RWE

Awel y Môr Offshore Wind Farm

Category 6: Environmental Statement

Volume 2, Chapter 4: Offshore Ornithology

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AWEL Y MÔR
Offshore Wind Farm

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RWE Renewables UK Swindon Limited

Windmill Hill Business Park
Whitehill Way
Swindon
Wiltshire SN5 6PB
T +44 (0)8456 720 090
www.rwe.com

Registered office:
RWE Renewables UK Swindon Limited
Windmill Hill Business Park
Whitehill Way
Swindon

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Glossary of terms

TERM	DEFINITION
Collision Risk Model (CRM)	General term to describe the method of estimating the collision risk of seabirds (estimated mortality) to operational turbines, which could be either deterministic or stochastic.
Mean High Water Springs (MHWS)	The height of mean high water during spring tides in a year.
Mean Low Water Springs (MLWS)	The height of mean low water during spring tides in a year.
Mean-Max Foraging Range	The mean-max foraging range is calculated as the maximum reported range that a species for each colony is known to have foraged, averaged across all colonies from the literature review undertaken by Woodward et al. (2019).
SeabORD	A tool developed to estimate the cost to individual seabirds, in terms of changes in adult survival and productivity, of displacement and barrier effects resulting from offshore renewable developments. See Searle et al. (2018).
Stochastic Collision Risk Model (sCRM)	A programme used to assess the collision risk (estimated mortality) of seabirds to operational turbines of offshore wind farms. A stochastic CRM is used to account for uncertainty around input variables.

Abbreviations and acronyms

TERM	DEFINITION
AEoI	Adverse Effect on Integrity
AyM	Awel y Môr Offshore Wind Farm
BDMPS	Biologically Defined Minimum Population Scale
BO1	Band Option 1
BO2	Band Option 2
BO3	Band Option 3
BoCC	Birds of Conservation Concern
BTO	British Trust for Ornithology
CEA	Cumulative Effects Assessment
CCW	Countryside Council for Wales
CFPS	Counterfactual of Final Population Size
CIEEM	Chartered Institute of Ecology and Environmental Management
CoCP	Code of Construction Practice
CPGR	Counterfactual of Population Growth Rate
CRM	Collision Risk Model
DCO	Development Consent Order
DML	Deemed Marine Licence
DTI	Department of Trade and Industry
ECC	Export Cable Corridor
ECR	Export Cable Route

TERM	DEFINITION
EEA	European Economic Area
EIA	Environmental Impact Assessment
EMMP	Environmental Mitigation and Monitoring Plan
EP	Evidence Plan
ES	Environmental Statement
ETG	Expert Topic Group
EU	European Union
GGOWF	Greater Gabbard Offshore Wind Farm
GPS	Global Positioning System
GyM	Gwynt y Môr Offshore Wind Farm
HAT	Highest Astronomical Tide
HRA	Habitats Regulations Assessments
IEMA	Institute of Environmental Management and Assessment
IPC	Infrastructure Planning Commission (note: the IPC was abolished in April 2012 and decision making is now by the Secretary of State for Business, Energy and Industrial Strategy)
JNCC	Joint Nature Conservation Committee
LAT	Lowest Astronomical Tide
LSE	Likely Significant Effect
MDS	Maximum Design Scenario
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MMMP	Marine Mammal Mitigation Protocol

TERM	DEFINITION
MPCP	Marine Pollution Contingency Plan
NE	Natural England
NERC	Natural Environment and Rural Communities
NERI	National Environmental Research Institute
NPS	National Policy Statement
NRW	Natural Resources Wales
NSIP	Nationally Significant Infrastructure Project
ORJIP	Offshore Renewables Joint Industry Programme
OSPs	Offshore Substation Platforms
OWEZ	Egmond aan Zee Offshore Wind Farm
OWF	Offshore Wind Farm
PCH	Potential Collision Height
PEIR	Preliminary Environmental Information Report
PEMP	Project Environmental Management Plan
PINS	Planning Inspectorate
pSPAS	Potential Special Protected Areas
PVA	Population Viability Analysis
RIAA	Report to Inform Appropriate Assessment
RSPB	Royal Society for the Protection of Birds
RWE	RWE Renewables UK
RYA	Royal Yachting Association
SAC	Special Areas of Conservation

TERM	DEFINITION
sCRM	Stochastic Collision Risk Modelling
SD	Standard Deviation
SMP	Seabird Monitoring Programme
SNCB	Statutory Nature Conservation Body
SOSS	Strategic Ornithological Support Services
SOSSMAT	Strategic Ornithological Support Services Migratory Assessment Tool
SPA	Special Protection Areas
SSSI	Sites of Special Scientific Interest
UK	United Kingdom
WTG	Wind Turbine Generator
WWT	Wildfowl and Wetlands Trust
ZOI	Zone of Influence

Units

UNIT	DEFINITION
cd	Candela (luminous intensity)
cm	Centimetres (distance)
dB	Decibel (intensity of sound)
km	Kilometre (distance)
km^2	Kilometre square (area)
m	Metre (distance)

UNIT	DEFINITION
m/s	Metres per second (speed)
NM	Nautical mile (distance)
RPM	Rotations per minute (speed)
°	Degrees (angle)
%	Percentage (proportion)

4 Offshore ornithology

1 This chapter of the Environmental Statement (ES) presents the assessment of the potential impacts on offshore ornithology from construction, operation (including maintenance) and decommissioning of Awel y Môr Offshore Wind Farm (AyM).

2 Offshore ornithology is defined as the environment seaward of mean low water springs (MLWS). Terrestrial and intertidal ornithology is considered separately in Volume 3, Chapter 5: Onshore Biodiversity and Nature Conservation (application ref: 6.3.5).

3 This chapter should be read in conjunction with the project description provided in Volume 2, Chapter 1: Offshore Project Description (application ref: 6.2.1), as well as Volume 2, Chapter 5: Benthic and Intertidal Ecology and Volume 2, Chapter 6: Fish and Shellfish Ecology (application ref: 6.2.6) which provide further information regarding potential impacts on prey species, and Report 5.1: Report to Inform Appropriate Assessment (RIAA) (application ref: 5.2) which provides specific assessment of the impacts on the national site network. This chapter is also supported by the following annexes:

- Volume 4, Annex 4.1: Offshore Ornithology Baseline Characterisation Report (application ref: 6.4.4.1);
- Volume 4, Annex 4.2: Offshore Ornithology Displacement Analysis (application ref: 6.4.4.2);
- Volume 4, Annex 4.3: Offshore Ornithology Collision Risk Modelling (application ref: 6.4.4.3); and
- Volume 4, Annex 4.4: Migratory Collision Risk Modelling (application ref: 6.4.4.4).

4 This chapter describes:

- The legislation, planning policy and other documentation that has informed the assessment (Section 4.1: Statutory and policy context);
- The outcome of consultation undertaken to date, including how matters relating to offshore ornithology within the Scoping Opinion and Section 42 responses have been addressed (Section 4.2: Consultation);

- The scope of the assessment for offshore ornithology (Section 4.3: Scope and methodology);
- The methods used for the baseline data gathering (Section 4.4: Methodology for baseline data gathering);
- The current and projected future baseline environments (Section 4.5: Existing environment);
- The relevant maximum design scenario and mitigation measures relevant to offshore ornithology (Section 4.6: Key parameters for assessment and Section 4.7: Mitigation measures);
- The assessment methods used for the ES (Section 4.8: Assessment criteria and assignment of significance);
- The assessment of potential impacts on offshore ornithology (Sections 4.9 – 4.11: Preliminary impact assessment and Section 4.14: Cumulative effects);
- Consideration of inter-related effects (Section 4.12: Inter-related effects)
- Consideration of transboundary effects (Section 4.13: Transboundary effects); and
- A summary of residual effects for offshore ornithology (Section 4.15: Residual effects).

4.1 Statutory and policy context

5 An overview of the relevant legislative context for AyM is provided in Volume 1, Chapter 2: Policy and Legislation (application ref: 6.1.2).

6 Legislation, policy and guidance relevant to offshore ornithology is identified in the following sections.

4.1.1 Legislation

7 There are a number of international and national (UK and Welsh) laws that need to be considered, specifically those regarding the protection of wildlife and the marine environment.

8 In undertaking the assessment, the following international legislation has been taken into account, including:

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

9 Within the UK, the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019 (known as the 'Habitats Regulations') came into force at the end of the EU-UK transition period on 31 December 2020, providing amendments to the 2017 Habitats Regulations. The 2019 Habitats Regulations transfer functions from the European Commission to the appropriate authorities in England and Wales, with all the processes or terms unchanged. The 2019 Habitats Regulations transpose aspects of the Birds Directive and the Habitats Directive into national law, covering all environments out to 12 nm.

10 The Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended) (known as the 'Offshore Marine Regulations') provide similar provisions to the 2017 Habitats Regulations in the offshore environment beyond 12 nm throughout the UK.

11 The Wildlife and Countryside Act 1981 operates in conjunction with the Habitats Regulations and is the principal mechanism for the legislative protection of wildlife in the UK. The Wildlife and Countryside Act 1981 has also been amended following EU withdrawal so that species of wild birds found in or regularly visiting either the UK or the European territory of a Member State will continue to be protected on land and down to MLWS.

12 In Wales, The Environment (Wales) Act 2016 replaces Section 40 and 42 in the Natural Environment and Rural Communities (NERC) Act 2006 and enables the planning and management of Wales' natural resources in a more proactive, sustainable and joined up manner. Birds listed as being of Principal Importance for Conservation of Biological Diversity in Wales are identified in Volume 4, Annex 4.1 (application ref: 6.4.4.1). Their Principal Importance status is accounted for in determining their conservation value as part of this assessment, outlined in Section 4.8.

4.1.2 Policy

13 AyM will comprise an array of offshore Wind Turbine Generators (WTGs) with an overall capacity of over 100 Megawatts (MW) and therefore constitutes a Nationally Significant Infrastructure Project (NSIP) under the Planning Act 2008. Guidance in relation to assessing impacts on offshore ornithology for NSIPs is set out within National Policy Statements (NPSs), which are the principle decision-making documents for NSIPs. Those relevant to offshore ornithology include:

- Overarching NPS for Energy (EN-1; DECC 2011a); and
- NPS for Renewable Energy Infrastructure (EN-3, DECC 2011b).

14 In addition to the current NPSs, further draft NPSs are also being consulted upon. The draft NPSs have been reviewed to determine the emerging expectations and changes from previous iterations of the NPSs. This includes the Draft Overarching NPS EN-1 (DECC, 2021a) and Draft EN-3 (DECC, 2021b). These are summarised in Table 1 below.

15 Additional policy requirements relevant to offshore ornithology as set out in the Welsh National Marine Plan (Welsh Government, 2019) are summarised in Table 2.

16 Further guidance on the issues to be assessed for offshore renewables energy developments has been obtained though reference to:

- The UK Marine Policy Statement (HM Government, 2011); and
- Future Wales – the National Plan 2040.

Table 1: National Policy Statements of relevance to offshore ornithology.

POLICY	POLICY DESCRIPTION	RELEVANCE TO ASSESSMENT
NPS EN-1	Paragraph 5.3.3 - states that "the applicant should ensure that the ES clearly sets out any effects on internationally, nationally and locally designated sites of ecological or geological conservation importance, on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity."	Protected sites are presented in Section 4.12.10. Assessment of the potential effects of AyM on the features of these protected sites is provided in Section 4.12.10. Further consideration and assessment for designated sites with potential connectivity to AyM is presented in the Report to Inform Appropriate Assessment (application ref: 5.2).
	Paragraph 5.3.6 – states that the IPC "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." It also notes that "the benefits of nationally significant low carbon energy infrastructure development may include benefits for biodiversity and geological conservation interests and these benefits may outweigh harm to these interests. The IPC [the Secretary of State] may take account of any such net benefit in cases where it can be demonstrated."	AyM delivers benefits as a nationally significant low carbon energy infrastructure development, providing a long-term benefit to biodiversity interests, outweighing any minor harm to these interests. Climate change is a significant threat to bird biodiversity interests (Pearce-Higgins & Crick 2019). AyM will contribute a significant amount of renewable energy (Volume 2, Chapter 1: Offshore Project Description (application ref: 6.2.1)), to the UK Government's target of

POLICY	POLICY DESCRIPTION	RELEVANCE TO ASSESSMENT
		producing 40GW of renewable energy from offshore wind by 2030 and achieving net zero by 2050 (BEIS 2020).
	Paragraph 5.3.7 - moots that "development 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."	AyM has been designed to avoid significant harm to biodiversity interests through the site selection process. Further details are provided in Volume 1, Chapter 4: Site Selection and Alternatives (application ref: 6.1.4) and summarised in Section 4.7.
	Paragraph 5.3.8 intimates that "the IPC [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."	The potential for effects on designated sites is considered in detail in Report 5.2: RIAA (application ref: 5.2). Assessment of the potential effects on other protected sites is provided in Section 4.12.10. Species of principal importance in Wales are considered in determining the conservation value of receptors as part of this assessment, outlined in Section 4.8.
	Paragraph 5.3.9– states that "the most important sites for biodiversity are those identified through international conventions and European Directives. The	The potential for effects on designated sites classified as a pSPA, SPA and / or Ramsar sites is considered in detail in Report 5.2: RIAA

POLICY	POLICY DESCRIPTION	RELEVANCE TO ASSESSMENT
	Habitats Regulations provide statutory protection for these sites but do not provide statutory protection for potential Special Protection Areas (pSPAs) before they have been classified as a Special Protection Area. For the purposes of considering development proposals affecting them, as a matter of policy the Government wishes pSPAs to be considered in the same way as if they had already been classified. Listed Ramsar sites should, also as a matter of policy, receive the same protection."	(application ref: 5.2). These designated sites are also account for in the summary of valued ornithological receptors and potential impacts in Table 14.
	Paragraph 5.3.15 – "Development proposals provide many opportunities for building-in beneficial biodiversity or geological features as part of good design. When considering proposals, the [the Secretary of State] should maximise such opportunities in and around developments, using requirements or planning obligations where appropriate."	The Applicant has explored, developed and created suitable opportunities for building-in beneficial biodiversity and geological features as part of good design for AyM, as detailed in the commitments listed in Volume 2, Chapter 1(application ref: 6.2.1).
	Paragraph 5.3.16 – reminds that "many individual wildlife species receive statutory protection under a range of legislative provisions."	Statutory protection afforded to bird species has been considered in determining the conservation value of receptors as part of this assessment, outlined in Section 4.8.

POLICY	POLICY DESCRIPTION	RELEVANCE TO ASSESSMENT
	Paragraph 5.3.17– explains that "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 IPC [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 IPC [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 IPC [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."	Species of principal importance in Wales are considered in determining the conservation value of receptors as part of this assessment, outlined in Section 4.8. AyM is committed to minimising potential impacts on biodiversity, and mitigation measures are described in Section 4.7. The Applicant has taken into account other bird species and habitats that have been identified as being of principal importance for the conservation of biodiversity in Wales and thereby requiring conservation action in Section 4.8. Relevant species are identified in Volume 4, Annex 4.1 (application ref: 6.4.4.1). The Applicant has ensured that these species and habitats are protected from the potentially adverse effects of AyM by accepting the need for requirements as part of the consenting process, as detailed in the commitments listed in Volume 2, Chapter 1 (application ref: 6.2.1. Any residual impacts are assessed within this ES and described in Sections 4.3.

POLICY	POLICY DESCRIPTION	RELEVANCE TO ASSESSMENT
		Climate change is a significant threat to bird biodiversity interests (Pearce-Higgins & Crick 2019). AyM will contribute a significant amount of renewable energy (Volume 2, Chapter 1: Offshore Project Description (application ref: 6.2.1)), to the UK Government's target of producing 40GW of renewable energy from offshore wind by 2030 and achieving net zero by 2050 (BEIS 2020), as outlined in F1.1: Planning Statement and F1.6: Statement of Need.
	Paragraph 5.3.18 – states that EIAs should include effects on and opportunities to enhance and mitigation for biodiversity	Potential effects and mitigation in relation to offshore ornithology have been incorporated into the assessment process where applicable. Mitigation measures and commitments are outlined in Section 4.7.

POLICY	POLICY DESCRIPTION	RELEVANCE TO ASSESSMENT
Draft NPS EN-1	Paragraph 5.4.5 – states that the IPC "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." It also notes that "the benefits of nationally significant low carbon energy infrastructure development may include benefits for biodiversity and geological conservation interests and these benefits may outweigh harm to these interests. The IPC [the Secretary of State] may take account of any such net benefit in cases where it can be demonstrated."	AyM delivers benefits as a nationally significant low carbon energy infrastructure development, providing a long-term benefit to biodiversity interests, outweighing any minor harm to these interests. Climate change is a significant threat to bird biodiversity interests (Pearce-Higgins & Crick 2019). AyM will contribute a significant amount of renewable energy (Volume 2, Chapter 1: Offshore Project Description (application ref: 6.2.1)), to the UK Government's target of producing 40GW of renewable energy from offshore wind by 2030 and achieving net zero by 2050 (BEIS 2020).
	Paragraph 5.4.6 - moots that "development 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."	AyM has been designed to avoid significant harm to biodiversity interests through the site selection process. Further details are provided in Volume 1, Chapter 4: Site Selection and Alternatives (application ref: 6.1.4) and summarised in Section 4.7.
	Paragraph 5.4.7 intimates that "the IPC [the Secretary of State] should ensure that appropriate weight is	The potential for effects on designated sites is considered in detail in Report 5.2: RIAA

POLICY	POLICY DESCRIPTION	RELEVANCE TO ASSESSMENT
	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."	(application ref: 5.2). Assessment of the potential effects on other protected sites is provided in Section 4.12.10. Species of principal importance in Wales are considered in determining the conservation value of receptors as part of this assessment, outlined in Section 4.8.
	Paragraph 5.4.8 – states that "the most important sites for biodiversity are those identified through international conventions and European Directives. The Habitats Regulations provide statutory protection for these sites but do not provide statutory protection for potential Special Protection Areas (pSPAs) before they have been classified as a Special Protection Area. For the purposes of considering development proposals affecting them, as a matter of policy the Government wishes pSPAs to be considered in the same way as if they had already been classified. Listed Ramsar sites should, also as a matter of policy, receive the same protection."	The potential for effects on designated sites classified as a pSPA, SPA and / or Ramsar sites is considered in detail in Report 5.2: RIAA (application ref: 5.2). These designated sites are also account for in the summary of valued ornithological receptors and potential impacts in Table 14.
	Paragraph 5.3.15 – "Development proposals provide many opportunities for building-in beneficial	The Applicant has explored, developed and created suitable opportunities for building-in

POLICY	POLICY DESCRIPTION	RELEVANCE TO ASSESSMENT
	biodiversity or geological features as part of good design. When considering proposals, the [the Secretary of State] should maximise such opportunities in and around developments, using requirements or planning obligations where appropriate."	beneficial biodiversity and geological features as part of good design for AyM, as detailed in the commitments listed in Volume 2, Chapter 1(application ref: 6.2.1).
	Paragraph 5.4.15– reminds that "many individual wildlife species receive statutory protection under a range of legislative provisions."	Statutory protection afforded to bird species has been considered in determining the conservation value of receptors as part of this assessment, outlined in Section 4.8.
	Paragraph 5.4.16 – explains that "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 IPC [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 IPC [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 IPC [the Secretary of State] should give substantial weight to	Species of principal importance in Wales are considered in determining the conservation value of receptors as part of this assessment, outlined in Section 4.8. AyM is committed to minimising potential impacts on biodiversity, and mitigation measures are described in Section 4.7. The Applicant has taken into account other bird species and habitats that have been identified as being of principal importance for the conservation of biodiversity in Wales and thereby requiring conservation action in Section 4.8. Relevant species are

POLICY	POLICY DESCRIPTION	RELEVANCE TO ASSESSMENT
	any such harm to the detriment of biodiversity features of national or regional importance which it considers may result from a proposed development.”	identified in Volume 4, Annex 4.1 (application ref: 6.4.4.1). The Applicant has ensured that these species and habitats are protected from the potentially adverse effects of AyM by accepting the need for requirements as part of the consenting process, as detailed in the commitments listed in Volume 2, Chapter 1 (application ref: 6.2.1. Any residual impacts are assessed within this ES and described in Sections 4.3. Climate change is a significant threat to bird biodiversity interests (Pearce-Higgins & Crick 2019). AyM will contribute a significant amount of renewable energy (Volume 2, Chapter 1: Offshore Project Description (application ref: 6.2.1)), to the UK Government’s target of producing 40GW of renewable energy from offshore wind by 2030 and achieving net zero by 2050 (BEIS 2020), as outlined in F1.1: Planning Statement and F1.6: Statement of Need.

POLICY	POLICY DESCRIPTION	RELEVANCE TO ASSESSMENT
NPS EN-3	Paragraph 2.6.64 - states that the "assessment of offshore ecology and biodiversity should be undertaken by the applicant for all stages of the lifespan of the proposed offshore wind farm."	Assessment of potential effects on offshore ornithology across all stages of AyM's lifespan have been described and considered within Sections 4.9 – 4.13.
	Paragraph 2.6.65 – states that "Consultation on the assessment methodologies should be undertaken at early stages with the statutory consultees as appropriate."	Agreement on the assessment approach and survey methods has been sought through discussions with Natural Resources Wales (NRW) and other statutory consultees through the Evidence Plan process (Section 4.2).
	Paragraph 2.6.68 – states that "the IPC [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."	The offshore ornithology aspects of marine ecology and biodiversity have been described and considered within this ES chapter for AyM.
	Paragraph 2.6.69 – explains that "the designation of an area as Natura 2000 site [a protected site] does not necessarily restrict the construction or operation of offshore wind farms in or near [or through] that area."	AyM has been designed to avoid and/ or mitigate potential adverse effects on the national site network, as described in Report 5.2: RIAA (application ref: 5.2).
	Paragraph 2.6.101 – explains that "offshore wind farms have the potential to impact on birds through: - collisions with rotating blades; - direct habitat loss;	Potential impacts on offshore ornithology are assessed in Sections 4.9 to 4.11.

POLICY	POLICY DESCRIPTION	RELEVANCE TO ASSESSMENT
	- disturbance from construction activities such as the movement of construction/decommissioning vessels and piling; - displacement during the operational phase, resulting in loss of foraging/roosting area; - impacts on bird flight lines (i.e. barrier effect) and associated increased energy use by birds for commuting flights between roosting and foraging areas.; - [impacts upon prey species and prey habitat; and - [protected sites (e.g. SPAs)."	
	Paragraph 2.6.102 - states that "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]."	Baseline survey methods have been presented to and agreed with NRW, Natural England (NE), Joint Nature Conservation Committee (JNCC) and the Royal Society for the Protection of Birds (RSPB) through the Evidence Plan Process (see Section 4.2).
	Paragraph 2.6.103 – states that "relevant data from operational offshore wind farms should be referred to in the applicant's assessment."	Relevant data from other operational OWFs both within the same region and from further afield have been referred to in the AyM ES and Report 5.2: RIAA (application ref: 5.2). Of particular relevance to offshore ornithology is post-construction monitoring data available

POLICY	POLICY DESCRIPTION	RELEVANCE TO ASSESSMENT
		from the abutting Gwynt y Môr OWF, which is presented in detail in Volume 4, Annex 4.1: Offshore Ornithology Baseline Characterisation Report (6.4.4.1). The use of relevant data presented within published literature is also considered throughout this ES chapter to inform the impact assessment process.
	Paragraph 2.6.104 - states that "it may be appropriate for the assessment to include collision risk modelling for certain bird species."	Collision risk modelling and displacement analysis has been undertaken using parameters that have been agreed with SNCBs through the Evidence Plan process, and is presented in Volume 4, Annex 4.3 (application ref: 6.4.4.3) and Volume 4, Annex 4.2 (application ref: 6.4.4.2). Potential effects from collision risk are presented and assessed in Section 4.12. Potential effects from displacement are presented and assessed in Section 4.10 and 4.12.
	Paragraph 2.6.107 – requires that "aviation and navigation lighting be minimised [and/ or on demand] to avoid attracting birds, taking into account impacts on safety."	AyM has been designed with consideration of and within the limits of, lighting requirements for aviation and navigation purposes, to minimise lighting in order to avoid attracting birds, taking

POLICY	POLICY DESCRIPTION	RELEVANCE TO ASSESSMENT
		into account potential impacts on safety. Further consideration to the effects of lighting is given in Section 4.12.
	Paragraph 2.6.108 – notes that, "subject to other constraints, wind turbines should be laid out within a site, in a way that minimises collision risk, where the collision risk assessment shows there is a significant risk of collision."	The design of AyM has been carefully considered in order to minimise collision risk, including a reduction in design between the Preliminary Environmental Information Report (PEIR) and ES (Section 4.3.1).
	Paragraph 2.6.109 – requires that "construction vessels associated with offshore wind farms should, where practicable and compatible with operational requirements and navigational safety, avoid rafting seabirds during sensitive periods."	Construction vessels associated with AyM will, where practicable and compatible with operational requirements and navigational safety, avoid rafting seabirds during sensitive periods. See Section 4.7.
	Paragraph 2.6.110 – explains that "the exact timing of peak migration events is inherently uncertain. Therefore, shutting down turbines within migration routes during estimated peak migration periods is unlikely to offer suitable mitigation."	Mitigation measures for offshore ornithology have been considered within the AyM assessment process where relevant (Section 4.7). Additional risks with regards to migratory movements are further considered within the Volume 4, Annex:4.4 (application ref: 6.4.4.4) and assessed in Section 4.12.
Draft NPS EN-3	Paragraph 2.24.5 - states that the "assessment of offshore ecology and biodiversity should be	Assessment of potential effects on offshore ornithology across all stages of AyM's lifespan

POLICY	POLICY DESCRIPTION	RELEVANCE TO ASSESSMENT
	undertaken by the applicant for all stages of the lifespan of the proposed offshore wind farm."	have been described and considered within Sections 4.9 – 4.13.
	Paragraph 2.24.6 – states that "Consultation on the assessment methodologies should be undertaken at early stages with the statutory consultees as appropriate."	Agreement on the assessment approach and survey methods has been sought through discussions with Natural Resources Wales (NRW) and other statutory consultees through the Evidence Plan process (Section 4.2).
	Paragraph 2.24.18 – states that "the IPC [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."	The offshore ornithology aspects of marine ecology and biodiversity have been described and considered within this ES chapter for AyM.
	Paragraph 2.24.19 – "However, where adverse effects on site integrity/conservation objectives are predicted, in coming to a decision, the Secretary of State should consider the extent to which the effects are temporary or reversible and the timescales for recovery."	AyM has been designed to avoid and/ or mitigate potential adverse effects on the national site network, as described in Report 5.2: RIAA (application ref: 5.2).
	Paragraph 2.29.1– explains that "offshore wind farms have the potential to impact on birds through: - collisions with rotating blades; - direct habitat loss;	Potential impacts on offshore ornithology are assessed in Sections 4.9 to 4.11.

POLICY	POLICY DESCRIPTION	RELEVANCE TO ASSESSMENT
	- disturbance from construction activities such as the movement of construction/decommissioning vessels and piling; - displacement during the operational phase, resulting in loss of foraging/roosting area; - impacts on bird flight lines (i.e. barrier effect) and associated increased energy use by birds for commuting flights between roosting and foraging areas.; - [impacts upon prey species and prey habitat; and [protected sites (e.g. SPAs)."	
	Paragraph 2.29.3 - states that "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]."	Baseline survey methods have been presented to and agreed with NRW, Natural England (NE), Joint Nature Conservation Committee (JNCC) and the Royal Society for the Protection of Birds (RSPB) through the Evidence Plan Process (see Section 4.2).
	Paragraph 2.29.4 – states that "collision risk modelling, as well as displacement and population viability assessments must be undertaken for certain bird species."	Collision risk modelling and displacement analysis has been undertaken using parameters that have been agreed with SNCBs through the Evidence Plan process, and is presented in Volume 4, Annex 4.3 (application ref: 6.4.4.3) and Volume 4, Annex 4.2 (application ref:

POLICY	POLICY DESCRIPTION	RELEVANCE TO ASSESSMENT
		6.4.4.2). Potential effects from collision risk are presented and assessed in Section 4.12. Potential effects from displacement are presented and assessed in Section 4.10 and 4.12.
	Paragraph 2.29.5 – requires that "aviation and navigation lighting be minimised [and/ or on demand] to avoid attracting birds, taking into account impacts on safety."	AyM has been designed with consideration of and within the limits of, lighting requirements for aviation and navigation purposes, to minimise lighting in order to avoid attracting birds, taking into account potential impacts on safety. Further consideration to the effects of lighting is given in Section 4.12.
	Paragraph 2.29.6 – notes that, "subject to other constraints, wind turbines should be laid out within a site, in a way that minimises collision risk, where the collision risk assessment shows there is a significant risk of collision."	The design of AyM has been carefully considered in order to minimise collision risk, including a reduction in design between the Preliminary Environmental Information Report (PEIR) and ES (Section 4.3.1).
	Paragraph 2.29.7 – requires that "construction vessels associated with offshore wind farms should, where practicable and compatible with operational requirements and navigational safety, avoid rafting seabirds during sensitive periods."	Construction vessels associated with AyM will, where practicable and compatible with operational requirements and navigational safety, avoid rafting seabirds during sensitive periods. See Section 4.7.

POLICY	POLICY DESCRIPTION	RELEVANCE TO ASSESSMENT
	Paragraph 2.29.8 – explains that "the exact timing of peak migration events is inherently uncertain. Therefore, shutting down turbines within migration routes during estimated peak migration periods is unlikely to offer suitable mitigation."	Mitigation measures for offshore ornithology have been considered within the AyM assessment process where relevant (Section 4.7). Additional risks with regards to migratory movements are further considered within the Volume 4, Annex:4.4 (application ref: 6.4.4.4) and assessed in Section 4.12.

Table 2: Welsh National Marine Plan and its relevance to offshore ornithology.

POLICY DESCRIPTION	RELEVANCE TO ASSESSMENT
Welsh National Marine Plan (Welsh Government, 2019)	
ENV_01: Resilient marine ecosystems. Proposals should demonstrate how potential impacts on marine ecosystems have been taken into consideration and should, in order of preference: a. avoid adverse impacts; and/or b. minimise impacts where they cannot be avoided; and/or c. mitigate impacts where they cannot be minimised. If significant adverse impacts cannot be avoided, minimised or mitigated, proposals must present a clear and convincing case for proceeding. Proposals that contribute to the protection, restoration and/or enhancement of marine ecosystems are encouraged.	The potential impacts on offshore ornithology have been assessed in Sections 4.9, 4.12 and 4.13. Consideration of the avoid, minimise and mitigate approach is given within the assessments as appropriate. Mitigation measures are detailed within Section 4.7.
ENV_02: Marine Protected Areas. Proposals should demonstrate how they: - avoid adverse impacts on individual Marine Protected Areas (MPAs) and the coherence of the network as a whole; - have regard to the measures to manage MPAs; and avoid adverse impacts on designated sites that are not part of the MPA network.	Designated sites within the region have been identified as appropriate, and any potential impacts to features and the site network have been assessed in Report 5.2: RIAA (application ref: 5.2).

POLICY DESCRIPTION	RELEVANCE TO ASSESSMENT
ENV_07: Fish species and habitats. Proposals potentially affecting important feeding, breeding (including spawning & nursery) and migration areas or habitats for key fish and shellfish species of commercial or ecological importance should demonstrate how they, in order of preference: a. avoid adverse impacts on those areas; and/or b. minimise adverse impacts where they cannot be avoided; and/or c. mitigate adverse impacts where they cannot be minimised. If significant adverse impacts cannot be avoided, minimised or mitigated, proposals must present a clear and convincing case for proceeding.	The potential effects on fish species and their habitats have been assessed in Sections 4.9, 4.12 and 4.13 in the context of how offshore ornithology receptor may be indirectly affected via impacts on prey species. The potential effects of AyM on fish and shellfish have been fully assessed in Volume 2, Chapter 6: Fish and Shellfish Ecology (application ref: 6.2.6).

4.1.3 Guidance

17 This ES chapter has been prepared with reference to the following relevant guidance for undertaking impact assessment:

- Chartered Institute of Ecology and Environmental Management (CIEEM) (2019) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine;
- Institute of Environmental Management and Assessment ('IEMA') (2017) Delivering Proportionate Environmental Impact Assessment ('EIA'): A Collaborative Strategy for Enhancing UK Environmental Impact Assessment Practice; and
- Planning Inspectorate (PINS) (2019) - Advice Note Seventeen: Cumulative Effects Assessment.

18 Attention has also been paid to the latest guidance notes relating to displacement analysis and collision risk modelling, which are detailed in Volume 4, Annex 4.2 (application ref: 6.4.4.2) and Volume 4, Annex 4.3 (application ref: 6.4.4.3), respectively.

4.2 Scoping and consultation

19 All details relating to the outcome of, and response to Scoping Opinion, S.42 Responses and ETG meetings is detailed in Volume 4, Annex 4.5: Offshore Ornithology Scoping & Consultation Responses (application ref: 6.4.4.5), with signposting to relevant sections of the ES where addressed.

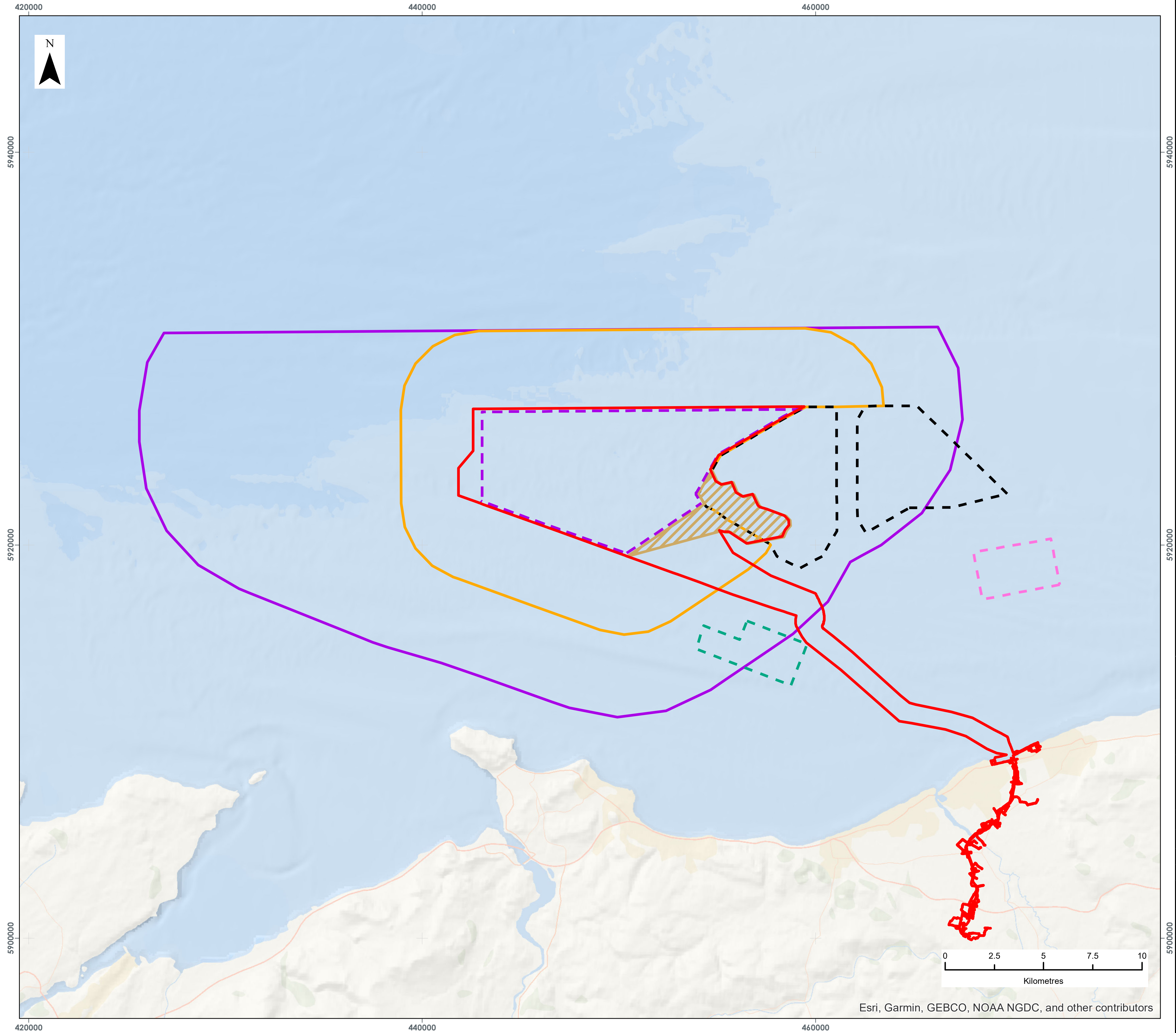
4.3 Scope and methodology

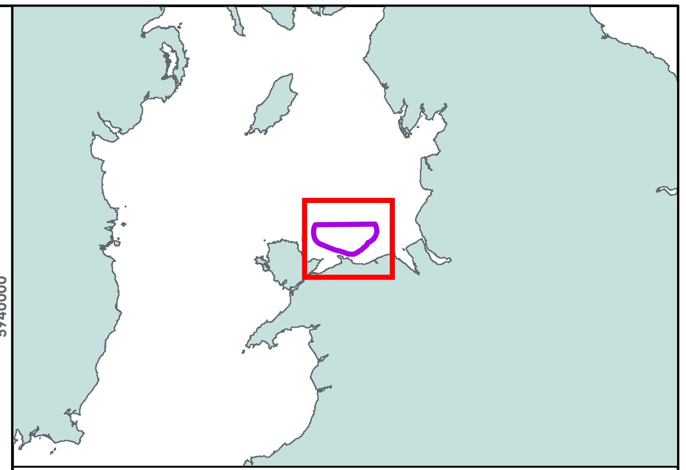
20 This section sets out the scope of the ES assessment for offshore ornithology. The scope has been developed as the AyM project design has evolved in response to stakeholder consultation received to date as set out in Volume 4, Annex 4.5: Offshore Ornithology Scoping & Consultation Responses (application ref: 6.4.4.5)

4.3.1 Study area

21 The study area for offshore ornithology is defined as the offshore part of the Order Limits together with the Zone of Influence (ZOI) for offshore ornithology. It is based on an area which is considered to represent a realistic maximum spatial extent of potential impacts on offshore ornithological receptors. The study area for the offshore ornithology assessment includes the array area with a 4 km buffer to the north and 8 km to the south (encompassing the Offshore Export Cable Corridor (ECC); Figure 1). The components are defined below.

22 The Order Limits have been refined since Scoping as part of the iterative EIA process following feedback from Scoping consultation.





LEGEND

- Order Limits
- Array Area
- Array Area 4 km Buffer (excluding GyM)
- AyM Survey Area
- Interlink Cable Area
- GyM Array Area
- Rhyl Flats OWF
- North Hoyle OWF

Data Source:

PROJECT TITLE:

AWEL Y MÔR OFFSHORE WINDFARM

FIGURE TITLE:

Study area

VER	DATE	REMARKS	Drawn	Checked
1	22/02/2022	For Issue	LB	MB

FIGURE NUMBER:

Figure 1

SCALE:	PLOT SIZE:	DATUM:	PROJECTION:
1:200,000	A3	WGS84	UTM30N

Fferm Wynt Alltraeth AWEL Y MÔR Offshore Wind Farm

P:\P00004817 GoBe - Awel y Mor Ornithology EIA\Data\00_GIS_assorted_shapefiles\ArcGIS\AYM_Survey_Map_A3_Landscape_UTM30N_v1.mxd

Array area

23 The array area is located approximately 10.5 km offshore covering an area of approximately 78 km^2. The inter-array area is where the WTGs, array cables and up to two Offshore Substation Platforms (OSPs) will be located.

Offshore export cable corridor

24 The Offshore ECC is where up to two (AC) export cables will be located, running from the OSPs to landfall, with each cable having a maximum length of approximately 71.3 km, and within a maximum cable corridor width of 1 km. All areas landward of MLWS, including the intertidal zone, are considered in Volume 3, Chapter 5 (application ref: 6.3.5).

4.3.2 Temporal scope

25 The temporal scope of the assessment of offshore ornithology is consistent with the period over which AyM would be present and therefore covers the construction, operational and decommissioning periods. The exact dates are unknown at this stage, but it is assumed that construction will begin in 2026, in order that the wind farm is fully operational by 2030; the anticipated operational lifetime of the wind farm is 25 years; and decommissioning activities will take a maximum of three years.

4.3.3 Potential receptors

26 The spatial and temporal scope of the assessment enables the identification of potential receptors which may experience a change as a result of AyM. As presented in Volume 4, Annex 4.1 (application ref: 6.4.4.1), the following potential receptors were identified, based on their presence within the study area during baseline surveys:

- Common scoter, *Melanitta nigra*;
- Red-breasted merganser, *Mergus serrator*;
- Great crested grebe, *Podiceps grisegena;*
- Kittiwake, Rissa tridactyla;
- Common gull, *Larus canus;*
- Great black-backed gull, *Larus marinus*;

- Herring gull, Larus argentatus;
- Lesser black-backed gull, *Larus fuscus*;
- Sandwich tern, Thalasseus sandvicensis;
- Common tern, *Sterna hirundo*;
- Arctic tern, Sterna paradisaea;
- Guillemot, *Uria aalge*;
- Razorbill, *Alca torda*;
- Black guillemot, *Cepphus grylle;*
- Puffin, Fratercula arctica;
- Red-throated diver, *Gavia stellata*;
- Fulmar, Fulmarus glacialis;
- Manx shearwater Puffinus puffinus;
- Gannet, Morus bassanus; and
- Cormorant, Phalacrocorax carbo.

27 In addition to these seabird species, there is also potential for AyM to affect non-seabird species passing through the study area during migration periods. Recording these potential non-seabird receptors using standard baseline survey methods is extremely complex however, given that migratory bird movements are often in short pulses through an area, at night and at high altitude. As such, an initial screening exercise was carried out to identify potential non-seabird receptors present across the study area during migration. A list of 35 species of birds (mostly migratory waterbirds) were considered further, with further details presented in Section 4.12.4 and in Volume 4, Annex 4.4 (application ref: 6.4.4.4).

4.3.4 Potential impacts

28 Potential impacts and the level of any subsequent effect on potential receptors are summarised in Table 3.

Table 3: Potential impacts and effects on offshore ornithology receptors.

POTENTIAL IMPACT	POTENTIAL EFFECT
Construction	
Disturbance and displacement: array Construction activities within the array area associated with foundations and WTGs may lead to disturbance and displacement of species within the array and potentially within surrounding buffers to a lower extent.	Disturbance and displacement reduce the amount of functional habitat available for foraging, resting and other activities and may therefore reduce survival or reproductive fitness of the birds involved.
Disturbance and displacement: offshore ECC Construction activities associated with export cable installation may lead to disturbance and displacement of species within the ECC and potentially within surrounding buffers to a lower extent.	Disturbance and displacement reduce the amount of functional habitat available for foraging, resting and other activities and may therefore reduce survival or reproductive fitness of the birds involved.
Indirect impacts due to impacts on prey species: array Turbine, OSP and array cable installation would lead to temporary disturbance of the seabed leading to an increase in suspended sediments (e.g. during installation of cables). These may alter the distribution, physiology or behaviour of bird prey species. It may also make it harder for foraging seabirds to locate their prey in the water column. These mechanisms could potentially result in less prey being available in the area adjacent to active construction works to foraging seabirds.	A reduction in prey availability may reduce the survival or reproductive fitness of the birds involved.

POTENTIAL IMPACT	POTENTIAL EFFECT
Indirect impacts due to impacts on prey species: offshore ECC Seabed preparation and export cable installation would lead to temporary disturbance of the seabed leading to an increase in suspended sediments (e.g. during installation of cables). These may alter the distribution, physiology or behaviour of bird prey species. It may also make it harder for foraging seabirds to locate their prey in the water column. These mechanisms could potentially result in less prey being available in the area adjacent to active construction works to foraging seabirds.	A reduction in prey availability may reduce the survival or reproductive fitness of the birds involved.
Operation and Maintenance	
Disturbance and displacement: array Activities associated with the operation and maintenance of WTGs and the presence of WTGs themselves may disturb and displace species within the array area and potentially within surrounding buffers to a lower extent.	Disturbance and displacement reduce the amount of functional habitat available for foraging, resting and other activities and may therefore reduce survival or reproductive fitness of the birds involved.
Disturbance and displacement: offshore ECC Activities associated with the operation and maintenance of the export cable/s may disturb and displace species within the ECC and potentially within the surrounding buffers to a lower extent.	Disturbance and displacement reduce the amount of functional habitat available for foraging, resting and other activities and may therefore reduce survival or reproductive fitness of the birds involved.

POTENTIAL IMPACT	POTENTIAL EFFECT
Collision risk: array Birds flying through the array area during the operational phase of the AyM may be at risk of collision with WTGs, both on migration or foraging flights.	Collisions are assumed to be fatal.
Barrier effect: array The presence of the array area could create a barrier to movements of breeding seabirds during foraging or migration.	A barrier effect increases energy expenditure involved in foraging or migratory movement and may reduce parental provisioning of dependent chicks. This may therefore reduce survival or reproductive fitness of the birds involved.
Impacts of navigation and aviation lighting Lighting on WTGs and associated infrastructure may be associated with changes to bird behaviour, including attraction, avoidance and disorientation.	Birds which avoid lighting may experience a displacement effect or a barrier effect. Birds which are attracted to lighting may be more vulnerable to collision. Migrating birds may become disoriented and have reduced fitness as a result.
Indirect impacts due to impacts on prey: array Installation of turbine foundations, OSP foundation, scour protection, array cabling and non-burial cable protection would lead to original habitat loss for bird prey species. Maintenance activities may lead to temporary seabed disturbance and the production of suspended sediments that may alter the distribution, physiology or behaviour of bird prey species. This may also make it harder for seabirds	A reduction in prey availability may reduce the survival or reproductive fitness of the birds involved.

POTENTIAL IMPACT	POTENTIAL EFFECT
to see their prey in the water column. These mechanisms could potentially result in less prey being available to foraging seabirds.	
Indirect impacts due to impacts on prey: offshore ECC Installation of export cabling, non-burial cable protection and cable crossing protection would lead to original habitat loss for bird prey species. Maintenance activities may lead to temporary seabed disturbance and the production of suspended sediments that may alter the distribution, physiology or behaviour of bird prey species. This may also make it harder for seabirds to see their prey in the water column. These mechanisms could potentially result in less prey being available to foraging seabirds.	A reduction in prey availability may reduce the survival or reproductive fitness of the birds involved.
Decommissioning	
As outlined in Volume 2, Chapter 1, there is uncertainty regarding likely decommissioning activities. For the purposes of the ES, impacts are assumed to be equal to or less than those resulting from construction activities.	

4.3.5 Activities or impacts scoped out of assessment

29 A single impact has been scoped out from further assessment, as it was determined as not having the potential to lead to a significant adverse effect (Innogy, 2020; Section 1.2) and this conclusion was agreed in the Secretary of State's scoping report (PINS, 2020; Section 1.2). The scoped-out activity or impact is considered in Table 4 and an indication given of whether the scope has evolved since Scoping.

Table 4: Activities or impacts scoped out of assessment.

ACTIVITY OR IMPACT	RATIONALE FOR SCOPING OUT
Indirect impacts through effects on prey species and habitats: Accidental pollution resulting from construction of AyM.	With implementation of an appropriate CoCP it has been agreed with stakeholders on consent applications for other OWF's, that complete mortality within the equivalent extent of a wind farm's array plus buffer area is considered very unlikely to occur, and a major incident that may impact any species at a population level is considered very unlikely. It has been predicted on other OWFs that any impact would be of local spatial extent, short term duration, and not significant in EIA terms. This is considered to be equally applicable to AyM for which construction will be comparable in scale and operation and within the same environment, whilst implementing an appropriate CoCP.

4.4 Methodology for baseline data gathering

30 Baseline data collection has been undertaken to obtain information across the study area described in Section 1.3: Scope of the assessment.

4.4.1 Desk study

31 The data sources that have been collected and used to inform this offshore ornithology assessment are summarised in Table 5.

Table 5: Data sources used to inform the offshore ornithology ES assessment.

SOURCE	DATE	SUMMARY	COVERAGE OF STUDY AREA
AyM – aerial digital survey data	2019 – 2021	Aerial digital surveys conducted by APEM Ltd. on a monthly basis between March 2019 and February 2021.	AyM array area plus a 4 km buffer to the north and an 8 km buffer to the south.
GyM OWF baseline characterisation data and post-consent monitoring	2003 – 2005	Boat-based and aerial visual surveys across the GyM zone and buffers. Data collection initiated in February 2003 for two years (end date May 2005).	AyM array area and approximately 95% of the buffer area.
	2010, 2012-13 & 2016-19	Aerial digital surveys across the GyM zone and buffers pre-construction (2010), during construction (2012-13) and post construction (2016-19).	AyM array area and approximately 95% of the buffer area.
Rhyl Flats OWF (RFOWF) post-construction monitoring	2009 – 2012	Aerial surveys conducted 2009 – 2012, covering RFOWF, a buffer around it, and the wider NW5 Survey Area.	The wider NW5 survey area covers the majority of the AyM study area. The buffer area around RFOWF covers the majority of the AyM offshore ECC and partially overlaps with the AyM array area and 4-8 km buffer.
Wildfowl and Wetlands Trust (WWT) – All	2001 – 2004	Aerial visual surveys of common scoter. Surveys undertaken by WWT on behalf	AyM array and buffer area.

SOURCE	DATE	SUMMARY	COVERAGE OF STUDY AREA
Wales Common Scoter Survey		of the Countryside Council for Wales (CCW).	
Wildfowl and Wetlands Trust (WWT) – aerial surveys of waterbirds in the UK	2007 – 2008	Aerial surveys of inshore waters commissioned by the Department of Energy and Climate Change (DECC) to inform further rounds of OWF development and for continued monitoring of SPAs.	AyM array area and buffer area.
National Environmental Research Institute (NERI) & WWT	2004 – 2005	Aerial visual surveys for the Department of Trade and Industry (DTI) as part of the survey programme for the Round 2 offshore wind farm strategic areas.	AyM array area and approximately 90% of the buffer area.
Lawson et al., 2016	2001 – 2011	Results from eight seasons of aerial observer surveys of the Liverpool Bay region, used to inform the extension to the Liverpool Bay SPA.	Area of search covers the entire AyM ECC and partially overlaps the AyM array area.
Existing offshore wind farm grey literature	Various dates	Information obtained from various offshore wind farm Environmental Statements (i.e. Rhyl Flats, North Hoyle, Burbo Bank and Burbo Bank Extension).	Potentially some overlap with AyM study area. Also provides information on birds in the wider context of the North Wales coast.

SOURCE	DATE	SUMMARY	COVERAGE OF STUDY AREA
NRW designated sites portal.	Various dates	Information on SPAs and other designations relevant to ornithological receptors with potential connectivity to AyM.	Country wide information on designated sites.
North Wales Wildlife Trust	Various dates	Information on breeding records, ringing recoveries etc. available from the North Wales Wildlife Trust and any other relevant nature organisations.	Regional data that can be drawn upon at an AyM specific scale, or a wider regional scale.
Large scale survey data sets	2014	Large scale seabird sensitivity mapping as part of the SeaMaST project (Bradbury et al., 2014); Marine Ecosystems Research Programme (MERP) distribution maps of seabird populations in the north-east Atlantic (Waggit 2019).	UK wide coverage with information that can be drawn upon at an AyM specific scale, or a wider regional scale.
Potential impacts of offshore wind farms on birds	Various dates	Published, peer reviewed scientific literature on bird behaviour and potential impacts from OWF e.g. Garthe and Hüppop (2004); Drewitt and Langston (2006); Stienen et al., (2007); Speakman et al., (2009); Langston (2010); Band (2012); Cook et	Generic information applicable to AyM ornithological receptors.

SOURCE	DATE	SUMMARY	COVERAGE OF STUDY AREA
		al., (2012); Furness and Wade (2012); Wright et al., (2012); Furness et al., (2013); Johnston et al., (2014a,b); Cook et al., (2014); Dierschke et al., (2017); SNCB (2017); Jarrett et al., (2018); Leopold & Verdaat (2018); Mendel et al., (2019).	
Bird population estimates and demographic rates	Various dates	Data on seabird populations and demographic rates for use in assessments e.g. Mitchell et al., 2004; BirdLife International, 2004; Eaton et al., 2020; Frost et al., 2020; Musgrove et al., 2013; Furness, 2015; Horswill et al., 2017, JNCC, 2020; Brenchley et al., 2013.	These sources contain information which can be drawn upon at an AyM specific scale, or a wider regional scale.
Bird breeding ecology	Various dates	Information on the breeding ecology of various bird species e.g. Cramp and Simmons (1977-94); Del Hoyo et al., (1992-2011); Robinson (2005); Brenchley et al., 2013.	Generic information applicable to AyM ornithological receptors.
Bird distribution	Various dates	Publicly available reports of bird distribution in UK waters e.g. Stone et al., (1995); Brown and Grice (2005);	UK wide coverage with information that can be drawn upon at an AyM specific scale, or a wider regional scale.

SOURCE	DATE	SUMMARY	COVERAGE OF STUDY AREA
		Kober et al., (2010); Balmer et al., (2013); WWT 2013; Brenchley et al., 2013; Camphuysen et al., 2004.	
Bird migration and foraging movements	Various dates	Bird movements during breeding season foraging trips and migratory movements e.g. Wernham et al., (2002); Thaxter et al., (2012); Woodward et al., (2019).	These sources contain information which can be drawn upon at an AyM specific scale, or a wider regional scale.

4.4.2 Offshore site surveys

32 Species accounts presented within this chapter for offshore ornithology are based upon data collected during 24 site-specific aerial digital surveys of the AyM array area plus buffer carried out between March 2019 and February 2021 inclusive, from which the baseline data relevant to this ES assessment has been extracted, as detailed in Volume 4, Annex 4.1.

33 Data from aerial and boat-based surveys conducted for Gwynt y Môr (GyM) OWF and the wider area overlap with the ES assessment boundary for AyM and were therefore also used to inform the EIA where appropriate. Data from Rhyl Flats OWF (RFOWF) post-construction monitoring also partially overlap with the AyM study area. A summary of these sources is given in Table 6.

34 Additional sources of information for the purpose of impact assessment were identified and details are provided in Volume 4, Annex 4.1.

Table 6: Site surveys undertaken.

SURVEY TYPE	SCOPE OF SURVEYS	COVERAGE OF STUDY AREA
AyM – aerial digital survey data (2019 – 2021)	Aerial digital surveys conducted by APEM Ltd. on a monthly basis between March 2019 and February 2021.	AyM array area plus a 4 km buffer to the north and an 8 km buffer to the south.
GyM OWF baseline characterisation data (2003 – 2019)	Boat-based and aerial visual surveys across the GyM OWF and buffers. Data collection initiated in February 2003 for two years (end date May 2005).	AyM array area and approximately 95% of the buffer area.
	Aerial digital surveys across the GyM zone and buffers pre-construction (2010), during construction (2012-13) and post construction (2016-19).	AyM array area and approximately 95% of the buffer area.

4.4.3 Data limitations

35 The marine environment can be highly variable, both spatially and temporally, meaning that seabird numbers may fluctuate greatly between months, bio-seasons and between different years at any given location, lowering the probability of being able to detect consistent patterns, directional changes or to generate reliable population estimates. Therefore, the site-specific data presented in this ES chapter for the purpose of baseline characterisation of AyM that was collected over a 24-month period and the method used to collect these data (aerial digital still imagery) may be considered to represent a snapshot of each month.

36 However, the most recent survey data used for describing the existing baseline are consistent with data obtained from surveys conducted for other OWF applications in UK waters and are in general agreement with information from the desk study literature and previous surveys conducted within the existing GyM OWF and RFOWF. Thus, these data are considered to be representative of the site for the purpose of baseline characterisation and should be considered to reduce any uncertainties within the impact assessment of AyM.

4.5 Existing environment

4.5.1 Current baseline offshore

37 A programme of 24-months of high-resolution aerial digital surveys has been completed, covering the AyM array plus a buffer of 4 km to the north and 8 km to the south. Full details of these surveys, along with other data sources considered, are presented in the Volume 4, Annex 4.1 (application ref: 6.4.4.1).

38 The following species were recorded within the study area between March 2019 and February 2021 (Table 14). Details of the estimated abundances of all species, along with information about recorded behaviours, are presented in the Volume 4, Annex 4.1: Offshore Ornithology Baseline Characterisation Report (application ref: 6.4.4.1). Species' conservation status is also provided in Table 7.

Table 7: Summary of nature conservation value of species considered at potential risk of impacts.

SPECIES	CONSERVATION STATUS
Common scoter	BoCC5 Red listed, Birds Directive Migratory Species; Species of Principal Importance under The Environment (Wales) Act (2016)
Red-breasted merganser	BoCC5 Amber listed
Great crested grebe	BoCC5 Green listed
Kittiwake	BoCC5 Red listed, Birds Directive Migratory Species
Common gull	BoCC5 Amber listed, Birds Directive Migratory Species
Great black-backed gull	BoCC5 Amber listed, Birds Directive Migratory Species
Herring gull	BoCC5 Red listed, Birds Directive Migratory Species; Species of Principal Importance under The Environment (Wales) Act (2016)
Lesser black-backed gull	BoCC5 Amber listed, Birds Directive Migratory Species

SPECIES	CONSERVATION STATUS
Sandwich tern	BoCC5 Amber listed, Birds Directive Migratory Species
Common tern	BoCC5 Amber listed, Birds Directive Migratory Species, Birds Directive Annex 1
Arctic tern	BoCC5 Amber listed, Birds Directive Migratory Species, Birds Directive Annex 1
Guillemot	BoCC5 Amber listed, Birds Directive Migratory Species
Razorbill	BoCC5 Amber listed, Birds Directive Migratory Species
Black guillemot	BoCC5 Amber listed
Puffin	BoCC5 Red listed, Birds Directive Migratory Species
Red-throated diver	BoCC5 Green listed, Birds Directive Migratory Species
Fulmar	BoCC5 Amber listed, Birds Directive Migratory Species
Manx shearwater	BoCC5 Amber listed, Birds Directive Migratory Species
Gannet	BoCC5 Amber listed, Birds Directive Migratory Species
Cormorant	BoCC5 Green listed, Birds Directive Migratory Species

4.5.2 Evolution of the baseline

39 The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 require that 'a description of the relevant aspects of the current state of the environment (baseline scenario) and 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 any ES.

40 The existing baseline is informed by data that are 'current' and a future baseline is informed by an extrapolation of the currently available data by reference to policy and plans, other proposal applications and expert judgement.

41 In the absence of AyM, numbers of marine birds occurring within the study area over the operational period of the project, would likely reflect changes in populations resulting from climatic factors (such as temperature change and subsequent impacts on species' ranges), or anthropogenic activities such as changes in fishing activities indirectly affecting marine bird communities. Furthermore, baseline conditions within the study area may also change in relation to other projects/ plans which may be implemented during this timeframe. Baseline conditions are therefore not static and are likely to exhibit some degree of change over time, with or without AyM in place.

42 Therefore, potential impacts have been assessed in the context of the envelope of change that might occur over the operational period of the AyM. Consideration of other projects/plans is undertaken through CEA in Section 4.16 and in doing so, their ability to modify the existing baseline is also considered.

4.6 Key parameters for assessment

43 Undertaking an assessment using a parameter-based design envelope approach means that the assessment considers a maximum design scenario (MDS) whilst allowing the flexibility to make improvements in the future in ways that cannot be predicted at the time of submission of the DCO Application. The assessment of the maximum adverse scenario establishes the maximum potential adverse impact and, as a result, effects of greater adverse significance will not arise should any other development scenario to that assessed within this chapter be taken forward in the final scheme design.

44 The design parameters that have been identified to be relevant to offshore ornithology are outlined in Table 8 below and are in line with the Project Description (Volume 2, Chapter 1 (application ref: 6.2.1)).

Table 8: Maximum design parameters for impacts on offshore ornithology.

POTENTIAL IMPACT	MAXIMUM DESIGN PARAMETERS
Construction	
Disturbance and displacement	As described in Volume 2, Chapter 1, the total indicative number of vessel movements (i.e. return trips) over a 42-month period on a 24/7 basis is 3,436 (start and finish dates to be confirmed). This includes all movements for the array area and offshore ECC.
Disturbance and displacement: offshore export cable corridor	As described in Volume 2, Chapter 1, the total indicative number of export cable installation spread vessel movements (i.e. return trips) over a 6-month period on a 24/7 basis is 187 (start and finish dates to be confirmed). In addition, approximately 5-10% of the 3,436 movements indicated above may be involved with cable laying activities. The indicative rate of cable laying is 45–400 m/hour. The total length of export cables is 79.4 km, with the maximum route length being 32.5 km.
Indirect impacts due to impacts on prey: array	Seabed preparation, turbine installation and array cable installation will take place over a 42-month period (start and finish dates to be confirmed). The maximum extent of the array is 78 km^2. In addition, there will be a 500 m safety zone around locations of active works. The area of seabed disturbed across the array is approximately 2.80 km^2. This is based on jack-up footprints of 0.34 km^2, anchor footprints of 0.14 km^2 during foundation installation and 0.24 km^2 during topside installation, and

POTENTIAL IMPACT	MAXIMUM DESIGN PARAMETERS
	pre-lay ploughing along 116 km of array cables to a disturbance width of 18 m (2.08 km^2).
Indirect impacts due to impacts on prey: offshore export cable	Seabed preparation and export cable installation (excluding intertidal) will take place over a 6-month period (start and finish dates to be confirmed). The maximum area for the offshore cabling corridor is 33.4 km^2. The indicative maximum area of seabed disturbed across export cable corridor during cable installation is 1.43 km^2. This is based on an 18 m width of seabed affected by the installation of each cable, along 79.4 km of offshore cabling.
Operation and maintenance	
Disturbance and displacement: array	For displacement, the assessment is based upon the maximum extent of the array (78 km^2) plus species-specific buffers (see Section 4.12.1). As described in Volume 2, Chapter 1, the annual indicative number of vessel movements (i.e. return trips) during the 25-year operating life of the array is 1,208 movements per year, comprising jack-up vessels (6 movements) service operations vessels (52 movements), crew transfer vessels (1,095 movements), lift vessels (6 movements) auxiliary vessels (48 movements) and a single cable maintenance vessel movement.
Disturbance and displacement: offshore export cable	A small number of vessel movements associated with inspections and monitoring to identify if the Offshore Export Cable becomes exposed over time and take appropriate remedial action.

POTENTIAL IMPACT	MAXIMUM DESIGN PARAMETERS
	Although the export cables are designed to require no maintenance or re-burials, it is assumed that the worst-case scenario of four such repairs are required over the project lifespan, each of which affects a 5 km length of cable and disturbs 6,000 m^2 of seabed.
Collision risk: array	The worst-case scenario is the greatest number of smaller turbines. Although the total frontal area is higher using larger turbines, the vast majority of bird flights are at low heights, e.g. for kittiwake 90.7% are below 25 m ASL and 99.995 % are below 100 m ASL (Cook et al., 2012). Therefore, a greater number of smaller turbines creates a higher collision risk (Johnston et al., 2016). As such, the following maximum parameters have been taken forward: Maximum extent of array = 78 km^2 Maximum number of WTGs = 50 Maximum rotor diameter = 250 m Minimum height of lower blade tip above HAT = 21.19 m
Barrier effects: array	For barrier effects, the assessment is based upon the maximum extent of the array (78 km^2).
Lighting: array	Synchronised navigational lighting will be placed on specific structures around the array perimeter, with a 5 NM nominal range on significant structures and 2 NM nominal range on intermediate structures, 6-30 m above

POTENTIAL IMPACT	MAXIMUM DESIGN PARAMETERS
	HAT, typically on the transition piece main access platform. All WTGs structures will also have 2,000 cd aviation lights at the hub. The met mast will have a navigational light with a 10 NM nominal range and a 2,000 cd aviation light.
Indirect impacts due to impacts on prey: array	Temporary seabed disturbance resulting from array cable repairs is expected to be required five times over the 25-year operational period, with 0.006 km^2 of seabed disturbed during each repair (0.030 km^2 in total over 25 years). Total area of original habitat loss is 1.44 km^2, comprising gravity-based turbine foundations (0.28 km^2), gravity-based OSP foundations (0.007 km^2), scour protection across all gravity-based turbine foundations (0.56 km^2), scour protection across all gravity-based OSP foundations (0.21 km^2), array cabling (0.03 km^2) and non-burial cable protection (0.19 km^2).
Indirect impacts due to impacts on prey: offshore export cable	Temporary seabed disturbance resulting from offshore export cable repairs is expected to be required four times over the 25-year operational period, with 0.006 km^2 of seabed disturbed during each repair (0.024 km^2 in total over 25 years). Total area of original habitat loss is 0.27 km^2, comprising offshore export cabling (0.02 km^2), non-burial cable protection (0.24 km^2), and cable crossing protection (0.03 km^2)

POTENTIAL IMPACT	MAXIMUM DESIGN PARAMETERS
Decommissioning	
All impacts	As outlined previously (see Section 4.3.4 and Volume 2, Chapter 1), there is uncertainty regarding likely decommissioning activities. For the purposes of the EIA, impacts are assumed to be equal to or less than those resulting from construction activities.

4.7 Mitigation measures

45 As part of the AyM design process, a number of mitigation measures have been adopted to reduce the potential for adverse effects on offshore ornithology receptors. Table 9 sets out the relevant mitigation measures that were identified and adopted as part of the evolution of the project design (embedded into the project design).

46 The mitigation includes embedded measures such as design changes and applied mitigation which is subject to further study or approval of details; these include avoidance measures that will be informed by pre-construction surveys, and necessary additional consents where relevant. The composite of embedded and applied mitigation measures apply to all parts of the AyM development works, including pre-construction, construction, O&M and decommissioning.

Table 9: Relevant mitigation measures for offshore ornithology.

PARAMETER	MITIGATION MEASURES
Project design	Since PEIR, the Applicant has committed to a reduction in the maximum number of WTGs from 91 to 50, significantly reducing predicted collision impacts. A Reduction in the array area has also been implemented since PEIR, from a maximum area of 88 km^2 to 78 km^2 reducing displacement impacts.
MMMP	A piling Marine Mammal Mitigation Protocol will be implemented as a condition in the Marine Licence (see Volume 4, Annex 7.2: Draft Outline MMMP). The MMMP will be secured as a condition within the Marine Licence. Whilst not specifically designed with seabirds in mind, this provides for, among other methods, a soft-start for any piling that allows for pursuit diving species (such as guillemot and razorbill) to move away from the piling activities ahead of more intensive noise levels being reached.

47 The Applicant would also welcome further discussion with SNCBs on the implementation of a vessel traffic management plan for AyM. This could include the following procedures to reduce disturbance of common scoter and red-throated divers:

- Restricting vessel movements to existing navigation routes (where the densities of divers are typically relatively low);
- Where it is necessary to go outside of established navigational routes, selecting routes that avoid known aggregations of birds;
- Maintaining direct transit routes (to minimise transit distances through areas used by divers);
- Avoidance of over-revving of engines (to minimise noise disturbance); and
- Briefing of vessel crew on the purpose and implications of these vessel management practices (through, for example, tool-box talks).

4.8 Methodology for assessment

48 The project-wide generic approach to impact assessments at the ES stage is set out in Volume 1, Chapter 3: Environmental Impact Assessment Methodology. The assessment methodology for offshore ornithology for the ES is consistent with that provided in the Scoping Report (Innogy, 2020).

49 The assessment approach uses a 'source-pathway-receptor' model, which identifies likely impacts on offshore ornithology receptors resulting from the proposed construction, operation and decommissioning of the offshore infrastructure. The parameters of this model are defined as follows:

- Source – the origin of a potential impact (noting that one source may have several pathways and receptors) e.g. an activity such as cable installation and a resultant effect such as re-suspension of sediments.
- Pathway – the means by which the effect of the activity could impact the receptor e.g. for the example above, re-suspended sediment could settle and smother immobile benthic species, causing a reduction in prey availability.
- Receptor – the element of the receiving environment that is impacted e.g. for the above example, seabirds which are unable to forage effectively due to a reduction in benthic prey availability.

4.8.1 Evaluating potential receptors

50 The assessment process involves identifying Valued Ornithological Receptors (VORs). These receptors and their conservation value are determined by the criteria defined in Table 10. These criteria are intended as a guide and are not definitive.

Table 10: Conservation value of receptors.

VALUE	DESCRIPTION
High	A species listed as a qualifying feature of an internationally designated site (e.g. SPA or Ramsar). Species populations present with sufficient conservation importance to meet criteria for SPA selection.

VALUE	DESCRIPTION
Medium	A species listed as a notified feature of a nationally designated site (e.g. SSSI). Species populations present with sufficient conservation importance to meet criteria for SSSI selection.
Low	A species occurring within SPAs, Ramsar sites and SSSIs, but not crucial to the integrity of the site. Species populations present falling short of SSSI selection criteria but with sufficient conservation importance to likely meet criteria for selection as a local site. Other species of conservation concern, including species listed as being of Principal Importance under The Environment (Wales) Act (2016), and those included on the fifth review of UK Birds of Conservation Concern (BoCC5) Red and Amber Lists (Stanbury et al., 2021).
Negligible	All other species that are widespread and common and which are not present in locally important (or greater) numbers and which are of low conservation concern (e.g. UK BoCC5 Green List species; Stanbury et al., 2021).

51 The assessment of potential receptors identified in Table 14 considers the importance of the AyM array area for the species under consideration. To illustrate the rationale of this approach, whilst common tern may be a species of high conservation importance using the criteria in Table 10, by virtue of being a designated feature of the Liverpool Bay SPA, the importance of AyM array area to this species is considered limited if only a single sighting of one bird over-flying the study area has been identified in the baseline.

52 As such, while the conservation value of the species is considered, the number of individuals of that species using AyM array area, and the nature and level of this use, is also considered as detailed in Table 14. An assessment is then made of the importance of AyM array area to the species in question.

4.8.2 Characterising potential impacts

53 The sensitivity of the receptors to potential impacts is determined subjectively based on species' ecology and behaviour, using the criteria set out in Table 11. The judgement takes account of information available on the responses of birds to various stimuli (e.g. predators, noise and visual disturbance) and whether a species' ecology makes it vulnerable to potential impacts (e.g. bird species that typically fly at heights that overlap with the rotor-swept area are considered to be more sensitive to collision risk with the moving blades of WTGs than species that fly much higher or lower that avoid the rotor-swept area). A detailed description is provided in Table 11 of how sensitivity might be assessed for the impact of disturbance by human activities, but the general approach can be applied to any impact.

54 Sensitivity can differ between similar species and between different populations of the same species. Thus, the behavioural responses of offshore ornithology receptors are likely to vary with both the nature and context of the stimulus and the experience of the individual bird. Sensitivity also depends on the activity of the bird.

55 In addition, individual birds of the same species will differ in their tolerance depending on the level of human disturbance that they regularly experience in a particular area, and have become habituated to (e.g. individuals that forage within close proximity to an area with high human activity levels are likely to have a greater tolerance than those that occupy remote locations with little or no human presence).

56 Consideration of the level of sensitivity with regards to individual ornithology receptors is one of the core components of the assessment of potential impacts and their effects.

57 In addition, each receptor's conservation value is also considered using reasoned judgement when determining their overall sensitivity to any potential impact or effect. For example, herring gull may be listed as a qualifying feature of an SPA but cannot be judged to be sensitive to disturbance given its propensity to forage and breed within urban environments. Such reasoned judgement is an important part of the overall narrative used to determine potential impact significance and is used, where relevant, as a mechanism for modifying the sensitivity of an effect assigned to a specific receptor.

58 Using expert judgement (CIEEM, 2019), both the conservation value (Table 10) and sensitivity (Table 11) of a receptor are used to determine their overall sensitivity in the assessment.

Table 11: Sensitivity of receptors.

SENSITIVITY	DESCRIPTION
High	Species that are highly likely to be affected by and, suffer highly adverse effects (including mortality) from, a given impact.
Medium	Species that are likely to be affected by and suffer adverse effects from an impact.
Low	Species which are likely to be affected to some extent by an impact, but the effect is likely to be small or not lead to serious adverse outcomes to the individuals affected.
Negligible	Species which are unlikely to be affected by an impact, or where any effect is likely to be small and not lead to adverse outcomes to the individuals affected.

59 Impacts on receptors are judged in terms of their magnitude. Magnitude refers to the scale of an impact and is determined on a quantitative basis where possible. This may relate to the area of habitat lost to the development footprint in the case of a habitat feature or predicted loss of individuals in the case of a population of a species of bird. Magnitude is assessed within four levels, as detailed in Table 12.

60 Knowledge of how rapidly the population or performance of a species is likely to recover following loss or disturbance (e.g. by individuals being recruited from other populations elsewhere) is also used to assess impact magnitude, where such information is available.

Table 12: Criteria used to determine the magnitude of impacts.

IMPACT MAGNITUDE	DESCRIPTION
High	A change in the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site that is predicted to irreversibly alter the population in the short to long-term and to alter the long-term viability of the population and/ or the integrity of the protected site. Recovery from that change predicted to be achieved in the long-term (i.e. more than five years) following cessation of the development activity.
Medium	A change in the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site that occurs in the short and long-term, but which is not predicted to alter the long-term viability of the population and/ or the integrity of the protected site. Recovery from that change predicted to be achieved in the medium-term (i.e. no more than five years) following cessation of the development activity.
Low	A change in the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site that is sufficiently small-scale or of short duration to cause no long-term harm to the feature/ population. Recovery from

IMPACT MAGNITUDE	DESCRIPTION
	that change predicted to be achieved in the short-term (i.e. no more than one year) following cessation of the development activity.
Negligible	Very slight change from the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site. Recovery from that change predicted to be rapid (i.e. no more than circa six months) following cessation of the development activity.

4.8.3 Determining significance

61 The CIEEM guidelines (2019) use only two categories to classify effects: "significant" or "not significant". The significance of an effect is determined by considering the overall importance (defined here as the overall sensitivity) of the receptor and the magnitude of the effect using a matrix-based approach (Table 13) and applying professional judgement as to whether the integrity of the feature will be affected.

62 The term integrity is used here in accordance with the definition adopted by the Office of the Deputy Prime Minister ('ODPM') Circular 06/2005 on Biodiversity and Geological Conservation whereby designated site integrity refers to "*…coherence of ecological structure and function…that enables it to sustain the habitat, complex of habitats and/or levels of populations of species for which it was classified*". Integrity, therefore, refers to the maintenance of the conservation status of a population of a species at a specific location or geographical scale.

63 Effects are more likely to be considered significant where they affect ornithological features of higher overall sensitivity) or where the magnitude of the effect is high. Effects not considered to be significant would be those where the integrity of the feature is not threatened, effects on features of lower overall sensitivity, or where the magnitude of the impact is low.

Table 13: Matrix to determine effect significance.

		SENSITIVITY			
		HIGH	MEDIUM	LOW	NEGLIGIBLE
ADVERSE MAGNITUDE	HIGH	Major	Major	Moderate	Minor
	MEDIUM	Major	Moderate	Minor	Negligible
	LOW	Moderate	Minor	Minor	Negligible
	NEGLIGIBLE	Minor	Minor	Negligible	Negligible
BENEFICIAL MAGNITUDE	NEGLIGIBLE	Minor	Minor	Negligible	Negligible
	LOW	Moderate	Minor	Minor	Negligible
	MEDIUM	Major	Moderate	Minor	Negligible
	HIGH	Major	Major	Moderate	Minor

Effects that are concluded to be of 'Major' or 'Moderate' significance are considered to be significant with regard to the EIA Regulations.

4.9 Evaluation of potential receptors and impacts

64 As agreed with the ETG (Volume 4, Annex 4.5 (application ref: 6.4.4.5)), and following the methodology set out in Section 4.8, an evaluation was undertaken to provide a succinct and clear rationale as to the selection of VORs, and those potential key impacts which have been scoped in and out for assessment (Table 14).

65 The evaluation accounts for conservation status (Table 7; Table 10), sensitivity to impact (Table 11) and known abundance (Volume 4; Annex 4.1 (application ref: 6.4.4.1)) within the AyM study area.

66 The assessment of impacts in this ES follows CIEEM guidelines (CIEEM, 2019) with regards to the emphasis being on "significant effects rather than all ecological effects". Therefore, potential receptors which are determined to be of low or negligible value are not considered further in this assessment. Significant effects on these species are not predicted given their infrequent occurrence in the survey area and/or low conservation status (see Table 14 for further rationale).

Table 14: Summary of Valued Ornithological Receptors and Potential Impacts.

POTENTIAL RECEPTOR	VALUE	RATIONALE (TABLE 10)	PEAK ABUNDANCE WITHIN ARRAY AREA/ ARRAY AREA PLUS 4 KM BUFFER (INDIVIDUALS)	NUMBER OF MONTHS RECORDED IN ARRAY AREA/ ARRAY AREA PLUS 4 KM BUFFER	CRM	DISTURBANCE AND DISPLACEMENT
Common scoter	High	Species afforded special protection (Schedule 1 and Annex I species) and a qualifying feature of an internationally designated site (e.g. SPA or Ramsar) with connectivity to AyM.	0/ 61	0/ 3	× a	✓
Red-throated diver			10/ 33	4/ 8	× a	✓
Kittiwake	Medium	Species that are not a qualifying feature of any designated site within the study area, but that are afforded special protection (Schedule 1 and Annex I species).	21/ 23	357/ 922	✓	× b
Gannet			312/ 1,325	13/ 16	✓	✓
Common gull			41/ 97	4/ 10	✓ e	× b
Herring gull			73/ 445	9/ 12	✓	× b
Lesser black-backed gull			8/ 17	1/ 3	× f	× b
Great black-backed gull			24/ 43	9/ 15	✓	× b
Fulmar			56/ 111	6/ 10	× c	× b
Manx shearwater			292/ 691	6/ 7	× c	✓ d
Guillemot			1,243/ 5,599	12*/ 13*	× c	✓
Razorbill			340/ 915	7*/ 8*	× c	✓
Puffin	Medium		9/ 26	1/ 4	× a	× f

POTENTIAL RECEPTOR	VALUE	RATIONALE (TABLE 10)	PEAK ABUNDANCE WITHIN ARRAY AREA/ ARRAY AREA PLUS 4 KM BUFFER (INDIVIDUALS)	NUMBER OF MONTHS RECORDED IN ARRAY AREA/ ARRAY AREA PLUS 4 KM BUFFER	CRM	DISTURBANCE AND DISPLACEMENT
'Commic' tern		Species that are afforded special protection (Schedule 1 and Annex I species) but are not a qualifying feature of any designated site within the study area and were only recorded infrequently.	8/ 34	2/ 4	✓ e	× f
Sandwich tern			0/ 17	0/ 3	✓ e	× f
Red-breasted merganser	Low	Species that are considered to be of medium/high conservation concern (species on the BoCC Red/Amber List) that are not a qualifying feature of any designated site within the study area and were only recorded infrequently.	0/ 0	0/ 0	× a	× g
Black guillemot			0/ 9	0/ 1	× a	× f
Great crested grebe	Negligible	Species of low conservation concern (i.e. species on the UK BoCC Green Lists that are not afforded any special protection) and that are not a qualifying feature of	16/ 17	3/ 4	× a	× f
Cormorant			8/ 18	1/ 2	× a	× f

POTENTIAL RECEPTOR	VALUE	RATIONALE (TABLE 10)	PEAK ABUNDANCE WITHIN ARRAY AREA/ ARRAY AREA PLUS 4 KM BUFFER (INDIVIDUALS)	NUMBER OF MONTHS RECORDED IN ARRAY AREA/ ARRAY AREA PLUS 4 KM BUFFER	CRM	DISTURBANCE AND DISPLACEMENT
		any designated site within the study area.				

Notes: * Months where guillemot and razorbill were identified to species level only; **a.** Not recorded flying within the AyM array area (Volume 4, Annex 4.1: application ref: 6.4.4.1); **b.** Classified as having low to very low vulnerability to disturbance and displacement (Bradbury et al., 2014; SNCB 2017); **c**. Species flight behavior indicates as very low risk of collision (Bradbury et al., 2014); **d**. Classified as having a very low vulnerability to disturbance and displacement (Bradbury et al., 2014; SNCB 2017). However, post consent monitoring at North Hoyle OWF has indicated potential avoidance (Dierschke et al., 2016). Therefore included as requested by SNCBs through Section 42 responses; **e**. Recorded during the migratory bio-seasons only, therefore species assessed for migratory collision risk only; **f.** Recorded in negligible numbers, therefore the level of potential impact would be indistinguishable from natural fluctuations in MDMPS baseline mortality. **g**. Not recorded within the AyM array area or 4 km buffer (Volume 4, Annex 4.1: application ref: 6.4.4.1).

4.10 Biological seasons, populations and demographics

67 Bird behaviour and abundance is recognised to differ across a calendar year dependent upon the biological seasons (bio-seasons) that may be applicable to different seabird species. Separate bio-seasons are recognised in this ES chapter in order to establish the level of importance any seabird species has within the offshore ornithology study area during any particular period of time. The biologically defined minimum population scales (BDMPS) bio-seasons are based on those in Furness (2015), hereafter referred to as BDMPS bio-seasons or bio-seasons (Table 15). The bio-seasons are defined within this ES chapter as: return migration, migration-free breeding, post-breeding migration, migration-free winter bio-seasons, breeding and non-breeding bio-seasons. These six bio-seasons can be applied to different periods within the annual cycle for most seabird species, though not all are applicable for all seabird species, with different combinations used depending on the biology and the life history of a species:

- Return migration: when birds are migrating to breeding grounds;
- Migration-free breeding: when birds are attending colonies, nesting and provisioning young;
- Post-breeding migration: when birds are either migrating to wintering areas or dispersing from colonies;
- Migration-free winter: when non-breeding birds are over-wintering in an area;
- Breeding and Non-breeding: For some species, there is significant overlap between migratory, breeding and wintering periods between colonies and individuals, and so the above bio-seasons cannot be appropriately applied. Therefore, two bio-seasons are defined:
  - Breeding from modal arrival to the colony at the beginning of breeding to modal departure from the colony; and
  - Non-breeding from modal departure from the colony at the end of breeding to modal return to the colony the following year.

68 Furness (2015) also provides population estimates for each species in each non-breeding bio-season in each BDMPS region. Total population sizes for the biogeographic population with connectivity to UK waters are also provided in Furness (2015).

69 For Great black-backed gull, Furness (2015) splits the UK Western waters into two separate BDMPS populations:

- The UK South-west and Channel BDMPS (total population size of 17,742 individuals); and
- The UK West of Scotland BDMPS (total population size of 34,380 individuals).

70 These two regions are presented in Figure 14.8 of Furness (2015), with the dividing line for the two regions being between the west Cumbrian coastline out to the Isle of Man. AyM lies within the northern most reaches of the UK South-west & Channel BDMPS, close to the dividing line between the two regions. When considering the SPA and non-SPA colonies which make up the two regional populations (Appendix A of Furness, 2015) AyM is likely to have equal connectivity to both regional populations. This is due to the majority of breeding great black-backed gulls within the two contributing BDMPSs being off the west coast of Scotland or the south west of England. For this reason, the Applicant has provided assessments of great black-backed gull against both BDMPS populations and also both BDMPS combined into a single wider BDMPS which for the purpose of this assessment is termed 'Combined Western Waters BDMPS' with a population of 52,122 individuals.

71 Breeding population sizes are based on colony counts from the national SMP database (JNCC, 2021) for all colonies within mean-max foraging range (Woodward et al., 2019). One apparently occupied nest (AON) was assumed to equal two breeding birds. Where possible, the average count from 2019 and 2020 was used (i.e. corresponding to the same years as the available aerial digital survey data), or the most recent count otherwise.

72 During the breeding season, in addition to birds associated with breeding colonies, there will be immature birds, juvenile birds and "sabbatical" birds (mature birds not breeding in a given year) present within the region. It was assumed that, of the BDMPS population in the bio-season immediately before the breeding season (usually the return migration bio-season), all mature birds return to breeding colonies, but all immature birds remain within the BDMPS.

73 The total regional population within the breeding season is therefore the sum of breeding adults associated with nearby colonies plus the proportion of immature birds from the BDMPS population, this is shown in Table 16. The bio-seasons, BDMPS population sizes and biogeographic population for each of the key species are provided in Table 17.

74 The method to assess the potential impact from additional mortality to the population due to AyM is assessed in terms of any change in relation to the baseline mortality rate for any given species within each of the recognised bio-seasons. The average mortality across all age classes for each species is presented in Table 18. The method presented assumes all age classes are at risk to the possible impacts of the proposed development equally and as such the baseline mortality rate is a weighted average based on all age classes. Demographic rates for each species were those provided in Horswill and Robinson (2015). These data were used to calculate the expected stable proportions in each age class for each species. Each age class survival rate was then multiplied by its stable age proportion and the total for all ages summed to give the weighted average survival rate converted to an average mortality rate.

Table 15: Bio-seasons used as the basis for assessment. Based on Furness (2015) unless specified otherwise.

SPECIES	RETURN MIGRATION	MIGRATION-FREE BREEDING	POST-BREEDING MIGRATION	MIGRATION-FREE WINTER	BREEDING	NON-BREEDING
Common scoter*	N/A	N/A	N/A	N/A	May to August	September to April
Kittiwake	January to April	May to July	August to December	N/A	N/A	N/A
Common gull**	January to April	May to July	August to December	N/A	N/A	N/A
Great black-backed gull	N/A	N/A	N/A	N/A	April to August	September to March
Herring gull	N/A	N/A	N/A	N/A	March to August	September to February
'Commic' tern***	April to May	June	July to September	N/A	N/A	N/A
Guillemot	N/A	N/A	N/A	N/A	March to July	August to February
Razorbill	January to March	April to July	August to October	November to December	N/A	N/A
Red-throated diver	February to April	May to August	September to November	December to January	N/A	N/A
Manx shearwater	March to May	June to July	August to October	N/A	N/A	N/A
Gannet	December to March	April to August	September to November	N/A	N/A	N/A

Table Notes: *Cramp & Simmons (1977). **Common gull is not included in Furness (2015) - based on kittiwake as closely related and have a similar life history. ***Furness (2015) includes separate entries for common and Arctic terns; however, the bio-seasons used here are appropriate for either; †Royal HaskoningDHV (2019); ‡Robinson (2005)

Table 16: Calculation of regional population during the breeding season.

SPECIES	BREEDING POPULATION AT COLONIES WITHIN MEAN-MAX FORAGING RANGE (JNCC, 2021)	BDMPS RETURN MIGRATION POPULATION SIZE (FURNESS, 2015)	PROPORTION OF JUVENILE, IMMATURE AND NON-BREEDING INDIVIDUALS (FURNESS, 2015)	JUVENILE, IMMATURE AND NON-BREEDING INDIVIDUALS	POTENTIAL TOTAL REGIONAL BASELINE POPULATION DURING NON-MIGRATORY BREEDING BIO-SEASON
Kittiwake	12,260	691,526	0.468	323,693	335,953
Common gull	0	13,036*	0.316***	4,119	4,119
Great black-backed gull	128	17,742**	0.558	9,892	10,020

SPECIES	BREEDING POPULATION AT COLONIES WITHIN MEAN-MAX FORAGING RANGE (JNCC, 2021)	BDMPS RETURN MIGRATION POPULATION SIZE (FURNESS, 2015)	PROPORTION OF JUVENILE, IMMATURE AND NON-BREEDING INDIVIDUALS (FURNESS, 2015)	JUVENILE, IMMATURE AND NON-BREEDING INDIVIDUALS	POTENTIAL TOTAL REGIONAL BASELINE POPULATION DURING NON-MIGRATORY BREEDING BIO-SEASON
(South-west & Channel BDMPS)					
Great black-backed gull (UK West of Scotland BDMPS)	128	34,380**	0.558	19,168	19,296
Great black-backed gull (Combined Western Waters BDMPS)	128	52,122**	0.558	29,059	29,187
Herring gull	764	173,299**	0.522	90,381	91,145
Lesser black-backed gull	905	163,304	0.405	66,099	67,004
Common tern	0	64,659	0.401	25,941	25,941
Arctic tern	0	71,398	0.367	26,209	26,209
Guillemot	7,393	1,139,220**	0.425	484,496	491,889
Razorbill	1,184	606,914	0.429	260,106	261,290
Red-throated diver	N/A	4,373	0.425	1,860	1,860
Fulmar	25,844	828,194	0.383	316,963	342,807
Manx shearwater	246,664	1,580,895	0.457	721,713	968,377
Gannet	178,534	661,888	0.448	296,204	474,738

SPECIES	BREEDING POPULATION AT COLONIES WITHIN MEAN-MAX FORAGING RANGE (JNCC, 2021)	BDMPS RETURN MIGRATION POPULATION SIZE (FURNESS, 2015)	PROPORTION OF JUVENILE, IMMATURE AND NON-BREEDING INDIVIDUALS (FURNESS, 2015)	JUVENILE, IMMATURE AND NON-BREEDING INDIVIDUALS	POTENTIAL TOTAL REGIONAL BASELINE POPULATION DURING NON-MIGRATORY BREEDING BIO-SEASON
Cormorant	294	9,602**	0.539	5,177	5,471

Table notes: * Not in Furness (2015); used Stone et al. (1995). ** Non-breeding bio-season population used.*** Not in Furness (2015); proportion of juveniles based on population structure given in **Table 18**.

Table 17: Bio-seasons, BDMPS population sizes and biogeographic population sizes. From Furness (2015) unless stated otherwise.

SPECIES	RETURN MIGRATION	MIGRATION-FREE BREEDING	POST-BREEDING MIGRATION	MIGRATION-FREE WINTER	BREEDING	NON-BREEDING	BIOGEOGRAPHIC POPULATION
Common scoter	-	-	-	-	May to August (N/A)	September to April (85,552)*1	550,000*2
Kittiwake (UK Western waters plus Channel)	January to April (691,526)	May to July (335,957)	August to December (911,586)	-	-	-	5,100,000
Common gull*3	January to April (13,036)	May to July (4,172)	August to December (13,036)	-	-	-	1,600,000
Great black-backed gull (UK South-west & Channel)	-	-	-	-	April to August (10,020)	September to March (17,742)	235,000
Great black-backed gull (UK West of Scotland BDMPS)	-	-	-	-	April to August ()	September to March (34,380)	
Great black-backed gull (Combined Western Waters BDMPS)	-	-	-	-	April to August ()	September to March (52,122)	
Herring gull (UK Western waters)	-	-	-	-	March to August (91,145)	September to February	1,098,000

SPECIES	RETURN MIGRATION	MIGRATION-FREE BREEDING	POST-BREEDING MIGRATION	MIGRATION-FREE WINTER	BREEDING	NON-BREEDING	BIOGEOGRAPHIC POPULATION
						(173,299)	
Lesser black-backed gull (UK Western waters)	March to April (163,304)	May to July (67,004)	August to October (163,304)	November to February (41,159)	-	-	864,000
'Commic' tern*4 (UK North Sea and Channel)	April to May (136,057)	June (52,150)	July to September (136,057)	-	-	-	1,108,000
Guillemot (UK Western waters)	-	-	-	-	March to July (491,889)	August to February (1,139,220)	4,125,000
Razorbill (UK Western waters)	January to March (606,914)	April to June (261,290)	August to October (606,914)	November to December (341,422)	-	-	1,707,000
Red-throated diver (UK Western waters plus Channel in migratory bio-seasons; NW England & Wales in winter bio-season)	February to April (4,373)	May to August (1,860)	September to November (4,373)	December to January (1,657)	-	-	27,000
Fulmar (UK Western waters plus Channel)	December to March (828,194)	April to August (N/A)	September to October (828,194)	November (556,367)	-	-	8,055,000
Manx shearwater (UK Western water plus Channel)	March to May (1,580,895)	June to July (968,377)	August to October (1,580,895)	-	-	-	2,000,000
Gannet (UK Western Waters)	December to March (661,888)	April to August (474,738)	September to November (454,954)	-	-	-	1,180,000

SPECIES	RETURN MIGRATION	MIGRATION-FREE BREEDING	POST-BREEDING MIGRATION	MIGRATION-FREE WINTER	BREEDING	NON-BREEDING	BIOGEOGRAPHIC POPULATION
Cormorant (SW England & Wales)	-	-	-	-	April to August (5,471)	September to March (9,602)	324,000

Table notes: *[1] Common scoter wintering population based on designated populations of Liverpool Bay SPA (Natural England, 2017), Carmarthen Bay SPA (NRW, 2008), Ribble and Alt Estuaries SPA (JNCC, 2015), Solway Firth SPA (NatureScot, 2020) and Cardigan Bay SAC (JNCC, 2015). *[2] Common scoter biogeographic population from Burfield & Van Bommel (2004). *[3] Common gull is not included in Furness (2015). BDMPS population estimates based on Stone et al. (1995). Biogeographic population from Stienen et al. (2007). *[4] 'Commic' tern population sizes are based on sum of common tern and Arctic tern population sizes presented in Furness (2015). The same bio-seasons are appropriate for either species.

Table 18: Demographic rates and population age ratios used to estimate average mortality for each key species assessed in this report, based on demographic values presented within Horswill and Robinson (2015).

SPECIES	PARAMETER	SURVIVAL (AGE CLASS)							PRODUCTIVITY (CHICKS PER PAIR)	AVERAGE MORTALITY
		0-1	1-2	2-3	3-4	4-5	5-6	ADULT		
Common scoter	Demographic Rate	0.749	0.749					0.783	1.838	0.238
	Population Age Ratio	0.352	0.264					0.384		
Kittiwake	Demographic Rate	0.790	0.854	0.854	0.854			0.854	0.690	0.157
	Population Age Ratio	0.168	0.133	0.114	0.097			0.488		
Common gull	Demographic Rate	0.410	0.710	0.828				0.828	0.543	0.259
	Population Age Ratio	0.186	0.076	0.054				0.684		
Great black-backed gull	Demographic Rate	0.798	0.930	0.930	0.930	0.930		0.930	1.139	0.093
	Population Age Ratio	0.178	0.142	0.132	0.123	0.114		0.312		
Herring gull	Demographic Rate	0.798	0.834	0.834	0.834	0.834		0.834	0.920	0.172
	Population Age Ratio	0.177	0.141	0.118	0.098	0.082		0.384		
	Demographic Rate	0.820	0.885	0.885	0.885	0.885		0.885	0.530	0.124

SPECIES	PARAMETER	SURVIVAL (AGE CLASS)							PRODUCTIVITY (CHICKS PER PAIR)	AVERAGE MORTALITY
		0-1	1-2	2-3	3-4	4-5	5-6	ADULT		
Lesser black-backed gull	Population Age Ratio	0.133	0.109	0.096	0.085	0.075		0.501		
Common tern	Demographic Rate	0.441	0.441	0.850				0.883	0.764	0.268
	Population Age Ratio	0.235	0.104	0.046				0.615		
Arctic tern	Demographic Rate	0.441	0.837	0.837	0.837			0.837	0.380	0.217
	Population Age Ratio	0.135	0.060	0.050	0.042			0.713		
Guillemot	Demographic Rate	0.560	0.792	0.917	0.939	0.939		0.939	0.672	0.143
	Population Age Ratio	0.173	0.097	0.077	0.071	0.066		0.516		
Razorbill	Demographic Rate	0.630	0.630	0.895	0.895			0.895	0.570	0.178
	Population Age Ratio	0.170	0.107	0.067	0.060			0.596		
Red-throated diver	Demographic Rate	0.600	0.620					0.840	0.571	0.233
	Population Age Ratio	0.196	0.118					0.686		
Fulmar	Demographic Rate	0.260						0.936	0.419	0.181
	Population Age Ratio	0.173						0.827		
Manx shearwater	Demographic Rate	0.870	0.870	0.870	0.870	0.870		0.870	0.697	0.130
	Population Age Ratio	0.149	0.129	0.113	0.098	0.085		0.427		

SPECIES	PARAMETER	SURVIVAL (AGE CLASS)							PRODUCTIVITY (CHICKS PER PAIR)	AVERAGE MORTALITY
		0-1	1-2	2-3	3-4	4-5	5-6	ADULT		
Gannet	Demographic Rate	0.424	0.829	0.891	0.895	0.895		0.919	0.700	0.188
	Population Age Ratio	0.191	0.081	0.067	0.060	0.054		0.547		
Cormorant	Demographic Rate	0.540	0.540					0.868	1.985	0.330
	Population Age Ratio	0.393	0.212					0.395		

4.11 Environmental assessment: construction phase

4.11.1 Disturbance and displacement: array

Overview

75 Disturbance and subsequent potential displacement of seabirds during the construction phase is primarily centred around where construction vessels and piling activities are planned to occur. The activities may displace individuals that would normally reside within and around the area of sea where AyM is proposed to be developed. This potentially reduces the area available to those seabirds to forage, loaf and/ or moult.

76 This displacement may contribute to individual birds experiencing fitness consequences, which at an extreme level could theoretically lead to the mortality of individuals (Searle et al., 2018), though this is unlikely during the construction phase of an OWF as such activities are spatially and temporally restricted.

77 Evidence suggests that some species are more susceptible than others to disturbance from OWF construction activities, which may lead to subsequent displacement. Dierschke et al., (2016) noted both avoidance and attraction to varying degrees depending upon the species in question. A screening process was undertaken for AyM to identify those species which are considered to be vulnerable to disturbance and displacement from OWF construction activities (Table 14).

78 Whilst gannet and Manx shearwater are considered to be of relatively low vulnerability to disturbance and displacement, they have been included in the assessment of potential displacement during the construction phase of AyM, as requested by SNCBs (Volume 4, Annex 4.5 (application ref: 6.4.4.5)). This is to provide SNCBs with confidence that any potential effects from construction activities have been considered in a quantitative manner.

79 Common scoter, guillemot, razorbill and red-throated diver have all been shown to exhibit behavioural responses to OWF construction activities and may be displaced as a consequence. Therefore, these species are considered further in relation to impacts from disturbance and displacement during construction.

80 Species which are known to be sensitive to disturbance and displacement but have been recorded in 'trivial' numbers during baseline data collection, are not considered further in the assessment. This is because the numbers of birds at risk from displacement are so small that there is no possibility of a significant effect occurring following the method to determine significance laid out in Section 4.8.

81 Following the evaluation of VORs and key potential impacts (Table 14) an assessment of displacement has been carried out for AyM. The methods and results are based on the following set of scenarios that recognise construction activities being temporally and spatially restricted (see Section 4.6):

- Construction activities being undertaken are within only a small portion of the array at any one time;
- Potential displacement is likely to only occur within the array, where vessels and construction activities are present; and
- Construction activities are temporally restricted (over approximately 25 months (see Section 4.6)).

82 Given that potential disturbance activities during the construction phase are likely to be both temporally and spatially restricted compared to the operation phase, the potential impact from and consequent displacement is also highly likely to be lower during the construction phase.

83 Few studies have provided definitive empirical displacement rates for the construction phase of OWF developments. Krijgsveld et al., (2011) demonstrated higher flight paths of gannets next to operating vs non-operating WTGs. Displacement rates for auks during construction have been shown to be either significantly lower or comparable to the operation phase (Royal Haskoning (2013); Vallejo et al., (2017). These studies suggest that although the level of disturbance from construction activities can be high it is focussed around a spatially restricted area within the development. Therefore, displacement rates for the entire site reflect reduced displacement within the site away from construction areas including areas where built non-operational WTGs are present.

84 As actual rates of displacement during the construction phase are difficult to determine from the available studies, the following methodology has been applied to determine potential impact levels. Given that construction is limited both spatially and temporarily and that any potential effects are unlikely to reach the same level as during the operation, the level to be used is a 50% reduction in the displacement rate used for operational phase assessments, as agreed with the ETG (Volume 4, Annex 4.5: Offshore Ornithology Scoping & Consultation Responses (application ref: 6.4.4.5)).

85 The evidence for displacement rates and appropriate buffer zones is discussed in detail in the operational phase assessment, as most evidence has been sourced from operational projects (see Section 4.12.1). The level of displacement assessed for each species during the construction phase is provided below:

- For gannet, the operational phase displacement assessment considered for the array area and surrounding 2 km buffer is a displacement rate of 60-80%. This therefore equates to a construction phase displacement rate of 30-40%;
- For guillemot and razorbill, operational phase displacement assessment considered for the array area and surrounding 2 km buffer is a displacement rate of 30-70%, with the Applicant's position being a displacement rate of 50%. This therefore equates to a construction phase displacement rate of 15-35%, with the Applicant's position being a displacement rate of 25%;

- For common scoter, the operational phase displacement assessment considered for the array area and surrounding 4 km buffer is a displacement rate of 100%. This therefore equates to a construction phase displacement rate of 50%;
- For red-throated diver, operational phase displacement assessment has been considered for the array area and surrounding 4-8 km buffer (4 km buffer consider to the north and 8km buffer considered to the south of the array area) based on a gradient approach with a displacement rate of 100-50%. This therefore equates to a construction phase displacement rate of between 50-25%; and
- For Manx shearwater, the operational phase displacement assessment considered for the array area and surrounding 2 km buffer is a displacement rate of 30-70%. This therefore equates to a construction phase displacement rate of 15-35%.
- To ensure that assessments are sufficiently precautionary for all species, the mortality rates considered for the construction phase remain the same as those used for operational phase impacts (please refer to Section 4.12.1 for justification of mortality rates applied throughout this section). It should be noted however that due to construction phase displacement impacts being both temporally and spatially restricted, it's highly likely that any associated consequential mortality rate will be less than that from operational impacts.

Common scoter

Potential magnitude of impact

86 The annual estimated mortality (when considering a displacement rate of 50% and a mortality rate of 1%) for common scoter resulting from disturbance and displacement during construction is less than one (0.2) individual. This is further broken down into relevant bio-seasons in Table 19.

87 As detailed in Volume 4, Annex 4.5: Offshore Ornithology Scoping & Consultation Responses (application ref: 6.4.4.5), for common scoter SNCBs consider that displacement assessment should present a mortality rate of up to 10%. Presentation of displacement impacts with a mortality rate of up to 10% for the construction phase is provided in Table 19 and a displacement matrix is provided in Table 26. The main focus of impact assessment is based on the Applicant's approach of a 1% mortality rate for construction phase displacement, considering the temporal and spatial restriction of construction impacts.

Table 19: Common scoter bio-season displacement estimates for AyM (construction).

BIO-SEASON (MONTHS)	SEASONAL ABUNDANCE (ARRAY AREA PLUS 4 KM BUFFER)	REGIONAL BASELINE POPULATIONS AND BASELINE MORTALITY RATES (INDIVIDUALS PER ANNUM)		ESTIMATED NUMBER OF COMMON SCOTER SUBJECT TO MORTALITY (INDIVIDUALS PER ANNUM)		INCREASE IN BASELINE MORTALITY (%)	
		POPULATION	BASELINE MORTALITY	50% DISPLACEMENT RATE; 1% MORTALITY RATE	50% DISPLACEMENT RATE; 10% MORTALITY RATE	50% DISPLACEMENT RATE; 1% MORTALITY RATE	50% DISPLACEMENT RATE; 10% MORTALITY RATE
Breeding (May-Aug)	0	N/A	N/A	0	0	N/A	N/A
Non-breeding (Sep-Apr)	31	85,552	20,358	0.2	1.5	0.001	0.007
Annual (BDMPS)	31	85,552	20,358	**0.2**	1.5	**0.001**	0.007
Annual (biogeographic)	31	550,000	130,878	**0.2**	1.5	**0.000**	0.001

Table Note: Values in bold represent the Applicant’s approach to assessment based on the available evidence and expert judgement.

88 During the breeding bio-season, zero common scoters were found in the array plus 4 km buffer, so the estimated mortality from disturbance and displacement is zero. This represents **no impact** to common scoter in the breeding bio-season.

89 During the non-breeding bio-season, the mean peak abundance for common scoter is 31 individuals within the array plus 4 km buffer. Using construction phase displacement rates of 50% and a mortality rate of 1% would result in less than one (0.2) common scoter being subject to mortality. The BDMPS population in the non-breeding bio-season is defined as 85,552 individuals (Table 17) and, using the average baseline mortality rate of 0.238 (Table 18), the natural predicted mortality in the non-breeding bio-season is 20,358 individuals per annum. The addition of less than one predicted additional mortality per annum would increase baseline mortality by 0.001%.

90 This level of impact is considered to be of **negligible magnitude during the non-breeding bio-season**, as it represents no discernible change to baseline mortality.

91 For all seasons combined, the predicted maximum number of common scoter subject to mortality due to displacement from AyM is less than one (0.2) common scoter per annum. Using the largest regional population of 85,552 individuals (Table 17), the addition of less than one predicted additional mortality per annum would increase baseline mortality by 0.001%. When considering displacement effects at the wider biogeographic population scale, then based on a population of 550,000 (Table 17), the natural annual mortality rate will be 130,878 individuals per annum. The addition of less than one predicted additional mortality per annum would increase the biogeographic baseline mortality by less than 0.001%.

92 This magnitude of impact is considered to be of **negligible magnitude overall**, as it represents no discernible change to baseline mortality.

Sensitivity of the receptor

93 As common scoter is a qualifying interest for Liverpool Bay SPA, and is Red listed in BoCC5 (Stanbury et al., 2021), this receptor is afforded a feature importance level of "international" to reflect that. With respect to behavioural sensitivity to disturbance and displacement, it is considered to be high (Table 14). As it is of high behavioural sensitivity, and of international importance, this leads to an overall sensitivity of this receptor to disturbance and displacement of **high**.

Significance of effect

94 Given a negligible magnitude of impact and a sensitivity of high, following the matrix approach set out in Table 13, the potential effect of displacement and disturbance from construction activities in the array plus 4 km buffer on common scoter has been assessed as minor. However, when considering expert opinion, given the potential impact level is well below one mortality per annum the overall significance of effect is considered to be negligible, which is **not significant**.

Guillemot

Potential magnitude of impact

95 The annual estimated mortality (when considering a displacement rate of 25% and a mortality rate of 1%, as determined in Section 4.1.1) for guillemot resulting from disturbance and displacement during construction is approximately 11 individuals, which is further broken down into relevant bio-seasons in Table 20.

96 As detailed in Volume 4, Annex 4.5: Offshore Ornithology Scoping & Consultation Responses (application ref: 6.4.4.5), for guillemot SNCBs consider that displacement assessment should consider a displacement rate of half that assessed for during the operational phase (from 30-70% to 15-35%) and present a range of mortality rates from 1-10%. Presentation of displacement impacts with the SNCB's rates for the construction phase is provided in Table 20 and a displacement matrix has also been compiled in Table 28. The main focus of impact assessment is based on the Applicant's approach of a 1% mortality rate for construction phase displacement, considering the temporal and spatial restriction of construction impacts.

Table 20: Guillemot bio-season displacement estimates for AyM (construction).

BIO-SEASON (MONTHS)	SEASONAL ABUNDANCE (ARRAY AREA PLUS 2 KM BUFFER)	REGIONAL BASELINE POPULATIONS AND BASELINE MORTALITY RATES (INDIVIDUALS PER ANNUM)		ESTIMATED NUMBER OF GUILLEMOTS SUBJECT TO MORTALITY (INDIVIDUALS PER ANNUM)		INCREASE IN BASELINE MORTALITY (%)	
		POPULATION	BASELINE MORTALITY	25% DISPLACEMENT RATE; 1% MORTALITY RATE	15-35% DISPLACEMENT RATE; 1-10% MORTALITY RATE	25% DISPLACEMENT RATE; 1% MORTALITY RATE	15-35% DISPLACEMENT RATE; 1-10% MORTALITY RATE
Breeding (Mar-Jul)	1,569	491,889	70,176	3.9	2.4 – 54.9	0.006	0.003 – 0.078
Non-breeding (Aug-Feb)	2,919	1,139,220	162,528	7.3	4.3 – 102.2	0.004	0.003 – 0.063
Annual (BDMPS)	4,488	1,139,220	162,528	**11.2**	6.7 – 157.1	**0.007**	0.004 – 0.097
Annual (biogeographic)	4,488	4,125,000	589,499	**11.2**	6.7 – 157.1	**0.002**	0.001 – 0.027

Table Note: Values in bold represent the Applicant's approach to assessment based on the available evidence and expert judgement.

97 During the breeding bio-season, the mean peak abundance for guillemot is 1,569 individuals within the array plus 2 km buffer. Using construction phase displacement rates of 25% and a mortality rate of 1% would result in approximately four (3.9) guillemots being subject to mortality. The regional population in the breeding bio-season is defined as 491,889 individuals (Table 17) and, using the average baseline mortality rate of 0.143 (Table 18), the natural predicted mortality in the breeding bio-season is 70,176 individuals per annum. The addition of four predicted mortalities per annum would increase baseline mortality by 0.006%.

98 This level of impact is considered to be of **negligible magnitude during the breeding bio-season**, as it represents no discernible change to baseline mortality.

99 During the non-breeding bio-season, the mean peak abundance for guillemot is 2,919 individuals within the array plus 2 km buffer. Using displacement rates of 25% and a mortality rate of 1% would result in seven (7.3) guillemots being subject to mortality per annum. The BDMPS population in the non-breeding bio-season is defined as 1,139,220 individuals (Table 17) and, using the average baseline mortality rate of 0.143 (Table 18), the natural predicted mortality in the non-breeding bio-season is 162,528 individuals per annum. The addition of seven predicted mortalities per annum would increase baseline mortality by 0.004%.

100 This level of impact is considered to be of **negligible magnitude during the non-breeding bio-season**, as it represents no discernible change to the baseline conditions due to the very small number of individuals subject to potential mortality per annum as a result of displacement.

101 For all seasons combined, the predicted maximum number of guillemots subject to mortality due to displacement from AyM is approximately 11 (11.2) per annum individuals. Using the largest BDMPS of 1,139,220 individuals (Table 17) and, using the average baseline mortality rate of 0.143 (Table 18), the natural predicted mortality rate across all seasons is 162,528 per annum. The addition of 11 predicted mortalities per annum would increase the baseline mortality rate by 0.007%. When considering displacement effects at the wider biogeographic population scale, then based on a population of 4,125,000 (Table 17), the natural predicted mortality rate is 588,499 individuals per annum. The addition of 11 predicted mortalities would increase the biogeographic baseline mortality rate by 0.002%.

102 The magnitude of impact across all seasons per annum is considered to be of **negligible magnitude overall**, as it represents no discernible increase to baseline mortality levels as a result of displacement.

Sensitivity of the receptor

103 As this receptor is a notified feature of two SSSIs considered to have potential connectivity to AyM, and is Amber listed in BoCC5 (Stanbury et al., 2021), this receptor is afforded a feature importance level of "national" to reflect that. With respect to behavioural sensitivity to disturbance and displacement, it is considered to be medium (Table 14). As it is of medium behavioural sensitivity, and it is of national importance leading to an overall sensitivity of this receptor to disturbance and displacement of **medium**.

Significance of effect

104 Given a magnitude of impact of negligible and a sensitivity of medium, following the matrix approach set out in Table 13, the potential effect of disturbance and displacement from construction activities in the array area plus 2 km buffer on guillemots has been assessed as minor, which is **not significant**.

Razorbill

Potential magnitude of impact

105 The annual estimated mortality (when considering a displacement rate of 25% and a mortality rate of 1%, as determined in Section 4.1.1) as a consequence of displacement during the construction phase of AyM for razorbill is approximately two individuals, which is further broken down into relevant bio-seasons in Table 21.

106 As detailed in Volume 4, Annex 4.5: Offshore Ornithology Scoping & Consultation Responses (application ref: 6.4.4.5), for razorbill SNCBs consider that displacement assessment should consider a displacement rate of half that assessed for during the operational phase (from 30-70% to 15-35%) and present a range of mortality rates from 1-10%. Presentation of displacement impacts with SNCB's rates for the construction phase is provided in Table 21 and a displacement matrix has also been compiled in Table 30. The main focus of impact assessment is based on the Applicant's approach of a 1% mortality rate for the construction phase displacement, considering the temporal and spatial restrictions of construction impacts.

Table 21: Razorbill bio-season displacement estimates for AyM (construction).

BIO-SEASON (MONTHS)	SEASONAL ABUNDANCE (ARRAY AREA PLUS 2 KM BUFFER)	REGIONAL BASELINE POPULATIONS AND BASELINE MORTALITY RATES (INDIVIDUALS PER ANNUM)		ESTIMATED NUMBER OF RAZORBILLS SUBJECT TO MORTALITY (INDIVIDUALS PER ANNUM)		INCREASE IN BASELINE MORTALITY (%)	
		POPULATION	BASELINE MORTALITY	25% DISPLACEMENT RATE; 1% MORTALITY RATE	15-35% DISPLACEMENT RATE; 1-10% MORTALITY RATE	25% DISPLACEMENT RATE; 1% MORTALITY RATE	15-35% DISPLACEMENT RATE; 1-10% MORTALITY RATE
Return migration (Jan-Mar)	336	606,914	108,228	0.8	0.5 – 11.8	0.001	0.000 – 0.011
Migration-free breeding (Apr-Jul)	140	261,290	46,595	0.4	0.2 – 4.9	0.001	0.000 – 0.011
Post-breeding migration (Aug-Oct)	66	606,914	108,228	0.2	0.1 – 2.3	0.000	0.000 – 0.002
Migration-free winter (Nov-Dec)	150	341,422	60,884	0.4	0.2 – 5.3	0.001	0.000 – 0.009
Annual (BDMPS)	692	606,914	108,228	**1.7**	1.0 – 24.2	**0.002**	0.001 – 0.022
Annual (biogeographic)	692	1,707,000	304,401	**1.7**	1.0 – 24.2	**0.001**	0.000 – 0.008

Table Note: Values in bold represent the Applicant's approach to assessment based on the available evidence and expert judgement.

107 During the return migration bio-season, the mean peak abundance for razorbill is 336 individuals within the array plus 2 km buffer. Using a construction phase displacement rate of 25% and a mortality rate 1% results in less than one (0.8) razorbill being subject to displacement mortality per annum. The regional population in the return migration bio-season is defined as 606,914 individuals (Table 17) and, using the average baseline mortality rate of 0.178 (Table 18), the natural predicted mortality in the return migration bio-season is 108,228 individuals per annum. The addition of less than one predicted mortality per annum would increase baseline mortality by 0.001%.

108 This level of impact is considered to be of **negligible magnitude during the return migration bio-season**, as it represents no discernible change to baseline mortality.

109 During the migration-free breeding bio-season, the mean peak abundance for razorbill is 140 individuals within the array plus 2 km buffer. Using a construction phase displacement rate of 25% and a mortality rate 1% results in less than one (0.4) razorbill being subject to displacement mortality per annum. The regional population in the migration-free breeding bio-season is defined as 261,290 individuals (Table 17) and, using the average baseline mortality rate of 0.178 (Table 18), the natural predicted mortality in the migration-free breeding bio-season is 46,595 individuals per annum. The addition of less than one predicted mortality per annum would increase baseline mortality by 0.001%.

110 This level of impact is considered to be of **negligible magnitude during the migration-free breeding bio-season**, as it represents no discernible change to baseline mortality.

111 During the post-breeding migration bio-season, the mean peak abundance for razorbill is 66 individuals within the array plus 2 km. Using a construction phase displacement rate of 25% and a mortality rate of 1% results in less than one (0.2) razorbill being subject to displacement mortality per annum. The regional population in the post-breeding migration bio-season is defined as 606,914 individuals (Table 17) and, using the average baseline mortality rate of 0.178 (Table 18), the natural predicted mortality in the return migration bio-season is 108,228 individuals per annum. The addition of less than one predicted mortality per annum would increase baseline mortality by less than 0.001%.

112 This level of impact is considered to be of **negligible magnitude during the post-breeding migration bio-season**, as it represents no discernible change to baseline mortality.

113 During the migration-free winter bio-season, the mean peak abundance for razorbill is 150 individuals within the array plus 2 km buffer. Using a construction phase displacement rate of 25% and a mortality rate of 1% results in less than one (0.4) razorbill being subject to displacement mortality per annum. The regional population in the migration-free winter bio-season is defined as 341,422 individuals (Table 17) and, using the average baseline mortality rate of 0.178 (Table 18), the natural predicted mortality in the migration-free winter bio-season is 60,884 individuals per annum. The addition of less than one predicted mortality per annum would increase the baseline mortality by 0.001%.

114 This level of impact is considered to be of **negligible magnitude during the migration-free winter bio-season**, as it represents no discernible change to baseline mortality.

115 For all seasons combined, the predicted maximum number of razorbills subject to mortality due to displacement from AyM is approximately two (1.7) individuals per annum. Using the largest UK western waters BDMPS of 606,914 individuals (Table 17) and, using the average baseline mortality rate of 0.178 (Table 18), the natural baseline mortality across all seasons is 108,228 individuals per annum. The addition of two predicted mortalities per annum would increase the baseline mortality by 0.002%. When considering displacement effects at the wider biogeographic population scale, then based on a population of 1,707,000 individuals (Table 17), the natural annual mortality will be 304,401 individuals per annum. The addition of two predicted mortalities per annum would increase the biogeographic baseline mortality by 0.001%.

116 This magnitude of impact is considered to be of **negligible magnitude overall**, as it represents no discernible increase to baseline mortality levels as a result of displacement.

Sensitivity of the receptor

117 As this receptor is a notified feature of two SSSIs considered to have potential connectivity to AyM, and is Amber listed in BoCC5 (Stanbury et al., 2021), this receptor is afforded a feature importance level of "national" to reflect that. With respect to behavioural sensitivity to disturbance and displacement, it is considered to be medium (Table 14). As it is of medium behavioural sensitivity, and it is of national importance leading to an overall sensitivity of this receptor to disturbance and displacement of **medium**.

Significance of effect

118 Given a magnitude of impact of negligible and a sensitivity of medium, following the matrix approach set out in Table 13, the potential effect of disturbance and displacement from construction activities in the array plus 2 km buffer on razorbills has been assessed as minor. However, when considering expert opinion, given the potential impact level is under two mortalities per annum the overall significance of effect is considered to be negligible, which is **not significant**.

Red-throated diver

Potential magnitude of impact

119 The annual estimated mortality (when considering a mortality rate of 1%, as determined in Section 4.1.1) during the construction phase of AyM for red-throated diver is less than on one (0.6) individual, which is further broken down into relevant bio-seasons in Table 23.

120 As detailed in Volume 4, Annex 4.5: Offshore Ornithology Scoping & Consultation Responses (application ref: 6.4.4.5), for red-throated diver SNCBs consider that displacement assessment should present a mortality rate of up to 10%. Presentation of displacement impacts with a mortality rate of up to 10% for the construction phase is provided in Table 22 and displacement matrices are provided in Table 33 to Table 36. The main focus of impact assessment is based on the Applicant's approach of a 1% mortality rate for construction phase displacement, considering the temporal and spatial restriction of construction impacts.

Table 22: Red-throated diver bio-season displacement estimates for AyM (construction).

BIO-SEASON (MONTHS)	WIND FARM AREA	SEASONAL ABUNDANCE (ARRAY AREA PLUS 4 KM BUFFER)	REGIONAL BASELINE POPULATIONS AND BASELINE MORTALITY RATES (INDIVIDUALS PER ANNUM)		DISPLACEMENT RATE	ESTIMATED NUMBER OF RED-THROATED DIVERS SUBJECT TO MORTALITY (INDIVIDUALS)		INCREASE IN BASELINE MORTALITY (%)	
			POPULATION	BASELINE MORTALITY		1% MORTALITY RATE	10% MORTALITY RATE	1% MORTALITY RATE	10% MORTALITY RATE
Return migration (Jan-Mar)	Array Area	9	4,373	1,019	100%	0.0	0.5	0.004%	0.044%
	0-5 km Buffer	28			90%	0.1	1.2	0.012%	0.122%
	5 - 8 km buffer	50			50%	0.1	1.2	0.012%	0.122%
	Total (array area plus 8 km buffer)	86			N/A	0.3	2.9	0.029%	0.287%
Migration-free breeding (Apr-Jul)	Array Area	0	1,860	433	100%	0.0	0.0	0.000%	0.000%
	0-5 km Buffer	5			90%	0.0	0.2	0.005%	0.047%
	5 - 8 km buffer	0			50%	0.0	0.0	0.000%	0.000%
	Total (array area plus 8 km buffer)	5			N/A	0.0	0.2	0.005%	0.047%
	Array Area	4	4,373	1,018	100%	0.0	0.2	0.002%	0.020%

BIO-SEASON (MONTHS)	WIND FARM AREA	SEASONAL ABUNDANCE (ARRAY AREA PLUS 4 KM BUFFER)	REGIONAL BASELINE POPULATIONS AND BASELINE MORTALITY RATES (INDIVIDUALS PER ANNUM)		DISPLACEMENT RATE	ESTIMATED NUMBER OF RED-THROATED DIVERS SUBJECT TO MORTALITY (INDIVIDUALS)		INCREASE IN BASELINE MORTALITY (%)	
			POPULATION	BASELINE MORTALITY		1% MORTALITY RATE	10% MORTALITY RATE	1% MORTALITY RATE	10% MORTALITY RATE
Post-breeding migration (Aug-Oct)	0-5 km Buffer	0			90%	0.0	0.0	0.000%	0.000%
	5 - 8 km buffer	58			50%	0.1	1.4	0.014%	0.141%
	Total (array area plus 8 km buffer)	62			N/A	0.2	1.6	0.016%	0.161%
Migration-free winter (Nov-Dec)	Array Area	4	1,657	386	100%	0.0	0.2	0.005%	0.052%
	0-5 km Buffer	5			90%	0.0	0.2	0.005%	0.052%
	5 - 8 km buffer	39			50%	0.1	1.0	0.025%	0.249%
	Total (array area plus 8 km buffer)	47			N/A	0.1	1.4	0.035%	0.354%
Annual (BDMPS)	Array Area	17	4373	1,018	100%	**0.1**	0.9	**0.008%**	0.083%
	0-5 km Buffer	32			90%	**0.1**	1.4	**0.014%**	0.141%

BIO-SEASON (MONTHS)	WIND FARM AREA	SEASONAL ABUNDANCE (ARRAY AREA PLUS 4 KM BUFFER)	REGIONAL BASELINE POPULATIONS AND BASELINE MORTALITY RATES (INDIVIDUALS PER ANNUM)		DISPLACEMENT RATE	ESTIMATED NUMBER OF RED-THROATED DIVERS SUBJECT TO MORTALITY (INDIVIDUALS)		INCREASE IN BASELINE MORTALITY (%)	
			POPULATION	BASELINE MORTALITY		1% MORTALITY RATE	10% MORTALITY RATE	1% MORTALITY RATE	10% MORTALITY RATE
	5 - 8 km buffer	146			50%	**0.4**	3.6	**0.036%**	0.357%
	Total (array area plus 8 km buffer)	195			N/A	**0.6**	5.9	**0.058%**	0.582%
Annual (biogeographic)	Array Area	17	27,000	6,288	100%	**0.1**	0.9	**0.001%**	0.014%
	0-5 km Buffer	32			90%	**0.1**	1.4	**0.002%**	0.023%
	5 - 8 km buffer	146			50%	**0.4**	3.6	**0.006%**	0.058%
	Total (array area plus 8 km buffer)	195			N/A	**0.6**	5.9	**0.009%**	0.094%

Table Note: Values in bold represent the Applicant's approach to assessment based on the available evidence and expert judgement.

121 During the return migration bio-season, the mean peak abundance for red-throated diver is 86 individuals within the array plus 8 km buffer. Using a construction phase mortality rate of 1% results in less than one (0.3) red-throated diver being subject to mortality per annum. The BDMPS population in the return migration bio-season is defined as 4,373 individuals (Table 17) and, using the average baseline mortality rate of 0.233 (Table 18), the natural predicted mortality in the return migration bio-season is 1,018 individuals per annum. The addition of less than one predicted mortality per annum would increase baseline mortality by 0.029%.

122 This minimal level of impact is considered to be of **negligible magnitude during the return migration bio-season**, as it represents no discernible change to baseline mortality.

123 During the migration-free breeding bio-season, the mean peak abundance for red-throated diver is five individuals within the array plus 8 km buffer. Using a construction phase mortality rate of 1% results in less than one (0.0) red-throated diver being subject to mortality per annum. The BDMPS population in the migration-free breeding bio-season is defined as 1,860 individuals (Table 17) and, using the average baseline mortality rate of 0.233 (Table 18), the natural predicted mortality in the migration-free breeding bio-season is 433 individuals per annum. The addition of less than one predicted mortality per annum would increase baseline mortality by 0.005%.

124 This minimal level of impact is considered to be of **negligible magnitude during the migration-free breeding bio-season**, as it represents no discernible change to baseline mortality.

125 During the post-breeding migration bio-season, the mean peak abundance for red-throated diver is 62 individuals within the array plus 8 km buffer. Using a construction phase mortality rate of 1% results in less than one (0.2) red-throated diver being subject to mortality per annum. The BDMPS population in the post-breeding migration bio-season is defined as 4,373 individuals (Table 17) and, using the average baseline mortality rate of 0.233 (Table 18), the natural predicted mortality in the post-breeding migration bio-season is 1,018 individuals per annum. The addition of less than one predicted mortality per annum would increase baseline mortality by 0.016%.

126 This minimal level of impact is considered to be of **negligible magnitude during the post-breeding migration bio-season**, as it represents no discernible change to baseline mortality.

127 During the migration-free winter bio-season, the mean peak abundance for red-throated diver is 47 individuals within the array plus 8 km. Using a construction phase mortality rate of 1% results in less than one (0.1) red-throated diver being subject to mortality per annum. The BDMPS population in the migration-free winter bio-season is defined as 1,657 individuals (Table 17) and, using the average baseline mortality rate of 0.233 (Table 18), the natural predicted mortality in the migration-free winter bio-season is 386 individuals per annum. The addition of less than one predicted mortality would increase baseline mortality by 0.035%.

128 This minimal level of impact is considered to be of **negligible magnitude during the migration-free winter bio-season**, as it represents no discernible change to baseline mortality.

129 For all seasons combined, the predicted maximum number of red-throated divers subject to mortality due to displacement from AyM is less than one individual per annum. Using the largest UK Western waters BDMPS population of 4,373 individuals (Table 17) and, using the average baseline mortality rate of 0.233 (Table 18), the natural predicted mortality across all bio-seasons is 1,018 individuals per annum. The addition of less than one predicted mortality per annum would increase the baseline mortality rate by 0.058%. When considering displacement effects at the wider biogeographic population scale, then based on a population of 27,000 individuals (Table 17), the natural annual mortality rate would be 6,288 individuals per annum. The addition of less than one predicted mortality per annum would increase the biogeographic baseline mortality rate by 0.009%.

130 This minimal level of potential change is considered to be an impact of **negligible magnitude overall**, as it represents no discernible increase to baseline mortality levels as a result of displacement.

Sensitivity of the receptor

131 As this receptor is a qualifying interest for Liverpool Bay SPA, and is Green listed in BoCC5 (Stanbury et al., 2021), this receptor is afforded a feature importance level of "international" to reflect that. With respect to behavioural sensitivity to disturbance and displacement, it is considered to be high (Table 14). As it is of high behavioural sensitivity, and of international importance, this leads to an overall sensitivity of this receptor to disturbance and displacement of **high**.

Significance of effect

132 Given a magnitude of impact of negligible and a sensitivity of high, following the matrix approach set out in Table 13, the potential effect of displacement and disturbance from construction activities in the array plus 4 km buffer on red-throated diver has been assessed as minor. However, when considering expert opinion, given the potential impact level is below one mortality per annum the overall significance of effect is considered to be negligible, which is **not significant**.

Gannet

Potential magnitude of impact

133 The annual estimated mortality (when considering a displacement rate range of 30-40% and a mortality rate of 1%) as a consequence of displacement during the construction phase of AyM for gannet is between one and two individuals, which is further broken down into relevant bio-seasons in Table 23.

134 As detailed in Volume 4, Annex 4.5: Offshore Ornithology Scoping & Consultation Responses (application ref: 6.4.4.5), for gannet SNCBs consider that displacement assessment should consider a construction displacement rate of half that assessed for the operational phase (from 03-81% to 30-40%) and present a range of mortality rates from 1-10%. Presentation of displacement impacts with the SNCB's rates for the construction phase is provided in Table 23 and a displacement matrix is provided in Table 38. The main focus of impact assessment is based on the Applicant's approach of a 1% mortality rate for construction phase displacement, considering the temporal and spatial restriction of construction impacts.

Table 23: Gannet bio-season displacement estimates for AyM (construction).

BIO-SEASON (MONTHS)	SEASONAL ABUNDANCE (ARRAY AREA PLUS 2KM BUFFER)	REGIONAL BASELINE POPULATIONS AND BASELINE MORTALITY RATES (INDIVIDUALS PER ANNUM)		ESTIMATED NUMBER OF GANNETS SUBJECT TO MORTALITY (INDIVIDUALS)		INCREASE IN BASELINE MORTALITY (%)	
		POPULATION	BASELINE MORTALITY	30-40% DISPLACEMENT RATE; 1% MORTALITY RATE	30-40% DISPLACEMENT RATE, 10% MORTALITY RATE	30-40% DISPLACEMENT RATE; 1% MORTALITY RATE	30-40% DISPLACEMENT RATE, 1-10% MORTALITY RATE
Return Migration (Dec-Mar)	0	661,888	124,188	0.0	0.0	0.000	0.000
Migration-free Breeding (Apr-Aug)	328	474,738	89,074	1.0 – 1.3	9.8 – 13.1	0.001 – 0.001	0.011 – 0.015
Post-breeding migration (Sep-Nov)	201	454,954	85,362	0.6 - 0.8	6.0 – 8.0	0.001 – 0.001	0.007 – 0.015
Annual (BDMPS)	528	661,888	124,188	**1.6 - 2.1**	15.8 – 21.1	**0.001 – 0.002**	0.013 – 0.017
Annual (biogeographic)	528	1,180,000	221,400	**1.6 - 2.1**	15.8 – 21.1	**0.001 – 0.001**	0.007 – 0.010

Table Note: Values in bold represent the Applicant's approach to assessment based on the available evidence and expert judgement.

135 During the return migration bio-season zero gannets are estimated to be at risk of displacement and so there is **no impact** in the return migration bio-season.

136 During the migration-free breeding bio-season, the mean peak abundance for gannet is 328 individuals within the array plus 2 km. Using a displacement rate range of 30–40% and a mortality rate 1% results in one (1.0-1.3) gannet being subject to mortality per annum. The regional population in the migration-free breeding bio-season is defined as 474,738 individuals (Table 17) and, using the average baseline mortality rate of 0.188 (Table 18), the natural predicted mortality in the migration-free breeding bio-season is 89,074 individuals per annum. The addition of one predicted mortality per annum would increase baseline mortality by 0.001%.

137 This minimal level of change is considered to be an impact of **negligible magnitude during the migration-free breeding bio-season**, as it represents no discernible change to baseline mortality.

138 During the post-breeding migration bio-season, the mean peak abundance for gannet is 201 individuals within the array area plus 2 km buffer. Using a displacement rate range of 30–40% and a mortality rate 1% results in less than one (0.6-0.8) gannet being subject to mortality per annum. The regional population in the post-breeding migration breeding bio-season is defined as 454,954 individuals (Table 17) and, using the average baseline mortality rate of 0.188 (Table 18), the natural predicted mortality in the post-breeding migration bio-season is 85,362 individuals per annum. The addition of less than one predicted mortality per annum would increase baseline mortality by 0.001%.

139 This minimal level of change is considered to be an impact of **negligible magnitude during the post-breeding migration bio-season**, as it represents as it represents between no discernible change to baseline mortality.

140 For all seasons combined, the predicted maximum number of gannets subject to mortality due to displacement from AyM is approximately two (1.6-2.1) gannets per annum. Using the largest BDMPS population of 661,888 individuals (Table 17) and, using the average baseline mortality rate of 0.188 (Table 18), the natural predicted mortality across all seasons is 124,188 per annum. The addition of two predicted mortalities would increase baseline mortality by 0.001-0.002%. When considering displacement effects at the wider biogeographic population scale, then based on a population of 1,180,000 (Table 17), the natural annual mortality rate would be 221,400 individuals. The addition of two predicted mortalities would increase the biogeographic baseline mortality by 0.001%.

141 This minimum level of change is considered to be an impact of **negligible magnitude at the UK Western Waters BDMPS scale and biogeographic scale overall**, as it represents no discernible increase to baseline mortality levels as a result of displacement.

Sensitivity of the receptor

142 This receptor is not connected with a large number of designated sites within the UK Western Waters BDMPS or wider bio-geographic population scales, but it is a qualifying feature of Grassholm SPA and also known to breed in Ireland's Eye SPA and Lambay Island SPA, all of which are within mean-max foraging range of AyM (Woodward et al., 2019). However, AyM is beyond the mean foraging range from those SPAs and indeed any known breeding colony (Woodward et al., 2019). Gannet is Amber listed in BoCC5 (Stanbury et al., 2021). Overall, this receptor is therefore afforded a feature conservation value of "medium" to reflect those facts. With respect to behavioural sensitivity to disturbance and displacement, it is considered to be low to medium (Table 14). As this receptor is of low to medium behavioural sensitivity, and it is of medium conservation value, this leads to an overall sensitivity of this receptor to disturbance and displacement of **medium**.

Significance of effect

143 Given a magnitude of impact of negligible and a sensitivity of medium, following the matrix approach set out in Table 13, the potential effect of disturbance and displacement from construction activities in the array area on gannets has been assessed as minor. However, when considering expert opinion, given the potential impact level is well below one mortality per annum the overall significance of effect is considered to be negligible, which is **not significant**.

Manx shearwater

Potential magnitude of impact

144 The annual estimated mortality rate (when considering a displacement rate range of 15-35% and a mortality rate of 1%) for Manx shearwater is between less than one to one individual per annum, which is further broken down into relevant bio-seasons in Table 24.

145 As detailed in Volume 4, Annex 4.5: Offshore Ornithology Scoping & Consultation Responses (application ref: 6.4.4.5), for Manx shearwater SNCBs consider that displacement assessment should consider a displacement rate of half that assessed for during the operational phase (from 30-70% to 15-35%) and present a range of mortality rates from 1-10%. Presentation of displacement impacts with SNCB's rates for the construction phase is provided in Table 24 and a displacement matrix is provided in Table 40. The main focus of impact assessment is based on the Applicant's approach of a 1% mortality rate for construction phase displacement, considering the temporal and spatial restriction of construction impacts.

Table 24: Bio-season displacement estimates for Manx shearwater for AyM (construction).

BIO-SEASON (MONTHS)	SEASONAL ABUNDANCE (ARRAY AREA PLUS 2 KM BUFFER)	REGIONAL BASELINE POPULATIONS AND BASELINE MORTALITY RATES (INDIVIDUALS PER ANNUM)		ESTIMATED NUMBER OF MANX SHEARWATER SUBJECT TO MORTALITY (INDIVIDUALS)		INCREASE IN BASELINE MORTALITY (%)	
		POPULATION	BASELINE MORTALITY	15-35% DISPLACEMENT RATE; 1% MORTALITY RATE	15-35% DISPLACEMENT RATE; 10% MORTALITY RATE	15-35% DISPLACEMENT RATE; 1% MORTALITY RATE	15-35% DISPLACEMENT RATE; 10% MORTALITY RATE
Return Migration (Mar-May)	177	1,580,895	205,516	0.3 – 0.6	2.7 – 6.2	0.000 – 0.000	0.001 – 0.003
Migration-free Breeding (Jun-Jul)	26	968,337	125,889	0.0 – 0.1	0.4 – 0.9	0.000 – 0.000	0.000 – 0.001
Post-breeding migration (Aug-Oct)	214	1,580,895	205,516	0.3 – 0.7	3.2 – 7.5	0.000 – 0.000	0.002 – 0.004
Annual (BDMPS)	417	1,580,895	205,516	**0.6 – 1.5**	6.3 – 14.6	**0.000 – 0.001**	0.003 – 0.007
Annual (biogeographic))	417	2,000,000	260,000	**0.6 – 1.5**	6.3 – 14.6	**0.000 – 0.001**	0.002 – 0.006

Table Note: Values in bold represent the Applicant's approach to assessment based on the available evidence and expert judgement.

146 During the return migration bio-season, the mean peak abundance for Manx shearwater is 177 individuals within the array plus 2 km buffer. Using displacement rates ranging between 15-35% and a mortality rate of 1% would result in less than one (0.3-0.6) Manx shearwaters being subject to mortality per annum. During the return migration bio-season, the total regional baseline population of Manx shearwaters is predicted to be 1,580,895 individuals (Table 17). When the average baseline mortality rate of 0.130 (Table 18) is applied, the natural predicted mortality in the return migration bio-season is 205,516 individuals per annum. The addition of less than one predicted mortality per annum would increase baseline mortality by less than 0.001%.

147 This minimal level of potential change is considered to be an impact of **negligible magnitude during the return migration breeding bio-season**, as it represents no discernible increase to baseline mortality.

148 During the migration-free breeding bio-season, the mean peak abundance for Manx shearwater is 26 individuals within the array plus 2 km. Using displacement rates ranging between 15–35% and mortality rates of 1% would result in less than one (0.0-0.1) Manx shearwaters being subject to mortality. During the migration-free breeding bio-season, the total regional baseline population of Manx shearwaters is predicted to be 968,377 individuals (Table 17). When the average baseline mortality rate of 0.130 (Table 18) is applied, the natural predicted mortality in the migration-free breeding bio-season is 205,516 individuals per annum. The addition of less than one predicted mortality per annum would increase baseline mortality by less than 0.001%.

149 This minimal level of potential change is considered to be an impact of **negligible magnitude during the migration-free breeding bio-season**, as it represents no discernible increase to baseline mortality.

150 During the post-breeding migration bio-season, the mean peak abundance for Manx shearwater is 214 individuals within the array plus 2 km buffer. Using displacement rates ranging between 15–35% and mortality rates of 1% would result in less than one (0.3-0.7) Manx shearwater being subject to mortality. During the post-breeding migration bio-season, the total regional baseline population is predicted to be 1,580,895 individuals (Table 17) and, using the average baseline mortality rate of 0.130 (Table 18), the natural predicted mortality in the post-breeding migration bio-season is 205,516 individuals per annum. The addition of less than one predicted mortality per annum would increase baseline mortality by less than 0.001%.

151 This minimal level of potential change is considered to be an impact of **negligible magnitude during the post-breeding migration bio-season**, as it represents no discernible increase to baseline mortality.

152 For all seasons combined, the predicted maximum number of Manx shearwater subject to mortality due to displacement from AyM is between less than one (0.6) and two (1.5) Manx shearwater per annum. Using the largest BDMPS population of 1,580,895 individuals (Table 17) and, using the average baseline mortality rate of 0.130 (Table 18), the natural predicted mortality is 205,516 individuals per annum. The addition of less than one and two predicted mortalities would increase baseline mortality by 0.000–0.001%. When considering displacement impacts at the wider biogeographic population scale, then based on a population of 2,000,000 (Table 17), the natural annual mortality rate would be 260,000 individuals per annum. On a biogeographic scale the addition of between less than one two predicted mortalities would increase baseline mortality by 0.000–0.001%.

153 This minimal level of potential change per annum is considered to be an impact of **negligible magnitude at both the UK Western Waters BDMPS scale and at the biogeographic scale**, as it represents no discernible difference to the baseline conditions due to the number of individuals subject to potential mortality as a result of displacement.

Sensitivity of the receptor

154 Manx shearwater are BoCC5 Amber listed (Stanbury et al., 2021) and are a Birds Directive Migratory Species. Manx shearwaters are a qualifying feature of seven SPAs (Copeland Islands, Irish Sea Front, Rum, St Kilda, Outer Firth of Forth and St Andrews Bay Complex, Glannau Aberdaron ac Ynys Enlli/ Aberdaron Coast and Bardsey Island, and Skomer, Skokholm and the Seas off Pembrokeshire/ Sgomer, Sgogwm a Moroedd Penfro) and given the extensive distance over which Manx shearwater forage, AyM is within the mean-max foraging range of 1,347 km (Woodward et al., 2019) from all of them. Therefore, Manx shearwater have been afforded a conservation value of high. Manx shearwaters are not considered to be especially vulnerable or sensitive to displacement. Dierschke et al. (2016) classified Manx shearwater as "weakly avoiding windfarms", although it is noted that evidence is lacking for this species. Bradbury et al. (2014) classify Manx shearwater as having "very low" population vulnerability to displacement. Therefore, Manx shearwater are categorised as having low sensitivity to displacement. Considering both the conservation value and sensitivity to the impact, the overall sensitivity of Manx shearwater is assessed as **medium**.

Significance of effect

155 Given a magnitude of impact of negligible and a sensitivity of medium, following the matrix approach set out in Table 13, the potential effect of displacement and disturbance from operational activities in the array area on Manx shearwater has been assessed as minor. However, when considering expert opinion, given the potential impact level is well between under one and under two mortalities per annum the overall significance of effect is considered to be negligible, which is **not significant.**

4.11.2 Disturbance and displacement: offshore ECC

156 Construction activities associated with offshore export cable installation may lead to disturbance and displacement of species within the offshore ECC and potentially within surrounding buffers to a lower extent.

157 Common scoter and red-throated diver have both been shown to be sensitive to vessel activities, with both species flushing from approaching vessels at a distance of >1 km (Schwemmer et al., 2011; Bradbury et al., 2014). There is evidence of a concentration of common scoter off the North Wales coast between Colwyn Bay and the Point of Ayr (Lawson et al., 2016), with peak densities of between 99.22 and 138.23 birds per km^2 in the area through which the offshore ECC is planned to run. In addition, Lawson et al. (2016) show peak red-throated diver densities of between 0.86 and 1.15 birds per km^2 are also present in this inshore area, offshore from Llandulas (see Volume 4, Annex 4.1).

158 The laying of the export cable between the array and cable landfall for AyM would be undertaken across a six-month period, involving a total of 191 vessel movements (Table 8). There is therefore potential for construction activities associated with seabed preparation and cable laying, namely the physical presence of the installation vessels, to lead to disturbance and displacement of common scoter and red-throated diver present within the offshore ECC should works occur during the non-breeding period.

Red-throated diver

159 The construction phase displacement rate of 100% has been applied to a 2 km buffer around each of two cable laying vessels. It is likely that any supporting vessels would be in the immediate vicinity of the cable laying vessels and so the displacement effect from those additional vessels would be included within this 2 km buffer. The total area subject to displacement is therefore 25.13 km^2.

160 Site specific survey information collected to inform the extension proposal for the Liverpool Bay SPA (Lawson et al., 2016) indicated that the peak density of red-throated diver in the region of the SPA crossed by the cable route was between 0.86 and 1.15 individuals per km^2. Therefore, using these data the total number of red-throated diver displaced at any one time would be between 10.8 and 14.4 birds.

161 It is considered that impacts relating to disturbance from the presence of vessels is highly unlikely to lead to impacts greater than those considered for the construction of an OWF's foundations and WTGs. Based on this understanding the Applicant considers that a mortality rate of 0.5-1% is sufficiently precautionary for assessment of the offshore ECC displacement impacts, further backed up by the fact that cable laying is both temporally and spatially restricted to a very small area of sea at any one time.

162 Therefore, the total estimated mortality is a maximum of less than a single red-throated diver (0.1-0.2). The BDMPS population in the migration-free winter bio-season is defined as 1,657 individuals (Table 17) and, using the average baseline mortality rate of 0.233 (Table 18), the natural predicted mortality in the migration-free winter migration bio-season is 386 individuals per annum. The addition of less than a single mortality would increase baseline mortality by up to 0.028-0.056%.

163 This level of impact is considered to be of **negligible magnitude**, as it represents no discernible change to the baseline conditions due to the very small number of individuals subject to potential mortality as a result of displacement.

164 As this species is a qualifying feature of Liverpool Bay SPA, and is Green listed in BoCC5 (Stanbury et al., 2021), this species is afforded a feature importance level of "international" to reflect that. With respect to behavioural sensitivity to disturbance and displacement, it is considered to be high (Table 14). As it is of high behavioural sensitivity, and of international importance, this leads to an overall sensitivity of this receptor to disturbance and displacement of **high**.

165 Given a negligible magnitude of impact and a sensitivity of high, following the matrix approach set out in Table 13, the potential effect of disturbance and displacement from construction activities in the ECC on red-throated diver has been assessed as minor. However, when considering expert opinion, given the potential impact level is well below one mortality per annum the overall significance of effect is considered to be negligible, which is **not significant**.

Common scoter

166 The construction phase displacement rate of 100% has been applied to a 2 km buffer around each of two cable laying vessels. It is likely that any supporting vessels will be in the immediate vicinity of the cable laying vessels and so the displacement effect from those additional vessels will be included within this 2 km buffer. The total area subject to displacement is therefore 25.13 km^2.

167 Site specific survey information collected to inform the extension proposal for the Liverpool Bay SPA (Lawson et al., 2016), which indicated that the peak density of common scoter in the region of the SPA crossed by the cable route was between 99.2 and 138.2 individuals per km^2. Therefore, the total number of common scoter displaced at any one time would be between 1,246.4 and 1,736.5 individuals.

168 It is considered that impacts relating to disturbance from the presence of vessels is highly unlikely to lead to impacts greater than those considered for the construction of an OWF's foundations and WTGs. Based on this understanding the Applicant considers that a mortality rate of 0.5-1% is sufficiently precautionary for assessment of the offshore ECC displacement impacts, further backed up by the fact that cable laying is both temporally and spatially restricted to a very small area of sea at any one time.

169 On this basis, the number of common scoter subject to mortality would be between 13 (12.5) to 35 (34.7). The BDMPS population in the non-breeding bio-season is defined as 85,552 individuals (Table 17) and, using the average baseline mortality rate of 0.238 (Table 18), the natural predicted mortality in the non-breeding bio-season is 20,361 individuals per annum. The addition of a maximum of 13 to 35 predicted mortalities would increase baseline mortality by 0.061-0.171%.

170 This level of impact is considered to be of **negligible magnitude**, as it represents no discernible change to the baseline conditions due to the small number of individuals subject to potential mortality as a result of displacement.

171 SNCBs consider that displacement of common scoter should be assessed using an overly precautionary mortality rate of 5%. When considering a mortality rate of 5%, the maximum number of common scoter subject to mortality would be 87 (86.8). The addition of a maximum of 87 predicted mortalities would represent an increase to the non-breeding bio-season baseline mortality of 0.426%.

172 This level of impact is considered to be of **negligible magnitude**, as it represents no discernible change to the baseline conditions due to the small number of individuals subject to potential mortality as a result of displacement.

173 As this species is a qualifying feature of the Liverpool Bay SPA, and is Red listed in BoCC5 (Stanbury et al., 2021), this species is afforded a conservation value of "high" to reflect that. With respect to behavioural sensitivity to disturbance and displacement, it is considered to be high (Table 14). As it is of high behavioural sensitivity, and of high conservation value, this leads to an overall sensitivity of this receptor to disturbance and displacement of **high**.

174 Given a negligible magnitude of impact and a sensitivity of high, following the matrix approach set out in Table 13, the potential effect of disturbance and displacement from construction activities in the ECC on common scoter has been assessed as minor, which is **not significant**.

Other species

175 The baseline characterisation report did not identify any other species of high sensitivity or high densities within the offshore ECC (Volume 4, Annex 4.1 (application ref: 6.4.4.1)). Works within the offshore ECC are likely to be spatially and temporally restricted, as described above. Therefore, the magnitude of impact from disturbance and displacement within the offshore ECC has been assessed as negligible on all other receptors and accordingly, following the matrix approach set out in Table 13, the effect has been assessed as **not significant** regardless of the sensitivity of the receptor.

4.11.3 Indirect impacts due to impacts on prey: array

176 During the construction phase of AyM, there is the potential for indirect effects on offshore ornithology arising from impacts on prey species affecting their availability. Underwater noise from piling may cause mobile prey species to avoid the construction area. Suspended sediments may cause fish and mobile invertebrates to avoid the construction area and may smother and hide immobile benthic prey. Increased suspended sediment may also make it harder for seabirds to see their prey in the water column. These mechanisms may result in less prey being available within the construction area to foraging seabirds.

177 The area of seabed predicted to be disturbed during construction within the array is predicted to be a maximum of 2.99 km^2 over a 25-month period, representing approximately 3% of the total array area. Therefore, both habitat disturbance to prey species and increases in suspended sediment will be temporary, short-term and small in extent. As no significant effects were identified to potential prey species (fish, shellfish or benthos) or on the habitats that support them in Volume 2, Chapter 5 (application ref: 6.2.5) and Volume 2, Chapter 6 (application ref: 6.2.6), then there is **no potential for any indirect effects of an adverse significance to occur on offshore ornithology receptors.**

4.11.4 Indirect impacts due to impacts on prey: offshore ECC

178 During the installation of the offshore export cables, there is the potential for indirect effects on offshore ornithology arising from impacts on prey species affecting their availability. Suspended sediments may cause fish and mobile invertebrates to avoid the construction area and may smother and hide immobile benthic prey. Increased suspended sediment may also make it harder for seabirds to see their prey in the water column. These mechanisms may result in less prey being available within the construction area to foraging seabirds.

179 The area of seabed predicted to be disturbed during construction within the array is predicted to be a maximum of 1.07 km^2 over a 13-month period, representing approximately 1.5% of the total offshore ECC. Therefore, both habitat disturbance to prey species and increases in suspended sediment will be temporary, short-term and small in extent. As no significant effects were identified to potential prey species (fish, shellfish or benthos) or on the habitats that support them in Volume 2, Chapter 5 (application ref: 6.2.5) and Volume 2, Chapter 6 (application ref: 6.2.6), then there is **no potential for any indirect effects of an adverse significance to occur on offshore ornithology receptors.**

4.12 Environmental assessment: operational phase

180 The potential effects of the offshore operation and maintenance of AyM have been assessed on offshore ornithology. The potential environmental effects arising from the operation and maintenance of AyM are listed in Table 3, whilst the MDS describes each impact that has been assessed in Table 8.

4.12.1 Disturbance and displacement: array

Overview

181 The presence of WTGs has the potential to directly disturb and displace seabirds that would normally reside within and around the area of sea where AyM is proposed to be developed. This potentially reduces the area available to those seabirds to forage, loaf and/ or moult that currently occur within and around AyM and may be susceptible to displacement from such a development. Displacement may contribute to individual birds experiencing fitness consequences, which at an extreme level could lead to the mortality of individuals.

182 Seabird species vary in their response to the presence of operational infrastructure associated with OWFs, such as WTGs and shipping activity related to maintenance activities. OWFs are a new feature in the marine environment and as a result there is limited evidence as to the effects of disturbance and displacement by operational infrastructure in the long-term.

183 Garthe and Hüppop (2004) developed a scoring system for such disturbance factors, which has been widely applied in OWF EIAs. Furness and Wade (2012) developed a similar system with disturbance ratings for particular species that was applied alongside scores for habitat flexibility and conservation importance to define an index value that highlights the sensitivity of each species to disturbance and displacement. Bradbury et al., (2014) provided an update to the Furness and Wade (2012) paper to consider seabirds in English waters.

184 Natural England and JNCC issued a joint Interim Displacement Guidance Note (Natural England and JNCC 2012), which provides recommendations for presenting information to enable the assessment of displacement effects in relation to OWF developments. This has been superseded more recently by a joint SNCB interim displacement advice note (SNCBs, 2017), which provides the latest advice for UK development applications on how to consider, assess and present information and potential consequences of seabird displacement from OWFs. These guidance notes have shaped the assessment provided below.

185 Some species are more susceptible than others to disturbance from OWF operation, which may lead to subsequent displacement. Dierschke et al., (2016) noted both displacement and avoidance to varying degrees by some seabird species while others were attracted to OWFs. A screening process was undertaken for AyM to identify those species that may be more susceptible than others and therefore which species may be considered for further assessment (Table 14).

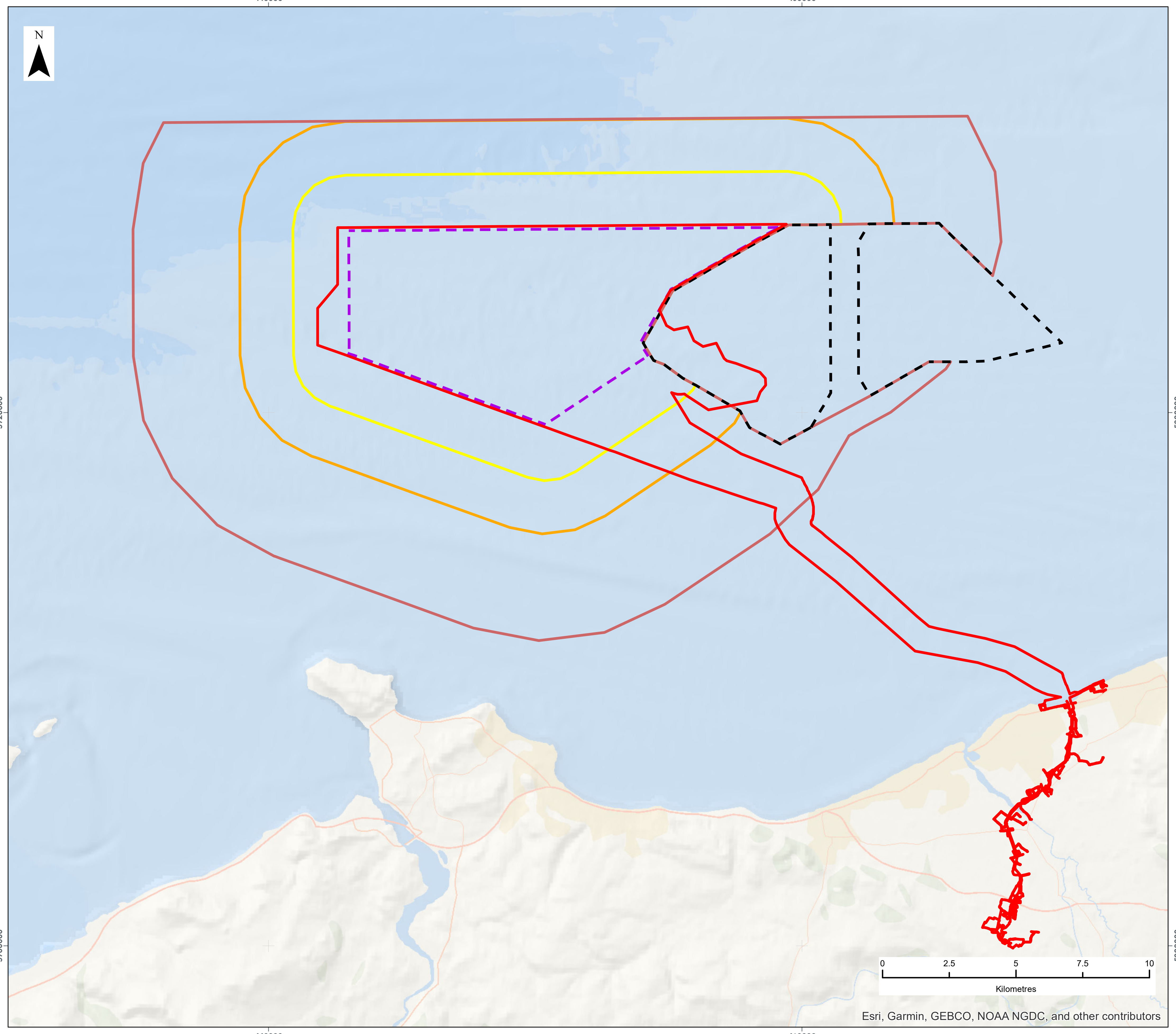
186 Whilst gannet and Manx shearwater are also considered to of relatively low vulnerability to disturbance, they have been included in the assessment of potential displacement during the operational phase of AyM as requested by SNCBs (Volume 4, Annex 4.5 (application ref: 6.4.4.5)). This is to provide SNCBs with confidence that any potential effects from operational disturbance and displacement have been considered in a quantitative manner.

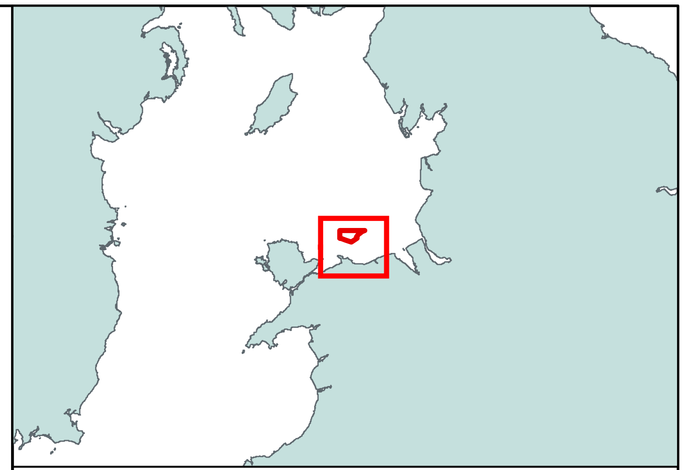
187 The six species that were scoped in for assessment for disturbance and displacement are gannet, guillemot, razorbill, Manx shearwater, common scoter and red-throated diver (Table 14).

188 Following the screening process (Table 14), an assessment of displacement was carried out for AyM, with detailed methods and results presented in Volume 4, Annex 4.2: Offshore Ornithology Displacement (application ref: 6.4.4.2), to provide information for six seabird species of interest identified as potentially at risk and of interest for impact assessment.

189 For each of the six species a review was undertaken of recent displacements rates applied by other assessments of displacement for OWFs. A further review of the displacement values derived from multiple post-consent monitoring reports was undertaken to quantify a suitable evidence-led approach and to provide SNCBs with transparency on how the displacement rates were calculated for this assessment. The displacement rates selected were then consulted on and agreed through the ETG (Volume 4, Annex 4.5 (application ref: 6.4.4.5)).

190 As AyM will be immediately adjacent to the existing GyM, this has been considered for the displacement analysis. Birds which were recorded within the GyM array would seem to be tolerant of the presence of WTGs and associated vessel traffic, and therefore AyM, being further away, would be unlikely to subsequently induce displacement (APEM, 2019). Further evidence of habituation to other OWFs comes from Royal Haskoning DHV (2013) and Leopold & Verdaat (2018). Therefore, in calculating the abundance of birds at risk from displacement from AyM, birds within the GyM array area have been excluded. This approach to assessment was agreed with the ETG (Volume 4, Annex 4.5 (application ref: 6.4.4.5)) and is presented in the buffers in Figure 2. A similar argument could apply to birds within a buffer zone around GyM; however, as a precautionary assumption no further adjustment has been made to the approach to displacement analysis.





LEGEND

- Order Limits
- Array Area
- GyM Array Area
- Array Area 2 km Buffer (excluding GyM)
- Array Area 4 km Buffer (excluding GyM)
- Array Area 8 km Buffer (excluding GyM)

Data Source:

PROJECT TITLE:

AWEL Y MÔR OFFSHORE WINDFARM

FIGURE TITLE:

Displacement buffers

VER	DATE	REMARKS	Drawn	Checked
1	09/03/2022	For Issue	LB	MB

FIGURE NUMBER:

Figure 2

SCALE:	PLOT SIZE:	DATUM:	PROJECTION:
1:150,000	A3	WGS84	UTM30N

Fferm Wynt Alltraeth
AWEL Y MÔR
Offshore Wind Farm

P:\P00004817 GeBe - Awel y Mor Ornithology EIA\Data\00_GIS_assorted_shapefiles\ArcGIS\AYM_Displacement_Buffers_A3_Landscape_UTM30N_v1.mxd

Common scoter

191 Common scoter are highly susceptible to disturbance from boat and helicopter traffic (Garthe and Hüppop, 2004), showing disturbance behaviours at distances of over 1 km from boats (Kaiser et al., 2006; Schwemmer et al., 2011). There is less evidence regarding their displacement behaviour from the permanent infrastructure associated with OWFs, with Dierschke et al. (2016) claiming that common scoters only weakly avoid OWFs themselves, with the majority of displacement the result of avoidance of boat and helicopter traffic associated with maintenance of OWFs.

192 The GyM post-consent monitoring found limited evidence of a displacement effect (APEM, 2019): within the GyM array area itself, the peak pre-construction abundance estimate was 36 birds, whereas no birds were observed within the array area in either the construction or operational phases. However, considering the GyM array area plus 2 km buffer, the peak pre-construction abundance estimate was 39 birds. This decreased to a peak abundance estimate of 5 birds during the construction phase, but then increased to a peak estimated abundance of 116 birds during operation (APEM, 2019). However, the small numbers of birds recorded (maximum raw count of 21 birds) mean that these results have limited power to inform a quantitative estimate of displacement rates.

193 Therefore, a displacement rate of 100% within the AyM array area plus 4 km buffer has been used. However, from the evidence available, it is apparent that this rate is highly precautionary.

194 The potential impacts of displacement on common scoter have been poorly studied. Kaiser et al. (2002) carried out a literature review and modelling study, which suggested that the impact of displacement from the construction of Rhyl Flats, Burbo Bank, Shell Flat and Gwynt y Môr OWFs would increase median overwinter morality for the Liverpool Bay population from 7.3% (based on a baseline of North Hoyle alone) to 11.7%, assuming 100% displacement from all OWFs and a 2 km buffer, an increase of 4.4%. Even this does not appear to have been substantiated, with latest population estimates showing no evidence of a decline (Lawson et al., 2016). The impact of a temporary and moving displacement effect would be lower, as any one area of food resource would only be unavailable for a matter of hours or days, and therefore food resource depletion would be correspondingly less.

195 Due to the limited evidence available, a mortality rate of 1-10% has been presented, with the Applicant's position being the use of a 1% mortality rate is most appropriate. However, the upper end of this range is recognised as being highly precautionary, on the basis that the data available do not indicate that such increases in mortality have occurred following the construction and operation of existing OWFs within Liverpool Bay.

Potential magnitude of impact

196 The annual estimated mortality (when considering a displacement rate of 100% and a mortality rate of 1-10%) as a consequence of displacement during the operation and maintenance phase of AyM for common scoter is less than one to three birds, which is further broken down into relevant bio-seasons in Table 25.

Table 25: Common scoter bio-season displacement estimates for AyM (operation).

BIO-SEASON (MONTHS)	SEASONAL ABUNDANCE (ARRAY AREA PLUS 4 KM BUFFER)	REGIONAL BASELINE POPULATIONS AND BASELINE MORTALITY RATES (INDIVIDUALS PER ANNUM)		ESTIMATED NUMBER OF COMMON SCOTER SUBJECT TO MORTALITY (INDIVIDUALS)		INCREASE IN BASELINE MORTALITY (%)	
		POPULATION	BASELINE MORTALITY	100% DISPLACEMENT RATE; 1% MORTALITY RATE	100% DISPLACEMENT RATE; 10% MORTALITY RATE	100% DISPLACEMENT RATE; 1% MORTALITY RATE	100% DISPLACEMENT RATE; 10% MORTALITY RATE
Breeding (May-Aug)	0	N/A	N/A	0.0	0.0	N/A	N/A
Non-breeding (Sep-Apr)	31	85,552	20,361	0.3	3.1	0.001	0.015
Annual (BDMPS)	31	85,552	20,361	**0.3**	3.1	**0.001**	0.015
Annual (biogeographic)	31	550,000	130,900	**0.3**	3.1	**0.000**	0.002

Table Note: Values in bold represent the Applicant's approach to assessment based on the available evidence and expert judgement.

197 During the breeding bio-season, no (zero) common scoters were found in the array plus 4 km buffer, and so the estimated mortality from disturbance and displacement is zero. This represents **no impact** to common scoter in the breeding bio-season.

198 During the non-breeding bio-season, a mean peak abundance of 31 common scoter within the array plus 4 km buffer are estimated to be at risk of displacement. Using operational phase displacement rates of 100% and a mortality rate of 1-10% would result in less than one (0.3) to three (3.1) common scoters being subject to mortality. The BDMPS population in the non-breeding bio-season is defined as 85,552 individuals (Table 17) and, using the average baseline mortality rate of 0.238 (Table 18), the natural predicted mortality in the non-breeding bio-season is 20,358 individuals per annum. The addition of less than one to three predicted mortalities would increase baseline mortality by 0.001-0.015%.

199 This level of change is considered to be an impact of **negligible magnitude during the non-breeding bio-season**, as it represents no discernible change to the baseline conditions due to the very small number of individuals subject to potential mortality as a result of displacement.

200 For all seasons combined, the maximum number of common scoter subject to mortality due to displacement from AyM is less than one to three individuals per annum. Using the largest regional population of 85,552 individuals (Table 17) and, using the average baseline mortality rate of 0.238 (Table 18), the natural predicted mortality across all seasons is 20,358 individuals per annum. The addition of less than one to three predicted mortalities will increase baseline mortality by 0.001-0.015%. When considering displacement effects at the wider biogeographic population scale, then based on a population of 550,000 (Table 17), the natural annual mortality rate will be 130,878 individuals per annum. The addition of less than one to three predicted mortalities will increase the biogeographic baseline mortality by 0.000-0.002%.

201 This level of potential change per annum is considered to be **negligible at the UK Western Waters BDMPS scale and negligible at the biogeographic scale**, as it represents between only a slight to a minor difference to the baseline conditions due to the number of individuals subject to potential mortality as a result of displacement.

Sensitivity of the receptor

202 As detailed in Section 4.11.1, this receptor is classified as high behavioural sensitivity, and of international importance, this leads to an overall sensitivity of this receptor to disturbance and displacement of **high**.

Significance of effect

203 Given a magnitude of impact of negligible and a sensitivity of high, following the matrix approach set out in Table 13, the potential effect of displacement and disturbance during the operational phase on common scoter has been assessed as minor. However, when considering expert opinion, given the potential impact level is most likely to be under one mortality per annum and an unlikely maximum of three then the overall significance of effect is considered to be negligible, which is **not significant**.

Table 26: Common scoter annual displacement matrix for AyM array area plus 4km buffer.

COMMON SCOTER ANNUAL DISPLACEMENT MATRIX (BASED ON ABUNDANCE OF 31 FOR AYM ARRAY AREA PLUS 4KM BUFFER)																
Displacement (%)	Mortality rates (%)															
	0	**1**	**2**	**3**	**4**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	1	1	1	2	2	2	2	3	3
20	0	0	0	0	0	0	1	1	2	2	3	4	4	5	5	6
30	0	0	0	0	0	0	1	2	3	4	5	5	6	7	8	9
40	0	0	0	0	0	1	1	2	4	5	6	7	9	10	11	12
50	0	0	0	0	1	1	2	3	5	6	8	9	11	12	14	15
60	0	0	0	1	1	1	2	4	5	7	9	11	13	15	16	18
70	0	0	0	1	1	1	2	4	6	9	11	13	15	17	19	21
80	0	0	0	1	1	1	2	5	7	10	12	15	17	20	22	24
90	0	0	1	1	1	1	3	5	8	11	14	16	19	22	25	27
100	0	**0**	1	1	1	2	3	6	9	12	15	18	21	24	27	31

Table Note: Values in bold represent the Applicant's approach to assessment based on the available evidence and expert judgement.

Auk species

Displacement rate evidence base

204 Auk species show a medium level of sensitivity to ship and helicopter traffic (Garthe and Hüppop, 2004; Furness and Wade, 2012; Langston, 2010; Bradbury et al., 2014). Displacement impacts from post-consent monitoring studies were collated and reviewed by Dierschke et al., (2016). This review summarises evidence of auk displacement obtained from studies of thirteen different European OWF sites that compared changes in seabird abundance between baseline and post-construction. The review concluded that the mean outcome across all OWFs for auks was 'weak displacement' but highly variable. Since the publication of this review, there have been a number of additional OWF sites which have reported displacement effects on auks (APEM 2017; Webb et al. 2017; Vanermen et al. 2019; Peschko et al. 2020; MacArthur Green 2021). Furthermore, previously published datasets from three OWF sites have recently been re-analysed utilising a novel modelling approach, which has resulted in different displacement effects being concluded for some (R-INLA; Zuur 2018; Leopold et al. 2018).

205 Since the Dierschke et al., (2016) review, a further study has been published using data from OWFs in the German North Sea indicating guillemot displacement rates are reduced during the breeding season compared to the non-breeding season by ~20% (Peschko et al, 2020). This is of important consideration as the mean displacement rates derived from the Dierschke et al., (2016) review was predominantly from data collected in the non-breeding season. Therefore, by applying a single displacement rate across all bio-seasons of 50% within the AyM array area and out to a 2 km buffer would ensure a precautionary rate is used for the assessment of displacement.

206 Hornsea Four OWF (Orsted, 2021) has recently submitted a summary review of all current post consent-monitoring studies undertaken to date within the North Sea and UK Western Waters. This review was completed by APEM (APEM, 2022), which provides an extensive study and analysis of empirical data from multiple OWFs expanding on from previous studies undertaken, such as that submitted by Norfolk Vanguard (2018). The review undertaken by Hornsea Four OWF found that auk displacement varied considerably within different study sites showing attraction, no significant effect or a displacement effect. The studies included: one OWF with positive displacement effects, eight OWFs with no significant effects or weak displacement effects, three with inferred displacement effects (but not statistically tested) and eight with negative displacement effects. The displacement effects from those studies which provided a defined displacement rate ranged from +112% to -75%. Examination of the analysis methods and quality of the datasets for these studies, found that some studies have not utilised the most appropriate statistical modelling methods for the data collected. These studies were coincidentally found to have high displacement rates due to low abundance and high numbers of zero counts, making displacement rate prediction highly problematic given natural spatial and temporal variation in auk abundance and distribution. As such, the displacement effects reported in these studies are most likely unreliable. The conclusion from this literature review suggested that a displacement rate of up to 50% for the array area and 2 km buffer would be the most applicable, whilst still being suitably precautionary for assessment.

207 Since the Dierschke et al., (2016) review, a further study has been published using data from OWFs in the German North Sea indicating guillemot displacement rates are reduced during the breeding season compared to the non-breeding season by ~20% (Peschko et a,l, 2020). This is of important consideration as the mean displacement rates derived from the Dierschke et al., (2016) review was predominantly from data collected in the non-breeding season. Therefore, by applying a single displacement rate across all bio-seasons of 50% within the AyM array area and out to a 2 km buffer would ensure a precautionary rate is used for the assessment of displacement.

208 Furthermore, evidence that an auk displacement rate of 50% is precautionary comes from studies that indicate auk habituation to OWFs. This was recently demonstrated at Thanet OWF, where auk displacement was shown to be statistically significant, but only in the short term, with abundances increasing within the wind farm from year two post-construction suggesting some level of habituation after one year of operation. Indeed, year two and three displacement rates for auks fell from a range of 75% to 85% in the first year of operation to a low of 31% to 41% within year two and three of operations (Royal Haskoning, 2013). There is also further emerging evidence as additional post-construction monitoring of OWFs continues, with reports of auk numbers increasing and observations of foraging behaviour within the wind farm itself (Leopold & Verdaat 2018). This would suggest that displacement rates are expected to diminish over the operational life of OWFs. Given that AyM is immediately adjacent to GyM, some habituation may already have occurred within local populations that would transfer to reduced avoidance of AyM compared to a new windfarm in a previously unimpacted region.

209 Therefore, in conclusion, there is strong evidence to support an auk displacement rate of 50% within OWF array areas and out to a 2 km buffer, which would still be considered as precautionary.

210 Given that AyM is immediately adjacent to GyM, it is evident that an appropriate method needs to be devised to account for buffer effects. A 2 km buffer around AyM would extend into GyM. It is unlikely that birds which remain within the footprint of the existing, operational GyM would then be displaced by the operation of WTGs within AyM that are further away than GyM WTGs which the birds are already tolerating.

211 Furthermore, if there is a displacement effect up to 2 km out from GyM, then the density of birds currently within the portion of the AyM within 2 km of GyM will already have been reduced by displacement, and it is likely that the remaining birds are more tolerant of WTGs and therefore less likely to be displaced by the presence of AyM's WTGs.

212 The solution, which in light of the above is considered to be precautionary, is to apply the standard displacement rates as discussed above to all birds within the AyM footprint and a 2 km buffer, except for the area of buffer that directly overlaps with GyM (agreed 22/04/2021 ID 107 Ornithology position paper NRW comments). Figure 2 shows the area considered in calculating auk displacement.

Effects of displacement on auk mortality

213 Current evidence suggests that the response of seabirds to OWFs varies depending on the species and of life stage of the individual birds. The levels both spatially and temporally to which birds avoid OWFs are likely to be based on key factors such as competition levels within the wider area and prey abundance within the OWF. The consequence of such avoidance may result in reduced foraging areas available to individuals. Mortalities are likely to correlate strongly with the quality of the area within the OWF that some individuals are displaced from, but conversely may offer increased foraging efficiency for those still entering the OWF area. If the OWF area is considered to be a key a foraging area and the area outside of the OWF is close to carrying capacity, then higher mortality rates may occur (Busche and Garthe 2016; SNCBs, 2017). Conversely, if birds are being displaced into an area of optimal habitat and closer to breeding colonies, then this could result in a positive impact due to species having a reduction in energy expenditure foraging (Searle et al., 2020).

214 For auk species SNCBs current guidance is to present and consider assessing displacement impacts using a mortality rate of up to 10% based on expert opinion (Natural England 2014), due to the lack of empirical evidence and to allow for precaution in assessments (SNCBs, 2017). As presented by Hornsea Four OWF (Orsted, 2021), since the interim guidance on displacement was published there have been two detailed studies with updates to predict consequence of displaced seabirds, including auks, from OWFs (Searle et al. 2014 and 2018, and van Kooten et al. 2019), and anecdotal evidence of implied low additional mortality rates from auk colony stability on Helgoland, where OWFs have been in operation since 2014 and auk displacement rates have been reported to be between 44-63% (Peschko et al. 2020).

215 Van Kooten et al. (2019) determined the cost of birds avoiding areas based on energy-budget models for two scenarios; using habitat utilization maps and a fixed 10% mortality rate. The results demonstrated that an additional 1% mortality for displaced auks is a more appropriate evidenced-based rate, in comparison to the overly precautionary 10% mortality rate.

216 Searle et al. (2014; 2018) assessed the effects displacement and barrier effects on breeding seabirds. The study was based on time and energy budget models being created to estimate the displacement effects on the breeding population of seabirds, including auks during the chick rearing period. The models provided evidence that displacement has the potential to impact on future survival prospects of an auk due to changes in time and energy budgets. The simulations concluded however, that during the breeding and non-breeding season displacement effects are unlikely to exceed an increase in mortality of 0.5%.

217 Further anecdotal evidence of low mortality rates as a consequence of displacement comes from the post monitoring of the Helgoland auk colony in the German North Sea. OWFs have been in operation in the area since 2014 and the displacement rate of auks is predicted to be between 44-63% (Peschko et al. 2020). The OWFs have therefore been in operation long enough for any correlations between colony demographics and operation of the OWF to be identified. The latest breeding population status on Helgoland shows a continued increase for both razorbill and guillemot over the latest five-year period, which has remained unchanged compared to long-term data (Gerlach et al. 2019), supporting an inferred conclusion that high mortality rates due to displacement are not occurring at the colony.

218 The detailed findings from APEM study (APEM, 2022) into auk displacement mortality rates provide an extensive study and analysis to further inform the assessment process. Therefore, based on these studies the Applicant considers a mortality rate of 1% to be sufficiently precautionary for assessment of consequential displacement mortality.

Guillemot

219 For the purpose of this assessment, an evidence-led displacement rate of 50% and mortality rate of 1% was applied to each bio-season based on evaluation of the published literature and in line with values used by other OWF displacement assessments. Additional consideration is provided by reference to the SNCB's preferred method of assessing potential impacts from displacement using a range of between 30% to 70% displacement and range of between 1% and 10% mortality rates (Volume 4, Annex 4.5: (application ref: 6.4.4.5)) as presented in Table 27, although the focus of assessment within this report is based on the Applicant's evidence-led approach.

220 It should be noted that due to the large expanse of available sea outside of the array area, the mortality rate due to displacement could be as low as 0% as the increase in density outside of the array area in comparison to the whole of the UK Western Waters would be negligible.

221 A complete range of displacement matrices are presented in Volume 4, Annex 4.2: Offshore Ornithology Displacement (application ref: 6.4.4.2), whilst Table 27 has been populated with data for guillemots during the breeding and non-breeding season within the AyM array as well as out to a 2 km buffer (excluding GyM). An annual displacement matrix for guillemot within the array area plus a 2 km buffer is also presented in Table 28 below.

Potential magnitude of impact

222 The annual estimated mortality (when considering a displacement rate of 50% and a mortality rate of 1%) as a consequence of displacement during the operation and maintenance phase of AyM for guillemot is 22 individuals, which is further broken down into relevant bio-seasons in Table 27.

Table 27: Guillemot bio-season displacement estimates for AyM (operation).

BIO-SEASON (MONTHS)	SEASONAL ABUNDANCE (ARRAY AREA PLUS 2 KM BUFFER)	REGIONAL BASELINE POPULATIONS AND BASELINE MORTALITY RATES (INDIVIDUALS PER ANNUM)		ESTIMATED NUMBER OF GUILLEMOTS SUBJECT TO MORTALITY (INDIVIDUALS)		INCREASE IN BASELINE MORTALITY (%)	
		POPULATION	BASELINE MORTALITY	50% DISPLACEMENT RATE; 1% MORTALITY RATE	30-70% DISPLACEMENT RATE; 1-10% MORTALITY RATE	50% DISPLACEMENT RATE; 1% MORTALITY RATE	30-70% DISPLACEMENT RATE; 1-10% MORTALITY RATE
Breeding (Mar-Jul)	1,569	491,889	70,176	7.9	4.7 – 109.8	0.011	0.007 – 0.157
Non-breeding (Aug-Feb)	2,919	1,139,220	162,528	14.6	8.8 – 204.3	0.009	0.005 – 0.126
Annual (BDMPS)	4,488	1,139,220	162,528	**22.4**	13.5 – 314.2	**0.014**	0.008 – 0.193
Annual (biogeographic)	4,488	4,125,000	588,499	**22.4**	13.5 – 314.2	**0.004**	0.002 - 0.053

Table Note: Values in bold represent the Applicant's approach to assessment based on the available evidence and expert judgement.

223 During the breeding bio-season, the mean peak abundance for guillemot is 1,569 individuals within the array plus 2 km buffer. When considering evidence-based displacement and mortality rates of 50% and 1%, respectively, this would result in approximately eight (7.9) guillemots being subject to mortality. During the breeding bio-season the total guillemot regional baseline population, including breeding adults and immature birds, is predicted to be 491,889 individuals (Table 17). Using the average baseline mortality rate of 0.143 (Table 18), the natural predicted mortality of guillemots in the breeding bio-season is 70,176 individuals per annum. The addition of eight predicted mortalities would increase baseline mortality by 0.011%.

224 This level of potential change is considered to be an impact of **negligible magnitude during the breeding bio-season**, as it represents only a slight difference to the baseline conditions due to the small number of individuals subject to potential mortality as a result of displacement.

225 During the non-breeding bio-season, the mean peak abundance for guillemot is 2,919 individuals within the array area and 2 km buffer. When considering evidence-based displacement and mortality rates of 50% and 1%, respectively, this would result in approximately 15 (14.6) guillemots being subject to mortality. The UK Western Waters BDMPS for the non-breeding bio-season is defined as 1,139,220 individuals (Table 17) and, using the average baseline mortality rate of 0.143 (Table 18), the natural predicted mortality in the non-breeding bio-season is 162,528 individuals per annum. The addition of 15 predicted mortalities would increase baseline mortality by 0.009%.

226 This level of potential change is considered to be an impact of **negligible magnitude during the non-breeding bio-season**, as it represents only a slight difference to the baseline conditions due to the small number of individuals subject to potential mortality as a result of displacement.

227 For all seasons combined, the estimated number of guillemots subject to mortality due to displacement from the AyM array plus 2 km buffer is 22 (22.4) individuals per annum. Using the largest UK Western Waters BDMPS population of 1,139,220 individuals (Table 17) as a proxy for the total BDMPS population across the year, with an average baseline mortality rate of 0.143 (Table 18), the natural predicted mortality across all seasons is 162,528 individuals per annum. The addition of 22 predicted mortalities would increase baseline mortality rate 0.014% at the BDMPS scale. When considering the annual potential level of change at the biogeographic scale, the natural predicted mortality of the biogeographic population of 4,125,000 (Table 17) across all seasons is 588,499 individuals per annum. On a biogeographic scale, the addition of 22 predicted mortalities would increase the baseline mortality by 0.004%.

228 This level of potential change per annum is considered to be an impact of **negligible magnitude at both the UK Western Waters BDMPS scale and negligible at the biogeographic scale**, as it represents only a slight difference to the baseline conditions due to the number of individuals subject to potential mortality as a result of displacement.

Sensitivity of the receptor

229 As detailed in Section 4.11.1, this receptor is classified as medium behavioural sensitivity, and it is of national importance leading to an overall sensitivity of this receptor to disturbance and displacement of **medium**.

Significance of effect

230 Given a magnitude of impact of negligible and a sensitivity of medium, following the matrix approach set out in Table 13, the potential effect of displacement and disturbance from operational activities in the array area on guillemots has been assessed as minor, which is **not significant**.

Table 28: Guillemot annual displacement matrix for AyM array area plus 2 km buffer.

GUILLEMOT ANNUAL DISPLACEMENT MATRIX (BASED ON ABUNDANCE OF 4,488 FOR AYM ARRAY AREA PLUS 2KM BUFFER)																
Displacement (%)	Mortality rates (%)															
	0	**1**	**2**	**3**	**4**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	1	1	2	2	4	9	13	18	22	27	31	36	40	45
10	0	4	9	13	18	22	45	90	135	180	224	269	314	359	404	449
20	0	9	18	27	36	45	90	180	269	359	449	539	628	718	808	898
30	0	13	27	40	54	67	135	269	404	539	673	808	942	1,077	1,212	1,346
40	0	18	36	54	72	90	180	359	539	718	898	1,077	1,257	1,436	1,616	1,795
50	0	**22**	45	67	90	112	224	449	673	898	1,122	1,346	1,571	1,795	2,020	2,244
60	0	27	54	81	108	135	269	539	808	1,077	1,346	1,616	1,885	2,154	2,423	2,693
70	0	31	63	94	126	157	314	628	942	1,257	1,571	1,885	2,199	2,513	2,827	3,142
80	0	36	72	108	144	180	359	718	1,077	1,436	1,795	2,154	2,513	2,872	3,231	3,590
90	0	40	81	121	162	202	404	808	1,212	1,616	2,020	2,423	2,827	3,231	3,635	4,039
100	0	45	90	135	180	224	449	898	1,346	1,795	2,244	2,693	3,142	3,590	4,039	4,488

Table Note: Values in bold represent the Applicant's approach to assessment based on the available evidence and expert judgement.

Razorbill

231 For the purpose of this assessment, an evidence-led displacement and mortality rate of 50% and 1%, respectively, was applied to each bio-season based on evaluation of the published literature and in line with values used by other OWF displacement assessments. Additional consideration is given to SNCBs preferred method of assessing potential impacts from displacement using a range of between 30% to 70% displacement and between 1% and 10% mortality rates (Volume 4, Annex 4.5 (application ref: 6.4.4.5)) as presented in Table 29, although the focus of assessment within this report is based on the Applicant's evidence-led approach.

232 It should be noted that due to the large expanse of available habitat outside of the OWF area, the mortality rate due to displacement could be as low as 0% as the increase in density outside of the OWF area, in comparison to the whole of the UK Western Waters, would be negligible.

233 A complete range of displacement matrices are presented in Volume 4, Annex 4.2: Offshore Ornithology Displacement (application ref: 6.4.4.2), whilst Table 29 has been populated with data for razorbills during each of the return migration, non-migratory breeding, post-breeding migration and non-migration wintering bio-seasons within the AyM array area as well as out to a 2 km buffer (excluding GyM). An annual displacement matrix for razorbill within the array area plus a 2 km buffer is also presented in Table 30 below

Potential magnitude of impact

234 The annual estimated mortality (when considering a displacement rate of 50% and a mortality rate of 1%) as a consequence of displacement during the operation and maintenance phase of AyM for razorbill is four individuals, which is further broken down into relevant bio-seasons in Table 29.

Table 29: Razorbill bio-season displacement estimates for AyM (operation).

BIO-SEASON (MONTHS)	SEASONAL ABUNDANCE (ARRAY AREA PLUS 2 KM BUFFER)	REGIONAL BASELINE POPULATIONS AND BASELINE MORTALITY RATES (INDIVIDUALS PER ANNUM)		ESTIMATED NUMBER OF RAZORBILLS SUBJECT TO MORTALITY (INDIVIDUALS)		INCREASE IN BASELINE MORTALITY (%)	
		POPULATION	BASELINE MORTALITY	50% DISPLACEMENT RATE; 1% MORTALITY RATE	30-70% DISPLACEMENT RATE; 1-10% MORTALITY RATE	50% DISPLACEMENT RATE; 1% MORTALITY RATE	30-70% DISPLACEMENT RATE; 1-10% MORTALITY RATE
Return migration (Jan-Mar)	336	606,914	108,228	1.7	1.0 – 23.5	0.002	0.001 – 0.022
Migration-free breeding (Apr-Jul)	140	261,290	46,595	0.7	0.4 – 9.8	0.002	0.001 – 0.021
Post-breeding migration (Aug-Oct)	66	606,914	108,288	0.3	0.2 – 4.6	0.000	0.000 – 0.004
Migration-free winter (Nov-Dec)	150	341,422	60,884	0.8	0.5 – 10.5	0.001	0.001 – 0.017
Annual (BDMPS)	692	606,914	108,228	**3.5**	2.1 – 48.5	**0.003**	0.002 – 0.045
Annual (biogeographic)	692	606,914	108,228	**3.5**	2.1 – 48.5	**0.003**	0.002 – 0.0045

Table Note: Values in bold represent the Applicant's approach to assessment based on the available evidence and expert judgement.

235 During the return migration bio-season, the mean peak abundance for razorbill is 336 individuals within the array and 2 km buffer. When considering evidence-based displacement and mortality rates of 50% and 1%, respectively, this would result in approximately two (1.7) razorbills being subject to mortality. The UK Western Waters BDMPS for the return migration bio-season is defined as 606,914 (Table 17) and, using the average baseline mortality rate of 0.178 (Table 18), the natural predicted mortality in the return migration bio-season is 108,228 individuals per annum. The addition of two predicted mortalities would increase baseline mortality by 0.002%.

236 This level of potential change is considered to be an impact of **negligible magnitude during the return migration bio-season**, as it represents only a slight difference to the baseline conditions due to the small number of individuals subject to potential mortality as a result of displacement.

237 During the migration-free breeding bio-season, the mean peak abundance for razorbill is 140 individuals within the array and 2 km buffer. When considering evidence-based displacement and mortality rates of 50% and 1%, respectively, this would result in approximately less than one (0.7) razorbill being subject to mortality. The regional population in the migration-free breeding bio-season is defined as 261,290 individuals (Table 17) and, using the average baseline mortality rate of 0.178 (Table 18), the natural predicted mortality in the migration-free breeding bio-season is 46,595 individuals per annum. The addition of less than one predicted mortality would increase baseline mortality by 0.002%.

238 This level of potential change is considered to be an impact of **negligible magnitude during the migration-free breeding bio-season**, as it represents no discernible change to baseline mortality.

239 During the post-breeding migration bio-season, the mean peak abundance for razorbill is 66 individuals within the array and 2 km buffer. When considering the evidence-based displacement and mortality rate of 50% and 1% respectively, this would result in less than one (0.3) razorbill being subject to mortality. The UK Western Waters BDMPS for the post-breeding migration bio-season is defined as 606,914 (Table 17) and, using the average baseline mortality rate of 0.178 (Table 18), the natural predicted mortality in the post-breeding migration bio-season is 108,228 individuals per annum. The addition of less than one predicted mortality would increase baseline mortality by less than 0.001%.

240 This level of potential change is considered to be an impact of **negligible magnitude during the post-breeding migration bio-season**, as it represents no discernible change to baseline mortality.

241 During the migration-free winter bio-season, the mean peak abundance for razorbills is 150 individuals within the array and 2 km. Using the evidence-based displacement and mortality rate of 50% and 1% would result in less than one (0.8) razorbill being subject to mortality. The BDMPS population in the migration-free winter bio-season is defined as 341,422 individuals (Table 17) and, using the average baseline mortality rate of 0.178 (Table 18), the natural predicted mortality in the migration-free winter bio-season is 60,884 individuals per annum. The addition of less than one predicted mortality would increase baseline mortality by 0.001%.

242 This level of potential change is considered to be an impact of **negligible magnitude during the migration-free winter bio-season**, as it represents no discernible change to baseline mortality.

243 For all seasons combined, the maximum number of razorbills subject to mortality due to displacement from the AyM array plus 2 km buffer is four (3.5) individuals per annum. Using the largest UK Western Waters BDMPS population of 606,914 individuals (Table 17), as a proxy for the total BDMPS population across the year, with an average baseline mortality rate of 0.178 (Table 18), the natural predicted mortality across all seasons is 108,228 individuals per annum. The addition of four predicted mortalities would increase baseline mortality by 0.003% at the BDMPS scale. When considering the annual potential level of change at the biogeographic scale, the natural predicted mortality of the biogeographic population of 1,707,000 (Table 17) across all seasons is 304,401 per annum. On a biogeographic scale, the addition of four predicted mortalities would increase baseline mortality by 0.001%.

244 This level of potential change per annum is considered to be an impact of **negligible magnitude at the UK Western Waters BDMPS scale and negligible magnitude at the biogeographic scale**, as it represents no discernible difference to the baseline conditions due to the very small number of individuals subject to potential mortality as a result of displacement.

Sensitivity of the receptor

245 As detailed in Section 4.11.1, this receptor is classified as medium behavioural sensitivity, and it is of national importance leading to an overall sensitivity of this receptor to disturbance and displacement of **medium**.

Significance of effect

246 Given a magnitude of impact of negligible and a sensitivity of medium, following the matrix approach set out in Table 13, the potential effect of displacement and disturbance from operational activities on razorbills has been assessed as minor. However, when considering expert opinion, given the potential impact level is well below one mortality per annum the overall significance of effect is considered to be negligible, which is **not significant**.

Table 30: Razorbill annual displacement matrix for AyM array area plus 2 km buffer.

RAZORBILL ANNUAL DISPLACEMENT MATRIX (BASED ON ABUNDANCE OF 693 FOR AYM ARRAY AREA PLUS 2KM BUFFER)																
Displacement (%)	Mortality rates (%)															
	0	**1**	**2**	**3**	**4**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	1	1	2	3	3	4	5	6	6	7
10	0	1	1	2	3	3	7	14	21	28	35	42	48	55	62	69
20	0	1	3	4	6	7	14	28	42	55	69	83	97	111	125	138
30	0	2	4	6	8	10	21	42	62	83	104	125	145	166	187	208
40	0	3	6	8	11	14	28	55	83	111	138	166	194	222	249	277
50	0	**3**	7	10	14	17	35	69	104	138	173	208	242	277	312	346
60	0	4	8	12	17	21	42	83	125	166	208	249	291	332	374	415
70	0	5	10	15	19	24	48	97	145	194	242	291	339	388	436	485
80	0	6	11	17	22	28	55	111	166	222	277	332	388	443	498	554
90	0	6	12	19	25	31	62	125	187	249	312	374	436	498	561	623
100	0	7	14	21	28	35	69	138	208	277	346	415	485	554	623	692

Table Note: Values in bold represent the Applicant's approach to assessment based on the available evidence and expert judgement.

Red-throated diver

Displacement rate evidence base

247 Red-throated diver has been identified as being particularly sensitive to human activities in marine areas, including through the disturbance effects of ship and helicopter traffic and the presence of WTGs (Garthe and Hüppop 2004; Schwemmer et al., 2011; Furness and Wade 2012; Furness et al., 2013; Bradbury et al., 2014).

248 A detailed review of observed red-throated diver displacement rates and distance of effect was undertaken by Norfolk Vanguard Ltd (2019), with a summary of the findings presented in Table 31. The findings clearly show that there is a great deal of variability in both the displacement rate (94–50%) and distance of effect observed out from an array area (0-12 km). Norfolk Vanguard suggested that the reason for such varying scales of displacement effects could be due to the differences in ecological and anthropogenic conditions between the OWF sites. For example, for OWF sites where optimal habitat is limited, birds might show lower displacement distances due to habitat suitability constraints. It is also suggested that the visibility of offshore structures and other anthropogenic influences could also lead to greater displacement effects.

249 It should be noted that although OWFs in the German Bight were observed to show the greatest effects of displacement (Mendel et al., 2019; Vilela et al., 2020), Vilela et al., (2020) stated that the results of the study should not be used for assessment of red-throated diver displacement for other areas of sea:

250 "In winter, large differences in the displacement distance to offshore wind farms were observed between the northern and southern sub-area, potentially due to the considerably lower diver densities and the resulting greater uncertainties in the analyses. Nevertheless, these differences show that seasonal and spatial factors may play a role in the specific response of divers to offshore wind farms and results found here are therefore not directly transferable to areas other than those considered in this study."

251 It is clear from the above statement that the displacement effects observed in the German Bight should not be used to infer predicted displacement effects for other areas of sea. Furthermore, Vilela et al., (2020) stated that although the distribution of red-throated divers has changed over the study period (2001-2018), the spring abundance of divers remained stable with no connection found between diver abundance and the expansion of wind power in the German North Sea.

Table 31: Summary of results of studies into red-throated diver displacement rates. From Norfolk Vanguard Ltd (2019).

WIND FARM	DISTANCE FROM OUTER TURBINES OVER WHICH DIVER DENSITY WAS SIGNIFICANTLY REDUCED (KM)	PERCENTAGE REDUCTION IN DIVER DENSITY WITHIN WIND FARM AREA	REFERENCE
Thanet	0.0	82	Percival (2013)
Kentish Flats Extension	0.5	89	Percival and Ford (2018)
Greater Gabbard	<1.0	(75)*	Gill et al. (2018)
Kentish Flats	1.0	-	Percival (2014)
Gunfleet Sands	1.0	-	Barker (2011)
London Array	<1.5	<50	APEM (2016)
Alpha Ventus	1.5	90	Welcker & Nehls (2016)

WIND FARM	DISTANCE FROM OUTER TURBINES OVER WHICH DIVER DENSITY WAS SIGNIFICANTLY REDUCED (KM)	PERCENTAGE REDUCTION IN DIVER DENSITY WITHIN WIND FARM AREA	REFERENCE
Horns Rev 1	2.0	90	Petersen et al. (2006)
North Hoyle	2.5	-	May (2008)
Lincs	2 – 6	-	Webb et al. (2015)
Horns Rev 2	5.5	50	Petersen et al. (2014)
Butendiek, Amrumbank, Nordsee Ost, Meerwind Süd/Ost, Dan Tysk	12.0	94	Mendel et al. (2019)

Table Note: * But not statistically significant due to high variance in data so a tentative estimate.

252 East Anglia ONE North and East Anglia TWO submitted a recent update, a summary of the studies considered in reaching that displacement rate conclusion is presented in Table 31 (EA1N to their red-throated diver assessment (MacArthur Green & Royal HaskoningDHV, 2021). The authors of that assessment carried out a modelling analysis, using survey data collected in the Outer Thames region between 2002 and 2018 across multiple survey programmes. This period ranges from before any OWF construction in the region (prior to 2005) through to the completed construction of Kentish Flats, Gunfleet Sands, London Array, Thanet and Greater Gabbard. The model was run separately based on 2013 and 2018 density distributions. Using the 2013 model, the predicted reduction in density as a result of EA1N was predicted to be a maximum of 42.2% within the EA1N array area, with reduced impact in each buffer zone out to a maximum of 8km from the array area, beyond which there was no predicted decrease in density. Using the 2018 density distribution, the model predicted a 44.2% reduction in density within the EA1N array area and no reduction in density beyond 9km from the array area. It was noted that the total number of birds predicted to be displaced (34 based on 2013 data and 9 based on 2018 data) were similar to the numbers estimated using an approach of 100% displacement from the array area plus 4 km buffer (40 and 12 birds displaced, based on 2013 and 2018 input data, respectively).

253 Based on the above information it is clear that a single all-encompassing red-throated diver assessment approach is wholly unsuitable, and that consideration of displacement effects need to be undertaken on a case-by-case basis. With this in mind, the most relevant data to infer likely displacement effects from AyM would be from the post-construction monitoring data of its sister project GyM (APEM, 2019).

254 Aerial digital surveys were carried out from 2010 through to 2019, covering pre-construction, during construction and post-construction phases of GyM and the surrounding wider NW5 region (Further details on the survey areas are included in the Volume 4, Annex 4.1: Offshore Ornithology Baseline Characterisation Report (application ref: 6.4.4.1)). A summary of the abundance of red-throated diver recorded within each phase of GyM development is presented in Table 32.

Table 32: Summary table of red-throated diver densities and abundance estimates from GyM post-consent monitoring (APEM, 2019).

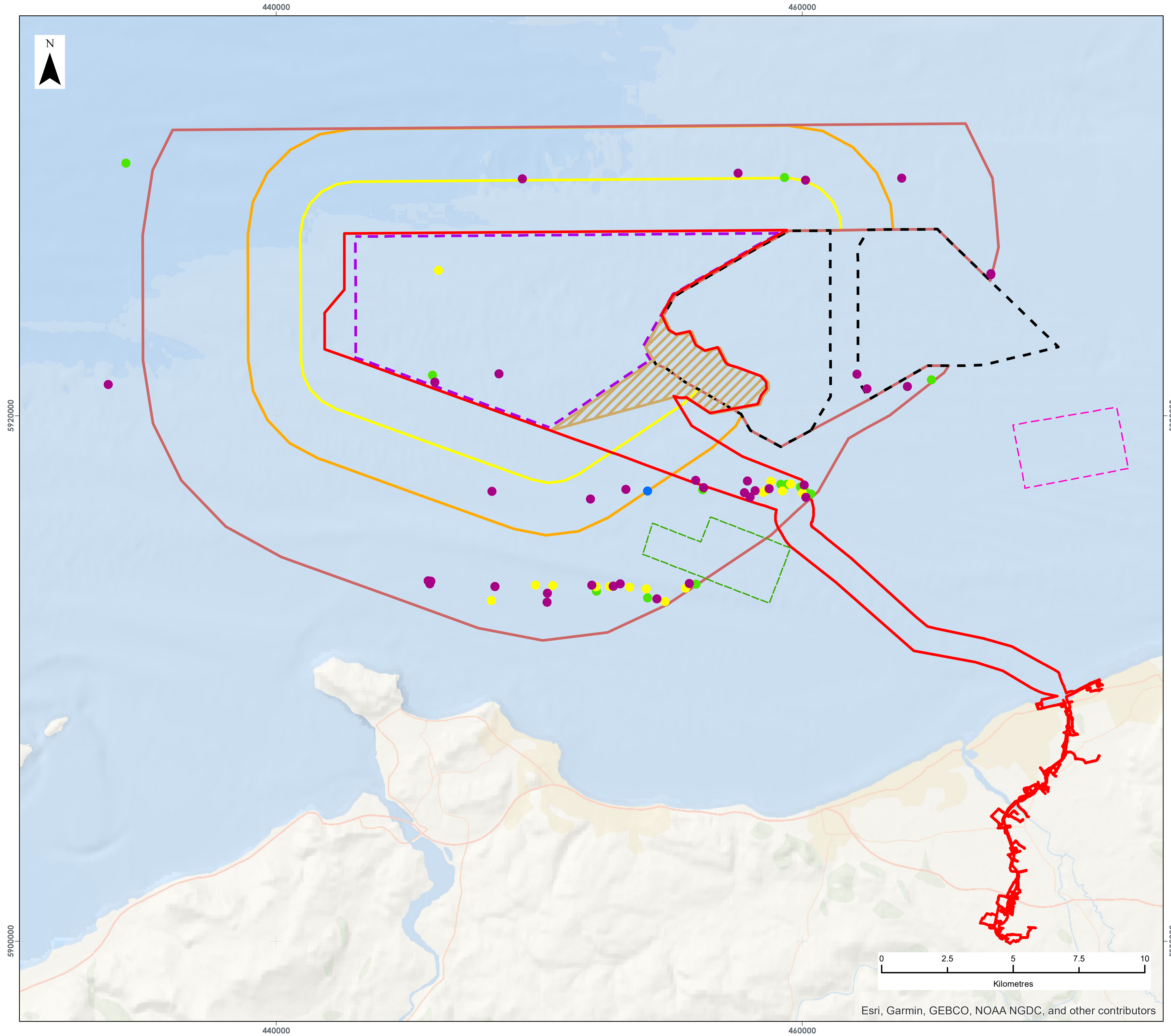
AREA	RED-THROATED DIVER MEAN DENSITY (BIRDS PER KM^2)	BIRDS PER SURVEY AREA (INDIVIDUALS)
Pre-construction		
Wind farm	0.00	0
Wind farm plus 2 km buffer	0.01	2
NW5	0.05	63
During construction		
Wind farm	0.02	2
Wind farm plus 2 km buffer	0.01	2
NW5	0.06	70
Post-construction		
Wind farm	0.01	1
Wind farm plus 2 km buffer	0.02	3
NW5	0.07	85

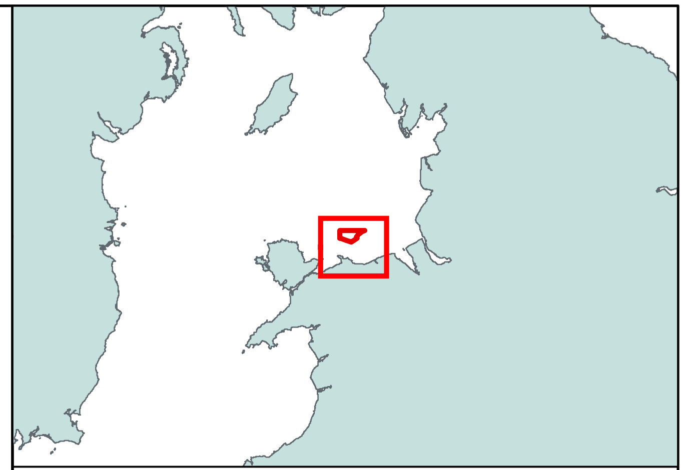
255 It is very clear from the results in Table 32 that the observed displacement rate of GyM can be considered low, as minimal changes in the abundance of red-throated divers were recorded between the pre-construction, construction and post-construction phases of GyM.

256 Given that red-throated diver numbers across the wider NW5 region increased over the monitoring period, it was perceived that there may still be some displacement effect – i.e. the numbers of birds within the array area and buffer may still be lower than they would have been in the counterfactual scenario where GyM was not constructed. However, additional modelling was carried out using an ANOVA approach and this found no evidence of any displacement effect even when accounting for the increase in population across the NW5 region (APEM, 2019). However, due to the low numbers of red-throated divers observed, the modelling results had limited power to quantify statistically significant displacement effects.

257 The limited displacement effect presented above from the presence of GyM, can be further evidenced from the distributions of red-throated diver recorded within the 24 months of AyM site specific aerial digital surveys (Figure 3). The distributions of red-throated divers in Figure 3 show only weak avoidance to the two current operational OWFs (Rhyl Flats and GyM) with birds found well within a couple of kilometres from the OWFs and even located within the GyM array area. This clearly contrasts with the distribution maps of the German Bight presented within Mendel et al., (2019) and Vilela et al., (2020), where there is clear high avoidance of OWFs and surrounding areas.

258 Despite the evidence above clearly suggesting that the rate of displacement from AyM is likely to be low, a precautionary approach to assessment has been agreed with SNCBs (written advice following ETG held on 12/11/202) that for this project, the displacement rates to be used are 100% displacement within the array area, 90% displacement in the 0-5 km buffer zone, and 50% displacement in the 5-8 km buffer zone (see Volume 4, Annex 4.2: Offshore Ornithology Displacement (application ref: 6.4.4.2) for a map of buffer zones). The advocation of such high displacement rates for AyM from SNCBs is based on studies from the German Bight, which as concluded above should not be used to infer predicted displacement impacts for other areas of seas (Vilela et al., 2020). Therefore, although used for this assessment, the Applicant regards these displacement rates as highly precautionary, and this should be taken into consideration by the reader when interpreting the results from this assessment.





LEGEND

- Order Limits
- Array Area
- GyM Array Area
- Array Area 2 km Buffer (excluding GyM)
- Array Area 4 km Buffer (excluding GyM)
- Array Area 8 km Buffer (excluding GyM)
- Interlink Cable Area
- Rhyl Flats OWF
- North Hoyle OWF
- Return Migration
- Post-breeding Migration
- Migration-free Winter
- Migration-free Breeding

Data Source:

PROJECT TITLE:

AWEL Y MÔR OFFSHORE WINDFARM

FIGURE TITLE:

Red-throated Diver Distributions

VER	DATE	REMARKS	Drawn	Checked
1	02/03/2022	For Issue	LB	MB

FIGURE NUMBER:

Figure 3

SCALE:	PLOT SIZE:	DATUM:	PROJECTION:
1:150,000	A3	WGS84	UTM30N

Fferm Wynt Alltraeth
AWEL Y MÔR
Offshore Wind Farm

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Effect of displacement on red-throated diver mortality

259 When considering the likely consequence of displacement in relation to an increase in red-throated diver's mortality rate, it is key to consider how displacement with affect their typical foraging behaviour. During winter red-throated divers are known to exhibit two different foraging strategies, Individuals tend to either consistently occupy a particular area of optimal foraging habitat each year or remain continually mobile throughout the winter period (Dierschke et al., 2017). As presented in Lawson et al. (2016) based on the eight winter seasons of monitoring used to inform the Liverpool Bay SPA selection/ extension process, there are distinct congregations of higher red-throated diver densities close to the Dee, Mersey and Ribble Estuaries to the East of the AyM array area and closer inshore to the south of the AyM array area. These areas of higher densities likely correlate with optimal habitat of red-throated divers off the North Wales coast. Within the AyM array area predominantly single individuals were recorded only (Figure 3), suggesting that the AyM array area is not located within optimal foraging habitat and the individuals recorded utilise a mobile foraging strategy. As suggested in Dierschke et al., (2017) if an OWF is displacing highly mobile over site faithful red-throated divers the impacts from displacement are likely to be low in comparison. Furthermore, if red-throated divers are displaced from AyM into the known areas of optimal habitat (Lawson et al., 2016), this could have a positive effect due to reduction in time and energy required for foraging in optimal habitat. This, therefore, suggests that consequential displacement mortality as a result of AyM is highly unlikely to be as high as recommended by SNCBs.

260 A similar conclusion was reached by Norfolk Vangaurd Ltd (2019b) and MacArthur Green & Royal HaskoningDHV (2021) in relationto the affect of displacement on red-throated diver mortality. Their literature reviews identified clear evidence that red-throated diver populations are not constrained by resources in wintering grounds, but by available breeding habitat. This would suggest that an increase in density in wintering areas as a result of displacement would not have a negative impact on survival, as there is more than sufficient resource to maintain the current population. They also noted that considering the area of OWFs already constructed, and extensive vessel traffic within the North Sea, if displacement led to a 10% mortality rate, this ought to be evident from an increase in population-level mortality rates, but no such increase has been observed. Both Norfolk Vangaurd Ltd (2019b) and MacArthur Green & Royal HaskoningDHV (2021) concluded that on the basis of available evidence, even a 1% mortality rate is likely to be precautionary and presented this as the respective applicants' preferred value.

261 The Crown Estate commissioned a plan-level HRA which considered the impacts of a potential extension to OWFs including GyM prior to AyM being awarded the Agreement for Lease (Niras, 2019). As part of the strategic plan, consideration was given to the potential impact of displacement on red-throated divers, which concluded:

262 "There is no evidence currently available that displacement will directly result in the mortality of individual birds. Mortality as a consequence of displacement is more likely to occur as a result of increased densities outside of the impacted area, which may lead to increased competition for resources. Displacement of birds from lower density areas (e.g. the area associated with the 4 km buffer associated with Gwynt y Môr), which are likely to be of lower habitat quality is less likely to result in mortality than would be the case in areas of high density and hence higher habitat quality. It is assumed that there are more opportunities for birds in lower quality habitats to relocate to habitats of similar quality. As such, the use of a 1% mortality rate is considered appropriate for this assessment."

263 On the basis of this evidence above and in line with The Crown Estate's assessment, a mortality rate of 1% of displaced birds is put forward as the Applicant's approach, whilst still retaining a significant degree of precaution.

264 For comparison, the SNCB's maximum precautionary rates of 10% mortality of displaced birds is also presented in Table 33 and displacement matrices for the abundance within the array area and assessed buffers are provided in Table 34 to Table 36.

Potential magnitude of impact

265 The annual estimated mortality (when considering a mortality rate of 1%) as a consequence of displacement during the operational and maintenance phase of AyM for red-throated diver is approximately one bird, which is further broken down into relevant bio-seasons in Table 33.

Table 33: Red-throated diver bio-season displacement estimates for AyM (operation).

BIO-SEASON (MONTHS)	WIND FARM AREA	SEASONAL ABUNDANCE (ARRAY AREA PLUS 4 KM BUFFER)	REGIONAL BASELINE POPULATIONS AND BASELINE MORTALITY RATES (INDIVIDUALS PER ANNUM)		DISPLACEMENT RATE	ESTIMATED NUMBER OF RED-THROATED DIVERS SUBJECT TO MORTALITY (INDIVIDUALS)		INCREASE IN BASELINE MORTALITY (%)	
			POPULATION	BASELINE MORTALITY		1% MORTALITY RATE	10% MORTALITY RATE	1% MORTALITY RATE	10% MORTALITY RATE
Return migration (Jan-Mar)	Array Area	9	4,373	1,019	100%	0.1	0.9	0.009%	0.088%
	0-5 km Buffer	28			90%	0.2	2.5	0.024%	0.243%
	5 - 8 km buffer	50			50%	0.2	2.5	0.024%	0.243%
	Total (array area plus 8 km buffer)	86			N/A	0.6	5.9	0.057%	0.574%
Migration-free breeding (Apr-Jul)	Array Area	0	1,860	433	100%	0.0	0.0	0.000%	0.000%
	0-5 km Buffer	5			90%	0.0	0.4	0.009%	0.094%
	5 - 8 km buffer	0			50%	0.0	0.0	0.000%	0.000%
	Total (array area plus 8 km buffer)	5			N/A	0.0	0.4	0.009%	0.094%

BIO-SEASON (MONTHS)	WIND FARM AREA	SEASONAL ABUNDANCE (ARRAY AREA PLUS 4 KM BUFFER)	REGIONAL BASELINE POPULATIONS AND BASELINE MORTALITY RATES (INDIVIDUALS PER ANNUM)		DISPLACEMENT RATE	ESTIMATED NUMBER OF RED-THROATED DIVERS SUBJECT TO MORTALITY (INDIVIDUALS)		INCREASE IN BASELINE MORTALITY (%)	
			POPULATION	BASELINE MORTALITY		1% MORTALITY RATE	10% MORTALITY RATE	1% MORTALITY RATE	10% MORTALITY RATE
Post-breeding migration (Aug-Oct)	Array Area	4	4,373	1,018	100%	0.0	0.4	0.004%	0.039%
	0-5 km Buffer	0			90%	0.0	0.0	0.000%	0.000%
	5 - 8 km buffer	58			50%	0.3	2.9	0.028%	0.282%
	Total (array area plus 8 km buffer)	62			N/A	0.3	3.3	0.032%	0.322%
Migration-free winter (Nov-Dec)	Array Area	4	1,657	386	100%	0.0	0.4	0.010%	0.104%
	0-5 km Buffer	5			90%	0.0	0.4	0.010%	0.105%
	5 - 8 km buffer	39			50%	0.2	1.9	0.050%	0.499%
	Total (array area plus 8 km buffer)	47			N/A	0.3	2.7	0.071%	0.707%
Annual (BDMPS)	Array Area	17	4373	1,018	100%	**0.2**	1.7	**0.017%**	0.167%

BIO-SEASON (MONTHS)	WIND FARM AREA	SEASONAL ABUNDANCE (ARRAY AREA PLUS 4 KM BUFFER)	REGIONAL BASELINE POPULATIONS AND BASELINE MORTALITY RATES (INDIVIDUALS PER ANNUM)		DISPLACEMENT RATE	ESTIMATED NUMBER OF RED-THROATED DIVERS SUBJECT TO MORTALITY (INDIVIDUALS)		INCREASE IN BASELINE MORTALITY (%)	
			POPULATION	BASELINE MORTALITY		1% MORTALITY RATE	10% MORTALITY RATE	1% MORTALITY RATE	10% MORTALITY RATE
	0-5 km Buffer	32			90%	**0.3**	2.9	**0.028%**	0.283%
	5 - 8 km buffer	146			50%	**0.7**	7.3	**0.071%**	0.714%
	Total (array area plus 8 km buffer)	195			N/A	**1.2**	11.9	**0.116%**	1.164%
Annual (biogeographic)	Array Area	17	27,000	6,288	100%	**0.2**	1.7	**0.003%**	0.027%
	0-5 km Buffer	32			90%	**0.3**	2.9	**0.005%**	0.046%
	5 - 8 km buffer	146			50%	**0.7**	7.3	**0.012%**	0.116%
	Total (array area plus 8 km buffer)	195			N/A	**1.2**	11.9	**0.019%**	0.189%

Table Note: Values in bold represent the Applicant's approach to assessment based on the available evidence and expert judgement.

266 During the return migration bio-season, the mean peak abundance for red-throated diver is 86 individuals within the array plus 8 km. Using the operational phase mortality rate of 1% would result in less than one (0.6) red-throated divers being subject to mortality. The BDMPS population in the return migration bio-season is defined as 4,373 individuals (Table 17) and, using the average baseline mortality rate of 0.233 (Table 18), the natural predicted mortality in the return migration bio-season is 1,018 individuals per annum. The addition of less than one predicted mortality would increase baseline mortality by 0.057%.

267 This level of change is considered to be an impact of **negligible magnitude during the return migration bio-season**, as it represents no discernible change to baseline mortality.

268 During the migration-free breeding bio-season, the mean peak for red-throated diver is five individuals within the array plus 8 km buffer. Using the operational phase mortality rate of 1% would result in approximately zero red-throated divers being subject to mortality. As this represents no change, there is **no impact in the migration-free breeding bio-season**.

269 During the post-breeding migration bio-season, the mean peak abundance for red-throated diver is 62 individuals within the array plus 8 km buffer. Using the operational phase mortality rate of 1% would result in less than one (0.3) red-throated diver being subject to mortality. The BDMPS population in the post-breeding migration bio-season is defined as 4,373 individuals (Table 17) and, using the average baseline mortality rate of 0.233 (Table 18), the natural predicted mortality in the post-breeding migration bio-season is 1,018 individuals per annum. The addition of less than one predicted mortality would increase baseline mortality by 0.032%.

270 This level of change is considered to be an impact of **negligible magnitude during the post-breeding migration bio-season**, as it represents no discernible change to baseline mortality.

271 During the migration-free winter bio-season, the mean peak abundance for red-throated diver is 47 individuals within the array plus 8 km buffer. Using the operational phase mortality rate of 1% would result in less than one (0.3) red-throated diver being subject to mortality. The BDMPS population in the migration-free winter bio-season is defined as 1,657 individuals (Table 17) and, using the average baseline mortality rate of 0.233 (Table 18), the natural predicted mortality in the return migration bio-season is 386 individuals per annum. The addition of less than one predicted mortality would increase baseline mortality by 0.071%.

272 This level of change is considered to be an impact of **negligible magnitude during the post-breeding migration bio-season**, as it represents no discernible change to baseline mortality.

273 For all seasons combined, the maximum number of red-throated divers subject to mortality due to displacement from AyM is approximately one (1.2) bird. Using the largest BDMPS population of 4,373 individuals (Table 17) and, using the average baseline mortality rate of 0.233 (Table 18), the natural predicted mortality across all seasons is 1,018 individuals per annum. The addition of one predicted mortality would increase the baseline mortality by 0.116%. When considering displacement effects at the wider biogeographic population scale, then based on a population of 27,000 (**Table 17**), the natural annual mortality rate would be 6,288 individuals. The addition of one predicted mortality would increase the biogeographic baseline mortality by 0.019%.

274 This level of potential change per annum is considered to be an impact of **negligible magnitude at both the UK Western Waters BDMPS scale and negligible at the biogeographic scale**, as it represents only a slight difference to the baseline conditions due to the number of individuals subject to potential mortality as a result of displacement.

Sensitivity of the receptor

275 As detailed in Section 4.11.1, this receptor is classified as high behavioural sensitivity, and of international importance, this leads to an overall sensitivity of this receptor to disturbance and displacement of **high**.

Significance of effect

276 Given a magnitude of impact of negligible and a sensitivity of high, following the matrix approach set out in Table 13, the potential effect of disturbance and displacement from operation and maintenance activities in the array plus 4 km buffer on red-throated diver has been assessed as minor. However, when considering expert opinion, given the potential impact level is only one mortality per annum the overall significance of effect is considered to be negligible, which is **not significant**.

Table 34: Red-throated diver annual displacement matrix for AyM array area only.

RED-THROATED DIVER ANNUAL DISPLACEMENT MATRIX (BASED ON ABUNDANCE OF 17 FOR AYM ARRAY AREA ONLY)																
Displacement (%)	Mortality rates (%)															
	0	**1**	**2**	**3**	**4**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	1	1	1	1	1	1	2	2
20	0	0	0	0	0	0	0	1	1	1	2	2	2	3	3	3
30	0	0	0	0	0	0	1	1	2	2	3	3	4	4	5	5
40	0	0	0	0	0	0	1	1	2	3	3	4	5	5	6	7
50	0	0	0	0	0	0	1	2	3	3	4	5	6	7	8	9
60	0	0	0	0	0	1	1	2	3	4	5	6	7	8	9	10
70	0	0	0	0	0	1	1	2	4	5	6	7	8	10	11	12
80	0	0	0	0	1	1	1	3	4	5	7	8	10	11	12	14
90	0	0	0	0	1	1	2	3	5	6	8	9	11	12	14	15
100	0	0	**0**	1	1	1	2	3	5	7	9	10	12	14	15	17

Table Note: Values in bold represent the Applicant's approach to assessment based on the available evidence and expert judgement.

Table 35: Red-throated diver annual displacement matrix for AyM 0-5 km buffer only.

RED-THROATED DIVER ANNUAL DISPLACEMENT MATRIX (BASED ON ABUNDANCE OF 37 FOR AYM 0-5 KM BUFFER ONLY)																
Displacement (%)	Mortality rates (%)															
	0	**1**	**2**	**3**	**4**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	1	1	1	2	2	3	3	3	4
20	0	0	0	0	0	0	1	1	2	3	4	4	5	6	7	7
30	0	0	0	0	0	1	1	2	3	4	5	7	8	9	10	11
40	0	0	0	0	1	1	1	3	4	6	7	9	10	12	13	15
50	0	0	0	1	1	1	2	4	5	7	9	11	13	15	16	18
60	0	0	0	1	1	1	2	4	7	9	11	13	15	18	20	22
70	0	0	1	1	1	1	3	5	8	10	13	15	18	20	23	26
80	0	0	1	1	1	1	3	6	9	12	15	18	20	23	26	29
90	0	**0**	1	1	1	2	3	7	10	13	16	20	23	26	30	33
100	0	0	1	1	1	2	4	7	11	15	18	22	26	29	33	37

Table Note: Values in bold represent the Applicant's approach to assessment based on the available evidence and expert judgement.

Table 36: Red-throated diver annual displacement matrix for AyM 5-8 km buffer only.

RED-THROATED DIVER ANNUAL DISPLACEMENT MATRIX (BASED ON ABUNDANCE OF146 FOR AYM 5-8 KM BUFFER ONLY)																
Displacement (%)	Mortality rates (%)															
	0	**1**	**2**	**3**	**4**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
10	0	0	0	0	1	1	1	3	4	6	7	9	10	12	13	15
20	0	0	1	1	1	1	3	6	9	12	15	17	20	23	26	29
30	0	0	1	1	2	2	4	9	13	17	22	26	31	35	39	44
40	0	1	1	2	2	3	6	12	17	23	29	35	41	47	52	58
50	0	**1**	1	2	3	4	7	15	22	29	36	44	51	58	65	73
60	0	1	2	3	3	4	9	17	26	35	44	52	61	70	79	87
70	0	1	2	3	4	5	10	20	31	41	51	61	71	81	92	102
80	0	1	2	3	5	6	12	23	35	47	58	70	81	93	105	116
90	0	1	3	4	5	7	13	26	39	52	65	79	92	105	118	131
100	0	1	3	4	6	7	15	29	44	58	73	87	102	116	131	146

Table Note: Values in bold represent the Applicant's approach to assessment based on the available evidence and expert judgement.

Gannet

277 Gannets show a low level of sensitivity to ship and helicopter traffic (Garthe and Hüppop, 2004; Furness and Wade, 2012). A study by Krijgsveld et al., (2011) using radar and visual observations to monitor the post-construction effects of the OWEZ established that 64% of gannets avoided entering the wind farm (macro-avoidance). The results of the post-consent monitoring surveys for Thanet OWF found that gannet densities reduced within the site in the third year, but the report did not quantify this (Royal Haskoning DHV, 2013). A more recent study by APEM (APEM, 2014) provided evidence that during their migration most gannets would avoid flying into areas with operational WTGs (macro-avoidance), with the estimated macro-avoidance being 95%. For the purpose of this assessment, the level of displacement considered across all bio-seasons is between 60-80%.

278 Table 37 has been populated with data for gannets during each of the return migration, non-migratory and post-breeding migration bio-seasons within the AyM array area plus a 2 km buffer, as requested by SNCBs (Volume 4, Annex 4.5 (application ref: 6.4.4.5)). An annual displacement matrix for gannet within the array area plus a 2 km buffer is also presented in Table 38 below.

279 A mortality rate of 1% was selected for this assessment, based on expert judgement supported by additional evidence that suggests that gannet have a large mean max (315 km) and maximum (709 km) foraging range (Woodward et al., 2019) and feed on a variety of different prey items that provide sufficient alternative foraging opportunities despite the potential reduced foraging activities within the AyM array area.

Potential magnitude of impact

280 The annual estimated mortality (when considering a displacement rate of 60-80% and a mortality rate of 1%) for gannet is three to four individuals, which is further broken down into relevant bio-seasons in Table 37.

Table 37: Bio-season displacement estimates for gannet for AyM (operation).

BIO-SEASON (MONTHS)	SEASONAL ABUNDANCE (ARRAY AREA PLUS 2 KM BUFFER)	REGIONAL BASELINE POPULATIONS AND BASELINE MORTALITY RATES (INDIVIDUALS PER ANNUM)		ESTIMATED NUMBER OF GANNETS SUBJECT TO MORTALITY (INDIVIDUALS)		INCREASE IN BASELINE MORTALITY (%)	
		POPULATION	BASELINE MORTALITY	60-80% DISPLACEMENT RATE; 1% MORTALITY RATE	60-80% DISPLACEMENT RATE; 10% MORTALITY RATE	60-80% DISPLACEMENT RATE; 1% MORTALITY RATE	60-80% DISPLACEMENT RATE; 10% MORTALITY RATE
Return Migration (Dec-Mar)	0	661,888	124,188	0.0 – 0.0	0.0 – 0.0	0.000 – 0.000	0.000- 0.000
Migration-free Breeding (Apr-Aug)	328	474,738	89,074	2.0 – 2.6	19.7 – 26.2	0.002-0.003	0.022 – 0.029
Post-breeding migration (Sep-Nov)	201	454,954	85,362	1.2 – 1.6	12.0 – 16.0	0.001 – 0.002	0.014 – 0.019
Annual (BDMPS)	528	661,888	124,188	**3.2 – 4.2**	31.7 – 42.2	**0.003 – 0.003**	0.026 – 0.034
Annual (biogeographic)	528	1,180,000	221,400	**3.2 – 4.2**	31.7 – 42.4	**0.001 – 0.002**	0.014 – 0.019

Table Note: Values in bold represent the Applicant's approach to assessment based on the available evidence and expert judgement.

281 During the return migration bio-season, no (zero) gannets were found in the array plus 2 km buffer, and so the estimated mortality from disturbance and displacement is zero. This represents **no impact** to gannet in the return migration bio-season.

282 During the migration-free breeding bio-season, the mean peak abundance for gannet is 328 individuals within the array area plus 2 km buffer. Using displacement rates between 60–80% and a mortality rate of 1% would result in approximately two (2.0) to three (2.6) gannets being subject to mortality. During the migration-free breeding bio-season, the total regional baseline population of breeding adults and immature gannets is predicted to be 474,738 individuals (Table 17). When the average baseline mortality rate of 0.188 (Table 18) is applied, the natural predicted mortality in the migration-free breeding bio-season is 89,074 individuals per annum. The addition of two to three predicted mortalities would increase baseline mortality by 0.002-0.003%.

283 This level of potential change is considered to be an impact of **negligible magnitude during the non-migratory breeding bio-season**, as it represents no discernible increase to baseline mortality levels due to the very small number of individuals subject to potential mortality as a result of displacement.

284 During the post-breeding migration bio-season, the mean peak abundance for gannet is 201 individuals within the array area plus 2 km buffer. Using displacement rates between 60–80% and a mortality rate 1% would result in approximately one (1.2) to two (1.6) gannets being subject to mortality. The UK Western Waters BDMPS for the post-breeding migration bio-season is defined as 454,954 individuals (Table 17) and, using the average baseline mortality rate of 0.188 (Table 18), the natural predicted mortality in the post-breeding migration bio-season is 85,362 individuals per annum. The addition of one to two predicted mortalities would increase baseline mortality by 0.001-0.002%.

285 This level of potential change is considered to be an impact of **negligible magnitude during the post-breeding migration bio-season**, as it represents no discernible increase to baseline mortality levels due to the very small number of individuals subject to potential mortality as a result of displacement.

286 For all seasons combined, the maximum number of gannets subject to mortality due to displacement from the AyM array area plus 2 km buffer is between three (3.2) and four (4.2) individuals per annum. Using the largest UK Western Waters BDMPS of 661,888 individuals (Table 17) and, using the average baseline mortality rate of 0.188 (Table 18), the natural predicted mortality across all seasons is 124,188 individuals per annum. The addition of between three to four predicted additional mortalities would increase baseline mortality by 0.003%. When considering displacement impacts at the wider biogeographic population scale, then based on a population of 1,180,000 (Table 17), the natural annual mortality rate would be 221,400 individuals. On a biogeographic scale the addition of between three and four predicted mortalities would increase baseline mortality by 0.001-0.002%.

287 This level of potential change per annum is considered to be an impact of **negligible magnitude at the UK Western Waters BDMPS scale and negligible at the biogeographic scale**, as it represents no discernible difference to the baseline conditions due to the small number of individuals subject to potential mortality as a result of displacement.

Sensitivity of the receptor

288 As detailed in Section 4.11.1, this receptor is classified as low to medium behavioural sensitivity, and it is of medium conservation value, this leads to an overall sensitivity of this receptor to disturbance and displacement of **medium**.

Significance of effect

289 Given a magnitude of impact of negligible and a sensitivity of medium, following the matrix approach set out in Table 13, the potential effect of displacement and disturbance from operational activities in the array area on gannets has been assessed as minor. However, when considering expert opinion, given the potential impact level is well between three and four mortalities per annum the overall significance of effect is considered to be negligible, which is **not significant**.

Table 38: Gannet annual displacement matrix for AyM array area plus 2 km buffer

GANNET ANNUAL DISPLACEMENT MATRIX (BASED ON ABUNDANCE OF 528 FOR AYM ARRAY AREA PLUS 2 KM BUFFER)																
Displacement (%)	Mortality rates (%)															
	0	**1**	**2**	**3**	**4**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	1	1	2	2	3	3	4	4	5	5
10	0	1	1	2	2	3	5	11	16	21	26	32	37	42	48	53
20	0	1	2	3	4	5	11	21	32	42	53	63	74	84	95	106
30	0	2	3	5	6	8	16	32	48	63	79	95	111	127	143	158
40	0	2	4	6	8	11	21	42	63	84	106	127	148	169	190	211
50	0	3	5	8	11	13	26	53	79	106	132	158	185	211	238	264
60	0	**3**	6	10	13	16	32	63	95	127	158	190	222	253	285	317
70	0	**4**	7	11	15	18	37	74	111	148	185	222	259	296	333	370
80	0	**4**	8	13	17	21	42	84	127	169	211	253	296	338	380	422
90	0	5	10	14	19	24	48	95	143	190	238	285	333	380	428	475
100	0	5	11	16	21	26	53	106	158	211	264	317	370	422	475	528

Table Note: Values in bold represent the Applicant's approach to assessment based on the available evidence and expert judgement.

Manx shearwater

Displacement rate evidence base

290 Most previous studies have not identified Manx shearwater as being sensitive to disturbance. Dierschke et al., (2016) classified Manx shearwater as "weakly avoiding wind farms", although it is noted that evidence is lacking for the species. Bradbury et al., (2014) classify Manx shearwater as having "very low" population vulnerability to displacement.

291 Dierschke et al., (2016) do suggest that Manx shearwater are avoiding North Hoyle wind farm, stating that an obvious distribution gap was observed at the OWF. It is not clear exactly how the authors reached this conclusion beyond applying subjective expert opinion to the results of the North Hoyle post-consent monitoring and concluding that fewer Manx shearwater were recorded than would be expected. Dierschke et al., (2016) also note that Manx shearwater have been recorded within Robin Rigg OWF.

292 Due to the limited evidence available for Manx Shearwater as to suitable displacement and mortality rates, as recommended by NRW and in line with the advice from the SNCBs (2017), a standard approach has been taken of applying a 30-70% displacement rate to the array area plus 2 km buffer, and 1-10% mortality of displaced individuals, although the Applicant considers that 1% mortality rate to be the more likely impact based on expert judgement. An annual displacement matrix for Manx shearwater within the array area plus a 2 km buffer is also presented in Table 40 below.

Potential magnitude of impact

293 The annual estimated mortality rate (when considering a displacement rate of 30-70% and a mortality rate of 1-10%) for Manx shearwater is between one (1.3) and 29 (29.2) individuals, which is further broken down into relevant bio-seasons in Table 39.

Table 39: Bio-season displacement estimates for Manx shearwater for AyM (operation).

BIO-SEASON (MONTHS)	SEASONAL ABUNDANCE (ARRAY AREA PLUS 2 KM BUFFER)	REGIONAL BASELINE POPULATIONS AND BASELINE MORTALITY RATES (INDIVIDUALS PER ANNUM)		ESTIMATED NUMBER OF GANNETS SUBJECT TO MORTALITY (INDIVIDUALS)		INCREASE IN BASELINE MORTALITY (%)	
		POPULATION	BASELINE MORTALITY	30-70% DISPLACEMENT RATE; 1% MORTALITY RATE	30-70% DISPLACEMENT RATE; 10% MORTALITY RATE	30-70% DISPLACEMENT RATE; 1% MORTALITY RATE	30-70% DISPLACEMENT RATE; 10% MORTALITY RATE
Return Migration (Mar-May)	117	1,580,895	205,516	0.5 – 1.2	5.3 – 12.4	0.000 – 0.001	0.003 – 0.001
Migration-free Breeding (Jun-Jul)	26	968,377	125,889	0.1 – 0.2	0.8 – 1.8	0.000 – 0.000	0.001 – 0.001
Post-breeding migration (Aug-Oct)	214	1,580,895	205,516	0.6 – 1.5	6.4 – 15.0	0.000 – 0.001	0.003 – 0.007
Annual (BDMPS)	417	1,580,895	205,516	**1.3 – 2.9**	12.5 – 29.2	**0.001 – 0.001**	0.006 – 0.014
Annual (biogeographic))	417	2,000,000	260,000	**1.3 – 2.9**	12.5 – 29.2	**0.000 – 0.001**	0.005 – 0.011

Table Note: Values in bold represent the Applicant's approach to assessment based on the available evidence and expert judgement.

294 During the return migration bio-season, the mean peak abundance for Manx shearwater is 117 individuals within the array area plus 2 km buffer. Using displacement rates between 30-70% and mortality rates of between 1-10% would result in less than one (0.5) to 12 (12.4) Manx shearwaters being subject to mortality. During the return migration bio-season, the total regional baseline population of Manx shearwaters is predicted to be 1,580,895 individuals (Table 17). When the average baseline mortality rate of 0.130 (Table 18) is applied, the natural predicted mortality in the return migration bio-season is 205,516 individuals per annum. The addition of less than one to 12 predicted mortalities would increase baseline mortality by 0.000-0.006%.

295 This level of potential change is considered to be an impact of **negligible magnitude during the return migration bio-season**, as it represents no discernible increase to baseline mortality levels due to the very small to small number of individuals subject to potential mortality as a result of displacement.

296 During the migration-free breeding bio-season, the mean peak abundance for Manx shearwater is 26 individuals within the array area plus 2 km buffer. Using displacement rates between 30–70% and mortality rates of 1-10% would result in approximately less than one (0.1) to two (1.8) Manx shearwaters being subject to mortality. During the migration-free breeding bio-season, the total regional baseline population is predicted to be 968,377 individuals (Table 17). When the average baseline mortality rate of 0.130 (Table 18) is applied, the natural predicted mortality in the migration-free breeding bio-season is 125,889 individuals per annum. The addition of less than one to two predicted mortalities would increase baseline mortality by 0.000–0.001%.

297 This level of potential change is considered to be an impact of **negligible magnitude during the migration-free breeding bio-season**, as it represents no discernible increase to baseline mortality levels due to the very small number of individuals subject to potential mortality as a result of displacement.

298 During the post-breeding migration bio-season, the mean peak abundance for Manx shearwater is 214 individuals within the array area plus 2 km buffer. Using displacement rates between 30–70% and mortality rates of 1-10% would result in approximately less than one (0.6) to 15 (15.0) Manx shearwaters being subject to mortality. During the post-breeding migration bio-season, the total regional baseline population is predicted to be 1,580,895 individuals (Table 17) and, using the average baseline mortality rate of 0.130 (Table 18), the natural predicted mortality in the post-breeding migration bio-season is 205,516 individuals per annum. The addition of less than one to 15 predicted mortalities would increase baseline mortality by 0.000–0.007%.

299 This level of potential change is considered to be an impact of **negligible magnitude during the post-breeding migration bio-season**, as it represents no discernible increase to baseline mortality levels due to the very small number of individuals subject to potential mortality as a result of displacement.

300 For all seasons combined, the maximum number of Manx shearwater subject to mortality due to displacement from AyM array plus a 2 km buffer is one (1.3) to 29 (29.2) Manx shearwaters per annum. Using the largest UK Western Waters BDMPS of 1,580,895 individuals (Table 17) and, using the average baseline mortality rate of 0.130 (Table 18), the natural predicted mortality across all seasons is 205,516 individuals per annum. The addition of one to 29 predicted mortalities would increase baseline mortality by 0.001–0.014%. When considering displacement impacts at the wider biogeographic population scale, then based on a population of 2,000,000 (Table 17), the natural annual mortality rate would be 260,000 individuals. On a biogeographic scale the addition of between one to 29 predicted mortalities per annum would increase baseline mortality by 0.000–0.011%.

301 This level of potential change per annum is considered to be an impact of **negligible magnitude at the UK Western Waters BDMPS scale and negligible at the biogeographic scale**, as it represents between only no discernible difference to the baseline conditions due to the number of individuals subject to potential mortality as a result of displacement.

302 In each bio-season and on an annual basis, the potential impact is considered to be of **negligible** magnitude, as it represents no discernible increase to baseline mortality levels as a result of displacement.

Sensitivity of the receptor

303 As detailed in Section 4.11.1, this receptor is classified as low sensitivity to displacement. Considering both the conservation value and sensitivity to the impact (Table 14), the overall sensitivity of Manx shearwater is assessed as **medium**.

Significance of effect

304 Given a magnitude of impact of negligible and a sensitivity of medium, following the matrix approach set out in Table 13, the potential effect of displacement and disturbance from operational activities in the array area on Manx shearwater has been assessed as minor. However, when considering expert opinion, given the more likely potential impact level is only one mortality per annum the overall significance of effect is considered to be negligible, which is **not significant.**

Table 40: Manx shearwater annual displacement matrix for AyM array area plus 2 km buffer.

MANX SHEARWATER ANNUAL DISPLACEMENT MATRIX (BASED ON ABUNDANCE OF 528 FOR AYM ARRAY AREA PLUS 2 KM BUFFER)																
Displacement (%)	Mortality rates (%)															
	0	**1**	**2**	**3**	**4**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1	1	2	2	3	3	3	4	4
10	0	0	1	1	2	2	4	8	13	17	21	25	29	33	38	42
20	0	1	2	3	3	4	8	17	25	33	42	50	58	67	75	83
30	0	**1**	3	4	5	6	13	25	38	50	63	75	88	100	113	125
40	0	**2**	3	5	7	8	17	33	50	67	83	100	117	133	150	167
50	0	**2**	4	6	8	10	21	42	63	83	104	125	146	167	188	209
60	0	**3**	5	8	10	13	25	50	75	100	125	150	175	200	225	250
70	0	**3**	6	9	12	15	29	58	88	117	146	175	204	234	263	292
80	0	3	7	10	13	17	33	67	100	133	167	200	234	267	300	334
90	0	4	8	11	15	19	38	75	113	150	188	225	263	300	338	375
100	0	4	8	13	17	21	42	83	125	167	209	250	292	334	375	417

Table Note: Values in bold represent the Applicant's approach to assessment based on the available evidence and expert judgement.

4.12.2 Disturbance and displacement: operational vessel disturbance

305 Vessel movements during the operation of the wind farm for maintenance activities have the potential to disturb receptors. However, within the confines of the wind farm site and assessed buffer, the magnitude of displacement from both AyM WTGs and any associated maintenance vessel movements are already accounted for within the displacement assessment in Section 4.12.1. As individuals are assumed to be already displaced to varying degrees as specific within Section 4.12.1 no further assessment for operational vessel movements within the AyM array area and out to 2 kms is required. Therefore, it is only that vessels associated with movements to and from AyM outside of the area outlined above that require additional assessment.

306 The O&M port has not been confirmed for AyM at this stage. As described in Volume 2, Chapter 1 (application ref: 6.2.1), the total indicative number of vessel movements (i.e. return trips) over the 25-year operating life of the array is 1,232 comprising jack-up vessels (JUVs, 10 movements) service operations vessels (52 movements), crew transfer vessels (1,095 movements), lift vessels (10 movements) auxiliary vessels (64 movements) and a single cable maintenance vessel movement. This would equate to approximately 1 vessel movement every 4 days. However, it is clear from consideration of the existing volume of shipping traffic through the Liverpool Bay region (average of 58 unique vessels per day; Volume 4, Annex 9.1: Navigational Risk Assessment (application ref: 6.4.9.1)) which includes the Liverpool Bay SPA that the addition of a small number (indicative maximum average of 22 on a single day, likely maximum of 6 on any day) of vessels transiting to and from the port during the 25 year operational lifetime of the AyM project and the wind farm will have a negligible effect on the levels of shipping disturbance over and above the large number of vessel movements per day (derived from AIS data, and therefore not including smaller vessels).

307 Additional potential measures may, however, also be implemented at project-level. This could include, for example, the agreement of an appropriate vessel traffic management plan to reduce disturbance of receptors, which would typically include:

- Restricting vessel movements to existing navigation routes (where the densities of divers are typically relatively low);
- Where it is necessary to go outside of established navigational routes, selecting routes that avoid known aggregations of birds;
- Maintaining direct transit routes (to minimise transit distances through areas used by divers);
- Avoidance of over-revving of engines (to minimise noise disturbance); and,
- Briefing of vessel crew on the purpose and implications of these vessel management practices (through, for example, tool-box talks) (See Vessel Management Plan as presented in Table 3).

308 Therefore, the magnitude of impact from disturbance and displacement due to vessel movements during the operational phase has been assessed as negligible on all receptors and accordingly, following the matrix approach set out in Table 13, the effect has been assessed as **not significant** regardless of the sensitivity of the receptor.

4.12.3 Disturbance and displacement: offshore ECC

309 The MDS for disturbance and displacement in the offshore cable corridor assumes occasional routine monitoring activity, and a maximum of four repair events over the operational lifetime of the project (Table 8).

310 Overall, the potential for disturbance and displacement will be very restricted both temporally and spatially. Whilst unscheduled repair events may occur at any time of year, they are expected to be very rare occurrences (maximum of four over the project lifespan) and any disturbance and displacement will be spatially restricted to the vicinity of the repair site and access routes, and temporally restricted to the time taken to conduct the repairs. Repairs will generally be undertaken in the shortest timespan possible in order to limit disruption to the operation and revenue generation of the OWF.

311 Therefore, the magnitude of impact from disturbance and displacement within the offshore ECC during the operational phase has been assessed as negligible on all receptors and accordingly, following the matrix approach set out in Table 13, the effect has been assessed as **not significant** regardless of the sensitivity of the receptor.

4.12.4 Collision risk: array

Overview

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

313 CRM has been carried out for AyM, with detailed methods and results presented in Volume 4, Annex 4.3: Offshore Ornithology Collision Risk Modelling (application ref: 6.4.4.3), to provide information for seabird species of interest identified as potentially at risk and of interest for impact assessment. An evaluation was undertaken based on the species abundance of flying birds recorded within the array area, consideration of their vulnerability to collision (identified from the published literature) and conservation value, with the results presented in Table 14. Following the evaluation process (Section 4.9), four species were scoped in for assessment: gannet, kittiwake, great black-backed gull and herring gull. Common gull and tern species were recorded during the migratory bio-seasons only and have, therefore, been considered for migratory collision risk only.

314 CRM was undertaken using the sCRM, developed by Marine Scotland (McGregor, 2018), run deterministically for each seabird species, to determine the risk of collision when in flight.

315 CRM accounts for several different species-specific behavioural aspects of the seabirds being assessed, including the height at which birds fly, their ability to avoid moving or static structures and how active they are diurnally and nocturnally. Details of these considerations are provided in Volume 4, Annex 4.3: Offshore Ornithology Collision Risk Modelling (application ref: 6.4.4.3).

316 The assessment of collision risk follows an evidence-led approach making use of a mixture of site-specific data collected from within the AyM array and the most recent literature on seabirds and their behaviour in relation to OWFs, the details of which are presented in Volume 4, Annex 4.3: Offshore Ornithology Collision Risk Modelling (application ref: 6.4.4.3).

317 In order to provide a range of values to capture variability for each species, the key input parameters were reviewed in order to provide 'mean', 'minimum' and 'maximum' estimates of collision rates for each species, with the focus of assessments being on the mean impacts. Full details of the parameters used to calculate each estimate are given in Volume 4, Annex 4.3: Offshore Ornithology Collision Risk Modelling (application ref: 6.4.4.3).

318 All estimates are presented using Band Option 2 (BO2), while for the large gulls Band Option 3 (BO3) is additionally presented. Sample sizes of flight height estimates from site-specific aerial digital surveys were too small to produce robust estimates of flight height and therefore Band Option 1 was not used.

319 BO2 applies a uniform distribution of bird flights between the lowest and the highest levels of the rotors. The proportion of birds at Potential Collision Height (PCH) was determined from the results of the Strategic Ornithological Support Services SOSS-02 project (Cook et al., 2012) that analysed the flight height measurements taken from boat surveys conducted around the UK. The project was updated following Johnston et al. (2014), and the revised published spreadsheet is used to determine the 'generic' percentage of flights at PCH for each species based on the proposed project's WTG parameters. This Band option has been considered for all four species.

320 The Extended Band model accounts for the skewed vertical distribution of bird flight heights between the lowest and the highest levels of the rotors. Most seabird species are observed flying more frequently at the lower level of the rotor swept height, which presents lower risk of collision (i.e. closer to the sea surface) than at heights equivalent to the rotor hub height where collision risk is greater or at the upper levels. By understanding the variation of bird flight through the rotor swept area the Extended Band model considers and applies different probabilities of being struck by the moving rotor blades through the rotor swept area vertically. The Extended Band model, using Band Option 3, relies on the data spreadsheet that accompanies Johnston et al., (2014), which is the result of a statistical analysis of a large number of offshore surveys across multiple study sites. These data are fed into the model in order to allow for the flight distribution to be calculated based upon the OWF parameters of the proposed project. This Band Option is considered the most appropriate for assessing both herring gull and great black-backed gull, in line Statutory Body advice (JNCC et al. 2014).

Precautionary Nature to CRM

321 It must be noted that a number of elements of additional precaution were included in the input parameters applied in the sCRM for this assessment, including considering a range of nocturnal activity factors and lower avoidance rates than that currently predicted from the latest scientific evidence. The nature of such precaution is evidenced through the findings of the Bird Collision Avoidance Study funded by ORJIP (Offshore Renewables Joint Industry Programme), which undertook a study to understand seabird behaviour at sea around offshore wind farms (Skov et al., 2018). The ORJIP project studied birds around Thanet offshore wind farm for a two-year period (between 2014 and 2016) recording over 12,000 bird movements throughout the day and night (Skov et al., 2018). The findings of this study presented updated values for both nocturnal activity and avoidance behaviour from an empirical data source, which it recommended for future incorporation in CRM. It also reported that only six birds (all gull species) collided with WTGs from over 12,000 birds recorded during the two-year period, providing evidence of the precautionary nature of collision risk modelling for all species of seabirds.

322 A further review of the data from the ORJIP project was undertaken by Bowgen and Cook (2018), which analysed all the data collected across the two-year period to understand more about seabird behaviour and provide evidence to support updates to the previous avoidance rates from Cook et al. (2014). The findings from this study were that for gannet and kittiwake higher avoidance rates were more appropriate of 99.5% and 99.0%, respectively. It concluded that even when applying these higher rates of avoidance, they considered that precaution remained within the estimated number of collision mortality rates.

323 Another recent study on gannets by APEM Ltd during the migratory period (APEM, 2014) found that overall avoidance of WTGs was certainly higher than the SNCBs recommended rate of 98.9%. This study found that all gannets avoided the WTGs within the study area, which provided evidence that gannets may actually have an avoidance rate as high as 100% during migratory periods at least. However, the concluding recommendation from APEM's research suggested that if it was not appropriate to use a 100% avoidance rate, then a rate of 99.5% for the autumn migration will still offer suitable precaution in collision estimates. This indicates that when estimating gannet collision mortality rates, the use of an avoidance rate of 98.9% is understood to overestimate the risk to this species, as noted by Cook et al., (2014), who acknowledged that precaution remained within the avoidance rates put forward for gannets and gull species.

324 Therefore, it is considered that the CRM input parameters used in the assessment of collision risk to seabirds for AyM and those from other developments at the cumulative level incorporate a high degree of precaution.

Results

325 The monthly collision rates and total annual collisions for all species assessed is shown in Table 41.

Table 41: Monthly and annual collision estimates for each species considered. Collision estimates presented are based on mean values with the minimum and maximum values in parentheses.

MONTH	GANNET (BO2)	KITTIWAKE (BO2)	HERRING GULL		GREAT BLACK-BACKED GULL	
			BO2	BO3	BO2	BO3
January	0.00 *(0.00 - 0.00)*	4.74 *(2.03 – 11.59)*	0.87 *(0.00 – 3.85)*	0.44 *(0.00 – 2.18)*	0.00 *(0.00 - 0.00)*	0.00 *(0.00 - 0.00)*
February	0.00 *(0.00 - 0.00)*	5.05 *(1.38 – 13.34)*	0.43 *(0.00 – 1.83)*	0.22 *(0.00 – 1.04)*	0.00 *(0.00 - 0.00)*	0.00 *(0.00 - 0.00)*
March	0.00 *(0.00 - 0.00)*	8.54 *(4.36 – 17.62)*	0.00 *(0.00 - 0.00)*	0.00 *(0.00 - 0.00)*	0.74 *(0.00–3.01)*	0.44 *(0.00 – 1.97)*
April	0.90 *(0.00 – 3.21)*	10.11 *(0.64 – 28.15)*	1.07 *(0.00 – 4.12)*	0.54 *(0.00 – 2.33)*	0.00 *(0.00 - 0.00)*	0.00 *(0.00 - 0.00)*
May	0.44 *(0.00 – 1.69)*	7.09 *(2.07 – 16.23)*	0.00 *(0.00 - 0.00)*	0.00 *(0.00 - 0.00)*	0.69 *(0.00 – 2.54)*	0.41 *(0.00 – 1.66)*
June	1.01 *(0.17 – 2.63)*	0.45 *(0.00 – 1.55)*	0.59 *(0.00 – 2.11)*	0.30 *(0.00 – 1.20)*	0.83 *(0.00 – 2.95)*	0.49 *(0.00 – 1.93)*
July	7.63 *(1.50 – 19.75)*	4.77 *(1.17 – 11.18)*	0.00 *(0.00 - 0.00)*	0.00 *(0.00 - 0.00)*	1.45 *(0.00 – 5.27)*	0.86 *(0.00 – 3.45)*
August	2.20 *(0.00 – 7.66)*	0.89 *(0.00 – 2.90)*	0.00 *(0.00 - 0.00)*	0.00 *(0.00 - 0.00)*	0.66 *(0.00 – 2.48)*	0.39 *(0.00 – 1.62)*
September	4.44 *(1.08 – 12.12)*	1.26 *(0.02 – 3.69)*	0.00 *(0.00 - 0.00)*	0.00 *(0.00 - 0.00)*	0.00 *(0.00 - 0.00)*	0.00 *(0.00 - 0.00)*
October	3.61 *(0.38 – 11.74)*	2.37 *(0.02 – 7.34)*	0.00 *(0.00 - 0.00)*	0.00 *(0.00 - 0.00)*	0.00 *(0.00 - 0.00)*	0.00 *(0.00 - 0.00)*
November	0.26 *(0.00 – 1.24)*	6.65 *(1.42 – 18.92)*	0.00 *(0.00 - 0.00)*	0.00 *(0.00 - 0.00)*	0.51 *(0.00 – 2.24)*	0.30 *(0.00 – 1.46)*
December	0.00 *(0.00 - 0.00)*	1.95 *(0.55 – 5.44)*	0.00 *(0.00 - 0.00)*	0.00 *(0.00 - 0.00)*	0.00 *(0.00 - 0.00)*	0.00 *(0.00 - 0.00)*
Annual total	**20.49 *(3.13 – 60.04)***	**53.86 *(13.66 – 137.94)***	**2.96 *(0.00 – 11.91)***	**1.49 *(0.00 – 6.74)***	**4.87 *(0.00 – 18.49)***	**2.89 *(0.00 – 12.10)***

Kittiwake

Potential magnitude of impact

326 The monthly estimated mortality rates are presented in Table 41, which vary from a minimum of less than one individual in June to a maximum of approximately 10 individuals in April. On an annual basis, the estimated mortality rate for collision risk from AyM is approximately 54 individuals, with a range of between 14 and 138 individuals using the minimum and maximum sCRM outputs (Table 41), which is further broken down into relevant bio-seasons in Table 42.

Table 42: Kittiwake bio-season collision risk estimates.

BIO-SEASON (MONTHS)	MEAN COLLISIONS (MIN – MAX)	REGIONAL BASELINE POPULATIONS AND BASELINE MORTALITY RATES (INDIVIDUALS PER ANNUM)		INCREASE IN BASELINE MORTALITY (%)
		POPULATION	BASELINE MORTALITY	
Return Migration (January – April)	28.4 (*8.4 – 70.7*)	691,526	108,570	0.026 (*0.008 – 0.065*)
Migration-free Breeding (May – July)	12.3 (*3.2 – 29.0*)	325,953	52,669	0.023 (*0.006 – 0.055*)
Post-breeding Migration (August – December)	13.1 (*2.0 – 38.3*)	911,586	142,914	0.009 (*0.001 – 0.027*)
Annual (BDMPS)	**53.9** (*13.7 – 137.9*)	911,586	142,914	**0.038** (*0.010 – 0.097*)
Annual (Biogeographic)	**53.9** (*13.7 – 137.9*)	5,100,000	799,555	**0.007** (*0.002 – 0.017*)

Table Note: Values in bold represent the Applicant's approach to assessment based on the available evidence and expert judgement.

327 During the return migration bio-season, 28 (28.4) kittiwakes may be subject to mortality. During the return migration bio-season, the BDMPS population is 691,526 kittiwakes (Table 17). When the average baseline mortality rate of 0.157 (Table 18) is applied, the natural predicted mortality in the return migration bio-season is 108,414 individuals per annum. The addition of 28 predicted mortalities would increase the mortality relative to baseline mortality by 0.026%.

328 This level of potential change is considered to be an impact of **negligible magnitude during the return migration bio-season**, as it represents only a slight difference to the baseline conditions due to the small number of estimated collisions.

329 During the migration-free breeding bio-season, 12 (12.3) kittiwakes may be subject to mortality. During the migration-free breeding bio-season, the total regional baseline population of breeding adults and immature birds is predicted to be 335,953 kittiwakes (Table 17). When the average baseline mortality rate of 0.157 (Table 18) is applied, the natural predicted mortality in the migration-free breeding bio-season is 52,669 individuals per annum. The addition of 12 predicted mortalities would increase the mortality relative to the baseline mortality rate by 0.023%.

330 This level of potential change is considered to be an impact of **negligible magnitude during the migration-free breeding bio-season**, as it represents only a slight difference to the baseline conditions due to the small number of estimated collisions.

331 During the post-breeding migration bio-season, 13 (13.1) kittiwakes may be subject to mortality. The BDMPS population for the post-breeding migration bio-season is defined as 911,586 (Table 17) and, using the average baseline mortality rate of 0.157 (Table 18), the natural predicted mortality in the post-breeding migration bio-season is 142,914 individuals. The addition of 13 predicted mortalities would increase the mortality relative to the baseline mortality rate by 0.009%.

332 This level of potential change is considered to be of **negligible magnitude during the post-breeding migration bio-season**, as it represents no discernible increase to baseline mortality levels due to a small number of estimated collisions.

333 The annual total of kittiwakes subject to mortality due to collision is estimated to be 54 (53.9) individuals. Using the largest BDMPS population of 911,586 (Table 17), as a proxy for the annual BDMPS population, with an average baseline mortality rate of 0.157 (Table 18), the natural predicted mortality is 142,914 individuals per annum. The addition of 54 predicted mortalities would increase baseline mortality by 0.038% when considering the annual BDMPS population. When considering the annual potential level of change at the biogeographic scale, the natural predicted mortality for the biogeographic population of 5,100,000 (Table 17) across all seasons is 799,555 individuals per annum. On a biogeographic scale, the addition of 54 predicted mortalities would increase baseline mortality by 0.007%.

334 This level of potential impact is considered to be an impact of **low magnitude on an annual basis at both the BDMPS and bio-geographic scales**, as it represents no discernible increase to baseline mortality levels due to the small number of estimated collisions.

Sensitivity of the receptor

335 As this receptor is a notified feature of one SSSI considered to have potential connectivity to AyM, and is Red listed in BoCC5 (Stanbury et al., 2021), this receptor is afforded a feature importance level of "national" to reflect that. With respect to behavioural sensitivity to collision, it is considered to be medium (Table 14). As it is of medium behavioural sensitivity, and it is of national importance leading to an overall sensitivity of this receptor to disturbance and displacement of **medium**.

Significance of effect

336 Following the matrix approach set out in Table 13 given a sensitivity of medium and a magnitude of impact of low, the overall effect is concluded to be minor, which is not significant in EIA terms.

Great black-backed gull

Potential magnitude of impact

337 The monthly estimated mortality rates are presented in Table 41. For the purpose of this assessment the Applicant considers BO3 to be the most appropriate model, as it takes into account skewed vertical distribution of bird flight heights between the lowest and the highest levels of the rotors. Monthly predicted collisions varied from zero individuals in six months to a maximum of approximately one individual in July. On an annual basis, the estimated mortality rate for collision risk from AyM is approximately three individuals. This is further broken down into relevant bio-seasons in Table 43.

338 As detailed in Section 4.10, due to the location of AyM in relation to the regional populations defined in Furness (2015), the Applicant has assessed impacts on great black-backed gull against two different BDMPS and a third combined BDMPS in order to fully encapsulate predicted impacts from AyM.

Table 43: Great black-backed gull bio-season collision risk estimates.

POPULATION	BIO-SEASON (MONTHS)	MEAN COLLISIONS (MIN – MAX)		REGIONAL BASELINE POPULATIONS AND BASELINE MORTALITY RATES (INDIVIDUALS PER ANNUM)		INCREASE IN BASELINE MORTALITY (%)	
		BO2	BO3	POPULATION	BASELINE MORTALITY	BO2	BO3
UK South-west & English Channel BDMPS	Breeding (April – August)	3.6 (0.0 – 13.2)	2.1 (0.0 – 8.7)	10,020	936	0.387 (0.000 – 1.414)	0.230 (0.000 – 0.925)
	Non-Breeding (September – March)	1.2 (0.0 – 5.2)	0.7 (0.0 – 3.4)	17,742	1,658	0.075 (0.000 – 0.316)	0.044 (0.000 – 0.207)
	Annual	4.9 (0.0 – 18.5)	**2.9** (0.0 – 12.1)	17,742	1,658	0.294 (0.000 – 1.115)	**0.174** (0.000 – 0.730)
UK West of Scotland BDMPS	Breeding (April – August)	3.6 (0.0 – 13.2)	2.1 (0.0 – 8.7)	19,296	1,803	0.201 (0.000 – 0.734)	0.119 (0.000 – 0.481)
	Non-Breeding (September – March)	1.2 (0.0 – 5.2)	0.7 (0.0 – 3.4)	34,380	3,213	0.039 (0.000 – 0.163)	0.023 (0.000 – 0.107)
	Annual)	4.9 (0.0 – 18.5)	**2.9** (0.0 – 12.1)	34,380	3,213	0.152 (0.000 – 0.575)	**0.090** (0.000 – 0.377)
Combined Western Waters BDMPS	Breeding (April – August)	3.6 (0.0 – 13.2)	2.1 (0.0 – 8.7)	29,187	2,728	0.133 (0.000 – 485)	0.087(0.000 – 0.485)
	Non-Breeding (September – March)	1.2 (0.0 – 5.2)	0.7 (0.0 – 3.4)	52,122	4,871	0.026 (0.000 – 0.108)	0.019 (0.000 – 0.108)
	Annual	4.9 (0.0 – 18.5)	**2.9** (0.0 – 12.1)	52,122	4,871	0.100 (0.000 – 0.380)	**0.068** (0.000 – 0.380)
Biogeographic	Annual	4.9 (0.0 – 18.5)	**2.9** (0.0 – 12.1)	235,000	21,962	0.022 (0.000 – 0.084)	**0.013** (0.000 – 0.055)

Table Note: Values in bold represent the Applicant's approach to assessment based on the available evidence and expert judgement.

339 During the breeding bio-season, two (2.1) great black-backed gulls may be subject to mortality. When assessing against the three different BDMPS populations in Table 43, the addition of two mortalities would increase baseline mortality by 0.079-0.230%.

340 This level of potential change is considered to be an impact of **Low magnitude during the return migration bio-season**, as it represents only a small difference to the baseline conditions due to the very small number of estimated collisions.

341 During the non-breeding bio-season, less than one (0.7) great black-backed gull may be subject to mortality. When assessing against the three different BDMPS populations in Table 43, the addition of less than one mortality would increase baseline mortality 0.015-0.044%.

342 This level of potential change is considered to be an impact of **negligible magnitude during the post-breeding migration bio-season**, as it represents no discernible change to baseline mortality due to the slight number of estimated collisions.

343 The annual total of great black-backed gulls subject to mortality due to collision is estimated to be three (2.9) individuals. When assessing against the three different BDMPS populations in Table 43, the addition of three mortalities would increase baseline mortality by 0.059-0.174% when considering the different annual BDMPS populations. When considering the annual potential level of change at the biogeographic scale, the natural predicted mortality for the biogeographic population of 235,000 (Table 17) across all seasons is 21,962 individuals per annum. On a biogeographic scale, the addition of three mortalities would increase baseline mortality by 0.013%.

344 This level of potential impact is considered to be an impact of **negligible magnitude on an annual basis at both the BDMPS and bio-geographic scales**, as it represents no discernible increase to baseline mortality levels due to the small number of estimated collisions.

Sensitivity of the receptor

345 As this receptor is not connected with a significant number of designated sites within the UK South-west and Channel BDMPS or wider bio-geographic population scales, but is Amber listed in BoCC5 (Stanbury et al., 2021), this receptor is afforded a feature importance level of "local" to reflect that. With respect to behavioural sensitivity to collision, it is considered to be high (Table 14). Whilst it may be of high behavioural sensitivity, it is only of local importance leading to an overall sensitivity of this receptor to collision risk of **medium**.

Significance of effect

346 Following the matrix approach set out in Table 13, given a sensitivity of medium and a magnitude of impact of negligible, the overall effect is concluded to be minor. However, when considering expert opinion, given the potential impact level is under three mortalities per annum the overall significance of effect is considered to be negligible, which is **not significant** in EIA terms.

Herring gull

Potential magnitude of impact

347 The monthly estimated mortality rates are presented in Table 41. For the purpose of this assessment the Applicant considers BO3 to be the most appropriate model, as it takes into account skewed vertical distribution of bird flight heights between the lowest and the highest levels of the rotors. Monthly predicted collisions varied from zero individuals in eight months to a maximum of one individual in April. On an annual basis, the estimated mortality rate from collision risk from AyM is approximately two individuals per annum, this is further broken down into relevant bio-seasons in Table 44.

Table 44: Herring gull bio-season collision risk estimates.

BIO-SEASON (MONTHS)	MEAN COLLISIONS (MIN – MAX)		REGIONAL BASELINE POPULATIONS AND BASELINE MORTALITY RATES (INDIVIDUALS PER ANNUM)		INCREASE IN BASELINE MORTALITY (%)	
	BO2	BO3	POPULATION	BASELINE MORTALITY	BO2	BO3
Breeding (March - August)	1.7 (0.0 – 6.2)	0.8 (0.0 – 3.5)	91,145	15,710	0.011 (0.000 – 0.040)	0.005 (0.000 – 0.022)
Non-breeding (September – February)	1.3 (0.0 – 5.7)	0.7 (0.0 – 3.2)	173,299	29,871	0.004 (0.000 – 0.019)	0.002 (0.000 – 0.011)
Annual (BDMPS)	3.0 (0.0 – 11.9)	**1.5** (0.0 – 6.7)	173,299	29,871	0.010 (0.000 – 0.040)	**0.005** (0.000 – 0.023)
Annual (Biogeographic)	3.0 (0.0 – 11.9)	**1.5** (0.0 – 6.7)	1,098,000	189,257	0.002 (0.000 – 0.006)	**0.001** (0.000 – 0.004)

Table Note: Values in bold represent the Applicant's approach to assessment based on the available evidence and expert judgement.

348 During the breeding bio-season, less than one (0.8) herring gull may be subject to mortality. During the breeding bio-season, the regional population is estimated to be 90,879 (Table 17). When the average baseline mortality rate of 0.172 (Table 18) is applied, the natural predicted mortality in the breeding bio-season is 15,631 individuals per annum. The addition of less than one predicted mortality would increase baseline mortality by 0.005%.

349 This level of potential change is considered to be an impact of **negligible magnitude during the breeding bio-season**, as it represents no discernible change to baseline mortality due to the very small number of estimated collisions.

350 During the non-breeding bio-season, less than one (0.7) herring gull may be subject to mortality. During the non-breeding bio-season, the BDMPS population is estimated to be 173,299 individuals (Table 17). When the average baseline mortality rate of 0.172 (Table 18) is applied, the natural predicted mortality in the non-breeding bio-season is 29,807 individuals per annum. The addition of less than one predicted mortality would increase baseline mortality by 0.002%.

351 This level of potential change is considered to be an impact of **negligible magnitude during the non-breeding bio-season**, as it represents no discernible change to baseline mortality due to the very small number of estimated collisions.

352 The annual total of herring gulls subject to mortality due to collision is estimated to be under two (1.5) individuals. Using the largest BDMPS population of 173,299 (Table 17), as a proxy for the annual BDMPS population, with an average baseline mortality rate of 0.172 (Table 18), the natural predicted mortality is 29,807 individuals per annum. The addition of two predicted mortalities would increase baseline mortality by 0.005%, when considering the annual BDMPS population. When considering the annual potential level of change at the biogeographic scale, the natural predicted mortality for the biogeographic population of 1,098,000 (Table 17) across all seasons is 188,856 individuals per annum. On a biogeographic scale, the addition of two predicted mortalities would increase baseline mortality by 0.001%.

353 This level of potential change is considered to be an impact of **negligible magnitude on an annual basis at both the BDMPS and bio-geographic scales**, as it represents no discernible increase to baseline mortality levels due to the very small number of estimated collisions.

Sensitivity of the receptor

354 As this receptor is not connected with a significant number of designated sites within the UK South-west and Channel BDMPS or wider bio-geographic population scales, but is Red listed in BoCC5 (Stanbury et al., 2021), this receptor is afforded a feature importance level of "local" to reflect that. With respect to behavioural sensitivity to collision, it is considered to be high (**Table 14**). Whilst it may be of high behavioural sensitivity, it is only of local importance leading to an overall sensitivity of this receptor to collision risk of **medium**.

Significance of effect

355 Following the matrix approach set out in Table 13 given a sensitivity of medium and a magnitude of impact of negligible, the overall effect is concluded to be minor. However, when considering expert opinion, given the potential impact level is under two mortalities per annum the overall significance of effect is considered to be negligible, which is **not significant** in EIA terms.

Gannet

Potential magnitude of impact

356 The monthly estimated mortality rates are presented in Table 41, which vary from a minimum of zero individuals in four different months to a maximum of approximately eight individuals in July. On an annual basis, the estimated mortality rate for collision risk from AyM is approximately 21 individuals, which is further broken down into relevant bio-seasons in Table 45.

Table 45: Gannet bio-season collision risk estimates.

BIO-SEASON (MONTHS)	MEAN COLLISIONS (MIN – MAX)	REGIONAL BASELINE POPULATIONS AND BASELINE MORTALITY RATES (INDIVIDUALS PER ANNUM)		INCREASE IN BASELINE MORTALITY (%)
		POPULATION	BASELINE MORTALITY	
Return Migration (December – March)	0.00 (0.00 – 0.00)	661,888	124,188	0.000 (0.000 – 0.000)
Migration-free Breeding (April – August)	12.2 (1.7 – 34.9)	474,738	89,074	0.014 (0.002 – 0.039)
Post-breeding Migration (September- November)	8.3 (1.5 – 25.1)	454,954	85,362	0.010 (0.002 – 0.029)
Annual (BDMPS)	**20.5** (3.1 – 60.0)	661,888	124,188	**0.016** (0.003 – 0.048)
Annual (Biogeographic)	**20.5** (3.1 – 60.0)	1,180,000	221,400	**0.009** (0.001 – 0.027)

Table Note: Values in bold represent the Applicant's approach to assessment based on the available evidence and expert judgement.

357 During the return migration bio-season, zero gannets are expected to be subject to mortality. There is therefore **no impact in the return migration bio-season**.

358 During the migration-free breeding bio-season, 12 (12.2) gannets may be subject to mortality. During the migration-free breeding bio-season, the total regional baseline population is predicted to be 474,738 gannets (Table 17). When the average baseline mortality rate of 0.188 (Table 18) is applied, the natural predicted mortality in the migration-free breeding bio-season is 89,074 individuals per annum. The addition of 12 predicted mortalities would increase baseline mortality by 0.014%.

359 This level of potential change is considered to be an impact of **negligible magnitude during the migration-free breeding bio-season**, as it represents no discernible difference to the baseline conditions due to the small number of estimated collisions.

360 During the post-breeding migration bio-season, eight (8.3) gannets may be subject to mortality. The BDMPS population for the post-breeding migration bio-season is defined as 454,954 (Table 17) and using the average baseline mortality rate of 0.188 (Table 18), the natural predicted mortality in the post-breeding migration bio-season is 85,362 individuals per annum. The addition of eight predicted mortalities would increase baseline mortality by 0.010%.

361 This level of potential change is considered to be an impact of **negligible magnitude during the post-breeding migration bio-season**, as it represents no discernible increase to baseline mortality levels due to a very small number of estimated collisions.

362 The annual total of gannets subject to mortality due to collision is estimated to be 21 (20.5) individuals. Using the largest BDMPS population of 661,888 (Table 17), as a proxy for the annual BDMPS population, with an average baseline mortality rate of 0.188 (Table 18), the natural predicted mortality is 124,188 individuals per annum. The addition of 21 predicted mortalities would increase baseline mortality by 0.016% of the annual BDMPS population. When considering the annual potential level of change at the biogeographic scale, the natural predicted mortality for the biogeographic population of 1,180,000 (Table 17) across all seasons is 221,400 individuals per annum. On a biogeographic scale, the addition of 21 predicted mortalities would increase baseline mortality by 0.009%.

363 This level of potential impact is considered to be **low on an annual basis at both the BDMPS and bio-geographic scales**, as it represents no discernible increase to baseline mortality levels due to the small number of estimated collisions.

Sensitivity of the receptor

364 As detailed in Section 4.11.1, this receptor is afforded a feature conservation value of "medium". With respect to behavioural sensitivity to collision, it is considered to be medium (**Table 14**). As this species is of medium behavioural sensitivity, and it is of medium conservation value, this leads to an overall sensitivity of this receptor to disturbance and displacement of **medium**.

Significance of effect

365 Following the matrix approach set out in **Table 13**, given a sensitivity of medium and a magnitude of impact of low, the overall effect is concluded to be minor, which is not significant in EIA terms.

Migratory seabirds and non-seabirds

366 In addition to the seabirds considered individually above, migrant seabirds and non-seabirds flying through the array during the operational phase are at risk of collision with WTG rotors and associated infrastructure. The result of such collisions may be fatal to the bird concerned. Migratory birds may not be reliably detected using aerial digital surveys or any other standard survey method. Migratory birds may move through in short pulses, in poor weather or at night (when no surveys take place), or at high altitudes, which makes recording their numbers extremely complex.

367 An assessment of the risk of collision to migratory birds has been carried out for AyM, with detailed methods and results presented in Volume 4, Annex 4.4: Migratory Collision Risk Modelling (application ref: 6.4.4.4). An initial screening exercise was carried out to identify species potentially at risk from collision during migration. A list of 35 species of birds (mostly migratory waterbirds and seabirds) were identified based on the screening exercise for assessment of migratory collision risk (screening rationale provided in Appendix 1 of Volume 4, Annex 4.4, application ref: 6.4.4.4). Migrant birds were then assessed using either a 'broad front' approach or APEM's bespoke modelling approach, using Migropath, to estimate the number of individuals expected to pass through the array area each year. For species assessed using Migropath, where the number of individuals predicted to pass through the array area exceeded 1% of the UK population, CRM was carried out using the Band (2012) CRM. Based on this assumption the following species were screened out: whooper swan, white-fronted goose (flavirostris), shelduck, wigeon, gadwall, teal, mallard, pintail, shoveler, tufted duck, cormorant (wintering only), hen harrier, golden plover (wintering only), grey plover, lapwing, dunlin (wintering only), snipe, bar-tailed godwit, whimbrel and curlew (breeding only), as less than 1% of the UK population was predicted to pass through the array area, and therefore the maximum impact would be of negligible magnitude.

368 CRM was carried out using Band Option 1 for all species and Band Option 2 for species where species-specific flight height distribution data were available in Johnston et al. (2014). As there is no specific avoidance rate calculated for the majority of species in Table 46 and Table 47 an avoidance rate of 98% was used for evaluation of collision risk as recommended in Cook et al. (2014), except for common gull which is based on the avoidance rate of 99.2% recommended by Cook et al. (2014). The evidence-led results of CRM for the remaining 17 species is shown in Table 46 and Table 47. Additional results are presented in Volume 4, Annex 4.4: Migratory Collision Risk Modelling (application ref: 6.4.4.4).

Table 46: Summary of collision risk assessment on migrant waterbirds from AyM.

SPECIES	UK POPULATION	ADULT BASELINE MORTALITY (ROBINSON, 2005)	UK BASELINE MORTALITY	AVOIDANCE RATE	ANNUAL COLLISION RATE (BO1)	INCREASE IN BASELINE MORTALITY (%)
Red-breasted Merganser (wintering)**	11,000	0.180	1,980	98.0%	0.0	0.002%
Cormorant (migratory breeding)*	17,800	0.132	2,350	98.0%	0.2	0.006%
Oystercatcher (Wintering)	305,000	0.120	36,600	98.0%	1.1	0.003%
Ringed plover (migratory breeding)	10,900	0.228	2,485	98.0%	0.0	0.002%
Ringed plover (passage)	42,500	0.228	9,690	98.0%	0.1	0.001%
Golden plover (migratory breeding)	65,000	0.270	17,550	98.0%	0.6	0.003%
Golden plover (migratory breeding)	101,000	0.270	27,270	98.0%	0.9	0.003%
Knot (Wintering)	265,000	0.159	42,135	98.0%	0.6	0.001%
Sanderling (Wintering)	20,000	0.170	3,400	98.0%	0.1	0.003%
Dunlin (migratory breeding)	17,200	0.260	4,472	98.0%	0.0	0.001%
Dunlin (migratory breeding)	21,000	0.260	5,460	98.0%	0.1	0.001%

SPECIES	UK POPULATION	ADULT BASELINE MORTALITY (ROBINSON, 2005)	UK BASELINE MORTALITY	AVOIDANCE RATE	ANNUAL COLLISION RATE (BO1)	INCREASE IN BASELINE MORTALITY (%)
Black-tailed godwit (Icelandic; Wintering)	41,000	0.060	2,460	98.0%	0.3	0.011%
Curlew (Wintering)	140,000	0.101	14,140	98.0%	0.5	0.003%
Greenshank (wintering)**	2,200	0.260	572	98.0%	0.0	0.002%
Redshank (robusta; Wintering)	150,000	0.260	39,000	98.0%	0.6	0.001%
Redshank (robusta; Wintering)	400,000	0.260	104,000	98.0%	1.5	0.001%
Redshank (totanus; wintering	25,000	0.260	6,500	98.0%	0.1	0.001%
Redshank (britannica; migratory breeding)	44,000	0.260	11,440	98.0%	0.2	0.001%
Turnstone (Wintering)	43,000	0.140	6,020	98.0%	0.1	0.002%

Table note: * denotes species that have adult mortality rates derived from Hornswill and Robinson (2015).** denotes species which have had to refer to related species as a proxy for adult mortality rates (in this instance goosander has been used as a proxy for Red-breasted merganser and redshank as a proxy for greenshank).

Table 47: Summary of collision risk assessment on migrant seabirds from AyM.

SPECIES	POPULATION SIZE ASSESSED	ADULT BASELINE MORTALITY (HORSWILL & ROBINSON, 2015)	BASELINE MORTALITY	AVOIDANCE RATE	ANNUAL COLLISION RATE (BO1)	ANNUAL COLLISION RATE (BO2)	INCREASE IN BASELINE MORTALITY (%)
Common gull	34,139	0.172	5,872	99.2%	0.2	0.1	0.002 – 0.004%
Sandwich tern	4329	0.102	442	98.0%	0.1	0.1	0.023 – 0.025%
Common tern	6244	0.117	731	98.0%	0.5	0.2	0.021 – 0.073%
Arctic tern	42,180	0.163	6,875	98.0%	0.8	0.5	0.007 – 0.011%

Potential magnitude of impact

369 The predicted collision risk values attributed to AyM as presented in Table 46 and Table 47 range from a minimum of zero predicted annual mortalities to a maximum of two predicted annual mortalities. For all migratory receptors the predicted increase in baseline mortality due to collision was found to be at most 0.025% per annum.

370 This level of potential impact is considered to be **negligible on an annual basis**, as it represents no discernible increase to baseline mortality levels due to the small number of estimated collisions.

Significance of effect

371 Given a magnitude of impact of negligible irrespective of the receptor's sensitivity, following the matrix approach set out in Table 13, the significance of effect has been assessed as minor at most, which is **not significant.**

4.12.5 Combined Operational Displacement and collision risk

Gannet

372 Due to gannet being scoped in for both displacement and collision risk assessments during the O&M phase, there is potential for these two potential impacts to adversely affect gannet populations cumulatively. Previous sections have concluded low and negligible predicted magnitudes of impact with respect to collision risk or displacement acting alone; however, the combined impact of both collision risk and displacement may be greater than either one acting alone. Further consideration of both impacts acting together is therefore required. However, it is recognised that assessing these two potential impacts together amounts 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.

Potential magnitude of impact

373 As detailed in Table 37 and Table 45, following the Applicant's evidence-led assessments the combined predicted mortality in the O&M phase (displacement and collision risk) equates to between 24 (23.7) and 25 (24.7) predicted additional mortality per annum. Using the largest BDMPS population of 661,888 (Table 17), as a proxy for the annual BDMPS population, with an average baseline mortality rate of 0.188 (Table 18), the natural predicted mortality is 124,188 individuals per annum. The addition of 24 to 25 predicted mortalities would increase baseline mortality by 0.019-0.020% of the annual BDMPS population. When considering the annual potential level of change at the biogeographic scale, the natural predicted mortality for the biogeographic population of 1,180,000 (Table 17) across all seasons is 221,400 individuals per annum. On a biogeographic scale, the addition of 24 to 25 predicted mortalities would increase baseline mortality by 0.011%. It should be noted that the impacts associated with both displacement and collision risk combined assessed in this simplistic additive manner are almost certainly an overestimate, as a bird which has been displaced from the array area can no longer collide with a turbine and vice versa.

374 This level of potential impact is considered to be an impact of **low magnitude on an annual basis at both the BDMPS and bio-geographic scales**, as it represents no discernible increase to baseline mortality levels due to the small number of estimated mortalities from both displacement and collision combined.

Sensitivity of the receptor

375 As detailed in Section 4.11.1 and 4.12.4, this receptor is afforded a feature conservation value of "medium". With respect to behavioural sensitivity to collision, it is considered to be medium (Table 14). As this receptor is of medium behavioural sensitivity, and it is of medium conservation value, this leads to an overall sensitivity of this receptor to disturbance and displacement of **medium**.

Significance of effect

376 Following the matrix approach set out in Table 13., given a sensitivity of medium and a magnitude of impact of low, the overall effect is concluded to be minor, which is not significant in EIA terms.

4.12.6 Indirect impacts due to impacts on prey: array

377 During the operational phase of AyM, there is the potential for indirect effects on offshore ornithology arising from impacts on prey species affecting their availability. Original loss of seabed habitats may reduce prey availability. Furthermore, temporary seabed disturbance resulting from array cable repairs may release sediment into the water column, causing fish and mobile invertebrates to avoid the array. Suspended sediment may also smother and hide immobile benthic prey. Increased suspended sediment would also make it harder for seabirds to see their prey in the water column. These mechanisms may result in less prey being available within the operational array to foraging seabirds.

378 However, the total area of original habitat loss within the array is predicted to be a maximum of 1.42 km^2, representing approximately 1.6% of the total array area. The total area of temporary seabed disturbance predicted to occur over the 25-year operational lifespan of the array is 0.036 km^2. Therefore, both original habitat loss for prey species and temporary increases in suspended sediment will be small in extent. As no significant effects were identified to potential prey species (fish, shellfish or benthos) or on the habitats that support them in Volume 2, Chapter 5 (application ref: 6.2.5) and Volume 2, Chapter 6 (application ref: 6.2.6), then there is **no potential for any indirect effects of an adverse significance to occur on offshore ornithology receptors.**

4.12.7 Indirect impacts due to impacts on prey: offshore ECC

379 During the operational phase of the offshore ECC, there is the potential for indirect effects on offshore ornithology arising from impacts on prey species affecting their availability. Original loss of seabed habitats may reduce prey availability. Furthermore, temporary seabed disturbance resulting from offshore export cable repairs may release sediment into the water column, causing fish and mobile invertebrates to avoid the array. Suspended sediment may also smother and hide immobile benthic prey. Increased suspended sediment would also make it harder for seabirds to see their prey in the water column. These mechanisms may result in less prey being available within the offshore ECC to foraging seabirds.

380 However, the total area of original habitat loss within the offshore ECC is predicted to be a maximum of 0.27 km^2, representing approximately 0.4% of the total offshore ECC. The total area of temporary seabed disturbance predicted to occur over the 25-year operational lifespan of AyM is 0.024 km^2. Therefore, both original habitat loss for prey species and temporary increases in suspended sediment will be small in extent. As no significant effects were identified to potential prey species (fish, shellfish or benthos) or on the habitats that support them in Volume 2, Chapter 5 (application ref: 6.2.5) and Volume 2, Chapter 6 (application ref: 6.2.6), then there is **no potential for any indirect effects of an adverse significance to occur on offshore ornithology receptors.**

4.12.8 Barrier effects: array

381 In the operational phase of AyM, the presence of WTGs could create a barrier to the movements of flying birds. This may result in permanent changes in flight routes for the birds concerned and an increase in energy demands associated with those movements. This might result in a lower rate of breeding success or in reduced survival chances for the individuals affected. This could affect both birds on annual migrations as well as diurnal movements between roosting/breeding areas and foraging sites.

382 For the purposes of assessment however, it is usually not possible to distinguish between displacement and barrier effects (for example, to define where individual birds may have intended to travel to, or beyond an offshore wind farm, even when tracking data are available). Therefore, it should be noted that the effects of displacement from the array during the operational phase of AyM encapsulate potential barrier effects for the receptors considered, due to the inclusion of flying and sitting birds (all behaviours) within the assessment of displacement, as recommended in SNCB guidance (2017).

Annual migrations

383 The small risk of impact to migrating birds resulting from flying around rather than through the WTG array of an OWF is considered a potential barrier effect. Speakman et al., (2009) and Masden et al., (2010, 2012) calculated that the costs of one-off avoidances during migration were small, accounting for less than 2% of available fat reserves. Therefore, **the potential magnitude of impacts on birds that only migrate through the site (including seabirds, waders and waterbirds on passage) are considered negligible**. As such, following the matrix approach set out in Table 13, this effect has been assessed as **not significant** for all receptors regardless of their sensitivity.

Diurnal movements

384 Consideration has also been given to the potential impact of barrier effects on species which move on a daily basis. In particular, common scoter overwintering in the region are known to overnight near the shore but then travel further out to forage during the day.

385 The potential for a barrier effect to arise was considered for GyM, and the Marine Licence requirements included ornithological monitoring to assess any such barrier effect. The ornithological monitoring programme covered the pre- during- and post-construction phases of GyM, spanning the period 2010 to 2019. The methodology and subsequent reports have been reviewed and agreed by NRW (APEM, 2019).

386 The ornithological monitoring programme for GyM found no evidence of a barrier effect for common scoter or any other species detected (APEM, 2019). The monitoring programme found evidence of common scoter and red-throated diver within the GyM array area post-construction, in comparable densities to pre-construction. Analysis of common scoter flight directions found no evidence that flight directions changed between pre- and post-construction monitoring.

387 Given this site-specific evidence that no barrier effect has occurred as a result of GyM, it follows that AyM will similarly lead to no detectable barrier effect. The **magnitude of impact has therefore been assessed as negligible**. As such, following the matrix approach set out in Table 13, this effect has been assessed as **not significant** for all receptors regardless of their sensitivity.

4.12.9 Impacts of aviation and navigation lighting: array

Sensitivity of the receptor

388 There is the potential that aviation and navigation lighting on WTGs could attract or repel birds moving through AyM at night. There is evidence that nocturnal lighting may cause changes in bird behaviour and habitat selection (reviewed in Drewitt and Langston, 2008) but as WTGs are less intensively lit in comparison with oil and gas platforms, which much of the evidence is based upon, so the impacts are likely to be less extreme.

389 The species that are likely to be present in largest numbers (fulmar, gannet, kittiwake and auk species) are unlikely to be active at night, either returning to colonies or roosting on the sea surface (Wade et al., 2016). A tracking study by Furness et al., (2018) reported that gannet flight and diving activity was minimal during the night. Gulls are known to have low to moderate levels of nocturnal activity, being visual foragers that are known to be attracted to lit fishing vessels and well-lit oil and gas platforms that attract fish to the surface waters (Burke et al., 2012). Kotzerka et al., (2010) reported that kittiwake foraging trips mainly occurred during daylight and birds were largely inactive at night and therefore at lower risk. Fulmar has a relatively high nocturnal activity rate, however very few flights are likely to be at collision risk height (Wade et al., 2016). Therefore, it is likely that all bird species in the marine environment would exhibit no more than a low to medium sensitivity to lighting from AyM.

Potential magnitude of impact

390 A significant impact would only occur if large numbers of migrants pass through the site in a single event, leading to mass disorientation or collisions. However, there is insufficient evidence from existing literature or any existing UK OWFs to suggest mass collision events occur as a result of aviation and navigation lighting that is typical for UK OWFs. Evidence from Kerlinger et al., (2010) and Welcker et al., (2017) found nocturnal migrants do not have a higher risk of collision with wind energy facilities than do diurnally active species, nor do mortality rates increase at OWFs with lighting compared to those without. Furthermore, studies have shown that nocturnal flight is altered to counteract the risk of WTG collision (Dirksen et al., 1998 and Desholm and Kahlert, 2005). Therefore, **the potential magnitude of impacts would be no greater than negligible to birds with respect to lighting**.

Significance of effect

391 As the magnitude of this impact is considered to be negligible, irrespective of the sensitivity of the receptor, the significance of the residual effect is **not significant** as defined in Table 13 and is not considered further in this assessment.

4.12.10 Impacts on local and national designated sites

392 There is the potential for AyM to impact on designated sites which are protected at a local or national level, including SSSIs and Local Nature Reserves (LNRs). This assessment has only considered designated sites with potential connectivity to AyM and designated sites which include offshore ornithological receptors as notified features.

Great Orme's Head SSSI

393 The citation for Great Orme's Head SSSI states:

"The site is important as it supports the largest breeding colony of seabirds in the East Gwynedd Area of Search. These occur on the sea cliffs predominantly between March and August of each year and include guillemot Uria aalge, razorbill Alca torda, and kittiwake Rissa tridactyla. Breeding pairs of cormorant Phalacrocorax carbo and shag Phalacrocorax aristotelis are also present."

394 Detailed assessment of potential impacts on guillemots, razorbills and kittiwakes are presented in Sections 4.12.1 and 4.12.4, above. In all cases, the magnitude of impact in the breeding season were found to be negligible in comparison to the regional population in the breeding season. As described in Section 4.10, the regional population in the breeding season consists of birds from breeding colonies within mean-max foraging range plus an estimated number of immature or non-breeding birds. Therefore, while no detailed apportionment has been carried out, impacts will be split between the various colonies and non-breeding birds approximately in proportion to their contribution to the regional population. Therefore, **it is expected that the conclusion of a magnitude of impact of negligible will apply to each individual colony.**

395 Species which have not been considered in the detailed assessments above have been screened out on the basis that they were not detected or detected in only trivial numbers by the aerial digital surveys, or have been assessed as showing very low sensitivity to potential impacts of AyM. Therefore, **there is no potential for anything more than a negligible magnitude of impact on any other species.**

396 With no magnitude of impact greater than negligible expected, the overall conclusion is that any effect on the features of Great Orme's Head SSSI will be **not significant**.

Little Orme's Head SSSI

397 The citation for Little Orme's Head SSSI states:

"The site is important for its nationally important numbers of breeding cormorant Phalacrocorax carbo, which occur on sea cliffs predominantly between March and August of each year. A bonus feature is the assemblage of breeding guillemot Uria aalge, razorbill Alca torda, kittiwake Rissa tridactyla and shag Phalacrocorax aristotelis, which regularly occur alongside the cormorant."

398 Detailed assessment of potential impacts on guillemots, razorbills and kittiwakes are presented in Sections 4.12.1 and 4.12.4, above. In all cases, the magnitude of impact in the breeding season were found to be negligible in comparison to the regional population in the breeding season. As described in Section 4.10, the regional population in the breeding season consists of birds from breeding colonies within mean-max foraging range plus an estimated number of immature or non-breeding birds. Therefore, while no detailed apportionment has been carried out, impacts will be split between the various colonies and non-breeding birds approximately in proportion to their contribution to the regional population. Therefore, **it is expected that the conclusion of a magnitude of impact of negligible will apply to each individual colony.**

399 Species which have not been considered in the detailed assessments above have been screened out on the basis that they were not detected or detected in only trivial numbers by the aerial digital surveys, or have been assessed as showing very low sensitivity to potential impacts of AyM. Therefore, **there is no potential for anything more than a negligible magnitude of impact on any other species.**

400 With no magnitude of impact greater than negligible expected, the overall conclusion is that any effect on the features of Little Orme's Head SSSI will be **not significant**.

Dee Estuary SSSI

401 The Dee Estuary SSSI citation states:

"The Dee Estuary/Aber Afon Dyfrdwy is one of the most important estuaries in Britain and amongst the most important in Europe for its populations of waders and wildfowl. The estuary is particularly important for its wintering bird populations and both waders and wildfowl achieve numbers of international importance. The estuary supports internationally important populations of a number of wader species, namely, oystercatcher Haematopus ostralegus, knot Calidris canutus, curlew Numenius arquata, redshank Tringa totanus, bar-tailed godwit Limosa lapponica, black-tailed godwit Limosa limosa, grey plover Pluvialis squatarola and dunlin Calidris alpina. The waders utilise the abundant invertebrate populations principally on the extensive intertidal flats, particularly the mudflats. Several wading bird species also make extensive use of the coastal grazing marshes and fields adjoining the estuary for feeding and roosting. Around the estuary are a number of high tide roost sites; principal sites include the Hilbre Islands, the foreshore at West Kirby, the shingle spit at Point of Ayr and the saltmarshes at Oakenholt. Wildfowl present in internationally important numbers include pintail Anas acuta, for which the Dee and Mersey have been the principal British wintering estuaries for many years, teal Anas crecca and shelduck Tadorna tadorna, whilst wigeon Anas penelope occur in nationally important numbers."

"The Dee Estuary/Aber Afon Dyfrdwy is also an important staging post for migrating birds during both spring and autumn. Nationally important numbers of ringed plover Charadrius hiaticula are regularly seen on passage. In addition the summering flock of non-breeding black-tailed godwit, one of the largest in the United Kingdom, is regarded as of national importance."

"The Dee Estuary/Aber Afon Dyfrdwy also supports nationally important numbers of feeding common tern Sterna hirundo. These birds historically nested on the Burton Marshes where they were frequently inundated by spring tides. They now nest on specially developed habitats on lagoons within the Shotton Steelworks complex outside the site. The large breeding population of redshank, which utilise the ungrazed and lightly grazed saltmarshes for nesting, is regarded as of national significance."

"The Dee Estuary/Aber Afon Dyfrdwy also supports nationally important flocks of cormorant Phalacrocorax carbo, which occur throughout the year and great crested grebe Podiceps cristatus, peak numbers of which occur in the autumn during the moult."

402 There is potential for AyM to impact on these features, in particular through the potential for collision risk of waterbirds migrating to/from the site. Note that AyM is beyond the maximum foraging range of common terns breeding at the Shotton Steelworks (Woodward et al., 2019).

403 The potential impact from collisions on migrating birds has been assessed in Section 4.12.4 and it was concluded that the **overall number of collisions for all species assessed is negligible**. The Dee Estuary SPA, the citation for which includes many of the same features as the Dee Estuary SSSI, is considered in greater detail in Report 5.2: RIAA (application ref: 5.2) that accompanies this ES and it is concluded that AyM will have no Adverse Effect on Integrity (AEoI) of that site. Therefore, it is reasonable to conclude that any effect on the Dee Estuary SSSI will also be **not significant**.

Puffin Island SSSI

404 The citation for Puffin Island SSSI contains the following relevant section:

"This Carboniferous limestone island lying less than a kilometre off the eastern tip of Anglesey is principally of interest for its nesting seabirds breeding both on its sea-cliffs and open grassland areas. The seabirds involved include the three auks, puffins, guillemots and razorbills, together with cormorant, shag, fulmar and gulls namely: kittiwakes, herring gull, greater black-backed gull [sic] and lesser black-backed gull. The island supports more than 1% of the breeding Great Britain population of cormorants. The breeding puffin population, which formerly numbered several thousand pairs, has declined significantly to currently number less than a hundred pairs. However, old records suggest substantial population fluctuations in the past. A large gullery dominated by herring gull is present."

405 Detailed assessment of potential impacts on guillemots, razorbills, kittiwakes, great black-backed gulls and herring gulls are presented in Sections 4.12.1 and 4.12.4, above. In all cases, the magnitude of impact in the breeding season were found to be negligible in comparison to the regional population in the breeding season. As described in Section 4.10, the regional population in the breeding season consists of birds from breeding colonies within mean-max foraging range plus an estimated number of immature or non-breeding birds. Therefore, while no detailed apportionment has been carried out, impacts will be split between the various colonies and non-breeding birds approximately in proportion to their contribution to the regional population. Therefore, **it is expected that the conclusion of a magnitude of impact of negligible will apply to each individual colony.**

406 Species which have not been considered in the detailed assessments above have been screened out on the basis that they were not detected or detected in only trivial numbers by the aerial digital surveys, or have been assessed as showing very low sensitivity to potential impacts of AyM. Therefore, **there is no potential for anything more than a negligible magnitude of impact on any other species.**

407 Puffin Island SPA, which has the cormorant colony as its main designated feature, is assessed in more detail within Report 5.2: RIAA (application ref: 5.2) that accompanies this ES and a conclusion of no AEoI of that SPA was reached.

408 With no magnitude of impact greater than negligible expected, and no AEoI of Puffin Island SPA expected, the overall conclusion is that any effect on the features of Puffin Island SSSI will be **not significant**.

Arfordir Gogleddol Penmon SSSI

409 The citation for Arfordir Gogleddol Penmon SSSI states:

"A nationally important breeding population of over 100 pairs of cormorant utilise the site's sea cliffs, and the cliffs below Fedw Fawr also support Britain's most southerly breeding colony of black guillemot. The cliffs are also used as breeding sites by peregrine falcon, fulmar and shag."

410 None of the species mentioned have been specifically considered in the detailed displacement or collision risk assessments above. However, this is because they have been screened out on the basis that they were not detected or detected in only trivial numbers by the aerial digital surveys, or have been assessed as showing very low sensitivity to potential impacts of AyM. Therefore, **there is no potential for anything more than a negligible magnitude of impact on any other species.**

411 With no magnitude of impact greater than negligible expected, the overall conclusion is that any effect on the features of Arfordir Gogleddol Penmon SSSI will be **not significant**.

The Skerries SSSI

412 The citation for The Skerries states:

"The Skerries used to be one of the major breeding sites for terns particularly arctic terns in the British Isles. Numbers declined from the several thousand pairs recorded in 1905 to being completely deserted in the 1960s. However arctic terns have returned and 150 pairs bred there in 1983. A gullery principally of herring and lesser black-backed gulls - 650/700 pairs in 1983 is also present. Other breeding species include puffin (150 pairs), shag, oystercatcher, red-breasted merganser and rock pipit. Bird migration studies have shown that the islands are a significant station for autumn migrants."

413 Detailed assessment of potential impacts on herring gull and migratory birds are presented in Section 4.12.4, above. In both cases, the magnitude of impact was found to be negligible. Note that the distance between the AyM array and The Skerries SSSI is approximately 47 km, which is well beyond the mean foraging range (14.9 ± 7.5 km) and close to the mean-max foraging range (58.8 ± 26. 8 km) of herring gulls (Woodward et al., 2019) and therefore there is likely to be relatively little connectivity during the breeding season.

414 Species which have not been considered in the detailed assessments above have been screened out on the basis that they were not detected or detected in only trivial numbers by the aerial digital surveys, or have been assessed as showing very low sensitivity to potential impacts of AyM. Therefore, **there is no potential for anything more than a negligible magnitude of impact on any other species.**

415 With no magnitude of impact greater than negligible expected, the overall conclusion is that any effect on the features of The Skerries SSSI will be **not significant**.

4.13 Environmental assessment: decommissioning phase

4.13.1 Overview

416 The impacts of the offshore decommissioning of AyM have been assessed for offshore ornithology features. The potential environmental impacts arising from the decommissioning of AyM are listed in Table 3. The MDS against which each decommissioning phase impact has been assessed is presented in Table 8.

4.13.2 Disturbance and displacement: array

417 Decommissioning activities within the array area associated with foundations and WTGs may lead to disturbance and displacement of species within the array and different degrees of buffers surrounding it.

418 The MDS for decommissioning activities within the array area is equal to or less than the MDS for the construction phase within the array (Table 8). Therefore, for the purposes of this assessment it is assumed that the impacts are likely to be similar. Closer to the time of decommissioning, it may be decided that removal would lead to a greater environmental impact than leaving some components in situ, in which case certain components may be cut off at or below seabed level (e.g. in the case of piled foundations), or left buried (e.g. in the case of subsea cables). This may reduce the amount of vessel activity required.

419 As potential effects from disturbance and displacement within the construction phase were deemed to be not significant (see Section 4.11.1), **no significant effects** are expected within the decommissioning phase.

4.13.3 Disturbance and displacement: offshore ECC

420 Decommissioning activities within the offshore ECC associated with decommissioning the export cable may lead to disturbance and displacement of species within the offshore export cable corridor and different degrees of buffers surrounding it.

421 Therefore, the impacts are likely to be similar. The MDS for decommissioning activities within the array area is equal to or less than the MDS for the construction phase within the array (Table 8). Therefore, for the purposes of this assessment it is assumed that the impacts are likely to be similar. Closer to the time of decommissioning, it may be decided that removal would lead to a greater environmental impact than leaving some components in situ, in which case certain components may be cut off at or below seabed level (e.g. in the case of piled foundations), or left buried (e.g. in the case of subsea cables). This may reduce the amount of vessel activity required.

422 As described in Section 4.11.2, construction activities may lead to a minor (not significant) adverse impact on red-throated diver and common scoter. Accordingly, on the assumption that impacts from decommissioning will be similar or lesser in extent, there is potential for a minor, **non-significant** impact on red-throated diver and common scoter during decommissioning.

423 For all other species, as potential effects of disturbance and displacement within the construction phase were deemed to be not significant (see Section 4.11.1), **no significant** effects are expected within the decommissioning phase either**.**

4.13.4 Indirect impacts due to impacts on prey: offshore ECC

424 During the decommissioning phase of AyM there is the potential for indirect effects arising from the displacement of prey species due to increased noise and disturbance, or to disturbance of habitats from increased suspended sediment and physical disturbance to the seabed. Underwater noise may cause fish and mobile invertebrates to avoid the construction area and also affect their physiology and behaviour. Suspended sediments may cause fish and mobile invertebrates to avoid the decommissioning area and may smother and hide immobile benthic prey. These mechanisms may result in less prey being available within the decommissioning area to foraging seabirds.

425 Closer to the time of decommissioning, it may be decided that removal would lead to a greater environmental impact than leaving some components in situ, in which case certain components may be cut off at or below seabed level (e.g. in the case of piled foundations), or left buried (e.g. in the case of subsea cables). However, for the purposes of this assessment it is assumed that all infrastructure will be removed, in which case it is expected to involve similar types and numbers of vessels and equipment as the construction phase.

426 However, as no significant effects were identified to potential prey species (fish or benthic) or on the habitats that support them in the assessments on fish and benthic ecology (see Volume 2, Chapter 5 and Volume 2, Chapter 6) then there is **no potential for any indirect effects of an adverse significance to occur on offshore ornithology receptors.**

4.13.5 Indirect impacts due to impacts on prey: array area

427 During the decommissioning phase of AyM there is the potential for indirect effects arising from the displacement of prey species due to increased noise and disturbance, or to disturbance of habitats from increased suspended sediment and physical disturbance to the seabed. Underwater noise may cause fish and mobile invertebrates to avoid the construction area and also affect their physiology and behaviour. Suspended sediments may cause fish and mobile invertebrates to avoid the decommissioning area and may smother and hide immobile benthic prey. These mechanisms may result in less prey being available within the decommissioning area to foraging seabirds.

428 However, as no significant effects were identified to potential prey species (fish or benthic) or on the habitats that support them in the assessments on fish and benthic ecology (see Volume 2, Chapter 5 and Volume 2, Chapter 6) then there is **no potential for any indirect effects of an adverse significance to occur on offshore ornithology receptors.**

4.14 Inter-relationships

429 The inter-related effects assessment considers potentially significant effects from multiple impacts and activities from the construction, operation and decommissioning of AyM on the same receptor, or group of receptors. These can include:

- Project lifetime effects: assessment of the scope for effects that occur throughout more than one phase of the project (construction, operational 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 key project stages (e.g. subsea noise effects from piling, operational WTGs, vessels and decommissioning); and
- Receptor led effects: assessment of the scope for all effects to interact, spatially and temporally, to create inter-related effects on a receptor. As an example, all effects on offshore ornithology, such as collision risk, disturbance and displacement, barrier effect and indirect effects may interact to produce a different, or greater effect on this receptor than when the effects are considered in isolation. Receptor-led effects might be short term, temporary or transient effects, or incorporate longer-term effects.

430 Consideration of the inter-relationships between EIA topics that may lead to environmental effects, is required under Schedule 4 of The Infrastructure Planning (EIA) Regulations 2017. Guidance on inter-related effects is provided within Section 4.13 of PINS Advice Note Nine: Rochdale Envelope (PINS, 2018), which states that "*inter-relationships consider impacts of the proposals on the same receptor. These occur where a number of separate impacts, (e.g. noise and air quality), affect a single receptor such as fauna*". The approach to inter-related effects has taken into account this Advice Note, along with all other guidance that exists at present.

431 The approach to the assessment of inter-related effects considers receptor-led effects; that is effects that interact spatially and/ or temporally resulting in interrelated effects upon a single receptor.

432 The assessment of inter-related effects has also been undertaken with specific reference to the potential for such effects to arise in relation to receptor groups. The term ‘receptor group’ is used to highlight the fact that the proposed approach to inter-relationships assessment has not, in the main, assessed every individual receptor assessed at the EIA stage, but rather, potentially sensitive groups of receptors.

433 The broad approach to inter-related effects assessment has followed the following key steps:

- review of effects for individual EIA topic areas;
- review of the assessment carried out for each EIA topic area, to identify "receptor groups" requiring assessment;
- potential inter-related effects on these receptor groups identified via review of the assessment carried out across a range of topics;
- development of lists for all potential receptor-led effects; and
- qualitative assessment on how individual effects may combine to create interrelated effects.

434 It is important to note that the inter-relationships assessment has only considered effects produced by AyM, and not those from other developments (these will be considered within the CEA in Section 4.16). Note that for receptors/ impacts scoped out of the EIA process based on the findings of the Impacts Register and the Scoping Report (Innogy, 2020), no inter-related assessment has been undertaken.

435 The construction, operation and decommissioning phases of AyM may cause a range of effects on offshore ornithological receptors. The magnitude of these effects has been assessed individually using expert judgement, drawing from a wide science base that includes project-specific surveys and previously acquired knowledge of the bird ecology of the Irish Sea.

436 These effects have the potential to form an inter-relationship, directly impacting the seabird receptors. They also have the potential to manifest as sources for impacts upon receptors other than those considered within the context of offshore ornithology.

437 In terms of how impacts to offshore ornithological interests may form inter-relationships with other receptor groups, assessments of significance are provided in the chapters listed in the second column of **Table 48** below. In addition, the table shows where other chapters have been used to inform the offshore ornithology inter-relationships assessment.

Table 48: Chapter topic inter-relationships.

TOPIC AND DESCRIPTION	RELATED CHAPTER
Indirect impacts through impacts on prey during construction (offshore ECC)	Volume 2, Chapter 5: Benthic Ecology (application ref: 6.2.5); and Volume 2, Chapter 6: Fish and Shellfish (application ref: 6.2.6).
Indirect impacts through impacts on prey during construction (array)	
Indirect impacts through impacts on prey during operation (array)	
Indirect impacts through impacts on prey during operation (offshore ECC)	
Indirect impacts through impacts on prey during decommissioning (offshore ECC)	
Indirect impacts through impacts on prey during decommissioning (array)	

438 However, as none of the offshore impacts on birds were assessed individually to have any greater than a minor adverse effect, it is considered highly unlikely that they will inter-relate to form an overall significant effect on offshore ornithology receptors.

4.15 Transboundary effects

439 Transboundary effects arise when impacts from a development within one European Economic Area (EEA) states affects the environment of another EEA state(s).

440 Transboundary impacts upon offshore ornithological receptors are possible due to the wide foraging and migratory ranges of typical bird species in the Irish Sea.

441 In particular, there is potential for transboundary collisions and displacement with those offshore renewable energy projects present, or in planning, in Irish waters, including the operational Arklow Bank. It is likely that there will be temporal overlap within the operational phases of at least some of these Irish offshore renewable energy projects. However, as outlined in Section 4.14, consideration of potential transboundary effects is limited by the data available upon which to base the assessment. The age of Arklow Bank means that it lacks a comparable dataset upon which to base an assessment. Furthermore, those developments which are not fully realised have not released their data into the public domain, and there is a high degree of uncertainty regarding which proposed developments will ultimately be consented.

442 During the breeding bio-season, it is highly unlikely that even those key receptors with relatively large mean-maximum foraging ranges such as gannet will travel further than the Irish and Celtic Seas (Wakefield et al., 2014; Woodward et al., 2019). Therefore, developments outside of UK and Irish waters will not contribute significantly to any transboundary effects.

443 During the non-breeding bio-season, key receptors are able to travel more widely and as such, may come into contact with developments elsewhere in European waters such as those operational, under construction or in planning in the Channel and North Sea. Given this larger spatial scale, any potential transboundary effects would be in relation to much larger populations than those considered at the UK-scale. Therefore, it is apparent that the scale of development within such a wide context would be relatively much smaller with respect to any potential impacts considered at the UK BDMPS scale.

444 Therefore, the inclusion of non-UK OWFs is considered very unlikely to alter the conclusions of the existing cumulative assessment, and highly likely to reduce estimated impacts at population levels if calculated at larger spatial scales.

4.16 Environmental assessment: cumulative effects

4.16.1 Overview

445 Cumulative effects can be defined as effects upon a single receptor from AyM when considered alongside other proposed and reasonably foreseeable plans and projects. This includes all developments that result in a comparative effect that is not intrinsically considered as part of the existing environment and is not limited to offshore wind projects.

446 Following the Planning Inspectorate's Advice Note Seventeen (PINS, 2019) and components of the RenewableUK cumulative impact assessment guidelines (RenewableUK, 2013), a number of reasonably foreseeable plans and projects were identified which may act cumulatively with AyM. This long list of developments that has been identified in relation to the offshore environment is set out in Volume 1, Annex 3.1: Cumulative Effects Assessment (application ref: 6.1.3.1). In assessing the potential cumulative impacts for AyM, it is important to bear in mind that some developments, predominantly those 'proposed' or identified in development plans, may not actually be taken forward, or fully built out as described within their MDS. There is therefore a need to build in some consideration of certainty (or uncertainty) with respect to the potential impacts which might arise from such proposals. For example, those other developments under construction are likely to contribute to cumulative impacts (providing effect or spatial pathways exist), whereas those proposals not yet approved are less likely to contribute to such an impact, as some may not achieve approval or may not ultimately be built due to other factors.

447 With this in mind, all other plans and projects considered alongside AyM have been allocated into 'tiers' and 'sub-tiers' reflecting their current stage within the planning and development process. This allows the cumulative impact assessment to present several future development scenarios, each with a differing potential for being ultimately built out. This approach also allows appropriate weight to be given to each scenario (tier) when considering the potential cumulative impact. The proposed tier structure is intended to ensure that there is a clear understanding of the level of confidence in the cumulative assessments provided in this report. An explanation of each tier is included in Table 49.

Table 49: Description of tiers of other developments considered for CEA (adapted from PINS Advice Note 17).

TIER	SUB-TIER	DESCRIPTION OF STAGE OF DEVELOPMENT OF PROJECT
Tier 1	Tier 1a	Project in operation
	Tier 1b	Project under construction
	Tier 1c	Permitted applications, whether under the Planning Act 2008 or other regimes, but not yet implemented
	Tier 1d	Submitted applications, whether under the Planning Act 2008 or other regimes, but not yet determined
Tier 2	N/A	Projects on the Planning Inspectorate's Programme of Projects where a Scoping Report has been submitted
Tier 3	Tier 3a	Projects on the Planning Inspectorate's Programme of Projects where a Scoping Report has not been submitted
	Tier 3b	Identified in the relevant Development Plan (and emerging Development Plans with appropriate weight being given as they move closer to adoption) recognising that much information on any relevant proposals will be limited
	Tier 3c	Identified in other plans and programmes (as appropriate) which set the framework for future development consents/approvals, where such development is reasonably likely to come forward

448 The plans and projects selected as relevant to the cumulative effects assessment (CEA) of impacts to offshore ornithology are based on a screening exercise undertaken on the long list (see Volume 1, Annex 3.1: Cumulative Effects Assessment Methodology (application ref: 6.1.3.1).

449 A Zone of Influence (ZOI) was applied to the long list to ensure that direct and indirect cumulative effects on offshore ornithological receptors were appropriately identified and assessed.

450 For the breeding bio-season, the ZOI was defined as the area within a receptors' mean-max foraging range (Woodward et al., 2019). For the key offshore ornithology receptors considered, gannet has the largest foraging range at 509 km (mean-max + 1SD; Woodward et al., 2019) and thus this distance was used to define the ZOI for all key receptors. Additional evidence with regards to tracking studies and expert judgement were also applied to ensure that assessments include a scientific approach, whilst also ensuring common sense.

451 For the non-breeding bio-season, the ZOI was defined as the BDMPS region (Furness 2015), or an equivalent region for any receptors not considered by Furness (2015).

452 Planned and operational projects were screened out of further consideration for potential cumulative effects on offshore ornithology based on there not being a potential impact-receptor-pathway across development phases for the following reasons:

- The plan/ project has already been accounted for within the offshore ornithology baseline;
- There is no conceptual effect-receptor pathway between plans/ projects;
- There is no physical effect-receptor overlap between plans/ projects;
- There is no temporal overlap between plans/ projects; or
- There is low data confidence or data are not available.

453 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. Many of the older developments did not address cumulative effects as fully as is required presently whilst those developments which are not fully realised have not released their data into the public domain. As such the CEA is carried out with the fullest dataset available whilst acknowledging that further cumulative effects may occur from existing or planned developments.

454 Those plans/projects screened into the CEA for offshore ornithology using the criteria set out above are presented in Table 50. A total of 67 plans/projects were considered to have the potential to give rise to cumulative effects including offshore renewables. Cabling projects, aggregate dredging, dredging and disposal projects, commercial fisheries, oil and gas, shipping and coastal projects were screened out based on the above criteria. The full list of plans and projects considered, including those screened out, are presented in Volume 1, Annex 3.1 (application ref: 6.1.3.1).

Table 50: Plans/projects considered within the offshore ornithology cumulative effect assessment.

TIER	PLAN/PROJECT	STATUS	DISTANCE TO AYM ARRAY (KM)	DISTANCE TO AYM OFFSHORE ECC (KM)	REASON FOR INCLUSION
1a	Arklow Bank OWF	Operational	147.1	154.5	Potential temporal overlap of operation with AyM.
1a	Barrow OWF	Operational	57.6	64.1	Potential temporal overlap of operation with AyM.
1a	Burbo Bank Extension OWF	Operational	15.6	16.9	Potential temporal overlap of operation with AyM.
1a	Burbo Bank OWF	Operational	25.6	23.0	Potential temporal overlap of operation with AyM.
1a	Gwynt y Môr OWF	Operational	0.0	0.0	Potential temporal overlap of operation with AyM.
1a	Holyhead Deep - 0.5MW Tidal Energy	Operational	64.4	71.2	Potential temporal overlap of operation with AyM.

TIER	PLAN/PROJECT	STATUS	DISTANCE TO AYM ARRAY (KM)	DISTANCE TO AYM OFFSHORE ECC (KM)	REASON FOR INCLUSION
	Demonstrator Site (Minesto)				
1a	Rhyl Flats OWF	Operational	5.1	0.0	Potential temporal overlap of operation with AyM.
1a	North Hoyle OWF	Operational	11.3	5.9	Potential temporal overlap of operation with AyM.
1a	Ormonde OWF	Operational	65.4	71.3	Potential temporal overlap of operation with AyM.
1a	Rampion I OWF	Operational	382.1	362.5	Potential temporal overlap of operation with AyM.
1a	Ramsey Sound Tidal Energy	Operational	200.2	202.3	Potential temporal overlap of operation with AyM.
1a	Robin Rigg East OWF	Operational	139.5	144.5	Potential temporal overlap of operation with AyM.

TIER	PLAN/PROJECT	STATUS	DISTANCE TO AYM ARRAY (KM)	DISTANCE TO AYM OFFSHORE ECC (KM)	REASON FOR INCLUSION
1a	Robin Rigg West OWF	Operational	138.5	143.4	Potential temporal overlap of operation with AyM.
1a	Strangford Lough Tidal Enery	Operational	148.0	160.4	Potential temporal overlap of operation with AyM.
1a	Walney 1 OWF	Operational	58.3	63.9	Potential temporal overlap of operation with AyM.
1a	Walney 2 OWF	Operational	61.0	66.4	Potential temporal overlap of operation with AyM.
1a	Walney Extension 3 OWF	Operational	66.1	71.3	Potential temporal overlap of operation with AyM.
1a	West of Duddon Sands OWF	Operational	51.2	57.1	Potential temporal overlap of operation with AyM.
1c	Arklow Bank Phase 2 OWF	Consented	147.1	154.5	Potential temporal overlap of

TIER	PLAN/PROJECT	STATUS	DISTANCE TO AYM ARRAY (KM)	DISTANCE TO AYM OFFSHORE ECC (KM)	REASON FOR INCLUSION
					construction and operation with AyM.
1c	Mull of Kintyre Tidal Energy (Phase 1)	Consented	238.8	250.2	Potential temporal overlap of construction and operation with AyM.
1c	Swansea Bay Tidal Lagoon	Consented (expired)	202.1	194.2	Potential temporal overlap of construction and operation with AyM.
1c	Torr Head Tidal Energy	Consented	236.6	248.5	Potential temporal overlap of construction and operation with AyM.
1c	West Anglesey Demonstration Zone Tidal Energy (Morlais)	Consented	60.2	66.9	Potential temporal overlap of construction and operation with AyM.
1d	Bardsey Sound Tidal Energy (Enlli)	Application submitted	96.3	100.0	Potential temporal overlap of

TIER	PLAN/PROJECT	STATUS	DISTANCE TO AYM ARRAY (KM)	DISTANCE TO AYM OFFSHORE ECC (KM)	REASON FOR INCLUSION
					construction and operation with AyM.
1d	Erebus OWF	Application submitted	246.3	248.1	Potential temporal overlap of construction and operation with AyM.
1d	DeepGreen 1/10 Tidal Energy	In planning	146.0	158.4	Potential temporal overlap of construction and operation with AyM.
1d	Dublin Array OWF	In planning	136.6	143.9	Potential temporal overlap of construction and operation with AyM.
1d	Fair Head Phase 1 Tidal Energy	Application submitted	241.3	253.2	Potential temporal overlap of construction and operation with AyM.

TIER	PLAN/PROJECT	STATUS	DISTANCE TO AYM ARRAY (KM)	DISTANCE TO AYM OFFSHORE ECC (KM)	REASON FOR INCLUSION
1d	Fair Head Phase 2 Tidal Energy	Application submitted	241.3	253.2	Potential temporal overlap of construction and operation with AyM.
1d	Solway Firth-Venturi Enhanced Turbine Technology (VETT) Tidal Energy	In planning	165.3	171.0	Potential temporal overlap of construction and operation with AyM.
1d	West Cumbrian Tidal Lagoon	In planning	133.5	138.6	Potential temporal overlap of construction and operation with AyM.
2	Holyhead Deep Tidal Energy	Scoping report submitted	63.6	70.5	Potential temporal overlap of construction and operation with AyM.
2	Rampion II OWf	PEIR report submitted	375.5	356.2	Potential temporal overlap of

TIER	PLAN/PROJECT	STATUS	DISTANCE TO AYM ARRAY (KM)	DISTANCE TO AYM OFFSHORE ECC (KM)	REASON FOR INCLUSION
					construction and operation with AyM.
2	Valorous (Blue Gem Floating Project) OWF	Scoping report submitted	257.7	259.6	Potential temporal overlap of construction and operation with AyM.
3a	Cardiff Bay Tidal Lagoon	Early planning	223.3	210.0	Potential temporal overlap of construction and operation with AyM.
3a	West Somerset Tidal Lagoon	In development	246.5	234.9	Potential temporal overlap of construction and operation with AyM.
3b	Celtic Sea OWF	Concept	266.5	271.8	Potential temporal overlap of construction and operation with AyM.

TIER	PLAN/PROJECT	STATUS	DISTANCE TO AYM ARRAY (KM)	DISTANCE TO AYM OFFSHORE ECC (KM)	REASON FOR INCLUSION
3b	Cobra & Flotation Energy Round 4 OWF	Concept/early planning	28.9	34.3	Potential temporal overlap of construction and operation with AyM.
3b	EnBW and BP 1 (Morgan) - Round 4 OWF	Concept/early planning	47.2	54.6	Potential temporal overlap of construction and operation with AyM.
3b	EnBW and BP 2 (Mona) - Round 4 OWF	Concept/early planning	47.2	54.6	Potential temporal overlap of construction and operation with AyM.
3c	Bardsey Sound Tidal Energy	Pre-planning	95.5	99.3	Potential temporal overlap of construction and operation with AyM.
3c	Braymore Point OWF	Concept	130.9	139.9	Potential temporal overlap of construction and operation with AyM.

TIER	PLAN/PROJECT	STATUS	DISTANCE TO AYM ARRAY (KM)	DISTANCE TO AYM OFFSHORE ECC (KM)	REASON FOR INCLUSION
3c	Clogher Head OWF	Concept	141.2	150.4	Potential temporal overlap of construction and operation with AyM.
3c	Codling Wind Park OWF	Concept	129.5	136.1	Potential temporal overlap of construction and operation with AyM.
3c	Codling Wind Park Extension OWF	Concept	130.9	137.3	Potential temporal overlap of construction and operation with AyM.
3c	Colwyn Bay Tidal Lagoon	Early concept	13.0	10.6	Potential temporal overlap of construction and operation with AyM.
3c	Cooley Point OWF	Concept	136.2	145.4	Potential temporal overlap of construction and operation with AyM.

TIER	PLAN/PROJECT	STATUS	DISTANCE TO AYM ARRAY (KM)	DISTANCE TO AYM OFFSHORE ECC (KM)	REASON FOR INCLUSION
3c	Duddon Estuary Tidal Lagoon	Concept	80.5	86.8	Potential temporal overlap of construction and operation with AyM.
3c	Fair Head Tidal Energy	Pre-planning	241.0	252.9	Potential temporal overlap of construction and operation with AyM.
3c	Inis Ealga Marine Energy Park OWF	Concept	294.8	300.6	Potential temporal overlap of construction and operation with AyM.
3c	Isle of Man OWF	Concept	74.9	82.3	Potential temporal overlap of construction and operation with AyM.
3c	Kilmichael Point OWF	Concept	149.4	156.1	Potential temporal overlap of construction and operation with AyM.

TIER	PLAN/PROJECT	STATUS	DISTANCE TO AYM ARRAY (KM)	DISTANCE TO AYM OFFSHORE ECC (KM)	REASON FOR INCLUSION
3c	North Irish Sea Array OWF	Pre-planning application	130.9	139.0	Potential temporal overlap of construction and operation with AyM.
3c	North Wales Tidal Energy Project	Early concept	12.9	6.8	Potential temporal overlap of construction and operation with AyM.
3c	Mersey Tidal Power	Pre-planning	44.6	32.0	Potential temporal overlap of construction and operation with AyM.
3c	Morecambe Bay Tidal Lagoon	Concept	73.0	80.0	Potential temporal overlap of construction and operation with AyM.
3c	Morlais Orbital O2 Tidal Energy	In development	226.0	225.1	Potential temporal overlap of construction and operation with AyM.

TIER	PLAN/PROJECT	STATUS	DISTANCE TO AYM ARRAY (KM)	DISTANCE TO AYM OFFSHORE ECC (KM)	REASON FOR INCLUSION
3c	Mull of Galloway Tidal Energy	In development	141.3	151.8	Potential temporal overlap of construction and operation with AyM.
3c	Mull of Kintyre Tidal Energy (Phase 2)	In development	238.8	250.2	Potential temporal overlap of construction and operation with AyM.
3c	Newport Tidal Lagoon	Early concept	219.6	205.1	Potential temporal overlap of construction and operation with AyM.
3c	Oriel OWF	Concept	148.5	160.6	Potential temporal overlap of construction and operation with AyM.
3c	Port of Mostyn Tidal Lagoon	Pre-planning	30.0	12.3	Potential temporal overlap of construction and operation with AyM.

TIER	PLAN/PROJECT	STATUS	DISTANCE TO AYM ARRAY (KM)	DISTANCE TO AYM OFFSHORE ECC (KM)	REASON FOR INCLUSION
3c	South Irish Sea Array OWF	Concept	146.7	152.1	Potential temporal overlap of construction and operation with AyM.
3c	South Pembrokeshire Demonstration Zone Wave Energy	Pre-planning	236.5	235.7	Potential temporal overlap of construction and operation with AyM.
3c	St. David's Head Tidal Energy	In development	197.5	199.7	Potential temporal overlap of construction and operation with AyM.
3c	Strangford Lough Array OWF	Pre-planning	145.6	158.1	Potential temporal overlap of construction and operation with AyM.
3c	Strumble Head Tidal Energy Project	Early planning	175.9	177.2	Potential temporal overlap of

TIER	PLAN/PROJECT	STATUS	DISTANCE TO AYM ARRAY (KM)	DISTANCE TO AYM OFFSHORE ECC (KM)	REASON FOR INCLUSION
					construction and operation with AyM.
3c	Wave Dragon Project - Milla Fjord Site Wave Energy	In planning	218.3	219.6	Potential temporal overlap of construction and operation with AyM.

455 Certain impacts assessed for the project alone are not considered in the cumulative assessment due to:

- The highly localised nature of the impacts (i.e they occur entirely within the AyM boundary only);
- Management measures proposed by AyM will also be in place for other projects reducing the risk of occurring; and/ or
- Where potential significance of the impact from AyM alone has been assessed as negligible and considered not to contribute in any meaningful way to an existing potential cumulative impact.

456 Other aspects, namely indirect impacts associated with prey distribution and availability and lighting 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 for the above reasons are:

- Export cable laying (construction) impacts on offshore ornithology receptors within or in close proximity to the ECC due to no plans or projects being identified that may have a source-impact-pathway that coincide spatially or temporally with AyM;
- Displacement of seabirds during the construction phase of AyM due to the potential impacts and effects predicted for AyM being negligible/ minor at most, spatially restricted and no plans or projects being identified that may have a source-impact-pathway that coincide spatially or temporally with AyM;
- Indirect impacts during any phase of AyM, as they will be spatially limited and all were predicted as negligible at most at a project level; and
- All impacts during the decommissioning phase, as potential impacts during this phase were all predicted to be negligible and there is no data or low confidence in data in relation to other plans and projects with respect to this potential source of impact.

457 Therefore, the impacts that are considered for cumulative assessment are as follows:

- Displacement of common scoter, guillemot, razorbill, red-throated diver, gannet and Manx shearwater during the operational and maintenance phase of AyM cumulatively with other planned, in-construction and operational developments screened in for CEA in Table 50; and

- Collision risk to gannet, kittiwake, herring gull and great black-backed gull during the operational and maintenance phase of AyM cumulatively with other planned, in-construction and operational developments screened in for CEA in Table 50.

458 The cumulative MDS described in Table 51 has been selected as having the potential to result in the greatest cumulative effect on an identified receptor group. The cumulative impacts presented and assessed in this section have been selected from the details provided in Volume 1, Annex 3.1 (application ref: 6.1.3.1), as well as the information available on other developments and plans in order to inform a cumulative MDS.

459 For the purpose of this assessment, it is assumed that all projects are developed to the full extent of the proposed design. This is precautionary as some projects may not ultimately receive consent, may reduce the proposed design prior to consent, or may not fully develop the area consented.

460 Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the project design envelope compared to that assessed here, be taken forward in the final design scheme.

Table 51: Cumulative MDS.

POTENTIAL EFFECT	SCENARIO	JUSTIFICATION
Operational Cumulative disturbance and displacement	MDS for AyM plus the cumulative full development of the following projects within the UK Western Waters and English Channel (where appropriate): Tier 1: - Operational offshore windfarms in the UK Western Waters and English Channel (where appropriate); - Offshore windfarms under construction in the UK Western Waters and English Channel (where appropriate); - Permitted offshore windfarm projects not yet implemented; and - Offshore windfarm projects with submitted applications not yet determined. Tier 2: - No Tier 2 projects identified with quantitative data available from PEIRs on developer's website (not yet available via PINS). Tier 3:	Maximum potential for interactive effects from operation and maintenance activities associated with and the operational effects of other developments considered within the relevant ZOI. This region was chosen as seabirds associated with AyM are expected to come from or move to other areas within the ZOI, that are also subject to interaction with other developments within this region.

POTENTIAL EFFECT	SCENARIO	JUSTIFICATION
	- No Tier 3 projects identified, as quantitative data not available on displacement of seabirds at this stage.	
Operational Cumulative collision risk	MDS for AyM plus the cumulative full development of the following projects within the UK Western Waters and English Channel (where appropriate): Tier 1: - Operational offshore windfarms in the UK Western Waters and English Channel (where appropriate); - Offshore windfarms under construction in the UK Western Waters and English Channel (where appropriate); - Permitted offshore windfarm projects not yet implemented; and - Offshore windfarm projects with submitted applications not yet determined. Tier 2: - One Tier 2 projects identified with quantitative data available from PEIRs on developer's website (not yet available via PINS).	Maximum potential for interactive effects from collision risk from other developments considered within the relevant ZOI. This region was chosen as seabirds associated with AyM are expected to come from or move to other areas within the ZOI, that are also subject to interaction with other developments within this region.

POTENTIAL EFFECT	SCENARIO	JUSTIFICATION
	Tier 3: - No Tier 3 projects identified, as quantitative data not available on displacement of seabirds at this stage.	

4.16.2 Cumulative disturbance and displacement: operational phase

461 There is potential for cumulative displacement as a result of operational and maintenance activities associated with AyM and other developments (Table 50). Developments in addition to AyM identified for this CEA are categorised as Tier 1 (sub-tiers 1a to 1d), as described in Table 51. Note that some of the other developments screened into assessment have been in operation for a number of years, and therefore may be decommissioned within AyM's operational lifespan or even prior to AyM's construction. It is therefore precautionary to carry out this CEA on the basis of all other developments having temporal overlap within the operational phase.

462 The presence of WTGs has the potential to directly disturb and displace seabirds that would normally reside within and around the area of sea where OWFs are located. This in effect potentially reduces the area available to those seabirds to forage, loaf and/ or moult that currently occur within and around OWFs that may be susceptible to displacement from such developments. Displacement may contribute to individual birds experiencing fitness consequences, which at an extreme level could lead to the mortality of individuals. Displacement may also contribute to individual birds being more productive during the breeding season, if they are deterred from foraging further than they may need to, therefore allowing for more efficient chick rearing. Cumulative displacement therefore has the potential to lead to effects on a wider scale, which in this case is defined as the wider non-breeding BDMPS populations of each species (adults and immature) within the relevant BDMPS defined by Furness (2015). For common scoter, which was not considered by Furness (2015), the equivalent region is the defined by the distinct population which overwinters in the Liverpool Bay and Carmarthen Bay areas.

463 Where relevant, estimated mortality rates of seabirds from underwater collisions with tidal devices at the West Anglesey Demonstration Zone (Morlais) have also been examined to ensure that the total predicted cumulative mortality rates for each receptor has been considered.

464 Currently this project has been granted consent on a 'deploy and monitor' basis, such that Phase One of the project will have a maximum capacity of 12 MW. To account for this significant reduction in project size and therefore impacts from the project compared to the closest assessment of a project size of 40MW, a logical approach has been taken and the impacts have been scaled down accordingly. Furthermore, the assessment of underwater turbine collision risk is still in its infancy and, therefore, knowledge and guidance on appropriate avoidance rates for species are currently unavailable. To account for this uncertainty a range of avoidance impact values from 95-99.9% are presented, although for the cumulative assessment within this report the central estimate has been included within the assessment.

Common scoter

Potential magnitude of impact

465 The estimated mortality resulting from disturbance and displacement from each relevant development is given in Table 52. Note that these are the mortality rates as reported by the developers in each case, and therefore the assumptions regarding displacement rates and mortality rates of displaced birds may not be consistent with those presented in this report.

466 Common scoter are only present in the region during non-breeding bio-season and therefore this species has only been assessed against that bio-season.

467 Due to the limited evidence available, a mortality rate of 1-10% has been assessed against, with the Applicant's position being the use of a 1% mortality rate. However, this is recognised as being highly precautionary, on the basis that the data available (Section 4.12.1) do not indicate that such increases in mortality have occurred following the construction and operation of existing OWFs within Liverpool Bay.

Table 52: Common scoter cumulative mortality from disturbance and displacement during operation.

DEVELOPMENT	PREDICTED MORTALITY (NON-BREEDING)
Arklow	Unknown
Burbo Bank Ext	4.0
Barrow	0.0
Burbo Bank	0.0
Gwynt y Môr	0.0
North Hoyle	0.1
Ormonde	0.0
Rhyl Flats	1.3
Walney Phase 1	0.0
Walney Phase 2	0.0
Walney Extension	0.0
West of Duddon Sands	0.0
Total excluding AyM (Consented Projects)	5.4
AyM	0.3* *(0.3-3.1)*
Total (All Projects)	*5.7 (5.7-8.5)*

Table note: *AyM value based on results presented within Table 25 and the Applicant's evidence-led position using a displacement rate of 100% and 1% mortality for the AyM array area plus 4 km buffer. Values in parenthesis are based on SNCBs advocated displacement rate of 100% and 1-10% mortality for the AyM array area plus 4 km buffer.

468 During the non-breeding bio-season, the total estimated mortality from disturbance and displacement across all relevant developments is six (5.7) to a maximum of nine (8.5) common scoter. The BDMPS population in the non-breeding bio-season is defined as 85,552 individuals (Table 17) and, using the average baseline mortality rate of 0.238 (Table 18), the natural predicted mortality in the non-breeding bio-season is 20,358 individuals per annum. The addition of six to nine predicted mortalities would increase baseline mortality by 0.028-0.042%.

469 This level of impact is considered to be of **negligible magnitude during the non-breeding bio-season**, as it represents no discernible change to the baseline conditions due to the very small number of individuals subject to potential mortality as a result of displacement.

Sensitivity of the receptor

470 As detailed in Section 4.11.1, this receptor is classified as high behavioural sensitivity and of international importance, leading to an overall sensitivity to disturbance and displacement of **high**.

Significance of effect

471 Given a magnitude of impact of negligible, following the matrix approach set out in Table 13, the potential cumulative effect of displacement and disturbance on common scoter has been assessed as minor, which is **not significant**.

Guillemot

Potential magnitude of impact

472 Due to limitations in the data for other OWFs, seasonal population estimates have been collated for two separate bio-seasons covering the entire annual cycle, one for breeding and one for non-breeding. For some projects, data were also not available for their array area plus 2 km buffer, so in these instances these data have been scaled up or down based on the available project data. The subsequent bio-season and annual abundance estimates for guillemot associated with each of the projects identified in Table 50 are presented in Table 53.

473 For cumulative displacement assessment of guillemot, the Applicant has assessed impacts using a displacement rate of 50% and a mortality rate of 1% based on an evidence-led approach with the justification for the selected parameters presented in Section 4.12.1. this approach to assessment can still be considered suitably precautionary due to the abundance data for all OWFS considering the peak mean for each bio-season. When these values are added together at a cumulative level, a highly unlikely total number of birds is estimated within these array areas and 2 km buffers. Furthermore, combining abundances in such a simplistic additive manner, does not account for the likelihood of double counting of individuals, especially considering the close proximity of the OWFs included within the cumulative assessment.

Table 53: Guillemot cumulative bio-season and total abundance estimates.

DEVELOPMENT	PREDICTED ABUNDANCE		
	BREEDING	NON-BREEDING	ANNUAL
Arklow	-	Unknown	-
Burbo Bank Ext	1,003	1,565	2,568
Barrow	-	0	0
Burbo Bank	-	0	0
Gwynt y Môr	-	0	0
North Hoyle	-	0	0
Ormonde	-	0	0
Rhyl Flats	-	0	0
Robin Rigg	-	0	0
Walney Phase 1	-	0	0
Walney Phase 2	-	0	0
Walney Extension	-	0	0
West of Duddon Sands	-	0	0

DEVELOPMENT	PREDICTED ABUNDANCE		
	BREEDING	NON-BREEDING	ANNUAL
Total excluding AyM (Consented Projects)	1,003	1,565	2,568
AyM	1,569	2,919	4,488
Total (AyM & Consented Projects)	2,572	4,484	7,056
Erebus	3,558	15,324	18,882
Total (All Projects)	6,130	19,808	25,938
DEVELOPMENT	**PREDICTED COLLISION MORTALITY**		
	BREEDING	**NON-BREEDING**	**ANNUAL**
Morlais Demonstration Zone Phase One	38.0 (*1.5 – 74.4*)	8.1 (*0.3 – 15.9*)	46.1 (*1.8 - 90.3*)

474 During the breeding bio-season, the cumulative abundance for guillemot is 6,130 individuals for all projects considered in Table 53. When considering the evidence-based displacement and mortality rates of 50% and 1%, respectively, this would result in approximately 69 (30.6 predicted mortalities from displacement plus 38.0 predicted mortalities from Morlais) guillemots being subject to mortality. During the breeding bio-season the total guillemot regional baseline population, including breeding adults and immature birds, is predicted to be 491,889 individuals (Table 17). Using the average baseline mortality rate of 0.143 (Table 18), the natural predicted mortality of guillemots in the breeding bio-season is 70,176 individuals per annum. The addition of 69 predicted mortalities due to cumulative displacement and predicted collision from Morlais, would increase baseline mortality by 0.098%.

475 This level of potential change is considered to be an impact of **negligible magnitude during the breeding bio-season**, as it represents only a slight difference to the baseline conditions due to the small number of individuals subject to potential mortality as a result of displacement.

476 During the non-breeding bio-season, the cumulative abundance for guillemot is 19,808 individuals for all projects considered in Table 53. When considering the evidence-based displacement and mortality rates of 50% and 1%, respectively, this would result in approximately 107 (99.0 predicted mortalities from displacement plus 8.1 predicted mortalities from Morlais) guillemots being subject to mortality. The UK Western Waters BDMPS for the non-breeding bio-season is defined as 1,139,220 individuals (Table 17) and, using the average baseline mortality rate of 0.143 (Table 18), the natural predicted mortality in the non-breeding bio-season is 162,528 individuals per annum. The addition of 107 predicted mortalities due to cumulative displacement and predicted collision from Morlais, would increase baseline mortality by 0.066%.

477 This level of potential change is considered to be an impact of **negligible magnitude during the non-breeding bio-season**, as it represents between only a slight difference to the baseline conditions due to the small number of individuals subject to potential mortality as a result of displacement.

478 For all seasons combined, the estimated cumulative number of guillemots subject to mortality is 176 (175.7) individuals per annum. Using the largest UK Western Waters BDMPS population of 1,139,220 individuals (Table 17) as a proxy for the total BDMPS population across the year, with an average baseline mortality rate of 0.143 (Table 18), the natural predicted mortality across all seasons is 162,528 individuals per annum. The addition of 176 predicted mortalities due to cumulative displacement and predicted collision from Morlais, would increase baseline mortality by 0.108% at the BDMPS scale. When considering the annual potential level of change at the biogeographic scale, the natural predicted mortality of the biogeographic population of 4,125,000 (Table 17) across all seasons is 588,499 individuals per annum. On a biogeographic scale, the addition of 176 predicted mortalities would increase the baseline mortality by 0.030%.

479 For all seasons combined, the cumulative predicted mortality when considering both collision risk and displacement combined equates to 81 (81.3) guillemots being subject to mortality per annum. Using the largest UK Western Waters BDMPS population of 1,139,220 individuals (Table 17) as a proxy for the total BDMPS population across the year, with an average baseline mortality rate of 0.143 (Table 18), the natural predicted mortality across all seasons is 162,528 individuals per annum. The addition of 81 predicted mortalities would increase baseline mortality rate 0.050% at the BDMPS scale. When considering the annual potential level of change at the biogeographic scale, the natural predicted mortality of the biogeographic population of 4,125,000 (Table 17) across all seasons is 588,499 individuals per annum. On a biogeographic scale, the addition of 81 predicted mortalities would increase the baseline mortality by 0.014%.

480 This level of potential change per annum is considered to be an impact of **negligible at the UK Western Waters BDMPS scale and negligible at the biogeographic scale**, as it represents only a slight difference to the baseline conditions due to the number of individuals subject to potential mortality as a result of displacement.

Sensitivity of the receptor

481 As detailed in Section 4.11.1, this receptor is classified as medium behavioural sensitivity and it is of national importance, leading to an overall sensitivity to disturbance and displacement of **medium**.

Significance of effect

482 Given a magnitude of impact of negligible and a sensitivity of medium, following the matrix approach set out in Table 13, the potential effect of cumulative disturbance and displacement from operational activities on guillemots has been assessed as minor, which is **not significant**.

Razorbill

Potential magnitude of impact

483 Due to limitations in the data for other OWFs, seasonal population estimates have been collated, where available. For some projects, data were also not available for their array area plus 2 km buffer, so in these instances these data have been scaled up or down based on the available project data. The subsequent bio-season and annual abundance estimates for razorbill associated with each of the projects identified in Table 50 are presented in Table 54.

484 For cumulative displacement assessment of razorbill, the Applicant has assessed impacts using a displacement rate of 50% and a mortality rate of 1% based on an evidence-led approach with the justification for the selected parameters presented in Section 4.12.1. this approach to assessment can still be considered suitably precautionary due to the abundance data for all OWFS considering the peak mean for each bio-season. When these values are added together at a cumulative level, a highly unlikely total number of birds is estimated within these array areas and 2 km buffers. Furthermore, combining abundances in such a simplistic additive manner, does not account for the likelihood of double counting of individuals, especially considering the close proximity of the OWFs included within the cumulative assessment.

Table 54: Razorbill cumulative bio-season and total abundance estimates.

DEVELOPMENT	PREDICTED ABUNDANCE				
	RETURN MIGRATION	BREEDING	POST-BREEDING MIGRATION	MIGRATION-FREE WINTER	ANNUAL
Arklow	0	-	0	0	0
Burbo Bank Ext	0	64	0	29	93
Barrow	0	-	0	0	0
Burbo Bank	0	-	0	0	0
Gwynt y Môr	0	-	0	0	0
North Hoyle	0	-	0	0	0
Ormonde	0	-	0	0	0
Rhyl Flats	0	-	0	0	0
Robin Rigg	0	-	0	0	0
Walney Phase 1	0	-	0	0	0
Walney Phase 2	0	-	0	0	0
Walney Extension	0	-	0	0	0
West of Duddon Sands	0	-	0	0	0

DEVELOPMENT	PREDICTED ABUNDANCE				
	RETURN MIGRATION	BREEDING	POST-BREEDING MIGRATION	MIGRATION-FREE WINTER	ANNUAL
Total excluding AyM (Consented Projects)	0	64	0	29	93
AyM	336	140	66	150	692
Total (AyM & Consented Projects)	336	204	66	179	785
Erebus	460	103	1,228	566	2,357
Total (All Projects)	796	307	1294	745	3,142
DEVELOPMENT	PREDICTED COLLISION MORTALITY				
	RETURN MIGRATION	MIGRATION-FREE BREEDING	POST-BREEDING MIGRATION	MIGRATION-FREE WINTER	ANNUAL
Morlais Demonstration Zone Phase One	-	11.7 (0.6 – 22.8)	-	11.7 (0.6 – 22.8)	23.4 (1.2 – 45.6)

485 During the return migration bio-season, the cumulative abundance for razorbill is 796 individuals for all projects considered in Table 54. When considering the evidence-based displacement and mortality rates of 50% and 1%, respectively, this would result in approximately four (4.0) razorbill being subject to mortality. The regional population in the return migration bio-season is defined as 606,914 individuals (Table 17) and, using the average baseline mortality rate of 0.178 (Table 18), the natural predicted mortality in the return migration bio-season is 108,228 individuals per annum. The addition of one predicted mortality due to displacement would increase baseline mortality by 0.004%.

486 This level of potential change is considered to be of **negligible magnitude during the return migration bio-season**, as it represents no discernible change to baseline mortality.

487 During the migration-free breeding bio-season, the cumulative abundance for razorbill is 307 individuals for all projects considered in Table 54. When considering the evidence-based displacement and mortality rates of 50% and 1%, respectively, this would result in approximately a 13 (1.5 predicted mortalities from displacement plus 11.7 predicted mortalities from Morlais) razorbill being subject to mortality. The regional population in the migration-free breeding bio-season is defined as 261,290 individuals (Table 17) and, using the average baseline mortality rate of 0.178 (Table 18), the natural predicted mortality in the migration-free breeding bio-season is 46,595 individuals per annum. The addition of 13 predicted mortality due to cumulative displacement and predicted collision from Morlais, would increase baseline mortality by 0.028%.

488 This level of potential change is considered to be of **negligible magnitude during the migration-free breeding bio-season**, as it represents no discernible change to baseline mortality.

489 During the post-breeding migration bio-season, the cumulative abundance for razorbill is 1,294 individuals for all projects considered in Table 54. When considering the evidence-based displacement and mortality rates of 50% and 1%, respectively, this would result in approximately a seven (6.5) razorbill being subject to mortality. The regional population in the post-breeding migration bio-season is defined as 606,914 individuals (Table 17) and, using the average baseline mortality rate of 0.178 (Table 18), the natural predicted mortality in the migration-free breeding bio-season is 108,228 individuals per annum. The addition of seven predicted mortality due to cumulative displacement, would increase baseline mortality by 0.006%.

490 This level of potential change is considered to be of **negligible magnitude during the post-breeding migration bio-season**, as it represents no discernible change to baseline mortality.

491 During the migration-free winter bio-season, the cumulative abundance for razorbills is 745 individuals for all projects considered in Table 54. Using the evidence-based displacement and mortality rate of 50% and 1% would result in less than 15 (3.7 predicted mortalities from displacement plus 11.7 predicted mortalities from Morlais) razorbill being subject to mortality. The BDMPS population in the migration-free winter bio-season is defined as 341,422 individuals (**Table 17**) and, using the average baseline mortality rate of 0.178 (**Table 18**), the natural predicted mortality in the migration-free winter bio-season is 60,884 individuals per annum. The addition of 15 predicted mortality due to cumulative displacement and predicted collision from Morlais, would increase baseline mortality by 0.025%.

492 This level of potential change is considered to be of **negligible magnitude during the migration-free winter bio-season**, as it represents no discernible change to baseline mortality.

493 For all seasons combined, the estimated cumulative number of razorbills subject to mortality is 39 (39.1) individuals per annum. Using the largest UK Western Waters BDMPS population of 606,914 individuals (**Table 17**), as a proxy for the total BDMPS population across the year, with an average baseline mortality rate of 0.178 (**Table 18**), the natural predicted mortality across all seasons is 108,228 individuals per annum. The addition of 39 predicted mortalities due to cumulative displacement and predicted collision from Morlais, would increase baseline mortality by 0.036% at the BDMPS scale. When considering the annual potential level of change at the biogeographic scale, the natural predicted mortality of the biogeographic population of 1,707,000 (**Table 17**) across all seasons is 304,401 per annum. On a biogeographic scale, the addition of 39 mortalities due to displacement would increase baseline mortality by 0.013%.

494 This level of potential change per annum is considered to be of **negligible magnitude at the UK Western Waters BDMPS scale and negligible magnitude at the biogeographic scale**, as it represents no discernible difference to the baseline conditions due to the very small number of individuals subject to potential mortality as a result of displacement.

Sensitivity of the receptor

495 As detailed in Section 4.11.1, this receptor is classified as medium behavioural sensitivity and it is of national importance, leading to an overall sensitivity to disturbance and displacement of **medium**.

Significance of effect

496 Given a magnitude of change of negligible and a sensitivity of medium, following the matrix approach set out in **Table 13**, the potential effect of displacement and disturbance from operational activities on razorbills has been assessed as minor, which is **not significant**.

Red-throated diver

Potential magnitude of impact

497 The expected number of birds displaced from each other development is given in **Table 55**. Note that these are the mortality rates as reported by the developers, and therefore the assumptions regarding displacement rates may not be consistent with those presented in this report. The impact from AyM is the sum of the impacts for the array area plus 8 km buffer given in Section 4.12.1.

498 During the migration-free winter bio-season, red-throated divers are a designated feature of local SPAs including Liverpool Bay. Therefore, previous assessments have focused only on the potential impact during the migration-free winter bio-season, and data were unavailable or inconsistently available for impacts in other bio-seasons. Therefore, this CEA has also focused on the migration-free winter bio-season only.

499 Furthermore, effects outside the winter bio-season are unlikely to be significant. As most birds move elsewhere, the density of birds within the region is lower and therefore competition for food is also lower. Displaced birds are therefore less likely to suffer mortality than in the winter bio-season.

500 For cumulative displacement assessment of red-throated diver the Applicant has assessed impacts using a mortality rate of 1% based on an evidence-led approach with the justification, being based on the evidence presented in Section 4.12.1. This approach to assessment can still be considered suitably precautionary due to the abundance data for all OWFS considering the peak mean for each bio-season. When these values are added together at a cumulative level, a highly unlikely total number of birds is estimated within these array areas buffers. Furthermore, combining abundances in such a simplistic additive manner, does not account for the likelihood of double counting of individuals, especially considering the close proximity of the OWFs included within the cumulative assessment.

Table 55: Red-throated diver cumulative mortality from disturbance and displacement during operation.

DEVELOPMENT	PREDICTED DISPLACEMENT (MIGRATION-FREE WINTER)	MORTALITY (1%)
Arklow	Unknown	Unknown
Burbo Bank Ext	30	0.3
Barrow	0	0.0
Burbo Bank	11	0.1
Gwynt y Môr	35	0.4
North Hoyle	0	0.0
Ormonde	0	0.0
Rhyl Flats	24	0.2
Walney Phase 1	0	0.0
Walney Phase 2	0	0.0
Walney Extension	0	0.0
West of Duddon Sands	0	0.0
Total excluding AyM (Consented Projects)	100	1.0
AyM	47*	0.3
Total (All Projects)	147	1.3
DEVELOPMENT	**PREDICTED COLLISION MORTALITY**	
Morlais Demonstration Zone Phase One	1.2 (0.0 – 2.4)	

Table note: *AyM value based on results presented within Table 33.

501 During the migration-free winter bio-season, the total estimated mortality from disturbance and displacement across all relevant developments is three (1.3 predicted mortalities from displacement plus 1.2 predicted mortalities from Morlais) red-throated diver when using an evidence-led mortality rate of 1%, of which AyM contributes less than one (0.3) predicted mortality. The BDMPS population in the migration-free winter bio-season is defined as 1,657 individuals (Table 17) and, using the average baseline mortality rate of 0.233 (Table 18), the natural predicted mortality in the migration-free winter migration bio-season is 386 individuals per annum. The addition of three predicted mortality due to cumulative displacement and predicted collision from Morlais, would increase baseline mortality by 0.648%.

502 Following the Applicant's evidence-led approach, this level of impact is considered to be of **negligible magnitude during the migration-free winter bio-season**, as it represents no detectable increase to the baseline mortality rates compared to natural variation.

Sensitivity of the receptor

503 As detailed in Section 4.11.1, this receptor is classified as high behavioural sensitivity and of international importance, this leads to an overall sensitivity of this receptor to disturbance and displacement of **high**.

Significance of effect

504 Given a magnitude of impact of negligible and a sensitivity of high, following the matrix approach set out in Table 13, the potential cumulative effect of displacement and disturbance from operational activities on red-throated diver has been assessed as minor, which is **not significant**.

Gannet

Potential magnitude of impact

505 Whilst there may be minor contributions from some of the Tier 1a operational offshore windfarm projects in Table 50, whose assessments pre-dated consideration of displacement impacts on this species, only a single project (Erebus) was found to have quantitative values available for consideration of cumulative displacement assessment.

506 For cumulative displacement assessment of gannet, the Applicant has assessed impacts using a displacement rate of 60-80% and a mortality rate of 1% based on an evidence-led approach with the justification for the selected parameters presented in Section 4.12.1.

Table 56: Gannet cumulative bio-season and total abundance estimates.

DEVELOPMENT	PREDICTED ABUNDANCE			
	RETURN MIGRATION	BREEDING	POST-BREEDING MIGRATION	ANNUAL
AyM	0	328	201	528
Erebus	100	224	334	658
Total (All Projects)	100	552	535	1,186

507 For all seasons combined, the estimated cumulative number of gannets subject to mortality is between seven (7.1) and 10 (9.5) individuals per annum. Using the largest UK Western Waters BDMPS population of 661,888 individuals (Table 17), as a proxy for the total BDMPS population across the year, with an average baseline mortality rate of 0.188 (Table 18), the natural predicted mortality across all seasons is 124,188 individuals per annum. The addition of seven to 10 predicted mortalities due to cumulative displacement, would increase baseline mortality by 0.006-0.008% at the BDMPS scale. When considering the annual potential level of change at the biogeographic scale, the natural predicted mortality of the biogeographic population of 1,180,000 (Table 17) across all seasons is 221,400 per annum. On a biogeographic scale, the addition of seven to 10 mortalities due to displacement would increase baseline mortality by 0.003-0.004%.

508 This level of potential change per annum is considered to be of **negligible magnitude at the UK Western Waters BDMPS scale and negligible magnitude at the biogeographic scale**, as it represents no discernible difference to the baseline conditions due to the very small number of individuals subject to potential mortality as a result of displacement.

Sensitivity of the receptor

509 As detailed in Section 4.11.1, as this receptor is classified as low to medium behavioural sensitivity and it is of medium conservation value, this leads to an overall sensitivity of this receptor to disturbance and displacement of **medium**.

Significance of effect

510 Therefore, the magnitude of impact resulting from cumulative collision risk on an annual basis is considered to be negligible and the sensitivity is medium. The significance of the residual effect is therefore minor, which is **not significant** as defined in the assessment of significance matrix (Table 13).

Manx shearwater

Potential magnitude of impact

511 Due to limitations in the data for other OWFs, seasonal population estimates have only been collated where available. For some projects, data were also not available for their array area plus 2 km buffer, so in these instances these data have been scaled up or down based on the available project data. The subsequent bio-season and annual abundance estimates for Manx shearwater associated with each of the projects identified in Table 50 are presented in Table 57.

512 Due to limited evidence being available (see Section 4.12.1) as to suitable displacement and mortality rates, as recommended by NRW and in line with the advice from the SNCBs (2017), a standard approach has been taken of applying a 30-70% displacement rate to the array area plus 2 km buffer, and 1-10% mortality of displaced individuals, although the Applicant considers that 1% mortality rate to be the more likely impact based on expert judgement.

Table 57: Manx shearwater cumulative bio-season and total abundance estimates.

DEVELOPMENT	PREDICTED ABUNDANCE			
	RETURN MIGRATION	BREEDING	POST-BREEDING MIGRATION	ANNUAL
Arklow	0	-	0	0
Burbo Bank Ext	0	444	0	444
Barrow	0	-	0	0
Burbo Bank	0	-	0	0
Gwynt y Môr	0	-	0	0
North Hoyle	0	-	0	0
Ormonde	0	-	0	0
Rampion I	0	33	0	33
Rhyl Flats	0	-	0	0
Robin Rigg	0	-	0	0

DEVELOPMENT	PREDICTED ABUNDANCE			
	RETURN MIGRATIO N	BREEDING	POST-BREEDING MIGRATION	ANNUAL
Walney Phase 1	0	-	0	0
Walney Phase 2	0	-	0	0
Walney Extension	0	-	0	0
West of Duddon Sands	0	-	0	0
Total excluding AyM (Consented Projects)	0	477	0	477
AyM	177	26	214	417
Total (AyM & Consented Projects)	177	503	214	894
Erebus	18	1,540	557	2,115
Rampion II	0	0	5	5
Total (All Projects)	195	2,043	776	3,014
DEVELOPMENT	**PREDICTED COLLISION MORTALITY**			
	RETURN MIGRATIO N	**MIGRATION-FREE BREEDING**	**POST-BREEDING MIGRATION**	**ANNUAL**
Morlais Demonstration Zone Phase One	-	0.3 (*0.0 – 0.6*)	-	0.3 (*0.0 – 0.6*)

513 During the return migration bio-season, the cumulative abundance for Manx shearwater is 195 individuals for all projects considered in Table 57. Using displacement rates between 30–70% and mortality rates of 1-10% would result in between approximately one (0.6) to 14 (13.7) Manx shearwaters being subject to mortality. During the return migration bio-season, the total regional baseline population is predicted to be 1,580,895 individuals (Table 17). When the average baseline mortality rate of 0.130 (Table 18) is applied, the natural predicted mortality in the return migration bio-season is 205,516 individuals per annum. The addition one to 14 predicted mortalities due to displacement would increase baseline mortality by 0.000% to 0.007%.

514 This level of potential change is considered to be of **negligible magnitude during the return migration bio-season** as it represents between only a slight difference to the baseline conditions due to the small number of individuals subject to potential mortality as a result of displacement.

515 During the migration-free breeding bio-season, the cumulative abundance for Manx shearwater is 2,043 individuals for all projects considered in Table 57. Using displacement rates between 30–70% and mortality rates of 1-10% would result in between approximately six to 143 (6.1 to 143.0 predicted mortalities from displacement plus 0.3 predicted mortalities from Morlais) Manx shearwaters being subject to mortality. During the migration-free breeding bio-season, the total regional baseline population is predicted to be 968,377 individuals (Table 17). When the average baseline mortality rate of 0.130 (Table 18) is applied, the natural predicted mortality in the migration-free breeding bio-season is 125,889 individuals per annum. The addition six to 143 predicted mortalities due to cumulative displacement and predicted collision from Morlais, would increase baseline mortality by 0.005% to 0.114%.

516 This level of potential change is considered to be of **negligible magnitude during the migration-free breeding bio-season** as it represents between only a slight difference to the baseline conditions due to the small number of individuals subject to potential mortality as a result of displacement.

517 During the post-breeding migration bio-season, the cumulative abundance for Manx shearwater is 776 individuals for all projects considered in Table 57. Using displacement rates between 30–70% and mortality rates of 1-10% would result in between approximately two (2.3) to 54 (54.3) Manx shearwaters being subject to mortality. During the post-breeding migration bio-season, the total regional baseline population is predicted to be 1,580,895 individuals (Table 17). When the average baseline mortality rate of 0.130 (Table 18) is applied, the natural predicted mortality in the post-breeding migration bio-season is 205,516 individuals per annum. The addition two to 54 predicted mortalities due to displacement would increase baseline mortality by 0.001% to 0.026%.

518 This level of potential change is considered to be of **negligible magnitude during the post-breeding migration bio-season** as it represents between only a slight difference to the baseline conditions due to the small number of individuals subject to potential mortality as a result of displacement.

519 For all seasons combined, the cumulative predicted mortality equates to between nine (9.3) and 211 (211.3) Manx shearwaters being subject to mortality per annum. Using the largest UK Western Waters BDMPS of 1,580,895 individuals (Table 17) and, using the average baseline mortality rate of 0.130 (Table 18), the natural predicted mortality across all seasons is 205,516 individuals per annum. The addition of nine to 211 predicted mortalities would increase baseline mortality by 0.005% to 0.103%. When considering displacement impacts at the wider biogeographic population scale, then based on a population of 2,000,000 (Table 17), the natural annual mortality rate would be 260,000 individuals. On a biogeographic scale the addition of between nine to 211 predicted mortalities per annum would increase baseline mortality by 0.004% to 0.081%.

520 This level of potential change per annum is considered to be an impact of **negligible at the UK Western Waters BDMPS scale and negligible at the biogeographic scale**, as it represents only a slight difference to the baseline conditions due to the number of individuals subject to potential mortality as a result of displacement.

Sensitivity of the receptor

521 As detailed in Section 4.11.1, this receptor is classified as low sensitivity to displacement. Considering both the conservation value and sensitivity to the impact (**Table 14**), the overall sensitivity of Manx shearwater is assessed as **medium**.

Significance of effect

522 Given a magnitude of impact of negligible and a sensitivity of medium, following the matrix approach set out in Table 13, the potential effect of disturbance and displacement from operational activities in the array area on Manx shearwater has been assessed as minor, which is **not significant.**

4.16.3 Cumulative collision risk

523 There is potential for cumulative collision risk to birds as a result of operational activities associated with AyM and other developments. The risk to birds is through potential collision with WTGs and associated infrastructure from OWFs, resulting in injury or fatality. This may occur when birds fly through the OWFs whilst foraging for food, commuting between breeding sites and foraging areas, or during migration. The only projects identified for this CEA are those defined as being within Tier 1 and Tier 2, as described in Table 51. The approach taken to assessing cumulative collision risk is a quantitative one, drawing upon the published information produced by the respective project developers. As such, the input parameters to CRM may vary from those put forward in this report.

524 One project that recently submitted collision risk modelling data within an ES Chapter is that of the proposed Erebus floating wind demonstration site. On review of the collision risk modelling supporting their impact assessments a number of anomalies were noted, including issues with the site-specific flight heights, that introduce a high level of uncertainty with regards to the output values provided, particularly when using Band Option 1 of the CRM. As the majority of other current assessments of collision risk for UK OWFs rely on Band Option 2 for gannet and kittiwake and either Band Option 2 or 3 for large gull species (including for AyM) the Applicant considers these values, where available from Erebus, to be more reliable and in keeping with other projects to allow a level playing field assessment for cumulative collision risk.

Kittiwake

Potential magnitude of impact

525 The expected number of birds subject to collision mortality as a result of other developments are presented in Table 58. Note that these are the collision mortality rates as reported by the developers, and therefore the modelling assumptions may not be consistent with those presented in this report. For AyM, results have been presented using recommended BO2 outputs (SNCBs, 2014).

526 As collision figures for other developments were not always available on a seasonal basis, this CEA has only been carried out on an annual basis only.

Table 58: Kittiwake cumulative collision mortality.

DEVELOPMENT	PREDICTED ANNUAL COLLISION MORTALITY
Arklow	Unknown
Barrow	0.0
Burbo Bank	0.0
Burbo Bank Extension	20.7
Gwynt y Môr	0.0
North Hoyle	0.0

DEVELOPMENT	PREDICTED ANNUAL COLLISION MORTALITY
Ormonde	0.0
Rampion I	121.5
Rhyl Flats	0.0
Robin Rigg	0.0
Walney Phase 1	0.0
Walney Phase 2	0.0
Walney Extension	187.6
West of Duddon Sands	0.0
Total excluding AyM (Consented Projects)	329.8
AyM*	53.9(*13.7-137.9*)
Total (AyM & Consented Projects)	383.7 (*343.5-467.7*)
Erebus	18.8
Rampion II	10.6
Total (All Projects)	413.1 (*372.9-497.1*)

Table note: *AyM value based on mean estimate presented within Table 42. Values in parenthesis present the minimum and maximum estimates for AyM.

527 The annual cumulative total of kittiwakes subject to mortality due to collision is estimated to be 413 (413.1) individuals, of which AyM contributes 54 (53.9) predicted mortalities per annum. Using the largest BDMPS population of 911,586 (Table 17), as a proxy for the annual BDMPS population, with an average baseline mortality rate of 0.157 (Table 18), the natural predicted mortality is 142,914 individuals per annum. The addition of 413 predicted mortalities would increase baseline mortality by 0.289%. When considering the annual potential level of change at the biogeographic scale, the natural predicted mortality for the biogeographic population of 5,100,000 across all seasons is 799,555 individuals per annum. On a biogeographic scale, the addition of 413 predicted mortalities would increase baseline mortality rate by 0.052%.

528 This level of potential change is considered to be an impact of **low and negligible magnitude on an annual basis at the BDMPS and bio-geographic scales**, respectively, as it represents limited increases to baseline mortality levels when compared to natural variation due to the number of estimated collisions.

Sensitivity of the receptor

529 As detailed in Section 4.12.4, this receptor's behavioural sensitivity to collision is considered to be medium (Table 14). As it is of medium behavioural sensitivity and it is of national importance, this leads to an overall sensitivity to collision risk of **medium**.

Significance of effect

530 The magnitude of impact resulting from collision risk on an annual basis is considered to be negligible to low and the sensitivity is medium. The significance of the effect is therefore negligible to minor, which is **not significant** as defined in the assessment of significance matrix (Table 13).

Great black-backed gull

Potential magnitude of impact

531 The expected number of birds subject to collision mortality as a result of other developments are presented in Table 59. Note that these are the collision mortality rates as reported by the developers, and therefore the modelling assumptions may not be consistent with those presented in this report. For AyM, results have been presented using the recommended BO3 outputs (SNCBs, 2014).

532 As collision figures for other developments are not always available on a seasonal basis, this CEA has only been carried out on an annual basis.

Table 59: Great black-backed gull cumulative collision mortality.

DEVELOPMENT	PREDICTED ANNUAL MORTALITY
Arklow	Unknown
Barrow	0.0
Burbo Bank	0.0

DEVELOPMENT	PREDICTED ANNUAL MORTALITY
Burbo Bank Extension	0.0
Gwynt y Môr	0.0
North Hoyle	0.0
Ormonde	0.0
Rampion I	26.0
Rhyl Flats	0.0
Robin Rigg	0.0
Walney Phase 1	0.0
Walney Phase 2	0.0
Walney Extension	28.2
West of Duddon Sands	0.0
Total excluding AyM (Consented Projects)	54.2
AyM*	2.9 *(0.0-12.1)*
Total (AyM & Consented Projects)	57.1 *(54.2-66.3)*
Erebus	0.8
Rampion II (PEIR)	4.0
Total (All Projects)	61.9 *(59.0-71.1)*

Table note: *AyM value based on BO3 mean estimate presented within Table 43. Values in parenthesis present the BO3 minimum and maximum estimates for AyM.

533 The annual cumulative total for all projects of great black-backed gulls subject to mortality due to collision is estimated to be 62 (61.9) individuals, of which AyM contributes three (2.9) predicted mortalities per annum. When considering the three different BDMPS populations as detailed in Section 4.10, the addition of 62 predicted mortalities would increase baseline mortality by 1.271-3.733%. When considering the annual potential level of change at the biogeographic scale, the natural predicted mortality for the biogeographic population of 235,000 (Table 17) across all seasons is 21,961 individuals per annum. On a biogeographic scale, the addition of 62 mortalities would increase the mortality relative to the baseline mortality rate by 0.282%.

534 As the predicted increase in baseline mortality of the BDMPS populations exceeds an increase of 1%, the Applicant has undertaken further consideration of such impact through Population Viability Analysis (PVA) as described in Volume 4, Annex 4.6: Great black-backed gull Population Viability Analysis (application ref: 6.4.4.6). A wider range of increases in mortality have been modelled and presented within Volume 4, Annex 4.6 (application ref: 6.4.4.6) for interoperation, to account for any possible changes in cumulative impacts over the course of the AyM examination process. The results of the PVA are presented below in Table 60 for the current level of predicted increase in mortality at the time of writing this ES only. The PVA metrics used for interpretation are the Counterfactual of Population Growth Rate (CPGR) and Counterfactual of Final Population Size (CFPS). These metrics have been used for assessment due to the density dependence not being included within the model, which means modelling doesn't account for population regulation leading to the final predicted impacted population sizes being wholly unsuitable for interpretation. It should be noted that although both CPGR and CFPS may predict reductions in the overall growth rate or population size, this does not necessarily mean the population is predicted to decline under such scenarios. To understand what influence the predicted CPGR and CFPS may have on a given population, inference should be made against the known population trends for a receptor.

535 When considering the current operational projects only, the closest increase in mortality modelled was for 55 (54.2) mortalities per annum, the results of the PVA predict a reduction in growth rate of 0.13-0.37% and a reduction in population size of 3.96-10.96% over the 30-year timeframe. Due to the age of these projects, any predicted impacts from these projects are highly likely to now be encapsulated within any population trends observed, and therefore should be excluded from interpretation.

536 When considering all projects in Table 59 The closest increase in mortality modelled equates to an increase in mortality of 60 (61.9), which predicted a reduction in growth rate of 0.14-0.41% and a reduction in final population size of 11.99-4.29% over the 30-year timeframe. The addition of AyM and other non-consented projects increase in the reduction in growth rate by 0.01-0.04% and the reduction in the final population size by 1.04-0.33% over the 30-year timeframe. Regardless of the receptors current population trend, when considering such a minimal increase in impact on the growth rate and final population size this predicted impact would almost certainly be indistinguishable from natural fluctuations in the population.

537 Due to the minimal level of potential change attributed AyM and other non-consented projects being well within natural baseline fluctuations to the overall cumulative impact total, the cumulative impact is considered of **low magnitude**.

Table 60: Great black-backed gull PVA results.

POPULATION	INCREASE IN MORTALITY (PER ANNUM)	DENSITY IN-DEPENDANT COUNTERFACTUAL (AFTER 30 YEARS)		REDUCTION IN GROWTH RATE	REDUCTION IN FINAL POPULATION SIZE
		GROWTH RATE	FINAL POPULATION SIZE		
The UK South-west & English Channel BDMPS	55	0.996 (0.997)	0.890	0.37%	10.96%
	60	0.996 (	0.880	0.41%	11.99%
	65	0.996	0.871	0.44%	12.89%
	70	0.995	0.862	0.48%	13.80%
The UK West of Scotland BDMPS	55	0.998	0.942	0.19%	5.79%
	60	0.998	0.936	0.21%	6.35%
	65	0.998	0.931	0.23%	6.87%
	70	0.998	0.926	0.25%	7.35%
Combined Western Waters BDMPS	55	0.999	0.960	0.13%	3.96%
	60	0.999	0.957	0.14%	4.29%
	65	0.998	0.954	0.15%	4.60%
	70	0.998	0.951	0.16%	4.95%

Sensitivity of the receptor

538 As detailed in Section 4.12.4, this receptor's behavioural sensitivity to collision is considered to be high (Table 14). Whilst it may be of high behavioural sensitivity it is only of local importance, leading to an overall sensitivity of this receptor to collision risk of **medium**.

Significance of effect

539 Following the matrix approach set out in Table 13, given a sensitivity of medium and a magnitude of impact of low, the overall effect is concluded to be minor, which is **not significant** in EIA terms.

Herring gull

Potential magnitude of impact

540 The expected number of birds subject to collision mortality from each other development are presented in Table 61. Note that these are the collision mortality rates as reported by the developers, and therefore the modelling assumptions may not be consistent with those presented in this report. For AyM, results have been presented using recommended BO3 outputs (SNCBs, 2014).

541 As collision figures for other developments are not always available on a seasonal basis, this CEA has only been carried out on an annual basis.

Table 61: Herring gull cumulative collision mortality.

DEVELOPMENT	PREDICTED MORTALITY (ANNUAL)
Arklow	Unknown
Barrow	0.0
Burbo Bank	0.0
Burbo Bank Extension	13.9
Gwynt y Môr	0.0
North Hoyle	0.0
Ormonde	0.0
Rhyl Flats	0.0

DEVELOPMENT	PREDICTED MORTALITY (ANNUAL)
Robin Rigg	0.0
Walney Phase 1	0.0
Walney Phase 2	0.0
Walney Extension	54.2
West of Duddon Sands	0.0
Total excluding AyM (Consented Projects)	68.1
AyM*	*1.5 (0.0-6.7)*
Total (AyM & Consented Projects)	*69.6 (68.1-72.8)*
Erebus	2.3
Total (All Projects)	*71.9 (70.4-75.1)*

Table note: *AyM value based on BO3 mean estimate presented within Table 44. Values in parenthesis present the BO3 minimum and maximum estimates for AyM.

542 The cumulative annual total of herring gulls subject to mortality due to collision is estimated to be 72 (71.9) individuals, of which AyM contributes two (1.5) predicted mortalities per annum. Using the largest BDMPS population of 173,299 (Table 17), as a proxy for the annual BDMPS population, with an average baseline mortality rate of 0.172 (Table 18), the natural predicted mortality is 29,871 individuals per annum. The addition of 72 predicted mortalities would increase baseline mortality by 0.241%. When considering the annual potential level of change at the biogeographic scale, the natural predicted mortality for the biogeographic population of 1,098,000 (Table 17) across all seasons is 189,257 individuals per annum. On a biogeographic scale, the addition of 72 predicted mortalities would increase baseline mortality by 0.038%.

543 This level of potential change is considered to be an impact of **low to negligible on an annual basis at the BDMPS and bio-geographic scales**, respectively, as it represents limited or no discernible increase to baseline mortality levels compared to natural variation due to the small number of estimated collisions.

Sensitivity of the receptor

544 As detailed in Section 4.12.4, this receptor behavioural sensitivity to collision is considered to be high (Table 14). Whilst it may be of high behavioural sensitivity, it is only of local importance leading to an overall sensitivity of this receptor to collision risk of **medium**.

Significance of effect

545 Therefore, the magnitude of impact resulting from cumulative collision risk on an annual basis is considered to be negligible to low and the sensitivity is medium. The significance of the residual effect is therefore minor, which is **not significant** as defined in the assessment of significance matrix (Table 13).

Gannet

Potential magnitude of impact

546 The expected number of birds at risk of collision mortality from each development are presented in Table 62. Note that these are the collision mortality rates as reported by the developers, and therefore the modelling assumptions may not be consistent with those presented in this report. For AyM, results have been presented using recommended BO2 outputs (SNCBs, 2014).

547 As collision figures for other developments are not always available on a seasonal basis, this CEA has only been carried out on an annual basis.

548 Predicted mortality from underwater collisions with tidal devices at the West Anglesey Demonstration Zone (Morlais) have also been examined to ensure that total predicted cumulative mortality for gannet has been considered.

549 Currently this project has been granted consent on a 'deploy and monitor' basis, such that Phase One of the project will have a maximum capacity of 12 MW. To account for this significant reduction in project size and therefore impacts from the project compared to the closest assessment of a project size of 40MW, a logical approach has been taken and the impacts have been scaled down accordingly. Furthermore, the assessment of underwater turbine collision risk is still in its infancy and therefore knowledge on appropriate avoidance rates for species are currently unavailable. To account for this uncertainty a range of avoidance impact values from 95-99.9% are presented, although for the cumulative assessment within this report the central estimate has been included within the assessment.

Table 62: Gannet cumulative collision mortality.

DEVELOPMENT	PREDICTED ANNUAL MORTALITY
Arklow	Unknown
Barrow	0.0
Burbo Bank	0.0
Burbo Bank Extension	10.4
Gwynt y Môr	0.0
North Hoyle	0.0
Ormonde	0.0
Rhyl Flats	0.0
Robin Rigg	0.0
Walney Phase 1	0.0
Walney Phase 2	0.0
Walney Extension	37.4
West of Duddon Sands	0.0
Morlais Demonstration Zone Phase 1	0.0 (*0.0- 0.0*)
Total excluding AyM (Consented Projects)	47.8
AyM*	20.5 (*3.1-60.0)*
Total (AyM & Consented Projects)	68.3 (*50.9-107.8)*

DEVELOPMENT	PREDICTED ANNUAL MORTALITY
Erebus	25.8
Total (All Projects)	94.1 *(76.7-133.6)*

Table note: *AyM value based on mean estimate presented within Table 45. Values in parenthesis present the BO3 minimum and maximum estimates for AyM.

550 The annual cumulative total of gannets subject to mortality due to collision is estimated to be 94 (94.1) individuals, of which AyM contributes 21 (20.5) predicted mortalities per annum. Using the largest BDMPS population of 661,888 (Table 17), as a proxy for the annual BDMPS population, with an average baseline mortality rate of 0.188 (Table 18), the natural predicted mortality is 124,188 individuals per annum. The addition of 94 predicted mortalities would increase baseline mortality by 0.076%. When considering the annual potential level of change at the biogeographic scale, the natural predicted mortality for the biogeographic population of 1,180,000 (Table 17) across all seasons is 221,400 individuals per annum. On a biogeographic scale, the addition of 94 predicted mortalities would increase baseline mortality by 0.043%.

551 This level of potential change is considered to be an impact of **negligible magnitude on an annual basis at both the BDMPS and bio-geographic scales**, as it represents no discernible increase to baseline mortality levels compared to natural variation due to the small number of estimated collisions.

Sensitivity of the receptor

552 As detailed in Section 4.12.4, this receptor's behavioural sensitivity to collision is considered to be medium (Table 14). As this species is of medium behavioural sensitivity and it is of medium conservation value, this leads to an overall sensitivity to collision risk of **medium**.

Significance of effect

553 Therefore, the magnitude of impact resulting from cumulative collision risk on an annual basis is considered to be negligible and the sensitivity is medium. The significance of the effect is therefore minor, which is **not significant** as defined in the assessment of significance matrix (Table 13).

Cumulative combined operational displacement and collision risk

Gannet

554 Due to gannet being scoped in for both displacement and collision risk assessments during the O&M phase, there is potential for these two impacts to cumulatively adversely affect gannet populations when combined. Previous sections have concluded both a negligible magnitude of impact from collision risk cumulatively and a negligible magnitude of impact from displacement cumulatively. However, the combined impact of both cumulative collision risk and cumulative displacement may be greater than either one acting alone. Further consideration of both impacts acting together is therefore required. It is recognised that assessing these two potential impacts together amounts 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.

Potential magnitude of impact

555 As detailed in Table 56 and Table 62, following the Applicant's evidence-led assessments the combined predicted mortality in the O&M phase (displacement and collision risk) equates to between 101 (101.2) and 104 (103.6) cumulative predicted additional mortality per annum. Using the largest BDMPS population of 661,888 (Table 17), as a proxy for the annual BDMPS population, with an average baseline mortality rate of 0.188 (Table 18), the natural predicted mortality is 124,188 individuals per annum. The addition of 101 to 104 predicted mortalities would increase baseline mortality by 0.082-0.083% of the annual BDMPS population. When considering the annual potential level of change at the biogeographic scale, the natural predicted mortality for the biogeographic population of 1,180,000 (Table 17) across all seasons is 221,400 individuals per annum. On a biogeographic scale, the addition of 101 to 103 predicted mortalities would increase baseline mortality by 0.046-0.047%. It should be noted that the impacts associated with both displacement and collision risk combined assessed in this simplistic additive manner are almost certainly an overestimate, as a bird which has been displaced from the array area can no longer collide with a turbine and vice versa.

556 This level of potential change is considered to be an impact of **negligible magnitude on an annual basis at both the BDMPS and bio-geographic scales**, as it represents between only a slight difference to the baseline conditions due to the number of individuals subject to potential mortality from both displacement and collision combined.

Sensitivity of the receptor

557 As detailed in Section 4.11.1 and 4.12.4, this receptor is afforded a feature conservation value of "medium". With respect to behavioural sensitivity, it is considered to be medium (Table 14). As this receptor is of medium behavioural sensitivity, and it is of medium conservation value, this leads to an overall sensitivity of this receptor to disturbance and displacement of **medium**.

Significance of effect

558 Therefore, the magnitude of impact resulting from collision risk and displacement combined on an annual basis is considered to be negligible and the sensitivity is medium. The significance of the residual effect is therefore, minor which is **not significant** as defined in the assessment of significance matrix (Table 13).

4.16.4 Cumulative barrier effects

559 There is the potential for barrier effects to act cumulatively if individual birds have to fly further or are unable to access larger areas of foraging as the result of avoiding more than one OWF. This CEA focuses on receptors that conduct short-range diurnal movements, such as common scoter which move between inshore areas overnight and foraging areas at sea. While it is possible that long distance migrants or seabirds that have a maximum foraging range of >100 km may encounter more than one OWF, this would be unlikely and would not correspond to any direct migratory routes or foraging pathways. The additional distance would therefore be negligible compared to the journey as a whole, and far less significant than the impact of normal variation in weather conditions.

560 As AyM will be immediately adjacent to GyM, this has the potential to create a larger barrier effect than AyM alone. The potential for a barrier effect to arise was considered for GyM alone, and the Marine Licence requirements included ornithological monitoring to assess any such barrier effect. The ornithological monitoring programme covered the pre-during- and post-construction phases of GyM, spanning the period 2010 to 2019. The methodology and subsequent reports have been reviewed and agreed by NRW (APEM, 2019).

561 The ornithological monitoring programme for GyM found no evidence of a barrier effect for common scoter or any other species detected (APEM, 2019). The monitoring programme found evidence of common scoter and red-throated diver within the GyM array area post-construction, in comparable densities to pre-construction. Analysis of common scoter flight directions found no evidence that flight directions changed between pre- and post-construction monitoring.

562 As there is evidence that no barrier effect has arisen from GyM alone, it seems implausible to suggest that this would change sufficiently to create a significant cumulative effect when considering both AyM and GyM together. Furthermore, it is considered that potential cumulative displacement effects encapsulate potential barrier effects for those species considered.

563 The magnitude of impact has therefore been assessed as negligible. As such, following the matrix approach set out in Table 13, this effect has been assessed as **not significant** for all receptors regardless of their sensitivity.

4.17 Summary of effects

564 Table 63 presents a summary of the preliminary assessment of significant effects, any relevant mitigation measures and residual effects on offshore ornithology receptors.

Table 63: Summary of effects.

IMPACT	SPECIES	MAGNITUDE	SENSITIVITY OF RECEPTOR	MITIGATION MEASURES	RESIDUAL EFFECT
CONSTRUCTION					
Disturbance and displacement: array	Common scoter & red-throated diver	Negligible	High	N/A	Negligible to Minor (Not Significant)
	Guillemot	Negligible	Medium	N/A	Minor (Not Significant)
	Razorbill, gannet & Manx shearwater	Negligible	Medium	N/A	Negligible to Minor (Not Significant)
Disturbance and displacement: offshore ECC	Red-throated diver	Negligible	High	N/A	Negligible to Minor (Not Significant)
	Common Scoter	Negligible	High	N/A	Minor (Not Significant)
Indirect impacts: array	All receptors	Negligible	Low to High	N/A	Negligible (Not Significant)
Indirect impacts: offshore ECC	All receptors	Negligible	Low to High	N/A	Negligible (Not Significant)
OPERATION					
Disturbance and displacement: array	Common Scoter & red-throated diver	Negligible	High	N/A	Negligible to Minor (Not Significant)
	Guillemot	Negligible	Medium	N/A	Minor (Not Significant)
	Razorbill, gannet & Manx shearwater	Negligible	Medium	N/A	Negligible to Minor (Not Significant)
Disturbance and displacement: operational vessels	All receptors	Negligible	Medium to High	N/A	Negligible (Not Significant)
Disturbance and displacement: offshore ECC	All receptors	Negligible	Medium to High	N/A	Negligible (Not Significant)

IMPACT	SPECIES	MAGNITUDE	SENSITIVITY OF RECEPTOR	MITIGATION MEASURES	RESIDUAL EFFECT
Collision risk: array	Kittiwake & gannet	Low	Medium	N/A	Minor (Not Significant)
	Great black-backed gull & herring gull	Negligible	Medium	N/A	Negligible to Minor (Not Significant)
	Migratory Receptors	Negligible	Low to Medium	N/A	Negligible to Minor (Not Significant)
Cumulative displacement and collision risk: array	Gannet	Low	Medium	N/A	Minor (Not Significant)
Barrier effects: array	All receptors	Negligible	Low	N/A	Negligible to Minor (Not Significant)
Lighting: array	All receptors	Negligible	Low	N/A	Negligible to Minor (Not Significant)
Indirect impacts: array	All receptors	Negligible	Low to High	N/A	Negligible to Minor (Not Significant)
Indirect impacts: offshore ECC	All receptors	Negligible	Low to High	N/A	Negligible to Minor (Not Significant)
DECOMMISSIONING					
Disturbance and displacement: array	Common Scoter & red-throated diver	Negligible	High	N/A	Negligible to Minor (Not Significant)
	Guillemot	Negligible	Medium	N/A	Minor (Not Significant)
	Razorbill, gannet & Manx shearwater	Negligible	Medium	N/A	Negligible to Minor (Not Significant)
Disturbance and displacement: offshore ECC	Red-throated diver	Negligible	High	N/A	Negligible to Minor (Not Significant)
	Common Scoter	Negligible	High	N/A	Minor (Not Significant)

IMPACT	SPECIES	MAGNITUDE	SENSITIVITY OF RECEPTOR	MITIGATION MEASURES	RESIDUAL EFFECT
Indirect impacts: array	All receptors	Negligible	Low to High	N/A	Negligible (Not Significant)
Indirect impacts: offshore ECC	All receptors	Negligible	Low to High	N/A	Negligible (Not Significant)
CUMULATIVE EFFECTS					
Disturbance and displacement	Common scoter & red-throated diver	Negligible	High	N/A	Minor (Not Significant)
	Guillemot, razorbill, gannet & Manx Shearwater	Negligible	Medium	N/A	Minor (Not Significant)
Collision risk	Kittiwake, great black-backed gull & gannet	Low	Medium	N/A	Minor (Not Significant)
	Herring gull	Low to Negligible	Medium	N/A	Minor (Not Significant)
Cumulative displacement and collision risk	Gannet	Low	Medium	N/A	Minor (Not Significant)
Barrier effects	All receptors	Negligible	Low	N/A	Negligible to Minor (Not Significant)

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Offshore Wind Farm

RWE Renewables UK Swindon Limited

Windmill Hill Business Park
Whitehill Way
Swindon
Wiltshire SN5 6PB
T +44 (0)8456 720 090
www.rwe.com

Registered office:
RWE Renewables UK Swindon Limited
Windmill Hill Business Park
Whitehill Way
Swindon