MORGAN AND MORECAMBE OFFSHORE WIND FARMS: TRANSMISSION ASSETS

Environmental Statement

Volume 2, Chapter 3: Fish and shellfish ecology

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Glossary

Term	Meaning
Applicants	Morgan Offshore Wind Limited (Morgan OWL) and Morecambe Offshore Windfarm Ltd (Morecambe OWL).
Commitment	This term is used interchangeably with mitigation and enhancement measures. The purpose of commitments is to avoid, prevent, reduce or, if possible, offset significant adverse environmental effects. Primary and tertiary commitments are taken into account and embedded within the assessment set out in the ES.
Cumulative Effects	The combined effect of the Transmission Assets in combination with the effects from other proposed developments, on the same receptor or resource.
Cumulative Study Area	The area within a 50 km buffer of the Transmission Assets, and a 100 km buffer for underwater sound which is assessed for potential cumulative impacts with other projects.
Development Consent Order	An order made under the Planning Act 2008, as amended, granting development consent.
EIA Scoping Report	A report setting out the proposed scope of the Environmental Impact Assessment process. The Transmission Assets Scoping Report was submitted to The Planning Inspectorate (on behalf of the Secretary of State) for the Morgan and Morecambe Offshore Windfarms Transmission Assets in October 2022.
Elasmobranch	The term refers to cartilaginous fishes which include sharks, rays, and skates.
Environmental Statement	The document presenting the results of the Environmental Impact Assessment process.
Generation Assets	The generation assets associated with the Morgan Offshore Wind Project and the Morecambe Offshore Windfarm include the offshore wind turbines, inter-array cables, offshore substation platforms and platform link (interconnector) cables to connect offshore substations.
Important Ecological Features	Habitats, species, ecosystems and their functions/processes that are considered to be important and potentially impacted by the Proposed Development.
Impulsive sound	Sound which is broadband, typically transient, brief (less than one second), broadband, and consist of high peak sound pressure with rapid rise time and rapid decay
Intertidal Infrastructure Area	The temporary and permanent area between Mean High Water Springs and Mean Low Water Springs.
Landfall	The area in which the offshore export cables make landfall (come on shore) and the transitional area between the offshore cabling and the onshore cabling. This term applies to the entire landfall area at Lytham St. Annes between Mean Low Water Springs and the transition joint bay inclusive of all construction works, including the offshore and onshore cable routes, intertidal working area and landfall compound(s).

Term	Meaning
Marine licence	The Marine and Coastal Access Act 2009 requires a marine licence to be obtained for licensable marine activities. Section 149A of the Planning Act 2008 allows an applicant for to apply for 'deemed marine licences' in English waters as part of the development consent process.
Maximum design scenario	The realistic worst case scenario, selected on a topic-specific and impact specific basis, from a range of potential parameters for the Transmission Assets.
Mitigation measures	This term is used interchangeably with Commitments. The purpose of such measures is to avoid, prevent, reduce or, if possible, offset significant adverse environmental effects.
Morecambe Offshore Windfarm: Generation Assets	The offshore generation assets and associated activities for the Morecambe Offshore Windfarm.
Morecambe Offshore Windfarm: Transmission Assets	The offshore export cables, landfall and onshore infrastructure required to connect the Morecambe Offshore Windfarm to the National Grid.
Morecambe OWL	Morecambe Offshore Windfarm Ltd is a joint venture between Zero-E Offshore Wind S.L.U. (Spain) (a Cobra group company) and Flotation Energy Ltd.
Morgan and Morecambe Offshore Wind Farms: Transmission Assets	The offshore and onshore infrastructure connecting the Morgan Offshore Wind Project and the Morecambe Offshore Windfarm to the national grid. This includes the offshore export cables, landfall site, onshore export cables, onshore substations, 400 kV grid connection cables and associated grid connection infrastructure such as circuit breaker compounds. Also referred to in this report as the Transmission Assets, for ease of reading.
Morgan Offshore Wind Project: Generation Assets	The offshore generation assets and associated activities for the Morgan Offshore Wind Project.
Morgan Offshore Wind Project: Transmission Assets	The offshore export cables, landfall and onshore infrastructure required to connect the Morgan Offshore Wind Project to the National Grid.
Morgan OWL	Morgan Offshore Wind Limited is a joint venture between bp Alternative Energy investments Ltd. and Energie Baden-Württemberg AG (EnBW).
National Policy Statement(s)	The current national policy statements published by the Department for Energy Security and Net Zero in 2023 and adopted in 2024.
Non impulsive (or continuous) sound	Sound which can be broadband, narrowband or tonal, brief or prolonged, continuous or intermittent and typically do not have a high peak sound pressure with rapid rise/decay time that impulsive sounds do.
Nursery habitat	A habitat where juveniles of a species regularly occur as a population.
Offshore export cables	The cables which would bring electricity from the Generation Assets to the landfall.
Offshore Order Limits	See Transmission Assets Order Limits: Offshore (below).
Offshore Permanent Infrastructure Area	The area within the Transmission Assets Order Limits (up to Mean Low Water Springs) where the permanent offshore electrical infrastructure (i.e. offshore export cables) will be located.

Term	Meaning
Onshore Infrastructure Area	The area within the Transmission Assets Order Limits landward of Mean High Water Springs. Comprising the offshore export cables from Mean High Water Springs to the transition joint bays, onshore export cables, onshore substations and 400 kV grid connection cables, and associated temporary and permanent infrastructure including temporary and permanent compound areas and accesses. Those parts of the Transmission Assets Order Limits proposed only for ecological mitigation/biodiversity benefit are excluded from this area.
Substation	Part of an electrical transmission and distribution system. Substations transform voltage from high to low, or the reverse by means of electrical transformers.
Transmission Assets	See Morgan and Morecambe Offshore Wind Farms: Transmission Assets (above)
Transmission Assets Order Limits	The area within which all components of the Transmission Assets will be located, including areas required on a temporary basis during construction and/or decommissioning.
Transmission Assets Order Limits: Offshore	The area within which all components of the Transmission Assets seaward of Mean Low Water Springs will be located, including areas required on a temporary basis during construction and/or decommissioning. Also referred to in this report as the Offshore Order Limits, for ease of reading.
Transmission Assets Scoping Boundary	The term used to define the boundary used at the time the Scoping Report was submitted.

Acronyms

Acronym	Meaning
AC	Alternating Current
AFBI	Agri-Food and Biosciences Institute
BBA	Biodiversity Benefit Area
BOWL	Beatrice Offshore Wind Limited
CBRA	Outline Cable Burial Risk Assessment
CEA	Cumulative Effects Assessment
Cefas	Centre for Environment Fisheries and Aquaculture Science
CIEEM	Chartered Institute of Ecology and Environmental Management
CMACS	Centre for Marine and Coastal Studies Ltd.
CMS	Construction Method Statement
COWRIE	Collaborative Offshore Wind Research into the Environment
CSIP	Outline Offshore Cable Specification and Installation Plan

Acronym	Meaning
CTV	Crew Transfer Vessel
DC	Direct Current
DCO	Development Consent Order
DDV	Drop Down Video
EIA	Environmental Impact Assessment
EMF	Electromagnetic Fields
EMODnet	European Marine Observation and Data Network
EMP	Outline Offshore Environmental Management Plan
EMU	Ecological Marine Unit
EPP	Evidence Plan Process
ES	Environmental Statement
EU	European Union
EWG	Expert Working Group
FEPA	Food and Environment Protection Agency
HVAC	High Voltage Alternating Current
ICES	International Council for the Exploration of the Sea
IEF	Important Ecological Feature
IEMA	Institute of Environmental Management and Assessment
INNS	Invasive Non-Native Species
ISAA	Information to Support Appropriate Assessment
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
MarLIN	Marine Life Information Network
MBES	Multibeam Echosounder
MCZ	Marine Conservation Zone
MDS	Maximum Design Scenario
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MMEA	Manx Marine Environmental Assessment
MMO	Marine Management Organisation
MNR	Marine Nature Reserve
MPA	Marine Protected Area
MPCP	Marine Pollution Contingency Plan
NEQ	Net Explosive Quantity

Acronym	Meaning
NINEL	Northern Ireland Herring Larvae Survey
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Policy Statement
NRW	Natural Resources Wales
NSIP	Nationally Significant Infrastructure Project
OCP	Organochlorine Pesticide
OSPAR	Oslo-Paris Conventions
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PDE	Project Design Envelope
PEIR	Preliminary Environmental Information Report
PSA	Particle Size Analysis
PTS	Permanent Threshold Shift
SAC	Special Area of Conservation
SBES	Single Beam Echosounder
SBP	Sub-Bottom Profiler
SEL_{cum}	Cumulative Sound Exposure Level
SOV	Service Operation Vessel
SPA	Special Protection Area
SPI	Species of Principal Importance
SPL_{pk}	Peak Sound Pressure Level
SPM	Suspended Particulate Matter
SSC	Suspended Sediment Concentration
SSS	Sidescan Sonar
TAC	Total Allowable Catch
TSC	Territorial Seas Committee
TTS	Temporary Threshold Shift
UHRS	Ultra High Resolution Seismic
UK	United Kingdom
UKOOA	United Kingdom Offshore Operators Association
UXO	Unexploded Ordnance
ZOI	Zone of Influence

Units

Unit	Description
%	Percentage
dB	Decibel
G	Gauss
Hz	Hertz
kg	Kilogram
kHz	Kilohertz
km	Kilometres
km^2	Square kilometres
kV	Kilovolts
m	Metres
m^2	Square metres
m^3	Cubic metres
mG	Milligauss
mg/l	Milligrams per litre
mm	Millimetres
m/s	Metres per second
MW	Megawatts
nm	Nautical mile
rms	Root mean square
μPa	Micropascal
μPa^2	Micropascal squared
μT	Microtesla
μV/cm	Microvolts per centimetre
mV/m	Millivolts per metre
μV/m	Microvolts per metre
T	Tesla
V/m	Volts per metre

3 Fish and shellfish ecology

3.1 Introduction

3.1.1 Overview

3.1.1.1 This chapter of the Environmental Statement (ES) presents the findings of the Environmental Impact Assessment (EIA) work undertaken to date for the Morgan and Morecambe Offshore Wind Farms: Transmission Assets. For ease of reference, the Morgan and Morecambe Offshore Wind Farms: Transmission Assets are referred to in this chapter as the 'Transmission Assets'. This ES accompanies the application to the Planning Inspectorate for development consent for the Transmission Assets.

3.1.1.2 The purpose of the Transmission Assets is to connect the Morgan Offshore Wind Project: Generation Assets and Morecambe Offshore Windfarm: Generation Assets (referred to collectively as the 'Generation Assets') to the National Grid. A description of the Transmission Assets can be found in Volume 1, Chapter 3: Project description of the ES.

3.1.1.3 This chapter considers the likely impacts and effects of the Transmission Assets on fish and shellfish ecology during the construction, operation and maintenance, and decommissioning phases of the project and, where appropriate, mitigation measures to manage any potential effects. Specifically, it relates to the offshore elements (Offshore Permanent Infrastructure Area) of the Transmission Assets seaward of Mean Low Water Springs (MLWS).

3.1.1.4 This ES chapter:

- identifies the key legislation, policy and guidance relevant to fish and shellfish ecology;
- details the EIA scoping and consultation process undertaken to date for fish and shellfish ecology;
- confirms the study area for the assessment, the methodology used to identify baseline environmental conditions and sets out the existing and future environmental baseline conditions, established from desk studies, surveys and consultation;
- identifies the scope of the assessment;
- details the mitigation and/or monitoring measures that are proposed to prevent, minimise, reduce or offset the possible environmental effects identified in the EIA process;
- defines the project design parameters used to inform for the impact assessment;
- identifies the impact assessment methodology and presents an assessment of the likely impacts and effects in relation to the construction, operation and maintenance and decommissioning phases of the Transmission Assets on fish and shellfish ecology (and, where

relevant, the impacts and effects of fish and shellfish ecology on the Transmission Assets); and

- identifies any cumulative, transboundary and/or inter-related effects in relation to the construction, operation and maintenance and decommissioning phases of the Transmission Assets on fish and shellfish ecology.

3.1.1.5 The assessment presented is informed by the following technical chapters and should be read in conjunction with:

- Volume 2, Chapter 1: Physical processes of the ES;
- Volume 2, Chapter 2: Benthic subtidal and intertidal ecology of the ES;
- Volume 2, Chapter 4: Marine mammals of the ES; and
- Volume 2, Chapter 6: Commercial fisheries of the ES.

3.1.1.6 This chapter also draws upon information to support the assessment contained within:

- Volume 1, Annex 5.2: Underwater sound technical report of the ES;
- Volume 2, Annex 2.1: Benthic subtidal and intertidal ecology technical report of the ES;
- Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES; and
- Volume 2, Annex 6.1: Commercial fisheries technical report of the ES.

3.1.1.7 The Preliminary Environmental Information Report (PEIR), submitted in October 2023, has informed pre-application consultation. Following consultation, comments on the PEIR have been reviewed and taken into account, where appropriate, in the preparation of this ES (see **section 3.3**).

3.2 Legislative and policy context

3.2.1 Legislation

3.2.1.1 The full relevant legislative context for the Transmission Assets has been detailed in Volume 1, Chapter 2: Policy and legislation context of the ES, with the legislation outlined below being the most relevant to fish and shellfish ecology. For the purposes of this assessment, shellfish is considered a generic term to define molluscs and crustaceans.

Habitats Regulations

3.2.1.2 In England and Wales, the Conservation of Habitats and Species Regulations 2017 (onshore and out to 12 nautical miles (nm)) and the Conservation of Offshore Marine Habitats and Species Regulations 2017 (between 12 nm and 200 nm), collectively referred to as ‘the Habitats Regulations’, are the principal means by which the Habitats Directive (Council Directive 92/43/European Economic Community) and certain elements of the Wild Birds Directive (Directive 2009/147/European Commission) are transposed into United Kingdom (UK) law. The Habitats

Regulations remain in force following the United Kingdom's departure from the European Union (EU), subject to certain amendments. These regulations require the assessment of significant effects on internationally important nature conservation sites, including the following:

- Special Areas of Conservation (SACs) or candidate SACs;
- Special Protection Areas (SPAs) or potential SPAs;
- Sites of Community Importance; and
- Ramsar sites.

3.2.1.3 These designated sites have been given full consideration in Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES and are given further consideration within this chapter where the impacts are assessed as likely to have an effect. As a matter of policy, in the UK, Ramsar sites are given the same protection as sites covered by the Habitats Regulations (Department for Energy Security & Net Zero, 2024a). Additionally, the potential impacts of the Transmission Assets on all habitats, species and sites protected under the Habitats Regulations are assessed in the HRA Stage 1 Screening Report (document reference E3) and Information to Support the Appropriate Assessment (ISAA) part 2 (document reference E2.2).

Marine and Coastal Access Act 2009

3.2.1.4 Parts three and four of the Marine and Coastal Access Act 2009 introduced a new marine planning and licensing system for overseeing the marine environment and a requirement to obtain a marine licence for certain activities and works at sea. Section 149A of the Planning Act 2008 allows applicants for development consent to apply for 'deemed marine licences' as part of the consenting process.

3.2.1.5 Part five of the Marine and Coastal Access Act 2009 enables the designation of Marine Conservation Zones (MCZs) in England and Wales as well as UK offshore areas. Consideration of MCZs is required for any marine licence application or an application for development consent which includes a deemed marine licence.

3.2.1.6 These designated sites have been given full consideration in Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES as well as in the Stage 1 MCZ Assessment (document reference E4) and are given further consideration within this chapter where the impacts are deemed likely to have a potential effect on fish and shellfish ecology.

Environment Act 2021

3.2.1.7 The Environment Act 2021 sets out targets, plans and policies for environmental protection in England. Schedule 15 of the Environment Act 2021 sets out provisions for Biodiversity Benefit Area (BBA) in respect of nationally significant infrastructure projects (NSIPs) and amends the Planning Act 2008. These provisions propose to include the requirement for the production of BNG statements for NSIPs, however these provisions are not expected to take effect until at least November 2025. Such provisions will only apply to applications that are submitted after the date that these provisions take effect for NSIPs.

3.2.2 Planning policy context

3.2.2.1 The Transmission Assets will be located in English offshore (beyond 12 nm from the English coast) and inshore waters (within 12 nm from the English coast), with the Onshore Infrastructure Area located wholly within England. As set out in Volume 1, Chapter 1: Introduction of the ES, the Secretary of State for the Department for Business, Energy and Industrial Strategy (the department which preceded the Department for Energy Security and Net Zero) has directed that the Transmission Assets are to be treated as a development for which development consent is required under the Planning Act 2008, as amended. As such, there is a requirement to submit an application for a Development Consent Order (DCO) to the Planning Inspectorate to be decided by the Secretary of State for the Department for Energy Security and Net Zero.

National Policy Statements

3.2.2.2 There are currently six energy National Policy Statements (NPSs), which came into force in 2024. Three of these NPS' contain policy relevant to offshore wind development and the Transmission Assets, however, only two NPS' have policies related to fish and shellfish ecology as outlined below.

- Overarching NPS for Energy (NPS EN-1) which sets out the United Kingdom (UK) Government's policy for the delivery of major energy infrastructure (Department for Energy Security and Net Zero 2024a).
- NPS for Renewable Energy Infrastructure (NPS EN-3) (Department for Energy Security and Net Zero 2024b).

3.2.2.3 **Table 3.1** sets out a summary of the policies within these NPSs, relevant to fish and shellfish ecology.

3.2.2.4 The policies within the current NPSs relevant to all topics in the ES can be viewed in the National Policy Statement Tracker (document reference J26) and Planning Statement (document reference J28), submitted with the Application.

Table 3.1: Summary of the NPS EN-1 and NPS EN-3 requirements relevant to this chapter

Summary of NPS provision	How and where considered in the ES
NPS EN-1	
[4.1.5] In considering any proposed development, in particular when weighing its adverse impacts against its benefits, the Secretary of State should take into account: • its potential benefits including its contribution to meeting the need for energy infrastructure, job creation, reduction of geographical disparities, environmental enhancements, and any long term or wider benefits • its potential adverse impacts, including on the environment, and including any long-term and cumulative adverse impacts, as well as any measures to avoid, reduce, mitigate or compensate for any adverse impacts, following the mitigation hierarchy	The existing ecology of the study area is laid out in the baseline environment in **section 3.6**, and was based on Volume 1, Chapter 3: Project Description and Volume 1, Chapter 4: Site selection and consideration of alternatives of the ES, with all relevant information used to inform the associated assessment of significant effects on this baseline in **section 3.11**. This can be used to allow weighing of impacts and benefits in the decision-making process. The potential for cumulative effects is assessed in **section 3.13**. Environmental benefits as a result of the project are presented within the Marine Enhancement Statement (document reference J12).
[4.1.6] In this context, the Secretary of State should take into account environmental, social and economic benefits and adverse impacts, at national, regional and local levels. These may be identified in this NPS, the relevant technology specific NPS, in the application or elsewhere (including in local impact reports, marine plans, and other material considerations).	Designated sites are set out in **section 3.6.2**, with Important Ecological Features (IEFs) defined in **section 3.6.5** based on their conservation, ecological and commercial importance. These can be used in accounting for national, regional, and local impacts on these projects, which are assessed alone in **section 3.11** and cumulatively in **section 3.13**.
[4.1.11] The energy NPSs have taken account of the National Planning Policy Framework, the Planning Practice Guidance for England, and Planning Policy Wales and Technical Advice Notes for Wales, where appropriate.	All guidance and policy frameworks in relation to fish and shellfish ecology have been identified in **section 3.2**, with specific relevant clauses addressed, and explanations given on how these have been considered within the ES and complied with throughout.
[4.3.3] The Regulations require an assessment of the likely significant effects of the proposed project on the environment, covering the direct effects and any indirect, secondary, cumulative, transboundary, short, medium, and long term, permanent and temporary, positive and negative effects at all stages of the project, and also of the measures envisaged for avoiding or mitigating significant adverse effects.	The impacts on fish and shellfish ecology in the short, medium and long term have been assessed in **section 3.11** for the project alone, with consideration of secondary, indirect and permanent or temporary effects throughout this section. The impacts have also been considered cumulatively with other relevant projects and plans in **section 3.13**, and potential transboundary effects have been identified and assessed in **section 3.14**. Measures to mitigate any potential impacts have been identified in **section 3.8** and in Volume 1, Annex 5.3: Commitments register of the ES.
[4.3.4] To consider the potential effects, including benefits, of a proposal for a project, the applicant must set out information on the likely significant environmental, social and economic effects of the development, and show	The impacts on fish and shellfish ecology have been assessed in **section 3.11**, with all other impacts assessed throughout the chapters. Measures adopted as part of the Transmission Assets for fish and shellfish are identified in **section**

Summary of NPS provision	How and where considered in the ES
how any likely significant negative effects would be avoided, reduced, mitigated or compensated for, following the mitigation hierarchy. This information could include matters such as employment, equality, biodiversity net gain, community cohesion, health and well-being.	**3.8**. Measures to mitigate any potential impacts are listed in Volume 1, Annex 5.3: Commitments register of the ES.
[4.3.5] For the purposes of this NPS and the technology specific NPSs the ES should cover the environmental, social and economic effects arising from pre-construction, construction, operation and decommissioning of the project.	The assessment of significant effects in **section 3.11** examines the impacts of all stages of the project on the environmental factors, and specifically the fish and shellfish ecology receptors, arising from the Transmission Assets.
[4.3.10] The applicant must provide information proportionate to the scale of the project, ensuring the information is sufficient to meet the requirements of the EIA Regulations.	Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES; the baseline in **section 3.6**; Maximum Design Scenario (MDS), and assessment of impacts sections examine the scale of potential impacts on the fish and shellfish ecology receptors.
[4.3.12] Where some details are still to be finalised, the Environmental Statement should, to the best of the applicant's knowledge, assess the likely worst-case environmental, social and economic effects of the proposed development to ensure that the impacts of the project as it may be constructed have been properly assessed.	The MDS (**Table 3.13**) provides the calculated MDS impacts on fish and shellfish ecology.
[4.5.8 to 4.5.9] Applicants for a Development Consent Order must take account of any relevant Marine Plans and are expected to complete a Marine Plan assessment as part of their project development, using this information to support an application for development consent. Applicants are encouraged to refer to Marine Plans at an early stage, such as in preapplication, to inform project planning, for example to avoid less favourable locations as a result of other uses or environmental constraints.	All relevant Marine Plans and guidelines are outlined in **section 3.2** with compliance to relevant fish and shellfish ecology clauses highlighted.
[4.10.5] In certain circumstances, measures implemented to ensure a scheme can adapt to climate change may give rise to additional impacts, for example as a result of protecting against flood risk, there may be consequential impacts on coastal change. In preparing measures to support climate change adaptation applicants should take reasonable steps to maximise the use of nature-based solutions alongside other conventional techniques.	The potential future impact of climate change on fish and shellfish ecology is examined in the future baseline scenario in **section 3.6.4**, and more broadly in Volume 4, Chapter 1: Climate change of the ES.
[4.12.5 and 4.12.7] Applicants should consult the Marine Management Organisation (MMO) (or Natural Resources Wales (NRW) in Wales) on energy NSIP projects which would affect, or would be likely to affect, any	The consultation process is outlined in **section 3.3** of this chapter, including any communications with the MMO, the Environment Agency and NRW, the

Summary of NPS provision	How and where considered in the ES
relevant marine areas as defined in the Planning Act 2008 (as amended by section 23 of the Marine and Coastal Access Act 2009). Applicants are encouraged to consider the relevant marine plans in advance of consulting the MMO for England or the relevant policy teams at the Welsh government. Applicants should make early contact with relevant regulators, including the Environment Agency or NRW and the MMO, to discuss their requirements for Environmental Permits and other consents, such as marine licences.	Expert Working Groups (EWGs), and stakeholder consultation, as indicated in the Consultation report (document reference E1).
[5.4.2] In the 25-Year Environment Plan, the government set out its vision for a quarter-of-a-century action to help the natural world regain and retain good health. A commitment to review the plan every 5 years was set into law in the Environment Act 2021. The Environmental Improvement Plan was published in 2023, which reinforces the intent of the 25-Year Environment Plan and sets out a plan to deliver on its framework and vision. The government's policy for biodiversity in England is set out in the Environmental Improvement Plan 2023, the National Pollinator Strategy and the UK Marine Strategy. The aim is to halt overall biodiversity loss in England by 2030 and then reverse loss by 2042, support healthy well-functioning ecosystems and establish coherent ecological networks, with more and better places for nature for the benefit of wildlife and people. This aim needs to be viewed in the context of the challenge presented by climate change. Healthy, naturally functioning ecosystems and coherent ecological networks will be more resilient and adaptable to climate change effects. Failure to address this challenge will result in significant adverse impact on biodiversity and the ecosystem services it provides.	The conservation status of habitats and species is considered throughout this chapter, with the baseline (**section 3.6**) and assessment of significant effects (**section 3.11**) examining this in detail. The potential future impact of climate change is examined in the future baseline scenario (**section 3.6.4**). The conservation status of habitats and species is considered further in the Marine Enhancement Statement (document reference J12).
[5.4.17] Where the development is subject to EIA the Applicant should ensure that the ES clearly sets out any effects on internationally, nationally, and locally designated sites of ecological or geological conservation importance (including those outside England), on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity, including irreplaceable habitats.	Designated sites are set out in **section 3.6.2**, with IEFs defined in **section 3.6.5** based on their conservation, ecological and commercial importance. The assessment of effect in **section 3.11** has been undertaken to consider the potential effects of the Transmission Assets on these IEFs.
[5.4.19] The Applicant should show how the project has taken advantage of opportunities to conserve and enhance biodiversity and geological conservation interests.	The conservation of biodiversity interests has been considered directly in the assessment of effects in **section 3.11**, with measures adopted as part of the Transmission Assets (**section 3.8**) proposed to reduce potential impacts where possible. Mitigation measures are further detailed in Volume 1, Annex 5.3: Commitments register of the ES. The conservation status of habitats and

Summary of NPS provision	How and where considered in the ES
	species is considered further in the Marine Enhancement Statement (document reference J12).
[5.4.22] The design of energy NSIP proposals will need to consider the movement of mobile/migratory species such as birds, fish and marine and terrestrial mammals and their potential to interact with infrastructure. As energy infrastructure could occur anywhere within England and Wales, both inland and onshore and offshore, the potential to affect mobile and migratory species across the UK and more widely across Europe (transboundary effects) requires consideration, depending on the location of development.	Diadromous and migratory fish species have been identified as IEFs in **section 3.6.5** and considered in Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES and throughout this chapter within the baseline (**section 3.6**) and the assessment of effects of offshore infrastructure on species movements across the study area (**sections 3.11** and **3.13**) and more widely (see Volume 1, Annex 5.4: Transboundary screening of the ES).
[5.4.35] Applicants should include appropriate avoidance, mitigation, compensation and enhancement measures as an integral part of the proposed development. In particular, the applicant should demonstrate that: • during construction, they will seek to ensure that activities will be confined to the minimum areas required for the works • the timing of construction has been planned to avoid or limit disturbance • during construction and operation best practice will be followed to ensure that risk of disturbance or damage to species or habitats is minimised, including as a consequence of transport access arrangements • habitats will, where practicable, be restored after construction works have finished • opportunities will be taken to enhance existing habitats rather than replace them, and where practicable, create new habitats of value within the site landscaping proposals. Where habitat creation is required as mitigation, compensation, or enhancement, the location and quality will be of key importance. In this regard habitat creation should be focused on areas where the most ecological and ecosystems benefits can be realised • mitigations required as a result of legal protection of habitats or species will be complied with.	The MDS presented in **Table 3.13** is a precautionary approach to assess the likely maximum habitat loss from a range of investigated impacts based upon a design envelope. It represents a realistic scenario without overcompensating for any one activity, in this sense it represents the maximum area required to work in the construction, operation and maintenance and decommissioning phases. Any specific measures adopted to avoid and/or minimise potential impacts and effects to habitats and biodiversity have been identified and justified (**section 3.8** and **Table 3.12**). Best practice during construction and maintenance will be set out in the Construction Method Statement (CMS; CoT49, **Table 3.12**), and the Offshore Environmental Management Plan (EMP; CoT65, **Table 3.12**).

Summary of NPS provision	How and where considered in the ES
[5.4.36] Applicants should produce and implement a Biodiversity Management Strategy as part of their development proposals. This could include provision for biodiversity awareness training to employees and contractors so as to avoid unnecessary adverse impacts on biodiversity during the construction and operation stages.	A Biodiversity management strategy will be incorporated into the Outline offshore EMP (CoT65, **Table 3.12**) to ensure avoidance of unnecessary adverse impacts on biodiversity during the construction and operation and maintenance phases of the project.
[5.4.40] In addition, in exercising functions in relation to Wales, the Secretary of State should consider Section 6 of the Environment (Wales) Act 2016 and seek to maintain and enhance biodiversity, and in so doing promote the resilience of ecosystems, so far as consistent with the proper exercise of the Secretary of State's functions.	The need for a biodiversity benefit strategy has been addressed herein and any specific mitigation measures to minimise disturbance or damage to habitats and biodiversity with regards to fish and shellfish ecology have been identified and justified in **section 3.8.** The conservation status of habitats and species is considered further in the Marine Enhancement Statement (document reference J12).
[5.4.42] As a general principle, and subject to the specific policies below, development should, in line with the mitigation hierarchy, aim to avoid significant harm to biodiversity and geological conservation interests, including through consideration of reasonable alternatives. Where significant harm cannot be avoided, impacts should be mitigated and as a last resort, appropriate compensation measures should be sought.	Mitigation is broadly assessed in the measures adopted as part of the Transmission Assets (**section 3.8**) and where appropriate in each impact assessment if the impact was deemed to be moderate or above. Mitigation measures are further detailed in Volume 1, Annex 5.3: Commitments register of the ES.
[5.4.48] In taking decisions, the Secretary of State should ensure that appropriate weight is attached to designated sites of international, national and local importance; protected species; habitats and other species of principal importance for the conservation of biodiversity; and to biodiversity and geological interests within the wider environment.	Nearby designated sites, and their associated habitats, and Species of Principal Importance (SPIs), have been identified in Volume 2: Annex 3.1: Fish and shellfish ecology technical report of the ES and are listed in **section 3.6.2**, with the identified IEFs listed in **section 3.6.5.**
[5.6.10] Where relevant, applicants should undertake coastal geomorphological and sediment transfer modelling to predict and understand impacts and help identify relevant mitigating or compensatory measures.	The potential impacts of suspended sediment concentrations have been modelled as detailed in Volume 2, Chapter 1: Physical processes of the ES, with their impacts on fish and shellfish ecology receptors assessed in **section 3.11.5.**
[5.12.6] Where sound impacts are likely to arise from the proposed development, the applicant should include the following in the noise assessment: • A description of the noise generating aspects of the development proposal leading to noise impacts, including the identification of any distinctive tonal characteristics, if the noise is impulsive, whether the	Sources of potential sound impacts have been modelled in Volume 1, Annex 5.2: Underwater sound technical report of the ES, and identified in the MDS in **Table 3.13**. and The assessment of effects from underwater sound on fish and shellfish ecology receptors have been assessed alone in **section 3.11**, and cumulatively in **section 3.13**. Specific measures adopted as part of the Transmission Assets have been identified and discussed in **section 3.8.**

Summary of NPS provision	How and where considered in the ES
noise contains particular high or low frequency content or any temporal characteristics of the noise • Identification of noise sensitive receptors and noise sensitive areas that may be affected • The characteristics of the existing noise environment • A prediction of how the noise environment will change with the proposed development – In the shorter term, such as during the construction period – In the longer term, during the operating life of the infrastructure – At particular times of the day, evening and night (and weekends) as appropriate, and at different times of year • An assessment of the effect of predicted changes in the noise environment on any noise-sensitive receptors, including an assessment of any likely impact on health and quality of life/well-being where appropriate, particularly among • those disadvantaged by other factors who are often disproportionately affected by noise-sensitive areas • If likely to cause disturbance, an assessment of the effect of underwater or subterranean noise • all reasonable steps taken to mitigate and minimise potential adverse effects on health and quality of life	
[5.12.11 to 5.12.12] In the marine environment, applicants should consider noise impacts on protected species, both at the individual project level and in-combination with other marine activities. Applicants should submit a detailed impact assessment and mitigation plan as part of any development plan, including the use of noise mitigation and noise abatement technologies during construction and operation.	All relevant protected fish and shellfish ecology receptors which could be impacted by sound generated during construction, operation and maintenance and decommissioning activities have been modelled in Volume 1, Annex 5.2: Underwater sound technical report of the ES and identified in **section 3.6**, and the impacts have been assessed alone in **section 3.11**, and cumulatively in **section 3.13.** Mitigation measures to reduce this impact, have been identified where appropriate, and discussed in **section 3.8**, and are further detailed in Volume 1, Annex 5.3: Commitments register of the ES.

Summary of NPS provision	How and where considered in the ES
NPS EN-3	
[2.8.32 to 2.8.33] The onus is on the applicant to ensure that the foundation design is technically suitable for the seabed conditions and that the application caters for any uncertainty regarding the geological conditions. Whilst the technical suitability of the foundation design is not in itself a matter for the Secretary of State, the Secretary of State will need to be satisfied that the foundations will not have an unacceptable adverse effect on marine biodiversity, the physical environment or marine heritage assets.	Potential impacts from the range of possible foundation design parameters were addressed in the PEIR MDS calculation. Foundations have been removed from the Project Design Envelope (PDE) and are no longer required to be considered in the ES. However, permanent habitat loss and introduction of hard substrata are considered in the ES MDS (**section 3.9.1** and **Table 3.13**), with the levels of impact on ecologically important fish and shellfish receptors assessed in the assessment of significant effects (**section 3.11**).
[2.8.72] Assessment of environmental effects of transmission infrastructure and any proposed offshore or onshore substations should assess effects both alone and cumulatively with other existing and proposed infrastructure.	The impacts of transmission/cabling infrastructure on fish and shellfish receptors during the construction, operation and maintenance and decommissioning phases have been identified in the key parameters for assessment (**section 3.7**) and assessed in the assessment of significant effects for the Transmission Assets alone (**section 3.11**) or cumulatively with other projects (**section 3.13**).
[2.8.83 to 2.8.85] Where requested by the Secretary of State applicants are required to undertake environmental monitoring (e.g., ornithological surveys, geomorphological surveys, archaeological surveys) prior to and during construction and operation. Monitoring must measure and document the effects of the development and the efficacy of any associated mitigation or compensation. This will enable an assessment of the accuracy of the original predictions and improve the evidence base for future mitigation and compensation measures, enabling better decision-making in future EIAs and HRAs.	Monitoring requirements are set out in **section 3.11.10.45**.
[2.8.101] Applicants must undertake a detailed assessment of the offshore ecological, biodiversity and physical impacts of their proposed development, for all phases of the lifespan of that development, in accordance with the appropriate policy for offshore wind farm EIAs, HRAs and MCZ assessments (See Sections 4.3 and 5.4 of EN-1).	The existing ecology and biodiversity within the study area has been examined in Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES and the baseline assessment (**section 3.6**). Any changes expected have been identified in the MDS calculation (**section 3.9.1** and **Table 3.13**), with the levels of impact on fish and shellfish receptors assessed in the assessment of significant effects (**section 3.11**). Further assessment is provided in the Stage 1 MCZ Assessment (document reference E4), the HRA Stage 1 Screening Report (document reference E3) and the Information to Support Appropriate Assessment part 1 and part 2 (document reference E2.1 and E2.2).

Summary of NPS provision	How and where considered in the ES
[2.8.103] Applicants should assess the potential of their proposed development to have net positive effects on marine ecology and biodiversity, as well as negative effects.	Both potential negative and positive effects on fish and shellfish ecology have been considered in the impact assessment presented in **section 3.11**.
[2.8.104] Applicants should consult at an early stage of pre-application with relevant statutory consultees and energy not-for profit organisations/non-governmental organisations as appropriate, on the assessment methodologies, baseline data collection, and potential avoidance, mitigation and compensation options which should be undertaken.	Consultation has been undertaken through the Benthic Ecology, Fish and Shellfish Ecology and Physical Processes EWGs as detailed in **section 3.2.3**. Further consultation is detailed in the Consultation Report (document reference E1).
[2.8.106] Any relevant data that has been collected as part of post-construction ecological monitoring from existing, operational offshore wind farms should be referred to where appropriate.	The impact assessment (**section 3.11**) has been undertaken considering post-construction monitoring from offshore wind farms in the UK and overseas, with these assessed in Volume 2, Annex 3.1: Fish and shellfish technical report of the ES.
[2.8.148] There is the potential for the construction and decommissioning phases, including activities occurring both above and below the seabed, to impact fish communities, migration routes, spawning activities and nursery areas of particular species.	This is highlighted and considered in the construction phases of the MDS (**section 3.9.1**) with the levels of impact on fish and shellfish receptors assessed in the assessment of significant effects (**section 3.11**). Further assessment is provided in the Stage 1 MCZ Assessment report (document reference E4), the HRA Stage 1 Screening Report (document reference E3) and the Information to Support Appropriate Assessment part 1 and part 2 (document reference E2.1 and E2.2).
[2.8.150] The applicant should identify fish species that are the most likely receptors of impacts with respect to: • spawning grounds; • nursery grounds; • feeding grounds; • over-wintering areas for crustaceans; • migration routes; and • protected sites.	Important habitats for fish and shellfish, including spawning, nursery and migration routes have been considered in Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES and summarised in **section 3.6**. Effects on these have been assessed in **section 3.11**.
[2.8.151] Applicant assessments should identify the potential implications of underwater sound from construction and unexploded ordnance including, where possible, implications of predicted construction and soft start noise levels in relation to mortality, permanent threshold shift (PTS),	The implications of underwater sound during construction on fish and shellfish receptors have been modelled in Volume 1, Annex 5.2: Underwater sound technical report of the ES, and examined in the assessment of effects of underwater sound from Unexploded Ordnance (UXO) clearance and geophysical surveys impacting fish and shellfish receptors (**section 3.11.3**) and

Summary of NPS provision	How and where considered in the ES
temporary threshold shift (TTS) and disturbance, and addressing both sound pressure and particle motion and EMFs on sensitive fish species.	underwater sound from all other activities (**section 3.11.4**). The effects of Electromagnetic Fields (EMFs) have been examined in the assessment of the effects (**section 3.11.7**).
[2.8.221] Applicants must develop an ecological monitoring programme to monitor impacts during the pre-construction, construction and operational phases to identify the actual impacts caused by the project and compare them to what was predicted in the EIA/HRA.	Proposed monitoring requirements are set out in **section 3.11.11**.
[2.8.239] Applicants should undertake a review of up-to-date research and all potential mitigation options presented as part of the application, having consulted the relevant JNCC mitigation guidelines.	The latest available research have been examined in **section 3.5.1**, with measures adopted as part of the project set out in **section 3.8**. Mitigation measures are further detailed in Volume 1, Annex 5.3: Commitments register of the ES.
[2.8.245 to 2.8.247] EMF in the water column during operation, is in the form of electric and magnetic fields, which are reduced by use of armoured cables for interarray and export cables. Burial of the cable increases the physical distance between the maximum EMF intensity and sensitive species. However, what constitutes sufficient depth to reduce impact may depend on the geology of the seabed. It is unknown whether exposure to multiple cables and larger capacity cables may have a cumulative impact on sensitive species. It is therefore important to monitor EMF emissions which may provide the evidence to inform future EIAs.	Specifications have been examined in the MDS (**section 3.9.1**) and the assessment of the limited effects of electromagnetic fields examined (**section 3.11.7**). Proposed monitoring requirements are set out in **section 3.11.11**.
[2.8.249] Construction of specific elements can also be timed to reduce impacts on spawning or migration. Underwater noise mitigation can also be used to prevent injury and death of fish species.	Measures adopted as part of the project to reduce potential impacts are set out in **section 3.8**. Mitigation measures are further detailed in Volume 1, Annex 5.3: Commitments register of the ES.
[2.8.302] The Secretary of State should consider the effects of a proposed development on marine ecology and biodiversity, considering all relevant information made available by the applicant.	The existing ecology is laid out in the baseline environment (**section 3.6**), with all relevant information used to inform the associated assessment of significant effects on this baseline (**section 3.11**).

Marine policy

UK Marine Policy Statement

3.2.2.5 **Table 3.2** sets out a summary of the specific policies set out in the UK Marine Policy Statement (HM Government, 2011) relevant to this chapter.

Table 3.2: Summary of inshore and offshore marine plan policies from UK Marine Policy Statement relevant to this chapter

Topic	Key provisions	How and where considered in the ES
Marine ecology and biodiversity – beneficial features	It is also recognised that the benefits of development may include benefits for marine ecology, biodiversity and geological conservation interests and that these may outweigh potential adverse effects. Development proposals may provide, where appropriate, opportunities for building-in beneficial features for marine ecology, biodiversity and geodiversity as part of good design; for example, incorporating use of shelter for juvenile fish alongside proposals for structures in the sea. When developing Marine Plans, marine plan authorities should maximise the opportunities for integrating policy outcomes.	The introduction of hard substrata and the potential benefits for marine ecology and biodiversity are discussed in **section 3.11.8**, and further detailed in the Marine Enhancement Statement (document reference J12)**.**
Marine ecology and biodiversity – designated sites and protected species	The marine plan authority should ensure that appropriate weight is attached to designated sites; to protected species; habitats and other species of principal importance for the conservation of biodiversity; and to geological interests within the wider environment. Many individual wildlife species receive statutory protection under a range of legislative provisions. Other species and habitats have been identified as being of principal importance for the conservation of biodiversity in the UK and thereby requiring conservation action or are subject to recommended conservation actions by an appropriate international organisation. Priority marine features are being defined in the seas around Scotland. The marine plan authority should ensure that development does not result in a significant adverse effect on the conservation of habitats or the populations of species of conservation concern and that wildlife species and habitats enjoying statutory protection are protected from the adverse effects of development in accordance with applicable legislation.	Designated sites and the associated qualifying features relevant to fish and shellfish ecology have been identified in **Table 3.7** and, along with other protection status, conservation actions and legislations, have been used to defined IEF as key receptors to take forward in the assessment (**Table 3.9**).
Renewable energy - introduction of	As yet, the potential for benefits such as introduction of artificial reef structures, which can yield biodiversity benefits and fishing	The introduction of hard substrata and the potential benefits for marine ecology and biodiversity are discussed in **section**

Topic	Key provisions	How and where considered in the ES
artificial reef structures	opportunities around wind farm sites, have not been fully explored. These should be considered further in the context of marine planning and for individual developments.	**3.11.8**, and further detailed in the Marine Enhancement Statement (document reference J12).
Renewable energy – noise and displacement	Renewable energy developments can potentially have adverse impacts on marine fish and mammals, primarily through construction noise and may displace fishing activity and have direct or indirect impacts on other users of the sea, including mariners. These and other potential adverse impacts, together with potential mitigation measures, are considered in the National Policy Statement for Renewable Energy Infrastructure (EN-3).	The impacts of construction, operation and maintenance and decommissioning phases (including impacts from underwater sound) on marine fish have been identified in the key parameters for assessment (**section 3.7**) and assessed in the assessment of significant effects (**sections 3.11** and **3.13**). Impacts on marine mammals, commercial fisheries and other sea users are presented in the relevant ES chapters (Volume 2, Chapter 4: Marine mammals of the ES, Volume 2, Chapter 6: Commercial fisheries of the ES and Volume 2, Chapter 9: Other sea users of the ES, respectively). Measures adopted as part of the project are set out in **section 3.8**. Mitigation measures are further detailed in Volume 1, Annex 5.3: Commitments register of the ES.
Renewable energy – Offshore Electricity Networks	An increase in underwater cables in the UK marine area will cause environmental impacts. Impacts from cable installations on the sea bed are low and mainly occur due to the physical disturbance involved with their placement. They tend to be of short duration with a relatively small area being affected. The main impact will be where cable protection, for example rock armour or concrete mattresses, is required where cable burial is not feasible. This is particularly the case where cables either run through, or have landfall within, any site designated as being of national or international nature conservation importance or other sensitive areas such as designated shell fisheries, spawning or nursery grounds for economically important fish species or marine archaeological sites.	The impacts of underwater cables (i.e., EMF, habitat loss/disturbance, introduction of hard substrata) on fish and shellfish have been identified in the key parameters for assessment (**section 3.7**) and assessed in the assessment of significant effects (**sections 3.11** and **3.13**).
Fisheries	In addition to marine fish stocks associated with commercial sea fishing, the coastal environment is important as a corridor for migrating Atlantic salmon and European eel and in providing the marine feeding ground for sea trout. These important species that support coastal and inland commercial fishing and recreational angling could be vulnerable to a wide range of coastal activities.	Diadromous fish and their migratory behaviours are presented in Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES and are considered in the assessment of effects in **sections 3.11** and **3.13.**

North West Inshore and North West Offshore Marine Plans 2021

3.2.2.6 **Table 3.3** sets out a summary of the specific policies set out in the North West Inshore and North West Offshore Marine Plan (HM Government, 2021) relevant to this chapter. A National Policy Statement Tracker (document reference J26) and Planning Statement (document reference J28) has been submitted alongside the application which collates compliance with relevant marine plans.

Table 3.3: Summary of inshore and offshore marine plan policies from North West Inshore and North West Offshore Marine Plans relevant to this chapter

Policy	Key provisions	How and where considered in the ES
NW-FISH-3	Proposals that enhance essential fish habitat, including spawning, nursery and feeding grounds and migratory routes, should be supported. Proposals that may have significant adverse impacts on essential fish habitat, including spawning, nursery and feeding grounds and migratory routes, must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts so they are no longer significant.	The areas of essential fish habitat potentially impacted have been identified in Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES; the baseline in **section 3.6** and assessed in detail in **section 3.11**.
NW-MPA-1	Proposals that support the objectives of marine protected areas and the ecological coherence of the marine protected area network will be supported. Proposals that may have adverse impacts on the objectives of marine protected areas must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts, with due regard given to statutory advice on an ecologically coherent network.	Marine Protected Areas (MPAs) and other designated sites with fish and shellfish features have been identified in **section 3.6.2**. Assessment of impacts on features of these sites, where relevant, are presented in **section 3.11**, with site specific information presented in **section 3.6.2**, section 1.3.9 of Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES and in the Stage 1 MCZ Assessment (document reference E4) for the Transmission Assets. Mitigation follows the mitigation hierarchy, and is broadly assessed in the measures adopted as part of the Transmission Assets (**section 3.8**), and where appropriate in each assessment of effects if the impact was deemed to be moderate or above.
NW-BIO-2	Proposals that enhance or facilitate native species or habitat adaptation or connectivity, or native species migration, will be supported. Proposals that may cause significant adverse impacts on native species or habitat adaptation or connectivity, or native species migration, must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts so they are no	Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES presents a detailed characterisation of the fish and shellfish ecology in the study area, which is summarised in **section 3.6**. Assessment of impacts, with consideration of mitigation measures, on these receptors is presented in **section 3.11**. Mitigation follows the mitigation hierarchy and is broadly assessed in the measures adopted

Policy	Key provisions	How and where considered in the ES
	longer significant d) compensate for significant adverse impacts that cannot be mitigated.	as part of the Transmission Assets (**section 3.8**).
NW-INNS-1	Proposals that reduce the risk of introduction and/or spread of non-native invasive species should be supported. Proposals must put in place appropriate measures to avoid or minimise significant adverse impacts that would arise through the introduction and transport of invasive non-native species, particularly when: 1) moving equipment, boats or livestock (for example fish or shellfish) from one water body to another 2) introducing structures suitable for settlement of invasive non-native species, or the spread of invasive non-native species known to exist in the area.	The prevention of the spread of Invasive Non-Native Species (INNS) has been highlighted and considered in **section 3.8**, dealing with measures adopted as part of the Transmission Assets (e.g., Biosecurity Method Statement and Invasive Species Management Plan, CoT65, **Table 3.12**), with justifications given. These are also considered in the impact assessment **section 3.11**.
NW-DIST-1	Proposals that may have significant adverse impacts on highly mobile species through disturbance or displacement must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts so they are no longer significant.	This has been examined specifically in the impacts of underwater sound during all phases of the development, as detailed in **sections 3.11.3** and **3.11.4**, as well as the whole of **section 3.11** more broadly. Mitigation follows the mitigation hierarchy, and is broadly assessed in the measures adopted as part of the Transmission Assets (**section 3.8**), and where appropriate in each assessment of effects if the impact was deemed to be moderate or above.
NW-UWN-2	Proposals that result in the generation of impulsive or non-impulsive noise must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts on highly mobile species so they are no longer significant. If it is not possible to mitigate significant adverse impacts, proposals must state the case for proceeding.	The potential impacts of underwater sound resulting from the construction, operation and maintenance and decommissioning phases have been considered in the underwater sound impact assessment (**sections 3.11.3** and **3.11.4**). Mitigation follows the mitigation hierarchy, and is broadly assessed in the measures adopted as part of the Transmission Assets (**section 3.8**), and where appropriate in each assessment of effects if the impact was deemed to be moderate or above.
NW-CE-1	Proposals which may have adverse cumulative effects with other existing, authorised, or reasonably foreseeable proposals must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse cumulative and/or in-combination effects so they are no longer significant.	The potential impacts on other existing, authorised, or reasonably foreseeable proposals have been examined in the Cumulative Effects Assessment (CEA) (**section 3.13**). Mitigation follows the mitigation hierarchy, and is broadly assessed in the measures adopted as part of the Transmission Assets (**section 3.8**), and where appropriate in each

Policy	Key provisions	How and where considered in the ES
		assessment of effects if the impact was deemed to be moderate or above.
NW-CBC-1	Proposals must consider cross-border impacts throughout the lifetime of the proposed activity. Proposals that impact upon one or more marine plan areas or terrestrial environments must show evidence of the relevant public authorities (including other countries) being consulted and responses considered.	Any potential cross-border impacts have been assessed in the transboundary effects (**section 3.13.9.1**) and inter-related effects (**section 3.15**) sections.

3.2.3 Relevant guidance

3.2.3.1 The fish and shellfish ecology assessment has followed the methodology set out in Volume 1, Chapter 5: Environmental assessment methodology of the ES. Specific to the fish and shellfish ecology EIA, the following guidance documents have also been considered.

- Guidelines for Ecological Impact Assessment in the UK and Ireland. Terrestrial, Freshwater and Coastal (Chartered Institute of Ecology and Environmental Management (CIEEM), 2022).
- Guidance on differentiating serious and non-serious injury of marine mammals provided by National Oceanic and Atmospheric Administration (NOAA) (National Marine Fisheries Service (NMFS), 2012).
- Guidance on Environmental Considerations for Offshore Wind Farm Development (Oslo-Paris Conventions (OSPAR), 2008).
- Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects (Judd, 2012).

3.2.3.2 In addition, the fish and shellfish ecology assessment has considered the legislative framework as set out in Volume 1, Chapter 2: Policy and legislation context of the ES.

3.3 Consultation

3.3.1 Scoping

3.3.1.1 On 28 October 2022, the Applicants submitted a Scoping Report to the Planning Inspectorate, which described the scope and methodology for the technical studies being undertaken to provide an assessment of any likely significant effects for the construction, operation and maintenance, and decommissioning phases of the Transmission Assets.

3.3.1.2 Following consultation with the appropriate statutory bodies, the Planning Inspectorate (on behalf of the Secretary of State) provided a Scoping Opinion on 8 December 2022.

3.3.2 Evidence plan process

3.3.2.1 Following scoping, consultation and engagement with interested parties specific to fish and shellfish ecology has continued. An Evidence Plan Process (EPP) has been developed for the Transmission Assets, seeking to ensure engagement with the relevant aspects of the EIA process throughout the pre-application phase. The development and monitoring of the Evidence Plan and its subsequent progress has been undertaken by the EPP Steering Group. The Steering Group comprises the Planning Inspectorate, the Applicants, the Marine Management Organisation, Natural England, Historic England, the Environment Agency and the Local Planning Authorities as the key regulatory and bodies.

3.3.2.2 As part of the EPP, EWGs were set up to discuss and agree topic specific queries with the relevant stakeholders.

3.3.2.3 To inform the EIA and HRA process during the pre-application stage of the Transmission Assets, consultation on the fish and shellfish ecology topic was undertaken via the Physical Processes, Benthic Ecology and Fish and Shellfish Ecology EWG, with meetings held prior to the PEIR, in March 2023 and July 2023. In addition to the EPP, consultation was also undertaken in February 2024 with Natural England, NRW and the Joint Nature Conservation Committee (JNCC) with regards to the subtidal benthic ecology survey scope, which included consideration for fish and shellfish ecology (particularly herring spawning and sandeel substrate suitability assessment).

3.3.2.4 The first EWG meeting (March 2023) provided an update on current site-specific surveys, including an assessment of habitat suitability for sandeel and herring and the presence of spawning and nursery grounds for various species within the study area, as defined in **section 3.4**. The approach to baseline characterisation and fish and shellfish ecology impact assessment was also discussed, including desktop data sources, physical processes modelling, relevant guidance and potential impacts. A summary of discussions and key points raised is set out in **Table 3.4** below.

3.3.2.5 The second EWG meeting (July 2023) provided another update on site-specific surveys and desktop data sources used to characterise the baseline for fish and shellfish ecology, including sandeel and herring habitat suitability, IEFs and designated sites. The presentation outlined the impacts that were scoped into the assessment, and the impact assessment methodology and guidance which has been used to determine the significance of impacts, based on the magnitude and sensitivity of the IEFs. The meeting also summarised the initial assessment outputs for key impacts on fish and shellfish ecology, and indicated the ongoing discussions regarding the sensitivity of herring to noise and habitat disturbance. The CEA approach for fish and shellfish ecology was also described, which included the Transmission Assets with both the Generation Assets and other relevant projects. The presentation listed the types and categories of projects considered in the CEA and explained the rationale for scoping out some impacts that are localised or temporally restrictive.

3.3.2.6 The third EWG meeting (February 2024) was held as two meetings following the statutory consultation for the PEIR, which closed at the end of November

2023; both of these meetings presented similar projects updates and information. The first of these was attended by the MMO, the Centre for Environment Fisheries and Aquaculture Science (Cefas) and the Environment Agency, and the second by Natural England, since they were not able to attend the initial meeting. The meeting presented a project update and parameter refinements, including a reduction in sandwave clearance, cable protection refinements and the removal of surface piercing infrastructure (including the removal of piling from the from the Transmission Assets Application). The Section 42 (S42) responses from the relevant stakeholders were discussed, mainly relating to seabed preparation (including impacts to smelt *Osmerus eperlanus* during cable installation), diadromous fish migration, underwater sound impacts (including UXO and High Resolution Geophysical (HRG) surveys) and sandeel and herring substrate suitability (including the use of OneBenthic Particle Size Analysis (PSA) data). Hence, the updated assessment methods and mitigation measures were outlined.

3.3.3 Statutory consultation responses

3.3.3.1 The preliminary findings of the EIA process were published in the PEIR in October 2023. The PEIR was prepared to provide the basis for formal consultation under the Planning Act 2008. This included consultation with statutory and non-statutory bodies under section 42 and 47 of the Planning Act 2008, as presented in **Table 3.4**.

3.3.3.2 The section 42 consultation closed at the end of November 2023 and have been reviewed. These comments have been discussed in the relevant EWG meetings and taken into account to help refine the assessment of effects for fish and shellfish ecology.

3.3.4 Summary of consultation responses received

3.3.4.1 A summary of the key items raised specific to fish and shellfish ecology is presented in **Table 3.4**, together with how these have been considered in the production of this chapter. It should however be noted that formal responses are provided for all consultation responses received and can be accessed in the Consultation Report (document reference E1).

Table 3.4: Summary of key consultation comments raised during consultation activities undertaken for the Transmission Assets relevant to fish and shellfish ecology

Date	Consultee and type of response	Comment raised	Response to comment raised and/or where considered in this chapter
Scoping Opinion			
December 2022	*Planning Inspectorate Scoping Response*	The Scoping Report does not specifically identify the potential impact of the effects of underwater sound on marine life due to jacket or monopile cutting and removal during decommissioning within the Fish and shellfish ecology, Marine mammals or Offshore ornithology sections. The outcomes of the assessment should be presented within the relevant ES chapters.	Refinement of the project design parameters has removed all piling, and therefore the need for jacket or monopile cutting within the Offshore Order Limits, and thus these impacts have not been assessed.
December 2022	*Planning Inspectorate Scoping Response*	**Table 3.2** 'Key Constraints Considered' should also include migration routes for Annex II diadromous fish.	Migration routes for diadromous fish are considered in the impact assessment (**sections 3.11** and **3.13**) with potential barriers to migration caused by the Transmission Assets and other projects.
December 2022	*Planning Inspectorate Scoping Response*	The baseline is supported by a desk-based analysis of multiple records set out in Scoping Report Table 4.7. However, considering the age of previous surveys within the area and that the proposed surveys are not specific to fish and shellfish, there is a risk that the baseline may not be robust. The desk study does not take into account the effectiveness of the surveys (for example, trawl surveys are not designed to capture shellfish) or the behaviour of species (for example, herring are also known to change specific locations of spawning each year and do not necessarily return to the same spot). Effort should be made to agree the approach to baseline characterisation with the relevant consultation bodies and the approach should be sufficiently justified in the ES.	The baseline has been characterised by the most up to date available data sources. Additional data sources have been included (see **section 3.6.1**) to strengthen the desk-based study presented in Volume 2, Annex 3.1: Fish and shellfish technical report of the ES, including data from the Northern Irish Ground Fish Surveys to corroborate peer-reviewed literature and historic regional survey effort. The approach to the baseline characterisation has been presented during the EWG process with feedback from consultation bodies taken into consideration in the assessment (**Table 3.4**). Assumptions and limitations of the assessment are described in **section 3.10.5**. This includes the original aims of the site-specific surveys and the justification for not undertaking fish and shellfish surveys. More details on the site-specific surveys and how the results, including the nonspecific fish and shellfish observations are used to characterise the baseline is provided in

Date	Consultee and type of response	Comment raised	Response to comment raised and/or where considered in this chapter
			Volume 2, Annex 3.1: Fish and shellfish ecology of the ES.
December 2022	*Planning Inspectorate Scoping Response*	Due to the extensive migration periods of various life stages of migratory fish and inshore foraging of sea trout and eel, determining key migration windows robustly is difficult. The Inspectorate advises that the ES should incorporate a worst case scenario that assumes that diadromous fish are present in the study area throughout the year.	All diadromous fish considered in the assessment (**section 3.6.5**, i.e., excluding Brook lamprey *Lampetra planeri* and bullhead *Cottus gobio* which are wholly freshwater species) are assessed as migrating through the study area without temporal specificity.
December 2022	*Planning Inspectorate Scoping Response*	The Scoping Report highlights herring as a species with high intensity spawning grounds within the Transmission Assets scoping boundary. The Applicants should note the statutory herring spawning closure in Manx waters (Douglas Bank herring closure).	Information on spawning periods is provided for consideration in the baseline (**section 3.6**), with more detailed descriptions provided in Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES. Herring was identified as an IEF and considered in the assessment of effects in **sections 3.11** and **3.13**, including the potential overlap with Douglas Bank herring closure in Manx waters.
December 2022	*Planning Inspectorate Scoping Response*	The Inspectorate notes that cod also has high intensity spawning grounds within the scoping boundary and that owing to their well-developed hearing capabilities should also be considered vulnerable to underwater sound impacts.	Gadoids species, including cod *Gadus morhua* are considered as a Group 3 species according to Popper *et al*. (2014) which are, with Group 4 fish species, more sensitive to the sound pressure component of underwater sound and the risk of behavioural effects in the intermediate and far fields are therefore greater for these species. Cod are considered in the assessment of underwater sound impact in **sections 3.11** and **3.13**.
December 2022	*Planning Inspectorate Scoping Response*	The description of underwater sound impacts in Table 4.11 is imprecise and it is not possible to determine which specific impact pathways described in **Table 3.6** of **Section 3.2** (underwater sound) are included in the assessment, e.g., it is not clear whether impacts from particle motion have been included. The description of impact pathways should be consistent across aspect chapters and technical appendices within the ES.	The impact assessment for underwater sound for fish and shellfish (modelled in Volume 1, Annex 5.2: Underwater sound technical report of the ES and assessed in **sections 3.11** and **3.13**) consider underwater sound from UXO clearance, geophysical and geotechnical site investigation surveys and vessel movements. Both particle motion (only qualitative due to lack of available supporting evidence) and sound pressure are included in underwater sound impacts.

Date	Consultee and type of response	Comment raised	Response to comment raised and/or where considered in this chapter
December 2022	*Planning Inspectorate Scoping Response*	Mitigation measures adopted as part of the project specify that soft-start piling and ramp-up measures will be implemented during construction. The Applicants should consider controlling the timing of activities during construction and operation to avoid key and sensitive periods to species, for example fish spawning and migration periods.	Mitigation measures have been outlined and justified in **section 3.8**, with relevant mitigation measures recommended where impacts are found likely to be significant. Soft-start piling and ramp-up measures are no longer required for construction due to no jackets or monopiles being installed as part of the Transmission Assets, and thus mitigation measures have also been removed (see **section 3.8**). Information on spawning and migration periods is provided for consideration in the baseline (**section 3.6**), with more detailed descriptions provided in Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES.
December 2022	*Planning Inspectorate Scoping Response*	The ES should also specify any restrictions on where ‘noisy’ measures may overlap e.g., piling and potential UXO detonation and describe any additional mitigation to be implemented e.g., twin walled piles or bubble curtains.	Potential inter-related effects are considered in **section 3.15** and in Volume 4, Chapter 3: Inter-relationships of the ES. UXO clearance is likely to be undertaken prior to commencement of construction operations. Mitigation measures have been outlined and justified in **section 3.8**, with relevant mitigation measures recommended where impacts are found likely to be significant.
December 2022	*Planning Inspectorate Scoping Response*	The ES should describe the proposed mitigation measures and signpost where they are secured in the application based on a worst-case scenario of noise impact and this should include any overlapping sources of noise e.g., multiple piles and UXO detonation. Effort should be made to agree the approach with the relevant consultation bodies.	Embedded mitigation measures adopted as part of the Transmission Assets and how the measures will be secured are described in **section 3.8**. Where an assessment identifies likely significant adverse effects, further secondary mitigation measures will be applied. Within the impact assessment, secondary measures both pre-mitigation and residual effects are presented (**sections 3.11** and **3.13**). The approach was agreed

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			with the relevant consultation bodies during the evidence plan process and the EWG.
December 2022	*Planning Inspectorate Scoping Response*	The assessment of impacts on spawning fish from underwater sound should consider the potential for disturbance/displacement/disruption of spawning fish over sequential spawning seasons (whilst there may be no direct temporal or spatial overlap between projects, the cumulative effects over several spawning seasons should be assessed).	The impact assessment for underwater sound for fish and shellfish (in **sections 3.11** and **3.13**) consider disturbance of spawning by underwater sound including over sequential spawning seasons.
December 2022	*Planning Inspectorate Scoping Response*	The Scoping Report does not consider the potential for direct damage to species. Whilst the Inspectorate acknowledges that fish are generally a mobile receptor, some species have a close affiliation with the seabed (i.e., sandeel and herring) and may be reliant on specific habitat for part of their life stages. In addition, sedentary shellfish species have limited ability to move in order to avoid danger. The Inspectorate considers that direct damage and disturbance to mobile demersal and pelagic fish and shellfish species should be scoped into the assessment for all phases of the development. Accordingly, the ES should include an assessment of these matters or evidence demonstrating agreement with the relevant consultation bodies that significant effects are not likely to occur.	Direct damage and disturbance have been considered in the impact assessments (**section 3.11**).
December 2022	*Planning Inspectorate Scoping Response*	The Scoping Report does not address potential impacts on fish feeding grounds or over-wintering areas for crustaceans. The ES should assess these impacts where significant effects are likely to occur.	Effects from the project activities on all fish habitats, including fish feeding, spawning and nursery habitats and crustacean overwintering grounds have been considered throughout the impact assessment in **section 3.11**.
December 2022	*Planning Inspectorate Scoping Response*	The ES should assess the potential for vessel collision with basking shark and any significant effects that are likely to occur.	Injury due to increased risk of collision with vessels (for basking shark *Cetorhinus maximus* only) has been scoped in and assessed in **sections 3.11** and **3.13**.

Date	Consultee and type of response	Comment raised	Response to comment raised and/or where considered in this chapter
December 2022	*Blackpool Council Scoping Response*	Further details are required to assist the understanding of any potential impacts upon the Ribble and Alt Estuaries and the biological heritage site at Blackpool Airport.	Impacts on fish and shellfish qualifying features for designated sites, including Sparling/European smelt for the Ribble Estuary MCZ (**Table 3.7**), are considered in the assessment (see **sections 3.11** and **3.13**). Other pathways of impact to physical processes and benthic subtidal and intertidal ecology receptors are considered in Volume 2, Chapter 1: Physical processes of the ES and Volume 2, Chapter 2: Benthic subtidal and intertidal ecology of the ES respectively.
December 2022	*Territorial Seas Committee (TSC) Scoping Response*	The TSC is a committee formed of a number of departments within the Isle of Man Government. The Isle of Man also meets its obligations under a range of multilateral agreements extended to the island via the UK, including all those noted in Section 2.3 of the Scoping Report, via a range of Manx statutory instruments, including the Wildlife Act 1990. As part of this, the TSC would request that appropriate consideration is given to the species and habitats which are protected and designated under this Act and ensure that there are no detrimental impacts on these features as part of this proposed project. In addition, the same would be requested in respect of the marine protected sites and the manner in which these are designated and managed, including any transboundary impacts arising from the project. Marine Nature Reserves (MNRs), the highest level of statutory conservation designation in the territorial sea, constitute important components of Biosphere Isle of Man, biodiversity and habitat conservation and fisheries management. As such the committee requests their inclusion and consideration in the assessment of all relevant receptors.	Basking shark, which are protected under the Wildlife Act 1990, have been identified as an IEF and, as such, have been assessed in **sections 3.11** and **3.13**. Other species and habitats protected and designated under the Wildlife Act 1990 are considered in the relevant chapters. Designated sites located within the study area have been included in the assessment along with the fish and shellfish receptors protected in those sites (**Table 3.7**). It encompasses the MNRs located within the Isle of Man territorial waters. Other conservation and fisheries management measures are covered in relevant sections of this chapter or in Volume 2, Chapter 6: Commercial fisheries of the ES.

Date	Consultee and type of response	Comment raised	Response to comment raised and/or where considered in this chapter
December 2022	*Territorial Seas Committee (TSC) Scoping Response*	It is noted that the cumulative effects will be thoroughly investigated. However, of particular importance and concern would be the habitats and species found within Isle of Man waters, particularly those protected under Manx law or identified as threatened or declining by the OSPAR (Oslo-Paris) Convention and which may be affected by the proposed developments. Comments included below request the inclusion of relevant, island-based conservation organisations which may also have relevant information and data of interest to the project.	Relevant fish and shellfish protected species under Manx law or those identified as threatened and/or declining by OSPAR will are assessed in the assessment of effects and the CEA (**sections 3.11** and **3.13**).
December 2022	*Territorial Seas Committee (TSC) Scoping Response*	The above proposal also has the possibility for potential trans-boundary impacts ion Manx land/seascapes and the TSC would particularly like to ensure that the impacts on wildlife/habitat conservation and fisheries in Manx waters and fully considered within the scope of this assessment.	The assessment of transboundary impacts is presented in Volume 1, Annex 5.4: Transboundary screening of the ES and summarised in **section 3.14**. Fish and shellfish ecology receptors within Manx waters are fully characterised within Volume 2, Annex 3.1: Fish and shellfish technical report of the ES, with the defined study area encompassing Manx waters. Impacts to relevant receptors in Manx waters are fully assessed within **section 3.11** or the project alone, and in **section 3.13** cumulatively with other projects and plans. Further assessment of fisheries within Manx waters is provided in Volume 2, Chapter 6: Commercial fisheries of the ES.
December 2022	*Territorial Seas Committee (TSC) Scoping Response*	The TSC would draw the application's attention to the Manx Marine Environmental Assessment (MMEA) which provides a useful overview of the Island's marine environment and should take into account as part of both the transboundary and possibly also the cumulative impacts assessment as part of this application. More detail will be provided below in respect of specific areas of the MMEA that should be reviewed.	The MMEA is referred to when appropriate in this chapter (**section 3.6**), in Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES, in Volume 2, Chapter 6: Commercial fisheries of the ES and in Volume 1, Annex 5.4: Transboundary screening of the ES.

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December 2022	*Territorial Seas Committee (TSC) Scoping Response*	The Committee notes that there are no specific references to the extensive literature available for Manx shellfish, noting that these data are generally produced and available from Bangor University, reference to which is included. However, specific reference to Isle of Man scallop survey data would acknowledge its inclusion in the assessment.	The outputs of the MMEA and scallop surveys from the Bangor University Fisheries and Conservation Science Group (Bloor *et al.*, 2019; Delargy *et al*., 2019) have been considered to inform the fish and shellfish ecology baseline characterisation (**section 3.6**) and commercial fisheries baseline characterisation (see Volume 2, Annex 6.1: Commercial fisheries technical report of the ES). Further details on fish and shellfish assemblages within the Irish Sea, including the Manx waters, are presented in Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES.
December 2022	*Territorial Seas Committee (TSC) Scoping Response*	Basking shark: noting that Manx Basking Shark Watch (now part of Manx Whale and Dolphin Watch) maintain public and research sightings data on this species.	The Manx Basking Shark Watch sightings have been used to inform the baseline characterisation (see Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES).
December 2022	*Territorial Seas Committee (TSC) Scoping Response*	Further, reference to 4.2.4.14 (Shellfish Assemblages) do not include those within Manx waters and adjacent stations, which are also surveyed annually by Bangor University, or annual scallop surveys in the east Irish Sea by Agri-food and Biosciences Institute (AFBI) (including shared stations with the Bangor survey). The connectivities between scallop fishing grounds in relation to recruitments processes should be more specifically acknowledged and the data sources more comprehensive to reflect these connections, particularly when data originates from the same organisational source. As such, the most up to date data and reports should be obtained from Bangor University and AFBI.	Data from annual scallop surveys undertaken by AFBI and Bangor University have been reviewed to characterise the shellfish assemblages within the study area, which includes the Manx waters (**section 3.6**). Further details on shellfish assemblages are presented in Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES.
December 2022	*Territorial Seas Committee (TSC) Scoping Response*	Section 4.2.4.18 and Table 4.8: There is no reference or apparent consideration of shellfish in relation to spawning and nursery grounds.	Shellfish spawning and nursery grounds are considered in the baseline characterisation (see Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES) where data sources are available. Shellfish IEFs are largely defined through the species importance to

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			commercial fisheries within Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES, however the assessment of effects presented in **sections 3.11** and **3.13** considers impacts to juvenile and adult shellfish, and effects on spawning.
December 2022	*Territorial Seas Committee (TSC) Scoping Response*	Also please note the statutory herring spawning closure in Manx waters in relation to sections 4.2.4.19 – 21. This was originally included within the EU Council Regulations No 850/98 (amended by EU Council Regulations 2723/1999) and has since been rescinded. However, the closure remains in place under Manx law.	Information on spawning periods is provided for consideration in the baseline (**section 3.6**), with more detailed descriptions provided in Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES. Herring was identified as an IEF and considered in the assessment of effects in **sections 3.11** and **3.13**, including for the potential overlap with Douglas Bank herring closure in Manx waters.
December 2022	*Territorial Seas Committee (TSC) Scoping Response*	Table 4.9: As noted elsewhere, it may appear inconsistent to have included MNRs within the fish and shellfish ecology section, but not within the benthic subtidal and intertidal ecology assessment and so perhaps explicit statement of exclusion in the latter could be noted for clarity.	All the MNRs around the Isle of Man have been considered in the fish and shellfish ecology and benthic subtidal and intertidal ecology sections (**Table 3.7**, Volume 2, Chapter 2: Benthic subtidal and intertidal ecology of the ES).
December 2022	*Territorial Seas Committee (TSC) Scoping Response*	With respect to Table 4.10 (Relevant protected fish and shellfish species) and acknowledging the jurisdictional boundaries of the developments site, but also the migratory nature of some species; it may be relevant to note that several of these species are also protected under the Isle of Man Wildlife Act 1990. The relevance in this section is for the developer to determine, or perhaps comprehensively consider under transboundary effects and which Section 4.2.10 appears to indicate that it will be.	Relevant fish and shellfish species protected under the Isle of Man Wildlife Act 1990 are considered as key receptors in **section 3.6.5**. Details on the migration and behaviour of fish and shellfish species are presented in Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES.
December 2022	*MMO Scoping Response*	The MMO note that very little information has been presented within the report which details the timing of the spawning seasons for the key marine fish species identified within the study area. The report has	Details on the spawning seasons of the identified species spawning in the study area, including the peak spawning months, are provided in Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the

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		considered the timing of seasonal migrations of migratory fish and has noted the potential for the works to cause disruption and barriers to migration. The report states that "the timing of fish migration will therefore be an important element of the baseline characterisation". Whilst the MMO recognise that a schedule of works for the project has not yet been confirmed, the MMO recommend that equal consideration is given to the timing of spawning seasons for the key marine fish species identified in relation to potential impacts from the project works in the PEIR.	ES based on Coull *et al*. (1998), Ellis *et al*. (2012) and Aires *et al*. (2014). Migratory periods of diadromous fish are also presented in Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES. Fish and shellfish ecology IEFs are assessed against all project phases for all potential impacts scoped in for assessment in **sections 3.11** and 3.13.
December 2022	*MMO Scoping Response*	The MMO note that the report scopes in both temporary habitat loss/disturbance and long term habitat loss as potential impacts of the project works. Permanent habitat loss has also been noted as potentially occurring under any infrastructure that is not decommissioned at the end of the Transmission Assets operational lifetime, which is currently assumed to be 35 years. However, the MMO consider that alterations to the habitat which will remain for such a significant amount of time should be considered permanent rather than temporary. The MMO also note that it has not yet been determined whether the infrastructure described in the PDE will be fully or partially removed or whether elements will be left in place upon decommissioning of the Transmission Assets. In addition, it cannot be guaranteed with any certainty that alterations made to the habitat will be reversed following the removal project infrastructure. As such, the MMO recommend that potential impacts relating to habitat loss be considered as permanent in further assessments.	Habitat loss that encompasses the entire lifetime of the Transmission Assets are considered under long term habitat loss (**sections 3.11.6** and **3.13.5**). This includes both temporary (i.e., infrastructure removed during the decommissioning phase) and permanent (i.e., infrastructures left in situ after decommissioning phase) habitat loss. Further details on the infrastructure that is expected to be left in situ are presented in **Table 3.13**.
December 2022	*MMO Scoping Response*	The MMO notes that for future assessments, that colonisation of hard structures results from the introduction of artificial structures into the marine	Introduction of hard substrata has been scoped in and is assessed in **sections 3.11** and **3.13** with the

Date	Consultee and type of response	Comment raised	Response to comment raised and/or where considered in this chapter
		environment during the construction phase of the project. Therefore, colonisation of artificial structures should be considered an effect, rather than an impact. To this regard, the introduction of artificial structures should be the direct impact from the project works which is scoped into the assessments, with colonisation of said structures by marine biota being noted as one of several subsequent effects (alongside localised increases in biodiversity and the aggregation of fish in the vicinity of structures, as correctly identified by the report). The MMO welcomes that the impact of introduction of artificial structures (and subsequent effect of colonisation of artificial structures) has been scoped into further assessments.	colonisation by marine biota as one of the subsequent effects.
December 2022	*MMO Scoping Response*	The MMO note that the proposed approach to determining the location/s of herring spawning habitat is to follow the method described by Boyle and New (2018), using Irish Sea herring larvae survey data collected by the AFBI of Northern Ireland to determine areas where active spawning is taking place. Site specific benthic grab samples will also be collected and PSA will be undertaken to inform suitability of the sediment within the Transmission Assets Order Limits to support herring spawning and sandeel habitat. Whilst the MMO agree that larval data present the most up to date information and provide the greatest confidence for determining areas where active spawning is taking place, it is unclear from reviewing the scoping report how the project intends to make use of the PSA data for the purpose of determining herring spawning habitat suitability. As recommended in our advice for the Scoping Opinions on both Morecambe Offshore Windfarm: Generation Assets and Morgan Offshore Wind Project: Generation Assets, the MarineSpace method (MarineSpace, 2013a) uses a suite of data assigned with scores to produce a heat	Long term Northern Ireland Herring Larvae Survey (NINEL) herring *Clupea harengus* larvae survey data from the north Irish Sea have been presented as bubble plots in Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES, along with a kernel density heat map of the aggregated larval density data from 2012 to 2021, to determine areas of consistently higher herring larval densities. This data is interpreted alongside separate substrate suitability plots based upon site-specific PSA data, PSA data extracted from the Cefas OneBenthic tool, broadscale EUSeaMap seabed substrate data and data from other surveys undertaken within the Offshore Order Limits for the Morgan Offshore Wind Project: generation Assets, and Morecambe Offshore Windfarm: Generation Assets within Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES. The PSA data is analysed using the criteria defined in Reach *et al.* (2013) to inform substrate suitability for herring spawning based upon the proportions of fines, sands and gravels within the sediment samples reviewed. This information is summarised within the baseline characterisation

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		map of potential herring spawning habitat based on the confidence of data. The herring potential spawning habitat sediment classes of 'Preferred', 'Marginal' and 'Unsuitable' used in MarineSpace (2013a) were adopted from the method described in Reach *et al*. (2013).	presented in **section 3.6**. The full approach is described in Volume 2, Annex 3,1: Fish and shellfish ecology technical report of the ES.
December 2022	*MMO Scoping Response*	The MMO also recommend the same approach should be applied to determining habitat suitability for sandeel, based on the methods described by Latto *et al*. (2013) and MarineSpace (2013b). This is consistent with the approach recommended to other offshore wind farm developments of a similar size and scale.	The approach to determine the habitat suitability for sandeel across the Offshore Order Limits uses the methods described by Latto *et al*. (2013), in combination with the baseline of sandeel habitat types investigated by MarineSpace Ltd (2013b), to assign the grab samples to the four sediment preference categories. The full approach is described in Volume 2, Annex 3,1: Fish and shellfish ecology technical report of the ES. Various data are used to provide an indication for sandeel habitation and spawning potential, drawing these together to provide a full description of the likelihood of these activities occurring within the Transmission Assets.
December 2022	*MMO Scoping Response*	The report notes that the projects intend to incorporate underwater sound modelling outputs from the Morecambe Offshore Windfarm: Generation Assets and Morgan Offshore Wind Project: Generation Assets into the Transmission Assets assessment of the magnitude of underwater sound impacts to fish (from UXO detonation, piling and similar activities). The proposed approach will use best practice guidelines (including Popper *et al*., 2014) as well as scientific literature. The MMO support this approach and recommend that fish should be modelled as stationary rather than fleeing receptors for the following reasons: It is known that fish will respond to loud noise and vibration, through observed reactions including schooling more closely; moving to the bottom of the water column; swimming away and burying in	In the sound modelling used in the impact of underwater sound on fish and shellfish ecology receptors, fish are modelled separately as static and moving receptors in Volume 1, Annex 5.2: Underwater sound technical report of the ES. The outputs for both models are presented in **section 3.11** (**section 3.11.3** and **section 3.11.4**). As a precautionary approach, the largest outputs will inform the significance of effect. Sound modelling was undertaken for eggs and larvae as static receptors.

Date	Consultee and type of response	Comment raised	Response to comment raised and/or where considered in this chapter
		substrate (Popper *et al*., 2014). However, this is not the same as fleeing, which would require a fish to flee directly away from the source over the distance shown in the modelling. The MMO are not aware of scientific or empirical evidence to support the assumption that fish will flee in this manner. Therefore, it is most appropriate to assume a stationary receptor. ii. The assumption that a fish will flee from the source of noise is overly simplistic as it overlooks factors such as fish size and mobility, biological drivers, as well as foraging, reproductive or migratory behaviours which may cause an animal to remain/return to the area of impact. This is of particular relevance to herring, as they are benthic spawners which spawn in specific locations with specific substrate composition. iii. Eggs and larvae have little to no mobility, which makes them vulnerable to trauma from exposure to noise and developmental effects. Accordingly, they should also be assessed and modelled as a stationary receptor, as per the Popper *et al*. (2014) guidelines.	
December 2022	*MMO Scoping Response*	Within the approach to underwater sound modelling, the report states that consideration will be given to the potential injury and disturbance to fish, including disruption to spawning activity as well as potential disruption 'barriers' to the migrations of diadromous fish species. For the purpose of modelling behavioural responses in herring at their spawning ground, the MMO recommend the inclusion of a 135 dB threshold based on startle responses observed in sprat by Hawkins *et al*. (2014). Sprat is considered a suitable proxy species for herring for the purpose of modelling likely behavioural responses in gravid herring at the spawning ground. It would be useful if the 135 dB noise contour was presented in mapped form (i.e., as an additional contour to the 186 dB, 203 dB and 207 dB, as per Popper *et al*., 2014. This is consistent	For Atlantic herring spawning only, a 135 dB re 1 μPa2 threshold for behavioural disturbance is used to inform the underwater sound impact assessment (modelled in Volume 1, Annex 5.2: Underwater sound technical report of the ES and presented in **section 3.11.3**). Given that the 135 dB re 1 μPa2 threshold is highly precautionary, based upon review of the Hawkins *et al*. (2014) study by Hawkins and Popper (2014), the 160 dB re 1 μPa2 is also used to inform the assessment as it is considered a more realistic scenario.

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		with the approach recommended to other offshore wind farm developments of a similar size and scale.	
December 2022	*MMO Scoping Response*	The MMO notes **section 3.2.5.1** states “there is the potential for underwater sound to impact sensitive ecological receptors. The potential effects on these receptors will be assessed within the relevant technical sections of the ES (marine mammals, fish and shellfish and commercial fisheries).” With this in mind, the MMO would like to see consideration of sensitive shellfish resources to underwater sound in the ES.	Sensitive shellfish receptors are considered where relevant in the underwater sound assessment (**section 3.11.3**).
December 2022	*Natural Resources Wales Advisory*	NRW (A) note that although fish spawning and nursery grounds are included in **Table 3.2** Key Constraints Considered, migration routes for Annex II diadromous fish are not. NRW (A) advise that, similar to Annex II habitat features outside SACs, diadromous fish migration routes are also included.	Migration routes for diadromous fish are considered in the impact assessment (**sections 3.11** and **3.13**) with potential barriers to migration caused by the Transmission Assets and other projects. Additional details on diadromous fish migration are presented in Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES.
December 2022	*Natural Resources Wales Advisory*	With reference to Table 4.7 Summary of key desktop datasets and reports – fish and shellfish ecology, NRW (A) advise that the Centre for Environment Fisheries and Aquaculture Science (Cefas) report ‘Spawning and nursery grounds of forage fish in Welsh and surrounding waters’ is included in the baseline.	The report ‘Spawning and nursery grounds of forage fish in Welsh and surrounding waters’ (Campanella and van der Kooij, 2021) has been used to inform the fish and shellfish ecology baseline characterisation. Details on spawning and nursery grounds of fish and shellfish receptors in the Irish Sea are presented in Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES.
December 2022	*Natural Resources Wales Advisory*	Regarding Section 4.2.4.11 Diadromous fish species, please note that Sea lamprey are recorded every year in the NRW operated fish trap on Chester weir on the Dee.	The River Dee and Bala Lake/Afon Dyfrdwy a Llyn Tegid SAC and Dee Estuary/Aber Dyfrdwy SAC and the qualifying features, which includes sea lamprey Petromyzon marinus, are considered for the baseline characterisation (**Table 3.7**, Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES).
December 2022	*Natural Resources Wales Advisory*	With reference to Section 4.2.4.13 Diadromous fish species, NRW (A) note that due to the extensive	All diadromous fish considered in the assessment (i.e., excluding Brook lamprey and bullhead which are wholly

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		migration periods of various life stages of migratory fish and inshore foraging of sea trout and eel, determining key migration windows robustly is difficult. NRW (A) therefore advise that diadromous fish are assumed to be present in the study area throughout the year.	freshwater species) are assessed as migrating through the study area without temporal specificity.
December 2022	*Natural Resources Wales Advisory*	NRW (A) note, in relation to Section 4.2.4.20 Spawning and nursery grounds, that cod also have high intensity spawning grounds within the Transmission Assets scoping boundary. Cod, like herring, have well developed hearing capabilities and use vocalisation during courtship and mating behaviour. As such, they should also be considered vulnerable to underwater sound impacts.	Gadoids species, including cod are considered as a Group 3 species according to Popper *et al*. (2014) which are, with Group 4 fish species, more sensitive to the sound pressure component of underwater sound and the risk of behavioural effects in the intermediate and far fields are therefore greater for these species. Cod are considered in the assessment of underwater sound impact in **sections 3.11** and **3.13**.
December 2022	*Natural Resources Wales Advisory*	Please note from Table 4.9: Summary of designated sites with relevant fish and shellfish ecology features within the fish and shellfish ecology study area, that brook lamprey *Lampetra planeri* (an Annex II feature of the River Dee and Bala Lake SAC) are a wholly freshwater species, therefore, there is no impact pathway for the species.	Brook lamprey have been scoped out of further consideration within this chapter, as it is a wholly freshwater species.
December 2022	*Natural Resources Wales Advisory*	With reference to Section 4.2.8 Potential cumulative effects, NRW (A) advise that when assessing potential impacts to spawning fish from underwater sound, the assessment considers the potential for disturbance/displacement/disruption of spawning fish over sequential spawning seasons. Whilst there may be no direct temporal or spatial overlap between projects, the cumulative effects over several spawning seasons should be assessed.	The impact assessment for underwater sound for fish and shellfish (in **sections 3.11** and **3.13**) considers disturbance of spawning by underwater sound UXO clearance and geophysical and geotechnical surveys, including over sequential spawning seasons.

Date	Consultee and type of response	Comment raised	Response to comment raised and/or where considered in this chapter
Expert Working Groups			
May 2023	*Natural England - EWG01 consultation meeting response*	Natural England broadly agrees to the approach to assessment for fish and shellfish ecology as presented at the EWG meeting on 30 March 2023.	The methodology is presented in **section 3.10** and is consistent with the EIA methodology outlined in Volume 1, Chapter 5: Environmental assessment methodology of the ES, so applies to all topics. The assessment of effects for fish and shellfish ecology is presented in **section 3.11** (assessment of effects) and **section 3.13** (cumulative effects assessment).
		Natural England broadly agrees to the scoping of impacts as presented at the EWG meeting on 30 March 2023.	The impacts scoped in are presented in **section 3.11** (assessment of effects) and **section 3.13** (cumulative effects assessment).
May 2023	*MMO - EWG01 consultation meeting response*	There was not a discussion in the meeting of the timing on the spawning seasons for the marine fish species identified within the Transmission Assets Red Line Boundary and this is something which should be discussed in the PEIR.	Details on the spawning seasons of the identified species spawning in the study area, including the peak spawning months, are provided in Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES based on Coull *et al.* (1998) and Ellis *et al.* (2012).
		Temporary habitat loss/disturbance and long term habitat loss have been scoped in as potential impacts of the project works. Given the lifespan of the project (expected to be 30+ years), and that it cannot be guaranteed that alterations made to the habitat will be reversed following the removal project infrastructure, we consider that alterations to the habitat should be considered permanent rather than temporary.	Habitat loss that encompasses the entire lifetime of the Transmission Assets are considered under long term habitat loss impact (**sections 3.11.6** and **3.13.5**). It includes both temporary (i.e., infrastructure removed during the decommissioning phase) and permanent (i.e., infrastructures left *in situ* after decommissioning phase) habitat loss. Further details on the infrastructure that is expected to be left *in situ* are presented in **Table 3.13.**
		For the purpose of modelling behavioural responses in herring at their spawning ground, the MMO recommend the inclusion of a 135 decibel (dB) threshold based on startle responses observed in sprat by Hawkins *et al*. (2014), and it would be useful if the 135 dB noise contour was presented in mapped form (i.e., as an additional contour to the 186 dB, 203 dB and 207 dB, as per Popper *et al*., 2014).	For Atlantic herring spawning only, a 135 dB re 1 μPa^2 threshold for behavioural disturbance is used to inform the underwater sound impact assessment (**section 3.11.3**). All noise contours are presented together in figures. Given that the 135 dB re 1 μPa^2 threshold is highly precautionary, based upon review of the Hawkins *et al.* (2014) study by Hawkins and Popper (2014), the 160 dB re 1 μPa^2 is also used to inform the

Date	Consultee and type of response	Comment raised	Response to comment raised and/or where considered in this chapter
			assessment as it is considered a more realistic scenario.
		The meeting minutes state that both fleeing and static fish receptors are being assumed for the underwater sound assessment. Fish receptors should be modelled as stationary rather than fleeing receptors for the following reasons. 1. Fish will respond to loud noise and vibration, through observed reactions including schooling more closely; moving to the bottom of the water column; swimming away, and burying in substrate (Popper *et al.*, 2014). This is not the same as fleeing, which would require a fish to flee directly away from the source over the distance shown in the modelling. The MMO are not aware of scientific or empirical evidence to support the assumption that fish will flee in this manner. Therefore, it is most appropriate to assume a stationary receptor. 2. The assumption that a fish will flee from the source of noise is overly simplistic as it overlooks factors such as fish size and mobility, biological drivers, as well as foraging, reproductive or migratory behaviours which may cause an animal to remain/return to the area of impact. This is of particular relevance to herring, as they are benthic spawners which spawn in specific locations with specific substrate composition. 3. Eggs and larvae have little to no mobility, which makes them vulnerable to trauma from exposure to noise and developmental effects. Accordingly, they should also be assessed and modelled as a stationary receptor, as per the Popper *et al.* (2014) guidelines.	The underwater sound modelling presented in Volume 1, Annex 5.2: Underwater sound technical report of the ES used in the impact of underwater sound on fish and shellfish ecology receptors, fish are modelled separately as static and moving receptors. The outputs for both models are presented in **section 3.11**. As a precautionary approach, the largest outputs have informed the significance of effect.

Date	Consultee and type of response	Comment raised	Response to comment raised and/or where considered in this chapter
		The slide pack and minutes refer to appropriate noise exposure criteria for fish, as per Popper *et al*. (2014). The MMO would expect to see mortality and recoverable injury, TTS and behavioural impacts considered (which have all been identified).	The impact of underwater sound during construction on fish and shellfish receptors have been considered in terms of mortality, recoverable injury, TTS, PTS and behavioural responses in the assessment of effects of underwater sound from UXO clearance and other sound sources (**section 3.11.4**).
		The Popper *et al.* (2014) criteria do not provide quantitative thresholds for behavioural responses to noise. Therefore, further discussions would be required on the approach to the behavioural assessment, especially if spawning herring are a concern.	The behaviour responses of fish and shellfish receptors to underwater sound have been estimated against Popper *et al.* (2014) qualitative criteria and the rationale further discussed in **sections 3.11.3** and **3.11.4**.
July 2023	*Cefas - EWG02 consultation meeting response*	Cefas noted that herring is expected to be considered of high sensitivity in respect of noise and their reliance on specific habitats. Cefas appreciates the benthic environment within the Transmission Assets Red Line Boundary not being suitable for herring spawning and as such putting herring as low sensitivity for habitat disturbance. Cefas anticipate that the PSA data will be presented in the Technical Report. If the spawning habitat is not suitable, Cefas are happy with the decision of low sensitivity. For the Isle of Man and the suitable habitats near the Isle of Man Cefas would expect high sensitivity.	The sensitivity to herring from underwater sound is described in **section 3.11.3**, the sensitivity of herring is considered to be high to underwater sound from UXO clearance, following discussion at EWG meeting 2. Herring is also considered to be of high sensitivity to temporary and long term habitat loss due to its substrate specificity, as outlined in **section 3.11.2** and **section 3.11.6** respectively. The spatial potential for habitat loss considered as part of the magnitude for these impacts in the above referenced sections. The baseline environment and substrate suitability assessment for herring spawning is presented in Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES. The PSA data (percentages of fines, sands and gravel) are presented in Volume 2, Annex 2.1: Benthic subtidal and intertidal ecology technical report of the ES, in Appendix C to support data interrogation.
July 2023	*Natural England – EWG02 consultation meeting response*	Natural England were pleased to note that the two Marine Conservation Zones (MCZs; Ribble and Wyre Lune) which have diadromous fish qualifying features	Designated sites identified within the study area are listed in **section 3.6.2**, with relevant fish features assessed for appropriate impacts in **section 3.11**.

Date	Consultee and type of response	Comment raised	Response to comment raised and/or where considered in this chapter
		(sparling or smelt *Osmerus eperlanus*) had been correctly identified.	
February 2024	*Cefas – EWG03 consultation meeting response*	Cefas have provided detailed responses to the underwater sound modelling and have requested further details on the modelling assumptions underlying the results.	The questions concerning modelling assumptions have been addressed and incorporated into Volume 1, Annex 5.2: Underwater sound technical report of the ES where relevant. The removal of piling has been addressed in **Table 3.13** and assessed in **sections 3.11.3** and **3.11.4**. The removal of the piling from the Transmission Assets should provide clarity in how the underwater sound impact is being assessed.
Section 42 Responses			
November 2023	*Natural England – S42 response*	It seems that some parameters associated with sandwave clearance have not been included, without these it is not clear how the figures for sandwave clearance and seabed preparation were derived. Natural England advise that additional parameters are included in **Table 3.5** to provide clarify around the sandwave volume MDS figures.	The PDE has undergone refinement between submission of the PEIR and the ES and the MDS has been refined accordingly. The parameters associated with sandwave clearance have been included in the MDS considered for the assessment of impacts in **section 3.9.1** (see **Table 3.16**).
		Natural England notes that while diadromous fish are highly mobile, consideration should be made regarding the potential impacts during construction, operation and maintenance phase and decommissioning phases of the works. Particularly within coastal waters in sensitive seasons, which may disrupt diadromous fish movements between protected sites.	Diadromous fish are already considered for all project stages, more explicit consideration will be given to key migratory periods, however the assessment is based upon the precautionary assumption that diadromous fish may be present within the area year-round, due to the uncertainties in their movements during their marine stage. The impacts from the Transmission Assets on diadromous fish which have been identified as IEFs are considered in each relevant impact assessment in **sections 3.11** (assessment of effects) and **3.13** (cumulative effects assessment).
		Natural England seeks confirmation that the proposed HDD works beneath the Ribble Estuary will take place 'bank to bank' thereby mitigating the potential impacts	The Applicant confirms that cable installation at the Ribble Estuary crossing will be undertaken bank to bank using horizontal directional drilling techniques

Date	Consultee and type of response	Comment raised	Response to comment raised and/or where considered in this chapter
		on MCZ. The submitted ES should confirm how HDD works will operate to confirm whether there will indeed be potential impacts on Smelt, a feature of the Ribble Estuary MCZ.	(either micro-tunnelling or a direct pipe, as outlined within Volume 1, Chapter 3: Project Description of the ES; CoT90, **Table 3.12**; outlined in **section 3.8**, with implementation of a bentonite breakout plan and pollution prevention plan) with no interaction with the intertidal or subtidal environments, and therefore no predicted effects to smelt.
		The modelling for an increase in suspended sediments has not been provided, and the physical processes chapter only references to the work done by the Generation Assets. The submitted ES should present the model outputs for changes to SSC from each aspect of the proposed development.	The changes to Suspended Sediment Concentrations (SSCs) are presented in the relevant impact assessment in **section 3.11.5** (assessment of effects) and **section 3.13.5** (cumulative effects assessment). The assessment undertaken was an evidence-based conceptual study, as agreed though the scoping process. Therefore, modelling of the Transmission Assets was not undertaken. Model outputs used to support the ES can be found within the technical annex, Volume 2, Annex 1.1: Physical Processes associated modelling studies. This includes both the Mona Offshore Wind Project, Environmental Statement, Volume 6, Annex 1.1: Physical processes technical report and Morgan Offshore Wind Project: Generation Assets, Environmental Statement, Volume 4, Annex 1.1: Physical Processes Technical Report.
		Natural England disagrees with the conclusions of minor adverse significance for herring in the CEA. They advise that robust mitigation measures are considered and presented in the submitted ES to address the risk of impacts during the herring spawning season. These measures will need to be presented with adequate justification on how they will minimise the risk.	It should be noted that the PDE has undergone revision from PEIR to ES, and all elements of the project which were originally planned to include pile-driving have now been removed from the Design. The updated MDS for the impact of "Underwater sound from piling, UXO clearance and geophysical surveys impacting fish and shellfish receptors" (at PEIR) is presented in **section 3.9.1,** and now reflects just UXO and geophysical survey, and potentially significant effects to spawning herring from underwater sound effects are not predicted.

Date	Consultee and type of response	Comment raised	Response to comment raised and/or where considered in this chapter
			Therefore, given that the removal of piling from the PDE has reduced the range at which instantaneous injury, mortality and behavioural effects could occur to fish from received sound levels, no additional measures have been considered for herring spawning. The measures adopted as part of the Transmission Assets are presented in **section 3.8**.
		Natural England comment that both species of shad are screened out despite their presence in the region. They advise that both species of shad be included within all assessments of impacts on diadromous fish, particularly underwater noise, or provide a justification for excluding them. The species is regionally present.	Both allis and twaite shad are included as IEFs for the ES (see **Table 3.10**),and are specifically assessed for relevant impacts within **section 3.11** and **3.12**.
		Natural England comment that some of the cumulative Tier 1 plans, projects and activities in the cumulative ZOI do not have figures for the predicted temporary habitat disturbance or loss. Therefore, the total figure presented at the bottom of the table is an underestimate. For projects that have been classified as “low level and intermittent throughout the licence period”, further information should be provided in the submitted ES to clarify their cumulative impact.	The cumulative effects assessment has been updated for ES and is presented in **section 3.13**, the methodology for which is outlined in **section 3.12**. It is not possible to include values for all projects included within the cumulative effects assessment, as not all projects have released information of that nature publicly, or projects are not at a stage where this information is available. The cumulative effect project list will be reviewed as the project progresses, and where updated information is available (i.e. where further information has been released into the public domain), further detail will be included within the magnitude sections of the ES cumulative effects assessment.
November 2023	*NRW – S42 Response*	NRW do not at agree that the impacts from underwater noise on fish receptors can be assessed as ‘minor adverse’ in-combination with other planned projects in Liverpool Bay.	It should be noted that the Project Design Envelope has undergone revision from PEIR to ES, and all elements of the project which were originally planned to include pile-driving have now been removed from the Design. The updated MDS for the impact of "Underwater sound from UXO clearance and

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			geophysical surveys impacting fish and shellfish receptors" is presented in **section 3.9. 1.** Since the removal of piling from the Project Design has reduced the range at which instantaneous injury, mortality and behavioural effects could occur to fish from received sound levels resulting from the Transmission Assets, the contribution to cumulative impacts to herring will be minor when compared to other contributing projects.
		NRW advise that due to the distribution of Atlantic cod and their vulnerability rating on the International Union for Conservation of Nature (IUCN) Red List and ICES advise for 2023 for the Eastern Irish Sea stock, the species should be given a sensitivity rating of 'high'. They also advise that mitigation measures for cod spawning are considered.	Sensitivity of cod to underwater sound impacts is considered high in this chapter of the ES. The justification for this rating and assessment of the underwater sound impact is presented in **sections 3.11** and **3.13**. It should be noted that the Project Design Envelope has undergone revision from PEIR to ES, and all elements of the project which were originally planned to include pile-driving have now been removed from the Design. The updated MDS for the impact of "Underwater sound from piling, UXO clearance and geophysical surveys impacting fish and shellfish receptors" (as at PEIR) is presented in **section 3.9. 1,** and now reflects just UXO and geophysical survey. Furthermore, the measures adopted as part of the Transmission Assets are presented in **section 3.8**. No additional measures have been considered for cod spawning as the removal of piling from the PDE has reduced the range at which instantaneous injury, mortality and behavioural effects could occur to fish from received sound levels.
		In relation to the cumulative assessment for noise impacts, NRW are unable to agree with the conclusion of 'minor adverse' for fish receptors, including Atlantic cod and herring. NRW advise that consideration is	It should be noted that the Project Design Envelope has undergone revision from PEIR to ES, and all elements of the project which were originally planned to include pile-driving have now been removed from the

Date	Consultee and type of response	Comment raised	Response to comment raised and/or where considered in this chapter
		given to further mitigation in terms of timing piling activities to avoid spawning seasons for cod and herring.	Design. The updated MDS for the impact of "Underwater sound from piling, UXO clearance and geophysical surveys impacting fish and shellfish receptors" (as at PEIR) is presented in **section 3.9.1,** and now reflects just UXO and geophysical survey. The measures adopted as part of the Transmission Assets are presented in **section 3.8**. No additional measures have been considered for cod or herring spawning as the removal of piling from the PDE has reduced the range at which instantaneous injury, mortality and behavioural effects could occur to fish from received sound levels.
November 2023	*MMO – S42 Response*	MMO agrees with the decision to scope out the effects of accidental pollution during construction, operation and maintenance and decommissioning.	Noted.
		The MMO requests the rational for adopting a threshold of 160 decibels (dB) peak sound pressure level (SPLpeak) for assessing behavioural effects in fish. They advise that evidence and justification must be provided prior to the application submission.	It should be noted that the Project Design Envelope has undergone revision from PEIR to ES, and all elements of the project which were originally planned to include pile-driving have now been removed from the Design. The updated MDS for the impact of "Underwater sound from piling, UXO clearance and geophysical surveys impacting fish and shellfish receptors" (as at PEIR) is presented in **section 3.9.1,** and now reflects just UXO and geophysical and geotechnical survey. Therefore, no further evidence of justification for this threshold have been provided.
		The MMO advise that the assessment for underwater sound from explosions of Unexploded Ordinance should be based on the Popper et al. (2014) threshold.	Underwater sound modelling for UXO clearance presented in Volume 1, Annex 5.2: Underwater sound technical report of the ES and in **section 3.11.3** is based upon impulsive sound thresholds defined by Popper *et al.* (2014).

Date	Consultee and type of response	Comment raised	Response to comment raised and/or where considered in this chapter
		MMO notes the presentation habitat suitability maps in Figures 1.24-1.25 (for herring) and 1.31-1.32 (for sandeel) which depict the broadscale distribution of ‘preferred’, ‘marginal’ and ‘unsuitable’ habitat sediments. Broadscale seabed sediment data taken from European Marine Observation and Data Network (EMODnet), have been overlain with site-specific particle size analysis (PSA) data, which is appropriate. However, there are large areas of the maps which present no broadscale seabed sediment data. MMO has assumed that the data layer has been clipped to present only the ‘relevant’ sediments, i.e., suitable and marginal ones, however this has not been outlined in the accompanying text and initially it appears as though no data are available, which is not the case. It would be more appropriate to present the full distribution of all seabed sediment types across the study area, to help contextualise the wider environment and the site-specific PSA data. For this purpose, MMO requests the Applicants presents the British Geological Survey (BGS) Seabed Sediment data which is classified according to the Folk Sediment classification units (Folk, 1954).	Sediments presented within habitat suitability maps in Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES are those which are consistent with the Folk classifications aligning with “preferred” or “marginal” sediment composition. A separate figure is provided showing the full BGS classification, however we suggest that presenting the “relevant” substrate types provides more clarity in the distribution of where preferred and marginal sediments are reported to occur. These habitat suitability figures are presented in Volume 2, Annex 3.1 fish and shellfish ecology technical report of the ES.
		The MMO note that the spawning period for herring is indicated as being that for the Mourne stock, whose spawning stocks are depleted and their contributions to the Irish Sea herring stock are considered minor. They note that the Isle of Man should be acknowledged as an important spawning ground for herring. The MMO advise that given the recent Northern Irish Herring Larvae (NINEL) surveys show that the Manx spawning grounds represent a more productive spawning ground and is closer to the Morgan Offshore Wind Project: Generation Assets, the Applicants	The spawning period for herring has been updated in Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the EA and in the baseline (**section 3.6**) to specifically reference the Douglas Bank Manx herring stock as outlined in Dickey-Collas *et al.,* (2001). This baseline has also been updated to refer to the Manx Stock which are reported to spawn consistently from late September for three to four weeks.

Date	Consultee and type of response	Comment raised	Response to comment raised and/or where considered in this chapter
		should narrow their assessment to this stock only. For Isle of Man herring, spawning is considered to take place over a period of 3-4 weeks from late September (Dickey-Collas et al., 2001) and so the period of spawning indicated in Table 1.4 should be updated to include the month of September.	
		The MMO advise that the sandeel habitat suitability assessment is revised following the MarineSpace method (Latto *et al.,* 2013) and provide a 'heat' map of sandeel potential habitat for the fish ecology study area.	A sandeel habitat suitability assessment was also completed using a similar method as described in this table above (for herring), where samples were categorised into preferred, marginal and unsuitable, based on their suitability as sandeel habitat. Classifications were derived from Latto *et al.* (2013) based on the proportion of sand and mud in the grab samples. The sample suitability distribution is mapped in Figure 3.4 and Figure 3.5 (Volume 2, Figures). Data was enhanced through the addition of regional data extracted from the Cefas OneBenthic tool. A heat map was not generated following the full Latto *et al.* (2013) method, as based upon the data available, this was not considered to provide any greater resolution in the distribution of suitable habitat for sandeel than what is provided.
November 2023	*Natural England and NRW – S42 responses relevant to the CEA*	Consideration should be given to the Westminster Gravel (aggregate extraction) proposal in the submitted CEA, which will be submitted in Q2 2024.	Where appropriate, these projects have been taken into consideration in the cumulative effects assessment presented in **section 3.13** for the relevant impacts. Aggregates extraction within Liverpool Bay in Area 457 by Westminster Gravels has been screened in for assessment within the cumulative effects assessment presented within **section 3.13**. The Mersey Tidal Power Project has been screened out of assessment for the fish and shellfish ecology cumulative effects assessment due to insufficient information to provide a meaningful assessment, and the anticipated lack of overlap with the Transmission
		Consideration may need to be given to the Mersey Tidal Power Project in the submitted CEA.	
		Consideration should be given to the offshore elements of ENI Hynet and to Mooir Vannin.	

Date	Consultee and type of response	Comment raised	Response to comment raised and/or where considered in this chapter
			Assets during the construction and operation and maintenance phases. The ENI Hynet and Mooir Vannin projects were considered to potentially result in a cumulative impact with the Transmission Assets for fish and shellfish ecology and have there been screened in for assessment within the cumulative effects assessment presented within **section 3.13**.
November 2023	*Natural England, NRW and the MMO – S42 responses relevant to piling*	Natural England notes that a risk of significant impacts has been identified on spawning herring from piling, but as yet no mitigation measures have been brought forward to address this impact. We advise that mitigation measures are considered and presented in the submitted ES to address the risk of impacts during the herring spawning season. NRW strongly advise that concurrent monopile scenarios are fully described and modelled as a potential worst-case scenario for fish and shellfish and that the impact in terms of TTS and behavioural effects are presented, in addition to those for injury. Mitigation measures and/or careful scheduling of piling activity may be necessary to reduce the impacts to fish, particularly with regard to fish considered to have a higher hearing sensitivity (including herring and cod). The MMO advise a more complete and robust assessment for the cumulative effects of underwater sound, including modelled underwater sound contours presented for projects with an overlapping construction period. The MMO does have concerns regarding the potential impacts to Manx herring at their spawning grounds from underwater noise (UWN) caused by piling activity.	Piling has been removed from the PDE since PEIR. As a result, there is a reduction in the range at which instantaneous injury, mortality and behavioural effects could occur to fish from received sound levels. The assessment of effects and cumulative effects assessment presented in **section 3.11** and **3.13**, respectively, has been updated in line with these changes.

Date	Consultee and type of response	Comment raised	Response to comment raised and/or where considered in this chapter
		The MMO requests that the underwater sound contour maps are presented according to Popper *et al*. (2014) guidelines for hearing thresholds for pile driving. They also request that these figures are presented as the worst-case scenario and that parameters used are included in figure titles. Overall, they advise the use of suitable metrics and revised modelling based for the modelling of underwater sound from piling.	

3.4 Study area

3.4.1.1 Fish and shellfish species, habitats and communities are spatially and temporally variable, therefore for the purpose of the fish and shellfish ecology baseline characterisation, a broad study area has been defined. The Offshore Order Limits fish and shellfish ecology study area (hereafter referred to as the ‘study area’) is presented in Figure 3.1 (see Volume 2, Figures).

3.4.1.2 The study area covers the east Irish Sea, extending seaward from Mean Low Water Spring west from the Mull of Galloway in Scotland to the west tip of Anglesey, following the 12 nm limit (territorial waters) of the Isle of Man. This study area has been selected to account for the spatial and temporal variability of fish and shellfish populations, including fish migration and to provide a wider context to the site-specific data collected. This area was considered appropriate as it will ensure the characterisation of all fish and shellfish receptors within the east Irish Sea and is therefore large enough to consider all direct (e.g., habitat loss/disturbance within project boundaries) and indirect impacts (e.g., underwater sound over a wider area, such as from UXO impacts) associated with the Transmission Assets on the identified receptors.

3.4.1.3 The study area defined for the Transmission Assets (Figure 3.1; see Volume 2, Figures) is consistent with the fish and shellfish ecology study area defined for the Morgan Offshore Wind Project: Generation Assets, and fully encompasses the study areas defined for fish and shellfish ecology for the Morecambe Offshore Windfarm: Generation Assets (Morgan Offshore Wind Ltd., 2024; Morecambe Offshore Wind Ltd., 2024). For the Morecambe Offshore Windfarm: Generation Assets, these were defined as the Zone of Influence (ZOI) in which sediment impacts could occur, and a radius of up to 100 km surrounding the Morecambe Offshore Windfarm: Generation Assets to assess underwater sound impacts.

3.5 Baseline methodology

3.5.1 Methodology for baseline studies

Desk studies

3.5.1.1 Information on fish and shellfish ecology within the study area was collected through a comprehensive desktop review of existing studies and datasets. Additionally, information collected as part of the commercial fisheries baseline characterisation (including landings data and consultation with fisheries organisations) has been incorporated into this baseline (see Volume 2, Annex 6.1: Commercial fisheries technical report of the ES), with regard given to the best practice advice for offshore wind assessments recently published by Natural England (2022).

3.5.1.2 The desktop sources provide an overview of the existing knowledge base of fish and shellfish populations within and around the Irish Sea. This information was related to sediment data and worked up to provide detail on habitat suitability for key species, including sandeel, herring, and king and queen scallop, and a wide range of other species of interest. Two sources have been used for broadscale fish population characterisations (Coull *et al*., 1998, and Ellis *et al*., 2012), with these being comprehensive data sources which are commonly used for fish and shellfish assessments, and their findings still align with more recent publications (Aires *et al*., 2014, and Campanella and van der Kooij, 2021), indicating that these sources are still applicable to the Irish Sea currently. These sources are summarised in **Table 3.5**. The desktop review has also drawn on the results of the site-specific baseline characterisation surveys undertaken for the Generation Assets which are treated as desktop studies and discussed alongside site-specific surveys completed for the Transmission Assets in **section 3.6.3**.

Table 3.5: Summary of desk study sources

Title	Source	Year	Author
Herring larvae surveys of the north Irish Sea	AFBI	1993 to 2021	AFBI
Annual scallop surveys	AFBI	1992 to 2022	AFBI
Isle of Man scallop surveys	Bangor University - Sustainable Fisheries Isle of Man	1992 to 2022	Bangor University Sustainable Fisheries and Aquaculture Group
Fisheries Sensitivity Maps in British Waters	United Kingdom Offshore Operators Association (UKOOA) Ltd.	1998	Coull *et al*.
Rhyl Flats Offshore Wind Farm, Fish and Fisheries Baseline Study	Marine Data Exchange	2002 to 2006	Coastal Fisheries Conservation and Management
Gwynt y Môr Offshore Wind Farm, Pre-construction Baseline Beam Trawl Data	Marine Data Exchange	2005	CMACS
Walney and West of Duddon Sands Offshore Wind Farms, Baseline Benthic Survey – Epifaunal Beam Trawl Results	Marine Data Exchange	2005	Titan Environmental Surveys Ltd.
Burbo Bank Offshore Wind Farm, Pre-construction Commercial Fish Survey (2 m Beam Trawl)	Marine Data Exchange	2006a, b	Centre for Marine and Coastal Studies Ltd. (CMACS)
Walney Offshore Wind Farm Pre-Construction Fish Survey	Marine Data Exchange	2009a	Brown and May Marine Ltd.
Ormonde Offshore Wind Farm Pre-Construction Juvenile & Adult Fish Survey	Marine Data Exchange	2009b, c	Brown and May Marine Ltd.
Burbo Bank Offshore Wind Farm, Post-construction (Year 3) Commercial Fish Survey	Marine Data Exchange	2010	CMACS
Ormonde Offshore Wind Farm, Construction (Year 1) Environmental Monitoring	Marine Data Exchange	2010	RPS Energy

Title	Source	Year	Author
Celtic Array (Zone 9) Autumn Fish Trawl Survey	Marine Data Exchange	2010	CMACS
West of Duddon Sands Offshore Wind Farm, Adult and Juvenile Fish and Epibenthic Pre-Construction Surveys	Marine Data Exchange	2012	Brown and May Marine Ltd.
Mapping the Spawning and Nursery Grounds of Selected Fish for Spatial Planning	Cefas	2012	Ellis *et al*.
Walney Offshore Wind Farm, Year 2 Post-construction Monitoring Fish and Epibenthic Survey	Marine Data Exchange	2013	Brown and May Marine Ltd.
Rhiannon offshore wind farm preliminary environmental information chapter 10: fish and shellfish ecology	Marine Data Exchange	2013	Celtic Array Ltd.
Northern Irish Ground Fish Trawl Survey (NIGFS)	International Council for the Exploration of the Sea (ICES)	2013	ICES
Welsh waters scallop survey – Cardigan Bay to Liverpool Bay July-August 2013	Bangor University	2014	Lambert *et al.*
Updating Fisheries Sensitivity Maps in British Waters	Scottish Marine and Freshwater Science Report	2014	Aires *et al.*
Marine Life Information Network (MarLIN)	MarLIN	2018	Marine Biological Association
Annual Fisheries Science Report	Bangor University Sustainable Fisheries and Aquaculture Group	2018	Jenkins *et al.*
Celtic Seas ecoregion fisheries overview	Summary of commercial fisheries in the Celtic Sea	2018	ICES
Manx Marine Environmental Assessment	Isle of Man Government - Fisheries Division	2018	Howe *et al*.
The novel use of pop-off satellite tags to investigate the migratory behaviour of European sea bass *Dicentrarchus labrax* (L., 1758) in the Celtic Sea area	O'Neill *et al*.	2018	O'Neill *et al*.
NBN Atlas	NBN Atlas	2019	NBN Atlas
Assessment of Queen Scallop stock status for the Isle of Man territorial sea 2019/2020	Bangor University	2019	Bloor *et al.*
Welsh Waters Scallop Surveys and Stock Assessment	Bangor University	2019	Delargy
JNCC MPA Mapper	JNCC	2019	JNCC

Title	Source	Year	Author
ICES scallop assessment working group	ICES	2020	ICES
Bass and Ray Ecology in Liverpool Bay	Bangor University Sustainable Fisheries and Aquaculture Group.	2020	Moore *et al.*
UK Sea Fisheries Annual Statistics Report	MMO	2020	MMO
Spawning and nursery grounds of forage fish in Welsh and surrounding waters	Cefas	2021	Campanella and van der Kooij
ICES working group on surveys on ichthyoplankton in the North Sea and adjacent seas	ICES	2022	ICES
Fisheries & Conservation Science Group	Bangor University	2022	Bangor University
Marine Recorder Public UK Snapshot	JNCC	2022	JNCC
Morgan Array Area Benthic Subtidal survey	Morgan Offshore Wind Project: Generation Assets	2024	Morgan Offshore Wind Ltd
SeaLifeBase*	https://www.sealifebase.ca/	2022	https://www.sealifebase.ca/
Morgan Array Area and ZOI Benthic Subtidal Survey	Morgan Offshore Wind Project: Generation Assets	2024	Morgan Offshore Wind Ltd
Morecambe Offshore Windfarm Generation Assets ES, Volume 5, Chapter 10: Fish and shellfish ecology of the ES	Morecambe Offshore Windfarm: Generation Assets	2024	Morecambe Offshore Windfarm Ltd
Morgan Offshore Wind Project Generation Assets ES, Volume 2, Chapter 3: Fish and shellfish ecology of the ES	Morgan Offshore Wind Project: Generation Assets	2024	Morgan Offshore Wind Ltd
Cefas Pelagic ecosystem in the western English Channel and eastern Celtic Sea (PELTIC) surveys	Cefas	Various	Cefas
Fish and shellfish survey results for the east Irish Sea	Environment Agency	Various	Environment Agency
Fish and shellfish sensitivity reports	https://www.marlin.ac.uk/activity/pressures_report	Various	Various

*For information on individual species

Site-specific surveys

3.5.1.3 In order to inform the ES, site-specific surveys were undertaken. A summary of the surveys undertaken in 2022 to inform the fish and shellfish ecology impact assessment is outlined in **Table 3.6**, with full details of rationale and methodology provided in Volume 2, Annex 2.1: Benthic ecology technical report of the ES. Note that the surveys were primarily designed to inform the benthic subtidal ecology baseline characterisation, but provide useful information on general seabed types, sediment suitability for fish spawning and/or habitat for benthic species (see Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES). These also provide opportunistic fish and shellfish records which have been extracted to inform the baseline characterisation.

Table 3.6: Summary of site-specific survey data

Title	Extent of survey	Overview of survey	Survey contractor	Date	Reference to further information
Benthic Subtidal Survey	Offshore Order Limits and Morgan Offshore Wind Project: Generation Assets and associated ZOI	Grab samples, Visual survey outputs (Drop Down Video (DDV) sampling) and laboratory testing	Gardline Limited	2022	Gardline Limited, 2023

3.6 Baseline environment

3.6.1 Desk study

3.6.1.1 Information on fish and shellfish ecology within the study area was collected through a detailed review of existing studies and datasets. These are summarised in **Table 3.5**.

3.6.2 Designated sites

3.6.2.1 All designated sites within the study area and qualifying interest features that could be affected by the construction, operation and maintenance, and decommissioning phases of the Transmission Assets are set out in **Table 3.7**, and are illustrated in Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES.

3.6.2.2 Note that species such as ocean quahog *Arctica islandica*, dog whelk *Nucella lapillus,* horse mussel *Modiolus modiolus* beds, spiny scallop *Mimachlamys varia,* blue mussel *Mytilus edulis* beds or flame shell *Limaria hians* which are features of interest of some MNRs are considered benthic subtidal and intertidal ecology features and are therefore characterised in Volume 2, Annex 2.1: Benthic subtidal and intertidal ecology technical report of the ES and assessed within Volume 2, Chapter 2: Benthic subtidal and intertidal ecology of the ES.

3.6.2.3 Whilst brook lamprey are listed as a qualifying feature of some of the identified designated sites, they are not assessed within this chapter, as it is a wholly freshwater species and there is therefore no impact pathway for the species.

3.6.2.4 European sites and MCZs, including all their relevant qualifying features are also assessed in the ISAA part 2 (document reference E2.2) and the Stage 1 MCZ Assessment (document reference E4), respectively.

Table 3.7: Designated sites and relevant qualifying interests

Designated site	Closest distance from the Transmission Assets (km)	Relevant features of interest
Ribble Estuary MCZ	0*	Sparling/European smelt
Langness MNR	16.7	European eel *Anguilla anguilla* Basking shark Lobster nursery ground Cod spawning and nursery ground
Wyre Lune MCZ	16.8	Sparling/European smelt
Little Ness MNR	20.4	Basking shark European eel Scallops Pectinidae spp. Common whelk *Buccinum undatum*
Douglas Bay MNR	22.3	European eel Scallops Pectinidae spp. Common whelk
Laxey Bay MNR	22.4	Atlantic salmon *Salmo salar* Sea trout *Salmo trutta* European eel Scallops Pectinidae spp. Common whelk
Ramsey Bay MNR	26.5	European eel Sea bass nursery Sandeel Ammodytidae spp. Scallops Pectinidae spp. Common whelk
Baie Ny Carrickey MNR	30.2	European eel Basking shark Spiny lobster Paniluridae sp.
Dee Estuary/Aber Dyfrdwy SAC	32.8	Sea lamprey River lamprey *Lampetra fluviatilis*
Calf of Man and Wart Bank MNR	35.8	European eel Basking shark Sandeel Ammodytidae spp. Spiny lobster Paniluridae sp.

Designated site	Closest distance from the Transmission Assets (km)	Relevant features of interest
Port Erin Bay MNR	40.0	Basking shark Plaice (nursery)
West Coast MNR	40.5	European eel Sandeel Ammodytidae spp. Seabass nursery Basking shark Scallops Pectinidae spp. Common whelk
Niarbyl Bay MNR	44.5	Basking shark
River Dee and Bala Lake/Afon Dyfrdwy a Llyn Tegid SAC	59.1	Sea lamprey River lamprey Atlantic salmon Brook lamprey
River Ehen SAC	62.5	Atlantic salmon Freshwater pearl mussel *Margaritifera margaritifera*
River Derwent and Bassenthwaite Lake SAC	71.3	Sea lamprey River lamprey Atlantic salmon Brook lamprey
Solway Firth SAC	84.3	Sea lamprey River lamprey
Afon Gwyrfai a Llyn Cwellyn SAC	88.2	Atlantic salmon
River Bladnoch SAC	89.5	Atlantic salmon
Solway Firth MCZ	98.8	Sparling/European smelt
River Eden SAC	124.8	Sea lamprey River lamprey Atlantic salmon

*As per CoT90, **Table 3.12**, activity overlapping with the Ribble Estuary MCZ will be undertaken bank to bank using horizontal directional drilling techniques.

3.6.3 Site-specific surveys

3.6.3.1 A summary of the findings (PSA and observations) relevant to fish and shellfish ecology from site-specific surveys is provided below.

3.6.3.2 PSA data can be used to assess habitat suitability for herring spawning. Two stations out of 103, located within the Offshore Order Limits, were considered suitable substrata for herring spawning, suggesting a relatively low potential for herring spawning throughout the Transmission Assets. EMODnet seabed substrate data can also be used to assign habitat suitability for herring spawning, showing sandy gravel and gravel as preferred spawning habitat and gravelly sand as marginal spawning habitat. The herring habitat suitability in the Irish Sea was mapped and compared to the spatial distribution of spawning grounds presented in the Coull *et al*. (1998) data, EMODnet seabed substrate data and the PSA data from the benthic surveys within the Transmission Assets (Figure 3.2; see Volume 2, Figures) and within the Generation Assets (Figure 3.3; see Volume 2, Figures; Gardline Limited, 2022; Ocean Ecology, 2022). Where no shading is present, the habitat in that area is unsuitable for herring spawning. The most suitable spawning grounds were located mostly outside of, but within 10 km to the north and north west of, the Offshore Order Limits, which is further supported by results from detailed site-specific survey PSA data (see Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES for full results). Spawning grounds are the areas of water or seabed where fish spawn or produce their eggs. As shown in Figure 3.2 and Figure 3.3 (see Volume 2, Figures), the site-specific and Generation Assets survey data found that the majority of the Transmission Assets reflected unsuitable sediment for herring spawning, with only small patches of suitable habitat mainly in the north west section of the Offshore Order Limits.

3.6.3.3 Sandeel have a close association with sandy substrates into which they burrow. They are largely stationary after settlement and show a strong preference to specific substrate types. Studies in the laboratory (Wright *et al.,* 2000) and in the natural environment (Holland *et al.,* 2005), have focused on identifying the sediment characteristics that define the seabed habitat preferred by sandeel. Both approaches produced similar results, indicating that sandeel preferred sediments with a high percentage of medium to coarse grained sand (particle size 0.25 mm to 2 mm) and avoided sediment containing >4% silt (particle size <0.063 mm) and >20% fine sand (particle size 0.063 mm to 0.25 mm). As the percentage of fine sand, coarse silt, medium silt and fine silt (particles <0.25 mm in diameter) increased, sandeel increasingly avoided the habitat (this finding was also supported by Wright *et al*. (2000) as reported by Mazik *et al.* (2015). Conversely, as the percentage of coarse sand and medium sand (particles ranging from 0.25 mm to 2.0 mm) increased, sandeel showed an increased preference for this substrate.

3.6.3.4 PSA data can be used to assess habitat preference for sandeel. Results illustrated that 83% of the surveyed stations comprised mud content in excess of 4%, rendering the majority of sediments within the Offshore Order Limits outside of the preferred sandeel habitat composition and therefore indicating low potential for this area constituting an important ground for sandeel habitation and spawning. The majority of the south east portion of the Offshore Order Limits was found to be unsuitable sandeel habitat. Figure 3.4 illustrates the results of site-specific PSA survey data within the Offshore Order Limits alongside EMODnet seabed substrate data and Figure 3.5 show the results from surveys undertaken for the Generation Assets which can also be used to assess habitat suitability for sandeel (see Volume 2, Figures; Gardline Limited, 2022; Ocean Ecology, 2022). To appropriately assess the suitability of habitats for sandeel across the study area, gravelly sand, (gravelly) sand and sand were classified from the EMODnet data as preferred habitat and sandy gravel as marginal habitat (see Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES for further details). Where no shading is present in the figures, this represents unsuitable habitat, while the PSA results were categorised into unsuitable, marginal and preferred, based on mud and sand ratios in grab samples, as defined by Latto *et al.* (2013).

3.6.3.5 The site-specific benthic survey results and EMODnet seabed substrate data is generally well aligned within the Transmission Assets, showing that a large portion of the Offshore Order Limits (mostly in south east section) is classified as unsuitable habitat, however in the west of the Offshore Order Limits an area of marginal habitat was identified, with further sparsely distributed stations considered preferred habitat. Benthic site-specific surveys found no sandeel within the Offshore Order Limits, although these particular surveys were not designed to target sandeel species and would not be appropriate to inform overall abundance of sandeel. It's worth noting that two benthic grab samples in close proximity to the west of the Offshore Order Limits recorded sandeel during a benthic survey for Morgan Offshore Wind Project: Generation Assets in 2021; more information is available within Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES.

3.6.3.6 No observations of Norway lobster *Nephrops norvegicus,* hereafter referred as *Nephrops*, were recorded in the Offshore Order Limits. However, incidental observations of *Nephrops* were recorded during the 2021 benthic survey for Morgan Offshore Wind Project: Generation Assets which correlated strongly with results of the biotope mapping, with all recordings of *Nephrops* through DDV surveys occurring within areas found to have gravelly muddy sands (Gardline Limited, 2022). Further fish and shellfish observations were also recorded within the Offshore Order Limits including razor clams *Ensis ensis*, blue mussel, king scallop *Pecten maximus*, unidentified scallops Pectinidae spp., common dragonet *Callionymus lyra*, red gurnard *Chelidonichthys cuculus*, greater pipefish *Syngnathus acus*, common dab *Limanda limanda*, haddock *Melanogrammus aeglefinus*, lemon sole *Microstomus kitt*, plaice *Pleuronectes platessa*, Dover sole *Solea solea*, solenette *Buglossidium luteum*, other flatfish *Pleuronectiformes* sp., spotted ray *Raja montagui* and lesser-spotted dogfish *Scyliorhinus canicula*.

3.6.3.7 Basking sharks were not sighted in the site-specific aerial surveys undertaken for birds and marine mammals across the Morgan Offshore Wind Project: Generation Assets and Morecambe Offshore Windfarm: Generation Assets.

3.6.4 Future baseline conditions

3.6.4.1 The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 requires that '*an outline of the likely evolution thereof without implementation of the development as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge'* is included within the ES. This section provides an outline of the likely future baseline conditions in the absence of the Transmission Assets. In the event that the

Transmission Assets does not come forward, an assessment of the future baseline conditions has been carried out and is described within this section.

3.6.4.2 The current baseline environment is accurately represented in the given description, accounting for seasonality and interannual variability. However, the baseline will exhibit larger degrees of natural change over longer time periods, due to naturally occurring cycles and processes and any potential changes resulting from climate change. This long term change will occur even if the Transmission Assets do not come forward. Therefore, when undertaking any impact assessments, it will be necessary to place any potential impacts into the context of the envelope of change that might occur over the expected operational lifetime of the Transmission Assets.

3.6.4.3 Variability and long term changes within the Irish Sea, including projected increases of average sea surface temperature of up to 1.9°C and changes in the timing of maximum and minimum temperatures (Olbert *et al*., 2012) may bring direct and indirect changes to fish and shellfish populations and communities. As sea temperatures rise, species adapted to cold water such as cod (Drinkwater, 2005) and herring will begin to seek cooler waters, while warm water adapted species will become more established in the previous locations. This potential future change will occur against the background of known overall dampening of production and stock recovery in Irish Sea fish populations due to the present impacts of climate change (Bentley *et al.,* 2020). Future changes are expected to be exacerbated by increasing temperatures and extreme weather events causing increased stratification of phytoplankton food sources in the Irish Sea leading to decoupling of predator and prey interactions and impacting fish population survivability (Morrison *et al.,* 2019).

3.6.4.4 Increasing temperatures can also potentially expand the geographical range and virulence of diseases affecting economically important shellfish populations (Rowley *et al.,* 2014), causing potential threats to long term survivability and thus negatively impacting overall population levels. A combination of this impact, increasing temperature and ocean acidification could also negatively impact shell strength (Mackenzie *et al.*, 2014) and thus reduce their protection against predators, with significant reductions in the economic value projected from these impacts to the shellfish population (Narita *et al.,* 2012).

3.6.4.5 Climate change presents many uncertainties as to how the marine environment will change in the future; therefore, the future baseline scenario is difficult to predict with accuracy. Any changes that may occur during the proposed operational lifespan of the Transmission Assets development should be considered in the context of both greater variability and sustained trends occurring on national and international scales in the marine environment.

3.6.5 Key receptors

3.6.5.1 IEFs are habitats, species, ecosystems and their functions/processes that are considered to be important and potentially impacted by the Transmission Assets. Guidance from CIEEM was used to assess IEFs within the area

(CIEEM, 2022). IEFs can be attributed to individual species (such as plaice) or species groups (for example other flat fish species). Each IEF is assigned a value or importance rating which are based on commercial, ecological and conservation importance, including SPIs and features of SACs. SPIs are those species most threatened, in greatest decline, or where England and Wales hold a significant proportion of the world's total population in some cases (SPIs are listed under the Natural Environment and Rural Communities (NERC) Act 2006, Section 42 and Environment (Wales) Act 2016, Section 7). rankings.

3.6.5.2 Table 3.8 details the criteria used for determining IEFs and Table 3.9 applies the defining criteria to specific species, providing justifications for importance rankings.

Table 3.8: Defining criteria for IEFs.

Value of IEF	Defining criteria
International	Internationally designated sites. Species protected under international law (i.e., Annex II species listed as qualifying interests of SACs).
National	Nationally designated sites. Species protected under national law. Annex II species which are not listed as qualifying interests of SACs in the study area. OSPAR List of Threatened or Declining Species and IUCN Red List species that have nationally important populations within the Transmission Assets, particularly in the context of species/habitat that may be rare or threatened in English and Welsh waters. Priority habitats and species (i.e., SPIs) have been deemed features characteristic of the English and Welsh marine environment and where nationally important habitats/communities are present in the study area. Species that have spawning or nursery areas within or in the immediate vicinity of the Transmission Assets that are important nationally (e.g., may be primary spawning/nursery area for that species).
Regional	OSPAR List of Threatened or Declining Species and IUCN Red List species that have regionally important populations within the Transmission Assets (i.e., are locally widespread or abundant). Priority habitats and species (i.e., SPIs) have been deemed features characteristic of the English and Welsh marine environment. Species that are of commercial value to the fisheries which operate within the Transmission Assets (through review of fisheries landings data; see Volume 2, Annex 6.1: Commercial fisheries technical report of the ES). Species that form an important prey item for other species of conservation or commercial value and that are key components of the fish assemblages within the Offshore Order Limits. Species that have spawning or nursery areas within the Offshore Order Limits that are important regionally (i.e., species may spawn in other parts of English and Welsh waters, but this is a key spawning/nursery area within the Offshore Order Limits).

Value of IEF	Defining criteria
Local	Species that are of commercial importance but do not form a key component of the fish assemblages within the Transmission Assets (e.g., they may be exploited in deeper waters outside the Transmission Assets). The spawning/nursery area for the species are outside the Offshore Order Limits. The species is common throughout English and Welsh waters but forms a component of the fish assemblages in the Transmission Assets.

3.6.5.3 **Table 3.9** identifies the fish and shellfish IEFs taken forward into the assessment and agreed with stakeholders through the consultation process, as presented in **section 3.3**.

Table 3.9: Key receptors taken forward to assessment

Receptor	Description	Value
Marine fish IEF species		
Plaice	Listed as a SPI. High intensity spawning and low intensity nursery grounds identified throughout the Generation Assets and low intensity spawning nursery grounds identified throughout the offshore export cable corridor, all within the Offshore Order Limits. Plaice is an important commercial species throughout the Offshore Order Limits and within the surrounding east Irish Sea.	Regional
Lemon sole	Intensity of spawning and nursery grounds are undetermined within the west portion of Offshore Order Limits and wider east Irish Sea. It is an important and abundant commercial fish species, but not in the immediate vicinity of the Transmission Assets (i.e. within the wider east Irish Sea).	Local
Dover sole	Listed as a SPI. High intensity spawning and nursery grounds identified across the majority of the Transmission Assets. Sole is an important commercial species throughout the Offshore Order Limits and within the surrounding east Irish Sea.	Regional
Other flatfish species	Other flatfish species, including common dab, solenette and flounder *Platichthys flesus*, are likely to occur within the Offshore Order Limits. These species either have no known spawning or nursery grounds or low intensity/undetermined spawning and nursey grounds within the area.	Local
Cod	Listed as a SPI. Listed by OSPAR as threatened or declining and listed as Vulnerable on the IUCN Red List. High intensity nursery grounds are present throughout the Offshore Order Limits, high intensity spawning grounds throughout the west portion of the Transmission	Regional

Receptor	Description	Value
	Assets and low intensity spawning grounds throughout the offshore export cable corridor. It continues to be a species of commercial importance following the collapse of the cod fishery in the Irish Sea although landings are generally low.	
Haddock	Listed as a SPI. Nursery grounds of unspecified intensity identified in the north east Irish Sea and marginally within the Offshore Order Limits. Haddock is an important commercial species throughout the Offshore Order Limits and within the surrounding east Irish Sea.	Regional
Whiting *Merlangius merlangus*	Listed as a SPI. Low intensity spawning and high intensity nursery grounds identified throughout the Offshore Order Limits. Whiting is an important commercial species throughout the Offshore Order Limits and within the surrounding east Irish Sea.	Regional
Other demersal species (species that live and feed on or near the seabed)	Species including anglerfish *Lophius piscatorius,* ling *Molva molva* and European hake *Merluccius merluccius* (all listed as SPI) are common throughout English and Welsh waters and are likely to be within the Offshore Order Limits. These species either have no known spawning or nursery grounds or low intensity spawning and nursey grounds within the area. They are important commercial species, but not in the immediate vicinity of the Transmission Assets (although present in the wider east Irish Sea).	Local
Sandeel species	Raitt's sandeel *Ammodytes marinus* listed as a SPI. There are five species of sandeel found in UK waters with lesser sandeel and greater sandeel *Hyperoplus lanceolatus* being the most commonly found species in British waters. Sandeel are important prey species for fish, birds and marine mammals. Both high and low intensity spawning grounds and low intensity nursery grounds are present across the Offshore Order Limits. Identified as likely to be present in the Offshore Order Limits based on historic data and habitat preference.	Regional
Herring	Listed as a SPI. Low intensity spawning grounds present immediately outside of the Offshore Order Limits and within the study area. High intensity nursery grounds present throughout the Offshore Order Limits. Although herring spawning grounds do not directly overlap the Offshore Order	National

Receptor	Description	Value
	Limits, this specific area of the Irish Sea has been denoted as key spawning habitat for the species. Herring is an important commercial species, including in the immediate vicinity of the Transmission Assets and in the wider east Irish Sea.	
Mackerel *Scomber scombrus*	Listed as a SPI. Important prey species for larger fish, birds and marine mammals. Low intensity spawning throughout the Offshore Order Limits and low nursery grounds throughout the west portion of the Transmission Assets and the wider east Irish Sea. Mackerel is an important commercial species, but not in the immediate vicinity of the Transmission Assets (i.e. in the wider east Irish Sea).	Regional
Sprat *Sprattus sprattus*	Important prey species for larger fish, birds and marine mammals. Unspecified intensity spawning grounds within the Offshore Order Limits. Sprat is an important commercial species, but not in the immediate vicinity of the Transmission Assets or in the wider east Irish Sea.	Regional
Horse mackerel *Trachurus trachurus*	Listed as a SPI. Low intensity spawning marginally overlapping the Offshore Order Limits. Horse mackerel is an important commercial species, but not in the immediate vicinity of the Transmission Assets or in the wider east Irish Sea.	Local
Elasmobranchs IEF species		
Basking shark	Listed as a SPI. The North East Atlantic population are classed as Endangered on the IUCN Red List. Additionally, they are listed under Convention on International Trade in Endangered Species of Wild Fauna and Flora Annex II and classified as a Priority Species under the UK Post-2010 Biodiversity Framework. Protected in the UK under the Wildlife and Countryside Act and in the Isle of Man under the Isle of Man Wildlife Act 1990. Basking shark are likely to be present in low abundances if present at all near the Isle of Man and in proximity to the Offshore Order Limits.	International
Tope shark *Galeorhinus galeus*	Listed as a SPI. Listed as Critically Endangered by the IUCN Red List and is a Priority Species under the UK Post-2010 Biodiversity Framework. Low intensity nursery grounds throughout the Offshore Order Limits.	Regional

Receptor	Description	Value
Spurdog *Squalus acanthias*	Listed as a SPI. Listed as Vulnerable by the IUCN Red List and is a Priority Species under the UK Post-2010 Biodiversity Framework. High intensity nursery grounds throughout the western of the Offshore Order Limits, further offshore.	Regional
Rays	Ray species including spotted ray and thornback ray. These species either have low intensity nursery grounds and/or no known spawning grounds within the Offshore Order Limits.	Regional
Shellfish IEF species		
Edible crab *Cancer pagurus*	Commercially important species. Identified as being likely to be present within the Offshore Order Limits.	Regional
Nephrops	Commercially important species. Identified as being likely to be present within the Offshore Order Limits. Intensity of spawning and nursery grounds are undetermined and unspecified throughout the western section of the Offshore Order Limits, further offshore.	Regional
European lobster *Homarus Gammarus*	Commercially important species. Identified as being likely to be present within the Offshore Order Limits.	Regional
King scallop	Commercially important species. Identified as being likely to be present within the Offshore Order Limits.	Regional
Queen scallop *Aequipecten opercularis*	Commercially important species. Identified as being likely to be present within the Offshore Order Limits.	Regional
Velvet swimming crab *Necora puber*	Commercially important species. Identified as being likely to be present within the Offshore Order Limits.	Local
Other crustaceans	Other crustaceans including, swimming crab, spider crab and shrimp have been identified as being likely to occur within the Offshore Order Limits. These are all important commercial species, but not in the immediate vicinity of the Offshore Order Limits (i.e. in the wider east Irish Sea).	Local
Diadromous fish IEF species		
Sea trout	Listed as a SPI. Listed as a species of Least Concern by the IUCN Red List. Listed as a OSPAR threatened/declining species. Likely to migrate through the Offshore Order Limits. Not a feature of any designated sites in the vicinity of the Offshore Order Limits.	National

Receptor	Description	Value
European eel	Listed as a SPI. Listed as Critically Endangered by the IUCN Red List. Listed as an OSPAR threatened/declining species. Likely to migrate through the Offshore Order Limits. This species is a qualifying feature of multiple MNRs in the vicinity of the Offshore Order Limits.	National
Sea lamprey	Listed as a SPI. Listed as a species of Least Concern by the IUCN Red List. Annex II species and listed as qualifying features of a number of SACs in the vicinity of the Offshore Order Limits. Likely to migrate through the Offshore Order Limits.	International
River lamprey	Listed as a SPI. Listed as a species of Least Concern by the IUCN Red List. Annex II species and listed as qualifying features of a number of SACs in the vicinity of the Offshore Order Limits. Likely to migrate through the Offshore Order Limits, although only in coastal/estuarine areas.	International
Twaite shad *Alosa fallax*	Listed as a SPI. Listed as a species of Least Concern by the IUCN Red List and is a Priority Species under the UK Post-2010 Biodiversity Framework. Likely to migrate through the Offshore Order Limits.	National
Allis shad *Alosa alosa*	Listed as a SPI. Listed as a species of Least Concern by the IUCN Red List and is a Priority Species under the UK Post-2010 Biodiversity Framework. Likely to migrate through the Offshore Order Limits.	National
Atlantic salmon	Listed as a SPI. Listed as Vulnerable by the IUCN Red List. Annex II species and listed as qualifying features of a number of SACs in the vicinity of the Transmission Assets. Likely to migrate through the Offshore Order Limits.	International
Sparling/European smelt	Listed as a SPI. Listed as a species of Least Concern by the IUCN Red List. This species is a qualifying feature of multiple MCZs in the vicinity of the Transmission Assets. Likely to migrate through the Offshore Order Limits, although only in coastal/estuarine areas.	National
Freshwater pearl mussel	Listed as a SPI. Listed in Annexes II and V of the Habitats Directive and Annex III of the Bern Convention. Listed as Endangered on the IUCN Red List. Annex II species and listed as qualifying features of a number of SACs in the vicinity of the Offshore Order Limits.	International

3.7 Scope of the assessment

3.7.1.1 The scope of this ES has been developed in consultation with relevant statutory and non-statutory consultees as detailed in **Table 3.4**. The assessment encompasses all stages of the Transmission Assets including those associated with seabed disturbance during the construction and operation and maintenance phases as well as those associated with the physical presence of infrastructure and underwater sound.

3.7.1.2 Taking into account the scoping and consultation process, **Table 3.10** summarises the impacts considered as part of this assessment.

Table 3.10: Impacts considered within this assessment

Activity	Impacts scoped into the assessment
Construction phase	
Jack-up events, cable installation, sandwave clearance deposition, anchor placements, cable removal	• Temporary habitat loss/disturbance.
Geophysical site investigation surveys and UXO clearance	• Underwater sound from UXO clearance and geophysical surveys impacting fish and shellfish receptors.
Vessel traffic and other sound-producing activities	• Underwater sound from all other activities during all phases.
Sandwave clearance and cable installation	• Increased SSCs and associated sediment deposition. • Disturbance/remobilisation of sediment-bound contaminants.
Cable protection and cable crossing protection	• Long term habitat loss. • Introduction and colonisation of hard substrata.
Vessels movements	• Injury to basking shark due to increased risk of collision with vessels.
Operation and maintenance phase	
Jack-ups for cables	• Temporary habitat loss/disturbance.
Vessel traffic and other sound-producing activities	• Underwater sound from all other activities.
Repair of cables	• Increased SSCs and associated sediment deposition. • Disturbance/remobilisation of sediment-bound contaminants.
Cable protection and cable crossing protection	• Long term habitat loss. • Introduction and colonisation of hard substrata.
Presence of cables	• EMF from subsea electrical cabling.
Vessels movements	• Injury to basking shark due to increased risk of collision with vessels.

Activity	Impacts scoped into the assessment
Decommissioning phase	
Jack-up events, cable removal, anchor placements	• Temporary habitat loss/disturbance.
Vessel traffic and other sound-producing activities	• Underwater sound from all other activities.
Cable removal	• Increased SSCs and associated sediment deposition. • Disturbance/remobilisation of sediment-bound contaminants.
Cable protection left *in situ*	• Long term habitat loss. • Introduction and colonisation of hard substrata.
Vessels movements	• Injury to basking shark due to increased risk of collision with vessels.

3.7.1.3 Impacts that are not likely to result in significant effects have been scoped out of the assessment. A summary of the effects scoped out, together with justification for scoping them out and whether the approach has been agreed with key stakeholders through either scoping or consultation, is presented in **Table 3.11**.

Table 3.11: Potential effects scoped out of the assessment

Potential effect	Justification
Accidental pollution during construction, operation and maintenance and decommissioning phases.	There is a risk of pollution being accidentally released during the construction, operation and maintenance and decommissioning phases from sources including vessels/vehicles and equipment/machinery. However, the risk of such events is managed by the implementation of measures set out in standard post-consent plans (e.g. Outline Offshore EMP (CoT65, **Table 3.12**), including Marine Pollution Contingency Plan (MPCP)). These plans include planning for accidental spills, address all potential contaminant releases and include key emergency contact details. It will also set out industry good practice and OSPAR, International Maritime Organisation and International Convention for the Prevention of Pollution from Ships guidelines for preventing pollution at sea. Therefore, the likelihood of an accidental spill occurring is very low and in the unlikely event that such events did occur, the magnitude of these will be minimised through measures such as MPCP. As such, this impact has been scoped out of further consideration within this chapter.

3.8 Measures adopted as part of the Transmission Assets (Commitments)

3.8.1.1 For the purposes of the EIA process, the term 'Measures adopted as part of the Transmission Assets' is used to include the following types of mitigation measures (adapted from Institute of Environmental Management and Assessment (IEMA), 2016). These measures are set out in the Commitments Register (Volume 1, Annex 5.3: Commitments register of the ES).

- Embedded mitigation. This includes the following.
  - Primary (inherent) mitigation - measures included as part of the project design. IEMA describes these as 'modifications to the location or design of the development made during the pre-application phase that are an inherent part of the project and do not require additional action to be taken'. This includes modifications arising through the iterative design process. These measures will be secured through the consent itself through the description of the project and the parameters secured in the DCO and/or marine licences. For example, a reduction in footprint or height.
  - Tertiary (inexorable) mitigation. IEMA describes these as '*actions that would occur with or without input from the EIA feeding into the design process. These include actions that will be undertaken to meet other existing legislative requirements, or actions that are considered to be standard practices used to manage commonly occurring environmental effects*'. It may be helpful to secure such measures through a Code of Construction Practice or similar.
- Secondary (foreseeable) mitigation. IEMA describes these as '*actions that will require further activity in order to achieve the anticipated outcome'*. These include measures required to reduce the significance of environmental effects (such as lighting limits) and may be secured through an EMP.

3.8.1.2 In addition, where relevant, measures have been identified that may result in enhancement of environmental conditions. Such measures are clearly identified within the Commitments Register (Volume 1, Annex 5.3: Commitments register of the ES. The measures relevant to this chapter are summarised in **Table 3.12**.

3.8.1.3 Embedded measures that will form part of the final design (and/or are established legislative requirements/good practice) have been taken into account as part of the initial assessment presented in **section 3.11** below (i.e., the initial determination of impact magnitude and significance of effects assumes implementation of these measures). This ensures that the measures that the Applicants are committed to are taken into account in the assessment of effects.

3.8.1.4 Where an assessment identifies likely significant adverse effects, further or secondary mitigation measures may be applied. These are measures that could further prevent, reduce and, where possible, offset these effects. They are defined by IEMA as actions that will require further activity in order to achieve the anticipated outcome and may be imposed as part of the planning consent, or through inclusion in the ES (referred to as secondary mitigation measures in IEMA, 2016). For further or secondary measures both pre-mitigation and residual effects are presented.

3.8.1.5 The Transmission Assets design has been revised from the PEIR to the ES following stakeholder consultation, including the removal of all foundation piling relating to Offshore Substation Platforms. These are now considered solely within the relevant Generation Assets design envelopes (Morgan Offshore Wind Project: Generation Assets and Morecambe Offshore Windfarm: Generation Assets). As such, the removal of all piling from the design envelope has considerably reduced the range at which instantaneous injury, mortality and behavioural effects could occur to fish from received sound. Impacts from UXO clearance and geophysical surveys are assessed for the Transmission Assets alone in **section 3.11.3** and cumulatively with other projects and plans in **section 3.13.3**.

Table 3.12: Measures (Commitments) adopted as part of the Transmission Assets

Commitment number	Measure adopted	How the measure will be secured
Embedded measures		
CoT45	The Outline Offshore Cable Specification and Installation Plan (CSIP) for the Fylde MCZ includes: details of cable burial depths, cable protection, and cable monitoring. The Outline CSIP also includes an Outline Cable Burial Risk Assessment (CBRA). Detailed CSIP(s) and CBRA(s) will be prepared by the Applicants covering the full extent of their respective offshore export cable corridors. Detailed CSIPs will be developed in accordance with the Outline CSIP and will ensure safe navigation is not compromised including consideration of under keel clearance. No more than 5% reduction in water depth (referenced to Chart Datum) will occur at any point on the offshore export cable corridor route without prior written approval from the MCA.	DCO Schedule 14 (Marine Licence 1: Morgan Offshore Wind Project Transmission Assets) Part 2 - Condition18(1)(e) (Pre-construction plans and documentation) and DCO Schedule 15 (Marine Licence 2: Morecambe Offshore Wind Farm Transmission Assets), Part 2 - Condition 18(1)(e) (Pre-construction plans and documentation)
CoT49	Construction Method Statement(s) (CMSs) including Offshore Cable Specification and Installation Plan(s), will be produced and implemented prior to construction. These will contain: – details of cable installation and methodology; and – details of foundation installation methodology covering scour protection and the deposition of material arising from drilling, dredging, and/or sandwave clearance.	DCO Schedule 14 (Marine Licence 1: Morgan Offshore Wind Project Transmission Assets) Part 2 - Condition18(1)(e) (Pre-construction plans and documentation) and DCO Schedule 15 (Marine Licence 2: Morecambe Offshore Wind Farm Transmission Assets), Part 2 - Condition 18(1)(e) (Pre-construction plans and documentation)
CoT54	An Outline Offshore Cable Specification and Installation Plan (CSIP) includes for cable burial to be the preferred option for cable protection, where practicable. Detailed CSIP(s) will be developed in accordance with the Outline CSIP.	DCO Schedule 14 (Marine Licence 1: Morgan Offshore Wind Project Transmission Assets) Part 2 - Condition18(1)(e) (Pre-construction plans and documentation) and DCO Schedule 15 (Marine Licence 2: Morecambe Offshore Wind Farm Transmission Assets), Part 2 - Condition 18(1)(e) (Pre-construction plans and documentation).
CoT64	Detailed Marine Mammal Mitigation Protocols (MMMPs) will be developed and implemented in accordance with the Outline MMMP, to reduce the risk of injury to marine mammals. The Detailed MMMP(s) will include measures to apply in advance of	DCO Schedule 14 (Marine Licence 1: Morgan Offshore Wind Project Transmission Assets) Part 2 – Condition

Commitment number	Measure adopted	How the measure will be secured
	UXO clearance. The Detailed MMMP(s) will include for the use of low order techniques, where possible, as the primary mitigation measure alongside other measures. The detailed MMMP(s) will be approved by Marine Management Organisation, in consultation with Natural England.	20(1)(b) (UXO clearance) and DCO Schedule 15 (Marine Licence 2: Morecambe Offshore Wind Farm Transmission Assets), Part 2 - Condition20(1)(b) (UXO clearance).
CoT65	Offshore Environmental Management Plan(s) (EMPs) will be developed and will include details of: – a marine pollution contingency plan to address the risks, methods and procedures to deal with any spills and collision incidents during construction and operation of the authorised scheme for activities carried out below MHWS; – a chemical risk review to include information regarding how and when chemicals are to be used, stored and transported in accordance with recognised best practice guidance; – waste management and disposal arrangements; – the appointment and responsibilities of a fisheries liaison officer; – a fisheries liaison and coexistence plan (which accords with the outline fisheries liaison and co-existence plan) to ensure relevant fishing fleets are notified of commencement of licensed activities pursuant to condition and to address the interaction of the licensed activities with fishing activities; – measures to minimise disturbance to marine mammals and rafting birds from vessels; and – measures to minimise the potential spread of invasive non-native species, including adherence to IMO ballast water management guidelines.	DCO Schedule 14 (Marine Licence 1: Morgan Offshore Wind Project Transmission Assets) Part 2 - Condition18(1)(f) (Pre-construction plans and documentation) and DCO Schedule 15 (Marine Licence 2: Morecambe Offshore Wind Farm Transmission Assets), Part 2 - Condition18(1)(f) (Pre-construction plans and documentation).
CoT69	Detailed Vessel Traffic Management Plan(s) (VTMP) will be developed pre-construction in line with legislation, guidance and industry best practice which will: – determine vessel routing to and from construction areas and ports; – include vessel standards and a code of conduct for vessel operators; and – minimise, as far as reasonably practicable, encounters with marine mammals and basking sharks. These plans will be developed in accordance with the Outline VTMP prepared and submitted with the application for development consent.	DCO Schedule 14 (Marine Licence 1: Morgan Offshore Wind Project Transmission Assets) Part 2 - Condition18(1)(h) (Pre-construction plans and documentation) and DCO Schedule 15 (Marine Licence 2: Morecambe Offshore Windfarm Transmission Assets), Part 2 -

Commitment number	Measure adopted	How the measure will be secured
		Condition18(1)(h) (Pre-construction plans and documentation).
CoT90	The Project Description (Volume 1, Chapter 3 of the Environmental Statement) sets out that the installation of the 400kV Grid Connection Cable Corridor beneath the River Ribble will be undertaken by direct pipe or micro tunnel trenchless installation techniques.	DCO Schedules 2A & 2B, Requirement 5(3) (Detailed design parameters onshore); and Requirement 8 (Code of Construction Practice).

3.9 Key parameters for assessment

3.9.1 Maximum design scenario

3.9.1.1 The MDS identified in **Table 3.13** have been selected as those having the potential to result in the greatest effect on fish and shellfish ecology receptors. These scenarios have been selected from the PDE provided in Volume 1, Chapter 3: Project description of the ES. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the PDE (e.g., different infrastructure layout), to that assessed here be taken forward in the final design.

3.9.1.2 The MDSs in **Table 3.13** and assessment of effects in **section 3.11** considers the relevant construction scenario (i.e. sequential or concurrent) that equate to the MDS for that impact pathway. For example, for temporary habitat loss/disturbance, the MDS is for the sequential construction scenario (i.e. construction will take place over a maximum of 30 months, noting that there is a potential for a gap between the construction periods for the Morgan Offshore Wind Project and the Morecambe Offshore Windfarm) as this equates to the greatest time over which impacts to fish and shellfish receptors may occur. It should, however, be noted that the total magnitude of each impact is the same for both the concurrent and sequential scenarios. For impacts such as increases in SSC and associated sediment deposition, the MDS is for activities to be carried out concurrently.

Table 3.13: Maximum design scenario considered for the assessment of impacts

<table>
<tr><th rowspan="2">Impact</th><th colspan="3">Phase[a]</th><th rowspan="2">Maximum design scenario</th><th rowspan="2">Justification</th></tr>
<tr><th>C</th><th>O</th><th>D</th></tr>
<tr><td>Temporary habitat loss/disturbance.</td><td>✓</td><td>✓</td><td>✓</td><td>Pre-construction UXO removal: clearance of up to 25 UXOs ranging from 25 kg up to 907 kg, with 130 kg being the most likely.
Construction phase
Up to 14,805,472 m² of subtidal seabed habitat loss/disturbance over of 30 months (sequential site preparation and construction scenario), noting that there is potential for a gap between the construction periods of the Morgan Offshore Wind Project and Morecambe Offshore Windfarm consisting of:
Export cable installation: up to 11,331,680 m² of temporary habitat disturbance from installation of up to 484 km of buried offshore export cables (assumes 100% of all cables are buried) comprising:
sandwave clearance: required for up to 9% of Morgan export cables and 9% of Morecambe export cables;
pre-lay preparation (boulder and debris clearance): is likely to be required across all export cables. Although, for the purposes of the MDS, boulder clearance only has been assumed across up to 91% of Morgan export cables and 91% of Morecambe export cables (see justification);
seabed disturbance width of up to 60 m for sandwave clearance along Morgan offshore export cables and up to 48 m for Morecambe offshore export cables;
seabed disturbance width of up to 20 m for boulder clearance along Morgan and Morecambe offshore export cables; and
seabed disturbance width of up 3 m for cable burial.
Sandwave clearance material deposition: Up to 2,853,600 m² of temporary habitat loss/disturbance associated with the deposition of:
up to 1,080,000 m³ of sandwave clearance material associated with the Morgan offshore export cables affecting up to 2,160,000 m²; and</td><td>Maximum footprint which would be affected during the pre-construction, construction, operation and maintenance and decommissioning phases.
The disturbance width is driven by the need to survey for UXO over the cable route. The actual disturbance width for cable installation is likely to be considerably less.
Construction phase
<u>Site preparation</u>:
The MDS assumes that the width of disturbance for sandwave and pre-lay preparation (boulder and debris clearance) also includes subsequent burial.
Pre-lay preparation (boulder and debris clearance) is likely to be required across all offshore export cables. For the purposes of the MDS and to avoid double counting of the total footprint with sandwave clearance activities, the MDS assumes up to 91% of Morgan offshore export cables will be subject to pre-lay preparation (boulder and debris clearance) only and up to 91% of Morecambe offshore export cables will be subject to pre-lay preparation (boulder and debris clearance) only.</td></tr>
</table>

Impact	Phase[a]			Maximum design scenario	Justification
	C	O	D		
				– up to 346,800 m^3 of sandwave clearance material associated with the Morecambe offshore export cables affecting up to 693,600 m^2. • Anchor placements: up to 60,000 m^2 of habitat disturbance from a 100 m^2 anchor set placement (five anchors per set) event every 500 m during offshore export cable installation within the nearshore area (10 km for each of four Morgan offshore export cables and each of the two Morecambe offshore export cables). • Cable removal: Up to 560,000 m^2 from the removal of 28 km of disused cables (disturbance width of up to 20 m). • Jack-up events to support offshore export cable pull: up to 192 m^2 of temporary habitat disturbance associated with two jack-up events for each of the four Morgan export cables and each of the two Morecambe export cables. Four legs per vessel, each with a 4 m^2 spud can affecting up to 16 m^2 per jack-up. • . Up to 151,632 m^2 of temporary intertidal habitat loss/disturbance over of 30 months (sequential site preparation and construction scenario), noting that there is potential for a gap between the construction periods of the Morgan Offshore Wind Project and Morecambe Offshore Windfarm due to: • Intertidal export cable installation: offshore export cable installation at the Landfall, including: – open cut trenching: up to 90,000 m^2 of temporary habitat loss/disturbance, based on a total of six export cables in six trenches, a trench length of up to 300 m and working areas (including trench) of up to 50 m width; – marinised trenching: up to 60,000 m^2 of temporary habitat loss/disturbance, based on a total of six export cables in six trenches, a trench length of up to 1200 m approximately and working areas (including trench) of up to 50 m width;	It is anticipated that the sandwaves requiring clearance are likely to be in the range of 5 m in height. The area of seabed affected by the placement of sandwave clearance material has been calculated based on the maximum volume of sediment to be placed on the seabed, assuming all this sediment is coarse material (i.e., is not dispersed through tidal currents; see 'Increased SSCs' impact below). The total footprint of seabed affected has been calculated, for the purposes of the MDS, assuming a mound of uniform thickness of 0.5 m height. Temporary loss of seabed habitat is assumed beneath this. The sequential construction scenario is included as the maximum design scenario as this results in the longest duration of impact. **Operation and maintenance phase:** MDS for habitat disturbance associated with offshore export cable maintenance includes repairs/reburial of both subtidal and intertidal cables. **Decommissioning phase:** MDS assumes the complete removal of all offshore export cables, but that cable protection may be left *in situ*.

Impact	Phase[a]			Maximum design scenario	Justification
	C	O	D		
				– intermediate pulling platforms: up to 1,400 m² of temporary habitat loss/disturbance, from up to two platforms for each of the six export cables each affecting an area of 120 m²; – jack-up events to support offshore export cable pull: up to 192 m² of temporary habitat disturbance associated with two jack-up events for each of the four Morgan export cables and each of the two Morecambe export cables. Four legs per vessel, each with a 4 m² spud can affecting up to 16 m² per jack-up; and – cable barge grounding, cable floats and roller boxes (and associated piles) within the 50 m working corridor. **Operation and maintenance phase** • Up to 4,397,680 m² of temporary subtidal habitat disturbance due to repair/reburial of offshore export cables. – Cable repair events: up to 1,680,000 m² of temporary habitat disturbance comprising: – up to 1,120,000 m² for repair of Morgan subtidal export cables: up to 14 repair events (one repair event for each of the four export cables every 10 years affecting up to 4 km per repair event with a 20 m width of disturbance; and – up to 560,000 m² for repair of Morecambe subtidal export cables: up to seven repair events (one repair for each of the two export cables every 10 years) affecting up to 4 km per repair event with a 20 m width of disturbance. • Cable reburial events: up to 2,716,000 m² of temporary habitat disturbance comprising: – Up to 2,240,000 m² for the reburial of Morgan subtidal export cables: one reburial event every five years (seven reburial events in total) affecting up to 16 km of export cables per event with a 20 m width of disturbance; and	

Impact	Phase[a]			Maximum design scenario	Justification
	C	O	D		
				– Up to 476,000 m^2 for the reburial of Morecambe subtidal export cables: one reburial event every five years (seven reburial events in total) affecting up to 3.4 km of export cables per event with a 20 m width of disturbance. • Jack-up events: up to 1,680 m^2 from up to two jack-up events per year for the Morgan export cables, and up to one jack-up event per year for the Morecambe export cables. Four legs per vessel, each with a 4 m^2 spud can affecting up to 16 m^2 per jack-up. Up to 552,000 m^2 of temporary intertidal habitat disturbance comprising: • Cable repair events: up to 272,000 m^2 of temporary intertidal habitat disturbance comprising: – up to 80,000 m^2 for repair of Morgan intertidal export cables: up to four repair events (one reapir event every ten years) affecting up to 1 km of intertidal cables per event with a 20 m width of disturbance; and – up to 192,000 m^2 for repair of Morecambe intertidal export cables: up to four repair events (one repair event every 10 years) affecting up to 2.4 km of intertidal cables per repair event with a 20 m width of disturbance. • Cable reburial events: up to 280,000 m^2 of temporary intertidal habitat disturbance comprising: – up to 140,000 m^2 for reburial of Morgan intertidal export cables: up to seven reburial events (one every five years) affecting up to 1 km of intertidal cables per event with a 20 m width of disturbance; – up to 140,000 m^2 for reburial of Morecambe intertidal export cables: up to 14 reburial event (two every five years) affecting up to 500 m per reburial event with a 20 m width of disturbance. • Operation and maintenance phase of up to 35 years. **Decommissioning phase** Temporary subtidal habitat loss/disturbance.	

Impact	Phase[a]			Maximum design scenario	Justification
	C	O	D		
				• Subtidal cable removal: disturbance from the removal of up to 484 km of Morgan and Morecambe offshore export cables.	
Underwater sound from UXO clearance and geophysical surveys impacting fish and shellfish receptors.	✓	x	x	**Construction phase** <u>Pre-construction UXO clearance:</u> • Clearance of up to 25 UXOs within the Offshore Order Limits. • A range of UXO sizes assessed from 25 kg up to 907 kg with 130 kg the most likely maximum. • For high order detonation donor charges of 1.2 kg (most common) and 3.5 kg (single barracuda blast charge). • Up to 0.5 kg Net Explosive Quantity (NEQ) clearance shot for neutralisation of residual explosive material at each location. • Clearance during daylight hours only. The MDS is for high order clearance but assessment also considered. • Low order clearance charge size of 0.08 kg. Low yield clearance configurations of 0.75 kg charges (up to 4 x 0.75 kg) <u>Pre-construction surveys:</u> • Geophysical site investigation activities at Transmission Assets include: – Multibeam Echosounder (MBES) – 200 kHz to 500 kHz; 180 dB to 240 dB re 1 μPa re 1 m (root mean square (rms)); – Side Scan Sonar (SSS) – 200 kHz to 700 kHz; 216 dB to 228 dB re 1 μPa re 1 m (rms); – Single Beam Echosounder (SBES) – 20 kHz to 400 kHz; 180 dB to 240 dB re 1 μPa re 1 m (rms); – Sub-bottom Profilers (SBP) – 0.2 kHz to 14 kHz chirp; 2 kHz to 7 kHz pinger; 200 to 240 chirp dB re 1 μPa re 1 m (rms); 200 to 235 pinger dB re 1 μPa re 1 m (rms); and – Ultra-High Resolution Seismic (UHRS, such as a sparker) (0.05 kHz to 4 kHz; 170 dB to 200 dB re 1 μPa re 1 m (rms)).	<u>UXO clearance</u> • Maximum number and maximum size of UXOs encountered at Morgan Offshore Wind Project: Generation Assets. Due to uncertainties in size of UXOs, the assessment presents a range, highlighting the most likely size (common) to be encountered. • Most likely and maximum donor charges assessed for high order detonation. • Assumption of a clearance shot of up to 0.5 kg at all locations although noting that this may not always be required. • For low order/low yield clearance charges are based on the maximum required to initiate clearance event. <u>Pre-construction surveys</u> • Range of geophysical and geotechnical activities likely to be undertaken using equipment typically employed for these types of surveys. Parameters chosen resulted in the greatest range of effect (e.g., highest source, fastest pulse rate, longest pulse duration) and as such were those that would lead to the greatest spatial extent for injury.

Impact	Phase[a]			Maximum design scenario	Justification
	C	O	D		
				• Geotechnical surveys – Cone penetration testing – Vibrocoring Pre-construction site investigation surveys will involve the use of several geophysical and geotechnical survey vessels and will take place over a period of up to eight months.	
Underwater sound from all other activities during all phases	✓	✓	✓	**Construction phase** • Maximum vessels within Offshore Order Limits: Offshore at any one time, assuming a 30month sequential site preparation and construction scenario: – Morgan Offshore Wind Project: Transmission Assets: ○ Up to a total of 19 construction vessels on site at any one time (two tug/anchor handlers, six cable lay installation and support vessels, one guard vessel, two survey vessels, four seabed preparation vessels, two Crew Transfer Vessels (CTV) and two cable protection installation vessels). – Morecambe Offshore Windfarm: Transmission Assets: ○ Up to a total of 11 construction vessels on site at any one time (one tug/anchor handlers, four cable lay installation and support vessels, one guard vessel, one survey vessels, two seabed preparation vessels, one CTVs and one cable protection installation vessels). • Maximum movement of vessels within Offshore Order Limits: Offshore during construction phase: – Morgan Offshore Wind Project: Transmission Assets: ○ Up to 226 installation vessel movements (return trips) during construction (8 movements for tug/anchor handlers, 40 movements for cable lay installation and support vessels, 18 movements for guard vessels, four movements for survey vessels, 16 movements for seabed preparation vessels, 120 movements for CTVs and 20 movements for cable protection installation vessels).	Vessel sound and other sound-producing activities • The MDS considers the maximum number of vessels on site at any one time and greatest number of round trips during each phase of the Transmission Assets. This represents the broadest range of vessel types and therefore sound signatures within the marine environment to affect fish and shellfish receptors. • The MDS considers the maximum durations which activities could be conducted. The sequential construction scenario is included as the maximum design scenario as this results in the longest duration of impact.

Impact	Phase[a]			Maximum design scenario	Justification
	C	O	D		
				– Morecambe Offshore Windfarm: Transmission Assets: ○ Up to 60 installation vessel movements (return trips) during construction (four movements for tug/anchor handlers, eight movements for cable lay installation and support vessels, 12 movements for guard vessels, two movements for survey vessels, four movements for seabed preparation vessels, 28 movements for CTVs and two movements for cable protection installation vessels). • Burial of up to 484 km of offshore export cables via trenching, jetting, mechanical cutting and pre-lay plough (assumes sequential construction scenario of 24 months): – Installation of 400 km of offshore export cables for the Morgan Offshore Wind Project installed over 18 months. – Installation of 84 km of offshore export cables for the Morecambe Offshore Windfarm installed over 6 months. **Operation and maintenance phase** • Vessels on site. – Up to a total of 14 operation and maintenance vessels on site at any one time (four CTVs/workboats, two jack-up vessels, two cable repair vessels, three Service Operation Vessels (SOV) or similar and three excavators/backhoe dredgers). • Vessel movements. – Up to 77 operation and maintenance vessel movements (return trips) each year (42 CTVs/workboats, three jack-up vessels, four cable repair vessels, 20 SOV or similar and eight excavators/backhoe dredgers). **Decommissioning phase** • Vessels used for a range of decommissioning activities such as removal of cables. Sound from vessels assumed to be consistent with the vessel activity described for the construction phase above.	

Impact	Phase[a]			Maximum design scenario	Justification
	C	O	D		
Increased SSCs and associated sediment deposition.	✓	✓	✓	**Construction phase** <u>Site preparation:</u> Sandwave clearance of up to 1,426,800 m^3 undertaken over 21 months (concurrent site preparation and construction scenario) • Morgan offshore export cable: sandwave clearance along 9% of 400 km of export cable length, with a width of 60 m and a maximum depth of 5 m. This equates to a total spoil volume of 1,080,000 m^3 associated with the cable corridor. • Morecambe offshore export cable: sandwave clearance along 9% of 84 km of export cable length, with a width of 48 m, to a maximum depth of 5 m. This equates to a total spoil volume of 346,800 m^3. • Removal of up to 28 km of disused cables. <u>Cable installation:</u> Total spoil volume of up to 2,178,000 m^3 for 484 km of cable installed over 18 months (concurrent construction scenario): • Morgan Offshore Wind Project Offshore export cables: Installation via trenching of up to 400 km of cable with a trench width of up to 3 m and a depth of up to 3 m. Total spoil volume of 1,800,000 m^3. • Morecambe Offshore Windfarm: Installation of up to 84 km of cable with a trench width of up to 3 m and a depth of up to 3 m. Total spoil volume of 378,000 m^3. **Operation and maintenance phase** • Project lifetime of 35 years. • Subtidal export cables. – One repair event for each of the six export cables (four Morgan cables and two Morecambe cables) every 10 years (21 repair events in total –	**Construction phase** <u>Site preparation.</u> • The volume of material to be cleared from individual sandwaves will vary according to the local dimensions of the sandwave (height, length and shape) and the level to which the sandwave must be reduced. Sandwaves are most prevalent within the Morgan Offshore Wind Project: Generation Assets where sandwave heights can be as great as 5 m at the bedforms crest. Given updated analysis of bedforms and morphology within the Offshore Order Limits, sandwave clearance values used within the ES have been significantly reduced from those used in PEIR. • Site clearance activities may be undertaken using a range of techniques, with the suction hopper dredger resulting in the greatest increase in suspended sediment and largest plume extent as material is released near the water surface during the disposal of material. • Boulder clearance activities will result in minimal increases in SSCs and have therefore not been considered in the assessment.

Impact	Phase[a]			Maximum design scenario	Justification
	C	O	D		
				– seven events in total for Morecambe and 14 events in total for Morgan) affecting up to 4 km per repair event. – Intertidal export cable repair of up to 2.4 km every 10 years for Morecambe and 1 km every 10 years for Morgan. • Subtidal export cable reburial of approximately 4 km per Morgan and 1.7 km per Morecambe of cable in one event every five years (seven reburial events in total for Morgan, and seven reburial events in total for Morecambe). **Decommissioning phase** • All export cables will be removed and disposed of onshore. • Cable protection will remain *in situ*.	• The scenario assessed relates to the largest potential volume of material related to site preparation activities. **Cable installation.** • Cable routes inevitably include a variety of seabed material and in some areas 3 m depth may not be achieved or may be of a coarser nature which settles in the vicinity of the cable route. The assessment therefore considers the upper bound in terms of suspended sediment and dispersion potential assuming a trench with 'v' shape cross section. • Cables may be buried by ploughing, trenching or jetting with jetting mobilising the greatest volume of material to increase SSCs. • Although open-cut trenching represents the MDS, cable installation within the Intertidal Infrastructure Area may require the use of HDD for Landfall. In the case that trenchless techniques are used, the volume of bentonite released would be controlled and mitigated using sheet piling to contain drilling fluids. This would occur for each of the six exit pits and therefore is limited to six occasions, with the bulk of material released on the initial punchout.

Impact	Phase[a]			Maximum design scenario	Justification
	C	O	D		
					• Cable installation for the Ribble Estuary crossing will be based on the use of trenchless techniques, with all activities undertaken bank to bank, with no interaction with the intertidal or subtidal environment (CoT90, **Table 3.12**). • The concurrent construction scenario is included as the maximum design scenario as this has the potential to result in the greatest increase in suspended sediments. **Operation and maintenance phase** • The greatest foreseeable number of cable reburial and repair events is considered to be the MDS for sediment dispersion. **Decommissioning phase** • The removal of cables may be undertaken using similar techniques to those employed during installation, therefore the potential increases in SSC and deposition would be in-line with the construction phase.
Long term habitat loss.	✓	✓	✓	**Construction and operation and maintenance phases** Up to 576,500 m^2 of long term habitat loss over the lifetime of the Transmission Assets. • Presence of cable protection: up to 484,000 m^2 of habitat loss comprising:	Maximum length of cables and cable protection resulting in greatest extent of habitat loss. Construction scenarios have no influence on the maximum design scenario of this impact as effects will primarily occur

Impact	Phase[a]			Maximum design scenario	Justification
	C	O	D		
				– Morgan offshore export cable protection: 400,000 m² from cable protection associated with up to 10% of the 400 km of Morgan export cables (with a width of 10 m); and – Morecambe offshore export cable protection: 84,000 m² from cable protection associated with up to 10% of the 84 km of Morecambe export cables (with a width of 10 m). • Presence of cable crossing protection: up to 92,500 m² of habitat loss comprising: – Morgan cable protection for cable crossings for offshore export cables: 65,500 m² from 41 crossings (each up to 50 m in length and 30 m in width); – Morecambe cable protection for cable crossings for offshore export cables: 27,000 m² from six crossings (each up to 50 m in length and 20 m in width). • Operational phase up to 35 years. **Decommissioning phase** Up to 576,500 m² of permanent subtidal habitat loss due to cable protection left *in situ* post decommissioning.	during the operation and maintenance phase. MDS for decommissioning (and permanent habitat loss following decommissioning) assumes removal of all cables, with greatest area of cable protection to be left *in situ*; if any additional infrastructure is decommissioned, this will result in a reduced area of permanent habitat loss.
EMF from subsea electrical cabling.	x	✓	x	**Operation and maintenance phase** Presence of offshore export cables. • Export cables: up to 484 km of 220 kV or 275 kV High Voltage Alternating Current (HVAC) cables. – Morgan export cables: 4 x 100 km (400 km total) of 220 kV HVAC cables – Morecambe export cables: 2 x 42 km (84 km total) of 220 kV or 275 kV HVAC cables • Minimum burial depth 0.5 m. • Up to 10% of Morgan export cables and 10% of Morecambe export cables may require additional cable protection.	Maximum length of offshore export cable route and minimum burial depth (the greater the burial depth, the greater the distance between the EMF source and the receptor, reducing the potential for exposure to receptors by enhanced EMFs).

Impact	Phase[a]			Maximum design scenario	Justification
	C	O	D		
				• Cable protection: cables will also require cable protection at asset crossings (up to 41 crossings for the Morgan export cables and up to six cable crossings for the Morecambe export cables). Operation and maintenance phase of up to 35 years.	
Introduction and colonisation of hard substrata.	✓	✓	✓	**Construction and operation and maintenance phase** Introduction of up to 576,500 m^2 of artificial structures over the 24-month (sequential) construction phase, remaining for the operational lifetime of the Transmission Assets comprising: • Cable protection: up to 484,000 m^2 from presence of cable protection associated with up to 484 km of offshore export cables: – assumes up to 10% of Morgan export cables may require protection resulting in creation of 400,000 m^2; and – Assumes up to 10% of Morecambe export cables may require protection resulting in creation of 84,000 m^2. • Cable crossing protection: Up to 92,500 m^2 from presence of cable protection for cable crossings. – Up to 41 crossings for each of the Morgan export cables (each up to 50 m in length and 30 m in width). – Up to six crossings for each of the Morecambe export cables (each up to 50 m in length and 20 m in width). Operational phase up to 35 years. **Decommissioning phase** • Up to 576,500 m^2 of artificial structures remaining post-decommissioning due to cable protection being left *in situ*.	Maximum length of cables and cable protection resulting in greatest surface area for colonisation. The maximum habitat creation from the presence of cable protection and cable crossing protection.
Injury to basking shark due to increased risk of collision with vessels.	✓	✓	✓	**Construction phase** The MDS as described above for vessel underwater sound from all other activities during construction phase applies. **Operation and maintenance phase**	MDS as per vessel underwater sound from all other activities impact above.

Impact	Phase[a]			Maximum design scenario	Justification
	C	O	D		
				The MDS as described above for vessel underwater sound from all other activities during operation and maintenance phase applies. **Decommissioning phase** The MDS as described above for vessel underwater sound from all other activities during decommissioning phase applies.	
Disturbance/remobilisation of sediment-bound contaminants.	✓	✓	✓	**Construction phase** The MDS as described above for increased SSC and associated deposition during the construction phase applies. **Operation and maintenance phase** The MDS as described above for increased SSC and associated deposition during the operation and maintenance phase applies. **Decommissioning phase** The MDS as described above for increased SSC and associated deposition during the decommissioning phase.	MDS as per increased SSCs and associated deposition impact above.

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

3.10 Assessment methodology

3.10.1 Overview

3.10.1.1 The approach to determining the significance of effects is a two-stage process that involves defining the magnitude of the impact and the sensitivity of the receptor. This section describes the criteria applied in this chapter to assign values to the magnitude of impacts and the sensitivity of the receptors. The terms used to define magnitude and sensitivity are based on those which are described in further detail in Volume 1, Chapter 5: Environmental assessment methodology of the ES.

3.10.2 Receptor sensitivity/value

3.10.2.1 The criteria for defining sensitivity in this chapter are outlined in **Table 3.14** below.

Table 3.14: Sensitivity criteria

Sensitivity	Definition
Very High	Very high importance and rarity, international and national scale and high vulnerability and low to no recoverability.
High	High importance and rarity, regional scale and high vulnerability and low to no ability to recover.
Medium	High or medium importance and rarity, international and national scale and medium vulnerability and medium recoverability. High or medium importance and rarity, regional scale and medium to high vulnerability and low recoverability. High or medium importance and rarity, local scale and high vulnerability and no ability to recover.
Low	Low or medium importance and rarity, international and national scale and low vulnerability and high recoverability. Low or medium importance and rarity, regional scale and low vulnerability and medium to high recoverability. Low or medium importance and rarity, local scale and medium to high vulnerability and low recoverability.
Negligible	Very low importance and rarity, local scale and low vulnerability and medium to high recoverability. No vulnerability to impacts regardless of value/importance.

3.10.3 Magnitude of impact

3.10.3.1 The criteria for defining magnitude in this chapter are outlined in **Table 3.15** below.

Table 3.15: Magnitude of impact criteria

Magnitude of impact		Definition
High	Adverse	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements.
	Beneficial	Large scale or major improvement or resource quality; extensive restoration or enhancement; major improvement of attribute quality.
Medium	Adverse	Loss of resource, but not adversely affecting the integrity; partial loss of/damage to key characteristics, features or elements.
	Beneficial	Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality.
Low	Adverse	Some measurable change in attributes, quality or vulnerability, minor loss or, or alteration to, one (maybe more) key characteristics, features or elements.
	Beneficial	Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of negative impact occurring.
Negligible	Adverse	Very minor loss or detrimental alteration to one or more characteristics, features or elements.
	Beneficial	Very minor benefit to, or positive addition of one or more characteristics, features or elements.
No change		No loss or alteration of characteristics, features or elements; no observable impact in either direction.

3.10.4 Significance of effect

3.10.4.1 The significance of the effect upon fish and shellfish ecology has been determined by taking into account the sensitivity of the receptor and the magnitude of the impact. The method employed for this assessment is presented in **Table 3.16**. Where a range of significance levels is presented, the final assessment for each effect is based upon expert judgement.

3.10.4.2 In all cases, the evaluation of receptor sensitivity, impact magnitude and significance of effect has been informed by professional judgement and is underpinned by narrative to explain the conclusions reached.

3.10.4.3 For the purpose of this assessment, any effects with a significance level of minor or less are not considered to be significant in terms of the EIA Regulations.

Table 3.16: Assessment matrix

Sensitivity of receptor	Magnitude of impact			
	Negligible	**Low**	**Medium**	**High**
Negligible	Negligible	Negligible or Minor	Negligible or Minor	Minor
Low	Negligible or Minor	Negligible or Minor	Minor	Minor or Moderate
Medium	Negligible or Minor	Minor	Moderate	Moderate or Major
High	Minor	Minor or Moderate	Moderate or Major	Major
Very High	Minor	Moderate or Major	Major	Major

3.10.4.4 The definitions for significance of effect levels are described as follows.

- Major: These beneficial or adverse effects are considered to be very important considerations and are likely to be material in the decision-making process. These effects are generally, but not exclusively, associated with sites or features of international, national or regional importance that are likely to suffer a most damaging impact and loss of resource integrity. However, a major change in a site or feature of local importance may also enter this category.
- Moderate: These beneficial or adverse effects have the potential to be important and may influence the key decision-making process. The cumulative effects of such factors may influence decision-making if they lead to an increase in the overall adverse or beneficial effect on a particular resource or receptor.
- Minor: These beneficial or adverse effects are generally, but not exclusively, raised as local factors. They are unlikely to be critical in the decision-making process but are important in enhancing the subsequent design of the project.
- Negligible: No effects or those that are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error.

3.10.5 Assumptions and limitations of the assessment

3.10.5.1 The data sources used in this chapter are detailed in **section 3.6.1** and Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES. This largely comprises a desk-based assessment of the study area, although the desktop data used is the most up to date publicly available information which can be obtained from the applicable data sources as cited. Data that has been collected is based on long term existing literature and survey datasets (including scientific literature, grey literature and commercial fisheries information). Recent literature and annual survey data within the study area are used to ensure that the baseline characterisation is up to date and in line with regional trends. In addition, consultation with stakeholders and identification of habitats which may support fish and shellfish species were used to ensure all relevant IEFs were appropriately identified and assessed within the defined study area and carried forward into the EIA.

3.10.5.2 Site-specific surveys were carried out for benthic ecology requirements (Volume 2, Chapter 2: Benthic subtidal and intertidal ecology of the ES) and were used to determine suitable herring spawning and sandeel habitats within the Offshore Order Limits. While these may not provide the same information as targeted fish and shellfish surveys, the collected data was reviewed alongside wider long term existing datasets and stakeholder consultation (including commercial fisheries organisations) to characterise the study area to a level of detail appropriate for the assessment of impacts. Similarly, the data available from Coull *et al.* (1998), Ellis *et al.* (2012) and Aires *et al.* (2014) provide a general overview of spawning grounds and times for many species in the area, but might not fully represent current habitat preferences alone. As such these have been supplemented with the most up to date information available (e.g., NINEL herring larvae surveys, AFBI and Bangor University scallop stock assessment surveys and site-specific seabed sediment data) during the desk-based study to best overcome this limitation and ensure a robust EIA.

3.10.5.3 One other limitation identified was that the NINEL herring larvae survey was benchmarked in 2012 and no longer used in Irish Sea herring stock assessments after that point, due to underestimating spawning populations significantly compared to higher resolution acoustic data. However, this data continued to be collected using the same methodology and was still mapped and assessed within Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES due to being a useful indicator of the spatial distribution of the spawning population, alongside Coull *et al.* (1998), Ellis *et al.* (2012) and Aires *et al.* (2014). The underestimation was dealt with through incorporation of recent acoustic survey and stock assessment data (ICES, 2021, ICES 2022), which is further examined in Volume 2, Annex 3.1: Fish and shellfish technical report of the ES and should not represent a significant impact on the predictability of the EIA.

3.11 Assessment of effects

3.11.1 Introduction

3.11.1.1 The impacts arising from the construction, operation and maintenance, and decommissioning phases of the Transmission Assets have been assessed. The impacts arising from all phases of the Transmission Assets are listed in **Table 3.13**, along with the MDS against which each impact has been assessed.

3.11.1.2 A description of the likely effect on receptors caused by each identified impact is given below.

3.11.2 Temporary habitat loss/disturbance

3.11.2.1 The construction, operation and maintenance, and decommissioning activities for the offshore export cables may lead to temporary habitat loss/disturbance. The MDS is represented by jack-up events, offshore cable installation and repair, sandwave clearance, anchor placement, pre-lay preparation (e.g. boulder and debris clearance), UXO clearance and cable removals and is summarised in **Table 3.13**.

Construction phase

Sensitivity of the receptor

Marine species

3.11.2.2 In general, mobile fish species can avoid areas subject to temporary habitat disturbance (Ecological Marine Unit (EMU), 2004). The most vulnerable species are likely to be shellfish which are much less mobile than fish, with fragile slow-recruiting species being most highly impacted by short term disturbance events (MacDonald *et al.,* 1996). For example, egg-bearing European lobster are thought to be more restricted to an area based on a mark and recapture study in Norway which showed that 84% of berried female European lobster remained within 500 m of their release site (Agnalt *et al.,* 2007). Evidence from other stocks around the world are less clear, with limited movement recorded for some stocks and long-distance migrations documented for others (Campbell and Stasko,1985; Comeau and Savoie, 2002).

3.11.2.3 Indirect effects on fish and shellfish species also include loss of feeding habitat and reduced prey availability. For example, crab and other crustaceans and small benthic fish species (as well as other benthic species; see Volume 2, Chapter 2: Benthic subtidal and intertidal ecology of the ES) are considered important prey species for larger fish. However, since this impact arising from construction is predicted to affect only a small proportion of seabed habitats in the study area at any one time, with similar habitats (and prey species) occurring throughout the study area (see Volume 2, Chapter 2: Benthic subtidal and intertidal ecology of the ES for habitat distributions and extents), these effects are likely to be limited and reversible. Conversely, benthic disturbance during the construction phase will also expose benthic infaunal species from the sediment (see Volume 2, Annex 2.1: Benthic subtidal and intertidal ecology technical report of the ES), potentially offering foraging opportunities to some opportunistic scavenging fish and shellfish species immediately after completion of works. The implications of changes in fish and shellfish prey species in the short term are also discussed for higher trophic level receptors (i.e., marine mammals and birds) in Volume 2, Chapter 4: Marine mammals of the ES and Volume 2, chapter 5: Offshore ornithology of the ES, respectively.

3.11.2.4 With 14,805,472 m^2 of seabed disturbed in the Transmission Assets due to seabed preparation and cable installation, the disturbance is minimal (2.34%) of the Offshore Order Limits, in comparison to the size of some spawning grounds, which cover large areas across the region beyond the study area (see Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES) and, therefore, spawning potential of the wider populations is not predicted to be impacted.

3.11.2.5 Whilst the nursery grounds of many species overlap with the Transmission Assets, the areas impacted by construction disturbance are small, relative to the size of the entire main nursery grounds, which extend around much of the north English, Irish and Scottish coast.

3.11.2.6 Juvenile stocks of fish are less sensitive to physical disturbance than spawning adults, as they have high levels of adaptability and tolerance to transient stress and disturbance. Furthermore, based on their extensive occurrence within the wider geographic context, any potential disturbance to these areas, due to construction operations, is not predicted to have a significant impact on future local fish populations.

3.11.2.7 Within the Irish Sea, the year one post-construction monitoring of the Walney Wind Farm Extension found a significantly degraded benthic and demersal fish and shellfish community overall compared to pre-construction reference sites within the Walney Array Area, but no significant difference between the communities associated with the pre-construction and post-construction transmission assets (CMACS, 2012). This pattern was repeated in the year three post-construction survey CMACS (2014a), but with a smaller difference between pre and post-construction studies than year one post-construction, showing a slow trend for recovery to baseline conditions, and relatively little overall impact.

3.11.2.8 The recoverability and rate of recovery of an area after large scale seabed disturbance (e.g., dredging or trawling activities) is linked largely to the substrate type (Newell *et al.,* 1998; Desprez, 2000), with recovery rates improved by the presence of conspecifics within a radius of 6 km following habitat disturbance (Lambert *et al.,* 2014), which applies to some species of interest within the study area (see Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES for detailed habitat distributions and spawning grounds). Gravelly and sandy habitats, similar to those found in the study area, have been shown to return to baseline species abundance after approximately five to 10 years (Foden *et al*., 2009), depending on replenishment rates related to tidal stress, currents and availability and transference of conspecifics from less impacted to more impacted environments.

Shellfish species

3.11.2.9 A number of commercially important shellfish species such as edible crab, European lobster, *Nephrops*, king and queen scallop, whelk, squid and velvet swimming crab are known to inhabit the study area. The total habitat loss/disturbance footprint represents a relatively small proportion of the area of the Offshore Order Limits (2.34%) and only a small proportion of this area would be affected at any one time with relatively rapid recovery of sediments following these disturbances based on analysis of recovery trends at other offshore wind farms (RPS, 2019). Following this, recovery of associated communities is also expected (see Volume 2, Chapter 2: Benthic subtidal and intertidal ecology of the ES) including shellfish populations moving back into these impacted areas.

3.11.2.10 King and queen scallop are known to be present within the study area and are targeted by commercial fisheries activities (see Volume 2, Chapter 6: Commercial fisheries chapter of the ES). Scallop are predominantly sessile organisms, however, they do have the ability to swim, which is ordinarily used as an escape response, although limited in distance (Marshall and Wilson, 2008). It has been documented that scallop have been able to move up to 30 m from a release site during a tagging study (Howell and Fraser, 1984). This response may allow slightly improved resilience to temporary habitat loss/disturbance compared to other sessile organisms, by being able to avoid areas of direct disturbance and relocate to areas nearby within approximately 30 m. Scallop tend to occur in aggregations as their larval distribution is reliant on relatively unpredictable hydrographic features (Brand, 1991, Delargy*,* 2019). As such, scallop are expected to continue spawning outside the project boundaries and within unimpacted areas of the study area. Given that suitable habitat for settlement will remain following cessation of construction, it is predicted that scallop will continue to be recruited into the Transmission Assets. Therefore, scallop will likely recover from any disturbance due to short term habitat loss. This is supported by the MarLIN sensitivity assessment for substratum loss (Marshall and Wilson, 2008) which concluded king scallop have a high recovery potential (i.e., recovery within months, with full recovery in a small number of years).

3.11.2.11 Larger crustacea (e.g., *Nephrops* and European lobster) are classed as equilibrium species (Newell *et al.,* 1998) and are only capable of recolonising an area once the original substrate type has returned. The sensitivity of these fish and shellfish IEFs is therefore higher than for smaller benthic organisms which move in and colonise new substrate immediately after the effect. Therefore, although recovery of benthic assemblages may occur over relatively fast timescales (i.e., within one to two years; see Volume 2, Chapter 2: Benthic subtidal and intertidal ecology of the ES), recovery of the equilibrium species may take up to ten years in some areas of coarse sediments (Phua *et al.,* 2002). It is notable that the absence of larger crustacean and flatfish species due to habitat disturbance can increase overall benthic abundance, due to a lowered rate of predation (Skold *et al.,* 2018), suggesting resilience among smaller fish and shellfish species which could contribute to a minor short term change in ecosystem function, which is likely to recover to the baseline in the long term.

3.11.2.12 Construction activities (including offshore export cable installation) within the study area may also impact on undetermined intensity spawning and nursery habitats for *Nephrops* (Coull *et al.,* 1998), as these areas overlap with a substantial portion of the study area (Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES) and any impact will affect individual *Nephrops* and their habitats directly. Larval settlement will increase the rate of recovery in an area (Phua *et al.,* 2002), with shellfish (*Nephrops*) spawning and nursery habitats in the vicinity of study area (see Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES) potentially increasing the rate of recovery in disturbed areas.

3.11.2.13 A recent study undertaken during construction of the Westermost Rough Offshore Wind Farm located on the north east coast of England, within a European lobster fishing ground, found that the size and abundance of European lobster individuals increased following temporary closure or the area for construction of the windfarm. This study indicates that the activities associated with construction of the wind farm, which included installation of wind turbines and cables, did not negatively impact on resident European lobster populations and instead allowed some respite from fishing activities for a short time-period before reopening following construction (Roach *et al.,* 2018).

3.11.2.14 Direct damage from the Transmission Assets could potentially impact immobile shellfish or shellfish with lower mobility (such as scallop) for those activities associated with temporary habitat loss. However, the Offshore Order Limits has not been identified as an important area for commercially important shellfish species and no rare species of shellfish have been identified in the study area (see Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES). Mobile species, even those which are slow-moving, are considered likely to move away from the disturbance area immediately after the initial disturbance event (e.g., vibration, underwater sound, suspended sediments) and therefore most individuals are unlikely to be injured by direct damage from infrastructure installation and other activities associated with the Transmission Assets. For immobile species, direct damage would only arise within the limited direct footprint of the activities which represent a small proportion of available similar habitat within the study area resulting in a limited potential number of injuries and mortalities.

3.11.2.15 No *Nephrops* nor their preferred biotope were identified in the Offshore Order Limits during site-specific survey in 2022 (Gardline Limited, 2023) and few *Nephrops* were observed in the west section of the Offshore Order Limits in 2021 (Gardline Limited, 2022). Considering that the Offshore Order Limits is unlikely to be an important area for *Nephrops* and that *Nephrops* are a mobile species, despite living in burrows, direct damage associated with Transmission Assets activities associated with temporary habitat loss are unlikely to lead to high levels of injury or mortality.

Fish species

3.11.2.16 The fish species within the study area likely to be most sensitive to temporary seabed habitat loss are those species that spawn on or near the seabed (e.g., herring, sandeel and elasmobranchs, including spotted ray). Other species are less likely to be impacted by temporary habitat loss from construction activities, especially most highly mobile elasmobranch species. Spotted ray (and other ray species), which spawn in demersal habitats, have broadscale low intensity spawning grounds overlapping the Transmission Assets (Ellis *et al.,* 2012) and these species have significant amounts of other habitat available within the rest of the study area, suggesting resilience in the local population to temporary habitat loss. In addition, due to the swimming capacities of all fish IEFs and the different water zones used (e.g., demersal, pelagic), direct injuries to individuals through activities associated with temporarily habitat loss and disturbance would be limited, as fish would likely move away once material or infrastructure are introduced into the water column. Further, with the limited footprint of the activities and infrastructure installed at any one time, the likelihood of direct injury and/or mortality is considered negligible at both individual and population scale.

Herring and sandeel

3.11.2.17 Of the IEF fish species that spawn on or near the seabed, sandeel and herring are known to spawn at low to high intensities within the study area (see Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES). Therefore, any significant seabed disturbance activities carried out during spawning periods may result in mortality of eggs and reduced spawning opportunity due to removal of suitable habitat. Further, physical disturbance to sandeel habitats may also lead to direct effects on adult and juvenile sandeel (e.g., increased mortality), where individuals are not able to colonise viable sandy habitats in the immediate vicinity, or where habitats may be at carrying capacity (Wright *et al.,* 2000). It has been noted that sandeel species have high sensitivity to the impact of direct physical disturbance (Wright *et al.,* 2000). Sandeel may also be particularly vulnerable during their winter hibernation period when they bury themselves in the seabed substrates and are therefore less mobile.

3.11.2.18 However, the Offshore Order Limits was found to be largely unsuitable for both herring and sandeel, with patches of marginal and preferred habitats mostly restricted to the Generation Assets areas of the Offshore Order Limits, and therefore effects of habitat loss/disturbance on these species are expected to be limited within the Transmission Assets, given the abundance of similar substrate types and the extensive nature of fish spawning grounds across the wider study area. Based on this, the potential for direct damage to sandeel, which burrow into the sediment, that could lead to injury or mortality is considered negligible, especially given the footprint of the Transmission Assets compared to the available habitat in the vicinity for this species group to inhabit.

3.11.2.19 Recovery of sandeel populations would be expected following construction activities, with the rate of recovery dependent on the recovery of sediments to a condition suitable for sandeel recolonisation. Effects of offshore wind farm construction (Jensen *et al*., 2004) and operation and maintenance (i.e., post-construction) activities (van Deurs *et al*., 2012) on sandeel populations have been examined through short term and long term monitoring studies at the Horns Rev offshore wind farm in the Baltic Sea, Denmark. These monitoring studies have shown that offshore wind farm construction and operation and maintenance activities have not led to significant adverse effects on sandeel populations and that recovery of sandeel occurs quickly following construction activities.

3.11.2.20 The recovery potential of sandeel populations can also be inferred from a study by Jensen *et al*. (2010), which found sandeel populations mix within fishing grounds to distances of up to 28 km. This suggests that some recovery of adult populations is likely following construction activities, with adults recolonising suitable sandy and gravelly substrates where available from adjacent un-impacted habitats. Recovery may also occur through larval recolonisation of suitable sandy sediments with sandeel larvae likely to be distributed throughout the study area during spring months following spawning in winter/spring (see Ellis *et al*., 2012; and Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES).

3.11.2.21 A recent monitoring study conducted at the Beatrice Offshore Wind Farm completed a post construction sandeel survey where sandeel abundance were compared pre- and post construction (Beatrice Offshore Wind Limited; BOWL, 2021a). The results showed that sandeel abundance either increased or remained at similar levels when comparing abundance from 2014 to 2020, with offshore construction commencing in April 2017. The study concluded that there was no evidence that the construction of Beatrice Offshore Wind Farm resulted in adverse impacts on the local sandeel population. This study builds on previous work conducted by Stenberg *et al*. (2011) which concluded that the construction of the Horns Rev 1 Offshore Wind Farm posed neither a threat nor direct benefit to sandeel over a seven-year period.

3.11.2.22 The conclusion drawn at Beatrice Offshore Wind Farm should be viewed in the context of an interpreted general increase in sandeel populations in the area (based on ICES set Total Allowable Catch (TAC) limits; note that TAC should be interpreted with caution as it does not always follow stock trends or scientific advice) alongside an increase in bycatch abundance from sandeel dredging, which may indicate the Beatrice Offshore Wind Farm site was generally healthier in 2020 than it was in 2014 (BOWL, 2021a).

3.11.2.23 Infrastructure installation will not occur simultaneously across the entire Offshore Order Limits during the construction phase (although some concurrent activities may occur) and once construction/infrastructure installation works are complete in a specific area, recovery of sediments and associated communities are expected to begin soon after as works progress into the next areas. Drawing on information from the monitoring studies above, it is highly likely that the displaced individuals will repopulate these previously disturbed areas, with recovery occurring throughout the construction phase rather than once the entire construction phase is completed.

3.11.2.24 As effects on sandeel (and other prey species) are predicted to be limited in extent (particularly in the context of available habitats in the study area), temporary and reversible, with recovery of sandeel populations occurring during and post-construction, species reliant on sandeel and other small prey species (e.g., sea trout and cod) would similarly not be expected to be significantly affected. The implications of changes in fish and shellfish prey species are also discussed for higher trophic level receptors (i.e., marine mammals and birds) in Volume 2, Chapter 4: Marine mammals of the ES and Volume 2, Chapter 5: Offshore ornithology of the ES.

3.11.2.25 Most fish and shellfish ecology IEFs in the study area are deemed to be of low vulnerability, high recoverability and local to national importance. The sensitivity of the receptor is **low**.

3.11.2.26 King and queen scallop are deemed to be of medium vulnerability, high recoverability and of regional importance. The sensitivity of the receptor is **low**.

3.11.2.27 European lobster and *Nephrops* are deemed to be of high vulnerability, medium to high recoverability and of regional importance. The sensitivity of these fish and shellfish IEFs is therefore **medium**.

3.11.2.28 Sandeel are deemed to be of high vulnerability, high recoverability and of regional importance. The sensitivity of sandeel is therefore **medium**.

3.11.2.29 Herring are deemed to be of high vulnerability, medium recoverability and of national importance. The sensitivity of herring to this impact is therefore **high**.

Diadromous species

3.11.2.30 Diadromous fish species are highly mobile and therefore are generally able to avoid areas subject to temporary habitat loss. Diadromous species that are likely to interact with the study area are only likely to do so by passing through the area during migrations to and from rivers located on the west coast of England and Wales, such as to rivers with designated sites with diadromous fish species listed as qualifying features (see Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES). The habitats within the study area are not expected to be particularly important for diadromous fish species and therefore habitat loss during the construction phase is unlikely to cause any direct impact to diadromous fish species or affect migration to and from rivers.

3.11.2.31 Indirect impacts on diadromous fish species may occur due to impacts on prey species, for example larger fish species for sea lamprey and sandeel for sea trout. As outlined for marine species above, the majority of large fish species would be able to avoid habitat loss effects due to their greater mobility but would recover into the areas affected following cessation of construction. Sandeel (and other less mobile prey species) would be affected by temporary habitat loss, although recovery of this species is expected to occur quickly as the sediments recover following installation of infrastructure and adults recolonise and also via larval recolonisation of the sandy sediments, which are known to occur throughout the study area and are known to recover quickly following cable installation (RPS, 2019).

3.11.2.32 Diadromous fish species are deemed to be of low vulnerability, high recoverability and national to international importance. However, based upon the migratory traits of the diadromous fish utilising the area and the sensitivity information presented herein, the probability of interacting with the Transmission Assets in such a way as to result in adverse effects is considered low. The sensitivity of the receptor is **negligible**.

Magnitude of impact

3.11.2.33 The installation of the Transmission Assets infrastructure within the study area will lead to temporary habitat loss/disturbance. The MDS accounts for up to 14,805,472 m^2 of temporary subtidal habitat loss/disturbance and up to 151,632 m^2 of temporary intertidal habitat loss/disturbance during the construction phase (**Table 3.13**). The spatial area of temporary subtidal habitat loss/disturbance equates to approximately 2.34% of the Offshore Order Limits overall, although only a small proportion of this will be impacted at any one time.

3.11.2.34 The depressions resulting from jack-up events will infill over time, although these may remain on the seabed for a number of years, as demonstrated by monitoring studies of UK offshore wind farms (BOWind, 2008; EGS, 2011). Monitoring at the Barrow offshore wind farm showed depressions were almost entirely infilled 12 months after construction (BOWind, 2008). Monitoring at the Lynn and Inner Dowsing offshore wind farm also showed some infilling of the footprints, although the depressions were still visible two years post-construction (EGS, 2011). In areas where mobile sands are present, such as in the Transmission Assets, jack-up depressions are likely to be temporary features which will only persist for a period of months to a small number of years, with this more likely given the relatively small overall area of predicted jack-up footprints (192 m^2, **Table 3.13**). Specifically, evidence from the three years post-construction survey of the nearby Walney Wind Farm Extension showed that fine sands and muds in this area were highly mobile and likely to return to a uniform relatively undisturbed habitat within this short period of time (CMACS, 2014a). These timeframes, relative to the maximum 30-month construction period and overall lifetime of the Transmission Assets, are considered to be short, and indicate relatively rapid recovery to otherwise undisturbed environmental conditions.

3.11.2.35 Cable installation (including pre-lay preparation such as boulder and sandwave clearance) of offshore export cables may result in up to 11,331,680 m^2 temporary habitat loss/disturbance. The components of this activity include the installation of 484 km of offshore export cable (assuming 100% of the cable is buried). Seabed preparation activities are expected to be required for offshore export cables and, for the purpose of the MDS, boulder clearance has been expected to occur for up to 91% of Morgan offshore export cables and 91% of Morecambe offshore export cables. Sandwave clearance is expected to be required for up to 9% of Morgan offshore export cables and 9% of Morecambe offshore export cables in line with the MDS.

3.11.2.36 Sandwave clearance deposition may affect up to 2,853,600 m^2 of temporary habitat loss/disturbance as a result of the deposition of 1,426,800 m^3 of sandwave clearance material associated with offshore export cable corridor. The total footprint of seabed affected has been calculated, for the purposes of modelling the MDS, assuming a mound of uniform thickness of 0.5 m height, although it should be noted that real mounds may be taller and more unevenly distributed. Any mounds of cleared material will, however, erode over time and displaced material will re-join the natural sedimentary regime, gradually reducing the size of the mounds.

3.11.2.37 Anchor placement may result in up to 60,000 m^2 of habitat disturbance from one 100 m^2 anchor placement event every 500 m during offshore export cable installation.

3.11.2.38 Additionally, the removal of disused cables within study area may result in up to 560,000 m^2 of temporary habitat loss/disturbance from the removal of 28 km of disused cables.

3.11.2.39 The clearance of up to 25 UXOs within the Offshore Order Limits is also considered. Studies undertaken for the Norfolk Vanguard offshore wind farm (Ordtek, 2018) considered the likely crater sizes for a range of UXOs. For the smallest UXO considered (55 kg, which is greater than the minimum considered within the Offshore Order Limits), the likely diameter of the crater was estimated at 8.91 m and a likely depth of 1.3 m. For a 150 kg UXO (the option most similar to the most likely maximum UXO within the Offshore Order Limits) the likely diameter of the crater was estimated at 12.61 m and a likely depth of 1.8 to 2.8 m. The project is committed to applying low order/low yield techniques where safe and logistically viable to do so (CoT64, **Table 3.12**) and therefore UXO clearance will most likely be within the 20 m of disturbance assumed for cable burial (including boulder clearance) and also the 60m width of disturbance assumed for sandwave clearance. Any craters created during detonation are expected to backfill by natural processes, the speed of which depending on the sediment transport regimes in the area.

3.11.2.40 A recent study reviewed the effects of cable installation on subtidal sediments and habitats, drawing on monitoring reports from over 20 UK offshore wind farms (RPS, 2019). This review showed that sandy sediments recover quickly following cable installation, with trenches infilling quickly following cable installation and little or no evidence of disturbance in the years following cable installation. It also presented evidence that remnant cable trenches in coarse and mixed sediments were conspicuous for several years after installation. However, these shallow depressions were of limited depth (i.e., tens of centimetres) relative to the surrounding seabed, over a horizontal distance of several metres and therefore did not represent a large shift from the baseline environment (RPS, 2019). Remnant trenches (and anchor drag marks) were observed years following cable installation within areas of muddy sand sediments, although these were also found to be relatively shallow features (i.e., a few tens of centimetres).

3.11.2.41 The MDS for this impact is the sequential construction scenario (i.e. offshore construction activities will take place over a maximum of 30 months, noting that there is potential for a gap between the construction periods for the Morgan Offshore Wind Project and the Morecambe Offshore Windfarm). This will reduce the potential temporal overlap between any migratory receptors and the construction activities. It should be noted that the total extent of habitat disturbance is the same for both the concurrent and sequential scenarios.

3.11.2.42 The impact on all fish and shellfish and diadromous fish ecology IEFs, except herring, is predicted to be of local spatial extent (due to the small footprint of the Offshore Order Limits relative to the available habitat within the wider study area), short to medium term duration (up to 30 months of construction), intermittent and of high reversibility. It is predicted that the impact will affect only some of the receptors directly. The magnitude is therefore **low**.

3.11.2.43 For herring, the impact is predicted to be of local spatial extent, short to medium term duration, intermittent and of high reversibility. It is predicted that the impact will affect the receptor directly. However, due to the limited suitable spawning substrates directly overlapping the Transmission Assets and the core herring spawning ground being located outside and to the north west of the Offshore Order Limits, the magnitude is therefore considered to be **negligible** for this receptor.

Significance of the effect

Marine species

3.11.2.44 Overall, for most fish IEFs, the magnitude of the impact is **low** and the sensitivity is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.2.45 For king and queen scallop, the sensitivity of the receptor is **low** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.2.46 For European lobster and *Nephrops*, the sensitivity of the receptor is **medium** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.2.47 For sandeel, the sensitivity of the receptor is **medium** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.2.48 For herring, the sensitivity of the receptor is **high** and the magnitude of the impact is **negligible**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Diadromous species

3.11.2.49 Overall, the sensitivity of the receptor is **negligible** and the magnitude of the impact is **low**. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This is due to the short term, limited spatial extent of the impact, which is considered unlikely to affect migration to or from key rivers, and the lack of direct impact on freshwater spawning habitats.

Operation and maintenance

Sensitivity of receptor

3.11.2.50 The sensitivity of the fish and shellfish IEFs, for both marine and diadromous species, can be found in the construction phase assessment (**paragraph 3.11.2.2** to **paragraph 3.11.2.32**), ranging from **negligible** to **high** sensitivity and these will equally apply in the operation and maintenance phase.

Magnitude of impact

3.11.2.51 Operation and maintenance activities within the study area will result in temporary habitat loss/disturbance. The MDS accounts for up to

4,397,680 m^2 of temporary subtidal habitat loss/disturbance within this phase and 552,000 m^2 of temporary intertidal habitat disturbance (total of 4,949,680 m^2; **Table 3.13**). This equates to a small proportion (0.73%) of the Offshore Order Limits area. It should also be noted that only a small proportion of the total temporary habitat loss/disturbance is likely to occur at any one time, with the MDS for temporary habitat loss/disturbance spread over the 35-year operational lifetime and therefore individual maintenance activities will be small scale and intermittent events.

3.11.2.52 Offshore export cable remedial burial may also contribute up to 2,716,000 m^2 of temporary habitat loss/disturbance. For Morgan offshore export cables, this value accounts for up to 16 km for reburial events with one event every five years (seven reburial events in total) and up to 4 km for cable repair in one event every 10 years (assuming 20 m width seabed disturbance) for each of the four export cables (14 repair events in total). For Morecambe offshore export cables, repair of up to 4 km of cable in one event every 10 years per offshore export cable (seven repair events in total) is expected and reburial of up to 3.4 km of export cable in one event every five years (seven reburial events in total).

3.11.2.53 The impacts of jack-up vessel activities will be similar to those identified for the construction phase above and will be restricted to cable repair sites, where the spud cans are placed on the seabed, with recovery occurring following removal of spud cans. The spatial extent of this impact is small in relation to the total study area. The repair and reburial of offshore export cables will affect benthic habitats and thus demersal IEFs in the immediate vicinity of these activities, with effects on seabed habitats and associated benthic communities expected to be similar to the construction phase, although much lower magnitude.

3.11.2.54 For most IEFs, the impact is predicted to be of local spatial extent, short term duration, intermittent and of high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore **low**.

3.11.2.55 For herring, the impact is predicted to be of local spatial extent, short term duration, intermittent and of high reversibility. It is predicted that the impact will affect the receptor directly. However, due to the limited suitable spawning substrates directly overlapping the Transmission Assets and the core herring spawning ground being located outside and to the north west of the Offshore Order Limits, the magnitude is therefore, considered to be **negligible** for this receptor.

Significance of effect

Marine species

3.11.2.56 Overall, the sensitivity of most fish and shellfish ecology IEFs is **low** and magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.2.57 For king and queen scallop, sensitivity of the receptor is **low** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.2.58 For European lobster and *Nephrops*, the sensitivity of the receptor is **medium** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.2.59 For sandeel, the sensitivity of the receptor is **medium** and magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.2.60 For herring, the sensitivity of the receptor is **high** and the magnitude of the impact is **negligible**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Diadromous species

3.11.2.61 Overall, the sensitivity of the receptor is **negligible** and the magnitude of the impact is **low**. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This is due to the short term, limited spatial extent of the impact, which is considered unlikely to affect migration to or from key rivers, and the lack of direct impact on freshwater spawning habitats.

Decommissioning

Sensitivity of receptor

3.11.2.62 The sensitivity of the fish and shellfish IEFs, for both marine and diadromous species, can be found in the construction phase assessment (**paragraph 3.11.2.2** to **paragraph 3.11.2.32**), ranging from **negligible** to **high** sensitivity and these will equally apply in the decommissioning phase.

Magnitude of impact

3.11.2.63 Decommissioning activities within the study area will result in temporary habitat loss/disturbance. The MDS for the decommissioning phase assumes disturbance from the removal of up to 484 km of Morgan and Morecambe offshore export cables and that the decommissioning sequence will generally be a reverse of the construction sequence.

3.11.2.64 The extent of temporary habitat disturbance that may occur as a result of decommissioning activities is predicted to be in line with that described for the construction phase in **paragraph 3.11.2.33** to **3.11.2.42**. However on the basis that there will be no requirement for sandwave clearance or pre-lay preparation during decommissioning, the magnitude of the impact is likely to be much lower than during construction.

3.11.2.65 For most IEFs, the impact is predicted to be of local spatial extent, short to medium term duration, intermittent and of high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore **low**.

3.11.2.66 For herring, the impact is predicted to be of local spatial extent, short to medium term duration, intermittent and of high reversibility. It is predicted that the impact will affect the receptor directly. However, due to the limited suitable spawning substrates directly overlapping the Transmission Assets and the core herring spawning ground being located outside and to the north west of the Offshore Order Limits, the magnitude is therefore, considered to be **negligible** for this receptor.

Significance of effect

Marine species

3.11.2.67 Overall, the sensitivity of most fish and shellfish ecology IEFs is **low** and magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.2.68 For king and queen scallop, sensitivity of the receptor is **low** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.2.69 For European lobster and *Nephrops*, the sensitivity of the receptor is **medium** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.2.70 For sandeel, the sensitivity of the receptor is **medium** and magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.2.71 For herring, the sensitivity of the receptor is **high** and the magnitude of the impact is **negligible**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Diadromous species

3.11.2.72 Overall, the sensitivity of the receptor is **negligible** and the magnitude of the impact is **low**. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This is due to the short term, limited spatial extent of the impact which is considered unlikely to affect migration to or from key rivers, and the lack of direct impact on freshwater spawning habitats.

3.11.3 Underwater sound from UXO clearance and geophysical surveys impacting fish and shellfish receptors

3.11.3.1 UXO clearance and geophysical surveys during the construction of Transmission Assets may lead to underwater sound impacting fish and shellfish receptors. The MDS is represented by undertaking UXO detonation and pre-construction geophysical surveys. Geotechnical surveys are also outlined within the MDS, however the source levels are considered to fall within the range of geophysical survey activities, and are therefore not assessed separately herein. The MDS is summarised in **Table 3.13**.

Construction phase

Sensitivity of receptor

3.11.3.2 The following sections apply to marine fish and shellfish species and diadromous fish species, with a summary for each of these receptor groups provided below.

3.11.3.3 Underwater sound can potentially have an adverse impact on fish species ranging from physical injury/mortality to behavioural effects. Peer reviewed guidelines have been published by the Acoustical Society of America and provide directions and recommendations for setting criteria (including injury and behavioural criteria) for fish. The Sound Exposure Guidelines for Fishes and Sea Turtles (Popper *et al*., 2014) are considered most relevant and the best available guidelines for impacts of underwater sound on fish species (see Volume 1, Annex 5.2: Underwater sound technical report of the ES). The Popper *et al*. (2014) guidelines broadly group fish into the following categories according to the presence or absence of a swim bladder and on the potential for that swim bladder to improve the hearing sensitivity and range of hearing.

- Group 1: Fishes lacking swim bladders (e.g., elasmobranchs and flatfish, lamprey). These species are only sensitive to particle motion, not sound pressure and show sensitivity to only a narrow band of frequencies.
- Group 2: Fishes with a swim bladder but the swim bladder does not play a role in hearing (e.g., salmonids and some Scombridae). These species are considered more sensitive to particle motion than sound pressure and show sensitivity to only a narrow band of frequencies.
- Group 3: Fishes with swim bladders that are close, but not connected, to the ear (e.g., gadoids and eels). These fishes are sensitive to both particle motion and sound pressure and show a more extended frequency range than Groups 1 and 2, extending to about 500 Hz.
- Group 4: Fishes that have special structures mechanically linking the swim bladder to the ear (e.g., clupeids such as herring, sprat and shad). These fishes are sensitive primarily to sound pressure, although they also detect particle motion. These species have a wider frequency range, extending to several kHz and generally show higher sensitivity to sound pressure than fishes in Groups 1, 2 and 3.

3.11.3.4 Relatively few studies have been conducted on impacts of underwater sound on invertebrates, including crustacean species and little is known about the effects of anthropogenic underwater sound upon them (Hawkins and Popper, 2016; Morley *et al*., 2013; Williams *et al*., 2015). Therefore, no injury criteria have been developed for shellfish species (Hawkins *et al*., 2014); however, these organisms are expected to be less sensitive than fish species and therefore injury ranges of fish could be conservative estimates for shellfish species (the risk of behavioural effects are discussed further below for shellfish).

3.11.3.5 An assessment of the potential for injury/mortality and behavioural effects to fish and shellfish IEFs with reference to the sensitivity criteria described above is presented in turn below.

Injury

UXO clearance

3.11.3.6 Modelling has been completed for underwater sound associated with UXO clearance, from a realistic worse case high order detonation to low order detonations (e.g., deflagration and the use of clearance shots).

3.11.3.7 The clearance of UXO prior to commencement of construction may result in the detonation of UXO. This activity has the potential to generate some of the highest peak sound pressures of all anthropogenic underwater sound sources (von Benda-Beckman *et al*., 2015) and is considered a high energy, impulsive sound source. The potential effects of this activity will depend upon sound source characteristics, the receptor species, distance from the sound source and sound attenuation within the environment.

3.11.3.8 Potential effects of underwater sound from high order UXO clearance on fish and shellfish IEFs include mortality, physical or auditory injury and/or disturbance depending on the proximity of the individuals to the UXO location and the size of the UXO. Mortality of fish resulting from UXO detonation is usually recorded in close proximity to the detonation location and as such this is expected to be a small-scale impact.

3.11.3.9 PTS ranges for low order, low yield and high order detonations are presented in **Table 3.17.** All UXO injury and disturbance ranges are based on a comparison to the relevant impulsive sound thresholds as set out in **Table 3.18.**

3.11.3.10 Estimates were conservative as the charge is assumed to be freely standing in mid-water, unlike an UXO which would be resting on or partially buried in the seabed, and could potentially be buried, degraded or subject to other significant attenuation. In addition, the explosive material is likely to have deteriorated over time, so maximum sound levels are likely to be over-estimates of true sound level potential.

3.11.3.11 For the purposes of modelling, it has been assumed that the MDS will be clearance of UXO with a NEQ of 907 kg cleared by either low order or high order techniques although clearance of UXO with an NEQ of 130 kg is considered the more likely (common) scenario. Primary mitigation can be employed to reduce the risk of injury by using low order techniques to clear UXOs where possible, noting however, that low order techniques are not always possible and are dependent upon the individual situations surrounding each UXO. Therefore, low order is included in the assessment. An explosive mass of 907 kg (high order explosion) yielded the largest PTS ranges for fish, with the greatest lower injury range of 985 m, however the more common 130 kg charge results in a reduced injury range of 514 m. Further detail on sound modelling of UXO clearance are provided in Volume 1, Annex 5.2: Underwater sound technical report of the ES.

Table 3.17: Injury ranges for all fish groups relating to varying orders of detonation

Detonation size (kg)	PTS range (m)	
	Fish lower range[1]	Fish higher range
Low Order and Low Yield Detonations		
0.08 (donor charge)	44	27
0.5 (clearing shot)	81	49
0.75 (x2)	117	70
0.75 (x4)	147	88
High Order Detonations		
1.2 (disposal donor)	108	65
3.5 (disposal donor)	154	93
25	297	179
130	514	309
907	985	590

1- The lower range and upper range refer to those provided within Volume 1, Annex 5.2: Underwater sound technical report of the ES, based upon the Popper *et al*. (2014) guidance for explosions, where thresholds are quoted as ranges. Values presented herein reflect those associated with the extremes of the ranges presented within Volume 1, Annex 5.2: Underwater sound technical report of the ES.

3.11.3.12 Given that TTS is a temporary and reversible hearing impairment, it is anticipated that any animals experiencing this shift in hearing would recover after they have moved beyond the effect or impact zone and are no longer exposed to elevated sound levels. The implication of animals experiencing TTS, leading to potential displacement, is not fully understood, but it is likely that aversive responses to anthropogenic sound could temporarily affect life functions. Therefore, in this respect animals exposed to sound levels that could induce TTS have similar susceptibility as those exposed to sound levels that could induce PTS. There is an important distinction, however, given that TTS is only temporary hearing impairment, it is less likely to lead to acute effects and will largely depend on recoverability. The degree and speed of hearing recovery will depend on the characteristics of the sound the animal is exposed to and on the degree of shift in hearing experienced.

High resolution geophysical surveys

3.11.3.13 There are no thresholds in Popper *et al.* (2014) in relation to sound from high frequency sonar (>10 kHz). This is because the hearing range of fish species falls well below the frequency range of high frequency sonar systems.

3.11.3.14 Fish and shellfish species will likely be exposed to pre-construction high resolution geophysical surveys within the Offshore Order Limits. These surveys typically involve a combination of equipment, including MBES, SBES, SSS, Magnetometer and SBP. Surveys can also include the use of UHRS systems, such as sparkers. Sub-bottom profilers favoured for offshore wind projects are typically based around parametric profiling, which utilise high frequency emissions and a very narrow beam width to achieve high vertical resolution in sub-seafloor strata. The narrow beam width associated with parametric SBPs supports reducing the footprint of the system's acoustic sound emission and therefore footprint of potential acoustic disturbance (Lamoni and Tougaard, 2023).

3.11.3.15 There is scarce published information available regarding the impacts of high resolution geophysical surveys on fish and shellfish ecology. As such, the wide array of resources available regarding the impacts of seismic sources are reviewed to provide a proxy for sparker source UHRS and air gun source SBP. These comparisons should be reviewed with a high level of caution and with the consideration that seismic source levels are generally of a much higher level than those associated with high resolution geophysics (i.e. SBP, as this is not an impulsive source). Therefore any impacts discussed are likely highly precautionary when applied to high resolution geophysical survey.

Marine fish responses – behaviour

UXO clearance

3.11.3.16 Although the underwater sound generated from UXO clearance also has the potential to cause injury at various ranges (**Table 3.17**), there are no agreed sound level thresholds for the onset of a behavioural response generated by explosives.

3.11.3.17 A study by Pearson *et al.* (1992) on the effects of sound from boat-based geophysical surveys on Group 2 rockfish *Sebastes* spp. in field enclosures observed a startle (C-turn) response at peak pressure levels beginning around 200 dB re 1 µPa, although this was less common with the larger fish. Studies by Curtin University in Australia for the oil and gas industry by McCauley *et al.* (2000) exposed various fish species in large cages to seismic airgun sound and assessed behaviour, physiological and pathological changes, with a general fish behavioural response to move to the bottom of the cage during periods of high level exposure (greater than rms) levels of around 156 dB to 161 dB re 1 µPa; approximately equivalent to SPL_{pk} levels of around 168 dB to 173 dB re 1 µPa). This was followed by a return to baseline behaviour within 30 minutes of cessation of airgun activities, with no significant long term physiological impacts noted, except for likely reversible hearing hair cell damage at shore range. The behaviour of moving towards the bottom of the water column was noted *in situ* by Fewtrell and McCauley (2012), with significant alarm responses noted in all investigated species at sound levels exceeding 147 dB to 151 dB re 1 $µPa^2$.s sound exposure level (SEL) in every case, although these responses were also temporary and returned to baseline behavioural conditions shortly thereafter.

3.11.3.18 Application of the abovementioned studies to wild fish should be interpreted with caution due to inherent differences in expected reactions between caged versus free-roaming fish and using seismic airgun impulse sound as a proxy for sound sources. UXO clearance is likely to comprise singular, or a small series of blasts of gradually increasing charge size and associated sound levels (where high order techniques are used), therefore the real-world impacts between the two are likely to differ significantly. In addition, explosions create a shockwave which can lead to barotrauma effects; this is not a characteristic of airgun sources. However specific studies relating to the impacts of UXO clearance on fish and shellfish receptors are limited and thus a proxy is required to support the evidence base for assessment. More general behavioural responses to sound include research into the European sea bass, with a monitoring survey indicating that sea bass swam faster and dived deeper in tighter shoals as a direct response to piling sounds (used with caution as a proxy for UXO clearance due to both being impulsive sound sources) before recovery to baseline behaviour following cessation of piling (Neo *et al*., 2015). Further research has suggested that repeated exposure to impulsive sounds may cause habituation of sea bass to a sound, with fewer and shallower diving responses as the number of impulsive sound trials increased throughout the experiment (Neo *et al*., 2018).

Defined sensitivity – marine fish

3.11.3.19 Most marine fish IEFs species, including sandeel and elasmobranch species, in the study area are deemed to be of low vulnerability, high recoverability and local to international importance. The sensitivity of the receptor is **low**.

3.11.3.20 Sprat are deemed to be of medium vulnerability, high recoverability and regional to national importance. The sensitivity of the receptor is **medium**.

3.11.3.21 Herring and cod are deemed to be of high vulnerability, high recoverability and national importance. The sensitivity of the receptor is **high**.

Diadromous species responses – behaviour

UXO clearance

3.11.3.22 As with marine species, although the underwater sound as a result of UXO clearance has the potential to cause injury at various ranges (**Table 3.17**), there are no agreed sound level thresholds for the onset of a behavioural response generated as a result of explosives.

3.11.3.23 Diadromous fish species are composed of species within all four groups described in **paragraph 3.11.3.3**. Those individuals which are in close proximity to UXO clearance at the time of detonation may suffer injury or mortality. However, the nature of diadromous fish species being highly mobile and tending to only utilise the environment within the study area to pass through during migration, the clearance of UXO is unlikely to result in significant mortality or injury of diadromous species, and is unlikely to generate population level effects.

3.11.3.24 Diadromous fish species may experience behavioural effects in response to sound from UXO clearance, including a startle response, disruption of feeding, or avoidance of an area. These behavioural responses may occur within a range of hundreds of metres to several kilometres from UXO clearance operations, depending on the species and their relative sensitivities to underwater sound (i.e., in order of lowest to highest sensitivities: Group 1 lamprey species, Group 2 Atlantic salmon and sea trout, Group 3 European eel and Group 4 shad species).

3.11.3.25 Lamprey species are known to have relatively simple ear structures (Popper and Hoxter, 1987), with very few responses to auditory stimuli noted overall (Popper, 2005), except a slight swimming speed increase and decrease in resting behaviour when exposed to continuous low frequency sound of 50 Hz to 200 Hz (Mickle *et al*., 2019), suggesting a low vulnerability to impacts associated with underwater sound overall. As such, there is negligible risk of disruption to migration of lamprey.

3.11.3.26 Smelt have the potential to be impacted by underwater sound, possibly in terms of disruption to migration to their preferred spawning habitats, such as in the Ribble Estuary and Wyre Lune MCZs as outlined in **section 3.6.2**. Evidence from a port study indicates that smelt are able to habituate to repeated impacts associated with underwater sound with no significant loss of ecological function (Jarv *et al*., 2015). As the underwater sound associated with UXO clearance will be very short term and intermittent in nature, smelt are likely to have low vulnerability and high recoverability to this impact, unless at very close range to the source at the point of detonation, and are therefore at negligible risk to this impact.

3.11.3.27 Direct impacts on salmonid species can range from barotrauma to behavioural responses, with increases in stress hormone production immediately following exposure to explosive blasts (Kolden, 2013). Experimental results have indicated that salmonid species have exhibited fewer alarm reactions to external stimuli after being exposed to sub-lethal explosions (Sverdrup *et al*., 1994), with heavy gull predation noted on stunned fish exposed to similar non-lethal explosive blasts (Teleki and Chamberlain, 1978). Research from Harding *et al.* (2016) failed to produce physiological or behavioural responses in Atlantic salmon when subjected to sound levels similar to piling, which is not planned in this case but is used to support the evidence base regarding underwater sound effects on diadromous fish. It should be noted that pile driving is not a consistent sound source with explosives due to explosives comprising a singular, or a small series of blasts of gradually increasing sound levels with associated shockwaves, as opposed to the highly impulsive nature of piling. Therefore, the application of piling studies to UXO clearance effects should be interpreted with caution. However, the sound levels tested were estimated at <160 dB re 1 µPa rms, below the level at which injury or behavioural disturbance would be expected for Atlantic salmon. Nedwell *et al*. (2006) used the slightly less sensitive sea trout as a model for comparison to Atlantic salmon and found no significant behavioural response from piling activities, with modelling suggesting a similar response in Atlantic salmon and sea trout. This built on a previous study that showed no behavioural reaction to impact piling (400 m away) or vibropiling (less than 50 m away) as well as no physical injuries (Nedwell *et al.*, 2003).

3.11.3.28 Physical impacts on migrating salmonids have been noted from piling producing sound levels of 218 dB re 1 µPa^2.s SEL (Bagocius, 2015), although at these levels, it would be expected that avoidance reactions would occur based on impulsive sound over a period of time, thus avoiding injury effects. Given the nature of UXO clearance however, comprising a singular or series of blasts over a short period of time, with a high degree of intermittency between clearance events, and the transient nature of migratory fish, there is considered a negligible risk of disruption to migration of these species. The low risk of effects on migration of Atlantic salmon and sea trout is likely to extend to the freshwater pearl mussel, as part of its life stage is reliant on diadromous fish species including Atlantic salmon and sea trout, although this has not been directly studied as disturbance studies have only focused on the impacts of underwater sound on the migration of the salmonid host species.

3.11.3.29 The European eel, a Group 3 species, is known to have a wide hearing range (Jerko *et al*., 1989), with startle responses (Sand *et al*., 2000) and more than a doubling of short term migration distances close to sources of infrasound deterrents (Piper *et al*., 2019). However, these impacts were noted on juveniles migrating towards the sea, with there being no significant impact expected on juveniles as a result. Eels are also known to be more vulnerable to predation due to difficulty in detecting predators compared to control groups when exposed to simulated underwater sound (Simpson *et al*., 2014), with recovery noted when the sound source was removed. Given the short term and intermittent nature of any UXO clearance activities alongside the relatively short migration window of eels through the affected zones of the study area, it is predicted that the sensitivity of European eel to this impact is low.

3.11.3.30 Shad species (i.e., allis and twaite shad), like herring, are known to be sensitive to underwater sound, particularly ultrasonic tones (e.g., these were found to be able to detect ultrasonic tones of 171 dB re 1 µPa SPL at a distance of up to 187 m (Mann *et al*., 1998) and evasive behaviours were commonly seen in direct response to ultrasonic stimuli (Platcha and Popper, 2003)). Due to this sensitivity and evasiveness, it is considered unlikely that shad species will remain in the vicinity of construction activities, for a long enough period to cause significant harm, and therefore representing a low vulnerability to this impact. With regard to disruption to migration, as noted above, sound modelling outputs discussed in the previous sections indicated that the fish lower range extended from 44 m for a 0.08 kg donor charge to 985 m for a 907 kg donor charge, and from 27 m to 590 m respectively for the fish higher range (**Table 3.17**). Further, the underwater sound impacts will be short term and intermittent in nature during the construction phase (i.e., instantaneous effects from UXO detonation of a high degree of intermittency throughout the construction phase) and shad would only have the potential to be affected if within close to medium range of the source during UXO clearance activities during the upstream spawning migratory period for these species, which is reported to occur from spring up until June, peaking in April and May (Acolas *et al.,* 2004). Until shad reach sexual maturity and in between spawning periods, individuals remain in estuaries and marine areas including the wider Atlantic Ocean. As such, the sensitivity of these species is considered to be low.

Defined sensitivity – diadromous fish

3.11.3.31 All diadromous fish species IEFs, except for allis and twaite shad, in the study area are deemed to be of low vulnerability, high recoverability and national to international importance. The sensitivity of the receptor is **low**.

3.11.3.32 Allis shad and twaite shad are deemed to be of medium vulnerability, high recoverability and national importance. The sensitivity of the receptor is **medium**.

Shellfish responses – injury and behavioural

3.11.3.33 As information on the impact of underwater sound on marine invertebrates is scarce, no attempt has been made to set standardised exposure criteria (Hawkins *et al*., 2014). Studies on marine invertebrates have shown their general sensitivity to substrate borne vibration (Roberts *et al*., 2016), with aquatic decapod crustaceans possessing a number of receptor types potentially capable of responding to the particle motion component of underwater sound (e.g., the vibration of the water molecules which results in the pressure wave) and ground borne vibration (Popper *et al*., 2001). Sound is detected more as particle motion through stimulation of sensory setae within statoliths (Carroll *et al*., 2017), although these animals also have other mechanoreceptor systems which could be capable of detecting vibration. Broadly, evidence exists of crustaceans being sensitive to sounds of frequency <1 kHz (Budelmann, 1992).

3.11.3.34 Scott *et al*. (2020) provides a review of the existing published literature on the influence of anthropogenic sound and vibration and on crustaceans, including IEF species. The review concluded that some literature sources identified behavioural and physiology effects on crustaceans from anthropogenic sound; however, there were several that showed no effect. The paper notes that to date no effect or influence of underwater sound or vibrations has been reported on mortality rates or fisheries catch rates or yields. In addition, no studies have indicated a direct effect of anthropogenic sound on mortality, immediate or delayed (Scott *et al*., 2020).

3.11.3.35 Of the shellfish IEF species within the study area, decapod crustaceans (e.g., European lobster, edible crab and *Nephrops*) are believed to be physiologically resilient to sound as they lack gas filled spaces within their bodies (Popper *et al*., 2001). To date no lethal effects of underwater sound have been described for edible crab, European lobster or *Nephrops*; however a number of sub-lethal physiological effects have been reported among *Nephrops* and related species, specifically a reduction in burying, bioregulation and locomotion behaviour in response to simulative sounds associated with shipping and construction in laboratory/tank-based settings, however, simulated shipping sounds had no effect on the physiology of *Nephrops* (Solan *et al*., 2016). Caution should be applied in the application of laboratory study (i.e. those within a controlled environment) results to wild fish and shellfish species, due to inherent variance in reactions in such differing conditions. Laboratory studies provide a useful reference to potential reactions and effects but cannot fully simulate real-world scenarios. However, given the scarcity of published literature on the subject, these studies are considered valid reference points to support assessment.

3.11.3.36 Sub-lethal physiological effects have been identified from impulsive sound sources including bruised hepatopancreas and ovaries in snow crab exposed to seismic survey sound emissions (at unspecified SPLs) (DFO, 2004). Changes in serum biochemistry and hepatopancreatic cells (Payne *et al*., 2007), increases in respiration in brown shrimp *Crangon crangon* (Solan *et al*., 2016), metabolic rate changes and reduced feeding behaviour in green shore crab *Carcinus maenas* (Wale *et al.,* 2013) and evidence of oxidative stress in blue mussel (Wale *et al*., 2019) have also been identified in laboratory conditions.

3.11.3.37 Another study on brown shrimp found elevated SPLs are implicated in increased incidences of cannibalism and significantly delayed growth, with reduced SPL consistent with increased growth and reduced aggression (Lagardère and Spérandio, 1981). The mud crab *Scylla paramamosain* and European spiny lobster *Palinurus elephas* have been reported to have aspects of life history disrupted by anthropogenic sound (e.g., movement and anti-predation behaviour). In contrast to *Nephrops*, increased movement has been seen in these species in response to simulated shipping sound and offshore activities (Filiciotto *et al*., 2016; Zhou *et al*., 2016). Such findings have implications with regard to species fitness, stress and compensatory foraging requirements, along with increased exposure to predators. Although these species are not IEFs within the study area, this research provides useful context for the sub-lethal effects from sound impacts which the shellfish IEF species will likely similarly be exposed to.

3.11.3.38 Regarding shellfish eggs and larvae, there is no direct evidence to suggest UK commercial crustacean stocks are at risk of direct harm from high amplitude anthropogenic underwater sound (Edmonds *et al.,* 2016). Evidence exists of underwater sound significantly decreasing the capacity of benthic shellfish larvae to settle following their planktonic larval phase (Stanley *et al.,* 2012), potentially impacting long term population recruitment. Of the few studies that have focused on the eggs and larvae of shellfish species, evidence of impaired embryonic development and mortality has been found to arise from playback of seismic survey sounds (received sound pressure level of 160 to 164 dB rms re 1 µPa, corresponding to a SEL of 161 to 165 dB rms re 1 µPa^{2}s) played in a tank, 5 cm to 10 cm from scallop larvae, with up to 46% of affected larvae developing abnormalities compared to control groups (De Soto *et al.,* 2013). There is limited information on the effect of impulsive sound upon crustacean eggs and no research has been conducted on commercially exploited decapod species in the UK, with all available studies focusing on seismic survey sound impacts. Similar to scallop larvae, exposure to sounds from seismic source arrays could be implicated in delayed hatching of snow crab eggs, causing resultant larvae to be smaller than controls (DFO, 2004). However, Pearson *et al.* (1994) found no statistically significant difference between the mortality and development rates of stage II Dungeness crab *Metacarcinus magister* larvae exposed to single field-based discharges (231 dB re 1 µPa (zero-peak) source level) from a seismic airgun, highlighting the heterogeneity of results in this field, with further study required to refine this understanding. The existing evidence suggests a medium vulnerability of shellfish eggs and larvae to this impact, although recoverability of shellfish into spawning habitats is predicted to be high.

3.11.3.39 At a population level, monitoring of European lobster catch rates at the Westernmost Rough Offshore Wind Farm indicated that there were no significant negative effects on shellfish species during and after construction compared to baseline conditions (Roach *et al.,* 2018), with the respite from fishing activities from construction exclusion zones actually having short term benefits for some populations. While there may be some residual uncertainty with regard to behavioural effects during construction activities, the evidence suggests that long term effects are unlikely to occur, and any effects will be reversible.

High resolution geophysical surveys

3.11.3.40 Shellfish will likely be exposed to pre-construction geophysical surveys within the Offshore Order Limits, which would include the use of SBPs and potentially UHRS using a sparker source. In evaluating this impact, a report by Christian *et al*. (2003) found no significant difference between acute effects of seismic airgun exposure (also an impulsive sound source; >189 dB re 1 µPa (peak to peak) @ 1 m) upon adult snow crabs *Chionoecetes opilio* in comparison with those in control cages with no exposure to seismic pulses. Whilst seismic surveys using air gun sources are not anticipated, there is limited evidence available regarding the effects of high resolution geophysical survey using UHRS and SBP on shellfish species, and due to the impulsive nature of the sound emissions associated with both high resolution geophysics and seismic surveys, studies relating to seismic surveys are considered the most appropriate proxy when considering UHRS acquisition, based upon a sparker source in use as this source is impulsive, despite the differences in overall sound levels and frequencies and the absence of airguns associated with this package. Given that seismic sources tend to achieve higher overall sound levels, these inferences should be interpreted with caution and any impacts discussed should be considered precautionary when applied to high resolution geophysics.

3.11.3.41 Another study investigated whether there was a link between seismic surveys and changes in commercial rock lobster *Panulirus cygnus* based on catch rates of surviving individuals, thereby providing a measurement of acute to mid-term mortality over a 26-year period. This found no statistically significant correlative link, with no evidence that rock lobster catch rates were affected in the short (weeks) or long term (years) by seismic surveys (Parry and Gason, 2006).

3.11.3.42 A review of seismic survey impact studies found that comparison between laboratory and field studies was difficult due to differing sound properties in these controlled and uncontrolled environments (Carroll *et al*., 2017) and therefore setting standardised minimum injury and mortality thresholds was challenging for this impact (Wright and Cosentino, 2015). Despite this difficulty, direct observation in the Bass Strait, Australia, has shown that scallop species in this region show no evidence of increased mortality within 10 months of seismic airgun exposure (Parry *et al*., 2002) and rock lobster *Jasus edwardsii* show the same trend eight months following exposure (Day *et al*., 2016), suggesting a low vulnerability and high recoverability to this sound source.

Defined sensitivity – shellfish

3.11.3.43 All shellfish IEFs, including European lobster, *Nephrops*, edible crab and king and queen scallops are deemed to be of low vulnerability, high recoverability and local to regional importance. The sensitivity of the receptor is **low**.

Magnitude of impact

UXO clearance

3.11.3.44 Potential effects of underwater sound from high order UXO clearance on fish and shellfish IEFs include mortality, physical or auditory injury and/or disturbance. The duration of impact (elevated sound) for each UXO detonation is very short (seconds) and therefore behavioural effects are predicted to be negligible, with a rapid return to natural behaviours following each detonation event. TTS is presented as a temporary auditory impairment but also represents a threshold for the onset of a moving away response.

3.11.3.45 Clearance will be completed prior to the construction phase (pre-construction). Until detailed pre-construction surveys are completed within the Offshore Order Limits, the precise number of potential UXO which will need to be cleared is unknown. For the purposes of this assessment, it has been assumed that the MDS will be clearance of UXO with a NEQ of 907 kg cleared by either low order or high order techniques. Detonation of UXO would represent a short term (i.e., seconds) increase in underwater sound (i.e., sound pressure levels and particle motion) which will be elevated to levels that may result in injury of or behavioural effects on fish and shellfish species. Details on mitigation measures for the reduction of impacts from UXO clearance are provided in the MMMP (CoT64, **Table 3.12**). Whilst the MMMP is not designed to mitigate impacts to fish and shellfish species, the measures within are considered to potentially benefit some species of fish.

3.11.3.46 It is anticipated that up to 25 UXO within the Offshore Order Limits are to be cleared. The maximum UXO size is assumed to be 907 kg, the most common size is 130 kg and the smallest UXO size is 25 kg (**Table 3.13**), thus all sizes have been assessed. A low order clearance donor charge of 0.08 kg is assumed whilst low-yield donor charges are multiples of 0.75 kg (up to four required for the largest UXO). For donor charges for high order clearance activities, charge weights of 1.2 kg (the most common) and 3.5 kg (single barracuda blast charge) have been included.

3.11.3.47 The clearance activities will be tide and weather dependant. The aim is to enable clearance of at least one UXO per tide, during the hours of daylight and good visibility. There is an assumption of up to 0.5 kg NEQ clearance shot for neutralisation of residual explosive material at each location.

3.11.3.48 The impact through UXO clearance is predicted to be of local spatial extent, short term duration, intermittent and of high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore **low**.

High resolution geophysical surveys

3.11.3.49 The hearing range of fish species falls well below the frequency range of high frequency sonar-like seabed imaging systems and, as such, no suitable acoustic thresholds have been defined. Consequently, the effects of sound from high frequency sonar surveys on fish have not been conducted as part of this study.

3.11.3.50 The pre-construction geophysical surveys, using any of the available techniques outlined in **Table 3.13**, are likely to be very short term and spatially limited as the source moves across a survey area, reducing the magnitude of their likely impact on fish and shellfish receptors. Surveys based around MBES, SSS, SBP and potentially UHRS with a sparker source, based on the magnitudes identified in **Table 3.13**, will also operate largely outside of the hearing frequencies of most fish and shellfish IEFs, thereby significantly reducing the potential for impacts to low or negligible levels. The magnitude is therefore considered to be **negligible** and is not considered further within the assessment.

Significance of effect

UXO clearance

3.11.3.51 For most marine fish, the sensitivity is **low** and the magnitude of the impact in relation to UXO clearance is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.3.52 For sprat, the sensitivity is **medium** and the magnitude of the impact in relation to UXO clearance is **low**. The effect will, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.3.53 For herring and cod, the sensitivity is **high** and the magnitude of the impact in relation to UXO clearance is **low**. This gives rise to a significance of effect of minor adverse or moderate adverse. Due to the short term (instantaneous) effects associated with UXO clearance, the high degree of intermittency in clearance activities (CoT64, **Table 3.12**) and the immediate reversibility of the effect on the soundscape, along with the limited windows of affect associated with spawning periods for both species, the overall significance is considered to be **minor adverse,** which is not significant in EIA terms.

3.11.3.54 For most diadromous fish species, the sensitivity is **low** and the magnitude of the impact in relation to UXO clearance is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.3.55 For allis and twaite shad, the sensitivity is **medium** and the magnitude of the impact in relation to UXO clearance is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.3.56 For shellfish species, the sensitivity is **low** and the magnitude of the impact in relation to UXO clearance is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

High resolution geophysical survey

3.11.3.57 For most marine fish, the sensitivity to high resolution geophysical surveys is **low** and the magnitude of the impact is **negligible**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. This significance has been concluded based on the lack of defined acoustic thresholds for most species in relation to geophysical survey impacts, and therefore a precautionary approach has been applied.

3.11.3.58 For sprat, the sensitivity is **medium** and the magnitude of the impact is **negligible**. The effect will, be of **minor adverse** significance, which is not significant in EIA terms. This significance has been concluded based on the lack of defined acoustic thresholds for most species in relation to geophysical survey impacts, and therefore a precautionary approach has been applied.

3.11.3.59 For herring and cod, the sensitivity is **high** to underwater sound effects and the magnitude of the impact is **negligible**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. This significance has been concluded based on the lack of defined acoustic thresholds for most species in relation to geophysical survey impacts, and therefore a precautionary approach has been applied.

3.11.3.60 For most diadromous fish species, the sensitivity is **low** and the magnitude of the impact is **negligible**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. This significance has been concluded based on the lack of defined acoustic thresholds for most species in relation to geophysical survey impacts, and therefore a precautionary approach has been applied.

3.11.3.61 For allis and twaite shad, the sensitivity is **medium** and the magnitude of the impact is **negligible**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. This significance has been concluded based on the lack of defined acoustic thresholds for most species in relation to geophysical survey impacts, and therefore a precautionary approach has been applied.

3.11.3.62 For shellfish species, the sensitivity is **low** and the magnitude of the impact is **negligible**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. This significance has been concluded based on the lack of defined acoustic thresholds for most species in relation to geophysical survey impacts, and therefore a precautionary approach has been applied.

3.11.4 Underwater sound from all other activities

3.11.4.1 The construction, operation and maintenance and decommissioning of offshore export cables may lead to underwater sound that could impact fish and shellfish receptors. The MDS is represented by vessels sound emissions and other sound-producing activities such as cable burial, and is summarised in **Table 3.13.**

3.11.4.2 Anthropogenic sources of sound in the marine environment include fishing boats, ships (non-impulsive), marine construction, seismic surveys and leisure activities (all could be either impulsive or non-impulsive), all of which add to ambient background sound. Other anthropogenic sound within the vicinity of the Transmission Assets will arise primarily from shipping, the offshore oil and gas industry, subsea geotechnical surveys and the offshore renewables industry.

Construction phase

Sensitivity of receptor

3.11.4.3 The sensitivity of fish and shellfish IEFs to underwater sound is presented in detail in **section 3.11.3.** and applied for the assessment underwater sound from all other activities. Results from studies specific to all other activities aside from UXO clearance and high resolution geophysical survey are presented in this section.

3.11.4.4 The ranges for recoverable injury and TTS for Groups 3 and 4 fish are presented in **Table 3.18** based on the thresholds contained in Popper *et al.* (2014). It should be noted that fish would need to be exposed within these potential impact ranges for a period of 48 hours continuously in the case of recoverable injury and 12 hours continuously in the case of TTS for the effect to occur. It is therefore considered that these ranges are highly precautionary and injury is unlikely to occur in reality.

3.11.4.5 Sound from the vessels themselves (e.g., propeller, thrusters and sonar (if used)) primarily dominates the emission level, hence sound from activities such as seabed preparation, trenching and rock placement (if required) have not been included separately.

3.11.4.6 A detailed underwater sound modelling assessment has been carried out to investigate the potential for injurious and behavioural effects on fish species resulting from elevated continuous underwater sound (non-impulsive sound), using the latest criteria (Volume 1, Annex 5.2: Underwater sound technical report of the ES). A conservative assumption has been made that all individual fish species will respond aversively to increases in vessel sound (i.e., that there is no intra or inter-specific variation or context-dependent differences). The distance over which effects may occur will, however, vary according to the species, the ambient sound levels, hearing ability, vertical space use and behavioural response differences. The assessment has focused on the impacts of impulsive sound sources, due to the potential of these to cause the greatest physical and behavioural responses. This is presented with the understanding that non-impulsive and continuous sound is occurring regularly throughout all phases of the Transmission Assets, but these impacts are likely to cause fewer impacts than high intensity impulsive sound sources.

3.11.4.7 SELs have been estimated for each vessel type based on 24 hours continuous operation, although it is important to note that it is highly unlikely that any fish would stay at a stationary location or within a fixed radius of a vessel for 24 hours. Therefore, the acoustic modelling has been undertaken based on an animal swimming away from the source (or the source moving away from an animal). The sound modelling results indicate that the threshold for injury was exceeded for installation vessels, construction vessels, rock placement vessels, cable installation and sandwave clearance vessels, survey vessels, support vessels, CTVs, scour/cable protection vessels, seabed preparation vessels and cable trenching and laying activities. However, the ranges for recoverable injury occurring to fish as a result of elevated underwater sound due to vessel movement or non-piling activities reach a maximum of < 10 m. Acoustic modelling was conducted for TTS for completeness (see Volume 1, Annex 5.2: Underwater sound technical report of the ES) however ranges indicated are likely to be overestimates. Ranges for TTS were, when thresholds were exceeded, between <10 m and 27 m for vessels and between 15 m and 27 m for cable burial activities (**Table 3.18**).

Table 3.18: Estimated recoverable injury and TTS ranges from vessels and other construction related operations for groups 3 and 4 fish.

Source/vessel	Injury zone radius (m)	
	Recoverable injury	TTS
	170 dB rms for 48 hrs	158 dB rms for 12 hrs
Construction operations		
Cable trenching	< 10	27
Cable laying	< 10	15
Jack-up rig	N/E	N/E
Vessels		
Boulder clearance	N/E	< 10
Installation vessel, construction vessel (DP)	< 10	27
Jack up rig	N/E	N/E
Tug/anchor handlers	N/E	< 10
Rock placement vessel, cable installation and sandwave clearance vessels	< 10	27
Guard vessels	N/E	< 10
Survey vessel and support vessels	N/E	< 20
CTVs	N/E	< 20
Scour/Cable Protection/Seabed Preparation/Installation Vessels	N/E	< 20

N/E- Not Exceeded

3.11.4.8 All fish and shellfish IEFs species, including elasmobranch species, in the study area are deemed to be of low vulnerability, high recoverability and local to international importance. The sensitivity of the receptor is **negligible**.

Magnitude of impact

3.11.4.9 During the construction phase of the Transmission Assets, the increased levels of vessel activity will contribute to the total underwater sound levels.

3.11.4.10 The MDS for construction activities associated with site preparation and cables installation is up to a total of 30 construction vessels on site at any one time in a concurrent construction scenario with up to 286 return trips throughout the construction phase. For the Transmission Assets, total installation vessels and movements include a maximum of ten cable lay and support vessels carrying out 48 trips; three tug/anchor handlers carrying out 12 trips; two guard vessels undertaking 30 return trips, three survey vessels carrying out six trips; six seabed preparation vessels carrying out 20 trips; three CTVs carrying out 148 trips, and three cable protection installation vessels carrying out 22 trips.

3.11.4.11 Whilst this will lead to an uplift in vessel activity, the movements will be limited to within the Offshore Order Limits and are likely to follow existing shipping routes to/from the ports.

3.11.4.12 The main drivers influencing the magnitude of the impact are vessel type, speed and ambient sound levels (Wilson *et al.,* 2007). Baseline levels of vessel traffic in the study area are at a high level, largely due to ferry routes. For example, commercial ferry routes between the UK mainland (Liverpool, Heysham) and the Isle of Man (Douglas) total approximately 1,912 crossings, between the UK mainland (Liverpool) and Northern Ireland (Belfast) 1,696 crossings, between UK mainland (Heysham) and Ireland (Dublin) 604 crossings and UK mainland (Heysham) and Northern Ireland (Warrenpoint) 1087 in 2019, highlighting there is a high ferry vessel baseline alone in the area.

3.11.4.13 As described in Volume 2, Annex 7.1: Navigation risk assessment of the ES, occasional vessel traffic movements associated with jack-ups and other platforms also occur in the region.

3.11.4.14 Other sound-generating activities for the Transmission Assets will include cable burial. This will comprise burial of 484 km of offshore export cables via pre-lay ploughing, trenching and jetting and mechanical cutting.

3.11.4.15 Whilst the likelihood of auditory injury to fish and shellfish receptors is considered unlikely, the maximum duration of the construction phase is up to 30 months (sequential construction).

3.11.4.16 The impact is predicted to be of limited spatial extent, medium term duration, intermittent and, although the impact itself is reversible (i.e., the elevation in underwater sound only occurs during the activities), the effect of PTS is permanent. It is predicted that the impact will affect the receptor directly. The PTS threshold was not predicted to be exceeded for jack-up rig and for some vessel types (i.e., boulder clearance, jack up rig, tug/anchor handlers and guard vessels) and the effect of behavioural disturbance is reversible as receptors are expected to recover within hours/days. The magnitude is therefore considered to be **negligible.**

Significance of effect

3.11.4.17 For all fish and shellfish IEFs, the sensitivity is **negligible** and the magnitude of the impact is **negligible**. Based upon the baseline conditions comprising high levels of vessel traffic across the range of vessel types predicted for the Transmission Assets and associated heavily trafficked soundscape, and the low likelihood of TTS or PTS occurring due to the necessary exposure time within the modelled ranges, the effect will therefore be of **negligible** significance, which is not significant in EIA terms.

Operation and maintenance

Sensitivity of receptor

3.11.4.18 The sensitivity of fish and shellfish species to underwater sound from vessels and other non-piling activities is described in **paragraph 3.11.4.4** to **paragraph 3.11.4.8**.

3.11.4.19 Underwater sound emissions from vessels and other activities during the operation and maintenance are unlikely to be at a level sufficient to cause injury to fish.

3.11.4.20 The ranges presented are based on the highly unlikely case of the source operating for 12 to 48 hours continuously within range of the same individual fish for both sound from vessels and jet cutting activities. The levels presented therefore represent an overestimation.

3.11.4.21 Group 3 and 4 fish injury and TTS ranges for vessels are presented in **Table 3.18.** For operation and maintenance activities (i.e., jet cutting), the ranges for recoverable injury and TTS occurring to fish were not modelled specifically, however the exposure time for trigger effects of TTS and recoverable injury are 12 and 48 hours, respectively. Mobile fish species are unlikely to remain consistently within sufficiently close range to activities such as jet cutting for these extended periods of time to result in an adverse effect. Impacts as a result of elevated underwater sound, due to vessels, reach a maximum of up to 15 m. Ranges for TTS were, when thresholds were exceeded, between < 10 m and 27 m for vessels, noting the exposure times required to trigger these modelled effects.

3.11.4.22 All fish and shellfish IEFs species, including elasmobranch species, in the study area are deemed to be of low vulnerability, high recoverability and local to international importance. The sensitivity of the receptor is **negligible**.

Magnitude of impact

3.11.4.23 Sound generated by vessels during the operation and maintenance phase of the Transmission Assets may lead to injury and/or disturbance to fish and shellfish receptors. Vessel types which will be required during the operation and maintenance phase include those used during routine inspections and offshore export cable repair or reburial (**Table 3.13**). This will involve 14 vessels including CTVs/workboats, jack up vessels, cable repair vessels, SOVs or similar vessels and excavators/backhoe dredgers. Up to 77 operation and maintenance vessel movements (return trips) associated with Transmission Assets will be carried out each year (42 CTVs/workboat trips, three jack-up vessels, four cable repair vessel trips, 20 SOV or similar vessel trips and eight trips by excavators/backhoe dredgers).

3.11.4.24 The uplift in vessel activity during the operation and maintenance phase is considered within the bounds of reasonable variation in the context of the baseline levels of vessel traffic in the study area. Presence of the Transmission Assets may divert some shipping routes and therefore, current traffic within the Offshore Order Limits is likely to be reduced. It is likely that this reduction will be ultimately counterbalanced by presence of maintenance vessels. Vessel movements will be within the Offshore Order Limits and are likely to follow existing shipping routes to and from ports.

3.11.4.25 The size and sound outputs from vessels during the operation and maintenance phase will be similar to those used in the construction phase and therefore will result in a similar maximum design spatial scenario (**Table 3.13**). However, the number of vessels, vessel round trips (port to port) and their frequency is much lower for the operation and maintenance phase compared to the construction phase.

3.11.4.26 The impact is predicted to be of local spatial extent, long term duration, intermittent and reversible (i.e., the elevation in underwater sound only occurs during the activities). It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **negligible**.

Significance of effect

3.11.4.27 For all fish and shellfish IEFs, the sensitivity is **negligible** and the magnitude of the impact is **negligible**. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms.

Decommissioning

Sensitivity of receptor

3.11.4.28 The sensitivity of fish and shellfish species to underwater sound from vessels and other activities is described in **paragraph 3.11.4.4** to **paragraph 3.11.4.8**. All fish and shellfish ecology IEFs are deemed to be of low vulnerability, high recoverability and local to international importance. The sensitivity of the receptor is **negligible**.

Magnitude of impact

3.11.4.29 Sound generated by vessels during the decommissioning phase of Transmission Assets may lead to injury and/or disturbance to fish and shellfish IEFs. Vessel types predicted during the decommissioning phase include those commissioned to undertake removal of cables (**Table 3.13**).

3.11.4.30 Since the numbers and types of vessel used to remove infrastructure (along with their size and sound outputs) are expected to be similar to those used for the construction phase, this impact is expected to result in a similar MDS as the construction phase described in **paragraph 3.11.4.9** to **paragraph 3.11.4.16**. The magnitude of the impact for the decommissioning phase for both injury and disturbance as a result of elevated underwater sound due to vessel sound is therefore not expected to differ or be greater than that assessed for the construction phase, where it has been assessed as **negligible**.

Significance of effect

3.11.4.31 For all fish and shellfish IEFs, the sensitivity is **negligible** and the magnitude of the impact is **negligible**. The effect will therefore be of **negligible** significance, which is not significant in EIA terms.

3.11.5 Increased SSCs and associated sediment deposition

3.11.5.1 The construction, operation and maintenance and decommissioning activities on the offshore export cables of the Transmission Assets may lead to increased SSCs and associated sediment deposition. The MDS is represented by sandwave clearance, removal of disused cables, cable installation and burial and cable reburial and is summarised in **Table 3.13**. Volume 2, Chapter 1: Physical processes of the ES provides a full description of the physical processes baseline characterisation, including numerical modelling used to inform the predictions made with respect to increases in suspended sediment and subsequent deposition.

3.11.5.2 For more generalised conditions, the Cefas Climatology Report 2016 (Cefas, 2016) and associated dataset provides the spatial distribution of average non-algal Suspended Particulate Matter (SPM) for the majority of the UK Continental Shelf. In the period of 1998 to 2005, the greatest plumes are associated with large rivers such as those that discharge into the Thames Estuary, The Wash and Liverpool Bay, which show mean values of SPM above 30 mg/l. Based on the data provided within this study, the SPM within the study area has been estimated as approximately 2 mg/l offshore to 40 mg/l inshore over the 1998 to 2015 period. Higher levels of SPM are experienced more commonly in the winter months; however, due to the tidal influence, even during summer months the levels remain elevated.

Construction phase

Sensitivity of receptor

Marine species

3.11.5.3 In terms of SSC, adult fish species are more mobile than many of the other fish and shellfish IEFs and therefore would be likely to show avoidance behaviour within areas affected by increased SSC (EMU, 2004), making them less susceptible to physiological effects of this impact. Juvenile fish are more likely to be affected by habitat disturbances such as increased SSC than adult fish, which is well researched for commercially important salmonid species (Bisson and Bilby, 1982; Berli *et al.,* 2014). This is due to the decreased mobility of juvenile fish, with these animals therefore being less able to avoid impacts. Juvenile fish are likely to occur throughout the study area, with some species using offshore areas as nursery habitats, while inshore areas, especially within the Isle of Man territorial waters and inshore Welsh waters, are more important as nurseries for other species (full list of species with spawning and nursery grounds overlapping the study area available in Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES).

3.11.5.4 The north Irish Sea experiences regular temporary increases in SSC, linked heavily to interannual changes in general meteorological conditions and the frequency of spring storms (White *et al.,* 2003), and juveniles typically inhabit inshore areas (where SSCs are typically higher). Also, seasonal variation of SSC is known to occur in Irish Sea, with an increase of up to a factor of 2.7 in winter compared to summer (Bowers *et al.,* 2010). Therefore, given the extent of these natural changes, it can be expected that most fish juveniles expected to occur in the study area will be largely unaffected by the relatively low-level temporary increases in SSC resulting from the construction phase. These concentrations are likely to be within the range of natural variability - generally <5 mg/l, but this can increase to over 100 mg/l during storm events with increased wave heights and will likely reduce to background concentrations within a very short period (approximately two tidal cycles), leading to there being little to no impact on mobile species, such as the identified elasmobranch IEF species.

3.11.5.5 A study by Appleby and Scarratt (1989) found development of fish eggs and larvae have the potential to be affected by suspended sediments at concentrations of thousands of mg/l. Modelling of SSC associated with the construction phase identified peak maximum concentrations of approximately 1,000 mg/l for sandwave clearance operations with the sediment plume extending approximately 5 km in a principally east/west orientation. This peak maximum level of SSC may affect the development of eggs and larvae; however, average concentrations are typically one tenth of this value and near background levels at the edge of the plume's extent. These concentrations are only expected to be present in the immediate vicinity of the release site, with dispersion of the released material continuing on successive tides. Sedimentation following the operation is in the order of 3 mm to 5 mm across the region where material is redistributed and <0.1 mm at the extent of the plume. These levels of sedimentation are unlikely to affect the development of most eggs and larvae.

3.11.5.6 Many shellfish species, such as edible crab and king and queen scallop, have a high tolerance to SSC and are reported to be insensitive to increases in turbidity (Wilber and Clarke, 2001); however, they are likely to avoid areas of consistently increased SSC as they rely on visual acuity during predation and feeding (Neal and Wilson, 2008; Speiser and Johnsen, 2008). In the case of possible burial during settlement of SSC, both king and queen scallop have the potential to be impacted negatively.

3.11.5.7 Queen scallop have the potential to suffer 74.1% to 88.9% mortality following continual burial under less than 5 cm of sediment for two to four consecutive days (Hendrick *et al.*, 2016). Emergence success was found to be lowest from burial beneath finer sediment fractions to this depth and no emergence was found from the 5 cm or 7 cm tested burial depths over any time period (Hendrick *et al.*, 2016). This indicates a high intolerance to high levels of sedimentation over relatively short time periods, with burial for longer than two days increasing mortality highly significantly. Sedimentation of greater than 5 cm thickness is expected in the immediate vicinity of the construction activities on the first day following cessation of construction encompassing a very small area around the source (see Volume 2, Chapter 1: Physical processes of the ES for average sedimentation figures), which has the potential to lead to mortality to queen scallop present, based upon laboratory results from Hendrick *et al*. (2016). Sediment is expected to dissipate to background levels for the area by the action of tidal cycles within approximately two days following the cessation of construction, which will reduce the potential for mortality of individuals.

3.11.5.8 The Hendrick *et al.* (2016) study was laboratory-based, with any sediment removed after the set investigated time period and then mortality checked by measurement of shell gape one minute following direct disturbance. Therefore, the mortality and emergence values might be overestimates compared to a real-world scenario, where buried queen scallop would only survive if they were able to emerge on their own typically within two days, or via hydrodynamic redistribution of deposited materials, which is expected within this time frame. Therefore, as a precautionary approach, it should be considered that any sedimentation of greater than 5 cm thickness would lead to no emergence and likely full mortality within the footprint of sedimentation, and any burial under sedimentation thicknesses of up to at least approximately 5 cm will significantly increase mortality if queen scallop individuals have not emerged in under two days.

3.11.5.9 King and queen scallop both have high intensity spawning grounds overlapping the Transmission Assets and are considered relatively mobile and are expected to avoid active events causing increases in SSC. This potential avoidance behaviour is less prevalent in juvenile king scallop when undergoing burial events, where burial from up to 5 cm of sediment deposition can reduce growth rates, potentially having impacts on future spawning times (Szostek, *et al.,* 2013). However, the overall sensitivity of king scallop at a population level in the short or long term is expected to be low.

3.11.5.10 It has been found that for both species, survival is strongly linked to the ability to emerge from sediment (Last *et al.*, 2011, Hendrick *et al.*, 2016). Evidence exists that indicates that individuals of 1 mm in length have the potential to detach from the substrate in the event of disturbance, followed by recession into local sediments where possible and, where not possible, this can lead to potential dispersal by currents and water turbulence (Minchin, 1992). Based on the findings of these studies, it is possible that juveniles and larvae of both species within the study area have the potential to survive short term increases in SSC and associated deposition. High levels of sedimentation are unlikely to occur outside of the immediate construction footprint at the Transmission Assets (see Volume 2, Chapter 1: Physical processes of the ES for average sedimentation figures). Whilst king and queen scallop should be considered in the context of being intolerant of burial under sediment for extended time periods, it is acknowledged that deposition levels of up to a maximum of 10 mm in the immediate vicinity of cable installation may occur, and 3 mm to 5 mm across the region where material is redistributed and <0.1 mm at the extent of the plume, therefore, it is unlikely that these bivalves would be affected beyond the point of sediment release.

3.11.5.11 Berried crustaceans (e.g., European lobster and *Nephrops*) are potentially more vulnerable to increased SSC as the eggs carried by these species require regular aeration. Increased SSC within the study area (which encompasses potential habitat for egg bearing and spawning *Nephrops*, which overlaps with the Generation Assets located within the Offshore Order Limits) is unlikely to impact *Nephrops*, as this species is not considered to be sensitive to increases in SSC or subsequent sediment deposition, since this is a burrowing species with the ability to excavate any sediment deposited within their burrows (Sabatini and Hill, 2008). Sediments are likely to settle to the seabed quickly following disturbance and will become reintegrated into the natural sediment transport regime (see assessment of magnitude below).

3.11.5.12 The fish species likely to be affected by sediment deposition are those which inhabit, feed and spawn on or near the seabed. Demersal spawners (species which deposit eggs onto the seabed during spawning) within the study area include sandeel and herring. Spawning areas for sandeel occur within the study area. Overall, 48% of stations from site-specific sampling were unsuitable, 37% of stations were marginal, 16% preferred, with patchy areas of marginal and preferred sediment located along the export cable corridors within the Offshore Order Limits, although much of the export cable corridors were considered unsuitable. Sandeel and their eggs are likely to be tolerant to some level of sediment deposition due to the nature of re-suspension and deposition within their natural high energy preferred habitat and spawning environment within the Irish Sea (MarineSpace Ltd, 2013b). Therefore, sandeel spawning populations are likely to have limited sensitivity to this impact. Sandeel populations prefer coarse to medium sands (Wright *et al.,* 2000), with sensitivity to changes in this habitat and show reduced selection or avoidance of gravel and fine sediments (Holland *et al.,* 2005). Therefore, any increase in the fine sediment fraction of their habitat may cause avoidance behaviour until such time that currents remove fine sediments from the seabed, although modelled deposition levels for fine sediments are expected to be highly localised and at very low levels (up to 10 mm, in close proximity to activities, 3 mm to 5 mm across the region where material is redistributed and <0.1 mm at the extent of the plume).

3.11.5.13 Herring occur mostly in entirely pelagic habitats but utilise benthic environments for spawning and are known to prefer gravelly and coarse sand environments for this purpose, specifically around the south east and north east of the Isle of Man, close to the north west border of the Transmission Assets (Coull *et al.,* 1998). With respect to the effects of sediment deposition on herring spawning activity, it has been shown that herring eggs may be tolerant of very high levels of SSC (Messieh *et al.,* 1981; Kiørboe *et al*., 1981). Therefore, effects on herring populations are predicted to be limited. Herring populations prefer coarse habitats and would show avoidance of muddy sediments which were present along much of the export cable corridors within the Offshore Order Limits (O'Sullivan *et al.* 2013). Therefore, any increase in the fine sediment fraction of their habitat may cause avoidance behaviour until such time that currents remove fine sediments from the seabed. Note that fine sediment would be dispersed over a large scale than coarser materials. Detrimental effects may be seen if smothering occurs and the deposited sediment is not removed by the currents (Birklund and Wijsmam, 2005), however this would be expected to occur quickly in this case (i.e., within a couple of tidal cycles) given the low levels of deposition expected. Furthermore, the limited amount of suitable sandy gravel sediments for herring spawning within the Transmission Assets, with the majority of the sediment habitats being unsuitable (Figure 3.2 and Figure 3.3 in Volume 2, Figures), will likely limit the potential for effects of SSC on herring spawning. This is supported by the mapping of spawning grounds (as described in **section 3.6**), which shows the highest intensity of herring spawning within the Isle of Man 12 nm territorial waters, just outside to the north west of the Transmission Assets, reducing any potential for impact of SSC.

3.11.5.14 Based on the increase in sensitivity of herring eggs to the smothering effects of increased sediment deposition, herring is deemed to be of medium vulnerability, high recoverability and of national importance and therefore the sensitivity of this receptor is **medium**.

3.11.5.15 All other fish and shellfish ecology IEFs in the study area, including sandeel, *Nephrops*, king and queen scallop and elasmobranch species, are deemed to be of low to medium vulnerability, high recoverability and local to national importance. The sensitivity of these IEFs is therefore considered **low**.

Diadromous species

3.11.5.16 Diadromous fish species known to occur in the area are also expected to have some tolerance to naturally high SSC, given their migration routes typically require them to travel through estuarine habitats, which have background SSC that are considerably higher than those expected in the offshore areas of the study area. As it is predicted that construction activities associated with the Transmission Assets will produce temporary and short-lived increases in SSC, with levels well below those experienced in estuarine environments, it would be expected that any diadromous species should only be temporarily affected (if they are affected at all, based on the timing of the construction phase). Any negative effects on these species are likely to be short term behavioural effects, such as avoidance (Boubee *et al.,* 1996), or temporary slightly erratic alarmed swimming behaviour (Chiasson, 2011) and are not expected to create any significant barrier to migration to rivers or estuaries used by these species in the study area. However, these studies were laboratory based and do not cover the species found within the study area (i.e., studies based on shortfinned elver *Anguilla australis,* longfinned elver *A. dieffenbachia,* banded kokopu *Galaxias fasciatus,* inanga *G. maculatus,* koaro *G. brevipinnis,* redfinned bully *Gobiomorphus huttoni*, rainbow smelt *Osmerus mordax*), so the potential for other responses does exist, but these are unlikely, given the naturally highly turbid nature of estuarine environments that these species are adapted to traverse.

3.11.5.17 Diadromous fish species IEFs in the study area are deemed to be of low vulnerability, high recoverability and national to international importance. The sensitivity of the receptors is therefore **low**.

Magnitude of impact

3.11.5.18 For the purposes of this assessment, the following activities have been considered (see **Table 3.13**).

- Seabed preparation (sandwave, boulder and debris clearance).
- Installation of offshore export cables.

3.11.5.19 The MDS for the sandwave clearance for the Morgan offshore export cables accounts for up to a 60 m wide corridor along 9% of 400 km of offshore export cable length to a maximum depth of 5 m, totalling a spoil volume of up to 1,080,000 m^3. The Morecambe offshore export cables sandwave clearance activities account for a much smaller total spoil volume of 346,800 m^3, based on clearance in a 48 m wide, 5 m deep corridor along 9% of 84 km of offshore export cables. The MDS for increases in SSC and associated deposition considers construction activities to be carried out concurrently.

3.11.5.20 The MDS for the installation of offshore export cables assumes installation via trenching. Trenches are expected to have a width of 3 m and a maximum depth of 3 m (target burial depth is 1 m), resulting in the mobilisation of up to 2,178,000 m^3 of material along the 484 km of offshore export cable length over a 30-month sequential construction scenario.

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

Significance of effect

Marine species

3.11.5.22 Overall, the sensitivity is **low** for the majority of fish and shellfish IEFs and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.5.23 Overall, the sensitivity for herring is **medium** and the magnitude of the impact is **low**. The effect will, therefore, be **of minor adverse** significance, which is not significant in EIA terms.

Diadromous species

3.11.5.24 Overall, the sensitivity of the diadromous fish IEF receptors is **low** and the magnitude of the impact is **low**. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This is due to the short range, short term, intermittent nature of the impact being unlikely to affect migration to or from key rivers and the tolerance of diadromous fish to higher SSC.

Operation and maintenance

Sensitivity of receptor

Marine species

3.11.5.25 The sensitivity of the marine fish and shellfish IEFs can be found in the construction phase assessment (**paragraph 3.11.5.3** to **paragraph 3.11.5.15**) and these will equally apply in the operation and maintenance phase. The sensitivity of these IEFs is therefore **low to medium.**

Diadromous species

3.11.5.26 The sensitivity of the diadromous fish and shellfish IEFs can be found in the construction phase assessment (**paragraph 3.11.5.16** to **paragraph**

3.11.5.17) and this will equally apply in the operation and maintenance phase. The sensitivity of these IEFs is therefore **low**.

Magnitude of impact

3.11.5.27 Maintenance activities within the study area may lead to increases in SSC and associated sediment deposition over the expected 35-year operational lifetime of the Transmission Assets. The MDS describes one repair event for each of the six export cables every 10 years (21 repair events in total) affecting up to 4 km per repair event. The MDS also describes the reburial of 4 km of Morgan offshore export cable in one event every five years (seven reburial events in total) and 1.7 km of Morecambe offshore export cable in one event every five years (seven reburial events in total).

3.11.5.28 The magnitude of the impacts would be a fraction of those quantified for the construction phase. The sediment plumes and sedimentation footprints would be dependent on which section of the cable is being repaired and the kind of sediment that the repairs took place in however, for the purposes of this assessment, the impacts of the operation and maintenance activities (i.e., cable repair and reburial) are predicted to be no greater than those for construction.

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

Significance of effect

Marine species

3.11.5.30 Overall, the sensitivity is **low** for the majority of fish and shellfish IEFs and the magnitude of the impact is **negligible**. This gives rise to an impact significance of negligible or minor adverse significance. Based on the low frequency of repair and reburial events predicted for the operation and maintenance phase, and the high degree of reversibility, the effect will, therefore, be of **negligible** significance, which is not significant in EIA terms.

3.11.5.31 Overall, the sensitivity for herring is **medium** and the magnitude of the impact is **negligible**. This gives rise to an impact significance of negligible or minor adverse significance. Based on the low frequency of repair and reburial events predicted for the operation and maintenance phase, and the high degree of reversibility, but considering the higher sensitivity of herring, the effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Diadromous species

3.11.5.32 Overall, the sensitivity of the receptor is **low** and the magnitude of the impact is **negligible**. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This is due to the short range, short term, intermittent nature of the impact being unlikely to affect migration to or from key rivers and the tolerance of diadromous fish to higher SSC.

Decommissioning

Sensitivity of receptor

Marine species

3.11.5.33 The sensitivity of the marine fish and shellfish IEFs can be found in the construction phase assessment (**paragraph 3.11.5.3** to **paragraph 3.11.5.15**) and these will equally apply in the decommissioning phase. The sensitivity of these IEFs is therefore **low** to **medium.**

Diadromous species

3.11.5.34 The sensitivity of the diadromous fish and shellfish IEFs can be found in the construction phase assessment (**paragraph 3.11.5.16** to **paragraph 3.11.5.17**) and this will equally apply in the decommissioning phase. The sensitivity of these IEFs is therefore **low**.

Magnitude of impact

3.11.5.35 Offshore export cables will be removed and disposed of onshore. Any cable protection will remain *in situ*.

3.11.5.36 For the purpose of this assessment, the impacts of decommissioning activities are therefore predicted to be no greater than those for construction. In actuality, the release of sediment in the decommissioning phase will be lower than the construction phase as it does not include seabed preparation.

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

Significance of effect

Marine species

3.11.5.38 Overall, the sensitivity is **low** for the majority of fish and shellfish IEFs and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.5.39 Overall, the sensitivity for herring is **medium** and the magnitude of the impact is **low**. The effect will, therefore, be **of minor adverse** significance, which is not significant in EIA terms.

Diadromous species

3.11.5.40 Overall, the sensitivity of the receptor is **low** and the magnitude of the impact is **low**. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This is due to the short range, short term, intermittent nature of the impact being unlikely to affect migration to or from key rivers and the tolerance of diadromous fish to higher SSC.

3.11.6 Long term habitat loss

3.11.6.1 The construction, operation and maintenance, and decommissioning activities of the Transmission Assets may lead to long term habitat loss. The MDS is represented by the installation and presence of cable and cable crossing protection and is summarised in **Table 3.13**. While this assessment considers long term habitat loss, in reality the impact will be represented not by a loss of habitat, but rather a change in a sedimentary habitat and replacement with hard artificial substrata (i.e., 'Physical change to another seabed type', as defined by Marine Evidence-based Sensitivity Assessment. While the habitat loss effects are considered in this section, the potential impact from the introduction of these hard substrata on fish and shellfish IEFs is considered in **section 3.11.8** below.

Construction phase

Sensitivity of receptor

Marine species

3.11.6.2 Fish and shellfish species that are reliant upon the presence of suitable sediment/habitat for their survival are typically more vulnerable to change depending on the availability of habitat within the wider geographical region. The seabed habitats removed by the installation of infrastructure within the Offshore Order Limits will reduce the amount of suitable habitat and available food resources for fish and shellfish species and communities associated with the baseline sediments, however this area represents a low percentage compared with the extensive nature of fish and shellfish habitats (e.g., for spawning, nursery, feeding or overwintering) located within the study area.

3.11.6.3 As confirmed by the detailed baseline characterisation (see **section 3.6**), the study area coincides with fish spawning and nursery habitats including plaice, sole, lemon sole, herring, sprat, European hake, ling, whiting, cod, haddock, sandeel, horse mackerel, mackerel, *Nephrops* and a range of elasmobranchs (Coull *et al.,* 1998; Ellis *et al.,* 2012; Aires *et al.,* 2014; see **section 3.6** and Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES).

3.11.6.4 The fish species most vulnerable to long term habitat loss include sandeel and herring, which are demersal spawning species (i.e., eggs are laid on the seabed), as these have specific habitat requirements for spawning (e.g., sandy sediments for sandeel and coarse, gravelly sediments for herring). Demersal-spawning elasmobranchs tend to have low intensity spawning grounds in the study area (see Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES) which extend well beyond the project boundaries and thus are unlikely to be significantly impacted by long term habitat loss. The study area is also located in the vicinity of known high and low intensity herring spawning habitat (see **section 3.6**). These occur primarily outside the Offshore Order Limits and therefore will not be negatively affected directly by long term habitat loss from project infrastructure.

3.11.6.5 Sandeel also have specific habitat requirements throughout their juvenile and adult life history, as well as being demersal spawners and loss of this specific type of habitat through construction and presence of infrastructure could represent an impact on this species. However, monitoring at Horns Rev I, located off the Danish coast, has indicated that the presence of operational wind farm structures has not led to significant adverse effects on sandeel populations in the long term (van Deurs *et al.,* 2012; Stenberg *et al*., 2011). Initial results of a pre- to post-construction monitoring study have reported that in some areas of the Beatrice Offshore Wind Farm, located in the north west of the North Sea, there was an increase in sandeel abundance (BOWL, 2021a). The findings of a single monitoring study are not able to categorically confirm the conclusion that offshore wind developments are beneficial to sandeel populations; however, it does provide additional evidence that there is no adverse effect on sandeel populations.

3.11.6.6 The study area coincides with high intensity sandeel spawning habitat (Ellis *et al.,* 2012) as confirmed by benthic site-specific surveys (see Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES for habitat distribution and suitability). The presence of offshore wind farm infrastructure will result in direct impacts on this habitat within the Offshore Order Limits, though as detailed above the proportion of habitat affected within the Transmission Assets is small and this area is smaller still in the context of the understood preferred and mapped sandeel habitats (including spawning and nursery habitats) based upon published literature and site-specific surveys in the study area.

3.11.6.7 Monitoring at Belgian offshore wind farms has reported that fish assemblages undergo no drastic changes due to the presence of offshore wind farms and their associated infrastructure (e.g. external cable protection) providing hard substrata (Degraer *et al.,* 2020). They reported slight, but significant increases in the density of some common soft sediment-associated fish species (common dragonet, solenette, lesser weever *Echiichthys vipera* and plaice) within the offshore wind farm (Degraer *et al.,* 2020). There was also some evidence of increases in numbers of species associated with hard substrata, including crustaceans (including edible crab), sea bass *Dicentrarchus labrax* and common squid *Alloteuthis subulata* (potentially an indication that foundations, or other hard substrata introduced as part of the project infrastructure, were being used for egg deposition; Degraer *et al.,* 2020). The author noted that these effects were site specific and therefore may not necessarily be extrapolated to other offshore wind farms, although this does indicate that the presence of artificial hard substrata from offshore wind farm infrastructure (including cable protection) does not lead to adverse, population-level effects.

3.11.6.8 More specific to the Irish Sea, the year three post-construction survey of introduced structures in the Walney Extension Wind Farm found the development of mussel and barnacle communities around introduced hard structures (CMACS, 2014b). This represents a changed species composition compared to the previous sedimentary communities, but this is unlikely to be highly significant in terms of ecosystem function, with only a slight overall reduction in biodiversity noted during post-construction surveys, with a slowly recovering trend towards baseline community diversity noted.

3.11.6.9 The Offshore Order Limits also directly overlaps grounds considered important to fishing and spawning of the commercially important queen and king scallop (see Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES for full details on known habitat distribution and suitability). Construction has the potential to directly damage these fishing and spawning grounds, but the potential is known to exist for recovery and increased maturity of the overall population due to decreased fishing pressure following completion of construction, with no significant change in resilience (Raoux *et al.,* 2019). Long term loss of habitat directly around the cables represent only a very small proportion of habitat available within study area and so are unlikely to cause significant impacts on the wider scallop populations.

3.11.6.10 Larger crustacea (e.g., *Nephrops* and European lobster) are classed as equilibrium species (Newell *et al.,* 1998) and are only capable of recolonising an area once the original substrate type has returned. The sensitivity of these fish and shellfish IEFs is therefore higher than for smaller benthic organisms which move in and colonise new substrate immediately after the effect. Therefore, recovery of European lobster surrounding lost habitats may take up to ten years in some areas of coarse sediments (Phua *et al.,* 2002). A recent study undertaken during construction of the Westermost Rough Offshore Wind Farm located on the north east coast of England, within a European lobster fishing ground, found that the size and abundance of European lobster individuals increased following temporary closure of the area for construction of the windfarm. This study indicates that the activities associated with construction of the wind farm, which included installation of cables, did not negatively impact on resident European lobster populations and instead allowed some respite from fishing activities for a short time-period before reopening following construction (Roach *et al.,* 2018).

3.11.6.11 *Nephrops* spawning and nursery habitat overlaps with the Generation Assets (i.e., within the Offshore Order Limits), with wider spawning habitats of undetermined intensity throughout the study area (please refer to Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES, for figures). Long term habitat loss is predicted to affect a small proportion of this habitat. Levels of impact on *Nephrops* offshore Irish Sea fishing grounds are known to be correlated directly to the intensity and frequency of the disturbance event (Ball *et al.,* 2000). As the proportion of the Transmission Assets affected by long term habitat loss is small and the proportion of *Nephrops* habitat available elsewhere in the study area is high, the overall impact of long term habitat loss is likely to be low.

3.11.6.12 Most fish and shellfish ecology IEFs in the study area are deemed to be of low vulnerability, high recoverability and local to national importance. The sensitivity of the receptor is **low**.

3.11.6.13 King and queen scallop are deemed to be of medium vulnerability, high recoverability and of regional importance. The sensitivity of the receptor is **low**.

3.11.6.14 European lobster and *Nephrops* are deemed to be of high vulnerability, medium to high recoverability and of regional importance. The sensitivity of these fish and shellfish IEFs is therefore **medium**.

3.11.6.15 Sandeel are deemed to be of high vulnerability, high recoverability and of regional importance. The sensitivity of sandeel is therefore **medium**.

3.11.6.16 Herring are deemed to be of high vulnerability, medium recoverability and of national importance. The sensitivity is therefore **high**.

Diadromous species

3.11.6.17 Diadromous fish species are highly mobile and therefore are generally able to avoid areas subject to long term subtidal habitat loss. Diadromous species that are likely to interact with the study area are only likely to do so by passing through the area during migrations to and from rivers located on the west coast of England and Wales (e.g., those designated sites with diadromous fish species listed as qualifying features; see **Table 3.7** and Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES). The habitats within the study area are not expected to be particularly important for diadromous fish species and therefore habitat loss during the construction and operation and maintenance phases of the Transmission Assets is unlikely to cause any direct impact to diadromous fish species and would not affect migration to and from rivers.

3.11.6.18 Indirect impacts on diadromous fish species may occur due to impacts on prey species, for example sandeel population impacts affecting food supplies to sea trout. As outlined previously for marine species, the majority of large fish species would be able to avoid habitat loss effects due to their greater mobility and would recover into the areas affected following cessation of construction. Sandeel (and other less mobile prey species) would be affected by long term subtidal habitat loss, although recovery of this species is expected to occur quickly (as the sediments recover following installation of infrastructure and adults recolonise) and also via larval recolonisation of the sandy and gravelly sediments which dominate the study area. These sediments are known to recover quickly following cable installation (RPS, 2019).

3.11.6.19 Diadromous fish species are deemed to be of low vulnerability, high recoverability and national to international importance. The sensitivity of the receptor is considered **low**.

Magnitude of impact

3.11.6.20 The presence of the Transmission Assets infrastructure within the study area will result in long term habitat loss. The MDS is for up to 576,500 m^2 of long term habitat loss due to the installation of cable protection and cable crossing protection (**Table 3.13**). This represents 0.096% of the Offshore Order Limits. The MDS for long term habitat loss is for the sequential construction scenario as this equates to the greatest time over which long term habitat loss may occur. It should be noted however, that the total extent of long term habitat loss is the same for both the concurrent and sequential scenarios.

3.11.6.21 Cable protection may account for up to 484,000 m^2 of long term habitat loss. The MDS assumes up to 10% of the 400 km of Morgan offshore export cables and 10% of the 84 km of Morecambe offshore export cables would require cable protection with a cable protection width of 10 m in both cases.

Additionally, cable crossing protection may result in up to 92,500 m^2 of long term habitat loss. Cable protection may be required for 41 crossings per cable for Morgan offshore export cables and six crossings per cable for the Morecambe offshore export cables.

3.11.6.22 Long term subtidal habitat loss impacts will occur during the construction phase and will be continuous from the date of installation of infrastructure.

3.11.6.23 For most fish and shellfish IEFs, the impact is predicted to be of local spatial extent, long term duration, continuous and irreversible during the operation and maintenance phase. It is predicted that the impact will affect the receptor directly. The magnitude is therefore **low**.

3.11.6.24 For herring, the impact is predicted to be of local spatial extent, long term duration, continuous and irreversible during the operation and maintenance phase which would normally give rise to a magnitude of low. However, due to the low proportions of substrate suitable for herring spawning within the Offshore Order Limits, the magnitude to herring is considered to be **negligible**.

Significance of effect

Marine species

3.11.6.25 Overall, the sensitivity of most fish IEFs is **low** and the magnitude of the impact **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.6.26 For king and queen scallop, the sensitivity of the receptor is **low** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.6.27 For European lobster and *Nephrops*, the sensitivity of the receptor is **medium** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.6.28 For sandeel, the sensitivity of the receptor is **medium** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.6.29 For herring, the sensitivity of the receptor is **high** and the magnitude of the impact is **negligible**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Diadromous species

3.11.6.30 Overall, the sensitivity of the receptor is **low** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Operation and maintenance

Sensitivity of receptor

Marine species

3.11.6.31 The sensitivity of the marine fish and shellfish IEFs can be found in the construction phase assessment (**paragraph 3.11.6.2** to **paragraph 3.11.6.16**), ranging from low to medium sensitivity and these will equally apply in the 35-year operation and maintenance phase. The sensitivity of the receptor is **low to high**.

Diadromous species

3.11.6.32 The sensitivity of the diadromous fish and shellfish IEFs can be found in the construction phase assessment (**paragraph 3.11.6.17** to **paragraph 3.11.6.19**), with low sensitivity and this will equally apply in the 35-year operation and maintenance phase. The sensitivity of the receptor is **low.**

Magnitude of impact

3.11.6.33 The impacts of long term habitat loss are likely to be identical to those introduced during the construction phase of the Transmission Assets, with the impacts predicted to be continuous over the 35-year operational period.

3.11.6.34 For most fish and shellfish IEFs the impact is predicted to be of local spatial extent, long term duration, continuous and irreversible during this phase. It is predicted that the impact will affect the receptor directly. The magnitude is therefore **low**.

3.11.6.35 For herring, the impact is predicted to be of local spatial extent, long term duration, continuous and irreversible during the operation and maintenance phase which would normally give rise to a magnitude of low. However, due to the low proportions of substrate suitable for herring spawning within the Offshore Order Limits, the magnitude to herring is considered to be **negligible**.

Significance of effect

Marine species

3.11.6.36 Overall, the sensitivity of most fish IEFs is **low** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.6.37 For king and queen scallop, the sensitivity of the receptor is **low** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.6.38 For European lobster and *Nephrops*, the sensitivity of the receptor is **medium** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.6.39 For sandeel, the sensitivity of the receptor is **medium** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.6.40 For herring, the sensitivity of the receptor is **high** and the magnitude of the impact is **negligible**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Diadromous species

3.11.6.41 Overall, the sensitivity of the receptor is **low** and the magnitude of the impact is **low**. The overlap of the effect with these receptors will be very low and will therefore be of **minor adverse** significance, which is not significant in EIA terms.

Decommissioning

Sensitivity of receptor

Marine species

3.11.6.42 The sensitivity of the marine fish and shellfish IEFs can be found in the construction phase assessment (**paragraph 3.11.6.2** to **paragraph 3.11.6.16**), ranging from low to medium sensitivity and these will equally apply in the decommissioning phase. The sensitivity of the receptor is **low to high**.

Diadromous species

3.11.6.43 The sensitivity of the diadromous fish and shellfish IEFs can be found in the construction phase assessment (**paragraph 3.11.6.17** to **paragraph 3.11.6.19**), with low sensitivity and this will equally apply in the decommissioning phase. The sensitivity of the receptor is **low.**

Magnitude of impact

3.11.6.44 Decommissioning will involve leaving the introduced cable protection and cable crossing protection in place, representing up to 576,500 m^2 of permanent subtidal habitat loss (i.e., 0.096% of the area of Offshore Order Limits).

3.11.6.45 The impact is predicted to be of local spatial extent, permanent and irreversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore **low**.

3.11.6.46 For herring, the impact is predicted to be of local spatial extent, long term duration, continuous and irreversible during the operation and maintenance phase which would normally give rise to a magnitude of low. However, due to the low proportions of substrate suitable for herring spawning within the Offshore Order Limits, the magnitude to herring is considered to be **negligible**.

Significance of effect

Marine species

3.11.6.47 Overall, the sensitivity of most fish IEFs is **low** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.6.48 For king and queen scallop, the sensitivity of the receptor is **low** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.6.49 For European lobster and *Nephrops*, the sensitivity of the receptor is **medium** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.6.50 For sandeel, the sensitivity of the receptor is **medium** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.6.51 For herring, the sensitivity of the receptor is **low** and the magnitude of the impact is **negligible**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Diadromous species

3.11.6.52 Overall, the sensitivity of the receptor is **low** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.7 EMF from subsea electrical cabling

3.11.7.1 The operation and maintenance activities on the Transmission Assets may lead to impacts from EMFs emitted from subsea electrical cabling. The MDS is represented by the presence and operation of the offshore export cables and is summarised in **Table 3.13**.

Operation and maintenance

Sensitivity of receptor

Marine species

3.11.7.2 Fish and shellfish species (particularly elasmobranchs) can detect applied or modified magnetic fields. Species for which there is evidence of a response to E and/or B fields include elasmobranchs (shark, skate and ray), plaice (Gill *et al.,* 2005; CSA, 2019) and crustaceans such as crab (Scott *et al.,* 2021). It can be inferred that the life functions supported by an electric haptic sense (Caputi *et al*., 2013) may include detection of prey, predators or conspecifics in the local environment (Pedraja *et al*., 2018) to assist with feeding, predator avoidance and social or reproductive behaviours. Life functions supported by a magnetic sense may include orientation, homing and navigation to assist with long or short-range migrations or movements (Gill *et al.,* 2005; Normandeau *et al.,* 2011, Formicki *et al.,* 2019).

3.11.7.3 Studies examining the effects of EMF from Alternating Current (AC) undersea power cables on fish behaviours have been conducted to determine the thresholds for detection and response to EMF. **Table 3.19** provides an up-to-date summary of the scientific studies conducted to assess sensitivity of EMF on varying fish species.

Table 3.19: Relationship between geomagnetic field detection, electrosensitivity and the ability to detect 50/60 Hz AC fields in common marine fish and shellfish species (adapted from CSA, 2019).

Species group	Detect geomagnetic field	Detect electric field	Evidence from laboratory studies of 50/60 Hz EMF from AC power cables	Evidence from field studies of AC power cables
Skate	Yes, multiple species (Normandeau *et al.,* 2011)	Yes, multiple species (Normandeau *et al.,* 2011)	No responses expected at 60 Hz (Kempster *et al*., 2013)	No attraction at California AC cable sites operating at up to 914 mG (Love *et al.*, 2016).
Flounder	Potentially, due to observed orientation behaviours (Metcalfe *et al.*, 1993)	Not tested	Not tested	No population-level effects, but some evidence of delayed cable crossing. It is unclear whether effect was due to cable EMF or prior sediment disturbance (Vattenfall and Skov-og, 2006).
Tuna and mackerel	Yes, for some species (Walker, 1984)	Not tested (Normandeau *et al.*, 2011)	Not tested	Some evidence of attraction of mackerel to monopile structure, but no effect from cables (Bouma and Lengkeek, 2008).
Lobster and crab	Yes, for some lobster species (Lohmann *et al.*, 1995; Hutchison *et al.,* 2018)	Not tested (Normandeau *et al.,* 2011)	No effect at 800,000 µT (Ueno *et al.,* 1986)	Distribution unaffected by 60 Hz AC cable operating up to 800 mG (Love *et al.*, 2017).

3.11.7.4 A number of field studies have observed behaviours of fish and other species around AC submarine cables in the USA (see citations in **Table 3.19**). Observations at three energized 35 kV AC undersea power cable sites off the coast of California that run from three offshore platforms to shore, which are unburied along much of the route, did not show that fish were repelled by or attracted to the cables (Love *et al*., 2016). A study investigating the effect of EMF on lesser sandeel larvae spatial distribution found that there was no effect on the larvae (Cresci *et al*., 2022) and a prior study concluded the same for herring (Cresci *et al*., 2020).

3.11.7.5 Elasmobranchs (i.e., shark, skate and ray) are known to be the most electro-receptive of all fish. These species possess specialised electro-receptors which enable them to detect very weak voltage gradients (down to 0.5 µV/m) in the environment, naturally emitted from their prey (Gill *et al*., 2005). Both attraction and repulsion reactions to electrical fields have been observed in elasmobranch species. Spurdog, an elasmobranch species known to occur within the study area, avoided electrical fields at 10 μV/cm (Gill and Taylor, 2001), although it should be noted that this level (i.e., 10 μV/cm is equivalent to 1,000 μV/m) is considerably higher than levels associated with offshore electrical cables. A Collaborative Offshore Wind Research into the Environment (COWRIE)-sponsored mesocosm study demonstrated that the lesser-spotted dogfish and thornback ray were able to respond to EMF of the type and intensity associated with subsea cables; the responses of some ray individuals suggested a greater searching effort when the cables were switched on (Gill *et al*., 2009). However, the responses were not predictable and did not always occur (Gill *et al*., 2009). In another study, EMF from 50/60 Hz AC sources appears undetectable in elasmobranchs. Kempster and Colin (2011) have noted the physiological capacity for detection of EMFs in basking shark, known to migrate through the study area, but no current evidence exists on specific impacts of EMFs of any strength on this species, apart from the likely detection capacity of a standard electrical field benchmark level of 1 V/m (Wilding *et al.,* 2020). More generally, Kempster *et al. (*2013) reported that small shark could not detect EMF produced at 20 Hz and above and Hart and Collin (2015) found no significant repellent effect of a magnetic field of 14,800 G (1.4 T) on shark catch rates, suggesting a low sensitivity to these fields.

3.11.7.6 Crustacea, including lobster and crab, have been shown to demonstrate a response to B fields, with the Caribbean spiny lobster *Panulirus argus* shown to use a magnetic map for navigation (CSA, 2019). EMF exposure has been shown to result in varying egg volumes for edible crab compared to controls. Exposed larvae were significantly smaller, but there were no statistically significant differences in hatched larval numbers, deformities, mortalities, or fitness (Scott, 2019). Exposure to EMF has also been shown to affect a variety of physiological processes within crustaceans. For example, Lee and Weis (1980) demonstrated that EMF exposure affected moulting in fiddler crab (*Uca pugilator* and *Uca pugnax*). Several studies have also suggested that EMFs affect serotonin regulation which may affect the internal physiology of crustaceans potentially leading to behavioural changes, although such changes have not been reported (Atema and Cobb, 1980; Scrivener, 1971).

3.11.7.7 Crab movement and location inside large cages has been reported to be unaffected by proximity to energized AC undersea power cables off south California and in Puget Sound, indicating crab also were not attracted to or repelled by energized AC undersea power cables that were either buried or unburied (Love *et al*., 2016) and no significant change in distance or speed of travel over time when American lobster *Homarus americanus* were exposed to 53 μT to 65 μT (Hutchison *et al*., 2020). However, studies on the Dungeness crab and edible crab have reported behavioural changes during exposure to increased EMF and both species showed increased activity when compared to crab that were not exposed (Scott *et al*., 2018; Woodruff *et al*., 2012). Crab may also spend less time buried, which is normally a natural predator avoidance behaviour (Rosaria and Martin, 2010) and some species have been noted not to cross undersea cables (Love *et al*., 2017), potentially reducing habitats available for predation.

3.11.7.8 It is uncertain if other crustaceans including commercially important European lobster and *Nephrops* respond to magnetic fields in this way. Limited research undertaken with the European lobster found no neurological response to magnetic field strengths considerably higher than those expected directly over an average buried power cable (Normandeau *et al*., 2011; Ueno *et al*., 1986). A field study by Hutchison *et al*. (2018) observed the behaviour of American lobster (a magneto-sensitive species) to Direct Current (DC) and AC fields from a buried cable and found that it did not cause a barrier to movement or migration, as both species were able to freely cross the cable route. However, American lobster were observed to make more turns when near the energised cable. Adult American lobster have been shown to spend a higher percentage of time within shelter when exposed to EMF. European lobster exposed to EMF have also been found to have a significant decrease in egg volume at later stages of egg development and more larval deformities (Scott *et al.*, 2020).

3.11.7.9 Scott *et al*. (2020) presents a review of the existing papers on the impact of EMF on crustacean species. Of the papers reviewed by Scott *et al*. (2020), three studied EMF effects on fauna in the field, the rest were laboratory experiments which directly exposed the target fauna to EMF (Scott *et al*., 2020). These laboratory experiments, while giving us an indication of crustacean behaviour to EMF, may be less applicable in the context of subsea cables in the marine environment. Of the field experiments, one demonstrated that lobster have a magnetic compass by tethering lobster inside a magnetic coil (Lohmann *et al*., 1995), one focused on freshwater crayfish and put magnets within the crayfish hideouts (Tański *et al*., 2005) and the last one looked at shore crab at an offshore wind farm and found no adverse impact on the population. The two former papers may not be directly applicable to offshore wind farm subsea cables and the latter found no adverse impact on the population of shore crab from the offshore wind farm (Langhamer *et al*., 2016).

3.11.7.10 Further research by Scott *et al.* (2021) found that physiological and behavioural impacts on edible crab occurred at 500 μT and 1000 μT, causing disruption to the L-Lactate and D-Glucose circadian rhythm and altering total haemocyte count and also causing attraction to EMF exposed areas and reduced roaming time. However, these physiological and behavioural effects did not occur at 250 μT. Seeing as even in the event of an unburied cable the maximum magnetic field reported was 78.27 μT (Normandeau *et al.*, 2011), it can be assumed that the magnetic fields generated by the Transmission Assets cables will be lower than 250 μT and therefore will not present any adverse effects on edible crab. Harsanyi *et al*. (2022) noted that chronic exposure to EMF effects could lead to physiological deformities and reduced swimming test rates in lobster and edible crab larvae. However, these deformities were in response to EMF levels of 2,800 μT and therefore are considerably higher than EMF effects expected for buried cables. The report recommends burying of cables associated with the Outline Offshore CSIP (CoT45) in line with the designed in mitigation measures outlined in **Table 3.12** in order to reduce any potential impacts**.**

3.11.7.11 In summary, the range over which these species can detect electric fields is limited to a scale of metres around electrical cables buried to a target depth of 0.9 m to 1.8 m (CSA, 2019). Pelagic species (species which live and feed within the water column) generally swim well above the seafloor and can be expected to rarely be exposed to the EMF at the lowest levels from AC undersea power cables buried in the seafloor, resulting in impacts that would therefore be localised and transient. Demersal species (e.g., elasmobranchs) that dwell on the bottom, will be closer to the undersea power cables and thus encounter higher EMF levels when near the cable. Demersal species and shellfish are also likely to be exposed for longer periods of time and may be largely constrained in terms of location. However, the rapid decay of the EMF with horizontal distance (Bochert and Zettler, 2006) (i.e., within metres) minimises the extent of potential impacts. Finally, fish that can detect the Earth's magnetic field are unlikely to be able to detect magnetic fields produced by 50/60 Hz AC power cables and therefore these species are unlikely to be affected in the field (CSA, 2019).

3.11.7.12 Most marine fish and shellfish ecology IEFs in the study area are deemed to be of low vulnerability, high recoverability and local to national importance. The sensitivity of the receptor is therefore **low**.

3.11.7.13 Decapod crustaceans and elasmobranchs in the study area are deemed to be of medium vulnerability, high recoverability and local to national importance. The sensitivity of the receptor is therefore **medium**.

Diadromous species

3.11.7.14 EMFs may also interfere with the navigation of sensitive diadromous species. Species for which there is evidence of a response to E and/or B fields include river lamprey, sea lamprey, European eel and Atlantic salmon (Gill *et al*., 2005; CSA, 2019). Effects of EMFs surrounding undersea cables on allis shad, twaite shad and European smelt are currently poorly researched, with recommendations made to investigate these potential effects in future (Gill *et al*., 2012; noting that shad species are pelagic and therefore unlikely to interact with EMF from installed cables). Lamprey possess specialised ampullary electroreceptors that are sensitive to weak, low frequency electric fields (Bodznick and Northcutt, 1981; Bodznick and Preston, 1983), which are hypothesised to be used for prey-detection, although further research is required in this area (Tricas and Carlston, 2012). Chung-Davidson *et al*. (2008) found that weak electric fields may play a role in the reproduction of sea lamprey and it was suggested that electrical stimuli mediate different behaviours in feeding-stage and spawning-stage individuals. This study showed that migration behaviour of sea lamprey was affected (i.e., adults did not move) when stimulated with electrical fields of intensities of between 2.5 mV/m and 100 mV/m with normal behaviour observed at electrical field intensities higher and lower than this range (Chung-Davidson *et al*., 2008). It should be noted, however, that these levels are considerably higher than modelled induced electrical fields expected from AC subsea cables (see **Table 3.21**). There is currently no evidence of lamprey responses to magnetic B fields (Gill and Bartlett, 2010).

3.11.7.15 Atlantic salmon and European eel have both been found to possess magnetic material of a size suitable for magnetoreception and these species can use the earth's magnetic field for orientation and direction-finding during migration (Gill and Bartlett, 2010; CSA, 2019). Mark and recapture experiments undertaken at the Nysted operational offshore wind farm showed that eel did cross the offshore export cable (Hvidt *et al*., 2003). Studies on European eel in the Baltic Sea have highlighted some limited effects of subsea cables (Westerberg and Lagenfelt, 2008), with evidence of direct detection of EMF through the lateral line of this species (Moore and Riley, 2009). The swimming speed during migration was shown to change in the short term (tens of minutes) with exposure to AC electric subsea cables, even though the overall direction remained unaffected (Westerberg and Langenfelt, 2008). The authors concluded that any delaying effect (i.e., on average 40 minutes) would not be likely to influence fitness in a 7,000 km migration, with little to no impact on migratory behaviour noted beyond 500 m from wind farm development infrastructure (Ohman *et al*., 2007). Research in Sweden on the effects of a High Voltage Direct Current cable on the migration patterns of a range of fish species, including salmonids, failed to find any effect (Westerberg *et al*., 2007; Wilhelmsson *et al*., 2010). Research conducted at the Trans Bay cable, a DC undersea cable near San Francisco, California, found that migration success and survival of chinook salmon *Oncorhynchus tshawytscha* was not impacted by the cable. However, as with the Hutchison *et al*. (2018) study on lobster, behavioural changes were noted when these fish were near the cable (Kavet *et al*., 2016) with salmon appearing to remain around the cable for longer periods. These studies demonstrate that while DC undersea power cables can result in altered patterns of fish behaviour, these changes are temporary and do not interfere with migration success or population health.

3.11.7.16 **Table 3.20** provides a summary of the scientific studies conducted to assess sensitivity of EMF on varying diadromous fish species.

Table 3.20: Relationship between geomagnetic field detection electrosensitivity and the ability to detect 50/60 Hz AC fields in diadromous fish species (adapted from CSA, 2019).

Group	Detect geomagnetic field	Detect electric field	Evidence from laboratory studies of 50/60 Hz EMF from AC power cables	Evidence from field studies of AC power cables
American/European Eel	Yes, for multiple species (Normandeau *et al.*, 2011)	Mixed evidence (Normandeau *et al.*, 2011)	No effect of 950 mG magnetic field at 50 Hz on swim behaviour or orientation (Orpwood *et al.*, 2015)	Unburied AC cable did not prevent migration of eel (Westerberg *et al.*, 2007).
Salmon	Yes, for multiple species (Yano *et al.*, 1997, Putman *et al.*, 2014)	Not tested (Normandeau *et al.*, 2011)	No effect of 950 mG magnetic field at 50 Hz on swim behaviour (Armstrong *et al.*, 2015)	Not surveyed.

3.11.7.17 Diadromous fish IEFs in the study area are deemed to be of low vulnerability, high recoverability and national to international importance. The sensitivity of the receptor is therefore **low**.

Magnitude of impact

3.11.7.18 EMF comprise both the electrical fields, measured in volts per metre (V/m) and the magnetic fields, measured in microtesla (μT) or milligauss (mG). Background measurements of the magnetic field are approximately 50 μT (equivalent to 500 mG) for example in the North Sea and Irish Sea (Tasker *et al.*, 2010; Eirgrid, 2015). It is common practice to block the direct electrical field using conductive sheathing, meaning that the only EMFs that are emitted into the marine environment are the magnetic field and the resultant induced electrical field. It is generally considered impractical to assume that cables can be buried at depths that will reduce the magnitude of the magnetic field and hence the sediment-sea water interface induced electrical field, to below that at which these fields could be detected by certain marine organisms on or close to the seabed (Gill *et al*., 2005; Gill *et al.*, 2009). By burying a cable, the magnetic field at the seabed is reduced due to the distance between the cable and the seabed surface, as a result of field decay with distance from the cable (CSA, 2019).

3.11.7.19 A variety of design and installation factors affect EMF levels in the vicinity of the cables. These include current flow, distance between cables, cable insulation, number of conductors, configuration of cable and burial depth. The flow of electricity associated with an AC cable changes direction (as per the frequency of the AC transmission) and creates a constantly varying electric field in the surrounding marine environment (Huang, 2005).

3.11.7.20 The strength of the magnetic field (and consequently, induced electrical fields) decreases rapidly horizontally and vertically with distance from source.

A recent study conducted by CSA (2019) found that inter-array and offshore export cables buried between depths of 1 m to 2 m reduces the magnetic field at the seabed surface four-fold. For cables that are unburied and instead protected by thick concrete mattresses or rock berms, the field levels were found to be similar to buried cables.

3.11.7.21 CSA (2019) investigated the link relationship between voltage, current and burial depth, the results of which are presented in **Table 3.21** which shows the magnetic and induced electric field levels expected directly over the undersea power cables and at distance from the cable for varying cable types. Directly above the cable, EMF levels decrease with increased distance from the seafloor to 1 m above the cable, while laterally away from the cable (i.e., at distances greater than 3 m), the magnetic fields at the seafloor and at 1 m above the seafloor are comparable.

Table 3.21: Typical magnetic field levels over AC undersea power cables (buried at target depth of 0.9 m to 1.8 m) from offshore wind energy projects (CSA, 2019)

Power cable type	Directly above cable		3 m to 7.5 m laterally away from cable	
	1 m above seafloor	At seafloor	1 m above seafloor	At seafloor
Magnetic field levels (mG)				
Inter-array cable	5 to 15	20 to 65	<0.1 to 7	<0.1 to 10
Export cable	10 to 40	20 to 165	<0.1 to 12	1 to 15
Induced electric field levels (mV/m)				
Inter-array cable	0.1 to 12	1 to 1.7	0.01 to 0.9	0.01 to 1.1
Export cable	0.2 to 2	1.9 to 3.7	0.02 to 1.1	0.04 to 1.3

3.11.7.22 During the operation and maintenance phase, 484 km cables of 220 kV or 275 kV HVAC offshore export cables (**Table 3.13**). The minimum burial depth for cables will be 0.5 m and the operation and maintenance phase is expected to last up to 35 years. Cables will also require cable protection at asset crossings (up to 41 crossings for the Morgan export cables and up to six cable crossings for the Morecambe export cables).

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3.11.7.24 The impact is predicted to be of local spatial extent, long term duration, continuous and of high reversibility (when the cables are decommissioned). It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **low**.

Significance of effect

Marine species

3.11.7.25 Overall, the sensitivity of most fish and shellfish IEFs is **low** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.7.26 The sensitivity of decapod crustaceans and elasmobranch IEFs is **medium** and the magnitude of impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Diadromous species

3.11.7.27 Overall, the sensitivity of diadromous fish IEFs is **low** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.8 Introduction and colonisation of hard substrata

3.11.8.1 The construction and operation and maintenance activities of the Transmission Assets through the installation of cable protection and cable crossing protection will lead to introduction of hard substrata with consequent effects on fish and shellfish populations. The MDS is summarised in **Table 3.13**. These effects are likely to continue beyond the decommissioning phase of the project in the case cable protection is left *in situ* post decommissioning (discussed in further detail below).

All phases

Sensitivity of receptor

Marine species

3.11.8.2 Hard substrata habitat created by the introduction of cable protection is likely to be primarily colonised within hours or days after installation by demersal and semi-pelagic fish species (Andersson, 2011), with more complex communities later likely attracted to the developing algal and suspension feeding communities as potential new sources of food (Karlsson *et al*., 2022). Continued colonisation has been seen for a number of years after the initial construction phase, until a stratified recolonised population is formed (Krone *et al*., 2013), subject to natural seasonal variability, but still representing a significant change from the baseline sedimentary environment (Kerckhof *et al*., 2010). Feeding opportunities or the prospect of encountering other individuals in the newly introduced heterogenous environment (Langhamer, 2012) may attract fish aggregations from the surrounding areas, which may increase the carrying capacity of the area in the long term (Andersson and Öhman, 2010; Bohnsack, 1989).

3.11.8.3 The dominant natural substrate character of the study area (largely sandy gravel and gravelly sand) will determine the number of new species found on the introduced hard surfaces. When placed on an area of seabed which is already characterised by typically high diversity rocky substrates, few species will be added to the area, but the increase in total hard substrata could sustain higher abundances (Andersson and Öhman, 2010). Conversely, when placed on a soft or sedimentary seabed, as will occur in this case, most of the colonising fish will be normally associated with rocky (or other hard bottom) habitats, thus the overall diversity of the area may increase (Andersson *et al*., 2009). A new baseline species assemblage will be formed via recolonisation and the original soft-bottom population will be displaced (Desprez, 2000). This was observed in studies by Leonhard *et al*. (Danish Energy Agency, 2013) at the Horns Rev offshore wind farm and Bergström *et al*. (2013) at the Lillgrund offshore wind farm, where an increase in fish species typically associated with reef structures was noted around the introduced artificial hard substates, including cable protection; similar trends were seen in the Walney Extension year three post-construction colonisation study (CMACS, 2014b).

3.11.8.4 Impacts on demersal fish and shellfish communities are varied, with the original sandy-bottom fish population near the Lillgrund offshore wind farm reported to be displaced by introduced hard substrate communities on the artificial structures and cable protection (Danish Energy Agency, 2013). However, a decrease in soft sediment species is contradictory to findings of Degraer *et al*. (2020) where an increase in density of soft sediment species was seen, although this increase may be related to reduced fishing pressure within the array. These increases may only be site-specific and cannot be extrapolated to all introduced hard structures without further research. However, a recent review (Dunkley and Solandt, 2022) has found that rates of bottom-towed fishing have decreased by 77% in almost all investigated offshore wind farm sites, with associated protection of demersal and pelagic fish and shellfish populations. Further, a meta-analysis by Gill *et al*., (2021) found no evidence of negative impacts from offshore wind farm construction and associated hard structure introduction on a range of demersal and pelagic fish, with positive effects in terms of increased biomass and abundance noted for shellfish.

3.11.8.5 The longest monitoring programme conducted to date, at the Lillgrund offshore wind farm in the Öresund Strait in south Sweden, showed no overall increase in fish numbers, although redistribution towards the foundations and introduced hard infrastructure including cable protection within the offshore wind farm area was noticed for some species (i.e., cod, eel and eelpout *Zoarcidae* sp.; Andersson, 2011). More species were recorded after construction than before, which is consistent with the hypothesis that localised increases in biodiversity may occur following the introduction of hard substrata in a soft sediment environment. Overall, results from earlier studies reported in the scientific literature did not provide robust data (e.g., some were visual observations with no quantitative data) that could be generalised to the effects of artificial structures on fish abundance in offshore wind farm areas (Wilhelmsson *et al*., 2010). More recent papers are, however, beginning to assess population changes and observations of recolonisation in a more quantitative manner (Bouma and Lengkeek, 2012; Krone *et al*., 2013), with hard substrata including cable protection structures consistently increasing species richness in the long term, but changing species composition towards a shellfish-dominated hard substrate community, thus impacting local ecological function (Coolen, *et al*., 2020).

3.11.8.6 There is some uncertainty as to whether artificial reefs facilitate recruitment in the local population, or whether the effects are simply a result of concentrating biomass from surrounding areas (Inger *et al*., 2009). Linley *et al*. (2007) concluded that finfish species were likely to have a neutral to positive likelihood of benefitting, which is supported by evidence demonstrating that abundance of fish can be greater within the vicinity of wind turbine foundations, and associated hard infrastructure including cable protection, than in the surrounding areas (Wilhelmsson *et al*., 2006a; Inger *et al*., 2009), with increases in species richness noted in some studies (Coolen *et al*., 2020). A number of studies on the effects of vertical structures and offshore wind farm structures on fish and benthic assemblages have been undertaken in the Baltic Sea (Wilhelmsson *et al*., 2006a; 2006b). These studies have shown evidence of increased abundances of small demersal fish species in the vicinity of structures, most likely due to the increase in abundance of epifaunal communities which increase the structural complexity of the habitat (e.g., mussel and barnacles *Cirripedia* spp.).

3.11.8.7 It was speculated that in true marine environments, such as the north Irish Sea, offshore wind farms may enhance local species richness and diversity, with small demersal species such as gobies or sandeel providing prey items for larger, commercially important species including demersal cod (which have been recorded aggregating around vertical steel constructions in the North Sea; Wilhelmsson *et al*., 2006a) and other pelagic species, although only in the direct vicinity of the altered habitats (Andersson, 2011). Monitoring of fish populations in the vicinity of an offshore wind farm off the coast of the Netherlands indicated that the offshore wind farms acted as a refuge for at least part of the cod population; which may potentially provide some low-level support to the recovery of cod in the Irish Sea following the stock collapse around the year 2000, given the presence of a cod spawning ground overlapping the Offshore Order Limits (Lindeboom *et al*., 2011; Winter *et al*., 2010). Similarly, horse mackerel, mackerel, herring and sprat have been found to utilise the new hard substrata for spawning, or predation on the newly developed community (Glarou *et al*., 2020).

3.11.8.8 In contrast, post construction fisheries surveys conducted in line with the Food and Environmental Protection Act (FEPA) licence requirements for the Barrow and North Hoyle offshore wind farms, found no evidence of fish abundance across these sites being affected, either positively or negatively, by the presence of the offshore wind farms (Cefas, 2009; BOWind, 2008). These suggested that any effects, if seen, are likely to be highly localised and while of uncertain duration, the evidence suggests effects are not necessarily adverse, although uncertainty does exist.

3.11.8.9 It is likely that the greatest potential for beneficial effects exist for crustacean species, such as crab and lobster, due to expansion of their natural habitats (Linley *et al*., 2007) and the creation of additional heterogenous hard substrata refuge areas. Where cable protection is placed within areas of sandy and coarse gravelly sediments, this will represent novel habitat and new potential sources of food in these areas and could potentially extend the habitat range of shellfish species such as edible crab, which strongly associate with structures such as wind farm foundations and associated hard infrastructure (Hooper and Austen, 2014). Post-construction monitoring surveys at the Horns Rev offshore wind farm in the North Sea noted that the hard substrata were used as a hatchery or nursery grounds for several species and was particularly successful for edible crab (BioConsult, 2006). They concluded that crustacean larvae and juveniles rapidly invade the hard substrata from the breeding areas (BioConsult, 2006). As both crab and lobster are commercially exploited in the vicinity of the study area, there is potential for benefits to the fisheries, depending on the materials used in construction of the Transmission Assets.

3.11.8.10 The colonisation of new habitats may also potentially lead to the introduction of INNS, which may have indirect adverse effects on shellfish populations as a result of competition. The site-specific benthic survey across the Transmission Assets identified no INNS as being currently present. However, this dataset is limited and cannot be used to draw conclusions about the entire study area, with the potential for INNS to currently be present or be introduced during the course of the construction and operation and maintenance phases. There is little evidence of adverse effects on fish and shellfish IEFs resulting from colonisation of other offshore wind farms by INNS. The post construction monitoring report for the Barrow offshore wind farm demonstrated no evidence of INNS on or around the monopiles (EMU, 2008a) and a similar study of the Kentish Flats monopiles only identified slipper limpet *Crepidula fornicata* (EMU, 2008b). A study into the spread of INNS by wind farm hard substrata colonisation suggested the risk of this occurring was minor and requires more research to fully understand, with implementation of precautionary built-in measures recommended to prevent spread where possible (Lasram *et al*., 2019). The impact of INNS on seabed habitats is further discussed and assessed in Volume 2, Chapter 2: Benthic subtidal ecology of the ES.

3.11.8.11 There is potential for impacts upon fish and shellfish species, resulting from increased predation by marine mammal species within offshore wind farms. Tagging of harbour seal *Phoca vitulina* and grey seal *Halichoerus grypus* around Dutch and UK windfarms provided significant evidence that the seal species were utilising wind farm sites as foraging habitats (Russell *et al*., 2014), specifically targeting introduced structures such as wind turbine foundations, which can be used broadly as a proxy for the development of communities which may occur around introduced hard cable protection measures. However, a further study using similar methods concluded that there was no change in behaviour within the wind farm (McConnell *et al*., 2012). Therefore, it is not certain exactly to what extent seals utilise offshore wind developments overall. More site-specific data from the north Irish Sea has found that harbour porpoise *Phocoena phocoena* and grey seal also utilise wind farm areas for feeding (Goold, 2008), suggesting a potential risk of foraging on fish and shellfish species around the infrastructure within the Offshore Order Limits.

3.11.8.12 Marine fish and shellfish ecology IEFs in the study area are deemed to be of low vulnerability and local to national importance (recoverability is not considered relevant to this impact). The sensitivity of the receptor is therefore **low**.

Diadromous species

3.11.8.13 Diadromous species that are likely to interact with the study area are only likely to do so when passing through the area during migration to and from rivers flowing into the east Irish Sea (i.e., on the west coast of England, south west coast of Scotland and north coast of Wales), with these sites designated based on the presence of diadromous fish species (see **section 3.6.2**). In most cases, it is expected that diadromous fish are unlikely to utilise the introduced hard substrata within the study area for feeding or shelter opportunities as they are only likely to be transient when in the vicinity.

3.11.8.14 As described in **paragraph 3.11.8.11**, there is potential for impacts upon diadromous fish species resulting from increased predation by marine mammal species within offshore wind farms. However, due to the small spatial and temporal overlaps between foraging behaviour and diadromous migrations, it is unlikely that this would result in significant increased predation on diadromous species. Research has shown that Atlantic salmon smolts spend little time in the coastal waters and instead are very active swimmers in coastal waters, making their way to feeding grounds quickly (Gardiner *et al*., 2018a; Gardiner *et al*., 2018b; Newton *et al*., 2017; Newton *et al*., 2019; Newton *et al*., 2021; see Volume 2, Annex 3.1: Fish and shellfish ecology technical report of the ES for further detail on Atlantic salmon migration). Due to the evidence that Atlantic salmon tend not to forage in coastal waters, it is unlikely that they will spend time foraging around installed infrastructure and therefore are at low risk of impact from increased predation from seals and other predators.

3.11.8.15 Sea trout may be at higher risk of increased predation from seals than Atlantic salmon due to their higher usage of coastal environments. Sea trout are generalist, opportunistic feeders with their diet comprising mainly of fish, crustaceans, polychaetes and surface insects, with the proportion of each of these prey categories varying by season (Rikardsen *et al*., 2006; Knutsen *et al*., 2001). Due to the potential for increase in juvenile crustacean species and other shellfish species which are potential prey items from sea trout, it is possible that foraging sea trout may be attracted to the hard substrata introduced by installation of the Transmission Assets. This attraction could in turn lead to increased predation by seal species upon sea trout. However, there is little evidence at present documenting an increased abundance of sea trout around installed infrastructure (increases in fish abundance tend to be hard bottom dwelling fish species), therefore the above effect of increased prey items attracting sea trout is only theoretical. Further, the Transmission Assets are situated in an area of both low and high intensity sandeel spawning and it is likely that sandeel will make up a considerable proportion of sea trout diet when in the marine environment (Svenning *et* al., 2005; Thorstad *et al., 2016)*. Sandeel species are unlikely to be directly associated with introduced hard substrata due to sandy habitat preferences. Therefore, sea trout may be less likely to be attracted to the potential prey associated with introduced hard substrata, given there is an existing abundance of prey species which are not associated with hard structure communities.

3.11.8.16 The low risk of effects on diadromous fish species extends to the freshwater pearl mussel, which has part of its life stage that is reliant on diadromous fish species including Atlantic salmon and sea trout and the potential of impact on these species is low.

3.11.8.17 Sea lamprey are parasitic in their marine phase, feeding off larger fish and marine mammals (Hume, 2017). As such, it is not expected that they will be particularly attracted to structures associated with the Transmission Assets. However, this is not certain, as there is limited information available on the utilisation of the marine environment by sea lamprey.

3.11.8.18 Diadromous fish species are deemed to be of low vulnerability, high recoverability and national to international importance. The sensitivity of the receptor is therefore **low**.

3.11.8.19 Sea trout are deemed to be of medium vulnerability, high recoverability and national importance. The sensitivity of the receptor is therefore **low**.

Magnitude of impact

3.11.8.20 The MDS is for up to 576,500 m^2 of habitat creation due to the installation of cable protection associated with offshore export cables as well as their associated cable crossings in subtidal habitats (**Table 3.13**). This equates to just 0.096% of the Offshore Order Limits area. It is expected that the cable protection will be colonised by epifaunal species already occurring within the area (e.g., tunicates, bryozoans, mussel and barnacles which are typical of temperate seas), which will likely attract increased abundances of demersal and pelagic fish species through predation behaviours. The MDS for the introduction and colonisation of hard substrata impact is for the sequential construction scenario as this equates to the greatest time over which colonisation may occur. Although it should be noted that the total extent of introduced artificial substrata is the same for both the concurrent and sequential scenarios.

3.11.8.21 Decommissioning will involve removal of the cables however all cable protection is proposed to remain *in situ* on the seafloor, with an MDS equivalent to the construction and operation and maintenance phases (i.e., 576,500 m^2) of residual introduced hard substrata.

3.11.8.22 The introduction of new hard substrata will represent a shift in the baseline conditions from soft substrate areas (i.e., muds, sands and gravels) to hard substrata in the areas where infrastructure is present. This may produce some potentially beneficial effects, for example the likely increase in biodiversity and individual abundance of reef species and total number of species over time, as observed at the monopile foundations, which provide a potential proxy for cable protection of a similar composition, installed at Lysekil research site (a test site for offshore wind-based research, north of Gothenburg, Sweden; Bender *et al*., 2020). Additionally, the increased structural complexity of the substrate may provide refuge as well as increasing feeding opportunities for larger and more fish and shellfish mobile species (Langhamer and Wilhelmsson, 2009), with an expected increase in ecosystem carrying capacity (Andersson and Ohman, 2010). A study of gravity-based foundations in the Belgian part of the North Sea by Mavraki *et al.* (2020) found that higher food web complexity was associated with zones of high accumulation of organic material, such as soft substrate or scour protection, suggesting potential reef effect benefits from the presence of the hard structures; this may also apply to cable protection measures.

3.11.8.23 The attraction of fish and shellfish species to installed hard structures is supported by the first year's monitoring from Beatrice offshore wind farm (APEM, 2021) which noted fish and shellfish at the base of foundations although no biological material was recorded on the seabed. Material may be rapidly consumed by organisms or relocated due to tidal currents and further monitoring will be required to clarify if biological material builds up over time (APEM, 2021). Any additional effects up the food chain in relation to marine mammals (Volume 2, Chapter 4: Marine mammals of the ES) and ornithology (Volume 2, Chapter 5: Offshore ornithology of the ES) are considered in their individual chapters.

3.11.8.24 The impact is predicted to be of local spatial extent, long term duration, continuous and irreversible, with cable protection predicted to remain *in situ* following decommissioning. It is predicted that the impact will affect the receptor directly. The magnitude is therefore **low**.

Significance of effect

Marine species

3.11.8.25 Overall, the sensitivity of all marine fish and shellfish IEFs is **low** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, at worst, which is not significant in EIA terms.

3.11.8.26 As outlined above, there is potential for beneficial effects to certain fish and shellfish IEFs, although there are uncertainties as to which species in particular would benefit and the significance of this positive effect.

Diadromous species

3.11.8.27 For diadromous fish IEFs, the sensitivity is **low** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.9 Injury to basking shark due to increased risk of collision with vessels

3.11.9.1 Guidance provided by NOAA has defined serious injury to basking shark and marine mammals as 'any injury that will likely result in mortality' (NMFS, 2012). NMFS clarified its definition of 'serious injury' in 2012 and stated their interpretation of the regulatory definition of serious injury as any injury that is 'more likely than not' to result in mortality, or any injury that presents a greater than 50% chance of death to the basking shark or marine mammal (NMFS, 2012; Helker *et al*., 2017). Non-serious injury is likely to result in short term impacts and may also have long term effects on health and lifespan.

3.11.9.2 Collisions of vessels with basking shark have the potential to result in both fatal and non-fatal injuries (Darling and Keogh, 1994; Scott and Gisborne, 2006). The potential therefore exists for collisions with basking shark in any vessel activities throughout the lifetime of the Transmission Assets.

Construction phase

Sensitivity of receptor

3.11.9.3 Basking shark and other large animals are generally able to detect and avoid vessels, however, it is unclear why some individuals do not always move out of the path of an approaching vessel (Schoeman *et al*., 2020). It has been suggested that behaviours such as resting, foraging, nursing and socialising could distract these animals from detecting the risk posed by vessels (Dukas, 2002), as well as their need to spend time near the surface for feeding (Pirotta *et al*., 2018). There can be consequences to a lack of response to disturbance, in terms of behavioural habituation that can result in decreased wariness of vessel traffic, which has the potential to result in an increased collision risk (Cates *et al*., 2017).

3.11.9.4 There were 63 reports of vessel collisions with basking shark over a 21-year study period within the vicinity of the Irish Sea (Solandt and Chassion, 2013), although it is possible that vessel strikes and potential mortality is under-recorded (Van Waerebeek *et al*., 2007). This should be considered in the context of the nearby Isle of Man territorial waters, where the designated MNRs have been identified as an area of potential conservation importance for migrating basking sharks (Dolton *et al*., 2020).

3.11.9.5 It should be noted that no basking shark were observed during 12 months of aerial surveys of the Transmission Assets (undertaken for the Morgan Offshore Wind Project: Generation Assets and Morecambe Offshore Windfarm: Generation Assets) and the frequency of sightings within the area is generally considered low when compared with areas such as the Isle of Man, north east of Northern Ireland and the west coast of Scotland, with very few confirmed sightings within the project region (NBN Atlas Partnership, 2023). As such, although they are known to occur in the area, there is no evidence to demonstrate that the Transmission Assets is particularly important for basking shark, therefore reducing the potential for collision risk.

3.11.9.6 Individual basking shark tend to show distressed behaviour and avoidance tendencies when disturbed by vessels (Bloomfield and Solandt, 2008). If physical impact does occur, the injuries can potentially be significant, although long term monitoring has noted successful healing of wounds from propellor injuries (Speedie *et al*., 2009) and ship collisions (Solandt and Chassion, 2013), with negative impacts only seen after repeated direct exposure to disturbance and damage (Kelly *et al*., 2004). Due to the implementation of an Outline offshore EMP for all vessels (CoT65, **Table 3.12**, see **section 3.8**), this repeated exposure and damage is unlikely to occur in this case, with any collisions unlikely to be lethal at the speeds most vessels are travelling.

3.11.9.7 The basking shark within the study area are deemed to be of low vulnerability, medium recoverability and international importance. The sensitivity of the receptor is therefore **medium.**

Magnitude of impact

3.11.9.8 Vessel traffic associated with the Transmission Assets has the potential to lead to an increase in vessel movements within the study area. This increase in vessel movement could lead to an increase in interactions between basking shark and vessels during offshore construction, with vessels travelling at higher speeds (>7 m/s) posing a higher risk because of the potential for a stronger impact (Schoeman *et al*., 2020). Except for CTVs, vessels involved in the construction phase are likely to be travelling considerably slower than this and all vessels will be required to follow an Outline offshore EMP (CoT65, **Table 3.12**, see **section 3.8**). The Outline offshore EMP (CoT65, **Table 3.12**) outlines instructions for vessel behaviour and vessel operators, including advice to operators to not deliberately approach basking shark and to avoid sudden changes in course or speed. Therefore, with these measures adopted as part of the Transmission Assets (as outlined in **section 3.8**), the risk of collision is anticipated to be reduced and would only be present for transiting vessels (as opposed to those which are stationary).

3.11.9.9 Vessel traffic associated with the construction activities will result in an increase in vessel movements within the study area with up to 286 return trips by construction vessels may be made throughout the construction phase and up to 30 construction vessels on site at any one time (assuming concurrent construction scenario) (**Table 3.13**). This could lead to an increase in the potential for interactions between vessels and basking shark over the potential four-year construction phase.

3.11.9.10 A proportion of vessels involved in construction will be relatively small in size (e.g., tugs/anchor handlers, CTVs) and due to good manoeuvrability, may be able to avoid basking shark, when detected (Schoeman *et al*., 2020). Larger vessels with lower manoeuvrability may need larger distances to avoid an animal, however they will also be travelling at slower speeds and have more time to react when basking shark are detected. In addition, the sound emissions from vessels involved in the construction phase are likely to deter animals from the potential zone of impact. The vessel movements will be contained within the Offshore Order Limits and will follow existing shipping routes to and from the ports.

3.11.9.11 The impact is predicted to be of local spatial extent, medium term duration, to be intermittent and, whilst the risk will only occur during vessel transits, the potential for collision is of medium to low reversibility (depending upon the extent of injuries). It is also of note that this additional vessel activity will occur in an area that is already subject to high numbers of vessel movements, therefore it will not reflect a material change from the existing activity landscape which would comprise a higher risk to basking shark. It is predicted that the impact will affect the receptor directly. With the measures adopted (as outlined in **section 3.8**), the risk of collision will be reduced.

Given the potential for a collision to lead to sustained injury, the magnitude is considered to be **low**.

Significance of effect

3.11.9.12 The sensitivity of basking shark is **medium** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Operation and maintenance

Sensitivity of receptor

3.11.9.13 The sensitivity of the basking shark can be found in the construction phase assessment (**paragraph 3.11.9.3** to **paragraph 3.11.9.7**), with **medium** sensitivity assigned, and this will equally apply in the operation and maintenance phase.

Magnitude of impact

3.11.9.14 Vessel usage during the operation and maintenance phase of the Transmission Assets may lead to injury to basking shark due to collision with vessels. Vessel types which will be required during the operation and maintenance phase include those used during routine inspections, repairs and replacement, and geophysical surveys (**Table 3.13**).

3.11.9.15 Any on-site activities will require vessel transit, with up to 12 vessels present at any one time within the Offshore Order Limits (assuming concurrent maintenance activities) and a maximum of 77 vessel movements to and from the site per year, with most of these being CTVs (42 return trips). Over the predicted 35-year lifetime of the Transmission Assets, this could lead to a maximum of 2,590 vessel movements overall, with each representing a collision risk to basking shark. However, implementation of the full offshore EMP in accordance with the outline offshore EMP and CoT65 (**Table 3.12**) will limit the risk of these collisions and the decreased number of vessels on-site at any one time during operation and maintenance will likely reduce the risk further when compared to the construction phase.

3.11.9.16 The impact is predicted to be of local spatial extent, long term duration, intermittent and of medium to low reversibility if collision occurs. It is predicted that the impact will affect the receptor directly. With designed-in measures in place through the Outline offshore EMP (CoT65, **Table 3.12**), collision risk will be reduced, however the overall magnitude of this impact is considered to be **low**.

Significance of effect

3.11.9.17 The sensitivity of basking shark is **medium** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Decommissioning

Sensitivity of receptor

3.11.9.18 The sensitivity of the basking shark can be found in the construction phase assessment (**paragraph 3.11.9.3** to **paragraph 3.11.9.7**), with **medium** sensitivity assigned, and this will equally apply in the decommissioning phase.

Magnitude of impact

3.11.9.19 Vessel movements during the decommissioning phase may potentially lead to collision risks with basking shark. Activities during this phase are expected to be a reversal of the construction phase, with similar vessel numbers and movements anticipated (see **paragraph 3.11.9.8** to **paragraph 3.11.9.10**).

3.11.9.20 The impact is predicted to be of local spatial extent, medium term duration, intermittent and of medium to low reversibility if collision occurs. It is predicted that the impact will affect the receptor directly. With measures in place, the risk of collision will be reduced, however the magnitude is considered to be **low**.

Significance of effect

3.11.9.21 The sensitivity of basking shark is **medium** and the magnitude of the impact is **low**. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

3.11.10 Disturbance/remobilisation of sediment-bound contaminants

3.11.10.1 The activities associated with seabed preparation and infrastructure installation and repair for the Transmission Assets during the construction, operation and maintenance, and decommissioning phases may lead to contaminants in the sediments within the Offshore Order Limits to be re-suspended and could have potential effects on fish and shellfish receptors. The MDS is represented by sandwave clearance and cable installation and reburial and is summarised in **Table 3.13**. Volume 2, Chapter 1: Physical processes of the ES provides a full description of the physical processes baseline characterisation, including numerical modelling used to inform the predictions made with respect to increases in SSCs.

Construction phase

Sensitivity of receptor

Marine species

3.11.10.2 Heavy metals are readily adsorbed by fine sediments which can lead to metals accumulating to concentrations far higher than the surrounding environment. These sediments can become re-suspended through bioturbation or through physical processes/disturbances. Metals will tend to accumulate in these fine-grained sediments and can become bioavailable to marine organisms through ingestion. The uptake of heavy metals by marine organisms can lead to bioaccumulation through trophic levels, leading to apex organisms accumulating metals to adverse and toxic levels. This could result in significant adverse effects including mortality, impaired reproduction, reduced growth and alterations in metabolism as a result of oxidative stress and disruption to the food chain.

3.11.10.3 Polychlorinated biphenyls (PCBs) are toxic to aquatic organisms including fish species, where contact with sediment can increase the risk of exposure. Reproductive and developmental problems have been observed in organisms at low PCB concentrations, with the early life stages being most susceptible. There is growing evidence linking PCBs and similar compounds with reproductive and immuno-toxic effects in wildlife. Due to their persistence and lipophilic nature, PCBs have the potential to bioaccumulate, particularly in lipid rich tissue. Bioaccumulation of PCBs is recorded in fish, birds and marine mammals and is known to cause sublethal toxicological effects. Accumulation of PCBs in sediments therefore poses a potential hazard to sediment-dwelling organisms.

3.11.10.4 Organochlorine pesticides (OCPs) are highly toxic contaminants that can persist in the environment and can disrupt the endocrine system of aquatic species including fish and shellfish. OCPs have been found to accumulate in fatty tissues and cause diseases and disrupt metabolic pathways. In fish, OCPs have been found to affect early development, act as neuroendocrine disruptors, suppress male and female reproductive systems, dysregulate immune functions and lipid biosynthesis and alter metabolic function (Martyniuk *et al.*, 2020).

3.11.10.5 Organotin compounds are ubiquitous contaminants in the environment and may lead to bioaccumulation in fish and shellfish. Organotins have been found to disrupt or inhibit some metabolic processes and enzymatic reactions that could lead to negative histological effects on various tissues or organs or development growth issues in fish (Fent, 1998).

3.11.10.6 Once ingested by fauna, polycyclic aromatic hydrocarbons (PAHs) may cause oxidative stress and lead to adverse effects in the organism. Most species have a limited ability to metabolise PAHs and as a result these can bioaccumulate to toxic levels.

3.11.10.7 The sensitivity of fish and shellfish receptors will vary depending on a range of factors including species and life stage. In terms of marine pollution, adult fish species, including migratory and diadromous species, are more mobile than many of the other fish and shellfish IEFs and therefore would be likely to show avoidance behaviour within areas affected by increased sediment-bound contaminants. However, they are still susceptible to potential long term effects of contaminants. For example, effects of mercury bioaccumulation have been examined for subtidal fish (i.e., flounder, common dab, whiting, plaice) and a positive correlation between fish size and mercury bioaccumulation was found (Baeyens *et al.,* 2003).

3.11.10.8 In comparison, fish eggs and larvae are likely to be more sensitive, with potential toxic effects of pollutants on fish eggs and larvae (Westernhagen, 1988). Specifically, re-suspended sediment-bound contaminants such as heavy metals and hydrocarbon pollution could lead to abnormal development, delayed hatching and reduced hatching success (Bunn *et al.*, 2000). Morphological and chromosomal malformations have been often reported as effects of pollutants with heavy metals (e.g., lead, copper, cadmium), producing malformed embryos (Westernhagen *et al.,* 1974; Kocan *et al.,* 1987; Geffard *et al.,* 2003; Jezierska *et al.*, 2009). The most susceptible stage to suffer from heavy metal intoxication and increased egg mortality occurs immediately after the fertilisation when the developing eggs are the most sensitive (Jezierska *et al.*, 2009). Therefore, effects of intoxication events will vary based on the species, development stage and pollutants involved. However, re-suspended sediment-bound contaminants are expected to be dispersed quickly in the environment and therefore, the duration when fish and shellfish would be in contact with any pollutants would be short reducing the potential exposure. In addition, diadromous fish are unlikely to be disturbed during their migration given the short period where contaminants would be re-suspended.

3.11.10.9 Given the lower dispersion rates of sediment-bound contaminants in intertidal areas compared to offshore environments, species that rely on such habitats (e.g., juvenile fish species or cockles) may be more sensitive. Therefore, re-suspension of contaminated sediments has the potential to affect juvenile fish species and shellfish (e.g., intertidal crustaceans and cockles) within a relatively limited extent. High concentrations of sediment contaminants in intertidal nursery areas have been shown to reduce growth rates in juvenile solenette by lowering the quality of the local habitat and affecting lipid storage capacities within the fish, thus affecting the energetic balance of the animal (Amara *et al.,* 2004). The reduced survival rates attributed to poor growth within a reduced quality habitat may therefore affect overwintering capabilities for juvenile fish populations. Similarly, exposure to oil contamination in pink shrimp *Pandalus borealis* larvae led to an increase in larval mortality and to a distinct fatty acid composition in embryos, however, no significant reduction of larval development rates was observed (Bechmann *et al.,* 2010).

3.11.10.10 A study has shown that filter feeders such as cockles take up heavy metals mainly from solution rather than from the sediment (Bryan and Gibbs, 1991) and are potentially affected by re-suspended contaminants only at very high concentrations. Levels within the sediments within the Offshore Order Limits were not found to reach those of concern for cockles. Cockles are predicted to have low sensitivity to heavy metal and hydrocarbon contamination, with high levels of recovery (Tyler-Walters, 2007). For molluscs, mercury is the most toxic metal, but this was not present in the intertidal sediments at levels at which effects in marine organisms would be expected. For species living in estuaries that are predicted to withstand higher level stress, responses to pollution are not expected to occur in the presence of well-studied contaminants (García-Alonso *et al.,* 2011; Elliott and Quintino, 2007). However, recoverability of sediments is likely to be low due to the likelihood of contaminants remaining in this environment for a longer period than in subtidal areas.

3.11.10.11 The effects of remobilised sediment-bound PAHs are well understood, with significant negative impacts noted on sandeel hatching success and survival

(Bunn *et al.,* 2000), and a wide literature base exists concerning other impacts on the identified marine IEFs. However, as all PAH concentrations were under thresholds, this impact would have little to no effect on any species present.

3.11.10.12 King and queen scallop are deemed to be of medium vulnerability, high recoverability and regional importance. The sensitivity of the receptor is therefore **low**.

3.11.10.13 Sandeel are deemed to be of medium vulnerability to PAHs specifically, medium recoverability and regional importance. The sensitivity of the receptor is therefore **medium**.

3.11.10.14 All other fish and shellfish IEFs are deemed to be of low vulnerability, high recoverability and local to national importance. The sensitivity of the receptor is therefore **low**.

Diadromous species

3.11.10.15 Diadromous species will likely only be present within the study area when migrating to or from rivers flowing into the east Irish Sea. Therefore, the possibility for temporal and spatial overlap of these species and the very short term remobilisation of sediment-bound contaminants, which will likely resettle within a small number of tidal cycles, is very low. Also, it is known that many diadromous species are exposed naturally to levels of PCBs, such as in trout (Atuma *et al.,* 1993), sea lamprey (Madenjian *et al.,* 2013), European eels (Bressa *et al.,* 1997) and Atlantic salmon (Zitko, 1974). Similarly, bioaccumulation of heavy organometals has been noted on trout gills (Tkachenko *et al*., 2019), alongside a range of other low levels of natural exposure in other IEF species. Given this acclimation to natural contaminants, with no significant detriments to health or spawning noted at low levels, it is therefore likely that this impact will have little impact on diadromous species during construction.

3.11.10.16 All diadromous IEF species are deemed to be of low vulnerability, high recoverability and national to international importance. The sensitivity of the receptor is therefore **low**.

Magnitude of impact

3.11.10.17 For the purposes of this assessment, the following activities have been considered (see **Table 3.13**).

- Seabed preparation (sandwave, boulder and debris clearance).
- Installation of offshore export cables.

3.11.10.18 The MDS for the sandwave clearance for the Morgan offshore export cables accounts for up to a 60 m wide corridor along 9% of 400 km of offshore export cable length to a maximum depth of 5 m, totalling a spoil volume of up to 1,080,000 m^3. The Morecambe offshore export cables sandwave clearance activities account for a much smaller total spoil volume of 346,800 m^3, based on clearance in a 48 m wide, 5 m deep corridor along 9% of 84 km of offshore export cables.

3.11.10.19 The MDS for the installation of offshore export cables assumes installation via trenching. Trenches are expected to have a width of 3 m and a depth of 3 m, resulting in the mobilisation of up to 2,178,000 m^3 of material along the 484 km offshore export cables over a sequential construction scenario of 30 months.

3.11.10.20 Volume 2, Annex 2.1: Benthic subtidal and intertidal ecology technical report of the ES concluded that most sites showed contaminant concentrations below thresholds of concern, with heavy metals, organotins, PCBs and PAHs generally at levels that would not be of concern to the marine environment. No contaminant exceeded all thresholds and sites where some contaminants would exceed one of the thresholds tended to be isolated and more nearshore.

3.11.10.21 The total area that is likely to be disturbed by construction activities and therefore the potential volume of material disturbed, resulting in the potential release of sediment bound contaminants such as arsenic and PAHs, is relatively small and localised (see **section 3.11.2**). In addition, the sediment composition showed a general trend of coarser sediments offshore with increasing fines in the central and nearshore parts of the Offshore Order Limits approaching the Landfall. Therefore, there is reduced opportunity for adsorption of contaminants to the sediments found further offshore. Following disturbance as a result of the construction activities outlined in **paragraph 3.11.10.17**, the majority of re-suspended sediments are expected to be deposited in the immediate vicinity of the works (see **section 3.11.5**). The release of contaminants such as arsenic and PAHs from the small proportion of fines in the offshore sediments is likely to be rapidly dispersed with the tide and/or currents and, therefore, increased bioavailability resulting in adverse ecotoxicological effects are not expected.

3.11.10.22 For intertidal areas such as in the Intertidal Infrastructure Area, where some contaminants were recorded at slightly higher levels, open cut trenching for the installation of the export cables in the intertidal zone has the potential to result in disturbance/remobilisation of sediment-bound contaminants. The majority of open cut trenching will be undertaken at low water and therefore the potential for resuspension of contaminated sediment is minimal. As in the subtidal zone, disturbance as a result of construction activities will result in sediment deposition in the immediate vicinity of the works. The release of contaminants from the small proportion of fine sediments is likely to be rapidly dispersed with the tide and, therefore, increased bioavailability resulting in adverse ecotoxicological effects are not expected.

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

Significance of effect

Marine species

3.11.10.24 For king and queen scallop the sensitivity is **low** and the magnitude of the impact is **low**. The effect will therefore be of **minor adverse** significance, which is not significant in EIA terms.

3.11.10.25 For sandeel the sensitivity is **medium** and the magnitude of the impact is **low**. The effect will therefore be of **minor adverse** significance, which is not significant in EIA terms.

3.11.10.26 For all other marine fish and shellfish IEFs the sensitivity is **low** and the magnitude of the impact is **low**. The effect will therefore be of **minor adverse** significance, which is not significant in EIA terms.

Diadromous species

3.11.10.27 The sensitivity of diadromous fish IEFs is **low** and the magnitude of the impact is **low**. The effect will therefore be of **minor adverse** significance, which is not significant in EIA terms.

Operation and maintenance

Sensitivity of receptor

Marine species

3.11.10.28 The sensitivity of the marine fish and shellfish IEFs can be found in the construction phase assessment (**paragraph 3.11.10.2** to **paragraph 3.11.10.12**) and these will equally apply in the operation and maintenance phase. The sensitivity of these IEFs is therefore **low** to **medium.**

Diadromous species

3.11.10.29 The sensitivity of the diadromous fish IEFs can be found in the construction phase assessment (**paragraph 3.11.10.15** to **paragraph 3.11.10.16**) and these will equally apply in the operation and maintenance phase. The sensitivity of these IEFs is therefore **low.**

Magnitude of impact

3.11.10.30 The potential for remobilisation or disturbance of sediment-bound contaminants is significantly lower during the planned 35-year operation and maintenance phase. The MDS describes the repair of up to 4 km per subtidal offshore export cable in one event for each of the six export cables every 10 years, up to 2.4 km of Morecambe intertidal offshore export cable every 10 years and up to 1 km of Morgan intertidal offshore export cable every 10 years.

3.11.10.31 The MDS also describes the reburial of 4 km of Morgan offshore export cable in one event every five years and 1.7 km of Morecambe offshore export cable in one event every five years.

3.11.10.32 These activities will most likely remobilise significantly smaller amounts of the low concentrations of sediment-bound contaminants present than during the construction phase and are therefore unlikely to pose an ecotoxicological risk to fish and shellfish receptors.

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

Significance of effect

Marine species

3.11.10.34 The sensitivity of king and queen scallop is **low** and the magnitude of the impact is **negligible**. This gives rise to an impact significance of negligible or minor adverse. Based on the low likelihood of ecotoxicological effects to these receptors and the low frequency of resuspension events due to operation and maintenance activities, the effect will therefore be of **negligible** significance, which is not significant in EIA terms.

3.11.10.35 The sensitivity of sandeel is **medium** and the magnitude of the impact is **negligible**. This gives rise to an impact significance of negligible or minor adverse. Based on the low likelihood of ecotoxicological effects to these receptors and the low frequency of resuspension events due to operation and maintenance activities, the effect will therefore be of **negligible** significance, which is not significant in EIA terms.

3.11.10.36 For all other marine fish and shellfish IEFs the sensitivity of the receptor is **low** and the magnitude of the impact is **negligible**. This gives rise to an impact significance of negligible or minor adverse. Based on the low likelihood of ecotoxicological effects to these receptors and the low frequency of resuspension events due to operation and maintenance activities, the effect will therefore be of **negligible** significance, which is not significant in EIA terms.

Diadromous species

3.11.10.37 The sensitivity of diadromous fish IEFs is **low** and the magnitude of the impact is **negligible**. This gives rise to an impact significance of negligible or minor adverse. Based on the low likelihood of ecotoxicological effects to these receptors and the low frequency of resuspension events due to operation and maintenance activities, the effect will therefore be of **negligible** significance, which is not significant in EIA terms.

Decommissioning

Sensitivity of receptor

Marine species

3.11.10.38 The sensitivity of the marine fish and shellfish IEFs can be found in the construction phase assessment (**paragraph 3.11.10.2** to **paragraph 3.11.10.12**) and these will equally apply in the decommissioning phase. The sensitivity of these IEFs is therefore **low** to **medium.**

Diadromous species

3.11.10.39 The sensitivity of the diadromous fish IEFs can be found in the construction phase assessment (**paragraph 3.11.10.15** to **paragraph 3.11.10.16**) and these will equally apply in the decommissioning phase. The sensitivity of these IEFs is therefore **low.**

Magnitude of impact

3.11.10.40 The distribution or remobilisation of sediment-bound contaminants that may occur as a result of decommissioning activities is predicted to be in line with that described for the construction phase in **paragraph 3.11.10.17** to **3.11.10.23**. On the basis that there will be no requirement for sandwave clearance or pre-lay preparation during decommissioning, the magnitude of the impact is likely to be considerably lower than during construction.

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

Significance of effect

Marine species

3.11.10.42 For king and queen scallop the sensitivity is **low** and the magnitude of the impact is **low**. The effect will therefore be of **minor adverse** significance, which is not significant in EIA terms.

3.11.10.43 For sandeel the sensitivity is **medium** and the magnitude of the impact is **low**. The effect will therefore be of **minor adverse** significance, which is not significant in EIA terms.

3.11.10.44 For all other marine fish and shellfish IEFs the sensitivity is **low** and the magnitude of the impact is **low**. The effect will therefore be of **minor adverse** significance, which is not significant in EIA terms.

Diadromous species

3.11.10.45 The sensitivity of diadromous fish IEFs is **low** and the magnitude of the impact is **low**. The effect will therefore be of **minor adverse** significance, which is not significant in EIA terms.

3.11.11 Future monitoring

3.11.11.1 The assessment of impacts on fish and shellfish ecology as a result of the construction, operation and maintenance, and decommissioning phases of the Transmission Assets are predicted to be not significant in EIA terms. Based on the predicted impacts to fish and shellfish ecology receptors, it is concluded that no specific monitoring to test the predictions made within the impact assessment is required.

3.12 Cumulative effect assessment methodology

3.12.1 Introduction

3.12.1.1 The CEA takes into account the impacts associated with the Transmission Assets together with other projects and plans. The projects and plans selected as relevant to the CEA presented within this chapter are based upon the results of a screening exercise (see Volume 1, Annex 5.5: Cumulative screening matrix and location plan of the ES). Each project has been considered on a case-by-case basis for screening in or out of this chapter's assessment based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved.

3.12.1.2 For the purposes of this ES, the CEA has been considered within the cumulative fish and shellfish ecology study area (hereafter referred to as 'cumulative study area'), defined as the area within a 50 km buffer of the Transmission Assets, and a 100 km buffer for underwater sound, using the Tiered approach outlined below.

3.12.1.3 The fish and shellfish ecology CEA methodology has followed the methodology set out in Volume 1, Chapter 5: Environmental assessment methodology of the ES.

3.12.1.4 The cumulative assessment considers six scenarios overall; Transmission Assets together with Morecambe Offshore Windfarm: Generation Assets only (scenario 1), Transmission Assets together with Morgan Offshore Wind Project: Generation Assets only (scenario 2) and Transmission Assets together with Morgan Offshore Wind Project: Generation Assets and Morecambe Offshore Windfarm: Generation Assets (scenario 3). These cumulative scenarios are followed by the cumulative assessment of all projects (scenarios 4a-4c), plans and activities allocated into three 'Tiers' reflecting their current stage within the planning and development process.

3.12.1.5 The cumulative assessment has been undertaken as follows.

- Scenario 1: Transmission Assets together with Morecambe Offshore Windfarm: Generation Assets.
- Scenario 2: Transmission Assets together with Morgan Offshore Wind Project: Generation Assets.
- Scenario 3: Transmission Assets together with Morgan Offshore Wind Project: Generation Assets and Morecambe Offshore Windfarm: Generation Assets.
- Scenario 4: Scenario 3 together with Tier 1, Tier 2 and Tier 3 projects, plans and activities, defined as follows.
  - Scenario 4a: Scenario 3 and Tier 1 projects, plans and activities which are:
    - under construction;
    - permitted application;
    - submitted application; or
    - those currently operational that were not operational when baseline data were collected, and/or those that are operational but have an ongoing impact.
  - Scenario 4b: Scenario 4a and Tier 2 projects, plans and activities which a:
    - Scoping Report has been submitted in the public domain.

- Scenario 4c: Scenario 4b and Tier 3 projects, plans and activities which are:
  - where a Scoping Report has not been submitted and it is not in the public domain;
  - identified in the relevant Development Plan; or
  - identified in other plans and programmes.

3.12.1.6 This Tiered approach is adopted to provide a clear assessment of the Transmission Assets alongside other projects, plans and activities.

3.12.1.7 The specific projects, plans and activities scoped into the CEA, are outlined in **Table 3.22** and shown in Figure 3.14 (see Volume 2, Figures).

3.12.1.8 A number of the impacts considered for the Transmission Assets alone, as outlined in **Table 3.13** and **section 3.11**, have not been considered within the CEA due to the localised and temporally restricted nature of these impacts or the low effect on fish and shellfish receptors. These impacts include:

- temporary habitat loss/disturbance – operation and maintenance phase;
- underwater sound from geophysical surveys impacting fish and shellfish receptors – all phases;
- underwater sound from all other activities – all phases;
- increase in SSCs and associated deposition – operation and maintenance phase; and
- disturbance/remobilisation of sediment-bound contaminants – all phases;
- Introduction and colonisation of hard substrata – construction and decommissioning phases.

Table 3.22: List of other projects, plans and activities considered within the CEA

Project/Plan	Status	Distance from the Offshore Order Limits (nearest point, km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Transmission Assets
Generation Assets						
Morecambe Offshore Windfarm: Generation Assets (Scenario 1 and 3)	Submitted	0.00	480 MW Offshore wind farm (generating assets)	2026 to 2029	2029 to 2064 (the operation and maintenance phase is 35 years, but the lease period is 60 years, therefore re-powering may occur beyond the 35-year operation and maintenance phase)	The construction, operation and maintenance, and decommissioning phases of this project will overlap with the construction, operation and maintenance and decommissioning phases of the Transmission Assets.
Morgan Offshore Wind Project: Generation Assets (Scenario 2 and 3)	Submitted	0.00	1.5 GW Offshore wind farm (generating assets)	2026 to 2030	2030 to 2065	The construction, operation and maintenance and decommissioning phases of this project will overlap with the construction, operation and maintenance and decommissioning phases of the Transmission Assets.
Tier 1- Offshore renewables projects						
Mona Offshore Wind Project	Submitted	9.73	Application for the 1.5 GW Mona Offshore wind project in the east Irish Sea	2028 to 2029	2030 to 2065	The construction, operation and maintenance and decommissioning phases of this project will overlap with the construction, operation and maintenance and

Project/Plan	Status	Distance from the Offshore Order Limits (nearest point, km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Transmission Assets
						decommissioning phases of the Transmission Assets.
Awel y Môr Offshore Wind Farm	Permitted	28.87	Up to 100 MW (48 to 91 wind turbines)	2026 to 2030	2030 to 2065	The construction, operation and maintenance and decommissioning phases of this project will overlap with the construction and operation and maintenance phases of the Transmission Assets.
Tier 1- Deposit and removal						
Hilbre Swash (392/393)	Operational	28.54	Licence to extract up to 12 million tonnes of aggregate (mainly sand) over 15 years.	n/a	2015 to 2029	The aggregate extraction activities associated with this site will overlap with the construction phase of the Transmission Assets.
Tier 1- Dredging activities and dredge disposal sites						
Liverpool 2 and River Mersey Approach Channel Dredging	Operational (with ongoing activities)	14.13	Capital dredging in front of the proposed terminal to create a berth pocket.	n/a	2019 to 2028	The dredging activities associated with this site will overlap with the construction phase of the Transmission Assets.
Mersey channel and river maintenance dredge disposal	Operational (with ongoing activities)	14.13	The Mersey Docks and Harbour Company Ltd, as the Harbour Authority for the Port	n/a	2021 to 2031	The dredging activities associated with this site will overlap with the

Project/Plan	Status	Distance from the Offshore Order Limits (nearest point, km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Transmission Assets
renewal (MLA/2021/00202)			of Liverpool has an obligation to dredge the approaches to Liverpool in order to maintain navigation into the Mersey Estuary for all river users.			construction and operation and maintenance phases of the Transmission Assets.
Walney Extension pontoon/jetty dredging and disposal (DC10142)	Operational	20.04	A marine licence is being sought for dredging and associated disposal activities for the Walney Extension Offshore Wind Farm operation and maintenance base at the Port of Barrow.	n/a	2019 to 2029	These maintenance activities will overlap with the construction phase of the Transmission Assets.
Douglas Harbour, Isle of Man	Operational (with ongoing activities)	22.74	Dredging to deepen harbour channels and capital dredging in front of the proposed terminal to create a berth pocket.	n/a	2016 to 2031	The dredging activities associated with this site will overlap with the construction and operation and maintenance phases of the Transmission Assets.
Port of Barrow maintenance dredging disposal licence (MLA/2015/00458/1)	Operational (with ongoing activities)	23.02	Dredging is required to maintain the Port of Barrow and its approach channel at its advertised navigational depth for all vessels entering and leaving the port.	n/a	2016 to 2026	The dredging activities associated with this site will overlap with the construction phase of the Transmission Assets.
West of Duddon Sands Pontoon Dredging Marine Licence	Operational	30.31	Maintenance dredging-up to 12,520 m^3. Sedimentation can cause the pontoon edge	n/a	2018 to 2028	These maintenance activities will temporally overlap with the

Project/Plan	Status	Distance from the Offshore Order Limits (nearest point, km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Transmission Assets
			adjacent to the harbour wall to be raised during spring low tides. The scope of the marine licence application covers dredging which will be required annually based on the current observed rates of accumulation.			construction phase of the Transmission Assets.
Tier 1 – Oil and gas projects						
Isle of Man Crogga Licence (112/25)	Permitted	7.66	Licence for exploratory geotechnical and geophysical surveys as well as exploratory drilling.	Ending 2025	2026 onwards	The operation and maintenance phase of this project will overlap with the construction and operation and maintenance phase of the Transmission Assets.
Tier 2- Offshore renewables projects						
Mooir Vannin Offshore Windfarm	Pre-application	2.59	Agreement for lease to develop a 700 MW offshore wind farm.	2030 to 2032	Operational in 2032 with end date unknown	This project will overlap with the operation and maintenance phase of the Transmission Assets.
ENI HyNet Carbon Capture and Storage (CCS)	Pre-application (for offshore elements of the project)	5.74	CCS project in the east Irish Sea. Works will include installation of a new Douglas CCS platform and work on the existing Hamilton, Hamilton	Unknown	Unknown	This project may overlap with the construction and operation and maintenance phases of the Transmission Assets.

Project/Plan	Status	Distance from the Offshore Order Limits (nearest point, km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Transmission Assets
			North and Lennox wellhead platforms.			
Tier 2- Deposit and removal						
Liverpool Bay (Area 457)	Pre-application	2.43	Proposed extraction of 18 million tonnes of aggregate (mainly sand and fine sediment) over 15 years.	n/a	Unknown	The aggregate extraction activities associated with this site may overlap with the construction and operation and maintenance phases of the Transmission Assets.
Tier 3						
MaresConnect	Pre-application	34.44	MaresConnect is a proposed 750 MW subsea and underground electricity interconnector system linking the electricity grids in Ireland and Great Britain.	2025 onwards	Unknown	This project will overlap with the construction, operation and maintenance phases of the Transmission Assets.
Isle of Man to UK Interconnector Cable 2	Pre-application	Unknown	A new 70 MW to 100 MW HVAC interconnector to be deployed by 2030 between Pulrose substation and north west England distribution network.	2024 to 2030	2030 onwards	This project will overlap with the Transmission Assets construction and operation and maintenance phases.
Mooir Vannin - UK Transmission Assets	Pre-application	N/A	Comprising of offshore export cables and a booster station to	Unknown	Unknown	The construction and operation and maintenance phases of this project may

Project/Plan	Status	Distance from the Offshore Order Limits (nearest point, km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Transmission Assets
			connect the Mooir Vannin Offshore Wind Farm to the UK.			temporally overlap with the operation and maintenance and decommissioning phases of the Transmission Assets.

3.12.2 Scope of cumulative effects assessment

3.12.2.1 The impacts identified in **Table 3.23** have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. The cumulative effects presented and assessed in this section have been selected from the PDE provided in Volume 1, Chapter 3: Project Description of the ES as well as the publicly available information on other projects and plans. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the PDE (e.g., different foundation type or substation layout), to that assessed here, be taken forward in the final design scheme.

Table 3.23: Scope of the assessment of cumulative effects

Cumulative effect	Phase[a]			Project(s) considered	Justification
	C	O	D		
Temporary habitat loss/disturbance	✓	x	x	**Scenario 1** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with the Morecambe Offshore Windfarm: Generation Assets. **Scenario 2** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with the Morgan Offshore Wind Project: Generation Assets. **Scenario 3** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with Morgan Offshore Wind Project: Generation Assets and Morecambe Offshore Windfarm: Generation Assets. **Scenario 4a: Scenario 3 +Tier 1** The MDS as described for Scenario 3 assessed cumulatively with the following other projects/plans. • Offshore renewables projects. – Mona Offshore Wind Project. – Awel y Môr Offshore Wind Farm. • Deposit and removal. – Hilbre Swash (392/393). • Dredging projects. – Liverpool 2 and River Mersey approach channel dredging. – Mersey channel and river maintenance dredge disposal renewal.	These projects all involve activities which will result in temporary habitat disturbance/loss which may contribute to the impact upon a habitat that the Transmission Assets will also affect.

Cumulative effect	Phase[a]			Project(s) considered	Justification
	C	O	D		
				– Douglas Harbour, Isle of Man. – Port of Barrow maintenance dredging disposal licence. – Walney Extension pontoon/jetty dredging and disposal. – West of Duddon Sands pontoon dredging marine licence. • Oil and gas projects. – Isle of Man Crogga licence. **Scenario 4b: Scenario 4a +Tier 2** The MDS as described for Scenario 4a assessed cumulatively with the following other projects/plans. • Tier 1 projects. • Offshore renewables projects. – ENI HyNet CCS Project. • Deposit and removal. – Liverpool Bay Area 457. **Scenario 4c: Scenario 4b +Tier 3** The MDS as described for Scenario 4b assessed cumulatively with the following other projects/plans. • Tier 1 and 2 projects. • Cables and pipelines. – MaresConnect. – Isle of Man to UK Interconnector Cable 2.	
	x	x	✓	**Scenario 1** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with the Morecambe Offshore Windfarm: Generation Assets.	These projects all involve activities which will result in temporary habitat disturbance/loss which may contribute to the impact upon a habitat that the Transmission Assets will also affect.

Cumulative effect	Phase[a]			Project(s) considered	Justification
	C	O	D		
				Scenario 2 MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with the Morgan Offshore Wind Project: Generation Assets. **Scenario 3** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with Morgan Offshore Wind Project: Generation Assets and Morecambe Offshore Windfarm: Generation Assets. **Scenario 4a: Scenarios 3 +Tier 1** The MDS as described for Scenario 3 assessed cumulatively with the following other projects/plans: • Offshore renewables projects: – Mona Offshore Wind Project. **Scenario 4b: Scenario 4a +Tier 2** The MDS as described for Scenario 4a assessed cumulatively with the following other projects/plans: • No Tier 2 projects are identified which overlap with this phase of the Transmission Assets. **Scenario 4c: Scenario 4b +Tier 3** The MDS as described for Scenario 4b assessed cumulatively with the following other projects/plans: • Tier 1 and 2 projects. • Cables/pipelines: – Mooir Vannin - UK Transmission Assets.	

Cumulative effect	Phase[a]			Project(s) considered	Justification
	C	O	D		
Underwater sound from UXO clearance impacting fish and shellfish receptors	✓	x	x	**Scenario 1** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with the Morecambe Offshore Windfarm: Generation Assets. **Scenario 2** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with the Morgan Offshore Wind Project: Generation Assets. **Scenario 3** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with Morgan Offshore Wind Project: Generation Assets and Morecambe Offshore Windfarm: Generation Assets. **Scenario 4a: Scenarios 3 +Tier 1** The MDS as described for Scenario 3 assessed cumulatively with the following other projects/plans. • Offshore renewables projects. – Mona Offshore Wind Project. – Awel y Môr Offshore Wind Farm. **Scenario 4b: Scenario 4a +Tier 2** The MDS as described for Scenario 4a assessed cumulatively with the following other projects/plans. • Tier 1 projects. • Offshore renewables projects. – ENI HyNet CCS Project. **Scenario 4c: Scenario 4b +Tier 3**	These projects all involve piling activities which will result in underwater sound which may coincide with the construction phase for the Transmission Assets contributing to the impact upon fish and shellfish IEFs cumulatively with the Transmission Assets.

Cumulative effect	Phase[a]			Project(s) considered	Justification
	C	O	D		
				The MDS as described for Scenario 4b assessed cumulatively with the following other projects/plans. • Tier 1 and 2 projects. • Cables and pipelines. – MaresConnect. – Isle of Man to UK Interconnector Cable 2.	
Increase in SSC and associated deposition	✓	x	x	**Scenario 1** Maximum design scenario as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with the Morecambe Offshore Windfarm: Generation Assets. **Scenario 2** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with the Morgan Offshore Wind Project: Generation Assets. **Scenario 3** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with Morgan Offshore Wind Project: Generation Assets and Morecambe Offshore Windfarm: Generation Assets. **Scenario 4a: Scenarios 3 +Tier 1** The MDS as described for Scenario 3 assessed cumulatively with the following other projects/plans. • Offshore renewables projects. – Mona Offshore Wind Project. – Awel y Môr Offshore Wind Farm. • Deposit and removal.	Outcome of the CEA will be greatest when the greatest number of other schemes are considered in combination. Including schemes and developments within the cumulative study area to capture the potential overlap of impacts during the construction, operation and maintenance and decommissioning phases. Activities from schemes that potentially increase SSCs during the temporal overlap with the Transmission Assets phases have been included as these may create a cumulative impact on physical features/receptors.

Cumulative effect	Phase[a]			Project(s) considered	Justification
	C	O	D		
				– Hilbre Swash (392/393). • Dredging projects. – Liverpool 2 and River Mersey approach channel dredging. – Mersey channel and river maintenance dredge disposal renewal. – Douglas Harbour, Isle of Man. – Port of Barrow maintenance dredging disposal licence. – Liverpool Marina Maintenance Dredging – sustainable relocation of dredged material to the River Mersey. – Walney Extension pontoon/jetty dredging and disposal. – West of Duddon Sands pontoon dredging marine licence. **Scenario 4b: Scenario 4a +Tier 2** The MDS as described for Scenario 4a assessed cumulatively with the following other projects/plans. • Tier 1 Projects. • Offshore renewables projects. – ENI HyNet CCS Project. • Deposit and removal. – Liverpool Bay Area 457. **Scenario 4c: Scenario 4b +Tier 3** The MDS as described for Scenario 4b assessed cumulatively with the following other projects/plans. • Tier 1 and 2 Projects. – MaresConnect.	

Cumulative effect	Phase[a]			Project(s) considered	Justification
	C	O	D		
				– Isle of Man to UK Interconnector Cable 2.	
	x	x	✓	**Scenario 1** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with the Morecambe Offshore Windfarm: Generation Assets. **Scenario 2** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with the Morgan Offshore Wind Project: Generation Assets. **Scenario 3** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with Morgan Offshore Wind Project: Generation Assets and Morecambe Offshore Windfarm: Generation Assets. **Scenario 4a: Scenarios 3 +Tier 1** The MDS as described for Scenario 3 assessed cumulatively with the following other projects/plans: • Offshore renewables projects: – Mona Offshore Wind Project. **Scenario 4b: Scenario 4a +Tier 2** The MDS as described for Scenario 4a assessed cumulatively with the following other projects/plans: • No Tier 2 projects are identified which overlap with this phase of the Transmission Assets. **Scenario 4c: Scenario 4b +Tier 3** The MDS as described for Scenario 4b assessed cumulatively with the following other projects/plans:	Outcome of the CEA will be greatest when the greatest number of other schemes are considered in combination. Including schemes and developments within the cumulative study area to capture the potential overlap of impacts during the construction and decommissioning phases. Activities from schemes that potentially increase SSCs during the temporal overlap with the Transmission Assets phases have been included as these may create a cumulative impact on fish and shellfish receptors.

Cumulative effect	Phase[a]			Project(s) considered	Justification
	C	O	D		
				• Tier 1 and 2 projects. • Cables/pipelines: – Mooir Vannin - UK Transmission Assets.	
Long term habitat loss	✓	✓	x	**Scenario 1** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with the Morecambe Offshore Windfarm: Generation Assets. **Scenario 2** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with the Morgan Offshore Wind Project: Generation Assets. **Scenario 3** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with Morgan Offshore Wind Project: Generation Assets and Morecambe Offshore Windfarm: Generation Assets. **Scenario 4a: Scenarios 3 +Tier 1** The MDS as described for Scenario 3 assessed cumulatively with the following other projects/plans. • Offshore wind farm projects. – Mona Offshore Wind Project. – Awel y Môr Offshore Wind Farm. • Oil and gas projects. – Isle of Man Crogga licence. **Scenario 4b: Scenario 4a +Tier 2**	These projects will all result in the installation of hard structures on the seabed which will lead to long term habitat loss within the cumulative study area meaning they may also affect habitats that the Transmission Assets will also affect.

Cumulative effect	Phase[a]			Project(s) considered	Justification
	C	O	D		
				The MDS as described for Scenario 4a assessed cumulatively with the following other projects/plans. • Tier 1 projects. • Offshore renewables projects. – Mooir Vannin Offshore Windfarm. – ENI HyNet CCS Project. **Scenario 4c: Scenario 4b +Tier 3** The MDS as described for Scenario 4b assessed cumulatively with the following other projects/plans. • Tier 1 and 2 projects. • Cables and pipelines. – MaresConnect. – Isle of Man to UK Interconnector Cable. – Mooir Vannin – UK Transmission Assets.	
	x	x	✓	**Scenario 1** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with the Morecambe Offshore Windfarm: Generation Assets. **Scenario 2** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with the Morgan Offshore Wind Project: Generation Assets. **Scenario 3** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with Morgan Offshore Wind Project:	These projects will all result in the installation of hard structures on the seabed which will lead to long term habitat loss within the cumulative study area meaning they may also affect habitats that the Transmission Assets will also affect.

Cumulative effect	Phase[a]			Project(s) considered	Justification
	C	O	D		
				Generation Assets and Morecambe Offshore Windfarm: Generation Assets. **Scenario 4a: Scenarios 3 +Tier 1** The MDS as described for Scenario 3 assessed cumulatively with the following other projects/plans: • Offshore wind farm projects: – Mona Offshore Wind Project. **Scenario 4b: Scenario 4a +Tier 2** The MDS as described for Scenario 4a assessed cumulatively with the following other projects/plans: • No Tier 2 projects are identified which overlap with this phase of the Transmission Assets. **Scenario 4c: Scenario 4b +Tier 3** The MDS as described for Scenario 4b assessed cumulatively with the following other projects/plans: • Tier 1 and 2 projects. • Cables/pipelines: – Mooir Vannin - UK Transmission Assets.	
EMFs from subsea electrical cabling	x	✓	x	**Scenario 1** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with the Morecambe Offshore Windfarm: Generation Assets. **Scenario 2** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with the Morgan Offshore Wind Project: Generation Assets.	These projects all involve activities which will result in EMF emissions which may coincide with the operation and maintenance phase for the Transmission Assets, contributing to this impact upon fish and shellfish IEFs cumulatively with the Transmission Assets.

Cumulative effect	Phase[a]			Project(s) considered	Justification
	C	O	D		
				Scenario 3 MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with Morgan Offshore Wind Project: Generation Assets and Morecambe Offshore Windfarm: Generation Assets. **Scenario 4a: Scenarios 3 +Tier 1** The MDS as described for Scenario 3 assessed cumulatively with the following other projects/plans. • Offshore wind farm projects. – Mona Offshore Wind Project. – Awel y Môr Offshore Wind Farm. **Scenario 4b: Scenario 4a +Tier 2** The MDS as described for Scenario 4a assessed cumulatively with the following other projects/plans. • Tier 1 projects. • Offshore renewables projects. – Mooir Vannin Offshore Windfarm. – ENI HyNet CCS Project. **Scenario 4c: Scenario 4b +Tier 3** The MDS as described for Scenario 4b assessed cumulatively with the following other projects/plans. • Tier 1 and 2 projects. • Cables and pipelines. – MaresConnect. – Isle of Man to UK Interconnector Cable. – Mooir Vannin – UK Transmission Assets.	

Cumulative effect	Phase[a]			Project(s) considered	Justification
	C	O	D		
Introduction and colonisation of hard substrata	x	✓	x	**Scenario 1** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with the Morecambe Offshore Windfarm: Generation Assets. **Scenario 2** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with the Morgan Offshore Wind Project: Generation Assets. **Scenario 3** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with Morgan Offshore Wind Project: Generation Assets and Morecambe Offshore Windfarm: Generation Assets. **Scenario 4a: Scenarios 3 +Tier 1** The MDS as described for Scenario 3 assessed cumulatively with the following other projects/plans. • Offshore wind farm projects. – Mona Offshore Wind Project. – Morgan Offshore Wind Project: Generation Assets. – Morecambe Offshore Windfarm: Generation Assets. – Awel y Môr Offshore Wind Farm. • Oil and gas projects. – Isle of Man Crogga licence. **Scenario 4b: Scenario 4a +Tier 2** The MDS as described for Scenario 4a assessed cumulatively with the following other projects/plans.	These projects will all result in the installation of hard structures on the seabed which could be colonised by new communities within the cumulative study area meaning they may also affect habitats that the Transmission Assets will also affect.

Cumulative effect	Phase[a]			Project(s) considered	Justification
	C	O	D		
				• Tier 1 projects. • Offshore renewables projects. – Mooir Vannin Offshore Windfarm. – ENI HyNet CCS Project. **Scenario 4c: Scenario 4b +Tier 3** The MDS as described for Scenario 4b assessed cumulatively with the following other projects/plans. • Tier 1 and 2 projects. • Cables and pipelines. – MaresConnect. – Isle of Man to UK Interconnector Cable. – Mooir Vannin – UK Transmission Assets.	
Injury due to increased risk of collision	✓	✓	✓	**Scenario 1** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with the Morecambe Offshore Windfarm: Generation Assets. **Scenario 2** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with the Morgan Offshore Wind Project: Generation Assets. **Scenario 3** MDS as described for the Transmission Assets (**Table 3.13**) assessed cumulatively with Morgan Offshore Wind Project: Generation Assets and Morecambe Offshore Windfarm: Generation Assets. **Scenario 4a: Scenarios 3 +Tier 1**	These projects all involve activities which will result in increased vessel traffic that may collide with basking shark, which may coincide with the construction, operation and maintenance, and decommissioning phases for the Transmission Assets, contributing to the impact on this fish IEF cumulatively with the Transmission Assets.

Cumulative effect	Phase[a]			Project(s) considered	Justification
	C	O	D		
				The MDS as described for Scenario 3 assessed cumulatively with the following other projects/plans. • Offshore renewables projects. – Mona Offshore Wind Project. – Morgan Offshore Wind Project: Generation Assets. – Morecambe Offshore Windfarm: Generation Assets. – Awel y Môr Offshore Wind Farm. • Oil and gas projects. – Isle of Man Crogga licence. **Scenario 4b: Scenario 4a +Tier 2** The MDS as described for Scenario 4a assessed cumulatively with the following other projects/plans. • Tier 1 projects. • Offshore renewables projects. – Mooir Vannin Offshore Windfarm. – ENI HyNet CCS Project. **Scenario 4c: Scenario 4b +Tier 3** The MDS as described for Scenario 4b assessed cumulatively with the following other projects/plans. • Tier 1 and 2 projects. • Cables and pipelines. – MaresConnect. – Isle of Man to UK Interconnector Cable. – Mooir Vannin – UK Transmission Assets.	

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

3.13 Cumulative effects assessment

3.13.1 Introduction

3.13.1.1 A description of the significance of cumulative effects upon fish and shellfish ecology receptors arising from each identified impact is given below.

3.13.1.2 The CEA is presented in a series of tables (one for each potential cumulative impact) and considers the following.

- Scenario 1: Transmission Assets together with Morecambe Offshore Windfarm: Generation Assets.
- Scenario 2: Transmission Assets together with Morgan Offshore Wind Project: Generation Assets.
- Scenario 3: Transmission Assets together with Morgan Offshore Wind Project: Generation Assets and Morecambe Offshore Windfarm: Generation Assets.
- Scenario 4a to 4c: Transmission Assets together with Morgan Offshore Wind Project: Generation Assets and Morecambe Offshore Windfarm: Generation Assets (Scenario 3) and other relevant projects and plans.

3.13.2 Temporary habitat loss or disturbance

3.13.2.1 There is the potential for cumulative temporary habitat loss as a result of construction and decommissioning activities associated with the Transmission Assets and other offshore wind farms (i.e., from cable burial, jack-up activities, anchor placements and seabed preparation), dredging activities, aggregate extraction activities and cables and pipelines (see **Table 3.23**). This additive impact has been assessed within the cumulative study area, defined as the area within a 50 km buffer of the Transmission Assets using the scenarios and Tiered approach outlined above. The 50 km buffer area captures a fair representation of potentially impacted fish and shellfish IEFs within the cumulative study area in proximity to the Transmission Assets. The potential effects of this impact alone were assessed for this project in **section 3.11.2**.

3.13.2.2 A summary cumulative effects assessment for temporary habitat loss or disturbance is presented in **Table 3.24** for Scenarios 1 to 3, and in **Table 3.25** for Scenario 4a to 4c. Further details to support defining the magnitude of impact for Scenarios 4a to 4c are presented in **Table 3.25.**

Table 3.24: Scenario 1 to 3: Temporary habitat loss or disturbance

	Scenario 1: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets	Scenario 2: Transmission Assets + Morgan Offshore Wind Project: Generation Assets	Scenario 3: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets and Morgan Offshore Wind Project: Generation Assets
Construction phase			
Sensitivity of receptor	The sensitivity of fish and shellfish ecology IEFs to this impact is described previously for the construction phase of the Transmission Assets alone in **paragraph 3.11.2.2** to **paragraph 3.11.2.32**. Most fish and shellfish ecology IEFs in the cumulative study area are deemed to be of low vulnerability, high recoverability and local to national value. The sensitivity of the receptor is therefore **low**. King and queen scallop are deemed to be of medium vulnerability, high recoverability and of regional value. The sensitivity of the receptor is therefore **low**. European lobster and Nephrops are deemed to be of high vulnerability, medium to high recoverability and of regional value. The sensitivity of these fish and shellfish IEFs is therefore **medium**. Sandeel are deemed to be of high vulnerability, high recoverability and of regional importance. The sensitivity of sandeel is therefore **medium**. Herring are deemed to be of high vulnerability, medium recoverability and of national importance. The sensitivity of herring to this impact is therefore **high**. Diadromous fish species are deemed to be of low vulnerability, high recoverability and national to international importance. The sensitivity of the receptor is therefore **negligible**.		
Magnitude of impact	The cumulative effects assessment for Scenario 1 for temporary habitat loss or disturbance considers the following: • Transmission Assets: 14.81 km^2. • Morecambe Offshore Windfarm: Generation Assets: 2.35 km^2. This equates to a total footprint of temporary habitat loss or disturbance of 17.26 km^2; this represents a relatively small area when compared to the extent of the cumulative fish	The cumulative effects assessment for Scenario 2 for temporary habitat loss or disturbance considers the following. • Transmission Assets: 14.81 km^2. • Morgan Offshore Wind Project: Generation Assets: 61.42 km^2. This equates to a total footprint of temporary habitat loss or disturbance of 76.23 km^2; this represents a relatively small area when compared to the extent of the cumulative	The cumulative effects assessment for Scenario 3 for temporary habitat loss or disturbance considers the following. • Transmission Assets: 14.81 km^2. • Morecambe Offshore Windfarm: Generation Assets: 2.35 km^2. • Morgan Offshore Wind Project: Generation Assets: 61.42 km^2. This equates to a total footprint of temporary habitat loss or disturbance of 78.58 km^2; this represents a relatively small area when

	Scenario 1: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets	Scenario 2: Transmission Assets + Morgan Offshore Wind Project: Generation Assets	Scenario 3: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets and Morgan Offshore Wind Project: Generation Assets
	study area relevant to this impact (13,065.53 km^2). The cumulative effect is predicted to be of local spatial extent, short to medium term duration, intermittent and of high reversibility. It is predicted that the impact will affect only some of the receptors directly. The magnitude is therefore, considered to be **low** for all fish and shellfish ecology IEFs, except herring. For herring, the cumulative effect is predicted to be of local spatial extent, short to medium term duration, intermittent and of high reversibility. It is predicted that the impact will affect the receptor directly. However, due to the limited suitable spawning substrates directly overlapping the Transmission Assets and the core herring spawning ground being located outside and to the north west of the cumulative study area, the magnitude is therefore, considered to be **negligible** to this receptor.	study area relevant to this impact (13,065.53 km^2). The magnitude is consistent with that presented in Scenario 1. The magnitude is considered to be **low** for all fish and shellfish ecology IEFs, except herring. The magnitude is considered to be **negligible** for herring.	compared to the extent of the cumulative study area relevant to this impact (13,065.53 km^2). The magnitude is consistent with that presented in Scenario 1. The magnitude is considered to be **low** for all fish and shellfish ecology IEFs, except herring. The magnitude is considered to be **negligible** for herring.
Significance of effect	For most fish and shellfish ecology IEFs in the cumulative study area, the sensitivity of the receptor is **low** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For king and queen scallop, the sensitivity of the receptor is **low** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For European lobster and Nephrops, the sensitivity of the receptor is **medium** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For sandeel, the sensitivity of the receptor is **medium** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.		

	Scenario 1: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets	Scenario 2: Transmission Assets + Morgan Offshore Wind Project: Generation Assets	Scenario 3: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets and Morgan Offshore Wind Project: Generation Assets
	For herring, the sensitivity of the receptor is **high** and the magnitude of the cumulative impact is **negligible**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For the diadromous fish species IEFs, the sensitivity of the receptor is **negligible** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **negligible** significance, which is not significant in EIA terms.		
Further mitigation and residual significance	Mitigation: None required Residual significance: Negligible to minor adverse		
Decommissioning phase			
Sensitivity of receptor	Please refer to the construction phase.		
Magnitude of impact	The cumulative effects assessment for Scenario 1 for temporary habitat loss or disturbance considers the following. • Transmission Assets; • Morecambe Offshore Windfarm: Generation Assets. The expected magnitude of temporary habitat loss or disturbance will be less than for the construction phase due to some construction-related activities not being required (e.g., sandwave clearance). As a precautionary measure, magnitudes are considered consistent with those presented for the Scenario 1 construction phase above.	The cumulative effects assessment for Scenario 2 for temporary habitat loss or disturbance considers the following. • Transmission Assets; • Morgan Offshore Wind Project: Generation Assets. As for Scenario 1, the expected magnitude of temporary habitat loss or disturbance will be less than for the construction phase due to some construction-related activities not being required. As a precautionary measure, magnitudes are considered consistent with those presented for the construction phase above. The magnitude is considered to be **low** for all fish and shellfish ecology IEFs, except herring.	The cumulative effects assessment for Scenario 3 for temporary habitat loss or disturbance considers the following. • Transmission Assets; • Morecambe Offshore Windfarm: Generation Assets; • Morgan Offshore Wind Project: Generation Assets. As for Scenarios 1 and 2, the expected magnitude of temporary habitat loss or disturbance will be less than for the construction phase due to some construction-related activities not being required. As a precautionary measure, magnitudes are considered consistent with those presented for the construction phase above.

	Scenario 1: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets	Scenario 2: Transmission Assets + Morgan Offshore Wind Project: Generation Assets	Scenario 3: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets and Morgan Offshore Wind Project: Generation Assets
	The magnitude is considered to be **low** for all fish and shellfish ecology IEFs, except herring. The magnitude is considered to be **negligible** for herring.	The magnitude is considered to be **negligible** for herring.	The magnitude is considered to be **low** for all fish and shellfish ecology IEFs, except herring. The magnitude is considered to be **negligible** for herring.
Significance of effect	Please refer to the construction phase.		
Further mitigation and residual significance	Mitigation: None required Residual significance: Negligible to minor adverse which is not significant in EIA terms.		

Table 3.25: Scenario 4: Temporary habitat loss or disturbance

	Scenario 4a: Scenario 3 (Transmission Assets and Generation Assets) + Tier 1	Scenario 4b: Scenario 4a + Tier 2	Scenario 4c: Scenario 4b + Tier 2
Construction phase			
Sensitivity of receptor	The sensitivity of fish and shellfish ecology IEFs to this impact is described previously for the construction phase of the Transmission Assets alone in **paragraph 3.11.2.2** to **paragraph 3.11.2.32**. Most fish and shellfish ecology IEFs in the cumulative study area are deemed to be of low vulnerability, high recoverability and local to national value. The sensitivity of the receptor is therefore **low**. King and queen scallop are deemed to be of medium vulnerability, high recoverability and of regional value. The sensitivity of the receptor is therefore **low**. European lobster and Nephrops are deemed to be of high vulnerability, medium to high recoverability and of regional value. The sensitivity of these fish and shellfish IEFs is therefore **medium**. Sandeel are deemed to be of high vulnerability, high recoverability and of regional importance. The sensitivity of sandeel is therefore **medium**. Herring are deemed to be of high vulnerability, medium recoverability and of national importance. The sensitivity of herring to this impact is therefore **high**. Diadromous fish species are deemed to be of low vulnerability, high recoverability and national to international importance. The sensitivity of the receptor is therefore **negligible**.		
Magnitude of impact	The cumulative effects assessment for Scenario 4a for temporary habitat loss or disturbance considers the Transmission Assets and Generation Assets (Scenario 3, 79.69 km^2) with the Tier 1 projects listed in **Table 3.22**, representing a total footprint of potential temporary habitat loss or disturbance of 155.31 km^2. When compared to the total area of the cumulative study area for this impact, this represents a relatively small area. The magnitude is consistent with that presented in Scenario 1.	The cumulative effects assessment for Scenario 4b for temporary habitat loss or disturbance considers the Transmission Assets and Generation Assets with the Tier 1 projects (Scenario 4a) and Tier 2 projects (ENI HyNet CCS Project and Liverpool Bay Area 457). No spatial quantification is available for the ENI HyNet CCS Project, however the scale of the proposed project infrastructure and likely footprint of temporary disturbance is considered small, and Area 457 represents a footprint of just 3.24 km^2.	The cumulative effects assessment for Scenario 4c for temporary habitat loss or disturbance considers the Transmission Assets and Generation Assets with the Tier 1 and 2 projects (Scenario 4b) and Tier 3 projects (MaresConnect and the Isle of Man to UK Interconnector 2). No spatial quantification is available for these projects, however the scale of the anticipated project infrastructure and spatial footprint of temporary disturbance is considered likely to represent only a small increase on the areas presented under Scenarios 4a and 4b.

	Scenario 4a: Scenario 3 (Transmission Assets and Generation Assets) + Tier 1	Scenario 4b: Scenario 4a + Tier 2	Scenario 4c: Scenario 4b + Tier 2
	The magnitude is considered to be **low** for all fish and shellfish ecology IEFs, except herring. The magnitude is considered to be **negligible** for herring.	As such, the magnitude is consistent with that presented in Scenario 1. The magnitude is considered to be **low** for all fish and shellfish ecology IEFs, except herring. The magnitude is considered to be **negligible** for herring.	As such, the magnitude is consistent with that presented in Scenario 1. The magnitude is considered to be **low** for all fish and shellfish ecology IEFs, except herring. The magnitude is considered to be **negligible** for herring.
Significance of effect	For most fish and shellfish ecology IEFs in the cumulative study area, the sensitivity of the receptor is **low** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For king and queen scallop, the sensitivity of the receptor is **low** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For European lobster and Nephrops, the sensitivity of the receptor is **medium** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For sandeel, the sensitivity of the receptor is **medium** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For herring, the sensitivity of the receptor is **high** and the magnitude of the cumulative impact is **negligible**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For the diadromous fish species IEFs, the magnitude of the cumulative impact is **low** and the sensitivity of the receptor is **negligible**. The cumulative effect will, therefore, be of **negligible** significance, which is not significant in EIA terms.		
Further mitigation and residual significance	Mitigation: None required Residual significance: Negligible to minor adverse which is not significant in EIA terms.		
Decommissioning phase			
Sensitivity of receptor	Please refer to the construction phase.		
Magnitude of impact	The cumulative effects assessment for Scenario 4a for temporary habitat loss or disturbance considers the Transmission Assets and Generation Assets with the other	No Tier 2 projects were identified under Scenario 4b with potential for cumulative effects with the decommissioning of the Transmission Assets.	The cumulative effects assessment for Scenario 4c for temporary habitat loss or disturbance considers the Transmission Assets and Generation Assets with the Tier 1

	Scenario 4a: Scenario 3 (Transmission Assets and Generation Assets) + Tier 1	Scenario 4b: Scenario 4a + Tier 2	Scenario 4c: Scenario 4b + Tier 2
	projects listed Scenario 3, and the Mona Offshore Wind Project. As for Scenarios 1, 2 and 3, the expected magnitude of temporary habitat loss or disturbance will be less than for the construction phase due to the absence of some construction-related activities. As a precautionary measure, magnitudes are considered consistent with those presented for the construction phase above. The magnitude is considered to be **low** for all fish and shellfish ecology IEFs, except herring. The magnitude is considered to be **negligible** for herring.		and 2 projects (Scenario 4b) and Tier 3 projects (Mooir Vannin – UK Transmission Assets). No spatial quantification is available for this project, however the scale of the anticipated project infrastructure and spatial footprint of temporary disturbance is considered likely to represent only a small increase on the areas presented under Scenarios 4a and 4b. As such, the magnitude is consistent with that presented in Scenario 1. The magnitude is considered to be **low** for all fish and shellfish ecology IEFs, except herring. The magnitude is considered to be **negligible** for herring.
Significance of effect	Please refer to the construction phase.		
Further mitigation and residual significance	Mitigation: None required Residual significance: Negligible to minor adverse which is not significant in EIA terms.		

3.13.3 Underwater sound from UXO clearance impacting fish and shellfish receptors

3.13.3.1 There is the potential for cumulative impacts from underwater sound generation as a result of construction phase of the Transmission Assets and other offshore wind farms and other relevant projects or plans. For the purposes of this ES, this impact has been assessed within the cumulative study area for underwater sound, defined as the area within a 100 km buffer of the Offshore Order Limits. The cumulative assessment considered the impact of disturbance from underwater sound generated from UXO clearance only; geophysical surveys are not considered within the CEA.

3.13.3.2 A summary of the cumulative effects assessment for underwater sound from UXO clearance is presented in **Table 3.26** for Scenarios 1 to 3, and in **Table 3.27** for Scenarios 4a to 4c. Further details to support defining the magnitude of impact for Scenarios 4a to 4c are presented in **Table 3.25.**

Table 3.26: Scenarios 1 to 3: Underwater sound from UXO clearance impacting fish and shellfish receptors

<table>
<tr><th></th><th>Scenario 1: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets</th><th>Scenario 2: Transmission Assets + Morgan Offshore Wind Project: Generation Assets</th><th>Scenario 3: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets and Morgan Offshore Wind Project: Generation Assets</th></tr>
<tr><td colspan="4">Construction phase</td></tr>
<tr><td>Sensitivity of receptor</td><td colspan="3">The sensitivity of fish and shellfish ecology IEFs to this impact is described previously for the construction phase of the Transmission Assets alone in paragraph 3.11.3.2 to paragraph 3.11.3.43.

Most fish and shellfish IEFs in the cumulative study area are deemed to be of low vulnerability, high recoverability and local to international importance. The sensitivity of the receptor is therefore low.

Sprat are deemed to be of medium vulnerability, high recoverability and regional importance. The sensitivity of the receptor is therefore medium.

Cod and herring are deemed to be of high vulnerability, high recoverability and national importance. The sensitivity of the receptor is therefore high.

Allis and twaite shad are deemed to be of medium vulnerability, high recoverability and national importance. The sensitivity of the receptor is therefore medium.</td></tr>
<tr><td>Magnitude of impact</td><td>The cumulative effects assessment for Scenario 1 for underwater sound from UXO clearance considers the following.
• Transmission Assets.
• Morecambe Offshore Windfarm: Generation Assets.

Based upon the scale and location of the two projects in Scenario 1, the quantity and sizes of UXO at the Morecambe Offshore Windfarm: Generation Assets requiring clearance are expected to be similar to or less than those for the Transmission Assets.

Each clearance event is considered of a short term, almost instantaneous nature, and is likely to result in close range mortality and mortal injury to fish and shellfish species. It</td><td>The cumulative effects assessment for Scenario 2 for underwater sound from UXO clearance considers the following:
• Transmission Assets.
• Morgan Offshore Wind Project: Generation Assets.

Fewer UXO are estimated to require clearance for the Morgan Offshore Wind Project: Generation Assets (13) than the Transmission Assets (25), and the maximum size of UXO is likely to be the same (130 kg as the most likely maximum) for both projects.</td><td>The cumulative effects assessment for Scenario 3 for underwater sound from UXO clearance considers the following.
• Transmission Assets.
• Morecambe Offshore Windfarm: Generation Assets.
• Morgan Offshore Wind Project: Generation Assets.

Up to 38 UXO are estimated to require clearance for the Transmission Assets and Morgan Offshore Wind Project: Generation Assets, with the Morecambe Offshore Windfarm: Generation Assets considered unlikely to represent a significant increase.</td></tr>
</table>

	Scenario 1: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets	Scenario 2: Transmission Assets + Morgan Offshore Wind Project: Generation Assets	Scenario 3: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets and Morgan Offshore Wind Project: Generation Assets
	is considered unlikely that the two projects will undertake clearance detonations simultaneously (i.e., at exactly the same moment), which would lead to a greater area of instantaneous ensonification. The cumulative effect is predicted to be of regional spatial extent, short term duration, intermittent and of high reversibility. It is predicted that the impact will affect some of the receptors directly. The magnitude is therefore, considered to be **low** for all fish and shellfish ecology IEFs.	As described for Scenario 1, it is considered unlikely that the two projects will undertake clearance detonations simultaneously. The magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish ecology IEFs.	As described for Scenario 1 and 2, it is considered unlikely that these projects will undertake clearance detonations simultaneously. The magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish ecology IEFs.
Significance of effect	For most fish and shellfish ecology IEFs in the cumulative study area, the sensitivity of the receptor is **low** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For sprat, the sensitivity of the receptor is **medium** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For cod and herring, the sensitivity of the receptor is **high** and the magnitude of the cumulative impact is **low**. This gives rise to a cumulative effect significance of minor adverse or moderate adverse. Cumulatively, the plans and projects considered within the cumulative effects assessment are unlikely to contribute to this impact due to the nature of UXO clearance and the very low likelihood that clearance activities (or detonations) at multiple projects would occur exactly simultaneously which could result in a larger area of instantaneous increased ensonification. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For allis and twaite shad, the sensitivity of the receptor is **medium** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance which is not significant in EIA terms.		
Further mitigation and residual significance	Mitigation: None required Residual significance: Minor adverse which is not significant in EIA terms.		

Table 3.27: Scenario 4: Underwater sound from UXO clearance impacting fish and shellfish receptors

	Scenario 4a: Scenario 3 (Transmission Assets and Generation Assets) + Tier 1	Scenario 4b: Scenario 4a + Tier 2	Scenario 4c: Scenario 4b + Tier 2
Construction phase			
Sensitivity of receptor	The sensitivity of fish and shellfish ecology IEFs to this impact is described previously for the construction phase of the Transmission Assets alone in **paragraph 3.11.3.2** to **paragraph 3.11.3.43**. Most fish and shellfish IEFs in the cumulative study area are deemed to be of low vulnerability, high recoverability and local to international importance. The sensitivity of the receptor is therefore **low**. Sprat are deemed to be of medium vulnerability, high recoverability and regional importance. The sensitivity of the receptor is therefore **medium**. Cod and herring are deemed to be of high vulnerability, high recoverability and national importance. The sensitivity of the receptor is therefore **high**. Allis and twaite shad are deemed to be of medium vulnerability, high recoverability and national importance. The sensitivity of the receptor is therefore **medium**.		
Magnitude of impact	The cumulative effects assessment for Scenario 4a **for** underwater sound from UXO clearance considers the Transmission Assets and Generation Assets (Scenario 3) with the Tier 1 projects listed in **Table 3.23**. As described for Scenario 1 and 2, it is considered unlikely that these projects will undertake clearance detonations simultaneously. The magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish ecology IEFs.	The cumulative effects assessment for Scenario 4b for underwater sound from UXO clearance considers the Transmission Assets and Generation Assets with the Tier 1 projects (Scenario 4a) and Tier 2 projects (ENI HyNet CCS Project). No information is available for the ENI HyNet CCS Project, however as described for Scenarios 1 to 4a, it is considered unlikely that these projects will undertake clearance detonations simultaneously and therefore cumulative effects are not expected. As such, the magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish ecology IEFs.	The cumulative effects assessment for Scenario 4c for underwater sound from UXO clearance considers the Transmission Assets and Generation Assets with the Tier 1 and 2 projects (Scenario 4b) and Tier 3 projects (MaresConnect and the Isle of Man to UK Interconnector 2). No information regarding UXO clearance is available for these projects, however as described for Scenarios 1 to 4a, it is considered unlikely that these projects will undertake clearance detonations simultaneously. As such, the magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish ecology IEFs.
Significance of effect	For most fish and shellfish ecology IEFs in the cumulative study area, the sensitivity of the receptor is **low** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.		

	Scenario 4a: Scenario 3 (Transmission Assets and Generation Assets) + Tier 1	Scenario 4b: Scenario 4a + Tier 2	Scenario 4c: Scenario 4b + Tier 2
	For sprat, the sensitivity of the receptor is **medium** and the magnitude of the cumulative impact is **low.** The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For cod and herring, the sensitivity of the receptor is **high** and the magnitude of the cumulative impact is **low**. This gives rise to a cumulative effect significance of minor adverse or moderate adverse. Cumulatively, the plans and projects considered within the cumulative effects assessment are unlikely to contribute to this impact due to the nature of UXO clearance and the very low likelihood that clearance activities (or detonations) at multiple projects would occur exactly simultaneously which could result in a larger area of instantaneous increased ensonification. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For allis and twaite shad, the sensitivity of the receptor is **medium** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance which is not significant in EIA terms.		
Further mitigation and residual significance	Mitigation: None required Residual significance: Minor adverse which is not significant in EIA terms.		

3.13.4 Increased SSCs and associated sediment deposition

3.13.4.1 Increased SSCs and associated sediment deposition is expected to occur in relation to the construction and decommissioning phases of the Transmission Assets, which was assessed for this impact alone in **section 3.11.5.** This may include the operational activities of nearby dredging and dredge disposal activities (see **Table 3.22**).

3.13.4.2 A summary of the cumulative effects assessment for increased SSCs and associated sediment deposition is presented in **Table 3.28** for Scenarios 1 to 3 and in **Table 3.29** for Scenarios 4a to 4c. Further details to support defining the magnitude of impact for Scenarios 4a to 4c are presented in **Table 3.25.**

Table 3.28: Scenarios 1 to 3: Increased SSCs and associated sediment deposition

<table>
<tr><th></th><th>Scenario 1: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets</th><th>Scenario 2: Transmission Assets + Morgan Offshore Wind Project: Generation Assets</th><th>Scenario 3: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets and Morgan Offshore Wind Project: Generation Assets</th></tr>
<tr><td colspan="4">Construction phase</td></tr>
<tr><td>Sensitivity of receptor</td><td colspan="3">The sensitivity of fish and shellfish ecology IEFs to this impact is described previously for the construction phase of the Transmission Assets alone in paragraph 3.11.5.3 to paragraph 3.11.5.17.
Most fish and shellfish ecology IEFs in the cumulative study area are deemed to be of low to medium vulnerability, high recoverability and local to national value. The sensitivity of the receptor is therefore low.
Herring are deemed to be of medium vulnerability, high recoverability and of national importance and therefore the sensitivity of this receptor is medium.</td></tr>
<tr><td>Magnitude of impact</td><td>The cumulative effects assessment for Scenario 1 for increased SSCs and associated sediment deposition considers the following.
• Transmission Assets: 3,604,800 m³ of disturbed sediments.
• Morecambe Offshore Windfarm: Generation Assets: 1,101,463 m³ of disturbed sediments.
This equates to a total spoil volume of 4,706,263 m³. The two projects combined are not expected to significantly increase the magnitude compared to the Transmission Assets alone, with sediment plumes creating the highest turbidity immediately adjacent to the release site and returning to background levels within a few tidal cycles. Deposited sediments are expected to be incorporated into the natural hydrodynamic regime and redistributed over the course of a series of spring tides.</td><td>The cumulative effects assessment for Scenario 2 for increased SSCs and associated sediment deposition considers the following.
• Transmission Assets: 3,604,800 m³ of disturbed sediments.
• Morgan Offshore Wind Project: Generation Assets: 20,261,920 m³ of disturbed sediment.
This equates to a total spoil volume of 23,866,720 m³. Whilst the total spoil volume is higher than for Scenario 1, the sediment plumes creating the highest turbidity are still anticipated to occur immediately adjacent to the release site, returning to background levels within a few tidal cycles.
Therefore, the magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be low for all fish and shellfish receptors.</td><td>The cumulative effects assessment for Scenario 3 for increased SSCs and associated sediment deposition considers the following.
• Transmission Assets: 3,604,800 m³ of disturbed sediments.
• Morecambe Offshore Windfarm: Generation Assets: 1,101,463 m³ of disturbed sediments.
• Morgan Offshore Wind Project: Generation Assets: 20,261,920 m³ of disturbed sediment.
This equates to a total spoil volume of 24,968,183 m³. This represents only a small increase in spoil volume when compared to Scenario 2.
Therefore, the magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be low for all fish and shellfish receptors.</td></tr>
</table>

	Scenario 1: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets	Scenario 2: Transmission Assets + Morgan Offshore Wind Project: Generation Assets	Scenario 3: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets and Morgan Offshore Wind Project: Generation Assets
	The cumulative effect is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **low.**		
Significance of effect	For most fish and shellfish ecology IEFs in the cumulative study area, the sensitivity of the receptor is **low** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For herring, the sensitivity of the receptor is **medium** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant.		
Further mitigation and residual significance	Mitigation: None required Residual significance: Minor adverse which is not significant in EIA terms.		
Decommissioning phase			
Sensitivity of receptor	Please refer to the construction phase.		
Magnitude of impact	The cumulative effects assessment for Scenario 1 for increased SSCs and associated sediment deposition considers the following. • Transmission Assets. • Morecambe Offshore Windfarm: Generation Assets. The expected magnitude of increased SSCs and associated sediment deposition will be less than for the construction phase due to	The cumulative effects assessment for Scenario 2 for increased SSCs and associated sediment deposition considers the following. • Transmission Assets. • Morgan Offshore Wind Project: Generation Assets. As for Scenario 1, the expected magnitude of increased SSCs and associated sediment deposition will be less than for the construction phase due to some	The cumulative effects assessment for Scenario 3 for increased SSCs and associated sediment deposition considers the following. • Transmission Assets. • Morecambe Offshore Windfarm: Generation Assets. • Morgan Offshore Wind Project: Generation Assets. As for Scenarios 1 and 2, the expected magnitude of increased SSCs and

	Scenario 1: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets	Scenario 2: Transmission Assets + Morgan Offshore Wind Project: Generation Assets	Scenario 3: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets and Morgan Offshore Wind Project: Generation Assets
	some construction-related activities not being required (e.g., sandwave clearance). As a precautionary measure, magnitudes are considered consistent with those presented for the Scenario 1 construction phase above. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.	construction-related activities not being required. As a precautionary measure, magnitudes are considered consistent with those presented for the construction phase above. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.	associated sediment deposition will be less than for the construction phase due to some construction-related activities not being required. As a precautionary measure, magnitudes are considered consistent with those presented for the construction phase above. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.
Significance of effect	Please refer to the construction phase.		
Further mitigation and residual significance	Mitigation: None required Residual significance: Minor adverse which is not significant in EIA terms.		

Table 3.29: Scenario 4: Increased SSCs and associated sediment deposition

	Scenario 4a: Scenario 3 (Transmission Assets and Generation Assets) + Tier 1	Scenario 4b: Scenario 4a + Tier 2	Scenario 4c: Scenario 4b + Tier 2
Construction phase			
Sensitivity of receptor	The sensitivity of fish and shellfish ecology IEFs to this impact is described previously for the construction phase of the Transmission Assets alone in **paragraph 3.11.5.3** to **paragraph 3.11.5.17**. Most fish and shellfish ecology IEFs in the cumulative study area are deemed to be of low to medium vulnerability, high recoverability and local to national value. The sensitivity of the receptor is therefore **low**. Herring are deemed to be of medium vulnerability, high recoverability and of national importance and therefore the sensitivity of this receptor is **medium**.		
Magnitude of impact	The cumulative effects assessment for Scenario 4a for increased SSCs and associated sediment deposition considers the Transmission Assets and Generation Assets (Scenario 3) with the Tier 1 projects listed in **section 3.12.2**,. Sediment plumes generated at Awel y Môr are expected to be of limited spatial extent and are therefore unlikely to interact with sediment plumes from the Transmission Assets. Sediment plumes from the Mona Offshore Wind Project may interact with those generated by the Transmission Assets, however high levels of SSC are expected to be limited to immediately adjacent to the release point for each project, with rapid assimilation into natural tidal cycles. The magnitude is therefore consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.	The cumulative effects assessment for Scenario 4b for increased SSCs and associated sediment deposition considers the Transmission Assets and Generation Assets with the Tier 1 projects (Scenario 4a) and Tier 2 projects (ENI HyNet CCS Project and Liverpool Bay Area 457). No quantification is available for the ENI HyNet CCS Project or Liverpool Bay Area 457, however sediment plumes are expected to be of limited spatial extent, with deposited sediments rapidly assimilated into the natural tidal regime. As such, the magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.	The cumulative effects assessment for Scenario 4c for increased SSCs and associated sediment deposition considers the Transmission Assets and Generation Assets with the Tier 1 and 2 projects (Scenario 4b) and Tier 3 projects (MaresConnect and the Isle of Man to UK Interconnector 2). No quantification is available for these Tier 3 projects, however the generated sediment plumes are expected to be of limited spatial extent, with deposited sediments rapidly assimilated into the natural tidal regime. As such, the magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.
Significance of effect	For most fish and shellfish ecology IEFs in the cumulative study area, the magnitude of the cumulative impact is low and the sensitivity of the receptor is low. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For herring, the magnitude of the cumulative impact is low and the sensitivity of the receptor is medium. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.		

	Scenario 4a: Scenario 3 (Transmission Assets and Generation Assets) + Tier 1	Scenario 4b: Scenario 4a + Tier 2	Scenario 4c: Scenario 4b + Tier 2
Further mitigation and residual significance	Mitigation: None required Residual significance: Minor adverse which is not significant in EIA terms.		
Decommissioning phase			
Sensitivity of receptor	Please refer to the construction phase.		
Magnitude of impact	The cumulative effects assessment for Scenario 4a for increased SSCs and associated sediment deposition considers the Transmission Assets and Generation Assets (Scenario 3), and the Mona Offshore Wind Project. As for Scenarios 1, 2 and 3, the expected magnitude of increased SSCs and associated sediment deposition will be less than for the construction phase due to the absence of some construction-related activities. As a precautionary measure, magnitudes are considered consistent with those presented for the construction phase above. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.	No Tier 2 projects were identified under Scenario 4b with potential for cumulative effects with the decommissioning of the Transmission Assets.	The cumulative effects assessment for Scenario 4c for increased SSCs and associated sediment deposition considers the Transmission Assets and Generation Assets with the Tier 1 and 2 projects (Scenario 4b) and Tier 3 projects (Mooir Vannin – UK Transmission Assets). No quantification is available for this Tier 3 project, however the generated sediment plumes are expected to be of limited spatial extent, with deposited sediments rapidly assimilated into the natural tidal regime. As such, the magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.
Significance of effect	Please refer to the construction phase.		
Further mitigation and residual significance	Mitigation: None required Residual significance: Minor adverse which is not significant in EIA terms.		

3.13.5 Long term habitat loss

3.13.5.1 Cumulative long term habitat loss is predicted to occur as a result of the presence of the Transmission Assets, which was assessed for this impact alone in **section 3.11.6**, alongside other relevant projects and plans within the cumulative study area. Long term habitat loss may result from the physical presence of cable protection and cable crossing protection.

3.13.5.2 A summary of the cumulative effects assessment for long term habitat loss is presented in **Table 3.30** for Scenarios 1 to 3, and in **Table 3.31** for Scenarios 4a to 4c. Further details to support defining the magnitude of impact for Scenarios 4a to 4c are presented in **Table 3.25**.

Table 3.30: Scenarios 1 to 3: Long term habitat loss

	Scenario 1: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets	Scenario 2: Transmission Assets + Morgan Offshore Wind Project: Generation Assets	Scenario 3: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets and Morgan Offshore Wind Project: Generation Assets
Construction and operation and maintenance phases			
Sensitivity of receptor	The sensitivity of fish and shellfish ecology IEFs to this impact is described previously for the construction and operation and maintenance phases of the Transmission Assets alone in **paragraph 3.11.6.2**to **paragraph 3.11.6.19**. Most fish and shellfish ecology IEFs in the cumulative study area are deemed to be of low vulnerability, high recoverability and local to national importance. The sensitivity of the receptor is therefore **low**. King and queen scallop are deemed to be of medium vulnerability, high recoverability and of regional importance. The sensitivity of the receptor is therefore **low**. European lobster and Nephrops are deemed to be of high vulnerability, medium to high recoverability and of regional importance. The sensitivity of these fish and shellfish IEFs is therefore **medium**. Sandeel are deemed to be of high vulnerability, high recoverability and of regional importance. The sensitivity of sandeel is therefore **medium**. Herring are deemed to be of high vulnerability, medium recoverability and of national importance. The sensitivity of herring to this impact is therefore **high**. Diadromous fish species are deemed to be of low vulnerability, high recoverability and national to international importance. The sensitivity of the receptor is therefore **low**.		
Magnitude of impact	The cumulative effects assessment for Scenario 1 for long term habitat loss considers the following. • Transmission Assets: 0.58 km^2. • Morecambe Offshore Windfarm: Generation Assets: 0.41 km^2. This equates to a total footprint of long term habitat loss of 0.99 km^2; this represents a small area when compared to the extent of the cumulative study area relevant to this impact (13,065.53 km^2).	The cumulative effects assessment for Scenario 2 for long term habitat loss considers the following. • Transmission Assets: 0.58 km^2. • Morgan Offshore Wind Project: Generation Assets: 1.31 km^2. This equates to a total footprint of long term habitat loss of 1.89 km^2; this represents a small area when compared to the extent of the cumulative study area relevant to this impact (13,065.53 km^2).	The cumulative effects assessment for Scenario 3 for long term habitat loss considers the following. • Transmission Assets: 0.58 km^2. • Morecambe Offshore Windfarm: Generation Assets: 0.41 km^2. • Morgan Offshore Wind Project: Generation Assets: 1.31 km^2. This equates to a total footprint of long term habitat loss of 2.3 km^2; this represents a relatively small area when compared to the

	Scenario 1: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets	Scenario 2: Transmission Assets + Morgan Offshore Wind Project: Generation Assets	Scenario 3: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets and Morgan Offshore Wind Project: Generation Assets
	Due to the absence of any overlap with mapped or reported herring spawning grounds, and the highly limited extent of substrate suitable for herring spawning, along with the highly localised spatial extent of the impact, it is predicted that this impact will not affect the receptor and the magnitude is therefore considered to be **negligible** for herring. For all other fish and shellfish IEFs, the impact is predicted to be of local spatial extent, long term duration, continuous and irreversible during the operation and maintenance phase. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.	The magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.	extent of the cumulative study area relevant to this impact (13,065.53 km^2). The magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.
Significance of effect	For most fish and shellfish ecology IEFs in the cumulative study area, the sensitivity of the receptor is **low** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For king and queen scallop, the sensitivity of the receptor is **low** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For European lobster and *Nephrops*, the sensitivity of the receptor is **medium** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For sandeel, the sensitivity of the receptor is **medium** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For herring, the sensitivity of the receptor is **high** and the magnitude of the cumulative impact is **negligible**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For the diadromous fish species IEFs, the sensitivity of the receptor is **low** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.		

	Scenario 1: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets	Scenario 2: Transmission Assets + Morgan Offshore Wind Project: Generation Assets	Scenario 3: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets and Morgan Offshore Wind Project: Generation Assets
Further mitigation and residual significance	Mitigation: None required Residual significance: Minor adverse which is not significant in EIA terms.		
Decommissioning phase			
Sensitivity of receptor	Please refer to the construction phase.		
Magnitude of impact	The cumulative effects assessment for Scenario 1 for long term habitat loss considers the following. • Transmission Assets. • Morecambe Offshore Windfarm: Generation Assets. The expected magnitude of long term habitat loss will be less than for the construction and operation and maintenance phases due to the removal of some infrastructure. As a precautionary measure, magnitudes are considered consistent with those presented for the Scenario 1 construction and operation and maintenance phases above. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.	The cumulative effects assessment for Scenario 2 for long term habitat loss considers the following. • Transmission Assets. • Morgan Offshore Wind Project: Generation Assets. As for Scenario 1, the expected magnitude of long term habitat loss will be less than for the construction and operation and maintenance phases due to the removal of some infrastructure. As a precautionary measure, magnitudes are considered consistent with those presented for the Scenario 1 construction and operation and maintenance phases above. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.	The cumulative effects assessment for Scenario 3 for long term habitat loss considers the following. • Transmission Assets. • Morecambe Offshore Windfarm: Generation Assets. • Morgan Offshore Wind Project: Generation Assets. As for Scenarios 1 and 2, the expected magnitude of long term habitat loss will be less than for the construction and operation and maintenance phases due to the removal of some infrastructure. As a precautionary measure, magnitudes are considered consistent with those presented for the Scenario 1 construction and operation and maintenance phases above. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.
Significance of effect	Please refer to the construction phase.		

	Scenario 1: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets	Scenario 2: Transmission Assets + Morgan Offshore Wind Project: Generation Assets	Scenario 3: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets and Morgan Offshore Wind Project: Generation Assets
Further mitigation and residual significance	Mitigation: None required Residual significance: Minor adverse which is not significant in EIA terms.		

Table 3.31: Scenario 4: Long term habitat loss

	Scenario 4a: Scenario 3 (Transmission Assets and Generation Assets) + Tier 1	Scenario 4b: Scenario 4a + Tier 2	Scenario 4c: Scenario 4b + Tier 2
Construction and operation and maintenance phases			
Sensitivity of receptor	The sensitivity of fish and shellfish ecology IEFs to this impact is described previously for the construction and operation and maintenance phases of the Transmission Assets alone in **paragraph 3.11.6.2** to **paragraph 3.11.6.19**. Most fish and shellfish ecology IEFs in the cumulative study area are deemed to be of low vulnerability, high recoverability and local to national importance. The sensitivity of the receptor is therefore **low**. King and queen scallop are deemed to be of medium vulnerability, high recoverability and of regional importance. The sensitivity of the receptor is therefore **low**. European lobster and Nephrops are deemed to be of high vulnerability, medium to high recoverability and of regional importance. The sensitivity of these fish and shellfish IEFs is therefore **medium**. Sandeel are deemed to be of high vulnerability, high recoverability and of regional importance. The sensitivity of sandeel is therefore **medium**. Herring are deemed to be of high vulnerability, medium recoverability and of national importance. The sensitivity of herring to this impact is therefore **high**. Diadromous fish species are deemed to be of low vulnerability, high recoverability and national to international importance. The sensitivity of the receptor is therefore **low**.		
Magnitude of impact	The cumulative effects assessment for Scenario 4a for long term habitat loss considers the Transmission Assets and Generation Assets (Scenario 3) with the Tier 1 projects listed in **section 3.12.2**,representing a total footprint of long term habitat loss of 6.19 km^2 (excluding Isle of Man Crogga). When compared to the total area of the cumulative study area for this impact, this represents a small area. The magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.	The cumulative effects assessment for Scenario 4b for long term habitat loss considers the Transmission Assets and Generation Assets with the Tier 1 projects (Scenario 4a) and Tier 2 projects (Mooir Vannin Offshore Wind Farm and ENI HyNet CCS Project_. No spatial quantification is available for these Tier 2 projects, however the Mooir Vannin Offshore Wind Farm is likely to be of a similar scale to the Morgan Offshore Wind Project: Generation Assets, and the scale of the proposed ENI HyNet CCS Project infrastructure and likely footprint of long term habitat loss is considered small.	The cumulative effects assessment for Scenario 4c for long term habitat loss considers the Transmission Assets and Generation Assets with the Tier 1 and 2 projects (Scenario 4b) and Tier 3 projects (MaresConnect, the Isle of Man to UK Interconnector 2 and Mooir Vannin – UK Transmission Assets). No spatial quantification is available for these projects, however the scale of the anticipated project infrastructure and spatial footprint of long term habitat loss is considered likely to represent only a small increase on the areas presented under Scenario 4b.

	Scenario 4a: Scenario 3 (Transmission Assets and Generation Assets) + Tier 1	Scenario 4b: Scenario 4a + Tier 2	Scenario 4c: Scenario 4b + Tier 2
		As such, the magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.	As such, the magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.
Significance of effect	For most fish and shellfish ecology IEFs in the cumulative study area, the sensitivity of the receptor is **low** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For king and queen scallop, the sensitivity of the receptor is **low** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For European lobster and *Nephrops*, the sensitivity of the receptor is **medium** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For sandeel, the sensitivity of the receptor is **medium** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For herring, the sensitivity of the receptor is **high** and the magnitude of the cumulative impact is **negligible**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For the diadromous fish species IEFs, the sensitivity of the receptor is **low** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.		
Further mitigation and residual significance	Mitigation: None required Residual significance: Minor adverse which is not significant in EIA terms.		
Decommissioning phase			
Sensitivity of receptor	Please refer to the construction phase.		
Magnitude of impact	The cumulative effects assessment for Scenario 4a for long term habitat loss considers the Transmission Assets and Generation Assets (scenario 3) and the Mona Offshore Wind Project. As for Scenarios 1, 2 and 3, the expected magnitude of long term habitat loss will be	No Tier 2 projects were identified under Scenario 4b with potential for cumulative effects with the decommissioning of the Transmission Assets.	The cumulative effects assessment for Scenario 4c for long term habitat loss considers the Transmission Assets and Generation Assets with the Tier 1 and 2 projects (Scenario 4b) and Tier 3 projects (Mooir Vannin – UK Transmission Assets). No spatial quantification is available for this project, however the scale of the anticipated

	Scenario 4a: Scenario 3 (Transmission Assets and Generation Assets) + Tier 1	Scenario 4b: Scenario 4a + Tier 2	Scenario 4c: Scenario 4b + Tier 2
	less than for the construction and operation and maintenance phases due to the removal of some infrastructure. As a precautionary measure, magnitudes are considered consistent with those presented for the Scenario 1 construction and operation and maintenance phases above. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.		project infrastructure and spatial footprint of long term habitat loss is considered likely to represent only a small increase on the areas presented under Scenarios 4a and 4b. As such, the magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.
Significance of effect	Please refer to the construction phase.		
Further mitigation and residual significance	Mitigation: None required Residual significance: Minor adverse which is not significant in EIA terms.		

3.13.6 EMFs from subsea electrical cabling

3.13.6.1 The operation of the subsea cabling laid and buried as part of the Transmission Assets will produce electromagnetic fields, with potential impacts on fish and shellfish receptors within the Offshore Order Limits. This could have impacts cumulatively with the operation and maintenance phases of other offshore energy projects and interconnector cables (**Table 3.22**).

3.13.6.2 A summary of the cumulative effects assessment for the impact of EMFs from subsea electrical cabling is presented in **Table 3.32** for Scenarios 1 to 3, and in **Table 3.33** for Scenarios 4a to 4c. Further details to support defining the magnitude of impact for Scenarios 4a to 4c are presented in **Table 3.25.**

Table 3.32: Scenarios 1 to 3: EMFs from subsea electrical cabling

	Scenario 1: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets	Scenario 2: Transmission Assets + Morgan Offshore Wind Project: Generation Assets	Scenario 3: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets and Morgan Offshore Wind Project: Generation Assets
Operation and maintenance phase			
Sensitivity of receptor	The sensitivity of fish and shellfish ecology IEFs to this impact is described previously for the construction and operation and maintenance phases of the Transmission Assets alone in **paragraph 3.11.7.2** to **paragraph 3.11.7.17**. Most fish and shellfish ecology IEFs in the cumulative study area are deemed to be of low vulnerability, high recoverability and local to international importance. The sensitivity of the receptor is therefore **low**. Decapod crustaceans and elasmobranchs in the cumulative study area are deemed to be of medium vulnerability, high recoverability and local to national importance. The sensitivity of the receptor is therefore **medium**.		
Magnitude of impact	The cumulative effects assessment for Scenario 1 for the impact of EMFs from subsea electrical cabling considers the following. • Transmission Assets. • Morecambe Offshore Windfarm: Generation Assets. Effects of EMFs are expected to be limited to a range of just metres from the cables associated with both projects. For all fish and shellfish IEFs, the impact is predicted to be of local spatial extent, long term duration, continuous and of high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.	The cumulative effects assessment for Scenario 2 for the impact of EMFs from subsea electrical cabling considers the following. • Transmission Assets. • Morgan Offshore Wind Project: Generation Assets. Effects of EMFs are expected to be limited to a range of just metres from the cables associated with both projects. The magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.	The cumulative effects assessment for Scenario 3 for the impact of EMFs from subsea electrical cabling considers the following. • Transmission Assets. • Morecambe Offshore Windfarm: Generation Assets. • Morgan Offshore Wind Project: Generation Assets. Effects of EMFs are expected to be limited to a range of just metres from the cables associated with all three projects. The magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.
Significance of effect	For most fish and shellfish ecology IEFs in the cumulative study area, the sensitivity of the receptor is **low** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.		

	Scenario 1: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets	Scenario 2: Transmission Assets + Morgan Offshore Wind Project: Generation Assets	Scenario 3: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets and Morgan Offshore Wind Project: Generation Assets
	For decapod crustaceans and elasmobranchs, the sensitivity of the receptor is **medium** and the magnitude of the cumulative impact is **low**. The cumulative effect is, therefore, considered to be of **minor adverse** significance, which is not significant in EIA terms.		
Further mitigation and residual significance	Mitigation: None required Residual significance: Minor adverse which is not significant in EIA terms.		

Table 3.33: Scenario 4: EMFs from subsea electrical cabling

	Scenario 4a: Scenario 3 + Tier 1	Scenario 4b: Scenario 4a + Tier 2	Scenario 4c: Scenario 4b + Tier 2
Operation and maintenance phase			
Sensitivity of receptor	The sensitivity of fish and shellfish ecology IEFs to this impact is described previously for the construction and operation and maintenance phases of the Transmission Assets alone in **paragraph 3.11.7.2** to **paragraph 3.11.7.17**. Most fish and shellfish ecology IEFs in the cumulative study area are deemed to be of low vulnerability, high recoverability and local to international importance. The sensitivity of the receptor is therefore **low**. Decapod crustaceans and elasmobranchs in the cumulative study area are deemed to be of medium vulnerability, high recoverability and local to national importance. The sensitivity of the receptor is therefore **medium**.		
Magnitude of impact	The cumulative effects assessment for Scenario 4a for the impact of EMFs from subsea electrical cabling considers the Transmission Assets and Generation Assets (Scenario 3) with the Tier 1 projects listed in **section 3.12.2**,. As outlined for Scenarios 1 to 3, the effects of EMFs are expected to be limited to a range of just metres from the cables associated with these projects. The magnitude is therefore consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.	The cumulative effects assessment for Scenario 4b for the impact of EMFs from subsea electrical cabling considers the Transmission Assets and Generation Assets with the Tier 1 projects (Scenario 4a) and Tier 2 projects (Mooir Vannin Offshore Wind Farm and ENI HyNet CCS Project). No details are available regarding electrical cable lengths or specifications; however, cables are expected to be buried where possible to a similar degree as those outlined for projects such as Mona Offshore Wind Project or Awel y Môr. As such, the magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.	The cumulative effects assessment for Scenario 4c for the impact of EMFs from subsea electrical cabling considers the Transmission Assets and Generation Assets with the Tier 1 and 2 projects (Scenario 4a 4b) and Tier 3 projects (MaresConnect, the Isle of Man to UK Interconnector 2 and Mooir Vannin – Uk Transmission Assets). No details are available regarding electrical cable lengths or specifications; however, cables are expected to be buried where possible. As such, the magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.
Significance of effect	For most fish and shellfish ecology IEFs in the cumulative study area, the sensitivity of the receptor is **low** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For decapod crustaceans and elasmobranchs, the sensitivity of the receptor is **medium** and the magnitude of the cumulative impact is **low**. The cumulative effect is, therefore, considered to be of **minor adverse** significance, which is not significant in EIA terms.		
Further mitigation and residual significance	Mitigation: None required Residual significance: Minor adverse which is not significant in EIA terms.		

3.13.7 Introduction and colonisation of hard substrata

3.13.7.1 The introduction of hard substrata into areas of predominantly soft sediments has the potential to alter community composition and biodiversity within the cumulative study area. Colonisation of hard substrata will occur over time, beginning in the construction phase and continuing through the operation and maintenance and decommissioning phases, with most potential colonisation occurring during the operation and maintenance phase. This impact was assessed alone for the Transmission Assets in **section 3.11.8**. Cumulative impacts may occur through the introduction of other projects within the cumulative study area.

3.13.7.2 A summary of the cumulative effects assessment for the introduction of hard substrata is presented in **Table 3.34** for Scenarios 1 to 3, and in **Table 3.35** for Scenarios 4a to 4c. Further details to support defining the magnitude of impact for Scenarios 4a to 4c are presented in **Table 3.25**.

Table 3.34: Scenarios 1 to 3: Introduction and colonisation of hard substrata

	Scenario 1: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets	Scenario 2: Transmission Assets + Morgan Offshore Wind Project: Generation Assets	Scenario 3: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets and Morgan Offshore Wind Project: Generation Assets
Operation and maintenance phase			
Sensitivity of receptor	The sensitivity of fish and shellfish ecology IEFs to this impact is described previously for the construction and operation and maintenance phases of the Transmission Assets alone in **paragraph 3.11.8.2** to **paragraph 3.11.8.19**. Most fish and shellfish ecology IEFs in the cumulative study area are deemed to be of low vulnerability, local to international importance (recoverability is not considered relevant to this impact during the operation and maintenance phase). The sensitivity of the receptor is therefore **low**. Sea trout are deemed to be of medium vulnerability and national importance (as previously mentioned, recoverability is not considered relevant to this impact during the operation and maintenance phase). The sensitivity of the receptor is therefore **low.**		
Magnitude of impact	The cumulative effects assessment for Scenario 1 for the introduction and colonisation of hard substrata considers the following. • Transmission Assets: 0.58 km^2. • Morecambe Offshore Windfarm: Generation Assets: 0.41 km^2. This equates to a total footprint of 0.99 km^2 of introduced habitat; this represents a small area of change when compared to the extent of the cumulative study area relevant to this impact (13,065.53 km^2). For all fish and shellfish IEFs, the impact is predicted to be of local spatial extent, long term duration, continuous and irreversible during the operation and maintenance phase. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.	The cumulative effects assessment for Scenario 2 for the introduction and colonisation of hard substrata considers the following. • Transmission Assets: 0.58 km^2. • Morgan Offshore Wind Project: Generation Assets: 1.79 km^2. This equates to a total footprint of introduced habitat of 2.37 km^2; this represents a small area of change when compared to the extent of the cumulative study area relevant to this impact (13,065.53 km^2). The magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.	The cumulative effects assessment for Scenario 3 for the introduction and colonisation of hard substrata considers the following. • Transmission Assets: 0.58 km^2. • Morecambe Offshore Windfarm: Generation Assets: 0.41 km^2. • Morgan Offshore Wind Project: Generation Assets: 1.79 km^2. This equates to a total footprint of introduced habitat of 2.8 km^2; this represents a relatively small area of change when compared to the extent of the cumulative study area relevant to this impact (13,065.53 km^2). The magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.-

	Scenario 1: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets	Scenario 2: Transmission Assets + Morgan Offshore Wind Project: Generation Assets	Scenario 3: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets and Morgan Offshore Wind Project: Generation Assets
Significance of effect	For most fish and shellfish ecology IEFs in the cumulative study area, the sensitivity of the receptor is **low** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For sea trout, the sensitivity of the receptor is **low** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.		
Further mitigation and residual significance	Mitigation: None required Residual significance: Minor adverse which is not significant in EIA terms.		

Table 3.35: Scenario 4: Introduction and colonisation of hard substrata

	Scenario 4a: Scenario 3 + Tier 1	Scenario 4b: Scenario 4a + Tier 2	Scenario 4c: Scenario 4b + Tier 2
Operation and maintenance phase			
Sensitivity of receptor	The sensitivity of fish and shellfish ecology IEFs to this impact is described previously for the construction and operation and maintenance phases of the Transmission Assets alone in **paragraph 3.11.8.2** to **paragraph 3.11.8.19**. Most fish and shellfish ecology IEFs in the cumulative study area are deemed to be of low vulnerability, local to international importance (recoverability is not considered relevant to this impact during the operation and maintenance phase). The sensitivity of the receptor is therefore **low**. Sea trout are deemed to be of medium vulnerability and national importance (as previously mentioned, recoverability is not considered relevant to this impact during the operation and maintenance phase). The sensitivity of the receptor is therefore **low**.		
Magnitude of impact	The cumulative effects assessment for Scenario 4a for the introduction and colonisation of hard substrata considers the Transmission Assets and Generation Assets (Scenario 3) with the Tier 1 projects listed in **section 3.12.2**, representing a total footprint of introduced habitat of 7.17 km^2 (excluding Isle of Man Crogga). When compared to the total area of the cumulative study area for this impact, this represents a relatively small area of change. The magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.	The cumulative effects assessment for Scenario 4b for the introduction and colonisation of hard substrata considers the Transmission Assets and Generation Assets with the Tier 1 projects (Scenario 4a) and Tier 2 projects (Mooir Vannin Offshore Wind Farm and ENI HyNet CCS Project). No spatial quantification is available for these Tier 2 projects, however the Mooir Vannin Offshore Wind Farm is likely to be of a similar scale to the Morgan Offshore Wind Project: Generation Assets, and the scale of the proposed ENI HyNet CCS Project infrastructure and likely footprint of introduced habitat is considered small. As such, the magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.	The cumulative effects assessment for Scenario 4c for the introduction and colonisation of hard substrata considers the Transmission Assets and Generation Assets with the Tier 1 and 2 projects (Scenario 4a 4b) and Tier 3 projects (MaresConnect, the Isle of Man to UK Interconnector 2 and Mooir Vannin – Uk Transmission Assets). No spatial quantification is available for these projects, however the scale of the anticipated project infrastructure and spatial footprint of introduced habitat is considered likely to represent only a small increase on the areas presented under Scenario 4b. As such, the magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.
Significance of effect	For most fish and shellfish ecology IEFs in the cumulative study area, the sensitivity of the receptor is **low** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For sea trout, the sensitivity of the receptor is **low** and the magnitude of the cumulative impact is **low**. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.		

	Scenario 4a: Scenario 3 + Tier 1	Scenario 4b: Scenario 4a + Tier 2	Scenario 4c: Scenario 4b + Tier 2
Further mitigation and residual significance	Mitigation: None required Residual significance: Minor adverse which is not significant in EIA terms.		

3.13.8 Injury to basking shark due to increased risk of collision with vessels

3.13.8.1 Increased levels of vessel activity related to the construction, operation and maintenance and decommissioning phases of the Transmission Assets will likely represent an increased risk of collision with basking shark, with this impact assessed alone in **section 3.11.9**. This could have cumulative impacts with the vessels involved in activities associated with other projects within the cumulative study area.

3.13.8.2 A summary of the cumulative effects assessment for injury to basking shark due to increased risk of collision with vessels is presented in **Table 3.36** for Scenarios 1 to 3 and in **Table 3.37** for Scenarios 4a to 4c. Further details to support defining the magnitude of impact for Scenarios 4a to 4c are presented in **Table 3.25**.

Table 3.36: Scenarios 1 to 3: Injury to basking shark due to increased risk of collision with vessels

	Scenario 1: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets	Scenario 2: Transmission Assets + Morgan Offshore Wind Project: Generation Assets	Scenario 3: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets and Morgan Offshore Wind Project: Generation Assets
All phases			
Sensitivity of receptor	The sensitivity of fish and shellfish ecology IEFs to this impact is described previously for the construction, operation and maintenance and decommissioning phases of the Transmission Assets alone in **paragraph 3.11.9.3** to **paragraph 3.11.9.7**. The basking shark within the cumulative study area are deemed to be of low vulnerability, medium recoverability and international importance. The sensitivity of the receptor is therefore **medium**.		
Magnitude of impact	The cumulative effects assessment for Scenario 1 for injury to basking shark due to increased risk of collision considers the following. • Transmission Assets. • Morecambe Offshore Windfarm: Generation Assets. For both projects in the construction phase, this equates to a total of 38 construction vessels on site at any one time, with up to 286 round trips expected for the Transmission Assets. For the operation and maintenance phase, the Transmission Assets predicts up to 14 vessels on site at any one time, and up to 74 round trips per year, and for decommissioning, vessels and numbers of vessel movements are expected to be consistent with the construction phase. Morecambe Offshore Windfarm: Generation Assets has not reported the maximum vessel numbers predicted to be on site at any one time post the construction phase, however	The cumulative effects assessment for Scenario 2 for injury to basking shark due to increased risk of collision considers the following. • Transmission Assets. • Morgan Offshore Wind Project: Generation Assets. For both projects in the construction phase, this equates to a total of 97 construction vessels on site at any one time, with up to 2,211 round trips expected for the Transmission Assets and Morgan Offshore Wind Project: Generation Assets cumulatively. For the operation and maintenance phase the two projects predict a cumulative maximum vessel number of 22 at any one time, with a total of 793 round trips. For the decommissioning phase both the maximum number of vessels on site concurrently, and the maximum number of vessel movements predicted are expected to	The cumulative effects assessment for Scenario 3 for injury to basking shark due to increased risk of collision considers the following. • Transmission Assets. • Morecambe Offshore Windfarm: Generation Assets. • Morgan Offshore Wind Project: Generation Assets. For both projects in the construction phase, this equates to a total of 164 construction vessels on site at any one time. For the operation and maintenance and decommissioning phases, predicted numbers of vessels on site and vessel movements are consistent with those presented in Scenario 2, with the maximum number of vessels on site at any one time for Morecambe Offshore Windfarm: Generation Assets expected to be of a similar level of lower than that predicted for the construction phase.

	Scenario 1: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets	Scenario 2: Transmission Assets + Morgan Offshore Wind Project: Generation Assets	Scenario 3: Transmission Assets + Morecambe Offshore Windfarm: Generation Assets and Morgan Offshore Wind Project: Generation Assets
	vessel numbers are expected to be similar to or lower than those predicted for construction. The baseline conditions in the area indicate relatively high levels of vessel traffic, therefore increases related to these projects are not expected to represent a substantial change from the baseline. For all fish and shellfish IEFs, the impact is predicted to be of regional spatial extent, long term duration, intermittent and of high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **low**.	be similar to those stated for the construction phase. The magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.	The magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.
Significance of effect	For basking shark, the sensitivity of the receptor is **medium** and the magnitude of the cumulative impact is **low**. The cumulative effect is, therefore, considered to be of **minor adverse** significance, which is not significant in EIA terms.		
Further mitigation and residual significance	Mitigation: None required Residual significance: Minor adverse which is not significant in EIA terms.		

Table 3.37: Scenario 4: Injury to basking shark due to increased risk of collision with vessels

	Scenario 4a: Scenario 3 + Tier 1	Scenario 4b: Scenario 4a + Tier 2	Scenario 4c: Scenario 4b + Tier 2
All phases			
Sensitivity of receptor	The sensitivity of fish and shellfish ecology IEFs to this impact is described previously for the construction, operation and maintenance and decommissioning phases of the Transmission Assets alone in **paragraph 3.11.9.3** to **paragraph 3.11.9.7**. The basking shark within the cumulative study area are deemed to be of low vulnerability, medium recoverability and international importance. The sensitivity of the receptor is therefore **medium**.		
Magnitude of impact	The cumulative effects assessment for Scenario 4a for injury to basking shark due to increased risk of collision considers the Transmission Assets and Generation Assets (Scenario 3) with the Tier 1 projects listed in **section 3.12.2**. The construction phase cumulative assessment is based upon a total maximum of 215 vessels on site at any one time (excluding Awel y Môr and Isle of Man Crogga, due to this information not being available), and up to 4,268 vessel movements (excluding Morecambe Offshore Windfarm: Generation Assets, Awel y Môr and Isle of Man Crogga). For the operation and maintenance phase, up to 51 vessels are predicted to be on site at any one time, with up to 1,642 vessel movements (excluding Morecambe Offshore Windfarm: Generation Assets, Awel y Môr and Isle of Man Crogga). For the decommissioning phase, vessel movements are expected to be of a similar level to that outlined for the construction phase. The magnitude is consistent with that presented in Scenario 1. The magnitude is	The cumulative effects assessment for Scenario 4b for injury to basking shark due to increased risk of collision considers the Transmission Assets and Generation Assets with the Tier 1 projects (Scenario 4a) and Tier 2 projects (Mooir Vannin Offshore Wind Farm and ENI HyNet CCS Project). No spatial quantification is available for these Tier 2 projects, however the Mooir Vannin Offshore Wind Farm is likely to be of a similar scale to the Morgan Offshore Wind Project: Generation Assets, and the scale of the proposed ENI HyNet CCS Project is expected to be much smaller with fewer vessels required for all project phases which overlap with the Transmission Assets. As such, the magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.	The cumulative effects assessment for Scenario 4c for injury to basking shark due to increased risk of collision considers the Transmission Assets and Generation Assets with the Tier 1 and 2 projects (Scenario 4a 4b) and Tier 3 projects (MaresConnect, the Isle of Man to UK Interconnector 2 and Mooir Vannin – UK Transmission Assets). No spatial quantification is available for these projects; however the scale and type of these projects suggests that additional vessel traffic is likely to represent only a small increase on that presented under Scenario 4b. As such, the magnitude is consistent with that presented in Scenario 1. The magnitude is therefore, considered to be **low** for all fish and shellfish receptors.

	Scenario 4a: Scenario 3 + Tier 1	Scenario 4b: Scenario 4a + Tier 2	Scenario 4c: Scenario 4b + Tier 2
	therefore, considered to be **low** for all fish and shellfish receptors.		
Significance of effect	For basking shark, the sensitivity of the receptor is **medium** and the magnitude of the cumulative impact is **low**. The cumulative effect is, therefore, considered to be of **minor adverse** significance, which is not significant in EIA terms.		
Further mitigation and residual significance	Mitigation: None required Residual significance: Minor adverse which is not significant in EIA terms.		

3.13.9 Future monitoring

3.13.9.1 Based upon the results of the assessment, no monitoring to test the predictions made within the impact assessment is considered necessary as no potentially significant effects to fish and shellfish ecology receptors are predicted.

3.14 Transboundary effects

3.14.1.1 A screening of transboundary impacts has been carried out and any potential for significant transboundary effects with regard to fish and shellfish ecology from the Transmission Assets upon the interests of other states has been assessed as part of this ES.

3.14.1.2 The potential transboundary impacts assessed within Volume 1, Annex 5.4: Transboundary screening of the ES are summarised below.

3.14.1.3 Transboundary impacts to fish and shellfish ecology IEFs may occur in Irish waters as a result of underwater sound generated during the construction phase of the Transmission Assets, during clearance of Unexploded Ordnance (UXO) by means of high order techniques, and high resolution geophysical surveys (**section 3.11.3**). All other impacts on fish and shellfish IEFs will be restricted to within the Transmission Assets and the immediate surrounding areas.

3.14.1.4 Underwater sound from UXO clearance and geophysical surveys impacting fish and shellfish IEFs within the construction phase has a low magnitude of impact and the sensitivity of the receptors to this impact is low to high with an impact significance of minor adverse concluded. Following the assessment presented herein, effects of underwater sound on fish and shellfish receptors from UXO clearance and geophysical surveys are not predicted to extend beyond UK and Isle of Man waters, with no transboundary impacts therefore predicted.

3.14.1.5 Based on the above assessment, no significant transboundary effects on fish and shellfish IEFs are predicted as a result of the Transmission Assets.

3.15 Inter-related effects

3.15.1.1 Inter-relationships are the impacts and associated effects of different aspects of the Transmission Assets on the same receptor, these are as follows.

- Project lifetime effects: Assessment of the scope for effects that occur throughout more than one phase of the Transmission Assets (construction, operation and maintenance, and decommissioning), to interact to potentially create a more significant effect on a receptor than if just assessed in isolation (e.g., disturbance effects due to sound from UXO clearance, operation of vessels and decommissioning).
- Receptor-led effects: Assessment of the scope for all effects (including inter-relationships between environmental topics) to interact, spatially and temporally, to create inter-related effects on a receptor. As an example, all effects on fish and shellfish ecology, such as temporary

habitat loss, underwater sound, increased SSCs and sediment deposition, long term habitat loss, EMF from subsea cabling, introduction of hard substrata, injury to basking shark from vessel collisions and disturbance or remobilisation of sediment-bound contaminants, may interact to produce a different, or greater effect on this receptor than when the effects are considered in isolation. Receptor-led effects may be short term, temporary or transient effects, or incorporate longer term effects.

3.15.1.2 A description of the likely interactive effects arising from the Transmission Assets on fish and shellfish ecology is provided in Volume 4, Chapter 3: Inter-relationships of the ES. There is no change in the significance of effects resulting from the inter-related assessment for fish and shellfish ecology.

3.16 Summary of impacts, mitigation measures and monitoring

3.16.1.1 Information on fish and shellfish ecology within the study area was collected through desktop review, with improved coverage of published literature ensured through stakeholder consultation and incorporation of some site-specific data opportunistically collected during site surveys.

3.16.1.2 **Table 3.38** presents a summary of the potential impacts, measures adopted as part of the Transmission Assets and residual effects in respect to fish and shellfish ecology. The impacts assessed include: temporary habitat loss/disturbance, underwater sound from UXO clearance and geophysical surveys impacting fish and shellfish receptors, underwater sound from all other activities, increased SSCs and associated sediment deposition, long term habitat loss, EMF from subsea electrical cabling, introduction of hard substrata and injury to basking shark due to increased risk of collision with vessels. Overall, it is concluded that there will be no significant effects arising from the Transmission Assets during the construction, operation and maintenance or decommissioning phases. No mitigation is considered required based upon the assessment outcomes.

3.16.1.3 **Table 3.39** presents a summary of the potential cumulative impacts, mitigation measures and residual effects. The cumulative impacts assessed include: temporary habitat loss/disturbance, underwater sound from UXO clearance impacting fish and shellfish receptors, increased SSCs and associated sediment deposition, long term habitat loss, EMF from subsea electrical cabling, introduction of hard substrata and injury to basking shark due to increased risk of collision with vessels. Overall, it is concluded that there will be no significant cumulative effects from the Transmission Assets alongside other projects/plans.

3.16.1.4 No potential significant transboundary impacts have been identified in regard to effects of the Transmission Assets.

Table 3.38: Summary of environmental effects, mitigation and monitoring

Description of impact	Phase[a]			Commitment number (Table 3.12)	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
	C	O	D							
Temporary habitat loss/disturbance	✓	✓	✓	CoT 45 CoT 54 CoT 49	C: Negligible to low O: Negligible to low D: Negligible to low	C: Marine – Low to high Diadromous – Negligible O: Marine – Low to high Diadromous – Negligible D: Marine – Low to high Diadromous – Negligible	C: Marine – Minor adverse Diadromous – Negligible O: Marine – Minor adverse Diadromous – Negligible D: Marine – Minor adverse Diadromous – Negligible	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Negligible O: Marine – Minor adverse Diadromous – Negligible D: Marine – Minor adverse Diadromous – Negligible	None proposed.
Underwater sound, UXO clearance and geophysical surveys impacting fish and shellfish receptors	✓	×	×	CoT 64 CoT 48	C: Negligible to low	C: Marine - Low to high Diadromous – Low to medium	C: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	C: Marine - Minor adverse Diadromous – Minor adverse	None proposed.
Underwater sound from all other activities	✓	✓	✓	CoT 49	C: Negligible O: Negligible D: Negligible	C: Negligible O: Negligible D: Negligible	C: Negligible O: Negligible D: Negligible	None proposed beyond existing Commitments.	C: Negligible O: Negligible D: Negligible	None proposed.
Increased SSCs and associated sediment deposition	✓	✓	✓	CoT 45 CoT 49 CoT 90	C: Low O: Negligible D: Low	C: Marine – Low to medium Diadromous – Low	C: Marine – Minor adverse Diadromous – Negligible	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Negligible	None proposed.

Description of impact	Phase[a]			Commitment number (Table 3.12)	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
	C	O	D							
						O: Marine – Low to medium Diadromous – Low D: Marine – Low to medium Diadromous – Low	O: Marine – Negligible to minor adverse Diadromous – Negligible D: Marine –Minor adverse Diadromous – Negligible		O: Marine – Negligible to minor adverse Diadromous – Negligible D: Marine – Negligible to minor adverse Diadromous – Negligible	
Long term habitat loss	✓	✓	✓	CoT 45 CoT 49	C: Negligible to low O: Negligible to low D: Negligible to low	C: Marine – Low to high Diadromous – Low O: Marine – Low to high Diadromous – Low D: Marine – Low to high Diadromous – Low	C: Marine – Minor adverse Diadromous – Minor adverse O: Marine – Minor adverse Diadromous – Minor adverse D: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Minor adverse O: Marine – Minor adverse Diadromous – Minor adverse D: Marine – Minor adverse Diadromous – Minor adverse	None proposed.
EMFs from subsea electrical cabling	×	✓	×	CoT 45 CoT 54	O: Low	O: Marine – Low to medium Diadromous – Low	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed.

Description of impact	Phase[a]			Commitment number (Table 3.12)	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
	C	O	D							
Introduction and colonisation of hard substrata	✓	✓	✓	CoT 45 CoT 49 CoT 65	C: Low O: Low D: Low	C: Marine – Low Diadromous – Low O: Marine – Low Diadromous – Low D: Marine – Low Diadromous – Low	C: Marine – Minor adverse Diadromous – Minor adverse O: Marine – Minor adverse Diadromous – Minor adverse D: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Minor adverse O: Marine – Minor adverse Diadromous – Minor adverse D: Marine – Minor adverse Diadromous – Minor adverse	None proposed.
Injury to basking shark due to increased risk of collision with vessels	✓	✓	✓	CoT 65 CoT 69	C: Low O: Low D: Low	C: Medium O: Medium D: Medium	C: Minor adverse O: Minor adverse D: Minor adverse	None proposed beyond existing Commitments.	C: Minor adverse O: Minor adverse D: Minor adverse	None proposed.
Disturbance/remobilisation of sediment-bound contaminants	✓	✓	✓	CoT 45	C: Low O: Negligible D: Low	C: Marine – Low to medium Diadromous – Low O: Marine – Low to medium Diadromous – Low	C: Marine – Minor adverse Diadromous – Minor adverse O: Marine – Negligible Diadromous – Negligible D: Marine – Minor adverse	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Minor adverse O: Marine – Negligible Diadromous – Negligible D: Marine – Minor adverse	None proposed.

Description of impact	Phase[a]			Commitment number (Table 3.12)	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
	C	O	D							
						D: Marine – Low to medium Diadromous – Low	Diadromous – Minor adverse		Diadromous – Minor adverse	

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

Table 3.39: Summary of cumulative environmental effects, mitigation and monitoring

Description of effect	Phase [a] C	O	D	Commitment number (Table 3.12)	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
Scenario 1										
Temporary habitat loss/disturbance	✓	×	✓	CoT 45 CoT 54 CoT 49	C: Negligible to low D: Negligible to low	C: Marine – Low to high Diadromous – Negligible D: Marine – Low to high Diadromous – Negligible	C: Marine – Minor adverse Diadromous – Negligible D: Marine – Minor adverse Diadromous – Negligible	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Negligible D: Marine – Minor adverse Diadromous – Negligible	None proposed.
Underwater sound from UXO clearance impacting fish and shellfish receptors	✓	×	×	CoT 64 CoT 48	C: Low	C: Marine – Low to high Diadromous – Low to medium	C: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Minor adverse	None proposed.
Increased SSCs and associated sediment deposition	✓	×	✓	CoT 45 CoT 49 CoT 90	C: Low D: Low	C: Marine – Low to medium Diadromous – Low D: Marine – Low to medium Diadromous – Low	C: Marine – Minor adverse Diadromous – Minor adverse D: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Minor adverse D: Marine – Minor adverse Diadromous – Minor adverse	None proposed.

Description of effect	Phase [a]			Commitment number (Table 3.12)	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
	C	O	D							
Long term habitat loss	✓	✓	✓	CoT 45 CoT 49	C: Negligible to low O: Negligible to low D: Negligible to low	C: Marine – Low to high Diadromous – Low O: Marine – Low to high Diadromous – Low D: Marine – Low to high Diadromous – Low	C: Marine – Minor adverse Diadromous – Minor adverse O: Marine – Minor adverse Diadromous – Minor adverse D: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Minor adverse O: Marine – Minor adverse Diadromous – Minor adverse D: Marine – Minor adverse Diadromous – Minor adverse	None proposed.
EMFs from subsea electrical cabling	×	✓	×	CoT 45 CoT 54	O: Low	O: Marine – Low to medium Diadromous – Low	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed.
Introduction and colonisation of hard substrata	×	✓	×	CoT 45 CoT 49 CoT 65	O: Low	O: Marine – Low Diadromous – Low	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed.
Injury to basking shark due to increased risk of collision with vessels	✓	✓	✓	CoT 65 CoT 69	C: Low O: Low D: Low	C: Medium O: Medium D: Medium	C: Minor adverse O: Minor adverse D: Minor adverse	None proposed beyond existing Commitments.	C: Minor adverse O: Minor adverse D: Minor adverse	None proposed.

Description of effect	Phase [a]			Commitment number (Table 3.12)	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
	C	O	D							
Scenario 2										
Temporary habitat loss/disturbance	✓	×	✓	CoT 45 CoT 54 CoT 49	C: Negligible to low D: Negligible to low	C: Marine – Low to high Diadromous – Negligible D: Marine – Low to high Diadromous – Negligible	C: Marine – Minor adverse Diadromous – Negligible D: Marine – Minor adverse Diadromous – Negligible	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Negligible D: Marine – Minor adverse Diadromous – Negligible	None proposed.
Underwater sound from UXO clearance impacting fish and shellfish receptors	✓	×	×	CoT 64 CoT 48	C: Low	C: Marine – Low to high Diadromous – Low to medium	C: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Minor adverse	None proposed.
Increased SSCs and associated sediment deposition	✓	×	✓	CoT 45 CoT 49 CoT 90	C: Low D: Low	C: Marine – Low to medium Diadromous – Low D: Marine – Low to medium Diadromous – Low	C: Marine – Minor adverse Diadromous – Minor adverse D: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Minor adverse D: Marine – Minor adverse Diadromous – Minor adverse	None proposed.

Description of effect	Phase [a]			Commitment number (Table 3.12)	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
	C	O	D							
Long term habitat loss	✓	✓	✓	CoT 45 CoT 49	C: Negligible to low O: Negligible to low D: Negligible to low	C: Marine – Low to high Diadromous – Low O: Marine – Low to high Diadromous – Low D: Marine – Low to high Diadromous – Low	C: Marine – Minor adverse Diadromous – Minor adverse O: Marine – Minor adverse Diadromous – Minor adverse D: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Minor adverse O: Marine – Minor adverse Diadromous – Minor adverse D: Marine – Minor adverse Diadromous – Minor adverse	None proposed.
EMFs from subsea electrical cabling	×	✓	×	CoT 45 CoT 54	O: Low	O: Marine – Low to medium Diadromous – Low	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed.
Introduction and colonisation of hard substrata	×	✓	×	CoT 45 CoT 49 CoT 65	O: Low	O: Marine – Low Diadromous – Low	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed.
Injury to basking shark due to increased risk of collision with vessels	✓	✓	✓	CoT 65 CoT 69	C: Low O: Low D: Low	C: Medium O: Medium D: Medium	C: Minor adverse O: Minor adverse D: Minor adverse	None proposed beyond existing Commitments.	C: Minor adverse O: Minor adverse D: Minor adverse	None proposed.

Description of effect	Phase [a]			Commitment number (Table 3.12)	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
	C	O	D							
Scenario 3										
Temporary habitat loss/disturbance	✓	×	✓	CoT 45 CoT 54 CoT 49	C: Negligible to low D: Negligible to low	C: Marine – Low to high Diadromous – Negligible D: Marine – Low to high Diadromous – Negligible	C: Marine – Minor adverse Diadromous – Negligible D: Marine – Minor adverse Diadromous – Negligible	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Negligible D: Marine – Minor adverse Diadromous – Negligible	None proposed.
Underwater sound from UXO clearance impacting fish and shellfish receptors	✓	×	×	CoT 64 CoT 48	C: Low	C: Marine – Low to high Diadromous – Low to medium	C: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Minor adverse	None proposed.
Increased SSCs and associated sediment deposition	✓	×	✓	CoT 45 CoT 49 CoT 90	C: Low D: Low	C: Marine – Low to medium Diadromous – Low D: Marine – Low to medium Diadromous – Low	C: Marine – Minor adverse Diadromous – Minor adverse D: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Minor adverse D: Marine – Minor adverse Diadromous – Minor adverse	None proposed.

Description of effect	Phase [a]			Commitment number (Table 3.12)	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
	C	O	D							
Long term habitat loss	✓	✓	✓	CoT 45 CoT 49	C: Negligible to low O: Negligible to low D: Negligible to low	C: Marine – Low to high Diadromous – Low O: Marine – Low to high Diadromous – Low D: Marine – Low to high Diadromous – Low	C: Marine – Minor adverse Diadromous – Minor adverse O: Marine – Minor adverse Diadromous – Minor adverse D: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Minor adverse O: Marine – Minor adverse Diadromous – Minor adverse D: Marine – Minor adverse Diadromous – Minor adverse	None proposed.
EMFs from subsea electrical cabling	×	✓	×	CoT 45 CoT 54	O: Low	O: Marine – Low to medium Diadromous – Low	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed.
Introduction and colonisation of hard substrata	×	✓	×	CoT 45 CoT 49 CoT 65	O: Low	O: Marine – Low Diadromous – Low	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed.
Injury to basking shark due to increased risk of collision with vessels	✓	✓	✓	CoT 65 CoT 69	C: Low O: Low D: Low	C: Medium O: Medium D: Medium	C: Minor adverse O: Minor adverse D: Minor adverse	None proposed beyond existing Commitments.	C: Minor adverse O: Minor adverse D: Minor adverse	None proposed.

Description of effect	Phase [a]			Commitment number (Table 3.12)	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
	C	O	D							
Scenario 4a: Tier 1										
Temporary habitat loss/disturbance	✓	×	✓	CoT 45 CoT 54 CoT 49	C: Negligible to low D: Negligible to low	C: Marine – Low to high Diadromous – Negligible D: Marine – Low to high Diadromous – Negligible	C: Marine – Minor adverse Diadromous – Negligible D: Marine – Minor adverse Diadromous – Negligible	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Negligible D: Marine – Minor adverse Diadromous – Negligible	None proposed.
Underwater sound from UXO clearance impacting fish and shellfish receptors	✓	×	×	CoT 64 CoT 48	C: Low	C: Marine – Low to high Diadromous – Low to medium	C: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Minor adverse	None proposed.
Increased SSCs and associated sediment deposition	✓	×	✓	CoT 45 CoT 49 CoT 90	C: Low D: Low	C: Marine – Low to medium Diadromous – Low D: Marine – Low to medium Diadromous – Low	C: Marine – Minor adverse Diadromous – Minor adverse D: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Minor adverse D: Marine – Minor adverse Diadromous – Minor adverse	None proposed.

Description of effect	Phase a			Commitment number (Table 3.12)	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
	C	O	D							
Long term habitat loss	✓	✓	✓	CoT 45 CoT 49	C: Negligible to low O: Negligible to low D: Negligible to low	C: Marine – Low to high Diadromous – Low O: Marine – Low to high Diadromous – Low D: Marine – Low to high Diadromous – Low	C: Marine – Minor adverse Diadromous – Minor adverse O: Marine – Minor adverse Diadromous – Minor adverse D: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Minor adverse O: Marine – Minor adverse Diadromous – Minor adverse D: Marine – Minor adverse Diadromous – Minor adverse	None proposed.
EMFs from subsea electrical cabling	×	✓	×	CoT 45 CoT 54	O: Low	O: Marine – Low to medium Diadromous – Low	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed.
Introduction and colonisation of hard substrata	×	✓	×	CoT 45 CoT 49 CoT 65	O: Low	O: Marine – Low Diadromous – Low	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed.
Injury to basking shark due to increased risk of collision with vessels	✓	✓	✓	CoT 65 CoT 69	C: Low O: Low D: Low	C: Medium O: Medium D: Medium	C: Minor adverse O: Minor adverse D: Minor adverse	None proposed beyond existing Commitments.	C: Minor adverse O: Minor adverse D: Minor adverse	None proposed.

Description of effect	Phase [a]			Commitment number (Table 3.12)	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
	C	O	D							
Scenario 4b: Tier 2										
Temporary habitat loss/disturbance	✓	×	✓	CoT 45 CoT 54 CoT 49	C: Negligible to low D: No Tier 2 projects identified	C: Marine – Low to high Diadromous – Negligible D: No Tier 2 projects identified	C: Marine – Minor adverse Diadromous – Negligible D: No Tier 2 projects identified	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Negligible D: No Tier 2 projects identified	None proposed.
Underwater sound from UXO clearance impacting fish and shellfish receptors	✓	×	×	CoT 64 CoT 48	C: Low	C: Marine – Low to high Diadromous – Low to medium	C: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Minor adverse	None proposed.
Increased SSCs and associated sediment deposition	✓	×	✓	CoT 45 CoT 49 CoT 90	C: Low D: No Tier 2 projects identified	C: Marine – Low to medium Diadromous – Low D: No Tier 2 projects identified	C: Marine – Minor adverse Diadromous – Minor adverse D: No Tier 2 projects identified	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Minor adverse D: No Tier 2 projects identified	None proposed.

Description of effect	Phase[a] C	O	D	Commitment number (Table 3.12)	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
Long term habitat loss	✓	✓	✓	CoT 45 CoT 49	C: Negligible to low O: Negligible to low D: No Tier 2 projects identified	C: Marine – Low to high Diadromous – Low O: Marine – Low to high Diadromous – Low D: No Tier 2 projects identified	C: Marine – Minor adverse Diadromous – Minor adverse O: Marine – Minor adverse Diadromous – Minor adverse D: No Tier 2 projects identified	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Minor adverse O: Marine – Minor adverse Diadromous – Minor adverse D: No Tier 2 projects identified	None proposed.
EMFs from subsea electrical cabling	×	✓	×	CoT 45 CoT 54	O: Low	O: Marine – Low to medium Diadromous – Low	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed.
Introduction and colonisation of hard substrata	×	✓	×	CoT 45 CoT 49 CoT 65	O: Low	O: Marine – Low Diadromous – Low	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed.
Injury to basking shark due to increased risk of collision with vessels	✓	✓	✓	CoT 65 CoT 69	C: Low O: Low D: Low	C: Medium O: Medium D: Medium	C: Minor adverse O: Minor adverse D: Minor adverse	None proposed beyond existing Commitments.	C: Minor adverse O: Minor adverse D: Minor adverse	None proposed.
Scenario 4c: Tier 3										

Description of effect	Phase [a]			Commitment number (Table 3.12)	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
	C	O	D							
Temporary habitat loss/disturbance	✓	×	✓	CoT 45 CoT 54 CoT 49	C: Negligible to low D: No Tier 3 projects identified	C: Marine – Low to high Diadromous – Negligible D: No Tier 3 projects identified	C: Marine – Minor adverse Diadromous – Negligible D: No Tier 3 projects identified	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Negligible D: No Tier 3 projects identified	None proposed.
Underwater sound from UXO clearance impacting fish and shellfish receptors	✓	×	×	CoT 64 CoT 48	C: Low	C: Marine – Low to high Diadromous – Low to medium	C: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Minor adverse	None proposed.
Increased SSCs and associated sediment deposition	✓	×	✓	CoT 45 CoT 49 CoT 90	C: Low D: No Tier 3 projects identified	C: Marine – Low to medium Diadromous – Low D: No Tier 3 projects identified	C: Marine – Minor adverse Diadromous – Minor adverse D: No Tier 3 projects identified	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Minor adverse D: No Tier 3 projects identified	None proposed.

Description of effect	Phase [a]			Commitment number (Table 3.12)	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
	C	O	D							
Long term habitat loss	✓	✓	✓	CoT 45 CoT 49	C: Negligible to low O: Negligible to low D: No Tier 3 projects identified	C: Marine – Low to high Diadromous – Low O: Marine – Low to high Diadromous – Low D: No Tier 3 projects identified	C: Marine – Minor adverse Diadromous – Minor adverse O: Marine – Minor adverse Diadromous – Minor adverse D: No Tier 3 projects identified	None proposed beyond existing Commitments.	C: Marine – Minor adverse Diadromous – Minor adverse O: Marine – Minor adverse Diadromous – Minor adverse D: No Tier 3 projects identified	None proposed.
EMFs from subsea electrical cabling	×	✓	×	CoT 45 CoT 54	O: Low	O: Marine – Low to medium Diadromous – Low	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed.
Introduction and colonisation of hard substrata	×	✓	×	CoT 45 CoT 49 CoT 65	O: Low	O: Marine – Low Diadromous – Low	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed beyond existing Commitments.	O: Marine – Minor adverse Diadromous – Minor adverse	None proposed.
Injury to basking shark due to increased risk of collision with vessels	✓	✓	✓	CoT 65 CoT 69	C: Low O: Low D: Low	C: Medium O: Medium D: Medium	C: Minor adverse O: Minor adverse D: Minor adverse	None proposed beyond existing Commitments.	C: Minor adverse O: Minor adverse D: Minor adverse	None proposed.

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

3.17 References

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