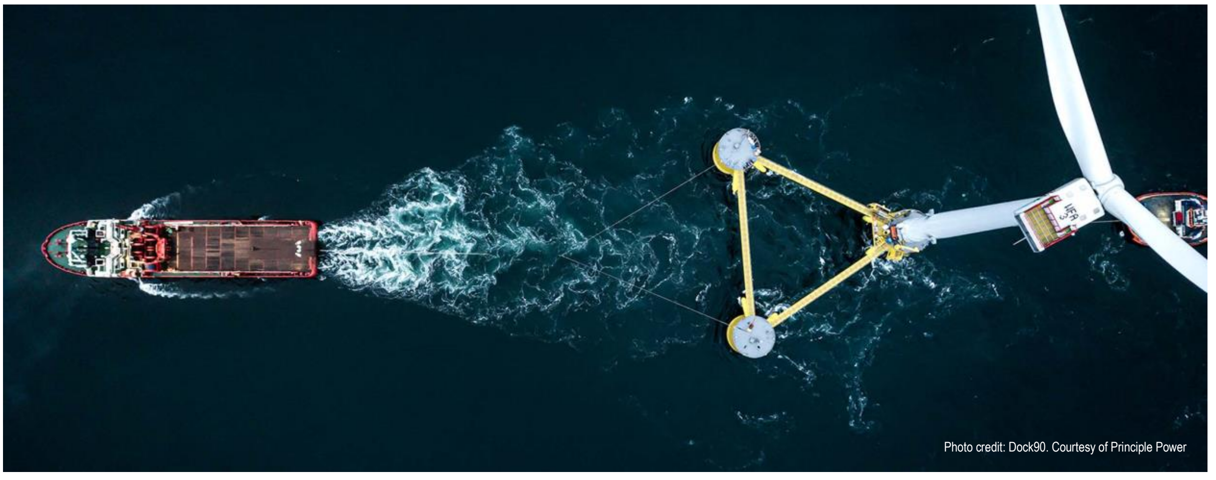

Project Erebus Environmental Statement
Chapter 11: Offshore Ornithology

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Acronyms

Term	Definition
BDMPS	Biologically Defined Minimum Population Scale
BTO	British Trust for Ornithology
CIEEM	Chartered Institute of Ecology and Environmental Management
CRM	Collision Risk Modelling
DAS	Digital Aerial Survey
EIA	Environmental Impact Assessment
ES	Environmental Statement
EU	European Union
FLOW	Floating Offshore Wind Farm
GSD	Ground Sample Distance
HRA	Habitats Regulations Assessment
IUCN	International Union for the Conservation of Nature
JNCC	Joint Nature Conservation Committee
KDE	Kernel Density Estimate
km	Kilometre
km^2	Square Kilometre
LDP	Local Development Plan
m	Metre
m^2	Square Metre
MCIEEM	Member of the Chartered Institute of Ecology and Environmental Management
MPS	Marine Policy Statement
MSc	Master of Science
n/a	Not Applicable
NE	Natural England
nm	Nautical Mile
NPS	National Policy Statement

Term	Definition
NRW	Natural Resources Wales
NSIP	Nationally Significant Infrastructure Project
PDE	Project Design Envelope
RiAA	Report to Inform Appropriate Assessment
RSPB	Royal Society for the Protection of Birds
sCRM	Stochastic Collision Risk Modelling
SD	Standard Deviation
SMP	Seabird Monitoring Programme
SNCB	Statutory Nature Conservation Body
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
UKBAP	United Kingdom Biodiversity Action Plan
UXO	Unexploded Ordnance
WNMP	Welsh National Marine Plan
WTG	Wind Turbine Generator
WTSWW	Wildlife Trust of South and West Wales

Chapter 11 Offshore Ornithology

11.1 Introduction

11.1.1.1 The proposed Project Erebus (the Project) is a demonstration scale Floating Offshore Wind (FLOW) development in the Celtic Sea region. The developer, Blue Gem Wind (BGW), is a joint venture between Simply Blue Energy (SBE) and TotalEnergies, set up to create a new low carbon offshore energy sector in the region; that contributes to climate change targets, supply chain diversification and energy security.

11.1.1.2 The array area is located approximately 35 km southwest of the Pembrokeshire coastline, covering an area of 43.5 km^2 in water depths of between 65-85 m. The array area is located outside of the 12 nm limit, but all elements of the Project, array area, offshore export cable corridor and landfall, fall within Welsh territorial waters or the Welsh Zone.

11.1.1.3 The Project comprises six to ten Wind Turbine Generators (WTG) with a total generating capacity up to 100 MW. Each WTG is housed on a semi-submersible floating platform, with a mooring system comprising a maximum of five catenary mooring lines, up to 870 m in length, and a range of foundation options including drag embedment anchors, driven piles, drilled piles and/or suction piles. Up to 10 dynamic array cables are proposed, with a lazy wave configuration from the semi-submersible floating platform to the seabed. The offshore export cable, up to 49 km in length, links the array area to landfall at West Angle Bay, Pembrokeshire.

11.1.1.4 This chapter of the Environmental Statement (ES) sets out the offshore ornithological interest of the Project array area, off the southwest Pembrokeshire coast in Wales. It considers those seabird species which are known to, or are likely to, occur within the array area and, where relevant, a 2 km buffer. The focus is on those seabird species that were recorded during the digital aerial survey work, undertaken by HiDef Aerial Surveying Limited in order to inform this assessment.

11.1.1.5 This assessment considers regional populations and seabird species as qualifying interests of Sites of Special Scientific Interest (SSSIs) and Special Protection Areas (SPAs) found within foraging range of the Project array area, as discussed in Volume 3, Technical Appendix 11.2: Apportioning. Impacts on offshore ornithological interests may arise during the construction, operation and decommissioning of the Project, and are discussed in detail in this Chapter.

11.1.1.6 Impacts are considered in relation to defined seabird populations for the breeding season and, where necessary, the non-breeding season. Populations are defined on a species-by-species basis and include those of designated sites such as SPAs and SSSIs. They also include regional Welsh populations defined according to the available literature (Pritchard *et al*., 2021).

11.1.1.7 Hidef Aerial Surveying Ltd (HiDef) have undertaken the survey data analysis, the apportioning calculations, the impact modelling (collision risk and displacement) and the population viability analysis as presented in Volume 3, Technical Appendices 11.1 – 11.6. This work has helped inform the ornithological impact assessment and cumulative impact assessment undertaken by MarineSpace as presented in this Chapter.

11.2 Legislation, Policy and Guidelines

11.2.1.1 The Project is seeking a Section 36 consent with deemed planning permission under the Electricity Act 1989 from Welsh Ministers, administered by Planning and Environment Decisions Wales (PEDW), and a Marine Licence under the Marine and Coastal Access Act 2009 (MCAA), issued by Natural Resources Wales (NRW).

11.2.1.2 A detailed overview of the relevant policy and legislation for the Project is provided in Chapter 5: Policy and Legislation. Details of relevant legislation, policy, and guidelines that have been taken into consideration during this assessment are outlined below.

11.2.2 Legislation

11.2.2.1 Relevant legislation has been reviewed and taken into account as part of this assessment. Of particular relevance is:

- EU Habitats Directive (Directive 92/43/EEC) on the Conservation of Natural Habitats and of Wild Fauna and Flora;
- EU Birds Directive (Council Directive 2009/147/EC) on the Conservation of Wild Birds;
- Conservation of European Wildlife and Natural Habitats Convention (Bern Convention);
- The Conservation of Habitats and Species Regulations 2017 (the Habitats Regulations), implements species protection requirements of the Habitats Directive in inshore waters;
- The Conservation of Offshore Marine Habitats and Species Regulations 2017 (the Offshore Habitats Regulations), implements the requirements of the Habitats Directive in the UK offshore marine area (beyond 12 nautical miles (nm));
- Environment (Wales) Act 2016;
- Marine and Coastal Access Act 2009;
- UK Post-2010 Biodiversity Framework, superseding the UK Biodiversity Action Plan (UKBAP), the UK Government’s response to the Convention on Biological Diversity (CBD) 1992; and
- The Wildlife and Countryside Act 1981 (as amended).

11.2.2.2 Other relevant legislation and policies have also been considered during this assessment (see Chapter 5: Policy and Legislation).

11.2.3 Policy

National Policy Statements

11.2.3.1 Although this Project is seeking Section 36 consent under the Electricity Act 1989, and a Marine Licence under the Marine and Coastal Access Act (MCAA) 2009, as opposed to a Development Consent Order (DCO), its size (up to 100 MW) is similar to the minimum threshold (100 MW) for Nationally Significant Infrastructure Projects (NSIPs). As such, guidance relevant to NSIPs is considered relevant to use for this Project. National Policy Statements (NPSs) were developed to provide guidance in the determination of NSIPs.

11.2.3.2 Those relevant for the assessment of impacts on offshore ornithology include[1]:

- Overarching National Policy Statement (NPS) for Energy (EN-1) (Department of Energy and Climate Change (DECC), 2011a); and
- NPS for Renewable Energy Infrastructure (EN-3), July 2011 (DECC, 2011b).

11.2.3.3 Review of these NPSs shows there are no specific references to offshore ornithology in the marine or coastal environment. Section 5.3 of EN-1 sets out the policy in relation to generic biodiversity impacts, which have been considered. Details of specific policies within EN-3, used to inform this assessment are provided in Table 11.1.

Table 11.1 – National Policy Statement EN-3 assessment provisions relevant to offshore ornithology

NPS Requirement	NPS Reference	ES Reference
Offshore wind farms have the potential to impact on birds through: collisions with rotating blades; direct habitat loss; disturbance from construction activities such as the movement of construction/decommissioning vessels and piling; displacement during the operational phase, resulting in loss of foraging/roosting area; and impacts on bird flight lines (i.e. barrier effect) and associated increased energy use by birds for commuting flights between roosting and foraging areas.	EN-3, Section 2.6.101	Potential impact to seabirds arising from construction, operation and decommissioning activities are assessed in Section 11.6.
The scope, effort and methods required for ornithological surveys should have been discussed with the relevant statutory advisor.	EN-3, Section 2.6.102	The scope, effort and methods for ornithological surveys were agreed in consultation with NRW, as presented in Table 11.4
It may be appropriate for assessment to include collision risk modelling for certain species of birds. Where necessary, the assessments carried out by Applicants should assess collision risk using survey data collected from the site at the pre-application EIA stage. The IPC [Infrastructure Planning Commission] will want to be satisfied that the collision risk assessment has been conducted to a satisfactory standard having had regard to the advice from the relevant statutory advisor.	EN-3, Section 2.6.104	Collision risk modelling has been undertaken where required, and is discussed further in Section 11.6 and Volume 3, Technical Appendix 11.3: Collision Risk Modelling.
Aviation and navigation lighting should be minimised to avoid attracting birds, taking into account impacts on safety.	EN-3, Section 2.6.107	The potential impacts to ornithology arising from aviation and navigation lighting is

[1] A period of consultation on a set of revised energy NPSs, managed by the Department of Business, Energy and Industrial Strategy (BEIS), ended on 29th November 2021.

NPS Requirement	NPS Reference	ES Reference
		discussed in Section 11.6 and Chapter 17: Aviation and Radar.
Subject to other constraints, wind turbines should be laid out within a site, in a way that minimises collision risk, where the collision risk assessment shows there is a significant risk of collision.	EN-3, Section 2.6.108	Assessment confirms no significant risk of collision, Section 11.6 and Volume 3, Technical Appendix 11.3: Collision Risk Modelling.
Construction vessels associated with offshore wind farms should, where practicable and compatible with operational requirements and navigational safety, avoid rafting seabirds during sensitive periods.	EN-3, Section 2.6.109	This is discussed in Section 11.4.6 and Section 11.6.

UK Marine Policy Statements

11.2.3.4 The UK Marine Policy Statement (MPS) provides the policy framework for the preparation of marine plans, and establishes how decisions affecting the marine area should be made in order to enable sustainable development. The MPS was adopted by all UK administrations in March 2011. The MPS sets out a vision of having ‘clean, healthy, safe, productive and biologically diverse oceans and seas’ by supporting the development of Marine Plans. It also sets out the framework for environmental, social and economic considerations that needs to be considered in marine planning. Requirements from the MPS relevant to the Project with regards to offshore ornithology are outlined in Table 11.2.

Table 11.2 – National and Regional Policy requirements from the Marine Policy Statement relevant to offshore ornithology

Policy Description	Reference	ES Reference
Certain bird species may be displaced by offshore wind turbines, which also have the potential to form barriers to migration or present a collision risk for birds.	Section 3.3.24	Displacement, barrier effects and collision risk are assessed in Section 11.6.

Welsh National Marine Plan (WNMP)

11.2.3.5 The Welsh Government published its first marine plan for Welsh inshore and offshore waters, the Welsh National Marine Plan (WNMP), in November 2019. The WNMP was developed in accordance with the MCAA 2009 and the UK MPS. The WNMP covers a 20-year period from its adoption in 2019. The publishing of the WNMP in November 2019 followed a period of consultation from 7 December 2017 to 29 March 2018 (the WNMP is discussed further in Chapter 5: Policy and Legislation).

11.2.3.6 Requirements relevant to the Project from the WNMP are outlined in Table 11.3.

Table 11.3 – Requirements from the Welsh National Marine Plan relevant to offshore ornithology

Policy Description	Reference	ES Reference
Proposals should demonstrate that they have considered man-made noise impacts on the marine environment and, in order of preference: a) avoid adverse impacts; and/or b) minimise impacts where they cannot be avoided; and/or c) mitigate impacts where they cannot be minimised. If significant adverse impacts cannot be adequately addressed, proposals should present a clear and convincing justification for proceeding.	ENV-05: Underwater Noise	The effects of underwater noise on offshore ornithology have been considered in Section 11.6. Further information is available in Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration.
Proposals should demonstrate that they have assessed potential cumulative effects and, in order of preference: a) avoid adverse effects; and/or b) minimise effects where they cannot be avoided; and/or c) mitigate effects where they cannot be minimised. If significant adverse effects cannot be adequately addressed, proposals should present a clear and convincing justification for proceeding. Proposals that contribute to positive cumulative effects are encouraged.	GOV_01: Cumulative Effects	Cumulative impacts are assessed in Section 11.10 and Chapter 30: Cumulative Effects.

11.2.4 Guidance

11.2.4.1 This offshore ornithological impact assessment adopts the good practice guidance set out in the documents below.

- CIEEM (2018): guidelines on the approach to EIA, recommend that conservation value is taken into account for ecological receptors;
- Furness *et al*. (2013): analysis of seabird species sensitivity to offshore wind farm developments, used to assess the sensitivity metrics in Table 11.6;
- Furness (2015): report on biologically defined minimum population scales (BDMPS), used to define seasonality for each species in Table 11.12;

- McGregor *et al.* (2018): guidance on a stochastic collision risk model for seabirds in flight. Used to estimate the risk that a bird will collide fatally with the blades of an offshore turbine. Used for the seabird impact assessment presented in Section 11.6. and Volume 3, Technical Appendix 11.3: Collision Risk Modelling;
- Searle *et al*. (2019): Natural England guidance on population modelling, used where the level of predicted impact is high enough that it may affect a species population status, reported in Volume 3, Technical Appendix 11.5: Population Viability Analysis;
- SNCB (2014): advice note from the joint statutory nature conservation bodies on avoidance rates to use in collision risk modelling, confirmed by NRW as the advice to follow, Section 11.6. and Volume 3, Technical Appendix 11.3: Collision Risk Modelling;
- SNCB (2017): advice note from the joint SNCBs on undertaking displacement assessment. Used to consider the risk that birds will be displaced from an operational wind farm development and to estimate the mortality that may arise as a result. Used for the seabird impact assessment presented in Section 11.6. and Volume 3, Technical Appendix 11.4: Displacement Analysis; and
- Woodward *et al*. (2019): defines the seabird foraging ranges used for screening designated sites into apportioning calculations, see Section 6.1.1.1 and Volume 3, Technical Appendix 11.2: Apportioning.

11.3 Consultation and Scoping

11.3.1.1 An EIA Scoping Report (MarineSpace Ltd, 2019) was produced and submitted to NRW in October 2019. NRW consulted with a number of statutory bodies and key stakeholders upon the contents. NRW provided a formal Scoping Opinion in January 2020. The comments from NRW relevant to this Chapter have been summarised in Table 11.4. These comments have been addressed fully in this Chapter, with the location of the relevant information highlighted under 'applicant action' for ease of reference.

Table 11.4 – Summary of Consultation relating to ornithology

Consultee	Response	Applicant Action
NRW/Joint Nature Conservation Committee (JNCC) /Royal Society for the Protection of Birds (RSPB) /various academia June 2019	Enquiries were made about existing seabird data sets to help inform the site selection process.	Publicly available data and data under licence from JNCC and NRW were identified and utilised to refine the site selection, specifically in relation to the array area. Further detail is provided in Chapter 3: Site Selection and Alternatives.
NRW marine ornithology survey comments October 2019	Proposed aerial survey methodology shared with NRW. Two years of survey data welcomed but required more information on flight height calculations due to known issues.	Detailed methodology of the aerial survey was provided and information on flight height calculations was shared, further information is presented in Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report.

Consultee	Response	Applicant Action
JNCC Scoping Advice Nov 2019	Requested that gannet colonies within recommended foraging range were considered within the submitted ES.	The recommended foraging range has been used to apportion the predicted impacts to different SPAs in this Chapter and in Volume 3, Technical Appendix 11.2: Apportioning.
JNCC Scoping Advice Nov 2019	The extents proposed for consideration of offshore cumulative, and in-combination, effects are largely insufficient for potential adverse effects to SPAs as search area extents for in-combination HRA should be based on foraging ranges of SPA features deemed to be affected by the Project, and applied to the SPA. This could potentially lead to areas much further than 200 km from the Project location being included.	Further details on the cumulative assessment are presented in Section 11.10 and Chapter 30: Cumulative Effects.
JNCC Scoping Advice Nov 2019	We would ask whether flight heights can be estimated with confidence from DAS? There are other methods of flight height estimation, and each method has its own limitations and biases. More than one method for estimating flight height distributions should be considered (e.g., GPS tracking, LiDAR, laser range-finder).	The manuscript on the flight height methodology as submitted for publication was shared to NRW/JNCC and was used in application of Band (2012) Option 1 in the sCRM. Further details are presented in Volume 3, Technical Appendix 11.3: Collision Risk Modelling.
JNCC Scoping Advice Nov 2019	Given the position of the windfarm in relation to Skomer, Skokholm and the Seas Off Pembrokeshire SPA, and that one of the conservation objectives of that site is to provide foraging habitat for several species of breeding birds, connectivity between the marine components of the SPA and the breeding colonies needs to be maintained. Therefore, it would be beneficial to collect data on flight-lines of birds from the colony to the marine components of the SPA in order to ascertain whether the project is likely to constitute a barrier to such flights, or to lead to increased energy expenditure as birds alter their flights to avoid the project (and a buffer).	Additional data were commissioned by the Applicant as referred to in Section 11.4.5 and referenced in the species account in Section 11.5.5. This includes data on connectivity between the array area and SPA.

Consultee	Response	Applicant Action
JNCC Scoping Advice Nov 2019	The project location appears to overlap with Skomer, Skokholm and the Seas Off Pembrokeshire SPA	There is a minimal overlap with the Project array area and the Skomer, Skokholm and Seas off Pembrokeshire/Sgomer, Sgogwm a Moroedd Penfro SPA within the marine component. This is considered further in Section 11.5.3.4 and Chapter 3: Site Selection and Alternatives.
NRW Scoping Opinion Jan 2020	Requested that gannet colonies within recommended foraging range are considered within the submitted ES.	The recommended foraging range has been used to apportion the predicted impacts to different SPAs in this Chapter and in Volume 3, Technical Appendix 11.2: Apportioning.
NRW Scoping Opinion Jan 2020	Advised that collision risk should be considered as a direct impact and include both injury and mortality.	Collision risk is assessed as a direct impact in Section 11.6 and in Volume 3, Technical Appendix 11.3: Collision Risk Modelling.
NRW Scoping Opinion Jan 2020	Queried screening of North Cardigan Bay SPA (designated for red-throated diver) in relation to screening of sites with ornithological features.	No confirmed red-throated diver were recorded in the two years of digital aerial survey work, Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report. Therefore, this species has not been scoped in for assessment.
NRW Scoping Opinion Jan 2020	Noted potential for effects of underwater noise on diving birds via pathways including UXO detonation and requested this be scoped into the assessment.	The potential impacts of underwater noise on diving birds has been assessed in Section 11.6 and Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration.
NRW/JNCC project kick off meeting July 2020	NRW advise that in previous OWF assessments flight height data were not able to be used. A method of calculating flight heights has been developed inhouse by HiDef.	The manuscript on the flight height methodology as submitted for publication was shared to NRW/JNCC and was used in application of the Band (2012) Option 1 in the sCRM, Volume 3, Technical Appendix 11.3: Collision Risk Modelling.
Wildlife Trust of South and West Wales (WTSWW) project discussion July 2020	There is evidence of Manx shearwater being attracted to port infrastructure/large vessel lights and therefore there is a collision risk.	This has been assessed in Section 11.6 and Volume 3, Technical Appendix 11.3: Collision Risk Modelling.
RSPB project discussion September 2020	Northern gannet need to be considered with regard to displacement.	Northern gannet have been assessed for displacement in Section 11.6 and in Volume 3,

Consultee	Response	Applicant Action
		Technical Appendix 11.4: Displacement Analysis.
RSPB second project discussion October 2020	RSPB are content that stochastic CRM (sCRM) would be appropriately applied. It was noted that RSPB advice differs from current SNCB guidance in respect of northern gannet avoidance rate. Ideally a mixture of digital aerial survey data, plus tagging/tracking data should be used.	Investigations were made into tracking/tagging data that could be available to the Project and these have been used to give context to the digital aerial survey data. The different advice on avoidance rate for gannet has been noted, but the sCRM has been based on the avoidance rates recommended in the SNCB (2014) guidance, as advised by NRW.
NRW/JNCC year 1 digital aerial survey discussion November 2020	NRW are unable to agree a list of species to be included in the collision risk modelling and the displacement and barrier effects assessment without seeing the full two years data from the digital aerial surveys. However, from the first year of survey data, the species proposed for inclusion in these assessments seem appropriate. JNCC is content to agree with NRW that, from the first year of survey data, the species proposed for inclusion in these assessments seem appropriate.	The 2 Year Survey Report was shared with NRW and JNCC, however, the Project timescales did not allow for a meeting to discuss further. These data are presented in Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report, and included as the basis for assessment in this Chapter and supporting appendices.
NRW/JNCC/RSPB year 1 digital aerial survey discussion November 2020	European storm-petrels are present at Skokholm with a population of 2,000 pairs in 2016.	European storm-petrels were not recorded in the Project array area (or buffer) during the two years of digital aerial survey work, however, they are assessed qualitatively in this Chapter.
NRW/JNCC/RSPB year 1 digital aerial survey discussion November 2020	Project specific surveys are not undertaken at either dawn or dusk and therefore birds, especially Manx shearwater, could be missed.	Additional data were commissioned by the Applicant as referred to in Section 11.4.5 and referenced in the species account in Section 11.5.5 to supplement the assessment in respect of diurnal activity.
Seabird data meeting (NRW/JNCC/RSPB/WTSWW/academia) January 2021	Discussion held on the Project, planned EIA approach and surveys to date. Introductions were given to a number of academic researchers who undertake tagging and tracking	Additional data were commissioned by the Applicant as referred to in Section 11.5.5.

Consultee	Response	Applicant Action
	and study seabirds from the Pembrokeshire islands.	
Additional seabird data April – July 2021	Following the meeting in January 2021 discussions were held with the academic researchers to discuss the commissioning of additional data to inform the ornithological impact assessment.	Additional data were commissioned by the Applicant as referred to in Section 11.5.5 including data on connectivity, crepuscular activity, seabird behaviour at sea and flight heights.
National Trust Erebus consultation August 2021	The principles behind the project are supported. Await the detailed assessment, particularly in relation to impacts on Manx shearwater, gannet, and guillemot. Should night-time lighting be used await details.	Detailed assessments on Manx shearwater, northern gannet and guillemot are presented in Section 11.6 and lighting impacts considered further in Section 11.6.4.59.
NRW/JNCC - Ornithology Assessment Methodology and Apportioning Calculations September 2021 (similar comments contained within separate responses)	NRW/JNCC had no objection on the seasons presented or approach to apportioning in the non-breeding season.	Submitted approach has been adopted for impact assessment as discussed in the Chapter and Volume 3, Technical Appendix 11.2: Apportioning.
JNCC - Ornithology Assessment Methodology and Apportioning Calculations September 2021	Great black-backed gull can be removed from HRA due to there being no SPAs within foraging range, however based on results of surveys cannot currently be ruled out from EIA. Although not designated at SPAs along the Welsh coast, fulmar should be considered for EIA purposes if detected during future surveys. Razorbill should be included within the "Short-list of Site Breeding Populations for each relevant Species". CRM: In advance of a joint advice note which is being produced by JNCC and other SNCBs it is recommended that the avoidance rates in Table A2 of Cook (2021) are used in impact assessments. It is also likely to recommend that a stochastic CRM is undertaken, and that Band Option 2 (stochastic version) is always	The JNCC advice has been adopted in this Chapter with the exception of the use of Cook (2021) for collision risk avoidance rates where NRW has updated its advice and advise using SNCB (2014) guidance.

Consultee	Response	Applicant Action
	presented, alongside other options which may be appropriate. The approach to displacement assessment and population modelling is agreed with. Woodward *et al.* (2019) is to be used for foraging ranges.	
NRW response to Ornithology Assessment Methodology and Apportioning Calculations September 2021	Population Assessment: Ensure all SSSIs and SPAs are included as per Woodward *et al* (2019) - European storm-petrels, razorbills etc. Ensure that all colonies are included when apportioning birds not just protected sites e.g. kittiwake colony on St Margaret's Island The great black-backed gull will not need to be assessed under HRA as there are no SPAs within foraging range. However, for EIA assessment regional population assessments will be required. For the breeding season, sites connected by Woodward *et al*. (2019) mean max +1 standard deviation (SD) for a regional population need to be assessed, whilst for winter and migration Furness *et al.* (2015) is recommended. Fulmar should be considered for EIA purposes, based on the results of the ongoing surveys and regional population assessment. CRM: The Basic Band model for gannet and kittiwake using the new avoidance rates in Table A2, Cook (2021) should be used. The use of the Extended Band model when baseline data is collected from digital aerial surveys, and there is no robust site-specific flight height distribution data available, cannot be accepted. Herring gull needs to be included within CRM calculations It is agreed that population modelling, as per Natural England's guidance 'A	On 22 October 2021 NRW confirmed it has updated its advice on avoidance rates for collision risk modelling and advises using SNCB (2014) guidance and not the new avoidance rates in Table A2, Cook (2021). EIA is undertaken against regional populations; defined in Pritchard *et al*. (2021) for the breeding season, and Furness (2015) for the non-breeding season. Whilst apportioning was carried out for SPAs and SSSIs named in the NRW advice, it was not technically feasible nor proportionate to apportion against every colony listed in Pritchard *et al.* (2021). The apportioning demonstrates that it is the closest and largest colonies, i.e., the SPAs, against which most impacts are assigned. There is no legal mechanism or legal requirement to consider off-site (at sea) impacts to SSSI populations in the way that it is possible to do for SPAs. There is no mechanism for defining connectivity between at sea concentrations of seabirds and breeding SSSI colonies in the way that there is for SPAs. This is a limitation of the site-based protection provided by SSSIs. CRM calculations have been provided for herring gull within the CRM Technical Appendix. The new avoidance rates in Table A2, Cook (2021) have not been used for collision risk avoidance rates as NRW has

Consultee	Response	Applicant Action
	Population Viability Analysis Modelling Tool for Seabird Species' is to be used. Apportioning calculation: welcome the use of Woodward *et al.* 2019 foraging ranges.	since updated its advice and advises using SNCB (2014) guidance.
WTSWW Ornithology Assessment methodology and Apportioning Calculations August 2021	WTSWW maintain their concern that DAS surveys are inadequate in measuring the usage of the area by SPA seabird species. The time and condition limited 'snap-shot' they provide has serious flaws for species in the Celtic Sea, that are known to be most active at dawn and dusk and at night and cannot record changes in activity or behavior in high-wind conditions. The use of the analysed tracking data will go some way to addressing this.	Additional data analysis was commissioned by the Applicant to supplement the ornithological impact assessment, as discussed in Section 11.4.5 including data on connectivity, crepuscular activity, seabird behaviour at sea and flight heights.
WTSWW Ornithology Assessment methodology and Apportioning Calculations August 2021	Extensive trials of the NE PVA application have been undertaken and found it be unreliable for some species. Its use could result in the impact assessments underestimating the potential threats to some of our seabird species, especially those already showing long-term declining population trends such as black-legged kittiwake.	This point is noted. However, as was acknowledged by WTSWW, the results of these trials have not yet been published. Once this is done it is expected that WTSWW would hold discussions directly with NE on behalf of the SNCBs, who commissioned this work. It should be emphasised that this concern was raised with emphasis on use for assessment of black-legged kittiwake. The Project has only applied PVA for assessment of northern gannet and common guillemot. As such, it is considered that there is minimal risk of unreliable results. However, should this work be published and lead to amendments in usage guidance, the Project team will take this into account and update any assessment accordingly.
WTSWW and Island Conservation Advisory Committee Project Update Call September 2021	Project and methodology updates shared. Requested the 2 Year Survey Report be shared.	Noted, report shared on 15 November 2021.
NRW, JNCC, RSPB, WTSWW, academics 2	The 2 Year Bird Survey Report was shared for information but	No action.

Consultee	Response	Applicant Action
Year Bird Survey Report, November 2021	due to the Project's imminent submission date it was not possible to programme in a meeting to discuss with stakeholders.	

11.4 Assessment Methodology and Significance Criteria

11.4.1.1 Detailed discussion on the EIA methodology can be found in Chapter 2: Overview of EIA Methodology. Impacts to offshore ornithology are based on the potential impacts identified within the EIA Scoping Report (MarineSpace 2019), and any additional potential impacts which have been identified via consultation with key stakeholders.

11.4.1.2 The assessment considers the potential impacts of the Project, as set out in the Project Design Envelope (PDE) and Chapter 4: Proposed Development Description, on key seabird species recorded in the Project array area from two years of digital aerial survey (Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report). It addresses the impacts that could arise on these receptors from the three key phases of development:

- Construction;
- Operation (and maintenance); and
- Decommissioning.

11.4.1.3 The impact assessment is informed by the following;

- Volume 3, Technical Appendix 11.1: Baseline Data;
- Volume 3, Technical Appendix 11.2: Apportioning;
- Volume 3, Technical Appendix 11.3: Collision Risk Modelling;
- Volume 3, Technical Appendix 11.4: Displacement Analysis;
- Volume 3, Technical Appendix 11.5: Population Viability Analysis;
- Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report;
- Volume 4 (Confidential), Technical Appendix 11.7: Langley L, and Votier S., July 2021. Grassholm Gannet Project – Analysis of tracking data to inform Erebus EIA (Heriot-Watt University);
- Volume 4 (Confidential), Technical Appendix 11.8: Davies K, Padget O, and Guilford T, July 2021. An analysis of Oxnav Manx shearwater tracking data in relation to the Erebus project (University of Oxford); and
- Volume 4 (Confidential), Technical Appendix 11.9: Birkhead T, September 2021. Skomer Common Guillemot long-term population study: analysis of survival data to inform Erebus EIA (University of Sheffield).

11.4.1.4 Detailed methodologies for the baseline assessments, analysis and modelling are summarise below, but further described in each corresponding technical appendix, which should be read in conjunction with this chapter.

Apportioning Methodology

11.4.1.5 Apportioning is used to determine the proportion of birds, which may be impacted as a result of the Project, that belong to each breeding colony or population. The apportioning undertaken for the Project follows the guidance set out by NatureScot (2018). Apportioning focussed on the breeding season and was carried out for following species, as they are qualifying features of SPAs and/or SSSI, which are discussed further under Section 11.5.5:

- Manx shearwater *Puffinus puffinus*;
- Northern gannet *Morus bassanus*;
- Lesser black-backed gull *Larus fuscus*;
- Black-legged kittiwake *Rissa tridactyla*;
- Atlantic puffin *Fratercula arctica*;
- Common guillemot *Uria aalge*; and
- Razorbill *Alca torda*;

11.4.1.6 Seabird populations, obtained from the Seabird Monitoring Programme database (JNCC, 2021) were used and, in line with guidance (NatureScot, 2018), apportioning was based on numbers of individuals at each colony for a defined baseline. The calculation is a weighting, based on population size, distance between the Project and breeding colonies, and areas of sea within the species-specific foraging range (Woodward *et al.*, 2019). Further details and the results of the apportioning exercise are provided in Volume 3, Technical Appendix 11.2: Apportioning and Section 11.5.4.

Collision Risk Modelling Methodology

11.4.1.7 Collision risk modelling (CRM) for the Project was undertaken using the stochastic CRM (sCRM) (McGregor *et al.*, 2018), which builds upon the previously accepted Band (2012) model for Offshore Wind Farms (OWFs). The model incorporates uncertainty and variability within the input parameters and produces estimates, along with confidence intervals, of the risk of seabirds entering the array area and colliding with the WTG blades.

11.4.1.8 Further detail, and the results of the CRM, can be found in Volume 3, Technical Appendix 11.3: Collision Risk Modelling; summaries of the methodology and the input are provided below.

11.4.1.9 Several input parameters are required in order to produce collision risk estimates for each species (McGregor *et al.*, 2018):

- Turbine scenarios, which include data such as location, number of WTGs, number of blades, rotor radius, hub height, maximum height and air gap;
- Turbine operation, which makes considerations for WTG downtime due to wind speed and maintenance, on a monthly basis;
- Seabird parameters, including dimensions (length and wingspan) as well as flight speed, nocturnal activity and type of flight (gliding or flapping);
- Seabird monthly densities, calculated as the monthly mean across two years of survey work;
- Avoidance rates, per species, taken from SNCB (2014) guidance; and
- sCRM model option:

- Option 1, which uses Project-specific flight height data; or
- Option 2, which uses generic flight height data (Johnston *et al.*, 2014).

11.4.1.10 Three WTG scenarios were considered in order to ensure a worst-case approach was taken:

- 10 x 9.5 MW WTGs with rotor radius of 87 m, upper height of 196 m and 22 m air gap;
- 7 x 14 MW WTGs with a 111 m rotor radius, 244 m upper height and 22 m air gap; and
- 6 x 16 to 18 MW WTGs with a 121 m rotor radius, 270 m upper height and 22 m air gap.

11.4.1.11 Turbine downtime input parameters ranged from 0.05% downtime in winter (January and February) to a peak of 0.13% downtime in June. This remained constant in all scenarios.

11.4.1.12 Seabird parameters were constant in the modelling and were obtained from several agreed sources. These include Pennycuick (1997), Alerstam *et al.* (2007) and Furness *et al.* (2018). The model uses generic values from these sources (McGregor *et al.*, 2018), except for flight speed for northern gannet and Manx shearwater, where site-specific tracking data were utilised (see Section 11.4.5).

11.4.1.13 Seabird density inputs were determined from the two years of surveying. Volume 3, Technical Appendix 11.1: Baseline provides detail on the values used in the CRM. The estimates include measures of uncertainty (standard deviation) which is input into the model.

11.4.1.14 Seabird avoidance rates input into the sCRM were obtained from SNCB (2014), with rates of 0.989 used for gannet and black-legged kittiwake, 0.995 for the gull species (herring, lesser black-backed and great black-backed) and 0.98 for the Manx shearwater and common guillemot.

11.4.1.15 Where Project-specific flight height data were available, sCRM Option 1 was used, which produced the worst-case assessment. For Manx shearwater and common guillemot, Project-specific flight height data were not available, and as such sCRM Option 2 was used, using generic flight height data (Johnston *et al.*, 2014).

Displacement Assessment Methodology

11.4.1.16 Displacement analysis was undertaken to consider potential effects associated with displacement of seabirds (defined by Furness *et al.* (2013) and Bradbury *et al.* (2014) as *"a reduced number of birds occurring within or immediately adjacent to an offshore wind* farm"). Furness *et al.* (2013) and Bradbury *et al.* (2014) provide displacement rankings for seabird species, based upon sensitivity to disturbance and habitat specialisation.

11.4.1.17 These rankings, along with Project-specific density data, were used in the model to produce displacement matrices in line with SNCB (2017) guidance. Several additional parameters, including Project area (plus the relevant species-specific buffer), defined seasons for each species (Furness, 2015), and mean seasonal peak population estimates from Project-specific survey data, were used to inform the analysis (Volume 3, Technical Appendix 11.1: Baseline).

11.4.1.18 Post-construction monitoring data from other OWF projects were used to provide insight into displacement rates. Projects with data on the aforementioned species were reviewed in detail, and displacement rates between 18% and 85% were found, depending on species and OWF development. In addition to this information, mortality rates of those birds that were displaced, were also estimated.

11.4.1.19 Further detail on the methodology, and the results of the analysis, are presented in Volume 3, Technical Appendix 11.4: Displacement Analysis.

Population Viability Analysis Methodology

11.4.1.20 Population viability analysis (PVA) was carried out using the PVA tool (Searle *et al.*, 2019) produced by the Centre for Hydrology and Ecology (CEH), as commissioned by Natural England. The tool takes several input parameters, including natural, or baseline, mortality rates and expected mortality rates from the Project, to produce future population projections, per species.

11.4.1.21 Northern gannet and common guillemot were the only species where the output of the worst-case CRM and displacement mortality scenarios were potentially significant against reference populations. For each species, several parameters, outlined below, were input into the PVA tool.

11.4.1.22 Demographic parameters include survival rate (juvenile, immature, and adult) and population growth rate. The data were primarily sourced from Horswill and Robinson (2015), however, adult common guillemot survival rates were amended to the estimate provided by Birkhead (2021). Species age class data were obtained from Horwsill and Robinson (2015) and input into the PVA tool, prior to running the models. The survival rate for both species increased with age, with the exception of adult survival for common guillemot, as the SPA-specific value was used (Birkhead, 2021).

11.4.1.23 The PVA models were run from the year the population census was conducted for each species, assuming a Project commissioning date of October 2027, with impacts lasting for 25 years. Each simulation was run 1,000 times, in order to obtain a population projection and uncertainty (standard deviation).

11.4.1.24 Each model was also run, taking adult collision and displacement mortality into consideration, allowing the impacts to scale with population over time.

11.4.1.25 Further details, and the results of the PVA, are provided in Volume 3, Technical Appendix 11.5: Population Viability Analysis.

11.4.2 Study Area

11.4.2.1 During the breeding season, the study area for seabird interests is defined on a species-by-species basis by the foraging range (mean maximum plus one standard deviation) as set out in Woodward *et al.* (2019) and detailed in Volume 3, Technical Appendix 11.2: Apportioning. A summary of the foraging ranges in presented in Table 11.5

Table 11.5 – Breeding season foraging ranges of species considered (Source: Woodward *et al.*, 2019)

Common Name	Latin Name	Foraging Range (km)		
		Mean Max	Standard Deviation	Sum
Northern fulmar	*Fulmarus glacialis*	542.3	657.9	1,200.2

Common Name	Latin Name	Foraging Range (km)		
		Mean Max	Standard Deviation	Sum
Manx shearwater	*Puffinus puffinus*	1,346.8	1,018.7	2,365.5
European storm-petrel	*Hydrobates pelagicus*	336.0	Insufficient Data	336.0
Northern gannet	*Morus bassanus*	315.2	194.2	509.4
Herring gull	*Larus argentatus*	58.8	26.8	85.6
Great black-backed gull	*Larus marinus*	73.0	Insufficient Data	73.0
Lesser black-backed gull	*Larus fuscus*	127.0	109.0	236.0
Black-legged kittiwake	*Rissa tridactyla*	156.1	144.5	300.6
Atlantic puffin	*Fratercula arctica*	137.1	128.3	265.4
Common guillemot	*Uria aalge*	73.2	80.5	153.7
Razorbill	*Alca torda*	88.7	75.9	164.6

11.4.2.2 Regional populations of breeding seabirds have been defined for Wales using Pritchard *et al.* (2021). In the non-breeding season, the species-specific study areas are defined using the Furness (2015) report on biologically defined minimum population scales (BDMPS). These species-specific study areas have been used for assessment of wind farm impacts against defined seabird populations in the breeding and non-breeding periods.

11.4.2.3 The Study Area includes the offshore components of the Project, including the array area and offshore export cable corridor (ECC) to landfall at West Angle Bay. Onshore ornithology is considered in Chapter 20: Terrestrial and Coastal Ecology and Onshore Ornithology.

11.4.3 Desk Study

11.4.3.1 'The Birds of Wales' (Pritchard *et al.,* 2021) provides a comprehensive summary of bird species present in Wales, historic and current trends, and future forecasts, in both terrestrial and marine environments. This has been referred to for each species baseline account provided in Section 11.5.5, and in order to define the regional populations used in determining magnitudes of impact (Table 11.8). Wales is important for the many different seabird species it supports, including large SPA colonies of Manx shearwater (*Puffinus puffinus)*, gannet (*Morus bassanus*) and guillemot (*Uria aalge*), all of which are addressed in this impact assessment.

11.4.3.2 The Seabird Monitoring Programme (SMP) Database (BTO, 2021) contains all records of breeding seabird populations around the UK, and has been consulted to obtain information for key SPAs and named SSSIs in Wales.

11.4.3.3 All counts for the most recent seabird census in the UK (Seabirds Count 2015-2019) have been collated and summarised in Volume 3, Technical Appendix 11.2: Apportioning. The populations thus collated are used in the apportioning calculations for the breeding season, as well as being referenced in the species accounts, Section 11.5.5.

11.4.3.4 During the breeding season, seabirds are central-based foragers, nesting in colonies on cliffs and islands and travelling out to sea each day to feed. The assessment considers which colonies are within foraging range of the Project, and then considers how to apportion the birds recorded on-site, between the different colonies within foraging range.

6.1.1.1. Apportioning is part of the desk study and, in the absence of any guidance issued by NRW, follows current guidance issued by NatureScot (2018) for marine renewables development. Foraging ranges are defined on a species-by-species basis, based on the mean max. foraging distance plus one standard deviation, given in Woodward et.al (2019). All SPAs within foraging range of the Proposed Development are included, and the apportioning calculation is a weighting based on:

- Population size (as taken from the SMP database);
- Distance between the Proposed Development and the designated sites within foraging range; and
- Area of sea included in the foraging range.

11.4.3.5 The outputs from the apportioning calculation are presented in Volume 3, Technical Appendix 11.2: Apportioning and Table 11.11, and can be used to inform assessments about which SPAs may have 'likely significant effect', see Volume 3, Technical Appendix 8.3: Report to Inform Appropriate Assessment.

11.4.3.6 In the non-breeding season, birds are not constrained by the requirements of breeding and will travel over large distances and mix freely in offshore waters. For the UK, biologically defined minimum population scales (BDMPS) have been defined in Furness (2015), for key species in the non-breeding season. These identify non-breeding populations of seabird species occurring in UK waters during migration and winter: BDMPS are defined on a species-by-species basis for each period and are used for reference against which to consider non-breeding season impacts from offshore wind development.

11.4.3.7 The Birds of Conservation Concern (Eaton *et al*., 2015) is published by the British Trust for Ornithology (BTO) and is a review of the status of birds in the UK, Channel Islands and Isle of Man. Using standardised criteria, 244 species with UK breeding, passage, or wintering populations are assessed, and assigned to the red, amber or green list of conservation concern. This 'traffic-lighting' system of conservation concern is informed by expert opinion. Reference to species conservation value is made in each of the summaries listed in Section 11.5.5.

11.4.4 Surveys

11.4.4.1 24 months of Digital Aerial Surveys (DAS) were commissioned by the Applicant, following consultation with NRW (October 2019). It was agreed surveys would be undertaken of the array area and a 4 km buffer, see Volume 2, Figure 11.1. The results of these surveys are presented in Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report, and relevant information summarised for assessment in Volume 3, Technical Appendix 11.1: Baseline Data.

11.4.4.2 The DAS focus on the seabird (and other marine fauna) interests that may be present in the array area and 4 km buffer, and aim to provide a representative sample of seasons, over a 24-month pre-construction period, to characterise the site.

11.4.4.3 Monthly surveys were flown from October 2019 to September 2021, with a survey design that placed 15 transects, spaced 1 km apart, across the array area and a 4 km buffer, comprising a total area of 200.11 km^2, see Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report. The transects had a principally north/south orientation, so that they were perpendicular to the depth gradient and potential oceanic fronts, thus helping to reduce variation in bird and mammal abundance between transects.

11.4.4.4 The DAS were undertaken using a specialist survey aircraft equipped with four Gen II cameras with sensors set to a resolution of 2 cm ground sample distance, when flown at about 550 m above sea level. Each camera sampled a strip of about 125 m width, separated from the next camera by approximately 25 m, which provided a combined sampled width of 500 m within a 575 m overall strip. Two cameras were analysed giving about a 25% sample coverage of the site.

11.4.4.5 Data analysis followed a two-stage process in which video footage was reviewed (with a 20% random sample used for audit), then the detected objects were identified to species or species group level (again with 20% selected at random for audit). The audit of both stages required 90% agreement to be achieved.

11.4.4.6 Density and abundance estimates were calculated using strip transect analysis and a statistical technique called kernel density estimation (KDE) was used to create density surface maps. A full summary of the survey methodology and survey results is available in Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report.

11.4.5 Additional Data

11.4.5.1 Following a meeting held on the 28 January 2021 with NRW, JNCC, RSPB, WTSWW and representatives from University of Oxford, Heriot-Watt University, University of Sheffield, University of Gloucestershire and the BTO, it became evident that data, in addition to those from the DAS, were available to inform the impact assessment. Further discussions were held with those researchers responsible for each data set and the following data analysis was commissioned by the Applicant:

- Langley L, and Votier S, July 2021. Grassholm Gannet Project – Analysis of tracking data to inform Erebus EIA (Heriot-Watt University). The report provides analysis of gannet tracking data including: analysis of connectivity between the array area (and 4 km buffer) and Grassholm SPA using existing GPS tracking data; an estimate of flux through the array area (including details of age of bird and season); behavioural usage of the array area, for example travelling/searching/feeding/resting; analysis of diurnal activity patterns of gannets within the array area including nocturnal and crepuscular activity; and average flight speed through the array area;
- Davies K, Padget O, and Guilford T, July 2021. An analysis of OxNav Manx shearwater tracking data in relation to the Erebus project (University of Oxford). The report provides analysis of Manx shearwater tracking data including: analysis of connectivity between the array area (and 4 km buffer) and the Skomer, Skokholm and Seas off Pembrokeshire/Sgomer, Sgogwm a Moroedd Penfro SPA, and other important SPA breeding colonies using existing GPS tracking data; analysis of diurnal activity patterns of Manx shearwaters, including nocturnal and crepuscular activity within the array area using GPS tracking data; provides an expert opinion on flight heights using currently unpublished on-board video-tracking data; and provides an assessment as to the importance of the Project array area for Balearic shearwaters and connectivity with Spanish SPAs; and

- Birkhead T, September 2021. Skomer Common Guillemot long-term population study: analysis of survival data to inform Erebus EIA (University of Sheffield). The report provides analysis of guillemot survival data based on the long-term population study on Skomer, running since 2007, comprising guillemot annual survival estimates of adults, immatures and juveniles.

11.4.5.2 The Project was keen to draw on as much data as possible, but most were privately held (i.e., not in the public domain) and so any analysis commissioned was being funded by the Applicant, in addition to the 24 month DAS. Therefore, proposals were prioritised based on the species and number of birds recorded during the DAS, to ensure they added value to the data gathered during the 24 months of aerial surveys and subsequent impact assessment. Discussions were held with the following organisations but no specific work was commissioned:

- Niall Burton and Chris Thaxter, BTO. Discussions were held with the BTO regarding analysis of lesser black-backed gull tracking data. Lesser black-backed gull were not as high a priority as gannets, Manx shearwater and guillemot, having been recorded in far fewer numbers and it was considered the data gathered during the 24 months DAS were sufficient to inform the EIA and HRA; and
- Matt Wood, seabird populations, University of Gloucestershire. Matt Wood co-ordinates the monitoring of survival (and in some cases productivity) for six species of seabirds on Skomer, other than guillemot (see above). These data could be helpful to inform population viability analysis (PVA) if required, but predicted impacts are so low that judgements on significance for most species can be made without the use of PVA.

11.4.5.3 The reports commissioned by the Applicant provide information that can be used in the EIA, and to confirm the connectivity between SPAs and the array area as required for HRA. The gannet and Manx shearwater data have been used to confirm the apportioning calculations, Volume 3, Technical Appendix 11.2: Apportioning, and have been used in the species accounts and assessments provided in this chapter, see Section 11.5.5 and 11.6. The guillemot data have been utilised in the population viability analysis for this species presented in Volume 3, Technical Appendix 11.5: Population Viability Analysis.

11.4.5.4 The academic reports prepared by Heriot-Watt University, The University of Sheffield and The University of Oxford are confidential but may be shared with the regulators (NRW, JNCC, PEDW, The Welsh Ministers), on a confidential basis, in order to corroborate the modelling and analysis performed as part of the environmental impact assessment. Release of the academic reports to other statutory consultees may be possible, subject to prior written confirmation from the Applicant, Blue Gem Wind, and execution of a non-disclosure agreement with the relevant university (if appropriate).

Assessment of Potential Effect Significance

11.4.5.5 The standard EIA methodology which has been presented in Chapter 2: EIA Methodology is being followed, but the approach is cognisant of CIEEM (2018) guidelines on predicting ecological impacts and effects, and on determining ecologically significant effects.

11.4.5.6 The scope of assessment is informed by the DAS work as reported in Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report.

11.4.5.7 Key seabird species that were recorded on-site, and which have been taken forward for assessment in Section 11.6 are:

- Northern fulmar *Fulmarus glacialis*;

- Manx shearwater *Puffinus puffinus*;
- Northern gannet *Morus bassanus*;
- Herring gull *Larus argentatus*;
- Great black-backed gull *Larus marinus*;
- Lesser black-backed gull *Larus fuscus*;
- Black-legged kittiwake *Rissa tridactyla*;
- Atlantic puffin *Fratercula arctica*;
- Common guillemot *Uria aalge*; and
- Razorbill *Alca torda*.

11.4.5.8 Some species are transient or have a predominantly coastal distribution and, as such, were infrequently recorded on-site during the two years of DAS (Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report). This limited presence is supported by seabird distribution mapping conducted by Kober *et al.* (2010). As such, these species are scoped out of further assessment:

- Great skua *Stercorarius skua*;
- Black-headed gull *Larus ridibundus*;
- Common gull *Larus canus*;
- Sabine's gull *Xema sabini*;
- Little gull *Hydrocoloeus minutus*;
- Sandwich tern *Sterna sandvicensis*;
- Common tern *Sterna hirundo*; and
- Arctic tern *Sterna paradisaea*.

11.4.5.9 Species that were not recorded on-site during the DAS, but which were identified as important receptors during pre-application discussion with NRW, JNCC, RSPB and WTSWW are listed below. These have been included in the impact assessment but in the absence of records from the DAS these assessments are qualitative, based on published literature and for Balearic shearwater, specifically, build on the expert opinion provided by Tim Guilford (Davies K, Padget O, and Guilford T, July 2021):

- European storm-petrel *Hydrobates pelagicus*; and
- Balearic shearwater *Puffinus mauretanicus*.

Sensitivity

11.4.5.10 For seabird sensitivity the available literature on sensitivity rankings for the impacts of marine renewable developments has been reviewed, and the following have been referred to:

- Garthe and Hüppop (2004);
- Furness and Wade (2012);
- Furness *et al*. (2013);
- Wade *et al*. (2016); and
- SNCB (2017).

Collision Sensitivity

11.4.5.11 Collision risk sensitivity is based on the collision risk assessments presented in Furness *et al*. (2013). The ranking considers species with a risk score of 500, or above, to be of high sensitivity to risk of collision with turbine blades, see Table 11.6.

11.4.5.12 Exceptions to Furness *et al*. (2013) collision risk ranking have also been applied, following consultation with NRW, JNCC, RSPB and WTSWW (November 2020). It was agreed that Manx shearwater and common guillemot would also be assessed as high sensitivity for collision risk.

Displacement Sensitivity

11.4.5.13 The displacement assessment follows SNCB (2017), which has been used to screen species sensitive to displacement. Those species identified as requiring further assessment, and taken forward, are scored under Furness *et al*. (2013), (Table 11.6) which is referred to for potential wind farm impacts in Welsh waters.

11.4.5.14 SNCB (2017) recognises that common cormorant and gull species are unlikely to require assessment as "*empirical studies have demonstrated these species can also be attracted as well as display no noticeable reaction to the presence of OWFs*". Furthermore, the guidance states, as a general guide, those species scoring less than 3 under Disturbance Susceptibility or Habitat Specialisation are considered less sensitive to displacement and do not need to be progressed to assessment "*unless there is strong empirical evidence to the contrary"* (SNCB, 2017). This approach was agreed in consultation with NRW and JNCC (September 2021). The following species scored less than 3 and are screened out requiring further assessment for displacement effects:

- Northern fulmar;
- Herring gull;
- Great black-backed gull; and
- Lesser black-backed gull.

11.4.5.15 Exceptions in the sensitivity ranking are made for northern gannet, Manx shearwater, and black-legged kittiwake. These species all score low for displacement impacts in SNCB (2017) and Furness *et al*. (2013), but following consultation with NRW, JNCC, RSPB and WTSWW (November 2020), have been assigned high sensitivity. Despite scores of less than 3, European storm-petrel will also undergo assessment, in agreement with NRW, JNCC, RSPB and WTSWW.

11.4.5.16 All species identified by SNCB (2017) with a score of ≥3 have been taken forward for assessment and have a displacement sensitivity ranking defined in Table 11.6. The ranking considers species with a concern index of ≥10 to be of high sensitivity to displacement.

Table 11.6 – Species sensitivity to collision risk with offshore wind turbines and displacement (Furness *et al.*, 2013)

Species	Sensitivity to collision risk		Sensitivity to displacement	
	Risk score	Sensitivity Level	Concern index	Sensitivity Level
Northern fulmar	48	Low	*Screened Out*	*Screened Out*
Manx shearwater	0*	High	2*	High

Species	Sensitivity to collision risk		Sensitivity to displacement	
	Risk score	Sensitivity Level	Concern index	Sensitivity Level
European storm-petrel	91	Low	2*	Low
Northern gannet	725	High	3*	High
Herring gull	1,306	High	*Screened Out*	*Screened Out*
Great black-backed gull	1,225	High	*Screened Out*	*Screened Out*
Lesser black-backed gull	960	High	*Screened Out*	*Screened Out*
Black-legged kittiwake	598	High	6*	High
Atlantic puffin	27	Low	10	High
Common guillemot	37*	High	14	High
Razorbill	32	Low	14	High

*Exceptions made to the sensitivity score based on pre-application advice, see Section 11.4.5.12.

11.4.5.17 The sensitivity of ornithological receptors to all other impacts was considered in terms of their ability to avoid, adapt, accommodate or recover from potential impacts. Data sources, feedback from consultation and expert judgement were used to inform the assessment of sensitivity of ornithological receptors as shown in Table 11.7.

Table 11.7 Sensitivity levels for offshore ornithology

Sensitivity	Description
High	Bird species has very limited or no tolerance, not adaptable, and unable to recover (permanent, >10 years) to sources of impact such as noise, light, vessel movements, habitat and/or prey species loss.
Medium	Bird species has limited tolerance, adaptability, and recoverability (e.g. 2-10 years) to sources of impact such as noise, light, vessel movements, habitat and/or prey species loss.
Low	Bird species has some tolerance, adaptability, and ability to recover within a short-term (e.g. 1 year) to sources of impact such as noise, light, vessel movements, habitat and/or prey species loss.
Negligible	Bird species is tolerant of, and adaptable to, sources of impact such as noise, light, vessel movements, habitat and/or prey species loss.

Magnitude

11.4.5.18 Magnitude of impact for collision risk and displacement for offshore ornithology is presented in Table 11.8. These definitions are made in the absence of published guidance, and noting inconsistencies in other published ESs. Reference is made to 'regional numbers'; in the breeding season these are the regional population estimates for Wales, defined in Pritchard *et al.* (2021). In the non-breeding season, these are the relevant BDMPS populations as defined in Furness (2015).

Table 11.8 – Magnitude of impact for offshore ornithology for collision risk and displacement

Magnitude	Description
High	Predicted collision or displacement mortalities are over 10% of regional numbers.
Medium	Predicted collision or displacement mortalities are between 5% and 10% of regional numbers.
Low	Predicted collision or displacement mortalities are between 1% and 5% of regional numbers.
Negligible	Predicted collision or displacement mortalities are under 1% of regional numbers.

11.4.5.19 For ornithological receptors, magnitude of impact for other impacts is based on the scale, duration, frequency and reversibility of the impact. Data sources, feedback from consultation and expert judgement were used to inform the assessment of the magnitude of impacts to ornithological receptors. The criteria for defining magnitude for the purposes of ornithological receptors are outlined in Table 11.9.

Table 11.9 – Magnitude of impact for offshore ornithology

Magnitude	Description
High	A change in the size or extent of distribution of the relevant biogeographic population resulting in irreversible/permanent change to that population in the short-long-term, and alter the long-term viability of that population. Recovery from that change not predicted (permanent) or to be achieved in the long-term (e.g. >10 years) following cessation of the Project activity.
Medium	A change in the size or extent of distribution of the relevant biogeographic population that occurs in the short-long-term, but which is not predicted to alter the long-term viability of that population. Recovery from that change predicted to be achieved in the medium-term (e.g. 2-10 years) following cessation of the Project activity.
Low	A change in the size or extent of distribution of the relevant biogeographic population that is small-scale, or of short duration, and causes no long-term deterioration of that population. Recovery from that change predicted to be achieved in the short-term (e.g. ≤1 year) following cessation of the Project activity.
Negligible	Immeasurable, or very slight change, from the size or extent of distribution of the relevant biogeographic population. Recovery from that

Magnitude	Description
	change predicted to be rapid (e.g. <6 months, a single breeding/non-breeding season) following cessation of the Project activity.

Significance of Effect

11.4.5.20 For EIA, the significance of the effect upon seabird species is determined by correlating the magnitude of the impact and the sensitivity of the receptor, as presented in Table 11.10. On this basis potential impacts are assessed as negligible, minor, moderate and major significance (definitions are provided in Chapter 2: Overview of EIA Methodology).

11.4.5.21 For the purposes of this assessment, any effects with a significance level of major and/or moderate have been deemed significant in EIA terms, while those of minor or negligible are deemed non-significant.

Table 11.10 – Effect Significance matrix

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

11.4.6 Standard Mitigation

11.4.6.1 A range of standard design measures has already been applied to the Project as part of the over-arching site selection and iterative outline plan process (see below and Chapter 3: Site Selection and Alternatives). These have been introduced to minimise potential impacts of the Project on any affected receptors.

11.4.6.2 Standard mitigation measures which the Project has already implemented, or is committed to in the future, in order to minimise potential impacts on offshore ornithology are listed below:

- Additional data sets were sourced from NRW and JNCC, both publicly available and under licence, to inform the original site selection process, further details are provided in Chapter 3: Site Selection and Alternatives. The offshore area of interest was refined to avoid areas of higher density seabird activity as identified in the following data sources:
    - NRW Seabird Data (Lle, 2019);
    - Royal Society for the Protection of Birds (RSPB) Future of the Atlantic Marine Environment (FAME) and Seabird Tracking and Research (START) Seabird Data (RSPB, 2019);
    - Thaxter *et al*. (2012). Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas;
    - European Seabirds at Sea (ESAS), (JNCC, 2019);

  - Seabirds at Sea (SAS) (sitting and flying) (Lle, 2019); and
  - Seabird Monitoring Programme (JNCC, 2019).
- Deflagration (low-order detonation) is the Project's preferred method for UXO clearance in order to minimise associated levels of subsea acoustic emissions;
- Minimum 22 m air gap beneath between rotor tip and mean sea level at all tidal states to avoid collisions with birds flying at lower heights;
- Remotely Operated Vehicle (ROV) inspections of the moorings and sub-structures;
- A pre-installation (post-consent) geophysical survey will be carried out to identify any potential UXO targets in the vicinity of the planned cable route. If a UXO target is identified, it is intended that the route will be adjusted to avoid the UXO and avoid interacting with it;
- Implementation of a Vessel Management Plan (VMP) which adopts best practice vessel handling protocols (e.g. following the Codes of Conduct provided by the WiSe Scheme[2], the Scottish Marine Wildlife Watching Code[3], or the Guide to best practice for watching marine wildlife[4]); and
- Where possible doorway and walkway lighting on the semi-submersible floating platforms will all be sensor activated.

Assessment for Residual Effect Significance

11.4.6.3 The impact assessments and conclusions on significance of effect presented in Section 11.6 assume that the design measures noted above have been successfully implemented. Where significant environmental impacts remain, even after these standard measures have been factored in, then project-specific mitigation measures are detailed and the residual significance of effect presented.

11.4.7 Limitations to Assessment

11.4.7.1 There are a number of limitations relating to DAS being used to characterise development sites offshore. They are a 'snapshot' and only undertaken during the day due to light conditions so may miss any aggregations of birds occurring at dawn or dusk. However, they are considered to be representative of general activity on-site, and for the Project have been supplemented by additional tracking data to provide insights to the behaviour and activities of seabirds during different times of the day.

11.4.7.2 Digital aerial studies are focused on seabird interests and not designed to pick up the migratory movements of wildfowl and waders which are better captured by tracking studies.

11.4.7.3 Flight heights for Manx shearwater, guillemot or razorbill could not be measured from the DAS. All three species were too dark to be detected by the flight height analysis tool utilised, and it was not possible to get a sufficient sample size, leading to doubts over the robustness of the data. Given that all of these species have low sensitivity to collision risk, it was concluded that the focus would be on Option 2 in the collision risk model which uses generic flight heights (Volume 3, Technical Appendix 11.3: Collision Risk Modelling).

[2] https://www.wisescheme.org/
[3] https://www.nature.scot/scottish-marine-wildlife-watching-code-smwwc-part-1
[4] https://www.nature.scot/guide-best-practice-watching-marine-wildlife-smwwc-part-2

11.5 Baseline Conditions

11.5.1 General Overview

11.5.1.1 This section describes the importance of the region for a number of seabird species; provides details of regional populations, colonies and designated sites; and a summary of the apportioning of seabirds to these colonies.

11.5.2 Digital Aerial Surveys

11.5.2.1 DAS work was undertaken between October 2019 and September 2021 providing 24 months, or two years of survey data. Surveys covered the array area and a 4 km buffer, a total area of 200.11 km^2.

11.5.2.2 Surveys successfully recorded 34,462 birds, of 18 species. Large aggregations of seabirds were observed, likely attributed to optimum foraging and nesting opportunities near the array area. Use of the array area + 4 km buffer differed vastly by season, with species such as kittiwake, guillemot and razorbill present through the winter, whilst puffin, Manx shearwater and gannet were present in high numbers in the breeding season.

11.5.2.3 Species recorded include those identified in Section 11.4.5.7, and peak population estimates, and details of when the species were recorded, are provided in Section 11.5.5.

11.5.3 Regional Populations, Colonies and Designated Sites

11.5.3.1 Additional information regarding key regional sites, and those identified in consultation with NRW (September 2021), are discussed further below.

11.5.3.2 *Grassholm SPA:* was classified in 1986, and covers the entire island of Grassholm; approximately 18 km off the southwest coast of Pembrokeshire, as well as several small islets and rocks, down to the mean low water mark. The original SPA covered a total of 10.77 ha (0.18 km^2), and following a marine extension in 2014, this increased to 17.4 km^2. The SPA is classified for the Annex I bird species northern gannet. As the SPA is classified for a single feature, there are no site-wide or generic conservation objectives for the Grassholm SPA.

11.5.3.3 *The Skomer, Skokholm and the seas off Pembrokeshire/Sgomer, Sgogwm a Moroedd Penfro SPA (hereafter referred to as the Skomer, Skokholm and the Seas off Pembrokeshire SPA*): a 1,668 km^2 site located in Welsh inshore and offshore waters, off the coast of Pembrokeshire. In 2014, the site SPA was reclassified, extending the boundary by a 4 km radius to include 143.5 km^2 of at sea areas, and foraging habitat for several seabird species, and following further consultation, the SPA was again reclassified in 2017, to include an additional 1,524 km^2 of marine area. The SPA is classified for the protection of breeding populations of European storm-petrel, lesser black-backed gull, Manx shearwater and Atlantic puffin, as well as for the protection of breeding seabird assemblages.

11.5.3.4 The Project overlaps the marine component of the Skomer, Skokholm and Seas off Pembrokeshire SPA, which is located within the array area and ECC. The overlap within the array area is approximately 550 m along the north and western perimeters, equating to approximately 4.5 km^2. The ECC is routed through the Skomer, Skokholm and Seas off Pembrokeshire SPA, and the Pembrokeshire Marine/Sir Benfro Forol Special Area of Conservation (SAC), equating to approximate 13 km^2 of overlap between the ECC and SPA.

11.5.3.5 The final array layout will avoid sea surface interaction with the marine component of the SPA, although there is potential that the mooring spread from the semi-submersible floating platforms will be sited within this small area.

11.5.3.6 *Castlemartin Range SSSI*: located in south Pembrokeshire and comprises a wide range of habitats including wetland, calcareous grasslands and heath. The site supports a population of over 20,000 seabirds, and features including guillemot, razorbill and black-legged kittiwake. Many of these bird colonies are focused on the coastal cliffs of the SSSI, in particular around the Stacks and Mewsform Point. Recent counts of featured species indicate a population of 18,611 guillemot and 1,682 razorbill within the SSSI.

11.5.3.7 *Gower Coast: Rhossili to Port Eynon SSSI:* located on the Gower peninsula and comprises extensive limestone cliffs at points rising to 70 m above sea level. The cliffs house a significant seabird colony, with recent counts of featured species indicating a population of 169 guillemot, and 83 razorbill.

11.5.3.8 *Aberarth – Carreg Wylan SSSI*: located in north Pembrokeshire, on the southern half of Cardigan Bay, and includes both Cardigan Island and parts of the Teifi estuary. Sea cliffs provide roosting habitat for a range of seabirds. Recent counts of featured species indicate a population of 664 black-legged kittiwake, and 724 lesser black-backed gull.

11.5.3.9 *Flat Holm SSSI:* an island located within the Severn estuary. The island comprises coarse grassland and coastal scrub alongside, alongside limestone cliffs on the eastern side of the SSSI. Recent counts of featured species indicate a population of 4,524 lesser black-backed gull.

11.5.3.10 *Ynysoedd y Gwylanod: Gwylan Islands SSSI:* located off the Gwynedd coast, towards the northern end of Cardigan Bay. It comprises two islands which are an important area for breeding Atlantic puffin. Recent counts of featured species indicate a population of 1,238 Atlantic puffin.

11.5.3.11 *St Margaret's Island SSSI*: located off of the south Pembrokeshire coast, close to Tenby, with an area of approximately 0.07 km^2. The island comprises limestone cliffs to the west, with limestone stacks to the south. Seabird colonies are found on both the western and northern cliffs, and include black-legged kittiwake, guillemot, razorbill and occasional puffin.

11.5.3.12 *Ramsey Island and Bishops and Clerks Island*: are located at the western point of Pembrokshire. Ramsey island is separated from the mainland by the Ramsey Sound, whilst Bishops and Clerks are located approximately 2.5 km further offshore from Ramsey island. The islands host a number of bird species including razorbill and guillemot on Ramsey island, and European storm petrel on Bishops and Clerks.

11.5.3.13 *The Skerries SSSI*: located within Gwynedd, off the coast of Anglesey. The groups of rocky islets host a wide range of bird species including herring gull, lesser black-backed gull and Atlantic puffin.

11.5.3.14 *Cumbria Coast Marine Conservation Zone (MCZ)*: was assigned razorbill as an additional feature in 2019. The MCZ stretches approximately 27 km along the Cumbria coast and covers an area of approximately 22 km^2.

11.5.3.15 *Lundy SSSI*: is an island located in the Bristol Channel, approximately 18 km offshore. The island is approximately 5 km^2, with exposed granite cliffs to the west, and more sheltered scrub to the east. The more sheltered eastern cliffs host populations of Atlantic puffin and Manx shearwater. Kittiwake, razorbill and guillemot are also known to nest on cliffs around the island. The Manx shearwater population resident to Lundy SSSI is known to use the Irish Sea Front SPA as a foraging ground during the breeding season.

11.5.3.16 *Irish Sea Front SPA*: is a 100% marine area, covering an area of 180 km^2 to the south of the Isle of Man, in the Irish Sea. The front located here contains the highest density of zooplankton in the western Irish Sea and supports a high abundance of marine life, notably herring, making it ideal foraging habitat for seabirds. The SPA is classified solely for at sea aggregations of Manx shearwater. The Manx shearwater population resident to Lundy SSSI is known to utilise the Irish Sea Front SPA for foraging during the breeding season.

11.5.4 Apportioning

11.5.4.1 Volume 3, Technical Appendix 11.2: Apportioning, identifies the key breeding colonies, SPAs and named SSSIs, within foraging range of the array area (Table 11.11). For SPAs there is a legally recognised process for considering off-site impacts to mobile qualifying interests. There is no such process for SSSIs, where only on-site impacts can be considered against the designated populations, and no account can be taken of impacts occurring at sea. Results from the apportionment are summarised in Table 11.11.

11.5.4.2 The impact assessments undertaken for all phases of the Project, Section 11.6, are considered in relation to defined seabird populations for the breeding season (Pritchard *et al.*, 2021) and, where necessary, the non-breeding season (Furness, 2015). Populations are defined on a species-by-species basis and include those of designated sites such as SPAs and SSSIs. They also include regional Welsh populations defined according to the available literature (Pritchard *et al*., 2021).

Table 11.11 – Apportionment of adult seabirds on site to breeding colonies (SPAs unless otherwise identified) within foraging range which include this species as a feature

Gannet					
Site	**Count of Adults**	**Distance to Project Array Area (km)**	**Inverse of Proportion of Foraging Range at Sea**	**Resulting Weight**	**Proportional Weight**
Grassholm	61,376	20	1.607	64.045	0.995
Saltee Islands	3,790	92	1.507	0.175	0.003
Skelligs	57,598	357	1.161	0.136	0.002
Manx shearwater					
Site	**Count of Adults**	**Distance to Erebus (km)**	**Inverse of Proportion of Foraging Range at Sea**	**Resulting Weight**	**Proportional Weight**
Skomer, Skokholm and the Seas off Pembrokeshire	302,000	24	1.073	108.812	0.995
Aberdaron Coast and Bardsey Island	32,366	148	1.072	0.306	0.003
Rum	240,000	602	1.072	0.137	0.001

Blasket Islands	39,068	362	1.068	0.062	0.001
Black-legged kittiwake					
Site	**Count of Adults**	**Distance to Erebus (km)**	**Inverse of Proportion of Foraging Range at Sea**	**Resulting Weight**	**Proportional Weight**
Skomer, Skokholm and the Seas off Pembrokeshire	2,472	24	1.774	4.275	0.817
Saltee Islands	2,076	92	1.733	0.239	0.046
Howth Head Coast	6,162	209	2.172	0.172	0.033
Lambay Island	6,640	226	2.206	0.161	0.031
Aberarth Carreg Wylan SSSI	664	84	2.007	0.106	0.020
Lundy SSSI	476	70	1.594	0.087	0.017
Ireland's Eye	3,220	218	2.165	0.082	0.016
Wicklow Head	1,546	167	2.172	0.068	0.013
Old Head of Kinsale	1,422	206	1.325	0.025	0.005
Rockabill	532	231	2.207	0.012	0.002
Helvick Head to Ballyquin	130	152	1.520	0.005	0.001
Isles of Scilly	150	170	1.193	0.003	0.001
Guillemot					
Site	**Count of Adults**	**Distance to Erebus (km)**	**Inverse of Proportion of Foraging Range at Sea**	**Resulting Weight**	**Proportional Weight**
Skomer, Skokholm and the Seas off Pembrokeshire	29,744	24	1.452	5.537	0.754
Castlemartin Range SSSI	18,611	41	1.568	1.282	0.175
Saltee Islands	25,851	92	1.600	0.361	0.049
Lundy SSSI	6,198	70	1.558	0.146	0.020

Wicklow Head	955	167	1.904	0.005	0.001
Helvick Head to Ballyquin	1,170	152	1.899	0.007	0.001
Gower Coast: Rhossili to Porteynon SSSI	169	80	1.974	0.004	0.001
Razorbill					
Site	**Count of Adults**	**Distance to Erebus (km)**	**Inverse of Proportion of Foraging Range at Sea**	**Resulting Weight**	**Proportional Weight**
Skomer, Skokholm and the Seas off Pembrokeshire	10,694	24	1.519	6.085	0.892
Castlemartin Range SSSI	1,682	41	1.614	0.348	0.051
Saltee Islands	6,519	92	1.612	0.268	0.039
Lundy SSSI	1,735	70	1.532	0.117	0.017
Gower Coast: Rhossili to Porteynon SSSI	83	80	1.930	0.005	0.001
Puffin					
Site	**Count of Adults**	**Distance to Erebus (km)**	**Inverse of Proportion of Foraging Range at Sea**	**Resulting Weight**	**Proportional Weight**
Skomer, Skokholm and the Seas off Pembrokeshire	38,342	24	1.744	32.404	0.997
Saltee Islands	390	92	1.784	0.023	0.001
Ynysoedd Y Gwylanod, Gwylan Islands	1,238	160	2.520	0.034	0.001
Lundy SSSI	375	70	1.550	0.033	0.001
Lesser black-backed gull					
Site	**Count of Adults**	**Distance to Erebus (km)**	**Inverse of Proportion of Foraging Range at Sea**	**Resulting Weight**	**Proportional Weight**

Skomer, Skokholm and the Seas off Pembrokeshire	12,836	24	1.728	17.891	0.978
Flat Holm SSSI	4,524	165	2.070	0.160	0.009
Isles of Scilly	4,944	170	1.084	0.086	0.005
Aberarth Carreg Wylan SSSI	724	84	1.943	0.093	0.005
Saltee Islands	502	92	1.773	0.049	0.003
Lambay Island	690	226	2.359	0.015	0.001

11.5.5 Species Accounts

11.5.5.1 The following species accounts summarise the information for each ornithological receptor; the numbers recorded on-site are based on the 24 months of digital aerial survey work (Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report), and the species sensitivity and conservation statuses are based on the available literature, as advised in Section 11.1.1.7.

11.5.5.2 All population counts have been taken from the Seabirds Monitoring Programme Database and issued to NRW and JNCC for review during pre-application consultation (July 2021).

11.5.5.3 The seasons of interest for impact assessment are defined and summarised based on Furness (2015), Table 11.12. The migration free breeding period is used, so that there is no overlap with the defined BDMPS in the non-breeding season. This approach was issued to NRW and JNCC for comment during pre-application consultation and no objection was raised (July 2021) (Table 11.4).

Table 11.12 – Seabird seasonality for impact assessment

Species	Migration free breeding season	BDMPS		
		Autumn migration	Non-breeding	Spring migration
Northern fulmar	Apr – Aug	Sep – Oct	Nov	Dec – Mar
Manx shearwater	Jun – Jul	Aug – Oct	n/a	Mar – May
Northern gannet	Apr – Aug	Sep – Nov	n/a	Dec – Mar
Herring gull	Mar – Aug	n/a	Sep – Feb	n/a
Great black-backed gull	May – Jul	n/a	Sep – Mar	n/a
Lesser black-backed gull	May – Jul	Aug – Oct	Nov – Feb	Mar – Apr

Species	Migration free breeding season	BDMPS		
		Autumn migration	Non-breeding	Spring migration
Black-legged kittiwake	May – Jul	Aug – Dec	n/a	Jan – Apr
Atlantic puffin	May – Jun	n/a	Aug – Mar	n/a
Common guillemot	Mar – Jun	n/a	Aug – Feb	n/a
Razorbill	Apr – Jun	Aug – Oct	Nov – Dec	Jan – Mar

Northern Fulmar

11.5.5.4 Northern fulmar *Fulmarus glacialis* are, essentially, a northern species, breeding on steep cliffs around the Atlantic Ocean and North Sea, from northern Greenland as far as northern France. They are a colonial breeder, and nest on narrow ledges or in hollows, on, or near, the coast. They are a long-lived species and may live for more than half a century (Pritchard *et al*., 2021).

11.5.5.5 Northern fulmar are entirely a marine species, when not present at their breeding sites. They have a very wide diet that includes marine vertebrate and invertebrate organisms. They also feed on fishery discards and often scavenge on dead vertebrates at sea. They normally fly low to the sea, with 0.2% estimated to occur at potential collision risk height, based on generic data (Johnston *et al.*, 2014).

11.5.5.6 Northern fulmar are of high conservation value in Wales, and since 2016 they have been amber-listed as a Bird of Conservation Concern (Pritchard *et al.*, 2021). They have an endangered status in Europe with more colonies showing a downwards trend than an increasing trend (Seabirds Count 2015-2019). Furthermore, there appears to be evidence of a decline in breeding numbers in Wales. There are no recent counts reported in Pritchard *et al*. (2021), but during Seabird 2000 (1998 – 2002) the Welsh regional population was 3,474 breeding pairs.

11.5.5.7 At the array area, they were one of the less abundant species to be recorded during the digital aerial survey work (Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report).

Manx Shearwater

11.5.5.8 Manx shearwater *Puffinus puffinus* have long straight slim wings, flying with a series of rapid stiff-winged flaps followed by long glides, occasionally banking or ‘shearing’. They are present in the UK over the summer and breed on offshore islands, such as in Skomer, Skokholm and Seas off Pembrokeshire SPA, where they are safe from rats and other ground predators. When not at their breeding site, they are an entirely maritime species. They also form large rafts on the sea near to their colonies prior to coming ashore at night, and travel large distances to their feeding areas from their breeding site at dawn and dusk, and do not visit the breeding site during the day.

11.5.5.9 Manx shearwater migrate to the coast of South America for the winter and travel back to the UK in late February and March. In the spring, large numbers are attracted to feed at the Irish Sea Front SPA, which is part of a large tidal front supporting high levels of zooplankton and important prey species, typically high-energy fish species such as sandeels, immature herring and sprats. The also feed extensively on fishery discards. At the array area, they are present during their migration-free breeding season in June and July (Table 11.5), as recorded during the digital aerial survey work, Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report. While they have a large foraging range (mean maximum foraging range (1,346.8 km) plus one standard deviation (1,018.7 km)), the majority of individuals (99.5%) are apportioned to the Skomer, Skokholm and Seas off Pembrokeshire SPA, the closest breeding colony, Volume 3, Technical Appendix 11.2: Apportioning.

11.5.5.10 In the Skomer, Skokholm and Seas off Pembrokeshire SPA, Manx shearwater number 455,156 breeding pairs (year 2018). The Welsh regional population is given as 487,471 breeding pairs in Pritchard *et al*. (2021) (Seabirds Count, 2015-19). The large confidence intervals on the counts mean that trends cannot be determined but sample plots, surveyed annually at Skomer, Skokholm and Seas off Pembrokeshire SPA, indicate that the population is at least stable, and could be increasing.

11.5.5.11 From the digital aerial survey work, the peak population estimate at the array area was 918 individual birds, recorded in July 2020 (Volume 3, Technical Appendix 11.1: Baseline Data). There were no birds recorded at the array area out with the breeding period; therefore, assessment focuses on the breeding season only. This assessment is carried out against the regional Welsh population noted above.

11.5.5.12 Manx shearwater have been well-studied by OxNav researchers at the University of Oxford and additional site-specific data were commissioned for the Project, as set out in Section 11.5.5 (Davies *et al*., 2021). This confirms that birds tracked from the Skomer, Skokholm and Seas off Pembrokeshire SPA are recorded using the array area and 4 km buffer, 21% of the total that were tracked (Davies *et al*., 2021).

11.5.5.13 The interaction of Manx shearwater and offshore wind turbines has not been well-studied as, so far, wind farms have not been built in areas regularly frequented by this species. Consultation with NRW, JNCC, RSPB and WTSWW has identified Manx shearwater as a key species, and the species sensitivity to collision risk and displacement has been adjusted accordingly. However it should be noted that Furness *et al*. (2013) consider Manx shearwaters' risk of collision to be zero, and generic flight height data suggests that 0% of flights occur at potential collision risk height (Johnston *et al*., 2014).

11.5.5.14 Data from tagging studies, and additional analysis undertaken for the Project, suggest that the peak time of day for interaction with the array area and 4 km buffer differs according to the stage of the breeding cycle, with peak numbers passing through the array area and 4 km buffer between 17:00 and 21:00 during the pre-incubation phase; between 02:00 and 07:00 during incubation; and throughout the day, peaking at 10:00, during chick-rearing (Davies *et al*., 2021).

11.5.5.15 Manx shearwater are considered to be of high conservation value in Wales; since 2002 they have been amber-listed as a Bird of Conservation Concern (Pritchard *et al.*, 2021) and are listed on Annex I of the EU Birds Directive (2009/147/EEC).

Balearic Shearwater

11.5.5.16 In response to concerns raised by NRW, JNCC, RSPB and WTSWW, at the request of the Applicant the Project specific academic data included an expert opinion as to the likely importance of the Project area for migratory Balearic shearwaters *Puffinus mauretanicus*; and on likely connectivity with Spanish SPAs or similarly protected colonies (Davies *et al*., 2021).

11.5.5.17 Balearic shearwater are the Mediterranean cousin of Manx shearwater, nesting solely in burrows and caves on the islands of Mallorca, Menorca and Ibiza. Davies *et al*. (2021) discusses the tracking data and recent ship-based sightings following their wintering movements, and indicates that large numbers of the birds, relative to their global population, are now known to utilise waters off northern France, southern England, and the southern Irish Sea. There is some evidence that between 2% and 23% of the global population will utilise the Celtic Sea front each year, near to the array area. This tidal mixing front is known to provide good foraging opportunities for diving seabirds, but the study did not provide data on their presence at the array area, and does not consider bias in the survey method employed.

11.5.5.18 Even though they were not recorded during digital aerial survey work (Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report), there is an unquantified risk that Balearic shearwater may utilise the array area, either accessing the Celtic Sea Front, or flying from this region through the array area to reach feeding areas to the northwest. They are of very high conservation value; red-listed as a Bird of Conservation Concern in Wales since 2016 and listed as a UKBAP priority species, a Section 7 species of principal importance under the Environment (Wales) Act 2016, and listed on Annex I of the EU Birds Directive (2009/147/EEC). Most importantly, they are also ‘critically endangered’ on the IUCN red-list.

European Storm-petrel

11.5.5.19 European storm-petrel *Hydrobates pelagicus* are the smallest species of seabird nesting in Britain and Ireland. Outside of the breeding season they spend the majority of their life at sea. European storm-petrel winter in the South Atlantic, off the coast of Namibia and South Africa.

11.5.5.20 They are vulnerable to mammalian predators such as rats, so virtually all the breeding colonies are on remote rocky islands. In the UK, over 80% of the population is found in Scotland, with smaller numbers recorded in western Wales and the Isles of Scilly.

11.5.5.21 European storm-petrel are entirely a marine species, when not present at their breeding sites. Their diet is mainly invertebrates or planktonic fish species. They also occasionally feed around trawlers at sea.

11.5.5.22 In Wales they have been amber-listed as a Bird of Conservation Concern since 2002 (Pritchard *et al.*, 2021) and they are listed on Annex 1 of the EU Birds Directive (2009/147/EEC). The breeding population at Skomer, Skokholm and Seas off Pembrokeshire SPA numbers 2,130 breeding pairs. The total Welsh population is slightly larger, given as 2,486 breeding pairs in Pritchard *et al*. (2021).

11.5.5.23 European storm-petrel are assessed for their sensitivity to offshore wind farm development in Furness *et al*. (2013), Table 11.6, which indicates that they are of low sensitivity to collision risk as they fly in the lowest 10 m height band above the sea (Cramp, 1977). European storm-petrel were not recorded in the array area or 4 km buffer during the DAS (Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report), so the assessment presented in Section 11.6 is qualitative only. HiDef records this species regularly during its surveys in suitable offshore habitats during the summer and post-breeding season.

11.5.5.24 This species is listed on Annex I of the EU Birds Directive (2009/147/EEC).

Northern Gannet

11.5.5.25 Northern gannet *Morus bassanus* are a wide-ranging seabird with breeding populations around the UK and Irish coastlines. They have a wide foraging range during the breeding season, as recorded in Woodward *et al*. 2019 (mean maximum foraging range (315.2 km) plus one standard deviation (194.2 km)) but the apportioning calculations indicate that the majority of birds recorded at the array area (99.5%) during digital aerial survey work are likely to be associated with Grassholm SPA. The SPA population numbers 36,011 breeding pairs (recorded in 2015) and is the same as the regional Welsh population recorded in Pritchard *et al*. (2021).

11.5.5.1 Northern gannet are a marine species, spending all of their time at sea when not present at their breeding sites. They feed on a wide range of prey; high-energy fish species such as mackerel *Scomber scombrus*, sandeels (Ammodytidae), immature herring *Clupea harrengus* and sprats *Sprattus sprattus* are especially important. They also feed extensively on fishery discards.

11.5.5.2 Northern gannet are an important ornithological receptor at the array area. They were present in all months of the DAS, and in slightly higher numbers over the summer, Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report. A peak population estimate of 160 individual birds was recorded in the array area in August 2020.

11.5.5.3 Northern gannet are considered to be of high conservation value in Wales, and since 2002 they have been amber-listed as a Bird of Conservation Concern (Pritchard *et al*., 2021).

11.5.5.4 Northern gannet have been well-studied by researchers previously based at Exeter University, and now at Heriot-Watt University, and site-specific additional data were commissioned for the Project, as set out in Section 11.5.5 (Langley and Votier, 2021). This confirms that 44.5% of adult birds tracked from the Grassholm SPA visited the array area and 4 km buffer at some point; but only 0.2%, on average, were present in this area at any one time.

11.5.5.5 Northern gannet behavioural usage of the array area and 4 km buffer was also estimated, with GPS fixes indicating the following estimates of behaviour: 39% resting, 37% travelling, and 24% foraging, with marked interannual variation. Resting was most frequent during the hours of darkness (when there was no travelling), whilst foraging and travelling behaviour peaked towards the middle of the day. This compared with the GPS fixes outside the array area and 4 km buffer, which had a higher percentage of resting birds (60%), but lower proportions of travelling (19%) and foraging (21%) (Langley and Votier, 2021).

11.5.5.6 Flight speed was also calculated (Langley and Votier, 2021) and used in the stochastic collision risk modelling for gannet, Volume 3, Technical Appendix 11.3: Collision Risk Modelling.

11.5.5.7 Northern gannet are identified as being of high sensitivity to collision risk impacts in Furness *et al*. (2013) and have been taken forward for assessment on this basis (Volume 3, Technical Appendix 11.3: Collision Risk Modelling). 59.3% of northern gannet recorded in the array area during digital aerial survey work were found to be flying at potential collision risk height, compared with generic flight height of 7.0% (Johnston *et al*., 2014), While previously considered to be of low sensitivity to displacement impacts there is increasing evidence that they could be at risk, and have been assessed as high sensitivity to displacement, as agreed with NRW, JNCC, RSPB and WTSWW (Volume 3, Technical Appendix 11.4: Displacement Analysis).

11.5.5.8 Assessment is undertaken for both the breeding and non-breeding periods. In the non-breeding season the reference population of northern gannet for the autumn migration is 545,954 individual birds in the 'UK western waters and Channel', and for the spring migration it is 661,888 individual birds in the same area (Furness, 2015).

Herring Gull

11.5.5.9 Herring gull *Larus argentatus* are a well-known British seabird, now found inland as much as on the coast. Due to ongoing population declines they are currently on the red list of the UK Birds of Conservation Concern (Eaton *et al*., 2015) and have been red-listed in Wales since 2010 (Pritchard *et al*., 2021). They are a UKBAP priority species, listed since 2007, and listed under Section 7 of the Environment (Wales) Act 2016.

11.5.5.10 Herring gull are a partial marine species selecting marine, intertidal and terrestrial habitats to feed at, when not present at their breeding sites. They have a very catholic diet that includes marine, terrestrial and intertidal vertebrate and invertebrate organisms. They also feed on fishery discards, and scavenge on human refuse.

11.5.5.11 As confirmed on the Seabird Monitoring Programme Database, there are no SPAs for herring gull found within foraging range (mean maximum foraging range (58.8 km) plus one standard deviation (26.8 km)) of the array area. The regional population in Wales is 7,988 breeding pairs, not including roof-nesting birds (Pritchard *et al*., 2021).

11.5.5.12 At the array area, they were one of the less abundant species to be recorded, and are only present very intermittently (Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report). Out of the 24 surveys undertaken between October 2019 and September 2021 they were recorded in only five instances, with the peak population estimate for the array area being for February 2021, estimated at 186 individual birds (Volume 3, Technical Appendix 11.1: Baseline Data).

11.5.5.13 According to Furness *et al.* (2013) they are considered to be of high sensitivity to collision risk mortality (Volume 3, Technical Appendix 11.3: Collision Risk Modelling) and low sensitivity to displacement (Table 11.6) (Volume 3, Technical Appendix 11.4 Displacement Assessment), and have been taken forward for assessment on this basis. During digital aerial survey work 60% of herring gull recorded in the array area were found to be flying at potential collision risk height, compared with generic flight heights of 19.3% (Johnston *et al*., 2014), (Volume 3, Technical Appendix 11.3: Collision Risk Modelling).

Great Black-backed Gull

11.5.5.14 Great black-backed gull *Larus marinus* are the largest of the gull species found at the array area. Norway holds 43% of the breeding pairs in Europe and a much smaller number (14%) is found in the UK. Of the UK population, most are found in Scotland and only 2.5% are recorded in Wales; a total of 504 breeding pairs (Pritchard *et al*., 2021). As confirmed on the Seabird Monitoring Programme Database, there are no SPAs for great black-backed gull found within foraging range of the array area (73 km mean max plus 0 km one standard deviation (Woodward *et al*., 2019). Great black-backed gulls are a partial marine species selecting marine, intertidal and terrestrial habitats to feed at, when not present at their breeding sites. They have a very catholic diet that includes marine, terrestrial and intertidal vertebrate and invertebrate organisms. They also feed on fishery discards, and scavenge on human refuse.

11.5.5.15 At the array area, great black-backed gull were recorded very intermittently and not at all during the breeding season (Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report). The peak population estimate in the array area was of 12 birds during December 2020 (Volume 3, Technical Appendix 11.1: Baseline Data).

11.5.5.16 According to Furness *et al*. (2013) they are considered to be of high sensitivity to collision risk mortality, therefore they have been included in the assessment even though the numbers at the array area are low (Volume 3, Technical Appendix 11.3: Collision Risk Modelling). During digital aerial survey work, 33.3% of great black-backed gull recorded in the array area were found to be flying at potential collision risk height, compared with generic flight height of 36.5% (Johnston *et al*., 2014), (Volume 3, Technical Appendix 11.3: Collision Risk Modelling). They are considered to be at relatively low risk of displacement (Furness *et al*., 2013) (Table 11.6) so have not been assessed further for this impact.

11.5.5.17 They are also considered to be of high conservation value in Wales, and since 2010 have been red-listed as a Bird of Conservation Concern (Pritchard *et al.*, 2021).

Lesser Black-backed Gull

11.5.5.18 Lesser black-backed gulls *Larus fuscus* are smaller than great black-back gulls and not as dark in colouration. The species is on the amber list of the UK Birds of Conservation Concern, because over 40% of the European population is found in Great Britain, and over half of them are found at fewer than ten breeding colonies (Eaton *et al*., 2015). Additionally, all individuals nesting in the United Kingdom are of the subspecies *graellsii*, which is used for defining the biogeographical population of this species when classifying SPAs. They are a migratory species with those that breed farthest north (such as Greenland and Siberia) moving the greatest distances south in winter, reaching as far as equatorial Africa (Pritchard *et al*., 2021).

11.5.5.19 Lesser black-backed gulls are a partial marine species selecting marine, intertidal and terrestrial habitats to feed at, when not present at their breeding sites. They have a very catholic diet that includes marine, terrestrial and intertidal vertebrate and invertebrate organisms. They also feed on fishery discards, and scavenge on human refuse.

11.5.5.20 At the array area, they were recorded in June and July with a peak population estimate of 69 individual birds in June 2021 (Volume 3, Technical Appendix 11.1: Baseline Data and Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report). Whilst there are a number of SPAs within foraging range, 97.8% of individuals are apportioned to Skomer, Skokholm and Seas off Pembrokeshire SPA (Volume 3, Technical Appendix 11.2: Apportioning).

11.5.5.21 The most recent count at this SPA is of 6,418 breeding pairs (2018-2019) and the Welsh count is of 10,190 breeding pairs at coastal locations, and a further 3,244 breeding pairs nesting on rooftops, although the count is not yet complete (Pritchard *et al.*, 2021). It is noted that increasing numbers are nesting on rooftops, particularly in Cardiff (Pritchard *et al*., 2021).

11.5.5.22 According to Furness *et al*. (2013), lesser black-backed gull are considered to be of high sensitivity to collision risk mortality, and have therefore been included for assessment (Volume 3, Technical Appendix 11.3: Collision Risk Modelling). During digital aerial survey work 77.2% of lesser black-backed gull recorded in the array area were found to be flying at potential collision risk height, compared with generic flight height of 25.8% (Johnston *et al*., 2014), (Volume 3, Technical Appendix 11.3: Collision Risk Modelling). They are not considered to be at significant risk of displacement (Furness *et al*., 2013), Table 11.6, and have not been assessed further for this impact.

11.5.5.23 Lesser black-backed gull are of high conservation value in Wales, and since 2002 have been amber-listed as a Bird of Conservation Concern (Pritchard *et al*., 2021).

Black-legged Kittiwake

11.5.5.24 Black-legged kittiwake *Rissa tridactyla* are a small gull species with a distinctive call and strictly coastal distribution. During the breeding season they can be found at seabird colonies around the UK, with the Welsh regional population estimated to be 4,527 breeding pairs (Pritchard *et al*., 2021). In late summer and autumn, they can be seen flying offshore, or gathering at roosts, and they migrate through Welsh waters from colonies lying to the north. They spend the winter months out at sea around the entire UK and in the central Atlantic. They normally fly low to the sea with 0.1% estimated to occur at potential collision risk height, based on generic data (Johnston *et al.*, 2014).

11.5.5.25 Black-legged kittiwake feed on a wide range of prey; high-energy fish species such as sandeels, immature herring and sprats are especially important. They feed in small numbers on fishery discards.

11.5.5.26 In some areas around the UK coast, including Wales, black-legged kittiwake breeding populations are in decline. The reasons why are unknown but may include a shortage of sandeels or their quality, possibly linked to climate change. As a result, black-legged kittiwake are currently on the red list of the UK Birds of Conservation Concern (Eaton *et al*., 2015) and have been red-listed in Wales since 2016 (Pritchard *et al.*, 2021).

11.5.5.27 They have a relatively large foraging range of mean maximum foraging range (156.1 km) plus one standard deviation (144.5 km) (Woodward *et al*., 2019). At the array area, black-legged kittiwake are recorded in low numbers during the summer months and in higher numbers in the non-breeding season during the autumn and spring migration (Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report).

11.5.5.28 According to Furness *et al*. (2013) black-legged kittiwake are considered to be sensitive to collision with operational turbines and during digital aerial survey work, 48.8% of black-legged kittiwake recorded in the array area were found to be flying at potential collision risk height, compared with generic flight height of 6.8% (Johnston *et al*., 2014), (Volume 3, Technical Appendix 11.3: Collision Risk Modelling). They are also considered to be sensitive to potential displacement from the array area. (Volume 3, Technical Appendix 11.4: Displacement Analysis).

11.5.5.29 The peak population estimate in the array area from the digital aerial survey work was 486 individual birds, recorded in January 2021 during the pre-breeding migration (Volume 3, Technical Appendix 11.1: Baseline Data). In contrast, the peak population in the array area over the two breeding seasons analysed, was just four birds, so it is not particularly important as a foraging area for breeding black-legged kittiwake (Volume 3, Technical Appendix 11.1: Baseline Data).

11.5.5.30 Assessment is carried out for both the breeding and the non-breeding periods. In the non-breeding season, the reference populations are 911,586 individual birds for the autumn migration in the ‘UK western waters and Channel’ and 691,526 individual birds for the spring migration again in the ‘UK western waters and Channel’ (Furness, 2015).

Atlantic Puffin

11.5.5.31 Atlantic puffin *Fratercula arctica* are one of the UK’s most-recognised seabirds. They are burrow-nesting so very vulnerable to terrestrial predators such as rats. As a result, they usually breed on offshore islands and steep coastal cliffs, and such is the case in Wales (Pritchard *et al*., 2021). Atlantic puffin are migratory, in Welsh waters they are most abundant during the spring and summer months and then disperse mainly westwards during the winter (Pritchard *et al*., 2021). Atlantic puffin undergo a complete moult of flight feathers in February or March, when they are believed to become flightless. They normally fly low to the sea with 0% estimated to occur at potential collision risk height, based on generic data (Johnston *et al.*, 2014).

11.5.5.32 At the array area, the highest numbers were recorded during April and June, with the peak population during the DAS estimated as 344 individual birds for April 2020 (Volume 3, Technical Appendix 11.1: Baseline Data). They were not recorded at all during the non-breeding season (Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report). Some will remain further offshore in the Celtic and Irish Seas, whereas others will head out to the mid- or west Atlantic. On this basis the assessment is focused on the breeding season only.

11.5.5.33 During the breeding season most individuals (99.7%) are apportioned to Skomer, Skokholm and Seas off Pembrokeshire SPA, with a breeding population of 19,171 breeding pairs (recorded in 2018) (Volume 3, Technical Appendix 11.2: Apportioning). The Welsh regional population is recorded as being 27,831 breeding pairs (Pritchard *et al*., 2021).

11.5.5.34 According to Furness *et al*. (2013) Atlantic puffin are considered to be of high sensitivity to displacement impacts and have been taken forward for assessment on this basis, (Volume 3, Technical Appendix 11.4: Displacement Analysis). They are not considered to be at risk of impact from colliding with the turbine blades as they do not fly high enough (Furness *et al*., 2013). They are of high conservation status in Wales, and since 2002 have been red-listed as a Bird of Conservation Concern (Pritchard *et al*., 2021).

*Common G*uillemot

11.5.5.35 Common guillemot *Uria aalge* are one of the most numerous seabird species recorded at sea around the UK's coasts. They come to land only to nest, and the remainder of the time are found at sea. They are the most abundant species recorded during the DAS within the array area, present in all months, with the highest numbers in 2020 and 2021 noted in August, September, October, November and December (Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report). Common guillemot become flightless for an extended period during July and August when the male parent accompanies its chick out to sea, as recorded at the array area during the DAS.

11.5.5.36 Common guillemot feed on a wide range of prey; high-energy fish species such as sandeels, immature herring, and sprats are especially important.

11.5.5.37 Common guillemot has a mean maximum foraging range of 73.2 km plus one standard deviation (80.5 km) and 75.4% of individuals are apportioned to the closest SPA, Skomer, Skokholm and Seas off Pembrokeshire SPA (Volume 3, Technical Appendix 11.2: Apportioning). The most recent count of common guillemot at this SPA is 29,744 individual birds (years 2017-2019) and the Welsh population is 96,802 individual birds (Pritchard *et al*., 2021). At the array area, the peak population estimated during the breeding season was 3,468 individual birds, recorded in the array area in March 2021 (Volume 3, Technical Appendix 11.1: Baseline Data). The peak population estimate in the non-breeding season was much higher: 11,002 individual birds recorded in the array area in August 2020 (Volume 3, Technical Appendix 11.1: Baseline Data).

11.5.5.38 As birds are present at the array area all year round, assessment is carried out both for the breeding and non-breeding seasons. Furness (2015) identifies a single non-breeding period from August through to February, see Table 11.9 above. During this time, the reference population is 1,139,220 individual birds, the total for the 'UK western waters and Channel' (Furness, 2015).

11.5.5.39 Common guillemot are of high conservation status in Wales, amber-listed since 2010 as a Bird of Conservation Concern (Pritchard *et al.*, 2021).

11.5.5.40 According to Furness *et al*. (2013), and as agreed with NRW, JNCC, RSPB and WTSWW, common guillemot are considered to be of high sensitivity to displacement impacts and assessed on this basis (Volume 3, Technical Appendix 11.4: Displacement Analysis). NRW, JNCC, RSPB and WTSWW also requested that common guillemot be modelled for collision risk (Volume 3, Technical Appendix 11.3: Collision Risk Modelling).

Razorbill

11.5.5.41 Razorbill *Alca torda* breed commonly around the UK, and occur widely at sea where they can sometimes occur in dense concentrations with common guillemot. The species is most abundant during the summer and autumn months, and disperses mainly southwards during the winter. Like common guillemot, the species becomes flightless for an extended period during July and August when the male parent accompanies its chick out to sea. They normally fly low to the sea with 0.8% estimated to occur at potential collision risk height, based on generic data (Johnston *et al.*, 2014).

11.5.5.42 Razorbill feed on a wide range of prey; high-energy fish species such as sandeels, immature herring and sprats are especially important.

11.5.5.43 Razorbill has a mean maximum foraging range of 88.7 km plus one standard deviation (75.9 km) and 89.2% of individuals are apportioned to the closest SPA, Skomer, Skokholm and Seas off Pembrokeshire SPA (Volume 3, Technical Appendix 11.2: Apportioning). This SPA has a breeding population of 10,694 individuals and the Welsh regional population, recorded in Pritchard *et al*. (2021), is 21,233 individual birds (Seabirds Count 2015-2019). In contrast the peak population estimate during the breeding season, recorded at the array area during the digital aerial survey work in April 2020, was 84 individual birds (Volume 3, Technical Appendix 11.1: Baseline Data).

11.5.5.44 In the non-breeding season, there are two BDMPS periods defined by Furness (2015): migration (August to October, and January to March), and winter (November to December). Peak population estimates in the array area during these periods were 250 individual birds in November 2019, and 363 individual birds in January 2021, respectively (Volume 3, Technical Appendix 11.1: Baseline Data). This compares to a reference population of 606,914 individual birds in the 'UK western waters and Channel' during migration and a reference population of 341,422 individual birds in the same region over winter Furness (2015).

11.5.5.45 According to Furness *et al*. (2013), razorbill are considered to be of high sensitivity to displacement impacts and are taken forward for assessment on this basis (Volume 3, Technical Appendix 11.4: Displacement Analysis). They are not considered to be at risk of collision with turbine blades as they do not fly high enough (Furness *et al*., 2013). Razorbill have been amber-listed as a Bird of Conservation Concern in Wales since 2016, and are considered to be of high conservation value.

Scoped Out Species

11.5.5.46 Some species were only recorded infrequently on-site, and have been scoped out of further assessment because they are transient or have a more coastal distribution (Table 4 and Table 5, Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report). These are presented in Table 11.13.

Table 11.13 – Summary of species scoped out of assessment

Species	Survey Findings/Records	Species Behaviour
Great skua *Stercorarius skua*	Total count of 2 individuals during two years of survey	Transient species
Black-headed gull *Larus ridibundus*	Total count of 2 individuals during two years of survey	Coastal species
Common gull *Larus canus*	Total count of 10 individuals during two years of survey	Coastal species
Sabine's gull *Xema sabini*	Total count of 1 individual during two years of survey	Transient species
Little gull *Hydrocoloeus minutus*	Total count of 4 individuals during two years of survey	Transient species
Sandwich tern *Sterna sandvicensis*	Total count of 1 individual during two years of survey	Coastal and transient species
Common tern *Sterna hirundo*	Total count of 2 individuals during two years of survey	Coastal and transient species
Arctic tern *Sterna paradisaea*	Total count of 10 individuals during two years of survey	Coastal and transient species

Seabird Summary

11.5.5.47 A summary of the seabird species of interest that were observed during the two years of Project-specific surveys is provided in Table 11.14. The study area for all species, other than northern fulmar, is the array area plus a 2 km buffer. Data for northern fulmar was collected for the array area plus a 4 km buffer.

Table 11.14 – Overview of seabird species recorded in the two years of surveys (refer to Volume 3, Technical Appendices 11.1, 11.4 and 11.6 for further details)

<table>
<tr><th>Species</th><th colspan="4">Summary of Project-specific Surveys</th></tr>
<tr><td>Northern fulmar
Fulmarus glacialis</td><td colspan="4">Northern fulmar observations peaked in November 2019, with a peak abundance estimate of 537 birds (+95% CI 20-1,463). Summer breeding season abundance estimates were much lower, ranging from 4 birds (+95% CI 0-12) in April 2020 to 16 birds (+95% CI 0-35) in September 2020. Similar numbers were recorded in the same months in 2021.</td></tr>
<tr><td rowspan="6">Manx shearwater
Puffinus puffinus</td><td colspan="4">Manx shearwater were predominantly recorded during the migration-free breeding season, with considerably fewer birds recorded in the autumn migration and very few in spring. The maximum population estimate is 918 (±95% CI 105-1,866), recorded in July 2020 (array area only). The mean peak population and density estimates for each season are presented below.</td></tr>
<tr><th>Season</th><th>Migration free breeding</th><th>Autumn migration</th><th>Spring migration</th></tr>
<tr><td>Population estimate</td><td>1,540</td><td>557</td><td>18</td></tr>
<tr><td>Confidence (lower-upper 95%)</td><td>472-2,920</td><td>216-964</td><td>4-38</td></tr>
<tr><td>Density estimate</td><td>14.08</td><td>5.09</td><td>0.16</td></tr>
<tr><td>Confidence (lower-upper 95%)</td><td>4.32-26.71</td><td>1.97-8.82</td><td>0.04-0.34</td></tr>
<tr><td>Balearic shearwater
Puffinus mauretanicus</td><td colspan="4" rowspan="2">Balearic shearwater and European storm-petrel are included here, as these were raised as potential receptors of concern during stakeholder consultation.
However, neither species was recorded during the two year Project-specific bird surveys of the array area and 4 km buffer.
Both species have been recorded in the autumn post-breeding season in surveys for other projects completed by HiDef, using the same camera equipment and image interpretation methods.
Therefore, the absence of observations is attributed to true absence of presence and not error in the equipment, interpretation or analyses.</td></tr>
<tr><td>European storm-petrel
Hydrobates pelagicus</td></tr>
</table>

<table>
<tr><th>Species</th><th colspan="4">Summary of Project-specific Surveys</th></tr>
<tr><td rowspan="6">Northern gannet
Morus bassanus</td><td colspan="4">Northern gannet were recorded in the highest numbers during the migration-free breeding season, with fewer birds recorded in the autumn migration and even fewer in spring. The maximum population estimate is 160 (±95% CI 47-333), recorded in August 2020, the highest density estimate was also recorded this month at 3.54 individuals/km^2 (±95% CI 0.99-7.63). The mean peak population and density estimates for each season are presented below.</td></tr>
<tr><td>**Season**</td><td>**Migration free breeding**</td><td>**Autumn migration**</td><td>**Spring migration**</td></tr>
<tr><td>Population estimate</td><td>224</td><td>334</td><td>100</td></tr>
<tr><td>Confidence (lower-upper 95%)</td><td>52-496</td><td>138-555</td><td>68-137</td></tr>
<tr><td>Density estimate</td><td>2.05</td><td>3.04</td><td>0.91</td></tr>
<tr><td>Confidence (lower-upper 95%)</td><td>0.48-4.54</td><td>1.25-5.07</td><td>0.61-1.25</td></tr>
<tr><td rowspan="5">Herring gull
Larus argentatus</td><td colspan="4">Herring gull were recorded in relatively low numbers in all seasons, with the population estimate peaking at 186 individuals (±95% CI 17-476) in February 2021. Peak density, however, was recorded in March 2020 at 0.25 birds/km^2 (±95% CI 0.00-0.74). The maximum absolute population estimates for the breeding season and non-breeding season are presented below.</td></tr>
<tr><td>**Season**</td><td colspan="2">**Migration free breeding**</td><td colspan="2">**Non-breeding**</td></tr>
<tr><td>Maximum population estimate</td><td colspan="2">8</td><td colspan="2">186</td></tr>
<tr><td>Confidence (lower-upper 95%)</td><td colspan="2">0-22</td><td colspan="2">17-476</td></tr>
<tr><td colspan="4">Note: due to low numbers recorded in the surveys, mean peak seasonal population and density estimates were not calculated; the maximum values are presented.</td></tr>
</table>

<table>
<tr><th>Species</th><th>Summary of Project-specific Surveys</th></tr>
<tr><td>Great black-backed gull

Larus marinus</td><td>Great black-backed gull were recorded in low numbers, with peak densities of 0.09 birds/km^2 (±95% CI 0.00-0.25) and 0.18 birds/km^2 (±95% CI 0.00-0.38) in December 2019 and 2020, respectively. There were sporadic recordings between May and July, however, the population estimate for the migration-free breeding season was 0 individuals. The maximum absolute population estimates for the breeding season and non-breeding season are presented below.
<table>
<tr><th>Season</th><th>Migration free breeding</th><th>Non-breeding</th></tr>
<tr><td>Maximum population estimate</td><td>0</td><td>12</td></tr>
<tr><td>Confidence (lower-upper 95%)</td><td>N/A</td><td>4-20</td></tr>
</table>
Note: due to low numbers recorded in the surveys, mean peak seasonal population and density estimates were not calculated; the maximum values are presented.</td></tr>
<tr><td>Lesser black-backed gull

Larus fuscus</td><td>Lesser black-backed gull were recorded in relatively low numbers in most seasons, with peak densities occurring during the migration-free breeding season. Density estimates peaked at 0.61 birds/km^2 (±95% CI 0.23-1.07) in July 2019, and at 0.86 birds/km^2 (±95% CI 0.17-1.60) in July 2020. The peak population estimate of 38 birds was recorded in the migration-free breeding season. The maximum absolute population estimates for the four seasons are presented below.
<table>
<tr><th>Season</th><th>Migration free breeding</th><th>Autumn migration</th><th>Non-breeding</th><th>Spring migration</th></tr>
<tr><td>Maximum population estimate</td><td>38</td><td>8</td><td>0</td><td>0</td></tr>
<tr><td>Confidence (lower-upper 95%)</td><td>11-69</td><td>0-17</td><td>N/A</td><td>N/A</td></tr>
</table>
Note: due to low numbers recorded in the surveys, mean peak seasonal population and density estimates were not calculated; the maximum values are presented.</td></tr>
</table>

<table>
<tr><th>Species</th><th>Summary of Project-specific Surveys</th></tr>
<tr><td>Black-legged kittiwake

Rissa tridactyla</td><td>Black-legged kittiwake density ranged from 0.00 birds/km^2 in April 2020 to a peak estimate of 4.99 birds/km^2 (±95% CI 2.72-7.19) in January 2021. Densities were generally higher in autumn and spring, as reflected in the peak mean population estimates (see below). Population estimates peaked in the spring migration at 486 birds (±95% CI 234-744) in June 2021. Taking the 2 km buffer into consideration, the peak population estimate of 3,428 birds (±95% CI 1,226-6,037) was recorded in October 2019, and a substantially higher seasonal peak was recorded during autumn migration than other seasons.
<table>
<tr><th>Season</th><th>Migration free breeding</th><th>Autumn migration</th><th>Spring migration</th></tr>
<tr><td>Population estimate</td><td>2</td><td>2,022</td><td>508</td></tr>
<tr><td>Confidence (lower-upper 95%)</td><td>0-6</td><td>829-3,420</td><td>305-730</td></tr>
<tr><td>Density estimate</td><td>0.02</td><td>18.50</td><td>4.65</td></tr>
<tr><td>Confidence (lower-upper 95%)</td><td>0.00-0.06</td><td>7.59-31.30</td><td>2.79-6.68</td></tr>
</table></td></tr>
<tr><td>Atlantic puffin

Fratercula arctica</td><td>Atlantic puffin were predominantly recorded during the breeding season (maximum population estimate: 242 birds (±95% CI 141-358) in June 2021), with considerably fewer birds recorded in the non-breeding season (maximum population estimate: 19 birds (±95% CI 0-51) in March 2021). The mean peak population and density estimates for each season are presented below.
<table>
<tr><th>Season</th><th>Migration free breeding</th><th>Non-breeding</th></tr>
<tr><td>Population estimate</td><td>449</td><td>32</td></tr>
<tr><td>Confidence (lower-upper 95%)</td><td>297-616</td><td>0-93</td></tr>
<tr><td>Density estimate</td><td>4.11</td><td>0.29</td></tr>
<tr><td>Confidence (lower-upper 95%)</td><td>2.71-5.62</td><td>0.00-0.85</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Species</th><th>Summary of Project-specific Surveys</th></tr>
<tr><td>Common guillemot
Uria aalge</td><td>Common guillemot were the most-recorded species in the surveys, however, population and density estimates varied greatly month to month and across seasons. The maximum population estimate for the non-breeding season was 11,002 birds (±95% CI 8,415-13,571), recorded in August 2020, with comparatively fewer birds recorded in the migration free breeding season (peak estimate of 3,468 birds (±95% CI 2,701-4,464) in March 2021). Taking the 2 km buffer into consideration, the peak population estimate (August 2020) increases to 22,963 birds (±95% CI 18,572-27,301). The mean peak population and density estimates for the breeding and non-breeding seasons are presented below.
<table>
<tr><th>Season</th><th>Migration free breeding</th><th>Non-breeding</th></tr>
<tr><td>Population estimate</td><td>3,558</td><td>15,324</td></tr>
<tr><td>Confidence (lower-upper 95%)</td><td>2,697-4,740</td><td>11,731-19,168</td></tr>
<tr><td>Density estimate</td><td>32.55</td><td>140.21</td></tr>
<tr><td>Confidence (lower-upper 95%)</td><td>24.67-43.37</td><td>107.33-175.40</td></tr>
</table></td></tr>
<tr><td>Razorbill
Alca torda</td><td>Recordings of razorbill in the array area varied month to month. The absolute maximum population estimate peaked in the spring migration period; however, the season peak mean was high in the autumn migration period. In the spring period, the peak maximum population was 363 birds (±95% CI 119-627) compared with 82 birds (±95% CI 28-137) in autumn. This is in contrast to the peak mean population and density estimates displayed below.
<table>
<tr><th>Season</th><th>Migration free breeding</th><th>Autumn migration</th><th>Non-breeding</th><th>Spring migration</th></tr>
<tr><td>Population estimate</td><td>103</td><td>1,228</td><td>566</td><td>460</td></tr>
<tr><td>Confidence (lower-upper 95%)</td><td>43-167</td><td>683-1,971</td><td>267-922</td><td>178-778</td></tr>
</table></td></tr>
</table>

Species	Summary of Project-specific Surveys				
	Density estimate	0.93	11.23	5.17	4.20
	Confidence (lower-upper 95%)	0.39-1.53	6.24-18.04	2.46-8.42	1.63-7.11

11.6 Potential Environmental Effects

11.6.1.1 For offshore ornithology the potential impacts considered are set out in the EIA Scoping Report (MarineSpace 2019), NRW Scoping Opinion (2020), and following consultation with regulators and key stakeholders (Table 11.4). These relate to the three main phases of development construction, operation and decommissioning. Key parameters, from the PDE (see Chapter 4: Proposed Development Description), that have been used to inform each impact assessment are presented in Table 11.15.

Table 11.15 – Project Design Envelopment parameters relevant to offshore ornithology.

Potential Pathway Change/Impact	Realistic Worst Case Scenario	Justification
Construction		
Indirect impacts as a result of displacement of prey due to construction activities.	Offshore construction = 8 month period.	This represents the maximum duration of offshore works across the array, export cable corridor and landfall. It is assumed that there will some displacement of prey items during offshore construction works.
Disturbance and displacement from increased vessel activity (array area and ECC).	Up to 6 x vessels active offshore at any one moment during construction phase.	Vessels required for mooring lay-down, floating platform hook-up, cable installation, landfall works.
Disturbance and displacement from underwater noise via construction activities (including piling and UXO).	Piling 35 piled anchors; Diameter: 2.5 m; Length: 55 m; Penetration depth: 52 m;	Maximum number of piles and hammer energy used to install piles, represents the Permanent Threshold Shift (PTS) and disturbance maximum design scenario.

	Hammer energy: 800 kJ; Piling duration: 114 min per pile (incl. soft-start and ramp-up); Total piling time for 35 anchors: 66.5 hours; Maximum 2 piles installed per day. Total 18 days piling. UXO The Project is seeking consent for one Unexploded Ordnance (UXO) detonation via deflagration (low-order). This is presented as the realistic worst case scenario throughout the ES. Low order detonation: 2 kg net explosive quantity (NEQ). High order detonation: 525 kg device.	Maximum number of detonations via deflagration (low-order) within the PDE. High order detonation of up to 525 kg device also modelled and assessed, although judged to be an unrealistic worst case scenario.
Operation and Maintenance		
Collision risk.	A series of scenarios was developed to inform the collision risk modelling. The scenarios present a hybrid of engineering parameters from the PDE according to the current design status of the Project. The scenarios do not reflect the parameters of a single WTG, but a combination of minimum and maximum values that are attributed to a range of potential WTG manufactures. The scenarios are as follows:	The worst case is defined on a species by species basis, depending on the proportion of seabirds flying at collision risk height.

	• Maximum number of turbines at minimum height (10 WTGs, 196 m minimum height, 109 m hub height, 174 m rotor diameter, 22 m air gap, 9.5 MW rated power); • Minimum number of turbines at maximum height (6 WTGs, 270 m maximum height, 150 m hub height, 242 m rotor diameter, 22 m air gap, 16–18 MW rated power); • Realistic worst case (7 WTGs, 244 m total height, 133 m hub height, 222 m rotor diameter, 22 m air gap, 14 MW rated power).	
Displacement.	10 x WTGs with a maximum spacing of 3,500 m between each turbine.	Largest area of seabed activity that may lead to displacement effects on seabirds.
Disturbance and displacement from vessel activity (O&M and cable repairs).	Vessel quantities per year: 2 x 12 hr day (Crew Transfer Vessel (CTV)) (transit 1.5-2 hrs).	The maximum numbers of vessels and associated vessel movements represents the maximum potential for collision risk and disturbance.
Disturbance to foraging birds from underwater noise and vibration via operational activities.	10 x semi-submersible floating platforms with up to 35 mooring lines.	Maximum number of project components that may generate subsea noise in the operational phase.
Barrier effect of wind turbine generators to regular movements of birds to and from breeding colonies or on migration.	Maximum offshore array area of 32 km^2 with a maximum of 10 WTGs, with minimum spacing of 3,500 m between each WTG.	These are the parameters that identify the infrastructure that can potentially give rise to a barrier effect and quantifies the upper limit of each for the maximum adverse scenario.
Indirect impacts through long-term effects on habitats and prey species.	Maximum operational period: 25 years.	Area of long-term habitat loss is predicted from maximum worst case areas impacted by (or under footprint) of

	Total habitat loss via project infrastructure: 163,001 m^2 (0.16km^2).	infrastructure and mooring line clumps.
Aggregating effects of turbine structures.	10 x triangular shaped (3-side) semi-submersible floating platforms with lengths of 112 x 123 x 96 m (331 m length of potential resting space per platform. Total = 3,310 m (x 10 platforms).	Maximum overall length of the hull sections of the floating platforms that will represent potential roosting habitat.
Entanglement risk from ghost fishing gear.	35 catenary mooring lines: • 870 m length mooring lines; • 800 m mooring radius (hull to anchor); • 60 m length mooring rope; • 810 m mooring chain; • 25 mooring clumps per line. 10 array cables: • Formation: Lazy Wave; • Length: 6.022 km each; • Length: 23.9 km total; • Diameter: 30 mm.	The maximum scale of the mooring lines and inter-array cables represents the maximum potential for barrier effects, entanglement and collision.
Attraction of nocturnal seabirds (shearwaters and petrels) to lighting on project infrastructure.	Medium intensity steady red light. Aviation lights - Switched on ½ – 1 hour before sunset and switched off ½ - 1 hour after sunrise. Height of the lights ca. 3-6 m above hub height (min. 112 m / max. 154 m above Floater Water Line). Illuminated at night only. Sensor-activated spotlights at tower doors, all walkways and boat landing, access platform/davit crane (50 Lux max). Marine lanterns (flashing yellow lights) visible at not less than 5 nautical miles on	As per standard MCA and THLS requirements.

	max. all WTGs, or min. at the corners (potentially flashing yellow lights visible at ot less than 2 nautical miles for the WTGs in between the corners).	
Decommissioning		
Indirect impacts as a result of displacement of prey due to construction activities.	As per construction phase.	As per construction phase.
Disturbance and displacement from increased vessel activity (array and ECC).	As per construction phase.	As per construction phase.
Disturbance and displacement from underwater noise via construction activities (including piling and UXO).	As per construction phase.	As per construction phase.

11.6.2 Construction

<u>Indirect impacts as a result of displacement of prey due to construction activities</u>

11.6.2.1 Alterations to the presence or behaviour of prey species, as a result of construction activities, may result in an indirect impact on seabird populations within the Project area. Changes to prey abundance, or the induction of behavioural changes in prey species, may lead to less prey being available to foraging seabirds within the region.

11.6.2.2 Construction activities including piling, export or array cable installation activities or increased vessel movements, may cause seabed disturbance, increased suspended sediment concentrations (SSC), and underwater noise from low-level, non-impulsive sources (i.e. vessel noise), piling and UXO. Whilst all of these changes may result in the avoidance behaviour of prey species, increased SSC also has the potential to result in the smothering of prey species, further reducing prey availability. The potential effect of these impacts on benthic and fish species has been assessed in Chapter 9: Marine and Coastal Ecology, and Chapter 10: Fish and Shellfish Ecology respectively. The conclusion of those assessments informs this assessment of indirect effects on offshore ornithology receptors.

11.6.2.3 The impact of seabed disturbance to both benthic, and fish and shellfish receptor groups is considered minor. This impact is considered as being temporary, of limited scale and being highly localised. The mobility of the majority of prey species (fish species such as Atlantic herring *Clupea harengus* and sprat *Sprattus sprattus*) will allow for avoidance strategies to occur, for the limited period during which seabed disturbance is occurring, following which populations are anticipated to return rapidly. As a result, the displacement of prey species due to seabed disturbance is considered as being of negligible magnitude.

11.6.2.4 Similarly, the impacts of increased SSC during construction is considered as minor or negligible for prey species. The population of key prey species for seabirds, including Atlantic herring, sprat and sandeel, are anticipated to be affected only temporarily. Whilst sediment settlement may result in the smothering of some prey species, it is likely that this effect will be limited to a single tidal cycle. As a result, the displacement of prey species due to increases in SSC is considered as being of negligible magnitude.

11.6.2.5 The impact of underwater noise on prey species during the construction period is likely to be limited to a small proportion of the wider Project area. Whilst physical injury or mortality in some prey species may occur, the assessments of underwater noise made in Chapter 10: Fish and Shellfish Ecology suggest that this will be limited to individuals within close proximity to piling and UXO sources only. Impacts on the wider population of these prey species are not anticipated, with the impact on this receptor group as a result of underwater noise during the construction phase, being assessed negligible or minor. As a result, the displacement of prey species due to underwater noise is considered as being of negligible magnitude.

11.6.2.6 Key prey species for a number of bird receptors include clupeid fish such as Atlantic herring and sprat. Whilst these species have a level of sensitivity to impacts from construction-related underwater noise, in particular to high-impulsive noise such as piling and UXO, the volume of water in which mortality will occur is negligible in the wider context of the study area. Further, the mobility of ornithological receptors will allow for predation to take place across a wide area, should prey availability be reduced within the Project area. Therefore, the sensitivity of all ornithological receptor groups, to indirect impacts as a result of displacement of prey due to construction activities, is considered negligible.

11.6.2.7 The magnitude of the impact has been assessed as negligible and the sensitivity of all ornithological receptors as negligible. Therefore, the impact of reduction in prey species is assessed as having **negligible** effect, which is not significant in EIA terms.

Additional Mitigation and Residual Effect

11.6.2.8 None of effects identified above is major or moderate adverse (significant in EIA terms). Therefore, no additional mitigation is required to reduce the significance to non-significant in EIA terms, and the significance of residual effects remains as detailed above.

Disturbance and displacement from increased vessel activity (array area and ECC)

11.6.2.9 The construction phase has the potential to affect seabirds in the marine environment through disturbance due to construction activities, including the installation of semi-submersible floating platforms and associated moorings, offshore export cable and increased vessel activity. Disturbance has the potential to displace seabirds from the Proposed Development including the array area, offshore export cable corridor (ECC) and routes used by vessels to access the Proposed Development during construction. Displacement would result in temporary habitat loss through a reduction in the area available to birds for feeding, resting/loafing, and moulting.

11.6.2.10 Information on vessel activity in the region, and within the array area and ECC, is presented in Chapter 16: Shipping and Navigation and Volume 3, Technical Appendix: 16.1 Navigational Risk Assessment. This is informed by Automatic Identification System (AIS) and radar data from 2019 and 2020, and vessel traffic surveys from 2020. Vessel traffic activity is defined by cargo vessels, tankers, passenger vessels, fishing vessels, recreational vessels, and tug and service vessels.

11.6.2.11 Four key routes identified in the shipping and navigation study area, collectively account for 1,200 vessel movements per year.

11.6.2.12 It is anticipated that there will be a maximum of 6 vessels offshore at any one time over the 8 month offshore construction period. Construction vessels are only expected to be present within a localised area for maximum of 24 hours during the cable laying process, while within the array area piling work is expected to take around 18 days. The limited time that vessels are present within the array area and ECC reduces the period where seabirds would be disturbed from foraging, and due to the localised nature of the works, limits the displacement to small areas within the proximity of construction vessels.

11.6.2.13 Any impacts from disturbance and displacement from vessel activity are considered to be short-term, temporary and reversible in nature, lasting only for the duration of construction activity, as seabirds would be expected to return to the area once the vessels have left the area. Furthermore, the low number of vessels associated with construction of the Project is considered insignificant, compared with the baseline levels of shipping and vessel activity in the region (1,200 vessel movements per year).

11.6.2.14 The embedded mitigation of a vessel management plan, see Section 11.4.6, will ensure that vessel traffic moves along predictable routes. It is highly likely that a proportion of vessels will be stationary, or slow-moving, for significant periods of time throughout construction activities. Therefore, the actual increase in vessel traffic moving around the array area and ECC, and to/from port to the Proposed Development, will occur over short periods of the offshore construction phase. The adoption of a vessel management plan will minimise the potential for any impact. Therefore, the risk of disturbance and displacement occurring as a result of the construction phase is of negligible magnitude.

11.6.2.15 Some bird species are more susceptible than others to disturbance from vessel activity, which may lead to subsequent displacement. Fliessbach *et al*. (2019) noted that species-specific disturbance responses differed considerably to an approaching vessel, with population disturbance ranging from 10% in black-headed gulls to 96% for diver species.

11.6.2.16 There are a number of different measures used to assess bird disturbance and displacement from vessel activity. Garthe and Hüppop (2004) developed a scoring system for disturbance by ship associated with OWF, on a scale of 1 (hardly any escape/avoidance behaviour and/or none/very low fleeing distance) to 5 (strong escape/avoidance behaviour and/or large fleeing distance). Furness and Wade (2012) developed disturbance ratings for particular species, alongside scores for habitat flexibility and conservation importance in Scottish waters. Bradbury *et al.* (2014) provided an update to the Furness and Wade (2012) paper, and these references have informed the sensitivity levels defined for the receptor groups discussed below (Table 11.16).

Table 11.16 Translation of Garthe and Hüppop (2004) scoring system to Receptor Sensitivity

Scoring System (Garthe and Hüppop 2004)	**Sensitivity**
1	Negligible
2	Low
3	Medium

Scoring System (Garthe and Hüppop 2004)	Sensitivity
4	Major
5	Major

11.6.2.17 Sensitivity assessment to disturbance from vessel activity has been conducted for seabird groups recorded in the digital aerial survey work for the array area, and applied as a worst case for the ECC.

Northern fulmar sensitivity to vessels

11.6.2.18 Northern fulmar *Fulmarus glacialis* was recorded in the array area and, based on the Garthe and Hüppop (2004) scoring system, was subjectively scored 1 representing hardly any escape behaviour to disturbance by ship (Bradbury *et al*., 2014). A more recent study, looking into ship traffic disturbance, found northern fulmar to show one of the lowest proportions of disturbance response to an approaching vessel (19%) (Fliessbach *et al*., 2019). The MMO's assessment on displacement and habituation in response to transport and traffic, assessed northern fulmar as having very low sensitivity to displacement by transport and traffic (MMO, 2018). Based on Garthe and Hüppop (2004) scoring system the sensitivity for this receptor is considered negligible.

11.6.2.19 The magnitude of the impact has been assessed as negligible and the sensitivity of northern fulmar as negligible. Therefore, disturbance from vessels during the construction phase on fulmar is concluded to result in a **negligible** effect, which is not significant in EIA terms.

Shearwaters and storm-petrel sensitivity to vessels

11.6.2.20 Manx shearwater *Puffinus puffinus* was a key seabird species recorded during the Project-specific DAS. Balearic shearwater *Puffinus mauretanicus* and European storm-petrel *Hydrobates pelagicus* were not recorded during the DAS; however following pre-application discussion with NRW, JNCC, RSPB and WTSWW, these two species have been included in the assessment.

11.6.2.21 Manx shearwater, Balearic shearwater and European storm-petrel have all been assessed a score of 1, based on the Garthe and Hüppop (2004) scoring system, representing hardly any escape behaviour to disturbance by ship and helicopter (Bradbury *et al*., 2014). The MMO's assessment on displacement and habituation in response to transport and traffic, assessed the species group as having very low sensitivity to displacement by transport and traffic (MMO, 2018). Based on the Garthe and Hüppop (2004) scoring system the sensitivity for this receptor is considered negligible.

11.6.2.22 The magnitude of the impact has been assessed as negligible and the sensitivity of shearwaters and storm-petrels as negligible. Therefore, disturbance from vessels during the construction phase, on shearwaters and storm-petrels, is concluded to result in a **negligible** effect, which is not significant in EIA terms.

Northern gannet sensitivity to vessels

11.6.2.23 Northern gannet *Morus bassanus* were recorded by the Project-specific DAS within the array area + 4 km buffer.

11.6.2.24 Northern gannet has been scored 2 to disturbance by ship traffic based on the Garthe and Hüppop (2004) scoring system (Bradbury *et al*., 2014). Fliessbach *et al.* (2019) recorded a population proportion of 45%, flying off as a response to an approaching vessel, and were seen to flush out a distance of 127 m (±82 SD). The MMO's assessment on displacement and habituation in response to transport and traffic, assessed northern gannet as having low sensitivity to displacement by transport and traffic (MMO, 2018). Based on the Garthe and Hüppop (2004) scoring system the sensitivity for this receptor is considered low.

11.6.2.25 The magnitude of the impact has been assessed as negligible and the sensitivity of northern gannet as low. Therefore, disturbance from vessel activity during the construction phase on northern gannet is concluded to result in a **negligible** effect, which is not significant in EIA terms.

Gull species sensitivity to vessels

11.6.2.26 A total of 4 gull species were recorded on-site, these were herring gull *Larus argentatus*, great black-backed gull *Larus marinus,* lesser black-backed gull *Larus fuscus* and black-legged kittiwake *Rissa tridactyla*.

11.6.2.27 Gulls are generally not considered susceptible to disturbance, and are often associated with fishing boats (e.g. Camphuysen, 1995; Hüppop and Wurm, 2000) and during construction of Greater Gabbard Offshore Wind Farm were not disturbed by construction activities (GGOWL, 2011). Gull species have been found close to active foundation piling activity at the Egmond aan Zee (OWEZ) wind farm (Leopold and Camphuysen, 2007).

11.6.2.28 All 4 gull species were assessed a score of 2 for disturbance susceptibility, based on the Garthe and Hüppop (2004) scoring system (Bradbury *et al.,* 2014). Black-legged kittiwake were observed to demonstrate the highest proportion of individuals showing disturbance response to an approaching vessel (32%), while herring gull showed the lowest response (15%) (Fliessbach *et al*., 2019). Lesser black-backed gull showed the furthest escape distance of 157 m (±105 SD) and great black-backed gull the shortest distance of 79 m (±81 SD) (Fliessbach *et al.,* 2019). The MMO's assessment on displacement and habituation in response to transport and traffic, assessed the gull group as having low sensitivity to displacement by transport and traffic (MMO, 2018). Based on Garthe and Hüppop (2004) scoring system the sensitivity for this receptor is considered low.

11.6.2.29 The magnitude of the impact has been assessed as negligible and the sensitivity of gulls as low. Therefore, disturbance from vessel activity during the construction phase on gulls is concluded to result in a **negligible** effect, which is not significant in EIA terms.

Auk sensitivity to vessels

11.6.2.30 A total of 3 auk species were recorded during the Project-specific DAS, Atlantic puffin *Fratercula arctica*, common guillemot *Uria aalge* and razorbill *Alca torda*.

11.6.2.31 The highest score assigned to auk species was 3, based on the Garthe and Hüppop (2004) scoring system (Bradbury *et al*., 2014). Fliessbach *et al*. (2019) recorded a razorbill population proportion of 78%, displaying an escape response to an approaching vessel, while unidentified auk recorded a population proportion of 94% showing an escape response. Mean escape distance for razorbill was 395 m (±216 SD), and 750 m (±379 SD) for unidentified auk. The MMO's assessment on displacement and habituation in response to transport and traffic, assessed auk species group as having moderate sensitivity to displacement by transport and traffic (MMO, 2018). Based on the Garthe and Hüppop (2004) scoring system the sensitivity for this receptor is considered medium.

11.6.2.32 The magnitude of the impact has been assessed as negligible and the sensitivity of auks as medium. Therefore, disturbance from vessel activity during the construction phase on auks is concluded to result in a **minor adverse** effect, which is not significant in EIA terms.

Additional Mitigation and Residual Effect

11.6.2.33 None of effects identified above is major or moderate adverse (significant in EIA terms). Therefore, no additional mitigation is required to reduce the significance to non-significant in EIA terms, and the significance of residual effects remains as detailed above.

Disturbance and displacement from underwater noise via construction activities (including piling and UXO)

11.6.2.34 Diving birds spend regular, intermittent, periods underwater during foraging activities. As a result, these species are at risk to the effects of underwater noise. Diving birds within this assessment are considered to be species which dive deeper than the first couple of metres, as a part of regular foraging behaviour. Diving bird species assessed within this chapter include northern gannet, Manx shearwater, common guillemot, razorbill and Atlantic puffin. Whilst the effects of underwater noise on receptor groups such as marine mammals are well understood, relatively little is known about the impacts on diving birds (Crowell *et al.*, 2015).

11.6.2.35 The Project is seeking consent for one UXO detonation via deflagration (low-order). This is presented as the realistic worst-case scenario (with regards to UXO clearance) throughout the Environmental Statement and has formed the basis of the impact assessment undertaken.

11.6.2.36 However, in line with the recommendations outlined within the recent position statement on UXO clearance[5] this impact assessment includes an assessment for high-order detonations, though this is considered unrealistic to occur in practice.

11.6.2.37 Deflagration (low-order) is the Project's preferred method for UXO clearance and, based on current industry knowledge and precedent set by other offshore projects (e.g. Greenlink Interconnector (Greenlink Interconnector Limited 2020); Sofia Offshore Wind Farm (Sofia Offshore Wind Farm UXO Clearance Marine Licence Application, MLA/2020/00489; GoBe 2021); Seagreen Offshore Wind Farm (Marine Licence Application – Unexploded Ordnance Clearance – Seagreen Alpha and Bravo Wind Farm Site – 00009272); is considered the realistic worst case scenario. High order UXO detonation, as an absolute worst case, has been modelled and reported in Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration Technical Report. However, this has been considered for completeness and is not deemed realistic, as the Project intends to employ deflagration (low-order) as the clearance method.

11.6.2.38 This approach is informed by the UXO Threat and Risk Assessment (6 Alpha Associates, 2020) completed to inform Project specific geotechnical surveys, which provides an assessment of potential threat sources and the likelihood of contamination across the array area and offshore export cable corridor. The Project is also cognisant of the recently consented Marine Licence for the Greenlink Interconnector and the UXO approach adopted for the cable route in Welsh waters, i.e., the same as proposed for the Project.

[5] DEFRA Policy Paper: Marine environment: unexploded ordnance clearance joint interim position statement. Published 16 November 2021

11.6.2.39 Furthermore, a pre-installation (post-consent) geophysical survey will also be carried out and include a magnetometer survey, designed to identify any potential UXO targets in the vicinity of the planned cable route. If a UXO target is identified, the intention would be to route around the UXO and avoid interacting with it. The offshore export cable corridor has sufficient width, built in, to allow this to occur. However, if it is not possible to route around the UXO a more detailed assessment of the specific target would be undertaken (potentially via ROV) to determine UXO risk, and only if no alternative existed, would the Project undertake UXO clearance via deflagration (low-order). This is considered the realistic worst case.

It is acknowledged that the Project will be associated with additional subsea acoustic emissions, such as underwater noise from cable installation and placement of cable protection. However, the potential for impact from these activities have been scoped out of assessment based on the low levels of associated effect predicted in Technical Appendix 12.2: Underwater Noise and Vibration.

11.6.2.40 A full assessment on the effects of underwater noise within the marine environment is presented in Technical Appendix 12.2: Underwater Noise and Vibration. Within Crowell *et al.* (2015), a number of diving bird species, including red-throated diver, northern gannet and a number of duck species, all showed greatest hearing sensitivity at 1,000-3,000 Hz using auditory brainstem response techniques. A similar study undertaken by Hansen *et al.* (2016) showed similar findings within great cormorant in response to underwater noise.

11.6.2.41 Although these studies indicate that diving birds are receptive to underwater noise, assessments on the risk of injury to these species has not been conducted, and no thresholds for temporary threshold shift (TTS) or mortality as a result of exposure have been quantified. Diving birds may, however, be alerted to potential underwater noise through exposure to airborne noise, which is likely to act as a deterrent.

11.6.2.42 This will allow a rapid fleeing response to take place, following which the foraging behaviour of the diving bird receptors will be able to take place outside of the area of underwater noise influence, until construction activities cease. Additionally, noise-making construction activities will be both short-term and restricted to a small portion of the habitat available to foraging birds. Therefore, the magnitude of this impact is assessed as being negligible.

11.6.2.43 Diving birds can spend considerable amounts of time underwater. Studies indicated that common guillemot, razorbill and Atlantic puffin spend between 25% and 14% of their time at sea underwater (Spencer *et al.*, 2010; Thaxter *et al.*, 2010). Calculations for these values are presented in Volume 3 Technical Appendix 11.6: 2-Year Bird Survey Report.

11.6.2.44 Should exposure to underwater noise occur, this will be limited to the time in which the individual is underwater, typically less than a minute. It is expected that dives would be aborted in the presence in noise levels high enough to have the potential for injury, allowing for the impact to be limited via exposure minimisation. Although these species can spend large periods of time underwater during foraging activities, the potential for fleeing behaviour will result in a low sensitivity to this impact. However, due to current limitations in available research on the sensitivities of diving birds to underwater noise, the sensitivity of this impact has conservatively been assessed as medium.

11.6.2.45 The magnitude of the impact has been assessed as negligible and the sensitivity of diving bird receptors as medium. Therefore, the significance of the effect of disturbance and displacement from underwater noise is assessed as having **minor adverse** effect, which is not significant in EIA terms.

Additional Mitigation and Residual Effect

11.6.2.46 None of effects identified above is major or moderate adverse (significant in EIA terms). Therefore, no additional mitigation is required to reduce the significance to non-significant in EIA terms, and the significance of residual effects remains as detailed above.

11.6.3 Operational Phase

11.6.3.1 The key potential impacts on birds, from the Project, during the operational phase are collision risk and displacement. Agreed methodologies exist to quantify these impacts which are discussed in the following sections. The assessment is presented on a species-by-species basis and, for certain species, the impact is summed.

Collision Risk

11.6.3.2 The WTG rotors and associated infrastructure pose a potential risk of collision to seabirds flying within the array area whilst foraging for food, commuting between breeding sites and foraging areas, or passing through on migration. Collision might result in injury or death. Collision Risk Modelling (CRM) has been performed to determine the probability of this occurring.

11.6.3.3 The collision risk modelling undertaken for the Project is modelled on 3 scenarios (Table 11.17). For all 3 scenarios, the minimum blade height, and therefore air gap between the sea and rotor swept area, is constant (22 m), but the scenarios vary depending on number of WTGs and blade tip height. The 14 MW scenario is considered a realistic worst case as this represents the parameters of a WTG most likely to be used for the Project.

11.6.3.4 The input parameters used in the CRM include details on turbine scenario, turbine operation, seabird biometric information, mean densities for each species recorded during digital aerial survey work, model option, and avoidance rates (Volume 3, Technical Appendix 11.3: Collision Risk Modelling).

11.6.3.5 The collision risk modelling assessed all scenarios and, in most cases, the turbine dimensions did not alter the results of the flight height analysis due to the constant minimum blade height. However, the assessment is based on the ‘worst case’ results from the modelling i.e. highest proportion of species recorded flying at collision risk height (Volume 3, Appendix 11.1: Baseline Data). The worst case is specified in each species assessment, and attributed to either the 9.5 MW, 14 MW or 16-18 MW scenario.

11.6.3.6 Band (2012) provides a consistent and quantitative method for offshore collision risk, estimating the likelihood that a bird entering the ‘risk window’, the sweep of the turbine blades, could be struck. As such, the calculation assumes no avoiding action, and this is factored in subsequently using an agreed avoidance rate. Birds will take avoiding action to avoid being struck, whether this is by avoiding the wind farm completely (macro-avoidance) or altering their flight path in proximity to the turbine blades (meso and micro-avoidance). There are limitations to the model, but it provides a standard approach to estimating relative risk to the seabird species of concern.

11.6.3.7 The stochastic collision risk model, sCRM (McGregor *et al*., 2018), builds on Band (2012) and incorporates measures of uncertainty and variability within the input parameters to the model. Volume 3, Technical Appendix 11.3: Collision Risk Modelling describes the realistic ‘worst case’ scenario, turbine parameters (Table 11.17) and seabird parameters, modelled for each species (Table 11.18).

Table 11.17 – Turbine scenarios for sCRM

Parameter	Turbine scenario		
	9.5 MW	14 MW	16-18 MW
Latitude (degrees)	51.4	51.4	51.4
Windfarm width (km)	7	7	7
Tidal offset (m)	0	0	0
No. turbines	10	7	6
No. blades	3	3	3
Rotor radius (m)	87	111	121
Air gap (m)	22	22	22
Max. blade width (m)	5.8	5.8	5.8
Upper blade height (m)	196	244	270
Rotation speed (rpm)	9.9	9.9	9.9
Pitch (degrees)	2	2	2

Table 11.18 – Summary of the sCRM seabird parameters

Species	Body length (m)	Wingspan (m)	Flight speed (m/sec)	Nocturnal activity	Flight type (flapping or gliding)
Manx shearwater	0.34	0.83	9.4	0.5	Flapping
Northern gannet	0.935	1.73	13.1	0	Flapping
Herring gull	0.595	1.44	12.8	0.5	Flapping
Great black-backed gull	0.71	1.58	13.7	0.5	Flapping
Lesser black-backed gull	0.58	1.43	12.8	0.5	Flapping
Black-legged kittiwake	0.39	1.08	13.1	0.25	Flapping
Common guillemot	0.395	0.67	19.1	0.25	Flapping

11.6.3.8 For CRM, the required input data are monthly means of the densities of flying seabirds. The densities are calculated as the monthly means across the two years of survey work – see Volume 3, Technical Appendix 11.7: 2-Year Bird Survey Report for the values used in assessment. The estimates include a measure of uncertainty, the standard deviation, which is inputted to the model.

11.6.3.9 sCRM model Option 1 uses site-specific data on flight height. The proportion of birds flying at collision risk height was calculated from the digital aerial survey data using HiDef's flight height analysis tool. sCRM model Option 2 uses the generic flight height data, collated in Johnstone *et al.* (2014), from a range of wind farm sites around the UK.

11.6.3.10 The modelling uses the R-code from the sCRM shiny app (McGregor *et al*., 2018) and a copy of the code can be made available on request.

11.6.3.11 For assessment purposes, the seasonal mortality estimates provided in Volume 3, Technical Appendix 11.3: Collision Risk Modelling have been rounded up or down to the nearest bird.

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11.6.3.12 To consider potential collision risk mortalities to seabird receptors, the impacts have to be apportioned by season, and considered against defined regional populations for each of the breeding and non-breeding (BDMPS) periods. These populations are summarised in Table 11.19, referring to Pritchard *et al.* (2021) for the Welsh regional breeding populations, and to Furness (2015) for the non-breeding BDMPS populations. For the breeding season, the populations are individual adult birds, whereas for the BDMPS, the populations are adults and immatures.

Table 11.19 – Seabird reference populations (regional numbers)

Species	Migration free breeding season	BDMPS		
		Autumn migration	Non-breeding	Spring migration
Northern fulmar	Apr–Aug 6,948	Sep–Oct 828,194	Nov 556,367	Dec–Mar 828,194
Manx shearwater	Jun–Jul 974,942	Aug–Oct 1,580,895	n/a	Mar–May 1,580,895
Northern gannet	Apr–Aug 72,022	Sep–Nov 545,954	n/a	Dec–Mar 661,888
Herring gull	Mar–Aug 15,976*	n/a	Sep–Feb 173,299	n/a
Great black-backed gull	May–Jul 1,008	n/a	Sep–Mar 17,742	n/a
Lesser black-backed gull	May–Jul 20,380*	Aug–Oct 163,304	Nov–Feb 41,159	Mar–Apr 163,304

Species	Migration free breeding season	BDMPS		
		Autumn migration	Non-breeding	Spring migration
Black-legged kittiwake	May–Jul 9,054	Aug–Dec 911,586	n/a	Jan–Apr 691,526
Common guillemot	Mar–Jun 96,802	n/a	Aug–Feb 1,139,220	n/a

* Population count does not include roof-nesting birds.

11.6.3.13 While the Welsh breeding population counts are certain (as recorded on the Seabird Monitoring Programme Database, and collated by Pritchard *et al.*, 2021), the BDMPS population estimates have a lot more uncertainty associated with them (Furness, 2015). However, at the current time they provide the only available information for impact assessment in the non-breeding season.

Northern fulmar

11.6.3.14 Northern fulmar were one of the less abundant species to be recorded in the array area, Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report. Northern fulmar normally fly low to the sea, with 0.2% estimated to occur at potential collision risk height based on generic data (Johnston *et al*., 2014). The predicted collision mortalities are 0, which are <1% of regional numbers (see Table 11.8). Therefore, magnitude is assessed as negligible.

11.6.3.15 Based on the sensitivity ranking (Furness *et al.*, 2013) northern fulmar are assigned low sensitivity to collision risk.

11.6.3.16 The magnitude of the impact has been assessed as negligible and the sensitivity as low. Therefore, the significance of the effect of collision risk during the operational phase is concluded to be of **negligible** significance, which is not significant in EIA terms.

Manx shearwater

11.6.3.17 Manx shearwater are considered to be at low risk of impacts from offshore wind farms (Johnston *et al*., 2014), however, in agreement with NRW, JNCC, RSPB and WTSWW, this species is assessed as having high sensitivity to collision (Volume 3, Technical Appendix 11.3: Collision Risk Modelling).

11.6.3.18 For collision risk, the mean monthly densities plus associated standard deviations are derived from the digital aerial survey results (Volume 3, Technical Appendix 11.1: Baseline Data), and inputted into the sCRM as set out in Volume 3, Technical Appendix 11.3: Collision Risk Modelling. The different types of model are discussed in that appendix, and all turbine scenarios are modelled (see Table 11.17). This assessment uses a ‘worst case’ based on a 14 MW turbine scenario, and model Option 2 using generic flight height data (Johnston *et al*., 2014) with an avoidance rate of 0.98 (SNCB, 2014). Other turbine scenarios are included in Volume 3, Technical Appendix 11.3: Collision Risk Modelling for context. For Manx shearwater, the modelling was carried out for all months, then subdivided by season and the results are presented in Table 11.20.

Table 11.20 – Manx shearwater reference populations (regional numbers) and estimated impacts

Species	Migration free breeding season	BDMPS		
		Autumn migration	Non-breeding	Spring migration
Manx shearwater	Jun – Jul	Aug – Oct	n/a	Mar – May
Ref. population	974,942	1,580,895	-	1,580,895
Collision mortality	0	0	-	0

11.6.3.19 Predicted collisions for Manx shearwater are zero, because no birds were predicted to be at potential collision risk height using the Johnston *et al.* (2014) flight height data. Although flight height could not be measured from the digital aerial survey data, the available tracking data have also confirmed a maximum flight height of 17.5 m (Davies *et al.*, 2021) and maximum potential height of 20 m (Tim Guilford, pers. comm.), below the lowest sweep of the rotor blades.

11.6.3.20 As predicted collisions are 0, the magnitude of impact is assessed as negligible as the predicted collision mortalities are <1% of regional numbers (see Table 11.8).

11.6.3.21 Although the Furness *et al.* (2013) ranking defined Manx shearwater as low sensitivity, following consultation with NRW, JNCC, RSPB and WTSWW this species is assessed as having high sensitivity to collision.

11.6.3.22 The magnitude of the impact has been assessed as negligible and the sensitivity as high. Therefore, the significance of effect during the operational phase is concluded to be of **minor adverse** significance, which is not significant in EIA terms.

Balearic shearwater

11.6.3.23 Balearic shearwater were not recorded on-site during the DAS, but were identified as an important receptor during pre-application discussion with NRW, JNCC, RSPB and WTSWW. Assuming Manx shearwater can be used as a suitable proxy for height, predicted collisions to Balearic shearwater are zero because no birds were predicted to be at potential collision risk height (Johnston *et al*., 2014). This would equate to a negligible magnitude of impact as the predicted collision mortalities are <1% of regional numbers (see Table 11.8).

11.6.3.24 Although the Furness *et al.* (2013) ranking defined Manx shearwater, and so by proxy, Balearic shearwaters as low sensitivity, following consultation with NRW, JNCC, RSPB and WTSWW this species is assessed as having high sensitivity to collision.

11.6.3.25 The magnitude of the impact has been assessed as negligible and the sensitivity of receptor as high. Therefore, the significance of the effect of collision risk during the operational phase is concluded to be of **minor adverse** significance, which is not significant in EIA terms.

European storm-petrel

11.6.3.26 European storm-petrel were not recorded in the array area (Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report). However, in agreement with NRW, JNCC, RSPB and WTSWW, European storm-petrel have been included in the impact assessment. Furness *et al*. (2013), indicate that European storm-petrel fly in the lowest 10 m height band above the sea (Cramp, 1977) and, therefore, are not at risk of collision. This would equate to 0 predicted collision mortalities, which is <1% of regional numbers (see Table 11.8). Therefore, magnitude is assessed as negligible.

11.6.3.27 Based on the sensitivity ranking (Furness *et al.*, 2013) European storm-petrel are assigned low sensitivity to collision risk.

11.6.3.28 The magnitude of the impact has been assessed as negligible and the sensitivity of receptor as low. Therefore, the significance of the effect of collision risk during the operational phase is concluded to be of **negligible** significance, which is not significant in EIA terms.

Northern gannet

11.6.3.29 Northern gannet are at potential risk of collision from the Project during its operational phase. For collision risk, the mean monthly densities plus associated standard deviations are derived from the digital aerial survey results (Volume 3, Technical Appendix 11.1: Baseline Data), and inputted into the sCRM, as set out in Volume 3, Technical Appendix 11.3: Collision Risk Modelling. The different types of model are discussed in that appendix and all turbine scenarios are modelled (see Table 11.17). This assessment is 'worst case' based on a 14 MW turbine scenario and model Option 1, using site-specific flight height data with an avoidance rate of 0.989 (SNCB, 2014).

11.6.3.30 Other model options and turbine scenarios are included in Volume 3, Technical Appendix 11.3: Collision Risk modelling for context. For northern gannet, the modelling was carried out for all months, then subdivided by season and the results are presented in Table 11.21.

Table 11.21 – Northern gannet reference populations (regional numbers) and estimated impacts

Species	Migration free breeding season	BDMPS		
		Autumn migration	Non-breeding	Spring migration
Northern gannet	Apr - Aug	Sep - Nov	n/a	Dec - Mar
Ref. population	72,022	545,954	-	661,888
Collision mortality	88	14	-	14

11.6.3.31 During the breeding season, the estimated northern gannet mortality from the Project is 0.12% of regional numbers. During the autumn migration BDMPS, the mortality estimate is 0.003% of regional numbers. During the spring migration BDMPS, the mortality estimate is 0.002% of regional numbers. These are all negligible magnitudes of impact, as the predicted collision mortalities are <1% of regional numbers (see Table 11.8).

11.6.3.32 As per the Furness *et al.* (2013) ranking (see Table 11.6), this species is assessed as having high sensitivity to collision.

11.6.3.33 The magnitude of the impact has been assessed as negligible and the sensitivity of receptor as high. Therefore, the significance of effect during the operational phase is concluded to be of **minor adverse** significance, which is not significant in EIA terms.

Herring gull

11.6.3.34 Herring gull are at potential risk of collision from the Project during its operational phase. The mean monthly densities plus associated standard deviations have been derived from the digital aerial survey results, Volume 3, Technical Appendix 11.1: Baseline Data, and inputted into the sCRM as set out in Volume 3, Technical Appendix 11.3: Collision Risk Modelling. The different types of model are discussed in that appendix and a number of different turbine scenarios are modelled (see Table 11.17).

11.6.3.35 This assessment is a 'worst case' based on a 14 MW turbine scenario and model Option 1, using site-specific flight height data with an avoidance rate of 0.995 (SNCB, 2014). Other model options and turbine scenarios are included in Volume 3, Technical Appendix 11.3 for context. For herring gull, the modelling was carried out for all months, then subdivided by season and the results are presented in Table 11.22.

Table 11.22 – Herring gull reference populations (regional numbers) and estimated impacts

Species	Migration free breeding season	BDMPS		
		Autumn migration	Non-breeding	Spring migration
Herring gull	Mar - Aug	n/a	Sep - Feb	n/a
Ref. population	15,976	-	173,299	-
Collision mortality	2	-	1	

11.6.3.36 During the breeding season, the estimated herring gull mortality from the Project is 0.01% of regional numbers. During the non-breeding season, the mortality estimate is 0.0006% of the non-breeding BDMPS. These are both negligible magnitudes of impact as the predicted collision mortalities are <1% of regional numbers (see Table 11.8).

11.6.3.37 As per the Furness *et al.* (2013) ranking (see Table 11.6), this species is assessed as having high sensitivity to collision.

11.6.3.38 The magnitude of the impact has been assessed as negligible and the sensitivity of receptor as high. Therefore, the significance of the effect of collision risk during the operational phase is concluded to be of **minor adverse** significance, which is not significant in EIA terms.

Great black-backed gull

11.6.3.39 Great black-backed gull are at potential risk of collision from the Project during its operational phase. The mean monthly densities plus associated standard deviations have been derived from the digital aerial survey results, Volume 3, Technical Appendix 11.1: Baseline Data, and inputted into the sCRM as set out in Volume 3, Technical Appendix 11.3: Collision Risk Modelling. The different types of model are discussed in that appendix and a number of different turbine scenarios are modelled (see Table 11.17).

11.6.3.40 This assessment is a 'worst case' based on a 14 MW turbine scenario, and model Option 1 using site-specific flight height data with an avoidance rate of 0.995 (SNCB, 2014). Other model options and turbine scenarios are included in Volume 3, Technical Appendix 11.3: Collision Risk Modelling for context. For great black-backed gull, the modelling was carried out for all months, then subdivided by season and the results are presented in Table 11.23.

Table 11.23 – Great black-backed gull reference populations (regional numbers) and estimated impacts

Species	Migration free breeding season	BDMPS		
		Autumn migration	Non-breeding	Spring migration
Great black-backed gull	May - Jul	n/a	Sep - Mar	n/a
Ref. population	1,008	-	17,742	-
Collision mortality	0	-	1	-

11.6.3.41 Great black-backed gull were not recorded in the array area during the breeding season and so there is no estimated mortality during this time. During the non-breeding season, the mortality estimate is 0.006% of the non-breeding BDMPS. These are negligible magnitudes of impact as the predicted collision mortalities are <1% of regional numbers (see Table 11.8).

11.6.3.42 As per the Furness *et al.* (2013) ranking (see Table 11.6), this species is assessed as having high sensitivity to collision.

11.6.3.43 The magnitude of the impact has been assessed as negligible and the sensitivity of receptor as high. Therefore, the significance of the effect of collision risk during the operational phase is concluded to be of **minor adverse** significance, which is not significant in EIA terms.

Lesser black-backed gull

11.6.3.44 Lesser black-backed gull are at potential risk of collision from the Project during its operational phase. The mean monthly densities, plus associated standard deviations, have been derived from the digital aerial survey results, Volume 3, Technical Appendix 11.1: Baseline Data, and inputted into the sCRM as set out in Volume 3, Technical Appendix 11.3: Collision Risk Modelling. The different types of model are discussed in that appendix, and a number of different turbine scenarios are modelled (see Table 11.17).

11.6.3.45 This assessment is a 'realistic worst case' based on a 14 MW turbine scenario, and model Option 1 using site-specific flight height data, with an avoidance rate of 0.995 (SNCB, 2014). Other model options and turbine scenarios are included in Volume 3, Technical Appendix 11.3: Collision Risk Modelling for context. For lesser black-backed gull, the modelling was carried out for all months, then subdivided by season and the results are presented in Table 11.24.

Table 11.24 – Lesser black-backed gull reference populations (regional numbers) and estimated impacts

Species	Migration free breeding season	BDMPS		
		Autumn migration	Non-breeding	Spring migration
Lesser black-backed gull	May - Jul	Aug - Oct	Nov - Feb	Mar - Apr
Ref. population	20,380	163,304	41,159	163,304
Collision mortality	6	0	0	0

11.6.3.46 During the breeding season, the estimate of lesser black-backed gull mortality from the Project is 0.03% of regional numbers. Estimates in the non-breeding season were zero, as set out more fully in Volume 3, Technical Appendix 11.3: Collision Risk Modelling. These are negligible magnitudes of impact as the predicted collision mortalities are <1% of regional numbers (see Table 11.8).

11.6.3.47 As per the Furness *et al.* (2013) ranking (see Table 11.6), this species is assessed as having high sensitivity to collision.

11.6.3.48 The magnitude of the impact has been assessed as negligible and the sensitivity of receptor as high. Therefore, the significance of the effect of collision risk during the operational phase concluded to be of **minor adverse** significance, which is not significant in EIA terms.

Black-legged kittiwake

11.6.3.49 Black-legged kittiwake are at potential risk of collision from the Project during its operational phase. Assessment of the impact has been undertaken, as described in this section.

11.6.3.50 For collision risk, the mean monthly densities plus associated standard deviations were derived from the digital aerial survey results (Volume 3, Technical Appendix 11.1: Baseline Data), and inputted into the sCRM as set out in Volume 3, Technical Appendix 11.3: Collision Risk Modelling. The different types of model are discussed in that appendix and a number of different turbine scenarios are modelled (see Table 11.17).

11.6.3.51 This assessment is a 'worst case' based on a 14 MW turbine scenario, see Section 11.6.1.2, and model Option 1 using site-specific flight height data with an avoidance rate of 0.989 (SNCB, 2014). Other model options and turbine scenarios are included in Volume 3, Technical Appendix 11.3: Collision Risk Modelling for context. For black-legged kittiwake, the modelling was carried out for all months, then subdivided by season and the results are presented in Table 11.25.

Table 11.25 – Black-legged kittiwake reference populations (regional numbers) and estimated impacts

Species	Migration free breeding season	BDMPS		
		Autumn migration	Non-breeding	Spring migration
Black-legged kittiwake	May - Jul	Aug - Dec	n/a	Jan - Apr

Species	Migration free breeding season	BDMPS		
		Autumn migration	Non-breeding	Spring migration
Ref. population	9,054	911,586	-	691,526
Collision mortality	1	38	-	19

11.6.3.52 During the breeding season, the estimate of kittiwake mortality from the Project is 0.01% of regional numbers. During the non-breeding season, the mortality estimate is 0.004% of the autumn migration BDMPS, and 0.003% of the spring migration BDMPS. These are all negligible magnitudes of impact as the predicted collision mortalities are <1% of regional numbers (see Table 11.8).

11.6.3.53 As per the Furness *et al.* (2013) ranking (see Table 11.6), this species is assessed as having high sensitivity to collision.

11.6.3.54 The magnitude of impact has been assessed as negligible and the sensitivity of receptor as high. Therefore, the significance of effect during the operational phase is concluded to be of **minor adverse** significance, which is not significant in EIA terms.

Common guillemot

11.6.3.55 Common guillemot are considered to be at low risk of collision from the Project during its operational phase, however, in agreement with NRW, JNCC, RSPB and WTSWW, they have been modelled for this impact (Volume 3, Technical Appendix 11.3: Collision Risk Modelling).

11.6.3.56 For collision risk, the mean monthly densities plus associated standard deviations were derived from the digital aerial survey results (Volume 3, Technical Appendix 11.1: Baseline Data), and inputted into the sCRM as set out in Volume 3, Technical Appendix 11.3: Collision Risk Modelling. The different types of model are discussed in that appendix and a number of different turbine scenarios are modelled (see Table 11.17).

11.6.3.57 This assessment is a 'worst case' based on a 14 MW turbine scenario, and model Option 2 using generic flight height data (Johnston *et al.*, 2014), with an avoidance rate of 0.98 (SNCB, 2014). Other turbine scenarios are included in Volume 3, Technical Appendix 11.3: Collision Risk Modelling for context. For common guillemot, the modelling was carried out for all months, then subdivided by season and the results are presented in Table 11.26.

Table 11.26 – Common guillemot reference populations (regional numbers) and estimated impacts

Species	Migration free breeding season	BDMPS		
		Autumn migration	Non-breeding	Spring migration
Common guillemot	Mar - Jun	n/a	Aug - Feb	n/a
Ref. population	96,802	-	1,139,220	-
Collision mortality	1	-	2	-

11.6.3.58 Predicted collisions to common guillemot are very low because few birds were predicted to be at potential collision risk height using the Johnston *et al*. (2014) flight height data.

11.6.3.59 During the breeding season, the estimate of common guillemot mortality from the Project is 0.001% of regional numbers. During the non-breeding BDMPS, the mortality estimate is 0.0002% of regional numbers. All magnitudes of impact are negligible as the predicted collision mortalities are <1% of regional numbers (see Table 11.8).

11.6.3.60 As set out in Section 11.5.5.37, impacts on guillemot during the breeding season also need to be considered against the population at Castlemartin Range SSSI (Volume 3, Technical Appendix 11.2: Apportioning). 17.5% of guillemot impacts during the breeding season are to be apportioned to this SSSI, giving an estimated mortality of 22 birds. This is considered against a breeding population of 29,744 birds, resulting in a mortality estimate of 0.07%. All magnitudes of impact are negligible as the predicted collision mortalities are <1% of regional numbers (see Table 11.8).

11.6.3.61 The magnitude of the impact has been assessed as negligible and the sensitivity of receptor as high (based on pre-application consultation with NRW, JNCC, RSPB and WTSWW). Therefore, the significance of the effect of collision risk during the operational phase is concluded to be of **minor adverse** significance, which is not significant in EIA terms.

Additional Mitigation and Residual Effect

11.6.3.62 None of effects identified above is major or moderate adverse (significant in EIA terms). Therefore, no additional mitigation is required to reduce the significance to non-significant in EIA terms, and the significance of residual effects remains as detailed above.

Displacement

11.6.3.63 Displacement of seabirds has the potential to occur following the introduction of a new OWF development. Disturbance and displacement of seabird species may result in the reduction in available foraging and resting grounds for affected species. Species likely to experience highest levels of disturbance through displacement effects are species which make use of a given sea area for an extended period, during either migratory or breeding periods. The effects of disturbance and displacement as a result of vessel traffic, barrier effects, aggregating device effects and lighting are considered within their own impact assessments (Section 11.6.4.5 onwards). The methodology and calculations used within this impact assessment are shown in full within Volume 3, Technical Appendix 11.4: Displacement Analysis.

11.6.3.64 Displacement is considered by Furness *et al.* (2013) and Bradbury *et al.* (2014) to be "*a reduced number of birds occurring within or immediately adjacent to an offshore wind farm".* Following a workshop held on 6-7 May 2015, the SNCBs, including NRW, issued interim advice on undertaking assessment of displacement impacts from offshore wind farms. This offers a consistent method for undertaking such assessment and promotes the use of 'displacement matrices' to give a range of displacement rates which are then considered in terms of adult mortality (SNCB, 2017).

11.6.3.65 Within Volume 3, Technical Appendix 11.4: Displacement Analysis, the seasonal displacement matrices for each species using the seasons defined in Furness (2015) (Table 11.6) are summarised. Unlike collision risk, displacement mortality estimates are given as 'whole birds' so no rounding of the figures is required.

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Reference Populations

11.6.3.66 To consider potential displacement mortalities to seabird receptors, the impacts have to be apportioned by season and considered against defined regional populations for each of the breeding and non-breeding (BDMPS) periods. These populations are summarised in Table 11.27, referring to Pritchard *et al.* (2021) for the Welsh regional breeding populations, and to Furness (2015) for the non-breeding BDMPS populations. For the breeding season the populations are individual adult birds whereas for the BDMPS the populations are adults and immatures.

Table 11.27 – Seabird reference populations (regional numbers)

Species	Migration free breeding season	BDMPS		
		Autumn migration	Non-breeding	Spring migration
Manx shearwater	Jun–Jul 974,942	Aug–Oct 1,580,895	n/a	Mar–May 1,580,895
Northern gannet	Apr–Aug 72,022	Sep–Nov 545,954	n/a	Dec–Mar 661,888
Black-legged kittiwake	May–Jul 9,054	Aug–Dec 911,586	n/a	Jan–Apr 691,526
Atlantic puffin	May–Jun 55,662	n/a	Aug–Mar 304,557	n/a
Common guillemot	Mar–Jun 96,802	n/a	1,139,220	n/a
Razorbill	Apr–Jun 21,233	Aug–Oct 606,914	Nov–Dec 341,422	Jan–Mar 606,914

* Population count does not include roof-nesting birds.

11.6.3.67 While the Welsh breeding population counts are certain (as recorded on the Seabird Monitoring Programme Database, and collated by Pritchard *et al*. (2021)), the BDMPS population estimates have a lot more uncertainty associated with them (Furness, 2015). However, at the current time, they are the only available information for impact assessment in the non-breeding season.

Manx shearwater

11.6.3.68 Manx shearwater are considered to be at low risk of impacts from offshore wind farms (Table 11.6), however, in agreement with NRW, JNCC, RSPB and WTSWW, they have been modelled for displacement (Volume 3, Technical Appendix 11.4: Displacement Analysis).

11.6.3.69 For displacement, the seasonal mean peaks for the Project array area plus a 2 km buffer were calculated from the digital aerial survey results (Volume 3, Technical Appendix 11.1: Baseline Data), and used to derive matrices of displacement impacts as recommended in SNCB guidance (SNCB, 2017). The results in Table 11.28 are a 'realistic worst case' based on a displacement rate of 10% from the array area plus 2 km buffer, a breeding season mortality of 1%, and a non-breeding season mortality of 1%. Full displacement matrices are presented in Volume 3, Technical Appendix 11.4: Displacement Analysis for context.

Table 11.28 – Manx shearwater reference populations (regional numbers) and estimated impacts

Species	Migration free breeding season	BDMPS		
		Autumn migration	Non-breeding	Spring migration
Manx shearwater	Jun - Jul	Aug - Oct	n/a	Mar - May
Ref. population	974,942	1,580,895	-	1,580,895
Displacement Mortality	2	1	-	1

11.6.3.70 During the breeding season, the estimate of Manx shearwater mortality from the Project is 0.0002% of regional numbers. During the migration BDMPS (August to October and March to May), the mortality estimate is 0.00006% of regional numbers. These are negligible magnitudes of impact as the predicted displacement mortalities are <1% of regional numbers (see Table 11.8).

11.6.3.71 As per agreement with NRW, JNCC, RSPB and WTSWW, this species is assessed as having high sensitivity to displacement.

11.6.3.72 The magnitude of impact has been assessed as negligible and the sensitivity of receptor as high. Therefore, the significance of effect from displacement is concluded to be of **minor adverse** significance, which is not significant in EIA terms.

Balearic shearwater

11.6.3.73 Balearic shearwater were not recorded on-site during the DAS, but were identified as an important receptor during pre-application discussion with NRW, JNCC, RSPB and WTSWW. Therefore, an assessment of magnitude for this species has been made, using Manx shearwater as a proxy. As the magnitude of impact resulting from displacement of Manx shearwater has been assessed as negligible, the magnitude for Balearic shearwater has also been assessed as negligible.

11.6.3.74 The potential impacts of offshore wind farms on Balearic shearwater are unknown, but assuming Manx shearwater can be used as a suitable proxy then, as per agreement with NRW, JNCC, RSPB and WTSWW, Balearic shearwater have a high sensitivity to displacement.

11.6.3.75 The magnitude of impact has been assessed as negligible and the sensitivity of receptor as high. Therefore, the significance of effect from displacement is concluded to be of **minor adverse** significance, which is not significant in EIA terms.

European storm-petrel

11.6.3.76 European storm-petrel were not recorded in the array area (Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report). However, in agreement with NRW, JNCC, RSPB and WTSWW, European storm-petrel have been included in the impact assessment.

11.6.3.77 Given the lack of European storm-petrel recorded during the DAS the likely mortalities arising from displacement would be 0, which equates to predicted displacement mortalities of <1% of regional numbers, which is assessed as negligible magnitude of impact (see Table 11.8).

11.6.3.78 Based on the sensitivity ranking (Furness *et al.*, 2013) European storm-petrel are assigned low sensitivity to displacement.

11.6.3.79 The magnitude of the impact has been assessed as negligible and the sensitivity of receptor as low. Therefore, the significance of the effect of displacement is concluded to be of **negligible** significance, which is not significant in EIA terms.

Northern gannet

11.6.3.80 Northern gannet are at potential risk of displacement from the Project during its operational phase. Assessment of the impact has been undertaken as described in this section.

11.6.3.81 For displacement, the seasonal mean peaks for the array area plus a 2 km buffer are calculated from the digital aerial survey results, Volume 3, Technical Appendix 11.1, and used to derive matrices of displacement impacts as recommended in SNCB guidance (2017). The results in Table 11.29 are a ‘realistic worst case’ based on a displacement rate of 70% from the Project array area plus 2 km buffer, a breeding season mortality of 2%, and a non-breeding season mortality of 1%. Full displacement matrices are presented in Volume 3, Technical Appendix 11.4: Displacement Analysis for context.

Table 11.29 – Gannet reference populations (regional numbers) and estimated impacts

Species	Migration free breeding season	BDMPS		
		Autumn migration	Non-breeding	Spring migration
Gannet	Apr - Aug	Sep - Nov	n/a	Dec - Mar
Ref. population	72,022	545,954	-	661,888
Displacement Mortality	4	3	-	1

11.6.3.82 During the breeding season, the estimate of gannet mortality from the Project is 0.006% of regional numbers. During the autumn migration BDMPS, the mortality estimate is 0.0005% of regional numbers. During the spring migration BDMPS, the mortality estimate is 0.0002% of regional numbers. These are all negligible magnitudes of impact as the predicted displacement mortalities are <1% of regional numbers (see Table 11.8).

11.6.3.83 As per the Furness *et al.* (2013) ranking (see Table 11.6), this species is assessed as having high sensitivity to displacement.

11.6.3.84 The magnitude of the impact has been assessed as negligible and the sensitivity of receptor as high. Therefore, the significance of the effect of displacement is concluded to be of **minor adverse** significance, which is not significant in EIA terms.

Black-legged kittiwake

11.6.3.85 Black-legged kittiwake are at potential risk of displacement from the Project during its operational phase.

11.6.3.86 For displacement, the seasonal mean peaks for the Project array area plus a 2 km buffer were calculated from the digital aerial survey results (Volume 3, Technical Appendix 11.1: Baseline Data), and used to derive matrices of displacement impacts as recommended in SNCB guidance (2017). The results in Table 11.30 are a 'realistic worst case' based on a displacement rate of 30% from the Project array area plus 2 km buffer, a breeding season mortality of 2%, and a non-breeding season mortality of 1%. Full displacement matrices are presented in Volume 3, Technical Appendix 11.4: Displacement Analysis for context.

Table 11.30 – Black-legged kittiwake reference populations (regional numbers) and estimated impacts

Species	Migration free breeding season	BDMPS		
		Autumn migration	Non-breeding	Spring migration
Black-legged kittiwake	May - Jul	Aug - Dec	n/a	Jan - Apr
Ref. population	9,054	911,586	-	691,526
Displacement Mortality	1	7	-	2

11.6.3.87 During the breeding season, the estimate of kittiwake mortality from the Project is 0.01% of regional numbers. During the non-breeding season, the mortality estimate is 0.0008% of the autumn migration BDMPS and 0.0003% of the spring migration BDMPS. These are all negligible magnitudes of impact as the predicted displacement mortalities are <1% of regional numbers (see Table 11.8).

11.6.3.88 As per the Furness *et al.* (2013) ranking (see Table 11.6), this species is assessed as having low sensitivity to displacement.

11.6.3.89 The magnitude of the impact has been assessed as negligible and the sensitivity of receptor as low. Therefore, the significance of the effect of displacement is concluded to be of **negligible** significance, which is not significant in EIA terms.

Atlantic puffin

11.6.3.90 Atlantic puffin are at potential risk of displacement from the Project during its operational phase. These potential displacement impacts are assessed in Volume 3, Technical Appendix 11.4: Displacement Analysis. The seasonal mean peaks for the Project array area plus a 2 km buffer were calculated from the digital aerial survey results (Volume 3, Technical Appendix 11.1: Baseline Data), and used to derive matrices of displacement impacts as recommended in SNCB guidance (2017).

11.6.3.91 The results in Table 11.31 are a 'realistic worst case' based on a displacement rate of 70% from the Project array area plus 2 km buffer, a breeding season mortality of 5%, and a non-breeding season mortality of 1%. Full displacement matrices are presented in Volume 3, Technical Appendix 11.4: Displacement Analysis for context.

Table 11.31 – Atlantic puffin reference populations (regional numbers) and estimated impacts

Species	Migration free breeding season	BDMPS		
		Autumn migration	Non-breeding	Spring migration
Atlantic puffin	May - Jun	n/a	Aug - Mar	n/a
Ref. population	55,662	-	304,557	-
Displacement Mortality	16	-	1	-

11.6.3.92 During the breeding season, the estimate of puffin mortality from the Project is 0.03% of regional numbers. During the non-breeding season, the mortality estimate is 0.0003% of the non-breeding BDMPS. These are all negligible magnitudes of impact as the predicted displacement mortalities are <1% of regional numbers (see Table 11.8).

11.6.3.93 As per the Furness *et al.* (2013) ranking (see Table 11.6), this species is assessed as having high sensitivity to displacement.

11.6.3.94 The magnitude of the impact has been assessed as negligible and the sensitivity of receptor as high. Therefore, the significance of the effect of displacement is concluded to be of **minor adverse** significance, which is not significant in EIA terms.

Common guillemot

11.6.3.95 Guillemot are considered to be at high risk of displacement, and this has been analysed in Volume 3, Technical Appendix 11.4: Displacement Analysis. For displacement, the seasonal mean peaks for the Project array area plus a 2km buffer were calculated from the digital aerial survey results (Volume 3, Technical Appendix 11.1: Baseline Data), and used to derive matrices of displacement impacts as recommended in SNCB guidance (2017).

11.6.3.96 The results in Table 11.32 are a 'realistic worst case' based on a displacement rate of 70% from the Project array area plus 2 km buffer, a breeding season mortality of 5%, and a non-breeding season mortality of 1%. Full displacement matrices are presented in Volume 3, Technical Appendix 11.4: Displacement Analysis for context.

Table 11.32 – Guillemot reference populations (regional numbers) and estimated impacts

Species	Migration free breeding season	BDMPS		
		Autumn migration	Non-breeding	Spring migration
Guillemot	Mar - Jun	n/a	Aug - Feb	n/a
Ref. population	96,802	-	1,139,220	-
Displacement Mortality	125	-	108	-

11.6.3.97 During the breeding season, the estimate of guillemot mortality from the Project is 0.13% of regional numbers. During the non-breeding BDMPS, the mortality estimate is 0.009% of regional numbers. Impacts on guillemot during the breeding season also need to be considered against the population at Castlemartin Range SSSI (Volume 3, Technical Appendix 11.2: Apportioning). 17.5% of guillemot impacts during the breeding season are to be apportioned to this SSSI giving an estimated mortality of 22 birds. This is considered against a breeding population of 29,744 birds, resulting in a mortality rate of 0.07%. All magnitudes of impact are negligible as the predicted displacement mortalities are <1% of regional numbers (see Table 11.8).

11.6.3.98 As per the Furness *et al.* (2013) ranking (see Table 11.6), this species is assessed as having high sensitivity to displacement.

11.6.3.99 The magnitude of the impact has been assessed as negligible and the sensitivity of receptor as high. Therefore, the significance of the effect of displacement on the regional, and the Castlemartin SSSI populations, is concluded to be of **minor adverse** significance, which is not significant in EIA terms.

Razorbill

11.6.3.100 Razorbill are at potential risk of displacement from the Project during its operational phase (paragraph 11.6.2.34). These potential displacement impacts are assessed in Volume 3, Technical Appendix 11.4: Displacement Analysis. The seasonal mean peaks for the Project array area plus a 2 km buffer were calculated from the digital aerial survey results (Volume 3, Technical Appendix 11.1: Baseline Data), and used to derive matrices of displacement impacts as recommended in SNCB guidance (2017). The results in Table 11.33 are a 'realistic worst case' based on a displacement rate of 70% from the Project array area plus 2 km buffer, a breeding season mortality of 5%, and a non-breeding season mortality of 1%. Full displacement matrices are presented in Volume 3, Technical Appendix 11.4: Displacement Analysis for context.

Table 11.33 – Razorbill reference populations (regional numbers) and estimated impacts

Species	Migration free breeding season	BDMPS		
		autumn migration	non-breeding	spring migration
Razorbill	Apr - Jun	Aug - Oct	Nov - Dec	Jan - Mar
Ref. population	21,233	606,914	341,422	606,914
Displacement Mortality	4	9	4	4

11.6.3.101 During the breeding season, the estimate of razorbill mortality from the Project is 0.02% of regional numbers. During the non-breeding season, the mortality estimate is 0.002% of the migration BDMPS (August-October and January-March) and 0.001% of the non-breeding BDMPS (November-December). These are all negligible magnitudes of impact, as the predicted displacement mortalities are <1% of regional numbers (see Table 11.8).

11.6.3.102 As per the Furness *et al.* (2013) ranking (see Table 11.6), this species is assessed as having high sensitivity to displacement.

11.6.3.103 The magnitude of the impact has been assessed as negligible and the sensitivity of receptor as high. Therefore, the significance of the effect of displacement is concluded to be of **minor adverse** significance, which is not significant in EIA terms.

11.6.4 Total Impact from Displacement Effects and Collision

11.6.4.1 SNCB (2017) guidance notes that, where applicable, effects of displacement and effects of collision impacts should be added together for assessment of total adverse effects. Whilst it is acknowledged that this may involve some degree of double counting, it is considered to represent a precautionary approach until it becomes feasible to distinguish between birds which might be subject to collision and those that may be displaced.

11.6.4.2 Table 11.34 provides total numbers of collision and displacement related mortalities as determined in Section 11.10.5 and contextualises these against reference populations (regional breeding populations as reported by Pritchard *et al.*, 2012 and BDMPS as reported by Furness, 2015).

Table 11.34 – Total numbers of mortalities predicted from collision events and displacement effects

Species	**Breeding Season**		**Total Mortalities**	**Reference Population**	**Mortalities as % of Reference Population**
	Displacement Mortalities	Collision mortalities			
Black-legged kittiwake	1	1	2	9,054	0.02
Common guillemot	125	1	126	96,802	0.13
Northern gannet	4	88	92	72,022	0.13
Species	**Post Breeding Season**				
	Displacement Mortalities	Collision mortalities	**Total Mortalities**	**Reference Population**	**Mortalities as % of Reference Population**
Black-legged kittiwake	7	38	45	911,586	0.005
Northern gannet	3	14	17	545,954	0.003
Species	**Pre-breeding Season**				
	Displacement Mortalities	Collision mortalities	**Total Mortalities**	**Reference Population**	**Mortalities as % of Reference Population**
Black-legged kittiwake	2	19	21	691,526	0.003
Northern gannet	1	14	15	661,888	0.002
Common guillemot	108	2	110	1,139,220	0.01

11.6.4.3 Given the small proportion of respective reference populations affected, it is not considered that the combined totals presented in Table 11.34 will result in combined effects of greater significance than the assessments provided for each impact pathway alone.

Additional Mitigation and Residual Effect

11.6.4.4 None of effects identified above is major or moderate adverse (significant in EIA terms). Therefore, no additional mitigation is required to reduce the significance to non-significant in EIA terms, and the significance of residual effects remains as detailed above

Disturbance and displacement from vessel activity (O&M and cable repairs).

11.6.4.5 Vessel activity associated with routine and unplanned maintenance also has the potential to disturb and displace birds, resulting in a reduction in the area available to birds for feeding, resting and moulting. The potential for impact on offshore birds from Operation and Maintenance (O&M) disturbance and displacement effects is greater for birds that occupy an area for a long period, such as when they are breeding nearby or are resident for the winter. Displacement of birds on passage (migration) is more appropriately considered in terms of a barrier effect (dealt with below).

11.6.4.6 Information on vessel activity in the region and within the array area and ECC is presented in Chapter 16: Shipping and Navigation and Volume 3, and Technical Appendix: 16.1 Navigational Risk Assessment.

11.6.4.7 The WTG units are expected to be serviced using crew transfer vessels and the predicted maximum number of vessel visits per turbine, during the various repair and remediation activities, is 6 visits per turbine per year. A total of 60 visits can therefore be expected within the array area (Chapter 4: Proposed Development Description). In contrast, a total of 22 offshore cable and array cable repairs and remediation events are expected over the lifetime of the Project.

11.6.4.8 The limited time that vessels are present within the array area and ECC reduces the period when seabirds would be disturbed from foraging and, due to the localized nature of the works, limits the displacement to small areas within the proximity of vessels. Therefore, any impacts from disturbance and displacement from vessel activity are considered to be short-term, temporary and reversible in nature. Furthermore, seabirds are expected to return to the area, once the vessels have left.

11.6.4.9 The embedded mitigation of a vessel management plan, see Section 11.4.6, will ensure that vessel traffic moves along predictable routes. Vessel traffic moving around the array area and ECC, and to/from port to the Proposed Development, will occur over short periods of the offshore O&M phase, and the adoption of a vessel management plan will minimise the potential for any impact. Therefore, the risk of disturbance and displacement occurring as a result of the O&M phase is of negligible magnitude.

11.6.4.10 There are a number of different measures used to assess bird disturbance and displacement from vessel activity and, as discussed in Section 11.6.2.9, the Garthe and Hüppop (2004) scoring system has been applied to receptor sensitivity. The same scoring has been applied to O&M as was applied to construction, and is summarised below.

Fulmar sensitivity to vessels

11.6.4.11 Based on the Garthe and Hüppop (2004) scoring system, northern fulmar was subjectively scored 1 representing hardly any escape behaviour to disturbance by ship (Bradbury *et al*., 2014), therefore the sensitivity for this receptor is considered negligible.

11.6.4.12 The magnitude of the impact has been assessed as negligible and the sensitivity of receptor as negligible. Therefore, disturbance from vessels during the O&M phase on fulmar is concluded to result in a **negligible** effect, which is not significant in EIA terms.

Shearwater and storm-petrel sensitivity to vessels

11.6.4.13 Manx shearwater was a key seabird species recorded during the Project specific DAS. Balearic shearwater and European storm-petrel were not recorded during the DAS. However, following pre-application discussion with NRW, JNCC, RSPB and WTSWW, these two species have been included in the assessment.

11.6.4.14 Manx shearwater, Balearic shearwater and European storm-petrel were all scored 1, based on the Garthe and Hüppop (2004) scoring system, representing hardly any escape behaviour to disturbance by ship (Bradbury *et al*., 2014), therefore the sensitivity for this receptor is considered negligible.

11.6.4.15 The magnitude of the impact has been assessed as negligible and the sensitivity of receptor as negligible. Therefore, disturbance from vessels during the O&M phase is concluded to result in a **negligible** effect, which is not significant in EIA terms.

Northern gannet sensitivity to vessels

11.6.4.16 Northern gannet has been scored 2 to disturbance by ship traffic, based on the Garthe and Hüppop (2004) scoring system. The sensitivity for this receptor is therefore considered low.

11.6.4.17 The magnitude of the impact has been assessed as negligible, and the sensitivity of northern gannet as low. Therefore, disturbance from vessel activity during the O&M phase on northern gannet is concluded to result in a **negligible** effect, which is not significant in EIA terms.

Gull sensitivity to vessels

11.6.4.18 A total of 4 gull species were recorded on-site, these are herring gull, great black-backed gull, lesser black-backed gull, and black-legged kittiwake. All 4 gull species were assessed a score of 2 for disturbance susceptibility, based on the Garthe and Hüppop (2004) scoring system (Bradbury *et al*., 2014). The sensitivity for this receptor is therefore considered low.

11.6.4.19 The magnitude of the impact has been assessed as negligible and the sensitivity of gulls as low. Therefore, disturbance from vessel activity during the O&M phase on gulls is concluded to result in a **negligible** effect, which is not significant in EIA terms.

Auk sensitivity to vessels

11.6.4.20 A total of 3 auk species were recorded during the Project-specific DAS, Atlantic puffin, common guillemot, and razorbill. The highest score assigned to these auk species was 3, based on the Garthe and Hüppop (2004) scoring system (Bradbury *et al*., 2014). The sensitivity for this receptor is therefore considered medium.

11.6.4.21 The magnitude of the impact has been assessed as negligible and the sensitivity of auks as medium. Therefore, disturbance from vessel activity during the O&M phase on auks is concluded to result in a **minor adverse** effect, which is not significant in EIA terms.

Additional Mitigation and Residual Effect

11.6.4.22 None of the effects identified above is major or moderate adverse (significant in EIA terms). Therefore, no additional mitigation is required to reduce the significance to non-significant in EIA terms, and the significance of residual effects remains as detailed above.

Disturbance to foraging birds from underwater noise and vibration via operational activities

11.6.4.23 As discussed in Section 11.6.2.34 the impact of underwater noise on diving birds is not well understood, due to limitations in available research. This is discussed further in Technical Appendix 12.2: Underwater Noise and Vibration, with key points summarised below. During operation, noise levels in the proximity of the offshore wind turbines are continuous and low-level, both above and below water. For both fish and marine mammals, the operational noise of the turbines is well below thresholds for TTS or injury under normal circumstances. For fish, individuals would need to spend 10-12 hours at proximities of <10 m from a turbine to experience TTS. For marine mammals' assessment is more complex, but an hour at a distance of 100 m would result in an exposure well below that required for TTS or injury.

11.6.4.24 Cable snapping has been identified in previous FLOW project Environmental Statements, and is thought to be a result of tension release from mooring lines. Monitoring of the Hywind Scotland Pilot Park Project (FLOW) recorded up to 23 'snaps' per day, with fewer than 10 snaps per day exceeding 160 dB SPL_{peak} at the measurement position, 150 m from the turbine. A potential cumulative Sound Exposure Level (SEL) of up to 157 dB re 1 μPa^2s over 24 hours, caused by snapping chains from six turbines, was determined by Xodus (2015) for the Hywind Scotland Pilot Park Project.

11.6.4.25 If cables are the source of the noise, this will be caused by the specific circumstances at Hywind: that is, the depth of water, length of cables in use, current, and current fluctuations. The findings at Hywind were isolated, and it does not necessarily follow that this will occur at the Project, but neither does it rule out the potential. On that basis, the impact of cable snapping has been assessed in Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration Technical Report, and the worst case considered further here.

11.6.4.26 For 10 semi-submersible floating platforms and 35 associated mooring lines, the maximum number for the Project, this is determined to equate to approximately 160 dB SEL re 1 μPa^2s. This prediction makes a series of worst-case assumptions (e.g., all turbines producing the maximum number of snaps in a day, equivalent noise levels from multiple locations affecting a receptor to the same degree) and this level is below any permanent threshold shift (PTS) or injury criteria for fish receptors. Therefore, in the absence of quantified data for the threshold of diving birds, and the consideration that diving birds are less likely to experience exposure due to their limited time underwater when compared to fish, the magnitude should be considered similarly, as negligible.

11.6.4.27 Whilst the above assessments suggest that the risk of TTS and injury or mortality to diving birds is unlikely as a result of underwater noise during operation, it is possible that disturbance may occur as a result of disruption to foraging success. However, the above values have been determined as being quieter than vessels at the same distance (Technical Appendix 12.2: Underwater Noise and Vibration). Further, studies have shown that fish populations increase in the vicinity of offshore wind farms, and so this is determined as being an unlikely pressure pathway (Stenberg *et al*., 2015). Sensitivity is therefore considered negligible.

11.6.4.28 Based on the above assessments, the magnitude of disturbance to foraging diving birds as a result from underwater noise and vibration is considered negligible, and the sensitivity to diving birds is also considered negligible. Therefore, the impact of disturbance to foraging diving birds from underwater noise and vibration via operational activities is assessed as having **negligible** effect, which is not significant in EIA terms.

Additional Mitigation and Residual Effect

11.6.4.29 None of the effects identified above is major or moderate adverse (significant in EIA terms). Therefore, no additional mitigation is required to reduce the significance to non-significant in EIA terms, and the significance of residual effects remains as detailed above.

Barrier effect of wind turbine generators to regular movements of birds to and from breeding colonies or on migration.

11.6.4.30 Following construction, the Project has the potential to act as a barrier to seabirds' movement. Regular seabird flight routes associated with migration and foraging behaviour may change as a result. A number of seabird species are known to exhibit avoidance behaviour following the introduction of offshore infrastructure. This assessment is limited to the Project infrastructure only, with the impact of vessels being assessed separately above.

11.6.4.31 Modelling of the additional energy requirements of bird species resulting from barrier effects, have been conducted within Masden *et al.* (2010), where a number of factors, including foraging range, number of trips, and flight speed, was considered for each bird species modelled. This study indicates that heavier seabird species including shag and great cormorant, followed by auks including common guillemot and Atlantic puffin, will have the most significant increase in energy expenditure per foraging trip should they be required to circumnavigate a barrier in order to access foraging grounds. However, as auks tend to undertake a larger number of smaller foraging trips, this group was determined to expend the most energy overall as a result of barrier effects.

11.6.4.32 The array area is limited to 7 km at its widest point, with a maximum of 10 WTG being considered. This limited array size, combined with significant empty sea space within the region, means that diversion in response to barrier effects is likely to be limited to approximately 1.7 km (based on the difference between a straight line from Skomer, through the array area; and a straight line from Skomer, diverting around the array and a 2 km buffer). As the array area is located approximately 35 km offshore, this results in the worst-case scenario being a 5% increase in distance between nesting and foraging grounds. The energy consumption required for this additional flight distance is small when compared to the impact of wind conditions, which can increase energy consumption during foraging flights for some seabirds by up to 100% in poor conditions (Furness and Bryant, 1996).

11.6.4.33 For migratory species the barrier effects of the Project will only impact individuals once per migration. The impact of barrier effects is therefore more limited when compared to the impact of barrier effects on foraging behaviour. The impact of single instance avoidances is assessed within Speakman *et al.* (2009), with worst-case assessments determining that migratory birds will consume an additional 2% of available fat reserves. Due to the small size of the windfarm, and the low energy costs associated with potential avoidance behaviour when compared to natural variation in weather conditions, the magnitude of this impact is therefore considered as negligible.

11.6.4.34 Not all species are sensitive to the barrier effects of OFWs. The avoidance and attraction of a number of seabird species is considered within Dierschke *et al.* (2016). Of the seabirds observed as a part of the project specific DAS (Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report), both northern gannet and northern fulmar showed consistent and strong avoidance behaviour associated with OWFs. Although this avoidance behaviour is primarily considered to constitute a displacement effect, such avoidance of a specific area may lead to increased distances travelled when travelling to or from foraging areas. Species including Manx shearwater, razorbill and common guillemot showed a reduced level of avoidance, whilst gull species showed a level of attraction to these structures.

11.6.4.35 Species known to be displaced from OWFs and, therefore, potentially affected by barrier effects (i.e. increased journey times to and from foraging areas), have been shown to be present in the Project study area. However, these species (northern gannet and northern fulmar) have very large foraging ranges and, therefore, it would be expected that avoidance of a relatively small OWF would have a relatively small impact on energy expenditure per foraging trip. As such, the sensitivity of seabirds to barrier effects has conservatively been assessed as low.

11.6.4.36 The magnitude of the impact has been assessed as negligible and the sensitivity of receptors as low. Therefore, the impact of barrier effect of wind turbine generators to regular movements of birds to and from breeding colonies or on migration is assessed as having **negligible** effect, which is not significant in EIA terms.

Additional Mitigation and Residual Effect

11.6.4.37 None of effects identified above is major or moderate adverse (significant in EIA terms). Therefore, no additional mitigation is required to reduce the significance to non-significant in EIA terms, and the significance of residual effects remains as detailed above.

Indirect impacts through effects on habitats and prey species

11.6.4.38 There is the potential for the indirect disturbance and displacement of seabird species to occur as a result of effects on habitats and prey species during the operational phase of the Project. Loss of seabed as a result of Project infrastructure, increased SSCs, and sediment deposition caused by operation and maintenance activities, and electro-magnetic field (EMF) effects might result in a change to the availability of prey species such as benthic species and fish and shellfish. Assessment of the above impacts on prey species are shown in Chapter 9: Marine and Coastal Ecology, and Chapter 10: Fish and Shellfish Ecology.

11.6.4.39 Loss of seabed habitat has the potential to impact benthic and fish and shellfish prey species through a reduction in viable habitat as well as a reduction in the availability of potential spawning and nursery grounds. As calculated in both Chapter 9: Marine and Coastal Ecology, and Chapter 10: Fish and Shellfish Ecology, the worst case scenario for long-term seabed habitat loss is 0.16 km^2, which is equivalent to 0.17% of the benthic habitat within the benthic near-field study area. This is considered to be of minor adverse significance to both benthic and fish and shellfish species, with the impact of temporary habitat disturbances caused by repair and remediation works also being considered of minor adverse significance. Therefore, loss of seabed habitat is considered of low magnitude with regards to the indirect effects it may have on bird receptors.

11.6.4.40 Increases in SSCs and sediment deposition as a result of repair and remediation works have the potential to cause displacement for mobile species and smothering for benthically associated species with limited to no mobility. These effects are assessed as being of limited spatial extent (likely limited to within the array and ECC areas), and duration, with any smothering effects likely removed over the extent of a single tidal cycle. For both benthic and fish and shellfish receptors these effects are considered of negligible to minor adverse significance. Therefore, increases in SSCs and sediment deposition are considered to be of low magnitude with regards to the indirect effects they may have on bird receptors.

11.6.4.41 The effects of EMF on both benthic and fish and shellfish receptors have been considered in Chapter 9: Marine and Coastal Ecology, and Chapter 10: Fish and Shellfish Ecology, with a full assessment on the operations of EMF being undertaken in Volume 3, Technical Appendix 7.2: EMF Assessment. Some marine organisms are sensitive to EMF, particularly those species that make use of electroreceptors for orientation, navigation and predator/prey detection. EMF effects will be introduced to a total volume of 0.0021 km^3 as a result of the Project. This volume of water is considered negligible in the wider context of the region, with magnitude being assessed as low for both benthic and fish and shellfish receptors. Therefore, EMF effects are considered of low magnitude with regards to the indirect effects they may have on seabird receptors.

11.6.4.42 Each of the above pathways for indirect impacts through effects on habitats and prey species is highly localised and, in the case of increased SSCs and sediment deposition, temporary. The high mobility of bird receptors will allow for rapid relocation, should any of the above effects result in a local, temporary change in prey species availability. Therefore, the sensitivity of bird receptors is considered negligible.

11.6.4.43 The magnitude of the impact has been assessed as low and the sensitivity of bird receptors as negligible. Therefore, the impact of indirect impacts through effects on habitats and prey species is assessed as having **negligible** effect, which is not significant in EIA terms.

Additional Mitigation and Residual Effect

11.6.4.44 None of effects identified above is major or moderate adverse (significant in EIA terms). Therefore, no additional mitigation is required to reduce the significance to non-significant in EIA terms, and the significance of residual effects remains as detailed above.

Aggregating effects of turbine structures

11.6.4.45 Following installation, the semi-submersible floating platforms have the potential to act as aggregating devices, by providing perching platforms for a number of seabird species. Bird species may be attracted to the rails and platforms that form part of the semi-submersible floating platform, in order to rest.

11.6.4.46 Observations of windfarms in the Netherlands have shown an increase in the abundance of great cormorants and gulls following construction (Leopold *et al.*, 2011). The available roosting grounds, in combination with potential fish aggregating effects (described in Chapter 10: Fish and Shellfish Ecology), may allow for both increased foraging potential whilst also providing a nearby area for species such as cormorants to dry their feathers (Leopold *et al.*, 2011; Vanermen *et al.*, 2013). Shag have also been observed exhibiting roosting behaviour on offshore wind platforms during post-construction monitoring of sites (Perrow, 2019).

11.6.4.47 Of the birds identified in the above literature, and of those species recorded in the array area during the DAS, only 4 are likely to be attracted to the semi-submersible floating platforms for perching opportunities: black-legged kittiwake; great black-backed gull; herring gull and lesser black-backed gull. These were only recorded in low numbers in the array area (see Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report).

11.6.4.48 The Project design comprises a maximum of 10 semi-submersible floating platforms, resulting in the introduction of a limited area for perching. New, albeit limited, perching areas may allow for rest and access to foraging grounds previously unavailable to seabirds, either as a result of the introduction of an aggregating device or an increase in the prey availability (Vanermen *et al.*, 2013).

11.6.4.49 However, it also has the potential to increase the risk of collision due to birds aggregating in close proximity to an operational WTG. The species discussed in this assessment, black-legged kittiwake, great black-backed gull; herring gull and lesser black-backed gull, were all assessed as having a high sensitivity to collision, however as the magnitude was considered negligible, the significance of effect was determined to be low (see Collision Risk under Section 11.6.3.2).

11.6.4.50 Given the limited number of semi-submersible floating platforms, limited area for perching, and low numbers of species likely to aggregate, there is unlikely to be a change in the size or extent of the population. On this basis the magnitude of impact is considered negligible.

11.6.4.51 The species present that are likely to aggregate on the semi-submersible floating platforms may benefit from access to new foraging grounds. However, the aggregating effect may also increase the risk of collision. Given the lack of research on this impact the sensitivity of the receptor has conservatively been assessed as high.

11.6.4.52 The magnitude of the impact has been assessed as negligible and the sensitivity of bird receptors as high. Therefore, the impact of aggregating effects is assessed as having **minor adverse** effect, which is not significant in EIA terms.

Additional Mitigation and Residual Effect

11.6.4.53 None of effects identified above is major or moderate adverse (significant in EIA terms). Therefore, no additional mitigation is required to reduce the significance to non-significant in EIA terms, and the significance of residual effects remains as detailed above.

Entanglement risk from ghost fishing gear

11.6.4.54 There is the potential risk of indirect entanglement to all diving seabird species if ghost/derelict fishing gear and other marine litter becomes attached to the sub-sea structures of the semi-submersible floating platforms. Research into the effects of ghost fishing on seabirds is limited when compared to marine mammals, however evidence suggests that diving birds including, but not limited to, shag, common cormorant, scoter and diver species are vulnerable to capture during foraging dives (Kaiser *et al.*, 1996; Good *et al.*, 2007). The PDE has identified that Remotely Operated Vehicle (ROV) inspections of the moorings and sub-structures will be conducted, and that their frequency will depend on findings. This should allow a better understanding of the true entanglement risk, and allow removal of any snagged derelict gear/marine litter, should this occur.

11.6.4.55 Given that ROV surveys of the moorings and sub-structures will be conducted, it is expected that any snagged derelict gear/marine litter can be identified and removed (noting that the removal of derelict gear/marine litter from the environment would be of beneficial effect) and, thus, the likelihood of entanglement, and so magnitude of impact is considered to be negligible. This falls in line with advice suggested for marine mammals provided in Garavelli (2020), as described in Chapter 12: Marine Mammals.

11.6.4.56 In the unlikely event that entanglement does occur it has the potential to result in injury or death to the individual and, as such, the sensitivity of all diving birds to entanglement is considered to be high.

11.6.4.57 The magnitude of the impact has been assessed as negligible and the sensitivity of diving bird receptors as high. Therefore, the impact of entanglement risk from ghost fishing gear is assessed as having **minor adverse** effect, which is not significant in EIA terms.

Additional Mitigation and Residual Effect

11.6.4.58 None of effects identified above is major or moderate adverse (significant in EIA terms). Therefore, no additional mitigation is required to reduce the significance to non-significant in EIA terms, and the significance of residual effects remains as detailed above.

Attraction of nocturnal seabirds (shearwaters and petrels) to lighting on project infrastructure

11.6.4.59 Artificial lighting in the marine environment has the potential to disrupt the behaviour of nocturnal seabird species. Seabird species have been observed to circle lit structures at night, increasing risk of collision and depleting energy reserves (Jones, 1980; Longcore *et al.*, 2013). This effect is particularly significant during periods of poor weather including rain and fog (Ronconi *et al.*, 2015).

11.6.4.60 Several species identified in the Project specific DAS (Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report) including Manx shearwater and Atlantic puffin are known to be attracted to/be susceptible to artificial light at night and in poor light conditions; especially where it is close to their nesting burrows and when the young birds are first fledging (Rich and Longcore, 2006; Raine *et al*., 2007; Deppe *et al*., 2017; Longcore *et al*., 2018; Rebke *et al.*, 2019; Commonwealth of Australia, 2020; D Ainley, pers. comm., 2021). Balearic shearwater and European storm-petrel were not recorded during the DAS; however these species are also known to be vulnerable to the effects of artificial lighting at night. These species have been included in this assessment following consultation with NRW, JNCC, RSPB and WTSWW.

11.6.4.61 Current literature suggests that the magnitude of attractive effects from artificial lighting on project infrastructure is primarily determined by the colour and mode (continuous vs blinking) of the lights. Continuous light has been shown to have a significantly greater attractive effect when compared to blinking lights across all colours, other than red light. Red light has been observed to have a very low attractive effect regardless of mode, with the attractive effect of continuous red light being similar to that of blinking lights of other colours (Rich and Longcore, 2006; Raine *et al*., 2007; Deppe *et al*., 2017; Longcore *et al*., 2018; Rebke *et al.*, 2019; Commonwealth of Australia, 2020; D Ainley, pers. comm., 2021).

11.6.4.62 The Project includes three distinct lighting components:

- Medium intensity, steady red aviation lights will be located on the nacelle and will only be switched on during night-time;

- Yellow marine lanterns to aid navigation will be located either at each corner of the array area (4 lanterns total), or on each semi-submersible floating platform (maximum 10 lanterns total). Should 4 lanterns be used, these will be visible from 5 nm, whereas should 10 lanterns be used they will be observable from 2 nm; and
- White sensor-activated spotlights will be located at tower doors, along walkways and at boat landings, access platforms and davit cranes. Sensor lights will only become operational when triggered by activity on the semi-submersible floating platform associated with an operations and maintenance operatives. Night-time works would only be undertaken in an emergency, due to the risk associated with night-time work in an offshore environment. Therefore, sensory lights will only be triggered at night on exceptional occasions. In the event that these lights are required, they will be restricted to a maximum of 50 lux.

11.6.4.63 The aggregating effect of lights has the potential to disrupt the behaviour of nocturnal seabird species and may also result in a reduction of energy reserves. Manx shearwater, Atlantic puffin, Balearic shearwater and European storm-petrel are known to be sensitive to artificial light and on that basis would be considered of high sensitivity to artificial lighting. However it should be noted that these species are either considered to be at low risk of collision (Johnston *et al*., 2014), or have been screened out due to there being no risk of collision. Collision risk assessments have been undertaken for Manx shearwater, Balearic shearwater and European storm-petrel in agreement with NRW, JNCC, RSPB and WTSWW but these assessments concluded the effect to be of minor adverse significance, which is not significant in EIA terms. Therefore, it does not automatically follow that a high sensitivity to artificial lighting would result in a greater risk of collision.

11.6.4.64 Lighting used on Project infrastructure will be limited to red continuous and yellow blinking, which are considered to have very low attractive effects. The only use of white lights will be during infrequent maintenance visits to the WTGs. It is anticipated this would be a maximum of 2 x 12 hours visits per WTG per year, which for a maximum of 10 WTGs would result in a total of 20 visits per year. The white lights (above doorways and on gangplanks) will be connected to motion sensors and only triggered when someone is present on the WTG.

11.6.4.65 Due to the limited lighting proposed and on the basis that an attraction to lighting would not result in greater collision risk it is unlikely there would be a measurable change from the size or extent of the relevant biogeographic population. Therefore, the magnitude of this impact is determined to be **negligible**.

11.6.4.66 Noting Manx shearwater, Atlantic puffin, Balearic shearwater and European storm-petrels attraction to artificial lighting the sensitivity of these species being attracted to lighting on the Project infrastructure is considered to be **high.**

11.6.4.67 The magnitude of the impact has been assessed as negligible and the sensitivity of seabird receptors as high. Therefore, the impact of attraction to lighting on project infrastructure is assessed as having **minor adverse** effect, which is not significant in EIA terms.

Additional Mitigation and Residual Effect

11.6.4.68 None of effects identified above is major or moderate adverse (significant in EIA terms). Therefore, no additional mitigation is required to reduce the significance to non-significant in EIA terms, and the significance of residual effects remains as detailed above.

11.6.5 Decommissioning

11.6.5.1 During the decommissioning phase there is potential for WTG, foundation and cable removal activities to impact ornithological receptors. The impacts identified to occur during decommission are the same of those assessed during construction and include:

- Indirect impacts as a result of displacement of prey due to construction activities;
- Disturbance and displacement from increased vessel activity and array and ECC; and
- Disturbance and displacement from underwater noise.

11.6.5.2 The magnitude of these effects and the sensitivity of the receptor groups is considered to remain the same as per the construction phase impacts, although in practice they are likely to be reduced for decommissioning. Therefore, the same conclusions on impact significance are predicted.

11.6.6 Effects on Human Health and Population

11.6.6.1 There will be no effects on population or human health in relation to offshore ornithology.

11.7 Additional Mitigation

11.7.1.1 All impacts assessed for offshore ornithology receptors during construction, O&M and decommissioning have been assessed as minor or negligible which are non-significant in EIA terms. Therefore, no additional mitigation is required to reduce the significance of the residual effects beyond that proposed in Section 11.4.6

11.8 Additional Monitoring

11.8.1.1 The following monitoring is proposed to form part of the Environmental Monitoring and Mitigation Plan, to be drafted in consultation with NRW prior to the commencement of works:

- It is expected that monitoring of key bird species will be required in the operational phase of the Project. It is envisaged that this monitoring would be designed to validate the key conclusions presented in the ES for the most sensitive bird species. A Monitoring Plan will be developed to specific the exact type, duration and methodologies for monitoring, via consultation with NRW/JNCC and other key stakeholders including WTSWW and RSPB (noting RSPB's request in the Scoping Opinion that monitoring be included) however, it is likely that any monitoring programmes would focus on elements including potential avoidance behaviour of birds around the WTGs; flight height distributions around the WTGs; and effects on survival and productivity of regional breeding colonies;
- It is also expected that tools and methods such as bird tagging; collision sensors in WTG blades; cameras; radar; DAS; and colony counts may all be used in some way; and
- The Applicant would also be keen to provide input/support to any regional-scale strategic studies into marine ornithology that may be developed as FLOW projects develop further in the Celtic Sea region.

11.9 Inter-Related Effects

11.9.1.1 Inter-relationships are considered to be the effects of different aspects of the proposed project on the same receptor. These are considered to be:

- *Project lifetime effects*: Assessment of the scope for effects that occur throughout more than one phase of the project (construction, O&M, and decommissioning); to interact to potentially create a more significant effect on a receptor than if just assessed in isolation in these three key project stages (e.g. subsea noise effects from piling, operational WTGs, vessels and decommissioning); and
- *Receptor led effects:* Assessment of the scope for all effects to interact, spatially and temporally, to create inter-related effects on a receptor. As an example, all effects on benthic ecology such as direct habitat loss or disturbance, sediment plumes, scour, jack-up vessel use etc., may interact to produce a different, or greater effect on this receptor, than when the effects are considered in isolation. Receptor-led effects might be short-term, temporary or transient effects, or incorporate longer term effects.

11.9.1.2 The assessment of impacts arising from construction, O&M and decommissioning of the Project indicates that impacts on receptors addressed in different aspects of the Project may potentially further contribute to the impacts assessed on offshore ornithology and *vice versa*. These are primarily from Chapter 9: Marine and Coastal Ecology; Chapter 10: Fish and Shellfish Ecology; and Chapter 15: Commercial Fisheries.

11.9.1.3 The worst-case impacts assessed within the chapter take these interactions into account, and, therefore, the impact assessments are considered conservative and robust. For clarity, the areas of interaction between impacts are listed below:

- Indirect impacts as a result of displacement of prey due to construction activities. This has been assessed within Section 11.6.3 of this chapter, with the impacts on prey being discussed in Chapter 9: Marine and Coastal Ecology, and Chapter 10: Fish and Shellfish Ecology;
- Disturbance and displacement from underwater noise via construction activities (including piling and UXO), and disturbance to foraging birds from underwater noise and vibration via operation activities. This has been assessed within Section 11.6.2 and Section 11.6.3 of this chapter, and discussed in Chapter 9: Marine and Coastal Ecology, and Chapter 10: Fish and Shellfish Ecology;
- Disturbance and displacement from vessels has been considered within both Section 11.6.2 and Section 11.6.3 of this chapter;
- Displacement from the Project during the Operations phase has been discussed in Section 11.6.3;
- Collision effects have been discussed in Section 11.6.3;
- Barrier effects are discussed in Section 11.6.3;
- Combined effects from collision and displacement are discussed in Section 11.6.4;
- Indirect impacts through effects on habitats and prey species are discussed in Section 11.6.3; and
- Attraction of nocturnal seabirds to lighting on project infrastructure are discussed in Section 11.6.3.

11.10 Cumulative Effects Assessment

11.10.1.1 A Cumulative Effects Assessment (CEA) has been made, based on existing and proposed developments in the Study Area (Chapter 30: Cumulative Effects). The approach to the CEA is described in Chapter 30: Cumulative Effects. Cumulative effects are defined as those effects on a receptor that may arise when the development is considered together with other reasonably foreseeable projects.

11.10.2 Tiers

11.10.2.1 In assessing the potential cumulative effects for the Project, it is important to recognise that certain projects, predominantly those 'proposed' or identified in development plans, may not actually be taken forward, or fully built out as described within their maximum design scenario (MDS). There is, therefore, a need to build in some consideration of certainty (or uncertainty) with respect to the potential impacts which might arise from such proposals. For example, those projects under construction are likely to contribute to cumulative impacts (providing effect or spatial pathways exist), whereas those proposals not yet approved are less likely to contribute to such an impact, as some may not achieve approval, or may not ultimately be built due to other factors.

11.10.2.2 With this in mind, all projects and plans considered alongside the Project have been allocated into 'tiers' reflecting their current stage within the planning and development process. This allows the cumulative assessment to present several future development scenarios, each with a differing potential for being ultimately built out. This approach also allows appropriate weight to be given to each scenario (tier) when considering the potential cumulative impact. The proposed tier structure is intended to ensure that there is a clear understanding of the level of confidence in the cumulative assessments provided in the Project ES. An explanation of each tier is included in Table 11.35.

11.10.2.3 The proposed tier structure for offshore ornithology is different from that presented for other receptors. This is due to the need to take into account greater levels of uncertainty in the degree and timing of overlap of activities, and to predominantly focus on other OWF projects and developments.

Table 11.35 – Description of tiers of other developments considered for CEA (adapted from PINS Advice Note 17) (PINS, 2019)

Tier	Description
Tier 1	Built and operational projects, where an ES, supplementary information and, potentially, post-construction monitoring have been submitted. Any design variation will have been identified. These projects are considered within the marine ornithology CEA and are not considered to be part of the baseline as effects may not yet be captured within the baseline data for the Project. **High** confidence.
Tier 2	Projects that are currently under construction, where an ES and any supplementary information will have been submitted. Any design variation will have been identified. **High** confidence.
Tier 3	Consented applications that have not yet began construction/been implemented. These projects will have submitted an ES and any supplementary information, however, it is noted that changes in design (within the scope of the PDE) may not yet been accounted for. These projects may or may not proceed. **Medium** confidence.

Tier	Description
Tier 4	Projects that have submitted applications that have not yet been determined. These projects will have an ES, however, may not have supplementary information and changes in design (within the scope of the PDE) will not have been identified yet. These projects may or may not proceed. **Low** confidence.
Tier 5	Future projects that have not yet submitted an application, however, may have submitted a scoping report. Confidence in these is considered low as this tier covers projects that have announced with no information submitted. These projects may or may not proceed, and changes in design are considered likely. **Low** confidence.

11.10.3 Screening

11.10.3.1 The plans and projects selected as relevant to the CEA for seabirds are based on an initial screening exercise undertaken on a long list (Chapter 30: Cumulative Effects Assessment). For offshore wind farms, the website https://www.4coffshore.com/ was used to identify all projects within the foraging range (plus 1 standard deviation) of Manx shearwater (2,365 km; Woodward *et al.*, 2019). For other offshore developments, The Crown Estate website and Emod.net were used to identify projects. It should be noted that within the CEA for individual receptor species, foraging ranges are only used to identify developments for assessment with respect to potential impacts to breeding colonies. Projects with potential to cause cumulative effects on non-breeding populations are identified based on their presence within the relevant BDMPS region (UK western waters). However, for the purposes of the initial long-list, the foraging range for Manx shearwater was used, as this provides the most extensive spatial scale that will require consideration.

11.10.3.2 The potential cumulative effects of the Pembrokeshire Demonstration Zone (PDZ) have not been considered at the time of writing, due to the lack of detail with which to assess the effects of the proposed project. An EIA Scoping Report was produced and issued to NRW in 2018 for a proposed wave/floating wind project; however, based on discussions with Celtic Sea Power (the 3rd party agents for the PDZ) and recent public presentations by members of Celtic Sea Power, it is understood the PDZ will be repurposed as an offshore electrical hub. In the absence of an updated EIA Scoping Report, and insufficient project information to allow the effects to be reasonably understood and a cumulative assessment undertaken, it has been omitted from this assessment.

11.10.3.3 For those reasons identified above, including the absence of EIA Scoping Reports, the potential cumulative effects of the recently announced Llŷr 1, Llŷr 2 and Whitecross FLOW projects are also omitted from this cumulative assessment.

11.10.3.4 As set out in PINS Guidance Note 17 (PINS, 2019), the Project proposed an assessment cut-off date of 1 October 2021 to allow the finalisation of the EIA and HRA assessments, even if project information came forward between the cut-off date and submission. This was agreed with NRW Marine Licensing, noting that in the absence of S.36/Marine Licence guidance, the Project was drawing upon the best available advice.

11.10.3.5 It is understood that should sufficient detail of these projects come forward following submission, the Project may be requested to provide additional information during the determination period.

11.10.3.6 The offshore plans or projects considered included:

- Marine renewables (wind, wave and tidal);
- Port and harbour developments;
- Marine aggregate extraction and dredging;
- Licensed disposal sites;
- Oil and gas exploration and extraction; and
- Subsea cables and pipelines.

11.10.3.7 A consideration of effect-receptor-pathways, data confidence and temporal and spatial scales has been given, in order to select projects for a topic-specific short-list. It is determined that, except where projects are in the local region, all sectors excluding marine renewables can be screened out of CEA due to absence of effect-pressure pathway.

11.10.3.8 Planned and operational marine energy projects were screened into the assessment depending on presence of a potential effect-receptor pathway during construction, operation and maintenance, or decommissioning.

11.10.3.9 Following geospatial review of the long-list and comparing the locations of projects, regional seas, the results of the apportioning analysis (Volume 3, Technical Appendix 11.2: Apportioning), and taking the SOSS-05 report (Wright *et al.*, 2012) into consideration, projects outside the following regions were screened out of the CEA:

- Celtic Sea;
- Irish Sea;
- English Channel;
- North of Scotland;
- Ireland and Northern Ireland; and
- The west and north coasts of France.

11.10.3.10 Connectivity between projects out with these regions, and the seabird colonies or populations, or migratory routes, that may interact with the Project, is deemed to be very low (see Volume 3, Technical Appendix 11.2: Apportioning; and Wright *et al.*, 2012). The Project-specific apportioning analysis suggests that the seabird populations that may be affected are localised and predominantly (often >99%) belong to nearby colonies or SPAs. Wright *et al.* (2012) shows limited connectivity between the screened out regions, such as the North Sea, and the Project.

11.10.3.11 In addition to this, most marine bird species avoid flying over land and, as such, there is distinct geographical separation between the Project and other projects outside the aforementioned regions. Therefore, it can be determined that any cumulative impacts with the Project, and projects outside these regions, on seabirds can be considered a **negligible** effect and therefore not significant in EIA terms.

11.10.3.12 Impacts associated with other projects that were included on the initial site long-list, and where located within the Celtic and Irish Seas, on the east coast of England and Scotland, and those in Ireland and Northern Ireland, as well as projects in the English Channel (UK and French) and on the north and west coast of France have been screened in for CEA, and considered for inclusion within the site short-list.

11.10.3.13 As such, the long-list of projects was screened to remove the following:

- All projects that are located outside of: the Celtic and Irish Seas, in Wales, on the east coast of England and Scotland, and those in Ireland and Northern Ireland, as well as projects in the English Channel (UK and French) and on the north and west coast of France (i.e., no spatial overlap);
- All operational/active projects where there is no ongoing risk of additional impact, as they are considered to be existing impacts included within the baseline (this includes all shipping ports, shipping routes and oil and gas pipelines). It should be noted that OWF projects are not included in this category as the full effects of the development are not yet displayed in available data;
- All projects where there is no expected temporal overlap with operation and maintenance of the Project;
- All projects where there is a lack of certainty over the timing of construction activities or project timeline; and
- All projects that have been cancelled or are fully decommissioned.

11.10.3.14 Following the above approach allows identification of all projects that must be considered within the CEA, whilst allowing the long-list to be reduced to manageable length, thus keeping the assessment "*proportionate*" and "[not] *any longer than is necessary to identify and assess any likely significant cumulative effects*", as per PINS Advice Note 17 (PINS, 2019).

11.10.3.15 The initial long-list contained 1,160 marine renewable energy (predominantly OWF) plans/projects within 2,365 km of the Project. The long-list also contained 398 projects from sectors other than offshore renewables (i.e. carbon capture and storage, dredge disposal, interconnector cables, natural gas storage, aggregate extraction etc.). Following refinement by location, and removal of cancelled and fully decommissioned projects, this list was reduced to 98 projects.

11.10.3.16 Several (23) of these 98 projects are located in French waters, and following review and thorough search of available literature and reports, no suitable data or information could be found in English. Therefore, these projects have been screened out of CEA on the basis that the data confidence is either very low or not available.

11.10.3.17 The remaining 75 projects were considered for CEA and underwent detailed and thorough review and search of documentation, including scoping reports, ESs, baseline data reports, pre- and post- construction monitoring and any other relevant documentation. Based on data availability, the projects were ascribed a 'Data Confidence' score of Low (i.e., no usable data or assessment available), Medium (i.e., no quantitative assessment available; qualitative assessment or monitoring reports may be available) or High (i.e., quantitative assessment of collision risk or displacement mortality available for at least one species).

11.10.3.18 For projects in early stages (i.e., ascribed Tier 5), there was, typically, insufficient project information in the public domain to allow the effects to be reasonably understood and a cumulative assessment undertaken. These were ascribed a Low data confidence and scoped out of CEA. Tier 1-4 projects were also reviewed, with the majority receiving a Low data confidence due to lack of data and assessment availability. A total of 11 other projects were ascribed a Medium or High score, these projects are screened in and considered in the CEA

11.10.3.19 The list of projects screened in for CEA, including relevant details and justification, is provided in Table 11.36.

Table 11.36 – Other projects screened in for marine ornithology cumulative effects assessment for the Project

Tier	Project (Sources)	Relevant Dates	Distance (km)	Data Confidence	Justification
1	Arklow Bank – Phase 1 (RPS, 2020)	Fully commissioned: 01/06/2004	146	Medium	The Environmental Statement (ES), survey reports and monitoring reports are not available for Phase 1 of the Arklow Bank project; however, the Arklow Bank Phase 2 Scoping Report is available. Only qualitative information relating to Arklow Bank Phase 1 is available in the Scoping Report for Phase 2, however, this can be used to indicate impacts to local populations of several seabird species.
1	Burbo Bank (SeaScape Energy Ltd, 2002, 2009)	Fully commissioned: 18/10/2007	275	Medium	The ES and pre- and post-construction monitoring reports are available for the project.

Tier	Project (Sources)	Relevant Dates	Distance (km)	Data Confidence	Justification
					The information contained within the ES and monitoring reports does not include species-specific mortality associated with displacement or collision risk, however, displacement impacts can be determined from mean-peak population values, and collision mortalities for some species are provided in MacArthur and Royal Haskoning, 2019. Only a qualitative assessment of collision risk can be made for other receptors.
1	Burbo Bank Extension (DONG energy, 2013a)	Fully commissioned: 01/04/2017	271	Medium	The ES, post construction monitoring reports, and raw ornithological monitoring data are available for the project. Displacement impacts can be determined from mean-peak population values, and collision mortalities for some species are provided in MacArthur and Royal Haskoning, 2019. Only a qualitative assessment of collision risk can be made for other receptors.

Tier	Project (Sources)	Relevant Dates	Distance (km)	Data Confidence	Justification
1	Gwynt y Môr (NPower, 2005)	Fully commissioned: 18/06/2015	257	Medium	The ES and post-construction monitoring reports are available for this project. Only qualitative assessments were made for displacement effects and collision risk, with no estimation of mortality rate available for either effect. Potential impacts can be inferred from monitoring reports.
1	North Hoyle (May, 2005)	Fully commissioned: 01/06/2004	258	Medium	The post-construction monitoring report is available, however, the ES, and therefore impact assessments, is not available. Impacts to seabirds can be inferred, although not quantified, from the monitoring report.
1	Ormonde (Percival, 2005; RBA, 2005)	Fully commissioned: 22/02/2012	323	Medium	The ES and construction monitoring reports, as well as seabird-specific impact assessment reports are available for this project.

Tier	Project (Sources)	Relevant Dates	Distance (km)	Data Confidence	Justification
					Collision risk model outputs are presented in the ES and its appendices, however, assessment is based on seawatching records from the nearest headland at Walney Island. This approach is considered to have low reliability and, as such, has not been used in cumulative assessment.
1	Rhyl Flats (ESS Ltd, 2007)	Fully commissioned: 02/12/2010	248	Medium	The full ES is not available for this project, however, ornithological baseline and monitoring reports are publicly available. As no ES is available, there is no available quantitative assessment of collision risk or displacement mortality, however, impacts associated with the development may be inferred from monitoring reports.
1	Robin Rigg (Natural Power, 2002)	Fully commissioned: 15/09/2010	384	Medium	The ES for this project is available, as are ornithological monitoring reports.

Tier	Project (Sources)	Relevant Dates	Distance (km)	Data Confidence	Justification
					Quantitative assessments for collision risk are presented in the ES, however, the species screened in for CEA for Erebus were screened out for Robin Rigg and, therefore, assessed qualitatively.
1	Walney – Phase 1 and 2 (DONG energy, 2006)	Fully commissioned: 14/06/2012	316	Medium	The full project ES and pre- and post-construction ornithological monitoring reports are available. Displacement impacts can be determined from mean-peak population values, and collision mortalities for some species are provided in MacArthur and Royal Haskoning, 2019. Only a qualitative assessment of collision risk can be made for other receptors.
1	Walney Extension (DONG energy, 2013b)	Fully commissioned: 06/09/2018	314	Medium	The scoping report, ES, and HRA are available; however, no pre- or post-construction ornithological monitoring reports are available.

Tier	Project (Sources)	Relevant Dates	Distance (km)	Data Confidence	Justification
					Displacement impacts can be determined from mean-peak population values, and collision mortalities for some species are provided in MacArthur and Royal Haskoning, 2019. Only a qualitative assessment of collision risk can be made for other receptors.
1	West of Duddon Sands RSK (2006)	Fully commissioned: 30/10/2014	312	Medium	The full ES and baseline bird surveys are available; however, ornithological monitoring reports are not available. The assessments for collision risk and displacement mortality are mostly qualitative and are based on mortality thresholds. Displacement impacts can be determined from mean-peak populations values, and collision mortalities for lesser black-backed gull are provided in MacArthur and Royal Haskoning, 2019. Only a qualitative assessment of collision risk can be made for other receptors.

11.10.3.20 Certain impacts assessed for the Project alone have not been included in the CEA, where these are:

- Of a highly localised spatial extent;
- Adjudged to cause changes of such small magnitude that these will not contribute in any meaningful way at a population level to a potential cumulative impact (based on determination for Project effects alone); or
- Will not take place for a considerable period of time and, therefore, there is insufficient certainty over relevant input parameters to reasonably allow assessment of likely cumulative effects.

11.10.3.21 Impacts scoped out of the CEA include:

- Impacts associated with the construction phase of the Project, including cable landfall, laying of the export cable within the ECC and installation of the WTGs and platforms and associated infrastructure within the offshore array area;
- Indirect impacts, such as habitat loss and effects on prey items, during any phase of the Project;
- Displacement effects associated with vessel movement during any stage of the Project, including operation and maintenance;
- Barrier effects during the operational phase, given that other developments screened into CEA are sufficiently distant (>270 km) that there will be no measurable cumulative barrier effects. The journey distance for any individuals that travel far enough to encounter multiple projects will be so long as to ensure that the small increase in distance will be negligible in comparison;
- All impacts during the decommissioning phase of the Project, as all impacts during this stage are likely to be of similar significance to those during the construction phase and were determined to be of negligible significance, and data and information available for other plans associated with this source of impact are of no, or low, confidence.

11.10.3.22 Following the screening process undertaken above, and considering the outcome of the assessments made for the Project, and for other projects, the following impacts are scoped in for CEA:

- Collision risk to Manx shearwater, northern gannet, herring gull, great black-backed gull, lesser black-backed gull, black-legged kittiwake and common guillemot during the operation and maintenance stage of the Project, cumulatively with other planned/proposed, in-construction, and installed offshore wind projects; and
- Displacement (and barrier) effects on Manx shearwater, northern gannet, black-legged kittiwake, Atlantic puffin, common guillemot and razorbill during the operation and maintenance stage of the Project, cumulatively with other planned/proposed, in-construction, and installed offshore wind projects.

11.10.4 Construction Phase

11.10.4.1 As set out in 11.10.3.22, following the screening process and considering the outcome of the assessments made for the Project, and for other projects, no impacts were scoped in for cumulative assessment during the construction phase.

11.10.5 Operation and Maintenance

Collision Risk

11.10.5.1 A detailed assessment of collision risk effects associated with the Project alone is provided in Section 11.6.3.2. The assessment concluded that, for all seabird receptors screened in for assessment, the significance of displacement is **negligible** effect or **minor adverse** effect, which is not significant in EIA terms.

11.10.5.2 The majority of other projects listed in Table 11.36 do not have suitable data nor a quantitative risk assessment for collision risk effects for most species screened in. However, where applicable, data on collision mortalities is taken from the database provided by MacArthur Green and Royal Haskoning (2019). This database provides a summary of offshore ornithological collision risk modelling data for UK offshore windfarms. The database provides comparability of collision related mortalities for those seabird species considered to be of particular risk of collision with wind turbines (northern gannet, black-legged kittiwake, herring gull, lesser black-backed gull and great black-backed gull). The database also provides the most recent and available as-built turbine parameters and, as such, is considered more accurate than values in ES, which correspond with ‘as applied for’ parameters.

11.10.5.3 Estimates of collision related mortalities, as reported by MacArthur and Royal Haskoning, together with estimates for the Proposed Development, as determined in Technical Appendix 11.3: Collision Risk Modelling are provided in Table 11.37.

11.10.5.4 For all other projects, only qualitative assessments or indications of impacts are available (natural power, 2002; SeaScape Energy Ltd, 2002, 2009; May, 2005; Npower, 2005; DONG energy, 2006; RSK, 2006; ESS Ltd, 2007; RPS, 2020). These have been considered where possible, however, cannot provide confident contribution to the CEA for collision risk.

Table 11.37: Collision risk mortality from project screened into the present assessment, as reported by MacArthur and Royal Haskoning and Technical Appendix 11.3: Collision Risk Modelling.

Project	Northern Gannet	Herring Gull	Great Black-backed Gull	Lesser Black-backed Gull	Black-legged Kittiwake
Erebus	116	3	1	6	58
Burbo Bank Extension	11	14	-	26	21
Walney 1 and 2	-	-	-	58	-
Walney Extension	38	55	29	13	188
West of Duddon Sands	-	-	-	45	-
Total	**165**	**72**	**30**	**148**	**267**

Collision Risk – Manx Shearwater

11.10.5.5 A mortality rate of zero is predicted for the Project alone. As such there is no pathway for cumulative effects with other developments. Accordingly, collision risk effects on Manx shearwater are screened out of assessment.

Collision Risk – Northern Gannet

11.10.5.6 The cumulative predicted collision risk mortality for northern gannet, in projects for which quantified values are available, is presented in Table 11.37. A mortality rate of 165 individuals represents 0.03% of the BDMPS population of 545,954 individuals September to November, 0.02% of the BDMPS population of 661,888 individuals December to March (Furness, 2015), and 0.02% of the migration free breeding season population of 72,022 individuals (Pritchard *et al.*, 2021). However, it should be noted that these values assume that all mortalities occur in a single season. It is highly likely that mortalities will be split between seasons and as such the actual proportion or respective seasons affected will be smaller than those reported. Other projects, where only qualitative assessments of collision risk on northern gannet are available, assess the risk to the species as very low or negligible.

11.10.5.7 Therefore, it is determined that the overall cumulative collision risk effect of the Project, along with the other projects scoped in for CEA, on northern gannet is **minor adverse** effect, which is not significant in EIA terms.

Collision Risk – Herring Gull

11.10.5.8 The cumulative predicted collision risk mortality for herring gull, in projects for which quantified values are available, is presented in Table 11.37. A mortality rate of 72 individuals represents 0.04% of the BDMPS population of 173,299 individuals September to February (Furness, 2015).

11.10.5.9 The apportioning analysis for the Walney Extension OWF (NIRAS, 2013a) indicates that the only colony at risk of collision effects is the Morecambe Bay population. This colony is located at least 300 km (at-sea) from the Project putting it outside the foraging range of herring gull (Woodward *et al.*, 2019). Therefore, there is no pathway for cumulative effects on breeding populatiosn from the Project in addition to Walney Extension.

11.10.5.10 Burbo Bank Extension OWF is located to the south of Walney Extension OWF, within Liverpool Bay, and although apportioning assessment results are not available for this project, it is considered likely that this will predominantly affect local populations of herring gull. Therefore, cumulative effects of the Project in addition to Burbo Bank Extension on breeding colonies are also considered very unlikely to occur.

11.10.5.11 It is noted that the ranges provided by Woodward *et al.* (2019) only account for foraging activities during the breeding season. However, given the small proportion of the relevant BDMPS predicted to be at risk, it is considered that this level of mortalities would result in negligible effects on the wider biogeographic population (with connectivity to UK waters) outside of the breeding season.

11.10.5.12 Other projects, where only qualitative assessments of collision risk on herring gull are available, assess the risk to the species as very low or negligible.

11.10.5.13 Therefore, it is determined that the overall cumulative collision risk effect of the Project, along with the other projects scoped in for CEA, on herring gull is **minor adverse** effect, which is not significant in EIA terms.

Collision Risk – Great Black-backed Gull

11.10.5.14 The cumulative predicted collision risk mortality for great black-backed gull, in projects for which quantified values are available, is presented in Table 11.37. A mortality rate of 30 individuals represents 0.16% of the BDMPS population of 17,742 individuals September to March (Furness, 2015). The other projects scoped in for CEA assess impacts to great black-backed gull from collision risk effects as minor or negligible, and monitoring reports for these projects show no impacts outside those predicted in the corresponding ES. Cumulatively, with the Project, mortality to the regional great black-backed gull population is not likely to be significant.

11.10.5.15 It is important to recognise that great black-backed gull has a foraging range of 73 km (SD not provided) (Woodward *et al.*, 2019) and that the Walney Extension OWF is located >300 km away from the Project array area. Therefore, there is very limited to no potential for the projects to interact with great black-backed gull from the same breeding colonies.

11.10.5.16 It is noted that the ranges provided by Woodward *et al.* (2019) only account for foraging activities during the breeding season. However, given the small proportion of the relevant BDMPS predicted to be at risk, it is considered that this level of mortalities would result in negligible effects on the wider biogeographic population (with connectivity to UK waters) outside of the breeding season

11.10.5.17 Therefore, it is determined that the overall cumulative collision risk effect of the Project, along with the other projects scoped in for CEA, on great black-backed gull is **minor adverse** effect, which is not significant in EIA terms.

Collision Risk – Lesser Black-backed Gull

11.10.5.18 The cumulative predicted collision risk mortality for lesser black-backed gull, in projects for which quantified values are available, is presented in Table 11.37. A mortality rate of 148 individuals represents 0.09% of the BDMPS population of 163,304 individuals August to October and March to April, and 0.36% of 41,159 individuals November to February (Furness, 2015). The other projects scoped in for CEA assess impacts to lesser black-backed gull from collision risk effects as minor or negligible, and monitoring reports for these projects show no impacts outside those predicted in the corresponding ES. Cumulatively, with the Project, mortality to the regional lesser black-backed gull population is not likely to be significant.

11.10.5.19 The apportioning analysis for the Project (Volume 3, Technical Appendix 11.2: Apportioning) suggests that 97.8% of lesser black-backed gull affected by the Project originate from the Skomer and Skokholm colony. This colony is located at least 275 km (at-sea distance) from both Walney and Burbo Bank OWFs, putting these projects outside the foraging range for the species (mean maximum foraging range (127 km) plus one standard deviation (109 km)) (Woodward *et al.*, 2019); therefore, there is very limited to no potential for these developments to affect the same lesser black-backed gull breeding season populations (DONG energy, 2013a-b).

11.10.5.20 It is noted that the ranges provided by Woodward *et al.* (2019) only account for foraging activities during the breeding season. However, given the small proportion of the relevant BDMPS predicted to be at risk, it is considered that this level of mortalities would result in negligible effects on the wider biogeographic population (with connectivity to UK waters) outside of the breeding season.

11.10.5.21 Other projects, where only qualitative assessments of collision risk on lesser black-backed gull are available, assess the risk to the species as very low or negligible.

11.10.5.22 Therefore, it is determined that the overall cumulative collision risk effect of the Project, along with the other projects scoped in for CEA, on lesser black-backed gull is **minor adverse** effect, which is not significant in EIA terms.

Collision Risk – Black-legged Kittiwake

11.10.5.23 The cumulative predicted collision risk mortality for black-legged kittiwake gull, in projects for which quantified values are available, is presented in Table 11.37. A mortality rate of 267 individuals represents 0.03% of the BDMPS population of 911,586 individuals August to December, and 0.04% of 691,526 individuals January to April (Furness, 2015). The other projects scoped in for CEA assess impacts to black-legged kittiwake from collision risk effects as minor or negligible, and monitoring reports for these projects show no impacts outside those predicted in the corresponding ES. Cumulatively, with the Project, mortality to the regional black-legged kittiwake population is not likely to be significant.

11.10.5.24 The apportioning analysis for the Project (Volume 3, Technical Appendix 11.2: Apportioning) suggests that 81.7% of black-legged kittiwake affected by the Project originate from the Skomer and Skokholm colony, 4.6% from Saltee Islands, 3.3% from Howth Head, 3.1% from Lambay Island and <2% from other colonies up to 231 km from the Project. The main colonies are located at least 275 km (at-sea distance) from both Walney and Burbo Bank OWFs, and because black-legged kittiwake foraging range is (mean maximum foraging range (73.2 km) plus one standard deviation (80.5 km)) (Woodward *et al.*, 2019), there is very limited potential for these developments to affect breeding season populations (DONG energy, 2013a-b).

11.10.5.25 It is noted that the ranges provided by Woodward *et al.* (2019) only account for foraging activities during the breeding season. However, given the small proportion of the relevant BDMPS predicted to be at risk, it is considered that this level of mortalities would result in negligible effects on the wider biogeographic population (with connectivity to UK waters) outside of the breeding season.

11.10.5.26 Other projects, where only qualitative assessments of collision risk on black-legged kittiwake are available, assess the risk to the species as very low or negligible.

11.10.5.27 Therefore, it is determined that the overall cumulative collision risk effect of the Project, along with the other projects scoped in for CEA, on black-legged kittiwake is **minor adverse** effect, which is not significant in EIA terms.

Collision Risk – Common Guillemot

11.10.5.28 All projects scoped in for CEA assess impacts to common guillemot from collision risk effects as minor or negligible, and monitoring reports for these projects show no impacts outside those predicted in the corresponding ES. Cumulatively, with the Project, mortality to the regional common guillemot population is not likely to be significant.

11.10.5.29 Other projects, where only qualitative assessments of collision risk on common guillemot are available, assess the risk to the species as very low or negligible.

11.10.5.30 Therefore, it is determined that the overall cumulative collision risk effect of the Project, along with the other projects scoped in for CEA, on common guillemot is **minor adverse** effect, which is not significant in EIA terms.

Displacement Effects

11.10.5.31 A detailed assessment of displacement effects associated with the Project alone is provided in Section 11.6.3.63. The assessment concluded that, for all seabird receptors screened in for assessment, the significance of displacement is **negligible** effect or **minor adverse** effect, which is not significant in EIA terms.

11.10.5.32 The majority of other projects listed in Table 11.36 do not have suitable data, nor a quantitative risk assessment for displacement effects for most species screened into assessment for displacement effects.

11.10.5.33 Mean-peak population estimates are provided for Manx shearwater and common guillemot at Burbo Bank Extension (DONG energy, 2013a) and for Manx shearwater, common guillemot, and razorbill at Walney Extension (DONG energy, 2013b). It should be noted that these figures are provided for the Burbo Bank Extension and Walney Extension array areas and a 4 km buffer and, as such, are not directly comparable with data for the Project, which is based on the array area with a 2 km buffer (in accordance with SNCB guidance (2107)). However, this increased buffer is likely to over-estimate potential impacts, and is therefore considered to be in accordance with a precautionary approach.

Displacement rates and associated mortality rates are variable among other historical projects as these are regularly updated within assessments based on the latest available data. As such, displacement will be calculated in accordance with the displacement rates and associated mortalities applied for assessment of Project effects alone.

11.10.5.34 For all other species, and for all other projects, only qualitative assessments or indications of impacts are available (natural power, 2002; SeaScape Energy Ltd, 2002, 2009; May, 2005; Npower, 2005; RBA, 2005; DONG energy, 2006; RSK, 2006; ESS Ltd, 2007; RPS, 2020). These have been considered, where possible, however, cannot provide confident contribution to the CEA for displacement effects.

Displacement Effects – Manx Shearwater

11.10.5.35 Table 11.38 summarises the predicted mortality levels based on the peak population estimates, displacement rates and mortality estimates provided for assessment.

Table 11.38 – Cumulative displacement mortality for Manx shearwater *Puffinus puffinus*

Project	**Peak Population Estimate**		**Displacement Rate (%)**	**Mortality Rate (%)**	**Predicted Mortalities (*n*)**
Walney Extension	Breeding season	1,417	10	1	2
	Post-breeding season	1,017			2
	Pre-breeding season	183			1
Burbo Bank Extension	Breeding season	2,937			3

Project	Peak Population Estimate		Displacement Rate (%)	Mortality Rate (%)	Predicted Mortalities (*n*)
Erebus	Breeding season	1,540			2
	Post-breeding season	557			1
	Pre-breeding season	18			1

11.10.5.40 During the breeding season a total of 7 mortalities are predicted, representing <0.001% of the reference migration free breeding population (974,942; Pritchard *et al.*, 2021). In addition, a total of 2 mortalities are predicted in the post-breeding season, corresponding with <0.001% of the post-breeding BDMPS (1,580,895 individuals August to October; Furness, 2015) and 2 mortalities are predicted during the pre-breeding season, representing <0.001% of the pre-breeding BDMPS (1,580,895 individuals March to May; Furness, 2015). The other projects scoped in for CEA assess impacts to Manx shearwater from displacement effects as minor or negligible, and monitoring reports for these projects show no impacts outside those predicted in the corresponding ES. Cumulatively, with the Project, mortality to the regional Manx shearwater population is not likely to be significant.

11.10.5.41 Therefore, it is determined that the overall cumulative displacement effect of the Project, along with the other projects scoped in for CEA, on Manx shearwater is **minor adverse** effect, which is not significant in EIA terms.

Displacement Effects – Northern Gannet

11.10.5.42 Table 11.39 summarises the predicted mortality levels based on the peak population estimates, displacement rates and mortality estimates provided for assessment.

Table 11.39 - Cumulative displacement mortality for northern gannet *Morus bassanus*

Project	Peak Population Estimate		Displacement Rate (%)	Mortality Rate (%)	Predicted Mortalities (*n*)
Walney Extension	Breeding season	172	70	2	3
	Post-breeding season	292		1	3
	Pre-breeding season	509			4

Project	Peak Population Estimate		Displacement Rate (%)	Mortality Rate (%)	Predicted Mortalities (*n*)
Burbo Bank Extension	Breeding season	429		2	7
Erebus	Breeding season	224		2	4
	Post-breeding season	334		1	3
	Pre-breeding season	100			1

11.10.5.50 During the breeding season a total of 14 mortalities are predicted, representing 0.02% of the reference migration free breeding population (72,022; Pritchard *et al.*, 2021). In addition, a total of 6 mortalities are predicted in the post-breeding season, corresponding with 0.001% of the post-breeding BDMPS (545,954 individuals September to November; Furness, 2015) and 5 mortalities are predicted during the pre-breeding season, representing <0.001% of the pre-breeding BDMPS (661,888 individuals December to March; Furness, 2015).

11.10.5.51 The other projects scoped in for CEA assess impacts to northern gannet from displacement effects as minor or negligible, and monitoring reports for these projects show no impacts outside those predicted in the corresponding ES. Cumulatively, with the Project, mortality to the regional northern gannet population is not likely to be significant.

11.10.5.52 Therefore, it is determined that the overall cumulative displacement effect of the Project, along with the other projects scoped in for CEA, on northern gannet is **minor adverse** effect, which is not significant in EIA terms.

Displacement Effects – Black-legged Kittiwake

11.10.5.53 Table 11.40 summarises the predicted mortality levels based on the peak population estimates, displacement rates and mortality estimates provided for assessment.

Table 11.40 - Cumulative displacement mortality for black-legged kittiwake *Rissa tridactyla*

Project	Peak Population Estimate		Displacement Rate (%)	Mortality Rate (%)	Predicted Mortalities (*n*)
Walney Extension	Breeding season	319	30	2	2
	Post-breeding season	1,114		1	4

Project	Peak Population Estimate		Displacement Rate (%)	Mortality Rate (%)	Predicted Mortalities (*n*)
	Pre-breeding season	1,467			5
Burbo Bank Extension	Breeding season	707		2	5
Erebus	Breeding season	2		2	1
	Post-breeding season	2,022		1	7
	Pre-breeding season	508			2

11.10.5.61 During the breeding season a total of 8 mortalities are predicted, representing 0.17% of the reference migration free breeding population (4,527; Pritchard *et al.*, 2021). In addition, a total of 11 mortalities are predicted in the post-breeding season, corresponding with 0.001% of the post-breeding BDMPS (911,586 individuals August to December; Furness, 2015) and 7 mortalities are predicted during the pre-breeding season, representing 0.001% of the pre-breeding BDMPS (691,526 individuals January to April; Furness, 2015).

11.10.5.62 The other projects scoped in for CEA assess impacts to black-legged kittiwake from displacement effects as minor or negligible, and monitoring reports for these projects show no impacts outside those predicted in the corresponding ES. Cumulatively, with the Project, mortality to the regional black-legged kittiwake population is not likely to be significant.

11.10.5.63 Therefore, it is determined that the overall cumulative displacement effect of the Project, along with the other projects scoped in for CEA, on black-legged kittiwake is **negligible** effect, which is not significant in EIA terms.

Displacement Effects – Atlantic Puffin

11.10.5.64 Table 11.41 summarises the predicted mortality levels based on the peak population estimates, displacement rates and mortality estimates provided for assessment.

Table 11.41 - Cumulative displacement mortality for Atlantic puffin *Fratercula arctica*

Project	Peak Population Estimate		Displacement Rate (%)	Mortality Rate (%)	Predicted Mortalities (*n*)
Walney Extension	Breeding season	191	70	5	7
	Non-breeding season	187		1	2
Burbo Bank Extension	Breeding season	493		5	18
Erebus	Breeding season	449		5	16
	Non-breeding season	32		1	1

11.10.5.69 During the breeding season a total of 41 mortalities are predicted, representing 0.07% of the reference migration free breeding population (55,622; Pritchard *et al.*, 2021). In addition, a total of 3 mortalities are predicted in the non-breeding season, corresponding with <0.001% of the non-breeding BDMPS (304,557 individuals August to March; Furness, 2015).

11.10.5.70 The other projects scoped in for CEA assess impacts to Atlantic puffin from displacement effects as minor or negligible, and monitoring reports for these projects show no impacts outside those predicted in the corresponding ES. Cumulatively, with the Project, mortality to the regional Atlantic puffin population is not likely to be significant.

11.10.5.71 Therefore, it is determined that the overall cumulative displacement effect of the Project, along with the other projects scoped in for CEA, on Atlantic puffin is **minor adverse** effect, which is not significant in EIA terms.

<u>Displacement Effects – Common Guillemot</u>

11.10.5.72 The apportioning analysis for the Project (Volume 3, Technical Appendix 11.2: Apportioning) suggests that 75.4% of common guillemot affected by the Project originate from the Skomer and Skokholm colony and 4.9% from Saltee Island. These colonies are located at least 275 km (at-sea distance) from both Walney and Burbo Bank OWFs, and common guillemot foraging range is mean maximum foraging range (73.2 km) plus one standard deviation (80.5 km) (Woodward *et al.*, 2019); therefore, there is very limited potential for these developments to affect the same common guillemot population (DONG energy, 2013a-b). As such, effects during the breeding season are screened out of cumulative assessment and not considered further herein.

11.10.5.73 Table 11.42 summarises the predicted mortality levels based on the mean-peak population estimates, displacement rates and mortality estimates provided for assessment.

Table 11.42 – Cumulative displacement mortality for common guillemot *Uria aalge*

Project	Peak Population Estimate		Displacement Rate (%)	Mortality Rate (%)	Predicted Mortalities (*n*)
Walney Extension	Non-breeding season	6,544	70	1	46
Burbo Bank Extension	Non-breeding season	3,448			25
Erebus	Non-breeding season	3,558			25

11.10.5.82 A total of 96 mortalities are predicted in the non-breeding season, corresponding to 0.08% of the post-breeding BDMPS (1,139,220 individuals August to February, Furness, 2015).

11.10.5.83 The other projects scoped in for CEA assess impacts to common guillemot from displacement effects as minor or negligible, and monitoring reports for these projects show no impacts outside those predicted in the corresponding ES. Cumulatively, with the Project, mortality to the regional population is not likely to be significant. Therefore, it is determined that the overall cumulative displacement effect of the Project, along with the other projects scoped in for CEA, on common guillemot is **minor adverse** effect, which is not significant in EIA terms.

Displacement Effects – Razorbill

11.10.5.84 The apportioning analysis for the Project (Volume 3, Technical Appendix 11.2: Apportioning) suggests that 89.2% of razorbill affected by the Project originate from the Skomer and Skokholm colony and 3.9% from Saltee Island. These colonies are located at least 275 km (at-sea distance) from both Walney and Burbo Bank OWFs, and razorbill foraging range is mean maximum foraging range (88.7 km) plus one standard deviation (75.9 km) (Woodward *et al.*, 2019); therefore, there is very limited potential for these developments to affect the same razorbill population (DONG energy, 2013a-b). As such, effects during the breeding season are screened out of cumulative assessment and not considered further herein.

11.10.5.85 Table 11.43 summarises the predicted mortality levels based on the mean-peak population estimates, displacement rates and mortality estimates provided for assessment.

Table 11.43 Cumulative displacement mortality for razorbill *Alca torda*

<table>
<tr><th>Project</th><th colspan="2">Peak Population Estimate</th><th>Displacement Rate (%)</th><th>Mortality Rate (%)</th><th>Predicted Mortalities (n)</th></tr>
<tr><td rowspan="3">Walney Extension</td><td>Post-breeding season</td><td>3,812</td><td rowspan="3">70</td><td rowspan="3">1</td><td>27</td></tr>
<tr><td>Non-breeding season</td><td>3,931</td><td>28</td></tr>
<tr><td>Pre-breeding season</td><td>2,008</td><td>15</td></tr>
<tr><td rowspan="3">Erebus</td><td>Post-breeding season</td><td>1,228</td><td rowspan="3">70</td><td rowspan="3">1</td><td>9</td></tr>
<tr><td>Non-breeding season</td><td>566</td><td>4</td></tr>
<tr><td>Pre-breeding season</td><td>460</td><td>4</td></tr>
</table>

11.10.5.87 A total of 36 mortalities are predicted during the post-breeding season, representing 0.005% of the reference migration free breeding population (606,914 individuals; August to October; Furness, 2015). In addition, a total of 32 mortalities are predicted in the non-breeding season, corresponding to 0.009% of the non-breeding BDMPS (341,422 individuals; November to December; Furness, 2015) and 19 mortalities predicted in the pre-breeding season, representing 0.005% of the pre-breeding BDMPS (341,422 individuals; November to December; Furness, 2015).

11.10.5.88 The other projects scoped in for CEA assess impacts to Manx shearwater from displacement effects as minor or negligible. Cumulatively, with the Project, it is determined that the overall cumulative displacement effect of the Project, along with the other projects scoped in for CEA, on razorbill is **minor adverse** effect, which is not significant in EIA terms,

11.10.6 Decommissioning

11.10.6.1 As set out in 11.10.3.22, following the screening process and considering the outcome of the assessments made for the Project, and for other projects, no impacts were scoped in for cumulative assessment during the decommissioning phase.

11.10.7 Summary

11.10.7.1 The CEA considered the effects of the Project together with those of several other OWF developments scoped into assessment. Only collision risk and displacement mortality effects were screened in for assessment. All other impacts (those associated with construction and decommissioning and minor effects associated with operation and maintenance, such as vessel disturbance, underwater noise and lighting effects) were screened out of assessment as impacts were predicted to be negligible, even in addition to other projects, or only qualitative assessments were made for the Project and the other projects scoped in for CEA.

11.10.7.2 Whilst individuals of certain species are known to be sensitive to displacement and/or collision risk effects, population level effects for the Project alone are determined to be either **negligible** effect or **minor adverse** effect. When the Project-specific mortality rates are added to those predicted for other OWF projects, cumulative impacts do not increase significantly, largely due to the small scale and magnitude of effects associated with the Project, but also due to geographical separation of other projects and regional populations.

11.10.7.3 As such, it can be determined that, for all seabird receptors, cumulative effects associated with collision risk and displacement mortality are either **negligible** effect or **minor adverse** effect, neither of which are significant in EIA terms.

11.10.7.4 Therefore, no additional mitigation is required.

11.11 Transboundary

11.11.1.1 Impacts have been considered against regional seabird populations during the breeding and non-breeding seasons. The apportioning carried out in Volume 3, Technical Appendix 11.2: Apportioning, indicates that there are no protected populations of seabirds in the rest of the UK, Ireland or in Europe that will be significantly affected by the Project, other than those assessed in Volume 3, Technical Appendix 8.3: Report to Inform Appropriate Assessment.

11.11.1.2 There may be displacement and collision risk effects associated with the Project due to the presence of WTGs. Project effects are likely to be highly localised (i.e., within 4 km of the Project), however, impacts to regional populations may be detectable at greater distances (e.g., within foraging range or migratory routes). Therefore, there is potential for transboundary effects to occur where far-ranging or migratory populations interact with the Project.

11.11.1.3 Project apportioning outputs concluded that a very limited proportion of individuals that may interact with the Project are associated with seabird colonies outside of UK waters. The apportioning results show that ≤0.5% of individual seabirds of any species recorded were attributable to SPA colonies outside of UK waters, with the following exceptions:

- Black-legged kittiwake:
  - Saltee Island SPA (4.6%);
  - Howth Head Coast SPA (3.3%);
  - Lambay Island SPA (3.1%);
  - Ireland’s Eye SPA (1.6%);
- Common guillemot:
  - Saltee Islands SPA (4.9%); and
  - Razorbill:

- Saltee Islands SPA (3.9%).

11.11.1.4 Mortality due to displacement and collision risk is very low, and as such, a negligible proportion of the seabirds attributed the above SPAs may experience mortality due to collision risk or displacement effects (refer to Volume 3, Technical Appendix 11.3: Collision Risk Modelling and Technical Appendix 11.4: Displacement Analysis, as well as Section 11.6.3 of this chapter). Therefore, the impact of a collision risk and displacement effects will not lead to a significant transboundary effect.

11.11.1.5 The overall risk to transboundary seabird populations is, therefore, determined to be **negligible** effect, which is not significant in EIA terms.

11.12 Summary

11.12.1.1 This Chapter assesses the potential impacts which may occur on offshore ornithology from the construction, operation and decommissioning of the Project.

11.12.1.2 Bird activity and usage of the array area was established through two years of digital aerial survey work undertaken by HiDef who have analysed and reported on the data.

11.12.1.3 The key bird species scoped in for assessment are:

- Northern fulmar *Fulmarus glacialis*;
- Manx shearwater *Puffinus puffinus*;
- Balearic shearwater *Puffinus mauretanicus*;
- European storm-petrel *Hydrobates pelagicus*;
- Northern gannet *Morus bassanus*;
- Herring gull *Larus argentatus*;
- Great black-backed gull *Larus marinus*;
- Lesser black-backed gull *Larus fuscus*;
- Black-legged kittiwake *Rissa tridactyla*;
- Atlantic puffin *Fratercula arctica*;
- Common guillemot *Uria aalge*; and
- Razorbill *Alca torda*.

11.12.1.4 Assessment considers breeding and non-breeding season impacts against defined regional populations that differ according to the season. Key impacts from the Project arise during the operational phase and include the risk of birds fatally striking the turbine blades (collision risk) or avoiding the wind farm area (displacement). Assessments have also been undertaken for impacts arising from the disturbance and displacement of seabirds from vessel activity and underwater noise during all phases of the Project; indirect impacts through effects on habitats and prey; the aggregating effects of WTGs; entanglement from ghost fishing gear; and the attraction of nocturnal seabirds to lighting on the Project infrastructure. These impacts have been quantified where possible and are assessed as **minor** or **negligible** significance for all species, which is not significant in EIA terms.

11.12.1.5 Assessment of cumulative effects considered all other OWF projects within the wider region and within species-specific foraging range of the same colonies. The cumulative effects assessment determined that impacts associated with the Project cumulatively with other offshore wind developments will not result in risk greater than for the Project alone for any effect on any seabird species. The assessment concluded **minor** or **negligible** significance for all species, which is not significant in EIA terms.

11.12.1.6 Transboundary effects were also considered, informed by the apportioning assessment, collision risk modelling and displacement assessment conducted determined that the Project will result in **negligible** effect on transboundary seabird populations for all species, which is not significant in EIA terms.

11.12.1.7 Assessment is based on a ‘realistic worst case’ scenario and considers inter-related effects. The impact assessment is informed by the following;

- Volume 3, Technical Appendix 11.1: Baseline Data;
- Volume 3, Technical Appendix 11.2: Apportioning;
- Volume 3, Technical Appendix 11.3: Collision Risk Modelling;
- Volume 3, Technical Appendix 11.4: Displacement Analysis;
- Volume 3, Technical Appendix 11.5: Population Viability Analysis;
- Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report;
- Volume 4 (Confidential), Technical Appendix 11.7: Langley L, and Votier S, July 2021. Grassholm Gannet Project – Analysis of tracking data to inform Erebus EIA (Heriot-Watt University);
- Volume 4 (Confidential), Technical Appendix 11.8: Davies K, Padget O, and Guilford T, July 2021. An analysis of Oxnav Manx shearwater tracking data in relation to the Erebus project (University of Oxford); and
- Volume 4 (Confidential), Technical Appendix 11.9: Birkhead T, September 2021. Skomer Common Guillemot long-term population study: analysis of survival data to inform Erebus EIA (University of Sheffield).

Table 11.44 – Summary of Effects

Description of Effect		Significance of Potential Effect (assuming standard mitigation implemented)		Additional Mitigation Measure	Significance of Residual Effect	
		Significance	Beneficial/Adverse		Significance	Beneficial/ Adverse
Construction						
Indirect impacts as a result of displacement of prey due to construction activities		Negligible	-	NA	Negligible	-
Disturbance and displacement from increased vessel activity (array and ECC)	Northern fulmar	Negligible	-	NA	Negligible	-
	Shearwaters and storm-petrels	Negligible	-	NA	Negligible	-
	Northern gannets	Negligible	-	NA	Negligible	-
	Gulls	Negligible	-	NA	Negligible	-
	Auks	Minor	Adverse	NA	Minor	Adverse
Disturbance and displacement from underwater noise via construction activities (including piling and UXO)		Negligible	-	NA	Negligible	-
Operation						
Collision risk	Northern fulmar	Negligible	-	NA	Negligible	-
	Manx shearwater	Minor	Adverse	NA	Minor	Adverse
	Balearic shearwater	Minor	Adverse	NA	Minor	Adverse

Description of Effect		Significance of Potential Effect (assuming standard mitigation implemented)		Additional Mitigation Measure	Significance of Residual Effect	
		Significance	Beneficial/Adverse		Significance	Beneficial/ Adverse
	European storm-petrel	Negligible	-	NA	Negligible	-
	Northern gannet	Minor	Adverse	NA	Minor	Adverse
	Herring gull	Minor	Adverse	NA	Minor	Adverse
	Great black-backed gull	Minor	Adverse	NA	Minor	Adverse
	Lesser black-backed gull	Minor	Adverse	NA	Minor	Adverse
	Black-legged kittiwake	Minor	Adverse	NA	Minor	Adverse
	Common guillemot	Minor	Adverse	NA	Minor	Adverse
Displacement	Manx shearwater	Minor	Adverse	NA	Minor	Adverse
	Balearic shearwater	Minor	Adverse	NA	Minor	Adverse
	Northern gannet	Minor	Adverse	NA	Minor	Adverse
	Black-legged kittiwake	Negligible	-	NA	Negligible	-
	Atlantic puffin	Minor	Adverse	NA	Minor	Adverse

Description of Effect		**Significance of Potential Effect (assuming standard mitigation implemented)**		**Additional Mitigation Measure**	**Significance of Residual Effect**	
		Significance	**Beneficial/Adverse**		**Significance**	**Beneficial/ Adverse**
	Common guillemot	Minor	Adverse	NA	Minor	Adverse
	Razorbill	Minor	Adverse	NA	Minor	Adverse
Disturbance and displacement from vessel activity (O&M and cable repairs)	Northern fulmar	Negligible	-	NA	Negligible	-
	Shearwaters and storm-petrels	Negligible	-	NA	Negligible	-
	Northern gannets	Negligible	-	NA	Negligible	-
	Gulls	Negligible	-	NA	Negligible	NA
	Auks	Minor	Adverse	NA	Minor	Adverse
Disturbance to foraging birds from underwater noise and vibration via operational activities		Negligible	-	NA	Negligible	-
Barrier effect of wind turbine generators to regular movements of birds to and from breeding colonies or on migration		Minor	Adverse	NA	Minor	Adverse
Indirect impacts through effects on habitats and prey species		Negligible	-	NA	Negligible	-

Description of Effect		Significance of Potential Effect (assuming standard mitigation implemented)		Additional Mitigation Measure	Significance of Residual Effect	
		Significance	Beneficial/Adverse		Significance	Beneficial/ Adverse
Aggregating effects of turbine structures		Minor	Adverse	NA	Minor	Adverse
Entanglement risk from ghost fishing gear		Minor	Adverse	NA	Minor	Adverse
Attraction of nocturnal seabirds (shearwaters and petrels) to lighting on project infrastructure		Minor	Adverse	NA	Minor	Adverse
Decommissioning						
Indirect impacts as a result of displacement of prey due to construction activities		Negligible	-	NA	Negligible	-
Disturbance and displacement from increased vessel activity (array and ECC)	Northern fulmar	Negligible	-	NA	Negligible	-
	Shearwaters and storm-petrels	Negligible	-	NA	Negligible	-
	Northern gannets	Negligible	-	NA	Negligible	-
	Gulls	Negligible	-	NA	Negligible	-
	Auks	Minor	Adverse	NA	Minor	Adverse
Disturbance and displacement from underwater noise via construction activities (including piling and UXO)		Negligible	-	NA	Negligible	-

Table 11.45 – Summary of Cumulative Effects

Receptor	Effect	Cumulative Developments	Significance of Cumulative Effect	
			Significance	Beneficial/ Adverse
Construction				
All seabird species	Vessel-related disturbance, temporary habitat loss, underwater noise	**Qualitative assessment only:** Arklow Bank OWF; Burbo Bank and Extension OWFs; Gwynt y Môr OWF; North Hoyle OWF; Ormonde OWF; Rhyl Flats OWF; Robin Rigg OWF; Walney (Phase 1 and 2) and Extension OWFs; West of Duddon Sands OWF	Negligible	-
Operation and Maintenance				
Manx shearwater	Collision risk	Screened out of cumulative assessment as no cumulative impact pathway identified.	NA	NA
	Displacement effects	Burbo Bank Extension OWF; Walney Extension OWF, Valorous OWF	Minor	Adverse
Northern gannet	Collision risk	Burbo Bank Extension OWF; Ormonde OWF; Walney Extension OWF	Minor	Adverse
	Displacement effects	**Qualitative assessment only:** Arklow Bank OWF; Burbo Bank and Extension OWFs; Gwynt y Môr OWF; North Hoyle OWF; Ormonde OWF; Rhyl Flats OWF; Robin Rigg OWF; Walney (Phase 1 and 2) and Extension OWFs; West of Duddon Sands OWF, Valorous OWF	Minor	Adverse
Herring gull	Collision risk	Burbo Bank Extension OWF; Ormonde OWF; Walney Extension OWF	Minor	Adverse

Receptor	Effect	Cumulative Developments	Significance of Cumulative Effect	
			Significance	Beneficial/ Adverse
Great black-backed gull	Collision risk	Ormonde OWF; Walney Extension OWF	Minor	Adverse
Lesser black-backed gull	Collision risk	Burbo Bank Extension OWF; Ormonde OWF; Walney OWF (Phases 1 and 2); Walney Extension OWF; West of Duddon Sands OWF	Minor	Adverse
Black-legged kittiwake	Collision risk	Burbo Bank Extension OWF; Ormonde OWF; Walney Extension OWF	Minor	Adverse
	Displacement effects	**Qualitative assessment only:** Arklow Bank OWF; Burbo Bank and Extension OWFs; Gwynt y Môr OWF; North Hoyle OWF; Ormonde OWF; Rhyl Flats OWF; Robin Rigg OWF; Walney (Phase 1 and 2) and Extension OWFs; West of Duddon Sands OWF, Valorous OWF	Negligible	-
Atlantic puffin	Displacement effects	**Qualitative assessment only:** Arklow Bank OWF; Burbo Bank and Extension OWFs; Gwynt y Môr OWF; North Hoyle OWF; Ormonde OWF; Rhyl Flats OWF; Robin Rigg OWF; Walney (Phase 1 and 2) and Extension OWFs; West of Duddon Sands OWF, Valorous OWF	Minor	Adverse
Common guillemot	Collision risk	Ormonde OWF	Minor	Adverse
	Displacement effects	Burbo Bank Extension OWF; Walney Extension OWF, Valorous OWF	Minor	Adverse
Razorbill	Displacement effects	Walney Extension OWF, Valorous OWF	Minor	Adverse

Receptor	Effect	Cumulative Developments	Significance of Cumulative Effect	
			Significance	Beneficial/ Adverse
All seabird species	Barrier effects	Valorous OWF	Negligible	-
Decommissioning				
All seabird species	Vessel-related disturbance, temporary habitat loss.	**No temporal overlap with decommissioning of the Project.** Arklow Bank OWF; Burbo Bank and Extension OWFs; Gwynt y Môr OWF; North Hoyle OWF; Ormonde OWF; Rhyl Flats OWF; Robin Rigg OWF; Walney (Phase 1 and 2) and Extension OWFs; West of Duddon Sands OWF	Negligible	-

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