Morecambe Offshore Windfarm: Generation Assets

Environmental Statement

Volume 5

Chapter 12 Offshore Ornithology

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Contents

Tables

Figures

Glossary of Acronyms

ASSI	Areas of Special Scientific Interest
AON	Apparently occupied nests
AOS	Apparently occupied sites
BDMPS	Biologically defined minimum population scales
BEIS	Department for Business, Energy and Industrial Strategy[1]
BoCC	Birds of Conservation Concern
BTO	British Trust for Ornithology
CCW	Countryside Council for Wales
CEA	Cumulative Effects Assessment
CIEEM	Chartered Institute of Ecology and Environmental Management
CRM	Collision Risk Model
DCO	Development Consent Order
DECC	Department for Energy and Climate Change[1]
DESNZ	Department for Energy Security and Net Zero
DEFRA	Department for Environment, Food & Rural Affairs
DEP	Dudgeon Offshore Wind Farm Extension Project
EATL	East Anglia THREE Limited
EC	European Commission
EEA	European Economic Area
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
EPP	Evidence Plan Process
ES	Environmental Statement
ETG	Expert Topic Groups
EWG	Expert Working Group
GGOWL	Greater Gabbard Offshore Windfarm Limited
GIS	Geographic Information Systems
GPS	Global Positioning System
HAT	Highest Astronomical Tide
HPAI	Highly Pathogenic Avian Influenza

[1] The Department of Energy and Climate Change (DECC) was merged with the Department for Business, Energy and Industrial Strategy (BEIS) in 2016. As of February 2023, BEIS is known as the Department for Energy Security and Net Zero (DESNZ).

HRA	Habitat Regulations Assessment
IPCC	Intergovernmental Panel on Climate Change
JNCC	Joint Nature Conservation Committee
LSE	Likely Significant Effect
MMO	Marine Management Organisation
MNR	Marine Nature Reserve
MSL	Mean Sea Level
MSS	Marine Scotland Science
NAF	Nocturnal activity factor
NNR	National Nature Reserve
NPS	National Policy Statement
NRW	Natural Resources Wales
NSIP	Nationally Significant Infrastructure Project
NW	North West
ORJIP	Offshore Renewables Joint Industry Programme
OSP	Offshore substation platform(s)
OWEZ	Egmond aan Zee Windfarm
OWF	Offshore Windfarm
PAWP	Prinses Amaliawindpark
PCH	Potential Collision Height
PDE	Project Design Envelope
PEIR	Preliminary Environmental Information Report
PEMP	Project Environmental Management Plan
PINS	Planning Inspectorate
pSPA	Proposed Special Protection Area
PVA	Population Viability Analysis
RIAA	Report to Inform Appropriate Assessment
RSPB	Royal Society for the Protection of Birds
sCRM	Stochastic Collision Risk Model
SEP	Sheringham Shoal Offshore Wind Farm Extension Project
SMP	Seabird Monitoring Programme
SNCB	Statutory Nature Conservation Bodies
SOSSMAT	Strategic Ornithological Support Services Migrant Assessment Tool
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
UK	United Kingdom

WTG	Wind turbine generator
ZoI	Zone of Influence

Glossary of Unit Terms

km	kilometre
m	metre
MW	Megawatts
rpm	Rotations per minute

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Glossary of Terminology

Applicant	Morecambe Offshore Windfarm Ltd
Application	This refers to the Applicant's application for a Development Consent Order (DCO). An application consists of a series of documents and plans which are published on the Planning Inspectorate's (PINS) website.
Biologically defined minimum population scale (BDMPS)	The estimated population size of a species within a defined biogeographic area during a biologically relevant season, as defined by Furness (2015). For many seabird species present in UK waters there are two defined biogeographic areas; UK Western waters and UK North Sea and Channel. However, some species have different defined BDMPS areas, dependent on the distribution and movements of the species population through the year. Furness (2015) defines the BDMPS for non-breeding seasons; the breeding season BDMPS is defined as the breeding population within foraging range from the project, plus non-breeders and immatures.
Biologically relevant seasons	Defined time periods during the year where a species population will predominantly be present in a certain biogeographic area and/or exhibits particular behaviours in relation to the species' life-cycle. Biologically relevant seasons, as defined by Furness (2015), include breeding, non-breeding, spring migration, autumn migration and winter. In many cases seasons will overlap, and not all seasons are relevant to all species.
Evidence Plan Process (EPP)	A voluntary consultation process with specialist stakeholders to agree the approach, and information to support, the Environmental Impact Assessment (EIA) and Habitats Regulations Assessment (HRA) for certain topics. The EPP provides a mechanism to agree the information required to be submitted to PINS as part of the DCO Application. This function of the EPP helps Applicants to provide sufficient information in their application, so that the Examining Authority can recommend to the Secretary of State whether or not to accept the application for examination and whether an appropriate assessment is required.
Expert Topic Group (ETG)	A forum for targeted engagement with regulators and interested stakeholders through the EPP.
Generation Assets (the Project)	Generation assets associated with the Morecambe Offshore Windfarm. This is infrastructure in connection with electricity production, namely the fixed foundation wind turbine generators (WTGs), inter-array cables, offshore substation platform(s) (OSP(s)) and possible platform link cables to connect OSP(s).
Inter-array cables	Cables which link the WTGs to each other and the OSP(s).
Landfall	Where the offshore export cables would come ashore.
Likely Significant Effect (LSE)	Meaning that there may be (as opposed to is likely to be) a significant effect of a proposal on the integrity of the site and its conservation objectives.
Migration free breeding season	The breeding season for migratory seabird species is defined as a wider breeding season and a narrower window known as the migration free breeding season. In a given species, the timing of breeding will

	vary depending on the location of the breeding area; with the start of breeding usually later in more northerly locations. Thus, while birds at some colonies are beginning to nest, others may still be migrating to breeding sites. A core or migration free breeding season is defined as the period when all or the majority of breeding adults of a given species are present at breeding colonies.
Morgan and Morecambe Offshore Wind Farms: Transmission Assets	The transmission assets for the Morgan Offshore Wind Project and the Morecambe Offshore Windfarm. This includes the OSP(s)[2], interconnector cables, Morgan offshore booster station, offshore export cables, landfall site, onshore export cables, onshore substations, 400kV cables and associated grid connection infrastructure such as circuit breaker infrastructure. Also referred to in this document as the Transmission Assets, for ease of reading.
Offshore export cables	The cables which would bring electricity from the OSP(s) to the landfall.
Offshore substation platform(s) (OSP(s))	A fixed structure located within the windfarm site, containing electrical equipment to aggregate the power from the WTGs and convert it into a more suitable form for export to shore.
Platform link cable	An electrical cable which links one or more OSP(s).
Procellariifomes	An order of seabirds that includes albatrosses, petrels, storm petrels and shearwaters.
Scour protection	Protective materials to avoid sediment being eroded away from the base of the foundations due to the flow of water.
Stochastic Collision Risk Model (sCRM)	A programme used to assess the collision risk (estimated mortality) of seabirds to operational turbines of offshore windfarms. A stochastic CRM is used to account for uncertainty around input variables.
Study area	This is an area which is defined for each EIA topic which includes the offshore development area as well as potential spatial and temporal considerations of the impacts on relevant receptors. The study area for each EIA topic is intended to cover the area within which an effect can be reasonably expected. For the purpose of the offshore ornithology assessment, this area includes the windfarm site and the Zone of Influence (ZoI) (see below), as well as wider areas within the Eastern Irish Sea from which Ornithology data can be reported.
Technical stakeholders	Technical consultees are considered to be organisations with detailed knowledge or experience of the area within which the Project is located and/or receptors which are considered in the EIA and Habitats Regulations Assessment (HRA). Examples of technical stakeholders

[2] At the time of writing the Environmental Statement (ES), a decision had been taken that the offshore substation platforms (OSP(s)) would remain solely within the Generation Assets application and would not be included within the Development Consent Order (DCO) application for the Transmission Assets. This decision post-dated the Preliminary Environmental Information Report (PEIR) that was prepared for the Transmission Assets. The OSP(s) are still included in the description of the Transmission Assets for the purposes of this ES as the Cumulative Effects Assessment (CEA) carried out in respect of the Generation/Transmission Assets is based on the information available from the Transmission Assets PEIR.

	include Marine Management Organisation (MMO), local authorities, Natural England and Royal Society for the Protection of Birds (RSPB).
Wind Turbine Generators (WTG)	A fixed structure located within the windfarm site that converts the kinetic energy of wind into electrical energy.
Windfarm site	The area within which the WTGs, inter-array cables, OSP(s) and platform link cables will be present.
Zone of Influence (ZoI)	The maximum anticipated spatial extent of a given potential impact.

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12 Offshore Ornithology

12.1 Introduction

12.1 This chapter of the Environmental Statement (ES) describes the potential effects of the proposed Morecambe Offshore Windfarm Generation Assets (the Project) on offshore ornithology. This chapter provides an overview of the existing environment followed by an assessment of the potential effects and associated mitigation, where identified, for the construction, operation and maintenance, and decommissioning phases.

12.2 The Environmental Impact Assessment (EIA) of the transmission assets, including offshore export cables to landfall and onshore infrastructure, is part of a separate Development Consent Order (DCO) application as outlined in **Chapter 1 Introduction** (Document Reference 5.1.1).

12.3 This assessment has been undertaken with specific reference to the relevant legislation and guidance, of which the primary sources were the National Policy Statements (NPS). Details of these and the methodology used for the EIA and Cumulative Effects Assessment (CEA) are presented in **Chapter 6 EIA Methodology** (Document Reference 5.1.6) and **Section 12.7** of this chapter.

12.4 This chapter should be read in conjunction with the following linked ES chapters and supporting documentation:

- **Chapter 9 Benthic Ecology** (Document Reference 5.1.9) (assessments inform this chapter)
- **Chapter 10 Fish and Shellfish Ecology** (Document Reference 5.1.10) (assessments inform this chapter)

12.5 These topics were relevant to the ornithology assessment, as they address effects on habitats and prey species that may be utilised by birds in the vicinity of the windfarm site. Inter-relationships with these chapters have been further described in **Section 12.9**.

12.6 Additional key information to support the ornithology assessment included:

- **Appendix 12.1 Offshore Ornithology Technical Report** (Document Reference 5.2.12.1) – this document includes information on the ornithological baseline considered in the assessment, and the outputs of abundance and density estimates, breeding season apportioning, collision risk modelling and displacement analysis.
- **Appendix 12.2 Aerial Survey Two Year Report March 2021 to February 2023** (Document Reference 5.2.12.2) (March 2021 to February 2023) and accompanying Annexes (I-VII) – this document provides the results of the two years of aerial bird surveys undertaken to inform the assessment.

12.7 Additionally, to inform assessment under the Conservation of Habitats and Species Regulations 2017 (as amended) and The Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended) (together 'the Habitats Regulations'), a Report to Inform Appropriate Assessment (RIAA) (Document Reference 4.9) has been provided alongside the ES, with further information provided in:

- RIAA – this document provides information for the 'competent authority' under the Habitats Regulations on the potential for adverse effect on the integrity of internationally designated sites (including relevant qualifying ornithological features) as a result of the Project.

12.2 Consultation

12.8 Consultation regarding offshore ornithology has been undertaken in line with the general process described in **Chapter 6 EIA Methodology**. The key consultation elements to date have included scoping (Scoping Opinion from the Planning Inspectorate (PINS), received on 2nd August 2022), comments received on the Preliminary Environmental Information Report (PEIR) which was published in April 2023 for statutory consultation and the Evidence Plan Process (EPP) via the Offshore Ornithology Expert Topic Group (ETG) meetings.

12.9 ETG meetings were held on 25th May 2022, 7th September 2022, 16th November 2022, 7th June 2023, 12th October 2023 and 25th January 2024, with attendees at some or all meetings including the following organisations:

- Natural England
- Royal Society for the Protection of Birds (RSPB)
- Marine Management Organisation (MMO)
- Isle of Man Government
- Merseyside Environmental Advisory Service

12.10 As part of the EPP, an Offshore Ornithology Method Statement was submitted to the Offshore Ornithology ETG in May 2022. This consultation was used to inform the data requirements and the methodology for the assessment of potential Project effects set out in the EIA Scoping Report submitted to PINS in June 2022 (Morecambe Offshore Windfarm Ltd, 2022).

12.11 The feedback received throughout this consultation process, including the Scoping Opinion published by PINS in August 2022 (PINS, 2022) and stakeholder responses to the PEIR, have been considered in preparing the ES. The key comments pertinent to this chapter are shown in **Table 12.1,** alongside details of how the Project team has considered the comments received and how they have been addressed within this chapter. The table has been edited to minimise repetition. In addition, stakeholder comments relevant to the RIAA have been included within this ES chapter given the crossover between the two assessments and to avoid the complexity in attempting to separate comments specific to each assessment.

12.12 The consultation process is described further in **Chapter 6 EIA Methodology**. Full details of the consultation undertaken throughout the EIA process has been presented in the Consultation Report (Document Reference 4.1) submitted as part of the DCO Application.

Table 12.1 Consultation responses received in relation to offshore ornithology and how these have been addressed in the ES

Consultee	Date	Comment	Response/where addressed in the ES
Scoping Opinion responses			
PINS (ref 3.6.1)	2nd August 2022	Displacement/disturbance/barrier effects due to presence of turbines and other infrastructure during construction and decommissioning - While these effects will principally occur during operation, the Scoping Report does not explain why they would not also occur during other phases of the development as when structures and cables are being installed or removed. In the absence of information such as evidence demonstrating clear agreement with relevant statutory bodies, the Inspectorate is not in a position to agree to scope these matters from the assessment. Accordingly, the ES should include an assessment of this matter or the information referred to demonstrating agreement with the relevant consultation bodies and the absence of LSE [likely significant effect].	This effect has been addressed in **Sections 12.6.2.1** and **12.6.4.1**.
PINS (ref 3.6.2)	2nd August 2022	Collision risk from operational wind turbines during construction and decommissioning - It is noted that this effect would only arise during the operational phase. The Inspectorate is content that this matter can be scoped out of the construction and decommissioning stage assessments.	Noted
PINS (ref 3.6.3)	2nd August 2022	Potential transboundary impacts during construction and decommissioning - As information on the species which could be affected and the likely construction/decommissioning activities is limited, the Inspectorate is not in a position to agree to scope these matters from the assessment. Accordingly, the ES should include an assessment of these matters or a justification as to why LSE would not arise.	Transboundary effects have been considered in **Section 12.8**.

Consultee	Date	Comment	Response/where addressed in the ES
PINS (ref 3.6.4)	2nd August 2022	Study area/identification of receptors - It is not clear from the Scoping Report how the study area for ornithology will be defined. Paragraph 465 refers to regional populations of seabirds and migratory birds and the possibility of connectivity with designated sites but does not explain how the regional populations or connectivity would be established. Paragraph 479 and Figure 8.6 describe the area covered by the aerial surveys which is stated to be based on the advice from the appropriate nature conservation bodies. The Scoping Report lists the species which have so far been recorded in the aerial surveys but does not explain if all these species would be considered in the assessment. The ES must clearly explain and justify how the receptors for the assessment have been identified, supported by evidence of agreement with relevant stakeholders wherever possible. It must also explain how regional populations and connectivity have been established.	Considered throughout the assessment. The study area has been set out in **Section 12.3.1**, with additional supporting information on the receptors in **Section 12.5**.
PINS (ref 3.6.5)	2nd August 2022	Approach to data collection - It is noted that the survey coverage (both temporal and spatial) has been based on advice from the Statutory Nature Conservation Bodies (SNCBs), particularly Natural England. The ES should provide the full rationale for the survey coverage, supported by evidence demonstrating agreement with relevant stakeholders. Where agreement cannot be reached then the ES should include a justification for the approach used.	Natural England were consulted on the survey methodology and sample plan. The survey area has also been discussed with Natural England at a meeting on 3rd November 2021, and subsequent ETG meetings, and has been set out in **Section 12.3.1**. It should be noted that the PEIR included the results of Year 1 surveys only; the full two years of survey data have been included within the ES.

Consultee	Date	Comment	Response/where addressed in the ES
PINS (ref 3.6.6)	2nd August 2022	Results from aerial survey data - Table 8.21 records substantial numbers of birds which have not been identified. While the Inspectorate recognises that it is not always possible to identify every bird to species level, surveys for offshore windfarms are normally able to at least put birds into categories such as 'large gulls'. The Applicant is encouraged to take a similar approach if at all possible. Where such large numbers of birds remain unidentified it may call into question the credibility of any assessments using the baseline data. The Applicant's attention is also drawn to the comments from Natural England in Appendix 2 of this Opinion.	All unidentified birds have been apportioned to species for the ES; refer to **Section 12.5.3.3** and Annex 1 of **Appendix 12.1**. The number of unidentified birds in each species group have been assigned to the appropriate species, based on the respective abundance ratio for that species group.
PINS (ref 3.6.7)	2nd August 2022	Baseline data - The Scoping Report refers to various surveys and studies relevant to seabird populations. It is noted that the list of datasets in paragraph 482 is not exhaustive. The ES should identify the datasets used to inform the baseline data and explain their age and geographical coverage in relation to the zone of influence (ZoI) of the Proposed Development.	Data sources have been discussed with stakeholders through the ETG, and set out within the ES, e.g., in **Section 12.4.2**, and throughout the assessment.
PINS (ref 3.6.8)	2nd August 2022	Population viability analysis (PVA) - The Scoping Report lists the various quantitative assessment methods which will be used in the ES assessments, including PVA. However, the Scoping Report does not explain which species would be subject to PVA. The Applicant should seek to agree this point with relevant stakeholders through the EPP.	The approach to PVA has been agreed with stakeholders during the ETG process. PVA has been undertaken for great black-backed gull cumulative collision risk; refer to **Section 12.7**. PVAs for Special Protection Area (SPA) populations have been described in the RIAA.
PINS (ref 3.6.9)	2nd August 2022	Methodology and scope of assessment - The Scoping Report states that the detailed methodology and scope of the assessment will be agreed with key stakeholders through the EPP. While this approach is welcomed, the Inspectorate notes that it has not always been possible for offshore wind farms to reach agreement with stakeholders	Noted. The approach to assessment has taken into account feedback from consultees through the ETG, particularly through Natural England's advice on the approach to collision risk modelling and displacement analysis (see below). Natural England has

Consultee	Date	Comment	Response/where addressed in the ES
		on the appropriate methods for analysis of effects on offshore ornithology. Where it is not possible to reach agreement with the relevant stakeholders, the ES should provide assessments based both on the Applicant's preferred approach and that recommended by statutory consultees.	provided advice on the approach to considering historic projects for the cumulative assessment, where no quantitative assessment is available. The Applicant has discussed this approach with the Mona and Morgan projects and an approach agreed between the three projects was set out in a separate note that has been submitted to Natural England and Natural Resource Wales (NRW) (via the Morecambe/Mona/Morgan projects). In this case it was not feasible to also present Natural England's preferred approach in full, but it is considered that sufficient information has been presented in **Section 12.7** to enable a robust cumulative assessment to be undertaken.
PINS (ref 3.6.10)	2nd August 2022	Bird displacement risk during construction and operation - The Scoping Report states that birds are considered to be most at risk from disturbance when they are resident in an area as opposed to being on passage. The ES should explain the evidence which supports this statement and whether it applies throughout the year.	Birds that are residing in an area during the breeding season, non-breeding period, or year-round are at higher risk than passage birds due to the much greater amount of time spent in that area. The construction displacement assessment has been presented in **Section 12.6.2.1**, and the operation displacement assessment has been presented in **Section 12.6.3.1.**
PINS (ref 3.6.11)	2nd August 2022	Barrier effects: The Scoping Report provides some information on the methodology for assessing displacement and collision related mortality but there is no explanation as to how barrier effects would be dealt with. The ES should explain the methodology to be used and evidence demonstrating agreement of relevant	For the purposes of displacement assessments, it is usually not possible to distinguish between displacement and barrier effects. Therefore, in this assessment the effects of displacement and barrier effects on the key species have been

Consultee	Date	Comment	Response/where addressed in the ES
		stakeholders. Where agreement is not possible then the ES should provide a justification for the approach used.	considered together in **Section 12.6.2.1** and **Section 12.6.3.1**.
Natural England	2nd August 2022	Tracking studies should also be used where available to evidence connectivity, or lack thereof, they should also be used to aid screening where possible.	Noted - relevant tracking studies (e.g. for lesser black-backed gull) have been used to inform the ES and RIAA, where available (noting that tracking studies were not available for all species).
Natural England	2nd August 2022	Natural England has provided some advice directly to the applicant, stating that within the upcoming SNCB guidance there will be a clear recommendation to use the stochastic collision risk model (sCRM). Natural England advise that CRM is not undertaken according to the existing guidance as this will in all likelihood be superseded at the point of submission.	Noted - sCRM has been used for the collision risk assessment – refer to **Section 12.6.3.2** and **Appendix 12.1.**
Natural England	2nd August 2022	The SNCB guidance note and supporting evidence are still being prepared and finalised, however Natural England have provided the applicant with avoidance rates and updated parameters to inform the approach to sCRM. Further discussions on the appropriate methodology including parameterisation of models can be discussed at the Offshore Ornithology ETG through the Evidence Plan process.	Noted – avoidance rates and parameters provided by Natural England have been used in the assessment.
ETG meetings			
Natural England	25th May 2022	Flight height data for Collision Risk Model (CRM) – Natural England have misgivings about use of data from aerial surveys.	These have not been used for the CRM, which uses 'Option 2' of the CRM model and generic data from Johnston *et al.* (2014a and b).
Natural England	25th May 2022	For cumulative assessment, Natural England wishes to use consented (as opposed to as-built) layouts [of existing operational windfarms], together with relevant post-construction monitoring.	It is confirmed that consented values have been used for the cumulative assessment.

Consultee	Date	Comment	Response/where addressed in the ES
Natural England	25th May 2022	Natural England will provide graduated displacement rates for red-throated diver to 10km from the offshore windfarm, to be used for the displacement analysis.	These have been received from Natural England. The approach to the red-throated diver assessment for Habitat Regulations Assessment (HRA) has been set out in the RIAA. It was noted that there was insufficient data (i.e. too few birds were present within the survey area) to undertake model-based density estimates (e.g. using MRSea) for this assessment.
Royal Society for the Protection of Birds (RSPB)	7th September 2022	RSPB does not support use of 70% macro-avoidance for gannet for the CRM, as recommended by Natural England.	Values including and excluding the 70% macro-avoidance have been provided in the collision risk assessment in **Sections 12.6.3.2** and **12.7.3.2**.
RSPB	7th September 2022	RSPB noted that a review of light effects on Manx shearwater are due to be published by Marine Science Scotland (MSS) in the near future.	The Marine Science Scotland (MSS) review has now been published, the results of which have been considered in the ES; refer to **Section 12.6.3.1** (**Paragraphs 12.247 - 12.250**).
RSPB and Natural England	7th September 2022	For the apportioning of birds to colonies, Natural England/RSPB recommend use of site-specific information (e.g. from tracking studies) where possible.	Noted. This information has been reviewed and incorporated into the RIAA where available/appropriate.
RSPB	7th September 2022	RSPB noted the potential effects of avian flu on the assessment.	The recently issued preliminary guidance on Highly Pathogenic Avian Influenza (HPAI) has been noted (Natural England, 2022b). A review of the potential impacts from HPAI has been provided in **Section 12.6.6**.
Isle of Man (Isle of	16th November 2022	Isle of Man Government asked how CRM was undertaken on a preliminary basis with just one year of survey data.	This was explained during the ETG – it was possible to undertake preliminary CRM for PEIR as the model can be run with 12

Consultee	Date	Comment	Response/where addressed in the ES
Man) Government			months' data. It is noted that this comment is no longer relevant as the CRM has been updated with the full two years of data to inform the ES.
Isle of Man Government	16th November 2022	Isle of Man Government queried why in slide 11 there was a n/a for common gull (collision risk autumn migration).	Common gull year has been divided into breeding and non-breeding periods. There was no separate autumn migration season for this species and therefore no collision risk estimate for this period.
Natural England	16th November 2022	Natural England clarified that for red-throated diver, potential increase in background mortality is not the impact Natural England is concerned with. The effective loss of habitat within Special Protection Areas (SPAs) due to displacement is the issue (i.e. habitat loss rather than mortality).	Noted. The Project would be outside and adjacent to the Liverpool Bay SPA, and the area of SPA closest to the Project was designated for little gull – so not the core areas for red-throated diver. The RIAA has included an assessment of both mortality and effective area of displacement.
Isle of Man Government	16th November 2022	Isle of Man Government queried whether it may be too early to scope out particular species for effects and asked how uncertainties (such as HPAI) will be dealt with in the assessment.	It was considered likely that the overall findings of the PEIR would not change with the addition of a second year of data, which is confirmed by the results presented within the ES using the full two years of survey data. **Section 12.4.6** summarises the uncertainties and limitations in the data/ assessment. A review of the potential impacts from HPAI has been provided in **Section 12.6.6**
Isle of Man Government	16th November 2022	Isle of Man Government asked about the assessment for non-seabird migrant species such as whooper swan and hen harrier.	The results of the migrant collision risk assessment were not available at the time of the ETG meeting, but have been presented in **Section 12.6.3.2**.

Consultee	Date	Comment	Response/where addressed in the ES
Natural England	7th September 2023	Potential vessel routes should be based on realistic worst-case criteria.	The final selection of the port facilities required to construct and operate the Project have not yet been determined, however it was assumed the construction port would be in the UK and the operational port would be within 50km of the windfarm site. It was assumed that, in a worst-case scenario, vessel movements would cross Liverpool Bay SPA. Embedded mitigation includes restricting vessel movements where possible to existing navigation routes, and best practice vessel management; refer to **Section 12.3.3.**
RSPB	7th September 2023	Tracking data of lesser black-backed gulls from Bowland Fells SPA represent only a small sub-sample and research has shown significant variation in foraging behaviour between individual lesser black-backed gulls. There are also potential changes that could occur during the project lifespan.	Impacts on lesser black-backed gulls associated with Bowland Fells SPA have been considered in the RIAA.
RSPB	7th September 2023	Request made for information on dead birds recorded during baseline surveys to be submitted to the RSPB and Natural England.	Information on dead birds recorded is presented in **Appendix 12.2**.
Isle of Man Government	7th September 2023	In relation to the Isle of Man designated sites, for other projects a separate report has been produced.	Isle of Man designated sites have been considered under transboundary impacts (**Section 12.8.1**) except for Ballaugh Curragh Ramsar site, which has been considered in the RIAA.
Isle of Man Government	7th September 2023	The proposed Isle of Man wind farm is noted and publication of project details may be forthcoming.	The Mooir Vannin Scoping Report has been published (Ørsted, 2023), but does not include ornithological assessment information that could be included in the cumulative assessment.

Consultee	Date	Comment	Response/where addressed in the ES
Natural England	12th October 2023	Natural England confirmed delay in work to address gaps in data for historical projects for the CEA. Natural England circulated a proposed draft approach to address this (agreed between Natural England and NRW) shortly before the meeting. Natural England suggested gap filling could be shared between Morecambe, Mona and Morgan offshore wind projects to reduce burden and risk of discrepancies.	The approach has been discussed with the developers of the Mona and Morgan projects and has been set out in **Section 12.7**.
Natural England	12th October 2023	Natural England agreed with the Applicant's approach to apportion SPA populations using the NatureScot tool. The preferred method is to use the Offshore Renewables Joint Industry Programme (ORJIP) AppSaS tool, but it was acknowledged that this was very unlikely to be available in time for submission.	Apportioning using the NatureScot tool has been undertaken in the RIAA.
Natural England	12th October 2023	Natural England welcomed the consideration of Manx shearwater under construction disturbance and displacement, and recommended use of 50% of operational effects for the construction phase.	Construction impacts on Manx shearwater have been assessed using the advised approach; refer to **Section 12.6.2.1**.
Isle of Man Government	12th October 2023	Isle of Man Government asked if Manx Birdlife has been contacted. The Applicant noted that most Manx seabird colony data is available on the Seabird Monitoring Programme (SMP) database (Joint Nature Conservation Committee (JNCC), 2023).	The Manx Birdlife report publication "The Isle of Man Seabird Census: Report on the census of breeding seabirds in the Isle of Man 2017-18" has been considered in the ES; refer to **Section 12.8.1.**
Isle of Man Government	12th October 2023	Isle of Man offshore windfarm (OWF) has not been included in the list of projects to be considered for the cumulative/in-combination assessment. The scoping report will be issued shortly. Mortality values will not be included in this, although if data exists it would be in Isle of Man's best interests to share this with other projects. Ørsted has carried out preliminary studies that may yield useful data.	The Mooir Vannin Scoping Report has been published (Ørsted, 2023), but does not include ornithological assessment information that could be included in the cumulative assessment It was not possible to quantify impacts of the Mooir Vannin Offshore Windfarm (OWF) without collision and displacement mortality values.

Consultee	Date	Comment	Response/where addressed in the ES
Statutory consultation feedback on the PEIR			
Natural England (ref E1)	2nd June 2023	The minimum rotor clearance above sea level at PEIR is 22m. Natural England highlight that increasing the minimum rotor clearance would reduce collision risk estimates generated by the project and request that the Applicant explore the feasibility of achieving greater clearance.	It was noted that the Natural England response referred to rotor clearance above LAT, but the Design Envelope provided in the PEIR assessment was 22m minimum above Highest Astronomical Tide (HAT). This was equivalent to approximately ~32m above LAT. Following stakeholder consultation, the rotor clearance above sea level (air gap) has been increased to 25m above HAT (i.e. ~35m above LAT). This air gap has been used as the basis for collision risk estimates in the ES; refer to **Sections 12.3.2 - 12.3.3**.
Natural England (ref E2)	2nd June 2023	Only 12 months of Digital Aerial Survey data are available to inform PEIR baseline characterisation. Natural England advises that 24 months of survey effort is the minimum expected evidence standard for ornithological impact assessment. Natural England cannot therefore make any conclusive judgements based on this PEIR and accordingly, our advice focuses on the methodologies employed.	The ES includes the full 24 months of digital aerial survey data. Project-alone and cumulative impact assessments have been updated accordingly since PEIR in **Sections 12.6** and **12.7**.
Natural England (ref E3)	2nd June 2023	Natural England note that species identifications are given confidence levels of definite, possible, or probable. All such records are treated as positively identified to generate an 'ID rate'. Natural England do not consider a generic rate, incorporating all species, to be particularly useful or informative. Natural England note that most birds (76%) with no species ID were potentially auks. Further, we note that the calculation of the average rate appears to be incorrect.	Annex VII of **Appendix 12.2** presents the identification confidence levels for each species across the survey period. The average monthly identification rate has been checked and an average of 96.05% was obtained.

Consultee	Date	Comment	Response/where addressed in the ES
Natural England (ref E4)	2nd June 2023	Natural England highlight some inconsequential errors in seasons presented e.g. black-headed gull and common gull are defined as breeding Apr-Jul whereas the reference used (SNH, 2014) states Apr-Aug.	The relevant table in the ES (**Table 12.15**) has been checked and corrected to ensure consistency with references used.
Natural England (ref E5)	2nd June 2023	Natural England notes the forthcoming publication of "Densities of qualifying species within Liverpool Bay / Bae Lerpwl SPA: 2015 to 2020" which will provide up to date density estimates for red-throated diver, common scoter and the waterbird assemblage within the original SPA boundary.	The publication (HiDef, 2023) has been considered in the RIAA.
Natural England (ref E6)	2nd June 2023	Natural England highlight that Manx shearwater is a surface diving species and data are available detailing foraging & diving behaviour. It may also be appropriate to consider availability bias for that species.	There was insufficient peer-reviewed data at the time of the ES assessment for other surface diving species such as Manx shearwater, therefore the availability bias correction has been limited to auk species (refer to **Appendix 12.2**).
Natural England (ref E7)	2nd June 2023	Natural England welcome the commitment to undertake the assessment in accordance with our best practice guidance.	The offshore ornithology impact assessment in the ES has been undertaken in accordance with Natural England's best practice guidance (refer to **Section 12.4.1.2**).
Natural England (ref E9)	2nd June 2023	The use of peak density estimates in assessments is described as "highly precautionary" throughout the PEIR. Natural England disagrees with this characterisation and recommends an alternative approach is taken in the submitted ES, reflecting that this method partially accounts for the high levels of uncertainty in a 'snapshot' DAS [Digital Aerial Survey] being representative.	References to "highly precautionary" in the assessment have been removed from the ES, although where there was uncertainty the need for precaution has been acknowledged.
Natural England (ref E10)	2nd June 2023	Manx shearwater has been screened out of assessment for disturbance and displacement during construction in the PEIR. There is no specific justification for this decision.	Manx shearwater were generally considered to have a low susceptibility to disturbance and displacement, particularly during

Consultee	Date	Comment	Response/where addressed in the ES
		Natural England note that the relative species abundance in the study area is high and there is low confidence in the (low) sensitivity to OWF disturbance and displacement estimate.	windfarm construction, based on previous studies e.g. Bradbury *et al.* (2014). However, on a precautionary basis, Manx shearwater have been included in the assessment of construction displacement in the ES (refer to **Section 12.6.2.1**).
Natural England (ref E11)	2nd June 2023	Natural England welcome the presentation of full displacement matrix tables, with shading of realistic scenarios. It would be useful if any cells that identify an impact leading to a >1% increase in baseline mortality for the relevant population were also highlighted.	Any impacts leading to an increase in baseline mortality of >1% have been highlighted where appropriate in **Sections 12.6** and **12.7**.
Natural England (ref E12)	2nd June 2023	Minor errors in the PEIR - the Manx Shearwater peak abundance figure is the same as the 95% UCI and common scoter mean peak site + 4km buffer population reported as 0.1 individuals.	Density and abundance estimates for the full 24 months of data have been reviewed and presented in the relevant sections of the ES and **Appendix 12.1**.
Natural England (ref E13)	2nd June 2023	Breeding season populations for EIA are calculated by adding the breeding populations within mean-max foraging range + 1SD to the immature birds from the preceding BDMPS population, on the assumption that those birds will remain in the area. Natural England are not convinced that this method is appropriate or suitably evidence based.	Natural England's preferred approach using the largest regional Biologically defined minimum population scale (BDMPS) breeding season population has been adopted for the ES.
Natural England (ref E14)	2nd June 2023	Natural England use guillemot as an example to question if any figures presented for cumulative mortality can be considered highly precautionary when they do not consider impacts from the majority of wind farms scoped into the assessment. No qualitative assessment is apparent. In this case we highlight that a >1% increase in baseline mortality is identified using a worst-case displacement impact scenario. Natural England consider this demonstrates the need to fill the data gaps identified during CEA.	The approach undertaken in the ES was considered appropriate to assess cumulative impacts on seabirds. The cumulative assessment has been updated taking into account historic projects; refer to **Section 12.7**.

Consultee	Date	Comment	Response/where addressed in the ES
Natural England (ref E15)	2nd June 2023	It is incorrect to conclude that the higher mortality value for the red-throated diver cumulative assessment would not materially alter the background mortality of the population. That is only true when assessing against the biogeographic population. Natural England guidance states that mortality should be considered against the largest BDMPS.	Mortality has been considered within the ES against the largest BDMPS and the biogeographic population. The maximum values were considered to be precautionary, and very unlikely to reflect the actual effect; the lower value (i.e. reflecting a displacement rate of 100% and mortality of 1%) was considered more realistic but still precautionary (**Section 12.6.3.1**).
Natural England (ref E16)	2nd June 2023	Construction displacement impacts only consider three 2km radius circles around individual turbines. Mention is made that the disturbance effect will incrementally increase as the array is built but this is not properly considered. Natural England advises that (in line with other projects) construction phase displacement impacts are simply assumed to be equivalent to 50% of operational and maintenance phase impacts to account for the incremental development of the array.	For the ES construction phase displacement impacts have been assumed to be 50% of operational and maintenance phase impacts; refer to **Section 12.6.2.1**.
Natural England (ref E17)	2nd June 2023	Construction and maintenance vessel routes have not been considered.	The final selection of the port facilities required to construct and operate the Project have not yet been determined, however it has been assumed the construction port would be in the UK and the operational port would be within 50km of the windfarm site. It was assumed within the ES that, in a worst-case scenario, vessel movements would cross Liverpool Bay SPA. Embedded mitigation includes restricting vessel movements where possible to existing navigation routes, and best practice vessel management; refer to **Section 12.3.3**.

Consultee	Date	Comment	Response/where addressed in the ES
Natural England (ref E18)	2nd June 2023	A 4km buffer has been used for assessing displacement impacts on red-throated diver. Natural England advise the use of a graduated 10km buffer.	Natural England confirmed during the fifth ETG meeting (12th October 2023) that a 4km buffer for red-throated diver was acceptable for the EIA (but noting that a 10km buffer has been used for the RIAA).
Natural England (ref E19)	2nd June 2023	A value of 1% is given for curlew Potential Collision Height (PCH). Natural England also note that ideally, CRM would be undertaken for the range of PCH values presented in Wright *et al.* (2012), e.g. for waders estimate impacts for 5% and 75% PCH in addition to 25%.	Reference to 1% was a transcription error. Migrant CRM Potential Collision Height (PCH) values have been revisited and amended where appropriate; refer to **Section 12.6.3.2**.
Natural England (ref E20)	2nd June 2023	Natural England note that we do not consider assessing mortality increase at the total biogeographic population scale to be relevant for EIA.	Annual mortalities within the ES have been assessed against both the biogeographic populations and the largest BDMPS to indicate the range of likely effects.
Natural England (ref E21)	2nd June 2023	The cumulative (and in-combination) assessments do not factor in impacts from a number of other projects due to a lack of data. Unknown impacts have been treated as zero which will inevitably underestimate impacts, potentially significantly. A qualitative assessment is mentioned for consideration of some projects, but this process is not detailed, or the results fully presented. Natural England consider this approach to be unacceptable, and hence consider it inappropriate to comment on the potential significance of cumulative (or in-combination) presented in the PEIR submission.	The approach undertaken in the ES was considered appropriate to assess cumulative impacts on seabirds. The cumulative assessment has been updated taking into account historic projects; refer to **Sections 12.4.4** and **12.7**.
Natural England (ref E22)	2nd June 2023	Breeding season apportioning has been undertaken using the NatureScot apportioning tool. Natural England retain some concerns regarding the current limitations of this approach and the apportioning values generated. However, updates to the method are being progressed through the ORJIP AppSaS project that we hope will address these concerns.	The Offshore Renewables Joint Industry Programme (ORJIP) AppSaS tool has not been made available in time for the DCO submission. Apportioning to SPA populations in the RIAA has therefore been undertaken using the NatureScot apportioning tool. This approach was agreed

Consultee	Date	Comment	Response/where addressed in the ES
			with Natural England through the ETG (12th October 2023).
Natural England (ref E23)	2nd June 2023	The use of a 100km buffer to screen sites for migratory non-seabirds is not a standard approach, though we recognise the need to identify a proportionate set of SPAs for a more detailed assessment.	The approach to assessing migratory non-seabird collision risk (presented during the second ETG meeting on 7th September 2022) was considered appropriate to screen sites for migratory non-seabirds; refer to **Section 12.6.3.2**. The approach was agreed with Natural England at a meeting on 25th September 2023.
Natural England (ref E24)	2nd June 2023	Natural England note that for seabirds in the non-breeding season potential connectivity has been assumed for SPA populations that contribute >1% of the BDMPS population. Whilst not in a position to confirm wider applicability of this method at this stage, Natural England considers it broadly appropriate for this particular project.	Impacts on SPA seabird populations have been considered in the RIAA.
Natural England (ref E25)	2nd June 2023	The method stated in paragraph 213 appears to be incorrect, "the percentage of the SPA population estimated to be present within the BDMPS region during the non-breeding season has been calculated". Natural England understand that the percentage of the BDMPS which is from the SPA (considering birds of all ages classes) has been calculated & presented in Table 8.5, for which the legend is correct.	This was an error; the approach detailed in the legend for Table 8.5 of the HRA Screening Report (Document Reference 4.10) is correct.
Natural England (ref E26)	2nd June 2023	Error in the figure given for common scoter abundance in paragraph 1.333 of the draft RIAA.	Common scoter abundance estimates have been checked and updated based on the full 24 months of baseline data, as presented in the RIAA.
Natural England (ref E27)	2nd June 2023	Breeding season apportioning in the draft RIAA has been undertaken using the NatureScot apportioning tool. Natural England retain some concerns regarding the current	The ORJIP AppSaS tool has not been made available in time for the DCO submission. Apportioning to SPA populations in the RIAA

Consultee	Date	Comment	Response/where addressed in the ES
		limitations of this approach. However, an updated method is being progressed through the ORJIP AppSaS project that we hope will address these concerns.	has therefore been undertaken using the NatureScot apportioning tool. This approach was agreed with Natural England through the ETG (12th October 2023).
Natural England (ref E28)	2nd June 2023	Natural England consider the calculation of an 'effective displacement area' for red-throated diver to be fundamentally flawed and misleading. There is no logical way to proportionally reduce the area of effective habitat loss by the expected level of displacement. The displaced proportion of the population cannot use any of the area, i.e., displacement is occurring over the full extent of the area. Birds that are not displaced are likely (but not necessarily) dispersed over the entire area. Ultimately, calculating a (reduced) area of effect in this way risks underestimating the % of the SPA that is subject to displacement effects. Natural England consider that it is appropriate to take into account the original SPA boundary when calculating the area of red-throated diver supporting habitat within the SPA that could be affected by the project, though given red-throated diver are likely to be present beyond the original boundary, albeit in lower densities, there is merit in presenting displacement values that include as well as exclude those parts of the SPA that fall beyond the original boundary.	The Applicant does not agree that application of the displacement gradient to the effective area of displacement was without merit. It has been established that the displacement effect would diminish as distance from the windfarm increases, and therefore it was logical to conclude that the effective area would also be reduced. It has been acknowledged that the application of the Natural England gradient was a proxy, but it should be noted that the total (uncorrected) values have also been presented for comparison. Displacement values for both the original and updated SPA boundary have been presented in the RIAA.
Natural England (ref E29)	2nd June 2023	The in-combination assessment in the draft RIAA suggests a 60% increase in baseline mortality for non-breeding lesser black-backed gull at Morecambe Bay and Duddon Estuary SPA yet concludes that an adverse effect is unlikely. Natural England accepts that the mortality estimate is likely to be precautionary, and the apportioning of impacts may be problematic. However, we highlight the	Project-alone and in-combination assessments in the RIAA have been updated with the full 24 months of baseline survey data. In respect of lesser black-backed gull, it was concluded that there would be no meaningful mortality contribution from the Project, and therefore no in-combination assessment was required.

Consultee	Date	Comment	Response/where addressed in the ES
		obvious need for thorough investigation into this impact, including through PVA. Tracking studies are used to evidence that the apportioning undertaken is not appropriate for the consideration of impacts. Natural England consider this suggests an alternative approach to apportioning should be investigated.	However, in-combination estimates (including PVA) have been presented as context to the assessment, but without prejudice to the conclusion of no adverse effect on integrity. PVA (EIA) has been undertaken for great black-backed gull cumulative collision risk; refer to **Section 12.7**.
Natural England (ref E30)	2nd June 2023	Awel-Y-Mor is not considered in-combination as impacts would not lead to a detectable increase in lesser-black backed gull mortality of the SPA population. Natural England advise that all impacts should be scoped into the in-combination assessment, i.e. impacts that do not result in >1% increases of baseline mortality should still be considered.	The RIAA has concluded that there would be no meaningful lesser black-backed gull mortality contribution from the Project, and therefore no in-combination assessment was required. However, in-combination estimates (including PVA) have been presented as context to the assessment, but without prejudice to the conclusion of no adverse effect on integrity. The in-combination estimates include all relevant projects, including Awel y Môr.
Natural England (ref E31)	2nd June 2023	Natural England does not agree that the results of the tracking study carried out by Clewley *et al.* (2020) comprise sufficient evidence to conclude that the birds identified in the study area are unlikely to originate from the Morecambe Bay and Duddon Estuary SPA, and therefore dismiss potential significant impacts. The study covered the period from 2016-2019 so there is no overlap with the aerial surveys carried out for the project. During that time connectivity with existing wind farms was found for >50% of the birds from the South Walney colony surveyed. The authors of the study noted that lesser black-backed gulls are more likely to forage offshore when rearing chicks. The study coincided with a period of very poor productivity at the South Walney colony. Productivity	The assessment presented in the RIAA includes data that assumed birds were apportioned to Morecambe and Duddon Bay Estuary SPA. However, it is noted that the Clewley (2020) data did indicate that this may result in an overestimate of the effects on this feature.

Consultee	Date	Comment	Response/where addressed in the ES
		has since improved; hence more offshore foraging may be occurring. Note there is also an error in the text whereby Clewley *et al*. (2021) is cited rather than Clewley *et al*. (2020).	
Natural England (ref E32)	2nd June 2023	Hodbarrow is to the Northeast of the windfarm site. Therefore, it is entirely possible that breeding Sandwich terns from the Morecambe Bay and Duddon Estuary SPA pass through the windfarm site on migration to reach known post-breeding roost sites on the North Wales coast via a relatively direct route.	The assessment of effects on Sandwich tern from Morecambe Bay and Duddon Estuary SPA (both Project-alone and in-combination) is presented in the RIAA.
NRW (ref 45/47)	21st May 2023	NRW (A) notes that only 12 months of Digital Aerial Survey data are available to inform Baseline Characterisation of the windfarm site, although a further 12 months have been collected, they are not presented and analysed for review in the PEIR and associated documents. Therefore, NRW (A) cannot make any conclusive judgements based on this PEIR and accordingly, our advice focuses on the methodologies employed. NRW (A) highlights the risk that the additional data analysis could have the potential to change the conclusions of the Environmental Statement (ES) from those set out in the PEIR, and raise new issues not flagged by the PEIR assessments.	Noted, with response outlined in detailed comments below.
NRW (ref 48)	21st May 2023	Once the full 24 months of data have been included, the Project-alone and in-combination assessments should be revisited to account for the complete baseline survey data and any updates to cumulative and in-combination totals. NRW (A) advise that where predicted impacts equate to >1% of baseline mortality of the relevant population, further consideration is required through Population Viability Analysis (PVA) modelling.	Project-alone and cumulative / in-combination assessments in the ES (**Section 12.7**) and RIAA have been updated with the full 24 months of baseline survey data. PVA has been undertaken for great black-backed gull (ES – **Section 12.7.3.1**) where predicted cumulative impacts equate to >1% of the baseline mortality of the

Consultee	Date	Comment	Response/where addressed in the ES
			population. This approach was agreed through the ETG.
NRW (ref 49)	21st May 2023	NRW (A) advise that in addition to the assessment of SPAs/Ramsar sites within HRA related reports, Sites of Special Scientific Interest (SSSI) and features need to be assessed within the ES. This includes where there is potential connectivity (e.g. within foraging range) and a potential impact pathway of seabird features of SSSI's that are not already assessed In the HRA reports as they are also features of SPA's/Ramsar sites. For example, the Pen y Gogarth / Great Orme's Head SSSI is designated for breeding kittiwake, guillemot and razorbill and the Morecambe generation assets project is located within foraging range of all three of these species. Hence quantitative assessments of displacement for guillemot and razorbill and collision for kittiwake should be undertaken for this site.	Effects on SSSI have been considered in **Section 12.6.5** in addition to SPAs/Ramsar sites in the RIAA.
NRW (ref 50)	21st May 2023	With reference to Section 12.111 of the PEIR, and throughout the document, the breeding season populations for EIA are calculated by adding the breeding populations within mean-max foraging range + 1SD to the immature birds from the preceding Biologically Defined Minimum Population Scales (BDMPS) population, on the assumption that those birds will remain in the area. NRW (A) are uncertain of the appropriateness of this approach and suggest that approaches to calculating regional breeding reference populations should be explored collaboratively through the relevant project Expert Working Group (EWG).	Following discussions on this matter during the ETG in October 2023, Natural England provided written advice (*'Advice regarding EIA scale reference populations for assessments'*). The preferred approach advised by Natural England uses the largest regional BDMPS breeding season population, calculated from data presented in Appendix A of Furness (2015). This approach has been adopted for the ES (**Sections 12.6** and **12.7**). NRW has confirmed that it welcomes this updated approach (14th March 2024).
NRW (ref 51)	21st May 2023	With reference to Table 12.19 of the PEIR, Construction disturbance and displacement screening: NRW (A) do not agree that gannet and Manx shearwater should have been	Gannet is considered to have a low sensitivity to construction disturbance and displacement. The species shows a low level

Consultee	Date	Comment	Response/where addressed in the ES
		screened out of assessment of construction displacement. There are empirical studies demonstrating that gannet is sensitive to displacement and barrier effects (Krijgsveld *et al*., 2011, Vanermen *et al*., 2013) and the SNCBs (2022) interim displacement advice note considers gannet to be a priority species for displacement assessment. With regard to Manx shearwater, NRW (A) note that the relative species abundance in the study area is high and there is low confidence in the low sensitivity to offshore wind farm disturbance and displacement estimate. NRW (A) also notes that Manx shearwaters have been shown to avoid the windfarm at North Hoyle in Liverpool Bay (see Table 3 of Dierschke *et al*., 2016). Therefore, NRW (A) advise that gannet and Manx shearwater should be fully considered within the construction disturbance and displacement assessment, as they have been for the operational phase assessment (this applies for HRA assessments as well).	of sensitivity to ship and helicopter traffic (Garthe and Hüppop, 2004, Furness and Wade, 2012, Furness *et al*., 2013), but appears to be more sensitive to displacement from structures such as offshore wind turbines (Wade *et al*., 2016). Furthermore, this species has high habitat flexibility (Furness and Wade, 2012) indicating that displaced birds could be predicted to readily find alternative habitats including foraging areas. Given the above, and taking into account the limited duration of construction activities, it was therefore considered reasonable to screen gannet out in respect of this impact pathway. It should be noted that an assessment of operational gannet displacement has been presented in the ES, which concluded a negligible impact (<0.01% increase in annual mortality); any construction impact would therefore be significantly below this level. Manx shearwater is also generally considered to have a low susceptibility to construction disturbance and displacement based on previous studies e.g. Bradbury *et al.* (2014). Dierschke *et al*. (2016) suggested that Manx shearwater were avoiding North Hoyle Windfarm, stating that an obvious distribution gap was observed at the OWF, although evidence for this appeared limited. Dierschke *et al*. (2016) also noted that Manx shearwater have been recorded within Robin Rigg OWF. However, on a precautionary basis, Manx shearwater have been included

Consultee	Date	Comment	Response/where addressed in the ES
			in the assessment of construction displacement in the ES (**Section 12.6.2.1**).
NRW (ref 52)	21st May 2023	The construction displacement assessments for the species assessed in Section 12.6.2.1 of the PEIR (guillemot, razorbill and red-throated diver) have been undertaken on three 2km radius circles around construction vessels. NRW (A) note that the construction phase presents a range of potential drivers that may cause displacement of seabirds. This includes vessel movement and construction activities (which may be both spatially and temporally limited), however the physical presence of the constructed turbines is also likely to cause a displacement response. As the construction phase progresses, more turbines are built and the spatial scale increases, until a point when the entire array is constructed, yet not operational, and may present the same displacement stimulus as an operational farm. Therefore, it should not be asserted that displacement will only occur where vessels and construction activities are present; instead NRW (A) consider that displacement is likely to occur within and around the constructed array area (due to the presence of turbines) and where construction activities are ongoing. This will represent an increasing spatial impact as construction progresses. NRW (A) advises that (in line with other projects) construction phase displacement impacts are simply assumed to be equivalent to 50% of operational and maintenance phase impacts to account for the incremental development of the array. This advice also applies for HRA assessments.	Noted. The approach to construction phase Disturbance, Displacement and Barrier Effects has been updated in accordance with advice from NRW and Natural England. For the ES (refer to **Section 12.6.2.1**) (and RIAA in respect of the red-throated diver and common scoter features of Liverpool Bay SPA), construction phase displacement impacts have been assumed to be 50% of operational and maintenance phase impacts.
NRW (ref 53)	21st May 2023	There has been no consideration given to construction vessel routes. NRW (A) advise that some indication should be given as to the port where construction vessels are	The final selection of the port facilities required to construct and operate the Project have not yet been determined, however it

Consultee	Date	Comment	Response/where addressed in the ES
		likely to sail from and note that routes through the Liverpool Bay SPA should follow best practice protocols (including adhering to existing routes wherever possible) to minimise disturbance to red-throated diver and common scoter. This is also relevant for HRA, particularly for Liverpool Bay SPA.	has been assumed the construction port would be in the UK and the operational port would be within 50km of the windfarm site. It has been also assumed within the RIAA that, in a worst-case scenario, construction vessel movements would cross Liverpool Bay SPA. Embedded mitigation includes restricting vessel movements where possible to existing navigation routes, and best practice vessel management; refer to **Section 12.3.3**.
NRW (ref 54)	21st May 2023	With reference to Section 12.159 of the PEIR, NRW (A) advise that once the full 24 months of data are included in the submission, the displacement assessments should use the mean seasonal peak population estimates based on the full 24 months of data. For example, for a species with a breeding season from April to July, this requires the average of the peak count between April and July in year one, and the peak count between April and July in a second year. This may require the counts to originate from different months in the two years (e.g. May in the first year and June in the second year). This allows for year-to-year variation in the precise time (and magnitude) of peak abundance estimates to be taken into account in arriving at a mean peak population estimate.	Agree with advised approach. The displacement assessment in the ES (**Section 12.6.2.1**) and RIAA utilised mean seasonal peak population estimates based on the full 24 months of data.

Consultee	Date	Comment	Response/where addressed in the ES
NRW (ref 55)	21st May 2023	As with construction displacement, no consideration of operation and maintenance vessel routes has been given. Again, some indication should be given as to the port where operation and maintenance vessels are likely to sail from and NRW (A) routes through the Liverpool Bay SPA should follow best practice protocols to minimise disturbance to red-throated diver and common scoter. This is also relevant for HRA.	The final selection of the port facilities required to construct and operate the Project have not yet been determined, however it has been assumed the construction port would be in the UK and the operational port would be within 50km of the windfarm site. It has been assumed in the ES and RIAA that, in a worst-case scenario, operation and maintenance vessel movements would cross Liverpool Bay SPA. Embedded mitigation includes restricting vessel movements where possible to existing navigation routes, and best practice vessel management; refer to **Section 12.3.3**.
NRW (ref 56)	21st May 2023	NRW (A) welcomes that the assessment of collision risk has been made for key sensitive seabird species and also for non-seabird migrant species that may have been missed by digital aerial surveys. However, NRW (A) advise that seabird species that may pass through the Morecambe generation assets site on migration (e.g. skuas, terns etc) should not be excluded from assessments based on low numbers recorded during site-based surveys alone. It would not be appropriate to use Strategic Ornithological Support Services Migrant Assessment Tool (SOSSMAT) for these species as they often migrate following coastlines at a distance offshore, rather than straight lines between point of origin and destination, which is an assumption of SOSSMAT/ Migropath. Alternative approaches are required, such as estimating the abundance of a species of bird migrating through a wind farm footprint area based on an apportionment of migrant bird numbers across a broad migratory front. This approach is broadly consistent with	In response to NRW's comments, an assessment of collision risk for migratory seabird species has been undertaken and has been set out in **Section 12.6.3.2**. As suggested by NRW, this used an approach adapted from the Scottish Government document Strategic assessment of collision risk of Scottish offshore wind farms to migrating birds (WWT Consulting and MacArthur Green, 2014).

Consultee	Date	Comment	Response/where addressed in the ES
		that taken in the report for the Marine Scotland project on strategic assessment of collision risk of OWFs to migrating birds (WWT Consulting Ltd. 2014): http://www.gov.scot/Resource/0046/00461026.pdf. As an example, for a species that might pass through the Irish Sea as part of a longer migratory route (such as great skua), the risks that the population is exposed to relates to the proportion of the broad migratory front that passes across the proposed wind farm area. For a species that migrates exclusively over the sea, the broad migratory front could be defined as the width of the Irish Sea. Consideration should also be given to the distribution of birds within the broad migratory front: birds could be distributed evenly, or they might have a skewed distribution – e.g. if the species tends to avoid the coast on migration through the Irish Sea, then distribution could be biased towards the centre of the Irish Sea.	
NRW (ref 57)	21st May 2023	With reference to Seabird CRM, NRW (A) welcomes that the preliminary collision risk modelling has been undertaken using the sCRM developed by Marine Scotland (McGregor *et al*., 2018) and agree that the impact assessments have been based on Option 2 outputs. Although the wind farm parameters and bird parameters (biometrics, avoidance rates and nocturnal activity) are presented in Tables 12.2 and 12.41 of the PEIR respectively, NRW (A) recommend that the log files (input and output) produced by the sCRM tool are provided.	Full details of input and outputs for the sCRM are provided in **Appendix 12.1**. Input and output log files in digital format (as generated by the sCRM tool) are available on request.
NRW (ref 58)	21st May 2023	With regards to Migrant CRM, Table 12.46 of the PEIR, the proportions of waterbird species at collision height (%PCH) for each species used in the CRM appear to be the central %PCH values for the relevant species groups from Table 3 of Wright *et al*., (2012). NRW (A) suggest that	Noted. The approach to assessing collision risk for migratory species has been updated for the DCO submission, including a range of PCH values. The PCH value for curlew in the PEIR was a transcription error; all values

Consultee	Date	Comment	Response/where addressed in the ES
		consideration should also be given to the ranges of %PCHs in Wright *et al*., (2012) to account for uncertainty. Clarification is required as to the source/justification of the 1% PCH listed for curlew, as Wright *et al*., (2012) indicates 25% PCH (range 5-75%) for waders. NRW (A) also advise that an example species Band (2012) input and output sheet are included. The CRM predictions for these species should also be apportioned out to the relevant SPAs in the HRA assessments.	have been checked and updated as appropriate and have been set out in **Section 12.6.3.2**.
NRW (ref 59)	21st May 2023	NRW (A) do not consider it appropriate to base the cumulative, and hence also in-combination, assessments on so many unknowns for impacts from many of the relevant other projects. Whilst these historic projects may not have undertaken quantitative assessments, or assessments using current approaches, estimates will need to be generated for these unknown projects in order to undertake meaningful assessments. NRW (A) suggest this should be explored collaboratively through the relevant EWG. These discussions could also cover potential issues over different avoidance rates, collision model options etc. used by other projects where there are data available. As a result, NRW (A) have not made any comments on the overall level of cumulative (or in-combination) impacts or their significance.	Noted. The approach to cumulative assessment presented in the ES has been reviewed and agreed between the Morecambe, Mona and Morgan offshore wind projects (**Sections 12.4.4** and **12.7**). The adopted approach was set out in a separate note that has been submitted to Natural England and NRW (via the Morecambe/Mona/Morgan projects) and was considered appropriate to assess cumulative impacts on seabirds. The cumulative assessment has been updated to reflect the most up to date information from other projects, and a qualitative assessment undertaken to account projects with unknown values for collision and displacement.
NRW (ref 60)	21st May 2023	Clarification is required as to the source of the Erebus figures that have been included in the cumulative assessments. NRW (A) note that if the figures included are from the original Erebus ES, then these will be incorrect, especially for auks as these numbers do not take account of apportionment of unidentified birds. NRW (A) advise that the figures in the Erebus Supplementary	Noted. Cumulative values for Erebus have been updated within the ES (**Section 12.7**) using information from the ‘Project Erebus Supplementary Environmental Information Addendum’.

Consultee	Date	Comment	Response/where addressed in the ES
		Environmental Information (SEI) report are used for auk displacement (Tables 5-1 to 5-3: Calculation of updated mean seasonal peaks) and for gannet, kittiwake and large gull collision (Table 5-36: Updated summary of collision risk mortalities): 'ORML2170 Project Erebus Supplementary Environmental Information Addendu'' (which is available through the public register https://publicregister.naturalresources.wales/). The appropriate figures for use for Manx shearwater and gannet displacement can be found in the original Erebus ES submission 'Offshore Ornithology 11.4 Technical Appendix – Displacement Analysis'.	
NRW (ref 61)	21st May 2023	With reference to Section 1.4.3 of the PEIR technical report, Collision Risk Modelling, whilst the input parameters (bird parameters and turbine parameters) are provided in Tables 1.1-1.3, NRW (A) recommend that the log files (input and output) produced by the sCRM tool be provided as an appendix. If the bird density data has been entered into the sCRM using the 1,000 samples from a distribution of mean densities (e.g. from a bootstrapped sample) option, then the bootstrapped data should be provided to enable the modelling to be re-run and the outputs checked. Please also see our comments in Paragraph 57 of the current document with reference to CRM in Chapter 12, Offshore Ornithology.	Full details of input and outputs for the sCRM are provided in **Appendix 12.1**. Input and output log files in digital format (as generated by the sCRM tool) are available on request.
NRW (ref 62)	21st May 2023	NRW (A) notes that species identifications are given confidence levels of 'Possible', 'Probable' or 'Definite' and that all records of these species confidence levels are treated as positively identified to generate an 'ID rate'. Following this, a generic ID rate is presented incorporating all species for each survey, which is not useful. Therefore, NRW (A) suggest that more information is required to describe the data more fully through presentation of the	Annex VII of **Appendix 12.2** presents the identification confidence levels for each species across the survey period. The average monthly identification rate has been checked and an average of 96.05% was obtained.

Consultee	Date	Comment	Response/where addressed in the ES
		proportions of data assigned to all identification confidence categories for each species for each survey.	
NRW (ref 63)	21st May 2023	As the Morecambe Generation Assets project is located wholly in English waters, NRW (A)'s primary area of interest for offshore ornithology for this project is on impacts to Welsh designated sites.	Noted.
NRW (ref 65)	21st May 2023	The Morecambe Generation Assets HRA screening and Stage 2 RIAA have been based on only 12 months of digital aerial survey data. Although NRW (A) note that a further 12 months have been collected, they are not presented and analysed for review in the PEIR and associated HRA documents. Until the full data set is available, NRW (A) are not in a position to agree to any conclusions as there isn't adequate survey data to screen out sites and/or species. At present NRW (A)consider that all Welsh sites (SPAs/Ramsar's/SSSIs) designated for seabirds and wintering estuarine birds should be screened in.	Noted. Project-alone and in-combination assessments in the RIAA have been updated considering the full 24 months of baseline survey data. The screening of SPAs and Ramsar sites has been discussed and agreed through the ETG process and was set out in the HRA Screening Report. Welsh sites have been assessed in the RIAA in accordance with the screening criteria set out in the HRA Screening Report. SSSIs were not relevant to the HRA, but it is noted that an assessment of effects on SSSIs (including Welsh sites) has been presented in the ES (**Section 12.6.5**).
NRW (ref 66)	21st May 2023	NRW (A) note the following regarding the LSE screening approach taken for offshore ornithology: ▪ Section 8.4.1 Seabirds non-breeding, Paragraph 214: For seabirds in the non-breeding season, potential connectivity has been assumed for Special Protected Area (SPA) populations that contribute >1% of the Biologically Defined Minimum Population Scales (DMPS) population. NRW (A) notes that this is not a standard approach and whilst it may seem broadly appropriate for this project, NRW (A) suggest that at this stage the applicability of the approach is	Noted. The approach to determining connectivity with SPAs and to screen sites for migratory non-seabirds has been discussed and agreed with Natural England through the ETG, and reflects the SPAs assessed within the RIAA. The screening of the great cormorant feature of Ynys Seiriol/Puffin Island SPA has been checked and it is confirmed that this feature has been screened in and assessed within the RIAA.

Consultee	Date	Comment	Response/where addressed in the ES
		discussed further through the relevant Expert Working Group (EWG). ▪ Section 8.4.2 Migratory birds other than seabirds, Paragraph 216: A 100km buffer has been used to screen SPAs/Ramsar's for migratory non-seabirds. NRW (A) advise that this is not a standard approach. NRW (A) recognise the need to identify a proportionate set of SPAs for a more detailed assessment and hence recommend that the merits of this approach be discussed further through the EWG. ▪ Appendix 2 screening outcome for UK SPA and Ramsar Sites with ornithology qualifying features: Ynys Seiriol / Puffin Island SPA, Great cormorant: NRW (A) query the conclusion of significance of effect for this site and feature to be no LSE (screened out). This is because the justification column states, "Project beyond the published foraging range (mean max +1SD), therefore no connectivity during the breeding season. Screened in for non-breeding season effects as species was recorded during baseline surveys, and >1% of birds within the BDMPS region during this period will originate from this population." NRW (A) advise that the screening of this site and feature is checked.	
NRW (ref 67)	21st May 2023	NRW (A) note that the assessments for a number of the Welsh designated sites are incomplete (e.g. Anglesey Terns SPA; Skomer, Skokholm and seas of Pembrokeshire (SSSP) SPA). This is because not all of the qualifying features that the HRA Screening Report has concluded to be screened in for LSE have been considered. NRW (A) Advise that once the full 24 months of data are available and the sites and features screened in for LSE have been reviewed, the RIAA should be	It is confirmed that the RIAA has been reviewed, based on the full 24 months of survey data. All sites screened into the assessment (i.e. where LSE was identified) are set out in the updated HRA Screening Report and have been assessed in the updated RIAA.

Consultee	Date	Comment	Response/where addressed in the ES
		reviewed and updated, and all relevant qualifying features of sites screened in should be assessed. NRW (A) are therefore unable to make any conclusive judgements as to levels of impact and significance of effect at this stage.	
NRW (ref 69)	21st May 2023	Consideration should be given to NRW (A) advice on the EIA methodologies above (e.g. regarding disturbance/displacement assessments and cumulative assessments) as these are also relevant for RIAA assessments for the Project-alone and in-combination. In addition, NRW (A) notes the following regarding the approaches taken for the assessments included for Welsh designated sites in the draft RIAA: ▪ With reference to Liverpool Bay SPA red-throated diver, Paragraph 1.319, NRW (A) notes that there was insufficient data to assess graduated displacement over 10 km buffer (as was advised by Natural England). This should be reviewed for analysis of the full data set once the 24 months of data are available. NRW (A) also highlight the potential to consider other relevant data sources if the projects survey data proves insufficient (e.g. Seabird Sensitivity and Mapping Tool, SeaMaST ▪ Liverpool Bay SPA red-throated diver (paragraphs 1.320, 1.322 & Table 8.6): NRW (A) does not agree with the calculation of an 'effective displacement area' as there is no logical way to proportionally reduce the area of effective habitat loss by the expected level of displacement. The displaced proportion of the red-throated diver population cannot use any of the area – displacement occurs over the full extent of the area. Birds that are not displaced are likely (but not necessarily) dispersed over the entire area. Ultimately, the approach taken appears to incorrectly	NRW's comments have been noted: ▪ Displacement assessment for red-throated diver in the RIAA has been based on the full 24-month survey dataset. ▪ It has been confirmed that the 24 months of data were insufficient to enable model-based density estimates for red-throated diver to be calculated. It was therefore agreed with Natural England during ETGs that a weighted average displacement rate would be calculated, using the displacement gradient provided by Natural England. This was the same approach used in the draft PEIR, and was considered to provide a suitable (and precautionary) level of assessment. ▪ The Applicant does not agree that application of the displacement gradient to the effective area of displacement was without merit. It has been established that the displacement effect would diminish as distance from the windfarm increases, and therefore it was logical to conclude that the effective area would also be reduced. It has been acknowledged that the application of a linear displacement gradient was a proxy, but it should be noted that the

Consultee	Date	Comment	Response/where addressed in the ES
		downplay the % of the SPA that is subject to displacement effects. NRW (A) consider that variable displacement rate should be applied to abundance figures and not to the area of effective habitat loss. Therefore, for the submission, NRW (A) advise that the area of effect within the SPA is calculated for both the original and extended SPA boundaries, without reducing the area proportionally according to the level of displacement of red-throated diver expected to occur. ▪ NRW (A) also advise that the area of the SPA subject to displacement for red-throated diver is considered in-combination with other plans and projects. ▪ With reference to Section 8.8 Glannau Aberdaron ac Ynys Enlli/ Aberdaron Coast and Bardsey Island SPA & SSSP SPA Manx shearwater, no evidence has been provided in the draft RIAA to support the assertion that 50% displacement for Manx shearwater can be considered realistic and NRW (A) note that there is currently no evidence for any particular range of displacement rates (1-10%, 50%, 30-70% or any other) for this species from offshore wind farms. Therefore, NRW (A) suggest that once the full dataset has been analysed, the whole apportioned annual matrices are provided for these sites and that these indicate where 1% of baseline mortality of the relevant colonies is exceeded. NRW (A) would then suggest that any further approach to the assessment is discussed collaboratively through the EWG. NRW (A) also recommend that following this, the appropriate impact figures for the Morecambe generation assets project to take through to the in-combination assessments for Manx shearwater at these sites is discussed through the EWG.	total (uncorrected) values (i.e. without the application of the gradient) have also been presented for comparison within the RIAA. Red-throated diver displacement values for both the original and updated SPA boundary have been presented in the RIAA. This matter has been discussed with Natural England during ETG meetings. ▪ It is confirmed that the area of displacement for red-throated diver has been considered within the in-combination assessment within the RIAA. ▪ Manx shearwater are generally considered to have a low susceptibility to disturbance and displacement, based on previous studies (e.g as set out in Bradbury *et al.* (2014)). A rate of 50% was therefore considered suitably precautionary; however, the assessment considered a range of displacement and mortality values (i.e. 30-70% and 1-10% respectively), and the full range has been made available (within **Appendix 12.1**) should NRW require this in order to consider its position. ▪ The most recent MS report on OWF lighting impacts on Manx shearwater (Deakin *et al.*, 2022) has been considered in the ES, and the conclusions of this referenced in the RIAA. Overall, it was considered that lighting was not likely to significantly

Consultee	Date	Comment	Response/where addressed in the ES
		▪ Furthermore, no consideration has been given to potential impacts of lighting during any phase on Manx shearwater at these sites. Deakin at al., (2022) notes that a higher level of disturbance to shearwaters and petrels may occur during the construction phase, when activity, noise and light levels may be greatest. ▪ Apportionment of impacts to colonies in the non-breeding season(s): It appears that the number of adult birds at colonies (e.g. SSSP SPA Manx shearwater Section 8.9.2.1 and Grassholm SPA gannet, Section 1.572) used in the non-breeding season(s) apportionment are not those from the Tables in Appendix A of Furness (2015) and are updated colony figures. However, the respective non-breeding season(s) BDMPS total figures used in the calculations have not been updated to account for new colony data and use those presented in the tables in Appendix A (Furness 2015). NRW (A) do not consider this to be appropriate as updating the SPA colonies figures presented in the tables in Appendix A of Furness (2015) with more recent figures is not recommended, unless there is evidence to suggest that the colony in question has increased or decreased significantly relative to other colonies. ▪ As an example, the proportion of SSSP SPA adult Manx shearwaters present at the Morecambe site during the migration seasons should be calculated using the information in Table 13 of Furness (2015) and calculated as: During the migration seasons for the UK western waters and Channel BDMPS, the number of SSSP SPA adult birds is 700,000 whilst the total number of Manx shearwaters of all ages across the BDMPS is 1,580,895 birds. Therefore, the proportion of SSSP SPA adult birds across the	affect Manx shearwaters, and that any such impacts would not affect the conclusions of the assessment. ▪ It is confirmed that the approach to apportioning outside of the breeding season has been updated in the RIAA in accordance with NRW's advice. ▪ The projects considered for the in-combination assessment have been agreed with Natural England through the ETG process.

Consultee	Date	Comment	Response/where addressed in the ES
		BDMPS during the migration seasons can be calculated as 44.3% (and not 57.6% as presented in Paragraph 1.549). ▪ Taking the same approach for Grassholm SPA gannets, NRW (A) advise the proportions of Grassholm SPA adult gannets present at the Morecambe site during the autumn and spring should be 14.4% and 11.9% respectively (rather than the 13.19% and 10.88% as presented in Section 1.572). ▪ In-combination assessments: In addition to NRW (A) comments above regarding data for existing projects to include in assessments, the in-combination assessment of impacts from other plans and projects should include all plans/projects located within foraging range of the colony in question in the breeding season and for the non-breeding season(s) should include impacts from a wider range of projects, i.e. all those located within the relevant non-breeding season BDMPS in Furness (2015). NRW (A) advise that all impacts should be scoped into the in-combination assessments, i.e. impacts that do not result in >1% increases of baseline mortality should still be considered - Project- alone impacts considered to be negligible should not be.	
Isle of Man Government	2nd June 2023	The TSC notes the results of the cumulative collision risk assessment in relation to great black-backed gull and look towards the more robust assessment from 2 years of data, in the Environmental Statement to come, noting a potential transboundary connection and the sensitivity of this species in the Isle of Man context (details below). It is also noted that a number of other species utilise the study and may form shared non-breeding populations with the Isle of Man, or connect with Isle of man breeding population, and	Noted. The updated assessment for great black-backed gull is presented in **Sections 12.6.3.2** (Project-alone) and **12.7.3.2** (cumulative). Effects on Isle of Man populations are considered in **Section 12.8.1**.

Consultee	Date	Comment	Response/where addressed in the ES
		Manx shearwaters were found in high numbers in July and August, but significant effects on the regional populations of those species is not expected, from the data so far.	
Isle of Man Government	2nd June 2023	Conservation Value – it has been noted that there are no SPAs on the Isle of Man, this being an EU designation and the Isle of Man has never been an EU Member State, nor has a European-level Assessment of seabird interest been undertaken for the Isle of Man, to date, though it is hoped that we can make such an assessment in the future, nevertheless, breeding seabird sites of national importance on the Isle of Man include Maughold Coast and Brooghs ASSI [Areas of Special Scientific Interest], Central Ayres ASSI/Ayres NNR [National Nature Reserve], Marine Drive ASSI, but also the Point of Ayre (terns), the Calf of Man (seabirds include a recovering colony of Manx shearwaters), and the Sugarloaf/Spanish Head section of coast. The latter two have protection under Manx National Heritage. There is also a series of MNRs [Marine Nature Reserves] with identified seabird interest of relevance.	Noted. Effects on Isle of Man designated sites are considered in **Section 12.8.1**.
Isle of Man Government	2nd June 2023	There is one designated Ramsar Site (Ballaugh Curragh) and potential further Ramsar sites have been identified in a report to the Overseas Territories Conservation Forum (https://www.ukotcf.org.uk/conventions/ramsar-2/). A nuanced discussion of conservation value has been provided and it is hoped that the Isle of Man status of site designations, being different from the UK, can be accounted for, without Manx site statuses skewing down the perceived conservation value of any species within the analyses (as non-SPA sites).	Impacts on Isle of Man designated sites have been considered under **Section 12.8** (except for Ballaugh Curragh Ramsar site which has been considered in the RIAA).
Isle of Man Government	2nd June 2023	The PEIR references Chapter 6 (EIA methodology) for the framework & approach, and Section 12.8 of Chapter 12 here, for the potential for effects, 'identified in relation to potential linkages to non-UK protected sites and sites with	Impacts on Isle of Man designated sites have been considered under transboundary impacts in **Section 12.8**. Impacts on great

Consultee	Date	Comment	Response/where addressed in the ES
		large concentrations of breeding, migrating or wintering birds'. In Section 12.8, however, it is not clear that such account has been taken with respect to Isle of Man sites, though we note that the analysis of great black-backed gull, in a cumulative assessment may be more fulsome once 2 years of survey data become available. Please note, with regard to conservation status and transboundary effects, that the Manx Birds of Conservation Concern provides up to date, evidence-based assessments of Manx bird statuses and this is available from http://manxbirdlife.im/wp-content/uploads/2021/08/BoCCIoM-2021-TABLESvWEB04-2021-07-30.pdf.	black-backed gull populations have been fully considered in the ES.
Isle of Man Government	2nd June 2023	Designated sites – the PEIR that connectivity with SPA, Ramsar and SSSI is considered. 12.67 notes that effects on SPAs and their component SSSIs are considered in the HRA and 'Accordingly, effects on designated sites are not discussed further within the PEIR'. As SPAs are not a Manx designation, we request that that the transboundary consideration take account of key Manx seabird sites to ensure no deleterious effects, as these will not have been considered within any UK HRA.	Impacts on Isle of Man designated sites have been considered under transboundary impacts in **Section 12.8** (except for Ballaugh Curragh Ramsar site which has been considered in the RIAA).
Isle of Man Government	2nd June 2023	Receptors–- those identified include internationally important designated sites for seabirds and migrant birds likely to pass through the study site. It is pointed out that aside from one designated Ramsar site on the Isle of Man, and Marine Nature Reserves with OSPAR recognition, international assessments have not, as yet, included a European level assessment (though we note that there is a report proposing further Ramsar Sites with boundaries and criteria considered). From a Manx perspective, assurance is sought via the Environmental Statement that no Manx bird populations will be significantly adversely affected,	Impacts on Isle of Man sites have been considered under transboundary impacts in **Section 12.8** (except for Ballaugh Curragh Ramsar site which has been considered in the RIAA).

Consultee	Date	Comment	Response/where addressed in the ES
		and data is available via the JNCC SMP Seabirds Count survey data and the Manx Birds of Conservation Concern data tables. It is noted that the table of receptors includes SPAs and SSSIs with mean maximum foraging range of qualifying breeding seabirds species, and SPAs and SSSIs where qualifying adult seabird population is >1% of the relevant non-breeding BDMPS population. In Manx terms this would relate to ASSIs, Ramsar Sites and Marine Nature Reserves, as a transboundary issue.	
Isle of Man Government	2nd June 2023	Potential effects during construction – In paragraph 12.94 of the PEIR it is noted that the Calf of Man has been recognised as the closest Manx shearwater colony to the study site, recognising a likely transboundary connection. It is noted that Manx shearwater was scoped out of construction disturbance and displacement screening (Table 12.20) but scoped into Operational disturbance and displacement (on a precautionary basis, due to high densities observed during the breeding season). It would be useful to have an explanation of the different approaches to the two sections in relation to this species.	Manx shearwater are generally considered to have a low susceptibility to disturbance and displacement, particularly during wind farm construction, based on previous studies e.g Bradbury *et al*. (2014). However, in response to comments received to the PEIR, a precautionary assessment of construction phase disturbance to Manx shearwaters has been included in **Section 12.6.3.1**.
Isle of Man Government	2nd June 2023	Potential effects during operation and maintenance – disturbance and displacement. Manx shearwater – no displacement effect is expected from the year of data available so far, in relation to background mortality in regional population during breeding, but it is queried whether there might be any effect on the Calf of Man breeding colony, which is relatively small, but recovering and increasing in shearwater numbers. Manx National Heritage and Manx Wildlife Trust (who currently warden it for MNH) will have the most up to date figures for the colony counts.	Seabird breeding data from the Calf of Man for 2022 has been obtained from Manx Wildlife Trust; refer to **Section 12.8.1.**

Consultee	Date	Comment	Response/where addressed in the ES
Isle of Man Government	2nd June 2023	Collision risk. PEIR paragraph 12.255 Common gull reference population – the text notes one breeding colony within mean max foraging range, with only one nest. It is pointed out that a small number of common gulls nest in the vicinity of the Point of Ayre on the Isle of Man (5 pairs according to the recent Manx Birds of Conservation Concern (BoCC). Although the breeding period collision risk is not high, it is not known whether there is a link between this breeding population and wintering within the study site. It is noted that no significant effect of collision risk was predicted in a regional context.	Collision risk modelling for common gull has been updated within the ES, based on 24 months survey data. Collision risk for this species has decreased since PEIR; refer to **Section 12.6.3.2**.
Isle of Man Government	2nd June 2023	Migrant collision risk 12.269 – features of SPAs and Ramsar sites were screened in. Note, please, that the Isle of Man does not have SPAs, nor has it had a European level assessment of interest for designation, however it does have a Ramsar Site, which is not listed in this section: Ballaugh Curragh, which has wintering hen harrier quoted as an interest in its designation (there is also a breeding population of significance on the Isle of Man – over 38 territorial pairs in the 2022 survey on the Isle of Man and the Greeba Mountain and Central Hills ASSI includes sites used for breeding http://manxbirdlife.im/wp-content/uploads/2022/10/Report-on-the-Isle-of-Man-Hen-Harrier-BreedingCensus-2022-v2022-10-10-PUBLIC-1.pdf). However, it is noted that hen harrier has been assessed (Table 12.47**)** and that no species assessed showed any prediction of collision, based on a 98% avoidance rate (and no hen harrier collision with no avoidance, either). The omission should not therefore have affected the result.	Noted. Impacts on Ballaugh Curragh Ramsar site have been considered in the RIAA. The migratory non-seabird collision risk assessment has predicted zero hen harrier collisions based on a 98% avoidance rate and 0.13 hen harrier collisions with no avoidance (**Section 12.6.3.2**); rates of this magnitude were considered to be negligible in EIA terms and would not affect any Isle of Man sites/populations.
Isle of Man Government	2nd June 2023	Cumulative effects–- noted that the Isle of Man wind farm has been acknowledged in the list, though there is no published data currently, and the PEIR states that	Effect on Isle of Man breeding colonies have been considered in **Section 12.8.1**. It should be noted that data used in the wider

Consultee	Date	Comment	Response/where addressed in the ES
		inclusion will be reviewed at the Environmental Statement stage. Also noted that great black-backed gull has potential to have a moderately adverse effect which is 'potentially significant' in EIA terms in relation to the regional population. It is pointed out that the Isle of Man has long held a significant population in a regional context, but that the Isle of Man breeding population is in severe decline, across the last 15 and 30 years (Manx BoCC data). Assurance is being sought that there is no threat to the Isle of Man population of this species. PVA may become appropriate and the Manx population should be taken into account in site apportioning.	assessment included available colony counts from Isle of Man in the Seabird Monitoring Programme (SMP) database. The Scoping Report for the Mooir Vannin offshore windfarm (Ørsted, 2023) was reviewed, but it is noted that no quantitative data is yet available for this project, so not included in cumulative estimates presented in **Section 12.7**.
Isle of Man Government	2nd June 2023	Transboundary effects – although the PEIR report notes that this will be revisited, it states that effects are likely to be lower than the cumulative effects due to larger reference populations. However, from the perspective of the Isle of Man, one of the transboundary nations which might be affected, the regional reference populations utilised, should already include the Isle of Man. Transboundary interests for the Isle of Man lie in a consideration of whether effects might have the potential to adversely impact Manx bird populations or key bird sites on the Isle of Man. The migrant analysis indicates that a migrant effect is unlikely, so the interest lies with the seabirds. One species likely to be of interest, taking account of the impacts assessment so far, is the great black-backed gull, as the Isle of Man has long held a significant population in the regional context, and also now due to the severe decline in the breeding pop on the Isle of Man. This population lies within foraging rage of the study site so a	Impacts on Isle of Man populations have been considered in **Section 12.8.1** (except for Ballaugh Curragh Ramsar site which has been considered in the RIAA).

Consultee	Date	Comment	Response/where addressed in the ES
		transboundary effect is indeed possible and warrants recognition and consideration in relation to the Isle of Man. Another species, mentioned above, is the Manx shearwater, with respect to any potential site effect, (but noting that no significant effect on the regional population has been predicted here, on the data so far, but there are much larger colonies within the region). The recent recovery of the Calf of Man breeding colony must be safeguarded. Also with regard to potential site effects, the Isle of Man seabird sites will not have been assessed within the HRA assessment as the Isle of Man has never been a Member State of the EU. The analysis in this section should therefore also consider whether there could be such effects or not, and may reference other sections of the analysis, if potential Isle of Man connections have been considered in other sections.	
Isle of Man Government	2nd June 2023	Aerial Surveys Report – Discussion paragraph 154 guillemot – 'The nearest colonies to the survey areas are likely to be those associated with the Rathlin Island or Ailsa Craig SPAs' – should this state, the nearest SPA-designated colonies? There will be many closer colonies, including those on the Isle of Man, though the peak was at the end of breeding post-breeding period so they may be coming from a wide area. Disc para 157–- Manx shearwater were mainly seen during July and Aug in this first year of data analysed. They have a very long foraging range but we note that the Calf of Man colony, for a Manx shearwater, is very close	Agree paragraph 154 should read 'The nearest SPA-designated colonies to the survey areas are likely to be those associated with the Rathlin Island or Ailsa Craig SPAs'. This has been updated in **Appendix 12.2.** Impacts on Manx shearwater associated with Calf of Man and other non-SPA colonies have been considered under transboundary impacts (**Section 12.8.1**).

Consultee	Date	Comment	Response/where addressed in the ES
		by and there is a high likelihood of a connection, as well as with some other colonies.	
RSPB	5th June 2023	Due to the parallel nature of the three PEIR consultations (Morecambe, Morgan and Mona) and resource constraints, we have not been able to review the documents provided to provide meaningful comments at this stage. We will instead provide our input on offshore ornithology matters via the expert working group in the Evidence Plan Process. However, we wish to confirm that the main breeding seabird species of interest to the RSPB includes Manx Shearwater, Northern Gannet, Black-legged Kittiwake, Common Guillemot and Razorbill along with non-breeding Red-throated Diver and Common Scoter.	Noted. The Applicant acknowledges the RSPB's contributions during the ETG meetings and agrees that Manx shearwater, gannet, kittiwake, guillemot, razorbill, red-throated diver and common scoter were among the key species for the assessment (other gulls have also been considered in the assessment of construction collision risk).
RSPB	5th June 2023	We also have concerns with breeding Lesser Black-backed Gull, despite the low frequency of occurrence during the reported survey work. This is because, with the exception of the Ribble and Alt Estuary SPA colony, the main Irish Sea breeding colonies (at Bowland Fells SPA and Morecambe Bay and Duddon Estuary SPA) require restoration to a favourable conservation status and the implications of this needs careful consideration via the Expert Working Groups.	Impact on SPA lesser black-backed gull colonies have been fully considered in the RIAA. Bowland Fells SPA lesser black-backed gull have been screened into the assessment, however, lack of breeding season connectivity with offshore areas has been noted, and this has been referenced in the RIAA.
RSPB	5th June 2023	Additionally, we are surprised that the Bowland Fells SPA, Large gull super colony was not mentioned within your documents as a recent paper published by the RSPB and Natural England as part of the Life on The Edge (LOTE) project stated that the 'Bowland Fells may be the largest lesser black-backed gull colony in the world', as previously mentioned, and despite its apparent size, the colony is still considered in recovery from the impact of decades of licenced culling.	Impact on SPA lesser black-backed gull colonies have been fully considered in the RIAA. Bowland Fells SPA lesser black-backed gull have been screened into the assessment, however, lack of breeding season connectivity with offshore areas has been noted, and this has been referenced in the RIAA.

Consultee	Date	Comment	Response/where addressed in the ES
North West Wildlife Trusts	22nd June 2023	Please note due to time restraints, we have not assessed the offshore ornithology section and echo all of RSPB comments. We look forward to viewing the updated assessment once the full 24 months of surveys have been undertaken. We expect that all impacts are minimised through the project deign and best use of available technology e.g. minimum tip height of turbines to reduce impacts, minimising moving parts and/or the number of turbine blades, slower rotation speeds, and blunt edges on the structure, slow start procedures for turbines. Given the number of OWF being developed in the Irish Sea, we expect a full cumulative impact assessment to be undertaken, including consideration of transboundary impacts. Concerns are raised over the possible disturbance, displacement and barrier effects on sensitive receptors, particular black-backed gulls.	The air gap has been increased between PEIR and ES to reduce collision effects. The maximum number of wind turbine generators (WTGs) and the maximum tip height have also been reduced. Further design details are not fixed at this stage in the process but as the design develops the use of best available technology would be considered as appropriate. A full cumulative impact assessment has been undertaken **in Section 12.7**. Impacts on great black-backed gull and lesser black-backed gull have been fully considered in the ES and RIAA. It was noted that gull species have been considered primarily to be at risk of collision impacts but have low sensitivity to disturbance and displacement effects; the assessment has been therefore focussed on the former.

12.3 Scope

12.3.1 Study area

12.13 The windfarm site (encompassing all Project infrastructure) is located in the Eastern Irish Sea and encompasses a seabed area of 87km^2. The nearest point from the windfarm site to shore (coast of northwest England) would be approximately 30km.

12.14 The study area for offshore ornithology has been defined on the basis of the area included in the baseline aerial surveys. This covers the windfarm site and a hybrid buffer (from 4km to 10km, see below); refer to **Figure 12.1**. The windfarm site boundary was reduced following submission of the PEIR, and therefore the survey area was larger than the required buffer areas in some areas (to the west of the windfarm site).

12.15 The survey area and buffers accord with Natural England guidance (Parker *et al*., 2022a) and have been agreed during consultation with Natural England (**Table 12.1**). This has been defined on the basis of the types of impacts to be considered by the assessment. For some offshore ornithology receptors (i.e. red-throated diver *Gavia stellata*), impacts could occur at greater distances than 4km. For this species, the study area has been extended to 10km, to the north and east of the windfarm site, where this overlaps with Liverpool Bay SPA, where this species is one of the designated features. Refer to **Section 12.5** for further information on the study area and the basis for defining the study area coverage.

12.3.2 Realistic worst-case scenario

12.16 The final design of the Project will be confirmed through detailed engineering design studies that would be undertaken post-consent to enable the commencement of construction. To provide a precautionary but robust impact assessment at this stage of the development process, realistic worst-case scenarios have been defined. The realistic worst-case scenario (having the most impact) for each individual impact has been derived from the Project Design Envelope (PDE) to ensure that all other design scenarios would have less or the same impact. Further details are provided in **Chapter 6 EIA Methodology**. This approach has been common practice for developments of this nature, as set out in PINS Advice Note Nine (PINS, 2018).

12.17 The realistic worst-case scenario for the assessment for offshore ornithology is summarised in **Table 12.2** (considering the largest number of WTGs with the largest rotor diameter within the 'smaller' WTG parameters) and has been presented in accordance with Natural England guidance (Parker *et al*., 2022c). This has been based on the PDE described in **Chapter 5 Project Description**

(Document Reference 5.1.5), which provides further details regarding specific activities and their durations. The envelope presented has been refined as much as possible between PEIR and ES, presenting a project description with design flexibility only where it would be needed.

12.18 The worst-case scenario for indirect effect (**Sections 12.6.2.2**, **12.6.3.4** and **12.6.4.2**) was as presented for disturbance/habitat loss impacts in Table 10.2 of **Chapter 10 Fish and Shellfish Ecology** and Table 9.2 of **Chapter 9 Benthic Ecology**.

Table 12.2 Realistic worst-case (direct effects) scenarios for offshore ornithology[3]

Parameter	Values
Latitude (decimal degrees)	53.8
Area of OWF (km^2)	86.79
Area of OWF + 2km buffer (km^2)	173.55
Area of OWF + 4km buffer (km^2)	285.36
Area of OWF + 10km buffer (to north and east) (km^2)	650.92
Width of OWF (km)[4]	10.46
Length of operational period (years)	35
Maximum number of WTGs	35
Number of blades per WTG	3
Maximum blade width (m)	6.45
Average blade pitch at mean predicted wind speed (degrees)	6
Rotor radius (m)	130
Average rotation speed at mean predicted wind speed (Rotations Per Minute (rpm))	7.74
Hub height relative to Highest Astronomical Tide (HAT) (m)	155
Minimum rotor clearance above sea level (air gap) (above HAT) (m)	25
Tidal offset (HAT- Mean Sea Level (MSL)) (m)	4.82

[3] Presented in format requested by Natural England.

[4] The width is calculated as the diameter of a circle with the same area as the offshore windfarm site (for the Project 86.79km^2).

12.3.3 Summary of mitigation embedded in the design

12.19 This section outlines the embedded mitigation relevant to the offshore ornithology assessment, which has been incorporated into the design of the Project (**Table 12.3**). Where other mitigation measures have been proposed, these have been detailed in the impact assessment (**Section 12.6**).

Table 12.3 Embedded mitigation measures related to offshore ornithology

Parameter	Mitigation measures embedded into the design of the Project
Site location	Location was selected as part of the Round Four site selection process undertaken by The Crown Estates. It is located outside of areas designated for their importance to bird populations.
Air gap	The Project design has an air gap (minimum rotor clearance above sea level) of 25m above HAT (approximately 35m above LAT). At PEIR the air gap was 22m above HAT which was set at a value greater than the minimum required for shipping and navigation safety to reduce the potential collision risk for offshore ornithology receptors. Between PEIR and the production of the ES, the air gap has been further increased to 25m above HAT in response to consultation feedback, providing further reduction of potential collision risk for offshore ornithology receptors.
Best practice protocol for minimising disturbance to red-throated diver and common scoter	Potential impacts on red-throated diver and common scoter during construction, operation and maintenance, and decommissioning works would be mitigated through: ▪ Restricting vessel movements where possible to existing navigation routes (where the densities of red-throated diver and common scoter are typically relatively low) ▪ As far as possible maintaining direct transit routes (to minimise transit distances through areas used by red-throated diver) ▪ Where it is necessary to go outside of established navigational routes, avoid rafting birds either en-route to the windfarm site from port and/or within the windfarm site (dependent on location) and where possible avoid disturbance to areas with consistently high bird densities ▪ Avoidance of over-revving of engines (to minimise noise disturbance) ▪ Briefing of vessel crew on the purpose and implications of these vessel management practices (through, for example, tool-box talks and issuing of 'Best Practice' guidance) The Project Team would make construction and maintenance vessel operators aware of the importance of these species and the associated mitigation measures through tool-box talks.

12.4 Impact assessment methodology

12.4.1 Policy, legislation and guidance

12.4.1.1 National Policy Statements

12.20 The assessment of potential effects on offshore ornithology has been made with specific reference to the relevant NPS. These are the principal decision-making documents for Nationally Significant Infrastructure Projects (NSIPs). Those relevant to the Project are:

- Overarching NPS for Energy (EN-1) (Department for Energy Security and Net Zero (DESNZ), 2023a)
- NPS for Renewable Energy Infrastructure (EN-3) (DESNZ, 2023b)

12.21 The specific assessment requirements for ornithology, as detailed in the NPS, are summarised in **Table 12.4**, together with an indication of the section of the ES chapter where each has been addressed.

Table 12.4 NPS assessment requirements

NPS requirement	NPS reference	ES reference
NPS for Energy (EN-1)		
Where the development is subject to EIA, the applicant should ensure that the ES clearly sets out any effects on internationally, nationally, and locally designated sites of ecological or geological conservation importance (including those outside England), on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity, including irreplaceable habitats.	Paragraph 5.4.17	Effects on offshore ornithology receptors and designated sites have been considered in **Sections 12.6** to **12.11.**
The applicant should show how the project has taken advantage of opportunities to conserve and enhance biodiversity and geological conservation interests.	Paragraph 5.4.19	This has been discussed throughout the assessment **Sections 12.6** to **12.10**.
The applicant should include appropriate mitigation measures as an integral part of the proposed development.	Paragraph 5.5.43	Embedded mitigation measures have been outlined in **Section 12.3.3**.
NPS for Renewable Energy (EN-3)		
Applicants should assess the potential of their proposed development to have net positive effects on marine ecology and biodiversity as well as negative effects.	Paragraph 2.11.40	This has been discussed throughout the assessment (**Section 12.6** to **Section 12.10**).
Any relevant data that has been collected as part of post-construction ecological monitoring from existing operational offshore wind farms should be referred to where appropriate.	Paragraph 2.8.106	Evidence from operational OWFs has been referred to throughout the assessment (**Section 12.6** to **Section 12.10**).
Applicants must undertake collision risk modelling, as well as displacement and population viability assessments for certain species of birds. Applicants are expected to seek advice from SNCBs.	Paragraph 2.8.144	Collision risk modelling has been undertaken as shown in **Section 12.6.3.2**. Displacement has been considered in all phases in **Section 12.6**. PVA has been undertaken for great

NPS requirement	NPS reference	ES reference
		black-backed gull cumulative collision risk; refer to **Section 12.7**. PVAs for SPA populations have been described in the RIAA.
Applicants should discuss the scope, effort and methods required for ornithological surveys with the relevant statutory advisor, taking into consideration baseline and monitoring data from operational windfarms.	Paragraph 2.8.143	Natural England were consulted on the survey programme by the Applicant, noting this was prior to the commencement of the EPP. Evidence from operational OWFs has been referred to throughout the assessment (**Section 12.6** to **Section 12.10**).
Applicants must undertake a detailed assessment of the offshore ecological, biodiversity and physical impacts of their proposed development, for all phases of the lifespan of that development, in accordance with the appropriate policy for offshore wind farm EIAs, HRAs and MCZ assessments. The assessment should be undertaken for all stages of the lifespan of the proposed wind farm in accordance with the appropriate policy and guidance for offshore wind farm EIAs.	Paragraph 2.8.101 and Paragraph 2.11.36	This has been discussed throughout the assessment **Sections 12.6** to **12.10**.

12.4.1.2 Additional relevant policy and guidance

12.22 In addition to the NPS, there are a number of pieces of guidance applicable to the assessment of offshore ornithology. These include:

- Chartered Institute of Ecology and Environmental Management (CIEEM) Guidelines for Ecological Impact Assessment in the UK and Ireland (CIEEM, 2018). The EIA methodology described in **Section 12.4.3** and applied in this chapter has been based on this guidance
- Guidance documents for the assessment of offshore windfarm impacts on offshore ornithology receptors produced by Natural England (Parker *et al*. 2022a, 2022b, 2022c)

12.23 A wide range of additional guidance has been referred to throughout the assessment as required.

12.24 Further detail has been provided in **Chapter 3 Policy and Legislation** (Document Reference 5.1.3). Of particular relevance to the ornithological assessment were:

- European Commission (EC) Directive 92/43/EEC (the Habitats Directive) and EC Directive 2009/147/EC on the conservation of wild birds (the Birds Directive). These Directives have been transposed into English and Welsh law by the Conservation of Habitats and Species Regulations 2017 (as amended) and Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended) ('the Habitats Regulations')
- The Convention on Wetlands of International Importance (Ramsar Convention)
- The Wildlife and Countryside Act 1981 (as amended)
- Marine and Coastal Access Act 2009

12.4.2 Data and information sources

12.4.2.1 Site-specific surveys

12.25 To provide site specific information on which to base the offshore ornithology impact assessment, site characterisation surveys of the Project study area (**Figure 12.1**) commenced in March 2021 and were concluded in February 2023. These surveys were undertaken once per month throughout this period (with two surveys undertaken in February 2023 due to unsuitable weather in January 2023), for a total of 24 months. The methodology employed was a digital aerial survey, using video.

12.26 Further information on the survey programme is provided in **Appendix 12.1** and **Appendix 12.2**.

12.4.2.2 Other available sources

12.27 Other data sources that have been used to inform the baseline and assessment have included:

- Sensitivity of birds to offshore windfarms (OWFs) (Wade *et al*., 2016; Furness *et al*., 2013; Furness and Wade, 2012; Langston, 2010; Stienen *et al*., 2007; Drewitt and Langston, 2006; Garthe and Hüppop, 2004)
- Displacement and barrier effects on birds (UK Statutory Nature Conservation Bodies (SNCBs), 2022; Dierschke *et al*., 2016; Masden *et al*., 2012, 2010; Speakman *et al*., 2009)
- Collision risk modelling, flight heights and flight behaviour in the vicinity of wind turbine generators, and avoidance rates for birds and OWFs, including the Band deterministic model, the stochastic model and the migratory species model (Ozsanlav-Harris *et al*., 2022; Natural England 2022; Tjørnløv *et al*., 2021; Bowgen and Cook, 2018; McGregor *et al*., 2018; Skov *et al*. 2018; Cook *et al*., 2014; Johnston *et al*., 2014a and b; SNCBs, 2014; Band, 2012; Wright *et al*., 2012; Cook *et al*., 2012, Parker *et al*., 2022c)
- Population viability analysis modelling tool for seabirds (Searle *et al*., 2019)
- Seabird foraging ranges and distribution at sea (Cleasby *et al*., 2018; Waggitt *et al*., 2019; Woodward *et al*., 2019; Wakefield *et al*., 2017, 2013; Kober *et al*., 2010; Stone *et al*., 1995) including specific surveys and studies relevant to SPA populations in the eastern Irish Sea (Clewley *et al*., 2021, 2017; Natural England, NRW and Joint Nature Conservation Committee (JNCC), 2016, Johnston *et al*., 2022, Lawson *et al*., 2016, Natural England and Countryside Council for Wales (CCW), 2010, Dean *et al*., 2013, 2015, Mackey and Giminez (undated))
- Bird population estimates (Furness, 2015; Mitchell *et al*., 2004; JNCC seabird monitoring programme database; designated site citations/departmental briefs/conservation advice from the websites of SNCBs)
- Relevant documents from applications for other OWFs in UK offshore waters, in particular the Irish Sea
- Relevant ecological studies for species included in EIA including peer reviewed scientific papers and 'grey' literature

12.4.3 Impact assessment methodology

12.28 **Chapter 6 EIA Methodology** provides a summary of the general impact assessment methodology applied to the Project. The following sections outline the methodology used to assess the potential effects on ornithology.

12.29 The impact assessment has been undertaken in line with the most recent guidance (CIEEM, 2018), and informed by expert opinion where necessary.

Key guidance documents on specific areas of the assessment such as estimating displacement (SNCBs, 2022) and collision risk (Band, 2012; McGregor *et al*., 2018; SNCBs, 2014; Wright *et al*., 2012) have also been utilised, as appropriate.

12.30 The assessment approach used the 'Source-Pathway-Receptor' model. The model identifies likely environmental effects on ornithology receptors resulting from the proposed construction, operation and maintenance and decommissioning of the Project infrastructure. This process provides an easy to follow assessment route between impact sources and potentially sensitive receptors, ensuring a transparent impact assessment. The parameters of this model have been defined as follows:

- **Source** – the origin of a potential impact (noting that one source may have several pathways and receptors) e.g. an activity such as cable installation and a resultant effect such as re-suspension of sediments
- **Pathway** – the means by which the effect of the activity could impact a receptor e.g. for the example above, re-suspended sediment could settle and smother the sea bed
- **Receptor** – the element of the receiving environment that is impacted e.g. for the above example, bird prey species living on or in the sea bed are unavailable to foraging birds

12.31 For each impact, the assessment identifies receptors sensitive to that impact and implements a systematic approach to understanding the impact pathways and the level of effect on given receptors.

12.4.3.1 Definitions of sensitivity, value and magnitude

Sensitivity

12.32 The sensitivity of a receptor is an expression of the likelihood of change to it when a pressure (i.e. a predicted impact) is applied. It is defined by the tolerance (or lack thereof) of a receptor to a particular impact, along with the capacity for recovery of the receptor. Definitions of tolerance for offshore ornithology receptors are presented in **Table 12.5**, whilst capacity for recovery definitions are presented in **Table 12.6**. A matrix showing how the definitions for tolerance and recovery can be combined to estimate receptor sensitivity is provided in **Table 12.7.**

12.33 The majority of seabirds have a low capacity for recovery, given that they are long-lived species with extensive maturation periods, low natural adult mortality levels and low fecundity. Approximate definitions for overall sensitivity are provided in **Table 12.8** using the impact example of disturbance due to construction activity, noting that the matrix is used as a guide only where sensitivity is above a negligible level.

12.34 Species assessed for potential effects are those which have been recorded during surveys and which were considered to be at potential risk either due to their abundance, conservation importance and/or potential sensitivity to OWF impacts. However, where appropriate, the assessment also considered species which may not have been recorded during baseline surveys, but were considered likely to use the study area, and the habitats surrounding them (e.g. migratory birds).

Table 12.5 Definition of tolerance for an offshore ornithology receptor

Tolerance	Definition
High	No or minor adverse change (which may not be detectable against existing variation) in key functional and physiological attributes through direct effects, because the receptor can avoid/adapt to/accommodate it.
Medium	Moderate decline in key functional and physiological attributes through direct mortality, reduced reproductive success, or other effects impacting receptor fitness. The receptor is less able to avoid/adapt to/accommodate the pressure.
Low	Substantial decline in key functional and physiological attributes through direct mortality, reduced reproductive success, or other effects impacting receptor fitness. The receptor is not able to avoid/adapt to/accommodate the pressure.

Table 12.6 Definition of recovery levels for an offshore ornithology receptor

Recovery	Definition
High	Short lived receptor (up to five years), first breeding within approximately one year, high natural annual adult mortality (>25%), high annual reproductive output (> five chicks per pair).
Medium	Moderately short lived receptor (approximately five to ten years), first breeding within two to three years, moderate natural annual adult mortality (15-25%), moderate annual reproductive output (two to five chicks per pair).
Low	Long lived receptor (more than ten years), first breeding in excess of three years, low natural annual adult mortality (<15%), low annual reproductive output (< two chicks per pair).

Table 12.7 Tolerance and capacity recovery matrix for determination of sensitivity of ornithological receptors

	Low tolerance	Medium tolerance	High tolerance
Low recovery	High	Medium	Low
Medium recovery	Medium	Medium	Low
High recovery	Low	Low	Low

Table 12.8 Definitions of sensitivity for an offshore ornithology receptor

Sensitivity	Definition
High	Receptor has very limited tolerance of a potential impact, e.g. strongly displaced by sources of disturbance such as noise, light, vessel movements and the presence of people
Medium	Receptor has limited tolerance of a potential impact, e.g. moderately displaced by sources of disturbance such as noise, light, vessel movements and the presence of people
Low	Receptor has some tolerance of a potential impact, e.g. partially displaced by sources of disturbance such as noise, light, vessel movements and the presence of people
Negligible	Receptor is generally tolerant of a potential impact e.g. not displaced by sources of disturbance such as noise, light, vessel movements and the presence of people

12.35 The sensitivity of each ornithological receptor to each impact pathway has been estimated by information identified by a literature review. The overall confidence in the information used to define the sensitivity of each seabird receptor has also been qualitatively assessed. This is a method adapted from Pérez-Domínguez *et al*. (2016), and consists of considering three aspects of an evidence base with regard to sensitivities to particular impacts:

- Quality of information: highest quality information from peer reviewed papers (either observation or experimental), or grey literature from reputable sources, with heavier reliance on grey literature and/or expert judgement being considered to represent a lower quality evidence base
- Applicability of evidence: evidence based on the same impacts arising from similar activities on the same species in the same geographical area is considered evidence with the highest associated confidence, followed by similar pressures/activities/species in other areas, followed by proxy information
- Concordance: situations where different evidence sources are in broad agreement in terms of sensitivity and magnitude of impact result in a higher confidence, compared to a situation where evidence is only in partial agreement, or not in agreement at all.

12.36 Whilst efforts have been made to estimate the sensitivity of all ornithology receptors, if no evidence existed, a receptor has been characterised as “not assessed". Where insufficient evidence existed to complete the sensitivity assessment, but there were concerns over potential impacts, receptors have been classed as "sensitive".

Conservation value

12.37 The conservation value (referred to as 'importance' under CIEEM guidelines, 2018) of species has been used to provide additional context to the impact assessment and may be used to refine predictions as appropriate. It was not a key input into the impact assessment process, as there has been a tendency for overreliance on conservation value to underestimate potential impacts on receptors with a lower conservation value (Box *et al*., 2017). For example, high conservation value and high sensitivity are not necessarily linked for a particular impact. A receptor could be of high conservation value (e.g. a qualifying feature of a SPA) but have a low or negligible physical/ecological sensitivity to an effect.

12.38 The conservation value of ornithological receptors is based on the population from which individuals are predicted to be drawn, reflected in the current understanding of the movements of bird species. Conservation value for a species can vary through the year depending on the relative sizes of the number of individuals predicted to be at risk of impact and the population from which they are predicted to be drawn. Ranking therefore corresponds to the degree of connectivity which was predicted between the Project and protected populations. Using this approach, the conservation importance of a species seen at different times of year may fall into any of the defined categories. Population status was also taken into account in the assessment. For example, effects on a declining species may be of more concern than those on an increasing species.

12.39 Example definitions of the conservation value levels for ornithology receptors are given in **Table 12.9**. These are related to connectivity with populations that are protected as qualifying species of SPAs, proposed SPAs (pSPAs) or Ramsar sites, which are internationally designated sites carrying strong protection for populations of qualifying bird species.

Table 12.9 Example definitions of the different conservation values for an offshore ornithology receptor

Conservation value	Definition
High	A receptor population for which individuals at risk can be clearly connected to a particular conservation site of international or national importance.
Medium	A receptor population for which individuals at risk may be drawn from particular conservation site of international or national importance, although other populations may also contribute to individuals at risk.

Conservation value	Definition
Low	A receptor population for which individuals at risk have no known connectivity to conservation sites of international or national importance.

Impact magnitude

12.40 The definitions of the impact magnitude levels (both adverse and beneficial) for offshore ornithology receptors are set out in **Table 12.10**. Generally, based on findings from population viability analyses for bird species, it would be considered that increases in mortality rates of less than 1% would be undetectable in terms of changes in population size. This has been used as a guide to define effect magnitudes throughout the assessment.

Table 12.10 Definition of magnitude for an offshore ornithology receptor

Magnitude	Definition
High	A change that is predicted to irreversibly alter the receptor population in the short term (over part of the project duration, e.g. during construction) to long term (over the duration of the project or beyond), and to alter the long term viability of the receptor population and/or the integrity of a protected site.
Medium	A change that occurs in the short and long term, but which is not predicted to alter the long-term viability of the receptor population and/or the integrity of a protected site.
Low	A change that is sufficiently small scale or of short duration to cause no long term harm to the receptor population and/or the integrity of a protected site.
Negligible	A very slight change that is sufficiently small scale or of such short duration that it may be undetectable in the context of natural variation.

Effect significance

12.41 The potential significance of effect for a given impact, is a function of the sensitivity of the receptor and the magnitude of the impact (see **Chapter 6 EIA Methodology** for further details). A matrix is used (**Table 12.11**) as a framework to determine the significance of an effect. Definitions of each level of significance are provided in **Table 12.12**. Impacts and effects may be deemed as being either positive (beneficial) or negative (adverse).

12.42 It is important that the matrix (and indeed the definitions of sensitivity and magnitude) is seen as a framework to aid understanding of how a judgement has been reached from the narrative of each effect assessment and it is not a prescriptive formulaic method.

12.43 Potential effects are described followed by a statement of whether the effect is significant in terms of the EIA regulations. Potential effects identified within the assessment as major or moderate are regarded as significant in terms of the EIA regulations. Whilst minor effects (or below) are not significant in EIA terms in their own right, it is important to distinguish these as they may contribute to significant effects cumulatively or through interactions.

12.44 Following initial assessment, if the effect does not require additional mitigation (or none is possible), the residual effect will remain the same. If, however, additional mitigation is proposed there will be an assessment of the post-mitigation residual effect.

Table 12.11 Significance of effect matrix

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

Table 12.12 Definition of effect significance

Significance	Definition
Major	Very large or large change in receptor condition, both adverse or beneficial, which are likely to be important considerations at a regional or district level because they contribute to achieving national, regional or local objectives, or could result in exceedance of statutory objectives and/or breaches of legislation.
Moderate	Intermediate change in receptor condition, which are likely to be important considerations at a local level.
Minor	Small change in receptor condition, which may be raised as local issues.
Negligible	No discernible change in receptor condition.
No change	No impact, therefore, no change in receptor condition.

12.4.4 Cumulative effects assessment methodology

12.45 The CEA (**Section 12.7**) considered other plans, projects and activities (including other offshore windfarms, marine aggregate extraction areas, oil and gas exploration and extraction, subsea cables and pipelines and commercial shipping) that may impact cumulatively with the Project. As part of this process, the assessment considered which of the residual impacts assessed for the Project on its own had the potential to contribute to a cumulative effect. **Chapter 6 EIA Methodology** provides further details of the general framework and approach to the CEA.

12.46 A key aspect of the CEA was the approach to assess impacts from historic offshore wind projects for which quantitative analyses were not undertaken at the time of the assessment and/or consent of those historic projects. During the Section 42 consultation, Natural England and NRW did not consider it appropriate to base the cumulative (and hence also in-combination) assessments on many 'unknowns' for impacts from many of the historical offshore wind projects (see **Table 12.1**). Specifically, Natural England stated that *"the cumulative (and in-combination) assessments do not factor in impacts from a number of other projects due to a lack of data. Unknown impacts have been treated as zero, which will inevitably underestimate impacts, potentially significantly. A qualitative assessment is mentioned for consideration of some projects, but this process is not detailed, or the results fully presented. Natural England consider this approach to be unacceptable, and hence consider it inappropriate to comment on the potential significance of cumulative (or in-combination) presented in the PEIR submission"*.

12.47 Natural England subsequently provided advice (dated 12th October 2023) on 'gap filling' for historical offshore wind projects, where fully quantitative assessments have not previously been provided. This recommended a two-step approach, the first of which was to obtain abundance data for historical offshore windfarm projects from ES chapters or other relevant documents and use this to run cumulative displacement and collision mortality assessments. If no quantitative data were available, the second recommended step was to use nearby windfarms with published estimates of mortality as proxies, scaled according to windfarm size and turbine specifications.

12.48 The first step recommended by Natural England has been used in the CEA, with collision mortality and abundance data obtained from project-specific documentation to derive cumulative collision and displacement mortality estimates. Qualitative assessments for historical offshore windfarm projects, for which quantitative consideration of collision and displacement impacts was not undertaken in project-specific documentation, have also been presented. Estimating impacts for these projects using nearby windfarms as proxies has not been undertaken; the Applicant does not consider it appropriate to apply proxy data to another windfarm in the area, as this would have been collected over a specific temporal and spatial scale relevant to that project.

12.49 Historic projects approaching end-of-life with limited (or no) overlap with the Project timeframe have been removed from the CEA, in accordance with Natural England advice. Therefore, three offshore windfarms with end-of-life prior to 2030 have been removed from the CEA (Arklow Bank Phase 1, Barrow and North Hoyle).

12.4.5 Transboundary effects assessment methodology

12.50 **Chapter 6 EIA Methodology** provides details of the general framework and approach to the assessment of transboundary effects.

12.51 For offshore ornithology the potential for transboundary effects (**Section 12.8**) has been identified in relation to potential linkages to non-UK (including Isle of Man (which is not a European Economic Area (EEA) state and not a formal transboundary consultee) and Republic of Ireland (RoI)) OWF projects, protected sites and sites with large concentrations of breeding, migratory or wintering birds (including the use of available information on tagged birds).

12.4.6 Assumptions and limitations

12.52 The assessment process contains a wide range of sources of uncertainty. These include the process of estimating seabird density and abundance estimates from baseline survey data, estimated values for seabird flight characteristics to be used in displacement modelling (e.g. displacement and mortality rates), CRM (e.g. flight height distributions, avoidance rates, bird size, flight speeds, bird behaviour), and the parameters of the turbines. This is not an exhaustive list. However, the assessment approach accorded with best practice and guidance (e.g. Parker *et al*. 2022c; SNCBs 2022), and has been based on the best currently available scientific information. Overall, it is considered that the assessment conclusions were precautionary.

12.53 Aerial surveys to inform the assessment baseline could not be undertaken in January 2023 due to poor weather. An additional survey was therefore undertaken in early February 2023, with a further survey later that month, to ensure that 24 surveys were completed. This was not considered to be a significant limitation to the baseline data and was discussed with Natural England and no concerns were raised during the ETG process.

12.54 The assumptions and limitations of the assessment have been discussed throughout the chapter where they apply.

12.5 Existing environment

12.55 The characterisation of the existing or baseline environment has been undertaken based on site-specific baseline surveys (**Section 12.4.2.1** and **Appendix 12.2**), along with a desk study which considered available relevant literature. The following sections summarise the species recorded during surveys, and present information from relevant literature to establish the likely level of importance of the study area to the species recorded. Finally, to provide further context, a review of existing pressures on the wider environment has been provided.

12.5.1 Study area

12.56 The study area within which aerial surveys have been undertaken comprised the windfarm site and a hybrid 4km to 10km buffer, as described in **Section 12.3.1** and shown on **Figure 12.1**. The study area followed best practice (i.e. as set out in advice from Natural England (2022a)) but was adapted to reflect the species that could occur on the site. A 4km buffer around a windfarm site was considered to be the minimum requirement to inform an ES, but 10km has been recommended 'for use in site characterisation where an array is within 10km of a SPA designated for non-breeding red-throated diver' (Parker *et al*., 2022a). Accordingly, the buffer was extended to 10km to the north and east of the windfarm site, where this buffer overlapped with Liverpool Bay SPA (for which red-throated diver is a qualifying species). There was no requirement to extend the buffer beyond 4km for areas outside of Liverpool Bay SPA, i.e. to the south and west of the windfarm site, as the presence of red-throated divers associated with Liverpool Bay SPA was not considered likely in this area. Accordingly, areas within the windfarm site and 4km buffer have been considered within the ES, while the areas within 10km of the windfarm site, where these overlap with Liverpool Bay SPA, are considered in the assessment for red-throated diver presented in the RIAA. This approach was discussed and agreed with Natural England as part of the ETG process. Natural England have confirmed through the ETG process that a 4km buffer was acceptable to assess impacts on red-throated diver within the EIA. Impacts within the 10km buffer overlapping Liverpool Bay SPA have been considered separately in the RIAA.

12.57 The assessment on ornithological receptors, set out in **Section 12.6**, utilised context-specific distances within the study area relevant to the impact pathway and affected species. This approach was in accordance with relevant best practice guidance (Parker *et al*., 2022c), and the population and density estimates used for each species-impact pathway assessment reflect the appropriate buffer used (i.e. windfarm site only, or windfarm site +2km/+4km buffers). The distances used in the assessment are provided in **Table 12.13**.

Table 12.13 Species-specific buffer/distances used for different impact pathways in the assessment

Development phase	Impact pathway	Species	Relevant distance/buffer
Construction and decommissioning	Disturbance, displacement and barrier effects	Red-throated diver	4km
		Common scoter	4km
		Other species	2km
	Indirect effects	All	Windfarm site only
Operation and maintenance	Disturbance, displacement and barrier effects	Red-throated diver	4km
		Common scoter	4km
		Other species	2km
	Collision	All	Windfarm site only
	Indirect effects	All	Windfarm site only

12.5.2 Relative importance of the study area

12.58 The relative importance of the region within which the Project would be situated to the species recorded has been investigated. The purpose of this was to provide context of the importance of the windfarm site, and the wider study area to offshore ornithology receptors. This also enables comment on whether the data collected by the baseline survey programme aligns with existing available information for the area.

12.59 A modelled at-sea dataset which provided details of density and distribution of several offshore ornithology receptors across the north east Atlantic Ocean (Waggitt *et al.*, 2019), indicated that for many offshore ornithology receptors recorded during the baseline surveys, the Project area was relatively unimportant in the context of the large area considered by the Waggit study. None of the 12 seabird species examined by Waggitt *et al.* (2019), which were considered to provide the best available broad-scale information on seabird distribution for UK waters, would be expected to occur in large numbers in the area occupied by the windfarm site during the breeding season. This is reflected by the fact that there are a limited number of large seabird breeding colonies within foraging range of the Project. Exceptions with respect to species included within this study were herring gull and lesser black-backed gull. These species breed in relatively modest numbers along the western Irish Sea coast, with notable concentrations around the Ribble Estuary; lesser black-backed gull is a qualifying species of Morecambe Bay and Duddon Estuary SPA and Ribble and Alt Estuaries SPA. These breeding locations lie within the mean maximum foraging range of the Project (Woodward *et al.*, 2019). Data presented in Waggitt *et al.* (2019) showed a concentration of these species on the coast adjacent to the Ribble Estuary during the breeding season, with the concentration of birds extending towards, but outside of, the windfarm site. Low densities of both species occurred during the non-breeding season.

12.60 Liverpool Bay SPA adjoins the windfarm site on its eastern boundary, and has been designated for its red-throated diver, common scoter and little gull populations during the non-breeding period, and common tern and little tern during the breeding season. The SPA formerly covered a smaller area to the east of the current boundary (i.e. not adjoining the windfarm site), and at that time the boundary was defined by the distribution of non-breeding common scoter and red-throated diver (Natural England *et al.*, 2016). Following site reclassification in October 2017, the SPA boundary was extended to the eastern boundary of the windfarm site by the addition of little gull as a qualifying feature, together with small extensions on the landward edge of the SPA around little tern and common tern breeding areas. Accordingly, the areas adjacent to the windfarm site are not considered to be of high importance for red-throated diver and common scoter. The baseline aerial surveys recorded little gulls in very low numbers during the non-breeding season, and the windfarm site would be outside the mean maximum foraging distance (based on Woodward *et al*., 2019) from known little and common tern breeding colonies. More recent abundance, density and distribution data for Liverpool Bay SPA, covering the original SPA boundary for the period 2015-2020, have recently been published by Natural England (HiDef Aerial Surveying Limited, 2023) and have been used to inform the impact assessment.

12.61 It is expected that a wide range of migratory birds (including seabirds and non-breeding waterbirds) may pass through the windfarm site during the autumn and spring migration seasons. These birds may be associated with nearby designated sites, such as Morecambe Bay and Duddon Estuary SPA and Ribble and Alt Estuaries SPA. Such birds move across seas in large numbers but over a short time period, often at night and sometimes in bad weather, so have often not been adequately recorded by baseline surveys (Wright *et al.*, 2012). Therefore, while these species were not recorded during Project surveys, they have been considered within the assessment.

12.62 Overall, whilst there were clearly a number of offshore ornithology receptors that required detailed consideration in this assessment, existing information indicated that generally, the study area did not seem to be of particularly high importance to seabirds at any time of year relative to some other areas in the wider Irish Sea, UK waters, and the northeast Atlantic.

12.5.3 Offshore ornithology receptors recorded during baseline surveys

12.5.3.1 Overview

12.63 Seabird species recorded by the site-specific digital video aerial surveys are listed in **Table 12.14** along with details of whether they were listed on Annex I of the Birds Directive, and their Birds of Conservation Concern (BoCC) status (Stanbury *et al.*, 2021).

Table 12.14 Seabird species recorded in the study area, along with information on their conservation status

Common name	Scientific name	Conservation status[5]
Arctic skua	*Stercorarius parasiticus*	BoCC Red
Arctic tern	*Sterna paradisaea*	Annex I, BoCC Amber
Black-headed gull	*Chroicocephalus ridibundus*	BoCC Amber
Common gull	*Larus canus*	BoCC Amber
Common scoter	*Melanitta nigra*	BoCC Red
Common tern	*Sterna hirundo*	Annex I, BoCC Amber
Cormorant	*Phalacrocorax carbo*	BoCC Green
Fulmar	*Fulmarus glacialis*	BoCC Amber
Gannet	*Morus bassanus*	BoCC Amber
Great black-backed gull	*Larus marinus*	BoCC Amber
Great skua	*Stercorarius skua*	BoCC Amber
Guillemot	*Uria aalge*	BoCC Amber
Herring gull	*Larus argentatus*	BoCC Red
Kittiwake	*Rissa tridactyla*	BoCC Red
Lesser black-backed gull	*Larus fuscus*	BoCC Amber
Little gull	*Hydrocoloeus minutus*	Annex I, BoCC Green
Manx shearwater	*Puffinus puffinus*	BoCC Amber
Puffin	*Fratercula arctica*	BoCC Red
Razorbill	*Alca torda*	BoCC Amber
Red-throated diver	*Gavia stellata*	Annex I, BoCC Green

[5] BoCC status (Stanbury *et al.*, 2021) uses a range of standardised criteria to establish the level of conservation concern (Red, Amber or Green) for UK bird species. Criteria include international conservation status, population and breeding range decline, and rarity. Annex I species are those listed on the Birds Directive as threatened because of a danger of extinction, risk to their habitat, restricted/small population, or have particular specific habitat needs.

Common name	Scientific name	Conservation status[5]
Sandwich tern	*Thalasseus sandvicensis*	Annex I, BoCC Amber
Shag	*Phalacrocorax aristotelis*	BoCC Red

12.64 Full details on the seabird species recorded during the baseline surveys (**Table 12.14**) have been presented in **Appendix 12.1**. This includes the seasons in which they were present, the abundance at which they were recorded across the study area, and the apportioning of seabirds to particular populations, with justification. The latter was essential for the impact assessment presented in **Section 12.6**, which placed predicted seasonal mortality into context by comparing it to relevant background populations, and the predicted increase in background mortality which could result.

12.5.3.2 Biologically relevant seasons

12.65 Impacts have been assessed in relation to relevant biological seasons, as defined by Furness (2015) for the majority of species. These are presented for relevant offshore ornithology receptors in **Table 12.15**. These seasonal definitions included overlapping months in some instances, due to variation in the timing of migration for birds which breed at different latitudes (i.e. individuals from breeding sites in the north of the species' range may still be on spring migration when individuals farther south have already commenced breeding). Where the full breeding season overlapped other seasons, impacts have been apportioned to the breeding season unless otherwise stated. The use of particular seasons and reference populations varied by species and is discussed below.

12.5.3.3 Species abundance and seasonal distribution

12.66 Monthly peak abundances and seasonal distribution of species recorded within the windfarm site and 4km buffer are provided in **Table 12.16.** This information has been included to provide an overview of the relative abundance of species recorded within the windfarm site and surrounding areas. Density and abundance estimates for the windfarm site and all buffers are provided in **Appendix 12.2** (Annex III-VI). The methods used to calculate species densities and abundances (including apportioning of unidentified birds) are also presented in **Appendix 12.2.**

Table 12.15 Biologically relevant seasons for offshore ornithology receptors

Species	Breeding season[6]	Migration-free breeding[6]	Autumn migration[6]	Non-breeding/ winter[6]	Spring migration[6]	Non-breeding[6]	Source
Arctic skua	May-Jul	Jun-Jul	Aug-Oct	Nov-Mar	Apr-May	Aug-Apr	Furness (2015)
Arctic tern	May-e.Aug	Jun	Jul-e.Sept	Oct-Mar	Apr-May	m.Aug-Apr	Furness (2015)
Black-headed gull	April-Aug	-	-	-	-	Sept-Mar	NatureScot (2020)
Common gull	Apr-Aug	-	-	-	-	Sept-Mar	NatureScot (2020)
Common scoter	-	-	-	-	-	Jul-Apr	NatureScot (2020)
Common tern	May-Aug	Jun-m.Jul	l.Jul-e.Sept	Oct-Mar	Apr-May	Sept-Apr	Furness (2015)
Cormorant	Apr-Aug	May-Jul	Aug-Oct	Nov-Jan	Feb-Apr	Sept-Mar	Furness (2015)
Fulmar	Jan-Aug	Apr-Aug	Sept-Oct	Nov	Dec-Mar	Sept-Dec	Furness (2015)
Gannet	Mar-Sept	Apr-Aug	Sept-Nov	-	Dec-Mar	Oct-Feb	Furness (2015)
Great black-backed gull	l.Mar-Aug	May-Jul	Aug-Nov	Dec	Jan-Apr	Sept-Mar	Furness (2015)
Great skua	May-Aug	May-Jul	Aug-Oct	Nov-Feb	Mar-Apr	Sept-Apr	Furness (2015)
Guillemot	Mar-Jul	Mar-Jun	Jul-Oct	Nov	Dec-Feb	Aug-Feb	Furness (2015)
Herring gull	Mar-Aug	May-Jul	Aug-Nov	Dec	Jan-Apr	Sept-Feb	Furness (2015)
Kittiwake	Mar-Aug	May-Jul	Aug-Dec	-	Jan-Apr	Sept-Feb	Furness (2015)
Lesser black-backed gull	Apr-Aug	May-Jul	Aug-Oct	Nov-Feb	Mar-Apr	Sept-Mar	Furness (2015)
Little gull	Apr-Jul	May-Jul	-	-	-	Aug-Apr	Cramp and Simmons (1983)

[6] Prefixes indicate early in month (“e.”), mid-month (“m.”) and late in month (“l.”).

Species	Breeding season[6]	Migration-free breeding[6]	Autumn migration[6]	Non-breeding/ winter[6]	Spring migration[6]	Non-breeding[6]	Source
Manx shearwater	Apr-Aug	Jun-Jul	Aug-e.Oct	m.Oct-m.Mar	l.Mar-May	Sept-Mar	Furness (2015)
Puffin	Apr-e.Aug	May-Jun	l.Jul-Aug	Sept-Feb	Mar-Apr	m.Aug-Mar	Furness (2015)
Razorbill	Apr-Jul	Apr-Jun	Aug-Oct	Nov-Dec	Jan-Mar	Aug-Mar	Furness (2015)
Red-throated diver	Mar-Aug	May-Aug	Sept-Nov	Dec-Jan	Feb-Apr	Sept-Feb	Furness (2015)
Sandwich tern	Apr-Aug	Jun	Jul-Sept	-	Mar-May	Sept-Mar	Furness (2015)
Shag	Feb-Aug	Mar-Jul	Aug-Oct	Nov	Dec-Feb	Sept-Jan	Furness (2015)

*Table 12.16 Apportioned population estimates (with 95% confidence intervals in parentheses) within the windfarm site and 4km buffer area in 24 months of baseline surveys (March 2021 to February 2023), with species-specific seasons delineated by shading (see * at bottom of table)*

Species	Year	J**	F	M	A	M	J	J	A	S	O	N	D
Arctic skua	Mar 21-Feb 22	0	0	0	0	0	0	0	0	0	0	0	0
	Mar 22-Feb 23	0	0	0	0	0	0	0	0	4 (0 – 12)	0	0	0
Arctic tern	Mar 21-Feb 22	0	0	0	0	0	0	0	13 (0 – 36)	9 (0 – 18)	0	0	0
	Mar 22-Feb 23	0	0	0	0	127 (57 – 200)	0	0	0	0	0	0	0
Black-headed gull	Mar 21-Feb 22	0	4 (0 – 12)	0	0	0	0	0	0	0	0	0	0

Species	Year	J**	F	M	A	M	J	J	A	S	O	N	D
	Mar 22-Feb 23	0	0	4 (0 – 12)	5 (0 – 12)	0	0	0	0	0	0	4 (0 – 12)	0
Common gull	Mar 21-Feb 22	70 (36 – 109)	37 (16 – 63)	57 (12 – 109)	0	5 (0 – 16)	0	0	0	7 (0 – 21)	16 (0 – 35)	17 (0 – 36)	57 (20 – 100)
	Mar 22-Feb 23	16 (0 – 36)	30 (9 – 58)	4 (0 – 12)	4 (0 – 12)	1 (0 – 1)	0	0	9 (0 – 24)	0	8 (0 – 20)	64 (27 – 108)	132 (93 – 171)
Common scoter	Mar 21-Feb 22	36 (0 – 108)	0	0	0	0	0	0	0	0	0	0	0
	Mar 22-Feb 23	9 (0 – 20)	0	5 (0 – 12)	5 (0 – 12)	0	0	0	0	0	0	0	51 (0 – 133)
Common tern	Mar 21-Feb 22	0	0	0	0	0	0	0	8 (0 – 24)	27 (5 – 57)	0	0	0
	Mar 22-Feb 23	0	0	0	0	14 (2 – 32)	0	0	0	4 (0 – 12)	0	0	0
Cormorant	Mar 21-Feb 22	0	0	0	0	0	0	0	0	0	0	0	0
	Mar 22-Feb 23	5 (0 – 13)	0	0	0	0	0	0	0	0	0	0	0
Dunlin	Mar 21-Feb 22	0	0	0	0	0	0	0	0	0	0	0	0
	Mar 22-Feb 23	0	0	0	0	26 (0 – 67)	0	0	0	0	0	0	0
Fulmar	Mar 21-Feb 22	0	0	9 (0 – 20)	4 (0 – 12)	0	0	0	31 (12 – 57)	0	0	0	0

Species	Year	J**	F	M	A	M	J	J	A	S	O	N	D
	Mar 22-Feb 23	0	0	0	8 (0 – 24)	97 (23 – 210)	0	12 (0 – 27)	0	0	0	12 (0 – 24)	0
Gannet	Mar 21-Feb 22	0	0	29 (4 – 63)	13 (0 – 28)	68 (28 – 117)	9 (0 – 20)	288 (215 – 384)	864 (621 – 1160)	158 (78 – 245)	13 (0 – 25)	13 (0 – 37)	0
	Mar 22-Feb 23	0	0	0	36 (4 – 88)	467 (136 – 908)	53 (24 – 88)	188 (111 – 280)	133 (87 – 182)	40 (16 – 68)	28 (8 – 49)	9 (0 – 20)	0
Great black-backed gull	Mar 21-Feb 22	8 (0 – 20)	4 (0 – 12)	0	0	5 (0 – 12)	0	16 (4 – 31)	4 (0 – 12)	17 (0 – 43)	4 (0 – 12)	6 (0 – 14)	0
	Mar 22-Feb 23	9 (0 – 24)			17 (0 – 44)	88 (8 – 216)	0	0	5 (0 – 12)	5 (0 – 13)	21 (4 – 40)	9 (0 – 20)	17 (0 – 41)
Great skua	Mar 21-Feb 22	0	0	0	0	4 (0 – 12)	0	0	5 (0 – 16)	0	0	0	0
	Mar 22-Feb 23	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	Mar 21-Feb 22	1870 (1192 – 2627)	2575 (1839 – 3401)	5557 (4478 – 6644)	1011 (861 – 1154)	715 (461 – 1028)	895 (581 – 1281)	7260 (6011 – 8479)	13110 (9325 – 17151)	640 (340-955)	4286 (3064 – 5650)	3257 (2439– - 4408	216 (128 – 333)
	Mar 22-Feb 23	939 (677 – 1195)	1031 (785 – 1280)	817 (495 – 1171)	1543 (1113 – 2057)	7639 (5207 – 11128)	3547 (2360 – 4882)	10929 (7957 – 14140)	11415 (10162-12929)	8957 (8136 – 9816)	7775 (6890 – 8766)	2737 (2217 – 3367)	3836 (3396 – 4338)

Species	Year	J**	F	M	A	M	J	J	A	S	O	N	D
Herring gull	Mar 21-Feb 22	43 (4 – 101)	33 (16 – 52)	134 (55 – 236)	13 (0 – 31)	0	9 (0 – 25)	12 (0 – 28)	48 (0 – 137)	178 (10 – 469)	49 (0 – 144)	28 (4 – 57)	17 (0 – 36)
	Mar 22-Feb 23	134 (12 – 350)	60 (16 – 130)	24 (8 – 44)	49 (18 – 84)	198 (44 – 460)	21 (4 – 40)	49 (12 – 104)	50 (0 – 142)	17 (4 – 32)	57 (0 – 151)	132 (52 – 232)	162 (97 – 246)
Kittiwake	Mar 21-Feb 22	27 (7 – 55)	53 (16 – 95)	611 (419 – 839)	221 (142 – 308)	423 (181 – 765)	417 (155 – 860)	217 (75 – 463)	2895 (681 – 5772)	3247 (1122 – 5937)	85 (40 – 135)	385 (243 – 563)	111 (76 – 144)
	Mar 22-Feb 23	105 (61 – 153)	236 (172 – 300)	511 (423 – 601)	998 (398 – 2060)	1015 (450 – 1968)	497 (362 – 633)	1290 (737 – 1987)	649 (473 – 850)	874 (564 – 1358)	317 (131 – 535)	433 (317 – 568)	386 (265 – 516)
Lesser black backed gull	Mar 21-Feb 22	5 (0 – 12)	17 (4 – 32)	5 (0 – 12)	0	4 (0 – 12)	0	33 (12 – 56)	129 (23 – 280)	136 (37 – 264)	5 (0 – 12)	0	0
	Mar 22-Feb 23	4 (0 – 12)	0	17 (0 – 36)	9 (0 – 20)	67 (13 – 148)	5 (0 – 12)	71 (34 – 115)	55 (20 – 97)	55 (8 – 119)	15 (0 – 40)	9 (0 – 20)	0
Little gull	Mar 21-Feb 22	12 (0 – 24)	13 (0 – 28)	36 (12 – 60)	0	0	0	0	0	0	0	13 (0 – 32)	9 (0 – 21)
	Mar 22-Feb 23	108 (43 – 185)	363 (196 – 554)	4 (0 – 12)	21 (8 – 36)	0	0	0	0	0	5 (0 – 13)	24 (4 – 49)	239 (170 – 308)
Manx shearwater	Mar 21-Feb 22	0	0	0	25 (0 – 60)	43 (8 – 92)	0	8699 (4654 – 13401)	3926 (2463 – 5760)	8 (0 – 21)	0	0	0

Species	Year	J**	F	M	A	M	J	J	A	S	O	N	D
	Mar 22-Feb 23	0	0	0	15 (0 – 33)	3697 (2183 – 5499)	2403 (711 – 4549)	1948 (1088 –2921)	3344 (2004 – 4847)	786 (98 – 2087)	0	0	0
Puffin	Mar 21-Feb 22	0	0	12 (3 – 22)	29 (5 – 58)	0	0	85 (50 – 123)	45 (19 – 77)	0	0	9 (2 – 20)	0
	Mar 22-Feb 23	0	0	0	16 (2 – 38)	33 (12 – 56)	12 (0 – 30)	0	0	3 (0 – 6)	16 (5 – 29)	41 (16 – 68)	0
Razorbill	Mar 21-Feb 22	164 (64 – 299)	524 (367 – 683)	736 (403 – 1181)	350 (150 – 606)	32 (11 – 62)	12 (0 – 29)	40 (15 – 73)	21 (1 – 49)	9 (0 – 24)	924 (555 – 1344)	471 (272 – 710)	126 (70 – 192)
	Mar 22-Feb 23	330 (197 – 482)	780 (543 – 1050)	525 (354 – 706)	265 (147 – 392)	175 (111 – 242)	255 (31 – 660)	35 (10 – 65)	0	1 (0 – 1)	799 (435 – 1275)	244 (127 – 373)	1282 (868 – 1702)
Red-throated diver (square brackets = windfarm site + 10km estimated population)	Mar 21-Feb 22	0 [0]	4 (0–-12) [9 (0–-20)]	0 [0]	0 [8 (0–-20)]	0 [0]	0 [0]	0 [0]	0 [0]	0 [0]	0 [0]	5 (0–-12) [8 (0–-20)]	12 (0 – 28) [51 (16–-90)]
	Mar 22-Feb 23	0 [24 (0–- 57)]	0 [24 (4–- 49)]	8 (0–-20) [64 (24–-116)]	0 [0]	0 [5 (0–-13)]	0 [0]	0 [0]	0 [0]	0 [0]	0 [0]	0 [5 (0–-13)]	12 (0 – 27) [5 (0 – 12)]

Species	Year	J**	F	M	A	M	J	J	A	S	O	N	D
Sandwich tern	Mar 21-Feb 22	0	0	0	0	0	0	0	0	43 (0 – 99)	13 (0 – 36)	0	0
	Mar 22-Feb 23	0	0	0	0	0	4 (0 – 12)	9 (0 – 31)	0	16 (0 – 36)	0	0	0
Shag	Mar 21-Feb 22	0	0	0	0	0	0	0	0	0	0	0	0
	Mar 22-Feb 23	0	0	0	0	0	0	0	8 (0 – 24)	0	0	0	0
Snipe *Gallinago gallinago*	Mar 21-Feb 22	0	0	0	0	0	0	0	0	0	8 (0 – 24)	0	0
	Mar 22-Feb 23	0	0	0	0	0	0	0	0	0	0	0	0

* For seabird species, dark blue = breeding season (full breeding season in all species), mid blue = migratory periods (months which do not overlap with the migration free or full breeding season), white = non-breeding / winter breeding season.

** The January 2023 survey was delayed to early February 2023 due to lack of available weather windows, therefore two surveys were carried out in February 2023 to compensate. This was discussed and agreed with Natural England via the ETG process. The early February 2023 survey data are presented in the January column, and the late February 2023 data are presented in the February column.

12.5.3.4 Demographic data

12.67 Demographic data for species scoped in for assessment for one or more potential impacts are provided in **Table 12.17**. As no information on seasonal population age structure was available from site data, it was necessary to calculate an average baseline mortality rate for all age classes for each species screened in for assessment. These were calculated using empirical information on the survival rates for each age class and their relative proportions in the wider population.

12.68 Demographic rates for each species from Horswill and Robinson (2015) were entered into a matrix population model. This was used to calculate the expected proportions in each age class. To obtain robust stable age class distributions for less well studied species (e.g. divers) the rates were modified to obtain a stable population size. Each age class survival rate was multiplied by its proportion and the total for all ages summed to give the average survival rate for all ages. Taking this value from 1 gives the average mortality rate.

Table 12.17 Average annual survival rates of offshore ornithology receptors across age classes, along with productivity and average mortality rate for entire population calculated using age-specific demographic rates and age class proportions

Species	Parameter	Age class 0-1	1-2	2-3	3-4	4-5	Adult	Productivity[7]	Average mortality
Arctic skua	Survival	0.346	0.346	0.346	0.346	-	0.910	0.487	0.519
	Proportion	0.150	0.090	0.090	0.090	-	0.580		
Arctic tern	Survival	0.441	0.837	0.837	0.837	-	0.837	0.380	0.217
	Proportion	0.135	0.060	0.050	0.042	-	0.713		
Black-headed gull	Survival	-	-	-	-	-	0.825	0.625	0.175
	Proportion	-	-	-	-	-	-		
Common gull	Survival	0.410	0.710	0.828	-	-	0.828	0.543	0.259
	Proportion	0.186	0.076	0.054	-	-	0.684		
Common scoter	Survival	0.749	0.749	-	-	-	0.783	1.838	0.238
	Proportion	0.352	0.264	-	-	-	0.384		
Common tern	Survival	0.441	0.441	0.850	-	-	0.883	0.764	0.268
	Proportion	0.235	0.104	0.046	-	-	0.615		
Cormorant	Survival	0.540	0.540	-	-	-	0.868	1.985	0.330
	Proportion	0.393	0.212	-	-	-	0.395		
Fulmar	Survival	0.260					0.936	0.419	0.181
	Proportion	0.173							

[7] Productivity is the estimated number of chicks fledged per pair, per annum.

Species	Parameter	Age class 0-1	1-2	2-3	3-4	4-5	Adult	Productivity[7]	Average mortality
Gannet	Survival	0.424	0.829	0.891	0.895	0.895	0.919	0.700	0.188
	Proportion	0.191	0.081	0.067	0.060	0.054	0.547		
Great black-backed gull	Survival	0.798	0.930	0.930	0.930	0.930	0.930	1.139	0.093
	Proportion	0.178	0.142	0.132	0.123	0.114	0.312		
Great skua	Survival	0.730	-	-	-	-	0.882	0.651	0.157
	Proportion	0.140	-	-	-	-	0.410		
Guillemot	Survival	0.560	0.792	0.917	0.939	0.939	0.939	0.672	0.143
	Proportion	0.173	0.097	0.077	0.071	0.066	0.516		
Herring gull	Survival	0.798	0.834	0.834	0.834	0.834	0.834	0.920	0.172
	Proportion	0.177	0.141	0.118	0.098	0.082	0.384		
Kittiwake	Survival	0.790	0.854	0.854	0.854	-	0.854	0.690	0.157
	Proportion	0.168	0.133	0.114	0.097	-	0.488		
Lesser black-backed gull	Survival	0.820	0.885	0.885	0.885	0.885	0.885	0.530	0.124
	Proportion	0.133	0.109	0.096	0.085	0.075	0.501		
Little gull	Survival	-	-	-	-	-	0.800	-	0.200
	Proportion	-	-	-	-	-	-		
Manx shearwater	Survival	0.870	0.870	0.870	0.870	0.870	0.870	0.697	0.130
	Proportion	0.149	0.129	0.113	0.098	0.085	0.427		
Puffin	Survival	-	-	0.709	0.760	0.805	0.906	0.617	0.866
	Proportion	0.180	-	0.068	0.068	0.068	0.550		

Species	Parameter	Age class 0-1	1-2	2-3	3-4	4-5	Adult	Productivity[7]	Average mortality
Razorbill	Survival	0.630	0.630	0.895	0.895	-	0.895	0.570	0.178
	Proportion	0.170	0.107	0.067	0.060	-	0.596		
Red-throated diver	Survival	0.600	0.620	-	-	-	0.840	0.571	0.233
	Proportion	0.196	0.118	-	-	-	0.686		
Sandwich tern	Survival	0.358	0.741	0.741	0.741	-	0.898	0.702	0.240
	Proportion	0.200	0.063	0.063	0.063	-	0.610		

Note: Values taken from Awel y Môr Offshore Wind Farm DCO submission (RWE, 2022); based on data from Horswill and Robinson (2015) and proportions of modelled populations from Furness (2015). Dash indicates immature age class does not apply to that species.

12.5.4 Existing pressures on wider environment and future baseline

12.69 There have been a number of pressures acting on offshore ornithology receptors in the Irish Sea and beyond, that would have the potential to affect the future baseline conditions within the study area in the absence of the Project. These include changes in prey availability, bycatch, invasive alien species, disturbance and displacement, collision risk and pollution (Dias *et al.*, 2019; Mitchell *et al.*, 2020; Royal HaskoningDHV, 2019).

12.70 A large body of evidence identified climate change as a major driver of seabird population demographics (Daunt *et al.*, 2017; Daunt and Mitchell, 2013; Mitchell *et al.*, 2020). Anthropogenic climate change has exposed ocean and coastal ecosystems to conditions that have been unprecedented over millennia, and this has greatly impacted life in the ocean and along its coasts (Intergovernmental Panel on Climate Change (IPCC), 2022). In the UK, seabird populations have generally been undergoing substantial declines, which have been occurring for at least two decades (Grandgeorge *et al.*, 2008; JNCC, 2020; Mitchell *et al.*, 2020). Whilst there were exceptions (for instance gannet), the wider population trend has been negative. This is reflected in the fact that according to the UK Marine Strategy, UK breeding seabirds have not achieved good environmental status (Department for Environment Food and Rural Affairs (DEFRA), 2019).

12.71 Climate change has the potential to impact seabird populations in two main ways; indirectly through prey availability impacts, and directly through impacts such as mortality or reduced breeding success due to extreme weather events. Whilst effects may not extend to all areas (e.g. some areas where prey recruitment may be less affected (ClimeFish, 2019; Frederiksen *et al.*, 2005)), climate models have generally predicted increased incidences of warming and extreme weather in the future (Palmer *et al.*, 2018). Indeed, such patterns have already been occurring (IPCC, 2021). This means that it is reasonable to assume that future trends would see effects on seabirds increase in both frequency and magnitude. Existing pressures on seabirds would therefore increase in future years as a direct consequence of climate change. Ocean conditions have been projected to continue diverging from a pre-industrial state, increasing risk of regional extirpations and global extinctions of marine species (IPCC, 2022).

12.72 In general, as mean breeding season temperatures have increased due to climate change, it seems some seabirds have struggled to find sufficient food for their chicks (Brander *et al.*, 2016). A range of interactions between prey availability and climate change have been demonstrated which explained these observations (Lindegren *et al.*, 2018; MacDonald *et al.*, 2019, 2018, 2015; Régnier *et al.*, 2019; Sandvik *et al.*, 2012, 2005; Wright *et al.*, 2018). In some cases, links have also been established between population declines and the rate of warming caused by climate change, rather than warming itself (Descamps *et al.*, 2017).

12.73 With respect to direct impacts, it is apparent that seabirds are susceptible to substantial population-level impacts due to poor weather and extreme weather events (Daunt *et al.*, 2017; Daunt and Mitchell, 2013; Jenouvrier, 2013; Mitchell *et al.*, 2020; Morley *et al.*, 2016; Newell *et al.*, 2015). The mechanisms by which these effects can manifest include chilling of eggs and killing of unfledged chicks during the breeding season, and impairment of foraging, which can occur at all times of year.

12.74 Whilst the significance of climate change impacts likely exceeds any other factor for a wide range of offshore ornithology receptors on a larger scale, there has been considerable geographical variation in the magnitude of the impact of other factors on population trends. For example, clear links between kittiwake breeding success and reduced sandeel availability due to fishing activities have been demonstrated (Carroll *et al.*, 2017; Daunt *et al.*, 2008; Frederiksen *et al.*, 2004; Furness and Tasker, 2000; Greenstreet *et al.*, 2010; Hayhow *et al.*, 2017; Lindegren *et al.*, 2018; Wright *et al.*, 2018). It has been identified that three traits that made kittiwake particularly sensitive to sandeel depletion by fisheries activity were the species' low ability to dive, lack of spare time in its daily time budget, and its low ability to switch diet (Furness and Tasker, 2000).

12.75 For offshore ornithology, the assessment has been carried out in a context of declining baseline populations of a number of receptor species. Furthermore, it was considered likely that a range of pressures would be likely to continue to impact offshore ornithology receptors, and these pressures would be likely to increase in the future. It is possible that the 2022 and 2023 HPAI outbreak has also affected seabird populations within the study area, with the long-term trajectory of the disease and its effects on seabird populations not yet known. Natural England have provided preliminary guidance on HPAI in respect of offshore windfarm assessment (2022b); however, at this stage there was insufficient information to establish whether such effects have occurred, or are likely to reoccur. A review of potential effects from HPAI is provided in **Section 12.6.6**.

12.76 The assessment considered whether a given impact would be likely to exacerbate a decline in the relevant reference population and prevent a receptor species from recovery should environmental conditions become more favourable.

12.6 Assessment of effects

12.77 Potential impacts included within the offshore ornithology assessment due to the construction, operation and maintenance and decommissioning of the Project would be as previously presented in the Scoping Report and PEIR, as follows:

In the construction phase:

- Impact 1: Disturbance and displacement covering work activity, vessel movements and lighting, as well as barrier effects due to presence of turbines and infrastructure (from erection of first turbines)
- Impact 2: Indirect impacts through effects on habitats and prey species

In the operational and maintenance phase:

- Impact 1: Displacement and barrier effects due to presence of turbines and infrastructure, as well as disturbance and displacement covering work activity, vessel movements and lighting
- Impact 2: Collision risk
- Impact 3: Combined collision risk and displacement
- Impact 4: Indirect impacts through effects on habitats and prey species

In the decommissioning phase:

- Impact 1: Disturbance and displacement covering work activity, vessel movements, lighting, as well as barrier effects due to presence of turbines and infrastructure (until final turbine is removed)
- Impact 2: Indirect impacts through effects on habitats and prey species

12.78 In the assessment of these potential effects, all impacts have been assessed for each phase following the impact assessment methodology described in **Section 12.4**, on the basis of the worst-case scenario set out in **Section 12.3.2** and accounting for the embedded mitigation described in **Section 12.3.3**.

12.6.1 Receptors

12.79 The principal receptors with respect to offshore ornithology were identified as:

- Seabird species occurring within the windfarm site and surrounding area during breeding and non-breeding periods
- Other bird species likely to pass through the windfarm site during migration
- Nationally and internationally important designated sites supporting the above species, where birds from those sites are likely to use the windfarm site and surrounding area at some stage during their life cycle; effects on

internationally important sites have been considered separately in the RIAA.

12.80 The specific features defined within these ornithology receptors as requiring further assessment are listed in **Table 12.18**.

Table 12.18 Ornithology receptors relevant to the Project

Receptor group	Receptor	Closest distance from windfarm site
Seabirds	Seabird species recorded in study area during aerial surveys (windfarm site plus 4km to 10km buffer): ▪ Arctic skua ▪ Arctic tern ▪ Black-headed gull ▪ Common gull ▪ Common scoter ▪ Common tern ▪ Cormorant ▪ Fulmar ▪ Gannet ▪ Great black-backed gull ▪ Great skua ▪ Guillemot ▪ Herring gull ▪ Kittiwake ▪ Lesser black-backed gull ▪ Little gull ▪ Manx shearwater ▪ Puffin ▪ Razorbill ▪ Red-throated diver ▪ Sandwich tern ▪ Shag	N/A (recorded within study area)
Migratory birds	Migratory bird species that are qualifying features of SPAs/Ramsar sites within 100km of the windfarm site.	N/A (potentially passing through study area)

Receptor group	Receptor	Closest distance from windfarm site
Designated sites (SPAs addressed in RIAA)	Liverpool Bay SPA	Adjoins the eastern boundary of the windfarm site; designated for its non-breeding red-throated diver, common scoter and little gull populations, and common tern and little tern during the breeding season.
	▪ SPAs and SSSIs within mean maximum foraging range (from Woodward *et al.*, 2019) of qualifying breeding seabird species above ▪ SPAs and SSSIs where qualifying adult seabird population was >1% of the relevant non-breeding BDMPS population (from Furness, 2015)	Closest site would be Morecambe Bay and Duddon Estuary SPA (25.9km) supporting breeding herring gull and lesser black-backed gulls.

12.6.2 Potential effects during construction

12.6.2.1 Impact 1: Disturbance, displacement and barrier effects

Description of impact

12.81 The Project has the potential to affect bird populations in the marine environment through disturbance from construction activity, leading to displacement of birds from construction sites and the areas that surround them. Barrier effects would also be possible as turbines are installed. This would effectively result in temporary habitat loss through reduction in the area available for feeding, loafing and moulting. The worst-case scenarios, outlined in **Table 12.2**, describe the elements of the Project considered within this assessment.

12.82 The duration of offshore construction for the Project would be approximately two and a half years, which would overlap with a maximum of three breeding seasons, three winter periods and up to six spring/autumn migration periods.

12.83 The construction phase would require the mobilisation of vessels, helicopters and equipment and the installation of foundations, inter-array and platform link cables and other infrastructure. These activities have the potential to disturb and displace birds from within and around the windfarm site. Causes of potential disturbance would comprise the presence of construction vessels and associated human activity, noise and vibration from construction activities and lighting associated with construction sites. The level of disturbance at each work location would differ dependent on the activities taking place, but there could be vessel movements at any time of day or night over the construction period.

12.84 Any impacts resulting from disturbance and displacement from construction activities would be short-term, temporary and reversible in nature, lasting only for the duration of construction activity, with birds expected to return to the area once construction activities have ceased. Construction related disturbance and displacement would be most likely to affect foraging birds. Furthermore, modelling of the consequences of displacement for fitness of displaced birds suggested that even in the case of breeding seabirds that would be displaced on a daily basis, there was likely to be little or no impact on survival unless the offshore windfarm was close to the relevant breeding colony (Searle *et al.,* 2014, 2017).

12.85 Bird species differ in their susceptibility to anthropogenic disturbance and in their responses to noise and visual disturbance stimuli. The principal source of noise during construction of the offshore windfarm would be subsea noise from piling works associated with the installation of foundations for wind turbines and associated offshore substations. While assessed for marine mammals and fish, subsea noise was not considered a risk factor for diving birds. Seabirds and other diving bird species spend most of their time above or on the water surface, where hearing will detect sound propagated through the air. It has been speculated, based on what is known about the physiology of hearing in birds, and comparison to the underwater hearing ability of humans, that birds do not hear well underwater (Dooling and Therrien, 2012). Anatomical studies of ear structure in diving birds suggested that there were adaptations for protection against the large pressure changes that may occur while diving, which may reduce hearing ability underwater but also protect the ear from damage due to acoustic over-exposure (Dooling and Thierren, 2012). Above water noise disturbance from construction activities has not been considered in isolation as a risk factor for birds; but rather, combined with the presence of vessels, man-made structures, and human activity, part of the overall disturbance stimulus that causes birds to avoid boats and other structures, as discussed below.

12.86 Lighting of construction sites, vessels and other structures at night may potentially be a source of attraction (phototaxis), as opposed to displacement, for birds. However, the areas affected would be very small, and restricted to offshore construction areas which are active at a given time. Phototaxis can be a serious hazard for fledglings of some seabird species (e.g. shearwater species), but typically occurs over short distances (hundreds of metres) in response to bright white light close to breeding colonies of these species. It has not been observed over large distances or in non-juvenile (i.e. adult and older immature) seabirds (Furness, 2018). Construction sites associated with the offshore development area would be far enough removed from any seabird breeding colonies as to render this risk negligible; the closest Manx shearwater colony identified in the SMP database was located at Calf of Man, 79.9km from the windfarm site, while the distance to the closest SPA population was, at Bardsey Island, approximately 146km from the windfarm site. Phototaxis of nocturnal migrating birds can be a problem, especially in autumn during conditions of poor visibility, but has been generally seen where birds were exposed to intense white lighting such as from lighthouses; light from construction sites is likely to be one or two orders of magnitude less powerful than that from lighthouses (Furness, 2018).

12.87 Considering variation between species in response to disturbance, gulls were not considered susceptible to disturbance, as they have often been associated with fishing boats (e.g. Camphuysen 1995; Hüppop and Wurm 2000) and have been noted in association with construction vessels at the Greater Gabbard Offshore Windfarm (Greater Gabbard Offshore Windfarm Limited (GGOWL) 2011) and close to active foundation piling activity at the Egmond aan Zee (OWEZ) windfarm, where they showed no noticeable reaction to the works (Leopold and Camphuysen, 2007). However, species such as divers and scoters have been observed to avoid shipping by several kilometres (Mitschke *et al.* 2001 from Exo *et al.,* 2003; Garthe and Hüppop 2004; Schwemmer *et al.,* 2011).

12.88 There have been a number of different measures used to assess bird disturbance and displacement from areas of sea in response to activities associated with an offshore windfarm. Garthe and Hüppop (2004) developed a scoring system for such disturbance factors which they applied to seabird species in German sectors of the North Sea. This was refined by Furness and Wade (2012) and Furness *et al.* (2013) with a focus on seabirds using Scottish offshore waters. The approach used information in the scientific and 'grey' literature, as well as expert opinion to identify disturbance ratings for individual species, alongside scores for habitat flexibility and conservation importance. These factors were used to define an index value that highlights the sensitivity of a species to disturbance and displacement. As many of these references related to disturbance from helicopter and vessel activities, these were considered relevant to this assessment.

12.89 Birds recorded during the species-specific spring and autumn migration periods have been assumed to be moving through the area between breeding and wintering areas. As these individuals would be present in the windfarm site for a short time and the potential zone of construction displacement would be comparatively small, it has been assumed that there would be negligible risks of impact at these times of year. Consequently, the following assessment focused on the breeding and non-breeding periods (seasons following Furness 2015; refer to **Table 12.15**).

12.90 To focus the assessment of disturbance and displacement, a screening exercise was undertaken to identify those species most likely to be at risk (**Table 12.19**). Any species recorded only in very small numbers within the study area (based on professional judgement, but typically where seasonal peak abundance was less than 30 birds) or species with a low sensitivity to displacement were screened out of further assessment.

12.91 A range of highly applicable existing information of high quality (encompassing peer-reviewed and other research, and previous OWF assessments) was referred to during the screening process. Confidence in the estimated sensitivity assigned to each receptor has also been presented. This was high where evidence of behaviour around anthropogenic disturbance sources in the marine environment was identified and this concorded with expert opinion (i.e. Furness and Wade (2012) and Garthe and Hüppop (2004)). Where no such evidence was identified, but expert opinion was available, a medium confidence level was assigned. Where expert opinion and any recorded effects did not concord, confidence was reduced accordingly.

12.92 The evidence used was predominantly a recent review by Fliessbach *et al.* (2019), the extensive, systematic literature review of the MMO (2018), and observations from the ornithological monitoring carried out at Sheringham Shoal, Lynn and Inner Dowsing and Lincs OWFs (Harwood *et al.*, 2018; Hi Def Aerial Surveying, 2017).

12.93 The relative frequency and abundances for each species were assigned qualitatively through assessment of the baseline survey data. In general, the low frequency category was used to describe species present within the study area in less than four months in any year during the survey programme. Medium frequency was used to describe species routinely present in the study area during a particular season, or with patchy abundance across multiple seasons, whilst the high frequency descriptor was reserved for species recorded on most or all surveys. The abundance descriptors were used to describe numbers of birds relative to the background population from which they likely originated.

12.94 The species screened in for construction disturbance and displacement assessment were common scoter, guillemot, Manx shearwater, razorbill and red-throated diver (**Table 12.19**). Common scoter and red-throated diver were recorded in low numbers/frequency during surveys but have been included due the proximity of the windfarm site to Liverpool Bay SPA and high sensitivity of these species to disturbance and displacement.

Table 12.19 Construction disturbance and displacement screening

Species	Estimated sensitivity to disturbance and displacement due to OWF construction	Confidence in sensitivity estimate	Relative frequency in study area	Relative abundance in study area	Screening result
Arctic skua	Low	Medium	Low	Low	Out
Arctic tern	Low	High	Low	Low	Out
Black-headed gull	Low	Medium	Low	Low	Out
Common gull	Low	High	Medium	Low	Out
Common scoter	High	High	Medium	Low	In
Common tern	Low	High	Low	Low	Out
Fulmar	Low	High	Medium	Low	Out
Gannet	Low	High	Medium	Medium	Out
Great black-backed gull	Low	High	Medium	Low	Out
Great skua	Low	Medium	Low (migrant)	Low	Out
Guillemot	Medium	High	High	High	In
Herring gull	Low	High	Medium	Medium	Out
Kittiwake	Low	High	High	High	Out
Lesser black-backed gull	Low	High	Medium	Medium	Out
Little gull	Medium	High	Medium	Low	Out

Species	Estimated sensitivity to disturbance and displacement due to OWF construction	Confidence in sensitivity estimate	Relative frequency in study area	Relative abundance in study area	Screening result
Manx shearwater	Low	Low	Medium	High	In
Puffin	Medium	Medium	Low	Low	Out
Razorbill	Medium	High	High	High	In
Red-throated diver	High	High	Low	Low	In
Sandwich tern	Low	High	Low	Low	Out
Shag	Medium	Medium	Low	Low	Out

Common scoter

12.95 Common scoter were recorded within the windfarm site in December 2022 and February 2023, with further occurrences in the 4km buffer in January, March and April 2022. This species has been noted to be highly susceptible to disturbance from boat and helicopter traffic (Garthe and Hüppop, 2004), showing disturbance behaviours at distances of over 1 km from vessels (Kaiser *et al*., 2006; Schwemmer *et al*., 2011, Bradbury *et al.* 2014)). Fliessbach *et al*. (2019) found that 81% of common scoters showed escape behaviour in response to ship traffic, and that escape distance for individual birds was higher than other species, with an average distance of 1,600m (reduced to 1,015m when birds were in a flock).

12.96 There would be potential for disturbance and displacement of common scoter due to construction activities, including the construction of wind turbines and other infrastructure, and associated vessel traffic. However, construction would not occur across the whole of the windfarm site simultaneously or every day but would be phased. Consequently, the effects would occur only in the areas where vessels would be operating at any given point and not the entire windfarm site. Once wind turbines (and other infrastructure) have been installed onto foundations, the impact of displacement would increase incrementally to the same levels as operational impacts (**Section 12.6.3.1**).

12.97 For this precautionary assessment, it has been assumed that common scoter displacement rates and resultant annual mortality would be 50% of the operation and maintenance phase effects; this was in accordance with recent advice from Natural England and NRW (refer to **Table 12.1**).

Common scoter – non-breeding season

12.98 During the non-breeding season, based on a seasonal peak mean population of 43 birds within the windfarm site and 4km buffer (see **Table 12.22**), between 0-2 common scoters would be subject to mortality annually from construction disturbance and displacement, assuming 50% of the operation and maintenance phase effect as set out in **Section 12.6.3.1.**

12.99 The average annual mortality rate for common scoter, across age classes, has been estimated as 0.238 (based on species specific data from Horswill and Robinson (2015); see **Table 12.17**). There is no biologically defined minimum population scale (BDMPS) for common scoter defined by Furness (2015) therefore the non-breeding reference population for this species has been taken as the most recent four-year (2015 & 2018-2020) peak mean population estimate for Liverpool Bay SPA; a population of 141,801 (HiDef, 2023). At the average baseline mortality rate for common scoter of 0.238, the number of individuals subject to mortality from the non-breeding population would be 33,749 (141,801 x 0.238). The addition of a maximum of two individuals to this increases the mortality rate by less than 0.01%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable.

12.100 This precautionary assessment (due to the Liverpool Bay SPA population being used as the reference population rather than the total regional population) generated a **negligible** impact magnitude. As common scoter is of **high** sensitivity to displacement, the effect significance would be **minor adverse** and not significant in EIA terms.

12.101 No impacts to this species have been predicted during the breeding season, therefore the year-round effects were also assessed as being **minor adverse** and not significant in EIA terms.

Guillemot

12.102 Guillemot were recorded in the windfarm site and surrounding 2km buffer during the breeding and non-breeding seasons in both years, with densities peaking in August 2021 (mean density in windfarm site 66.25/km^2; refer to Annex 1 of **Appendix 12.1**) and at their lowest in December 2021 (mean density in windfarm site 0.71/km^2). Guillemots were considered to have a medium sensitivity to disturbance and displacement, based on their sensitivity to ship and helicopter traffic in Garthe and Hüppop (2004), Furness and Wade (2012), Furness *et al.* (2013) and Bradbury *et al.* (2014).

12.103 There would be potential for disturbance and displacement of guillemots due to construction activities, including the construction of wind turbines and other infrastructure and associated vessel traffic. However, construction would not occur across the whole of the proposed windfarm site simultaneously or every day but would be phased. Consequently, the effects would occur only in the areas where vessels would be operating at any given point and not the entire windfarm site. Once wind turbines (and other infrastructure) have been installed onto foundations, the impact of displacement would increase incrementally to the same levels as operational impacts (**Section 12.6.3.1**).

12.104 For the purpose of this assessment, it has been assumed that guillemot displacement rates and resultant annual mortality would be 50% of the operation and maintenance phase effects as set out in **Section 12.6.3**; this was in accordance with recent advice from Natural England and NRW (refer to **Table 12.1**).

Guillemot – breeding season

12.105 During the breeding season, based on the seasonal peak mean population of 6,374 birds within the windfarm site and 2km buffer (see **Table 12.27**), between 10 and 223 guillemots would be subject to mortality annually from construction disturbance and displacement, assuming 50% of the operation and maintenance phase effect as set out in **Section 12.6.3.1** subject to mortality.

12.106 Based on an average annual mortality rate of 0.143 (Horswill and Robinson 2015), 163,811 guillemots would be subject to mortality each year from the breeding season BDMPS for this species (1,145,528; UK Western Waters, Furness 2015). The addition of a maximum of 223 birds to the existing annual mortality would increase the mortality rate by 0.14%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable.

12.107 This assessment generated an effect of **negligible** impact magnitude. As the species is of **medium** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Guillemot – non-breeding season

12.108 During the non-breeding season, based on the seasonal peak mean population of 8,315 birds within the windfarm site and 2km buffer (see **Table 12.28**), between 13 and 291 guillemots would be subject to mortality annually from construction disturbance and displacement, assuming 50% of the operation and maintenance phase effect as set out in **Section 12.6.3.1**.

12.109 The average annual mortality rate for guillemot, across age classes, has been estimated as 0.143 (based on species specific data from Horswill and Robinson (2015); see **Table 12.17**). Based on this, 162,908 birds would be subject to mortality each year from the non-breeding season BDMPS for this species (1,139,220; UK Western Waters, Furness 2015). The addition of a maximum of 291 birds to the existing annual mortality would increase the mortality rate of this reference population by 0.18%. This magnitude of increase in mortality would not materially alter the background mortality of the reference population and would be undetectable.

12.110 This assessment generated a **negligible** impact magnitude. As guillemot is of **medium** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Guillemot – year-round

12.111 The estimated annual guillemot mortality arising from construction disturbance/displacement would be between 22 and 514 individuals, assuming 50% of the operation and maintenance phase effect, as set out in **Section 12.6.3.1**.

12.112 At the average baseline mortality rate for guillemot of 0.143, the number of individuals subject to mortality from the largest BDMPS population throughout the year would be 163,811 (1,145,528 x 0.143). The addition of a maximum of 514 individuals to the existing annual mortality would increase the mortality rate of this reference population by 0.31%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable.

12.113 This assessment generated an effect of **negligible** impact magnitude. As the species is of **medium** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Razorbill

12.114 Razorbills were recorded in the windfarm site in all months of both years except September 2021, with highest numbers in December 2022 (mean density in windfarm site 6.97/km^2). Razorbills were considered to have a medium general sensitivity to disturbance and displacement, based on their sensitivity to ship and helicopter traffic in Garthe and Hüppop (2004), Furness and Wade (2012), Furness *et al.* (2013) and Bradbury *et al.* (2014).

12.115 There would be potential for disturbance and displacement of razorbills due to construction activities, including the construction of wind turbines and other infrastructure and associated vessel traffic. However, construction would not occur across the whole of the proposed windfarm site simultaneously or every day but would be phased. Consequently, until wind turbines (and other structures) have been placed on foundations, the effects would occur only in the areas where vessels would be operating at any given point and not the entire windfarm site. Once wind turbines (and other infrastructure) have been installed onto foundations, the impact of displacement would increase incrementally to the same levels as operational impacts (**Section 12.6.3.1**).

12.116 For the purpose of this assessment, it has been assumed that razorbill displacement rates and resultant annual mortality would be 50% of the operation and maintenance phase effects as set out in **Section 12.6.3**; this was in accordance with recent advice from Natural England and NRW (refer to **Table 12.1**).

Razorbill – breeding season

12.117 During the breeding season, based on the seasonal peak mean population of 252 birds within the windfarm site and 2km buffer (see **Table 12.30**), between one and nine razorbills would be subject to mortality annually from construction disturbance and displacement, assuming 50% of the operation and maintenance phase effect as set out in **Section 12.6.3.1**.

12.118 Based on the average mortality for the species (0.178; Horswill and Robinson 2015), a total of 35,416 razorbills would be subject to mortality each year from the breeding season BDMPS for this species (198,969; UK Western Waters, Furness 2015). The addition of a maximum of nine birds predicted to be impacted by construction disturbance and displacement would increase the mortality rate by 0.03%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable.

12.119 This assessment generated an effect of **negligible** impact magnitude. As the species is of **medium** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Razorbill – autumn migration season

12.120 During autumn migration, based on the seasonal mean peak population of 694 birds within the windfarm site and 2km buffer (see **Table 12.31**), between one and 25 razorbills would be subject to mortality annually from construction disturbance and displacement, assuming 50% of the operation and maintenance phase effect as set out in **Section 12.6.3.1**.

12.121 The average annual mortality rate for razorbill, across age classes, has been estimated as 0.178 (based on species specific data from Horswill and Robinson (2015); see **Table 12.17**. Based on this, 108,031 birds would be subject to mortality each year from the autumn migration BDMPS for this species (606,914; Furness 2015). The addition of a maximum of 25 birds to this would increase the mortality rate by 0.02%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable.

12.122 This assessment generated an effect of **negligible** impact magnitude. As the species is of **medium** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Razorbill – winter season

12.123 During the winter period, based on the seasonal mean peak population of 651 birds within the windfarm site and 2km buffer (see **Table 12.32**), between one and 23 razorbills would be subject to mortality annually from construction disturbance and displacement, assuming 50% of the operation and maintenance phase effect as set out in **Section 12.6.3.1**.

12.124 Based on the average mortality for razorbill (0.178; Horswill and Robinson 2015), a total of 60,773 birds would be subject to mortality each year from the winter BDMPS for this species (341,422; Furness 2015). The addition of a maximum of 23 birds would increase the mortality rate by 0.04%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable.

12.125 This assessment generated an effect of **negligible** impact magnitude. As the species is of **medium** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Razorbill – spring migration season

12.126 During spring migration, based on the seasonal mean peak population of 382 birds within the windfarm site and 2km buffer (see **Table 12.33**), between one and 14 razorbills would be subject to mortality annually from construction disturbance and displacement, assuming 50% of the operation and maintenance phase effect as set out in **Section 12.6.3.1**.

12.127 Based on the average mortality for the species, a total of 108,031 birds would be subject to mortality each year from the spring migration UK Western Waters BDMPS for this species (606,914; Furness 2015). The addition of a maximum of 14 birds would increase the mortality rate by 0.01%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable.

12.128 This assessment generated an effect of **negligible** impact magnitude. As the species is of **medium** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Razorbill – year-round

12.129 The estimated annual razorbill mortality arising from construction disturbance/displacement was between three and 70 individuals, assuming 50% of the operation and maintenance phase effect, as set out in **Section 12.6.3.1**.

12.130 At the average baseline mortality rate for razorbill of 0.178, the number of individuals subject to mortality from the largest UK Western Waters BDMPS population throughout the year would be 108,031 (606,914 x 0.178). The addition of a maximum of 70 individuals to this increases the mortality rate by 0.06%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable.

12.131 This assessment generated an effect of **negligible** impact magnitude. As the species is of **medium** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Manx shearwater

12.132 Manx shearwater were generally considered to have a low susceptibility to disturbance and displacement. Dierschke *et al*., (2016) described Manx shearwater as "weakly avoiding wind farms", but noted that evidence was lacking for the species. Bradbury *et al.* (2014) classified Manx shearwater as having "very low" population vulnerability to displacement. Dierschke *et al.*, (2016) suggested that Manx shearwater were avoiding North Hoyle Windfarm, stating that an obvious distribution gap was observed at the OWF, although also noting evidence for this appeared to be limited. Dierschke *et al.* (2016) also noted that Manx shearwater have been recorded within Robin Rigg OWF.

12.133 Manx shearwater has by far the largest foraging distance from colonies of all regularly breeding UK and Ireland seabirds (mean maximum (+1SD) of 2,366km; Woodward *et al*., 2019). Birds from Skomer have been found to make trips of up to 727km from the colony (Dean, 2012) and birds tracked from colonies in Ireland had foraging ranges of up to 1,109 km (Wischnewski *et al*., 2019). Studies on Rum, Copeland, Skomer and Lundy found that birds foraged near their respective colonies, with little overlap between colonies, but individuals from all colonies also travelled to a more distant shared foraging area at the Irish Sea Front and nearby waters of the Western Irish Sea (Dean *et al*., 2015). Given the species' large foraging range and the distance to the nearest colony (approximately 85km; Calf of Man) the windfarm site was considered unlikely to be of particular importance to foraging Manx shearwaters compared with more productive areas over the continental shelf, such as the Irish Sea Front SPA.

12.134 There would be potential for disturbance and displacement of Manx shearwaters due to construction activities, including the construction of wind turbines and other infrastructure and associated vessel traffic. However, construction would not occur across the whole of the proposed windfarm site simultaneously or every day but would be phased. Consequently, until wind turbines (and other structures) have been placed on foundations, the effects would occur only in the areas where vessels were operating at any given point and not the entire windfarm site. Once wind turbines (and other infrastructure) have been installed onto foundations, the impact of displacement would increase incrementally to the same levels as operational impacts (**Section 12.6.3.1**).

12.135 For the purpose of this assessment, it has been assumed that Manx shearwater displacement rates and resultant annual mortality would be 50% of the operation and maintenance phase effects; this was in accordance with Natural England and NRW recent advice (refer to **Table 12.1**).

Manx shearwater – breeding season

12.136 During the breeding season, based on the seasonal peak mean population of 4,705 birds within the windfarm site and 2km buffer (see **Table 12.35**), between seven and 165 Manx shearwaters would be subject to mortality annually from construction disturbance and displacement, assuming 50% of the operation and maintenance phase effect as set out in **Section 12.6.3.1**.

12.137 Based on an average annual mortality rate of 0.130 (Horswill and Robinson 2015), 236,801 Manx shearwaters would be subject to mortality each year from the breeding season BDMPS for this species (1,821,544). The addition of a maximum of 165 Manx shearwaters would increase the mortality rate of this reference population by 0.07%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding period, the impact magnitude has been assessed as **negligible**. As the species is of **low** sensitivity to disturbance, the effect significance would be **negligible adverse** and not significant in EIA terms.

Manx shearwater – autumn migration season

12.138 During autumn migration, based on a seasonal peak mean population of 2,650 birds within the windfarm site and 2km buffer (see **Table 12.36**), between four and 93 Manx shearwaters would be subject to mortality annually from construction disturbance and displacement, assuming 50% of the operation and maintenance phase effect as set out in **Section 12.6.3.1**.

12.139 Based on an average annual mortality rate of 0.130 (Horswill and Robinson 2015), 205,516 Manx shearwaters would be subject to mortality each year from the autumn migration BDMPS for this species (1,580,895; Furness 2015). The addition of a maximum of 93 Manx shearwaters would increase the mortality rate of this population by 0.05%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during autumn migration, the impact magnitude has been assessed as **negligible**. As the species is of **low** sensitivity to disturbance, the effect significance would be **negligible adverse** and not significant in EIA terms.

Manx shearwater – spring migration

12.140 During spring migration, based on a seasonal peak mean population of 1,617 birds within the windfarm site and 2km buffer (see **Table 12.37**) between three and 57 Manx shearwaters would be subject to mortality annually from construction disturbance and displacement, assuming 50% of the operation and maintenance phase effect as set out in **Section 12.6.3.1**.

12.141 Based on an average annual mortality rate of 0.130 (Horswill and Robinson 2015), 205,516 Manx shearwaters would be subject to mortality each year from the spring migration BDMPS for this species (1,580,895; Furness 2015). The addition of a maximum of 57 Manx shearwaters would increase the mortality rate of this population by 0.03%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding period, the impact magnitude has been assessed as **negligible**. As the species is of **low** sensitivity to disturbance, the effect significance would be **negligible adverse** and not significant in EIA terms.

Manx shearwater – year-round

12.142 The estimated annual Manx shearwater mortality arising from construction disturbance/displacement would be between 14 and 314 individuals, assuming 50% of the operation and maintenance-phase effect, as set out in **Section 12.6.3.1**.

12.143 At the average baseline mortality rate for guillemot of 0.130, the number of individuals subject to mortality from the largest BDMPS population throughout the year would be 236,801 (1,821,544 x 0.13). The addition of a maximum of

314 individuals to the existing annual mortality would increase the mortality rate of this reference population by 0.13%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the impact magnitude has been assessed as **negligible**. As the species is of **low** sensitivity to disturbance, the effect significance would be **negligible adverse** and not significant in EIA terms.

Red-throated diver

12.144 During baseline aerial surveys, small numbers of red-throated divers were recorded within the windfarm site and 4km buffer which overlapped with Liverpool Bay SPA. This species was most abundant during the winter period, with a mean peak estimated population of 12 birds within the windfarm site and 4km buffer in December 2021. Lower numbers were present during spring and autumn migration.

12.145 Red-throated diver have been identified as being particularly sensitive to human activities in marine areas, including through the disturbance effects of ship and helicopter traffic (Garthe and Hüppop 2004; Bellebaum *et al.* 2006; Schwemmer *et al.* 2011; Furness and Wade 2012; Furness *et al.* 2013; Bradbury *et al.* 2014; Mendel *et al.,* 2019). A selectivity index derived from aerial surveys in the German North Sea indicated that the numbers of divers (red- and black-throated divers could not be reliably distinguished during the surveys) were significantly lower in shipping lanes than in other areas, although there were insufficient data to estimate flush distances of divers from ships (Schwemmer *et al.,* 2011); in this study it was assumed that the responses of red- and black-throated divers to disturbance was similar. Observational studies of responses of marine birds to disturbance in Orkney inshore waters found that red-throated and black-throated divers showed similar flush behaviour from ferries (with respectively 75% (n=88) and 62% (n=21) of birds showing an evasive response within 300m of a passing ferry). Red-throated divers were highly likely to fly in response to marine activity whereas black-throated divers were more likely to swim away (although these differences may have been related to differences in the timing of moult in the two species, which affects flight ability) (Jarrett *et al.,* 2018).

12.146 There would be potential for disturbance and displacement of red-throated divers due to construction activities, including the construction of wind turbines and other infrastructure (e.g. offshore substation platform(s) (OSP(s))) and associated vessel traffic. However, construction would not occur across the whole of the proposed windfarm site simultaneously or every day but would be phased, with activity focused on a particular wind turbine, offshore platform or cable location at any time (assumed to be three discrete locations for the purposes of this assessment). Consequently, until turbines (and other structures) have been placed on foundations, the effects would occur only in the areas where vessels were operating at any given point and not the entire windfarm site. At such time as wind turbines (and other infrastructure) have been installed onto foundations the impact of displacement would increase incrementally to the same levels as operational impacts (**Section 12.6.3.1**).

12.147 For the purpose of this assessment, it has been assumed that red-throated diver rates and resultant annual mortality would be 50% of the operation and maintenance phase effects; this was in accordance with Natural England and NRW's recent advice (refer to **Table 12.1**).

12.148 Definitive mortality rates associated with red-throated diver displacement are not known and precautionary estimates have therefore been used. There was no empirical evidence that displaced birds would suffer any consequent mortality; any mortality due to displacement would be most likely a result of increased density in areas outside the affected area, resulting in increased competition for food where density was elevated. Such impacts were most likely to be negligible (Dierschke *et al.,* 2017), and below levels that could be quantified. Impacts of displacement were also likely to be context-dependent. In years when food supply has been severely depleted, as for example by unsustainably high fishing mortality of sandeel stocks as has occurred several times in recent decades (Lindegren *et al.* 2018), displacement of sandeel-dependent seabirds from optimal habitat may increase mortality. In years when food supply was good, displacement would be unlikely to have any negative effect on seabird populations. Red-throated divers may feed on sandeels, but take a wide diversity of small fish prey, so would be buffered to an extent from fluctuations in abundance of other fish species.

12.149 However, based on advice from Natural England, this assessment has assumed the precautionary maximum mortality rate associated with the displacement of red-throated diver would be 1-10% (i.e. 1-10% of displaced individuals suffer mortality as a direct consequence).

Red-throated diver – autumn migration season

12.150 During autumn migration, based on a seasonal peak mean population of two red-throated divers within the windfarm site and 4km buffer (see **Table 12.40**), the number of red-throated divers subject to mortality annually from construction disturbance and displacement has been estimated at 0-1, assuming 50% of the operation and maintenance phase effect as set out in **Section 12.6.3.1.**

12.151 Based on an average annual mortality rate of 0.233 (Horswill and Robinson 2015), 1,019 red-throated divers would be subject to mortality annually each year from the autumn migration BDMPS for the species (4,373; Furness 2015). The addition of a maximum of one bird would increase the mortality rate of this population by 0.1%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the impact magnitude has been assessed as **negligible**. As the species is of **high** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Red-throated diver – winter season

12.152 During the winter period, based on a seasonal peak mean population of 12 red-throated divers within the windfarm site and 4km buffer (see **Table 12.41**), the number of red-throated divers subject to mortality annually from construction disturbance and displacement has been estimated at between zero and one, assuming 50% of the operation and maintenance phase effect as set out in **Section 12.6.3.1**.

12.153 At the average annual mortality rate of 0.233, 386 birds would be subject to mortality each year from the winter BDMPS for this species (1,657; Furness 2015). The addition of a maximum of one bird to this would increase the mortality rate by 0.26%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the impact magnitude has been assessed as **negligible**, even on the basis of this precautionary approach. As the species is of **high** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Red-throated diver – spring migration season

12.154 During spring migration, based on a seasonal peak mean population of six red-throated divers within the windfarm site and 4km buffer (see **Table 12.42**), the number of red-throated divers subject to mortality annually from construction disturbance and displacement has been estimated at between zero and one, assuming 50% of the operation and maintenance phase effect as set out in **Section 12.6.3.1.**

12.155 Based on an average annual mortality rate of 0.233 (Horswill and Robinson 2015), 1,019 red-throated divers would be subject to mortality annually each year from the spring migration BDMPS for the species (4,373; Furness 2015). The addition of a maximum of one bird would increase the mortality rate of this population by 0.1%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the impact magnitude has been assessed as **negligible**. As the species is of **high** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Red-throated diver – year-round

12.156 The estimated annual red-throated diver mortality arising from construction disturbance/displacement would be between zero and one individuals, assuming 50% of the operation and maintenance phase effect, as set out in **Section 12.6.3.1**.

12.157 At the average baseline mortality rate for red-throated diver of 0.233, the number of individuals subject to mortality over one year from the largest BDMPS would be 1,019 (4,373 x 0.233). The addition of a maximum of one bird would increase the mortality rate of this population by 0.1%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the impact magnitude has been assessed as **negligible**. As the species is of **high** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

12.6.2.2 Impact 2: Indirect effects through impacts on habitats and prey species

12.158 Indirect disturbance and displacement of birds may occur during the construction phase if there are impacts on prey species and the habitats of prey species. These indirect effects include those resulting from the production of underwater noise (e.g. during piling) and the generation of suspended sediments (e.g. during preparation of the seabed for foundations) that may alter the behaviour or availability of bird prey species. Underwater noise may cause fish and mobile invertebrates to avoid the construction area and also affect their physiology and behaviour. Suspended sediments may cause fish and mobile invertebrates to avoid the construction area and may smother and hide immobile benthic prey. These mechanisms may result in less prey being available to foraging seabirds within the construction area. Such potential effects on benthic invertebrates and fish have been assessed in **Chapter 9 Benthic Ecology** and **Chapter 10 Fish and Shellfish Ecology** and the conclusions of those assessments inform this assessment of indirect effects on ornithology receptors.

12.159 With regard to noise impacts on fish, **Chapter 10 Fish and Shellfish Ecology** discussed the potential impacts on fish relevant to ornithology as prey species. For species such as herring, sprat and sandeel, which are the main prey items of seabirds such as gannet and auks, underwater noise impacts (physical injury or behavioural changes) during construction were considered to be of minor adverse significance (see Table 10.29 of **Chapter 10 Fish and Shellfish Ecology**). With a minor effect on fish that are bird prey species, it has been concluded that the indirect effect significance on seabirds occurring in or around the Project during the construction phase would similarly be a **minor adverse** effect and not significant in EIA terms.

12.160 With regard to changes to the seabed and to suspended sediment levels, **Chapter 7 Marine Geology, Oceanography and Physical Processes** (Document Reference 5.1.7) and **Chapter 9 Benthic Ecology** discussed the nature of any change and impacts on the seabed and benthic habitats. Such changes during the construction phase were considered to be temporary, small scale and highly localised (see **Chapter 9 Benthic Ecology**, Section 9.6.2). The consequent indirect impact on fish through habitat loss was considered to be minor or negligible adverse significance for key prey species (herring, sprat and sandeel) for seabirds such as gannet and auks. With a minor or negligible effect on fish that are bird prey species, it has been concluded that the indirect effect significance on seabirds occurring in or around the Project during the construction phase would be similarly a **minor adverse** effect and not significant in EIA terms.

12.6.3 Potential effects during operation and maintenance

12.6.3.1 Impact 1: Disturbance, displacement and barrier effects

Description of impact

12.161 The presence of wind turbines and associated infrastructure and operational and maintenance activities have the potential to directly disturb and displace birds from within and around the windfarm site. This has been assessed as an indirect habitat loss, as it has the potential to reduce the area available to birds for feeding, loafing and moulting, and may result in reduction in survival rates of displaced birds. The presence of wind turbines; associated ancillary structures, vessel activity and factors such as the lighting of wind turbines could also attract certain species of birds.

12.162 As offshore windfarms are relatively new features in the marine environment, there was limited robust empirical evidence about the disturbance and displacement effects of the operational infrastructure in the long term, although the number of available studies of post-construction monitoring has been increasing (e.g. Dierschke *et al.,* 2016, Vallejo *et al.,* 2017, MMO 2018). Dierschke *et al.* (2016) reviewed evidence from 20 operational offshore windfarms in European waters. They found strong avoidance by divers, gannet, great crested grebe, and fulmar; less consistent displacement by razorbill, guillemot, little gull and sandwich tern; no evidence of any consistent response by kittiwake, common tern and Arctic tern; evidence of weak attraction to operating offshore windfarms for common gull, black-headed gull, great black-backed gull, herring gull, lesser black-backed gull and red-breasted merganser; and strong attraction for shags and cormorants. Thaxter *et al.* (2018) also found no evidence of macro-avoidance of offshore windfarms by lesser black-backed gulls. Displacement has been apparently stronger when wind turbines were rotating. For cormorants and shags the presence of structures for roosting and drying plumage was a factor in attraction, while other species, such as lesser black-backed and herring gulls, appeared to benefit from increases in food abundance within operational offshore windfarms. A recent study of windfarms in the Belgian North Sea (Vanerman *et al.* in Degraer *et al.* (Eds), 2023) indicated that there was only a small difference between densities of guillemots within and outside of windfarms, while for razorbills densities were higher inside the windfarms than outside. This indicated limited displacement effect in respect of guillemot, and potential attraction for razorbill.

12.163 During operation and maintenance, the wind turbine array and OSP(s) would have lights for aviation safety and navigational safety. There would be other lighting for personnel working at night, however these would not be continuous and would not be as bright as air and navigational safety lighting. Air safety lights would be placed high on the wind turbine structures, and as a minimum on wind turbines at the periphery of the windfarm. Navigational lights for shipping would be placed lower on wind turbine structures and other offshore structures. A review of the potential effects of operational lighting on birds considered eight categories of potential effect on birds: disruption of photoperiod physiology; extension of daytime activity; phototaxis of seabirds; phototaxis of nocturnal migrant birds; ability of birds to use artificial light to feed at night or to feed on prey aggregating under artificial lights; increased predation risk for nocturnal migrant birds; birds better able to avoid collision when structures are illuminated; displacement of birds due to avoidance of artificial lights (Furness 2018). The available evidence suggested that lights on offshore wind turbines in European shelf seas were extremely unlikely to have any detectable effect on birds as a consequence of any of the processes listed above. The effects of operational lighting have therefore not been assessed separately. Specific discussion of potential effects on Manx shearwater has been provided in **Paragraphs 12.247 - 12.250** in **Section 12.6.3.1**.

12.164 There was no empirical evidence that birds displaced from windfarms, or exposed to barrier effects, suffered increased mortality. Any mortality due to displacement would most likely be a result of increased densities of foraging birds in locations outside the affected area, resulting in increased competition for food. This would be unlikely for seabirds that have large areas of alternative habitat available but would be more likely to affect seabirds with highly specialised habitat requirements that are limited in availability (Furness and Wade 2012; Bradbury *et al.,* 2014). Impacts of displacement are also likely to be dependent on other environmental factors such as food supply, and are expected to be greater in years of low prey availability (e.g. as could result from unsustainably high fisheries pressures or effects of climatic changes on fish populations). Furthermore, modelling of the consequences of displacement for fitness of displaced birds suggested that even in the case of breeding seabirds that would be displaced on a daily basis, there was likely to be little or no impact on survival unless the offshore windfarm was close to the breeding colony (Searle *et al.* 2014, 2017).

12.165 The assessment below has been based on best practice guidance (SNCBs 2022, Parker *et al*., 2022c).

12.166 Displacement has been defined as 'a reduced number of birds occurring within or immediately adjacent to an offshore windfarm' (Furness *et al.,* 2013) and involves birds present in the air and on the water (SNCBs, 2022i). Birds that did not intend to utilise a windfarm area but would have previously flown through the area on the way to a feeding, resting or nesting area, and which either stop short or detour around a development, would be subject to barrier effects (SNCBs, 2022).

12.167 Birds are considered to be most at risk from operational disturbance and displacement effects when they are resident in an area, for example during the breeding season or wintering season, as opposed to passage or migratory seasons. Birds that are resident in an area may regularly encounter and be displaced by an offshore windfarm, for example during daily commuting trips to foraging areas from nest sites, whereas birds on passage may encounter (and potentially be displaced from) a particular offshore windfarm only once during a given migration journey.

12.168 For the purposes of assessment of displacement for resident birds, it is usually impossible to distinguish between displacement and barrier effects – for example, to define where individual birds may have intended to travel to, or beyond an offshore windfarm, even when tracking data was available. Therefore, in this assessment the effects of displacement and barrier effects on the key resident species have been considered together.

12.169 The small risk of impact to migrating birds resulting from flying around rather than through the wind turbine array of an offshore windfarm was considered a potential barrier effect and has been scoped out of the assessment. Masden *et al.* (2010, 2012) and Speakman *et al.* (2009) calculated that the costs of one-off avoidances during migration were small, accounting for less than 2% of available fat reserves. Therefore, the impacts on birds that only migrate through the windfarm site (including seabirds, waders and waterbirds on passage) were considered negligible and these have been scoped out of detailed assessment.

12.170 The focus of this section is therefore on the disturbance and displacement of birds due to the presence and operation of wind turbines, other offshore infrastructure and any maintenance operations associated with them. The methodology presented in the SNCB Advice Note (SNCBs, 2022) and advised by Natural England (Parker *et al*., 2022c) recommended that a matrix should be presented for each key species showing bird losses at differing rates of displacement and mortality. This assessment used the range of predicted losses, in association with the scientific evidence available from post-construction monitoring studies, to quantify the level of displacement and the potential losses as a consequence of the Project. These losses were then placed in the context of the relevant population (e.g. SPA or BDMPS) to determine the impact magnitude.

12.171 In order to focus the assessment of disturbance and displacement, a screening exercise was undertaken to identify those species most likely to be at risk during the operation and maintenance phase (**Table 12.20**), focussing on the main species described in **Appendix 12.1**. The species identified as at risk were then assessed within the biological seasons within which effects were potentially likely to occur.

12.172 Any species with a low sensitivity to displacement, and/or recorded only in very small numbers within the windfarm site during the breeding and non-breeding seasons, were screened out of further assessment. **Table 12.20** presents the general sensitivity to disturbance and displacement for each species. Displacement rates (based on observations of macro-avoidance - that is avoidance at the level of the whole windfarm rather than the wind turbine) have been derived from a review of monitoring reports at constructed windfarms (Krijgsveld *et al.*, 2011, Leopold *et al.*, 2011, Vanermen *et al.,* 2013, Walls *et al.*, 2013, Mendel *et al.,* 2014, Braasch *et al.,* 2015, Skov *et al.,* 2018, Cook *et al.,* 2018).

Table 12.20 Operational disturbance and displacement screening

Species	Estimated sensitivity to disturbance and displacement from operational OWFs[8]	Screening result	Season(s)	Rationale
Arctic skua	Low	Out	N/A	Recorded in low numbers and have low sensitivity to displacement.
Arctic tern	Low	Out	N/A	Recorded in low numbers and have low sensitivity to displacement.
Black-headed gull	Low	Out	N/A	No clear evidence of displacement from operational wind turbines.
Common gull	Low	Out	N/A	No clear evidence of displacement from operational wind turbines.
Common scoter	High	In	Non-breeding / year-round	Although recorded in low numbers, this is a qualifying species for Liverpool Bay SPA and would be sensitive to disturbance and displacement. Therefore, scoped in on a precautionary basis.
Common tern	Low	Out	N/A	Recorded in low numbers and have low sensitivity to displacement.
Fulmar	Low	Out	N/A	Generally considered to have low sensitivity to operational disturbance and displacement. The species has a maximum habitat flexibility score of 1 in Furness and Wade (2012), suggesting it utilises a wide range of habitats over a large area.

[8] With reference to Garthe and Hüppop, 2004; Furness and Wade, 2012, Furness *et al*., 2013, Wade *et al*., 2016, Dierschke *et al*., 2016.

Species	Estimated sensitivity to disturbance and displacement from operational OWFs[8]	Screening result	Season(s)	Rationale
Gannet	Considered low in some studies, but possibly high (Dierschke *et al.,* 2016) and have a high macro-avoidance rate. Overall assessed Medium.	In	Breeding, autumn migration, year-round	Potentially susceptible to displacement from wind turbines and recorded in moderate numbers during breeding and autumn migration periods.
Great black-backed gull	Low	Out	N/A	No clear evidence of displacement from operational wind turbines.
Great skua	Low	Out	N/A	Recorded in very low numbers during passage migration periods.
Guillemot	Medium	In	Non-breeding, breeding, year-round	Abundant within study area and potentially susceptible to displacement from operational wind turbines.
Herring gull	Low	Out	N/A	No clear evidence of displacement from operational wind turbines.
Kittiwake	Low	Out	N/A	No clear evidence of displacement from operational wind turbines.
Lesser black-backed gull	Low	Out	N/A	No clear evidence of displacement from operational wind turbines
Little gull	Low	Out	N/A	No clear evidence of displacement from operational wind turbines

Species	Estimated sensitivity to disturbance and displacement from operational OWFs[8]	Screening result	Season(s)	Rationale
Manx shearwater	Low	In	Breeding, autumn, spring, year-round	Considered to have low susceptibility to disturbance but was recorded at relatively high densities and scoped in on a precautionary basis.
Puffin	Low	Out	N/A	Recorded in low numbers and considered to have low sensitivity to operational displacement.
Razorbill	Medium	In	Autumn, winter, spring, breeding, year-round	Frequent within study area and potentially susceptible to displacement from operational wind turbines.
Red-throated diver	High	In	Autumn, winter, spring, year-round	Recorded in low numbers within the study area but considered highly sensitive to displacement.
Sandwich tern	Low	Out	N/A	Recorded in low numbers and considered to have low sensitivity to operational displacement.
Shag	Low	Out	N/A	Recorded in low numbers and considered to have low sensitivity to operational displacement.

12.173 The population estimate used for each species to assess the displacement effects was the mean of each relevant seasonal peak (i.e. the mean of the highest monthly value in each survey year, for the months within each season). The seasonal peaks were calculated as follows: first the mean abundance for each calendar month was calculated (derived from the values presented in **Appendix 12.1** and **12.2**), then the highest value from the months within each season extracted for each survey year. The mean value of the peak from each year was then calculated. Standard deviation and 95% confidence intervals for each value were also calculated from the combined bootstrap samples for the seasonal peak month in each year. As per the SNCB advice note (SNCBs, 2022), for red-throated diver and common scoter the assessment used all data recorded within the windfarm site and 4km buffer, for all other species the assessment used all data recorded within the windfarm site and 2km buffer. Seasonal site population estimates for species included in the displacement assessment are included in **Table 12.21**.

12.174 Birds are considered to be most at risk from operational disturbance and displacement effects when they are resident (e.g. during the breeding season or wintering season). The small risk of impact to migrating birds could be better considered in terms of barrier effects. However, the joint SNCB advice note (SNCBs, 2022) stated that there was insufficient evidence to separate displacement and barrier effects and suggested, therefore, that migration periods should also be assessed using the matrix approach. This has been undertaken where appropriate.

12.175 For each species and season assessed, the predicted mortality due to displacement was determined and the effect of this assessed in terms of the change in the baseline mortality rate of the relevant population. It has been assumed that all age classes would be equally at risk of displacement in proportion to their presence in the population. Baseline mortality was calculated in accordance with **Section 12.5.3.4** and **Table 12.17**.

Table 12.21 Seasonal peak mean populations for species assessed for displacement

Species	Area considered for displacement	Autumn migration	Winter	Spring migration	Non-breeding	Breeding
Common scoter	Windfarm + 4km buffer	-	-	-	43	0
Gannet	Windfarm + 2km buffer	124	-	8	-	541
Guillemot	Windfarm + 2km buffer	-	-	-	8315	6374
Manx shearwater	Windfarm + 2km buffer	2650	-	1617	-	4705
Razorbill	Windfarm + 2km buffer	694	651	382	-	252
Red-throated diver	Windfarm + 4km buffer	2	12	6	-	0

Note: Dash indicates season was not applicable to that species. Refer to Annex 1 of **Appendix 12.1** for source data.

12.176 Natural England advice was that displacement effects estimated in different seasons should be combined to provide an annual effect for assessment which should then be assessed in relation to the largest of the component BDMPS populations (SNCBs, 2022). Natural England has acknowledged that summing impacts in this manner almost certainly over-estimates the number of individuals at risk through double counting (i.e. some individuals may potentially be present in more than one season; SNCBs, 2022) and assessing against the BDMPS almost certainly under-estimates the population from which they are drawn (which must be at least this size and is likely to be considerably larger as a consequence of turnover of individuals). However, at the time of writing there was no agreed alternative method for undertaking assessment of annual displacement and therefore the above approach has been presented, albeit with the caveat that the approach is precautionary and the outputs should be interpreted accordingly.

Common scoter

12.177 Common scoter were recorded within the windfarm site in December 2022 and February 2023, with further occurrences in the 4km buffer in January, March and April 2022. Common scoter were noted to be highly susceptible to disturbance from boat and helicopter traffic (Garthe and Hüppop, 2004), showing disturbance behaviours at distances of over 1 km from boats (Kaiser *et al.*, 2006; Schwemmer *et al.*, 2011). Fliessbach *et al.* (2019) found that 81%

of common scoters showed escape behaviour in response to ship traffic, and that escape distance for individual birds was higher than other species, with an average distance of 1,600m. This response was reduced to 1,015m when birds were in a flock. There was less evidence regarding their displacement behaviour from the permanent infrastructure associated with OWFs, with Dierschke *et al.* (2016) claiming that common scoters only weakly avoided OWFs themselves, with the majority of displacement resulting from avoidance of boat and helicopter traffic associated with maintenance of OWFs.

12.178 Displacement effects for common scoter for the Project were assessed during the non-breeding period, based on peak mean population of 43 individual birds (**Table 12.22**), calculated for the windfarm site and a 4km buffer, in line with recommendations within the SNCB guidance (SNCBs, 2022). The inclusion of all birds within the 4km buffer to determine the total number of birds subject to displacement was precautionary as in reality the avoidance rate would be likely to fall with distance from the windfarm site.

12.179 Displacement matrices for common scoter during the non-breeding period (calculated for the windfarm site and the 4km buffer) are presented in **Table 12.22**. Due to the limited evidence available, a displacement rate of 90-100% and mortality rate of 1-10% has been presented. Given that 10% mortality rate would represent a rate approximately half of the expected 'natural' annual mortality (i.e 23.8%; see **Paragraph 12.181**), this rate has been considered very unlikely. Accordingly, a 1% mortality rate is considered to be most appropriate, with the upper end of the assessed range (i.e. 10%) considered to be precautionary.

Common scoter – non-breeding/year-round

12.180 Based on a seasonal mean peak abundance of 43 birds within the windfarm site and 4km buffer (**Table 12.22**) displacement rates of 90-100% and a precautionary mortality rate of 1-10%, the number of individual common scoter which could potentially suffer mortality as a consequence of displacement during the non-breeding period has been estimated as between zero and four individuals (cells highlighted **Table 12.22**; refer also to **Appendix 12.1**).

12.181 There was no BDMPS for common scoter defined by Furness (2015), and therefore the non-breeding reference population for this species has been taken as the most recent four-year (2015 and 2018-2020) peak mean population estimate for Liverpool Bay SPA; a population of 141,801 (HiDef, 2023). At the average baseline mortality rate for common scoter of 0.238, the number of individuals subject to mortality from the non-breeding population would be 33,749 (141,801 x 0.238). The addition of a maximum of four individuals to this would increase the mortality rate by 0.01%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable.

12.182 Therefore, during the non-breeding period (and year-round, since this was the only season in which this species was recorded), the magnitude of impact has been assessed as **negligible**. As the species is of **high** sensitivity to displacement, the effect significance would be **minor adverse** and not significant in EIA terms.

12.183 No impacts to this species have been predicted during the breeding season, therefore the year-round effects were also assessed as being **minor adverse** and not significant in EIA terms.

Table 12.22 Year-round displacement matrix for common scoter (windfarm site plus 4km buffer)

Year-round	Mortality										
Displacement	**1%**	**2%**	**3%**	**4%**	**5%**	**10%**	**20%**	**30%**	**50%**	**80%**	**100%**
10%	0	0	0	0	0	0	1	1	2	3	4
25%	0	0	0	0	1	1	2	3	5	9	11
30%	0	0	0	1	1	1	3	4	6	10	13
40%	0	0	1	1	1	2	3	5	9	14	17
50%	0	0	1	1	1	2	4	6	11	17	22
60%	0	1	1	1	1	3	5	8	13	21	26
70%	0	1	1	1	2	3	6	9	15	24	30
80%	0	1	1	1	2	3	7	10	17	28	34
90%	0	1	1	2	2	4	8	12	19	31	39
100%	0	1	1	2	2	4	9	13	22	34	43

Note: The cells show the number of birds predicted to be subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Gannet

12.184 Gannets have shown a low level of sensitivity to ship and helicopter traffic (Garthe and Hüppop, 2004, Furness and Wade, 2012, Furness *et al.*, 2013), but appeared to be more sensitive to displacement from structures such as offshore wind turbines (Wade *et al.,* 2016) and on this basis the joint SNCB advice (SNCBs, 2022) indicated that a detailed assessment of potential displacement should be carried out as standard.

12.185 Cook *et al.* (2018) reviewed a number of gannet displacement studies from offshore windfarms. Where quantified, macro-avoidance rates (the percentage of birds taking action to avoid entering the wind turbine array) of 64-100% were reported. Some studies however reported no displacement response from gannets, possibly in areas where low densities of birds were present. Cook *et al.* (2018) recommended that the lowest of the quantified macro-avoidance rates, 64% for OWEZ (Krijgsveld *et al.,* 2011) was appropriate for this species. A study of seabird flight behaviour at Thanet offshore windfarm, not included in Cook *et al.* (2018)'s review, found a macro-avoidance rate of 79.7% for gannets approaching within 3km of the windfarm (Skov *et al.,* 2018).

12.186 Displacement effects for gannets from the Project were assessed during the breeding, autumn migration and spring migration periods, based on respective peak mean populations of 541, 124 and eight individual birds (**Table 12.23** to **Table 12.25**, with year-round values in **Table 12.26**), calculated for the windfarm site and a 2km buffer, in line with recommendations within the SNCB guidance (SNCBs, 2022). The inclusion of all birds within the 2km buffer, to determine the total number of birds subject to displacement, was precautionary, as in reality the avoidance rate would be likely to fall with distance from the windfarm site. This has been demonstrated in a study of gannet distribution in relation to the Greater Gabbard windfarm (APEM, 2014).

12.187 Displacement matrices for gannet (calculated for the windfarm site and a 2km buffer) are presented in **Table 12.23** to **Table 12.26**. For this species, based on the recommendations of Cook *et al.* (2018) and also the findings of Skov *et al.* (2018) (see **Paragraph 12.185** above), mortality rates of displaced birds have been assumed to be a maximum of 1%, as this species has high habitat flexibility (Furness and Wade, 2012) indicating that displaced birds would readily find alternative habitats including foraging areas.

Gannet – breeding season

12.188 The estimated number of gannets subject to operational disturbance/displacement during the breeding season would be 541 individuals. Within the range of 60-80% displacement and a precautionary 1% mortality, the maximum number of individual gannets which could potentially suffer mortality as a consequence of displacement during the breeding period has been estimated as between three and four individuals (**Table 12.23** highlighted cells).

12.189 The nearest gannet breeding colony to the Project is Middle Mouse, which is located approximately 66km to the south west of the windfarm site. However, this colony has been noted to support a low number of birds (28 adults in 2022), and therefore it is more likely that birds present at the windfarm site would be associated with the colonies at Ailsa Craig (approximately 190km north; 66,452 adults in 2014) and Scare Rocks (approximately 122km north; 4,752 adults in 2014). There are other gannet colonies within the mean maximum foraging range of this species, including Grassholm and the Saltee Islands. However, data presented by Wakefield *et al*. (2013) indicated that the foraging ranges of gannets from different breeding colonies tended not to overlap, and that the windfarm site would therefore be located outside of the core foraging area for adult birds from these colonies.

12.190 The regional BDMPS gannet population during the breeding season can be defined as the sum of adult and immature birds at all colonies in the region, as provided in Furness (2015). This gave a total breeding season population of 522,888.

12.191 At the average baseline mortality rate for gannet of 0.188 (**Table 12.17**) the number of individuals subject to mortality from the breeding season BDMPS would be 98,303 (522,888 x 0.188). The addition of four individuals (**Table 12.23**) to this would increase the mortality rate by <0.01%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. During the breeding period, the impact magnitude has been assessed as **negligible**. As the species is of **medium** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Gannet – autumn migration season

12.192 The estimated number of gannets subject to operational disturbance/displacement during the autumn migration period would be 124 individuals. Based on displacement rates of 60-80% and a precautionary mortality rate of 1%, the number of individual gannets which could potentially suffer mortality as a consequence of displacement during the autumn migration period has been estimated as one individual (**Table 12.24** highlighted cells).

12.193 The BDMPS for gannet in autumn is 545,954 (Furness, 2015). At the average baseline mortality rate for gannet of 0.188, the number of individuals subject to mortality in the autumn BDMPS would be 102,639 (545,954 x 0.188). The addition of a maximum of one individual to this would increase the mortality rate by <0.01%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the impact magnitude has been assessed as **negligible**. As the species is of **medium** sensitivity to displacement, the effect significance would be **minor adverse** and not significant in EIA terms.

Gannet – spring migration season

12.194 The estimated number of gannets subject to operational disturbance/displacement during the spring migration period would be eight individuals. Based on displacement rates of 60-80% and a precautionary mortality rate of 1%, the number of individual gannets which could potentially suffer mortality as a consequence of displacement during the autumn migration period has been estimated as zero individuals (**Table 12.25** highlighted cells).

12.195 The BDMPS for gannet in spring is 661,888 (Furness, 2015). At the average baseline mortality rate for gannet of 0.188, the number of individuals subject to mortality in the spring BDMPS would be 124,435. No additional mortality from collisions has been predicted during this period, therefore there would be no change in EIA terms.

Gannet – year-round

12.196 The estimated number of gannets subject to operational disturbance/displacement throughout the year would be 673 individuals (sum of above seasons) of which between four and five individuals would be subject to mortality (**Table 12.26** highlighted cells).

12.197 At the average baseline mortality rate for gannet of 0.188, the number of individuals subject to mortality from the largest BDMPS population throughout the year would be 124,435 (661,888 x 0.188). The addition of a maximum of five individuals to this would increase the mortality rate by <0.01%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the impact magnitude has been assessed as **negligible**. As the species is of **medium** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Table 12.23 Breeding season displacement matrix for gannet (windfarm site plus 2km buffer)

Breeding	Mortality										
Displacement	1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
10%	1	1	2	2	3	5	11	16	27	43	54
20%	1	2	3	4	5	11	22	32	54	87	108
30%	2	3	5	6	8	16	32	49	81	130	162
40%	2	4	6	9	11	22	43	65	108	173	216
50%	3	5	8	11	14	27	54	81	135	216	271
60%	3	6	10	13	16	32	65	97	162	260	325
70%	4	8	11	15	19	38	76	114	189	303	379
80%	4	9	13	17	22	43	87	130	216	346	433
90%	5	10	15	19	24	49	97	146	243	390	487
100%	5	11	16	22	27	54	108	162	271	433	541

Note: The cells show the number of birds predicted to be subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Table 12.24 Autumn migration period displacement matrix for gannet (windfarm site plus 2km buffer)

Autumn	Mortality									
Displacement	1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
10%	0	0	0	0	1	1	2	4	6	10	12
20%	0	0	1	1	1	2	5	7	12	20	25
30%	0	1	1	1	2	4	7	11	19	30	37
40%	0	1	1	2	2	5	10	15	25	40	50
50%	1	1	2	2	3	6	12	19	31	50	62
60%	1	1	2	3	4	7	15	22	37	59	74
70%	1	2	3	3	4	9	17	26	43	69	87
80%	1	2	3	4	5	10	20	30	50	79	99
90%	1	2	3	4	6	11	22	33	56	89	111
100%	1	2	4	5	6	12	25	37	62	99	124

Note: The cells show the number of birds predicted to be subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Table 12.25 Spring migration period displacement matrix for gannet (windfarm site plus 2km buffer)

Autumn	**Mortality**										
Displacement	**1%**	**2%**	**3%**	**4%**	**5%**	**10%**	**20%**	**30%**	**50%**	**80%**	**100%**
10%	0	0	0	0	0	0	0	0	0	1	1
20%	0	0	0	0	0	0	0	0	1	1	2
30%	0	0	0	0	0	0	0	1	1	2	2
40%	0	0	0	0	0	0	1	1	2	3	3
50%	0	0	0	0	0	0	1	1	2	3	4
60%	0	0	0	0	0	0	1	1	2	4	5
70%	0	0	0	0	0	1	1	2	3	4	6
80%	0	0	0	0	0	1	1	2	3	5	6
90%	0	0	0	0	0	1	1	2	4	6	7
100%	0	0	0	0	0	1	2	2	4	6	8

Note: The cells show the number of birds predicted to be subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Table 12.26 Year-round displacement matrix for gannet (windfarm site plus 2km buffer)

Year-round	Mortality										
Displacement	1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
10%	1	1	2	3	3	7	13	20	34	54	67
20%	1	3	4	5	7	13	27	40	67	108	135
30%	2	4	6	8	10	20	40	61	101	161	202
40%	3	5	8	11	13	27	54	81	135	215	269
50%	3	7	10	13	17	34	67	101	168	269	336
60%	4	8	12	16	20	40	81	121	202	323	404
70%	5	9	14	19	24	47	94	141	235	377	471
80%	5	11	16	22	27	54	108	161	269	431	538
90%	6	12	18	24	30	61	121	182	303	484	606
100%	7	13	20	27	34	67	135	202	336	538	673

Note: The cells show the number of birds predicted to be subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Auks – guillemot and razorbill

12.198 Auks are considered to have medium sensitivity to disturbance and displacement from operational offshore windfarms based on available monitoring data and information on their responses to man-made disturbance, for example for ship and helicopter traffic (Garthe and Hüppop, 2004; Schwemmer *et al.,* 2011; Furness and Wade, 2012; Furness *et al.,* 2013; Bradbury *et al.,* 2014; MMO, 2018).

12.199 Available pre- and post-construction data for operational offshore windfarms have yielded variable results; they indicated that auks may be displaced to some extent by some windfarms, but displacement was partial and apparently negligible at others (Dierschke *et al.,* 2016).

12.200 Common guillemots were displaced at Blighbank (Vanermen *et al.,* 2012, 2014) and only in a minority of surveys at two Dutch windfarms (OWEZ and Prinses Amaliawindpark (PAWP); Leopold *et al.,* 2011, Krijgsveld *et al.,* 2011), but were not significantly displaced at Horns Rev (although the data suggested that slight displacement was probably occurring; Petersen *et al.,* 2006) or Thornton Bank (Vanermen *et al.* 2012). Razorbills were displaced in one out of six surveys at two of four North Sea windfarms (OWEZ and PAWP; Leopold *et al.,* 2011, Krijgsveld *et al.,* 2011), but not at Horns Rev (Petersen *et al.* 2006) or Thornton Bank (Vanermen *et al.,* 2012). At Blighbank, razorbills were found to be significantly displaced when considering the windfarm area and a buffer of 0.5km, but not when considering the windfarm area and a 3km buffer, or the buffer alone (0.5-3km from the windfarm; Vanermen *et al.,* 2014). The recent study of operational windfarms in the Belgian North Sea (Vanerman *et al.* in Degraer *et al.* (Eds), 2023) indicated that there was only a small difference between densities of guillemots within and outside of windfarms, while for razorbills densities were higher inside the windfarms than outside. This indicated limited displacement effect in respect of guillemot, and potential attraction for razorbill.

12.201 Following statutory guidance (SNCBs, 2022) the mean peak seasonal abundance estimates for each auk species for the windfarm and a 2km buffer for the most relevant biological periods have been placed into individual displacement matrices. Each matrix shows displacement rates and mortality rates for each species (Section 3 of **Appendix 12.1**).

12.202 In accordance with SNCB guidance (2022), and as agreed with Natural England through the ETG process, a range of mortality rates of 1-10% and displacement rates of 30-70% have been considered for auks, with 70% displacement and 10% mortality as the worst-case. However, there is evidence to show that mortality for auks is likely to be at the low end of the range, as set out below. The natural adult annual mortality for razorbill is 10.5% and for guillemot is 6% (Horswill and Robinson 2015); an additional

10% mortality for displaced birds would effectively double (razorbill) and more than double (guillemot) the natural mortality.

12.203 A review of available evidence for auk displacement, prepared for the assessment of the Norfolk Vanguard Offshore Windfarm (Norfolk Vanguard Limited 2019b) concluded that displacement of guillemots and razorbills by offshore windfarms was uncertain, and may reduce with habituation, and that offshore windfarms may in the long-term increase food availability to guillemots and razorbills through providing enhanced habitat for fish populations. Mortality due to displacement might arise if displacement increased competition for resources in the remaining areas of auk habitat outside the windfarm. The increase in density of auks outside the windfarm area would be negligible, because the rest of the available habitat would be vast. Thus, the mortality rate due to displacement may well be 0% and is highly unlikely to represent levels of mortality anywhere near to the 6% or 10% total annual mortality that occur due to the combination of many natural factors plus existing human activities. Norfolk Vanguard Limited (2019b) suggested that precautionary rates for operational windfarms would be 50% displacement and 1% mortality of displaced birds.

12.204 For the purpose of this assessment a displacement rate range of 30 to 70% and a mortality rate range of 1-10% have been highlighted in each displacement matrix, with the 70%/10% combination representing a worst-case scenario.

12.205 The regional BDMPS auk populations during the breeding season can be defined as the sum of adults and immature birds at all colonies in the region, as provided in Furness (2015). This gives total breeding season populations of 1,145,528 guillemots and 198,969 razorbills.

12.206 For guillemot, there is only one defined non-breeding season (August–February), while for razorbill there are three (August–October, November–December and January–March; **Table 12.15**). The number of birds which could potentially be displaced has been estimated for each species-specific relevant season.

Guillemot – breeding season

12.207 The estimated number of guillemots subject to operational disturbance/displacement during the breeding season would be 6,374 individuals (**Table 12.21**). Of these, the estimated number of birds subject to mortality would be between 19 and 446 individuals (from 30%/1% to 70%/10%, **Table 12.27**). The breeding season BDMPS is 1,145,528 individuals (Furness, 2015).

12.208 At the average baseline mortality rate for guillemot of 0.143 (**Table 12.17**), the number of individuals subject to mortality in the breeding season would be

163,811 (1,145,528 x 0.143). The addition of a maximum of 446 individuals to this would increase the mortality rate by 0.27%. This value is considered precautionary and taking into account the background mortality rate (i.e. c.14%), it is implausible that a rate of 10% would be caused from this single source. Based on a more realistic background rate (i.e. 1%) the addition of a maximum of 45 individuals would increase the mortality rate by 0.03%.

12.209 During the breeding season, these magnitudes of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding period, the impact magnitude has been assessed as **negligible**. As the species is of **medium** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Guillemot – non-breeding season

12.210 The estimated number of guillemots subject to operational disturbance/displacement during the non-breeding season would be 8,315 individuals (**Table 12.21**). Of these, the estimated number of birds subject to mortality due to displacement from the windfarm site would be between 25 and 582 individuals (within the range of displacement/mortality of 30%/1% to 70%/10%, **Table 12.28**). The relevant BDMPS for the UK Western Waters was 1,139,220 (Furness, 2015).

12.211 At the average baseline mortality rate for guillemot of 0.143 (**Table 12.17**) the number of individuals subject to mortality in the non-breeding season would be 162,908 (1,139,220 x 0.143). The addition of a maximum of 582 individuals to this would increase the mortality rate by 0.36%. This value is considered precautionary and taking into account the background mortality rate (i.e. c.14%), it is implausible that a rate of 10% would be caused from this single source. Based on a more realistic background rate (i.e. 1%) the addition of a maximum of 58 individuals would increase the mortality rate by 0.04%.

12.212 During the non-breeding season, these magnitudes of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the non-breeding season, the impact magnitude has been assessed as **negligible**. As the species is of **medium** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Guillemot – year-round

12.213 The estimated number of guillemots subject to operational disturbance/displacement year-round is 14,689 individuals. Of these, the estimated number of birds subject to mortality due to displacement from the windfarm site throughout the year would be between 44 and 1,028 individuals (**Table 12.29**).

12.214 At the average baseline mortality rate for guillemot of 0.143, the number of individuals subject to mortality from the largest BDMPS population throughout the year would be 163,811 (1,145,528 x 0.143). The addition of a maximum of 1,028 individuals to this would increase the mortality rate by 0.63%. In relation to the biogeographic population with connectivity to UK waters of 4,125,000 (Furness 2015), the number of individuals subject to mortality annually would be 589,875 (4,125,000 x 0.143). The addition of a maximum of 1,028 individuals to this would increase the mortality rate by 0.18%.

12.215 The additional mortality of 1,028 individuals is considered precautionary and taking into account the background mortality rate (i.e. c.14%) it is implausible that a rate of 10% would be caused from this single source. Based on a more realistic background rate (i.e. 1%) the addition of a maximum of 103 individuals would increase the mortality rate of the BDMPS population by 0.06%. In relation to the biogeographic population, the mortality rate would increase by 0.02%.

12.216 These magnitudes of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the year-round impact magnitude has been assessed as **negligible**. As the species is of **medium** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms. This conclusion would be unchanged even if the upper (10%) mortality rate was applied.

Table 12.27 Breeding season displacement matrix for guillemot (windfarm site plus 2km buffer)

Breeding	Mortality										
Displacement	**1%**	**2%**	**3%**	**4%**	**5%**	**10%**	**20%**	**30%**	**50%**	**80%**	**100%**
10%	6	13	19	25	32	64	127	191	319	510	637
20%	13	25	38	51	64	127	255	382	637	1020	1275
30%	19	38	57	76	96	191	382	574	956	1530	1912
40%	25	51	76	102	127	255	510	765	1275	2040	2550
50%	32	64	96	127	159	319	637	956	1594	2550	3187
60%	38	76	115	153	191	382	765	1147	1912	3060	3825
70%	45	89	134	178	223	446	892	1339	2231	3570	4462
80%	51	102	153	204	255	510	1020	1530	2550	4080	5099
90%	57	115	172	229	287	574	1147	1721	2868	4590	5737
100%	64	127	191	255	319	637	1275	1912	3187	5099	6374

Note: The cells show the number of birds predicted to be subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Table 12.28 Non-breeding season displacement matrix for guillemot (windfarm site plus 2km buffer)

Non-breeding	Mortality										
Displacement	1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
10%	8	17	25	33	42	83	166	249	416	665	831
20%	17	33	50	67	83	166	333	499	831	1330	1663
30%	25	50	75	100	125	249	499	748	1247	1996	2494
40%	33	67	100	133	166	333	665	998	1663	2661	3326
50%	42	83	125	166	208	416	831	1247	2079	3326	4157
60%	50	100	150	200	249	499	998	1497	2494	3991	4989
70%	58	116	175	233	291	582	1164	1746	2910	4656	5820
80%	67	133	200	266	333	665	1330	1996	3326	5322	6652
90%	75	150	225	299	374	748	1497	2245	3742	5987	7483
100%	83	166	249	333	416	831	1663	2494	4157	6652	8315

Note: The cells show the number of birds predicted to be subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Table 12.29 Year-round displacement matrix for guillemot (windfarm site plus 2km buffer)

Year-round	Mortality									
Displacement	**1%**	**2%**	**3%**	**4%**	**5%**	**10%**	**20%**	**30%**	**50%**	**80%**	**100%**
10%	15	29	44	59	73	147	294	441	734	1175	1469
20%	29	59	88	118	147	294	588	881	1469	2350	2938
30%	44	88	132	176	220	441	881	1322	2203	3525	4407
40%	59	118	176	235	294	588	1175	1763	2938	4701	5876
50%	73	147	220	294	367	734	1469	2203	3672	5876	7345
60%	88	176	264	353	441	881	1763	2644	4407	7051	8814
70%	103	206	308	411	514	1028	2056	3085	5141	8226	10282
80%	118	235	353	470	588	1175	2350	3525	5876	9401	11751
90%	132	264	397	529	661	1322	2644	3966	6610	10576	13220
100%	147	294	441	588	734	1469	2938	4407	7345	11751	14689

Note: The cells show the number of birds predicted to be subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Razorbill – breeding season

12.217 The estimated number of razorbills subject to operational disturbance/displacement during the breeding season period would be 252 individuals (**Table 12.21**). Of these, the estimated number of birds subject to mortality due to displacement from the windfarm site would be between one and 18 individuals (from 30%/1% to 70%/10%, **Table 12.30**). The breeding season BDMPS is 198,969.

12.218 At the average baseline mortality rate for razorbill of 0.178, the number of individuals subject to mortality in the breeding season would be 35,416 (198,969 x 0.178). The addition of a maximum of 18 to this would increase the mortality rate by 0.05% This value is considered precautionary (**Paragraphs 12.202** – **12.203**); based on a realistic mortality rate (i.e. 1%) the addition of a maximum of two individuals would increase the background mortality by <0.01%.

12.219 During the breeding season, these magnitudes of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding period, the impact magnitude has been assessed as **negligible**. As the species is of **medium** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Razorbill – autumn migration season

12.220 The estimated number of razorbills subject to operational disturbance/displacement during the autumn migration period would be 694 individuals (**Table 12.21**). Of these, the estimated number of birds subject to mortality due to displacement from the windfarm site would be between two and 49 individuals (within the range of displacement/mortality of 30%/1% to 70%/10%, **Table 12.31**). The autumn BDMPS for the UK Western Waters is 606,914 (Furness, 2015).

12.221 At the average baseline mortality rate for razorbill of 0.178 (**Table 12.17**) the number of individuals subject to mortality in the autumn migration period would be 108,031 (606,914 x 0.178). The addition of a maximum of 49 individuals to this would increase the mortality rate by 0.05%. This value is considered precautionary (**Paragraphs 12.202 – 12.203**); based on a realistic mortality rate (i.e. 1%) the addition of a maximum of five individuals would increase the background mortality by <0.01%.

12.222 During the autumn migration season, these magnitudes of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the impact magnitude has been assessed as **negligible**. As the species is of

medium sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Razorbill – winter season

12.223 The estimated number of razorbills subject to operational disturbance/displacement during the winter period would be 651 individuals (**Table 12.21**). Of these, the estimated number of birds subject to mortality due to displacement from the windfarm site would be between two and 46 individuals (within the range of displacement/mortality of 30%/1% to 70%/10%, **Table 12.32**). The winter BDMPS for the UK Western Waters is 341,422 (Furness, 2015).

12.224 At the average baseline mortality rate for razorbill of 0.178 the number of individuals subject to mortality in the winter period would be 60,773 (341,422 x 0.178). The addition of a maximum of 46 individuals to this would increase the mortality rate by 0.08%. This value is considered precautionary (**Paragraphs 12.202 – 12.203**); based on a realistic mortality rate (i.e. 1%) the addition of a maximum of five individuals would increase the background mortality by <0.01%.

12.225 During the winter season, these magnitudes of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the winter period, the impact magnitude has been assessed as **negligible**. As the species is of **medium** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Razorbill – spring migration season

12.226 The estimated number of razorbills subject to operational disturbance/displacement during the spring migration period would be 382 individuals (**Table 12.21**). Of these, the estimated number of birds subject to mortality due to displacement from the windfarm site would be between one and 27 individuals (within the range of displacement/mortality of 30%/1% to 70%/10%; **Table 12.33**). The spring BDMPS for the UK Western Waters is 606,914 (Furness, 2015).

12.227 At the average baseline mortality rate for razorbill of 0.178 the number of individuals subject to mortality in the spring migration period would be 108,031 (606,914 x 0.178). The addition of a maximum of 27 individuals to this would increase the mortality rate by 0.02%. This value is considered precautionary (**Paragraphs 12.202 – 12.203**); based on a realistic mortality rate (i.e. 1%) the addition of a maximum of three individuals would increase the background mortality by <0.01%.

12.228 During the spring migration season, these magnitudes of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the impact magnitude has been assessed as **negligible**. As the species is of **medium** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Razorbill – year-round

12.229 The estimated number of razorbills subject to construction disturbance/displacement throughout the year is 1,979 individuals (summing the seasonal totals above), of which between six and 139 individuals would be subject to mortality (**Table 12.34**). At the average baseline mortality rate for razorbill of 0.178, the number of individuals subject to mortality from the largest BDMPS population throughout the year would be 108,031 (606,914 x 0.178). The addition of a maximum of 139 individuals to this would increase the mortality rate by 0.13%.

12.230 The additional mortality of 139 individuals is considered precautionary (**Paragraphs 12.202 – 12.203**); based on a realistic background rate (i.e. 1%) the addition of a maximum of 14 individuals would increase the mortality rate of the BDMPS population by 0.01%.

12.231 Year round, these magnitudes of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the impact magnitude has been assessed as **negligible**. As the species is of **medium** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms. This conclusion would be unchanged even if the upper (10%) mortality rate was applied.

Table 12.30 Breeding season displacement matrix for razorbill (windfarm site plus 2km buffer)

Breeding	Mortality										
Displacement	**1%**	**2%**	**3%**	**4%**	**5%**	**10%**	**20%**	**30%**	**50%**	**80%**	**100%**
10%	0	1	1	1	1	3	5	8	13	20	25
20%	1	1	2	2	3	5	10	15	25	40	50
30%	1	2	2	3	4	8	15	23	38	61	76
40%	1	2	3	4	5	10	20	30	50	81	101
50%	1	3	4	5	6	13	25	38	63	101	126
60%	2	3	5	6	8	15	30	45	76	121	151
70%	2	4	5	7	9	18	35	53	88	141	177
80%	2	4	6	8	10	20	40	61	101	162	202
90%	2	5	7	9	11	23	45	68	114	182	227
100%	3	5	8	10	13	25	50	76	126	202	252

Note: The cells show the number of birds predicted to be subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Table 12.31 Autumn migration period displacement for razorbill (windfarm site plus 2km buffer)

Autumn	Mortality										
Displacement	**1%**	**2%**	**3%**	**4%**	**5%**	**10%**	**20%**	**30%**	**50%**	**80%**	**100%**
10%	1	1	2	3	3	7	14	21	35	56	69
20%	1	3	4	6	7	14	28	42	69	111	139
30%	2	4	6	8	10	21	42	62	104	167	208
40%	3	6	8	11	14	28	56	83	139	222	278
50%	3	7	10	14	17	35	69	104	174	278	347
60%	4	8	12	17	21	42	83	125	208	333	416
70%	5	10	15	19	24	49	97	146	243	389	486
80%	6	11	17	22	28	56	111	167	278	444	555
90%	6	12	19	25	31	62	125	187	312	500	625
100%	7	14	21	28	35	69	139	208	347	555	694

Note: The cells show the number of birds predicted to be subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Table 12.32 Winter period displacement for razorbill (windfarm site plus 2km buffer)

Winter	Mortality									
Displacement	**1%**	**2%**	**3%**	**4%**	**5%**	**10%**	**20%**	**30%**	**50%**	**80%**	**100%**
10%	1	1	2	3	3	7	13	20	33	52	65
20%	1	3	4	5	7	13	26	39	65	104	130
30%	2	4	6	8	10	20	39	59	98	156	195
40%	3	5	8	10	13	26	52	78	130	208	260
50%	3	7	10	13	16	33	65	98	163	260	326
60%	4	8	12	16	20	39	78	117	195	313	391
70%	5	9	14	18	23	46	91	137	228	365	456
80%	5	10	16	21	26	52	104	156	260	417	521
90%	6	12	18	23	29	59	117	176	293	469	586
100%	7	13	20	26	33	65	130	195	326	521	651

Note: The cells show the number of birds predicted to be subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Table 12.33 Spring migration period displacement for razorbill (windfarm site plus 2km buffer)

Spring	Mortality									
Displacement	**1%**	**2%**	**3%**	**4%**	**5%**	**10%**	**20%**	**30%**	**50%**	**80%**	**100%**
10%	0	1	1	2	2	4	8	11	19	31	38
20%	1	2	2	3	4	8	15	23	38	61	76
30%	1	2	3	5	6	11	23	34	57	92	114
40%	2	3	5	6	8	15	31	46	76	122	153
50%	2	4	6	8	10	19	38	57	95	153	191
60%	2	5	7	9	11	23	46	69	114	183	229
70%	3	5	8	11	13	27	53	80	134	214	267
80%	3	6	9	12	15	31	61	92	153	244	305
90%	3	7	10	14	17	34	69	103	172	275	343
100%	4	8	11	15	19	38	76	114	191	305	382

Note: The cells show the number of birds predicted to be subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCBs advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Table 12.34 Year-round displacement matrix for razorbill (windfarm site plus 2km buffer)

Year-round	Mortality									
Displacement	**1%**	**2%**	**3%**	**4%**	**5%**	**10%**	**20%**	**30%**	**50%**	**80%**	**100%**
10%	2	4	6	8	10	20	40	59	99	158	198
20%	4	8	12	16	20	40	79	119	198	317	396
30%	6	12	18	24	30	59	119	178	297	475	594
40%	8	16	24	32	40	79	158	238	396	633	792
50%	10	20	30	40	49	99	198	297	495	792	990
60%	12	24	36	48	59	119	238	356	594	950	1188
70%	14	28	42	55	69	139	277	416	693	1108	1385
80%	16	32	48	63	79	158	317	475	792	1267	1583
90%	18	36	53	71	89	178	356	534	891	1425	1781
100%	20	40	59	79	99	198	396	594	990	1583	1979

Note: The cells show the number of birds predicted to be subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Manx shearwater

12.232 Manx shearwater have generally been considered to have a low susceptibility to disturbance and displacement. Dierschke *et al.* (2016) described Manx shearwater as "weakly avoiding wind farms" but noted that evidence was lacking for the species. Bradbury *et al.* (2014) classified Manx shearwater as having "very low" population vulnerability to displacement. Dierschke *et al.* (2016) suggested that Manx shearwater were avoiding North Hoyle Windfarm, stating that an obvious distribution gap was observed at the OWF, although evidence for this appeared limited. Dierschke *et al.* (2016) also noted that Manx shearwater had been recorded within Robin Rigg OWF.

12.233 Manx shearwater has by far the largest foraging distance from colonies of all regularly breeding UK and Ireland seabirds (mean maximum (+1SD) of 2366km; Woodward et al., 2019). Birds from Skomer have been found to make trips of up to 727km from the colony (Dean, 2012) and birds tracked from colonies in Ireland had foraging ranges of up to 1,109 km (Wischnewski et al., 2019). Studies on Rum, Copeland, Skomer and Lundy found that birds foraged near their respective colonies, with little overlap between colonies, but individuals from all colonies also travelled to a more distant shared foraging area at the Irish Sea Front and nearby waters of the Western Irish Sea (Dean et al., 2015). Given the species' large foraging range and the distance to the nearest colony (Calf of Man; 79.9km) the windfarm site was considered unlikely to be of particular importance to foraging Manx shearwaters compared with more productive areas over the continental shelf such as the Irish Sea Front.

12.234 Due to the limited evidence available for Manx Shearwater as to suitable displacement and mortality rates, in line with the advice from the SNCBs (2022), a standard approach has been taken of applying a 30-70% displacement rate to the array area plus 2km buffer, and 1-10% mortality of displaced individuals. However, it is considered that 1% mortality rate would be the more likely impact based on expert judgement and evidence relating to Manx shearwater biology and foraging range.

Manx shearwater – breeding season

12.235 The estimated number of Manx shearwaters subject to operational disturbance/displacement during the breeding season was 4,705 individuals (**Table 12.21**). Of these, the estimated number of birds subject to mortality due to displacement from the windfarm site would be between 14 and 329 individuals (from 30%/1% to 70%/10%; **Table 12.35**). The breeding season BDMPS is 1,821,544 (Furness, 2015).

12.236 At an average baseline mortality rate for Manx shearwater of 0.130, the number of individuals subject to mortality in the breeding season would be 236,801 (1,821,544 x 0.13). The addition of a maximum of 329 to this increases the mortality rate by 0.14%. This value is considered precautionary and taking into account the background mortality rate (i.e. c.13%), it is implausible that a rate of 10% would be caused from this single source. Based on a more realistic background rate (i.e. 1%; **Paragraphs 12.232** to **12.234**) the addition of 33 individuals would increase the mortality rate by 0.01%.

12.237 During the breeding season, these magnitudes of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding period, the impact magnitude has been assessed as **negligible**. As the species is of **low** sensitivity to disturbance, the effect significance would be **negligible adverse** and not significant in EIA terms.

Manx shearwater – autumn migration season

12.238 The estimated number of Manx shearwaters subject to operational disturbance/displacement during spring migration was 2,650 individuals (**Table 12.21**). Of these, the estimated number of birds subject to mortality due to displacement from the windfarm site would be between eight and 186 individuals (from 30%/1% to 70%/10%, **Table 12.36**). The BDMPS is 1,580,895 (Furness, 2015).

12.239 At an average baseline mortality rate for Manx shearwater of 0.130, the number of individuals subject to mortality in the autumn migration period would be 205,516 (1,580,895 x 0.13). The addition of a maximum of 186 to this would increase the mortality rate by 0.09%. This value is considered precautionary and taking into account the background mortality rate (i.e. c.13%), it is implausible that a rate of 10% would be caused from this single source. Based on a more realistic background rate (i.e. 1%; **Paragraphs 12.232** to **12.234**) the addition of 19 individuals would increase the mortality rate by <0.01%.

12.240 During autumn migration, these magnitudes of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during autumn, the impact magnitude has been assessed as **negligible**. As the species is of **low** sensitivity to disturbance, the effect significance would be **negligible adverse** and not significant in EIA terms.

Manx shearwater – spring migration season

12.241 The estimated number of Manx shearwaters subject to operational disturbance/displacement during spring migration would be 1,617 individuals (**Table 12.21**). Of these, the estimated number of birds subject to mortality due to displacement from the windfarm site would be between five and 113 individuals (from 30%/1% to 70%/10%; **Table 12.37**). The BDMPS is 1,580,895 (Furness, 2015).

12.242 At the average baseline mortality rate for Manx shearwater of 0.130, the number of individuals subject to mortality in the spring migration period is 205,516 (1,580,895 x 0.13). The addition of a maximum of 113 to this would increase the mortality rate by 0.05%. This value is considered precautionary and taking into account the background mortality rate (i.e. c.13%; **Paragraphs 12.232** to **12.234**), it is implausible that a rate of 10% would be caused from this single source. Based on a more realistic background rate (i.e. 1%) the addition of 11 individuals would increase the mortality rate by <0.01%.

12.243 During spring migration, these magnitude of increases in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during spring, the impact magnitude has been assessed as **negligible**. As the species is of **low** sensitivity to disturbance, the effect significance would be **negligible adverse** and not significant in EIA terms.

Manx shearwater – year-round

12.244 The estimated number of Manx shearwaters subject to operational disturbance/displacement throughout the year is 8,972 individuals. Of these, the estimated number of birds subject to mortality due to displacement from the windfarm site would be between 27 and 628 individuals (**Table 12.38**).

12.245 At the average baseline mortality rate for Manx shearwater of 0.13, the number of individuals subject to mortality from the largest BDMPS population (1,821,544 during the breeding season) throughout the year would be 236,801 (1,821,544 x 0.13). The addition of a maximum of 628 individuals to this would increase the mortality rate by 0.27%. This value is considered precautionary and taking into account the background mortality rate (i.e. c.13%; **Paragraphs 12.232** to **12.234**), it is implausible that a rate of 10% would be caused from this single source. Based on a more realistic background rate (i.e. 1%) the addition of 63 individuals would increase the mortality rate by 0.03%.

12.246 These magnitudes of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the impact magnitude has been assessed as **negligible**. As the species is of **low** sensitivity to disturbance, the effect significance would be **negligible adverse** and not significant in EIA terms. This conclusion would be unchanged even when the upper (10%) mortality rate is used.

Effects of artificial lighting on Manx shearwater disturbance/displacement

12.247 There was evidence to suggest that Manx shearwaters can be affected by artificial light (e.g. from human dwellings or lighthouses), which can result in disorientation, attraction or repulsion (Guilford *et al.*, 2019; Syposz, 2020). This effect would be more likely to occur during conditions of low ambient light (e.g. a new moon), and during conditions of fog, mist or light rain. Guilford *et al*. (2019) showed experimentally that, during foggy conditions but not clear nights, light emanating from windows resulted in disorientation of adult Manx Shearwaters, causing them to collide with the lit building. The strongest effects have been recorded at, or close to, breeding colonies, where recently fledged birds have been regularly recorded 'grounding' around lit-up areas (Syposz, 2020).

12.248 The extent of long-range attraction of Manx shearwaters to artificial light is more difficult to quantify (Deakin *et al*., 2022). Some studies suggested that birds were not attracted over large distances, or if so, only a small proportion of individuals were affected or recovered. For example, the number of fledgling Manx shearwaters recovered in the town of Mallaig (Syposz *et al*., 2018) broadly corresponded, given the size and distance of the likely source colony (Rum, 27km away), with the number of birds that would be expected if birds had dispersed randomly in all directions from the colony. This indicted that the small proportion recovered at Mallaig were attracted at very short range, and hence that there was no attraction effect at greater distances. There are no quantitative estimates of Manx shearwater attraction in the literature, but studies of other Procellariifomes indicate that fledglings have been attracted to coastal illumination from distances up to 10km (e.g. Troy *et al*., 2013).

12.249 It is possible that differences in the sensory systems used for navigation by shearwaters may result in important differences in their sensitivities to attraction/disorientation by light of particular wavelengths (Deakin *et al*., 2022). Evidence indicates that the behavioural response in shearwaters is affected by the intensity and wavelength (colour) of the light, with blue and green lights showing the greatest, and red lights showing the least effect (Syposz, 2020). Research indicated that there was no difference in birds' behaviour when exposed to red light compared to no light. This was supported by observations at Bardsey lighthouse which changed to a red flashing light in 2014, resulting in a huge reduction in collisions of Manx shearwaters (Deakin *et al*., 2022). It is therefore considered unlikely that red navigational lights on turbines would have any discernible effect on this species.

12.250 In summary, there is greater uncertainty about the effects of artificial light on Manx shearwaters (both adult and immature birds) away from breeding colonies. It is clear that the species can become disorientated by artificial light, with recently fledged young being particularly vulnerable in close proximity to breeding colonies, however there is a lack of evidence on which to judge the existence and strength of light attraction (Deakin *et al*., 2022). Given the absence of breeding colonies in the vicinity, it is considered unlikely that the very limited lighting associated with the Project (see **Paragraph 12.163**) would significantly affect disturbance and displacement effects (and by extension, any collision risk) on Manx shearwater. Therefore, the conclusions of the disturbance and displacement assessment for this species, as set out above, remain unchanged.

Table 12.35 Breeding season displacement matrix for Manx shearwater (windfarm site plus 2km buffer)

Breeding season	Mortality									
Displacement	1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
10%	5	9	14	19	24	47	94	141	235	376	471
20%	9	19	28	38	47	94	188	282	471	753	941
30%	14	28	42	56	71	141	282	423	706	1129	1412
40%	19	38	56	75	94	188	376	565	941	1506	1882
50%	24	47	71	94	118	235	471	706	1176	1882	2353
60%	28	56	85	113	141	282	565	847	1412	2258	2823
70%	33	66	99	132	165	329	659	988	1647	2635	3294
80%	38	75	113	151	188	376	753	1129	1882	3011	3764
90%	42	85	127	169	212	423	847	1270	2117	3388	4235
100%	47	94	141	188	235	471	941	1412	2353	3764	4705

Note: The cells show the number of birds predicted to be subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Table 12.36 Autumn migration displacement matrix for Manx shearwater (windfarm site plus 2km buffer)

Breeding season	Mortality										
Displacement	**1%**	**2%**	**3%**	**4%**	**5%**	**10%**	**20%**	**30%**	**50%**	**80%**	**100%**
10%	3	5	8	11	13	27	53	80	133	212	265
20%	5	11	16	21	27	53	106	159	265	424	530
30%	8	16	24	32	40	80	159	239	398	636	795
40%	11	21	32	42	53	106	212	318	530	848	1060
50%	13	27	40	53	66	133	265	398	663	1060	1325
60%	16	32	48	64	80	159	318	477	795	1272	1590
70%	19	37	56	74	93	186	371	557	928	1484	1855
80%	21	42	64	85	106	212	424	636	1060	1696	2120
90%	24	48	72	95	119	239	477	716	1193	1908	2385
100%	27	53	80	106	133	265	530	795	1325	2120	2650

Note: The cells show the number of birds predicted to be subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Table 12.37 Spring migration displacement matrix for Manx shearwater (windfarm site plus 2km buffer)

Breeding season	Mortality										
Displacement	**1%**	**2%**	**3%**	**4%**	**5%**	**10%**	**20%**	**30%**	**50%**	**80%**	**100%**
10%	2	3	5	6	8	16	32	49	81	129	162
20%	3	6	10	13	16	32	65	97	162	259	323
30%	5	10	15	19	24	49	97	146	243	388	485
40%	6	13	19	26	32	65	129	194	323	517	647
50%	8	16	24	32	40	81	162	243	404	647	809
60%	10	19	29	39	49	97	194	291	485	776	970
70%	11	23	34	45	57	113	226	340	566	906	1132
80%	13	26	39	52	65	129	259	388	647	1035	1294
90%	15	29	44	58	73	146	291	437	728	1164	1455
100%	16	32	49	65	81	162	323	485	809	1294	1617

Note: The cells show the number of birds predicted to be subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Table 12.38 Year-round displacement matrix for Manx shearwater (windfarm site plus 2km buffer)

Breeding season	**Mortality**										
Displacement	**1%**	**2%**	**3%**	**4%**	**5%**	**10%**	**20%**	**30%**	**50%**	**80%**	**100%**
10%	9	18	27	36	45	90	179	269	449	718	897
20%	18	36	54	72	90	179	359	538	897	1436	1794
30%	27	54	81	108	135	269	538	807	1346	2153	2692
40%	36	72	108	144	179	359	718	1077	1794	2871	3589
50%	45	90	135	179	224	449	897	1346	2243	3589	4486
60%	54	108	161	215	269	538	1077	1615	2692	4307	5383
70%	63	126	188	251	314	628	1256	1884	3140	5024	6280
80%	72	144	215	287	359	718	1436	2153	3589	5742	7178
90%	81	161	242	323	404	807	1615	2422	4037	6460	8075
100%	90	179	269	359	449	897	1794	2692	4486	7178	8972

Note: The cells show the number of birds predicted to be subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Red-throated diver

12.251 Red-throated divers are considered to have a very high general sensitivity to disturbance and displacement and have been noted to avoid disturbed areas such as shipping lanes, as well as offshore windfarms (Garthe and Hüppop 2004; Bellebaum *et al.,* 2006; Petersen *et al.,* 2006; Schwemmer *et al.,* 2011 Furness and Wade 2012; Furness *et al.,* 2013; Bradbury *et al.,* 2014; Percival 2014; Dierschke *et al.*, 2017; Mendell *et al.,* 2019; Irwin *et al.,* 2019).

12.252 A detailed review of the evidence for displacement of red-throated divers from offshore windfarms, and the likely effects on displacement on population mortality rates, was included in Norfolk Vanguard Limited (2019a). Based on this review, displacement distances of red-throated divers from offshore windfarms reported in various studies are summarised in **Table 12.39**. Most studies found a marked decrease (around 90%) in red-throated diver densities within operational windfarms when compared to pre-construction data, however the distance outside the windfarm over which diver densities were reduced was more variable. At the extremes, Percival (2013) found no reduction in diver density outside Thanet offshore windfarm even within 500m of the outer wind turbines, whereas Mendel *et al.* (2019) found a statistically detectable reduction in density up to 16km from the outer wind turbines. This variation was unexplained. It may have been related to ecological conditions or to the seascape/landscape of the site, as explained below.

12.253 Behaviour may vary seasonally, for example, depending on ecological constraints at different times of year, such as may arise during flight-feather moult when birds may become flightless. Birds might show greater avoidance distances where they are unconstrained. At sites where suitable or optimal habitat is limited, birds might show lower displacement distances because of constraints imposed by habitat availability. Alternatively, divers may show stronger avoidance of visible structures at sea where these present against an ‘empty’ background seascape. Where structures are in front of a cluttered background of coast, in particular a coast with industrial development, wind turbines may appear less prominent and/or may be seen by divers as less threatening. The largest distances from offshore windfarms over which diver densities were reduced were in the German Bight, a very large area of open sea far from the coast. The smallest displacement distances from offshore windfarms were at sites close to the UK coast where anthropogenic influences on the coastal scenery would be high (Thanet, Kentish Flats) (MacArthur Green, 2019).

Table 12.39 Summary of reported displacement distances and reductions in density for red-throated diver in relation to offshore windfarms[9]

Windfarm	Distance from outer turbines over which diver density was significantly reduced (km)	Percentage reduction in diver density within windfarm area	Reference
Thanet	0.0	82	Percival, 2013
Kentish Flats Extension	0.5	89	Percival and Ford, 2018
Greater Gabbard	<1.0	(75)[10]	Gill *et al.,* 2018
Kentish Flats	1.0	-	Percival 2014
Gunfleet Sands	1.0	-	Barker 2011
London Array	<1.5	<50	APEM 2016
Alpha Ventus	1.5	90	Welcker and Nehls 2016
Horns Rev 1	2.0	90	Petersen *et al.* 2006
North Hoyle	2.5	-	May 2008
Lincs	2-6	-	Webb *et al.* 2015
Horns Rev 2	5.5	50	Petersen *et al.* 2014
Butendiek, Amrumbank, Nordsee Ost, Meerwind Süd/Ost, Dan Tysk	12.0	94	Mendel *et al.* 2019

12.254 Displacement rates of 60% to 80% were reported for OWEZ (Leopold *et al.,* 2011). The Offshore Renewables Joint Industry Programme (ORJIP) bird avoidance study at Thanet offshore windfarm (Skov *et al.*, 2018) reported records of 82 radar tracks and 42 laser rangefinder tracks of red-throated divers. This would appear to provide an adequate sample size to assess macro-avoidance of that windfarm, although avoidance behaviour of this species was not assessed in the report as it was not one of the key species in that study. Two aerial surveys of red-throated divers in the Outer Thames Estuary SPA in February 2018 (Irwin *et al.,* 2019) found that densities were notably increased in waters either side of shipping lanes and the London Array windfarm, indicative of displacement behaviour. There were significant differences in the mean density of birds within areas of the SPA outside the footprints of windfarms (>3 birds per km^2), and those within windfarm footprints

[9] Based on Table 2.1 in Norfolk Vanguard Limited (2019a).

[10] But not statistically significant due to high variance in data so a tentative estimate.

(<1 bird per km²), however these displacement effects were not quantified in any further detail in the survey report.

12.255 Monitoring studies of red-throated divers at the Kentish Flats offshore windfarm found an observable shift of birds away from the wind turbines, particularly within 500m of the site (Percival, 2010). Further pre-construction and post-construction abundance and distribution studies have provided displacement values for both the site footprint and within distance bands away from the site boundary. Percival (2014) reported that while displacement within the windfarm boundary was around 80% (compared to pre-construction), this declined to 10% at 1km from the windfarm and was 0% beyond 2km. A similar within windfarm reduction in density was reported at Thanet, but there was no detectable displacement beyond the windfarm boundary (Percival, 2013).

12.256 A study of pre-construction and post-construction abundance and distribution of birds conducted at Horns Rev offshore windfarm, Denmark, found that red-throated divers avoided areas of sea that were apparently suitable (favoured habitat, suitable depth and abundant food sources) following the construction of an offshore windfarm, and that this effect remained for the three-year period of the study (Peterson *et al.,* 2006).

12.257 A large-scale and long-term analysis of the distribution of red-throated divers in the German North Sea found decreases in abundance detectable as far as about 16km from the closest operational offshore windfarm (Mendel *et al.,* 2019).

12.258 If red-throated divers were to habituate over time to offshore windfarms, then habitat loss might reduce to negligible in the long term. There is no clear evidence, however, for habituation (Norfolk Vanguard Limited, 2019a).

12.259 Modelling of data from pre-construction, construction and post-construction surveys of the London Array Windfarm considered 1km buffers extending around the windfarm up to 15km. Red-throated diver density close to the windfarm was found to decline significantly between the pre-construction and construction periods; preliminary data from the post-construction period, however, suggested that divers recolonised the windfarm and surrounding areas after construction had been completed (APEM, 2016). It was noted that the densities of divers in the study area varied to a large extent between years, and, as well as the presence of offshore windfarms and shipping activities, the total numbers of birds present as well as changes in other environmental conditions could influence the distribution of birds in a given year.

12.260 Displacement could influence the survival of individual red-throated divers through increased energy costs and/or decreased energy intake. The former could arise if birds had to fly more to avoid offshore windfarms or to reach more distant foraging areas. The latter could arise if birds were displaced to lower quality habitat where food capture rates were reduced, and/or if displacement resulted in an increase in the density of divers and an increase in intra-specific competition. Alternatively, displacement may have no effect on individuals if birds were displaced into equally good habitat so that their energy budget was unaffected, or if birds could buffer any impact on energy budget by adjusting their time budget (for example by spending a higher proportion of the time foraging rather than resting in order to compensate for an increase in energy budget) (Norfolk Vanguard Limited, 2019a).

12.261 Natural England has advised during the ETG process that the assessment of red-throated diver displacement from the windfarm should be based on a displacement rate of 100% within the offshore windfarm site and the 4km buffer, and a mortality rate of up to 10% for displaced birds. The assessment below has followed this advice. However, evidence presented by MacArthur Green (2019), Thompson *et al.* (2023) and Vilela *et al.* (2020 and 2021) suggested that there would be little or no impact on adult survival as a result of displacement, and that any impact would probably be undetectable at the population level. No evidence has been identified which supports the upper range of the potential mortality effects for birds displaced from OWFs, currently advised by Natural England (i.e. up to 10%). Based on this evidence, a mortality rate of 1% is therefore considered to be appropriately precautionary.

12.262 A separate assessment in respect of red-throated divers associated with Liverpool Bay SPA has been presented in the RIAA, which considered the displacement effect within the SPA to a distance of 10km from the windfarm, in accordance with SNCBs (2022) and Natural England (Parker *et al*., 2022c) guidance.

12.263 In relation to the degree of displacement from a windfarm and 4km buffer, it is noted that displacement has been demonstrated to decline with distance from a site (e.g. see **Table 12.39**). Norfolk Vanguard Limited (2019a) recommended a precautionary rate of 90% displacement from an offshore windfarm and a 4km buffer based on a detailed review of available evidence, and this was considered to be a more realistic but still precautionary assumption.

12.264 During baseline aerial surveys, low numbers of red-throated divers were recorded within the footprint of the windfarm site and the 4km buffer, which overlapped with Liverpool Bay SPA. Highest numbers were recorded during the winter period, with a mean peak estimated population of 12 birds within the windfarm site and 4km buffer in December 2021. Smaller numbers were present during spring and autumn migration. Given the low numbers of birds within the windfarm site and 4km buffer, and the review above of the likely effects of displacement during the non-breeding season on survival rates of red-throated divers, it was considered that 1% mortality would be a more appropriate precautionary estimate.

12.265 The displacement matrices in **Table 12.40** to **Table 12.43** have been populated with data for red-throated diver during the winter, autumn migration and spring migration periods, within the windfarm site and a 4km buffer, in line with recommendations (SNCBs, 2022). It should be noted that the inclusion of all birds within the 4km buffer, to determine the total number of birds subject to displacement was considered precautionary as in reality displacement has been demonstrated to decline with distance from a site.

Red-throated diver – autumn migration season

12.266 The estimated number of red-throated divers subject to operational disturbance/displacement during the autumn migration period would be two individuals (**Table 12.21**). Within the range of 100% displacement and 1-10% mortality, the number of individuals that could potentially suffer mortality as a consequence of displacement from the windfarm site has been estimated as zero (**Table 12.40**).

12.267 The BDMPS for red-throated diver in autumn is 4,373 (Furness, 2015). At the average baseline mortality rate for red-throated diver of 0.233 (**Table 12.17**) the number of individuals subject to mortality in the autumn BDMPS would be 1,019 (4,373 x 0.233). No additional mortality from operational disturbance/displacement has been predicted during this period, therefore there would be no change in EIA terms.

Red-throated diver – winter season

12.268 The estimated number of red-throated divers subject to operational disturbance/displacement during the winter period was 12 individuals (**Table 12.21**). Within the range of 100% displacement and 1-10% mortality, the number of individuals that could be impacted as a consequence of displacement from the windfarm site has been estimated as between zero and one individuals (**Table 12.41**). The BDMPS for red-throated diver in winter is 1,657 (Furness, 2015).

12.269 At the average baseline mortality rate for red-throated diver of 0.233, the number of individuals subject to mortality in the winter BDMPS would be 386 (1,657 x 0.233). The addition of a maximum of one to this would increase the mortality rate by 0.26%. This value is considered precautionary as an upper range of 10% mortality of displaced birds due to displacement is very unlikely (**Paragraph 12.261**). Therefore, based on a more realistic background mortality rate (i.e. 1%) there would be no predicted increase in red-throated diver mortality.

12.270 During the winter period, these magnitudes of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the winter period, the impact magnitude has been assessed as **negligible**. As the species is of **high** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Red-throated diver – spring migration season

12.271 The estimated number of red-throated divers subject to operational disturbance/displacement during the spring migration period was six individuals (**Table 12.21**). Within the range of 100% displacement and 1-10% mortality, the number of individuals that could potentially be impacted as a consequence of displacement from the windfarm site has been estimated as between zero and one individuals (**Table 12.42**). The BDMPS for red-throated diver in spring is 4,373 (Furness, 2015).

12.272 At the average baseline mortality rate for red-throated diver of 0.233, the number of individuals subject to mortality in the spring BDMPS is 1,019 (4,373 x 0.233). The addition of a maximum of one bird increased the mortality rate by 0.1%. This value is considered precautionary as during this period birds would be passing through the windfarm site during migration, and the upper range of 10% mortality of displaced birds due to displacement seemed very unlikely (**Paragraph 12.261**). Based on a more realistic background mortality rate (i.e. 1%) there would be no predicted increase in red-throated diver mortality.

12.273 During spring, these magnitudes of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the impact magnitude has been assessed as **negligible**. As the species is of **high** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Red-throated diver – year-round (non-breeding period)

12.274 Considering the year-round effects, which for this species equates to the non-breeding period, the number of red-throated divers subject to mortality as a result of displacement from the windfarm site, at a displacement rate of 100% and mortality of 1-10%, would be between zero and two (**Table 12.43**). This has been calculated by adding the numbers predicted to be displaced during autumn migration, winter, and spring, and noting that the totals in each table and the combined total have been rounded to the nearest integer. The largest BDMPS is 4,373 during spring and autumn migration, and the biogeographic red-throated diver population with connectivity to UK waters is 27,000 (Furness, 2015).

12.275 At the average baseline mortality rate for red-throated diver of 0.233, the number of individuals subject to mortality over one year from the BDMPS would be 1,019 (4,373 x 0.233). The addition of a maximum of two individuals to would increase the mortality rate by 0.19%. In relation to the biogeographic population, the number of individuals subject to mortality over one year would be 6,291 (27,000 x 0.233). The addition of a maximum of two birds would increase the mortality rate by 0 - 0.03%. This value is considered precautionary, as the upper range of 10% mortality of birds due to displacement is very unlikely (**Paragraph 12.261**). Based on a more realistic background mortality rate (i.e. 1%) there would be no predicted increase in red-throated diver mortality.

12.276 These magnitudes of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the year-round impact magnitude has been assessed as **negligible**. As the species is of **high** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Table 12.40 Displacement matrix for red-throated diver during the autumn migration period (windfarm site plus 4km buffer)

Autumn	Mortality										
Displacement	**1%**	**2%**	**3%**	**4%**	**5%**	**10%**	**20%**	**30%**	**50%**	**80%**	**100%**
10%	0	0	0	0	0	0	0	0	0	0	0
20%	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	1	1
40%	0	0	0	0	0	0	0	0	0	1	1
50%	0	0	0	0	0	0	0	0	1	1	1
60%	0	0	0	0	0	0	0	0	1	1	1
70%	0	0	0	0	0	0	0	0	1	1	1
80%	0	0	0	0	0	0	0	1	1	1	2
90%	0	0	0	0	0	0	0	1	1	2	2
100%	0	0	0	0	0	0	0	1	1	2	2

Note: The cells show the number of birds predicted to be subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Table 12.41 Displacement matrix for red-throated diver during the winter period (windfarm site plus 4km buffer)

Winter	Mortality										
Displacement	1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
10%	0	0	0	0	0	0	0	0	1	1	1
20%	0	0	0	0	0	0	0	1	1	2	2
30%	0	0	0	0	0	0	1	1	2	3	3
40%	0	0	0	0	0	0	1	1	2	4	5
50%	0	0	0	0	0	1	1	2	3	5	6
60%	0	0	0	0	0	1	1	2	3	6	7
70%	0	0	0	0	0	1	2	2	4	6	8
80%	0	0	0	0	0	1	2	3	5	7	9
90%	0	0	0	0	1	1	2	3	5	8	10
100%	0	0	0	0	1	1	2	3	6	9	12

Note: The cells show the number of birds predicted to be subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Table 12.42 Displacement matrix for red-throated diver during the spring migration period (windfarm site plus 4km buffer)

Spring	Mortality										
Displacement	1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
10%	0	0	0	0	0	0	0	0	0	0	1
20%	0	0	0	0	0	0	0	0	1	1	1
30%	0	0	0	0	0	0	0	1	1	1	2
40%	0	0	0	0	0	0	0	1	1	2	2
50%	0	0	0	0	0	0	1	1	1	2	3
60%	0	0	0	0	0	0	1	1	2	3	4
70%	0	0	0	0	0	0	1	1	2	3	4
80%	0	0	0	0	0	0	1	1	2	4	5
90%	0	0	0	0	0	1	1	2	3	4	5
100%	0	0	0	0	0	1	1	2	3	5	6

Note: The cells show the number of predicted to be subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Table 12.43 Year-round displacement matrix for red-throated diver (windfarm site plus 4km buffer)

Year-round	Mortality										
Displacement	1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
10%	0	0	0	0	0	0	0	1	1	2	2
20%	0	0	0	0	0	0	1	1	2	3	4
30%	0	0	0	0	0	1	1	2	3	5	6
40%	0	0	0	0	0	1	2	2	4	6	8
50%	0	0	0	0	0	1	2	3	5	8	10
60%	0	0	0	0	1	1	2	4	6	9	12
70%	0	0	0	1	1	1	3	4	7	11	14
80%	0	0	0	1	1	2	3	5	8	13	16
90%	0	0	1	1	1	2	4	5	9	14	18
100%	0	0	1	1	1	2	4	6	10	16	20

Note: The cells show the number of birds predicted to be subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

12.6.3.2 Impact 2: Collision risk

12.277 Birds flying through the wind turbine arrays of offshore windfarms may collide with rotor blades. This could result in fatality or injury to birds that fly through the windfarm site during migration, whilst foraging for food, or commuting between breeding sites and foraging areas.

12.278 CRM has been used in this assessment to estimate the risk to birds associated with the windfarm site. CRM, using the sCRM (McGregor, 2018) has been used to produce predictions of mortality for particular species across biological seasons and annually. The approach to the sCRM is summarised here and further details are provided in **Appendix 12.1**.

Stochastic CRM

12.279 Collision risk has been estimated for each key seabird species using the sCRM Option 2. This option uses generic estimates of flight height for each species to calculate the percentage of birds flying at PCH derived from flight height data from a number of UK offshore windfarm sites, presented in Johnston *et al.* (2014a, 2014b).

12.280 The sCRM was run through the web-based ‘shiny app’. In accordance with advice from Natural England, a single ‘worst-case’ option was used for the sCRM, comprising 35 x representative ‘smaller’ (130m rotor radius) turbines. The OWF parameters used in the model are presented in **Table 12.2**. In order to generate confidence intervals for the collision risk outputs, the shiny app was set to run 1,000 iterations of each model.

Baseline survey densities

12.281 The densities of birds in flight used in the sCRM were calculated by taking the mean of the two years’ density estimates for each month from the survey data (**Table 12.45** and **Appendix 12.1**). The standard deviations and 95% confidence intervals were calculated using the combined raw bootstrap outputs for each month from the survey data. Using a method which generated 1,000 random distribution samples for each species in each month, from the combined bootstrap outputs, the samples were modelled in the sCRM tool as a truncated normal distribution.

Seabird input parameters

12.282 Seabird input parameters used in the sCRM are presented in **Table 12.44**. These accorded with guidance issued to the Project by Natural England in July 2022 (**Table 12.1**), utilising data unpublished at the time of assessment from draft SNCB guidance and avoidance rates based on those presented in Ozsanlav-Harris *et al*. (2022). Natural England has stated that it wishes to see use of these data in this ES chapter in preference to existing published values (e.g. in Cook *et al*., 2014), recognising that there was a small risk that some values may be adjusted prior to final publication of the SNCB guidance. Where individual species data were not provided by Natural England, existing published values were used (e.g. from Robinson, 2005, Cook *et al.*, 2014, Garthe and Hüppop, 2004 and Furness *et al.*, 2013).

Windfarm input parameters

12.283 The windfarm input parameters used in the sCRM have been based on the realistic worst-case scenario, set out in **Section 12.3.2** and **Table 12.2**. The parameters assumed the 'worst-case' 35 x representative 'smaller' (130m rotor radius) wind turbines. This represents the worst-case as it assumes the largest number of turbines with the largest rotor diameter (for that number of turbines) resulting in the largest swept area for the turbine blades.

sCRM outputs and screening

12.284 The following sections provide a summary of the outputs for assessment, using the seasons defined in **Table 12.15**. An overview of annual collision risk estimates for all species (using the sCRM model Option 2) are presented in **Table 12.46**, using the species parameters in **Table 12.44**. The annual collision risk estimates presented in **Table 12.46** were used to identify species to be scoped in for assessment in relation to collision risk. Each species was assigned a sensitivity rating for collision risk, based on available data on the percentage time spent flying at heights within the rotor diameter of offshore wind turbines, flight agility, the percentage of time flying, the extent of nocturnal flight activity and conservation importance (with reference to Garthe and Hüppop, 2004; Furness and Wade, 2012, Furness *et al.*, 2013, Wade *et al.*, 2016).

12.285 Several species had very low predicted annual collision risks at the windfarm site (i.e. worst-case mean prediction was below one bird per year; **Table 12.46**). These were red-throated diver, black-headed gull, Sandwich tern, common tern, guillemot and razorbill. For Manx shearwater, the predicted annual collision risk was zero birds per year. As the magnitudes of predicted impact were negligible and/or species were considered to have low susceptibility to collision risk (e.g. for auk species), even for the worst-case, no further assessment for these species was considered necessary.

12.286 Several other seabird species recorded within the study area were not recorded flying within the windfarm site, and therefore were not considered to be at risk of collision. These were Arctic skua, common scoter, cormorant, fulmar, great skua, puffin and shag.

12.287 The seasonal collision estimates for species scoped into the collision risk assessment (gannet, kittiwake, little gull, common gull, lesser black-backed gull, herring gull and great black-backed gull) are presented in **Table 12.47**. For gannet, a 70% macro-avoidance rate was applied to the collision estimates, i.e. output values from the CRM were reduced to 30% of their original value. It is noted that Natural England advised that the macro-avoidance should be applied to the input density estimates for the CRM. Applying the correction to outputs (rather than inputs), however, makes no material difference to the generated collision estimates. The 70% macro-avoidance rate (as advised by Natural England) took into account empirical evidence of macro-avoidance by this species and was more precautionary than the mean gannet macro-avoidance rate of 85.64% calculated in a recent study (Pavat et al., 2023). Gannet collision estimates have also been presented without the 70% macro-avoidance rate for comparison.

12.288 For all other species assessed, mean annual collision risk was estimated to be less than one bird, and/or species were considered to have low vulnerability to collision risk, and therefore negligible effects (either alone or cumulatively) would be predicted. All species have been included in **Table 12.46**, but only the species identified above were taken forward to detailed assessment (**Table 12.47**).

Table 12.44 Seabird parameters used in the sCRM

Species	Flight type	% flights upwind	Body length m (±SD)	Wingspan m (±SD)	Flight speed m/s (±SD)	Nocturnal activity (±SD)	Avoidance rate (±SD) *et al*
Red-throated diver	Flapping	50	0.61*	1.11*	14.5$^{\times}$	0.0$^{\times\times}$	0.991 (±0.0004)**
Manx shearwater	Flapping	50	0.34*	0.82*	14.1 (Spivey *et al.*, 2014)	0.5$^{\times\times}$	0.991 (±0.0004)**
Gannet	Flapping	50	0.94 (±0.0325)**	1.72 (±0.0375)**	14.9 (±0)**	0.08 (±0.10)**	0.993 (±0.0003)**
Kittiwake	Flapping	50	0.39 (±0.0.005)**	1.08 (±0.0625)**	13.1(±0.40)**	0.375 (±0.0637)**	0.993 (±0.0003)**
Little gull	Flapping	50	0.26*	0.78*	11.50$^{\times}$	0.25$^{\times\times}$	0.993 (±0.0003)**
Black-headed gull	Flapping	50	0.36*	1.05*	9.50$^{\times}$	0.5$^{\times\times}$	0.995 (±0.0002)**
Common gull	Flapping	50	0.41*	1.20*	9.50$^{\times}$	0.5$^{\times\times}$	0.995 (±0.0002)**
Herring gull	Flapping	50	0.6 (±0.0225)**	1.44 (±0.03)**	12.8 (±1.80)**	0.375 (±0.0637)**	0.994 (±0.0004)**
Lesser black-backed gull	Flapping	50	0.58 (±0.03)**	1.42 (±0.0375)**	13.1 (±1.90)**	0.375 (±0.0637)**	0.994 (±0.0004)**
Great black-backed gull	Flapping	50	0.71 (±0.035)**	1.58 (±0.0375)**	13.7 (1.20)**	0.375 (±0.0637)**	0.994 (±0.0004)**
Sandwich tern	Flapping	50	0.38 (±0.005)**	1 (±0.04)**	10.3 (±3.4)**	0.0$^{\times\times}$	0.991 (±0.0004)**

Species	Flight type	% flights upwind	Body length m (±SD)	Wingspan m (±SD)	Flight speed m/s (±SD)	Nocturnal activity (±SD)	Avoidance rate (±SD) *et al*
Common tern	Flapping	50	0.33*	0.88*	10.00[x]	0.0[xx]	0.991 (±0.0004)**
Arctic tern	Flapping	50	0.34*	0.80*	(10.00) (based on common tern value)	0.0[xx]	0.991 (±0.0004)**
Guillemot	Flapping	50	0.40*	0.67*	19.10[x]	0.25[xx]	0.991 (±0.0004)**
Razorbill	Flapping	50	0.38*	0.66*	19.10[x]	0.0[xx]	0.991 (±0.0004)

*From Robinson (2005). Where published values do not include SDs, these have been set to zero for the sCRM.

**From Natural England (2022). Note that Standard Deviation (SD) values have been included for species where provided by Natural England (2022).

[x] From Cook (2014)

[xx] From Garthe and Hüppop (2004) and Furness (2013)

Table 12.45 Bird densities used in the sCRM (SDs calculated from the combined bootstrap samples for each month in each year)

Species		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Red-throated diver	Mean birds/km^2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
	SD birds/km^2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
Manx shearwater	Mean birds/km^2	0.00	0.00	0.00	0.02	1.17	0.73	7.13	4.16	0.02	0.00	0.00	0.00
	SD birds/km^2	0.00	0.00	0.00	0.04	1.24	0.85	6.01	3.22	0.04	0.00	0.00	0.00
Gannet	Mean birds/km^2	0.00	0.00	0.00	0.05	0.14	0.02	0.09	1.05	0.15	0.00	0.02	0.00
	SD birds/km^2	0.00	0.00	0.00	0.06	0.16	0.04	0.12	1.04	0.15	0.00	0.04	0.00
Little gull	Mean birds/km^2	0.16	0.34	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.91
	SD birds/km^2	0.18	0.38	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.95
Kittiwake	Mean birds/km^2	0.07	0.18	1.01	0.48	1.25	1.10	1.40	1.16	2.02	0.14	0.71	0.50
	SD birds/km^2	0.06	0.09	0.21	0.42	0.50	1.10	1.10	0.71	1.06	0.08	0.42	0.23
Black-headed gull	Mean birds/km^2	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SD birds/km^2	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Common gull	Mean birds/km^2	0.11	0.07	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.13	0.39
	SD birds/km^2	0.13	0.07	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.10	0.30
Herring gull	Mean birds/km^2	0.05	0.05	0.07	0.02	0.04	0.02	0.03	0.02	0.00	0.07	0.00	0.11
	SD birds/km^2	0.07	0.04	0.06	0.04	0.05	0.04	0.04	0.04	0.00	0.09	0.00	0.13
Lesser black-backed gull	Mean birds/km^2	0.00	0.02	0.02	0.00	0.05	0.00	0.06	0.16	0.18	0.00	0.00	0.00
	SD birds/km^2	0.00	0.04	0.04	0.00	0.04	0.00	0.05	0.11	0.20	0.00	0.00	0.00
Great black-backed gull	Mean birds/km^2	0.00	0.00	0.00	0.02	0.05	0.00	0.00	0.00	0.00	0.00	0.05	0.07

Species		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	SD birds/km^2	0.00	0.00	0.00	0.04	0.08	0.00	0.00	0.00	0.00	0.00	0.04	0.11
Sandwich tern	Mean birds/km^2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00
	SD birds/km^2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00
Common tern	Mean birds/km^2	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.52	0.00	0.00	0.00
	SD birds/km^2	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.17	0.00	0.00	0.00
Arctic tern	Mean birds/km^2	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.03	0.00	0.00	0.00
	SD birds/km^2	0.00	0.00	0.00	0.00	0.59	0.00	0.00	0.00	0.04	0.00	0.00	0.00
Guillemot	Mean birds/km^2	0.05	0.12	0.28	0.05	0.19	0.12	0.23	0.00	0.00	0.23	0.07	0.43
	SD birds/km^2	0.06	0.08	0.31	0.06	0.11	0.18	0.12	0.00	0.00	0.28	0.09	0.42
Razorbill	Mean birds/km^2	0.00	0.00	0.09	0.12	0.00	0.00	0.00	0.00	0.00	0.29	0.04	0.27
	SD birds/km^2	0.00	0.00	0.07	0.14	0.00	0.00	0.00	0.00	0.00	0.26	0.07	0.31

*Table 12.46 Annual Collision Risk Estimates (Stochastic model Option 2, avoidance rates as per **Table 12.44**). Values are the Mean number of birds and 95% Confidence Intervals (CI). Species in bold underline are those scoped into the collision risk assessment*

Species	Estimated sensitivity to collision risk		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Red-throated diver	Low	Mean collisions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04
		95% LCI	-	-	-	-	-	-	-	-	-	-	-	0.00	0.00
		95% UCI	-	-	-	-	-	-	-	-	-	-	-	0.29	0.29
Manx shearwater	Low	Mean collisions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n/a
		95% LCI	-	-	-	-	-	-	-	-	-	-	-	-	n/a
		95% UCI	-	-	-	-	-	-	-	-	-	-	-	-	n/a
<u>Gannet</u>	Medium	Mean collisions	0.00	0.00	0.00	0.13	0.38	0.06	0.25	2.92	0.40	0.00	0.07	0.00	4.20
		95% LCI	-	-	-	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	-	0.23
		95% UCI	-	-	-	0.69	1.74	0.36	1.32	11.04	2.05	-	0.42	-	13.78
<u>Gannet</u> (collision risk estimates reduced to reflect 70%	Medium	Mean collisions	0.00	0.00	0.00	0.04	0.11	0.02	0.08	0.88	0.12	0.00	0.02	0.00	1.26
		95% LCI	-	-	-	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	-	0.07
		95% UCI	-	-	-	0.21	0.52	0.11	0.40	3.31	0.62	-	0.13	-	4.13

Species	Estimated sensitivity to collision risk		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
macro-avoidance)[11]															
Little gull	Medium	Mean collisions	0.33	0.65	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	1.85	2.92
		95% LCI	0.00	0.00	0.00	-	-	-	-	-	-	-	0.00	0.00	0.00
		95% UCI	1.05	2.08	0.25	-	-	-	-	-	-	-	0.26	5.22	6.81
Kittiwake	Medium	Mean collisions	0.17	0.45	2.72	1.17	3.28	2.74	3.42	2.99	5.05	0.37	1.75	1.33	25.45
		95% LCI	0.00	0.00	1.47	0.00	1.23	0.85	0.59	0.30	1.57	0.00	0.22	0.42	14.50
		95% UCI	0.52	0.94	4.36	3.30	6.66	4.98	9.64	7.07	11.01	0.88	4.03	2.93	39.15
Black-headed gull	Medium	Mean collisions	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
		95% LCI	-	0.00	-	-	-	-	-	-	-	-	-	-	0.00
		95% LCI	-	0.23	-	-	-	-	-	-	-	-	-	-	0.23
Common gull	Medium	Mean collisions	0.35	0.21	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.44	1.24	2.39
		95% LCI	0.00	0.00	0.00	-	-	-	-	-	-	0.00	0.00	0.13	0.64
		95% UCI	1.44	0.75	0.43	-	-	-	-	-	-	0.39	1.25	3.52	5.28

[11] 70% macro-avoidance has been applied in accordance with Natural England advice.

Species	Estimated sensitivity to collision risk		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Herring gull	High	Mean collisions	0.41	0.38	0.58	0.19	0.36	0.17	0.30	0.18	0.00	0.59	0.00	1.00	4.15
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	-	0.00	0.97
		95% UCI	2.13	1.26	1.76	1.10	1.60	0.95	1.14	1.17	-	2.54	-	3.76	9.21
Lesser black-backed gull	High	Mean collisions	0.00	0.15	0.15	0.00	0.36	0.00	0.46	1.20	1.25	0.00	0.00	0.00	3.57
		95% LCI	-	0.00	0.00	-	0.00	-	0.00	0.00	0.00	-	-	-	0.91
		95% UCI	-	0.80	0.94	-	1.27	-	1.52	3.58	5.63	-	-	-	9.24
Great black-backed gull	High	Mean collisions	0.00	0.00	0.00	0.21	0.45	0.00	0.00	0.00	0.00	0.00	0.45	0.65	1.75
		95% LCI	-	-	-	0.00	0.00	-	-	-	-	-	0.00	0.00	0.00
		95% UCI	-	-	-	1.34	2.78	-	-	-	-	-	1.46	3.77	5.54
Sandwich tern	Low	Mean collisions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.33
		95% LCI	-	-	-	-	-	-	-	-	0.02	-	-	-	0.02
		95% UCI	-	-	-	-	-	-	-	-	1.07	-	-	-	1.07
Common tern	Low	Mean collisions	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.22
		95% LCI	-	-	-	-	0.00	-	-	-	0.01	-	-	-	0.05
		95% UCI	-	-	-	-	0.22	-	-	-	0.37	-	-	-	0.52

Species	Estimated sensitivity to collision risk		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Arctic tern	Low	Mean collisions	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.37
		95% LCI	-	-	-	-	0.01	-	-	-	0.00	-	-	-	0.01
		95% UCI	-	-	-	-	1.57	-	-	-	0.09	-	-	-	1.65
Guillemot	Low	Mean collisions	0.02	0.04	0.16	0.03	0.09	0.09	0.11	0.00	0.00	0.12	0.03	0.17	0.86
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	0.00	0.00	0.00	0.00
		95% UCI	0.15	0.33	1.23	0.22	0.64	0.68	0.79	-	-	0.92	0.27	1.28	5.56
Razorbill	Low	Mean collisions	0.00	0.00	0.05	0.09	0.00	0.00	0.00	0.00	0.00	0.16	0.03	0.12	0.45
		95% LCI	-	-	0.00	0.00	-	-	-	-	-	0.00	0.00	0.00	0.00
		95% UCI	-	-	0.30	0.60	-	-	-	-	-	1.04	0.16	0.75	2.77

Table 12.47 Seasonal collision risk estimates for species scoped in for collision risk assessment. Values are the mean number of birds.

Species	Breeding season	Autumn migration	Non-breeding/ winter	Spring migration	Annual
Gannet	Mar-Sep 4.14	Oct-Nov 0.07	-	Dec-Feb 0.00	4.20
Gannet (collision risk estimates reduced to reflect 70% macro-avoidance)	Mar-Sep 1.24	Oct-Nov 0.02	-	Dec-Feb 0.00	1.26
Little gull	Apr-Jul 0.00	-	Aug-Apr 2.92	-	2.92
Kittiwake	Mar-Aug 16.32	Sep-Dec 8.50	-	Jan-Feb 0.62	25.45
Common gull	May-Jul 0.00	-	Aug-Apr 2.39	-	2.39
Herring gull	Mar-Aug 1.78	-	Sep-Feb 2.38	-	4.15
Lesser black-backed gull	Apr-Aug 2.02	Sep-Oct 1.25	Nov-Feb 0.15	Mar 0.15	3.57
Great black-backed gull	Mar-Aug 0.66	-	Sep-Feb 0.45	-	1.75

Breeding season reference populations for collision assessment

12.289 Impacts during the breeding season have been assessed in relation to the largest seasonal BDMPS (Furness, 2015), rather than the breeding populations plus immature birds within species' foraging ranges, in accordance with guidance provided to the Project by Natural England (2023).

Non-breeding period reference populations for collision assessment

12.290 Impacts during the non-breeding periods have been assessed in relation to the relevant BDMPS (Furness, 2015) except for little gull. As there was no agreed biogeographic population value for this species (little gull was not included in Furness, 2015) the assessment below also included a comparison against the EU winter population (EC, 2022). This was considered reasonable given the generally northern European breeding distribution of this species, suggesting that a significant proportion of this population would be likely to pass through waters around the UK and Ireland during passage to wider wintering grounds in the North Atlantic.

Collision impact effects

12.291 The effects arising from potential collision risk on the populations have been assessed in terms of the change in the baseline mortality rate that could result. It has been assumed that all age classes were equally at risk of collisions (i.e. in proportion to their presence in the population), therefore it was necessary to calculate an average baseline mortality rate for all age classes for each species assessed. These were calculated using the different survival rates for each age class and their representative quantity of the population.

12.292 The first step was to calculate an average survival rate for the population in question. The demographic rates for each species were taken from reviews of the relevant literature (e.g. Horswill and Robinson, 2015) and examples of population modelling (e.g. East Anglia THREE (EATL), 2016). The rates were entered into a matrix population model to calculate the expected abundance in each age class. For each age class the survival rate was multiplied by its proportion and the total for all ages summed to give the average survival rate for all ages. Taking this value away from 1 gave the average mortality rate. The demographic rates and the age class proportions and baseline average mortality rates calculated from them are presented in **Table 12.17**.

12.293 The percentage increases in background mortality rates of seasonal and annual populations due to predicted collisions with the wind turbines are shown in **Table 12.48**.

12.294 The annual collision predictions resulted in increases in background mortality of 0.26% for little gull, 0.07% for common gull, 0.04% for great black-backed gull and 0.02% or less for all other species. Increases of such small magnitude would not materially alter the background mortality of the population and would be undetectable. Therefore, the impact magnitudes due to collision mortality for gannet, little gull, kittiwake, common gull, herring gull, lesser black-backed gull and great black-backed gull were considered to be **negligible**. Sensitivity of these species to collision with wind turbines has been classed as **high** (herring, lesser black-backed and great black-backed gulls) or **medium** (gannet, little gull, common gull and kittiwake) (**Table 12.47**), resulting in a **minor adverse** effect in all cases, and not significant in EIA terms.

Table 12.48 Precautionary estimates of percentage increases in the background mortality rate of seasonal and annual populations due to predicted collisions

Species		Gannet	Gannet (70% macro-avoidance	Little gull	Kittiwake	Common gull	Herring gull	Lesser black-backed gull	Great black-backed gull
Baseline average mortality rate		0.188	0.188	0.200	0.157	0.259	0.172	0.124	0.093
Breeding Season	Reference population	522,888	522,888	n/a	245,234	n/a	217,167	240,750	44,753
	Baseline seasonal mortality	98,303	98,303	n/a	38,502	n/a	37,353	29,853	4,162
	Mean seasonal mortality from collision	4.14	1.24	n/a	16.32	n/a	1.78	2.02	0.66
	Increase in background mortality (%)	<0.01%	<0.01%	n/a	0.04%	n/a	<0.01%	<0.01%	0.02%
Autumn Migration	Reference population	545,954	545,954	n/a	911,586	n/a	n/a	163,304	n/a
	Baseline seasonal mortality	102,639	102,639	n/a	143,119	n/a	n/a	20,250	n/a
	Mean seasonal mortality from collision	0.07	0.02	n/a	8.50	n/a	n/a	1.25	n/a

Species		Gannet	Gannet (70% macro-avoidance	Little gull	Kittiwake	Common gull	Herring gull	Lesser black-backed gull	Great black-backed gull
	Increase in background mortality (%)	<0.01%	<0.01%	n/a	<0.01%	n/a	n/a	<0.01%	n/a
Non-breeding/ winter	Reference population	n/a	n/a	5,700*	n/a	13,036	173,299	41,159	17,742
	Baseline seasonal mortality	n/a	n/a	1,140	n/a	3,376	29,807	5,104	1,650
	Mean seasonal mortality from collision	n/a	n/a	2.92	n/a	2.39	2.38	0.15	1.10
	Increase in background mortality (%)	n/a	n/a	0.26%	n/a	0.07%	0.01%	<0.01%	0.07%
Spring Migration	Reference population	661,888	661,888	n/a	691,526	n/a	n/a	163,304	n/a
	Baseline seasonal mortality	124,435	124,435	n/a	108,570	n/a	n/a	20,25	n/a
	Mean seasonal mortality	0.00	0.00	n/a	0.62	n/a	n/a	0.15	n/a
	Increase in background mortality (%)	0.00%	0.00%	n/a	<0.01%	n/a	n/a	<0.01%	n/a

Species		Gannet	Gannet (70% macro-avoidance	Little gull	Kittiwake	Common gull	Herring gull	Lesser black-backed gull	Great black-backed gull
Annual (largest BDMPS)	Reference Population	661,888	661,888	n/a*	911,586	13,036	217,167	240,750	44,753
	Baseline annual mortality	124,435	124,435	n/a	143,119	3,376	37,353	29,853	4,162
	Mean annual mortality from collision	4.20	1.26	2.92	25.45	2.39	4.15	3.57	1.75
	Increase in background mortality (%)	<0.01%	<0.01%	n/a	0.02%	0.07%	0.01%	0.01%	0.04%
Annual (Biogeo-graphic)	Reference Population	1,180,000	1,180,000	5,700*	5,100,000	1,600,000	1,098,000	864,000	235,000
	Baseline annual mortality	221,840	221,840	1,140	800,700	414,400	188,856	107,136	21,855
	Mean annual mortality from collision	4.20	1.26	2.92	25.45	2.39	4.15	3.57	1.75
	Increase in background mortality (%)	<0.01%	<0.01%	0.26%	<0.01%	<0.01%	<0.01%	<0.01%	0.01%

* Note: The annual mortalities have been assessed against both the biogeographic populations and the largest BDMPS to indicate the range of likely effects. As there was no agreed BDMPS or biogeographic population value for little gull, a predicted estimate of increase in background mortality has been made against the minimum EU wintering population (EC, 2022).

Migrant collision risk

12.295 The potential collision risk posed by the Project to a range of bird species has been undertaken using the British Trust for Ornithology (BTO) Strategic Ornithological Support Services Migrant Assessment Tool (SOSSMAT; Wright *et al.*, 2012).

12.296 As agreed during the Project ETG consultation, bird species were screened into the assessment if named as qualifying features of SPAs and/or Ramsar sites within 100km of the Project; refer to **Table 12.1**. The relevant sites were:

- Morecambe Bay and Duddon Estuary
- Ribble and Alt Estuaries
- Mersey Narrows and North Wirral Foreshore
- Martin Mere
- The Dee Estuary
- Bowland Fells
- Mersey Estuary
- Leighton Moss
- Traeth Lafan/ Lavan Sands, Conway Bay
- Solway Firth
- Migneint-Arenig-Dduallt
- Berwyn
- South Pennine Moors Phase 2
- North Pennine Moors

12.297 It was considered that the potential sensitivity of these receptors to collision would be medium. Confidence in this prediction however was low, as potential collision impacts of operational OWFs on migrating non-breeding waterbirds had not been extensively studied at the time of writing. Parameters used in the assessment (such as avoidance rate) were, however, precautionary and therefore it was considered very unlikely that the predicted collision mortality had been underestimated, i.e. the assessment conclusions were deemed to be suitably precautionary.

12.298 Population sizes and migration routes were obtained from Wright *et al*. (2012). To select the migration routes relevant to the Project, the site boundary was overlaid on the SOSSMAT migration route dataset in Geographic Information System (GIS) software. Any migration routes intersecting the windfarm site boundary were included in the assessment. Relevant migrant route crossings included those from named sections of coastline which included connections between the following coastal sections:

- England and Wales Bristol Channel
- England and Wales Irish Sea
- Northern Ireland Celtic Seas coast
- RoI Celtic Seas eastern coast
- Scottish Mainland Celtic Seas coast
- Spanish north coast

12.299 This included all crossings that were likely to intersect the windfarm site boundary. From this, SOSSMAT generated a percentage of birds migrating through the Irish Sea which could encounter the windfarm during migration. To generate the number of birds passing through the windfarm site, the relevant population size presented in Wright *et al.* (2012) was multiplied by the relevant percentage of birds passing through the windfarm site.

12.300 The avoidance rate was set at 0.980 for all species, which was considered to be a precautionary figure based on expert judgment.

12.301 The "migrant collision risk" element of the Band (2012) CRM spreadsheet was utilised for the calculation of collision risk for each species. Input parameters with regard to biometric parameters, PCH and nocturnal activity factor (NAF) are presented in **Table 12.49**.

12.302 The windfarm parameters used were as for sCRM carried out for seabirds, as presented in **Table 12.2**.

Table 12.49 Biometric parameters for offshore ornithology receptors screened into the SOSSMAT assessment

Species	Flight type	Body length (m)	Wingspan (m)	Flight speed (m/s)	% PCH (typical)	% PCH (lower)	%PCH (upper)	NAF
Bar-tailed godwit *Limosa lapponica*	Flapping	0.38	0.75	18.3	25	5	75	5
Bewick's swan *Cygnus columbianus*	Flapping	1.21	1.96	18.5	50	10	90	5
Black-tailed godwit *Limosa limosa*	Flapping	0.44	0.82	18.3	25	5	75	5
Common scoter *Melanitta nigra*	Flapping	0.49	0.84	17.7	1	0	11.6	5

Species	Flight type	Body length (m)	Wingspan (m)	Flight speed (m/s)	% PCH (typical)	% PCH (lower)	%PCH (upper)	NAF
Curlew *Numenius arquata*	Flapping	0.55	0.9	22.1	25	5	75	5
Dunlin *Calidris alpina*	Flapping	0.18	0.40	15.3	25	5	75	5
Golden plover *Pluvialis apricaria*	Flapping	0.28	0.72	17.9	25	5	75	5
Goldeneye *Bucephala clangula*	Flapping	0.46	0.72	21.2	15	0.1	60	5
Grey plover *Pluvialis squatarola*	Flapping	0.28	0.77	17.9	25	5	75	5
Knot *Calidris canutus*	Flapping	0.24	0.59	20.1	25	5	75	5
Lapwing *Vanellus vanellus*	Flapping	0.30	0.84	11.9	25	5	75	5
Oystercatcher *Haematopus ostralegus*	Flapping	0.42	0.83	13.9	25	5	75	5
Pink-footed goose *Anser brachyrhynchus*	Flapping	0.68	1.52	15	30	5	75	5
Pintail *Anas acuta*	Flapping	0.58	0.88	16.6	15	0.1	60	5
Redshank *Tringa totanus*	Flapping	0.28	0.62	18.3	25	5	75	5
Ringed plover *Charadrius hiaticula*	Flapping	0.19	0.52	10.6	25	5	75	5
Sanderling *Calidris alba*	Flapping	0.2	0.42	17.7	25	5	75	5
Shelduck *Tadorna tadorna*	Flapping	0.62	1.12	15.4	15	0.1	60	5
Short-eared owl *Asio flammeus*	Flapping	0.38	1.02	9.7	50	10	95	1
Shoveler *Spatula clypeata*	Flapping	0.48	0.77	16.9	15	0.1	60	5
Teal *Anas crecca*	Flapping	0.36	0.61	16.9	15	0.1	60	5

Species	Flight type	Body length (m)	Wingspan (m)	Flight speed (m/s)	% PCH (typical)	% PCH (lower)	%PCH (upper)	NAF
Turnstone *Arenaria interpres*	Flapping	0.23	0.54	17.7	25	5	75	5
Whooper swan *Cygnus cygnus*	Flapping	1.52	2.30	17.3	50	10	90	5
Wigeon *Anas penelope*	Flapping	0.48	0.80	18.5	15	0.1	60	5

SOSSMAT Outputs

12.303 Potential annual collision mortality for migrant birds passing through the windfarm site, as estimated by SOSSMAT, is presented in **Table 12.50**. The national non-breeding populations of the species (as per Wright *et al.*, 2012) is also presented. Full SOSSMAT outputs are presented in **Appendix 12.1**.

12.304 For all species, there would be no detectable increase in collisions, and therefore no measurable effect on the national population. The effect significance would be **no change**.

*Table 12.50 SOSSMAT-derived annual collision mortality for migrant birds that are qualifying features of SPAs/Ramsar sites within 100km of the Project, based on realistic worst-case turbine deployment scenario (**Table 12.2**) (Band CRM, Option 1)*

		Collisions per annum (Band 2012, Option 1) (PCH = proportion at collision height)					
		Typical PCH		Lower PCH		Upper PCH	
Species	Estimated migrant population (Britain and/or Ireland)	Zero avoidance	0.980 avoidance rate	Zero avoidance	0.980 avoidance rate	Zero avoidance	0.980 avoidance rate
Bar-tailed godwit	38,000	2.04	0.04	0.41	0.01	6.12	0.12
Bewick's swan	380	0.05	0.00	0.01	0.00	0.09	0.00
Bittern	600	0.26	0.01	0.03	0.00	0.49	0.01
Black-tailed godwit *Limosa limosa islandica*	43,000	1.54	0.03	0.31	0.01	4.62	0.09
Black-tailed godwit *Limosa limosa limosa*	104	0.00	0.00	0.00	0.00	0.00	0.00
Common gull	700,000	32.17	0.64	27.49	0.55	45.33	0.91
Common scoter	100,000	0.14	0.00	0.00	0.00	1.62	0.03
Curlew (breeding)	214,000	7.47	0.15	1.49	0.03	22.41	0.45
Curlew (non-breeding)	140,000	4.88	0.10	0.98	0.02	14.64	0.29
Dunlin *Calidris alpina alpina* (passage & winter)	350,000	19.04	0.38	3.81	0.08	57.12	1.14
Dunlin *Calidris alpina schinzii* & *C.a.arctica* (passage)	19,800	0.60	0.01	0.12	0.00	1.80	0.04
Eider	60,500	0.00	0.00	0.00	0.00	0.00	0.00

		Collisions per annum (Band 2012, Option 1) (PCH = proportion at collision height)					
		Typical PCH		Lower PCH		Upper PCH	
Species	Estimated migrant population (Britain and/or Ireland)	Zero avoidance	0.980 avoidance rate	Zero avoidance	0.980 avoidance rate	Zero avoidance	0.980 avoidance rate
Eurasian wigeon	440,000	11.26	0.23	0.08	0.00	45.04	0.90
Golden plover (breeding)	45,200	1.44	0.03	0.29	0.01	4.32	0.09
Golden plover (non-breeding)	400,000	12.76	0.26	2.55	0.05	38.28	0.77
Goldeneye	20,000	0.41	0.01	0.00	0.00	1.64	0.03
Great black-backed gull	76,000	4.42	0.09	3.74	0.07	5.99	0.12
Great crested grebe	19,000	0.46	0.01	0.05	0.00	1.84	0.04
Greater scaup	5,200	0.13	0.00	0.00	0.00	0.52	0.01
Great skua	19,268	0.12	0.00	0.07	0.00	0.36	0.01
Grey plover	43,000	1.37	0.03	0.27	0.01	4.11	0.08
Hen harrier (breeding)	1,140	0.13	0.00	0.07	0.00	0.26	0.01
Hen harrier (non-breeding)	750	0.00	0.00	0.00	0.00	0.00	0.00
Herring gull	730,000	39.53	0.79	30.51	0.61	53.12	1.06
Knot	320,000	9.78	0.20	1.96	0.04	29.34	0.59
Lapwing	620,000	21.60	0.43	4.32	0.09	64.80	1.30
Lesser black-backed gull	120,000	5.58	0.11	4.01	0.08	8.85	0.18
Marsh harrier	402	0.00	0.00	0.00	0.00	0.00	0.00
Oystercatcher (breeding)	113,000	4.11	0.08	0.82	0.02	12.33	0.25

		Collisions per annum (Band 2012, Option 1) (PCH = proportion at collision height)					
		Typical PCH		Lower PCH		Upper PCH	
Species	Estimated migrant population (Britain and/or Ireland)	Zero avoidance	0.980 avoidance rate	Zero avoidance	0.980 avoidance rate	Zero avoidance	0.980 avoidance rate
Oystercatcher (non-breeding)	320,000	11.62	0.23	2.32	0.05	34.86	0.70
Pink-footed goose	360,000	0.64	0.01	0.11	0.00	1.60	0.03
Pintail	29,000	0.66	0.01	0.00	0.00	2.64	0.05
Red-breasted merganser	8,400	0.18	0.00	0.00	0.00	5.00	0.01
Redshank (British) (breeding)	77,600	2.45	0.05	0.49	0.01	7.35	0.15
Redshank (European) (non-breeding)	n/a	0.00	0.00	0.00	0.00	0.00	0.00
Redshank (Iceland) (non-breeding)	120,000	3.79	0.08	0.76	0.02	11.37	0.23
Ringed plover (breeding)	10,876	0.35	0.01	0.07	0.00	1.05	0.02
Ringed plover (non-breeding)	34,000	1.09	0.02	0.22	0.00	3.27	0.07
Sanderling	16,000	0.48	0.01	0.10	0.00	1.44	0.03
Shelduck	61,000	1.46	0.03	0.01	0.00	5.84	0.12
Short-eared owl	7,000	0.56	0.01	0.11	0.00	1.06	0.02
Shoveler	18,000	0.41	0.01	0.00	0.00	1.64	0.03
Teal	210,000	4.20	0.08	0.03	0.00	16.80	0.34

		Collisions per annum (Band 2012, Option 1) (PCH = proportion at collision height)					
		Typical PCH		Lower PCH		Upper PCH	
Species	Estimated migrant population (Britain and/or Ireland)	Zero avoidance	0.980 avoidance rate	Zero avoidance	0.980 avoidance rate	Zero avoidance	0.980 avoidance rate
Turnstone	48,000	1.48	0.03	0.30	0.01	4.44	0.09
Whooper swan	11,000	1.37	0.03	0.27	0.01	2.47	0.05

Seabird migrant collision risk

12.305 An assessment of the potential collision risk posed by the Project to seabird species during migration has been undertaken. This has been completed in response to comments on the PEIR received from NRW (**Table 12.1**) to provide an understanding of the potential risk to migrating seabirds, particularly where these were not recorded, or recorded only in low numbers, during baseline surveys of the Project windfarm site.

12.306 There is no agreed method for assessing collision risk for migrating seabirds. The assessment for the Project therefore used an adapted method based on the Scottish Government document *Strategic assessment of collision risk of Scottish offshore wind farms to migrating birds* (WWT Consulting and MacArthur Green, 2014; hereafter 'the Scottish migrant assessment').

12.307 The Scottish migrant assessment approach uses a 'migration front' to predict the likelihood that migrating seabirds will pass through the windfarm site. The assessment considered 27 seabird species, each of which was assigned one of five 'migration bands', based on the distance from the coast within which each species will typically migrate:

- 0-10km
- 0-20km
- 0-40km
- 0-60km
- 1-60km

12.308 As the Project site would be located approximately 30km from the coast at its closest point, only seabird species assigned to the 0-40km migration band and above would be likely to migrate through the windfarm site, as species in the 0-10 and 0-20km bands would not be expected to regularly occur so far from the coast. A total of 10 species were therefore included within the assessment (**Table 12.51**). For each species, it was assumed that birds would be migrating broadly north-south, either through the Irish Sea or along the western Atlantic coast, and therefore there would be three potential coastal routes along which birds could migrate; the west England/Scotland coast, the Irish east coast, and Irish west coast. The total migration front width was calculated based on the maximum band width (0-40km or 0-60km) multiplied by three for the three potential routes; i.e. a total of 120km or 180km, dependent on species.

12.309 The windfarm width was calculated as the diameter of a circle with the same total area as the windfarm site (86.79km^2); i.e.10.52km. This is the approach used to calculate windfarm width in the sCRM tool (McGregor, 2018), and was considered appropriate as it provides an 'average' width that takes into account different directions of approach that birds may take. For each species therefore, the proportion of the migrant population that could pass through the windfarm site was calculated as the windfarm width (10.52km) as a proportion of the total migration front (either 120 or 180km).

12.310 The spring and autumn migrant populations used in the calculation were based on values presented in the Scottish migrant assessment. This provided an estimate of the number of individuals that migrate through Scottish waters during the spring and autumn periods, and also the percentage of that population that would pass along the west Scottish coast. Given the relative proximity of the windfarm site to the Scottish west coast, these values were considered a suitable proxy for the Project assessment. For each species therefore, the total number of birds that could pass through the windfarm site was calculated based on the total west coast migrant population in spring and autumn, multiplied by the proportion of the migrant front that could pass through the windfarm site.

12.311 Collision risk for each species was calculated based on the spring and autumn populations that could pass through the windfarm site, using the migrant assessment in the Band (2012) CRM spreadsheet (Option 1). Species parameters used in the model were those used in the Scottish migrant assessment, but with avoidance rates updated to those recommended by Natural England (Ozsanlav-Harris *et al.*, 2022), including 70% macro-avoidance for gannet. Windfarm parameters were the same as for the sCRM (**Table 12.2**). The increase in mortality was calculated using survival data presented in Horswill and Robinson (2015) and a reference population based on the largest seasonal BDMPS presented in Furness (2015). For species where these data were unavailable, alternative sources were used, as set out in **Table 12.51**.

12.312 Results of the migratory seabird CRM are summarised in **Table 12.52**. For each of the ten species assessed, there would be no measurable increase in background mortality (<0.01%). For nine species, total annual mortality would be less that one bird, and for kittiwake it has been estimated that approximately 2.4 birds would die per annum. It was noted that in respect of kittiwake, the highest recorded density used in the sCRM (refer to **Table 12.46**) occurred during September, with a further peak recorded in March. It was therefore considered likely that the Project survey data included migrant birds, and these have been accounted for within the sCRM. Results for the migrant seabird CRM may therefore double-count the mortality values. Accordingly, no significant increase to overall collision risk was predicted for any species. The impact magnitude due to collision mortality for all migrant seabird species was considered to be **negligible**. Assuming a worst-case **medium** sensitivity to collision risk, this would be a **minor adverse** effect in all cases, and not significant in EIA terms.

Table 12.51 Key parameters used for the migrant seabird collision risk assessment

Species	Total width of migrant front (km)[1]	Windfarm width as proportion of migrant front[2]	Spring population[3]	Autumn population[3]	Spring population crossing windfarm footprint	Autumn population crossing windfarm footprint	Percentage at collision Height	Avoidance Rate
Great northern diver	120	8.77%	1,800	1,800	158	158	2%	0.990
Fulmar	180	5.84%	700,000	700,000	40,911	40,911	0.20%	0.990
Storm petrel	180	5.84%	90,000	90,000	5,260	5,260	1%	0.990
Leach's storm-petrel	180	5.84%	180,000	450,000	10,520	26,300	1%	0.990
Gannet	120	8.77%	200,000	300,000	17,533	26,300	9.60%	0.992
Great skua	120	8.77%	15,000	15,000	1,315	1,315	4.30%	0.990
Pomarine skua	120	8.77%	2,100	1,400	184	123	5%	0.990
Kittiwake	180	5.84%	600,000	600,000	35,067	35,067	15.70%	0.992
Black headed gull	180	5.84%	36,000	36,000	2,104	2,104	7.90%	0.995
Puffin	180	5.84%	700,000	700,000	40,911	40,911	0.10%	0.990

[1] Assuming three north-south migration fronts of 40km or 60km

[2] Assuming windfarm width of 10.52km

[3] Based on Scottish population in *Strategic assessment of collision risk of Scottish offshore wind farms to migrating birds* (2014), corrected for west coast only

Table 12.52 Migrant seabird collision risk assessment results (Band CRM, Option 1)

Species	Annual collision mortality	Reference population	Average annual mortality rate[4]	Reference population baseline mortality	% increase in background mortality
Great northern diver	0.00	300[1]	0.228[5]	68	0.00%
Fulmar	0.05	828,194[1]	0.181	149,903	0.00%
Storm petrel	0.02	51,300[2]	0.1[6]	5,130	0.00%
Leach's storm petrel	0.09	96,094[2]	0.13[6]	12,492	0.00%
Gannet	0.35	661,888[1]	0.188	124,435	0.00%
Great skua	0.03	25,090[1]	0.157	3,939	0.00%
Pomarine skua	0.00	3,000[3]	0.519	1,557	0.00%
Kittiwake	2.35	911,586[1]	0.157	143,119	0.00%
Black-headed gull	0.04	140,000	0.175	24,500	0.00%
Puffin	0.02	304,557[1]	0.866	263,746	0.00%

[1] Largest relevant seasonal BDMPS population from Furness (2015)

[2] UK population from Seabird 2000 (Mitchell *et al*., 2004)

[3] Migrant population from *Strategic assessment of collision risk of Scottish offshore wind farms to migrating birds* (2014)

[4] From Horswill and Robinson (2015) unless otherwise stated

[5] Based on rate for red-throated diver in Horswill and Robinson (2015)

[6] Approximation from Deakin *et al*., 2022

[7] Based on rate for Arctic skua in Horswill and Robinson (2015)

12.6.3.3 Impact 3: Combined operational collision risk and displacement

12.313 The only species in the assessment considered sensitive to both collision risk and displacement is gannet. This has therefore been considered for combined assessment of both impact pathways during the operation and maintenance phase of the Project. The combined effect on this species is considered below.

Gannet

12.314 As a species which has been scoped in for collision and displacement impacts from offshore windfarms, it is possible that these could combine to adversely affect gannet populations. These two impact pathways could not act on the same individuals, as birds which do not enter a windfarm cannot be subject to mortality from collision, and birds that do enter a windfarm cannot be subject to displacement effects. Avoidance rates for offshore windfarms used in collision risk modelling take account of macro-avoidance (where birds avoid entering a windfarm), meso-avoidance (avoidance of the rotor swept zone within a windfarm) and micro-avoidance (avoiding wind turbine blades). Thus, birds which exhibit macro-avoidance could be subject to mortality from displacement.

12.315 As noted in **Section 12.6.3.2**, the estimated annual gannet collision mortality arising from the Project would be 1.26 individuals (when applying the 70% macro-avoidance correction). The estimated mean annual mortality for gannet displacement would be 4-5 birds at a displacement rate of 60-80% and mortality of 0-1% (**Section 12.6.3.1**).

12.316 Based on the largest Annual BDMPS for the UK Western Waters, of 661,888 (Furness, 2015) and baseline mortality of 0.188 (**Table 12.17**), 124,435 individual gannets would be subject to mortality each year. The addition of a maximum of seven individuals would represent an increase in annual mortality of <0.01%. Based on the annual biogeographic population with connectivity to UK waters of 1,180,000 (Furness, 2015), 338,400 individuals would be subject to mortality and the addition of a maximum of seven individuals would represent an increase in mortality of <0.001%. These magnitudes of increase would not materially alter the background mortality of the population and would be undetectable.

12.317 Thus, the combined effect of displacement and collision risk on gannet would be of **negligible** magnitude and the effect significance for a receptor of **medium** sensitivity would be **minor adverse** and not significant in EIA terms.

12.6.3.4 Impact 4: Indirect effects through impacts on habitats and prey species

12.318 Indirect disturbance and displacement of birds may occur during the operation and maintenance phase of the Project if there are impacts on prey species and the habitats of prey species. These indirect effects include those resulting from the production of underwater noise (e.g. the turning of the wind turbines), electromagnetic fields (EMF) and the generation of suspended sediments (e.g. due to scour or maintenance activities) that may alter the behaviour or availability of bird prey species. Underwater noise and EMF may cause fish and mobile invertebrates to avoid the operational area and also affect their physiology and behaviour. Suspended sediments may cause fish and mobile invertebrates to avoid the operational area and may smother and hide immobile benthic prey. These mechanisms could result in less prey being available within the operational area to foraging seabirds. Changes in fish and invertebrate communities due to changes in presence of hard substrate (resulting in colonisation by epifauna) may also occur, and changes in fishing activity could influence the communities present.

12.319 With regard to noise impacts on fish, **Chapter 10 Fish and Shellfish Ecology** discussed the potential impacts upon fish relevant to ornithology as prey species. With regard to behavioural changes related to underwater noise impacts on fish, **Chapter 10 Fish and Shellfish Ecology**, Section 10.6.3.3 concluded a negligible adverse effect on fish during the operation and maintenance of the Project. With a negligible adverse effect on fish that are bird prey species, it has been concluded that the indirect impact on seabirds occurring in or around the windfarm site during the operational phase would be similarly a negligible adverse effect.

12.320 With regard to changes to the seabed and to suspended sediment levels, **Chapter 9 Benthic Ecology** discussed the nature of any change and impact. It concluded that impacts as a result of change in habitats due to presence of OWF infrastructure and change in hydrodynamic conditions, would be negligible to low magnitude (see **Chapter 9 Benthic Ecology,** Section 9.6.4) This would be an effect of minor adverse significance. With a minor adverse effect on benthic habitats and species, it has been concluded that the indirect impact on seabirds occurring in or around the windfarm site during the operational phase would be similarly a **minor adverse** effect.

12.321 With regard to EMF and temperature effects from subsea cables, these have been identified as highly localised with cables to be buried to a target depth of 1.5m where possible, further reducing the impact (see **Chapter 9 Benthic Ecology,** Section 9.6.4.3). The magnitude of impact was considered negligible on benthic invertebrates. **Chapter 10 Fish and Shellfish Ecology** identified a negligible to low adverse effect on fish and shellfish. With a negligible to minor adverse impact on invertebrates and fish, it has been concluded that the indirect impact on seabirds occurring in or around the offshore development area during the operational phase would be similarly a **minor adverse** effect and not significant in EIA terms.

12.322 The impact of the introduction of hard substrate was seen as a minor adverse effect in terms of benthic ecology (as it would be a change from the baseline conditions). However, localised fish aggregations have been known to occur around subsurface structures (Hansen *et al.*, 2012). Thus, the consequences for seabirds may be positive or negative locally but were not predicted to be significant (either beneficially or adversely) in EIA terms, at a wider scale.

12.6.4 Potential effects during decommissioning

12.323 Any effects generated during the decommissioning phase of the Project would be expected to be similar, or of reduced magnitude, to those generated during the construction phase, as certain activities such as piling would not be required. Decommissioning would generally involve a reverse of the construction phase through the removal of some structures and materials installed.

12.324 Potential impacts predicted during the decommissioning phase included those associated with disturbance and displacement and indirect effects on birds through effects on habitats and prey species.

12.325 It is anticipated that any future activities would be programmed in close consultation with the relevant statutory marine and nature conservation bodies, to allow any future guidance and best practice to be incorporated to minimise any potential impacts.

12.6.4.1 Impact 1: Disturbance and displacement

12.326 Disturbance and displacement would be likely to occur due to the presence of working vessels and crews and the movement, noise and light associated with these. Such activities have already been assessed for relevant bird species in the construction phase assessment (**Section 12.6.2.1**) and have been found to be of negligible negative impact magnitude.

12.327 Any impacts generated during the decommissioning phase of the Project would be expected to be similar, but likely of reduced magnitude compared to those generated during the construction phase; therefore, the impact magnitude was predicted to be **negligible**. This impact magnitude on a range of species of **low** to **high** sensitivity to disturbance would be an effect of **negligible** to **minor adverse** significance and not significant in EIA terms.

12.6.4.2 Impact 2: Indirect effects through impacts on habitats and prey

12.328 Indirect effects such as displacement of seabird prey species would be likely to occur as structures are removed. Such activities have already been assessed for relevant bird species in the construction section above and have been found to be of negligible magnitude.

12.329 Any impacts generated during the decommissioning phase of the Project would be expected to be similar, but likely of reduced magnitude compared to those generated during the construction phase, therefore the impact magnitude was predicted to be negligible. This impact magnitude on a range of species of **low** to **high** sensitivity to disturbance would be an effect of **negligible** to **minor adverse** significance and not significant in EIA terms.

12.6.5 Potential effects on designated sites

12.330 The offshore ornithology section of the Project HRA Screening Report identified a large number offshore and coastal SPAs and Ramsar sites with potential connectivity to the Project. Effects on SPAs and Ramsar sites that were 'screened in' have been considered through the HRA process and have been reported separately in the RIAA. Accordingly, effects on these internationally designated sites have not been discussed further within the ES.

12.6.6 Potential effects from HPAI

12.331 The H5N1 Highly Pathogenic Avian Influenza (HPAI) outbreak devastated populations of North Atlantic seabirds in the 2022 breeding season, spreading generally north to south across the UK and beyond with major outbreaks reported sequentially for a range of species (Cunningham *et al.,* 2022). Seabird species affected during summer 2022 included great skua, roseate, common, Sandwich and Arctic tern, guillemot, black-headed gull, kittiwake and gannet (Natural England, 2022c, NatureScot, 2023). The outbreak continued to impact seabirds in 2023. In Scotland almost 10,000 dead and sick wild birds were reported between April and October, the majority of which were guillemots and kittiwakes[12]. Impacts were also widely reported in 2023 on black-headed gull, herring gull and tern populations (RSPB, 2023).

12.332 A review of the impact of HPAI on relevant UK seabird colonies was recently carried out in relation to the assessment of Sheringham Shoal Offshore Wind Farm Extension Project (SEP) and Dudgeon Offshore Wind Farm Extension Project (DEP) (Equinor, 2023). For most species, it was concluded that HPAI mortality recorded during 2022 was unlikely to affect the conclusions of the

[12] https://www.nature.scot/avian-flu-causes-another-challenging-summer-seabirds

assessment for SEP and DEP in an EIA context. However, it was acknowledged that data provided were likely to represent underestimates of the true mortality numbers, and there was considerable uncertainty as to how HPAI would impact colonies in future years.

12.333 In relation to the Project, small numbers of dead seabirds were recorded during baseline surveys, including gannet, kittiwake and guillemot (refer to **Appendix 12.2**). It is possible that some of these birds were from breeding colonies within the species' mean maximum foraging ranges from the windfarm site, and therefore there could be potential connectivity between these colonies and the Project. However, for all species the assessment has concluded impacts of negligible magnitude from collision and disturbance (minor adverse effects in the worst case) and accordingly, any reduction in the wider seabird populations as a result of HPAI would be expected to result in a proportionate reduction in any collision or disturbance effects. Furthermore, no mechanisms or pathways have been identified whereby the Project would interact with or exacerbate impacts from HPAI. On this basis, it has been concluded that the effects of HPAI would not result in any changes to the conclusions of the EIA.

12.7 Cumulative effects

12.334 In order to undertake the CEA, and as per the PINS advice note (PINS, 2019), the potential for cumulative effects has been established considering each Project-alone effect (and the ZoI of each impact) alongside the list of other plans and projects that could potentially interact. These stages are detailed below.

12.7.1 Identification of potential cumulative effects

12.335 Part of the cumulative assessment process was the identification of which individual impacts assessed for the Project have the potential for a cumulative effect on receptors (impact screening). This information is set out in **Table 12.53**. Screening considered the ZoI of the impacts and the plans and projects identified in **Table 12.54**. Impacts for which the residual significance of effect have been assessed in the Project-alone assessment as 'negligible', or above, have been considered in the CEA screening (i.e. only those assessed as 'no change' were not taken forward as there was no potential for them to contribute to a cumulative effect).

Table 12.53 Potential cumulative effects (impact screening)

Impact	Project alone residual effect	Potential for cumulative effect?	Rationale
Construction phase			
Impact 1: Direct disturbance and displacement	Minor adverse	Yes	The likelihood that there would be a cumulative impact is low because the contribution from the Project would be small and dependent on a temporal and spatial co-incidence of disturbance/displacement from other plans or projects. However, potential cumulative effects with the Morecambe and Morgan OWFs Transmission Assets did present a pathway given the proximity to the windfarm site.
Impact 2: Indirect impacts through effects on habitats and prey species	Minor adverse	No	The likelihood that there would be a cumulative impact is low because the contribution from the Project would be small and dependent on a temporal and spatial co-incidence of disturbance/displacement from other plans or projects. While there would be other projects in proximity and on a similar timescale, as no significant cumulative effects have been found on habitats and prey species there would be no significant effects on ornithology receptors.
Operation and maintenance phase			
Impact 1: Direct disturbance and displacement	Minor adverse	Yes	There is a sufficient likelihood of a cumulative impact to justify a detailed, quantitative cumulative impact assessment.
Impact 2: Collision risk	No change to Minor adverse	Yes	There is a sufficient likelihood of a cumulative impact to justify a detailed, quantitative cumulative impact assessment.
Impact 3: Combined collision risk and displacement	Minor adverse	Yes	There is a sufficient likelihood of a cumulative impact to justify a detailed, quantitative cumulative impact assessment.

Impact	Project alone residual effect	Potential for cumulative effect?	Rationale
Impact 4: Indirect impacts through effects on habitats and prey species	Minor adverse	No	The likelihood that there would be a cumulative impact is low because the contribution from the Project would be small. While there would be other projects in proximity and on a similar timescale, as no significant cumulative effects have been found on habitats and prey species there would be no significant effects on ornithology receptors.
Decommissioning phase			
Impact 1: Direct disturbance and displacement	Minor adverse	Yes	The likelihood that there would be a cumulative impact is low because the contribution from the Project would be small and dependent on a temporal and spatial co-incidence of disturbance/ displacement from other plans or proposed projects. However cumulative effects with the Morecambe and Morgan OWFs Transmission Assets did present a potential pathway (if these were to be decommissioned at the same time as the Project) given the proximity to the windfarm site.
Impact 2: Indirect impacts through effects on habitats and prey species	Minor adverse	No	The likelihood that there would be a cumulative impact is low because the contribution from the Project would be small and dependent on a temporal and spatial co-incidence of disturbance/displacement from other plans or projects. While there would be other projects in proximity and on a similar timescale, as no significant cumulative effects have been found on habitats and prey species there would be no significant effects on ornithology receptors.

12.7.2 Identification of other plans, projects and activities

12.336 The identification and review of other plans, projects and activities that may result in cumulative effects (described as 'project screening') has been undertaken alongside an understanding of Project-alone effects. The classes of projects considered for the cumulative assessment of offshore ornithological receptors included:

- Offshore windfarms
- Marine aggregate extraction
- Oil and gas exploration and extraction
- Sub-sea cables and pipelines
- Commercial shipping
- Wave and tidal energy projects

12.337 Of these, only offshore windfarms and wave/tidal energy projects have been considered to have potential to contribute to cumulative operational displacement and collision risk, i.e. the effects screened in for cumulative assessment. The cumulative assessment focused on offshore windfarms and wave/tidal energy projects located on the western seaboard of the UK, i.e. located within the Celtic and Irish Seas and the North West Shelf to the west of Scotland. Other (non-windfarm) projects were screened out for one or all of the following reasons:

- The plan/project has already been accounted for within the offshore ornithology baseline
- No likely effect-receptor pathway between plans/projects has been identified
- There was no physical effect-receptor overlap between plans/projects
- There was no temporal overlap between plans/projects
- There was low data confidence, or data were not available

12.338 The identification of offshore windfarms to include in the cumulative assessment has been based on:

- Approved plans
- Constructed projects
- Approved but as yet unconstructed projects
- Projects for which an application has been made, were under consideration at the time of assessment and may be consented before the Project

12.339 In addition, other ‘foreseeable’ projects have been included, i.e. those for which an application has not been made but have been the subject of consultation by the developer, or those listed in plans that have clear delivery mechanisms. For such projects, the absence of robust or relevant data could preclude a quantitative cumulative assessment being carried out.

12.340 The projects listed in **Table 12.54,** from within the CEA long list presented in **Appendix 6.1 CEA Project Long List** (Document Reference 5.2.6.1), have been identified as having potential cumulative effects following the approach proposed in PINS Advice Note Seventeen (PINS, 2019).

12.341 The level of data available and the ease with which impacts could be combined across the windfarms included within the CEA were quite variable, reflecting the availability of relevant data for older projects and the approach to assessment taken. The approach to the cumulative assessment in respect of cumulative projects for which limited or no data were available is set out in **Section 12.4.4**. This has sought data for historic projects where possible, and where no data were available, and appraisal of the potential effect of missing data on the conclusions of the assessment has been presented, where possible.

Table 12.54 Summary of projects considered for the CEA in relation to ornithology

Project	MW	Distance from windfarm site (km)	Planning status	Development status (at time of assessment)	Ornithology assessment status	Screened into CEA	Rationale
Morgan and Morecambe OWF: Transmission Assets	n/a	0	Early planning	Pre-application stage. PEIR published October 2023	PEIR assessment included quantitative data for ornithology receptors being assessed	Y	Cumulative effects would be possible given the proximity to the Project during construction and decommissioning.
Mona Offshore Wind Project	1500	10.0	Early planning	Pre-application stage. PEIR published 2023.	Quantitative data presented for the ornithology receptors being assessed	Y	PEIR outputs were available and have been included in the CEA. ES values were not available at the time of the assessment.
Morgan Offshore Wind Project Generation Assets	1500	16.7	Early planning	Pre-application stage. PEIR published 2023.	Quantitative data presented for the ornithology receptors being assessed	Y	PEIR outputs were available and have been included in the CEA. ES values were not available at the time of the assessment.
West of Duddon Sands OWF	389	12.9	Consented 2004	Operational	EIA included semi-quantitative/qualitative assessment only for ornithological assessment. Data were not comparable to current approach.	Y	Quantitative outputs have been generated and included in the CEA.

Project	MW	Distance from windfarm site (km)	Planning status	Development status (at time of assessment)	Ornithology assessment status	Screened into CEA	Rationale
Walney 3 & 4 / Extension OWF	659	18.8	Consented 2014	Operational	Quantitative data presented for the ornithology receptors being assessed	Y	ES outputs were available and have been included in the CEA.
Walney 1 & 2 / OWF	367	20.3	Consented 2007	Operational	EIA included semi-quantitative/qualitative assessment only for ornithological assessment. Data were not comparable to current approach.	Y	Operational for a sufficiently long time that its effects will have been incorporated in surveys but not yet in population responses. Qualitative assessment only for most species.
Barrow OWF	90	21.0	Consented 2003	Operational (to 2028)	EIA included qualitative assessment only for ornithology	N	Historic project with lifespan that has no overlap with the operational timeframe for the Project.
Ormonde OWF	150	27.0	Consented 2007	Operational	EIA included semi-quantitative/qualitative assessment only for ornithological assessment. Data were not comparable to current approach.	Y	Quantitative outputs have been generated and included in the CEA.
Gwynt y Môr OWF	576	28.9	Consented 2008	Operational	EIA included qualitative assessment only for	Y	Included as an operational project that does not yet form part of the baseline. Qualitative

MORECAMBE

Project	MW	Distance from windfarm site (km)	Planning status	Development status (at time of assessment)	Ornithology assessment status	Screened into CEA	Rationale
					ornithological assessment		assessment only for most species.
Awel y Môr OWF	1100	28.9	Consented Sept 2023	Pre-construction	Quantitative data presented for the ornithology receptors being assessed	Y	Outputs from the ES have been included in the assessment.
Burbo Bank Extension OWF	258	29.1	Consented 2014	Operational	Limited quantitative data presented for species assessment	Y	Quantitative outputs have been generated and included in the CEA.
Burbo Bank OWF	90	33.4	Consented 2007	Operational	EIA included qualitative assessment only for ornithological assessment. Post-construction monitoring 2008-09 – no changes to assessment conclusions.	Y	Included as an operational project that does not yet form part of the baseline. Qualitative assessment only for most species.
North Hoyle OWF	60	36.3	Consented 2002	Operational (to 2029)	EIA included qualitative assessment only for ornithological assessment	N	Historic project with lifespan that has no overlap with the operational timeframe for the Project.

Project	MW	Distance from windfarm site (km)	Planning status	Development status (at time of assessment)	Ornithology assessment status	Screened into CEA	Rationale
Mooir Vannin OWF	700	43.7	Concept/ pre-planning (Scoping Report submitted October 2023, application due to be submitted 2025)	Unknown	No assessment to date	N	The project has been noted, however there was limited information on the project to facilitate an assessment at this stage.
Rhyl Flats OWF	90	40.0	Consented 2002	Operational	EIA included qualitative assessment only for ornithological assessment	Y	Operational for a sufficiently long time that its effects will have been incorporated in surveys but not yet in population responses. Qualitative assessment only for most species.
Morlais / West Anglesey (tidal energy)	-	83.1	Consented 2021	Construction	Quantitative data presented for the ornithology receptors being assessed	Y	ES outputs were available and have been included in the CEA.
Holyhead Deep (tidal energy)	80	83.3	Consented 2017	Operational	Quantitative data presented for the ornithology receptors being assessed	Y	ES outputs were available and have been included in the CEA.

Project	MW	Distance from windfarm site (km)	Planning status	Development status (at time of assessment)	Ornithology assessment status	Screened into CEA	Rationale
Robin Rigg OWF	174	101.0	Consented 2003	Operational	EIA included qualitative assessment only for ornithological assessment	Y	Operational for a sufficiently long time that its effects will have been incorporated in surveys but not yet in population responses. Qualitative assessment only for most species.
Braymore Wind Park OWF	1000	139	Concept/ pre-planning	Unknown	No assessment to date	N	Currently no data available for assessment.
North Irish Sea Array OWF	500	138	Concept/ pre-planning	Unknown	No assessment to date	N	Currently no data available for assessment.
Clogher Head/ Cooley Point OWF	800	146	Concept/ pre-planning	Unknown	No assessment to date	N	Currently no data available for assessment.
Codling Wind Park Offshore OWF	900 – 1300	154	Concept/ pre-planning	Unknown	No assessment to date	N	Currently no data available for assessment.
Oriel OWF	375	155	Concept/ pre-planning	Unknown	No assessment to date	N	Currently no data available for assessment.
Dublin Array Offshore OWF	700-824	156	Pre-application	Expected to be operational in 2027	No assessment to date	N	Currently no data available for assessment.

Project	MW	Distance from windfarm site (km)	Planning status	Development status (at time of assessment)	Ornithology assessment status	Screened into CEA	Rationale
Arklow Bank OWF Phase 1	25	186	Consented 2002	Operational (to 2029)	No planning documents identified	N	Historic project with lifespan that has no overlap with the operational timeframe for the Project.
South Irish Sea (Energia) OWF	600-1330	177	Concept/ pre-planning	Unknown	No assessment to date	N	No data available for assessment.
Kilmichael Point OWF	500	182	Early planning	Unknown	No assessment to date	N	No data available for assessment.
Erebus OWF	100	285	Consented March 2023	Pre-construction	Quantitative data presented for the ornithology receptors being assessed	Y	ES outputs were available and have been included in the CEA.
White Cross OWF	100	306	Planning	Application submitted March 2023	Quantitative data presented for the ornithology receptors being assessed	Y	ES outputs were available and have been included in the CEA.
Llŷr 1 & 2 OWF	-	287	Scoping April 2022	Pre-planning	No assessment to date	N	No data available for assessment.
TwinHub OWF	32	399	Consented 2020	Construction to commence 2024	Quantitative data presented for the ornithology receptors being assessed	Y	ES outputs were available and have been included in the CEA.

Project	MW	Distance from windfarm site (km)	Planning status	Development status (at time of assessment)	Ornithology assessment status	Screened into CEA	Rationale
West of Orkney OWF	2000	553	Planning	Application submitted November 2023	Quantitative data presented for the ornithology receptors being assessed	Y	ES outputs were available and have been included in the CEA.
Rampion OWF	400	403	Consented 2014	Operational	Quantitative data presented for the ornithology receptors being assessed	Y	ES outputs were available and have been included in the CEA for relevant species where both Projects would be located within the same BDMPS (kittiwake and great black-backed gull).
Rampion 2 OWF	1,200	398	Planning	Construction to commence 2026	Quantitative data presented for the ornithology receptors being assessed	Y	ES outputs were available and have been included in the CEA for relevant species where both Projects would be located within the same BDMPS (kittiwake and great black-backed gull).

12.7.3 Assessment of cumulative effects

12.7.3.1 Cumulative assessment – the Project and Transmission Assets (combined assessment)

12.342 While the Morgan and Morecambe Transmission Assets[13] are being considered in a separate ES as part of a separate DCO application (combined with the Morgan Offshore Wind Project transmission assets), given the functional link, a 'combined' assessment has been made considering both the Project and the Transmission Assets for the purposes of cumulative assessment. This provides an assessment including impact interactions and additive effects and thus any change in the significance of effects as assessed separately.

12.343 The Transmission Assets PEIR (Morgan Offshore Wind Limited and Morecambe Offshore Wind Limited, 2023) informed the assessment.

12.344 Only the marine elements of the Transmission Assets would interact with the Project in relation to offshore ornithology, including:

- Export cables adjoining the Morgan Offshore Wind Project Generation Assets and the Project and making landfall south of Blackpool
- Booster station required for the Morgan Offshore Wind Project
- OSP(s) (for the Project and Morgan Offshore Wind Project)

12.345 The following (Project-alone) impacts were concluded in the Transmission Assets PEIR (Morgan Offshore Wind Limited and Morecambe Offshore Windfarm Ltd, 2023):

- Disturbance and/or displacement from airborne sound, underwater sound, and presence of vessels and infrastructure during the construction, operation and maintenance, and decommissioning phases – **minor adverse or negligible effect** for all receptors (not significant in EIA terms).
- Indirect impacts from underwater sound, habitat loss and increased suspended sediment concentrations affecting prey species during the construction, operation and maintenance, and decommissioning phases – **minor adverse or negligible effect** for all receptors (not significant in EIA terms).

[13] As the Transmission Assets includes infrastructure associated with both the Project and the Morgan Offshore Wind Project Generation Assets, it should be noted that the combined assessment considers the transmission infrastructure for both the Project and the Morgan Offshore Wind Project Generation Assets (and includes all infrastructure as described in the Transmission Assets PEIR).

- Temporary habitat loss/disturbance and increased SSCs (all phases) – **minor adverse or negligible effect** for all receptors (not significant in EIA terms).

12.346 There would be the potential for cumulative disturbance and displacement effects with the Project during the construction, operation and maintenance, and decommissioning phases, and these interactions have been considered further in the following sections. For other impacts assessed in the Transmission Assets PEIR, it was considered that the small level of effect and spatial isolation between the Project and Transmission Assets would be unlikely to result in measurable interaction between the two projects.

Cumulative assessment of construction and decommissioning displacement

12.347 Displacement due to activities associated with the Morgan and Morecambe Transmission Assets project relate to the presence of construction vessels and associated human activity, noise from construction activities and lighting associated with construction sites. This has been assessed in the Morgan and Morecambe Transmission Assets PEIR (Morgan Offshore Wind Limited and Morecambe Offshore Windfarm Ltd, 2023).

Common scoter

12.348 The Transmission Assets PEIR concluded an annual common scoter mortality of between 11 and 123 birds as a result of construction and decommissioning disturbance assuming a mortality range of 1-10%, but stated that the lower value (i.e. 1% mortality/11 birds) was considered suitably precautionary. Combined with the predicted Project construction phase mortality (0-2 birds), total annual mortality would be between 11 and 125 birds. At the average annual mortality rate of 0.238 (Horswill and Robinson, 2015), 33,749 birds would be subject to mortality each year from the Liverpool Bay SPA population for this species (141,801). The addition of a maximum of 125 birds to this would increase the mortality rate by 0.37% (assuming a precautionary 10% mortality). This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable.

12.349 This precautionary assessment generated an effect of negligible impact magnitude. As the species is of high sensitivity to disturbance, the effect significance for the combined effects of the Project and the Transmission Assets would be **minor adverse**, and not significant in EIA terms.

Red-throated diver

12.350 The Transmission Assets PEIR concluded an annual red-throated diver mortality between 0.08 and 0.79 birds as a result of construction and decommissioning disturbance assuming a mortality range of 1-10%, but stated that the lower value (i.e. 1% mortality/0.08 birds) was considered suitably precautionary. Combined with the predicted construction mortality as a result of the Project (0-1 birds), total annual mortality would be between 0.08 and 1.79 birds. At the average annual mortality rate of 0.233, 386 birds would be subject to mortality each year from the winter BDMPS for this species (1,657, North West (NW) England and Wales; Furness 2015). The addition of a maximum of 1.79 birds to this would increase the mortality rate by 0.46% (assuming a precautionary 10% mortality), or 0.02% assuming a more realistic (but still precautionary) 1% mortality. For either rate, this magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable.

12.351 This precautionary assessment (due to the use of high predicted displacement and mortality rates due to displacement), generated an effect of negligible impact magnitude. As the species is of high sensitivity to disturbance, the effect significance for the cumulative effects of the Project and the Transmission Assets would be **minor adverse**, and not significant in EIA terms.

All other receptors

12.352 The Transmission Assets PEIR concluded that there would be negligible effects on all other ornithology receptors during the construction and decommissioning phases, due to the localised and short duration of the works. Therefore, there would be no significant cumulative disturbance effects with the Project on Manx shearwater, guillemot and razorbill.

Cumulative assessment of operational and maintenance displacement

Common scoter

12.353 The Transmission Assets PEIR concluded an annual common scoter mortality between five and 59 birds as a result of operation and maintenance phase disturbance assuming a mortality range of 1-10%, but stated that the lower value (i.e. 1% mortality/five birds) was considered suitably precautionary. Combined with the predicted operation and maintenance phase mortality as a result of the Project (0-4 birds), total annual mortality would be between five and 63 birds. At the average annual mortality rate of 0.238 (Horswill and Robinson 2015), 33,749 birds would be subject to mortality each year from the Liverpool Bay SPA population for this species (141,801; refer to **Paragraph 12.99**). The addition of a maximum of 63 birds to this would increase the mortality rate by 0.19% (assuming a precautionary 10% mortality). This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable.

12.354 This precautionary assessment (due to the use of high predicted displacement and mortality rates due to displacement), generated an effect of **negligible** impact magnitude. As the species is of **high** sensitivity to disturbance, the effect significance for the cumulative effects of the Project and the

Transmission Assets would be **minor adverse**, and not significant in EIA terms.

Red-throated diver

12.355 The Transmission Assets PEIR concluded an annual red-throated diver mortality between 0.10 and 0.95 birds as a result of operation and maintenance phase disturbance, assuming a mortality range of 1-10%, but stated that the lower value (i.e. 1% mortality/0.08 birds) was considered suitably precautionary. Combined with the predicted construction-phase mortality as a result of the Project (0-2 birds), total annual mortality would be between 0.10 and 2.95 birds. At the average annual mortality rate of 0.233, 386 birds would be subject to mortality each year from the winter BDMPS for this species (1,657, NW England and Wales; Furness 2015). The addition of a maximum of 2.95 birds to this would increase the mortality rate by 0.76% (assuming a precautionary 10% mortality), or 0.03% assuming a more realistic (but still precautionary) 1% mortality. For either rate, this magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable.

12.356 This assessment generated an effect of **negligible** magnitude. As the species is of **high** sensitivity to disturbance, the effect significance for the cumulative effects of the Project and the Transmission Assets would be **minor adverse,** and not significant in EIA terms.

All other receptors

12.357 The Transmission Assets PEIR concluded that there would be negligible effects on all other ornithology receptors considered for the project during the operation and maintenance phase, due to the localised spatial extent of the works. Therefore, there would be no significant cumulative effects with the Project for all other ornithology receptors, including Manx shearwater, gannet, guillemot and razorbill.

Cumulative assessment of operational collision risk

All ornithology receptors

12.358 The Transmission Assets PEIR scoped out the risk of collision impacts to ornithological receptors for all development phases, as this project would not include infrastructure (such as WTGs) associated with collision. Therefore, there would be no cumulative effects with the Project in respect of this impact pathway.

Cumulative assessment of operational collision risk and displacement

Gannet

12.359 Gannet was the only species assessed for the combined effects of the Project due to collision and displacement. As negligible effects on this species have been predicted by the Transmission Assets PEIR, this would not contribute to significant cumulative effects with the Project.

Summary

12.360 A summary of the combined assessment is given in **Table 12.55**.

Table 12.55 Summary of impacts from the Project and Transmission Assets alone and combined (note: wording of impacts has been summarised to encompass both projects)

Impact	Transmission Assets significance of effect	As per projects-alone residual significance of effect	Combined assessment
Construction/decommissioning phases			
Disturbance and displacement – common scoter	Minor adverse	Minor adverse	Minor adverse
Disturbance and displacement – red-throated diver	Minor adverse	Minor adverse	
Disturbance and displacement – all other receptors considered by the Project	Negligible	Minor adverse	
Operation and maintenance phase			
Disturbance and displacement – common scoter	Minor adverse	Minor adverse	Minor adverse
Disturbance and displacement – red-throated diver	Minor adverse	Minor adverse	
Disturbance and displacement – all other receptors considered by the Project	Negligible	Negligible/Minor adverse	

12.7.3.2 Cumulative assessment – All plans and projects

12.361 Based on both the impacts (**Table 12.53**) and other plans and projects (**Table 12.54**) identified, where required, a detailed cumulative assessment was undertaken considering all relevant information from the Project and other plans and projects (including the Transmission Assets).

Cumulative assessment of construction and decommissioning displacement

12.362 Any impacts resulting from disturbance and displacement from construction activities would be short-term, temporary and reversible in nature. Impacts would last only for the duration of construction activity, with birds expected to return to the area once construction activities have ceased (unless affected by operation and maintenance activities, which are addressed below). While there was the potential for cumulative effects, no significant increase to the impact magnitude was anticipated given the types of activities planned, the transient nature of works and the limited temporal or spatial overlap between projects, as well as mitigations implemented by each project. In relation to all species, the receptor sensitivity was high or medium and the magnitude would be negligible, resulting in an at most minor adverse effect and not significant in EIA terms.

Cumulative assessment of operational and maintenance displacement

12.363 The species assessed for the Project-alone operational displacement impacts (and the relevant seasons) were common scoter (non-breeding), gannet (breeding, autumn, spring), guillemot (breeding, non-breeding), razorbill (breeding, autumn, winter, spring), Manx shearwater (breeding, autumn, spring) and red-throated diver (autumn, winter, spring).

12.364 A review of the BDMPS regions for each species indicated that for Manx shearwater, gannet, guillemot, and razorbill, all the projects identified for inclusion in the CEA in **Table 12.54** had the potential to contribute a cumulative effect. For red-throated diver, the BDMPS is NW England and Wales. There is no BDMPS for common scoter defined by Furness (2015), and therefore the NW England and Wales BDMPS area for red-throated diver has also been used for this species. This encompasses the key SPAs on the western side of the UK designated for common scoter (Liverpool Bay, Carmarthen Bay, Ribble and Alt Estuaries and Solway Firth). Windfarms located outside of this area (e.g. White Cross, Rampion) were not considered likely to contribute to a cumulative displacement effect for red-throated diver and common scoter. Data from other projects used in the cumulative assessment have been derived from application/PEIR documents from the respective projects (where these were available), and from cumulative assessment undertaken for more recent applications, including Awel y Môr (RWE, 2022).

12.365 Due to the limited available data from a number of relevant projects, it was not possible to undertake the cumulative assessment for each species by biological season. Therefore, the assessment below considered annual (year-round) values only. It should also be noted that mortality rates for other projects used in the cumulative assessment were as reported by the developers in each case, and in some cases the method used to calculate these values may have differed and/or was not clear. Therefore, the assumptions regarding displacement rates and mortality rates of displaced birds may not be consistent with those presented in this report.

Common scoter

12.366 The estimated number of common scoter subject to displacement impacts from each relevant project is given in **Table 12.56**. The total (cumulative) number of individual common scoter which could potentially suffer mortality because of displacement has been estimated as between seven and 74 (refer to **Table 12.57**). Based on a non-breeding season population of 141,801 (HiDef, 2023) and an average baseline mortality rate for common scoter of 0.238 (Horswill and Robinson, 2015), the number of individuals subject to mortality from the non-breeding population would be 33,749 (141,801 x 0.238). The addition of a maximum of 74 individuals to this increased the mortality rate by 0.22%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable.

12.367 A number of offshore windfarm projects for which no quantitative assessment was available were located within, or close to, SPAs where common scoter is a qualifying species. These comprise:

- Solway Firth SPA: Robin Rigg OWF
- Ribble and Alt Estuaries SPA/Liverpool Bay SPA: Burbo Bank, Rhyl Flats, Gwynt y Môr, West of Duddon Sands, Walney Phase 1, 2 and Extension OWFs

12.368 In each case, where a qualitative assessment was undertaken for these projects, no significant effect on common scoter was concluded. Data presented for the Gwynt y Môr windfarm demonstrated that common scoter were largely absent from this project area, and also from around Burbo Bank, Rhyl Flats, West of Duddon Sands and the Walney OWF projects (RWE Group, 2005). This was supported by data recently published on densities of this species within Liverpool Bay SPA (HiDef, 2023). Similarly, data presented for the Robin Rigg windfarm (Natural Power, 2002) demonstrated that the main concentrations of common scoter occurred outside of the windfarm. Therefore, it can be concluded that these projects would contribute very little, if any, additional mortality to the cumulative value. For all other projects considered in the cumulative assessment (**Table 12.56**), they were or would be located outside of areas where concentrations of common scoter are known to occur. Overall, therefore, it was considered very unlikely that these projects would contribute significant additional mortality to the cumulative value, and certainly nothing close to the additional annual mortality of c. 264 birds that would be required to exceed the 1% mortality increase threshold. This conclusion was further supported by the precautionary nature of the quantitative assessments, and recently published evidence to indicate that this species has increased in in Liverpool Bay since the SPA was designated (HiDef, 2023).

12.369 During the non-breeding period, the magnitude of impact has therefore been assessed as **negligible**. As the species is of **high** sensitivity to displacement, the effect significance would be **minor adverse**. No impacts to this species have been predicted during the breeding season, therefore the year-round effects have also been assessed as **minor adverse** and not significant in EIA terms.

Table 12.56 Common scoter cumulative abundance estimates for disturbance and displacement during operation and maintenance

Project	Annual population estimate
Awel y Môr OWF	31
Burbo Bank Extension OWF	40
Mona OWF	0
Morgan OWF Generation Assets	0
Morgan and Morecambe Transmission Assets	588
Ormonde OWF	35
Total excluding the Project	**694**
The Project	**43**
Total (all projects)	**737**
Projects without quantitative assessment	
Burbo Bank OWF	Evidence presented for Gwynt y Môr (RWE, 2005), HiDef (2023) and Robin Rigg (Natural Power, 2002) indicated that no significant concentrations of common scoter occurred around these projects, and therefore significant additional displacement mortality would be unlikely to occur.
Rhyl Flats OWF	
Gwynt y Môr OWF	
West of Duddon Sands OWF	
Walney 1 & 2 OWF	
Walney 3 & 4 / Extension OWF	
Robin Rigg OWF	
Erebus OWF	

Project	Annual population estimate
Holyhead Deep (tidal energy)	These projects are located outside of areas where concentrations of common scoter are likely to occur; therefore no significant additional mortality was predicted.
Morlais / West Anglesey (tidal energy)	
TwinHub OWF	
West of Orkney OWF	
White Cross OWF	

Table 12.57 Common scoter cumulative disturbance and displacement mortality during operation and maintenance

Year-round	Mortality										
Displacement	1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
10%	1	1	2	3	4	7	15	22	37	59	74
25%	1	3	4	6	7	15	29	44	74	118	147
30%	2	4	7	9	11	22	44	66	111	177	221
40%	3	6	9	12	15	29	59	88	147	236	295
50%	4	7	11	15	18	37	74	111	184	295	369
60%	4	9	13	18	22	44	88	133	221	354	442
70%	5	10	15	21	26	52	103	155	258	413	516
80%	6	12	18	24	29	59	118	177	295	472	590
90%	7	13	20	27	33	66	133	199	332	531	663
100%	7	15	22	29	37	74	147	221	369	590	737

Note: The cells show the number of birds subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Gannet

12.370 The estimated number of gannet subject to displacement impacts from each relevant project is given in **Table 12.58**. The total (cumulative) number of individual gannets that could potentially suffer mortality as a consequence of displacement has been estimated at between 47 and 62 (refer to **Table 12.59**). At the average baseline mortality rate for gannet of 0.188, the number of individuals subject to mortality from the largest BDMPS population throughout the year would be 124,435 (661,888 x 0.188). The addition of a maximum of 62 individuals to this increased the mortality rate by 0.05%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable.

12.371 For all offshore windfarm projects where a qualitative assessment was undertaken, no significant effect on gannet was concluded, and it was considered very unlikely that a significant number of birds would be impacted by these projects. In order to reach the threshold where a significant effect could occur (i.e. 1% increase in background mortality) approximately 14,700 additional birds would need to be present at the five windfarms for which no data were available. Based on the numbers present at other sites in the region, it is extremely unlikely that such a threshold would be reached. When considered cumulatively, therefore, the magnitude of impact has been assessed as **negligible**. As the species is of **medium** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Table 12.58 Gannet cumulative abundance estimates for disturbance and displacement during operation and maintenance

Project	Annual population estimate
Awel y Môr OWF	528
Burbo Bank Extension OWF	695
Erebus OWF	658
Mona OWF	693
Morgan OWF Generation Assets	454
Morgan and Morecambe Transmission Assets	0
Ormonde OWF	199
TwinHub OWF	397
Walney 3 & 4 / Extension OWF	433
West of Duddon Sands OWF	431
West of Orkney OWF	2,188
White Cross OWF	456

Project	Annual population estimate
Total excluding the Project	**7,132**
The Project	**673**
Total (all projects)	**7,805**
Projects without quantitative assessment	
Burbo Bank OWF	Where assessed, all projects considered that there would be 'low' or 'negligible' effects on gannet. Surveys undertaken for Gwynt y Môr (RWE Group, 2005) showed no significant concentrations of this species in the wider Liverpool Bay area. Given the relatively low sensitivity of this species, there was considered to be no risk that mortality risk could approach a significant level (i.e. 1% increase in background mortality).
Gwynt y Môr OWF	
Rhyl Flats OWF	
Robin Rigg OWF	
Walney 1 & 2 OWF	

Table 12.59 Gannet cumulative disturbance and displacement mortality during operation and maintenance

Breeding	Mortality										
Displacement	1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
10%	8	16	23	31	39	78	156	234	390	624	780
20%	16	31	47	62	78	156	312	468	780	1249	1561
30%	23	47	70	94	117	234	468	702	1171	1873	2341
40%	31	62	94	125	156	312	624	937	1561	2498	3122
50%	39	78	117	156	195	390	780	1171	1951	3122	3902
60%	47	94	140	187	234	468	937	1405	2341	3746	4683
70%	55	109	164	219	273	546	1093	1639	2732	4371	5463
80%	62	125	187	250	312	624	1249	1873	3122	4995	6244
90%	70	140	211	281	351	702	1405	2107	3512	5619	7024
100%	78	156	234	312	390	780	1561	2341	3902	6244	7805

Note: The cells show the number of birds subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Guillemot

12.372 The estimated number of guillemot subject to displacement impacts from each relevant project is given in **Table 12.60**. The total (cumulative) number of individual guillemots which could potentially suffer mortality as a consequence of displacement has been estimated at between 305 and 7,107 (refer to **Table 12.61**). With the addition of the average predicted underwater collision mortality from the Morlais and Holyhead Deep tidal energy sites (46 and eight birds per annum respectively), in accordance with the approach used by the Awel y Môr OWF application (RWE, 2022); this results in a total mortality of 359 to 7,161 birds per annum.

12.373 At the average baseline mortality rate for guillemot of 0.143, the number of individuals subject to mortality from the largest BDMPS population throughout the year would be 163,811 (1,145,528 x 0.143). The addition of 359 individuals would increase mortality by 0.22%, while a maximum of 7,161 individuals would increase the mortality rate by 4.37%. In relation to the biogeographic population with connectivity to UK waters, 4,125,000 (Furness 2015), the number of individuals subject to mortality annually would be 589,875 (4,125,000 x 0.143). The addition of 359 individuals would increase mortality by 0.06%, and a maximum of 7,161 individuals to this increased the mortality rate by 1.21%.

12.374 The maximum values set out above were considered to be precautionary, and very unlikely to reflect the actual effect; a lower value (i.e. reflecting a displacement rate of 50% and mortality of 1%) was considered to be realistic. For a threshold of 1% mortality increase to be exceeded, a displacement rate of 50% and mortality of 3% of displaced birds would have to be exceeded (**Table 12.61**); this would be significantly above realistic, evidence-based rates (refer to **Paragraphs 12.198** to **12.206** in **Section 12.6.3.1**).

12.375 It was considered very unlikely that the contribution of historic projects where no quantitative data are available would affect the conclusions of the cumulative assessment. Assuming a realistic displacement/mortality rate of 50%/1%, mortality would need to increase by 1,076 birds to exceed a 1% increase in background mortality for the BDMPS, which would require in excess of 215,000 birds to be present at the three projects for which data are unavailable (Burbo Bank, Gwynt y Môr and Rhyl Flats; refer to **Table 12.60**). Such numbers were considered extremely unlikely given that none of the projects identified high numbers of guillemots, and the densities of birds recorded at similar sites in the region.

12.376 The assessment, based on the lower realistic values, therefore concluded that these magnitudes of increase in mortality would not materially alter the background mortality of the population and would be undetectable. On this basis, the year-round impact magnitude has been assessed as **negligible**. As the species is of **medium** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Table 12.60 Guillemot cumulative abundance estimates for disturbance and displacement during operation and maintenance

Project	Annual population estimate
Awel y Môr OWF	4,488
Burbo Bank Extension OWF	2,562
Erebus OWF	35,339
Mona OWF	11,912
Morgan OWF Generation Assets	8,994
Morgan and Morecambe Transmission Assets	0
Ormonde OWF	912
Robin Rigg OWF	138
TwinHub OWF	256
Walney 1 & 2	1,321
Walney 3 & 4 / Extension OWF	6,096
West of Duddon Sands OWF	1,321
West of Orkney OWF	9,136
White Cross OWF	4,363
Total excluding the Project	**86,837**
The Project	**14,689**
Total (all projects)	**101,526**
Projects without quantitative assessment	
Burbo Bank OWF	‘Negligible numbers occur within 2km of Burbo’. ‘Low levels of disturbance’ resulting in ‘very low’ significance of impact (effect) (Casella Stanger, 2002).
Gwynt y Môr OWF	‘Low’ significance. Main concentrations recorded away from the windfarm (RWE Group, 2005)
Rhyl Flats OWF	‘Negligible’ effect (Celtic Offshore Wind Ltd., 2002).

Table 12.61 Guillemot cumulative disturbance and displacement mortality during operation and maintenance

Breeding	Mortality										
Displacement	1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
10%	102	203	305	406	508	1015	2031	3046	5076	8122	10153
20%	203	406	609	812	1015	2031	4061	6092	10153	16244	20305
30%	305	609	914	1218	1523	3046	6092	9137	15229	24366	30458
40%	406	812	1218	1624	2031	4061	8122	12183	20305	32488	40610
50%	508	1015	1523	2031	2538	5076	10153	15229	25382	40610	50763
60%	609	1218	1827	2437	3046	6092	12183	18275	30458	48732	60916
70%	711	1421	2132	2843	3553	7107	14214	21320	35534	56855	71068
80%	812	1624	2437	3249	4061	8122	16244	24366	40610	64977	81221
90%	914	1827	2741	3655	4569	9137	18275	27412	45687	73099	91373
100%	1015	2031	3046	4061	5076	10153	20305	30458	50763	81221	101526

Note: The cells show the number of birds subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Razorbill

12.377 The estimated number of razorbill subject to displacement impacts from each relevant project is given in **Table 12.62**. The total (cumulative) number of individual razorbills which could potentially suffer mortality as a consequence of displacement has been estimated at between 47 and 1,104 (refer to **Table 12.63**). With the addition of the average predicted underwater collision mortality from the Morlais and Holyhead Deep tidal energy sites (23 and one birds per annum respectively), in accordance with the approach used by the Awel y Môr OWF application (RWE, 2022); this would result in a total mortality of 71 to 1,128 birds per annum.

12.378 At the average baseline mortality rate for razorbill of 0.178, the number of individuals subject to mortality from the largest BDMPS population throughout the year would be 108,031 (606,914 x 0.178). The addition of 71 individuals would increase mortality by 0.07%, while a maximum of 1,128 individuals would increase the mortality rate by 1.04%. In relation to the biogeographic population with connectivity to UK waters, 1,707,000 (Furness 2015), the number of individuals subject to mortality annually would be 303,846 (1,707,000 x 0.178). The addition of 71 individuals would increase mortality by 0.02%, and a maximum of 1,128 individuals to this increases the mortality rate by 0.37%.

12.379 The maximum values set out above were considered to be precautionary, and very unlikely to reflect the actual effect; a lower value (i.e. reflecting a displacement rate of 50% and mortality of 1%) was considered to be realistic. For a threshold of 1% mortality increase to be exceeded, a displacement rate of 70% and mortality of 10% of displaced birds would be required; this would be significantly above realistic, evidence-based rates (refer to **Paragraphs 12.198** to **12.206** in **Section 12.6.3.1**).

12.380 It was considered very unlikely that the contribution of historic projects where no quantitative data were available would affect the conclusions of the cumulative assessment. Assuming a realistic displacement/mortality rate of 50%/1%, mortality would need to increase by 977 birds to exceed a 1% increase in background mortality for the BDMPS, which would require in excess of 195,000 birds to be present at the four projects for which data were unavailable (Burbo Bank, Gwynt y Môr, Rhyl Flats and Walney 1&2; refer to **Table 12.62**). Such numbers are considered extremely unlikely given that none of the projects identified high numbers of razorbills, and the densities of birds recorded at similar sites in the region.

12.381 The assessment, based on the lower realistic values, therefore concludes that these magnitudes of increase in mortality would not materially alter the background mortality of the population and would be undetectable. On this basis, the year-round impact magnitude has been assessed as **negligible**. As the species is of **medium** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Table 12.62 Razorbill cumulative abundance estimates for disturbance and displacement during operation and maintenance

Project	Annual population estimate
Awel y Môr OWF	692
Burbo Bank Extension OWF	93
Erebus OWF	3,867
Mona OWF	2,883
Morgan OWF Generation Assets	622
Morgan and Morecambe Transmission Assets	0
Ormonde OWF	174
Robin Rigg OWF	63
TwinHub OWF	65
Walney 3 & 4 / Extension OWF	4,016
West of Duddon Sands OWF	202
West of Orkney OWF	326
White Cross OWF	786
Total excluding the Project	**13,789**
The Project	**1,979**
Total (all projects)	**15,768**
Projects without quantitative assessment	
Burbo Bank OWF	'Absent from Burbo'. 'Low levels of disturbance' resulting in 'very low' significance of impact (effect) (Casella Stanger, 2002).
Gwynt y Môr OWF	'Low' significance. Main concentrations recorded away from the windfarm (RWE Group, 2005)
Rhyl Flats OWF	'No significant effects' (Celtic Offshore Wind Ltd., 2002).
Walney 1 & 2 OWF	'Low' significance (DONG, 2006)

Table 12.63 Razorbill cumulative abundance estimates for disturbance and displacement during operation and maintenance

Breeding	Mortality										
Displacement	**1%**	**2%**	**3%**	**4%**	**5%**	**10%**	**20%**	**30%**	**50%**	**80%**	**100%**
10%	16	32	47	63	79	158	315	473	788	1261	1577
20%	32	63	95	126	158	315	631	946	1577	2523	3154
30%	47	95	142	189	237	473	946	1419	2365	3784	4731
40%	63	126	189	252	315	631	1261	1892	3154	5046	6307
50%	79	158	237	315	394	788	1577	2365	3942	6307	7884
60%	95	189	284	378	473	946	1892	2838	4731	7569	9461
70%	110	221	331	442	552	1104	2208	3311	5519	8830	11038
80%	126	252	378	505	631	1261	2523	3784	6307	10092	12615
90%	142	284	426	568	710	1419	2838	4257	7096	11353	14192
100%	158	315	473	631	788	1577	3154	4731	7884	12615	15768

Note: The cells show the number of birds subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Manx shearwater

12.382 The estimated number of Manx shearwater subject to displacement impacts from each relevant project is given in **Table 12.64**. The total (cumulative) number of individual Manx shearwaters which could potentially suffer mortality as a consequence of displacement has been estimated at between 93 and 2,177 (refer to **Table 12.65**). At the average baseline mortality rate for Manx shearwater of 0.13, the number of individuals subject to mortality from the largest BDMPS population throughout the year would be 236,801 (1,821,544 x 0.13). The addition of 93 individuals would increase mortality by 0.04%, while a maximum of 2,177 individuals would increase the mortality rate by 0.92%. Therefore, even under these higher rates the cumulative mortality would be below the 1% threshold that could lead to a potentially significant effect. As the higher mortality rates (i.e. 10%) would be close to the expected natural background mortality, it was considered that much lower rates (i.e. 1%) would be more likely, and would result in effects well below the 1% threshold. In relation to the biogeographic population with connectivity to UK waters of 2,000,000 (Furness 2015), the number of individuals subject to mortality annually would be 260,000 (2,000,000 x 0.13). The addition of 93 individuals would increase mortality by 0.04%, and a maximum of 2,177 individuals to this increased the mortality rate by 0.84%.

12.383 It was considered very unlikely that the contribution of historic projects where no quantitative data were available would affect the conclusions of the cumulative assessment. Assuming a realistic displacement/mortality rate of 50%/1% (given the species low susceptibility to disturbance and displacement; refer to **Paragraphs 12.232** to **12.234** in **Section 12.6.3.1**, and natural background mortality rate) mortality would need to increase by 2,213 birds to exceed a 1% increase in background mortality for the BDMPS, which would require in excess of 400,000 birds to be present at the five projects for which data were unavailable (Burbo Bank, Gwynt y Môr, Robin Rigg, Rhyl Flats and Walney 1&2; refer to **Table 12.64**). Such numbers were considered extremely unlikely given that none of the projects identified high numbers of Manx shearwaters, and the densities of birds recorded at similar sites in the region.

12.384 The year-round impact magnitude has therefore been assessed as **negligible**. As the species is of **low** sensitivity to disturbance, the effect significance would be **negligible** and not significant in EIA terms.

Table 12.64 Manx shearwater cumulative abundance estimates for disturbance and displacement during operation and maintenance

Project	Annual population estimate
Awel y Môr OWF	417
Burbo Bank Extension OWF	443
Erebus OWF	2,115
Holyhead Deep (tidal energy)	0
Morlais / West Anglesey (tidal energy)	0
Mona OWF	2,232
Morgan OWF Generation Assets	993
Morgan and Morecambe Transmission Assets	0
Ormonde OWF	1,001
TwinHub OWF	1,274
Walney 3 & 4 / Extension OWF	912
West of Duddon Sands OWF	544
West of Orkney OWF	10
White Cross OWF	12,181
Total excluding the Project	**22,123**
The Project	**8,972**
Total (all projects)	**31,095**
Projects without quantitative assessment	
Burbo Bank OWF	Species noted as not recorded during site surveys; no impact therefore assumed.
Rhyl Flats OWF	Species noted as not recorded during site surveys; no impact therefore assumed.
Robin Rigg OWF	'Very low' significance. Species recorded primarily away from the OWF site (Natural Power, 2002)
Gwynt y Môr OWF	'Low' significance. Species recorded primarily away from the OWF site (RWE Group, 2005)
Walney 1 & 2 OWF	'Low' significance (DONG, 2006)

Table 12.65 Manx shearwater cumulative disturbance and displacement mortality during operation and maintenance

Breeding	**Mortality**										
Displacement	**1%**	**2%**	**3%**	**4%**	**5%**	**10%**	**20%**	**30%**	**50%**	**80%**	**100%**
10%	31	62	93	124	155	311	622	933	1555	2488	3109
20%	62	124	187	249	311	622	1244	1866	3109	4975	6219
30%	93	187	280	373	466	933	1866	2799	4664	7463	9328
40%	124	249	373	498	622	1244	2488	3731	6219	9950	12438
50%	155	311	466	622	777	1555	3109	4664	7774	12438	15547
60%	187	373	560	746	933	1866	3731	5597	9328	14925	18657
70%	218	435	653	871	1088	2177	4353	6530	10883	17413	21766
80%	249	498	746	995	1244	2488	4975	7463	12438	19901	24876
90%	280	560	840	1119	1399	2799	5597	8396	13993	22388	27985
100%	311	622	933	1244	1555	3109	6219	9328	15547	24876	31095

Note: The cells show the number of birds subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Red-throated diver

12.385 The estimated number of red-throated diver subject to displacement impacts from each relevant project is given in **Table 12.66**. The total (cumulative) number of individual red-throated divers which could potentially suffer mortality as a consequence of displacement has been estimated at between three and 26 (refer to **Table 12.67**). At the average baseline mortality rate for red-throated diver of 0.233, the number of individuals subject to mortality from the largest BDMPS population throughout the year would be 1,019 (4,373 x 0.233). The addition of three individuals would increase mortality by 0.29%, while a maximum of 26 individuals would increase mortality by 2.55%.

12.386 In relation to the biogeographic population with connectivity to UK waters of 27,000 (Furness 2015), the number of individuals subject to mortality annually would be 6,291 (27,000 x 0.233). The addition of three individuals would increase mortality by 0.05%, and a maximum of 26 individuals to this increased the mortality rate by 0.41%.

12.387 The maximum values set out above were considered to be precautionary and very unlikely to reflect the actual effect; the lower value (i.e. reflecting a displacement rate of 100% and mortality of 1%) was considered to be realistic (e.g. refer to **Paragraph 12.261** in **Section 12.6.3.1**). Therefore, the assessment based on the lower realistic values concluded that these magnitudes of increase in mortality would not materially alter the background mortality of the population and would be undetectable.

12.388 It was considered very unlikely that the contribution of historic projects where no quantitative data were available would affect the conclusions of the cumulative assessment. Assuming a realistic displacement/mortality rate of 100%/1%, mortality would need to increase by eight birds to exceed a 1% increase in background mortality for the BDMPS, which would require approximately 760 birds to be present at the three projects for which data were unavailable (Burbo Bank, Robin Rigg and Walney 1&2; refer to **Table 12.66**). Such numbers were considered extremely unlikely given that none of the projects identified high numbers of red-throated divers, and the densities of birds recorded at similar sites in the region.

12.389 On this basis, the year-round impact magnitude has been assessed as **negligible**. As the species is of **high** sensitivity to disturbance, the effect significance would be **minor adverse** and not significant in EIA terms.

Table 12.66 Red-throated diver cumulative abundance estimates for disturbance and displacement during operation and maintenance

Project	Annual population estimate
Awel y Môr OWF	47
Burbo Bank Extension OWF	58
Erebus OWF	0
Gwynt y Môr OWF	35
Holyhead Deep (tidal energy)	0
Morlais / West Anglesey (tidal energy)	0
Mona OWF	0
Morgan OWF Generation Assets	0
Morgan and Morecambe Transmission Assets	0
Ormonde OWF	17
Rhyl Flats OWF	24
TwinHub OWF	0
Walney 3 & 4 / Extension OWF	53
West of Duddon Sands OWF	2
West of Orkney OWF	0
White Cross OWF	0
Total excluding the Project	**236**
The Project	**20**
Total (all projects)	**256**
Projects without quantitative assessment	
Burbo Bank OWF	'No preference by red-throated diver for Burbo study area'. 'Medium' significance effect on 'single figures of birds' (Casella Stanger, 2002).
Robin Rigg OWF	'No significant disturbance impacts predicted' (Natural Power, 2002).
Walney 1 & 2 OWF	'Negligible' significance (DONG, 2006)

Table 12.67 Red-throated diver cumulative disturbance and displacement mortality during operation and maintenance

Autumn	Mortality										
Displacement	**1%**	**2%**	**3%**	**4%**	**5%**	**10%**	**20%**	**30%**	**50%**	**80%**	**100%**
10%	0	1	1	1	1	3	5	8	13	20	26
20%	1	1	2	2	3	5	10	15	26	41	51
30%	1	2	2	3	4	8	15	23	38	61	77
40%	1	2	3	4	5	10	20	31	51	82	102
50%	1	3	4	5	6	13	26	38	64	102	128
60%	2	3	5	6	8	15	31	46	77	123	154
70%	2	4	5	7	9	18	36	54	90	143	179
80%	2	4	6	8	10	20	41	61	102	164	205
90%	2	5	7	9	12	23	46	69	115	184	230
100%	3	5	8	10	13	26	51	77	128	205	256

Note: The cells show the number of birds subject to mortality (rounded to the nearest integer) at a given rate of displacement and mortality. Blue highlighted cells are considered to be the most realistic scenario, in accordance with SNCB advice (SNCBs, 2022). Numbers highlighted in red represent displacement impacts which would lead to a >1% increase in the background mortality rate.

Cumulative assessment of operational collision risk

12.390 The species assessed for Project-alone collision impacts (and the relevant seasons) were gannet (breeding, autumn), little gull (non-breeding), kittiwake (breeding, autumn, spring), common gull (breeding, non-breeding), herring gull (breeding, non-breeding), lesser black-backed gull (breeding, autumn, winter, spring) and great black-backed gull (breeding, autumn, winter, spring).

12.391 A review of the BDMPS regions for each species indicated that all projects identified in **Table 12.54** have the potential to contribute to cumulative effects, and all have therefore been considered in the cumulative assessment.

12.392 Due to the limited available data from a number of relevant projects, it has not been possible to undertake the cumulative assessment for each species by biological season. Therefore, the assessment below considered annual (year-round) values only. It should also be noted that mortality rates for other projects used in the cumulative assessment were as reported by the developers in each case. Data from other projects used in the cumulative assessment have been derived from application documents (including PEIRs for projects not yet submitted) from the respective projects, where these were available.

12.393 For projects where avoidance rates differed from the most recent published guidance (i.e. as set out in **Table 12.44**); these were recalculated using the avoidance values used for the Project-alone assessment (**Table 12.44**). In addition, the 70% macro-avoidance rate for gannet was applied to all projects (except Mona and Morgan Offshore Wind Projects, where macro-avoidance was already applied). This approach was in accordance with Natural England advice, to improve consistency for the cumulative assessment. Values for the Mona and Morgan Offshore Wind Projects were obtained from their respective PEIR documents.

12.394 It should be noted that the cumulative collision estimates include a substantial level of precaution as consented, rather than as-built, parameters have been used for existing projects. It is thought that use of consented OWF parameters will result in an overestimation of collision rates by up to 40% (MacArthur Green, 2017; The Crown Estate and Womble Bond Dickinson, 2021), and therefore the values presented in the following sections are therefore likely to significantly overestimate the actual collision risk.

Gannet

12.395 The estimated gannet annual collision risk is given in **Table 12.68**. The total (cumulative) number of individual gannets which could potentially suffer mortality as a consequence of collision has been estimated as 50 individuals. At the average baseline mortality rate for gannet of 0.188, the number of individuals subject to mortality from the largest BDMPS population throughout the year would be 124,435 (661,888 x 0.188). The addition of a maximum of 50 individuals to this increased the mortality rate by 0.04%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the year-round impact magnitude has been assessed as **negligible**. As the species is of **medium** sensitivity to collision risk, the effect significance would be **minor adverse** and not significant in EIA terms.

12.396 Six historic projects have been identified where no quantitative collision mortality data were available; refer to **Table 12.68**. It was considered very unlikely that these projects would affect the conclusions of the cumulative assessment. In order to exceed 1% increase in background mortality (i.e. the level at which a significant increase in mortality was considered possible), annual mortality of approximately 1,180 additional birds would be required. Given the low levels of mortality that have been predicted for projects where such data was provided (i.e. fewer than 10 birds in almost all cases, assuming 70% macro-avoidance), it is inconceivable that the contribution of these projects would approach anything close to this mortality level.

12.397 It is noted that during consultation, RSPB stated that it did not accept the 70% macro-avoidance applied to the gannet CRM (refer to **Table 12.1**). For comparison, this macro-avoidance rate has been removed from the cumulative collision mortality estimates presented in **Table 12.68**. This results in a cumulative mortality total for collision of approximately 165 birds. Based on the assumptions above, this would result in an increase in annual mortality within the BDMPS population of 0.13%. This would not affect the conclusion above, i.e. the impact magnitude assessed as **negligible**, with the effect significance of **minor adverse**, which is not significant in EIA terms.

Table 12.68 Gannet cumulative mortality from collision risk during operation and maintenance

Project	Annual mortality	Annual mortality excluding 70% macro-avoidance
Awel y Môr OWF	3.91	13.04
Burbo Bank OWF	Not assessed	-
Burbo Bank Extension OWF	3.57	11.90
Erebus OWF	1.34	4.46
Gwynt y Môr OWF	‘Low’ significance	-
Holyhead Deep (tidal energy)	0.01	0.01
Morlais / West Anglesey (tidal)	1	1
Mona OWF	2.47	8.23

Project	Annual mortality	Annual mortality excluding 70% macro-avoidance
Morgan OWF Generation Assets	2.15	7.17
Ormonde OWF	2.00	6.67
Rhyl Flats OWF	'Negligible' significance	-
Robin Rigg OWF	'Low/negligible' significance	-
TwinHub OWF	7.62	25.39
Walney 1 & 2 OWF	'Low' significance	-
Walney 3 & 4 / Extension OWF	9.85	32.84
West of Duddon Sands OWF	'Low'	-
West of Orkney OWF	14.24	47.47
White Cross OWF	0.64	2.14
Total excluding the Project	**48.80**	**160.32**
The Project	**1.26**	**4.20**
Total (all projects)	**50.06**	**164.52**

Little gull

12.398 The estimated little gull annual collision risk is given in **Table 12.69**. The total (cumulative) number of individual little gulls which could potentially suffer mortality as a consequence of collision was unchanged from the Project-alone value i.e. 2.92 individuals. At the average baseline mortality rate of 0.2, the number of individuals subject to mortality from the largest regional population throughout the year would be 1,140 (5,700[14] x 0.2). The addition of a maximum of three individuals to this increased the mortality rate by 0.26%.

12.399 It was noted that all projects, except the Project, have presented no mortality data for this species. This reflects the relative scarcity of little gulls in the Irish and Celtic Sea and wider area. All windfarm array areas are or would be located outside of the area for which the Liverpool Bay SPA extension for little gull was designated. It was therefore concluded that the lack of data for other projects reflected the true situation, i.e. that few (and in many cases no) little

[14] *Note: As there is no agreed BDMPS or biogeographic population value for little gull, a predicted estimate of increase in background mortality has been made against the minimum EU wintering population (European Commission, 2022).

gulls would regularly occur at the project sites and that very low levels of additional mortality have the potential to occur.

12.400 The magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, the year-round impact magnitude has been assessed as **negligible**. As the species is of **medium sensitivity** to collision risk, the effect significance would be **minor adverse** and not significant in EIA terms.

Table 12.69 Little gull cumulative mortality from collision risk during operation and maintenance

Project	Annual mortality
Awel y Môr OWF	-
Burbo Bank OWF	-
Burbo Bank Extension OWF	-
Erebus OWF	-
Gwynt y Môr OWF	-
Holyhead Deep (tidal energy)	-
Morlais / West Anglesey (tidal energy)	-
Mona OWF	-
Morgan OWF Generation Assets	-
Ormonde OWF	-
Rhyl Flats OWF	-
Robin Rigg OWF	-
TwinHub OWF	-
Walney 1 & 2 OWF	-
Walney 3 & 4 / Extension OWF	-
West of Duddon Sands OWF	-
West of Orkney OWF	-
White Cross OWF	-
Total excluding the Project	**0**
The Project	**2.92**
Total (all projects)	**2.92**

Kittiwake

12.401 The estimated kittiwake annual collision risk is given in **Table 12.70**. The total (cumulative) number of individual kittiwakes that could potentially suffer mortality as a consequence of collision has been estimated as 563 individuals. At the average baseline mortality rate for kittiwake of 0.157, the number of individuals subject to mortality from the largest BDMPS population throughout the year would be 143,119 (911,586 x 0.157). The addition of a maximum of 563 individuals to this increased the mortality rate by 0.39%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable.

12.402 Six historic projects have been identified where no quantitative collision mortality data were available; refer to **Table 12.70**. It was considered very unlikely that these projects would affect the conclusions of the cumulative assessment. In order to exceed 1% increase in background mortality (i.e. the level at which a significant increase in mortality was considered possible), mortality of approximately 868 additional birds would be required. This would require average mortality of in excess of 140 birds for each of the six projects, which is higher than any existing project for which collision data were available. It is therefore extremely unlikely that the contribution of these projects would approach anything close to this mortality level.

12.403 The year-round impact magnitude has therefore been assessed as **negligible**. As the species is of **medium sensitivity** to collision risk, the effect significance would be **minor adverse** and not significant in EIA terms.

Table 12.70 Kittiwake cumulative mortality from collision risk during operation and maintenance

Project	Annual mortality
Awel y Môr OWF	34.27
Burbo Bank OWF	Not assessed
Burbo Bank Extension OWF	22.40
Erebus OWF	36.60
Gwynt y Môr OWF	‘Negligible’ significance
Holyhead Deep (tidal energy)*	0
Morlais / West Anglesey (tidal energy)*	0
Mona OWF	37.05
Morgan OWF Generation Assets	39.81
Ormonde OWF	2.16
Rampion OWF	77.32

Project	Annual mortality
Rampion 2 OWF	94.56
Rhyl Flats OWF	'Negligible' significance
Robin Rigg OWF	'Low/negligible' significance
TwinHub OWF	9.48
Walney 1 & 2 OWF	'Negligible' significance
Walney 3 & 4 / Extension OWF	117.03
West of Duddon Sands OWF	'Negligible' significance
West of Orkney OWF	52.98
White Cross OWF	13.66
Total excluding the Project	**537.32**
The Project	**25.45**
Total (all projects)	**562.77**

*underwater collision

Common gull

12.404 The estimated common gull annual collision risk is given in **Table 12.71**. The total (cumulative) number of individual common gulls which could potentially suffer mortality as a consequence of collision has been estimated as 2.59 individuals. At the average baseline mortality rate for common gull of 0.259, the number of individuals subject to mortality from the largest regional population throughout the year would be 3,376 (13,036 x 0.259). The addition of a maximum of three individuals to this increased the mortality rate by 0.09%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable.

12.405 It is noted that the majority of cumulative projects have presented no mortality data for this species. This reflects the relative scarcity of common gulls in the Irish and Celtic Sea and wider area. It was therefore concluded that the lack of data for other projects reflected the true situation, i.e. that few (and in many cases no) common gulls would regularly occur at the project sites and that very low levels of additional mortality have the potential to occur.

12.406 The year-round impact magnitude has therefore been assessed as **negligible**. As the species is of **medium sensitivity** to collision risk, the effect significance would be **minor adverse** and not significant in EIA terms.

Table 12.71 Common gull cumulative mortality from collision risk during operation and maintenance

Project	Annual mortality
Awel y Môr OWF	0.2
Burbo Bank OWF	-
Burbo Bank Extension OWF	-
Erebus OWF	-
Gwynt y Môr OWF	-
Holyhead Deep (tidal energy)*	-
Morlais / West Anglesey (tidal energy)*	-
Mona OWF	-
Morgan OWF Generation Assets	-
Ormonde OWF	-
Rhyl Flats OWF	-
Robin Rigg OWF	-
TwinHub OWF	-
Walney 1 & 2 OWF	-
Walney 3 & 4 / Extension OWF	-
West of Duddon Sands OWF	-
West of Orkney OWF	-
White Cross OWF	-
Total excluding the Project	**0.2**
The Project	**2.39**
Total (all projects)	**2.59**

*underwater collision

Herring gull

12.407 The estimated herring gull annual collision risk is given in **Table 12.72**. The total (cumulative) number of individual herring gulls which could potentially suffer mortality as a consequence of collision has been estimated as 161 individuals. At the average baseline mortality rate for herring gull of 0.172, the number of individuals subject to mortality from the largest BDMPS population throughout the year would be 37,353 (217,167 x 0.172). The addition of 161 individuals to this increased the mortality rate by 0.43%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable.

12.408 Six historic OWF projects have been identified where no quantitative collision mortality data were available; refer to **Table 12.72**. It was considered very unlikely that these projects would affect the conclusions of the cumulative assessment. In order to exceed 1% increase in background mortality (i.e. the level at which a significant increase in mortality was considered possible), mortality of approximately 213 additional birds would be required. This would require average mortality of in excess of 35 birds for each of the six projects, which is higher than all but one existing project for which collision data were available, and significantly greater than the average across these projects (approximately 13 birds/project). It is therefore unlikely that the contribution of these projects would approach this mortality level.

12.409 The year-round impact magnitude has therefore been assessed as **negligible**. As the species is of **high** sensitivity to collision risk, the effect significance would be **minor adverse** and not significant in EIA terms.

Table 12.72 Herring gull cumulative mortality from collision risk during operation and maintenance

Project	Annual mortality
Awel y Môr OWF	1.79
Burbo Bank OWF	Not assessed
Burbo Bank Extension OWF	28.50
Erebus OWF	4.52
Gwynt y Môr OWF	'Low' significance
Holyhead Deep (tidal energy)*	0
Morlais / West Anglesey (tidal energy)*	0
Mona OWF	2.00
Morgan OWF Generation Assets	11.81
Ormonde OWF	0.43
Rhyl Flats OWF	'Negligible' significance
Robin Rigg OWF	'Low/negligible' significance
TwinHub OWF	33.00
Walney 1 & 2 OWF	'Negligible' significance
Walney 3 & 4 / Extension OWF	74.40
West of Duddon Sands OWF	'Negligible' significance

Project	Annual mortality
West of Orkney OWF	0
White Cross OWF	0.33
Total excluding the Project	**156.79**
The Project	**4.15**
Total (all projects)	**160.94**

*underwater collision

Lesser black-backed gull

12.410 The estimated lesser black-backed gull annual collision risk is given in **Table 12.73**. The total (cumulative) number of individual lesser black-backed gulls which could potentially suffer mortality as a consequence of collision has been estimated as 279 individuals. At the average baseline mortality rate for lesser black-backed gull of 0.124, the number of individuals subject to mortality from the largest BDMPS population throughout the year would be 29,853 (240,750 x 0.124). The addition of 279 individuals to this increased the mortality rate by 0.93%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable.

12.411 It is noted that for one historic project (Robin Rigg OWF) no quantitative collision mortality data have been presented. It seems likely that this reflects the low numbers of lesser black-backed gulls present at this site, as a qualitative assessment of 'low/negligible' effect significance was made. In order to exceed 1% increase in background mortality (i.e. the level at which a significant increase in mortality was considered possible), an annual mortality of approximately 22 additional birds would be required for this project. This would be above the average across all projects for which data were available (approximately 15 birds), and given the relatively small scale of Robin Rigg OWF, it is unlikely that such a threshold would be met.

12.412 The year-round impact magnitude has therefore been assessed as **negligible**. As the species is of **high** sensitivity to collision risk, the effect significance would be **minor adverse** and not significant in EIA terms.

Table 12.73 Lesser black-backed gull cumulative mortality from collision risk during operation and maintenance

Project	Annual mortality
Awel y Môr OWF	0
Burbo Bank OWF	2.40
Burbo Bank Extension OWF	52.80
Erebus OWF	8.08
Gwynt y Môr OWF	6
Holyhead Deep (tidal energy)	0
Morlais (tidal energy)	0
Mona OWF	1.89
Morgan OWF Generation Assets	0.99
Ormonde OWF	26.52
Rhyl Flats OWF	1.20
Robin Rigg OWF	'Low/negligible' significance
TwinHub OWF	8.16
Walney 1 & 2 OWF	68.64
Walney 3 & 4 / Extension OWF	35.16
West of Duddon Sands OWF	62.88
West of Orkney OWF	0
White Cross OWF	0.36
Total excluding the Project	**275.07**
The Project	**3.57**
Total (all projects)	**278.64**

*underwater collision

Great black-backed gull

12.413 The estimated great black-backed gull annual collision risk is given in **Table 12.74**. The total (cumulative) number of individual great black-backed gulls which could potentially suffer mortality as a consequence of collision has been estimated as 117.09 individuals per annum. The relevant population against which the potential impact has been assessed is the largest seasonal population of the UK South-west & Channel BDMPS; 44,753. This is the sum of adult and immature population estimates for all colonies within the BDMPS, calculated using data presented in Table 46 of Furness (2015) and following Natural England (2023) advice. At the average baseline annual mortality rate for great black-backed gull of 0.093 (determined based on data presented in Horswill and Robinson (2015) and proportions of modelled populations from Furness (2015); see **Table 12.17**), the number of individuals subject to mortality from the largest BDMPS population throughout the year would be 4,162 (44,753 x 0.093). The addition of 117 individuals to this increased the mortality rate by 2.81%. In relation to the biogeographic population with connectivity to UK waters (235,000; Furness 2015), the number of individuals subject to mortality annually would be 21,855 (235,000 x 0.093). The addition of 117 individuals would increase mortality by 0.54%. This magnitude of increase in mortality would be above the threshold where such an effect may be considered significant (i.e. >1%) in respect of the BDMPS population, but would not be significant (<1%) in terms of the biogeographic population.

12.414 Within the geographical area from which there was considered to be a risk of cumulative effects on the BDMPS population, seven historic projects have been identified where no quantitative great black-backed gull collision mortality data were available; refer to **Table 12.74**. Whilst inclusion of these projects would probably increase the background mortality rate of the BDMPS population above 2.81%, it was considered unlikely it would exceed 1% of the biogeographic population as this would require mortality of an additional 102 birds per year across the seven projects. This equates to an average mortality of approximately 14.5 birds per project, whereas the average mortality across OWF projects where quantitative data was available was fewer than 10 birds (**Table 12.74**). Five of the seven historic projects predicted ‘low’ or ‘negligible’ impact significance on great black-backed gull. Although great black-backed gull was recorded at Burbo Bank and Burbo Bank Extension OWFs, this species was not assessed for these projects, however given their location and proximity to Awel y Môr and Gwynt y Môr OWFs which predicted 5.88 collisions per annum and ‘low’ significance mortality respectively (see **Table 12.74**), it was considered unlikely that the predicted annual collision mortality would exceed an average of 10 birds per project. On this basis, the increase in background mortality from all projects would continue to be not significant (<1%) in terms of the biogeographic population.

12.415 A PVA was undertaken for great black-backed gull. This predicted that the cumulative collision impact from OWFs (117 individuals per annum) would reduce the annual growth rate of the largest seasonal BDMPS population (44,753) by 0.32%, and result in a 10.78% decrease in population size relative to the unimpacted population by the end of the 35-year model run. The PVA also predicted a positive growth rate for the BDMPS population of 1.0233 at the identified level of impact, compared with 1.0265 with the unimpacted population. A summary of the PVA outputs is provided in **Table 12.75**. This confirms that the Project would make negligible difference to the outputs of the PVA, with the reduction in growth rate predicted to be 0.31%, and reduction in population size at the end of the 35-year period 10.64%, for all cumulative projects excluding the Project. Further details are provided in **Appendix 12.1**. Given the predicted 'low' or 'negligible' predicted effect from historic projects where quantitative data was unavailable (as described above), it was considered unlikely that these projects would significantly affect the conclusions of the PVA.

12.416 Based on the available data, it was considered likely that the great black-backed gull cumulative mortality from collision risk would represent a **low magnitude negative impact**. As the species is of **high sensitivity** to collision risk, the effect significance would be **moderate adverse** and significant in EIA terms. It is noted that the Project has provided mitigation that has reduced collision risk to this species (i.e. through increased air gap to 25m above HAT), and also the very small contribution of the Project (less than 1.5% of total predicted mortality) to the cumulative effect. It is unlikely that the contribution of the Project would make any measurable difference to the assessment outcome, or that the contribution of the Project could be significantly reduced by additional mitigation (even if that was possible) that the Project could deliver.

Table 12.74 Great black-backed gull cumulative mortality from collision risk during operation and maintenance

Project	Annual mortality
Awel y Môr OWF	5.88
Burbo Bank OWF	Not assessed
Burbo Bank Extension OWF	Not assessed
Erebus OWF	0.80
Gwynt y Môr OWF	'Low' significance
Holyhead Deep (tidal energy)*	0
Morlais (tidal energy)	0
Mona OWF	7.41

Project	Annual mortality
Morgan OWF Generation Assets	2.10
Ormonde OWF	0.29
Rampion OWF	24.00
Rampion 2 OWF	19.80
Rhyl Flats OWF	‘Negligible’ significance
Robin Rigg OWF	‘Low/negligible’ significance
TwinHub OWF	15.60
Walney 1 & 2 OWF	‘Negligible’ significance
Walney 3 & 4 / Extension OWF	25.44
West of Duddon Sands OWF	‘Negligible’ significance
West of Orkney OWF	13.18
White Cross OWF	0.84
Total excluding the Project	**115.34**
The Project	**1.75**
Total (all projects)	**117.09**

*underwater collision

Table 12.75 Great black-backed gull PVA summary for cumulative mortality from collision risk during operation and maintenance

Scenario	Predicted mortality	Growth rate	Mean CPGR	Mean CPS	Reduction in growth rate	Reduction in population size
Baseline (unimpacted)	0	1.0265	1.0000	1.0000	n/a	n/a
Cumulative collision mortality (Including the Project)	117.09	1.0233	0.9968	0.8922	0.32%	10.78%
Cumulative collision mortality (Excluding the Project)	115.34	1.0233	0.9969	0.8936	0.31%	10.64%

Cumulative assessment of operational collision risk and displacement

Gannet

12.417 As a species which has been scoped in for collision and displacement impacts from offshore windfarms, it is possible that the impacts of cumulative collision risk and cumulative displacement could combine to adversely affect gannet populations. Obviously, they would not act on the same individuals, as birds which do not enter a windfarm cannot be subject to mortality from collision, and vice versa. Avoidance rates for offshore windfarms used in collision risk monitoring take account of macro-avoidance (where birds avoid entering a windfarm), meso-avoidance (avoidance of the rotor swept zone within a windfarm), and micro-avoidance (avoiding wind turbine blades). Thus, birds which exhibit macro-avoidance could be subject to mortality from displacement.

12.418 As set out above (**Table 12.68**), the estimated cumulative annual total for gannet collision mortality was either 50 individuals with the 70% macro-avoidance correction, or 165 individuals without the 70% macro-avoidance correction. The estimated cumulative total for gannet displacement was 47-62 birds (**Table 12.59**).

12.419 At the average baseline mortality rate for gannet of 0.188, the number of individuals subject to mortality from the largest BDMPS population throughout the year would be 124,435 (661,888 x 0.188). The addition of a maximum of 112 individuals to this increased the mortality rate by 0.09% with the 70% macro-avoidance correction, and the addition of a maximum of 227 individuals to this increased the mortality rate by 0.18% without the 70% macro-avoidance correction.

12.420 These magnitudes of increase in mortality would not materially alter the background mortality of the population and would be undetectable. When considered cumulatively, therefore, the impact magnitude has been assessed as **negligible**. As the species is of **medium** sensitivity, the effect significance would be **minor adverse** and not significant in EIA terms. These conclusions would not be affected by the contribution of historic projects for which quantitative data was not available, for the reasons set out in the respective cumulative assessments for this species.

12.7.4 Potential cumulative effects on designated sites

12.421 This section considers potential cumulative effects of the Project on statutory designated sites where birds have been listed as qualifying or notified features. Sites which may have connectivity to the windfarm site include those designated for breeding and non-breeding seabird populations. In addition, sites designated for terrestrial/coastal/marine ornithological interests (typically overwintering waterbird aggregations) may also be relevant, particularly where bird populations from these sites have the potential to pass through the windfarm site on migration. Effects on SPAs and Ramsar sites have been reported separately in the RIAA, and have not, therefore, been included within this section.

12.422 The Project may impact SSSIs with terrestrial/coastal/marine ornithological interests. The SSSIs that were considered most likely to have potential connectivity to the Project (based on published seabird foraging ranges) are listed in **Table 12.76** along with the bird species/assemblages that are notified/special features. Features of Isle of Man Marine Nature Reserves have been considered in **Section 12.8**.

Table 12.76 SSSIs and relevant notified features considered in the assessment

SSSI	Approximate distance from windfarm site	Relevant species (notified feature)
Pen y Gogarth / Great Orme's Head SSSI	52km	Kittiwake, guillemot, razorbill
Creigiau Rhiwledyn / Little Ormes Head SSSI	52km	Kittiwake, guillemot, razorbill
Puffin Island SSSI	59km	Kittiwake, herring gull, lesser black-backed gull, great black-backed gull, guillemot, razorbill
St. Bees Head SSSI	75km	Kittiwake, guillemot, razorbill
The Skerries SSSI	78km	Herring gull, lesser black-backed gull
Abbey Burn Foot to Balcary Point SSSI	115km	Kittiwake, guillemot, razorbill
Scare Rocks SSSI	122km	Gannet
Mull of Galloway SSSI	124km	Kittiwake, razorbill
Sanda Islands SSSI	210km	Manx shearwater, kittiwake
Lundy SSSI	295km	Manx shearwater
Treshnish Isles SSSI	346km	Manx shearwater
Canna and Sanday SSSI	407km	Manx shearwater
Annet SSSI	466km	Manx shearwater

12.423 The assessment of potential impacts on the relevant seabird species listed in **Table 12.76** are described in **Sections 12.6.2 – 12.6.4** (Project-alone) and **12.7.3** (cumulative). For all species, adverse impacts (i.e. predicted increases in mortality) were assessed as being of **negligible** magnitude in comparison to the regional population (in most cases the largest BDMPS) except for great black-backed gull (cumulative collision risk - **low magnitude negative** impact).

12.424 While no detailed apportionment of seabirds to SSSIs has been carried out, the relative distance of the SSSIs from the windfarm site, and small population sizes relative to the reference regional populations, will mean that mortality apportioned to each SSSI is expected to be roughly proportionate to regional estimates presented in **Sections 12.6.2 – 12.6.4** and **12.7.3**. In other words, percentage increases in background mortality for each species would be similar (or less) than those estimated for regional populations. On this basis, it has been predicted that impacts on individual SSSIs would also be of **negligible** magnitude except for Puffin Island SSSI, for which there is the risk of a **low magnitude negative** impact on great black-backed gull. As a worst-case scenario, for SSSIs supporting species with high sensitivity to collision or disturbance, the effect significance would be **minor adverse** and not significant in EIA terms except for Puffin Island SSSI, for which the worst-case scenario would be **moderate adverse** for great black-backed gull and significant in EIA terms. As noted in the cumulative assessment for great black-backed gull in **Section 12.7.3.2**, the unapportioned contribution of the Project to great black-backed gull mortality was very small (1.75 birds per annum and less that 1.5% of the total). Accordingly, the predicted mortality apportioned to Puffin Island SSSI would be much less than one bird per annum, and inconsequential. It is also noted that the Project has provided mitigation to minimise collision risk (i.e. increase of air gap to 25m above HAT), and that, as the contribution of the Project would be so small, there would be no potential for additional Project mitigation (even if this was possible) to make a measurable difference to the assessment conclusion.

12.8 Transboundary effects

12.425 There is the potential that Project collisions and displacement could affect seabird populations and designated sites with ornithological interest in other countries and territories. There is also the potential that cumulative transboundary effects could arise from collisions and displacement at offshore windfarms outside UK territorial waters, although no such projects (where quantitative data were available) were identified (**Table 12.54**). Such impacts were most likely to be associated with the Isle of Man (noting the IoM is not an EEA state but a self-governing British Crown Dependency and not a formal transboundary consultee) and RoI; significant transboundary effects in relation to other countries and territories were considered unlikely. Effects on transboundary SPAs/Ramsar sites are considered separately within the RIAA.

12.8.1 Isle of Man

12.426 The Isle of Man supports a number of significant seabird breeding colonies, including Calf of Man, Peel Hill and Sugar Loaf. A comprehensive census of seabirds on the Isle of Man was undertaken in 2017-18, the results of which indicated that while some species such as guillemot and cormorant have increased, the majority of species have experienced declines since the previous census in 1999 in common with populations elsewhere across the British Isles (Hill *et al*., 2019; refer to **Table 12.77**). Disturbance at colonies, mammalian predation and climate change have been suggested as contributing factors in these declines.

Table 12.77 Overview of Isle of Man seabird census 2017-18 results (Hill et al., 2019)

Species	Count unit	Count 1985-86	Count 1999	Count 2017	Change 1985-86 to 2017	Change 1999 to 2017
Fulmar	Apparently occupied sites (AOS)	2,328	3,143	1,095	-53%	-65%
Manx shearwater	AOS	0	0	c.400	n/a	n/a
Storm petrel	AOS	0	0	0	n/a	n/a
Cormorant	Apparently occupied nests (AON)	Max. 54	134	251	+374%	+87%
Shag	AON	Max. 664	912	Max. 446	-33%	-51%
Black-headed gull	AON	74	2	6	-92%	+200%
Common gull	AON	0	3	Max. 5	n/a	+33%
Lesser black-backed gull	AON	Max. 105	114	36	-66%	-68%
Herring gull	AON	Max. 9,871	7,127	1,251	-87%	-82%
Great black-backed gull	AON	380	396	85	-78%	-79%
Kittiwake	AON	1,257	1,045	685	-46%	-34%
Arctic tern[15]	AON	13	Max. 10	56	+331%	+460%

[15] Arctic Tern is increasing due to recruitment from other colonies as the productivity of the Isle of Man population is too low to sustain itself. A 331%/460% increase gives a false impression of the productivity of the colony (Louse Samson pers. comm., in Hill *et al*., 2019).

Species	Count unit	Count 1985-86	Count 1999	Count 2017	Change 1985-86 to 2017	Change 1999 to 2017
Little tern	AON	Max. 60	20	26	-57%	+30%
Guillemot	Birds	2,092	4,010	5,217	+149%	+30%
Razorbill	Birds	814	1,524	682	-16%	-55%
Black guillemot	Birds	261	602	211	-19%	-65%
Puffin	AOB	Min. 50	-	8	-84%	n/a

12.427 The Calf of Man, located 79.9km from the windfarm site, is of particular importance for its breeding colony of Manx shearwater. In 2022 the population was estimated at between 1,000 and 1,200 pairs; this followed a gradual increase in the total estimated population between 2018-2021 (Manx Wildlife Trust, pers. comm.). The Calf of Man has been an international priority for removal of invasive predators to restore the Manx Shearwater population (Ratcliffe et al. 2009). Baiting and trapping of the brown rat population on the Calf of Man has been undertaken; this was not the case on the mainland Isle of Man (Hill et al., 2019). Other breeding seabirds on the Calf of Man include guillemot (106 pairs in 2022), razorbill (92 pairs in 2022), herring gull (588 AON (apparently occupied nests) in 2022), lesser black-backed gull (38 AON in 2022) and great black-backed gull (66 AON in 2022; Manx Wildlife Trust, pers. comm).

12.428 The majority of other seabird colonies on the Isle of Man have been designated as nature conservation sites. As of April 2023, the Isle of Man had 25 Areas of Special Scientific Interest (ASSIs), one National Nature Reserve (NNR), 10 Marine Nature Reserves (MNRs), one Area of Special Protection and five Bird Sanctuaries. Those designated sites for which there would be potential for transboundary impacts based on their bird populations and potential connectivity to the Project are listed in **Table 12.78** below. There was also one Ramsar site, Ballaugh Curragh, which has been considered separately in the RIAA.

Table 12.78 Isle of Man designated sites with potential for transboundary impacts

Designated site	Approximate distance from windfarm site	Relevant ornithological reasons for notification (i.e. with potential connectivity to the Project)
Baie ny Carrickey MNR	76km	Breeding kittiwake, guillemot, razorbill and puffin.
Ballagh Curragh ASSI	84km	Wintering (roosting) hen harrier.
Calf and Wart Bank MNR	80km	Breeding Manx shearwater.

Designated site	Approximate distance from windfarm site	Relevant ornithological reasons for notification (i.e. with potential connectivity to the Project)
Central Ayres ASSI / The Ayres NNR	86km	Intertidal and coastal habitats supporting a range of foraging species including gannet, guillemot, razorbill, terns, divers and waders.
Cronk y Bing ASSI	88km	Coastal species including curlew and oystercatcher.
Dalby Coast ASSI	86km	Breeding fulmar and great black-backed gull.
Dhoon Glen ASSI	71km	Breeding fulmar and herring gull.
Glen Maye ASSI	86km	Breeding fulmar, herring gull and great black-backed gull.
Langness, Sandwich and Derbyhaven ASSI, MNR and Bird Sanctuary	74km	Wintering and migrant waders and waterfowl including teal, wigeon, shelduck, redshank, lapwing, ringed plover and oystercatcher.
Marine Drive ASSI	70km	Breeding fulmar, herring gull and great black-backed gull.
Maughold Cliffs & Brooghs ASSI	73km	Breeding fulmar, kittiwake, guillemot, razorbill and puffin.
Port St Mary Ledges & Kallow Point ASSI	82km	Breeding herring gull.
Poyll Vaaish Coast ASSI	78km	Coastal species including curlew, lapwing, golden plover, whooper swan, plus hen harrier.
West Coast MNR	85km	Breeding fulmar, kittiwake, guillemot, razorbill and puffin.

12.429 The assessment of potential impacts on the relevant seabird species listed in **Table 12.77** are described in **Sections 12.6.2** to **12.6.4 and 12.7.3**. For all species, adverse impacts (i.e. predicted increases in mortality) were assessed as being of **negligible** magnitude in comparison to the regional population (in most cases the largest BDMPS), with the exception of great black-backed gull (cumulative collision risk - **low magnitude negative** impact).

12.430 While no detailed apportionment of seabirds to Isle of Man populations or designated sites has been carried out, adverse impacts would be split proportionately between the Isle of Man populations and designated sites in approximate proportion to their respective contributions to the regional BDMPS population. On this basis, it has been predicted that impacts on Isle of Man populations and designated sites would also be of **negligible** magnitude except for Dalby Coast ASSI, Glen May ASSI and Marine Drive ASSI, for which there is the risk of a **low magnitude negative** impact on great black-backed gull. As a worst-case scenario for species with high sensitivity to collision or disturbance, the effect significance would be **minor adverse** and not significant in EIA terms except for Dalby Coast ASSI, Glen May ASSI and Marine Drive ASSI, for which the worst-case scenario would be **moderate adverse** for great black-backed gull and significant in EIA terms. As noted in the cumulative assessment for great black-backed gull in **Section 12.7.3.2**, the unapportioned contribution of the Project to great black-backed gull mortality was very small (1.75 birds per annum and less that 1.5% of the total). Accordingly, the predicted mortality apportioned to the Isle of Man ASSIs would be much less than one bird per annum, and inconsequential. It is also noted that the Project has provided mitigation to minimise collision risk (i.e. increase of air gap to 25m above HAT), and that, as the contribution of the Project would be so small, there would be no potential for additional Project mitigation (even if this was possible) to make a measurable difference to the assessment conclusion.

12.8.2 Republic of Ireland

12.431 Many of the largest and most important seabird colonies in the RoI have been designated as SPAs. Those with potential connectivity to the project have been considered in the RIAA.

12.432 Due to the distance between the Project and the RoI, any transboundary impacts during the breeding season would be limited to species with large foraging ranges, such as gannet and Manx shearwater. While no detailed apportionment of seabirds to (non-SPA) RoI populations or designated sites has been carried out, adverse impacts would be split proportionately between the RoI populations in approximate proportion to their respective contributions to the regional BDMPS population. On this basis, it is predicted that transboundary effects on RoI seabird populations and designated sites would also be of **negligible** magnitude except for great black-backed gull (cumulative collision risk - **low magnitude negative** impact). As a worst-case scenario, for species with high sensitivity to collision and disturbance, the transboundary effect significance would be **minor adverse** and not significant in EIA terms except for great black-backed gull, for which the worst-case scenario would be **moderate adverse** and significant in EIA terms. As noted in the cumulative assessment for great black-backed gull in **Section 12.7.3.2**, the unapportioned contribution of the Project to great black-backed gull mortality was very small (1.75 birds per annum and less that 1.5% of the total). Accordingly, the predicted mortality apportioned to the RoI populations would be much less than one bird per annum, and inconsequential. It is also noted that the Project has provided mitigation to minimise collision risk (i.e. increase of air gap to 25m above HAT), and that, as the contribution of the Project would be so small, there would be no potential for additional Project mitigation (even if this was possible) to make a measurable difference to the assessment conclusion.

12.9 Inter-relationships

12.433 There were clear inter-relationships between the ornithology topic and several other topics that have been considered within this ES. **Table 12.79** provides a summary of the principal inter-relationships and signposts to where those issues have been addressed in the relevant chapters.

Table 12.79 Ornithology inter-relationships

Impact	Related chapter	Where addressed in this chapter	Rationale
Construction phase			
Indirect impacts through effects on habitats and prey during construction	**Chapter 9 Benthic Ecology** and **Chapter 10 Fish and Shellfish Ecology**	**Section 12.6.2.2**	Potential impacts on benthic ecology and fish and shellfish during construction could affect the prey resource for birds.
Operation and maintenance phase			
Indirect impacts through effects on habitats and prey during operation and maintenance	**Chapter 9 Benthic Ecology** and **Chapter 10 Fish and Shellfish Ecology**	**Section 12.6.3.4**	Potential impacts on benthic ecology and fish and shellfish during operation and maintenance could affect the prey resource for birds.
Decommissioning phase			
Indirect impacts through effects on habitats and prey during decommissioning	**Chapter 9 Benthic Ecology** and **Chapter 10 Fish and Shellfish Ecology**	**Section 12.6.4.2**	Potential impacts on benthic ecology and fish and shellfish during decommissioning could affect the prey resource for birds.

12.10 Interactions

12.434 The impacts identified and assessed in this chapter have the potential to interact with each other. The areas of potential interaction between impacts are presented in **Table 12.80** (for construction and decommissioning phases) and **Table 12.81** (for operation and maintenance phase). This provides a screening tool for which impacts have the potential to interact. The impacts have been assessed relative to each development phase (i.e. construction, operation and maintenance or decommissioning) to see if (for example) multiple construction impacts affecting the same receptor could increase the level of impact upon that receptor.

12.435 Following this, a lifetime assessment has been undertaken, which considered the impact interactions identified, as well as effects on receptors across all development phases (**Table 12.82**).

Table 12.80 Interaction between impacts – screening (construction and decommissioning phases)

	Potential interaction between construction phase impacts	
	Impact 1: Disturbance and displacement from construction activity	Impact 2: Indirect effects through impacts on habitats and prey species
Impact 1: Disturbance and displacement from construction activity		Yes, possible medium to long term effects on birds, but spatial magnitude very small
Impact 2: Indirect effects through impacts on habitats and prey species	Yes, possible medium to long term effects on birds, but spatial magnitude very small	
	Potential interaction between decommissioning phase impacts	
	It is anticipated that the decommissioning impacts would be similar in nature to those of construction.	

Table 12.81 Interaction between impacts – screening (operation and maintenance phase)

	Potential interaction between operation and maintenance phase impacts		
	Impact 1: Disturbance, displacement and barrier effects	Impact 2: Collision risk	Impact 4: Indirect effects through impacts on habitats and prey species
Impact 1: Disturbance, displacement and barrier effects		No (birds that were displaced would not be at risk of collision)	No (direct displacement of birds overrides prey effects)
Impact 2: Collision risk	No (birds that were displaced would not be at risk of collision)		No (collision mortality overrides prey effects)
Impact 4: Indirect effects through impacts on habitats and prey species	No (direct displacement of birds overrides prey effects)	No (collision mortality overrides prey effects)	

Table 12.82 Interaction between effects – phase and lifetime assessment

Receptor	Highest significance of effect level				
	Construction	**Operation**	**Decommissioning**	**Phase assessment**	**Lifetime assessment**
Common scoter, red-throated diver, razorbill and guillemot (displacement) All species (impacts to habitats and prey species)	Minor adverse	Minor adverse	Minor adverse	**No greater than individually assessed impact.** Impact 1: Disturbance and displacement from construction (or decommissioning) /operation and maintenance activity and Impact 2: Indirect effects through impacts to habitats and prey species were assessed separately as having negligible magnitudes of impact. They have the theoretical potential to interact, however any birds displaced from the offshore development area would not be impacted by impacts upon prey species (either the birds would be displaced from the area or	**No greater than individually assessed impact.** There would be potential for disturbance and displacement due to construction (or decommissioning) /operation and maintenance activity, including the construction of wind turbines and other infrastructure and associated vessel traffic. However, construction would not occur across the whole of the windfarm site simultaneously or every day but would be phased, with activity focused on particular wind turbine, OSP or cable locations at any time. When wind turbines (and other infrastructure) have been installed onto foundations, the impact of displacement would increase incrementally to the same levels as operational impacts. Effectively therefore the construction impacts simply extend the duration of the operational impacts.

Receptor	Highest significance of effect level				
	Construction	Operation	Decommissioning	Phase assessment	Lifetime assessment
				would be affected by changes to prey within the area, but not both).	It was therefore considered that over the Project lifetime these impacts would not combine and represent an increase in the significance level.

12.11 Potential monitoring requirements

12.436 Monitoring requirements have been described in the In-Principle Monitoring Plan (IPMP) (Document Reference 6.4) submitted alongside the DCO Application and would be further developed and agreed with stakeholders prior to construction, based on the IPMP and taking account of the final detailed design of the Project.

12.437 Post-consent, the final detailed design of the Project will refine the worst-case parameters assessed in **Section 12.6**. The Applicant is supportive, in-principle, of proportionate joint industry projects or alternative site- based monitoring of existing seabird activity within the windfarm site and would consider collaboration opportunities from SNCBs, NGOs or other developers in strategic monitoring programmes. This would likely be managed outwith the IPMP.

12.438 The Project Environmental Management Plan (PEMP) (to be submitted post-consent in accordance with the Outline PEMP; Document Reference 6.2), is also relevant to offshore ornithology and would set out the Applicant's intentions for managing potential impacts on red-throated divers. The requirement for and final design and scope of measures would be agreed with the regulator and relevant stakeholders and included within the final PEMP, prior to construction works commencing.

12.12 Assessment summary

12.439 This chapter provides an assessment of the potential effects on offshore ornithology receptors that may arise from the construction, operation and maintenance and decommissioning of the Project. It describes the consultation that has occurred with stakeholders (including Natural England, RSPB and Isle of Man Government) through the ornithology ETG. This has included discussions regarding the overall approach to the impact assessment on offshore ornithology receptors. The chapter sets the scope and methodology of the assessment, and the baseline state of the study area.

12.440 The study area was surveyed using high resolution digital aerial surveys over a period of 24 months. Data from these surveys have been used to estimate the abundance and assemblage of birds using the study area.

12.441 The impacts that could potentially occur on offshore ornithology receptors during the construction, operation and maintenance and decommissioning of the Project were discussed during the ETG meetings, including with Natural England and RSPB. It was agreed that the potential impacts that required detailed assessment were:

- In the construction phase:
  - Impact 1: Disturbance and displacement from construction activity

- Impact 2: Indirect effects through impacts on habitats and prey species
- In the operation and maintenance phase:
  - Impact 1: Disturbance, displacement and barrier effects
  - Impact 2: Collision risk
  - Impact 3: Combined collision risk and displacement
  - Impact 4: Indirect effects through impacts on habitats and prey species
- In the decommissioning phase:
  - Impact 1: Disturbance and displacement from decommissioning activity
  - Impact 2: Indirect impacts through effects on habitats and prey species

12.442 The potential effects on offshore ornithology receptors have been minimised through the site selection process which located the windfarm site outside of areas designated for their importance to bird populations. In addition, the turbine minimum rotor clearance above sea level (air gap) has been raised since PEIR from 22m to 25m above HAT (approximately 35m above LAT), providing an associated reduction of potential collision risk for offshore ornithology receptors.

12.443 A summary of predicted effects on ornithology receptors is presented in **Table 12.83**. During the construction and decommissioning phases of the Project, no Project-alone effects have been assessed to be greater than minor adverse significance for any offshore ornithology receptor in any biologically relevant season. This included the more sensitive receptors screened into detailed assessment for disturbance, displacement and barrier effects during these phases i.e. common scoter, guillemot, razorbill, Manx shearwater and red-throated diver.

12.444 During the operational phase of the Project, Project-alone impacts due to disturbance, displacement and barrier effects on the more sensitive receptors screened into detailed assessment (common scoter, gannet, guillemot, razorbill, Manx shearwater and red-throated diver) would not result in effects of more than minor adverse significance during any biological season.

12.445 The risk posed to offshore ornithology receptors due to collisions with Project operational turbines has been assessed as no greater than minor adverse significance for all species recorded in flight at the windfarm site for all biologically relevant seasons. This included the species screened into detailed assessment (gannet, little gull, kittiwake, common gull, herring gull, lesser black-backed gull and great black-backed gull).

12.446 Three potential effects were screened in for cumulative assessment for the Project, namely construction and decommissioning disturbance and displacement, operational displacement and operational collision risk, as well as the combined effects of both operational impacts. Other potential effects would be temporary, small scale and localised. A screening process determined that within the offshore environment only other offshore windfarms and wave/tidal projects that were operational, under construction, consented but not constructed, subject to current applications or subject to consultation were screened in. The potential effects of 'historic' projects where no quantitative data were available were also considered, to establish whether these could affect the conclusions of the quantitative assessment.

12.447 The risk to ornithological receptors from cumulative displacement and collisions has been assessed as no greater than minor adverse significance for all species, except for great black-backed gull (collision risk – moderate adverse, noting that the contribution of the Project would be so small, there would be no potential for additional Project mitigation (even if this was possible) to make a measurable difference to the assessment conclusion). Minor adverse effects were not significant in EIA terms, while a moderate adverse effect would be considered significant.

12.448 Transboundary impacts on seabird populations and designated sites in other countries and territories were assessed. For these populations, adverse impacts would be split in approximate proportion to their respective contributions to the regional BDMPS population, and would therefore be of no more than minor adverse significance. Transboundary impacts with existing or planned OWFs in other countries and territories were considered unlikely to alter the conclusion of the existing assessment.

Table 12.83 Summary of potential effects on offshore ornithology receptors

Potential impact	Receptor	Sensitivity	Magnitude	Significance of effect	Additional mitigation measures proposed	Residual effect	Cumulative residual effect
Construction phase							
Impact 1: Disturbance and displacement from construction activity	Common scoter	High	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	As per Project-alone
	Guillemot	Medium	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	
	Razorbill	Medium	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	
	Manx shearwater	Low	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	
	Red-throated diver	High	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	

Potential impact	Receptor	Sensitivity	Magnitude	Significance of effect	Additional mitigation measures proposed	Residual effect	Cumulative residual effect
Impact 2: Indirect effects through impacts on habitats and prey species	All offshore ornithology receptors	Medium	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	As per Project-alone
Operation and maintenance phase							
Impact 1: Disturbance displacement and barrier effects	Common scoter	High	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	As per Project-alone
	Gannet	Medium	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	
	Guillemot	Medium	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	
	Razorbill	Medium	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	
	Manx shearwater	Low	Negligible	Not Significant (Negligible adverse)	None	Not Significant (Negligible adverse)	

Potential impact	Receptor	Sensitivity	Magnitude	Significance of effect	Additional mitigation measures proposed	Residual effect	Cumulative residual effect
	Red-throated diver	High	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	
Impact 2: Collision risk	Gannet	Medium	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	As per Project-alone
	Little gull	Medium	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	
	Kittiwake	Medium	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	
	Common gull	Medium	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	
	Herring gull	High	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	

Potential impact	Receptor	Sensitivity	Magnitude	Significance of effect	Additional mitigation measures proposed	Residual effect	Cumulative residual effect
	Lesser black-backed gull	High	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	
	Great black-backed gull	High	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	Significant (moderate adverse)
	Migrant bird species	Medium	No pathway	No change	None	No change	As per Project-alone
	Migrant seabirds	Medium	Negligible	Not Significant (Minor adverse)	None	As per Project-alone	
Impact 3: Combined collision risk and displacement	Gannet	Medium	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	As per Project-alone
Impact 4: Indirect effects through impacts on habitats and prey species	All offshore ornithology receptors	Medium	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	As per Project-alone

Potential impact	Receptor	Sensitivity	Magnitude	Significance of effect	Additional mitigation measures proposed	Residual effect	Cumulative residual effect
Decommissioning phase							
Impact 1: Disturbance and displacement from construction activity	Common scoter	High	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	As per Project-alone
	Guillemot	Medium	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	
	Razorbill	Medium	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	
	Manx shearwater	Low	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	
	Red-throated diver	High	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	
Impact 2: Indirect effects through impacts on habitats and prey species	All offshore ornithology receptors	Medium	Negligible	Not Significant (Minor adverse)	None	Not Significant (Minor adverse)	As per Project-alone

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