MORGAN OFFSHORE WIND PROJECT: GENERATION ASSETS

Preliminary Environmental Information Report

Volume 2, chapter 10: Offshore ornithology

Image of an offshore wind farm

April 2023

FINAL

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Glossary

Term	Meaning
Air Gap	The gap between the mean sea level and the lowest point of a turbine rotor blade.
Avoidance	Probability that a bird takes successful evasive action to avoid collision with a turbine.
Bio-season	Bird behaviour and abundance is recognised to differ across a calendar year, with particular months recognised as being part of different seasons. The biologically defined minimum population scales (BDMPS) bio-seasons used in this report are based on those in Furness (2015), hereafter referred to as bio-seasons. Separate bio-seasons are recognised in this technical report in order to establish the level of importance any seabird species has within the study area during any particular period of time.
Biologically Defined Minimum Population Scales	Seasonal subdivision of bird population size. The rationale behind these subdivisions is that the likely origin of a bird in a particular location depends on the time of year.
Bootstrapping	Bootstrapping is a statistical procedure that resamples a single dataset to create many simulated samples.
Collision risk	Risk of a bird lethally colliding with a wind turbine within a wind farm.
Collision risk model	A model that calculates collision risk for a species within a wind farm based on a set of wind farm and bird species specific parameters. Collision risk models can be run deterministically or stochastically.
Confidence Interval	A confidence interval displays the probability that a parameter will fall between a pair of values around the mean.
Design-based Abundance Estimates	An estimated total abundance of birds within a given area. The design-based method is based on the premise that the portion of the study area that is surveyed is representative of the remainder of the study area.
Deterministic model	Model where a single value for each input parameter that goes into the model is used, leading to a single output without variation.
Disturbance sensitivity	Disturbance by wind farm structures, ship and helicopter traffic factor used scores from 1 (limited escape behaviour and a very short flight distance when approached), to 5 (strong escape behaviour, at a large response distance).
Habitat specialisation	The habitat specialisation factor represents the range of habitats species are able to use and whether they use these as specialists or generalists. This score classifies species into categories from 1 (tend to forage over large marine areas with little known association with particular marine features) to 5 (tend to feed on very specific habitat features, such as shallow banks with bivalve communities, or kelp beds).
Large array correction	Adjustment to the probability of bird collision to account for the depletion of bird density in later rows of a wind farm with a large array of wind turbines.
Light Detection And Ranging (LiDAR)	A remote sensing method using pulsed lasers to measure distances to the earth.
Lowest Astronomical Tide	The lowest level of the sea surface with respect to the land.
Mean Sea Level	The average level of the sea surface with respect to the land.
MRSea	The ” Marine Renewables Strategic Environmental Assessment” statistical package for R to model spatial count data and predict spatial abundances. This package has been developed by the Centre for Research into Ecological and Environmental Modelling (CREEM) specifically for dealing with data collected for offshore wind farm projects.
Nocturnal Activity Factor	The percentage of a bird species that is considered active at night.
Ornithology	Ornithology is a branch of zoology that concerns the study of birds.
Parameter	Parameters are the input elements of a model that together affect the output of a model. In collision risk models, examples of parameters are the number of wind turbines and the length of the bird.
Significant effect	The significance of an effect is determined by considering the overall importance of the receptor and the magnitude of the effect using a matrix-based approach and applying professional judgement.
Stochastic model	Model where the input parameters that go into the model are allowed to vary, leading to a range of output.

Acronyms

Acronym	Description
BDMPS	BDMPS Biologically Defined Minimum Population Scales
BEIS	Department for Business, Energy and Industrial Strategy
BoCC	Birds of Conservation Concern
BTO	British Trust for Ornithology
CEA	Cumulative Effects Assessment
CFP	Common Fishieries Policy
CRM	Collision Risk Modelling
DCO	Development Consent Order
EIA	Environmental Impact Assessment
EWG	Expert Working Group
HRA	Habitats Regulation Assesment
JNCC	Joint Nature Conservation Committee
LAT	Lowest Astronomical Tide
MDS	Maximum Design Scenario
MLWS	Mean Low Water Springs
MRSea	Marine Renewables Strategic Environmental Assessment
NERC	Natural Environment and Research Council
NPS	National Policy Statements
NRW	Natural Resources Wales

Acronym	Description
NSIPs	Nationally Signficiant Infrastructure Projects
PEIR	Preliminary Environmental Information Report
sCRM	Stochastic Collision Risk Model
SD	Standard Deviation
SMP	Seabird Monitoring Programme
SNCB	Statutory Nature Conservation Body
SOSS-MAT	Strategic Ornithological Support Services Migration Assessment Tool
SPAs	Special Protection AreasZone
SSCs	Suspended Sediment Concentrations
UK	United Kingdom
ZOI	Zone Of Influence

Units

Unit	Description
%	Percentage
km^2	Square kilometres
km	kilometres
m	metre
MW	Megawatt

10 Offshore ornithology

10.1 Introduction

10.1.1 Overview

10.1.1.1 This chapter of the Preliminary Environmental Information Report (PEIR) presents the assessment of the potential impact of the Morgan Offshore Wind Project: Generation Assets (hereafter referred to as the Morgan Generation Assets) on offshore ornithology. Specifically, this chapter considers the potential impact of the Morgan Generation Assets during the construction, operations and maintenance, and decommissioning phases.

10.1.1.2 The assessment presented is informed by the following technical reports:

- Volume 4, annex 10.1: Offshore ornithology baseline characterisation of the PEIR
- Volume 4; annex 10.2: Offshore ornithology displacement assessment of the PEIR
- Volume 4, annex 10.3: Offshore ornithology non-migratory seabird collision risk assessment of the PEIR
- Volume 4 annex 10.4: Offshore ornithology migratory non-seabird collision risk modelling of the PEIR
- Volume 4, Annex 10.5: Offshore ornithology apportioning assessment of the PEIR
- Volume 4, Annex 10.6: Offshore ornithology population viability analysis of the PEIR.

10.1.1.3 The offshore ornithology chapter deals with any seabirds that are present at some point in their life cycle in the study areas and non-seabirds species using the study areas during migratory flights. The overarching term 'seabird' is used to refer to species that depend on the marine environment for survival at some point in their life cycle. Therefore, in addition to the true seabirds, seaducks and divers and grebes are also included because of their additional reliance on marine areas, especially in the non-breeding season.

10.1.2 Purpose of chapter

10.1.2.1 The primary purpose of the PEIR is outlined in volume 1, chapter 1: Introduction of the PEIR. In summary, the primary purpose of an Environmental Statement is to support the Development Consent Order (DCO) application for the Morgan Generation Assets under the Planning Act 2008 (the 2008 Act). The PEIR constitutes the Preliminary Environmental Information for the Morgan Generation Assets and sets out the findings of the Environmental Impact Assessment (EIA) to date to support the pre-application consultation activities required under the 2008 Act. The EIA will be finalised following completion of pre-application consultation and the Environmental Statement will accompany the application to the Secretary of State for Development Consent.

10.1.2.2 The PEIR forms the basis for statutory consultation which will last for 47 days and conclude on 4 June 2023 as outlined in volume 1, chapter 2: Policy and legislation of the PEIR. At this point, comments received on the PEIR will be reviewed and incorporated (where appropriate) into the Environmental Statement, which will be submitted in support of the application for Development Consent scheduled for quarter one of 2024.

10.1.2.3 In particular, this PEIR chapter:

- Presents the existing environmental baseline established from desk studies, site-specific surveys and consultation
- Identifies any assumptions and limitations encountered in compiling the environmental information
- Presents the potential environmental effects on offshore ornithology arising from the Morgan Generation Assets, based on the information gathered and the analysis and assessments undertaken
- Highlights any necessary monitoring and/or mitigation measures which could prevent, minimise, reduce or offset the possible environmental effects of the Morgan Generation Assets on offshore ornithology.

10.1.3 Study area

10.1.3.1 There are two study areas for the offshore ornithology assessment. These are:

- Morgan Offshore Ornithology Array Area study area: this includes the Morgan Array Area plus a 10km buffer (Figure 10.1). This area was defined by the extent of the digital aerial bird surveys
- Cumulative Morgan Offshore Ornithology study area: this was identified by consideration of the foraging ranges of seabird species recorded within the Morgan Offshore Ornithology Array Area study area. As the extent of the breeding and foraging ranges varies greatly between species (Woodward *et al*., 2019), the Zone Of Influence (ZOI) of the Morgan Generation Assets therefore varies between the species considered in the assessment. The ZOI of the Morgan Generation Assets was defined according to the species-specific foraging ranges (as compiled by Woodward *et al.,* 2019). However, the Cumulative Morgan Offshore Ornithology study area extended up to 500km around the Morgan Array Area. This is based on the approximate published mean-maximum foraging range for northern gannet (315.2±194.2km), which was chosen as a reasonable maximum extent within which cumulative effects might be likely to occur as a result of the Morgan Generation Assets. For the non-breeding season, the ZOI was defined by the relevant Biologically Defined Minimum Population Scales (BDMPS) region (Furness, 2015).

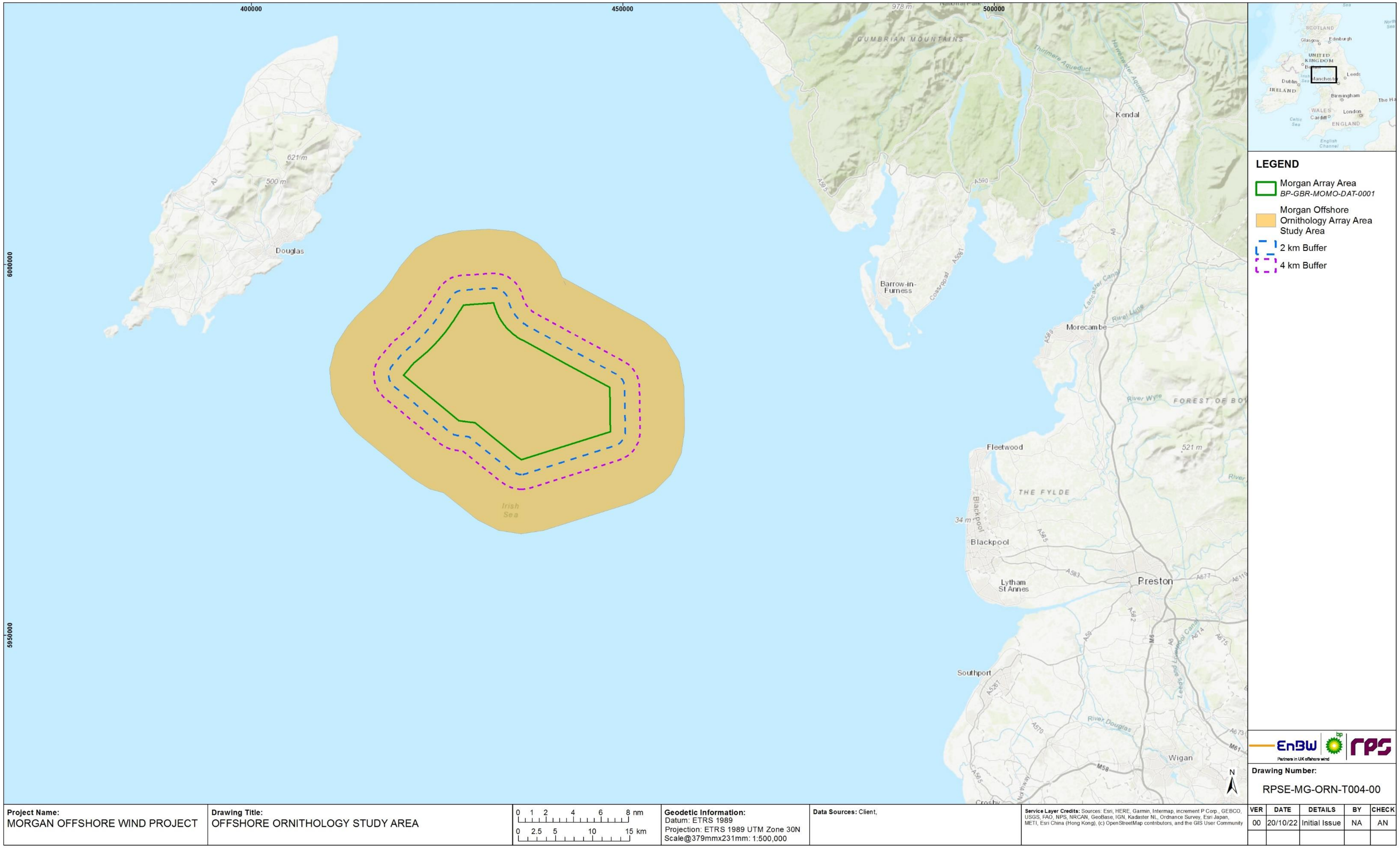

Figure 10.1: Morgan Offshore Ornithology Array Area study area.

10.2 Policy context

10.2.1 National Policy Statements

10.2.1.1 Planning policy on renewable energy infrastructure is presented in volume 1, chapter 2: Policy and legislation of the PEIR. Planning policy on offshore renewable energy Nationally Significant Infrastructure Projects (NSIPs), specifically in relation to offshore ornithology, is contained in the Overarching National Policy Statement (NPS) for Energy (EN-1; DECC, 2011a) and the NPS for Renewable Energy Infrastructure (EN-3, DECC, 2011b).

10.2.1.2 NPS EN-1 and NPS EN-3 include guidance on what matters are to be considered in the assessment. These are summarised in Table 10.1. NPS EN-1 and NPS EN-3 also highlight a number of factors relating to the determination of an application and in relation to mitigation. These are summarised below (Table 10.1).

10.2.1.3 Table 10.1 refers to the current NPSs, specifically NPS EN-1 (DECC, 2011a) and NPS EN-3 (DECC, 2011b). If the NPSs are updated prior to the application for Development Consent, the revised NPSs will be fully considered in relation to offshore ornithology within the Environmental Statement.

Table 10.1: Summary of the NPS EN-1 and NPS EN-3 provisions relevant to offshore ornithology.

Summary of NPS EN-3 and EN-1 provision	How and where considered in the PEIR
NPS-EN1	
Where the development is subject to EIA the applicant should ensure that the Environmental Statement (ES) clearly sets out any effects on internationally, nationally and locally designated sites of ecological or geological conservation importance, on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity. (NPS EN-1 paragraph 5.4.3)	Important protected areas for seabirds are discussed in volume 4, annex 10.1: Offshore ornithology baseline characterisation of the PEIR. Assessment of the potential effects of the Morgan Generation Assets on the features of these protected sites are provided in section 10.8.
"the Secretary of State should ensure that appropriate weight is attached to designated sites of international, national and local importance; protected species; habitats and other species of principal importance for the conservation of biodiversity; and to biodiversity and geological interests within the wider environment". (NPS EN-1 paragraph 5.4.7)	Species of principal importance are considered in determining the conservation value of receptors as part of this assessment, as outlined in section 10.4.4.
Important sites for biodiversity are those identified through international conventions and the Habitats Regulations. (NPS EN-1 paragraph 5.4.8)	These designated sites are considered in determining the conservation value of receptors as part of this assessment, outlined in section 10.4.4.
Many individual wildlife species receive statutory protection under a range of legislative provisions. (NPS EN-1 paragraph 5.4.15)	Statutory protection afforded to bird species has been considered in determining the conservation value of receptors as part of this assessment (section 10.4.4).
Other species and habitats have been identified as being of principal importance for the conservation of biodiversity in England and Wales and thereby requiring conservation action. The Secretary of State should ensure that these species and habitats are protected from the adverse effects of development by using requirements or planning obligations. The Secretary of State should refuse consent where harm to the habitats or species and their habitats would result, unless the benefits (including need) of the development outweigh that harm. In this context the Secretary of State should give substantial weight to any such harm to the detriment of biodiversity features of national or regional importance which it considers may result from a proposed development. (NPS EN-1 paragraph 5.4.16)	Species of principal importance are considered in determining the conservation value of receptors as part of this assessment, as outlined in section 10.4.4.
The applicant should include appropriate mitigation measures as an integral part of the proposed development. In particular, the applicant should demonstrate that: • During construction, they will seek to ensure that activities will be confined to the minimum areas required for the works • The timing of construction has been planned to avoid or limit disturbance to birds during the breeding season • During construction and operation best practice will be followed to ensure that risk of disturbance or damage to species or habitats is minimised, including as a consequence of transport access arrangements • Habitats will, where practicable, be restored after construction works have finished • Mitigation measures should take into account existing habitats and should generally seek opportunities to enhance them, rather than replace them. Where practicable, mitigation measures should seek to create new habitats of value within the site landscaping proposals. Habitats will, where practicable, be restored after construction works have finished. (NPS EN-1 paragraph 5.4.18)	Measures adopted as part of the Morgan Generation Assets relevant for seabirds are detailed in section 10.8.
NPS-EN3	
Assessment of offshore ecology and biodiversity should be undertaken by the applicant for all stages of the lifespan of the proposed Offshore Wind Farm and in accordance with the appropriate policy for Offshore Wind Farm EIAs. (NPS EN-3 paragraph 2.6.64)	The construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets have been assessed in section 10.8.

Summary of NPS EN-3 and EN-1 provision	How and where considered in the PEIR
Consultation on the assessment methodologies should be undertaken at early stages with the statutory consultees as appropriate. (NPS EN-3 paragraph 2.6.65)	Consultation with relevant statutory and non-statutory stakeholders have been carried out (e.g. via the Evidence Plan Process Expert Working Groups (EWG)) and are presented in section 10.3.
The the Secretary of State should consider the effects of a proposal on marine ecology and biodiversity [and the physical environment] taking into account all relevant information made available to it. (NPS EN-3 paragraph 2.6.68)	Section 10.8. presents the assessment of effects of the Morgan Generation Assets on offshore ornithology receptors.
Offshore wind farms have the potential to impact on birds through: • Collisions with rotating blades; • Direct habitat loss • Disturbance from construction activities such as the movement of construction/decommissioning vessels and piling • Displacement during the operations phase, resulting in loss of foraging/roosting area • Impacts on bird flight lines (i.e. barrier effect) and associated increased energy use by birds for commuting flights between roosting and foraging areas. (NPS EN-3 paragraph 2.6.101)	Potential impacts on offshore ornithology are assessed in section 10.8.
The scope, effort and methods required for ornithological surveys should have been discussed with the relevant statutory advisor, [taking into consideration baseline and monitoring data from operational windfarms]. (NPS EN-3 paragraph 2.6.102)	Baseline survey methods have been discussed with Natural Resources Wales (NRW), Natural England , Joint Nature Conservation Committee (JNCC) and the Royal Society for the Protection of Birds (RSPB) through the Evidence Plan Process EWG.
Relevant data from operations offshore wind farms should be referred to in the applicant's assessment. (NPS EN-3 paragraph 2.6.103)	Relevant data from other operations offshore wind farms has been considered to inform the assessment of potential significant effects of the Morgan Generation Assets and the cumulative effects assessment in section 10.10.
It may be appropriate for the assessment to include collision risk modelling for certain bird species. (NPS EN-3 paragraph 2.6.104)	Collision risk modelling has been undertaken for migratory and non-migratory birds using parameters that have been agreed with SNCBs through the Evidence Plan process EWG, Potential effects from collision risk are presented and assessed in section 11.8.

Table 10.2: Summary of NPS EN-1 policy on decision making relevant to offshore ornithology.

Summary of NPS EN-1 provision	How and where considered in the PEIR
The NPS' aim is to ensure a halting, and if possible, a reversal, of declines in priority habitats and species, with wild species and habitats as part of healthy, functioning ecosystems. (NPS EN-1 paragraph 5.3.5)	The conservation status of habitats and species is considered throughout this assessment and measures have been adopted, where reasonably practicable, impacts are reduced (section 10.7).
In having regard to the aim of the Government's biodiversity strategy the Secretary of State should take account of the context of the challenge of climate change: failure to address this challenge will result in significant adverse impacts to biodiversity. (NPS EN-1 paragraph 5.3.6)	The future impact of climate change on the habitats in the east Irish Sea has been considered in section 10.4.1.
Developments should aim to avoid significant harm to biodiversity and geological conservation interests, including through mitigation and consideration of reasonable alternatives; where significant harm cannot be avoided, then appropriate compensation measures should be sought. (NPS EN-1 paragraph 5.3.7)	No impacts were considered to be significant in EIA terms therefore no secondary impacts were considered to be requried.
In taking decisions, the Secretary of State should ensure that appropriate weight is attached to designated sites of international, national and local importance; protected species; habitats and other species of principal importance for the conservation of biodiversity; and to biodiversity and geological interests within the wider environment. (NPS EN-1 paragraph 5.3.8)	As part of this chapter, the process of identifying designated sites has been undertaken for the Morgan Offshore Ornithology study areas (sections 10.4.3 and 10.4.4). This was done to ensure all features and species of conservation importance were considered, where relevant, in this assessment.

10.2.2 North West Inshore and North West Offshore Coast Marine Plans

10.2.2.1 The assessment of potential changes to offshore ornithology has also been made with consideration to the specific policies set out in the North West Inshore and North West Offshore Coast Marine Plans (MMO, 2021). Key provisions are set out in Table 10.3 along with details as to how these have been addressed within the assessment.

Table 10.3: North West Inshore and North West Offshore Marine Plan policies of relevance to offshore ornithology.

Policy	Key provisions	How and where considered in the PEIR
NW-SCP-1	Proposals within or relatively close to nationally designated areas should have regard to the specific statutory purposes of the designated area. Great weight should be given to conserving and enhancing landscape and scenic beauty in National Parks and Areas of Outstanding Natural Beauty.	As part of this chapter (as well as volume 4, annex 10.1: Offshore ornithology baseline characterisation of the PEIR), designated sites with mobile features connected to the Morgan Generation Assets have been identified. This is to ensure that all features and species of conservation importance were considered, where relevant, in this assessment. The Habitats Regulations Assessment Screening Report considers the direct or indirect effects on features of relevant SPA sites, and where relevant will be included in the Information to Inform an Appropriate Assessment (ISAA) report.

Policy	Key provisions	How and where considered in the PEIR
NW-MPA-1	Proposals that support the objectives of marine protected areas and the ecological coherence of the marine protected area network will be supported.	As part of this chapter (as well as volume 4, annex 10.1: Offshore ornithology baseline characterisation), designated sites with mobile features connected to the Morgan Generation Assets have been identified (section 10.4.3). This is to ensure that all features and species of conservation importance were considered, where relevant, in this assessment. The Habitats Regulations Assessment Screening Report considers the direct or indirect effects on features of relevant SPA sites, and where relevant will be included in the ISAA.
NW-BIO-1	NW-BIO-1 encourages and supports proposals that enhance the distribution of priority habitats and priority species.	The Morgan Generation Assets will aim to conserve habitats and species as far as reasonably practicable through the measures adopted as part of the Morgan Generation Assets to reduce the impact of the Morgan Generation Assets (section 10.8).
NW-BIO-2	NW-BIO-2 requires proposals to manage negative effects which may significantly adversely impact the functioning of healthy, resilient and adaptable marine ecosystems.	In addition to measures adopted as part of the Morgan Generation Assets and sensitive project design, secondary mitigation has been considered where an impact is considered to be significant in EIA terms This assessment is undertaken for each impact although no significant impacts have been identified.
NW-CE-1	Proposals which may have adverse cumulative effects with other existing, authorised, or reasonably foreseeable proposals must demonstrate that they will avoid, minimise and mitigate.	Cumulative effects have been quantified and their significance assessed in section 10.10.

10.3 Consultation

10.3.1.1 A summary of the key issues raised during consultation activities undertaken to date specific to offshore ornithology is presented in Table 10.4 below, together with how these issues have been considered in the production of this PEIR chapter. Further detail is presented in annexes listed below:

- Volume 4, annex 10.1: Offshore ornithology baseline characterisation of the PEIR
- Volume 4; annex 10.2: Offshore ornithology displacement assessment of the PEIR
- Volume 4, annex 10.3: Offshore ornithology non-migratory seabird collision risk assessment of the PEIR
- Volume 4 annex 10.4: offshore ornithology migratory non-seabird collision risk modelling of the PEIR.

10.3.2 Evidence plan

10.3.2.1 The purpose of the Evidence Plan process is to agree the information the Morgan Generation Assets needs to supply to the Secretary of State, as part of a DCO application for the Morgan Generation Assets, with Natural England and JNCC.

10.3.2.2 The Evidence Plan seeks to ensure compliance with the Habitats Regulations Assessment (HRA) and EIA. Consultation on offshore ornithology was undertaken via the Offshore Ornithology EWG, with meetings held in February 2022, July 2022, and November 2022.

10.3.2.3 The first EWG meeting (February 2022) provided an update on current site-specific surveys and approach to baseline characterisation (including desktop data sources), as set out in the Morgan EIA Scoping Report. The second EWG meeting (July 2022) provided an update on the approach used to characterise the baseline conditions and assess the effects on ornithological receptors. A summary of discussions and key issues raised is set out in Table 10.5 below.

10.3.2.4 A series of technical papers detailing the approach to assessing the baseline conditions and the main effects (i.e. collision and displacement) was distributed to the EWG for consultation. Following the responses from the stakeholders on the technical papers, agreed changes were incorporated in the assessment of the baseline conditions and the main effects. The responses provided by the stakeholders through the EWG are summarized in Table 10.5 together with changes implemented in the technical reports underpinning the PEIR.

Table 10.4: Summary of key topic and issues raised during consultation activities undertaken for the Morgan Generation Assets relevant to offshore ornithology.

Date	Consultee and type of response	Topics and issues raised	Response to issue raised and/or were considered in this chapter
February 2022	**Offshore Ornithology Expert Working Group 1** – Natural England, Joint Nature Conservation Committee (JNCC), The Wildlife Trust (TWT), Marine Management Organisation (MMO), and the Royal Society for the Protection of Birds (RSPB).	Agreement on broad approach to digital aerial surveys. Agree with the broad approach to aerial survey, as we understand it, with regards to the use of digital aerial surveys, a grid-based sampling design, monthly surveys, and the use of a 10km buffer in every direction for Morgan.	The buffer for the Morgan aerial survey reaches 10km all the way round the Morgan Array Area.
June 2022	**Scoping Opinion** The Planning Inspectorate	The Environmental Statement should provide a full description of the nature of the operations and maintenance activities, including type, frequency, and potential for overlapping activities with those associated with existing and planned wind farms in the area, or set out the assumptions made where exact information is not known.	Within the cumulative assessment in the PEIR, impacts across each phase have been detailed and justified ensuring all relevant information is included.
		In light of the number of ongoing developments within the vicinity of the Proposed Development application site, the Environmental Statement should clearly state which developments will be assumed to be part of the baseline and those which are to be considered as other development for the purposes of the cumulative effects assessment. It is noted from the Scoping Report that the proposed onshore operations and maintenance base will be progressed under a separate consent application (it is not stated as intended to be part of the transmission assets application). The Environmental Statement should take this into account in the cumulative effects assessment. Respondents to the Scoping Report have identified proposed developments or provided advice on the types of projects, plans, or activities that should be included (see Appendix 2 of this Opinion); these should be taken into account in the cumulative effects assessment. The Applicant should seek to agree the scope of the projects assessed with these consultation bodies.	The Cumulative Effects Assessment (CEA) takes into account the impact associated with the Morgan Generation Assets together with other projects and plans. The projects and plans selected as relevant to the CEA presented within the PEIR are based upon the results of a screening exercise. Each project has been considered on a case by case basis for screening in or out of this chapter's assessment based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved.
		Effects of underwater noise on marine life due to jacket or monopile cutting and removal. The Scoping Report proposes to assess the effects of underwater noise on marine life due to jacket or monopile cutting and removal during decommissioning. However, the Scoping Report does not specifically identify this potential impact within the Fish and shellfish ecology, Marine mammals or Offshore ornithology sections. The outcomes of this assessment should be presented within the relevant Environmental Statement chapters.	The indirect impact of underwater sound on prey species relevant to ornithological receptors has been assessed for the construction, operations and maintenance and decommissioning phases.
		Collision risk from presence of wind turbines during construction and decommissioning. The Inspectorate acknowledges that this potential impact is associated with the presence of operational wind turbines, and agrees to scope this matter out of the construction and decommissioning phases.	Collision effect during construction and decomissioning phases has been scoped out of the assessment in the PEIR.
		Barrier effects from presence of wind turbines during construction and decommissioning. The Inspectorate acknowledges that this potential impact is associated with the presence of operational wind turbines, and agrees to scope this matter out of the construction and decommissioning phases.	Only the barrier effect resulting from the operations phase has been assessed in the PEIR.

Date	Consultee and type of response	Topics and issues raised	Response to issue raised and/or were considered in this chapter
		The Inspectorate concurs with the view that operational turbine noise is unlikely to result in disturbance/displacement, and that displacement is to be accounted for in the above-water assessment. The Inspectorate agrees that disturbance and displacement from underwater noise from the operation of turbines can be scoped out. However, the Inspectorate notes that assessment of noise from vessel traffic and other operational activities is proposed to be scoped in and the Inspectorate agrees with this approach. The Inspectorate acknowledges that no piling is proposed for decommissioning, however, potential effects from underwater noise associated with cutting and removal of foundations, towers, platforms and turbines may occur. In the absence of sufficient justification with regards to the sources and levels of underwater noise from decommissioning activities, the Inspectorate advises the Environmental Statement should include an assessment of this matter where significant effects are likely to occur.	Disturbance and displacement from airborne noise, underwater sound, presence of vessels and infrastructure has been assessed in-combination for all phases whilst the indirect effect of underwater sound on prey availability has been assessed for the construction and the operations phases.
		The risk of pollution is proposed to be managed through the implementation of measures set out in post-consent plans including an Environmental Management Plan and a MPCP.	The implementation of an offshore Environmental Management Plan is considered in the PEIR.
		It is noted that the approach to obtaining density and spatial abundance estimates will be discussed within the Evidence Plan process. The Inspectorate advises that given the fundamental importance of this discussion to the outcomes of the EIA process, the Applicant should seek to agree the modelling parameters used and the methodology applied with the relevant consultees, giving careful consideration to the sharing of information through the Evidence Plan process.	Noted with all parameters used within modelling agreed with SNCBs and following latest guidance document from SNCBs. Approach is detailed in Volume 4, Annex 10.3: Offshore ornithology non-migratory seabird collision risk assessment of the PIER.
		The Scoping Report identifies potential barrier effects from the presence of wind turbines, however consideration should be given in the Environmental Statement to the collective impact of the turbines and the proposed offshore platforms in this regard, in particular with respect to the number and location of the platforms in proximity to the turbine array.	The barrier effect resulting from all infrastructure has been assessed in the PEIR for the operations phase.
		Vessel Management Plan Environmental Management Plan Marine Pollution Contingency Plan. The Scoping Report does not provide any detail on the specific measures to be included within these plans, noting they may evolve as the EIA progresses. Where these measures are being relied upon for the assessments in the Environmental Statement they must be set out in the Environmental Statement in detail, including how they are to be secured (e.g. by DCO requirement).	Within the PEIR, a number of measures (primary and tertiary) have been adopted as part of the Morgan Generation Assets to reduce the potential for impacts on offshore ornithology. These primary and tertiary measures have been detailed in Table 10.21.
		The Inspectorate advises that the breeding, non-breeding, and migratory seasons (where applicable) are defined for each relevant bird species assessed. Effort should be made to agree the definitions of each season with the relevant consultees including where the use of seasonal peaks is part of the modelling methodology.	Bio-seasons are based on Furness 2015 definitions and approach has been agreed with SNCBs through the evidence plan process.

Date	Consultee and type of response	Topics and issues raised	Response to issue raised and/or were considered in this chapter
		Other Residues and Emissions – dust, pollutants, light, noise and vibration. These aspects are proposed to be assessed in other relevant chapters and therefore are not proposed to be assessed in standalone chapters. They will be assessed in: • Physical processes; • Benthic subtidal and intertidal ecology; • Fish and shellfish; • Marine mammals; • Offshore ornithology; • Underwater noise; and • Seascape, landscape and visual resources. It is noted that currently, the Scoping Report does not report on all of these impacts within the referenced aspect chapters, for example, lighting is not addressed in the offshore ornithology or other biological assessment chapters and the lighting proposed is not described in the front end of the Scoping Report. Provided other residues and emissions are referenced within the relevant Chapters listed above and cross-references are made where appropriate, the Inspectorate is content with this approach.	Assessment of the collision effect in the PEIR is based on the maximum number of structures in the wind farm, with maximum intensity and extent of red and white light sources to increase the likelihood that birds will be attracted to structures and therefore susceptible to collision risk at night.
July 2022	**Offshore Ornithology Expert Working Group 2 –** Natural England, Joint Nature Conservation Committee (JNCC), and the Royal Society for the Protection of Birds (RSPB).	Agreement on the approach to baseline characterisation as set out in the baseline characterisation technical paper.	Approach is presented in volume 4, annex 10.1: Offshore ornithology baseline characterisation of the PEIR and summarised in section 10.4 of the PEIR.
		Agreement to the approach to stochastic Collision Risk Model (sCRM) as discussed in the EWG02 meeting, which superceed the Morgan CRM technical paper following the Natural England advice.	Approach to the sCRM is presented in volume 4, annex 10.3: Offshore ornithology non-migratory seabird collision risk assessment of the PEIR and summarised in section 10.4 of the PEIR.
	Scoping Opinion Natural England	We note the Preliminary Environmental Information Report (PEIR) for the Morgan Offshore Wind Project will only present data analysis of 12 months of the digital and aerial surveys for both birds and marine mammals, with the full 24 months being presented in the Environmental Statement. Natural England highlight the risk that the additional data analysis could have potential to change the conclusions of the Environmental Statement from those set out in the PEIR, which could cause potential delays to the project. More generally, Natural England advises that 24 months of survey effort is the minimum expected evidence standard for bird and marine mammal data.	Use of all data will be clearly indicated with any results stated to be based on partial data and that all results may be subject to change once full data is available.
		The advice within this letter is provided with respect to the generation assets scoping report provided, but we consider that the transmission assets are an integral part of the project and therefore the Environmental Statement should, at the point of submission, be in a position to consider the project as a whole. Therefore the final Environmental Statement, when considering the project as a whole, will include additional impacts and designated sites than those mentioned within the Morgan Offshore Wind Project: Generation Assets Scoping Report.	Noted with cumulative assessment based on the appropriate projects scoped in, with all scoped in projects detailed with justification provided in the PEIR.
		We advise that secondary scour protection impacts on seabed habitats are scoped in until further detailed methods and impacts can be assessed and justification provided to scope out of the Environmental Statement.	Indirect impacts on seabird prey species have been addressed within the PEIR impact assessment.
		Tracking studies should also be used where available to evidence connectivity, or lack thereof, they should also be used to aid screening where possible.	Tracking data available from the Seabird Tracking Database (Birdlife International, 2021) have been reviewed and summarized for each species in the offshore ornithology baseline characterisation of the PEIR

Date	Consultee and type of response	Topics and issues raised	Response to issue raised and/or were considered in this chapter
		An impact assessment should identify, describe, and evaluate the effects that are likely to result from the project in combination with other projects and activities that are being, have been or will be carried out. The following types of projects should be included in such an assessment (subject to available information): • existing completed projects; • approved but uncompleted projects; • ongoing activities; • plans or projects for which an application has been made and which are under consideration by the consenting authorities; and • plans and projects which are reasonably foreseeable, (i.e. projects for which an application has not yet been submitted, but which are likely to progress before completion of the development) and for which sufficient information is available to assess the likelihood of cumulative and in-combination effects.	CEA screening annex has been produced with details regarding whch projects have been scoped in and why.
		Natural England does not hold local information on local sites, local landscape character, priority habitats and species or protected species. Local environmental data should be obtained from the appropriate local bodies. This may include the local environmental records centre, the local wildlife trust, local geo-conservation group or other recording society	A desk study for the baseline characterisation has been provided within volume 4, annex 10.1: Offshore ornithology baseline characterisation of the PEIR.
		The Environmental Statement should thoroughly assess the impact of the proposals on habitats and/or species listed as 'Habitats and Species of Principal Importance' within the England Biodiversity List, published under the requirements of S41 of the Natural Environment and Rural Communities (NERC) Act 2006. Section 40 of the NERC Act 2006 places a general duty on all public authorities, including local planning authorities, to conserve and enhance biodiversity. Further information on this duty is available here https://www.gov.uk/guidance/biodiversity-duty-public-authority-duty-to-have-regard-to- conserving-biodiversity.	Conservation values have been provided within the PEIR.
		Although Natural England questions the utility of flight height data derived by the 'size-based' and similar methods, if this data has been produced, we would welcome its inclusion for comparison with the generic flight height distributions (Johnston et al., 2014), noting that we would not expect it to be used in Collision Risk Modelling (CRM). Confirmation on if information on flight height has been processed.	Generic flight height data from Johnston et al., (2014) were used in volume 4, annex 10.3: Offshore ornithology non-migratory seabird collision risk assessment of the PEIR as site-specific data collected were deemed not to be suitable.
July – August 2022	JNCC and Natural England – displacement technical paper provided and agreed as part of the Offshore Ornithology Expert Working Group 2.	Advise that whole displacement matrices are presented for black-legged kittiwake *rissa tridactyla* and manx shearwater *puffinus puffinus* using a range of mortality rates from 1 to 10%.	Displacement matrices (using a range of mortality rates) for both Manx Shearwater and black-legged kittiwake are presented in volume 4, annex 10.2: Offshore ornithology displacement assessment of the PEIR.
		Advise that a combined estimate of the number of birds on the water (corrected for survey coverage) and of the number of birds in flight (corrected for survey coverage) are used for an assessment of Manx shearwater displacement.	The assessment of Manx shearwater presented in volume 4, annex 10.2: Offshore ornithology displacement assessment of the PEIR is based on the combined estimate of birds on the water and birds in flight.
		Advise that a displacement assessment is also carried out for the construction and decommissioning phases. This should assume that 50% of the annual displacement impact resulting from the operations phase will occur during construction, and decommissioning, phases.	Displacement assessment was carried out for the construction, operations, and decomisioning phases assuming that 50% of the annual displacement impact resulting from the operations phase will occur during construction and decommissioning phases.
		Advise that assessments of displacement should use the information on uncertainty and variability in the input parameters (e.g. bird densities, mortality and displacement rates) to allow consideration of the range of values predicted impacts may fall within, and to allow an assessment of confidence in the conclusions made regarding adverse effects on site integrity and significance of impacts for populations.	The magnitude of impact predicted in the PEIR account for the full range of uncertainty and variability in the input parameters (i.e. bird densities with upper and lower confidence limits, mortality and displacement rate).

Date	Consultee and type of response	Topics and issues raised	Response to issue raised and/or were considered in this chapter
		Advise that black-legged kittiwake is screened into the displacement assessment as recent evidence suggests that they can be sensitive to displacement from offshore wind farms.	Displacement assessment has been conducted for black-legged kittiwake and is presented in volume 4, annex 10.2: Offshore ornithology displacement assessment of the PEIR.
		Advise that model-or design-based estimates of abundance and density of divers and scoters are presented to determine whether or not a displacement assessment should be carried out for red-throated diver and seaducks.	Density estimates of all species encountered during the digital aerial surveys are presented in volume 4, annex 10.1: Offshore ornithology baseline characterisation of the PEIR.
	JNCC and Natural England – collision technical paper provided and agreed as part of the Offshore Ornithology Expert Working Group 2.	Advise the use of a migration-free breeding season.	Collision risk is reported for each 'bio-season'. Bio-seasons were defined according to the breeding, non-breeding and migratory periods using seasonal divisions proposed for BDMPS by Furness (2015).
		Recommend the use of the sCRM for the basic Band model (i.e. Options 1 and 2) with update parameters from the joint SNCB.CRM draft guidance note (SNCB, in prep).	Collision risk modelling was undertaken using the sCRM developed by Marine Scotland (McGregor *et al*., 2018) and using parameters from the joint SNCB.CRM draft guidance note (SNCB,in prep). The results are presented in volume 4, annex 10.3: Offshore ornithology non-migratory seabird collision risk assessment of the PEIR.
		Advise that collision risk assessment use the information on uncertainty and variability in the input parameters (e.g. bird densities, flight heights, avoidance rates, nocturnal activity) to allow consideration of the range of values predicted impacts may fall within, and to allow an assessment of confidence in the conclusions made regarding adverse effects on site integrity and significance of impacts for populations.	Collision risk modelling was undertaken using the Stochastic Collision Risk Model (sCRM) developed by Marine Scotland (McGregor *et al*., 2018) and the results are presented in volume 4, annex 10.3: Offshore ornithology non-migratory seabird collision risk assessment of the PEIR.
		Agree with the list of species provided as being expected to require a collision-risk assessment, but cannot rule out other species at this stage until density estimates across species for the array plus buffer (based on baseline survey data collection) have been presented.	Density estimates of all species encountered during the digital aerial surveys are presented in 4, annex 10.1: Offshore ornithology baseline characterisation of the PEIR.
	JNCC and Natural England – baseline characterisation paper provided and agreed as part of the Offshore Ornithology Expert Working Group 2.	Advise that the applicant also provides records of all species detected from aerial surveys.	All species recorded during the digital aerial surveys are presented in volume 4, annex 10.1: Offshore ornithology baseline characterisation of the PEIR.
		Recommend that a power analysis is undertaken to demonstrate that survey coverage is appropriate. Although analysis of 12% of the sea surface is likely to be sufficient, best practice would be to conduct a power analysis to determine the level and distribution of survey coverage to analyse.	Consideration to power analysis is under review.
		Advise that red-throated diver density data contained within Bradbury *et al.* (2014) are extracted to generate maps and abundance estimates for red-throated diver in the Morgan Array Areas plus a 10km buffer zone to complement the spatial coverage of the digital aerial surveys.	Red-throated diver density maps displaying data contained within Bradbury *et al*. (2014) and covering the Morgan Array Area plus 10km buffer zone are shown in volume 4, annex 10.1: Offshore ornithology baseline characterisation of the PEIR.
		Recommend that the apportioning of unidentified species and availability bias correction should be carried out the order of apportioning then availability correction to ensure that all unidentified species (once apportioned) are corrected for availability bias.	Agreed and considered in volume 4, annex 10.1: Offshore ornithology baseline characterisation of the PEIR.
		Advise that MRSea is used to predict spatial density and abundance for the array area plus 10km buffer for each of the most abundant species (black-legged kittiwake, northern gannet, common guillemot, razorbill and Manx shearwater).	Model-based estimates are produced for each buffer zone (2km, 4km and 10km) in volume 4, annex 10.1: Offshore ornithology baseline characterisation of the PEIR.
November 2022	**Offshore Ornithology Expert Working Group 3 –** Natural England, JNCC, RSPB, NRW, Isle of Man government.	Discussion on Offshore Ornithology	Due to the timing of the workshop ahead of publishing the PEIR, discussion outputs will be incorporated into the Environmental Statement.

10.4 Baseline environment

10.4.1 Methodology to inform baseline

Desktop study

10.4.1.1 Information on offshore ornithology within the Morgan Offshore Ornithology Array Area study area was collected through a detailed desktop review of existing studies and datasets. These are summarised at Table 10.5 below with full details presented in volume 4, annex 10.1: Offshore ornithology baseline characterisation of the PEIR.

Table 10.5: Summary of key desktop reports.

Title	Source	Year	Author
Identifying important at-sea areas for seabirds using species distribution models and hotspot mapping.	Biological Conservation	2020	Cleasby, I. R., Owen, E., Wilson, L., Wakefield, E. D., O'Connell, P., and Bolton, M.
Distribution maps of cetacean and seabird populations in the northeast Atlantic.	Journal of Applied Ecology	2020	Waggitt, J.J., Evans, P.G., Andrade, J., Banks, A.N., Boisseau, O., Bolton, M., Bradbury, G., Brereton, T., Camphuysen, C.J., Durinck, J. and Felce, T.
All Wales Common Scoter survey: report on 2002/03 work programme.	CCW Contract Science Report no 615	2004	Cranswick, PA, C Hall and L Smith.
An assessment of the numbers and distributions of inshore aggregations of waterbirds using Liverpool Bay during the non-breeding season in support of possible SPA identification.	JNCC Report No. 373	2006	Webb, A., McSorley, C.A., Dean, B.J., Reid, J.B., Cranswick, P.A., Smith, L. and Hall, C.
An assessment of the numbers and distribution of wintering waterbirds and seabirds in Liverpool Bay/Bae Lerpwl area of search.	JNCC Report No 576	2016	Lawson, J., Kober, K., Win, I., Allcock, Z., Black, J. Reid, J.B., Way, L. and O'Brien, S.H.
SEA678 Data Report for Offshore Seabird Populations.	Coastal and Marine Resources Centre, Environmental Research Institute, University College, Cork	2006	Mackey and Giménez
Seabird Tracking Database	BirdLife International	2022	BirdLife International
Mona Offshore Wind Project Preliminary Environmental Information Report (volume 6, chapter 10: Offshore Ornithology).	Mona Offshore Wind Ltd	2023	RPS

Identification of designated sites

10.4.1.2 All designated sites within the Morgan Offshore Ornithology Array Area study area and the Cumulative Morgan Offshore Ornithology study area with qualifying interest features that could be affected by the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets were identified using the three-step process described below:

- Step 1: All designated sites of international, national and local importance which overlap with the Morgan Offshore Ornithology Array Area study area and the Cumulative Morgan Offshore Ornithology study area were identified using a number of sources. These sources included the JNCC online resource on the SPAs network (https://jncc.gov.uk) and a review of the foraging ranges of seabird species from Woodward *et al*. (2019)
- Step 2: Information was compiled on the relevant seabird species qualifying interests for each of these sites
- Step 3: Using the above information and expert judgement, sites were included for further consideration if they:
  - Overlap with the location of the Morgan Offshore Ornithology Array Area study area or within the area in which potential direct effects from the Morgan Generation Assets could extend (e.g. displacement effects extending beyond the boundary of the Morgan Array Area)
  - Include seabird qualifying features that use the waters in and around the Morgan Offshore Ornithology Array Area study area (e.g. for foraging with the mean-max + 1 standard deviation (SD) of the breeding colony)
  - Include qualifying features which may fly through the Morgan Offshore Ornithology Array Area study area during migration.

Site specific surveys

10.4.1.3 In order to inform the PEIR, site-specific surveys were undertaken, as agreed with the statutory bodies (see Table 10.4 for further details). A summary of the surveys undertaken to inform the offshore ornithology impact assessment is outlined in Table 10.6 below. Whilst a 24-month programme of site-specific surveys is being undertaken and due to be completed in March 2023, the PEIR is based on the results of the first 12-months of site-specific surveys which covered the April 2021 to March 2022 period.

Table 10.6: Summary of site-specific survey data.

Title	Extent of survey	Overview of survey	Survey contractor	Date	Reference to further information
Digital Aerial Surveys	Morgan Array Area with buffer zone (up 10km)	Digital aerial surveys to characterise the distribution and abundance of seabirds within the Morgan Offshore Ornithology Array Area study area.	APEM	April 2021 to March 2022	Volume 4, annex 10.1: Offshore ornithology baseline characterisation of the PEIR.

10.4.2 Baseline environment

Desktop studies review findings

10.4.2.1 The Morgan Offshore Ornithology Array Area study area is situated in the central part of the Irish Sea. The Irish Sea separates the islands of Ireland and Great Britain; linked to the Celtic Sea in the south by St George's Channel, and to the Inner Seas off the West Coast of Scotland in the north by the North Channel, also known as the Straits of Moyle.

10.4.2.2 Twenty one species of seabird have been reported as regularly nesting on beaches or cliffs around the Irish Sea (Mitchell *et al.,* 2004) and a large proportion of the Manx shearwater *Puffinus puffinus* biogeographic population has been found breeding on offshore islands around the Irish Sea. Most of the worlds Manx shearwater population is found in the UK and over 90% of the UK population is found on the Islands of Rum, Egg (Scotland), Skomer and Skokholm (Wales) (Mitchell *et al*., 2004; JNCC, 2020).

10.4.2.3 During the non-breeding season, large populations of common scoter *Melanitta nigra* and red-throated diver *Gavia stellata* use the shallow waters of Liverpool Bay (Lawson *et al*., 2016).

10.4.2.4 For the most widespread and abundant seabirds of the central Irish Sea, namely northern gannet *Morus bassanus*, common guillemot *Uria aalge*, European herring gull *Larus argentatus*, black-legged kittiwake *Rissa tridactyla*, lesser black-backed gull *Larus fuscus*, Manx shearwater and razorbill *Alca torda*, there are a number of breeding colonies within the species-specific foraging ranges (mean-maximum foraging ranges compiled by Woodward *et al.* (2019)) from the Morgan Offshore Ornithology Array Area study area.

10.4.2.5 Desktop review of boat-based and aerial survey data analysed by Waggitt *et al*. (2020) and Bradbury *et al*. (2014) revealed key patterns of temporal and spatial use in the Morgan Offshore Ornithology Array Area study area. These are summarised below with full details presented in volume 4, annex 10.1: Offshore ornithology baseline characterisation of the PEIR.

10.4.2.6 Waggitt et al. (2020) showed that the lowest abundance estimates of black-legged kittiwake were recorded during the breeding season (March to August). Although distribution was similar during the non-breeding season, there was a net increase in densities across the Morgan Offshore Ornithology Array Area study area. In contrast, Bradbury *et al*. (2014) found the highest densities to be further inshore during the breeding season whilst distribution was patchy during the non-breeding season.

10.4.2.7 It is also evident from Waggitt et al. (2020) and Bradbury et al. (2014) that European herring gull has a very restricted coastal distribution during the breeding season (April to August) owing to their small foraging range (Woodward *et al*., 2019). Whilst abundance was much lower during the non-breeding season, the species had a wider distribution.

10.4.2.8 Lesser black-backed gull has a very restricted coastal distribution during the breeding season (April to August) owing to their small foraging range (Woodward *et al*., 2019), whilst distribution extended further offshore during the non-breeding season (Bradbury *et al*. 2014).

10.4.2.9 As with black-legged kittiwake, Waggitt *et al*. (2020) found the distribution of common guillemot to be similar between the breeding (March to July) and the non-breeding season (August to February), although abundance was greater during the non-breeding season, with over one bird per km^2 predicted to the northwest of the Morgan Array Area. The work from Bradbury *et al*. (2014), which examined densities at a much higher spatial resolution showed hotspots of activity to the southeast of the Morgan Array Area during the non-breeding season. However, both studies indicate that the Morgan Array Area does not overlap with hotspots of abundance.

10.4.2.10 Waggitt *et al*. (2020) showed that Razorbill had a similar seasonal distribution to that of common guillemot, although abundance was much lower. Waggitt *et al.* (2020) found Atlantic puffin in very low densities across the Morgan Offshore Ornithology Array Area study area, whilst Bradbury *et al*. (2014) predicted absence of Atlantic puffin in the area.

10.4.2.11 Bradbury *et al.* (2014) showed densities of Northern fulmar to be low and distribution to be widespread from September to December (non-breeding season) and during the breeding season (January to August). Waggitt *et al*. (2020) showed densities of Northern fulmar to be low and to increase with increasing distance from the coast.

10.4.2.12 Monthly population estimates of Manx shearwater extracted from Waggitt *et al.* (2020) were very low and ranged from 1 to 36 individuals in the Morgan Offshore Ornithology Array Area study area. As expected, densities were low during the non-breeding season (September to March) as Manx shearwater overwinter off the coast of South America. Bradbury *et al*. (2014) also showed densities to be relatively low during the breeding season (April to August), although a hotspot of abundance was found north of the Morgan Offshore Ornithology Array Area study area.

10.4.2.13 The work by Waggitt *et al*. (2020), based on aerial and boat-based survey data collected between 1980 to 2018, indicated that northern gannet were found in the highest densities to the west of the Morgan Offshore Ornithology Array Area study area during the breeding (March to September) and the non-breeding seasons (October to February) whilst Bradbury *et al.* (2014) found the highest densities to be northeast of the Morgan Offshore Ornithology Array Area study area during the breeding season.

10.4.2.14 Digital aerial surveys carried out for the Mona Offshore Wind Project between March 2020 and February 2022 showed that Common guillemot was the most abundant seabird species recorded (albeit distribution was heterogeneous depending on year and month). Within the Mona Offshore Ornithology Array Area study area, the highest estimates were recorded in March in Year 1 and in Year 2, with 17,177 (95% CI range: 9,723 to 27,481) and 11,786 (95% CI range: 6,325 to 20,451) individuals respectively. Black-legged kittiwake was most abundant in March at the start of the breeding season. Thereafter, the predicted abundance varied greatly for the rest of the breeding season (April to August). Black-legged kittiwake were also present in moderate numbers throughout the non-breeding season. MRSea modelled estimates for monthly black-legged kittiwake numbers in the Mona Offshore Ornithology Array Area study area peaked at 4,066 individuals (95% CI range: 2,675 to 5,843) in March 2021. Other gull species (i.e. great black-backed gull, European herring gull and lesser black-backed gull) were also recorded in very low numbers across the Mona Offshore Ornithology Array Area study area between March 2020 and February 2022. The highest abundance of Manx shearwater was recorded in June 2021, with an estimated 8,378 birds (95% range: 2,062 to 22,154). The distribution of northern gannet during the key breeding months was patchy. In Year 1, the highest abundance in the Mona Offshore Ornithology Array Area study area was recorded in July and August, with

669 (95% range: 440 to 942) and 509 (95% range: 272 to 841) respectively. In contrast the highest abundance was recorded at the start of the breeding season in Year 2 with 833 individuals (95% range: 413 to 1,434) in March 2022. Seaducks and divers were almost absent from the site given the distance to the coastline and water depth. It is of note that only four red-throated diver were recorded in the Mona Offshore Ornithology Array Area study area between March 2020 and February 2022 (Mona Offshore Wind Ltd, 2023).

Site-specific survey findings

10.4.2.15 Table 10.7 presents the species and species groups recorded within the Morgan Offshore Ornithology Array Area study area between April 2021 and March 2022 as part of the site-specific digital aerial surveys and spatiotemporal use of the area is summarized below for key species. The assessment in the PEIR is based on the results of the first 12 months of site-specific surveys (April 2021 to March 2022) available to date. The site-specific digital aerial surveys are part of a 24-month programme which is due to be completed in March 2023.

10.4.2.16 Design-based abundance estimates of all species are presented in the volume 4, annex 10.1: Offshore ornithology baseline characterisation of the PEIR together with model-based abundance (using the MRSea package) for the most abundant seabird species.

10.4.2.17 Black legged kittiwake was the most abundant species in winter (December and January) and at the start of the breeding season (March and April). The predicted abundance varied greatly for the rest of the breeding season (April to August) and the predicted distribution within the Morgan Array Area Offshore Ornithology study area appeared to be variable, with high inter-month variability recorded. MRSea estimates for monthly black-legged kittiwake numbers in the Morgan Offshore Ornithology Array Area study area peaked at 3,336 individuals (95% CI range: 2,365 to 4,515) in December 2021. This figure was validated by the design-based estimate of 3,361 individuals (95% CI range: 2,763 to 4,023) (Table 10.7).

10.4.2.18 There were 75 sightings of great black-backed gull recorded across the digital aerial surveys between April 2021 and March 2022 (Table 10.7). The species was most frequently recorded during the non-breeding period. The highest population estimate was recorded in January 2022 with 230 individuals (95% CI range: 79 to 417) for the Morgan Offshore Ornithology Array Area study area (Table 10.7).

10.4.2.19 There were 144 sightings of European herring gull recorded across the digital aerial surveys between April 2021 and March 2022. The species was most frequently recorded outside the breeding season. Within the Morgan Offshore Ornithology Array Area study area, the highest population estimate (all behaviour) was recorded in January 2022, with 599 individuals (95% CI range: 126 to 1,209) (Table 10.7).

10.4.2.20 There were 74 sightings of lesser black-backed gull recorded across the digital aerial surveys between April 2021 and March 2022. The species was most frequently recorded during the breeding season. Within the Morgan Offshore Ornithology Array Area study area, the highest population estimate was recorded in September 2021 with 322 individuals (95% CI range: 115 to 624) (Table 10.7).

10.4.2.21 Common guillemot was the most abundant seabird species recorded during the digital aerial surveys, with most birds found on the sea. Within the Morgan Offshore Ornithology Array Area study area, the highest estimates were recorded in April 2021 with 13,281 individuals (95% CI range: 10,543 to 16,504) (Table 10.7). Numbers declined into the breeding season, suggesting that the Morgan Offshore Ornithology Array Area study area was of lower importance for common guillemot during the breeding season.

10.4.2.22 Common guillemot distribution was heterogeneous depending on year and month. Whilst birds were widespread across Morgan Offshore Ornithology Array Area study area during pre-breeding in March 2022 and April 2021, the birds were distributed to the southeast and east of the Morgan Array Area from June to December 2021 confirming the general pattern of usage of desk-based studies.

10.4.2.23 Although present in much lower abundance than common guillemot, the highest number of razorbill was recorded in December 2021, with an abundance estimate of 1,184 individuals (95% CI range: 582 to 1,843) (Table 10.7). At this time of the year, the species is wintering and foraging far out at sea.

10.4.2.24 Norther fulmar was also frequently recorded (54 sightings), albeit as single individuals. The design-based estimates peaked in January 2022 with 143 birds (95% CI range: 8 to 293) (Table 10.7). This was followed by a decline in the predicted abundance throughout the breeding and post-breeding season.

10.4.2.25 Within the Morgan Offshore Ornithology Array Area study area, the highest abundance of Manx shearwater was recorded in August 2021, with an estimated 2,096 birds (95% range: 658 to 6,883) (Table 10.7). The presence of Manx shearwater in the breeding season suggested that these birds might be associated with the Welsh colonies or the Isle of Man colonies and thus foraged within the Morgan Offshore Ornithology Array Area study area.

10.4.2.26 The distribution of northern gannet during the key breeding months was patchy, and the highest densities were found outside the Morgan Array Area in the north and the southeast. This suggests that the Morgan Array Area is not favoured by foraging Northern gannet.

10.4.2.27 The highest abundance in the survey area was recorded in August, with 679 (95% range: 377 to 1,080) (Table 10.7). As expected, abundance was low during the non-breeding season with most of the birds departing to wintering grounds off the coast of West Africa

Table 10.7: Species/groups and sum of raw counts recorded during the April 2021 to March 2022 surveys, in order of total number of sightings.

Species/groups	Sum of raw counts
Common guillemot	6,126
Unidentified Common guillemot/razorbill	2,138
Black-legged kittiwake	1,702
Manx shearwater	655
Northern gannet	355
Razorbill	291

Species/groups	Sum of raw counts
European herring gull	144
Great black-backed gull *Larus marinus*	75
Lesser black-backed gull	74
Northern fulmar	56
Auk species/shearwater species	44
Auk species (unidentified common guillemot/razorbill/Atlantic puffin)	32
Unidentified large gull species	30
Unidentified herring gull/lesser black-backed gull/great black-backed gull species	30
Common gull	20
Unidentified thrush species	18
Unidentified bird species	11
Unidentified gull species	11
Atlantic puffin *Fratercula arctica*	10
Ruff *Philomachus pugnax*	10
Unidentified small gull species	6
Common tern *Sterna hirundo*	6
Unidentified tern species	6
Little gull *Hydrocoloeus minutus*	5
Turnstone *Arenaria interpres*	4
'Commic' tern (unidentified Arctic tern/common tern)	3
Unidentified lesser black-backed gull/great black-backed gull species	3
Great skua *Stercorarius skua*	2
Unidentified wader species	1
Unidentified sherwater species	1

10.4.3 Designated sites

10.4.3.1 Designated sites identified for the offshore ornithology assessment are described below in Table 10.8.

Table 10.8: Designated sites and relevant qualifying interests for the offshore ornithology assessment. Sites are ordered according to distance from the Morgan Array Area within each category of site: marine SPAs, breeding seabird colony SPAs and passage/wintering bird SPAs.

Designated site	Closest Distance to the Morgan Array Area (km)	Relevant Qualifying interest
Marine SPAs (designated for feeding and rafting seabirds)		
Liverpool Bay SPA	10	Red-throated diver
		Little gull
		Common scoter
		Little tern *Sternula albifrons*
		Common tern
		Waterbird assemblage
Irish Seafront SPA	57.2	Manx Shearwater
Skomer, Skokholm and the Seas off Pembrokeshire SPA	220.6	European storm-petrel *Hydrobates pelagicus*
		Manx shearwater
		Lesser black-backed gull
		Seabird assemblage (breeding) including the components:
		Razorbill
		Common guillemot
		Black-legged kittiwake
		Atlantic puffin
		Lesser black-backed gull
		Manx shearwater
SPA designated for breeding seabirds		
Ribble and Alt Estuaries SPA	37.2	Lesser black-backed gull
Morecambe Bay and Duddon Estuary SPA	47	Lesser black-backed gull
		European herring gull
Lambay Island SPA	128.9	Lesser black-backed gull
		European herring gull
		Black-legged kittiwake
		Common guillemot
		Razorbill
Howth Head Coast SPA	134.4	Black-legged kittiwake

Designated site	Closest Distance to the Morgan Array Area (km)	Relevant Qualifying interest
Ireland's Eye SPA	134.7	European herring gull
		Black-legged kittiwake
		Common guillemot
		Razorbill
Wicklow Head SPA	148.8	Black-legged kittiwake
Ailsa Craig SPA	166.9	Northern gannet
		Common guillemot
		European herring gull
		Black-legged kittiwake
		Lesser black-backed gull
		Seabird assemblage including the components: • Common guillemot • Northern gannet • Lesser black-backed gull • European herring gull • Black-legged kittiwake
Rathlin Island SPA	207.7	Common guillemot
		Razorbill
		Black-legged kittiwake
		Lesser black-backed gull
		European herring gull
Grassholm SPA	229.4	Northern gannet
Saltee Islands SPA	236.8	Northern gannet
		Lesser black-backed gull
		European herring gull
		Black-legged kittiwake
		Common guillemot
		Razorbill
North Colonsay and Western Cliffs SPA	281.7	Black-legged kittiwake
		Common guillemot
Helvick Head to Ballyquin SPA	292.4	European herring gull
		Black-legged kittiwake
Rum SPA	365.5	Black-legged kittiwake
		Common guillemot
Old Head of Kinsale SPA	377.7	Black-legged kittiwake
		Common guillemot
Canna and Sanday SPA	384.5	European herring gull
		Black-legged kittiwake
		Common guillemot
Isles of Scilly SPA/Ramsar	433.3	Great-black backed gull
		Lesser black-backed gull
Shiant Isles SPA	467.5	Common guillemot
		Black-legged kittiwake
		Razorbill
Handa SPA	505.1	Common guillemot
		Black-legged kittiwake
		Razorbill
St Kilda SPA	514.2	Northern gannet
		Common guillemot
		Black-legged kittiwake
		Razorbill
Cape Wrath SPA	527.1	Black-legged kittiwake
		Common guillemot
		Atlantic puffin
		Razorbill
Flannan Isles SPA	535.5	Common guillemot
		Black-legged kittiwake
		Razorbill
Sule Skerry and Sule Stack SPA	573.3	Northern gannet
		Common guillemot
North Rona and Sula Sgeir SPA	592.7	Northern gannet
		Great black-backed gull
		Common guillemot
		Black-legged kittiwake
		Razorbill

Designated site	Closest Distance to the Morgan Array Area (km)	Relevant Qualifying interest
SPA designated for passage and wintering waterbirds		
Dee Estuary SPA	34.5	Pintail Anas acuta
		Teal Anas crecca
		Dunlin Calidris *alpina alpina*
		Knot *Calidris canutus*
		Oystercatcher *Haematopus ostralegus*
		Bar-tailed godwit *Limosa lapponica*
		Black-tailed godwit
		Curlew *Numenius arquata*
		Grey plover *Pluvialis squatarola*
		Shelduck *Tadorna tadorna*
		Redshank *Tringa totanus*
Ribble Alt Estuaries SPA	37.2	Pintail
		Teal
		Wigeon *Anas penelope*
		Greylag goose *Anser anser*
		Sanderling *Calidris alba*
		Dunlin
		Knot
		Ringed plover *Charadrius hiaticula*
		Bewick's swan *Cygnus columbianus bewickii*
		Oystercatcher
		Bar-tailed godwit
		Black-tailed godwit
		Curlew
		Whimbrel *Numenius phaeopus*
		Ruff *Philomachus pugnax*
		Golden plover *Pluvialis apricaria*
		Grey plover
		Shelduck
		Redshank
		Lapwing *Vanellus vanellus*
Mersey Narrows and North Wirral Foreshore SPA	39.3	Sanderling
		Dunlin
		Knot
		Oystercatcher
		Bar-tailed godwit
		Grey plover
		Redshank
Morecambe Bay and Duddon Estuary SPA	47	Pintail
		Pink-footed goose *Anser brachyrhynchus*
		Turnstone *Arenaria interpres*
		Sanderling
		Dunlin
		Knot
		Ringed plover
		Mute swan *Cygnus cygnus*
		Little egret *Egretta garzetta*
		Oystercatcher
		Bar-tailed godwit
		Black-tailed godwit
		Curlew
		Ruff
		Golden plover
		Grey plover
		Shelduck
		Redshank
Traeth Lafan/Lavan Sands, Conway Bay SPA	36.6	Oystercatcher
		Curlew
		Redshank

10.4.4 Important ecological features

10.4.4.1 The Important Ecological Features (IEFs) included within the assessment are those species recorded during the site-specific surveys and identified in the desktop study review that could be potentially affected by the Morgan Generation Assets.

10.4.4.2 The offshore ornithology IEFs have been selected (Table 10.9) based on the conservation status of the ornithological receptor, their sensitivity to impact (for each impact which has been scoped in for the assessment) and known abundance from site specific surveys and desktop studies (volume 4, annex 10.1: Offshore ornithology baseline characterisation of the PEIR).

10.4.4.3 For each IEF identified, it has been stated whether the identified species are listed on Annex I of the European Commission ('EC') Directive 2009/147/EC (codified version of 79/409/EC) on the Conservation of Wild Birds (the 'Birds Directive'). Within the UK, the Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended) implement the species protection requirements of the Habitats and Birds Directives offshore (more than 12 nautical miles from the coast).

10.4.4.4 For species not listed under Annex I, the level of conservation concern was assessed with the Birds of Conservation Concern (BoCC) (Stanbury *et al*., 2021), which uses quantitative assessments against standardised criteria to allocate species to Red, Amber or Green lists depending on their level of conservation concern. Furthermore, species of principal importance for the conservation of biodiversity in England (priority species) were included in the assessment as listed under section 41 of the Natural Environment and Rural Communities (NERC) Act.

10.4.4.5 The assessment of Birds of Conservation Concern in the Isle of Man (BoCCIoM) 2021 Ushagyn ta Feme Coadey ayns Ellan Vannin 2021 is the first comprehensive assessment of the conservation status of all regularly occurring species of wild bird in the self-governing British Crown Dependency of the Isle of Man.

10.4.4.6 The conservation status of all regularly occurring species of wild bird in the Isle of Man was based on the Birds of Conservation Concern in the Isle of Man (BoCCIoM, 2021) which follows the proven methodology of Birds of Conservation Concern (BoCC) (Stanbury *et al*., 2021), ensuring results are broadly comparable, while adjusting for the Island's smaller territorial size.

10.4.4.7 Following the evaluation, the IEFs identified in Table 10.9 were taken forward for consideration in the impact assessment. Species that were recorded in very small numbers or very infrequently during the site-specific surveys and the desktop studies review are excluded because a population-level impact will be negligible and thus undetectable.

10.4.4.8 The IEFs included in the assessment showed some seasonality in their distribution and abundance during the site-specific surveys, which reflected the timing of the breeding and non-breeding seasons and migratory periods (i.e. pre- and post-breeding).

10.4.4.9 Species-specific impacts have been assessed in relation to their seasonality as defined in Furness (2015). Regional population estimates for the non-breeding, wintering and autumn and spring migration periods have been defined in Table 10.10 and calculated using the Biologically Defined Minimum Population Scales (BDMPS) relevant for each species (Furness, 2015). Population estimates for the breeding population were based on SPA and non-SPA sites located within the species' foraging range of the Mona Offshore Wind Project. Breeding Colony counts were extracted from the Seabird Monitoring Programme (SMP) online database (https://app.bto.org/seabirds/public/index.jsp).

10.4.4.10 Baseline mortality rates for all species (including juvenile and adult survival) and productivity rates were taken from Horswill and Robinson (2015).

Table 10.9: Evaluation of IEFs showing species assessed for significance of effect at the Morgan Generation Assets. Species vulnerability to collision and disturbance/displacement is adapted from scores (1 to 5) derived by Wade *et al.* (2016). Abundance is derived from total number of sightings recorded during the site-specific surveys (Table 10.7) and the level of abundance is categorised as follows: absent; very low < 19 individuals; low: 20 to 99; moderate: 100 to 499; high: 500 to 4,999 and very high: 5000+.

Important ecological features	UK conservation status	Isle of Man conservation status	Species of principal importance in England	Abundance recorded in the Offshore Ornithology Array Area study area	Sensitivity to collision	Sensitivity to disturbance and displacement	Assessed for significance of effects at the Morgan Generation Assets
Arctic skua	Red list	Green list	N	Absent	Medium	Low	N
Arctic tern	Annex 1	Red list	N	Absent	Low	Low	N
Atlantic puffin	Red List	Red list	N	Very low	Very low	Medium	Y
Black guillemot	Amber list	Red list	N	Absent	Very low	Medium	N
Black-headed gull	Amber list	Red List	N	Absent	Medium	Low	N
Black-legged kittiwake	Red list	Red list	N	High	Medium	Low	Y
Black-throated diver	Annex 1	Amber list	N	Absent	Low	Very high	N
Common guillemot	Red list	Red list	N	Very high	Very low	Medium	Y
Common gull	Amber list	Amber list	N	Low	Medium	Low	N
Common scoter	Red list	Amber list	Y	Absent	Very low	Very high	N
Common tern	Annex 1	Red list	N	Very low	Low	Low	N
European shag	Red list	Red list	N	Absent	Low	Medium	N
European storm petrel	Annex 1	Green list	N	Absent	Very low	Low	N
Great black-backed gull	Amber list	Red list	N	Low	Medium	Low	N
Great cormorant	Green List	Amber list	N	Absent	Low	Medium	N
Great northern diver	Annex 1	Amber list	N	Absent	Low	Very high	N
Great skua	Amber list	Green list	N	Very low	Medium	Low	N
Herring gull	Red list	Red list	Y	Moderate	Medium	Low	N
Leach's storm-petrel	Annex 1	Not assessed	N	Absent	Very low	Low	N
Lesser black-backed gull	Amber list	Red list	N	Low	Medium	Low	N
Little gull	Annex 1	Not assessed	N	Very low	Low	Low	N
Little tern	Annex 1	Red list	N	Absent	Low	Low	N
Manx shearwater	Amber list	Amber list	N	High	Low	Medium	Y
Mediterranean gull	Annex 1	Green list	N	Absent	Medium	Low	N
Northern gannet	Amber list	Green list	N	High	Medium	Medium	Y

Important ecological features	UK conservation status	Isle of Man conservation status	Species of principal importance in England	Abundance recorded in the Offshore Ornithology Array Area study area	Sensitivity to collision	Sensitivity to disturbance and displacement	Assessed for significance of effects at the Morgan Generation Assets
Northern fulmar	Amber list	Red list	N	Moderate	Low	Low	Y
Razorbill	Amber list	Red list	N	Moderate	Very low	Medium	Y
Red-throated diver	Annex 1	Amber list	N	Absent	Low	Very high	N
Roseate tern	Annex 1	Not assessed	N	Absent	Low	Low	N
Sandwich tern	Annex 1	Green list	N	Absent	Low	Low	N

Seasonality

10.4.4.11 The IEFs included in the assessment showed some seasonality in their distribution and abundance during the site-specific surveys, which reflected the timing of the breeding and non-breeding seasons and migratory periods (i.e. pre- and post-breeding).

10.4.4.12 The seasonal definitions in Furness (2015) include overlapping months in some instances due to variation in the timing of migration for birds which breed at different latitudes (i.e. individuals from breeding sites in the north of the species' range may still be on spring migration when individuals farther south have already commenced breeding). Bio-seasons used within the assessment were defined according to the breeding, non-breeding and migratory periods (autumn and spring migration), from Furness (2015), shown in Table 10.10.

Table 10.10: Seasonal definitions as the basis for assessment, from Furness (2015).

Species	Pre-breeding season/spring migration	Breeding season	Post-breeding season/autumn migration	Non-breeding/winter season
Atlantic puffin	n/a	April to early August	n/a	Mid-August to March
Black-legged kittiwake	January to April	April to August	August to December	n/a
Common guillemot	n/a	March to July	n/a	August to February
European herring gull	n/a	March to August	n/a	September to February
Great black-backed gull	n/a	Late March to August	n/a	September to March
Lesser black-backed gull	March to April	April to August	August to October	November to February
Northern fulmar	December to March	January to August	September to October	November
Northern gannet	December to March	March to September	September to November	n/a
Manx shearwater	Late March to May	April to August	August to early October	n/a
Razorbill	January to March	April to July	August to October	November to December

Reference populations

10.4.4.13 Regional population estimates for the non-breeding, wintering and autumn and spring migration periods have been defined in Table 10.10.

10.4.4.14 and calculated using the Biologically Defined Minimum Population Scales (BDMPS) relevant for each species (Furness, 2015). Population estimates for the breeding population were based on SPA and non-SPA sites located withing the species' foraging range (using Woodward *et al.,* 2019) of the Morgan Generation Assets. Breeding Colony counts were extracted from the Seabird Monitoring Programme (SMP) online database (https://app.bto.org/seabirds/public/index.jsp).

10.4.4.15 During the breeding season, in addition to seabirds associated with breeding colonies, there will be immature seabirds, juvenile seabirds and 'sabbatical' seabirds (mature seabirds not breeding in a given year) present within the region. Population counts therefore must be adjusted to account for these seabirds. It was assumed that all immature seabirds in the Biological Defined Minimum Population Scales (BDMPS) population in the bio-season immediately before the breeding season (usually the return migration bio-season) return to breeding colonies. The total regional population within the breeding season is therefore the sum of breeding adults associated with nearby colonies plus the proportion of immature seabirds from the BDMPS return migration population. This is shown in Table 10.11.

Table 10.11: Calculation of regional population during the breeding season.

Species	Breeding population within mean-max foraging range (JNCC, 2022)	BDMPS return migration population (Furness, 2015)	Proportion of juvenile and immature (Furness, 2015)	Juvenile and immature individuals	Total regional breeding population
Common guillemot	135,788	1,139,220	42.5%	484,169	619,957
Razorbill	20,910	606,914	42.9%	260,366	281,276
Atlantic puffin	34,316	304,557	49.4%	150,451	184,767
Northern gannet	152,372	661,888	44.7%	295,863	448,235
Black-legged kittiwake	75,000	691,526	46.6%	322,251	397,251
Manx shearwater	1,253,612	1,580,895	45.6%	720,888	1,974,500
European herring gull	14,392	173,299	55.2%	95,661	100,561
Lesser black-backed gull	17,772	163,304	40.5%	66,138	96,971
Great black-backed gull	594	17,742	55.8%	9,892	10,480

10.4.4.16 In the non-breeding season, seabirds are not constrained by colony location and can, depending on individual species, range widely within UK seas and beyond. The ZOI for seabird species where an assessment in the non-breeding season and migratory periods is deemed to be required is based on the 'UK Western Waters' populations defined by Furness (2015).

10.4.4.17 All population estimates based on bio-season are provided within Table 10.12.

Table 10.12: Bio-season population sizes used within the assessment.

Species	Pre-breeding season/spring migration	Breeding season	Post-breeding season/autumn migration	Non-breeding/winter season
Common guillemot	n/a	March to July (619,957)	n/a	August to February (1,139,220)
Razorbill	January to March (606,914)	April to July (281,276)	August to October (606,914)	November to December (341,422)
Atlantic puffin	n/a	April to early August (34,316)	n/a	Mid-August to March (304,557)
Northern gannet	December to March (661,888)	March to September (448,235)	September to November (545,954)	n/a
Black-legged kittiwake	January to April (691,526)	April to August (397,251)	August to December (911,586)	n/a
Manx shearwater	March to May (1,580,895)	April to-August (1,974,500)	August to early October (1,580,895)	n/a
European herring gull	n/a	March to August (100,561)	n/a	September to February (173,299)
Lesser black-backed gull	March to April (163,304)	April to August (96,971)	August to October (163,304)	November to February (41,159)
Great black-backed gull	n/a	Late March to August (10,480)	n/a	September to March (17,742)

Baseline mortality rates

10.4.4.18 The impact of additional mortality due to wind farm effects is assessed in terms of the change in the baseline mortality rate, which could result in significant effects on the population size. It has been assumed that all age classes are equally at risk of effects, with each age class affected in proportion to its presence in the population. Therefore, a weighted average baseline mortality rate has been calculated which is appropriate for all age classes for use in assessments, calculated for those species screened in for assessment. These were calculated using the different rates for each age class and their relative proportions in the population. Only those species for which impacts have been assessed (i.e. those scoped in for specific impacts in section 10.8) have been included.

10.4.4.19 Demographic rates for each species were taken from Horswill and Robinson (2015) and entered into a matrix population model. This was used to calculate the expected stable proportions in each age class (note, to obtain robust stable age class distributions for less well studied species such as divers it was necessary to adjust the rates in order to obtain a stable population size). Each age class survival rate was multiplied by its stable age proportion and the total for all ages summed to give the weighted average survival rate for all ages. Taking this value from 1 gives the average mortality rate. The demographic rates, and the age class proportions and average mortality rates calculated from them, are presented in Table 10.13.

Table 10.13: Demographic rates from Horswill and Robinson (2015) and population age ratios calculated from stable population models used to estimate average mortality for use in impact assessment.

		Age Class								
Species	Parameter	0-1	1-2	2-3	3-4	4-5	5-6	Adult	Productivity	Average mortality
Common guillemot	Survival	0.560	0.792	0.917	0.939	0.939	n/a	0.939	0.672	0.139
	Proportion in population	0.167	0.090	0.069	0.061	0.056	n/a	0.557	n/a	n/a
Razorbill	Survival	0.630	0.630	0.895	0.895	n/a	n/a	0.895	0.570	0.174
	Proportion in population	0.161	0.103	0.066	0.060	n/a	n/a	0.610	n/a	n/a
Atlantic puffin	Survival	0.709	0.709	0.709	0.760	0.805	n/a	0.906	0.617	0.181
	Proportion in population	0.164	0.119	0.086	0.062	0.048	n/a	0.521	n/a	n/a
Northern gannet	Survival	0.424	0.829	0.891	0.895	0.895	n/a	0.919	0.700	0.187
	Proportion in population	0.191	0.081	0.067	0.059	0.053	n/a	0.549	n/a	n/a
Black-legged kittiwake	Survival	0.790	0.854	0.854	0.854	n/a	n/a	0.854	0.690	0.157
	Proportion in population	0.169	0.131	0.111	0.093	n/a	n/a	0.496	n/a	n/a
Manx shearwater	Survival	0.870	0.870	0.870	0.870	0.870	n/a	0.870	0.697	0.131
	Proportion in population	0.150	0.128	0.109	0.092	0.078	n/a	0.442	n/a	n/a
European herring gull	Survival	0.798	0.834	0.834	0.834	0.834	n/a	0.834	0.920	0.172
	Proportion in population	0.178	0.141	0.117	0.097	0.082		0.384	n/a	n/a
Lesser black-backed gull	Survival	0.820	0.885	0.885	0.885	0.885		0.885	0.530	0.124
	Proportion in population	0.133	0.109	0.096	0.085	0.075		0.501		n/a
Great black-backed gull	Survival	0.798	0.930	0.930	0.930	0.930		0.930	1.139	0.095
	Proportion in population	0.193	0.138	0.114	0.095	0.079		0.381		n/a

10.4.1 Future baseline scenario

10.4.1.1 The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 requires that "an outline of the likely evolution thereof without implementation of the development as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge" is included within the PEIR. In the event that the Morgan Generation Assets does not come forward, an assessment of the future baseline conditions has been carried out and is described within this section.

10.4.1.2 The UK holds internationally important populations of seabirds (Mitchell *et al*., 2004). UK seabird populations have shown a marked decline over the last two decades (JNCC, 2020; Mitchell *et al*., 2020) with over a third of species experiencing declines in breeding abundance of up to 30% or more since the early 1990s (Mitchell *et al.,* 2020).

10.4.1.3 A recent study suggests that, in terms of number of species affected and the average impact, the key three threats to seabird populations globally are invasive species (165 species across all the most threatened groups), bycatch in fisheries (100 species but with the greatest average impact) and climate change (96 species affected) (Dias *et al*., 2019 and Mitchell *et al*., 2020).

10.4.1.4 Most seabird species in the UK are at the south limit of their range in the northeast Atlantic and therefore an increase in global temperatures could result in a shift in species' range with the potential for overall declines in population size (Frederiksen *et al*., 2007, 2013 and Mitchell *et al*., 2020). In the UK and Ireland, climate change is considered to be the likely primary cause of decline in seabird populations in the future, with anticipated depletion of breeding conditions for most species either indirectly, through changes in prey abundance, or directly during extreme weather events (Mitchell *et al.*, 2020).

10.4.1.5 Fisheries management will also likely impact on future seabird populations in the UK and Ireland. For many years, seabird species have benefitted from bycatch and fisheries discards; for scavenging species such as European herring gull, black-legged kittiwake, great skua and fulmar, population levels may already be above those that naturally occurring food sources would sustain (Votier *et al.,* 2004 and Frederiksen *et al.,* 2013), however the introduction between 2015 and 2019 of the Common Fisheries Policy (CFP) Landings Obligation ('discard ban') will likely reduce the discard available and ultimately put more pressure on scavenging species.

10.4.2 Data limitations

10.4.2.1 Baseline characterisation of the Morgan Offshore Ornithology Array Area study area and resulting assessments of significance use site-specific data (digital aerial surveys) conducted over a period of 12 months (April 2021 to March 2022). As sampling is undertaken once a month for a period of 12 months, it may be considered to represent a snapshot of each month. Indeed, seabird numbers may fluctuate both spatially and temporally in response to environmental conditions. However, the sampling regime adopted at the Morgan Generation Assets is similar to other baseline characterisation surveys at offshore wind farms projects which have been previously agreed by SNCBs as suitable for baseline characterisation. Furthermore, the PEIR is based on the findings of the first 12 months of data (April 2021 to March 2022) as the rest of the surveys are ongoing and due to be completed in March 2023. However, the Environmental Statement will include 24 months of digital aerial surveys.

10.4.2.2 The level of precision of the abundance estimates is crucial as reliable abundance underpins the robustness of the predictions and the assessment of the effects on the IEFs. To characterise the baseline conditions, model-based estimates using the Marine Renewables Strategic environmental assessment (MRSea) package were produced in order to predict numbers across the survey area alongside 95% confidence intervals to provide a level of uncertainty. Design based estimates for bird numbers and densities in each month were also generated and compared to the MRSea estimates to provide additional validation of the MRSea outputs and provide estimates for months where low raw abundances prevented the use of the MRSea model. Flight heights for the sCRM were derived from the published literature rather than site-specific data. Generic flight height distributions published by Johnston *et al*. (2014a, 2014b) were therefore used in sCRM for this assessment. The application of site-specific flight height data collected by LiDAR survey was considered at the outset of the survey programme, but was not proceeded following consultation with Natural England. At the time of consultation, Natural England did not endorse the use of LiDAR as a method for collecting flight height data to parameterise CRMs due to the lack of an established body of scientific evidence. Other methods to collect site-specific flight height data (e.g. derived from aerial imagery) were not currently considered to be sufficiently robust or precise in their estimates and have associated issues with the application of appropriate avoidance rates. The use of generic flight heights conforms to current best practice and has been agreed through the Evidence Plan Process EWG as presented in section 10.3.

10.4.2.3 The impact of the short, medium and long-term effects of the 2022 Highly Pathogenic Avian Influenza (HPAI) outbreak on seabird colony abundance and vital rates (productivity and survival) on UK breeding colonies is unclear. It is also unclear how the distribution and abundance of seabirds at sea has been affected during the 2022 summer outbreak. The disease has affected 61 bird species, including species such as Northern gannet, razorbill, guillemot, puffin, manx shearwater, Northern fulmar and small and large gull species (BTO, 2022). The impact has affected Northern gannet and Great skua colonies profoundly, with both species now facing increased risk of global extinction (BTO, 2022) (the United Kingdom supports 55.6% of the global Northern gannet population and 60% of the global Great Skua population; JNCC, 2021). As HPAI remains a threat to UK breeding seabirds, it is expected that guidance and recommendations will be developed regarding the validity of digital aerial surveys data collected in summer 2022 and beyond.

10.5 Impact assessment methodology

10.5.1 Overview

10.5.1.1 The offshore ornithology impact assessment has followed the methodology set out in volume 1, chapter 5: EIA methodology of the PEIR. Specific to the offshore ornithology impact assessment, the following guidance documents have also been considered:

- Offshore Wind Marine Environmental Assessments: Best Practice Advice for Evidence and Data Standards. Phase I: Expectations for pre-application baseline data for designated nature conservation and landscape receptors to support offshore wind applications (Natural England, 2022a)
- Offshore Wind Marine Environmental Assessments: Best Practice Advice for Evidence and Data Standards. Phase II: Expectations for pre-application engagement and best practice guidance for the evidence plan process (Natural England, 2022b)

- Offshore Wind Marine Environmental Assessments: Best Practice Advice for Evidence and Data Standards. Phase III: Expectations for data analysis and presentation at examination for offshore wind applications (Natural England, 2022c).

10.5.1.2 In addition, the offshore ornithology impact assessment has considered the legislative framework as defined by:

- The Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019 and the 2017 Habitats Regulations
- European Commission ('EC') Directive 2009/147/EC (codified version of 79/409/EC) on the Conservation of Wild Birds (the 'Birds Directive')
- Ramsar Convention on Wetlands of International Importance 1971.

10.5.2 Impact assessment criteria

10.5.2.1 The criteria for determining the significance of effects is a two-stage process that involves defining the magnitude of the impacts and the sensitivity of the receptors. This section describes the criteria applied in this chapter to assign values to the magnitude of potential impacts and the sensitivity of the receptors. The terms used to define magnitude and sensitivity are based on those which are described in further detail in volume 1, chapter 5: EIA methodology of the PEIR.

10.5.2.2 The criteria for defining magnitude in this chapter are outlined in Table 10.14 below. This set of definitions has been determined on the basis of changes to bird populations.

Table 10.14: Definition of terms relating to the magnitude of an impact.

Magnitude of impact	Definition
High	A change in the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site that is predicted to irreversibly alter the population in the short to long term and to alter the long-term viability of the population and/or the integrity of the protected site. Impacts felt long-term. Impacts predicted to be reversed in the long-term (i.e. more than five years) following cessation of the project activity.
Medium	A change in the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site that occurs in the short and long-term, but which is not predicted to alter the long-term viability of the population and/or the integrity of the protected site. Impacts felt mediumt to long term. Impacts predicted to be reversed in the medium-term (i.e. no more than five years) following cessation of the project activity.
Low	A change in the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site that is sufficiently small-scale or of short duration to cause no long-term harm to the feature/population. Impacts present for a short to medium duration. Impacts predicted to be reversed in the short-term (i.e. no more than one year) following cessation of the project activity.
Negligible	Very slight change from the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site. Impacts present for a short duration Impacts predicted to be reversed rapidily (i.e. no more than circa six months) following cessation of the project related activity.
No change	No loss or alteration of characteristics, features or elements; no observable impact either adverse or beneficial.

10.5.2.3 The criteria for defining recoverability and sensitivity in this chapter are outlined in Table 10.15 and Table 10.16 below. The definition of sensitivity considers the vulnerability and recoverability of a receptor as well as taking into account the conservation importance of each receptor (outlined in Table 10.14).

10.5.2.4 It should be noted that high vulnerability and/or low recoverability are not necessarily linked with high conservation value within a particular impact. A receptor could be categorised as being of high conservation value (e.g. an interest feature of a SPA) but have a low or negligible physical/ecological vulnerability to an effect and vice versa. Determination of sensitivity takes these differing aspects into consideration.

Table 10.15: Definition of recoverability

Sensitivity	Definition
High	A species with a low to medium reproductive success and a stable or increasing UK trend in breeding abundance and productivity.
Medium	A species with a low reproductive success and a stable or increasing UK long-term trend in breeding abundance and productivity.
Low	A species with a low reproductive success and a declining UK long-term trend in breeding abundance and productivity or uncertainty regarding the the long-term trend (due to data availability).

Table 10.16: Definition of sensitivity of the receptor.

Sensitivity	Definition
Very High	Bird species has high conservation value, very high vulnerability to impact and has no ability to recover.
High	Bird species has high conservation value, medium vulnerability to impact and has low recoverability.
	Bird species has medium conservation value, high vulnerability to impact and has low recoverability.
Medium	Bird species has high conservation value, low vulnerbility to impact and has medium recoverability.
	Bird species has high conservation value, low vulnerability to impact and has low recoverability.
	Bird species has medium conservation value, high vulnerability to impact and has medium recoverability.
	Bird species has medium conservation value, medium vulnerability to impact and has medium recoverability.
	Bird species has medium conservation value, low vulnerability to impact and has medium recoverability.
Low	Bird species has medium conservation value, medium vulnerability to impact and high recoverability.
	Bird species has low conservation value, medium to high vulnerability to impact and medium to high recoverability.
Negligible	Bird species has low conservation value, low vulnerability to impact and medium to high recoverability.

Sensitivity	Definition
	Bird species is not vulnerable to impacts.

10.5.2.5 The conservation value of ornithological receptors is based on the population from which individuals are predicted to be drawn. This reflects current understanding of the movements of species, with site-based protection (e.g. SPAs) generally limited to specific periods of the year (e.g. the breeding season). Therefore, conservation value 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 estimated to be drawn. Conservation value therefore corresponds to the degree of connectivity which is predicted between the wind farm site 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 (Table 10.17).

Table 10.17: Definition of conservation values relating to the sensitivity of the receptor.

Sensitivity	Definition
High	A species for which individuals at risk can be clearly connected to a particular SPA.
Medium	A species for which individuals at risk are probably drawn from particular SPA populations, although other colonies (both SPA and non-SPA) may also contribute to individuals observed on the Morgan Generation Assets.
Low	A species for which it is not possible to identify the SPAs from which individuals on the Morgan Generation Assets have been drawn, or for which no SPAs are designated.

10.5.2.6 The significance of the effect upon offshore ornithology is determined by correlating the magnitude of the impact and the sensitivity of the receptor. The method employed for this assessment is presented in Table 10.18. Where a range of significance of effect is presented in Table 10.18, the final assessment for each effect is based upon expert judgement.

10.5.2.7 For the purposes of this assessment, any effects with a significance level of 'Moderate' or 'Major' have been concluded to be significant in terms of The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017.

Table 10.18: Matrix used for the assessment of the significance of the effect.

Sensitivity of Receptor	Magnitude of Impact				
	No Change	Negligible	Low	Medium	High
Negligible	No change	Negligible	Negligible or Minor	Negligible or Minor	Minor
Low	No change	Negligible or Minor	Negligible or Minor	Minor	Minor or Moderate
Medium	No change	Negligible or Minor	Minor	Moderate	Moderate or Major
High	No change	Minor	Minor or Moderate	Moderate or Major	Major
Very High	No change	Minor	Moderate or Major	Major	Major

10.5.3 Designated sites

10.5.3.1 Where National Site Network sites (i.e. internationally designated sites) are considered, this chapter summarises the assessments made on the interest features of internationally designated sites as described within section 10.4.3 of this chapter (with the assessment on the site itself deferred to the ISAA). With respect to nationally and locally designated sites, where these sites fall within the boundaries of an internationally designated site, only the international site has been taken forward for assessment. This is because potential effects on the integrity and conservation status of the nationally designated site are assumed to be inherent within the assessment of the internationally designated site (i.e. a separate assessment for the national site is not undertaken).

10.5.3.2 The ISAA is currently being prepared in accordance with Advice Note Ten: Habitats Regulations Assessment Relevant to Nationally Significant Infrastructure Projects (Planning Inspectorate, 2022) and will be submitted as part of the application for Development Consent.

10.6 Key parameters for assessment

10.6.1 Maximum design scenario

10.6.1.1 The maximum design scenarios (MDSs) identified in Table 10.19 have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. These scenarios have been selected from the Project Design Envelope provided in volume 1, chapter 3: Project description of the PEIR. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the Project Design Envelope (e.g. different infrastructure layout), to that assessed here be taken forward in the final design scheme.

Table 10.19: Maximum design scenario considered for the assessment of potential impacts on offshore ornithology.

[a] C=construction, O=operations and maintenance, D=decommissioning

Potential impact	Phase[a] C	O	D	Maximum Design Scenario	Justification
Disturbance and displacement from airborne noise, underwater sound, and presence of vessels and infrastructure.	✓	✓	✓	**Construction phase** Installation of wind turbines, Offshore Substation Platforms (OSPs), inter-array and interconnector cables in the Morgan Array Area of up to 322km^2. • Monopiles (spatial maximum) – Wind turbines: installation of up to 68 wind turbines with a 16m diameter monopile foundations installed by impact piling – OSPs: installation of one OSP with foundations consisting of two 16m diameter piled monopile foundations installed by impact piling – Maximum hammer energy up to 5,500kJ – Up to two vessels piling concurrently (minimum distance 875m, maximum distance 28.5km, between piling vessels) – Up to 9.5 hours of piling per monopile, with a realistic maximum of 6.4 hours – Assuming concurrent piling and two monopiles installed within 24 hours = 35 piling days. • Monopiles (temporal maximum) – Wind turbines: installation of up to 107 monopiles with up to 12m diameter piled monopile foundations – OSPs: installation of up to four OSPs with foundations consisting of four 12m diameter piled monopile foundations – Maximum hammer energy of up to 4,500kJ (wind turbine and OSP) – Single piling vessel – Up to 4.25 hours of piling per monopile (wind turbine and OSP) – Assuming one monopile installed within 24 hours = 111 piling days. • Pin piles (spatial maximum) – Wind turbines: installation up to 68 3-legged jacket foundations with either one or two piles per leg (a total of up to 408 piles) and each pile with a diameter of 5.5m installed by impact piling – OSP: installation of one OSP with 6-legged jacket foundations, with three piles per leg (a total of 18 piles) and each pile with a diameter of 5.5m – Maximum hammer energy of up to 3,700kJ – Up to two vessels piling concurrently (minimum distance 875m, maximum distance 28.5km, between piling vessels) – Up to 6.4 hours of piling per pin pile – Total duration of piling per OSP foundation =115.2 hours with total installation of up to 5 days. – Consecutive piling over a maximum of 24 hours. Single piling of 68 days for wind turbine plus approx. 5 days for OSP = 73 days (maximum temporal) or 37 days for two vessels (maximum spatial). • Pin piles (temporal maximum) – Wind turbines: installation of up to 107 piled 4-legged jacket foundations, with two piles per leg (a total of 856 piles) and each pile with a diameter of 3.2m – OSP: installation of up to four OSPs with piled 3-legged jacket foundations, with three piles per leg (a total of 36 piles) and each pile with a diameter of 3.5m – Maximum hammer energy of up to 1,900kJ (wind turbines and OSP) – Single piling vessel – Up to 8.02 hours of piling per pin pile (turbine and OSP) – Assuming single piling and four piles installed within 24 hours = 107 piling days.	Represents the maximum density of wind turbines and structures across the maximum Morgan Array Area that would cause greatest extent of disturbance and displacement to birds or the greatest duration of impact. Represents the maximum underwater sound impacts from impact piling for each of the relevant infrastructure foundation options. Represents the maximum number of vessel and helicopter movements that would cause greatest visual and noise disturbance and displacement to birds from the Morgan Array Area.

Potential impact	Phase[a]			Maximum Design Scenario	Justification
	C	O	D		
				• Total piling phase (foundation installation) of up to two years within a four-year construction programme • Up to 1,876 installation vessel movements (return trips) during construction (521 main installation and support vessels, 74 tug/anchor handlers, 8 cable lay installation and support vessels, 50 guard vessel, 29 survey vessels, 18 seabed preparation vessels, 1,135 CTVs, 42 scour protection installation vessels and 2 cable protection installation vessels) • Up to a total of 63 construction vessels on site at any one time • Up to 1,460 helicopter movements by up to 7 helicopters on site at any one time • Other activities: – Drilling of up to 107 4-legged wind turbine jacket foundations with pin pile diameter of 3.5m and four 4-legged OSP jacket foundations with a pin pile diameter of 3.5m; up to two concurrent drilling vessels • Maximum offshore construction duration of up to four years. **Operations and maintenance phase** Disturbance and displacement from presence of operations, wind turbines and associated operations and maintenance activity, including increased vessel, helicopter and inspection drone activity: • Presence of up to 107 operating wind turbines and four OSPs occupying the Morgan Array Area of up to 322km^2 • Minimum spacing of 875m between wind turbines • Up to 2,351 operations and maintenance vessel movements (return trips) each year • Up to a total of 21 operations and maintenance vessels on site at any one time • Up to 639 helicopter return trips per year with up to 7 on site at any one time • Up to 214 inspection drones return trips per year (operated from vessel, two inspections per wind turbine per year as a maximum) • Operational lifetime of up to 35 years. **Decommissioning phase** • Vessels used for a range of decommissioning activities such as removal of foundations • Noise from vessels assumed to be as per vessel activity described for construction phase above.	
Indirect impacts from underwater sound affecting prey species	✓	×	✓	**Construction phase** • As described in volume 2, chapter 8: Fish and shellfish ecology of the PEIR for: – Injury and/or disturbance to fish and shellfish from underwater sound and vibration. **Decommissioning phase** • As described in volume 2, chapter 8: Fish and shellfish ecology of the PEIR for: – Injury and/or disturbance to fish and shellfish from underwater sound and vibration.	As described in volume 2, chapter 8: Fish and shellfish ecology of the PEIR.
Temporary habitat loss/disturbance and increased suspended sediment concentrations (SSCs)	✓	✓	✓	**Construction phase** • As described in volume 2, chapter 8: Fish and shellfish ecology of the PEIR for: – Increased suspended sediment concentrations and associated sediment deposition. **Operations and maintenance phase** • As described in volume 2, chapter 8: Fish and shellfish ecology of the PEIR for: – Increased suspended sediment concentrations and associated sediment deposition. **Decommissioning phase** • As described in volume 2, chapter 8: Fish and shellfish ecology of the PEIR for: – Increased suspended sediment concentrations and associated sediment deposition.	As described in volume 2, chapter 8: Fish and shellfish ecology of the PEIR.
Collision risk	×	✓	×	**Operations and maintenance phase** • Presence of up to 107 wind turbines within the Morgan Array Area • Minimum lower blade tip height of 34m above LAT • Maximum hub height of 168m above LAT	The potential for collision risk is derived from wind turbines parameters including rotor diameter, chord width, rotor speed and minimum lower blade tip height. The parameters associated with the most numerous wind turbine parameters (107) represents the MDS because it will result in the greatest potential for collision risk.

Potential impact	Phase[a]			Maximum Design Scenario	Justification
	C	O	D		
				• Maximum blade tip height of 293m above LAT • Maximum rotor diameter of 250m • Maximum chord width of 6.8m • Maximum rotor speed of 8.4rpm (with maximum average speed of 6.4rpm) • Operational lifetime of up to 35 years.	
Barrier to movement	×	✓	×	**Operations and maintenance phase** • Presence of up to up to 107 wind turbines, four OSPs within the Morgan Array Area of 322km^2 with a minimum spacing of 1,000m between rows of wind turbines and 875m between wind turbines within a row.	Maximum density of wind turbines and structures across the Morgan Array Area, which maximises the potential barrier to foraging grounds and migration routes for bird species.

10.6.2 Impacts scoped out of the assessment

10.6.2.1 On the basis of the baseline environment and the description of development outlined in volume 1, chapter 3: Project description of the PEIR, a number of impacts are proposed to be scoped out of the assessment at the scoping stage for offshore ornithology. These impacts are outlined, together with a justification for scoping them out, in Table 10.20.

Table 10.20: Impacts scoped out of the assessment for offshore ornithology.

Potential impact	Justification
Direct disturbance and displacement impacts from underwater sound during operations and maintenance phases.	Underwater sound as a result of operation of the wind turbines is extremely unlikely to result in noise levels that would harm birds. In the unlikely event that such low levels of noise emission result in displacement of birds away from wind turbines, this impact would already be accounted for by the above-water operational displacement assessment.
Accidental pollution during all phases of the Morgan Generation Assets.	Pollution impacts (accidental oil/fuel spills) during all phases of the Morgan Generation Assets are scoped out on the basis that the implementation of a Marine Pollution Contingency Plan (MPCP) will avoid the risk of significant pollution events. Consequently, seabirds and shorebirds are extremely unlikely to be significantly affected by any such pollution impacts.
Indirect impact from underwater sound from wind turbine operation on prey fish species during operations and maintenance phase.	Noise generated by operational wind turbines is of a very low frequency and low sound pressure level (Andersson *et al*., 2011). Studies have found that sound levels are only high enough to possibly cause a behavioural reaction within metres from a wind turbine (Sigray and Andersson, 2011) and therefore such levels are not considered to have potentially significant effects on fish. The Marine Management Organisation (MMO, 2014) review of post-consent monitoring at offshore wind farms found that available data on the operational wind turbine noise, from the UK and abroad, in general showed that noise levels from operational wind turbines are low and the spatial extent of the potential impact of the operational noise is low. This is supported by project specific modelling which indicated that effects on fish (e.g. injury or behavioural effects) are unlikely to occur for the modelled operations wind turbines. See volume 3, annex 3.1: Underwater sound technical report of the PEIR for further detail.

10.7 Measures adopted as part of the Morgan Generation Assets

10.7.1.1 For the purposes of the EIA process, the term 'measures adopted as part of the project' is used to include the following measures (adapted from IEMA, 2016):

- Measures included as part of the project design. These include modifications to the location or design envelope of the Morgan Generation Assets which are integrated into the application for consent. These measures are secured through the consent itself through the description of the development and the parameters secured in the DCO and/or marine licences (referred to as primary mitigation in IEMA, 2016)
- Measures required to meet legislative requirements, or actions that are standard practice used to manage commonly occurring environmental effects and are secured through the DCO requirements and/or the conditions of the marine licences (referred to as tertiary mitigation in IEMA, 2016).

10.7.1.2 A number of measures (primary and tertiary) have been adopted as part of the Morgan Generation Assets to reduce the potential for impacts on offshore ornithology. These are outlined in Table 10.21 below. As there is a secured commitment to implementing these measures for the Morgan Generation Assets, they have been considered in the assessment presented in section 10.8 below (i.e. the determination of magnitude and therefore significance assumes implementation of these measures).

Table 10.21: Measures adopted as part of the Morgan Generation Assets.

Measures adopted as part of the Morgan Generation Assets	Justification	How the measure will be secured
Primary measures: Measures included as part of the project design		
Increasing air draught to reduce bird collision.	The Applicant has committed to a minimum lower blade tip height (air draught) of 34m above Lowest Astronomical Tide (LAT). Air draught is known to be an important factor for collision risk, with typically fewer collisions predicted with increasing air draught.	Proposed to be secured through a condition in the marine licence(s).
Tertiary measures: Measures required to meet legislative requirements, or adopted standard industry practice		
Offshore Environmental Management Plan (EMP) which will include measures to minimise disturbance to rafting birds from transiting vessels.	The development of and adherence to an offshore EMP which will include measures to minimise disturbance to rafting seabirds.	Proposed to be secured as a requriement of the DCO.
Offshore EMP	Implementation of an offshore EMP including a MPCP which will include planning for accidental spills, address all potential contaminant releases and include key emergency details.	Proposed to be secured as a requriement of the DCO.

10.8 Assessment of significant effects

10.8.1.1 The impacts of the construction, operations and maintenance, and decommissioning phases of the Morgan Generation Assets have been assessed on offshore ornithology. These potential impacts are listed in Table 10.19, along with the MDS against which each impact has been assessed.

10.8.1.2 A description of the potential effect on offshore ornithology receptors caused by each identified impact is given below.

10.8.1 Disturbance and displacement from airborne noise, underwater sound, and presence of vessels and infrastructure

10.8.1.1 The construction, operations and maintenance, and decommissioning phases of the Morgan Generation Assets may lead to disturbance and displacement of birds. The MDS is represented by the maximum density of wind turbines and structures across the maximum array area that would cause the greatest extent of disturbance and displacement to birds, or the greatest duration of impact. The MDS also represents the maximum underwater sound impacts from impact piling for each of the relevant infrastructure foundation options and the maximum number of vessel and helicopter movements that would cause greatest visual and noise disturbance and displacement to birds from the array area. The MDS is summarised in Table 10.19.

10.8.1.2 Disturbance as the result of activities during the construction, operations and maintenance and decommissioning phases of an offshore wind farm has the potential to displace seabirds from an area of sea in which the activity is occurring. In relation to offshore wind farm development, displacement is defined as a reduction in the number of seabirds occurring within or immediately adjacent to an offshore wind farm (Furness *et al*., 2013).

10.8.1.3 As the result of disturbance, displaced birds may move to areas already occupied by other birds and thus face higher intra- or inter-specific competition due to a higher density of individuals competing for the same resource. Alternatively, displaced birds may be forced to move into areas of lower quality (e.g. areas of lower prey availability). Such disturbance and resulting displacement could ultimately affect their demographic fitness (i.e. survival rates and breeding productivity) as well as potentially impacting on other birds in areas that displaced birds move to.

10.8.1.4 Disturbance as a result of activities during the construction of a wind farm (such as installing foundations, wind turbines, intra-array cabling and associated vessel movements) has the potential to displace birds. Construction activities then result in a point source of disturbance, for example when construction vessels are at a location to undertake piling and install foundations or the wind turbines. The level of disturbance associated with each location would vary depending on the activity undertaken. With regards to vessels in the Morgan Generation Assets, there is no method to quantify the displacement impact of the activities due to their highly local and temporary nature. An offshore EMP that includes measures to minimise disturbance to rafting birds from transiting vessels will be secured within the draft DCO and agreed pre-construction. It is expected that impacts of vessels on seabirds are negligible and this has not been taken forward to further assessment.

10.8.1.5 During the operations and maintenance phase, the presence of operational wind turbines has the potential to directly disturb seabirds leading to displacement from the offshore wind farm array area including an area of variable size or buffer around it (Dierschke *et al*., 2016). Therefore, the presence of wind turbines at the Morgan Array Area has the potential to directly disturb and displace seabirds that would normally reside within and around the area of sea. Additionally, activities associated with the operations and maintenance of wind turbines (e.g. vessel, helicopter and inspection drone activity) may disturb and displace species within the Morgan Array Area and potentially within surrounding buffers to a lower extent.

10.8.1.6 The displacement assessment for the Morgan Generation Assets is based on the use of the SNCB Matrix table approach, which was agreed during consultation with the Offshore Ornithology Expert Working Group on 13 July 2022 as part of the Evidence Plan process. As sensitivity to displacement differs considerably between seabird species, species were screened and progressed for the Matrix table approach using 'Disturbance Sensitivity' and 'Habitat Specialization' scores from Bradbury *et al*. (2014) and Wade *et al*. (2016) as recommended by the Joint SNCB Interim Displacement Advice Note (JNCC, 2017). In addition to the species' sensitivity rating, the abundance of birds in the Morgan Array Area was considered as to whether species were progressed to the matrix stage.

10.8.1.7 For each of the species considered (common guillemot, razorbill, Atlantic puffin, black-legged kittiwake, northern gannet and Manx shearwater, Table 10.9), displacement impacts were quantified for the population derived within the Morgan Array Area plus 2km buffer.

10.8.1.8 SNCBs recommend for most species a standard displacement buffer of 2km with the exception of the species groups of divers and seaducks as they can be affected at distances over 4km (Natural England, 2021). Red-throated diver and other seaducks were rarely recorded in the Morgan Offshore Ornithology Array Area study area during the baseline surveys and have therefore been excluded from the assessment of displacement from the Morgan Array area.

10.8.1.9 The full approach of the displacement assessment is detailed in volume 4, annex 10.2: Offshore ornithology displacement assessment of the PEIR.

Construction phase

Magnitude of impact

Common guillemot

10.8.1.10 The estimated mortality (when considering a displacement rate of 15 to 35% and a mortality rate of 1% to 10%) resulting from displacement during construction was assessed for each bio-season and for the combined bio-seasons (Table 10.22) as detailed in volume 4, annex 10.2: Offshore ornithology displacement assessment of the PEIR.

10.8.1.11 In both bio-seasons and for the combined bio-seasons, the predicted increase in the baseline mortality rate does not surpass the 1% threshold.

10.8.1.12 The impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.

Table 10.22: Common guillemot bio-season and annual displacement estimates for the Morgan Array Area plus 2km buffer during construction.

Bio-season	Seasonal Abundance (Morgan Array Area + 2km buffer)	Regional baseline population		Number of common guillemot subject to mortality (no. of indiv.)	Increase in baseline mortality (%)
		Population	Baseline mortality		
Breeding					
Mean	4,893	619,957	86,174	7 to 171	0.008 to 0.198
LCI	3,913	619,957	86,174	6 to 137	0.007 to 0.159
UCI	5,999	619,957	86,174	9 to 210	0.010 to 0.244
Non-breeding					
Mean	4,101	1,139,220	158,352	6 to 144	0.004 to 0.091
LCI	2,444	1,139,220	158,352	4 to 86	0.003 to 0.054

Bio-season	Seasonal Abundance (Morgan Array Area + 2km buffer)	Regional baseline population: Population	Regional baseline population: Baseline mortality	Number of common guillemot subject to mortality (no. of indiv.)	Increase in baseline mortality (%)
UCI	6,180	1,139,220	158,352	9 to 216	0.006 to 0.136
Annual (BMPS)					
Mean	8,994	1,139,220	158,352	13 to 315	0.008 to 0.199
LCI	6,357	1,139,220	158,352	10 to 223	0.006 to 0.141
UCI	12,179	1,139,220	158,352	18 to 426	0.011 to 0.269

Razorbill

10.8.1.13 The estimated mortality (when considering a displacement rate of 15 to 35% and a mortality rate of 1% to 10%) resulting from displacement during construction was assessed for each bio-season and for the combined bio-seasons (Table 10.23) as detailed in volume 4, annex 10.2: Offshore ornithology displacement assessment of the PEIR.

10.8.1.14 In all four bio-seasons (breeding, non-breeding, autumn, and spring migration) and for the combined bio-seasons, the predicted increase in the baseline mortality rate does not surpass the 1% threshold.

10.8.1.15 The impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.

Table 10.23: Razorbill bio-season and annual displacement estimates for the Morgan Array Area plus 2km buffer during construction.

Bio-season	Seasonal Abundance (Morgan Array Area + 2km buffer)	Regional baseline population: Population	Regional baseline population: Baseline mortality	Number of razorbill subject to mortality (indiv.)	Increase in baseline mortality (%)
Spring Migration					
Mean	166	606,914	105,603	0 to 6	0.000 to 0.006
LCI	63	606,914	105,603	0 to 2	0.000 to 0.002
UCI	317	606,914	105,603	0 to 11	0.000 to 0.010
Breeding					
Mean	120	281,276	48,942	0 to 4	0.000 to 0.008
LCI	52	281,276	48,942	0 to 2	0.000 to 0.004
UCI	195	281,276	48,942	0 to 7	0.000 to 0.014

Bio-season	Seasonal Abundance (Morgan Array Area + 2km buffer)	Regional baseline population: Population	Regional baseline population: Baseline mortality	Number of razorbill subject to mortality (indiv.)	Increase in baseline mortality (%)
Autumn Migration					
Mean	103	606,914	105,603	0 to 4	0.000 to 0.004
LCI	49	606,914	105,603	0 to 2	0.000 to 0.002
UCI	181	606,914	105,603	0 to 6	0.000 to 0.006
Non-breeding					
Mean	233	341,422	59,407	1 to 8	0.002 to 0.013
LCI	48	341,422	59,407	0 to 2	0.000 to 0.003
UCI	485	341,422	59,407	2 to 17	0.003 to 0.029
Annual (BDMPS)					
Mean	622	606,914	105,603	1 to 22	0.001 to 0.021
LCI	212	606,914	105,603	0 to 8	0.000 to 0.008
UCI	1,178	606,914	105,603	2 to 41	0.002 to 0.039

Atlantic puffin

10.8.1.16 The estimated mortality (when considering a displacement rate of 15 to 35% and a mortality rate of 1% to 10%) resulting from displacement during construction was assessed for each bio-season and for the combined bio-seasons (Table 10.24) as detailed further in volume 4, annex 10.2: Offshore ornithology displacement assessment of the PEIR.

10.8.1.17 In both bio-seasons and for the combined bio-seasons, the predicted increase in the baseline mortality rate does not surpass the 1% threshold.

10.8.1.18 The impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.

Table 10.24: Atlantic puffin bio-season and annual displacement estimates for the Morgan Array Area plus 2km buffer during construction.

Bio-season	Seasonal Abundance (Morgan Array Area + 2km buffer)	Regional baseline population Population	Baseline mortality	Number of Atlantic puffin subject to mortality (indiv.)	Increase in baseline mortality (%)
Breeding					
Mean	18	184,767	33,443	0 to 1	0.000 to 0.003
LCI	0	184,767	33,443	0 to 0	0.000 to 0.000
UCI	43	184,767	33,443	0 to 2	0.000 to 0.006
Non-breeding					
Mean	0	304,557	55,125	0 to 0	0.000 to 0.000
LCI	0	304,557	55,125	0 to 0	0.000 to 0.000
UCI	0	304,557	55,125	0 to 0	0.000 to 0.000
Annual (BDMPS)					
Mean	18	304,557	55,125	0 to 1	0.000 to 0.002
LCI	0	304,557	55,125	0 to 0	0.000 to 0.000
UCI	43	304,557	55,125	0 to 2	0.000 to 0.004

Northern gannet

10.8.1.19 The estimated mortality (when considering a displacement rate of 30% to 40% and a mortality rate of 1% to 10%) resulting from displacement during construction was assessed for each bio-season and for the combined bio-seasons (Table 10.25) as detailed further in volume 4, annex 10.2: Offshore ornithology displacement assessment of the PEIR.

10.8.1.20 In all three bio-seasons (spring, breeding and autumn) and for the combined bio-seasons, the predicted increase in the baseline mortality rate does not surpass the 1% threshold.

10.8.1.21 The impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.

Table 10.25: Northern gannet bio-season and annual displacement estimates for the Morgan Array Area plus 2km buffer during construction.

Bio-season	Seasonal Abundance (Morgan Array Area + 2km buffer)	Regional baseline population Population	Baseline mortality	Number of Northern gannet subject to mortality (indiv.)	Increase in baseline mortality (%)
Spring Migration					
Mean	53	661,888	123,773	0 to 2	0.000 to 0.002
LCI	15	661,888	123,773	0 to 1	0.000 to 0.001
UCI	105	661,888	123,773	0 to 4	0.000 to 0.003
Breeding					
Mean	209	448,235	83,820	1 to 8	0.001 to 0.010
LCI	131	448,235	83,820	0 to 5	0.000 to 0.006
UCI	305	448,235	83,820	1 to 12	0.001 to 0.014
Autumn Migration					
Mean	192	545,954	102,093	1 to 8	0.001 to 0.008
LCI	93	545,954	102,093	0 to 4	0.000 to 0.004
UCI	346	545,954	102,093	1 to 14	0.001 to 0.014
Annual (BDPMS)					
Mean	454	661,888	123,773	2 to 18	0.002 to 0.015
LCI	239	661,888	123,773	0 to 10	0.000 to 0.008
UCI	756	661,888	123,773	2 to 30	0.002 to 0.024

Black-legged kittiwake

10.8.1.22 The estimated mortality (when considering a displacement rate of 15% to 35% and a mortality rate of 1% to 10%) resulting from displacement during construction was assessed for each bio-season and for the combined bio-seasons (Table 10.26) as detailed further in volume 4, annex 10.2: Offshore ornithology displacement assessment of the PEIR.

10.8.1.23 In all three bio-seasons (spring, breeding and autumn) and for the combined bio-seasons, the predicted increase in the baseline mortality rate does not surpass the 1% threshold.

10.8.1.24 The impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.

Table 10.26: Black-legged kittiwake bio-season and annual displacement estimates for the Morgan Array Area plus 2km buffer during construction.

Bio-season	Seasonal Abundance (Morgan Array Area + 2km buffer)	Regional baseline population Population	Baseline mortality	Number of black-legged kittiwake subject to mortality (indiv.)	Increase in baseline mortality (%)
Spring Migration					
Mean	645	691,526	108,570	1 to 23	0.001 to 0.021
LCI	438	691,526	108,570	1 to 15	0.001 to 0.014
UCI	895	691,526	108,570	1 to 31	0.001 to 0.029
Breeding					
Mean	460	397,251	62,368	1 to 16	0.002 to 0.026
LCI	317	397,251	62,368	0 to 11	0.000 to 0.018
UCI	631	397,251	62,368	1 to 22	0.002 to 0.035
Autumn Migration					
Mean	1,619	911,586	143,119	2 to 57	0.001 to 0.040
LCI	1,190	911,586	143,119	2 to 42	0.001 to 0.029
UCI	2,319	911,586	143,119	3 to 81	0.002 to 0.057
Annual (BDPMS)					
Mean	2,724	911,586	143,119	4 to 96	0.003 to 0.067
LCI	1,945	911,586	143,119	3 to 68	0.002 to 0.048
UCI	3,945	911,586	143,119	5 to 134	0.003 to 0.094

Manx shearwater

10.8.1.25 The estimated mortality (when considering a displacement rate of 1% to 10% and a mortality rate of 0% to 5%) resulting from displacement during construction was assessed for each bio-seasons and for the combined bio-seasons (Table 10.27) as detailed further in volume 4, annex 10.2: Offshore ornithology displacement assessment of the PEIR.

10.8.1.26 In all three bio-seasons (spring, breeding and autumn) and for the combined bio-seasons, the predicted increase in the baseline mortality rate does not surpass the 1% threshold.

10.8.1.27 The impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.

Table 10.27: Manx shearwater bio-season and annual displacement estimates for the Morgan Array Area plus 2km buffer during construction.

Bio-season	Seasonal Abundance (Morgan Array Area + 2km buffer)	Regional baseline population Population	Baseline mortality	Number of Manx shearwater subject to mortality (indiv.)	Increase in baseline mortality (%)
Spring Migration					
Mean	59	1,580,895	207,097	0 to 1	0.000 to 0.000
LCI	19	1,580,895	207,097	0 to 0	0.000 to 0.000
UCI	165	1,580,895	207,097	0 to 2	0.000 to 0.001
Breeding					
Mean	467	1,974,500	258,660	0 to 5	0.000 to 0.002
LCI	220	1,974,500	258,660	0 to 2	0.000 to 0.001
UCI	1,828	1,974,500	258,660	2 to 18	0.001 to 0.007
Autumn Migration					
Mean	467	1,580,895	207,097	0 to 5	0.000 to 0.002
LCI	138	1,580,895	207,097	0 to 1	0.000 to 0.000
UCI	1,828	1,580,895	207,097	2 to 18	0.001 to 0.009
Annual (BDPMS)					
Mean	993	1,974,500	258,660	0 to 11	0.000 to 0.004
LCI	377	1,974,500	258,660	0 to 3	0.000 to 0.001
UCI	3,813	1,974,500	258,660	2 to 38	0.001 to 0.015

Sensitivity of the receptor

Common guillemot

10.8.1.28 According to Wade *et al*. (2016), common guillemot are considered to be sensitive to disturbance from vessels and helicopters at offshore wind farms, with a vulnerability score of three (out of five). Whilst there is evidence from studies that common guillemot respond negatively to vessel traffic (Ranconi and St. Clair, 2002), behavioural response to underwater and airborne sounds resulting from construction activities are unknown. Although common guillemot are likely to respond to visual stimuli during the construction phase, the impacts of disturbance/displacement are short-term and common guillemot have the ability to return to the baseline abundance and distribution after construction.

10.8.1.29 Although the species has a low reproductive success (i.e. laying one egg and not breeding until five years old) (Robinson, 2005), common guillemot have a medium recoverability given their increasing trend in abundance and productivity in the UK (JNCC, 2020).

10.8.1.30 Common guillemot is a qualifying interest for several SPAs likely to be connected to the Morgan Array Area (within the mean-max + SD foraging range), however as large colonies from non-SPA sites are also within close proximity (e.g. St Bee's Head, Muck Island and Larne Lough to Portmuck) the species is considered to be of medium value.

10.8.1.31 Common guillemot is deemed to be of medium vulnerability, medium recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **medium**.

Razorbill

10.8.1.32 As with common guillemot, razorbill are deemed to be sensitive to disturbance from vessels and helicopters at offshore wind farms, with a vulnerability score of three (out of five). Although razorbill are likely to respond to visual stimuli during the construction, the impacts of disturbance/displacement are short-term and razorbill have the ability to return to the baseline conditions after construction.

10.8.1.33 Although the species has a low reproductive success (only laying one egg) and does not breed until four years old (Robinson, 2005), razorbill are deemed to have a medium recoverability given their increasing trend in abundance in the UK (JNCC, 2020).

10.8.1.34 Razorbill is a qualifying interest for several SPAs likely to be connected to the Morgan Array Area (within the mean-max + SD foraging range), however as large colonies from several non-SPA colonies are also within range of the Morgan Array Area (e.g. Muck Island and Larne Lough to Portmuck) the species is considered to be of medium value.

10.8.1.35 Razorbill is deemed to be of medium vulnerability, medium recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **medium**.

Atlantic puffin

10.8.1.36 Together with other auk species, Atlantic puffin are considered to be sensitive to disturbance from vessel and helicopter at offshore wind farm. The species is assigned a vulnerability score of three (out of five) by Wade *et al*. (2016).

10.8.1.37 Although Atlantic puffin are likely to respond to visual stimuli during the construction, the impacts of disturbance/displacement are short-term and the population using the Morgan Array Area has the ability to return to the baseline conditions after construction.

10.8.1.38 Atlantic puffin has a low reproductive success (i.e., laying one egg and not breeding until five years old) (Robinson, 2005) and are deemed to have a low recoverability given the lack of up-to-date census of the size of the UK breeding population and the overall declining trend in abundance (1986-2018) (JNCC, 2020).

10.8.1.39 Atlantic puffin is a qualifying interest for several SPAs likely to be connected to the Morgan Array Area (within the mean-max + SD foraging range), with low to no Atlantic puffin likely coming from the few non-SPA sites within foraging range due to those non-SPA sites consisting of less than 100 birds. The species is therefore considered to be of high value.

10.8.1.40 Atlantic puffin is deemed to be of medium vulnerability, low recoverability and high value. The sensitivity of the receptor is therefore, considered to be **high**.

Northern gannet

10.8.1.41 Northern gannet are considered to have a medium sensitivity to other sources of disturbance such as ship and helicopter traffic (Garthe and Hüppop, 2004; Furness and Wade, 2012), and so northern gannet are considered to be of medium vulnerability.

10.8.1.42 Although northern gannet has a low reproductive success (only laying one egg) and does not breed until five years old (Robinson, 2005), the species is deemed to have a medium recoverability given the consistent increasing trend in abundance since the 1990s (JNCC, 2020). However, the species has suffered significant losses from the outbreak of HPAI during the 2022 breeding season, with it being estimated that around at least 25% of Northern gannet within the UK have died due to the disease. It is yet still unclear how badly abundances at colonies around the coast have been affected.

10.8.1.43 Northern gannet is a qualifying interest for several SPAs likely to be connected to the Morgan Array Area (within the mean-max + SD foraging range), with a large non-SPA colony within close proximity (Monreith Cliffs and Scar Rocks), the species is therefore considered to be of medium value.

10.8.1.44 Northern gannet is deemed to be of medium vulnerability, medium recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **medium**.

Black-legged kittiwake

10.8.1.45 In terms of behavioural responses to vessel and helicopter at offshore wind farms, black-legged kittiwake are considered to be of low to medium vulnerability to displacement (with a score of two out of five) by Wade *et al*. (2016).

10.8.1.46 Although the reproductive success of black-legged kittiwake is higher (i.e. laying two eggs and breeding until four years old) than auk species and northern gannet (Robinson, 2005), the species is deemed to have a low recoverability given the continuing decline in abundance observed between 1986 and 2018 in the UK (JNCC, 2020). During this period, breeding productivity has declined as the result of food shortage, although it has stabilised in recent years (JNCC, 2020).

10.8.1.47 Black-legged kittiwake is a qualifying interest for several SPAs likely to be connected to the Morgan Array Area (within the mean-max + SD foraging range), with several non-SPA colonies within range and so the species is considered to be of medium value.

10.8.1.48 Black-legged kittiwake is deemed to be of low vulnerability, low recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **medium**.

Manx shearwater

10.8.1.49 In terms of behavioural responses to vessel and helicopter at offshore wind farms, Manx shearwater are considered to be of low vulnerability to displacement (score of one) by Wade *et al*. (2016).

10.8.1.50 Owing to their large foraging range, Manx shearwater is a qualifying interest for several SPAs likely to be connected to the Morgan Array Area (within the mean-max

+ SD foraging range). Most of the world population is found in the UK and over 90% of the UK population is found on the Islands of Rum and Eigg (Scotland) and Skomer and Skokholm (Wales) (Mitchell *et al*., 2004; JNCC, 2020). Therefore, the species is considered to be of high value.

10.8.1.51 Manx shearwater has a low reproductive success (i.e. only laying one egg and not breeding until five years old; Robinson, 2005). There is an incomplete spatial-temporal coverage of breeding abundance at UK colonies and thus a lack of long-term trend (JNCC, 2020). In the light of uncertainly and low reproductive success, Manx shearwater are therefore deemed to have a low recoverability.

10.8.1.52 Manx shearwater is deemed to be of low vulnerability, low recoverability and high value. The sensitivity of the receptor is therefore, considered to be **medium.**

Significance of the effect

10.8.1.53 Given that construction activities will only take place within a small area of the site at any time, displaced birds will be able to resettle within the Morgan Array Area or beyond. As alternative habitats exist, species shown in Table 10.26 are therefore not predicted to suffer a significant decline in bird fitness at a population level. Indeed, the displacement assessment analysis showed the magnitude of the increase in mortality to be negligible and below the 1% threshold increase for the species assessed in Table 10.28. For common guillemot, which had a magnitude of impact of negligible and sensitivity of medium, negligible was selected from the negligible to minor range due to the impact not exceeding a 0.5% increase in baseline mortality. Additionally, the population is vast and a change in baseline mortality greater than 0.1% would be unnoticeable and hence, was not regarded as a minor significance of effect. For razorbill, northern gannet, black-legged kittiwake and Manx shearwater, which had a magnitude of impact of negligible and sensitivity of medium, negligible was selected from the negligible to minor range due to the impact not exceeding a 0.1% increase in baseline mortality and hence, was not regarded as a minor significance of effect.

Table 10.28: Table summarising the significance of effect during construction.

Species	Magnitude of impact	Sensitivity of receptor	Significance of effect
Common guillemot	Negligible	Medium	**Negligible, not significant in EIA terms**
Razorbill	Negligible	Medium	**Negligible, not significant in EIA terms**
Atlantic puffin	Negligible	High	**Minor adverse, not significant in EIA terms**
Northern gannet	Negligible	Medium	**Negligible, not significant in EIA terms**
Black-legged kittiwake	Negligible	Medium	**Negligible, not significant in EIA terms**
Manx shearwater	Negligible	Medium	**Negligible, not significant in EIA terms**

Operations and maintenance phase

Magnitude of impact

Common guillemot

10.8.1.54 The estimated mortality (when considering a displacement rate of 30% to 70% and a mortality rate of 1% to 10%) resulting from displacement during operations was assessed for each bio-season and for the combined bio-seasons (Table 10.29) as detailed in volume 4, annex 10.2: Offshore ornithology displacement assessment of the PEIR.

10.8.1.55 In both bio-seasons and for the combined bio-seasons, the predicted increase in the baseline mortality rate does not surpass the 1% threshold increase.

10.8.1.56 The impact is predicted to be of local spatial extent, medium-term duration, continuous and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.

Table 10.29: Common guillemot bio-seasons and annual displacement estimates for the Morgan Array Area plus 2km buffer during operations.

Bio-season	Seasonal Abundance (Morgan Array Area + 2km buffer)	Regional baseline population		Number of common guillemot subject to mortality (indiv.)	Increase in baseline mortality (%)
		Population	Baseline mortality		
Breeding					
Mean	4,893	619,957	86,174	15 to 343	0.017 to 0.398
LCI	3,913	619,957	86,174	12 to 274	0.014 to 0.318
UCI	5,999	619,957	86,174	18 to 420	0.021 to 0.487
Non-breeding					
Mean	4,101	1,139,220	158,352	12 to 287	0.008 to 0.181
LCI	2,444	1,139,220	158,352	7 to 171	0.004 to 0.108
UCI	6,180	1,139,220	158,352	19 to 433	0.012 to 0.273
Annual (BMPS)					
Mean	8,994	1,139,220	158,352	27 to 630	0.017 to 0.398
LCI	6,357	1,139,220	158,352	19 to 445	0.012 to 0.281
UCI	12,179	1,139,220	158,352	37 to 853	0.023 to 0.539

Razorbill

10.8.1.57 The estimated mortality (when considering a displacement rate of 30% to 70% and a mortality rate of 1% to 10%) resulting from displacement during operation was assessed for each bio-season and for the combined bio-seasons (Table 10.30) as detailed in volume 4, annex 10.2: Offshore ornithology displacement assessment.

10.8.1.58 In all bio-seasons and for all bio-seasons combined, the predicted increase in the baseline mortality rate does not surpass the 1% threshold increase.

The impact is predicted to be of local spatial extent, medium-term duration, continuous and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.

Table 10.30: Razorbill bio-seasons and annual displacement estimates for the Morgan Array Area plus 2km buffer during operation.

Bio-season	Seasonal Abundance (Morgan Array Area + 2km buffer)	Regional baseline population: Population	Regional baseline population: Baseline mortality	Number of razorbill subject to mortality (indiv.)	Increase in baseline mortality (%)
Spring Migration					
Mean	166	606,914	105,603	0 to 7	0.000 to 0.007
LCI	63	606,914	105,603	0 to 3	0.000 to 0.003
UCI	317	606,914	105,603	1 to 13	0.001 to 0.012
Breeding					
Mean	120	281,276	48,942	0 to 5	0.000 to 0.010
LCI	52	281,276	48,942	0 to 2	0.000 to 0.004
UCI	195	281,276	48,942	0 to 8	0.000 to 0.016
Autumn Migration					
Mean	103	606,914	105,603	0 to 4	0.000 to 0.004
LCI	49	606,914	105,603	0 to 2	0.000 to 0.002
UCI	181	606,914	105,603	0 to 7	0.000 to 0.007
Non-breeding					
Mean	233	341,422	59,407	0 to 9	0.000 to 0.015
LCI	48	341,422	59,407	0 to 2	0.000 to 0.003
UCI	485	341,422	59,407	1 to 19	0.002 to 0.032
Annual (BDMPS)					
Mean	622	606,914	105,603	0 to 25	0.000 to 0.024
LCI	212	606,914	105,603	0 to 9	0.000 to 0.009
UCI	1,178	606,914	105,603	2 to 47	0.002 to 0.045

Atlantic puffin

10.8.1.59 The estimated mortality (when considering a displacement rate of 30% to 70% and a mortality rate of 1% to 10 %) resulting from displacement during operation was assessed for each bio-season and for the combined bio-seasons (Table 10.31) as detailed in volume 4, annex 10.2: Offshore ornithology displacement assessment of the PEIR.

10.8.1.60 In both bio-seasons and for all bio-seasons combined, the predicted increase in baseline mortality does not surpass the 1% increase threshold.

10.8.1.61 The impact is predicted to be of local spatial extent, medium-term duration, continuous and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible.**

Table 10.31: Atlantic puffin bio-seasons and annual displacement estimates for the Morgan Array Area plus 2km buffer during operation.

Bio-season	Seasonal Abundance (Morgan Array Area + 2km buffer)	Regional baseline population: Population	Regional baseline population: Baseline mortality	Number of Atlantic puffin subject to mortality (indiv.)	Increase in baseline mortality (%)
Breeding					
Mean	18	184,767	33,443	0 to 1	0.000 to 0.003
LCI	0	184,767	33,443	0 to 0	0.000 to 0.000
UCI	43	184,767	33,443	0 to 2	0.000 to 0.006
Non-breeding					
Mean	0	304,557	55,125	0 to 0	0.000 to 0.000
LCI	0	304,557	55,125	0 to 0	0.000 to 0.000
UCI	0	304,557	55,125	0 to 0	0.000 to 0.000
Annual (BDMPS)					
Mean	18	304,557	55,125	0 to 1	0.000 to 0.002
LCI	0	304,557	55,125	0 to 0	0.000 to 0.000
UCI	43	304,557	55,125	0 to 2	0.000 to 0.004

Northern gannet

10.8.1.62 The estimated mortality (when considering a displacement rate of 60% to 80% and a mortality rate of 1% to 10%) resulting from displacement during operation was assessed for each bio-season and for the combined bio-seasons (Table 10.32) as detailed in volume 4, annex 10.2: Offshore ornithology displacement assessment.

10.8.1.63 In all three bio-seasons (spring, breeding and autumn) and for the bio-seasons combined, the predicted increase in baseline mortalities remains well the below the 1% increase threshold.

10.8.1.64 The impact is predicted to be of local spatial extent, medium-term duration, continuous and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be negligible.

Table 10.32: Northern gannet bio-seasons and annual displacement estimates for the Morgan Array Area plus 2km buffer during operation.

Bio-season	Seasonal Abundance (Morgan Array Area + 2km buffer)	Regional baseline population		Number of Northern gannet subject to mortality (indiv.)	Increase in baseline mortality (%)
		Population	Baseline mortality		
Spring Migration					
Mean	53	661,888	123,773	0 to 4	0.000 to 0.003
LCI	15	661,888	123,773	0 to 1	0.000 to 0.001
UCI	105	661,888	123,773	1 to 8	0.001 to 0.006
Breeding					
Mean	209	448,235	83,820	1 to 15	0.001 to 0.018
LCI	131	448,235	83,820	1 to 10	0.001 to 0.012
UCI	305	448,235	83,820	2 to 24	0.002 to 0.029
Autumn Migration					
Mean	192	545,954	102,093	1 to 15	0.001 to 0.015
LCI	93	545,954	102,093	1 to 7	0.001 to 0.007
UCI	346	545,954	102,093	2 to 28	0.002 to 0.027
Annual (BDPMS)					
Mean	454	661,888	123,773	2 to 36	0.002 to 0.029
LCI	239	661,888	123,773	2 to 18	0.002 to 0.015
UCI	756	661,888	123,773	5 to 60	0.004 to 0.048

Black-legged kittiwake

10.8.1.65 The estimated mortality (when considering a displacement rate of 30% to 70% and a mortality rate of 1% to 10%) resulting from displacement during operation was assessed for each bio-season and for the combined bio-seasons (Table 10.33) as detailed in volume 4, annex 10.2: Offshore ornithology displacement assessment.

10.8.1.66 In all three bio-seasons (spring, breeding and autumn) and all bio-seasons combined, the predicted increase in baseline mortalities remains well below the 1% increase threshold.

The impact is predicted to be of local spatial extent, medium-term duration, continuous and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is, therefore, considered to be **negligible.**

Table 10.33: Black-legged kittiwake bio-seasons and annual displacement estimates for the Morgan Array Area plus 2km buffer during operation.

Bio-season	Seasonal Abundance (Morgan Array Area + 2km buffer)	Regional baseline population		Number of black-legged kittiwake subject to mortality (indiv.)	Increase in baseline mortality (%)
		Population	Baseline mortality		
Spring Migration					
Mean	645	691,526	108,570	2 to 45	0.002 to 0.041
LCI	438	691,526	108,570	1 to 31	0.001 to 0.029
UCI	895	691,526	108,570	3 to 63	0.003 to 0.058
Breeding					
Mean	460	397,251	62,368	1 to 32	0.002 to 0.051
LCI	317	397,251	62,368	1 to 22	0.002 to 0.035
UCI	631	397,251	62,368	2 to 44	0.003 to 0.071
Autumn Migration					
Mean	1,619	911,586	143,119	5 to 113	0.003 to 0.079
LCI	1,190	911,586	143,119	4 to 83	0.003 to 0.058
UCI	2,319	911,586	143,119	7 to 162	0.005 to 0.113
Annual (BDPMS)					
Mean	2,724	911,586	143,119	8 to 176	0.006 to 0.123
LCI	1,945	911,586	143,119	6 to 127	0.004 to 0.089
UCI	3,945	911,586	143,119	11 to 250	0.008 to 0.175

Manx shearwater

10.8.1.67 The estimated mortality (when considering a displacement rate of 1% to 10% and a mortality rate of 1% to 10%) resulting from displacement during operation was assessed for each bio-season and for the combined bio-seasons (Table 10.34) as detailed in volume 4, annex 10.2: Offshore ornithology displacement assessment.

10.8.1.68 In all three bio-seasons (spring, breeding season and autumn migration) and for all bio-seasons combined, the predicted increase in baseline mortalities does not surpass the 1% increase threshold.

10.8.1.69 The impact is predicted to be of local spatial extent, medium-term duration, continuous and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible.**

Table 10.34: Manx shearwater bio-seasons and annual displacement estimates for the Morgan Array Area plus 2km buffer during operation.

Bio-season	Seasonal Abundance (Morgan Array Area + 2km buffer)	Regional baseline population Population	Baseline mortality	Number of Manx shearwater subject to mortality (indiv.)	Increase in baseline mortality (%)
Spring Migration					
Mean	59	1,580,895	207,097	0 to 1	0.000 to 0.000
LCI	19	1,580,895	207,097	0 to 0	0.000 to 0.000
UCI	165	1,580,895	207,097	0 to 2	0.000 to 0.001
Breeding					
Mean	467	1,974,500	258,660	0 to 5	0.000 to 0.002
LCI	220	1,974,500	258,660	0 to 2	0.000 to 0.001
UCI	1,828	1,974,500	258,660	2 to 18	0.001 to 0.009
Autumn Migration					
Mean	467	1,580,895	207,097	0 to 5	0.000 to 0.002
LCI	138	1,580,895	207,097	0 to 1	0.000 to 0.000
UCI	1,828	1,580,895	207,097	2 to 18	0.000 to 0.007
Annual (BDPMS)					
Mean	993	1,974,500	258,660	0 to 11	0.000 to 0.004
LCI	377	1,974,500	258,660	0 to 3	0.000 to 0.001
UCI	3,813	1,974,500	258,660	2 to 38	0.001 to 0.015

Sensitivity of receptor

Common guillemot

10.8.1.70 Common guillemot is considered to have a high vulnerability to displacement from offshore wind farms, being assigned a score of 4 (out of 5) by Wade *et al.* (2016).

10.8.1.71 Although the species has a low reproductive success (i.e., laying one egg and not breeding until five years old; Robinson, 2005), common guillemot have a medium recoverability given their increasing trend in abundance and productivity in the UK (JNCC, 2020).

10.8.1.72 Common guillemot is a qualifying interest for several SPAs likely to be connected to the Morgan Array Area (within the mean-max + SD foraging range), however as large colonies from non-SPA sites are also within close proximity (e.g. St Bee's Head) the species is considered to be of medium value.

10.8.1.73 Common guillemot is deemed to be of high vulnerability, medium recoverability and medium value. The sensitivity of the receptor is, therefore, considered to be **medium**.

Razorbill

10.8.1.74 Razorbill is considered to have a high vulnerability to displacement from offshore wind farms, being assigned a score of 4 (out of 5) by Wade *et al*. (2016).

10.8.1.75 Although the species has a low reproductive success (Robinson, 2005), razorbill are deemed to have a medium recoverability given their increasing trend in abundance in the UK (JNCC, 2020).

10.8.1.76 Razorbill is a qualifying interest for several SPAs likely to be connected to the Morgan Array Area (within the mean-max + SD foraging range), however as several non-SPA colonies are also within range of the Morgan Array Area, the species is considered to be of medium value.

10.8.1.77 Razorbill is deemed to be of high vulnerability, medium recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **medium**.

Atlantic puffin

10.8.1.78 Atlantic puffin is considered to have a medium vulnerability to displacement from offshore wind farms, being assigned a score of 3 (out of 5) by Wade *et al*. (2016).

10.8.1.79 Although the species has a low reproductive success (i.e. laying one egg and not breeding until five years old) (Robinson, 2005), Atlantic puffin are deemed to have a low recoverability given the lack of up-to-date census of the size of the UK breeding population and the overall declining trend in abundance (1986-2018) (JNCC, 2020).

10.8.1.80 As Atlantic puffin is a qualifying interest for several SPAs likely to be connected to the Morgan Array Area (within the mean-max + SD foraging range) the species is considered to be of high value.

10.8.1.81 Atlantic puffin is deemed to be of medium vulnerability, low recoverability and high value. The sensitivity of the receptor is therefore, considered to be **high**.

Northern gannet

10.8.1.82 In terms of behavioural response to wind farm structures, Northern gannet are considered to be of high vulnerability, with a score of four out of five assigned by Wade *et al*. (2016). During the breeding season, northern gannet showed a strong avoidance of offshore wind farms (Peschko *et al*., 2021).

10.8.1.83 Northern gannet is a qualifying interest for several SPAs likely to be connected to the Morgan Array Area (within the mean-max + SD foraging range), with a large non-SPA colony within close proximity (Monreith Cliffs and Scar Rocks), the species is therefore considered to be of medium value.

10.8.1.84 Although northern gannet has a low reproductive success (only laying one egg) and does not breed until five years old (Robinson, 2005), the species is deemed to have a medium recoverability given the consistent increasing trend in abundance since the 1990s (JNCC, 2020). However, the species has suffered from the outbreak of avian flu during the 2022 breeding season.

10.8.1.85 Northern gannet is deemed to be of high vulnerability, medium recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **medium**.

Black-legged kittiwake

10.8.1.86 In terms of behavioural response to wind farm structures, black-legged kittiwake are considered to be of low vulnerability, with a score of two (out of five) assigned by Wade *et al.* (2016).

10.8.1.87 Black-legged kittiwake is a qualifying interest for several SPAs likely to be connected to the Morgan Array Area (within the mean-max + SD foraging range), with several non-SPA colonies within range and so the species is considered to be of medium value.

10.8.1.88 Although the reproductive success of black-legged kittiwake is higher (i.e. laying two eggs and breeding until four years old) than auk species and northern gannet (Robinson, 2005), the species is deemed to have a low recoverability given the continuing decline in abundance observed between 1986 and 2018 in the UK (JNCC, 2020). During this period, breeding productivity has declined as the result of food shortage, although it has stabilised in recent years (JNCC, 2020).

10.8.1.89 Black-legged kittiwake is deemed to be of low vulnerability, low recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **medium**.

Manx shearwater

10.8.1.90 In terms of behavioural responses to vessel and helicopter at offshore wind farms, Manx shearwater are considered to be of very low vulnerability to displacement (score of one) by Wade *et al*. (2016).

10.8.1.91 Owing to their large foraging range, Manx shearwater is a qualifying interest for several SPAs likely to be connected to the Morgan Array Area (within the mean-max + SD foraging range). Most of the world population is found in the UK and over 90% of the UK population is found on the Islands of Rum and Eigg (Scotland) and Skomer and Skokholm (Wales) (Mitchell *et al*., 2004; JNCC, 2020). Therefore, the species is considered to be of high value.

10.8.1.92 Manx shearwater has a low reproductive success (i.e. only laying one egg and not breeding until five years old) (Robinson, 2005). There is an incomplete spatial-temporal coverage of breeding abundance at UK colonies and thus a lack of long-term trend (JNCC, 2020). In the light of uncertainly and low reproductive success, Manx shearwater are therefore deemed to have a medium recoverability.

10.8.1.93 Manx shearwater is deemed to be of low vulnerability, medium recoverability and high value. The sensitivity of the receptor is therefore, considered to be **medium.**

Significance of effect

10.8.1.94 The period of time and constancy that individuals within a population may be subject to displacement impacts is uncertain. It is likely that the impacts will be felt at greatest intensity during the first year of exposure, before there is any opportunity for habituation. Mortality is likely to be greatest in this year while in subsequent years it is possible that birds may become habituated to a certain extent, thereby reducing mortality rates.

10.8.1.95 Indeed, the displacement assessment analysis during the operational phase showed the magnitude of the increase in mortality to be negligible and below the 1% threshold increase for the species assessed in Table 10.35. For common guillemot, which had a magnitude of impact of negligible and sensitivity of medium, negligible was selected from the negligible to minor range due to the impact not exceeding a 0.5% increase in baseline mortality. Additionally, the population is vast and a change in baseline mortality greater than 0.1% would be unnoticeable and hence, was not regarded as a minor significance of effect. For razorbill, northern gannet, black-legged kittiwake and Manx shearwater, which had a magnitude of impact of negligible and sensitivity of medium, negligible was selected from the negligible to minor range due to the impact not exceeding a 0.1% increase in baseline mortality and hence, was not regarded as a minor significance of effect.

Table 10.35: Table summarising the significance of effect during operations and maintenance

Species	Magnitude of impact	Sensitivity of receptor	Significance of effect
Common guillemot	Negligible	Medium	**Negligible, not significant in EIA terms**
Razorbill	Negligible	Medium	**Negligible, not significant in EIA terms**
Atlantic puffin	Negligible	High	**Minor adverse, not significant in EIA terms**
Northern gannet	Negligible	Medium	**Negligible, not significant in EIA terms**
Black-legged kittiwake	Negligible	Medium	**Negligible, not significant in EIA terms**
Manx shearwater	Negligible	Medium	**Negligible, not significant in EIA terms**

Decommissioning phase

10.8.1.96 Decommissioning activities within the Morgan Array Area are equal to or less than those carried out during the construction phase within the Morgan Array Area. Therefore, for the purpose of this assessment it is assumed that the level of disturbance is likely to be similar and the potential impact on each species is deemed to be reversible in the short-term as birds are likely to return when activities have been completed.

All receptors

10.8.1.97 Overall, the magnitude of the impact during decommissioning is deemed to be negligible and the sensitivity of the receptor is considered to be medium to high, depending on the species. The effect will, therefore, be of **negligible to minor** adverse significance depending on species (Table 10.28), which is not significance in EIA terms.

10.8.2 Indirect impacts from underwater sound affecting prey species

10.8.2.1 Potential effects on the fish assemblages during the construction and decommissioning phases of the Morgan Generation Assets, as identified in volume 2, chapter 8: Fish and shellfish ecology of the PEIR, may have indirect effects on offshore ornithology receptors. Potential effects resulting from changes to prey and habitats during the operations and maintenance has been scoped out of the assessment.

10.8.2.2 Herring and sandeel are sensitive to offshore wind development (including underwater sound). Both species are listed as main prey items for several seabird species (Cramp and Simmons, 1983). Volume 2, chapter 8: Fish and shellfish ecology of the PEIR detailed the findings of the desktop studies in the Morgan Fish and Shellfish Ecology study area. High and low intensity sandeel spawning grounds have been identified by Ellis *et al*. (2012) as being present throughout the Morgan Fish and Shellfish Ecology study area. Herring spawning grounds have also been identified by Coull *et al*. (1998) as being present within the Morgan Fish and Shellfish Ecology study area. The overlap of possible spawning grounds with the Morgan Array Area has the potential to indirectly affect the distribution of seabirds, in particular the species showing a high level of specialisation and which feed predominantly on young herring and sandeel.

10.8.2.3 Underwater sound produced during piling activities at the construction stage may impact upon the availability of prey items. Indeed, underwater sound may cause fish and mobile invertebrates to avoid the construction area. Underwater sound may also affect the physiology and behaviour of fish and mobile invertebrates.

10.8.2.4 Species were screened and progressed for the assessment of significance on the basis of habitat specialisation (using scoring from Wade *et al.*, 2016), knowledge of the prey species targeted by each species (Cramp and Simmons, 1983) and their abundance in the Morgan Array Area.

10.8.2.5 Because the auk species (i.e., Atlantic puffin, razorbill and common guillemot) foraging behaviour and prey species are similar, the species are considered together for the purpose of the assessment of significance.

Table 10.36: Species considered for assessment of underwater sound affecting prey species based on habitat specialisation score (Wade *et al*., 2016).

Ornithological receptor	Habitat specialisation	Abundance recorded in the Morgan Offshore Ornithology Array Area study area	Assessed for significance
Arctic skua	Low	Very Low	N
Arctic tern	Medium	Very Low	N
Atlantic puffin	Medium	Low	Y
Black guillemot	Medium	Absent	N
Black-headed gull	Low	Very Low	N
Black-legged kittiwake	Low	High	N
Black-throated diver	High	Absent	N
Common guillemot	Medium	Very high	Y
Common gull	Low	Low	N
Common scoter	High	Absent	N
Common tern	Medium	Very low	N
European shag	Low	Very low	N
European storm petrel	Very low	Absent	N
Great black-backed gull	Low	Moderate	N
Great cormorant	Medium	Very low	N
Great northern diver	Medium	Absent	N
Great skua	Low	Very low	N
Herring gull	Very low	Low	N
Leach's storm-petrel	Very low	Very low	N
Lesser black-backed gull	Very low	Low	N
Little gull	n/a	Low	N
Little tern	High	Absent	N
Manx shearwater	Very low	Moderate	N
Mediterranean gull	n/a	Absent	N
Northern gannet	Very low	High	N
Northern fulmar	Very low	Moderate	N
Razorbill	Medium	High	Y
Red-throated diver	High	Very low	N
Roseate tern	Medium	Absent	N
Sandwich tern	Medium	Very low	N

Construction phase

Magnitude of impact

Auk species (common guillemot, razorbill and Atlantic puffin)

10.8.2.6 Auks directly responding to visual cues are likely to be displaced during construction; the magnitude of the impact on the baseline mortality has been assessed using a displacement assessment matrix in section 10.8.1. However, in addition to direct visual disturbance, birds may be indirectly displaced due to a reduction in prey availability. Because of the short-term duration of the construction work and localised nature, it is however expected that birds will be able to re-settle in the Morgan Array Area or beyond.

10.8.2.7 In the absence of quantitative information available, the magnitude is considered qualitatively and taking into consideration the assessment of significance presented in volume 2, chapter 8: Fish and shellfish ecology of the PEIR, which concluded of minor adverse significance for herring, cod, sprat and sandeel.

10.8.2.8 The impact is predicted to be of local spatial extent, short-duration, intermittent and reversible. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.

Sensitivity of the receptor

Auk species (common guillemot, razorbill and Atlantic puffin)

10.8.2.9 Although the impact of underwater sound on fish has been well studied, there is no published evidence to our knowledge linking reduction of prey availability to avoidance/displacement of seabirds. In absence of information on vulnerability to underwater sound and reduction of prey availability at offshore wind farms, all species were considered to have a medium vulnerability.

10.8.2.10 Auk species have a low reproductive success (Robinson, 2005), and a low to medium recoverability given their increasing trend in abundance, particularly common guillemot and razorbill (JNCC, 2020).

10.8.2.11 As all three species are qualifying interests for several SPAs likely to be connected to the Morgan Array Area (within the mean-max + SD foraging range) the species were considered to be of medium to high value.

10.8.2.12 Auk species are deemed to be of medium vulnerability, low to medium recoverability and high value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of the effect

Auk species (common guillemot, razorbill and Atlantic puffin)

10.8.2.13 Overall, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Decommissioning phase

10.8.2.14 Decommissioning activities within the Morgan Array Area are equal to or less than those carried out during the construction phase within the Morgan Array Area. Therefore, for the purpose of this assessment it is assumed that the level of disturbance is likely to be similar and the potential impact is deemed to be reversible in the short-term as birds are likely to return when activities have been completed.

Significance of the effect

Auk species (common guillemot, razorbill and Atlantic puffin)

10.8.2.15 Overall, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptors is considered to be medium. The effect will, therefore, be of **negligible** adverse significance, which is not significant in EIA terms.

10.8.3 Temporary habitat loss/disturbance and increased suspended sediment concentrations (SSCs)

Construction phase

10.8.3.1 Seabirds may be indirectly disturbed and displaced during the construction phase as a result of direct impacts on habitat and increased SSCs, which may result in the loss of a food resource to birds in the Morgan Array Area.

10.8.3.2 As a result, displaced seabirds may move to areas already occupied by other birds and thus face higher intra/inter-specific competition due to a higher density of individuals competing for the same resource. Alternatively, displaced birds may be forced to move into areas of lower quality (e.g. areas of lower prey availability). Such disturbance and resulting displacement could ultimately affect their demographic fitness (i.e. survival rates and breeding productivity) as well as potentially impacting on other birds in areas that displaced birds move to.

10.8.3.3 The potential construction phase impacts on fish and shellfish receptors are provided in volume 2, chapter 8: Fish and shellfish ecology of the PEIR and include temporary subtidal habitat loss/disturbance and increased suspended sediment concentrations and associated sediment deposition.

Magnitude of impact

All receptors

10.8.3.4 The increase in SSCs may lead to a short-term avoidance of affected areas that support fish and shellfish species which are susceptible to respond to increased SSCs. However, many fish and shellfish species are considered to be tolerant of turbid environments and regularly experience changes in the SSC due to the natural variability in the Irish Sea.

10.8.3.5 In the absence of quantitative information available, the magnitude is considered qualitatively and taking into consideration the assessment of significance on marine fish species presented in volume 2, chapter 8: Fish and shellfish ecology of the PEIR, which concluded of minor adverse significance, which is not significant in EIA terms.

10.8.3.6 Temporary habitat loss could potentially affect spawning, nursery or feeding grounds of fish and shellfish receptors, with demersal fish and shellfish, and demersal spawning species the most vulnerable. The MDS assessed in volume 2, chapter 8: Fish and shellfish ecology of the PEIR represented a very small proportion of the Morgan Generation Assets.

10.8.3.7 The impact is predicted to be of local spatial extent, short-duration, intermittent and reversible. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.

Sensitivity of the receptor

All receptors

10.8.3.8 Seabirds are deemed to be of medium vulnerability, medium recoverability and medium to high value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of the effect

All receptors

10.8.3.9 Overall, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptors is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Operations and maintenance

Magnitude of impact

All receptors

10.8.3.10 Maintenance activities within Morgan Array Area may lead to increases in SSCs and associated sediment deposition over the operational lifetime of the Morgan Generation Assets. The magnitude of the impacts would be a small fraction of those quantified for the construction phase.

10.8.3.11 The impact is predicted to be of local spatial extent, short-duration, intermittent and reversible. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.

Sensitivity of the receptor

All receptors

10.8.3.12 Seabirds are deemed to be of medium vulnerability, medium recoverability and high value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of the effect

All receptors

10.8.3.13 Overall, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptors is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Decommissioning phase

10.8.3.14 Decommissioning activities within the Morgan Array Area are equal to or less than those carried out during the construction phase within the Morgan Array Area. Therefore, for the purpose of this assessment it is assumed that the level of disturbance is likely to be similar and the potential impact is deemed to be reversible in the short-term as seabirds are likely to return when activities have been completed.

Significance of the effect

All receptors

10.8.3.15 Overall, the magnitude of the impact is deemed to be negligible and the sensitivity of the receptors is considered to be medium to high. The effect will, therefore, be of **negligible to minor** adverse significance depending on the species, which is not significant in EIA terms.

10.8.4 Collision risk

10.8.4.1 During the operation phase of the Morgan Generation Assets, the turning rotors of the wind turbines may present a risk of collision for seabirds. Stationary structures, such as the tower, nacelle or when rotors are not operating, are not expected to result in a material risk of collision. When a collision occurs between the turning rotor blade and the bird, it is assumed to result in direct mortality of the bird, which potentially could result in population level impacts.

10.8.4.2 The ability of seabirds to detect and manoeuvre around wind turbine blades is a factor that is considered when modelling and assessing the risk. In response to this it is standard practice to calculate differing levels of avoidance for different species or species groups. Avoidance rates are applied to collision risk models to predict levels of impact more realistically, based on available literature and expert advice about seabird behaviour and their flight response to wind turbines.

10.8.4.3 Species differ in their susceptibility to collision risk, depending on their flight behaviour and avoidance responses, and the vulnerability of their populations (Garthe and Hüppop, 2004; Furness and Wade, 2012; Wade *et al*., 2016). As sensitivity to collision differs considerably between species, species were screened and progressed for assessment of significance on the basis of the density of flying birds recorded within the Morgan Array Area and consideration of their perceived risk from collision (Garthe and Hüppop, 2004; Furness and Wade, 2012; Wade *et al*., 2016) (Table 10.37).

10.8.4.4 Five seabird species were identified as potentially at risk due to their recorded abundance in the Morgan Array Area and their likelihood of flying at potential collision height between the lowest and highest sweep of the wind turbine rotor blades above sea level. Additionally, consideration was given to species that may not have been accurately captured during baseline digital aerial surveys due to the diurnal timing of the surveys, with such species likely to be more active during the nocturnal, dusk and dawn periods (e.g. Manx shearwater and northern fulmar). In total, the significance of the collision effect was assessed for seven seabird species (Table 10.37). The magnitude of change was determined by calculating the estimated number of collisions with the wind turbines and the resulting percentage increase in the background mortality rate.

10.8.4.5 There is the potential that aviation and navigation lighting on wind turbines might attract seabirds and thus increase the risk of collision. Conversely, aviation and navigation lighting could repel birds moving through the Morgan Generation Assets. There is little published evidence showing the effects of lighting on seabird collision and displacement, although earlier work on seaducks by Desholm and Kahlert (2005) showed that migrating flocks were more prone to enter the wind farm but the higher risk of collision in the dark was counteracted by increasing distance from individual turbines and flying in the corridors between turbines. For true seabirds, there is published evidence showing that seabirds are less active at night compared to daytime (Kotzerka *et al*., 2010; Furness *et al*., 2018). Wade *et al.* (2016) ranked vulnerability of seabirds to collision by accounting for the nocturnal activity rate of seabirds.

10.8.4.6 Collision risk modelling was undertaken using the Stochastic Collision Risk Model (sCRM) developed by Marine Scotland (McGregor *et al*., 2018). The User Guide for the sCRM Shiny App provided by Marine Scotland (Donovan, 2017) has been followed for the modelling of collision impacts predicted for the Morgan Array Area. The full methodology is provided in volume 4, annex 10.3: Offshore ornithology non-migratory seabird collision risk assessment of the PEIR.

10.8.4.7 It is acknowledged that migratory passage movements may be 'missed' by aerial survey methods. Therefore, for migratory birds (excluding 'true seabirds', gulls, cormorants and divers), the Strategic Ornithological Support Services Migration Assessment Tool (SOSS-MAT) was used, which assessed theoretical biannual passage movements based on estimated flyway populations. The resulting number of birds estimated to cross the Morgan Array Area was inputted into the Band (2012) single transit collision risk model. The methodology and results of the collision risk modelling for migratory birds are provided in volume 4, annex 10.4: Offshore ornithology migratory non-seabird collision risk modelling.

Table 10.37: Seabird species considered for assessment of collision based on sensitivity and abundance.

Ornithological receptor	Sensitivity to collision	Abundance recorded in the Morgan Offshore Ornithology Array Area study area	Assessed for significance
Arctic skua	Medium	Very Low	N
Arctic tern	Low	Very Low	N
Atlantic puffin	Very low	Low	N
Black guillemot	Very low	Absent	N
Black-headed gull	Medium	Very Low	N
Black-legged kittiwake	Medium	High	Y
Black-throated diver	Low	Absent	N
Common guillemot	Very low	Very high	N
Common gull	Medium	Low	N
Common scoter	Very low	Absent	N
Common tern	Low	Very low	N
European shag	Low	Very low	N
European storm petrel	Very low	Absent	N
Great black-backed gull	Medium	Moderate	Y
Great cormorant	Low	Very low	N
Great northern diver	Low	Absent	N
Great skua	Medium	Very low	N
European herring gull	Medium	Low	Y
Leach's storm-petrel	Very low	Very low	N
Lesser black-backed gull	Medium	Low	Y
Little gull	Low	Low	N
Little tern	Low	Absent	N
Manx shearwater	Low	Moderate	Y
Mediterranean gull	Medium	Absent	N
Northern gannet	Medium	High	Y
Northern fulmar	Low	Moderate	Y
Razorbill	Very low	High	Y
Red-throated diver	Low	Very low	N
Roseate tern	Low	Absent	N
Sandwich tern	Low	Very low	N

Operations and maintenance phase

Magnitude of impact

Black-legged kittiwake

10.8.4.8 In all three bio-seasons (pre-breeding, breeding and post breeding) and for all bio-seasons combined the estimated increase in baseline mortalities remains well below the 1% increase threshold. As breeding black-legged kittiwake forage mainly in daytime, aviation and navigation lighting at the Morgan Generation Assets is unlikely to result in increasing collision risk.

10.8.4.9 The impact is predicted to be of local spatial extent, medium to long term duration, continuous and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.

Table 10.38: Black-legged kittiwake expected additional mortality due to collisions with wind turbines across bio-seasons.

Bio-season	Regional baseline population	Baseline mortality	Collision mortality (number of birds)	Increase in baseline mortality (%)
Pre-breeding	691,526	108,570	7.7 to 20.3	0.0071 to 0.0187
Breeding	397,251	62,368	2.5 to 8.7	0.0040 to 0.0139

Bio-season	Regional baseline population	Baseline mortality	Collision mortality (number of birds)	Increase in baseline mortality (%)
Post-breeding	911,586	143,119	12.8 to 33.1	0.0090 to 0.0231
Annual	911,586	143,119	23.1 to 62.2	0.0161 to 0.0434

Great black-backed gull

10.8.4.10 In both bio-seasons (breeding and non-breeding) and for all bio-seasons combined the estimated increase in baseline mortalities remains well below the 1% increase threshold.

10.8.4.11 The impact is predicted to be of local spatial extent, medium to long term duration, continuous and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Table 10.39: Great black-backed gull expected additional mortality due to collisions with wind turbines across bio-seasons.

Bio-season	Regional baseline population	Baseline mortality	Collision mortality (number of birds)	Increase in baseline mortality (%)
Breeding	10,480	1,006	0.6 to 5.6	0.0631% to 0.5581%
Non-breeding	17,742	1,703	0.3 to 1.3	0.0188% to 0.0790%
Annual	17,742	1,703	1.0 to 7.0	0.0561% to 0.4086%

European herring gull

10.8.4.12 In both bio-seasons (breeding and non-breeding) and for all bio-seasons combined, the estimated increase in baseline mortalities remains well below the 1% increase threshold. As breeding gulls forage mainly in daytime, aviation and navigation lighting at the Morgan Generation Assets is unlikely to result in increasing collision risk.

10.8.4.13 The impact is predicted to be of local spatial extent, medium to long term duration, continuous and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.

Table 10.40: European herring gull expected additional mortality due to collisions with wind turbines across bio-seasons.

Bio-season	Regional baseline population	Baseline mortality	Collision mortality (number of birds)	Increase in baseline mortality (%)
Breeding	100,561	17,296	0.6 to 7.3	0.0033% to 0.0422%
Non-breeding	173,299	29,807	3.5 to 19.4	0.0118% to 0.0650%
Annual	173,299	29,807	4.1 to 26.7	0.0138% to 0.0895%

Lesser black-backed gull

10.8.4.14 When using an avoidance rate of 0.994 (±0.0004), the estimated mortalities in all four bio seasons and for all bio-seasons combined were very low and did not surpass the 1% increase threshold. As breeding gulls forage mainly in daytime, aviation and navigation lighting at the Morgan Generation Assets is unlikely to result in increasing collision risk.

10.8.4.15 The impact is predicted to be of local spatial extent, medium to long term duration, continuous and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.

Table 10.41: Lesser black-backed gull expected additional mortality due to collisions with wind turbines across bio-seasons.

Bio-season	Regional baseline population	Baseline mortality	Collision mortality (number of birds)	Increase in baseline mortality (%)
Pre-breeding	163,304	20,250	0.0 to 0.0	0.0000% to 0.0000%
Breeding	96,971	12,024	0.0 to 0.0	0.0000% to 0.0000%
Post-breeding	163,304	20,250	0.1 to 1.9	0.0005% to 0.0092%
Non-breeding	41,159	5,104	0.1 to 1.4	0.0017% to 0.0279%
Annual	163,304	20,250	0.2 to 3.3	0.0009% to 0.0162%

Northern gannet

10.8.4.16 In all three bio-seasons (pre-breeding, breeding and post-breeding) and for all bio-seasons combined, the estimated increase in baseline mortalities remains well below the 1% increase threshold when using an avoidance rate of 0.993 (±0.0003). As breeding Northern gannet forage mainly in daytime, aviation and navigation lighting at the Morgan Generation Assets is unlikely to result in increasing collision risk.

10.8.4.17 The impact is predicted to be of local spatial extent, medium to long term duration, continuous and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.

Table 10.42: Northern gannet expected additional mortality due to collisions with wind turbines across bio-seasons.

Bio-season	Regional baseline population	Baseline mortality	Collision mortality (number of birds)	Increase in baseline mortality (%)
Pre-breeding	661,888	123,773	0.0 to 0.6	0.0000% to 0.0005%
Breeding	448,235	83,820	0.4 to 4.0	0.0005% to 0.0047%
Post-breeding	545,954	102,093	0.1 to 0.6	0.0001% to 0.0006%
Annual (BDPMS)	661,888	123,773	0.5 to 5.2	0.0004% to 0.0042%

Northern fulmar

10.8.4.18 When using an avoidance rate of 0.991 (±0.0004), the estimated increase in baseline mortality represents no change or negligible changes in all four bio-seasons and for the combined bio-seasons (Table 10.43). In the absence of quantitative information available on the effect of aviation and navigation lighting on collision risk, the magnitude is considered qualitatively for breeding Northern fulmar. Although the species has a higher activity rate than most seabird species, aviation and navigation lighting at the Morgan Generation Assets is unlikely to result in increasing collision risk and displacement.

10.8.4.19 The impact is predicted to be of local spatial extent, medium to long term duration, continuous and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.

Table 10.43: Northern fulmar expected additional mortality due to collisions with wind turbines across bio-seasons.

Bio-season	Regional baseline population	Baseline mortality	Collision mortality (number of birds)	Increase in baseline mortality (%)
Pre-breeding	828,194	149,903	0.0 to 1.7	0.0000% to 0.0011%
Breeding	393,701	71,260	0.0 to 0.4	0.0000% to 0.0005%
Post-breeding	828,194	149,903	0.0 to 0.0	0.0000% to 0.0000%
Non-breeding	556,367	100,702	0.0 to 0.0	0.0000% to 0.0000%
Annual	828,194	149,903	0.0 to 2.0	0.0000% to 0.0014%

Manx shearwater

10.8.4.20 When using an avoidance rate of 0.991 (±0.0004), there are no predicted collisions during the operation phase of the wind farm, and thus no increase in mortality relative to the baseline mortality. As breeding Manx shearwater forage mainly in daytime, aviation and navigation lighting at the Morgan Generation Assets is unlikely to result in increasing collision risk.

10.8.4.21 The impact is predicted to be of local spatial extent, medium to long term duration, continuous and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **no change**.

Table 10.44: Manx shearwater expected additional mortality due to collisions with wind turbines across bio-seasons.

Bio-season	Regional baseline population	Baseline mortality	Collision mortality (number of birds)	Increase in baseline mortality (%)
Pre-breeding	1,580,895	207,097	0.0 to 0.0	0.0000 to 0.0000
Breeding	1,974,500	254,336	0.0 to 0.0	0.0000 to 0.0000
Post-breeding	1,580,895	207,097	0.0 to 0.0	0.0000 to 0.0000
Annual (BDPMS)	1,974,500	254,336	0.0 to 0.0	0.0000 to 0.0000

Migratory birds (excluding 'true seabirds', gulls, cormorants and divers).

10.8.4.22 Predictions using a range of avoidance rates are provided in volume 4, annex 10.4: Offshore ornithology migratory non-seabird collision risk modelling of the PEIR. Even assuming a highly precautionary avoidance rate of 98.00%, the estimated numbers of collisions were low and predicted to be below one bird per annum for the majority of species found to be crossing the Morgan Array Area. Because of their very large biogeographic population size and migration routes through the Irish Sea, wader species were at the greatest risk of collision.

10.8.4.23 Of the species/populations considered, European golden plover, Northern lapwing, dunlin, common snipe, Eurasian curlew and common redshank were predicted to be above one collision per year (assuming a 98.00% avoidance rate).

10.8.4.24 In the context of their large populations, the estimated increase in baseline mortalities of wader species as the result of collision during migration is expected to be minimal and undetectable given the size of the bio-geographic populations.

10.8.4.25 The impact is predicted to be of local spatial extent, medium to long term duration, continuous and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.

Sensitivity of the receptor

Black-legged kittiwake

10.8.4.26 Black-legged kittiwake was rated as relatively highly vulnerable to collision impacts by Wade *et al*. (2016), due to the proportion of flights likely to occur at potential risk height and percentage of time in flight. In terms of nocturnal activity rate, black-legged kittiwake are considered to have a medium rate of activity at night with a score of 3 (out of 5) (Wade *et al.* 2016).

10.8.4.27 Despite a higher reproductive success (i.e. laying two eggs and breeding until four years old) than most seabird species (Robinson, 2005), the species is deemed to have a low recoverability given the continuing decline in abundance observed between 1986 and 2018 in the UK (JNCC, 2020). During this period, breeding productivity has declined as the result of food shortage, although it has stabilised in recent years (JNCC, 2020).

10.8.4.28 Black-legged kittiwake is a qualifying interest for several SPAs likely to be connected to the Morgan Array Area (within the mean-max + SD foraging range), with several non-SPA colonies within range and so the species is considered to be of medium value.

10.8.4.29 Black-legged kittiwake is deemed to be of high vulnerability, low recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **high**.

Great black-backed gull

10.8.4.30 Great black-backed gull was rated as one of the most vulnerable seabird species to collision impacts by Wade *et al*. (2016), due to the proportion of flights likely to occur at potential risk height and percentage of time in flight. In terms of nocturnal activity rate, great black-backed gull are considered to have a medium rate of activity at night with a score of 3 (out of 5) (Wade *et al.* 2016).

10.8.4.31 The abundance of breeding great black-backed gull in the UK has changed relatively little between census (JNCC, 2020). The species is deemed to have a medium recoverability due to a low reproductive success and the stable trend in breeding abundance.

10.8.4.32 As great black-backed gull is a qualifying interest for several SPAs likely to be connected to the Morgan Array Area (within the mean-max + SD foraging range), with a non-SPA colony within range and so the species is considered to be of medium value.

10.8.4.33 Great black-backed gull is deemed to be of high vulnerability, medium recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **medium.**

European herring gull

10.8.4.34 European herring gull was rated as one of the most vulnerable seabird species to collision impacts by Wade *et al*. (2016), due to the proportion of flights likely to occur at potential risk height and percentage of time in flight. In terms of nocturnal activity rate, European herring gull are considered to have a medium rate of activity at night with a score of 3 (out of 5) (Wade *et al.* 2016).

10.8.4.35 As European herring gull is a qualifying interest for several SPAs likely to be connected to the Morgan Array Area (within the mean-max + SD foraging range) with multiple non-SPA colonies within range, the species is considered to be of medium value.

10.8.4.36 Although European herring gull have a relatively high reproductive success, breeding abundance is declining in the coastal natural nesting population, and this may be indicative of decline in the entire UK breeding population (JNCC, 2020). There is evidence that the urban nesting gull population has increased in recent years, but census of these sites is lacking to derive a UK wide trend that includes both the urban and natural populations. The species is therefore deemed to be of medium recoverability.

10.8.4.37 European herring gull is deemed to be of high vulnerability, medium recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **medium.**

Lesser black-backed gull

10.8.4.38 Lesser black-backed gull was rated as one of the most vulnerable seabird species to collision impacts by Wade *et al*. (2016), due to the proportion of flights likely to occur at potential risk height and percentage of time in flight. In terms of nocturnal activity rate, lesser black-backed gull are considered to have a medium rate of activity at night with a score of 3 (out of 5) (Wade *et al.* 2016).

10.8.4.39 As lesser black-backed gull is a qualifying interest for several SPAs likely to be connected to the Morgan Array Area (within the mean-max + SD foraging range), with multiple non-SPA colonies within range, the species is considered to be of medium value.

10.8.4.40 Although lesser black-backed gull has a relatively high reproductive success, the species breeding abundance has exhibited a downward trend over the last 15-20 years in the UK (JNCC, 2020). It must be noted that this trend excludes urban nesting gulls from the sample and, therefore, may not be representative of trends in the entire UK population. The species is deemed to be of medium recoverability.

10.8.4.41 Lesser black-backed gull is deemed to be of high vulnerability, medium recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **medium**.

Northern gannet

10.8.4.42 Although the latest scientific guidance showed the species to display a high level of macro-avoidance (Peschko *et al*., 2021), the species is rated as relatively vulnerable to collision impacts by Wade *et al*. (2016). In terms of nocturnal activity rate, Northern gannet are considered to have a low rate of activity at night with a score of 2 (out of 5) (Wade *et al.* 2016).

10.8.4.43 Northern gannet is a qualifying interest for several SPAs likely to be connected to the Morgan Array Area (within the mean-max + SD foraging range), with a large non-SPA colony within close proximity (Monreith Cliffs and Scar Rocks), the species is therefore considered to be of medium value.

10.8.4.44 Although northern gannet has a low reproductive success, the species is deemed to have a medium recoverability given the consistent increasing trend in abundance since the 1990s (JNCC, 2020). It is of note that the species has suffered from the outbreak of avian flu during the 2022 breeding season. The species is deemed to be of medium recoverability.

10.8.4.45 Northern gannet is deemed to be of medium vulnerability, medium recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **medium**.

Northern fulmar

10.8.4.46 Northern fulmar was rated as the least vulnerable seabird to collision impacts by Wade *et al.* (2016). In terms of nocturnal activity rate, Northern fulmar are considered to have a high rate of activity at night with a score of 5 (out of 5) (Wade *et al.* 2016).

10.8.4.47 As northern fulmar is a qualifying interest for several SPAs likely to be connected to the Morgan Array Area (within the mean-max + SD foraging range) with multiple non-SPAs within range, the species is considered to be of medium value. Furthermore, the northern fulmar population is endemic to the North Atlantic and most breed in Britain and Ireland (Mitchell *et al*., 2004).

10.8.4.48 The species has a very low reproductive success (Robinson, 2005). Long term trend data suggests that breeding abundance peaked in 1996 (JNCC, 2020) and recent declines represent a period of 're-adjustment' following a period of artificially inflated population size. The species is deemed to be of medium recoverability.

10.8.4.49 Northern fulmar is deemed to be of low vulnerability, medium recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **low**.

Manx shearwater

10.8.4.50 Manx shearwater was rated as the least vulnerable seabirds to collision impacts by Wade *et al*. (2016). In terms of nocturnal activity rate, Manx shearwater are considered to have a medium rate of activity at night with a score of 3 (out of 5) (Wade *et al.* 2016).

10.8.4.51 As Manx shearwater is a qualifying interest for several SPAs likely to be connected to the Morgan Array Area (within the mean-max + SD foraging range) the species is considered to be of high value. Furthermore, the Manx shearwater population is endemic to the North Atlantic and most breed in Britain and Ireland (Mitchell *et al*., 2004).

10.8.4.52 The species has a very low reproductive success (Robinson, 2005). Most of the world population is found in the UK and over 90% of the UK population is found on the Islands of Rum and Eigg (Scotland) and Skomer and Skokholm (Wales) (Mitchell *et al*., 2004; JNCC, 2020). Therefore, the species is considered to be of high value.

10.8.4.53 Manx shearwater has a low reproductive success (i.e. only laying one egg and not breeding until five years old; Robinson, 2005). There is an incomplete spatial-temporal coverage of breeding abundance at UK colonies and thus a lack of long-term trend (JNCC, 2020). In the light of uncertainly and low reproductive success, Manx shearwater are therefore deemed to have a medium recoverability.

10.8.4.54 Manx shearwater is deemed to be of low vulnerability, medium recoverability and high value. The sensitivity of the receptor is therefore, considered to be **medium.**

Migratory non-seabird species

10.8.4.55 Although migratory non-seabird species have not been significantly studied in the offshore environment, vulnerability to collisions is likely to be generally low, since most migration will occur on a broad front and also above rotor height, although during periods of poor weather this risk may increase.

10.8.4.56 Recoverability of populations of migrants may vary considerably, with smaller wader species with a relatively favourable conservation status (e.g. dunlin) faring better than larger species with lower reproductive rates (e.g. Eurasian curlew).

10.8.4.57 On a precautionary basis and purposes of this assessment these species are assumed to have **medium** sensitivity to collision.

Significance of the effect

10.8.4.58 A summary of collision impacts in the operations and maintenance phase on each receptor is presented in Table 10.45. The significance of impacts ranges from **negligible to minor adverse** with no effects considered to be significant in EIA terms. For black legged kittiwake, which had a magnitude of impact of negligible and sensitivity of high, negligible was selected from the negligible to minor range due to the impact not exceeding a 0.5% increase in baseline mortality. Additionally, the population is vast and a change in baseline mortality greater than 0.1% would be unnoticeable and hence, was not regarded as a minor significance of effect. For European herring gull, lesser black backed gull, northern gannet, northern fulmar and migratory birds, which had a magnitude of impact of negligible and sensitivity of medium, negligible was selected from the negligible to minor range due to the impact not exceeding a 0.1% increase in baseline mortality and hence, was not regarded as a minor significance of effect.

Table 10.45: Table summarising the impact of collisions on the significance of effect during operations and maintenance.

Species	Magnitude of impact	Sensitivity of receptor	Significance of effect
Black-legged kittiwake	Negligible	High	**Minor adverse, not significant in EIA terms**
Great black-backed gull	Low	Medium	**Minor adverse, not significant in EIA terms**
European herring gull	Negligible	Medium	**Negligible, not significant in EIA terms**
Lesser black-backed gull	Negligible	Medium	**Negligible, not significant in EIA terms**
Northern gannet	Negligible	Medium	**Negligible, not significant in EIA terms**
Northern fulmar	Negligible	Medium	**Negligible, not significant in EIA terms**
Manx shearwater	No change	Medium	**No change, not significant in EIA terms**
Migratory birds	Negligible	Medium	**Negligible, not significant in EIA terms**

10.8.5 Barrier to movement

10.8.5.1 Barrier effects may arise in addition to displacement. Whilst displacement is a reduction in the number of seabirds occurring within or immediately adjacent to an offshore wind farm (Furness *et al*., 2013), the barrier effect refers to the disruption of preferred flight lines. This might impose an additional energetic cost to movements, particularly during the breeding season when seabirds make daily commutes between foraging grounds at sea and nesting sites. Additional energetic costs could have long-term implications for individuals and impact bird fitness (breeding productivity and survival). Birds may also have to navigate around the wind farms during migratory movements. In the case of migrating birds, avoidance of a single wind farm may be trivial relative to the total length and cost of the journey. There is a general lack of empirical data on the barrier effects for migratory birds.

10.8.5.2 For breeding seabirds, in a study of the effects of wind farms as barriers to movement on seabirds of differing morphology, Masden *et al*. (2010) found additional costs, expressed in relation to typical daily energetic expenditures, to be the highest per unit flight for seabirds with high wing loadings, such as cormorants. Most importantly the authors found costs of extra flight to avoid a wind farm to appear to be much less than those imposed by low food abundance or adverse weather, although such costs will be additive to these.

10.8.5.3 Although the site lies within the mean-maximum foraging ranges of several breeding colonies, connectivity has to be established to the Morgan Array Area and it is unlikely that the site will provide a barrier to foraging movements given that birds generally forage widely within their mean-maximum foraging ranges. The risk of collision (as detailed in paragraph 10.8.4) is deemed to be greater than the risk of barrier effect.

10.8.5.4 Because the magnitude of the effect is likely to be similar amongst bird species moving through the area, receptors are grouped in the assessment of the barrier effect.

Operations and maintenance phase

Magnitude of impact

All receptors

10.8.5.5 In the absence of quantitative information available, the magnitude is considered qualitatively for breeding seabird and migratory non-seabirds.

10.8.5.6 As breeding seabirds generally forage widely within their foraging range of breeding colonies, the Morgan Generation Assets is unlikely to form a significant barrier to the movement from any breeding colonies. Furthermore, the Morgan Generation Assets is unlikely to form a barrier to the movement of migratory birds given that migratory movements at sea occur over a broad front.

10.8.5.7 The impact is predicted to be of local spatial extent, long term duration, continuous and reversible. It is predicted that the impact will affect the receptor directly. Due to the likely absence of any detectable impact on the fitness of individuals and the demography of the populations, the magnitude is therefore, considered to be **negligible.**

Sensitivity of receptor

10.8.5.8 Seabird species vary in their vulnerability to barrier effects. Some species such as gulls, fulmar, gannet and tern are considered to have a low sensitivity (Maclean et al., 2009). Other species such as divers and auks are considered to have higher sensitivity to barrier effects due to a higher wing-loading (i.e. they have a higher ratio of body weight to wing area and therefore energy expenditure during flight is likely to be higher. These species are notable by their characteristically direct flight paths) compared with other species (Maclean et al., 2009). Evidence from studies at operational wind farms (Everaert, 2006; Everaert and Kuijken, 2007; Lawrence *et al.,* 2007; Krijgsveld *et a*l., 2011) has shown that gulls are unlikely to see wind turbines as a barrier to movement.

10.8.5.9 Overall breeding seabirds and migratory non-seabirds are deemed to be of low to medium vulnerability, medium to high recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **medium.**

Significance of effect

10.8.5.10 Overall, the magnitude of the impact is deemed to be negligible to low and the sensitivity of the receptor is considered to be low to medium. The effect will, therefore, be of **negligible** adverse significance, which is not significant in EIA terms.

10.8.6 Future monitoring

10.8.6.1 Future monitoring will be considered where there is uncertainty around potential effects. Any proposed monitoring would be discussed with the Offshore Ornithology EWG before application for the DCO.

10.9 Cumulative effects assessment

10.9.1 Methodology

10.9.1.1 The Cumulative Effects Assessment (CEA) takes into account the impact associated with the Morgan Generation Assets together with other projects and plans. The projects and plans selected as relevant to the CEA presented within this chapter are based upon the results of volume 3, annex 5.1: CEA screening matrix of the PEIR. Each project has been considered on a case-by-case basis for screening in or out of this chapter's assessment based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved.

10.9.1.2 The offshore ornithology CEA methodology has followed volume 1, chapter 5: EIA methodology of the PEIR. As part of the assessment, all projects and plans considered alongside the Morgan Generation Assets have been allocated into 'tiers' reflecting their current stage within the planning and development process, these are listed below.

10.9.1.3 The tiered approach uses the following categorisations:

- Tier 1
  - Under construction
  - Permitted application
  - Submitted application
  - Those currently operational that were not operational when baseline data was collected, and/or those that are operational but have an on-going impact
- Tier 2
  - Scoping report has been submitted and is in the public domain
- Tier 3
  - Scoping report has not been submitted and is not in the public domain
  - Identified in a relevant development plan
  - Identified in other plans and programmes.

10.9.1.4 This tiered approach is adopted to provide a clear assessment of the Morgan Generation Assets alongside other projects, plans and activities.

10.9.1.5 The specific projects, plans and activities screened in to the CEA are outlined in Table 10.46. The location of screened in projects and their proximity to the Morgan Generation Assets are further shown in Figure 10.2. Projects screened out are detailed within volume 3, annex 5.1 CEA screening annex of the PEIR.

10.9.1.6 Some of the potential impacts considered within the Morgan Generation Assets alone assessment are specific to a particular phase of development (e.g. construction, operations and maintenance or decommissioning). Where the potential for cumulative effects with other plans or projects only have potential to occur where there is spatial or temporal overlap with the Morgan Generation Assets during certain phases of development, impacts associated with a certain phase may be omitted from further consideration where no plans or projects have been identified that have the potential for cumulative effects during this period.

10.9.1.7 Other aspects, namely indirect impacts associated with prey distribution and availability are very difficult to quantify, and although it is acknowledged that cumulative effects are possible, the magnitude of these impacts is not considered to be significant at a population level for any offshore ornithology receptor and is therefore not considered further within the CEA. The impacts excluded from the cumulative assessment are:

- Indirect impacts (affecting prey species) from airborne noise, underwater sound and the presence of vessels at any phase of the Morgan Generation Assets as they will be spatially limited and all were predicted as negligible
- Temporary habitat loss/disturbance and increased suspended sediment concentrations (SSCs) at any phase of the Morgan Generation Assets as there is low potential for cumulative effect because the contribution from the Morgan Generation Assets and surrounding wind farms is small (and even if these occurred at the same time this would not constitute a significant effect)
- Impacts associated with the construction phase of the Morgan Generation Assets. Adjudged to cause changes of such small magnitude that these will not contribute in any meaningful way at a population level to a potential cumulative impact (based on determination for the Morgan Generation Assets effects alone).

10.9.1.8 Impacts considered in the cumulative assessment are as follows:

- Disturbance and displacement from infrastructure (and barrier effects)
- Collision risk.

Table 10.46: List of other projects, plans and activities considered within the offshore ornithology CEA.

Project/Plan	Status	Distance from the Morgan Array Area (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Morgan Offshore Wind Project
Tier 1-						
Walney Extension 3 offshore wind farm	Operational	7.6km	40 8.25MW wind turbines. Hub height 113m. Rotor diameter 164m.	2017	2018 to 2039	Project Operations and maintenance Phase overlap.
Walney Extension 4 offshore wind farm	Operational	7.6km	47 7MW wind turbines. Hub height 111m. Rotor diameter 154m.	2017	2018 to 2039	Project Operations and maintenance Phase overlap.
Walney 2 offshore wind farm	Operational	11.9km	51 3.6MW wind turbines. Hub height 84m. Rotor diameter 107m.	2011	2012 to 2032	Project Operations and maintenance Phase overlap.
West of Duddon Sands offshore wind farm	Operational	15.2km	108 3.6MW wind turbines. Hub height 90m Rotor diameter 120m.	2013	2014 to 2033	Project Operations and maintenance Phase overlap.
Walney 1 offshore wind farm	Operational	15.5km	51 3.6MW wind turbines. Hub height 84m. Rotor diameter 107m.	2010	2011 to 2032	Project Operations and maintenance Phase overlap.
Ormonde offshore wind farm	Operational	23.3km	30 5MW wind turbines. Hub Height 100m. Rotor diameter 126m.	2010	2012 to 2036	Project Operations and maintenance Phase overlap.
Barrow offshore wind farm	Operational	30.0km	30 3MW wind turbines. Hub height 75m. Rotor diameter 90m.	2005	2006 to 2028	Project Operations and maintenance Phase overlap.
Awel y Môr offshore wind farm	Submitted application	47.2km	1,100MW capacity.	2026	2030 onwards	Potential Construction Phase Overlap with Proposed Development Construction Phase. Project Operations and maintenance Phase Overlap.
Gwynt y Môr offshore wind farm	Operational	51.5km	160 3.MW wind turbines. Hub height 98m. Rotor diameter 107m.	2012	2015 to 2033	Project Operations and maintenance Phase overlap.
Burbo Bank Extension offshore wind farm	Operational	56.0km	32 8.0MW wind turbines. Hub height 105m. Rotor diameter 160m	2016	2017 to 2045	Project Operations and maintenance Phase overlap.
Rhyl Flats offshore wind farm	Operational	60.5km	25 3.6MW wind turbines. Hub height 80m. Rotor diameter 107m.	2007	2009 to 2027	Project Operations and maintenance Phase overlap.
North Hoyle offshore wind farm	Operational	61.1km	30 2MW wind turbines. Hub height 70m. Rotor diameter 80m.	2003	2004 to 2028	Project Operations and maintenance Phase overlap.
Burbo Bank offshore wind farm	Operational	61.6km	23 3.6MW wind turbines. Hub height 78m. Rotor diameters 107m.	2006	2007 to 2039	Project Operations and maintenance Phase overlap.
Robin Rigg offshore wind farm	Operational	75.3km	58 3MW wind turbines. Hub height 80m Rotor diameter 90m.	2009	2010 to 2023	Project Operations and maintenance Phase overlap.

Project/Plan	Status	Distance from the Morgan Array Area (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Morgan Offshore Wind Project
Arklow Bank Phase 1 offshore wind farm	Operational	176.2km	7 3.6MW wind turbines. Hub height 73.5m. Rotor diameter 124m.	2002	2004 to 2028	Project Operations and maintenance Phase overlap.
Erebus offshore wind farm	Submitted application	289.9km	100MW capacity.	2025	unknown	Potential Construction Phase Overlap with Proposed Development Construction Phase. Project Operations and maintenance Phase Overlap.
Tier 2-						
Mona Offshore Wind Project	Pre-application	5.5km	1,500MW capacity.	2026	unknown	Potential Construction Phase Overlap with Proposed Development Construction Phase. Project Operations and maintenance Phase Overlap.
Morecambe Generation Assets Offshore Wind Project	Pre-application	11.2km	480MW capacity, Area: 497km^2.	2026	unknown	Potential Construction Phase Overlap with Proposed Development Construction Phase. Project Operations and maintenance Phase Overlap.
Morgan Offshore Wind Project and Morecambe Offshore Wind Farm: Transmission Assets	Pre-application	11.2km	n/a	2026 to 2029	2029 to 2065	Potential Construction Phase Overlap.
North Irish Sea Array offshore wind farm	Pre-application	107.6km	500MW capacity.	unknown	unknown	Project Operations and maintenance Phase overlap.
Oriel offshore wind farm	Pre-application	119.4km	375MW capacity, spead over 28km^2.	unknown	unknown	Project Operations and maintenance Phase overlap.
Dublin Array offshore wind farm	Pre-application	134.4km	600MW offshore wind power project. Area of 54km^2.	unknown	unknown	Project Operations and maintenance Phase overlap.
Codling Wind Park offshore wind farm	Pre-application	141.2km	900MW planned capacity, off of the coast Wicklow. Spread over an area of 125km^2.	unknown	unknown	Project Operations and maintenance Phase overlap.
Arklow Bank Phase 2 offshore wind farm	Pre-application	165.3km	800MW capacity.	unknown	unknown	Project Operations and maintenance Phase overlap.
Shelmalere offshore wind farm	Pre-application	201.4km	100MW capacity.	2024 to 2025	2026 to 2051	Project Operations and maintenance Phase overlap.
Llyr 2 offshore wind farm	Pre-application	295.0km	1,000MW capacity.	unknown	unknown	Project Operations and maintenance Phase overlap.
Llyr 1 offshore wind farm	Pre-application	298.5km	100MW capacity.	unknown	unknown	Project Operations and maintenance Phase overlap.
White Cross offshore wind farm	Pre-application	319.6km	Test and Demonstration Floating Wind Farm.	unknown	unknown	Project Operations and maintenance Phase overlap.
Inis Ealga Marine Energy Park offshore wind farm	Pre-application	327.0km	1,000MW capacity.	unknown	unknown	Project Operations and maintenance Phase overlap.

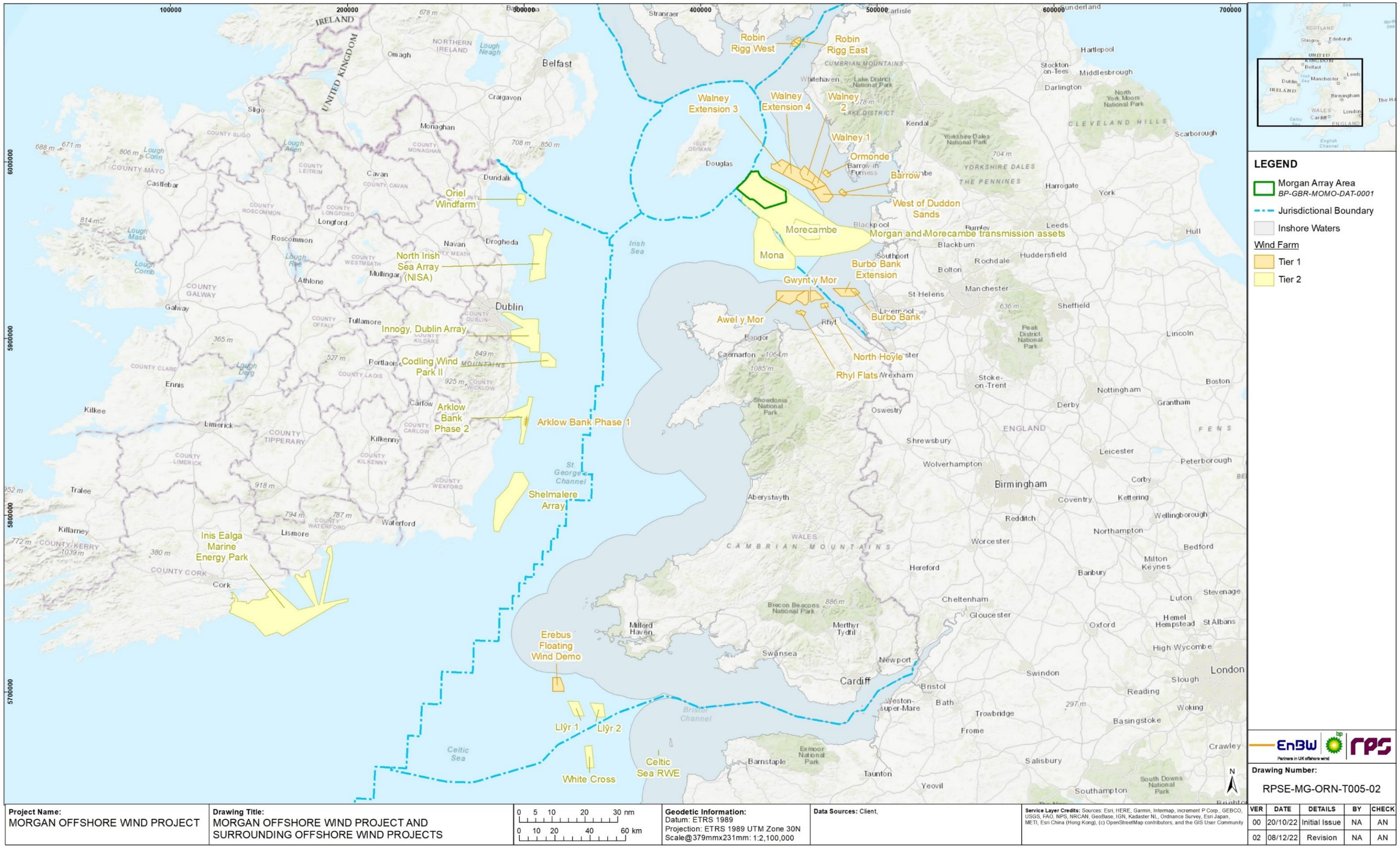

Figure 10.2: Other projects, plans and activities screened into the cumulative effects assessment[1].

[1] The Awel y Môr agreement for lease area extends further to the west than the application boundary presented, however Awel y Môr Offshore Wind Farm Ltd. have decided to develop in the area presented in this figure.

10.9.1.9 The MDSs identified in Table 10.47 have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. The cumulative effects presented and assessed in this section have been selected from the MDS table above, Table 10.19 due to there being a potential for cumulative effects. Effects of greater adverse significance are not predicted to arise should any other development scenario (e.g. different turbine layout), to that assessed here, be taken forward in the final design scheme.

Table 10.47: Maximum design scenario considered for the assessment of potential cumulative effects on offshore ornithology.

a C=construction, O=operations and maintenance, D=decommissioning
b Barrier effect is included as CEA is based on SNCB Matrix approach (JNCC, 2017)

Potential cumulative effect	Phase[a]			Maximum Design Scenario	Justification
	C	O	D		
Disturbance and displacement from infrastructure[1]	✓	✓	✓	MDS as described for the Morgan Generation Assets (Table 10.19) assessed cumulatively with the following wind farms: **Construction** **Tier 1** • Awel y Môr • Erebus. **Tier 2** • Mona Offshore Wind Project • Morecambe Offshore Wind Farm: Generation Assets. **Operations and maintenance Phase** **Tier 1** • Barrow • Burbo Bank • Burbo Bank Extension • North Hoyle • Ormonde • Walney 1 • Walney 2 • Walney 3 • Walney 4 • West of Duddon Sands • Gwynt y Môr • Rhyl Flats • Robin Rigg • Arklow Bank Phase 1 • Awel y Môr • Erebus. **Tier 2** • Mona Offshore Wind Project • Morecambe Offshore Wind Farm: Generation Assets. • North Irish Sea Array • Codling Wind Park • Dublin Array • Oriel • Arklow Bank Phase 2 • Shelmalere	There is a possibility that construction could overlap temporally with Awel y Môr, the Mona Offshore Wind Project, Morecambe Generation Assets and Erebus. There is a possibility that decomissioning could overlap temporally with Awel y Môr and Erebus. However, the impact from construction and decommissioning are of small, temporary magnitude. There is potential for a cumulative effect from operations and maintenance activities and so a quantitative cumulative effect assessment is required.

Potential cumulative effect	Phase[a]			Maximum Design Scenario	Justification
	C	O	D		
				• Llyr 1 • Llyr 2 • White Cross • Inis Ealga Marine Energy Park. **Decommissioning Phase** **Tier 1** • Awel y Môr • Erebus.	
Collision risk	×	✓	×	MDS as described for the Morgan Generation Assets (Table 10.19) assessed cumulatively with the following wind farms: **Operations and maintenance Phase** **Tier 1** • Barrow • Burbo Bank • Burbo Bank Extension • North Hoyle • Ormonde • Walney 1 • Walney 2 • Walney 3 • Walney 4 • West of Duddon Sands • Gwynt y Môr • Rhyl Flats • Robin Rigg • Arklow Bank Phase 1 • Awel y Môr • Erebus. **Tier 2** • Mona Offshore Wind Project • Morecambe Offshore Wind Farm: Generation Assets. • North Irish Sea Array • Codling Wind Park • Dublin Array • Oriel • Arklow Bank Phase 2 • Shelmalere • Llyr 1	There is potential for a cumulative effect from operations and maintenance activities so a detailed, quantitative cumulative effect assessment is required.

Potential cumulative effect	Phase[a]			Maximum Design Scenario	Justification
	C	O	D		
				• Llyr 2 • White Cross • Inis Ealga Marine Energy Park.	

10.10 Cumulative effects assessment

10.10.1.1 A description of the significance of cumulative effects upon offshore ornithology receptors arising from each identified impact is given below.

10.10.1.2 The CEA is limited by the data available upon which to base the assessment. Due to the age of developments in the Irish Sea and surrounding areas which have the potential to have a cumulative impact upon receptors, few have comparable datasets upon which to base an assessment.

10.10.1.3 Additionally, older developments did not carry out certain impact assessments (e.g. displacement and/or collision risk) for species such as black-legged kittiwake, northern gannet, northern fulmar, Manx shearwater and gull species (herring gull, great black-backed gull and lesser black-backed gull) due to limited data at the time of assessment on the species' behavioural response to the presence of offshore wind turbines. As such the CEA is carried out using data from wind farms with available species data to do so. For projects in early stages (i.e. Tier 3) there was insufficient project information in the public domain to allow the effects to be reasonably understood and a cumulative assessment undertaken. Tier 3 projects therefore at this time have not been included in the cumulative assessment below.

10.10.1.4 For the cumulative assessment, impacts from Tier 1 and Tier 2 projects have been assessed together where applicable.

10.10.2 Disturbance and displacement from airborne noise, underwater sound, and presence of vessels and infrastructure

10.10.2.1 There is potential for cumulative displacement as a result of construction and operational activities associated with the Morgan Generation Assets along with other developments.

10.10.2.2 Disturbance and subsequent displacement of seabirds during the construction phase is primarily centred around where construction vessels and piling activities are occurring. The activities may displace individuals that would normally reside within and around the area of sea where the Morgan Generation Assets is located. This in effect represents indirect habitat loss, which will potentially reduce the area available to those seabirds to forage, loaf and/or moult.

10.10.2.3 The level of data available and the ease with which disturbance and displacement impacts can be combined across the wind farms is quite variable, reflecting the availability of relevant data for other projects and the approach to assessment taken. A maximum design approach would be to assume complete overlap in construction for all projects, while the minimum design approach would be to assume no overlap. The most realistic assumption is that at most there will be a degree of construction overlap (and hence increased vessel and helicopter activity), but that it will be limited to a small number of cumulative effects assessment projects and other activities.

10.10.2.4 During the operations and maintenance phase, the presence of offshore wind turbines has the potential to directly disturb and displace seabirds that would normally reside within and around the area of sea where offshore wind farms are located. Displacement may contribute to individual birds experiencing fitness consequences, which at an extreme level could lead to the mortality of individuals. Cumulative displacement therefore has the potential to lead to effects on a wider scale.

10.10.2.5 The species assessed for cumulative displacement impacts were common guillemot, razorbill, Atlantic puffin, northern gannet, and black-legged kittiwake.

10.10.2.6 The cumulative results are presented as displacement matrices ranging from 1% to 100% mortality and 5% to 100% displacement. Each cell presents potential cumulative bird mortality following displacement from the Morgan Generation Assets and the other offshore wind farm projects during each bio-season. Light blue highlighted cells are based on the displacement and mortality rates used in the project alone displacement assessment volume 4, annex 10.2: Offshore ornithology displacement assessment of the PEIR. Additionally, orange highlighted cells which represent a displacement rate of 50% and a mortality rate of 1% are shown in each bio-season matrices for all species except northern gannet (for which a mortality rate of 1% and a displacement rate of 70% is highlighted instead), in line with values used by other offshore wind farm displacement assessments.

10.10.2.7 It is of note that the northwest corner of the 2km buffer of the Morgan Array Area overlaps with the 2km buffer of the tier 3 Isle of Man (IoM) offshore wind farm . This overlap comprises 2.67% of the total 2km buffer area of the Morgan Array Area. It is possible that birds displaced from these two wind farms could meet in the overlapping zone, potentially increasing mortality due to enhanced competition. The potential impact of a 2.67% overlap between these 2km buffer areas is very small and no further information on the IoM offshore wind farm is available, therefore it has not been taken into further consideration.

10.10.2.8 With regards to vessels in the Morgan Generation Assets, there is no method to quantify the displacement impact of the activities due to their local and temporary nature. An offshore EMP that will contain measures to minimise disturbance to rafting birds from transiting vessels will be secured as a requirement of the draft DCO/ML. It is therefore expected that impacts of vessels on seabirds are negligible due to the management of vessel traffic.

Tier 1 and Tier 2

Construction phase

Magnitude of impact

Common guillemot

10.10.2.9 The estimated mean peak cumulative abundances of guillemot from the relevant projects (projects that potentially overlap in their construction activities with Morgan Generation Assets) during each bio-season are presented in Table 10.48.

Table 10.48: Guillemot cumulative abundances for potential overlapping construction phase offshore wind projects for disturbance and displacement assessment.

Project	Annual Cumulative Abundance	Breeding Season Cumulative Abundance	Non-breeding Season Cumulative Abundance
Tier 1			
Awel y Môr	4,488	1,569	2,919
Erebus	18,882	3,558	15,324
Tier 2			
Mona Offshore Wind Project	11,912	6,461	5,451
Morecambe Offshore Wind Farm: Generation Assets.	unknown	unknown	unknown
North Irish Sea Array	unknown	unknown	unknown
Codling Wind Park	unknown	unknown	unknown
Dublin Array	unknown	unknown	unknown
Oriel	unknown	unknown	unknown
Arklow Bank Phase 2	unknown	unknown	unknown
Shelmalere	unknown	unknown	unknown
Llyr 1	unknown	unknown	unknown
Llyr 2	unknown	unknown	unknown
White Cross	unknown	unknown	unknown
Inis Eagla Marine Energy Park	unknown	unknown	unknown
TOTAL (minus Morgan Generation Assets)	**35,282**	**11,588**	**23,694**
Morgan Generation Assets	8,994	4,893	4,101
TOTAL (all projects)	**44,276**	**16,481**	**27,795**

10.10.2.10 The following displacement matrices provide the estimated cumulative mortality of guillemot predicted to occur due to displacement during construction, as determined by the relevant specified rates of displacement and mortality (Table 10.49 to Table 10.51). The approach used for the cumulative displacement assessment follows volume 4, annex 10.2: Offshore ornithology displacement assessment of the PEIR.

Table 10.49: Construction phase cumulative guillemot mortality following displacement from offshore wind farms in the breeding season.

Common guillemot — Breeding	Mortality level (% of displaced birds at risk of mortality)						
Displacement level (% at risk of displacement)	1%	2%	5%	10%	25%	50%	100%
5%	8	16	41	82	206	412	824
10%	16	33	82	165	412	824	1,648
15%	25	49	124	247	618	1,236	2,472
20%	33	66	165	330	824	1,648	3,296
25%	41	82	206	412	1,030	2,060	4,120
30%	49	99	247	494	1,236	2,472	4,944
35%	58	115	288	577	1,442	2,884	5,768
60%	99	198	494	989	2,472	4,944	9,889
80%	132	264	659	1,318	3,296	6,592	13,185
100%	165	330	824	1,648	4,120	8,241	16,481

Table 10.50: Construction phase cumulative guillemot mortality following displacement from offshore wind farms in the non-breeding season.

Common guillemot — Non-breeding	Mortality level (% of displaced birds at risk of mortality)						
Displacement level (% at risk of displacement)	1%	2%	5%	10%	25%	50%	100%
5%	14	28	69	139	347	695	1,390
10%	28	56	139	278	695	1,390	2,780
15%	42	83	208	417	1,042	2,085	4,169
20%	56	111	278	556	1,390	2,780	5,559
25%	69	139	347	695	1,737	3,474	6,949
30%	83	167	417	834	2,085	4,169	8,339
35%	97	195	486	973	2,432	4,864	9,728
60%	167	334	834	1,668	4,169	8,339	16,677
80%	222	445	1,112	2,224	5,559	11,118	22,236
100%	278	556	1,390	2,780	6,949	13,898	27,795

Table 10.51: Construction phase cumulative guillemot mortality following displacement from offshore wind farms annually.

Common guillemot Annual	Mortality level (% of displaced birds at risk of mortality)						
Displacement level (% at risk of displacement)	1%	2%	5%	10%	25%	50%	100%
5%	22	44	111	221	553	1,107	2,214
10%	44	89	221	443	1,107	2,214	4,428
15%	66	133	332	664	1,660	3,321	6,641
20%	89	177	443	886	2,214	4,428	8,855
25%	111	221	553	1,107	2,767	5,535	11,069
30%	133	266	664	1,328	3,321	6,641	13,283
35%	155	310	775	1,550	3,874	7,748	15,497
60%	266	531	1,328	2,657	6,641	13,283	26,566
80%	354	708	1,771	3,542	8,855	17,710	35,421
100%	443	886	2,214	4,428	11,069	22,138	44,276

10.10.2.11 During the breeding season, the potential displacement from construction when using a displacement rate of 25% (range: 15 to 35%) and a mortality of 1% (range: 1% to 10%), results in an additional loss of 41 (25 to 577) individuals from the breeding population (Table 10.49).

10.10.2.12 During the non-breeding season, the displacement from construction results in an additional loss of 69 (42 to 973) individuals from the non-breeding population (Table 10.50).

10.10.2.13 For the combined bio-seasons, the annual estimated mortality resulting from displacement during construction is 111 (66 to 1,550) individuals (Table 10.51).

10.10.2.14 Using the largest BDMPS population of 1,139,220 individuals and, using the average baseline mortality rate of 0.139 (population and rates taken from volume 4, annex 10.2: Offshore ornithology displacement assessment of the PEIR), the background predicted mortality would be 158,352. The addition of 111 (66 to 1,550) mortalities would increase the baseline mortality rate by 0.069% (0.042% to 0.979%). The annual predicted mortality from the cumulative assessment during construction is below the 1% threshold increase.

10.10.2.15 The cumulative effect is predicted to be of national spatial extent, medium term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **negligible**.

Razorbill

10.10.2.16 The estimated cumulative abundance of razorbill from the relevant projects (projects that overlap in their construction activities with Morgan) are presented in Table 10.52.

Table 10.52: Razorbill cumulative abundances for overlapping construction phase offshore wind projects for disturbance and displacement assessment.

Project	Annual Cumulative Abundance	Pre-breeding Cumulative Abundance	Breeding Season Cumulative Abundance	Post-breeding Cumulative Abundance	Non-breeding Cumulative Abundance
Tier 1					
Awel y Môr	692	336	140	66	150
Erebus	2,357	460	103	1,228	566
Tier 2					
Mona Offshore Wind Project	2,883	2,283	173	140	287
Morecambe Offshore Wind Farm: Generation Assets	unknown	unknown	unknown	unknown	unknown
North Irish Sea Array	unknown	unknown	unknown	unknown	unknown
Codling Wind Park	unknown	unknown	unknown	unknown	unknown
Dublin Array	unknown	unknown	unknown	unknown	unknown
Oriel	unknown	unknown	unknown	unknown	unknown
Arklow Bank Phase 2	unknown	unknown	unknown	unknown	unknown
Shelmalere	unknown	unknown	unknown	unknown	unknown
Llyr 1	unknown	unknown	unknown	unknown	unknown
Llyr 2	unknown	unknown	unknown	unknown	unknown
White Cross	unknown	unknown	unknown	unknown	unknown
Inis Eagla Marine Energy Park	unknown	unknown	unknown	unknown	unknown
TOTAL (minus Morgan Generation Assets)	**5,932**	**3,079**	**416**	**1,434**	**1,003**
Morgan Generation Assets	622	166	120	103	233
TOTAL (all projects)	**6,554**	**3,245**	**536**	**1,537**	**1,236**

10.10.2.17 The following displacement matrices provide the estimated cumulative mortality of guillemot predicted to occur due to displacement during construction, as determined by the relevant specified rates of displacement and mortality (Table 10.53 to Table

10.57). The approach used follows volume 4, annex 10.2: Offshore ornithology displacement assessment of the PEIR.

Table 10.53: Construction phase cumulative razorbill mortality following displacement from offshore wind farms in the pre-breeding season.

Razorbill Pre-breeding		Mortality level (% of displaced birds at risk of mortality)						
		1%	2%	5%	10%	25%	50%	100%
Displacement level (% at risk of displacement)	5%	2	3	8	16	41	81	162
	10%	3	6	16	32	81	162	325
	15%	5	10	24	49	122	243	487
	20%	6	13	32	65	162	325	649
	25%	8	16	41	81	203	406	811
	30%	10	19	49	97	243	487	974
	35%	11	23	57	114	284	568	1,136
	60%	19	39	97	195	487	974	1,947
	80%	26	52	130	260	649	1,298	2,596
	100%	32	65	162	325	811	1,623	3,245

Table 10.54: Construction phase cumulative razorbill mortality following displacement from offshore wind farms in the breeding season.

Razorbill Breeding		Mortality level (% of displaced birds at risk of mortality)						
		1%	2%	5%	10%	25%	50%	100%
Displacement level (% at risk of displacement)	5%	0	1	1	3	7	13	27
	10%	1	1	3	5	13	27	54
	15%	1	2	4	8	20	40	80
	20%	1	2	5	11	27	54	107
	25%	1	3	7	13	34	67	134
	30%	2	3	8	16	40	80	161
	35%	2	4	9	19	47	94	188
	60%	3	6	16	32	80	161	322
	80%	4	9	21	43	107	214	429
	100%	5	11	27	54	134	268	536

Table 10.55: Construction phase cumulative razorbill mortality following displacement from offshore wind farms in the post-breeding season.

Razorbill Post-breeding		Mortality level (% of displaced birds at risk of mortality)						
		1%	2%	5%	10%	25%	50%	100%
Displacement level (% at risk of displacement)	5%	1	2	4	8	19	38	77
	10%	2	3	8	15	38	77	154
	15%	2	5	12	23	58	115	231
	20%	3	6	15	31	77	154	307
	25%	4	8	19	38	96	192	384
	30%	5	9	23	46	115	231	461
	35%	5	11	27	54	134	269	538
	60%	9	18	46	92	231	461	922
	80%	12	25	61	123	307	615	1,230
	100%	15	31	77	154	384	769	1,537

Table 10.56: Construction phase cumulative razorbill mortality following displacement from offshore wind farms in the non-breeding season.

Razorbill Non-breeding		Mortality level (% of displaced birds at risk of mortality)						
		1%	2%	5%	10%	25%	50%	100%
Displacement level (% at risk of displacement)	5%	1	1	3	6	15	31	62
	10%	1	2	6	12	31	62	124
	15%	2	4	9	19	46	93	185
	20%	2	5	12	25	62	124	247
	25%	3	6	15	31	77	155	309
	30%	4	7	19	37	93	185	371
	35%	4	9	22	43	108	216	433
	60%	7	15	37	74	185	371	742
	80%	10	20	49	99	247	494	989
	100%	12	25	62	124	309	618	1,236

Table 10.57: Construction phase cumulative razorbill mortality following displacement from offshore wind farms annually.

Razorbill Annual	Displacement level (% at risk of displacement)	Mortality level (% of displaced birds at risk of mortality) 1%	2%	5%	10%	25%	50%	100%
	5%	3	7	16	33	82	164	328
	10%	7	13	33	66	164	328	655
	15%	10	20	49	98	246	492	983
	20%	13	26	66	131	328	655	1,311
	25%	16	33	82	164	410	819	1,639
	30%	20	39	98	197	492	983	1,966
	35%	23	46	115	229	573	1,147	2,294
	60%	39	79	197	393	983	1,966	3,932
	80%	52	105	262	524	1,311	2,622	5,243
	100%	66	131	328	655	1,639	3,277	6,554

10.10.2.18 During the spring migration (pre-breeding) season the displacement from construction when using a displacement rate of 25% (range: 15% to 35%) and a mortality of 1% (range: 1 to 10%), results in an additional loss of 8 (5 to 114) individuals (Table 10.53).

10.10.2.19 During the breeding season, displacement from construction results in the loss of 1 (1 to 15) individual from the breeding population (Table 10.54).

10.10.2.20 During the autumn migration season (post-breeding), displacement from construction results in a loss of 1 (1 to 19) individual from the migratory population (Table 10.55).

10.10.2.21 During the non-breeding season (winter season), displacement from construction results a in a loss of 3 (2 to 43) individuals from the non-breeding population (Table 10.56).

10.10.2.22 The annual estimated mortality resulting from displacement during construction is 16 (10 to 229) individuals (Table 10.57).

10.10.2.23 Using the largest BDMPS population of 606,914 individuals and, using the average baseline mortality rate of 0.174 (population and rates taken from volume 4, annex 10.2: Offshore ornithology displacement assessment of the PEIR), the background predicted mortality would be 105,603. The addition of 16 (10 to 229) mortalities would increase the baseline mortality rate by 0.016% (0.009% to 0.217%). The annual predicted mortality from the cumulative assessment is below the 1% threshold increase in baseline mortality.

10.10.2.24 The cumulative effect is predicted to be of national spatial extent, medium term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **negligible**.

Atlantic puffin

10.10.2.25 The estimated cumulative abundance of Atlantic puffin from the relevant projects is presented in Table 10.58.

Table 10.58: Atlantic puffin cumulative abundances for overlapping construction phase offshore wind projects for disturbance and displacement assessment.

Project	Annual Cumulative Abundance	Breeding Season Cumulative Abundance	Non-breeding Season Cumulative Abundance
Tier 1			
Awel y Môr	unknown	unknown	unknown
Erebus	481	449	32
Tier 2			
Mona Offshore Wind Project	30	16	14
Morecambe Offshore Wind Farm: Generation Assets	unknown	unknown	unknown
North Irish Sea Array	unknown	unknown	unknown
Codling Wind Park	unknown	unknown	unknown
Dublin Array	unknown	unknown	unknown
Oriel	unknown	unknown	unknown
Arklow Bank Phase 2	unknown	unknown	unknown
Shelmalere	unknown	unknown	unknown
Llyr 1	unknown	unknown	unknown
Llyr 2	unknown	unknown	unknown
White Cross	unknown	unknown	unknown
Inis Eagla Marine Energy Park	unknown	unknown	unknown
TOTAL (minus Morgan Generation Assets)	**511**	**465**	**46**
Morgan Generation Assets	18	18	0
TOTAL (all projects)	**529**	**483**	**46**

10.10.2.26 The following displacement matrices provide the estimated cumulative mortality of Atlantic puffin predicted to occur due to displacement, as determined by the relevant specified rates of displacement and mortality (Table 10.59 to Table 10.61). The approach used for the cumulative displacement assessment follows volume 4, annex 10.2: Offshore ornithology displacement assessment.

Table 10.59: Construction phase cumulative Atlantic puffin mortality following displacement from offshore wind farms in the breeding season.

Atlantic puffin Breeding	Mortality level (% of displaced birds at risk of mortality)						
Displacement level (% at risk of displacement)	1%	2%	5%	10%	25%	50%	100%
5%	0	0	1	2	6	12	24
10%	0	1	2	5	12	24	48
15%	1	1	4	7	18	36	72
20%	1	2	5	10	24	48	97
25%	1	2	6	12	30	60	121
30%	1	3	7	14	36	72	145
35%	2	3	8	17	42	85	169
60%	3	6	14	29	72	145	290
80%	4	8	19	39	97	193	386
100%	5	10	24	48	121	242	483

Table 10.60: Construction phase cumulative Atlantic puffin mortality following displacement from offshore wind farms in the non-breeding season.

Atlantic puffin Non-breeding	Mortality level (% of displaced birds at risk of mortality)						
Displacement level (% at risk of displacement)	1%	2%	5%	10%	25%	50%	100%
5%	0	0	0	0	1	1	2
10%	0	0	0	0	1	2	5
15%	0	0	0	1	2	3	7
20%	0	0	0	1	2	5	9
25%	0	0	1	1	3	6	12
30%	0	0	1	1	3	7	14
35%	0	0	1	2	4	8	16
60%	0	1	1	3	7	14	28
80%	0	1	2	4	9	18	37
100%	0	1	2	5	12	23	46

Table 10.61: Construction phase cumulative Atlantic puffin mortality following displacement from offshore wind farms annually.

Atlantic puffin Annual	Mortality level (% of displaced birds at risk of mortality)						
Displacement level (% at risk of displacement)	1%	2%	5%	10%	25%	50%	100%
5%	0	1	1	3	7	13	26
10%	1	1	3	5	13	26	53
15%	1	2	4	8	20	40	79
20%	1	2	5	11	26	53	106
25%	1	3	7	13	33	66	132
30%	2	3	8	16	40	79	159
35%	2	4	9	19	46	93	185
60%	3	6	16	32	79	159	317
80%	4	8	21	42	106	212	423
100%	5	11	26	53	132	265	529

10.10.2.27 During the breeding season, the displacement from construction when using a displacement rate of 25% (range: 15% to 35%) and a mortality of 1% (range: 1 to 10%), results in an additional loss of one (1 to 17) individual from the breeding population (Table 10.59).

10.10.2.28 During the non-breeding season, the displacement from construction results in an additional loss of zero (0 to 2) individuals from the non-breeding population (Table 10.60).

10.10.2.29 The annual estimated mortality resulting from displacement during construction is one (1 to 19) individuals (Table 10.61).

10.10.2.30 Using the largest BDMPS of 304,557 individuals and, using the average baseline mortality rate of 0.181 (population and rates taken from volume 4, annex 10.2: Offshore ornithology displacement assessment) the background estimated mortality across all seasons is 55,125. The addition of one (1 to 19) mortality would increase the baseline mortality rate by 0.001% (0.001% to 0.017%). The annual predicted mortality from the cumulative assessment is well below the 1% threshold increase in baseline mortality.

10.10.2.31 The cumulative effect is predicted to be of national spatial extent, medium term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.

Northern gannet

10.10.2.32 The estimated cumulative abundance of northern gannet from the relevant projects is presented in Table 10.62.

Table 10.62: Northern gannet cumulative abundances for overlapping construction phase offshore wind projects for disturbance and displacement assessment.

Project	Annual Cumulative Abundance	Pre-breeding Cumulative Abundance	Breeding Season Cumulative Abundance	Post-breeding Cumulative Abundance
Tier 1				
Awel y Môr	529	0	328	201
Erebus	658	224	334	100
Tier 2				
Mona Offshore Wind Project	693	105	351	237
Morecambe Offshore Wind Farm: Generation Assets.	unknown	unknown	unknown	unknown
North Irish Sea Array	unknown	unknown	unknown	unknown
Codling Wind Park	unknown	unknown	unknown	unknown
Dublin Array	unknown	unknown	unknown	unknown
Oriel	unknown	unknown	unknown	unknown
Arklow Bank Phase 2	unknown	unknown	unknown	unknown
Shelmalere	unknown	unknown	unknown	unknown
Llyr 1	unknown	unknown	unknown	unknown
Llyr 2	unknown	unknown	unknown	unknown
White Cross	unknown	unknown	unknown	unknown
Inis Eagla Marine Energy Park	unknown	unknown	unknown	unknown
TOTAL (minus Morgan Generation Assets)	**1,641**	**277**	**871**	**493**
Morgan Generation Assets	454	53	209	192
TOTAL (all projects)	**2,334**	**382**	**1,222**	**730**

10.10.2.33 The following displacement matrices provide the estimated cumulative mortality of northern gannet predicted to occur due to displacement, as determined by the relevant specified rates of displacement and mortality (Table 10.63 to Table 10.66). The approach used for the cumulative displacement assessment follows volume 4, annex 10.2: Offshore ornithology displacement assessment.

Table 10.63: Construction phase cumulative northern gannet mortality following displacement from offshore wind farms in the pre-breeding season.

Northern gannet Pre-breeding	Mortality level (% of displaced birds at risk of mortality)						
Displacement level (% at risk of displacement)	1%	2%	5%	10%	25%	50%	100%
10%	0	1	2	4	10	19	38
20%	1	2	4	8	19	38	76
30%	1	2	6	11	29	57	115
35%	1	3	7	13	33	67	134
40%	2	3	8	15	38	76	153
60%	2	5	11	23	57	115	229
70%	3	5	13	27	67	134	267
80%	3	6	15	31	76	153	306
90%	3	7	17	34	86	172	344
100%	4	8	19	38	96	191	382

Table 10.64: Construction phase cumulative northern gannet mortality following displacement from offshore wind farms in the breeding season.

Northern gannet Breeding	Mortality level (% of displaced birds at risk of mortality)						
Displacement level (% at risk of displacement)	1%	2%	5%	10%	25%	50%	100%
10%	1	2	6	12	31	61	122
20%	2	5	12	24	61	122	244
30%	4	7	18	37	92	183	367
35%	4	9	21	43	107	214	428
40%	5	10	24	49	122	244	489
60%	7	15	37	73	183	367	733
70%	9	17	43	86	214	428	855
80%	10	20	49	98	244	489	978
90%	11	22	55	110	275	550	1,100
100%	12	24	61	122	306	611	1,222

Table 10.65: Construction phase cumulative northern gannet mortality following displacement from offshore wind farms in the post-breeding season.

Northern gannet Post-breeding	Mortality level (% of displaced birds at risk of mortality)						
Displacement level (% at risk of displacement)	1%	2%	5%	10%	25%	50%	100%
10%	1	1	4	7	18	37	73
20%	1	3	7	15	37	73	146
30%	2	4	11	22	55	110	219
35%	3	5	13	26	64	128	256
40%	3	6	15	29	73	146	292
60%	4	9	22	44	110	219	438
70%	5	10	26	51	128	256	511
80%	6	12	29	58	146	292	584
90%	7	13	33	66	164	329	657
100%	7	15	37	73	183	365	730

Table 10.66: Construction phase cumulative northern gannet mortality following displacement from offshore wind farms annually.

Northern gannet Annual	Mortality level (% of displaced birds at risk of mortality)						
Displacement level (% at risk of displacement)	1%	2%	5%	10%	25%	50%	100%
10%	2	5	12	23	58	117	233
20%	5	9	23	47	117	233	467
30%	7	14	35	70	175	350	700
35%	8	16	41	82	204	408	817
40%	9	19	47	93	233	467	934
60%	14	28	70	140	350	700	1,400
70%	16	33	82	163	408	817	1,634
80%	19	37	93	187	467	934	1,867
90%	21	42	105	210	525	1,050	2,101
100%	23	47	117	233	584	1,167	2,334

10.10.2.34 During the spring migration (pre-breeding) season the displacement from construction when using a displacement rate of 35% (range: 30% to 40%) and a mortality of 1% (range: 1 to 10%), results in an additional loss of one (1 to 15) individuals (Table 10.63).

10.10.2.35 During the breeding season, displacement from construction results in the loss of four (4 to 49) individuals from the breeding population (Table 10.65).

10.10.2.36 The annual estimated mortality resulting from displacement during construction is eight (7 to 93) individuals (Table 10.66).

10.10.2.37 Using the largest UK Western Waters BDMPS population of 661,888 individuals, with an average baseline mortality rate of 0.187 (population and rates taken from volume 4, annex 10.2: Offshore ornithology displacement assessment), the background predicted mortality would be 123,773. The addition of eight (7 to 93) mortalities would increase the baseline mortality rate by 0.007% (0.006% to 0.075%). The annual predicted mortality from the cumulative assessment is below the 1% threshold increase in baseline mortality.

10.10.2.38 The cumulative effect is predicted to be of national spatial extent, medium term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.

Black-legged kittiwake

10.10.2.39 The estimated cumulative abundance of black-legged kittiwake from the relevant projects is presented in Table 10.67.

Table 10.67: Black-legged kittiwake cumulative abundances for overlapping construction phase offshore wind projects for disturbance and displacement assessment.

Project	Annual Cumulative Abundance	Pre-breeding Cumulative Abundance	Breeding Season Cumulative Abundance	Post-breeding Cumulative Abundance
Tier 1				
Awel y Môr	unknown	unknown	unknown	unknown
Erebus	2,532	2	2,022	508
Tier 2				
Mona Offshore Wind Project	2,397	1,135	479	783
Morecambe Offshore Wind Farm: Generation Assets	unknown	unknown	unknown	unknown
North Irish Sea Array	unknown	unknown	unknown	unknown
Codling Wind Park	unknown	unknown	unknown	unknown
Dublin Array	unknown	unknown	unknown	unknown
Oriel	unknown	unknown	unknown	unknown
Arklow Bank Phase 2	unknown	unknown	unknown	unknown
Shelmalere	unknown	unknown	unknown	unknown
Llyr 1	unknown	unknown	unknown	unknown

Project	Annual Cumulative Abundance	Pre-breeding Cumulative Abundance	Breeding Season Cumulative Abundance	Post-breeding Cumulative Abundance
Llyr 2	unknown	unknown	unknown	unknown
White Cross	unknown	unknown	unknown	unknown
Inis Eagla Marine Energy Park	unknown	unknown	unknown	unknown
TOTAL (minus Morgan Generation Assets)	**4,929**	**1,137**	**2,501**	**1,291**
Morgan Generation Assets	2,724	645	460	1,619
TOTAL (all projects)	**7,653**	**1,782**	**2,961**	**2,910**

10.10.2.40 The following displacement matrices provide the estimated cumulative mortality of black-legged kittiwake predicted to occur due to displacement, as determined by the relevant specified rates of displacement and mortality (Table 10.68 to Table 10.71). The approach used for the cumulative displacement assessment follows that of volume 4, annex 10.2: Offshore ornithology displacement assessment.

Table 10.68: Construction phase cumulative black-legged kittiwake mortality following displacement from offshore wind farms in the pre-breeding season.

Black-legged kittiwake Pre-breeding – Displacement level (% at risk of displacement)	Mortality level (% of displaced birds at risk of mortality) 1%	2%	5%	10%	25%	50%	100%
5%	1	2	4	9	22	45	89
10%	2	4	9	18	45	89	178
15%	3	5	13	27	67	134	267
20%	4	7	18	36	89	178	356
25%	4	9	22	45	111	223	446
30%	5	11	27	53	134	267	535
35%	6	12	31	62	156	312	624
60%	11	21	53	107	267	535	1,069
80%	14	29	71	143	356	713	1,426
100%	18	36	89	178	446	891	1,782

Table 10.69: Construction phase cumulative black-legged kittiwake mortality following displacement from offshore wind farms in the breeding season.

Black-legged kittiwake Breeding – Displacement level (% at risk of displacement)	Mortality level (% of displaced birds at risk of mortality) 1%	2%	5%	10%	25%	50%	100%
5%	1	3	7	15	37	74	148
10%	3	6	15	30	74	148	296
15%	4	9	22	44	111	222	444
20%	6	12	30	59	148	296	592
25%	7	15	37	74	185	370	740
30%	9	18	44	89	222	444	888
35%	10	21	52	104	259	518	1,036
60%	18	36	89	178	444	888	1,777
80%	24	47	118	237	592	1,184	2,369
100%	30	59	148	296	740	1,481	2,961

Table 10.70: Construction phase cumulative black-legged kittiwake mortality following displacement from offshore wind farms in the post-breeding season.

Black-legged kittiwake Post-breeding – Displacement level (% at risk of displacement)	Mortality level (% of displaced birds at risk of mortality) 1%	2%	5%	10%	25%	50%	100%
5%	1	3	7	15	36	73	146
10%	3	6	15	29	73	146	291
15%	4	9	22	44	109	218	437
20%	6	12	29	58	146	291	582
25%	7	15	36	73	182	364	728
30%	9	17	44	87	218	437	873
35%	10	20	51	102	255	509	1,019
60%	17	35	87	175	437	873	1,746
80%	23	47	116	233	582	1,164	2,328
100%	29	58	146	291	728	1,455	2,910

Table 10.71: Construction phase cumulative black-legged kittiwake mortality following displacement from offshore wind farms annually.

Black-legged kittiwake Annual		Mortality level (% of displaced birds at risk of mortality)						
Displacement level (% at risk of displacement)		1%	2%	5%	10%	25%	50%	100%
	5%	4	8	19	38	96	191	383
	10%	8	15	38	77	191	383	765
	15%	11	23	57	115	287	574	1,148
	20%	15	31	77	153	383	765	1,531
	25%	19	38	96	191	478	957	1,913
	30%	23	46	115	230	574	1,148	2,296
	35%	27	54	134	268	670	1,339	2,679
	60%	46	92	230	459	1,148	2,296	4,592
	80%	61	122	306	612	1,531	3,061	6,122
	100%	77	153	383	765	1,913	3,827	7,653

10.10.2.41 During the spring migration (pre-breeding) season the displacement from construction when using a displacement rate of 25% (range: 15% to 35%) and a mortality of 1% (range: 1 to 10%), results in an additional loss of four (3 to 62) individuals (Table 10.68).

10.10.2.42 During the breeding season, displacement from construction results in the loss of seven (4 to 104) individuals from the breeding population (Table 10.69).

10.10.2.43 During the autumn migration season (post-breeding), displacement from construction results in a loss of seven (4 to 102) individuals from the migratory population (Table 10.70).

10.10.2.44 The annual estimated mortality resulting from displacement during construction is 19 (11 to 268) individuals (Table 10.71).

10.10.2.45 Using the largest UK Western Waters BDMPS population of 911,586 individuals, with an average baseline mortality rate of 0.157 (population and rates taken volume 4, annex 10.2: Offshore ornithology displacement assessment), the background predicted mortality would be 143,119. The addition of 19 (11 to 268) mortalities would increase the baseline mortality rate by 0.013% (0.008% to 0.187%). The annual predicted mortality from the cumulative assessment is below the 1% threshold increase in baseline mortality.

10.10.2.46 The cumulative effect is predicted to be of national spatial extent, medium term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.

Sensitivity of the receptor

Common guillemot

10.10.2.47 Evidence of common guillemot sensitivity to displacement from the construction phase of offshore wind farms is summarised from paragraph 10.10.2.9 onwards. Overall, based on evidence from studies and reviews, common guillemot is deemed to be of medium vulnerability, medium recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **medium**.

Razorbill

10.10.2.48 Evidence of razorbill sensitivity to displacement from the construction phase of offshore wind farms is summarised in paragraph 10.10.2.16 onwards. Overall, based on evidence from studies and reviews, razorbill is deemed to be of medium vulnerability, medium recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **medium.**

Atlantic puffin

10.10.2.49 Evidence of Atlantic puffin sensitivity to displacement from the construction phase of offshore wind farms is summarised in paragraph 10.10.2.25 onwards. Overall, based on evidence from studies and reviews, Atlantic puffin is deemed to be of medium vulnerability, low recoverability and high value. The sensitivity of the receptor is therefore, considered to be **high**.

Northern gannet

10.10.2.50 Evidence of northern gannet sensitivity to displacement from the construction phase of offshore wind farms is summarised in paragraph 10.10.2.32 onwards. Based on evidence from operational wind farms demonstrating that northern gannet show a high avoidance of offshore wind farms, this species is deemed to be of medium vulnerability, medium recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **medium.**

Black-legged kittiwake

10.10.2.51 Evidence of black-legged kittiwake sensitivity to displacement from the construction phase of offshore wind farms is summarised in paragraph 10.10.2.39 onwards. For kittiwake, there is evidence from other operating offshore wind farm projects that displacement is not likely to occur to any significant level. However, due to low reproductive rates, black-legged kittiwake is deemed to be of low vulnerability, low recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **medium.**

Significance of effect

10.10.2.52 Overall, the magnitude of cumulative displacement from construction with surrounding wind farms in the ZOI are defined as being of **negligible to minor** adverse significance (Table 10.72) depending on the species, which is not significant in EIA terms. For common guillemot, razorbill, northern gannet and black-legged kittiwake, which had a magnitude of impact of negligible and sensitivity of medium, negligible was selected from the negligible to minor range due to the impact not exceeding a 0.1% increase in baseline mortality and hence, was not regarded as a minor significance of effect.

Table 10.72: Table summarising the significance of effect of displacement from cumulative impacts during construction

Species	Magnitude of impact	Sensitivity of receptor	Significance of effect
Common guillemot	Negligible	Medium	**Negligible, not significant in EIA terms**
Razorbill	Negligible	Medium	**Negligible, not significant in EIA terms**
Atlantic puffin	Negligible	High	**Minor, not significant in EIA terms**
Northern gannet	Negligible	Medium	**Negligible, not significant in EIA terms**
Black-legged kittiwake	Negligible	Medium	**Negligible, not significant in EIA terms**

Tier 1 and Tier 2

Operations and maintenance phase

Magnitude of impact

Common guillemot

10.10.2.53 The estimated cumulative abundance of guillemot from the relevant projects with available data is presented in Table 10.73.

Table 10.73: Guillemot cumulative abundances for offshore wind projects for disturbance and displacement assessment during operations.

Project	Annual Cumulative Abundance	Breeding Season Cumulative Abundance	Non-breeding Season Cumulative Abundance
Tier 1			
Barrow	unknown	unknown	unknown
Burbo Bank	unknown	unknown	unknown
Burbo Bank Extension	5,963	2,414	3,549
North Hoyle	unknown	unknown	unknown
Ormonde	238	238	unknown
Walney 1 + 2	unknown	unknown	unknown
Walney 3 + 4	6,093	4,167	1,926
West of Duddon Sands	833	347	486
Gwynt y Môr	unknown	unknown	unknown
Rhyl Flats	unknown	unknown	unknown
Robin Rigg	28	28	unknown
Arklow Bank Phase 1	unknown	unknown	unknown
Awel y Môr	4,488	1,569	2,919
Erebus	18,882	3,558	15,324
Tier 2			
Mona Offshore Wind Project	11,912	6,461	5,451
Morecambe Offshore Wind Farm: Generation Assets	unknown	unknown	unknown
North Irish Sea Array	unknown	unknown	unknown
Codling Wind Park	unknown	unknown	unknown
Dublin Array	unknown	unknown	unknown
Oriel	unknown	unknown	unknown
Arklow Bank Phase 2	unknown	unknown	unknown
Shelmalere	unknown	unknown	unknown
Llyr 1	unknown	unknown	unknown
Llyr 2	unknown	unknown	unknown
White Cross	unknown	unknown	unknown
Inis Eagla Marine Energy Park	unknown	unknown	unknown
Total (minus Morgan Generation Assets)	**48,437**	**18,782**	**29,655**
Morgan Generation Assets	8,994	4,893	4,101
Cumulative total (all projects)	**57,431**	**23,675**	**33,756**

10.10.2.54 The following displacement matrices provide the estimated cumulative mortality of guillemot predicted to occur due to displacement, as determined by the relevant specified rates of displacement and mortality Table 10.74 to Table 10.76). The approach used for the cumulative displacement assessment follows that of volume 4, annex 10.2: Offshore ornithology displacement assessment.

Table 10.74: Operations and maintenance phase cumulative guillemot mortality following displacement from offshore wind farms in the breeding season.

Common guillemot – Breeding	Mortality level (% of displaced birds at risk of mortality)						
Displacement level (% at risk of displacement)	**1%**	**2%**	**5%**	**10%**	**25%**	**50%**	**100%**
10%	24	47	118	237	592	1,184	2,368
20%	47	95	237	474	1,184	2,368	4,735
30%	71	142	355	710	1,776	3,551	7,103
40%	95	189	474	947	2,368	4,735	9,470
50%	118	237	592	1,184	2,959	5,919	11,838
60%	142	284	710	1,421	3,551	7,103	14,205
70%	166	331	829	1,657	4,143	8,286	16,573
80%	189	379	947	1,894	4,735	9,470	18,940
90%	213	426	1,065	2,131	5,327	10,654	21,308
100%	237	474	1,184	2,368	5,919	11,838	23,675

Table 10.75: Operations and maintenance phase cumulative guillemot mortality following displacement from offshore wind farms in the non-breeding season.

Common guillemot – Non-breeding	Mortality level (% of displaced birds at risk of mortality)						
Displacement level (% at risk of displacement)	**1%**	**2%**	**5%**	**10%**	**25%**	**50%**	**100%**
10%	34	68	169	338	844	1,688	3,376
20%	68	135	338	675	1,688	3,376	6,751
30%	101	203	506	1,013	2,532	5,063	10,127
40%	135	270	675	1,350	3,376	6,751	13,502
50%	169	338	844	1,688	4,220	8,439	16,878
60%	203	405	1,013	2,025	5,063	10,127	20,254
70%	236	473	1,181	2,363	5,907	11,815	23,629
80%	270	540	1,350	2,700	6,751	13,502	27,005
90%	304	608	1,519	3,038	7,595	15,190	30,380
100%	338	675	1,688	3,376	8,439	16,878	33,756

Table 10.76: Operations and maintenance phase cumulative guillemot mortality following displacement from offshore wind farms annually.

Common guillemot – Annual	Mortality level (% of displaced birds at risk of mortality)						
Displacement level (% at risk of displacement)	**1%**	**2%**	**5%**	**10%**	**25%**	**50%**	**100%**
10%	57	115	287	574	1,436	2,872	5,743
20%	115	230	574	1,149	2,872	5,743	11,486
30%	172	345	861	1,723	4,307	8,615	17,229
40%	230	459	1,149	2,297	5,743	11,486	22,972
50%	287	574	1,436	2,872	7,179	14,358	28,716
60%	345	689	1,723	3,446	8,615	17,229	34,459
70%	402	804	2,010	4,020	10,050	20,101	40,202
80%	459	919	2,297	4,594	11,486	22,972	45,945
90%	517	1,034	2,584	5,169	12,922	25,844	51,688
100%	574	1,149	2,872	5,743	14,358	28,716	57,431

10.10.2.55 During the breeding season, the displacement from operations when using a displacement of 50% (range of 30 to 70%) and a mortality of 1% (range of 1 to 10%), results in an additional loss of 118 (71 to 1,657) individuals from the breeding population (Table 10.74).

10.10.2.56 During the non-breeding season, the displacement from operations results in an additional loss of 169 (101 to 2,363) individuals from the non-breeding population (Table 10.75).

10.10.2.57 For the combined bio-seasons, the annual estimated mortality resulting from displacement during construction is 287 (172 to 4,020) individuals (Table 10.76).

10.10.2.58 Using the largest BDMPS population of 1,139,220 individuals and, using the average baseline mortality rate of 0.139 (population and rates taken from volume 4, annex 10.2: Offshore ornithology displacement assessment), the background predicted mortality would be 158,352. The addition of 287 (172 to 4,020) mortalities would increase the baseline mortality rate by 0.181 % (0.108% to 2.539%).

10.10.2.59 These numbers demonstrate that the operations phase of the Morgan Generation Assets, combined with the operations phase of the surrounding wind farms in the Irish Sea could cumulatively cause a significant impact to common guillemot populations if the upper range of displacement and mortality are used (displacement rate of 60% and mortality rate of 5% and above).

10.10.2.60 If the upper ranges of displacement and mortality are used, the predicted increase in baseline mortality of the BDMPS populations for common guillemot would exceed an increase of 1%, and a PVA would be needed as a first step to understand if further mitigation is required.

10.10.2.61 These impacts were assessed in volume 4, annex 10.6: Offshore ornithology population viability analysis (PVA).

10.10.2.62 The PVA revealed that the most extreme scenario of 70% displacement and 10% mortality would reduce the population growth rate by 0.393% which would result in a maximum decrease in population size by 13.208%. The more likely scenario of 50% displacement and 1% mortality resulted in a growth rate reduction of 0.028% resulting in a 1.004% decrease in population size after 35 years.

10.10.2.63 Regardless of whether the most likely displacement and mortality scenario (50% and 1%) or the maximum scenario (70% and 10%) is utilised, the common guillemot population in the UK Western waters BDMPS is observed to be growing. It is assumed therefore that despite any additional mortality, the population is still expected to continue to grow and will be larger after 35 years than that what is currently recorded.

10.10.2.64 The reduction in growth rate by between 0.017 to 0.393% (depending on the displacement and mortality rate used) would not trigger a risk of population decline and would only result in a slight reduction in the growth rate currently seen in the BDMPS population, which is not significant in EIA terms.

10.10.2.65 Due to the minimal level of change to baseline conditions, the cumulative effect is predicted to be of national spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Razorbill

10.10.2.66 The estimated cumulative abundance of razorbill from the relevant projects with available data is presented in Table 10.77.

Table 10.77: Razorbill cumulative abundances for offshore wind projects for disturbance and displacement assessment during operations.

Project	Annual Cumulative Abundance	Pre-breeding Cumulative Abundance	Breeding Season Cumulative Abundance	Post-breeding Cumulative Abundance	Non-breeding Cumulative Abundance
Tier 1					
Barrow	unknown	unknown	unknown	unknown	unknown
Burbo Bank	unknown	unknown	unknown	unknown	unknown
Burbo Bank Extension	unknown	unknown	unknown	unknown	unknown
North Hoyle	2,354	534	193	375	1,252
Ormonde	unknown	unknown	unknown	unknown	unknown
Walney 1 + 2	85	85	unknown	unknown	unknown
Walney 3 + 4	unknown	unknown	unknown	unknown	unknown
West of Duddon Sands	3,938	0	873	3,065	0
Gwynt y Môr	455	91	121	152	91
Rhyl Flats	unknown	unknown	unknown	unknown	unknown
Robin Rigg	7	7	unknown	unknown	unknown
Arklow Bank Phase 1	unknown	unknown	unknown	unknown	unknown
Awel y Môr	692	336	140	66	150
Erebus	2,357	460	103	1,228	566
Tier 2					
Mona Offshore Wind Project	2,883	2,283	173	140	287
Morecambe Offshore Wind Farm: Generation Assets	unknown	unknown	unknown	unknown	unknown
North Irish Sea Array	unknown	unknown	unknown	unknown	unknown
Codling Wind Park	unknown	unknown	unknown	unknown	unknown
Dublin Array	unknown	unknown	unknown	unknown	unknown
Oriel	unknown	unknown	unknown	unknown	unknown
Arklow Bank Phase 2	unknown	unknown	unknown	unknown	unknown
Shelmalere	unknown	unknown	unknown	unknown	unknown
Llyr 1	unknown	unknown	unknown	unknown	unknown
Llyr 2	unknown	unknown	unknown	unknown	unknown
White Cross	unknown	unknown	unknown	unknown	unknown
Inis Eagla Marine Energy Park	unknown	unknown	unknown	unknown	unknown
Total (minus Morgan Generation Assets)	**12,771**	**3,796**	**1,603**	**5,026**	**2,346**
Morgan Generation Assets	622	166	120	103	233
Cumulative total (all projects)	**13,393**	**3,962**	**1,723**	**5,129**	**2,579**

10.10.2.67 The following displacement matrices provide the estimated cumulative mortality of razorbill predicted to occur due to displacement, as determined by the relevant specified rates of displacement and mortality (Table 10.78 to Table 10.82). The approach used for the cumulative displacement assessment follows that of volume 4, annex 10.2: Offshore ornithology displacement assessment.

Table 10.78: Operations and maintenance phase cumulative razorbill mortality following displacement from offshore wind farms in the pre-breeding season.

Razorbill Pre-breeding		Mortality level (% of displaced birds at risk of mortality)						
		1%	2%	5%	10%	25%	50%	100%
Displacement level (% at risk of displacement)	10%	4	8	20	40	99	198	396
	20%	8	16	40	79	198	396	792
	30%	12	24	59	119	297	594	1,189
	40%	16	32	79	158	396	792	1,585
	50%	20	40	99	198	495	991	1,981
	60%	24	48	119	238	594	1,189	2,377
	70%	28	55	139	277	693	1,387	2,773
	80%	32	63	158	317	792	1,585	3,170
	90%	36	71	178	357	891	1,783	3,566
	100%	40	79	198	396	991	1,981	3,962

Table 10.79: Operations and maintenance phase cumulative razorbill mortality following displacement from offshore wind farms in the breeding season.

Razorbill Breeding		Mortality level (% of displaced birds at risk of mortality)						
		1%	2%	5%	10%	25%	50%	100%
Displacement level (% at risk of displacement)	10%	2	3	9	17	43	86	172
	20%	3	7	17	34	86	172	345
	30%	5	10	26	52	129	258	517
	40%	7	14	34	69	172	345	689
	50%	9	17	43	86	215	431	862
	60%	10	21	52	103	258	517	1,034
	70%	12	24	60	121	302	603	1,206
	80%	14	28	69	138	345	689	1,378
	90%	16	31	78	155	388	775	1,551
	100%	17	34	86	172	431	862	1,723

Table 10.80: Operations and maintenance phase cumulative razorbill mortality following displacement from offshore wind farms in the post-breeding season.

Razorbill Post-breeding		Mortality level (% of displaced birds at risk of mortality)						
		1%	2%	5%	10%	25%	50%	100%
Displacement level (% at risk of displacement)	10%	5	10	26	51	128	256	513
	20%	10	21	51	103	256	513	1,026
	30%	15	31	77	154	385	769	1,539
	40%	21	41	103	205	513	1,026	2,052
	50%	26	51	128	256	641	1,282	2,565
	60%	31	62	154	308	769	1,539	3,077
	70%	36	72	180	359	898	1,795	3,590
	80%	41	82	205	410	1,026	2,052	4,103
	90%	46	92	231	462	1,154	2,308	4,616
	100%	51	103	256	513	1,282	2,565	5,129

Table 10.81: Operations and maintenance phase cumulative razorbill mortality following displacement from offshore wind farms in the non-breeding season.

Razorbill Non-breeding		Mortality level (% of displaced birds at risk of mortality)						
		1%	2%	5%	10%	25%	50%	100%
Displacement level (% at risk of displacement)	10%	3	5	13	26	64	129	258
	20%	5	10	26	52	129	258	516
	30%	8	15	39	77	193	387	774
	40%	10	21	52	103	258	516	1,032
	50%	13	26	64	129	322	645	1,290
	60%	15	31	77	155	387	774	1,547
	70%	18	36	90	181	451	903	1,805
	80%	21	41	103	206	516	1,032	2,063
	90%	23	46	116	232	580	1,161	2,321
	100%	26	52	129	258	645	1,290	2,579

Table 10.82: Operations and maintenance phase cumulative razorbill mortality following displacement from offshore wind farms annually.

Razorbill Annual		Mortality level (% of displaced birds at risk of mortality)						
		1%	2%	5%	10%	25%	50%	100%
Displacement level (% at risk of displacement)	10%	13	27	67	134	335	670	1,339
	20%	27	54	134	268	670	1,339	2,679
	30%	40	80	201	402	1,004	2,009	4,018
	40%	54	107	268	536	1,339	2,679	5,357
	50%	67	134	335	670	1,674	3,348	6,697
	60%	80	161	402	804	2,009	4,018	8,036
	70%	94	188	469	938	2,344	4,688	9,375
	80%	107	214	536	1,071	2,679	5,357	10,714
	90%	121	241	603	1,205	3,013	6,027	12,054
	100%	134	268	670	1,339	3,348	6,697	13,393

10.10.2.68 During the spring migration (pre-breeding) season the displacement from operation when using the displacement of 50% (range of 30 to 70%) and a mortality rate of 1% (range of 1 to 10%), results in an additional loss of 20 (12 to 277) individuals (Table 10.78).

10.10.2.69 During the breeding season, displacement from operations results in the loss of nine (5 to 121) individuals from the breeding population (Table 10.79).

10.10.2.70 During the autumn migration season (post-breeding), displacement from operations results in a loss of 26 (15 to 359) individuals from the migratory population (Table 10.80).

10.10.2.71 During the non-breeding season (winter season), displacement from operations results a in a loss of 13 (8 to 181) individuals from the non-breeding population (Table 10.81).

10.10.2.72 The annual estimated mortality resulting from displacement during construction is 67 (40 to 938 individuals) (Table 10.82).

10.10.2.73 Using the largest BDMPS population of 606,914 individuals and, using the average baseline mortality rate of 0.174 (population and rates taken from volume 4, annex 10.2: Offshore ornithology displacement assessment), the background predicted mortality would be 105,603. The addition of 67 (40 to 938 individuals) mortalities would increase the baseline mortality rate by 0.063% (0.038 to 0.888%). The annual predicted mortality from the cumulative assessment is below the 1% threshold increase in baseline mortality.

10.10.2.74 The cumulative effect is predicted to be of national spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.

Atlantic puffin

10.10.2.75 The estimated cumulative abundance of Atlantic puffin from the relevant projects is presented in Table 10.83. There are a number of projects for which there are no, or limited, data on the number of Atlantic puffin predicted to be displaced, in particular, for some of the earlier developments.

Table 10.83: Atlantic puffin cumulative abundances for offshore wind projects for disturbance and displacement assessment during operations.

Project	Annual Cumulative Abundance	Breeding Season Cumulative Abundance	Non-breeding Season Cumulative Abundance
Tier 1			
Barrow	unknown	unknown	unknown
Burbo Bank	unknown	unknown	unknown
Burbo Bank Extension	**10**	10	0
North Hoyle	unknown	unknown	unknown
Ormonde	1	1	unknown
Walney 1 + 2	unknown	unknown	unknown
Walney 3 + 4	172	53	119
West of Duddon Sands	96	61	35
Gwynt y Môr	unknown	unknown	unknown
Rhyl Flats	unknown	unknown	unknown
Robin Rigg	0	0	0
Arklow Bank Phase 1	unknown	unknown	unknown
Awel y Môr	unknown	unknown	unknown
Erebus	481	449	32
Tier 2			
Mona Offshore Wind Project	30	16	14
Morecambe Offshore Wind Farm: Generation Assets	unknown	unknown	unknown
North Irish Sea Array	unknown	unknown	unknown
Codling Wind Park	unknown	unknown	unknown
Dublin Array	unknown	unknown	unknown
Oriel	unknown	unknown	unknown
Arklow Bank Phase 2	unknown	unknown	unknown
Shelmalere	unknown	unknown	unknown
Llyr 1	unknown	unknown	unknown

Project	Annual Cumulative Abundance	Breeding Season Cumulative Abundance	Non-breeding Season Cumulative Abundance
Llyr 2	unknown	unknown	unknown
White Cross	unknown	unknown	unknown
Inis Eagla Marine Energy Park	unknown	unknown	unknown
Total (minus Morgan Generation Assets)	**790**	**590**	**200**
Morgan Generation Assets	18	18	0
Cumulative total (all projects)	**808**	**608**	**200**

10.10.2.76 The following displacement matrices provide the estimated cumulative mortality of Atlantic puffin predicted to occur due to displacement, as determined by the relevant specified rates of displacement and mortality (Table 10.84 to Table 10.86). The approach used for the cumulative displacement assessment follows that of volume 4, annex 10.2: Offshore ornithology displacement assessment.

Table 10.84: Operations and maintenance phase cumulative Atlantic puffin mortality following displacement from offshore wind farms in the breeding season.

Atlantic puffin Breeding	Mortality level (% of displaced birds at risk of mortality)						
Displacement level (% at risk of displacement)	1%	2%	5%	10%	25%	50%	100%
10%	1	1	3	6	15	30	61
20%	1	2	6	12	30	61	122
30%	2	4	9	18	46	91	182
40%	2	5	12	24	61	122	243
50%	3	6	15	30	76	152	304
60%	4	7	18	36	91	182	365
70%	4	9	21	43	106	213	426
80%	5	10	24	49	122	243	486
90%	5	11	27	55	137	274	547
100%	6	12	30	61	152	304	608

Table 10.85: Operations and maintenance phase cumulative Atlantic puffin mortality following displacement from offshore wind farms in the non-breeding season.

Atlantic puffin Non-breeding	Mortality level (% of displaced birds at risk of mortality)						
Displacement level (% at risk of displacement)	1%	2%	5%	10%	25%	50%	100%
10%	0	0	1	2	5	10	20
20%	0	1	2	4	10	20	40
30%	1	1	3	6	15	30	60
40%	1	2	4	8	20	40	80
50%	1	2	5	10	25	50	100
60%	1	2	6	12	30	60	120
70%	1	3	7	14	35	70	140
80%	2	3	8	16	40	80	160
90%	2	4	9	18	45	90	180
100%	2	4	10	20	50	100	200

Table 10.86: Operations and maintenance phase cumulative Atlantic puffin mortality following displacement from offshore wind farms annually.

Atlantic puffin Annual	Mortality level (% of displaced birds at risk of mortality)						
Displacement level (% at risk of displacement)	1%	2%	5%	10%	25%	50%	100%
10%	1	2	4	8	20	40	81
20%	2	3	8	16	40	81	162
30%	2	5	12	24	61	121	242
40%	3	6	16	32	81	162	323
50%	4	8	20	40	101	202	404
60%	5	10	24	48	121	242	485
70%	6	11	28	57	141	283	566
80%	6	13	32	65	162	323	646
90%	7	15	36	73	182	364	727
100%	8	16	40	81	202	404	808

10.10.2.77 During the breeding season, the displacement from operation when using the displacement rate of 50% (range of 30 to 70%) and a mortality rate of 1% (range of 1 to 10%), results in an additional loss of three (2 to 43) individuals from the breeding population (Table 10.84).

10.10.2.78 During the non-breeding season, the displacement from operations results in an additional loss of one (1 to 14) individuals from the non-breeding population (Table 10.78).

10.10.2.79 The annual estimated mortality resulting from displacement during construction is four (2 to 57) individuals (Table 10.86).

10.10.2.80 Using the largest BDMPS of 304,557 individuals and, using the average baseline mortality rate of 0.181 (population and rates taken volume 4, annex 10.2: Offshore ornithology displacement assessment) the background estimated mortality across all seasons is 55,125. The addition of four (2 to 57) mortalities would increase the baseline mortality rate by 0.007 % (0.002 to 0.103%). The annual predicted mortality from the cumulative assessment is below the 1% threshold increase in baseline mortality.

10.10.2.81 The cumulative effect is predicted to be of national spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.

Northern gannet

10.10.2.82 The estimated cumulative abundance of northern gannet from the relevant projects is presented in Table 10.87. There are a number of projects for which there are no, or limited, data on the number of northern gannet predicted to be displaced, in particular, for some of the earlier developments.

Table 10.87: Northern gannet cumulative abundances for offshore wind projects for disturbance and displacement assessment during operations.

Project	Annual Cumulative Abundance	Breeding Season Cumulative Abundance	Non-breeding Season Cumulative Abundance
Tier 1			
Barrow	unknown	unknown	unknown
Burbo Bank	unknown	unknown	unknown
Burbo Bank Extension	unknown	unknown	unknown
North Hoyle	unknown	unknown	unknown
Ormonde	unknown	unknown	unknown
Walney 1 + 2	unknown	unknown	unknown
Walney 3 + 4	unknown	unknown	unknown
West of Duddon Sands	unknown	unknown	unknown
Gwynt y Môr	unknown	unknown	unknown
Rhyl Flats	unknown	unknown	unknown
Robin Rigg	unknown	unknown	unknown
Arklow Bank Phase 1	unknown	unknown	unknown
Awel y Môr	529	0	328
Erebus	658	224	334
Tier 2			
Mona Offshore Wind Project	693	105	351
Morecambe Offshore Wind Farm: Generation Assets	unknown	unknown	unknown
North Irish Sea Array	unknown	unknown	unknown
Codling Wind Park	unknown	unknown	unknown
Dublin Array	unknown	unknown	unknown
Oriel	unknown	unknown	unknown
Arklow Bank Phase 2	unknown	unknown	unknown
Shelmalere	unknown	unknown	unknown
Llyr 1	unknown	unknown	unknown
Llyr 2	unknown	unknown	unknown
White Cross	unknown	unknown	unknown
Inis Eagla Marine Energy Park	unknown	unknown	unknown
Total (minus Morgan Generation Assets)	**1,880**	**329**	**1,013**
Morgan Generation Assets	454	53	209
Cumulative total (all projects)	2,334	382	1,222

10.10.2.83 The following displacement matrices provide the estimated cumulative mortality of northern gannet predicted to occur due to displacement, as determined by the relevant specified rates of displacement and mortality (Table 10.88 to Table 10.91).

10.10.2.84 The approach used for the cumulative displacement assessment follows that of 4, annex 10.2: Offshore ornithology displacement assessment.

Table 10.88: Operations and maintenance phase cumulative northern gannet mortality following displacement from offshore wind farms in the pre-breeding season.

Northern gannet Pre-Breeding	Displacement level (% at risk of displacement)	Mortality level (% of displaced birds at risk of mortality) 1%	2%	5%	10%	25%	50%	100%
	10%	0	1	2	4	10	19	38
	20%	1	2	4	8	19	38	76
	30%	1	2	6	11	29	57	115
	40%	2	3	8	15	38	76	153
	50%	2	4	10	19	48	96	191
	60%	2	5	11	23	57	115	229
	70%	3	5	13	27	67	134	267
	80%	3	6	15	31	76	153	306
	90%	3	7	17	34	86	172	344
	100%	4	8	19	38	96	191	382

Table 10.89: Operations and maintenance phase cumulative northern gannet mortality following displacement from offshore wind farms in the breeding season.

Northern gannet Breeding	Displacement level (% at risk of displacement)	Mortality level (% of displaced birds at risk of mortality) 1%	2%	5%	10%	25%	50%	100%
	10%	1	2	6	12	31	61	122
	20%	2	5	12	24	61	122	244
	30%	4	7	18	37	92	183	367
	40%	5	10	24	49	122	244	489
	50%	6	12	31	61	153	306	611
	60%	7	15	37	73	183	367	733
	70%	9	17	43	86	214	428	855
	80%	10	20	49	98	244	489	978
	90%	11	22	55	110	275	550	1100
	100%	12	24	61	122	306	611	1222

Table 10.90: Operations and maintenance phase cumulative northern gannet mortality following displacement from offshore wind farms in the post-breeding season.

Northern gannet Post-breeding	Displacement level (% at risk of displacement)	Mortality level (% of displaced birds at risk of mortality) 1%	2%	5%	10%	25%	50%	100%
	10%	1	1	4	7	18	37	73
	20%	1	3	7	15	37	73	146
	30%	2	4	11	22	55	110	219
	40%	3	6	15	29	73	146	292
	50%	4	7	18	37	91	183	365
	60%	4	9	22	44	110	219	438
	70%	5	10	26	51	128	256	511
	80%	6	12	29	58	146	292	584
	90%	7	13	33	66	164	329	657
	100%	7	15	37	73	183	365	730

Table 10.91: Operations and maintenance phase cumulative northern gannet mortality following displacement from offshore wind farms annually.

Northern gannet Annual	Displacement level (% at risk of displacement)	Mortality level (% of displaced birds at risk of mortality) 1%	2%	5%	10%	25%	50%	100%
	10%	2	5	12	23	58	117	233
	20%	5	9	23	47	117	233	467
	30%	7	14	35	70	175	350	700
	40%	9	19	47	93	233	467	934
	50%	12	23	58	117	292	584	1,167
	60%	14	28	70	140	350	700	1,400
	70%	16	33	82	163	408	817	1,634
	80%	19	37	93	187	467	934	1,867
	90%	21	42	105	210	525	1,050	2,101
	100%	23	47	117	233	584	1,167	2,334

10.10.2.85 During the spring migration (pre-breeding) season the displacement from operation when using the displacement rate of 70% (range of 60 to 80%) and a mortality rate of 1% (range of 1 to 10%), results in an additional loss of three (2 to 31) individuals (Table 10.88).

10.10.2.86 During the breeding season, displacement from operation results in the loss of nine (7 to 98) individuals from the breeding population (Table 10.89).

10.10.2.87 During the autumn migration season (post-breeding), displacement from operation results in a loss of five (4 to 58) individuals from the migratory population (Table 10.90).

10.10.2.88 The annual estimated mortality resulting from displacement during construction is 16 (14 to 187) individuals (Table 10.91).

10.10.2.89 Using the largest UK Western Waters BDMPS population of 661,888 individuals, with an average baseline mortality rate of 0.187 (population and rates taken from volume 4, annex 10.2: Offshore ornithology displacement assessment), the background predicted mortality would be 123,773. The addition of 16 (14 to 187) mortalities would increase the baseline mortality rate by 0.013% (0.011 to 0.151%). The annual predicted mortality from the cumulative assessment is below the 1% threshold increase in baseline mortality.

10.10.2.90 The cumulative effect is predicted to be of national spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.

Black-legged kittiwake

10.10.2.91 The estimated cumulative abundance of black-legged kittiwake from the relevant projects is presented in Table 10.92. There are several projects for which there are no, or limited, data on the number of black-legged kittiwake predicted to be displaced, for some of the earlier developments

Table 10.92: Black-legged kittiwake cumulative abundances for offshore wind projects for disturbance and displacement assessment during operations.

Project	Annual Cumulative Abundance	Pre-breeding Cumulative Abundance	Breeding Season Cumulative Abundance	Post-breeding Cumulative Abundance
Tier 1				
Barrow	unknown	unknown	unknown	unknown
Burbo Bank	unknown	unknown	unknown	unknown
Burbo Bank Extension	unknown	unknown	unknown	unknown
North Hoyle	unknown	unknown	unknown	unknown
Ormonde	unknown	unknown	unknown	unknown
Walney 1 + 2	unknown	unknown	unknown	unknown
Walney 3 + 4	unknown	unknown	unknown	unknown
West of Duddon Sands	unknown	unknown	unknown	unknown
Gwynt y Môr	unknown	unknown	unknown	unknown
Rhyl Flats	unknown	unknown	unknown	unknown
Robin Rigg	unknown	unknown	unknown	unknown
Arklow Bank Phase 1	unknown	unknown	unknown	unknown
Awel y Môr	unknown	unknown	unknown	unknown
Erebus	2,532	2	2,022	508
Tier 2				
Mona Offshore Wind Project	2,397	1,135	479	783
Morecambe Offshore Wind Farm: Generation Assets	unknown	unknown	unknown	unknown
North Irish Sea Array	unknown	unknown	unknown	unknown
Codling Wind Park	unknown	unknown	unknown	unknown
Dublin Array	unknown	unknown	unknown	unknown
Oriel	unknown	unknown	unknown	unknown
Arklow Bank Phase 2	unknown	unknown	unknown	unknown
Shelmalere	unknown	unknown	unknown	unknown
Llyr 1	unknown	unknown	unknown	unknown
Llyr 2	unknown	unknown	unknown	unknown
White Cross	unknown	unknown	unknown	unknown
Inis Eagla Marine Energy Park	unknown	unknown	unknown	unknown
Total (minus Morgan Generation Assets)	**4,929**	**1,137**	**2,501**	**1,291**
Morgan Generation Assets	2,724	645	460	1,619
Cumulative total (all projects)	**7,653**	**1,782**	**2,961**	**2,910**

10.10.2.92 The following displacement matrices provide the estimated cumulative mortality of black-legged kittiwake predicted to occur due to displacement, as determined by the relevant specified rates of displacement and mortality (Table 10.93 to Table 10.96).

The approach used for the cumulative displacement assessment follows that of volume 4, annex 10.2: Offshore ornithology displacement assessment of the PEIR.

Table 10.93: Operations and maintenance phase cumulative black-legged kittiwake mortality following displacement from offshore wind farms in the pre-breeding season.

Black-legged kittiwake Pre-breeding		Mortality level (% of displaced birds at risk of mortality)						
		1%	2%	5%	10%	25%	50%	100%
Displacement level (% at risk of displacement)	10%	2	4	9	18	45	89	178
	20%	4	7	18	36	89	178	356
	30%	5	11	27	53	134	267	535
	40%	7	14	36	71	178	356	713
	50%	9	18	45	89	223	446	891
	60%	11	21	53	107	267	535	1,069
	70%	12	25	62	125	312	624	1,247
	80%	14	29	71	143	356	713	1,426
	90%	16	32	80	160	401	802	1,604
	100%	18	36	89	178	446	891	1,782

Table 10.94: Operations and maintenance phase cumulative black-legged kittiwake mortality following displacement from offshore wind farms in the breeding season.

Black-legged kittiwake Breeding		Mortality level (% of displaced birds at risk of mortality)						
		1%	2%	5%	10%	25%	50%	100%
Displacement level (% at risk of displacement)	10%	3	6	15	30	74	148	296
	20%	6	12	30	59	148	296	592
	30%	9	18	44	89	222	444	888
	40%	12	24	59	118	296	592	1,184
	50%	15	30	74	148	370	740	1,481
	60%	18	36	89	178	444	888	1,777
	70%	21	41	104	207	518	1,036	2,073
	80%	24	47	118	237	592	1,184	2,369
	90%	27	53	133	266	666	1,332	2,665
	100%	30	59	148	296	740	1,481	2,961

Table 10.95: Operations and maintenance phase cumulative black-legged kittiwake mortality following displacement from offshore wind farms in the post-breeding season.

Black-legged kittiwake Post-breeding		Mortality level (% of displaced birds at risk of mortality)						
		1%	2%	5%	10%	25%	50%	100%
Displacement level (% at risk of displacement)	10%	3	6	15	29	73	146	291
	20%	6	12	29	58	146	291	582
	30%	9	17	44	87	218	437	873
	40%	12	23	58	116	291	582	1,164
	50%	15	29	73	146	364	728	1,455
	60%	17	35	87	175	437	873	1,746
	70%	20	41	102	204	509	1,019	2,037
	80%	23	47	116	233	582	1,164	2,328
	90%	26	52	131	262	655	1,310	2,619
	100%	29	58	146	291	728	1,455	2,910

Table 10.96: Operations and maintenance phase cumulative black-legged kittiwake mortality following displacement from offshore wind farms annually.

Black-legged kittiwake Annual		Mortality level (% of displaced birds at risk of mortality)						
		1%	2%	5%	10%	25%	50%	100%
Displacement level (% at risk of displacement)	10%	8	15	38	77	191	383	765
	20%	15	31	77	153	383	765	1,531
	30%	23	46	115	230	574	1,148	2,296
	40%	31	61	153	306	765	1,531	3,061
	50%	38	77	191	383	957	1,913	3,827
	60%	46	92	230	459	1,148	2,296	4,592
	70%	54	107	268	536	1,339	2,679	5,357
	80%	61	122	306	612	1,531	3,061	6,122
	90%	69	138	344	689	1,722	3,444	6,888
	100%	77	153	383	765	1,913	3,827	7,653

10.10.2.93 During the spring migration (pre-breeding) season the displacement from operation when using the displacement rate of 50% (range of 30 to 70%) and a mortality rate of 1% (range of 1 to 10%), results in an additional loss of nine (5 to 125) individuals (Table 10.94).

10.10.2.94 During the autumn migration season (post-breeding), displacement from operations results in a loss of 15 (9 to 204) individuals from the migratory population (Table 10.95).

10.10.2.95 The annual estimated mortality resulting from displacement during construction is 38 (23 to 536) individuals (Table 10.96).

10.10.2.96 Using the largest UK Western Waters BDMPS population of 911,586 individuals, with an average baseline mortality rate of 0.157 (population and rates taken from volume 4, annex 10.2: Offshore ornithology displacement assessment), the background predicted mortality would be 143,119. The addition of 38 (23 to 536) mortalities would increase the baseline mortality rate by 0.028 % (0.016% to 0.374%). The annual predicted mortality from the cumulative assessment is below the 1% threshold increase in baseline mortality.

10.10.2.97 The cumulative effect is predicted to be of national spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.

Sensitivity of the receptor

Common guillemot

10.10.2.98 Evidence of guillemot sensitivity to displacement from offshore wind farms is summarised from paragraph 10.10.2.53 onwards. Common guillemot is deemed to be of medium vulnerability, medium recoverability and medium value. Overall, based on evidence from post-construction studies and reviews, guillemot is deemed to be of medium vulnerability, medium recoverability and high value. The sensitivity of the receptor is therefore, considered to be **medium**.

Razorbill

10.10.2.99 Evidence of razorbill sensitivity to displacement from offshore wind farms is summarised from paragraph 10.10.2.66 onwards. Overall, based on evidence from post-construction studies and reviews, razorbill is deemed to be of medium vulnerability, medium recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **medium.**

Atlantic puffin

10.10.2.100 Evidence of Atlantic puffin sensitivity to displacement from offshore wind farms is summarised from paragraph 10.10.2.75 onwards. Overall, based on evidence from post-construction studies and reviews, Atlantic puffin is deemed to be of medium vulnerability, low recoverability and high value. The sensitivity of the receptor is therefore, considered to be **high**.

Northern gannet

10.10.2.101 Evidence of Northern gannet sensitivity to displacement from offshore wind farms is summarised from paragraph 10.10.2.82 onwards. Based on evidence from operation wind farms demonstrating that Northern gannet show a high avoidance of offshore wind farms, Northern gannet is deemed to be of high vulnerability, medium recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **medium.**

Black-legged kittiwake

10.10.2.102 Evidence of black-legged kittiwake sensitivity to displacement from offshore wind farms is summarised from paragraph 10.10.2.91 onwards. For kittiwake, there is evidence from other operating offshore wind farm projects that displacement is not likely to occur to any significant level. However, due to low reproductive rates, black-legged kittiwake is deemed to be of low vulnerability, low recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **medium.**

Significance of effect

10.10.2.103 Overall, the magnitude of cumulative displacement from operational offshore wind farms within the ZOI is deemed to be of **negligible to minor** adverse significance (Table 10.97) depending on the species, which is not significant in EIA terms. For razorbill, northern gannet and black-legged kittiwake, which had a magnitude of impact and medium sensitivity, negligible was selected from the negligible to minor range due to the impact not exceeding a 0.1% increase in baseline mortality and hence, was not regarded as a minor significance of effect.

Table 10.97: Table summarising the significance of effect of displacement from cumulative impacts during operations and maintenance.

Species	Magnitude of impact	Sensitivity of receptor	Significance of effect
Common guillemot	Low	Medium	**Minor, not significant in EIA terms**
Razorbill	Negligible	Medium	**Negligible, not significant in EIA terms**
Atlantic puffin	Negligible	High	**Minor, not significant in EIA terms**
Northern gannet	Negligible	Medium	**Negligible, not significant in EIA terms**
Black-legged kittiwake	Negligible	Medium	**Negligible, not significant in EIA terms**

Decommissioning phase

10.10.2.104 During the decommissioning phase, cumulative disturbance and displacement of red-throated diver, guillemot and razorbill would only occur if these activities occur at the same time across wind farms. Disturbance effects during the decommissioning phase are anticipated to be like construction (section 10.10.2.7 onwards) if the decommissioning schedule of the Morgan Generation Assets will overlap with that for the other wind farms within the CEA study area. The magnitude of impact would be negligible, with significance ranging from **negligible** to **minor** depending on the species, which is not significant in EIA terms.

10.10.3 Collision risk

Tier 1 and Tier 2

Operations and maintenance phase

Magnitude of impact

10.10.3.1 The Morgan Generation Assets, together with other offshore wind farms in the Irish Sea, may contribute to cumulative collision risk, in the event the operations phases of different projects overlap. Seabirds are highly mobile, therefore they can encounter different offshore wind farms, and be at risk of collisions, across large areas.

10.10.3.2 As stated, data used within the assessing cumulative collision risk is based on published information produced by the respective project developers. As such, the input parameters (e.g. avoidance rates) and the collision risk model used (e.g. deterministic) may vary from those put forward in this chapter.

The expected mean annual collision mortality has been compiled from relevant wind farms and is shown in Table 10.98.

Table 10.98: Expected annual collision mortality across relevant wind farms for the five species considered (KI = black-legged kittiwake, GB = great black-backed gull, LB = lesser black-backed gull, HG = herring gull, GX = northern gannet).

Project	KI collisions	GB collisions	LB collisions	HG collisions	GX collisions
Tier 1					
Barrow	unknown	unknown	unknown	unknown	unknown
Burbo Bank	unknown	unknown	2.0	unknown	unknown
Burbo Bank Extension	35.2	unknown	44.0	23.8	18.7
North Hoyle	unknown	unknown	1.0	unknown	unknown
Ormonde	5.0	unknown	22.1	3.3	10.3
Walney 1 + 2	unknown	unknown	28.6	unknown	unknown
Walney 3 + 4	187.6	28.2	28.3	54.5	37.4
West of Duddon Sands	unknown	unknown	26.2	unknown	unknown
Gwynt y Môr	unknown	unknown	5.0	unknown	unknown
Rhyl Flats	unknown	unknown	1.0	unknown	unknown
Robin Rigg	unknown	unknown	unknown	unknown	unknown
Arklow Bank Phase 1	unknown	unknown	unknown	unknown	unknown
Awel y Môr	93.7	9.8	unknown	4.0	36.3
Erebus	58.0	1.0	6.0	3.0	116.0
Tier 2					
Mona Offshore Wind Project	37.1	7.4	1.9	2.0	2.5
Morecambe Offshore Wind Farm: Generation Assets.	unknown	unknown	unknown	unknown	unknown
North Irish Sea Array	unknown	unknown	unknown	unknown	unknown
Codling Wind Park	unknown	unknown	unknown	unknown	unknown
Dublin Array	unknown	unknown	unknown	unknown	unknown
Oriel	unknown	unknown	unknown	unknown	unknown
Arklow Bank Phase 2	unknown	unknown	unknown	unknown	unknown
Shelmalere	unknown	unknown	unknown	unknown	unknown
Llyr 1	unknown	unknown	unknown	unknown	unknown
Llyr 2	unknown	unknown	unknown	unknown	unknown
White Cross	unknown	unknown	unknown	unknown	unknown
Inis Eagla Marine Energy Park	unknown	unknown	unknown	unknown	unknown
Total (minus Morgan Generation Assets)	**416.6**	**46.4**	**166.1**	**90.6**	**221.2**
Morgan Generation Assets	39.8	2.8	1.0	11.8	2.1

Project	KI collisions	GB collisions	LB collisions	HG collisions	GX collisions
Total (all projects)	**456.4**	**49.2**	**167.1**	**102.4**	**223.3**

Black-legged kittiwake

10.10.3.3 The estimated cumulative collision mortality of black-legged kittiwake from the relevant projects with available data is 456.4 per year (Table 10.98).

10.10.3.4 Using the largest UK Western Waters BDMPS population of 911,586 individuals, with an average baseline mortality rate of 0.157 (population and rates taken from volume 4, annex 10.3: Offshore ornithology non-migratory collision risk assessment), the background predicted mortality would be 143,119. The addition of 456.4 mortalities would increase the baseline mortality rate by 0.319%. The annual predicted mortality from the cumulative collision risk assessment is below the 1% threshold increase in baseline mortality.

10.10.3.5 The cumulative effect is predicted to be of national spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Great black-backed gull

10.10.3.6 The estimated cumulative collision mortality of great black-backed gull from the relevant projects with available data is 49.2 per year (Table 10.98).

10.10.3.7 Using the largest UK southwest and Channel Waters BDMPS population of 17,742 individuals, with an average baseline mortality rate of 0.096 (population and rates taken from the Morgan Generation Assets displacement assessment in volume 4, annex 10.3: Offshore ornithology non-migratory collision risk assessment), the background predicted mortality would be 1,703. The addition of 49.2 mortalities would increase the baseline mortality rate by 2.889%.

10.10.3.8 Therefore, the operations phase of the Morgan Generation Assets, combined with the operations phase of the surrounding wind farms in the Irish Sea could cumulatively cause a significant impact to great black-backed gull populations.

10.10.3.9 The PVA revealed that the addition of great black-backed gull collision impacts from cumulative wind farms would reduce the growth rate of the smallest BDMPS population (UK SouthWest and English Channel BDMPS) by no more than 0.410%. The model also predicts a positive rate of growth for the population based on growth rate of 1.026 per annum at that level of impact, compared to 1.028 within the unimpacted population.

10.10.3.10 It is assumed that despite any additional mortality, the population is still expected to continue to grow and will be larger after 35 years than that what is currently recorded. The reduction in growth rate by 0.334% (LCI; 0.292 to UCI;0.410%) would not trigger a risk of population decline and would only result in a slight reduction in the growth rate currently seen in the BDMPS population.

10.10.3.11 Due to the minimal level of change to baseline conditions, the cumulative effect is predicted to be of national spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Herring gull

10.10.3.12 The estimated cumulative collision mortality of herring gull from the relevant projects with available data is 99.4 per year (Table 10.98).

10.10.3.13 Using the largest UK Western Waters BDMPS population of 173,299 individuals, with an average baseline mortality rate of 0.172 (population and rates taken from volume 4, annex 10.3: Offshore ornithology non-migratory collision risk assessment), the background predicted mortality would be 29,807. The addition of 99.4 mortalities would increase the baseline mortality rate by 0.343%. The annual predicted mortality from the cumulative collision risk assessment is below the 1% threshold increase in baseline mortality.

10.10.3.14 The cumulative effect is predicted to be of national spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Lesser black-backed gull

10.10.3.15 The estimated cumulative collision mortality of lesser black-backed gull from the relevant projects with available data is 161.1 per year (Table 10.98).

10.10.3.16 Using the largest UK Western Waters BDMPS population of 163,304 individuals, with an average baseline mortality rate of 0.124 (population and rates taken from volume 4, annex 10.3: Offshore ornithology non-migratory seabird collision risk assessment), the background predicted mortality would be 20,250. The addition of 161.1 mortalities would increase the baseline mortality rate by 0.825%. The annual predicted mortality from the cumulative collision risk assessment is below the 1% threshold increase in baseline mortality.

10.10.3.17 The cumulative effect is predicted to be of national spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Northern gannet

10.10.3.18 The estimated cumulative collision mortality of northern gannet from the relevant projects with available data is 107.3 per year (Table 10.98).

10.10.3.19 Using the largest UK Western Waters BDMPS population of 661,888 individuals, with an average baseline mortality rate of 0.187 (population and rates taken from volume 4, annex 10.3: Offshore ornithology non-migratory collision risk assessment), the background predicted mortality would be 123,773. The addition of 107.3 mortalities would increase the baseline mortality rate by 0.180%. The annual predicted mortality from the cumulative collision risk assessment is well below the 1% threshold increase in baseline mortality.

10.10.3.20 The cumulative effect is predicted to be of national spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low.**

Sensitivity of the receptor

Black-legged kittiwake

10.10.3.21 Evidence of black-legged kittiwake sensitivity to collision from the operations and maintenance phase of offshore wind farms is summarised from paragraph 10.8.4.26 onwards. Overall, based on evidence from studies and reviews, black-legged kittiwake is deemed to be of high vulnerability, low recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **high.**

Great black-backed gull

10.10.3.22 Evidence of great black-backed gull sensitivity to collision from the operations and maintenance phase of offshore wind farms is summarised from paragraph 10.8.4.30 onwards. Overall, based on evidence from studies and reviews, great black-backed gull is deemed to be high vulnerability, medium recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **medium.**

European herring gull

10.10.3.23 Evidence of European herring gull sensitivity to collision from the operations and maintenance phase of offshore wind farms is summarised from paragraph 10.8.4.34 onwards. Overall, based on evidence from studies and reviews, European herring gull is deemed to be of high vulnerability, medium recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **medium.**

Lesser black-backed gull

10.10.3.24 Evidence of lesser black-backed gull sensitivity to collision from the operations and maintenance phase of offshore wind farms is summarised from paragraph 10.8.4.38 onwards. Overall, based on evidence from studies and reviews, lesser black-backed gull is deemed to be of high vulnerability, medium recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **medium**.

Northern gannet

10.10.3.25 Evidence of Northern gannet sensitivity to collision from the operations and maintenance phase of offshore wind farms is summarised from paragraph 10.8.4.43 onwards. Overall, based on evidence from studies and reviews, Northern gannet is deemed to be of high vulnerability, medium recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of the effect

10.10.3.26 Overall, the magnitude of the cumulative impact is low for all species ((Table 10.99). Although sensitivity of the receptor varies from medium to high, the effect is expected to be of **minor** adverse significance for all species, which is not significant in EIA terms. For black-legged kittiwake, which has a magnitude of impact of low and sensitivity of high, minor was selected from the minor to moderate range due to the impact not exceeding a 1% increase in baseline mortality and hence, was not regarded as a moderate significance of effect

Table 10.99: Table summarising the significance of effect of collision from cumulative impacts during operations and maintenance

Species	Magnitude of impact	Sensitivity of receptor	Significance of effect
Black-legged kittiwake	Low	High	**Minor, not significant in EIA terms**
Great black-backed gull	Low	Medium	**Minor, not significant in EIA terms**
European herring gull	Low	Medium	**Minor, not significant in EIA terms**
Lesser black-backed gull	Low	Medium	**Minor, not significant in EIA terms**
Northern gannet	Low	Medium	**Minor, not significant in EIA terms**

10.10.4 Combined displacement and collision risk

Tier 1 and Tier 2

Operations and maintenance phase

Magnitude of impact

10.10.4.1 For species such as black-legged kittiwake and northern gannet, that are both adversely affected by displacement and collision during the operations and maintenance phase, impacts must be combined in order for the true magnitude of impact to be understood.

10.10.4.2 It is recognised that assessing these two potential impacts together could amount to double counting, as birds that are subject to displacement would not be subject to potential collision risk as they are already assumed to have not entered the array area. Equally, birds estimated to be subject to collision risk mortality would not be able to be subjected to displacement consequent mortality as well. As a more refined method to consider displacement and collision together whilst reducing any double counting of impacts is not agreed with SNCBs the precautionary and highly unlikely approach is presented in this assessment.

10.10.4.3 Outputs from the combined impact from displacement and collision from the Morgan Generation Assets, together with other offshore wind farms in the Irish Sea are tabulated and presented in Table 10.100.

Table 10.100: Black-legged kittiwake and northern gannet combined displacement and collision cumulative impacts.

Species	Annual displacement mortality	Annual collision mortality	Total combined annual impact
Black-legged kittiwake	38 (23 to 536)	456.4	494.4 (479.4 to 992.4)
Northern gannet	16 (14 to 187)	223.3	239.3 (237.3 to 410.3)

Black-legged kittiwake

10.10.4.4 The combined mortality for black-legged kittiwake from displacement and collision for the relevant projects with available data is 494.4 (479.4 to 992.4) individuals per annum.

10.10.4.5 Using the largest UK Western Waters BDMPS population of 911,586 individuals, with an average baseline mortality rate of 0.157 (population and rates taken from volume 4, annex 10.3: Offshore ornithology non-migratory collision risk assessment), the background predicted mortality would be 143,119. The addition of 494.4 (479.4 to 992.4) mortalities would increase the baseline mortality rate by 0.345% (0.335 to 0.693%). The annual predicted mortality from the combined cumulative displacement and collision risk assessment is below the 1% threshold increase in baseline mortality.

10.10.4.6 The combined cumulative effect is predicted to be of national spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low.**

Northern gannet

10.10.4.7 The combined mortality for Northern gannet from displacement and collision for the relevant projects with available data is 239.3 (237.3 to 410.3) individuals per annum.

10.10.4.8 Using the largest UK Western Waters BDMPS population of 661,888 individuals, with an average baseline mortality rate of 0.187 (population and rates taken from volume 4, annex 10.3: Offshore ornithology non-migratory collision risk assessment), the background predicted mortality would be 123,773. The addition of 239.3 (237.3 to 410.3) mortalities would increase the baseline mortality rate by 0.193 % (0.191 to 0.331%). The annual predicted mortality from the cumulative collision risk assessment is below the 1% threshold increase in baseline mortality.

10.10.4.9 The cumulative effect is predicted to be of national spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low.**

Sensitivity of the receptor

Black-legged kittiwake

10.10.4.10 As seen in displacement and collision, black-legged kittiwake is deemed to be of overall medium vulnerability, low recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **medium**.

Northern gannet

10.10.4.11 As seen in displacement and collision, northern gannet is deemed to be overall of medium vulnerability, medium recoverability and medium value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of the effect

Black-legged kittiwake

10.10.4.12 Overall, the magnitude of the combined displacement and collision cumulative impact is low, and the sensitivity of the receptor is medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Northern gannet

10.10.4.13 Overall, the magnitude of the combined displacement and collision cumulative impact is low and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

10.11 Transboundary effects

10.11.1.1 A screening of transboundary impacts has been carried out and any potential for significant transboundary effects with regard to offshore ornithology from the Morgan Generation Assets upon the interests of other states has been assessed as part of the EIA. The potential transboundary impacts assessed within sections 10.9 and 10.10 are summarised below:

- Disturbance and displacement (including impacts on species which may have connectivity to UK SPAs) during the construction, operations and maintenance and decommissioning phases. Overall, the effect will be of negligible adverse to minor adverse significance, which is not significant in EIA terms
- Indirect disturbance and displacement resulting from changes to prey and habitats (including impacts on species which may have connectivity to UK SPAs) during the construction, operations and maintenance and decommissioning phases. Overall, the effect will be of minor adverse significance, which is not significant in EIA terms
- Collision risk (including impacts on species which may have connectivity to UK SPAs) during the construction, operations and maintenance and decommissioning phases. Overall, the effect will be of negligible to minor adverse significance, which is not significant in EIA terms
- Barrier effect (including impacts on species which may have connectivity to UK SPAs) during the construction, operations and maintenance and decommissioning phases. Overall, the effect will be of negligible adverse significance, which is not significant in EIA terms.

10.12 Inter-related effects

10.12.1.1 Inter-relationships are considered to be the impacts and associated effects of different aspects of the proposal on the same receptor. These are considered to be:

- Project lifetime effects: Assessment of the scope for effects that occur throughout more than one phase of the Morgan Generation Assets (construction, operations and maintenance, and decommissioning), to interact to potentially create a more significant effect on a receptor than if just assessed in isolation in these three phases (e.g. underwater sound effects from piling, operational wind turbines, vessels and decommissioning)

- Receptor led effects: Assessment of the scope for all effects to interact, spatially and temporally, to create inter-related effects on a receptor. As an example, all effects on offshore ornithology, such as displacement/disturbance, collision and increased concentrations of suspended sediments, may interact to produce a different, or greater effect on this receptor than when the effects are considered in isolation. Receptor-led effects may be short term, temporary or transient effects, or incorporate longer term effects.

10.12.1.2 A description of the likely interactive effects arising from the Morgan Generation Assets on offshore ornithology is provided in volume 2, chapter 15: Inter-related effects of the PEIR.

10.13 Summary of impacts, mitigation measures and monitoring

10.13.1.1 Information on offshore ornithology within the Morgan Offshore Ornithology Array Area study area was collected through review of available literature, other offshore wind farm assessments, UK statutory guidance, detailed analysis of the data collected during the site-specific aerial surveys and intertidal surveys, and consultation with relevant stakeholders.

- Table 10.101 presents a summary of the potential impacts, measures adopted as part of the project and residual effects in respect to offshore ornithology. The impacts assessed include: disturbance and displacement from airborne noise, underwater sound, and presence of vessels and infrastructure, indirect impacts from underwater sound affecting prey species, temporary habitat loss/disturbance and increased suspended sediment concentrations (SSCs), collision risk and barrier to movement. Overall it is concluded that there will be no significant effects arising from the Morgan Generation Assets during the construction, operations and maintenance or decommissioning phases.
- Table 10.102 presents a summary of the potential cumulative impacts, mitigation measures and residual effects. The cumulative impacts assessed include: disturbance and displacement from airborne noise, underwater sound, and presence of vessels and infrastructure and collision risk. Overall it is concluded that there are no significant cumulative effects to any species from the Morgan Generation Assets alongside other projects/plans.
- Potential transboundary impacts have been identified in relation to offshore ornithology. Overall, it is concluded that there will be no significant transboundary effects arising from the Morgan Generation Assets.

Table 10.101: Summary of potential environmental effects, mitigation and monitoring.

[a] C=construction, O=operations and maintenance , D=decommissioning

Description of impact	Phase[a]			Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
	C	O	D							
Disturbance and displacement from airborne noise, underwater sound, and presence of vessels and infrastructure.	✓	✓	✓	Offshore EMP which will include measures to minimise disturbance to rafting birds from transiting vessels	Common guillemot C: Negligible O: Negligible D: Negligible Razorbill C: Negligible O: Negligible D: Negligible Atlantic puffin C: Negligible O: Negligible D: Negligible Northern gannet C: Negligible O: Negligible D: Negligible Black-legged kittiwake C: Negligible O: Negligible D: Negligible Manx shearwater C: Negligible O: Negligible D: Negligible	Common guillemot C: Medium O: Medium D: Medium Razorbill C: Medium O: Medium D: Medium Atlantic puffin C: High O: High D: High Northern gannet C: Medium O: Medium D: Medium Black-legged kittiwake C: Medium O: Medium D: Medium Manx shearwater C: Medium O: Medium D: Medium	Common guillemot C: Negligible adverse O: Negligible adverse D: Negligible adverse Razorbill C: Negligible adverse O: Negligible adverse D: Negligible adverse Atlantic puffin adverse C: Minor adverse O: Minor adverse D: Minor adverse Northern gannet C: Negligible adverse O: Negligible adverse D: Negligible adverse Black-legged kittiwake C: Negligible adverse O: Negligible adverse D: Negligible adverse Manx shearwater C: Negligible adverse O: Negligible adverse D: Negligible adverse	None	Common guillemot C: Negligible adverse O: Negligible adverse D: Negligible adverse Razorbill C: Negligible adverse O: Negligible adverse D: Negligible adverse Atlantic puffin adverse C: Minor adverse O: Minor adverse D: Minor adverse Northern gannet C: Negligible adverse O: Negligible adverse D: Negligible adverse Black-legged kittiwake C: Negligible adverse O: Negligible adverse D: Negligible adverse Manx shearwater C: Negligible adverse O: Negligible adverse D: Negligible adverse	None
Indirect impacts from underwater sound affecting prey species.	✓	✗	✓	None	Auk species C: Negligible D: Negligible	Auk species C: Medium D: Medium	Auk species C: Negligible adverse D: Negligible adverse	None	Auk species C: Negligible adverse D: Negligible adverse	None
Temporary habitat loss/disturbance and increased suspended sediment concentrations (SSCs).	✓	✓	✓	None	All receptors C: Negligible O: Negligible D: Negligible	All receptors C: Medium O: Medium D: Medium	All receptors C: Negligible adverse O: Negligible adverse D: Negligible adverse	None	All receptors C: Negligible adverse O: Negligible adverse D: Negligible adverse	None

Description of impact	Phase[a]			Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
	C	O	D							
Collision risk	×	✓	×	Increasing air draught to reduce bird collision.	Black-legged kittiwake O: Negligible Great black-backed gull O: Low European herring gull O: Negligible Lesser black-backed gull O: Negligible Northern gannet O: Negligible Northern fulmar O: Negligible Manx shearwater O: No change Migratory birds (non-seabirds) O: Negligible	Black-legged kittiwake O: High Great black-backed gull O: Medium European herring gull O: Medium Lesser black-backed gull O: Medium Northern gannet O: Medium Northern fulmar O: Medium Manx shearwater O: Medium Migratory birds (non-seabirds) O: Medium	Black-legged kittiwake O: Minor adverse Great black-backed gull O: Minor adverse European herring gull O: Negligible adverse Lesser black-backed gull O: Negligible adverse Northern gannet O: Negligible adverse Northern fulmar O: Negligible adverse Manx shearwater O: No change Migratory birds (non-seabirds) O: Negligible adverse	None	Black-legged kittiwake O: Minor adverse Great black-backed gull O: Minor adverse European herring gull O: Negligible adverse Lesser black-backed gull O: Negligible adverse Northern gannet O: Negligible adverse Northern fulmar O: Negligible adverse Manx shearwater O: No change Migratory birds (non-seabirds) O: Negligible adverse	None
Barrier to movement	×	✓	×	Offshore EMP which will include measures to minimise disturbance to rafting birds from transiting vessels.	All receptors O: Negligible	All receptors O: Medium	All receptors O: Negligible adverse	None	All receptors O: Negligible adverse	None

Table 10.102: Summary of potential cumulative environmental effects, mitigation and monitoring.

[a] C=construction, O=operations and maintenance , D=decommissioning

Description of effect	Phase[a]			Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
	C	O	D							
Tier 1 and Tier 2										
Disturbance and displacement from airborne noise, underwater sound, and presence of vessels and infrastructure.	✓	✓	✓	Offshore EMP which will include measures to minimise disturbance to rafting birds from transiting vessels.	Common guillemot C: Negligible O: Low D: Negligible Razorbill C: Negligible O: Negligible D: Negligible Atlantic puffin C: Negligible O: Low D: Negligible Northern gannet C: Negligible O: Negligible D: Negligible Black-legged kittiwake C: Negligible O: Negligible D: Negligible	Common guillemot C: Medium O: Medium D: Medium Razorbill C: Medium O: Medium D: Medium Atlantic puffin C: High O: High D: High Northern gannet C: Medium O: Medium D: Medium Black-legged kittiwake C: Medium O: Medium D: Medium	Common guillemot C: Negligible adverse O: Minor adverse D: Negligible adverse Razorbill C: Negligible adverse O: Negligible adverse D: Negligible adverse Atlantic puffin C: Minor adverse O: Minor adverse D: Minor adverse Northern gannet C: Negligible adverse O: Negligible adverse D: Negligible adverse Black-legged kittiwake C: Negligible adverse O: Negligible adverse D: Negligible adverse	None	Common guillemot C: Negligible adverse O: Minor adverse D: Negligible adverse Razorbill C: Negligible adverse O: Negligible adverse D: Negligible adverse Atlantic puffin C: Minor adverse O: Minor adverse D: Minor adverse Northern gannet C: Negligible adverse O: Negligible adverse D: Negligible adverse Black-legged kittiwake C: Negligible adverse O: Negligible adverse D: Negligible adverse	None
Collision Risk	✗	✓	✗	Increasing air draught to reduce bird collision.	Black-legged kittiwake O: Low Great black-backed gull O: Medium European herring gull O: Low Lesser black-backed gull O: Low Northern gannet O: Low	Black-legged kittiwake O: High Great black-backed gull O: Medium European herring gull O: Medium Lesser black-backed gull O: Medium Northern gannet O: Medium	Black-legged kittiwake O: Minor adverse Great black-backed gull O: Moderate adverse European herring gull O: Minor adverse Lesser black-backed gull O: Minor adverse Northern gannet O: Minor adverse	None	Black-legged kittiwake O: Minor adverse Great black-backed gull O: Minor adverse European herring gull O: Minor adverse Lesser black-backed gull O: Minor adverse Northern gannet O: Minor adverse	None
Combined collision risk and disturbance and displacement from airborne noise, underwater sound, and presence of vessels and infrastructure.	✗	✓	✗	Increasing air draught to reduce bird collision.	Black-legged kittiwake O: Low Northern gannet O: Low	Black-legged kittiwake O: Medium Northern gannet O: Medium	Black-legged kittiwake O: Minor adverse Northern gannet O: Minor adverse	None	Black-legged kittiwake O: Minor adverse Northern gannet O: Minor adverse	None

10.14 Next steps

10.14.1.1 Only 12 months of site-specific surveys (i.e. digital aerial surveys) within the Morgan Array Area were available to inform this chapter for the purposes of the PEIR. The baseline description and impact assessments in this chapter will therefore be updated with an additional 12 months of digital aerial survey data for the Environmental Statement.

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