium and the magnitude of the impact is negligible. The medium sensitivity and negligible magnitude of the impact on gannet results in an imperceptible effect, which is not significant in EIA terms based on the matrix approach in Table 15 9.

Project Option 2

Impacts from Project Option 2 are predicted to be equal to or less than those from Project Option 1. Therefore, the medium sensitivity and negligible magnitude of the impact on gannet results in an imperceptible effect at worst, which is not significant in EIA terms based on the matrix approach in Table 15 9.

15.9.8 Cumulative Impact 4: Combined collision risk and displacement risk (operational phase)

For gannet which has been assessed for both cumulative collision and displacement impacts in the operational phase, a combined assessment is needed to fully understand the magnitude of the impacts from the proposed development and other projects cumulatively.

Results from collision and displacement, and the total combined impacts for gannet in the operational phase for the proposed development and other projects are presented in Table 15.127 below. Results are presented based on the main approach displacement values, with a range presented for gannet in brackets as carried out within Section 15.5.3.

15.9.8.1 Gannet

Sensitivity of gannets

As outlined in Section 15.5, gannets have an overall sensitivity of medium to both collision and displacement impacts.

Tier 1

No Tier 1 projects have been scoped into the offshore and intertidal ornithology cumulative effects assessment.

Tier 1 and 2

Magnitude of impact

The estimated annual mean gannet collisions from tier 1 and 2 projects are presented in Table 15.126 below.

Table 15.126 Gannet combined displacement and collision cumulative effects for tier 1 and 2 projects

Project	Annual displacement mortality based on 70% displacement and 1% mortality (with a range of 60% to 80% displacement in brackets)	Annual collision mortality	Total combined annual impact
Tier 1 and 2 projects	13.3 (11.4 – 15.2)	17.0	30.3 (28.4 – 32.2)
The proposed development	4.1 (2.7–4.7)	1.4	5.5 (4.1–6.1)
Total	**17.3 (14.0 – 19.8)**	**18.4**	**35.8 (32.5 – 38.2)**

The predicted annual cumulative total of gannets subject to combined collision and displacement mortality is 36 (35.8) individuals, of which the proposed development contributes six (5.5) mortalities. Based on the largest regional population size of 643,917 individuals (Table 15.17) and a baseline mortality of 116,984 individuals per annum (based on an average mortality rate of 0.182; Table 15.18), the addition of 36 combined collision and displacement consequent mortalities would represent a 0.031% increase in baseline mortality. Considering the upper displacement range, the total number of mortalities would increase to 38 (38.2), which would represent a 0.033% increase in baseline mortality.

Considering the biogeographic population size of 1,180,000, with a baseline mortality of 214,377 individuals per annum, the addition of 166 displacement consequent mortalities would represent a 0.017% increase in baseline mortality, or 0.018% when considering the upper displacement value.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from collision for tier 1 and 2 projects would be negligible (Table 15.7).

Significance of the effect

At both the regional population and biogeographic population scales, impacts across all bio-seasons would represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect). Therefore, the magnitude is considered to be negligible. Based on a sensitivity of medium (Table 15.6) and a magnitude of negligible (Table 15.7), the overall significance of the potential cumulative effect on gannets is imperceptible, which is not significant in EIA terms during the operational phase based on the matrix approach in Table 15.8.

Tier 1, 2 and 3 projects

Magnitude of impact

The predicted annual total number of birds subject to combined collision and displacement mortality as a result of the proposed development combined with other developments is presented in Table 15.127 below.

Table 15.127 Gannet combined displacement and collision cumulative effects for all tier projects

Project	Annual displacement mortality based on 70% displacement and 1% mortality (with a range of 60% to 80% displacement in brackets)	Annual collision mortality	Total combined annual impact
Tier 1, 2 and 3 projects	51.6 (44.2–59.0)	108.9	160.5 (153.1 – 167.8)
The proposed development	4.1 (2.7–4.7)	1.4	5.5 (4.1–6.1)
Total	**55.7 (47.7–63.6)**	**110.3**	**166.0 (157.2 – 173.9)**

The predicted annual cumulative total of gannets subject to combined collision and displacement mortality is 166 (166.0) individuals, of which the proposed development contributes six (5.5) mortalities. Based on the largest regional population size of 643,917 individuals (Table 15.17) and a baseline mortality of 116,984 individuals per annum (based on an average mortality rate of 0.182; Table 15.18), the addition of 166 combined collision and displacement consequent mortalities would represent a 0.142% increase in baseline mortality. Considering the upper displacement range, the total number of mortalities would increase to 174 (173.9), which would represent a 0.149% increase in baseline mortality.

Considering the biogeographic population size of 1,180,000, with a baseline mortality of 214,377 individuals per annum, the addition of 166 displacement consequent mortalities would represent a 0.077% increase in baseline mortality, or 0.081% when considering the upper displacement value.

At both the regional population and biogeographic population scales, the impacts from the proposed development for each bio-season and summed across all bio-seasons represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect).

Consequently, the magnitude of cumulative impact from Project Option 1 and Project Option 2 resulting from collision for tier 1 and 2 projects would be negligible (Table 15.7).

Significance of the effect

At both the regional population and biogeographic population scales, impacts across all bio-seasons would represent a <1% increase in baseline mortality (the threshold below which additional mortality is considered to have an undetectable effect). Therefore, the magnitude is considered to be low. Based on a sensitivity of medium (Table 15.6) and a magnitude of low (Table 15.7), the overall significance of the potential cumulative effect on gannets is slight, which is not significant in EIA terms during the operational phase based on the matrix approach in Table 15.8.

15.9.9 Summary of Impacts

An overview of the significant of potential cumulative effects is provided in below.

Table 15.128 Overview of the significance of potential cumulative effects

Potential Impact	Significance of Effect – Project Option 1	Significance of Effect – Project Option 2
Disturbance and displacement (construction)	**Guillemot** Slight (Tier 1 and 2) Slight (Tier 1, 2 and 3) **Razorbill** Slight (Tier 1 and 2) Slight (Tier 1, 2 and 3) **Puffin** Imperceptible (Tier 1 and 2) Imperceptible (Tier 1, 2 and 3) **Manx shearwater** Imperceptible (Tier 1 and 2) Imperceptible (Tier 1, 2 and 3) **Gannet** Imperceptible (Tier 1 and 2) Imperceptible (Tier 1, 2 and 3)	**Guillemot** Slight (Tier 1 and 2) Slight (Tier 1, 2 and 3) **Razorbill** Slight (Tier 1 and 2) Slight (Tier 1, 2 and 3) **Puffin** Imperceptible (Tier 1 and 2) Imperceptible (Tier 1, 2 and 3) **Manx shearwater** Imperceptible (Tier 1 and 2) Imperceptible (Tier 1, 2 and 3) **Gannet** Imperceptible (Tier 1 and 2) Imperceptible (Tier 1, 2 and 3)
Disturbance and displacement (operation)	**Guillemot** Slight (Tier 1 and 2) Slight (Tier 1, 2 and 3) **Razorbill** Slight (Tier 1 and 2) Slight (Tier 1, 2 and 3) **Puffin** Imperceptible (Tier 1 and 2) Imperceptible (Tier 1, 2 and 3) **Manx shearwater** Imperceptible (Tier 1 and 2) Imperceptible (Tier 1, 2 and 3) **Gannet** Imperceptible (Tier 1 and 2) Imperceptible (Tier 1, 2 and 3)	**Guillemot** Slight (Tier 1 and 2) Slight (Tier 1, 2 and 3) **Razorbill** Slight (Tier 1 and 2) Slight (Tier 1, 2 and 3) **Puffin** Imperceptible (Tier 1 and 2) Imperceptible (Tier 1, 2 and 3) **Manx shearwater** Imperceptible (Tier 1 and 2) Imperceptible (Tier 1, 2 and 3) **Gannet** Imperceptible (Tier 1 and 2) Imperceptible (Tier 1, 2 and 3)
Collision risk	**Kittiwake** Moderate (Tier 1 and 2) Moderate (Tier 1, 2 and 3) **Common gull** Imperceptible (Tier 1 and 2) Imperceptible (Tier 1, 2 and 3) **Great black-backed gull** Moderate (Tier 1 and 2) Moderate (Tier 1, 2 and 3) **Herring gull** Moderate (Tier 1 and 2)	**Kittiwake** Moderate (Tier 1 and 2) Moderate (Tier 1, 2 and 3) **Common gull** Imperceptible (Tier 1 and 2) Imperceptible (Tier 1, 2 and 3) **Great black-backed gull** Moderate (Tier 1 and 2) Moderate (Tier 1, 2 and 3) **Herring gull** Moderate (Tier 1 and 2)

Potential Impact	Significance of Effect – Project Option 1	Significance of Effect – Project Option 2
	Moderate (Tier 1, 2 and 3) **Lesser black-backed gull** Not significant (Tier 1 and 2) Moderate (Tier 1, 2 and 3) **Roseate tern** Imperceptible (Tier 1 and 2) Imperceptible (Tier 1, 2 and 3) **Common tern** Imperceptible (Tier 1 and 2) Imperceptible (Tier 1, 2 and 3) **Arctic tern** Imperceptible (Tier 1 and 2) Imperceptible (Tier 1, 2 and 3) **Gannet** Imperceptible (Tier 1 and 2) Imperceptible (Tier 1, 2 and 3)	Moderate (Tier 1, 2 and 3) **Lesser black-backed gull** Not significant (Tier 1 and 2) Moderate (Tier 1, 2 and 3) **Roseate tern** Imperceptible (Tier 1 and 2) Imperceptible (Tier 1, 2 and 3) **Common tern** Imperceptible (Tier 1 and 2) Imperceptible (Tier 1, 2 and 3) **Arctic tern** Imperceptible (Tier 1 and 2) Imperceptible (Tier 1, 2 and 3) **Gannet** Imperceptible (Tier 1 and 2) Imperceptible (Tier 1, 2 and 3)
Combined collision risk and displacement risk	**Gannet** Imperceptible (Tier 1 and 2) Imperceptible (Tier 1, 2 and 3)	**Gannet** Imperceptible (Tier 1 and 2) Imperceptible (Tier 1, 2 and 3)

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