Cenos Offshore Windfarm Limited

Cenos EIA

Chapter 13 – Fish and Shellfish Ecology

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ACRONYMS

ACRONYM	DEFINITION
1SW	One Sea-Winter
AC	Alternating Current
AIS	Automatic Identification System
ALDFG	Abandoned, Lost or Discarded Fishing Gear
BEIS	Department for Business, Energy and Industrial Strategy
BOWL	Beatrice Offshore Windfarm Ltd
BRUV	Baited remove underwater video
CaP	Cable Plan
CBD	Convention on Biological Diversity
CBRA	Cable Burial Risk Assessment
CIEEM	Chartered Institute for Ecology and Environmental Management
DSLP	Development Specification and Layout Plan
EMP	Environmental Management Plan
CMS	Construction Method Statement
CNS	central North Sea
CPUE	Catch Per Unit Effort
CR	Critically Endangered
cUXO	Confirmed UXO
dB	Decibels
DC	Direct Current
EBS	Environmental Baseline Survey
eDNA	Environmental DNA
EEA	Exclusive Economic Area
EICC	Export/Import Cable Corridor
EEA	Exclusive Economic Area
EGL	Eastern Green Link
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EICC	Export/Import Cable Corridor
EMF	Electromagnetic Field
EMP	Environmental Management Plan

ACRONYM	DEFINITION
EN	Endangered
FAD	Fish Aggregation Device
FeAST	Feature Activity Sensitivity Tool
FTU	Floating Turbine Unit
FU	Functional Unit
FWPM	Fresh Water Pearl Mussel
HDD	Horizontal Directional Drilling
Hz	Hertz
HRA	Habitats Regulation Appraisal
HVAC	High Voltage Alternating Current
HVDC	High Voltage Directional Current
IAC	Inter-Array Cables
IBTS	International Bottom Trawl Survey
ICES	International Council for Exploration of the Sea
iE	Induced electric (field)
IHLS	International Herring Larvae Survey
INNS	Invasive Non-Native Species
INNSMP	Invasive Non Native Species Management Plan
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
kHz	Kilo hertz
km	Kilometre
LC	Least Concern
LSE	Likely Significant Effect
m	Metre
MarLIN	Marine Life Information Network
MARPOL	International Convention for the Prevention of Pollution from Ships
MCS	Marine Conservation Society
MD-LOT	Marine Directorate - Licensing Operations Team
MHWS	Mean High Water Springs
MLA	Marine Licence Application
MMO	Marine Management Organisation

ACRONYM	DEFINITION
MPA	Marine Protected Area
MPCP	Marine Pollution Contingency Plan
MPI	multi-purpose interconnector
MSW	Multi sea-winter
mT	milli Tesla
MW	Megawatt
NBN	National Biodiversity Network
NCMPA	Nature Conservation Marine Protected Area
NEQ	Net Explosive Quantity
NM	Nautical Mile
NMPI	National Marine Plan Interactive
NSAS	North Sea Autumn Spawning
NT	Near Threatened
OEMP	Outline Environmental Management Plan
OESEA	Offshore Energy Strategic Environmental Assessment
OSCPs	Offshore Substation and Converter Platforms
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic
OWEC	Offshore Wind Evidence and Change
OWF	Offshore Wind Farm
PLGR	Pre-Lay Grapnel Runs
PMF	Priority Marine Feature
PrePARED	Predators and Prey Around Renewable Energy Developments
PS	Piling Strategy
PSA	Particle Size Analysis
PTS	Permanent Threshold Shift
pUXO	Potential UXO
RIAA	Report to Inform Appropriate Assessment
ROV	Remotely Operated Vehicles
SAC	Special Area of Conservation
SOPEP	Shipboard Oil Pollution Emergency Plans
SNH	Scottish Natural Heritage
SOV	Service Operations Vessel

ACRONYM	DEFINITION
SPL	Sound Pressure Level
SSC	Suspended Sediment Concentration
TAC	Total Allowable Catch
TLP	Tension Leg Platform
TTS	Temporary Threshold Shift
µT	Microtesla
µV	Microvolts
µV/m	Microvolts per metre
UK	United Kingdom
UXO	Unexploded Ordnance
VU	Vulnerable
WSDOT	Washington State Department of Transport
WTG	Wind Turbine Generator
ZoI	Zone of Influence

GLOSSARY

TERM	DEFINITION
2023 Scoping Opinion	Scoping Opinion received in June 2023, superseded by the 2024 Scoping Opinion.
2023 Scoping Report	Environmental Impact Assessment (EIA) Scoping Report submitted in 2023, superseded by the 2024 Scoping Report.
2024 Scoping Opinion	Scoping Opinion received in September 2024, superseding the 2023 Scoping Opinion.
2024 Scoping Report	EIA Scoping Report submitted in April 2024, superseding the 2023 Scoping Report.
Area of Opportunity	The area in which the limits of electricity transmission via High Voltage Alternating Current (HVAC) cables can reach oil and gas assets for decarbonisation. This area is based on assets within a 100 kilometre (km) radius of the Array Area.
Array Area	The area within which the Wind Turbine Generators (WTGs), floating substructures, moorings and anchors, Offshore Substation Converter Platforms (OSCPs) and Inter-Array Cables (IAC) will be present.
Cenos Offshore Windfarm ('the Project')	'The Project' is the term used to describe Cenos Offshore Windfarm. The Project is a floating offshore windfarm located in the North Sea, with a generating capacity of up to 1,350 Megawatts (MW). The Project which defines the Red Line Boundary (RLB) for the Section 36 Consent and Marine Licence Applications (MLA), includes all offshore components seaward of Mean High Water Springs (MHWS) (WTGs, OSCPs, cables, floating substructures moorings and anchors and all other associated infrastructure). The Project is the focus of this Environmental Impact Assessment Report (EIAR).
Cenos Offshore Windfarm Ltd. (The Applicant)	The Applicant for the Section 36 Consent and associated Marine Licences.

TERM	DEFINITION
Cumulative Assessment	The consideration of potential impacts that could occur cumulatively with other relevant projects, plans, and activities that could result in a cumulative effect on receptors.
Developer	Cenos Offshore Windfarm Ltd., a Joint Venture between Flotation Energy and Vårgrønn As (Vårgrønn).
Environmental Impact Assessment (EIA)	The statutory process of evaluating the likely significant environmental effects of a proposed project or development. Assessment of the potential impact of the proposed Project on the physical, biological and human environment during construction, operation and maintenance and decommissioning.
Environmental Impact Assessment Regulations	This term is used to refer to the Environmental Impact Assessment Regulations which are of relevance to the Project. This includes the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017, the Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (as amended); and the Marine Works (Environmental Impact Assessment) Regulations 2007.
Environmental Impact Assessment Report	A report documenting the findings of the EIA for the Project in accordance with relevant EIA Regulations.
Export/Import Cable	High voltage cable used to export/import power between the OSCPs and Landfall.
Export/Import Cable Bundle (EICB)	Comprising two Export/Import Cables and one fibre-optic cable bundled in a single trench.
Export/Import Cable Corridor (EICC)	The area within which the Export/Import Cable Route will be planned and the Export/Import Cable will be laid, from the perimeter of the Array Area to MHWS.
Export/Import Cable Route	The area within the Export/Import Export Corridor (EICC) within which the Export/Import Cable Bundle (EICB) is laid, from the perimeter of the Array Area to MHWS.

TERM	DEFINITION
Floating Turbine Unit (FTU)	The equipment associated with electricity generation comprising the WTG, the floating substructure which supports the WTG, mooring system and the dynamic section of the IAC.
Flotation Energy	Joint venture partner in Cenos Offshore Windfarm Ltd.
Habitats Regulations	The Habitats Directive (Directive 92/43/ECC) and the Wild Birds Directive (Directive 2009/147/EC) were transposed into Scottish Law by the Conservation (Natural Habitats &c) Regulations 1994 ('Habitats Regulations') (up to 12 NM); by the Conservation of Offshore Marine Habitats and Species Regulations 2017 ('Offshore Marine Regulations') (beyond 12 NM); the Conservation of Habitats and Species Regulations 2017 (of relevance to consents under Section 36 of the Electricity Act 1989); the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001; and the Wildlife and Countryside Act 1981. The Habitats Regulations set out the stages of the Habitats Regulations Appraisal (HRA) process required to assess the potential impacts of a proposed project on European Sites (Special Areas of Conservation, Special Protection Areas, candidate SACs and SPAs and Ramsar Sites).
Habitats Regulations Appraisal	The assessment of the impacts of implementing a plan or policy on a European Site, the purpose being to consider the impacts of a project against conservation objectives of the site and to ascertain whether it would adversely affect the integrity of the site.
High Voltage Alternating Current (HVAC)	Refers to high voltage electricity in Alternating Current (AC) form which is produced by the WTGs and flows through the IAC system to the OSCPs. HVAC may also be used for onward power transmission from the OSCPs to assets or to shore over shorter distances.
High Voltage Direct Current (HVDC)	Refers to high voltage electricity in Direct Current (DC) form which is converted from HVAC to HVDC at the OSCPs and transmitted to shore over longer distances.
Horizontal Directional Drilling (HDD)	An engineering technique for laying cables that avoids open trenches by drilling between two locations beneath the ground's surface.

TERM	DEFINITION
Innovation and Targeted Oil & Gas (INTOG)	In November 2022, the Crown Estate Scotland (CES) announced the Innovation and Targeted Oil & Gas (INTOG) Leasing Round, to help enable this sector-wide commitment to decarbonisation. INTOG allowed developers to apply for seabed rights to develop offshore windfarms for the purpose of providing low carbon electricity to power oil and gas installations and help to decarbonise the sector. Cenos is an INTOG project and in November 2023 secured an Exclusivity Agreement as part of the INTOG leasing round.
Inter-Array Cable (IAC)	The cables which connect the WTGs to the OSCPs. WTGs may be connected with IACs into a hub or in series as a 'string' or a 'loop' such that power from the connected WTGs is gathered to the OSCPs via a single cable.
Joint Venture	The commercial partnership between Flotation Energy and Vårgrønn, the shareholders which hold the Exclusivity Agreement with CES to develop the Cenos site as an INTOG project.
Landfall	The area where the Export/Import Cable from the Array Area will be brought ashore. The interface between the offshore and onshore environments.
Marine Licence	Licence required for certain activities in the marine environment and granted under the Marine and Coastal Access Act 2009 and/or the Marine (Scotland) Act 2010.
Marine Protected Area (MPA)	Marine sites protected at the national level under the Marine (Scotland) Act 2010 out to 12 NM, and the Marine and Coastal Access Act 2009 between 12-200 NM. In Scotland MPAs are areas of sea and seabed defined so as to protect habitats, wildlife, geology, underseas landforms, historic shipwrecks and to demonstrate sustainable management of the sea.
Marine Protected Area (MPA) Assessment	A three-step process for determining whether there is a significant risk that a proposed development could hinder the achievement of the conservation objectives of an MPA.
Mean High Water Springs (MHWS)	The height of Mean High Water Springs is the average throughout the year, of two successive high waters, during a 24-hour period in each month when the range of the tide is at its greatest.

<table>
<tr><th>TERM</th><th>DEFINITION</th></tr>
<tr><td>Mean Low Water Springs (MLWS)</td><td>The height of Mean Low Water Springs is the average throughout a year of the heights of two successive low waters during periods of 24 hours (approximately once a fortnight).</td></tr>
<tr><td>Mitigation Measures</td><td>Measures considered within the topic-specific chapters in order to avoid impacts or reduce them to acceptable levels.
Primary mitigation - measures that are an inherent part of the design of the Project which reduce or avoid the likelihood or magnitude of an adverse environmental effect, including location or design;
Secondary mitigation – additional measures implemented to further reduce environmental effects to 'not significant' levels (where appropriate) and do not form part of the fundamental design of the Project; and
Tertiary mitigation – measures that are implemented in accordance with industry standard practice or to meet legislative requirements and are independent of the EIA (i.e. they would be implemented regardless of the findings of the EIA).
Primary and tertiary mitigation are referred to as embedded mitigation. Secondary mitigation is referred to as additional mitigation.</td></tr>
<tr><td>Mooring System</td><td>Comprising the mooring lines and anchors, the mooring system connects the floating substructure to the seabed, provides station-keeping capability for the floating substructure and contributes to the stability of the floating substructure and WTG.</td></tr>
<tr><td>Nature Conservation Marine Protected Area (NCMPA)</td><td>MPA designated by Scottish Ministers in the interests of nature conservation under the Marine (Scotland) Act 2010.</td></tr>
<tr><td>Offshore Substation Converter Platforms (OSCPs)</td><td>An offshore platform on a fixed jacket substructure, containing electrical equipment to aggregate the power from the WTGs and convert power between HVAC and HVDC for export/import via the export/import cable to/from the shore. The OSCPs will also act as power distribution stations for the Oil & Gas platforms.</td></tr>
<tr><td>Onward Development</td><td>Transmission projects which are anticipated to be brought forward for development by 3rd party oil and gas operators to enable electrification of assets via electricity generated by the Project. All Onward Development will subject to separate marine licensing and permitting requirements.</td></tr>
<tr><td>Onward Development Area</td><td>The area within which oil and gas assets would have the potential to be electrified by the Project.</td></tr>
</table>

TERM	DEFINITION
Onward Development Connections	Oil and gas assets located in the waters surrounding the Array Area will be electrified via transmission infrastructure which will connect to the Project's OSCPs. These transmission cables are referred to as Onward Development Connections.
Project Area	The area that encompasses both the Array Area and EICC.
Project Design Envelope	A description of the range of possible elements that make up the Project design options under consideration and that are assessed as part of the EIA for the Project.
Study Area	Receptor specific area where potential impacts from the Project could occur.
Transboundary Assessment	The consideration of impacts from the Project which have the potential to have a significant effect on another European Economic Area (EEA) state's environment. Where there is a potential for a transboundary effect, as a result of the Project, these are assessed within the relevant EIA chapter.
Transmission Infrastructure	The infrastructure responsible for moving electricity from generating stations to substations, load areas, assets and the electrical grid, comprising the OSCPs, and associated substructure, and the Export/Import Cable.
Vårgrønn As (Vårgrønn)	Joint venture partner in Cenos Offshore Windfarm Ltd.
Wind Turbine Generator (WTG)	The equipment associated with electricity generation from available wind resource, comprising the surface components located above the supporting substructure (e.g., tower, nacelle, hub, blades, and any necessary power transformation equipment, generators, and switchgears).
Worst-Case Scenario	The worst-case scenario based on the Project Design Envelope which varies by receptor and/or impact pathway identified.

13 FISH AND SHELLFISH ECOLOGY

13.1 Introduction

This chapter of the Environmental Impact Assessment Report (EIAR) presents the Fish and Shellfish Ecology receptors (i.e. fish and shellfish species) of relevance to the Project and assesses the potential impacts from the construction, operation and maintenance and decommissioning of the Project on these receptors. Where required, mitigation is proposed, and the residual impacts and their significance are assessed. Potential cumulative and transboundary impacts are also considered.

Table 13-1 below provides a list of all the supporting studies which relate to and should be read in conjunction with the Fish and Shellfish Ecology impact assessment. All supporting studies are appended to this EIAR.

Table 13-1 Supporting studies

DETAILS OF STUDY	SUPPORTING STUDIES AND LOCATION (WHERE RELEVANT)
Habitat Assessment Reports	EIAR Vol. 4, Appendix 8 EIAR Vol. 4, Appendix 9
Environmental Baseline Reports	EIAR Vol. 4, Appendix 10 EIAR Vol. 4, Appendix 11 EIAR Vol. 4, Appendix 12
EMF Assessment Reports	EIAR Vol. 4, Appendix 14A EIAR Vol. 4, Appendix 14B EIAR Vol. 4, Appendix 14C
Underwater Noise Modelling Report	EIAR Vol. 4, Appendix 15

The impact assessment presented herein draws upon information presented within other impact assessments within this EIAR, including:

- EIAR Vol. 3, Chapter 8: Marine Geology, Oceanography, and Coastal Processes – assesses the impacts of temporary increases in Suspended Sediment Concentrations (SSC) and associated sediment deposition. Changes to SSC and sediment properties can have a direct impact on fish and shellfish species by resulting in habitat disturbance or indirectly for their prey species;
- EIAR Vol. 3, Chapter 9: Marine Water and Sediment Quality – assesses the impacts associated with changes in water quality. These changes can result in indirect impacts on fish and shellfish species, including spawning habitats, which may be sensitive to water quality, sediment disturbance, and contamination; and
- EIAR Vol. 3, Chapter 10: Benthic Ecology - changes in benthic habitats can lead to an indirect impact on fish spawning and nursery grounds which rely on these habitats. Direct impacts to benthic habitats from the Project are assessed within EIAR Vol. 3, Chapter 10: Benthic Ecology. Habitat loss of spawning and nursery grounds from the Project are assessed within Section 13.6.1.1 and Section 13.6.2.1 of this chapter.

Equally, the Fish and Shellfish Ecology impact assessment also informs other impact assessments in relation to impacts to prey for EIAR Vol. 3, Chapter 11: Marine Mammal Ecology and EIAR Vol. 3, Chapter 12: Ornithology as well as potential impacts to commercially important fish and shellfish species (EIAR Vol. 3, Chapter 14: Commercial Fisheries). This interaction between the impacts assessed within different topic-specific chapters on a receptor is defined as an 'inter-relationship'. The chapters and impacts related to the assessment of potential effects on Fish and Shellfish Ecology are provided in Section 9.8.3

Where information from other chapters is used to inform the Fish and Shellfish Ecology impact assessment, reference to the relevant EIAR Chapter is given.

Annex II diadromous fish and associated features, such as Atlantic salmon (*Salmo salar*), sea lamprey (*Petromyzon marinus*), river lamprey (*Lampetra fluviatilis*), and Freshwater Pearl Mussel (FWPM)[1] (*Margaritifera margaritifera*), are qualifying features of Special Areas of Conservation (SAC) and have been considered through the Habitats Regulations Appraisal (HRA) process, which has been undertaken alongside this EIAR. The HRA screening process, undertaken in consultation with NatureScot and Marine Directorate – Licensing Operations Team (MD-LOT) (and presented in RIAA, Appendix A: HRA Stage One Screening Report), concluded that there will be no potential for Likely Significant Effects (LSE) in relation to effects on sea lamprey or river lamprey as qualifying features of European sites, and therefore no further assessment is required under Stage 2 of the HRA process within the Report to Inform the Appropriate Assessment (RIAA). The assessment on Atlantic salmon and FWPM is limited to the EIA only, due to the inability to accurately apportion impacts to relevant European sites for these species. This methodology has been endorsed by NatureScot and MD-LOT for previous projects[2,3] and has been agreed with these bodies through Project consultation.

Fish and shellfish species may also be designated features of Nature Conservation Marine Protected Areas (NCMPAs) in Scottish waters. As part of the MPA Screening Assessment undertaken and presented as part of the EIA Scoping process (see Section 13.3 below), the Turbot Bank NCMPA, designated for sandeels (Ammodytes sp.), was screened in for further assessment. The Turbot Bank NCMPA is adjacent to, although outside of the area for the Project Area. As there is no direct overlap of the Project Area with this NCMPA, the pathways for impact on the sandeel designated feature of the Turbot Bank NCMPA are limited and the only impact scoped in for further assessment was underwater noise and vibration (i.e. UXO detonation) impacts during construction. The Applicant has undertaken a detailed assessment of underwater noise and vibration on sandeels within the Turbot Bank NCMPA, reaching the conclusion that there is no risk of the Project hindering the conservation objectives of the NCMPA. For further details, refer to the Marine Protected Area Assessment which has been submitted alongside the Marine Licence applications for the Project.

The following specialists have contributed to the assessment:

- Shona Morrison, Xodus Group;
- Jane Gordon, Xodus Group;
- Christina McIntyre, Xodus Group; and
- Ewan Edwards, Xodus Group.

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[1] *FWPM are reliant on salmonoids during the larval stage of their lifecycle, living on the gills of Atlantic salmon or sea trout as parasites. For this reason, the FWPM can be indirectly affected through impacts to salmon or trout species, therefore, has been included within this EIAR.*
[2] *https://marine.gov.scot/sites/default/files/cambois_connection_-_hra_stage_1_screening_report_response.pdf*
[3] *https://marine.gov.scot/sites/default/files/west_of_orkney_windfarm_-_hra_screening_response_and_appendix_1_-_final.pdf*

13.2 Legislation, policy, and guidance

The wider marine planning, legislation, policy and guidance is discussed in EIAR Vol. 2, Chapter 3: Policy and Legislative Context. The following legislation, policy, and guidance are relevant to the assessment of impacts from the Project on Fish and Shellfish Ecology:

- Legislation:
  - International:
    - Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (known as the 'EU Habitats Directive');
    - The Convention for the Protection of the Marine Environment of the North East Atlantic ('OSPAR Convention'; 1992);
    - The Convention on the Conservation of European Wildlife and Natural Habitats ('the Bern Convention'; 1979);
    - Convention on Biological Diversity ('CBD'; 1992); and
    - The Convention on the Conservation of Migratory Species of Wild Animals ('the Bonn Convention'; 1979).
  - National:
    - Wildlife & Countryside Act 1981 (as amended);
    - Nature Conservation (Scotland) Act 2004 (as amended);
    - Wildlife and Natural Environment (Scotland) Act 2011 (as amended);
    - Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003 (as amended);
    - The Conservation of Salmon (Scotland) Regulations 2016 (as amended);
    - The Conservation (Natural Habitats, &c.) Regulations 1994 ('Habitats Regulations') (as amended);
    - The Conservation of Habitats and Species Regulations 2017 ('Habitats Regulations') (as amended);
    - The Conservation of Offshore Marine Habitats and Species Regulations 2017 ('Habitats Regulations') (as amended);
    - The Conservation (Natural Habitats, &c.) (EU Exit) (Scotland) (Amendment) Regulations 2019;
    - The Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019; and
    - The Fisheries Act 2020.
- Policy:
  - Prepared in accordance with the United Kingdom (UK) Marine Policy Statement, 2010, which outlines the framework for marine plans for the UK marine environment. The following policies of the Scotland's National Marine Plan (NMP) (Scottish Government, 2015) apply to this Fish and Shellfish Ecology assessment. Following the most recent review of the NMP in 2021, the Scottish Ministers announced, in 2022, their intention to update the National Marine Plan. This update is underway but has not yet reached a draft consultation stage. A stakeholder engagement strategy and statement of public participation was published in August 2024:
    - GEN 9 Natural Heritage: Development and use of the marine environment must: (a) Comply with legal requirements for protected areas and protected species. (b) Not result in significant impact on the national status of Priority Marine Features. (c) Protect and, where appropriate, enhance the health of the marine area;
    - GEN 13 Noise: Development and use in the marine environment should avoid significant adverse effects of man-made noise and vibration, especially on species sensitive to such effects;

        - WILD FISH 1: The impact of development and use of the marine environment on diadromous fish species should be considered in marine planning and decision-making processes. Where evidence of impacts on salmon and other diadromous species is inconclusive, mitigation should be adopted where possible and information on impacts on diadromous species from monitoring of developments should be used to inform subsequent marine decision making; and
        - FISHERIES 1 – 4.
    - Scottish Biodiversity Strategy (Scottish Government, 2022a):
        - The Scottish Biodiversity strategy is made up of two documents: Scotland's Biodiversity: It's in Your Hands and the 2020 Challenge for Scotland's Biodiversity. The aims of the strategy are to: protect and restore biodiversity on land and in our seas, and to support healthy ecosystems, connect people with the natural world, for their health and well-being, and to involve them more in decision making and maximise the benefits for Scotland of a diverse natural environment and the services it provides, contributing to sustainable economic growth;
    - Priority Marine Features (PMFs):
        - Scotland adopted a list of 81 PMFs in 2014, representing species and habitats on existing conservation lists that were assessed against a set of criteria, including the abundance of the feature in Scottish seas, the conservation status and the functional role played by the feature. Several fish and shellfish species are listed as PMFs;
    - Scottish Wild Salmon Strategy (Scottish Government, 2022b):
        - Published in January 2022, the Scottish Wild Salmon Strategy outlines the objectives, actions to improve the conditions of Scotland's rivers and better manage salmon stocks;
    - Eel Management plans for the United Kingdom: Scotland River Basin District (Defra, 2010):
        - Established in 2010 in response to the Eel Recovery Plan (formed under European Commission Council Regulation No 1100/2007) with the aim of improving the European eel stocks;
    - National Framework Policy: Policy 3 Biodiversity:
        - To protect biodiversity, reverse biodiversity loss, mitigate potential negative effects, deliver positive effects from development and strengthen nature networks.
    - UK Post 2010 Biodiversity Framework (JNCC & Defra, 2012).
        - Published in 2012 on behalf of the Four Countries' Biodiversity Group, which provides a framework to achieve the Aichi Targets and the aims of the EU biodiversity strategy.
- Guidance:
    - Guidance on Environmental Considerations for Offshore Wind Farm Development (OSPAR, 2008);
    - Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects (Cefas, 2012);
    - Impacts from Piling on Fish at Offshore Wind Sites: Collating Population Information, Gap Analysis and Appraisal of Mitigation Options (Boyle and New, 2018);
    - Chartered Institute for Ecology and Environmental Management (CIEEM) Guidelines for Ecological Impact Assessment in the UK and Ireland – Terrestrial, Freshwater, Coastal and Marine (CIEEM, 2018); and
    - Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report (Popper *et al.*, 2014).

13.3 Scoping and consultation

Stakeholder consultation has been ongoing throughout the Environmental Impact Assessment (EIA) and has played an important part in ensuring the scope of the baseline characterisation and impact assessment are appropriate with respect to the Project and the requirements of the regulators and their advisors.

The 2024 Scoping Report was submitted to MD-LOT in April 2024, relevant stakeholders were consulted. The Scoping Opinion was received in September 2024. The 2024 Scoping Report and Scoping Opinion supersedes the 2023 Scoping Report and Scoping Opinion for the Project. Relevant comments from the Scoping Opinion specific to Fish and Shellfish Ecology are provided in Table 13-2 below, which sets out how these comments have been addressed within the EIAR.

A Scoping Workshop was held on the 29th February 2024 (as detailed in EIAR Vol. 2, Chapter 1: Introduction). Relevant points specific to Fish and Shellfish Ecology are provided in Table 13-2 below, which sets out how these points have been addressed within the EIAR. No other consultation specific to Fish and Shellfish Ecology has been undertaken.

Table 13-2 Comments from the Scoping Workshop and Scoping Opinion relevant to Fish and Shellfish Ecology

REGULATOR/CONSULTEE	COMMENT	RESPONSE
Scottish Ministers	The Developer considers the impacts on fish ecology in chapter 12 of the Scoping Report. The Scottish Ministers advise that the study area as described in section 12.3 of the Scoping Report may need to be extended dependent on the underwater noise modelling, the Developer is directed to the NatureScot representation in this regard.	The Fish and Shellfish Ecology Study Area has been increased to a 60 km buffer around the Project Area (Figure 13-3). This is defined by the modelled maximum range of disturbance of fish due to underwater noise originating from impact piling, based on the unweighted 150 dB SEL_{rms} sound pressure level defined by Hastings *et al.*, (2002) as the criterion for onset of behavioural effects. Please refer EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report for more information.
Scottish Ministers	In relation to the baseline characterisation, the Scottish Ministers are generally content with the data sources listed in table 12-4 of the Scoping Report to be used to inform the baseline, however, highlight that the desk-based study should be supplemented by benthic sampling and eDNA surveys. This is a view supported by NatureScot in its representation.	Although no project-specific surveys for Fish and Shellfish Ecology were conducted, Environmental Baseline Surveys were undertaken, and reports are available for the Array Area and the Export/Imprt Cable Corridor (EICC) (EIAR Vol. 4, Appendix 11: Environmental Baseline Report – OWF and EIAR Vol. 4, Appendix 12: Environmental Baseline Report - EICC)). The Particle Size Analysis (PSA) results from these reports have been used to assess habitat suitability for herring spawning and sandeel populations. Benthic eDNA sampling (i.e. eDNA analysis of sediment samples) was carried out at six sample stations within the Array Area to provide a comprehensive spatial coverage (EIAR Vol. 4, Appendix 13: Benthic eDNA Analysis Report). The eDNA samples were analysed against a DNA database containing invertebrate sequence data and therefore exclude fish and other vertebrate organisms.
Scottish Ministers	The Scottish Ministers are broadly content with the impacts proposed to be scoped in and out of the EIA Report in table 12-11 of the Scoping Report. However, the impact of the Proposed	Noted. Basking shark are included within the assessment due to potential pathways for EMF, collision, entanglement, and collision. (Sections 13.6.1.4 and Section 13.6.2.7).

REGULATOR/CONSULTEE	COMMENT	RESPONSE
	Development on basking shark must be scoped in for assessment, particularly in relation to EMF, entanglement and collision. Additionally, secondary entanglement should be scoped into the EIA Report for the operation and maintenance phase of the Proposed Development.	
Scottish Ministers	Noting that underwater noise and vibration is scoped in for assessment, the Scottish Ministers highlight the advice provided by NatureScot in its representation to consider the results from the study on characterisation of underwater noise from Hywind Scotland and Kincardine Offshore Wind Farm in the assessment.	Noted. The results from the study at the Hywind Scotland and Kincardine demonstrator sites (Risch *et al.*, 2023) have been considered within this impact pathway and outlined in Section 13.6.2.3.
Scottish Ministers	The Scottish Ministers agree with the proposed approach to assessment of impacts to fish ecology. In relation to Priority Marine Features ("PMF"), the Scottish Ministers highlight the NatureScot representation and advise the assessment should quantify, where possible, the likely impacts to key PMFs and consider whether this could lead to a significant impact on the national status of the PMFs under consideration.	More detail on PMFs is included in Section 13.4.4.8. The likely impacts on the national status of PMFs is considered throughout the assessment of potential effects (Section 13.6). A summary is provided in Section 13.6.4 and 13.7.5.
Scottish Ministers	The Scottish Ministers highlight the NatureScot representation in relation to underwater noise assessment methodology relative to the impact of piling on fish receptors and advise the Developer to engage with NatureScot in this regard.	EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report has been prepared in support of this EIAR. This includes modelled impacts on Fish and Shellfish Ecology receptors. The assessment methods for consideration of underwater noise impacts from driven piles are described in Section 13.6.1.2. Underwater noise effects on fish and shellfish species are assessed in this Chapter (Sections 13.6.1.2 and 13.7.2).

REGULATOR/CONSULTEE	COMMENT	RESPONSE
Scottish Ministers	The Scottish Ministers note the embedded mitigation measures detailed in section 12.7 of the Scoping Report and advise that further mitigation may be required following assessment should impacts be predicted. This is in line with the NatureScot representation.	Noted. Embedded mitigation measures have been described, in Section 13.5.4. No secondary mitigation, over and above the embedded mitigation measures, is either required or proposed in relation to the potential effects of the Project on Fish and Shellfish Ecology as no adverse significant impacts are predicted.
Scottish Ministers	With regard to cumulative effects, in addition to underwater noise, the Scottish Ministers advise that EMF impacts and suspended sediment concentrations are included in the cumulative impacts assessment. The Developer is directed to the NatureScot representation in this regard.	The Applicant acknowledges the concern over EMF and SSC effects in-combination with other projects in the North Sea. EMF effects and potential changes to SSC are assessed cumulatively in Section 13.7.2 and 13.7.3.
Scottish Ministers	The Scottish Ministers agree with the Developer's proposal to scope in transboundary effects on fish ecology.	As the 60 km buffer for the Fish and Shellfish Ecology Study Area overlaps with Norwegian waters (Figure 13-1), Fish and Shellfish Ecology has been scoped in for the assessment of transboundary effects. Transboundary effects are assessed in Section 13.11.
NatureScot	The Study Area for fish ecology is described in Section 12.3 of the Scoping Report. The Study Area has been defined as the Project Area together with a 15 km ZoI, which has been defined considering the extent of tidal excursions. Close to shore the tidal ellipse is narrow, extending approximately 15 km on a north-south axis. The ellipse reduces in length with distance offshore and close to the eastern end of the ECC it is approximately 5 km long on a north by north-east to south by south-west axis, and up to 1 km wide. The Study Area for diadromous fish has been defined as all waters located within the north-east anadromous fish region boundary.	The Fish and Shellfish Ecology Study Area has been increased to a 60 km buffer around the Project Area (Figure 13-3), which is defined by the modelled maximum range of disturbance of fish due to underwater noise originating from impact piling, based on the unweighted 150 dB SELrms sound pressure level defined by Hastings *et al.*, (2002) as the criterion for onset of behavioural effects. Please refer to EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report for more information.

REGULATOR/CONSULTEE	COMMENT	RESPONSE
	A larger Study Area may be required if the ZoI is determined by underwater noise and not just suspended sediment concentration. The Study Area should be reassessed after the underwater noise modelling has been completed.	
NatureScot	The data sources to be used to inform the baseline characterisation for fish are listed in Table 12-4. We note that no specific fish surveys have been conducted. The occurrence of fish species in the area has been assessed using landings data. We highlight that this would exclude many species, including sandeel (which is acknowledged in paragraph 12.11.2.3). However, Coull *et al.* (1998) has been used to characterise the distribution of potential nursery and spawning grounds, which did identify sandeel. We would expect the desk-based study to be assessed alongside benthic sampling surveys to inform the baseline characterisation for fish, especially for sandeel habitat and herring spawning habitat. Further, eDNA surveys undertaken should also inform the baseline for fish. Noting our comments above, we largely agree that the data sources listed in Table 12-4 are sufficient to inform the baseline characterisation for fish.	No project-specific surveys were conducted to characterise the Fish and Shellfish Ecology baseline. It was considered that there is sufficient receptor information and available data related to Fish and Shellfish Ecology from other publicly available surveys and catch data. Fisheries data from the International Council for Exploration of the Sea (ICES) rectangles have been utilised for further details on the fish and shellfish species that may be present within the Fish and Shellfish Ecology Study Area. The data provided has been used alongside the datasets listed in Table 13-3 Summary of key datasets and reports which further support the baseline study. While it is recognised that landings data would not provide a comprehensive baseline of fish presence, it is used as a relevant regional source of supporting evidence to characterise the fish community in the Fish and Shellfish Ecology Study Area. Although no project-specific surveys for Fish and Shellfish Ecology receptors were conducted, Environmental Baseline Surveys were undertaken, and reports are available for the Array Area and EICC (EIAR Vol. 4, Appendix 11: Environmental Baseline Report – OWF and EIAR Vol. 4, Appendix 12: Environmental Baseline Report - EICC). The Particle Size Analysis (PSA) results from these reports have been used to assess habitat suitability for herring spawning and sandeel populations. Benthic eDNA sampling was carried out in six sample stations within

REGULATOR/CONSULTEE	COMMENT	RESPONSE
		the Array Area to provide a comprehensive spatial coverage of the area (EIAR Vol. 4, Appendix 13: Benthic eDNA Analysis Report). However, the eDNA samples analysed against a DNA database containing invertebrate sequence data and therefore exclude fish and other vertebrate organisms. No shellfish eDNA was detected.
NatureScot	The fish and shellfish ecology receptors are discussed in Section 12.5 and the potential impacts resulting from the Project are discussed in Section 12.8. We are largely content that all receptors and potential impacts have been identified, with one exception below. As we advised both in the Scoping Workshop (29th February 2024) and the written advice we provided after the workshop (2nd April 2024), we reiterate that basking shark should be scoped into the EIA as there are potential impact pathways (namely EMF, entanglement and collision). We understand that there is limited data on the distribution of basking shark in this region, but they do need to be considered through a qualitative assessment.	We note NatureScot's request that basking shark should be included within the assessment due to potential pathways. Therefore, basking shark have been included within the scope of this chapter (Sections 13.4.4.5.1 and 13.6).
NatureScot	We note that underwater noise and vibration has been considered across all Project phases. There is emerging evidence showing that the movement of mooring and anchoring cables can be noisy. Results from the Hywind and Kincardine demonstrator sites should be considered in the desk-based study.	With respect to underwater noise and vibration during the operation and maintenance phase of the Project, the results from the study at the Hywind Scotland and Kincardine demonstrator sites (Risch *et al*., 2023) have been considered within this impact pathway and outlined in Section 13.6.2.3.
NatureScot	*Changes in Prey Species Availability* Many of the species included within the Study Area fish assemblage are important prey species for other receptors. We	The effect of impacts to fish and shellfish species on other trophic groups, including marine predators such as marine mammals (EIAR Vol. 3, Chapter 11: Marine Mammal Ecology) and seabirds (EIAR Vol. 3, Chapter 12: Ornithology), are considered within relevant chapters. Fish

REGULATOR/CONSULTEE	COMMENT	RESPONSE
	note that the fish and shellfish assessment will also be considered within the marine mammal and offshore ornithology chapters of the EIA Report. In addition, 'changes to prey resources' has been included as an impact pathway scoped into the marine mammal assessment (see Table 10-8) as well as the ornithology assessment (see Table 11-8). Clear links should be made between those assessments and the fish and shellfish assessment. Most EIA Reports concentrate on receptor specific impacts; however, we increasingly need to understand impacts at the ecosystem scale. Therefore, consideration across key trophic levels will enable better understanding of the consequences (positive or negative) of any potential changes in prey distribution and abundance on marine mammal (and other top predator) interests and how this may influence population level impacts. Consideration of how this loss and or disturbance may affect the recruitment of key prey (fish) species through impacts to important spawning or nursery ground habitats should also be assessed. In addition, the PrePARED (Predators and Prey Around Renewable Energy Developments) project may be helpful in the understanding of predator-prey relationships in and around offshore wind farms.	and shellfish as prey species has been considered throughout the assessment of potential effects (Section 13.6) and the ecosystem effects assessment (Section 13.10). The Crown Estate's Offshore Wind Evidence + Change (OWEC) funded Predators and Prey Around Renewable Energy Developments (PrePARED) project, commissioned in 2022, has been using baited remote underwater video (BRUV) monitoring, integrated with bomb calorimetry to improve the understanding of the value of offshore wind farms in terms of food availability and prey quality for marine predators (PrePARED., 2024). For example, data from BRUV monitoring are used to assess the presence, abundance and size of demersal fish species close to offshore wind farm turbines. Bomb calorimetry is used to measure the energy content of prey fish in the context of food for predators (seabirds and marine mammals) and this information can provide insights about the value of offshore wind farms compared to reference areas outside wind farms to predators. PrePARED project fieldwork has taken place around fixed-bottom offshore wind projects off the east coast of Scotland, and as a result it is not clear whether the findings from e.g. Beatrice and Moray East fixed-bottom offshore wind farms would be representative of a floating project in deeper waters, such as Cenos. Nevertheless, PrePARED has revealed some notable early results, such as increased abundance, individual size and mean energy content of fish species observed using BRUVs close to the turbines at established

REGULATOR/CONSULTEE	COMMENT	RESPONSE
		fixed-bottom offshore wind farms, when compared with reference sites further from the turbine foundations. Monitoring at offshore wind farms in the Forth and Tay Region via acoustic surveys, trawl sampling, BRUV monitoring and fish traps, has been used to identify habitat preferences to develop species distribution models and better understand small-scale effects within the offshore wind farm footprint. No small scale effects were identified for sandeel, yet a decrease in common dab abundance was observed. The sampling was conducted over 500 m from turbine locations, and therefore, the decreased abundance at this distance was likely caused by an increased abundance closer to turbine locations (PrePARED, 2024). The potential for offshore wind farms to influence the distribution and abundance of fish and shellfish species is considered in Section 13.6 and also Section 13.10, although as previously mentioned it is not possible to say whether similar changes to those observed in the PrePARED project monitoring would be reflected at this Project, or whether those effects would be significant, or even whether there would be positive, negative or neutral effects on the fish and shellfish community.
NatureScot	We are largely content with the impacts scoped in and out, as per Table 12-11. However, please see one exception below. Table 12-3 in the Consultation Section 12.4 states that during the Scoping Workshop on 29th February 2024 "it was agreed to scope out entanglement" for fish. This was not agreed with NatureScot during the workshop, and we confirmed in our written response	The impact pathway for secondary entanglement, on fish and shellfish species has been acknowledged, scoped in and assessed in Section 13.6.2.6.

REGULATOR/CONSULTEE	COMMENT	RESPONSE
	(2nd April 2024) that secondary entanglement (e.g. ghost nets entangled on subsea mooring lines) should be scoped in as a potential impact pathway during the operation and maintenance phase. "Subsea mooring systems may cause entanglement resulting in injury and/or mortality" is proposed to be scoped out for fish in Table 12-11. The information presented in Appendix 5G (Approach to secondary entanglement as a potential impact) is helpful and indicates that risk of secondary entanglement is likely to be low. However, we advise that this impact pathway (secondary entanglement) should be scoped in to the EIA for fish, due to the high uncertainty around this potential impact, the lack of monitoring to date, and the scale of the development which is greater than previous infrastructure projects in the area. We would not expect to see a quantitative assessment, rather the information provided in the Scoping Report could be used in the EIA to support qualitative assessment of sensitivity and magnitude of impacts.	
NatureScot	The proposed approach to the EIA is described in Section 12.11. Most of the approaches are to use 'source-pathway receptor model', with the exception of underwater noise which will be modelled, and EMF which will look at the sensitivity thresholds of key species against EMF produced by the proposed subsea cables. We agree with the proposed approaches to assessment for fish ecology.	Noted.
NatureScot	*Priority Marine Features (PMFs)*	More detail on PMFs is detailed in Section 13.4.4.8 and the likely impacts on the national status of PMFs is considered throughout the

REGULATOR/CONSULTEE	COMMENT	RESPONSE
	Section 12.5.2 refers to the presence of numerous PMFs within the fish and shellfish ecology Study Area. We recommend that the assessment should quantify, where possible, the likely impacts to key fish and shellfish PMFs. It should assess whether these could lead to a significant impact on the national status of the PMFs being considered.	assessment of potential effects (Section 13.6). A summary is provided in Section 13.6.4 and 13.7.5.
NatureScot	*Migratory fish* We note that for diadromous fish species there is limited knowledge of distribution and behaviour of these species in the marine environment. For example, the precise migration routes of adult or juvenile Atlantic salmon or direction taken by migrating adult European eels is not fully known. Published information indicates that European smelt and River lamprey are primarily, though probably not exclusively, associated with estuarine environments. Shad might also prefer estuarine environments. Furthermore, for some species, like seals, we have a reasonable understanding of connectivity to individual SACs. We also have population estimates for nearly all seal SAC populations in the standard data forms which forms part of the citation package. For diadromous fish species we do not have population data for any salmon or lamprey SAC on the data forms. This inability to understand connectivity to and within individual rivers to the development area, currently prohibits an informed assessment of the impact on individual site integrity. This is a necessary step within HRA assessment process.	It is acknowledged that there is a generally poor understanding of how migratory fish species utilise the marine environment and to what extent. Therefore, the Diadromous Fish Study Area takes in to account the extensive open ocean and inshore migrations that diadromous fish species undertake (Malcolm *et al.*, 2010) and captures rivers and the Scottish Marine Regions that may have potential for connectivity with the activities associated with the Project. The Diadromous Fish Study Area includes all Scottish Salmon Rivers located in the east of Scotland and the Forth and Tay, North East, Moray Firth, Fladen and Moray Firth, and Long Forties Scottish Marine Regions and Offshore Marine Regions (identified in Figure 13-2). Given historic observations and survey data, it is unlikely that neither European smelt or Allis/twaite shad would be found in the Fish and Shellfish Ecology Study Area, especially in offshore waters.

REGULATOR/CONSULTEE	COMMENT	RESPONSE
NatureScot	The recently updated ScotMER evidence map process for diadromous fish confirms these evidence gaps, particularly with respect to spatial and temporal distribution as well as uncertainty around migration routes, potential impact pathways and connectivity to protected sites. The ScotMER process is an important vehicle for helping to address these evidence gaps and uncertainties. We specifically welcome the ScotMER project Diadromous Fish in the Context of Offshore Wind – Review of Current Knowledge & Future Research, due to be published soon. This research may change conclusions on how diadromous fish are treated in both EIA and HRA going forward. However, we advise, based on evidence currently available to us, it is not possible for us to carry out an assessment of diadromous fish to the level required under HRA. We therefore advise that diadromous fish species should be assessed through EIA only and not through HRA.	Noted. Diadromous fish are assessed through EIA rather than HRA. The Applicant notes the ScotMER project 'Diadromous Fish in the Context of Offshore Wind- Review of Current Knowledge & Future Research' was published at the end of October 2024, However as this publication was not available at the time of the assessment, however, the most recent, available data has been used to inform the assessment on diadromous fish (Section 13.4.4.6).
NatureScot	*Sensitivity* For determining sensitivity of species, please note that all Priority Marine Features (PMFs) and some prey fish species are now available on the Feature Activity Sensitivity Tool (FeAST).	Noted, the FeAST tool has been applied within the assessment in Sections 13.6.1 and 13.6.2.
NatureScot	*Underwater noise modelling* There is a lack of information provided in the Scoping Report regarding the underwater noise modelling approach for fish. Assessment methods for consideration of underwater noise	An underwater noise modelling appendix has been prepared in support of this EIAR (**EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report**). This includes modelled impacts on fish species (including adult fish and eggs and larvae). The assessment methods for consideration of underwater sound impacts from driven piles are described in Section 13.6.1.2. Underwater noise effects on fish and

REGULATOR/CONSULTEE	COMMENT	RESPONSE
	impacts from driven/drilled piles will be required, should this option remain within the Project Design Envelope.	shellfish species are assessed in this chapter (Sections 13.6.1.2 and 13.7.2).
NatureScot	Potential cumulative effects on fish ecology are considered in Section 12.9 of the Scoping Report. As well as assessing the cumulative effects of underwater noise, we advise the Applicant to consider the cumulative effect of suspended sediment concentration closer inshore along the EICC. Regarding EMF, we have observed a tendency for wind farm projects to reach a no LSE conclusion for electromagnetic field (EMF) impacts from a cumulative perspective. However, noting the proposed number of offshore wind developments in Scottish waters, we are concerned that the spatial and temporal scale is not being sufficiently considered cumulatively across the network of cables, including those out with of the proposed development. Thus, we advise that EMF impacts are considered in the cumulative assessment.	The Applicant acknowledges the concern over EMF and SSC effects in-combination with other projects in the North Sea. EMF effects and changes in SSC are assessed cumulatively in Section 13.7. The cumulative assessments from several other offshore windfarm's Environmental Statements (Hornsea Three Offshore Wind Farm, Seagreen Offshore Wind Farm, and Mona Offshore Wind Project) have been reviewed. These Environmental Statements have concluded no or minor adverse effects on Fish and Shellfish Ecology receptors from EMF arising cumulatively as this effect is expected to be highly localised and the receptors widely distributed. Further details are included in Section 13.7.3.4.
NatureScot	The embedded mitigation measures are detailed in Section 12.7 of the Scoping Report. In principle, we agree that the embedded mitigation measures described provide a suitable means for managing and mitigating the potential effects of the Project on fish and shellfish receptors. However, we note that most proposed mitigation measures are based around future plans rather than specific measures. In addition, further mitigation and monitoring may be needed if impacts are predicted.	Noted. Embedded mitigation measures have been described in Section 13.5.4. No secondary mitigation, over and above the embedded mitigation measures, is either required or proposed in relation to the potential effects of the Project on Fish and Shellfish Ecology as no adverse significant impacts are predicted.
NatureScot	Potential transboundary effects on fish ecology are considered in Section 12.10 of the Scoping Report and Appendix 5D:	As the 60 km buffer for the Fish and Shellfish Ecology Study Area overlaps with Norwegian waters (Figure 13-1), Fish and Shellfish Ecology

REGULATOR/CONSULTEE	COMMENT	RESPONSE
	Transboundary Screening Matrix. It is considered that there is the potential for long range acoustic effects on spawning grounds for Atlantic mackerel and sandeel in adjacent Norwegian waters. We agree that fish ecology should be scoped in for the assessment of transboundary effects.	has been scoped in for the assessment of transboundary effects. Transboundary effects are assessed in Section 13.11.
Scottish Fishermen's Federation (SFF)	Ch. 12. Fish and Shellfish Ecology Scoping Questions Question: Do you agree with the potential impacts scoped in and out? SFF's response: SFF is not content with scoping out the "Accidental release of pollutants" because if a vessel was to sink during any of the phases of the project life-span then an accidental release of pollutants would happen. Therefore, we would propose the 'accidental release of pollutants' be scoped in.	The Applicant acknowledges the concern relating to the 'accidental release of pollutants'. However, the Applicant notes the comment from NatureScot agreeing to scope out the impact for benthic receptors given the inclusion of standard mitigation, as detailed in Section 10.5.4 (Table 10-11) of EIAR Vol. 3, Chapter 10: Benthic Ecology. *'We also agree that "accidental spills to the marine environment" can be scoped out of the assessment. This advice is based on the inclusion of standard and well-established preventative measures confirmed as embedded mitigation.'*
Ugie District Salmon Fishery Group	We are very concerned about the sheer number of these applications. On behalf of the Ugie District Salmon Fishery Board, I would like assurances from the developers that in the construction phase and during the operation of this project, that the populations of salmon and sea trout, whilst migrating in the sea and when in the River Ugie, will not be adversely affected by the project.	Noted. The potential for significant effects on salmon and sea trout populations have been considered through the EIA scoping process and are assessed in detail within this chapter. Effects on diadromous fish have been assessed in Section 13.6. Overall, the effects of construction will be short-term and temporary, therefore migratory routes are not anticipated to be significantly affected. Diadromous fish are also highly mobile in the marine environment, therefore during the operations and maintenance phase, there is not thought to be any pathway for connectivity between these species and EMF and thermal emissions attributed to cables.
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REGULATOR/CONSULTEE	COMMENT	RESPONSE
NatureScot	NatureScot advised that impacts to basking shark are scoped in with a qualitative assessment of EMF effects, entanglement and collision.	Impacts to basking sharks have been considered within this chapter (see Section 13.4.4.5.1 and Section 13.6).
NatureScot	Requested for Priority Marine Features (PMFs) to be considered within the Fish and Shellfish Ecology chapter.	PMFs have been considered within this chapter (see Section 13.4 and Section 13.6).
NatureScot	Requested clear description of embedded mitigation.	A definition for embedded mitigation is included in Section 13.5.4. Further details are included in EIAR Vol. 2, Chapter 7: EIA Methodology.
NatureScot	Clarified position on considering effects on Annex II diadromous fish within the EIA only and not within the HRA.	Noted, effects on diadromous fish are considered within the EIAR only.

13.4 Baseline characterisation

This section outlines the current baseline for the Fish and Shellfish Ecology Study Area (as defined within Section 13.4.1). The characterisation of the baseline environment was undertaken by a desk-based review of publicly available data and information sources (as outlined within Section 13.4.2). The baseline considers the fish, including basking shark, and shellfish species that commonly occur throughout the Fish and Shellfish Ecology Study Area and, where appropriate, the wider North Sea marine region.

13.4.1 Study Area

The Fish and Shellfish Ecology Study Area (hereafter referred to as the 'Study Area') is based on a 60 km buffer around the Project Area (Figure 13-1). The Study Area is defined by the modelled maximum range of disturbance of fish due to underwater noise originating from impact piling at the 150 dB rms sound pressure level. Based on work by Hastings (2002), an unweighted sound pressure level of 150 dB re 1 µPa (rms) has been utilised as the criterion for onset of behavioural effects (see EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report for more information).

Data from ICES statistical rectangles have been used in this Chapter to provide more detail on which species are likely to be present in the area. A full commercial fisheries impact assessment is presented in EIAR Vol. 3, Chapter 14: Commercial Fisheries. Data from the ICES statistical rectangles which intersect the Study Area (Figure 13-1) have been used to inform the Fish and Shellfish Ecology baseline, based on commercial catches and fish surveys which are commonly reported at ICES rectangle scale.

The Diadromous Fish Study Area takes into account the extensive and poorly understood migrations that some diadromous fish species undertake (Malcolm *et al.*, 2010) and captures rivers and the Scottish Marine Regions that may have potential for connectivity with the activities associated with the Project. The Diadromous Fish Study Area includes all Scottish salmon rivers located in the east of Scotland, as well as the neighbouring maritime area, i.e. the Forth and Tay, North East, Moray Firth, Fladen and Moray Firth, and Long Forties Scottish Marine Regions and Offshore Marine Regions (identified in Figure 13-2). This large marine area is required given the uncertainty regarding the marine migrations of diadromous fish.

The EICC is assessed from the Array Area to Mean High Water Spring (MHWS). The section of the EICC from MHWS to 12 Nautical Miles (NM) is the same as the NorthConnect Cable Corridor. Cenos Offshore Windfarm Limited has entered into a binding agreement to acquire NorthConnect Limited (the "Acquisition"). Completion of the Acquisition is subject to receipt of customary regulatory approvals. Once this acquisition is complete, Cenos will hold the benefit of the Marine Licences granted in respect of the NorthConnect project as well as the planning permissions that have been granted for the onshore substation and cable infrastructure. Discussions remain ongoing as to whether Cenos will utilise the full NorthConnect route to develop a multi-purpose interconnector (MPI) that connects the Project (as well as future oil and gas Onward Development Connections) to Scotland and Norway. Cenos intends to utilise the shoreward part of the NorthConnect cable corridor for its offshore transmission infrastructure, although it is applying for new marine licences to reflect the fact that its transmission infrastructure would not be part of an exempt interconnector cable and instead connected to an offshore generating station. For the avoidance of doubt, only one set of infrastructure will be placed within the consented cable corridor.

The section of the EICC from MHWS to 12 NM has previously been assessed within the EIAR submitted for NorthConnect Limited (application reference number 06771 & 06870). The previous EIA work for NorthConnect is considered in assessing the EICC from MHWS to 12 NM, updated by any other readily available information presented within this EIAR.

The Fish and Shellfish Ecology temporal scope is defined as the entire lifetime of the Project including the construction, operation and maintenance, and decommissioning phases.

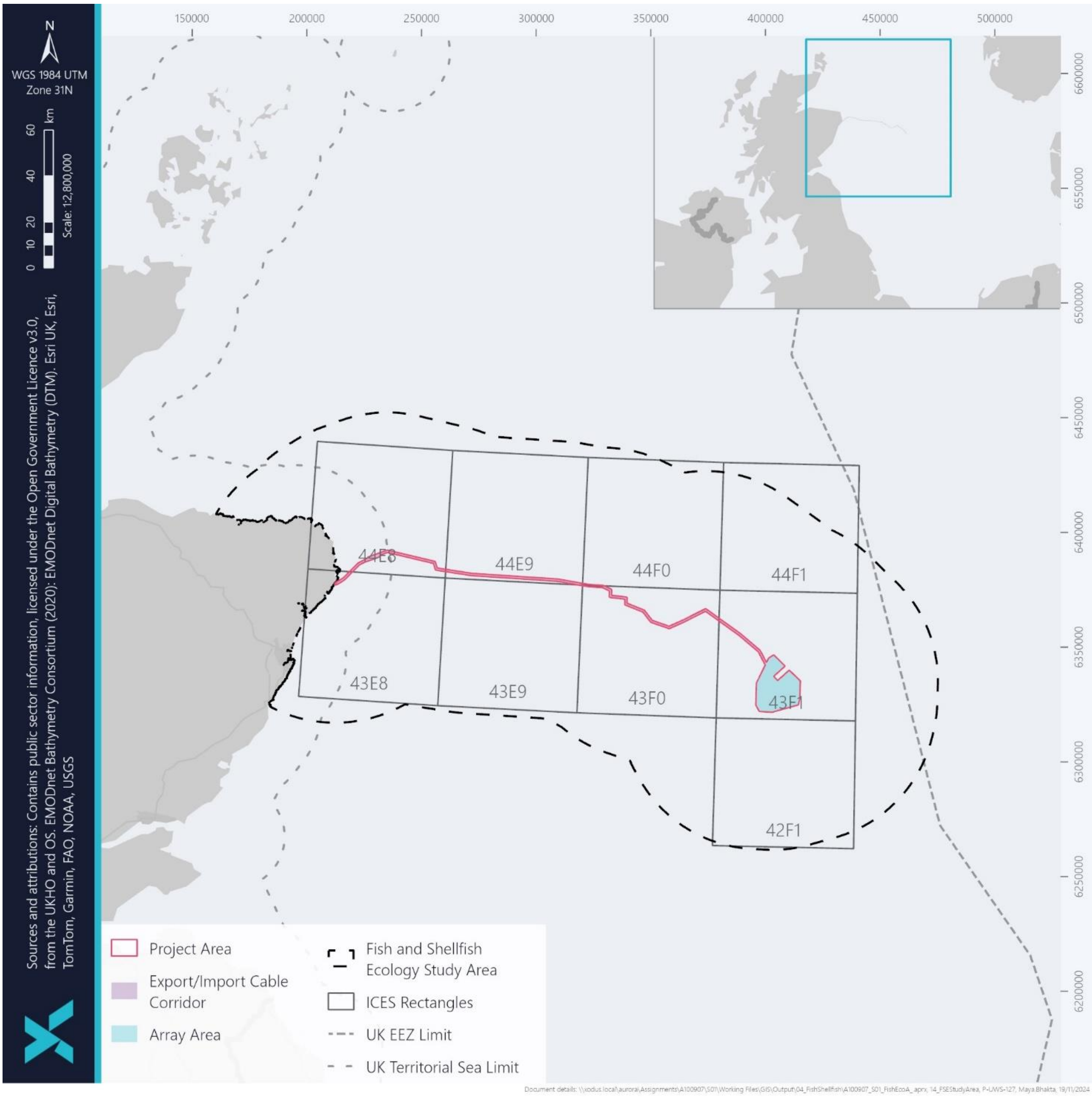

Figure 13-1 Fish and Shellfish Ecology Study Area

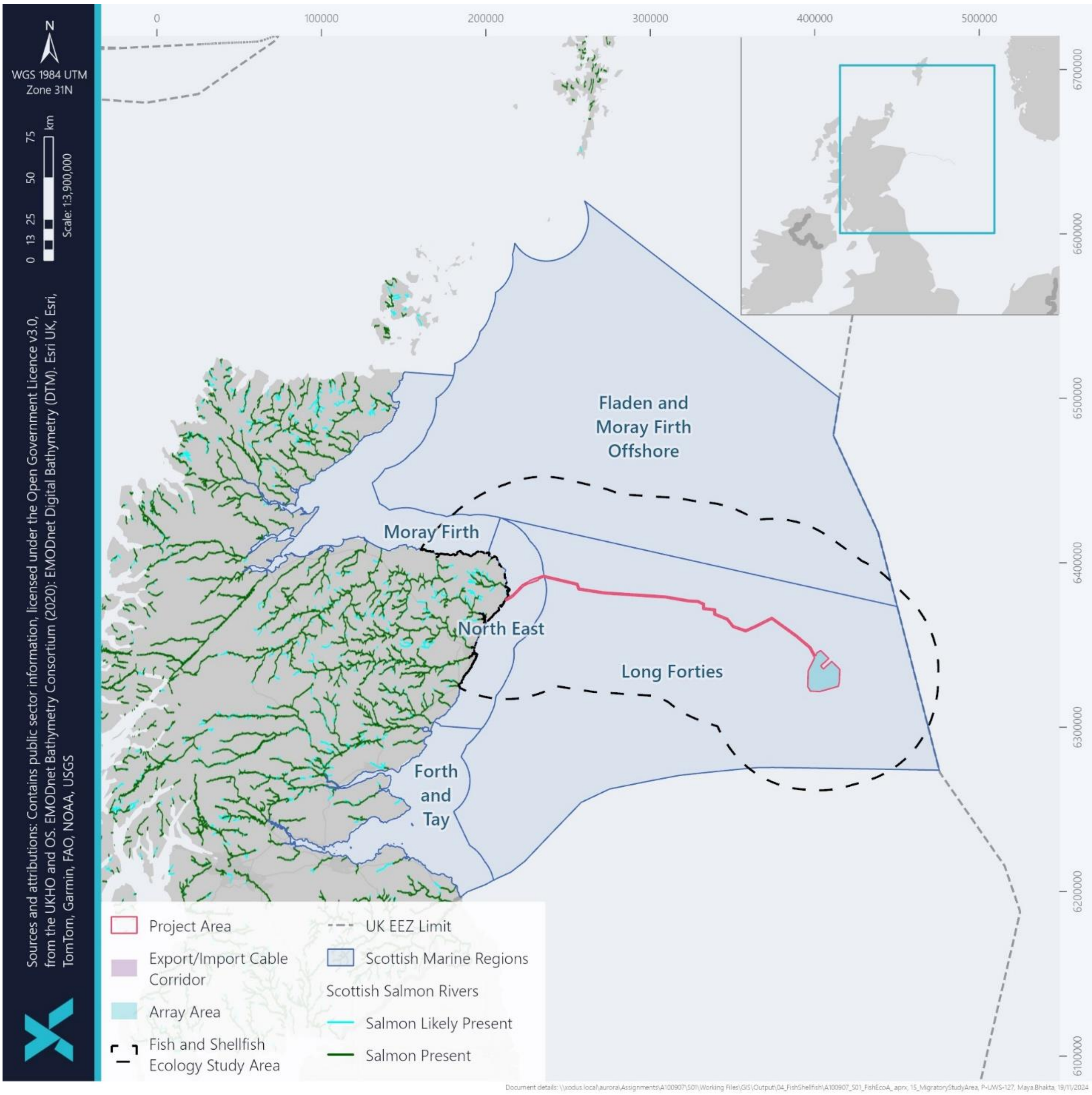

Figure 13-2 Diadromous Fish Study Area

13.4.2 Data sources

The existing data sets and literature with relevant coverage to the Project, which have been used to inform the baseline characterisation for Fish and Shellfish Ecology are outlined in Table 13-3. Project specific data obtained and used to inform this topic assessment are presented in Section 13.1.

Table 13-3 Summary of key datasets and reports

TITLE	SOURCE	YEAR	AUTHOR
Fisheries Sensitivity Maps in British Waters	https://www.cefas.co.uk/media/o0fgfobd/sensi_maps.pdf	1998	Coull *et al.*
Spawning and nursery grounds of selected fish species in UK waters	https://www.cefas.co.uk/publications/techrep/TechRep147.pdf	2012	Ellis *et al.*
Spawning grounds of Atlantic cod (*Gadus morhua*) in the North Sea	https://academic.oup.com/icesjms/article/73/2/304/2614292 (available to download via National Marine Plan Interactive (NMPi)).	2016a	González-Irusta and Wright
Spawning grounds of haddock (*Melanogrammus aeglefinus)* in the North Sea and West of Scotland	https://research-scotland.ac.uk/handle/20.500.12594/10859?show=full (available to download via NMPi).	2016b	González-Irusta and Wright
Spawning grounds of whiting (*Merlangius merlangus*)	https://pubag.nal.usda.gov/catalog/5733845 (available to download via NMPi).	2017	González-Irusta and Wright
Updating Fisheries Sensitivity Maps in British Waters	https://data.marine.gov.scot/dataset/updating-fisheries-sensitivity-maps-british-waters (available to download via NMPi).	2014	Aires *et al.*
Developing essential fish habitat maps: report	https://www.gov.scot/publications/developing-essential-fish-habitat-maps-fish-shellfish-species-scotland-report/	2023	Franco *et al.*

TITLE	SOURCE	YEAR	AUTHOR
International Herring Larvae Survey (IHLS) reports	https://www.ices.dk/data/dataset-collections/Pages/default.aspx	2020 – 2022a	ICES
A verified distribution model for the lesser sandeel *Ammodytes marinus*	Available to download via NMPi.	2021	Langton *et al.*
Landings data (value and weight) by species	https://www.gov.uk/government/statistics/uk-sea-fisheries-annual-statistics-report-2022	2018 – 2022	Marine Management Organisation (MMO)
Review of migratory routes and behaviour of Atlantic salmon, sea trout and European eel in Scotland's coastal environment: implications for the development of marine renewables	https://data.marine.gov.scot/dataset/review-migratory-routes-and-behaviour-atlantic-salmon-sea-trout-and-european-eel-scotland%E2%80%99s	2010	Malcolm *et al.*
Depth use and migratory behaviour of homing Atlantic salmon (*Salmo salar*) in Scottish coastal waters	https://academic.oup.com/icesjms/article/72/2/568/2801299	2015	Godfrey *et al.*
The Marine Life Information Network (MarLIN)	https://www.marlin.ac.uk/	2024	MarLIN
ICES Statistical Rectangles and Area	https://marine.gov.scot/information/ices-statistical-rectangles-and-areas	2022b	ICES
Environmental baseline (and associated Appendices) of the UK Offshore Energy Strategic Environmental Assessment 4 (OESEA 4)	https://www.gov.uk/government/consultations/uk-offshore-energy-strategic-environmental-assessment-4-oesea4	2022	Department for Business, Energy and Industry Strategy (BEIS)
Sectoral Marine Plan for Offshore Wind Energy	https://www.gov.scot/publications/sectoral-marine-plan-offshore-wind-energy/	2020	Scottish Government
Analysis of Basking Shark Watch Database 1987 to 2020	https://www.nature.scot/doc/naturescot-research-report-1279-analysis-basking-shark-watch-database-1987-2020	2024	Pikesley *et al.*
ScotMER Fish and Fisheries Evidence Map	https://www.gov.scot/publications/fish-and-fisheries-specialist-receptor-group/	2024a	ScotMER
ScotMER Diadromous Fish Evidence Map	https://www.gov.scot/publications/diadromous-fish-specialist-receptor-group/	2024b	ScotMER

13.4.3 Project site-specific surveys

No site-specific surveys have been undertaken to specifically inform the EIAR for Fish and Shellfish Ecology. This assessment has been undertaken as a desk-based study using available, relevant datasets, with the addition of evidence from Environmental Baseline Surveys.

The Environmental Baseline Survey (EBS) reports (EIAR Vol. 4, Appendix 10: Environmental Baseline and Habitat Assessment Report – Inshore EICC, EIAR Vol. 4, Appendix 11: Environmental Baseline Report – OWF, EIAR Vol. 4, Appendix 12: Environmental Baseline Report – EICC) present data gathered along the EICC and Array Area, which contribute to the characterisation of the Fish and Shellfish Ecology baseline. Particle Size Analysis (PSA) enable a determination of habitat suitability for herring (*Culpea harengus*) spawning and sandeel (*Ammodytes marinus*).

Six of the sediment samples collected from the Array Area were selected for analysis of sediment eDNA to provide a comprehensive spatial coverage of the area (see EIAR Vol. 4, Appendix 13: Benthic eDNA Analysis Report). However, the eDNA samples were analysed against a DNA database containing invertebrate sequence data and therefore exclude fish and other vertebrate organisms. The section of the EICC from MHWS to 12 NM has previously been surveyed and assessed within the EIAR submitted for NorthConnect Limited (application reference number 06771 & 06870) and judged acceptable through the consenting of NorthConnect. The survey data obtained for NorthConnect has been made available to Cenos and is used herein to provide characterisation of the inshore section of the EICC (MMT, 2018).

13.4.4 Existing baseline

A review of literature and available data sources has been undertaken to describe the current baseline environment for Fish and Shellfish Ecology.

13.4.4.1 Overview

Fish and Shellfish Ecology receptors relevant to the Study Area have been categorised into groups, which include:

- Marine finfish (teleosts), such as pelagic and demersal fish species;
- Elasmobranchs (sharks and rays);
- Diadromous fish (including anadromous and catadromous fish); and
- Shellfish (crustaceans and molluscs).

The grouping of fish species has informed the structure of the baseline sections of this chapter.

13.4.4.2 Spawning and nursery grounds

The waters off the north east coast of Scotland, including the Study Area, serve as potential spawning and nursery grounds for several commercially and ecologically important species (Table 13-4 and Figure 13-3, Figure 13-4 and Figure 13-5).

Coull *et al.* (1998) and Ellis *et al.* (2012) mapped fish spawning and nursery grounds for the North Sea[4]. Table 13-4 and Figure 13-3, Figure 13-4, and Figure 13-5 summarise the fish spawning and nursery grounds that overlap with the Study Area. Further detail on the potential spawning and nursery grounds that overlap the Study Area is provided in Sections 13.4.4.2.1 and 13.4.4.2.2, respectively.

[4] *The spawning and nursery areas identified by Coull et al. (1998) and Ellis et al. (2012) are based on predictions and may vary spatially and temporally from actual trends observed in the Study Area. Coull et al. (1998) and Ellis et al. (2012) represent the most comprehensive dataset available and have been supplemented, where applicable, by more recent data.*

Table 13-4 Spawning and nursery grounds of fish and shellfish species within the Study Area (Coull et al., 1998; Ellis et al., 2012)

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Anglerfish (*Lophius piscatorius*)	N	N	N	N	N	N	N	N	N	N	N	N
Blue Whiting (*Micromesistius poutassou*)	N	N	N	N	N	N	N	N	N	N	N	N
Cod (*Gadus morhua*)	SN	S*N	S*N	SN	N	N	N	N	N	N	N	N
Common skate (*Dipturus batis*)	N	N	N	N	N	N	N	N	N	N	N	N
European hake (*Merluccius merluccius*)	N	N	N	N	N	N	N	N	N	N	N	N
Haddock (*Melanogrammus aeglefinus*)	N	N	N	N	N	N	N	N	N	N	N	N
Herring (*Culpea harengus*)	N	N	N	N	N	N	N	SN	SN	N	N	N
Lemon Sole (*Microstomus kitt*)	N	N	N	SN	SN	SN	SN	SN	SN	N	N	N
Ling (*Molva molva*)	N	N	N	N	N	N	N	N	N	N	N	N
Mackerel (*Scomber scombrus*)	N	N	N	N	S*N	S*N	S*N	SN	N	N	N	N
Nephrops	SN	SN	SN	S*N	S*N	S*N	SN	SN	SN	SN	SN	SN
Norway Pout (*Trisopterus esmarkii*)	SN	S*N	S*N	SN	N	N	N	N	N	N	N	N
Plaice (*Pleuronectes platessa*)	S*N	S*N	SN	N	N	N	N	N	N	N	N	SN
Saithe (*Pollachius virens*)	N	N	N	N	N	N	N	N	N	N	N	N
Sandeel (*Ammodytes marinus*)	SN	SN	N	N	N	N	N	N	N	N	SN	SN
Spotted ray (*Raja montagui*)	N	N	N	N	N	N	N	N	N	N	N	N
Sprat (*Sprattus sprattus*)	N	N	N	N	S*N	S*N	SN	SN	N	N	N	N
Spurdog (*Squalus acanthias*)	N	N	N	N	N	N	N	N	N	N	N	N
Tope shark (*Galeorhinus galeus*)	N	N	N	N	N	N	N	N	N	N	N	N
Whiting (*Merlangius merlangus*)	N	SN	SN	SN	SN	SN	N	N	N	N	N	N

S = Spawning, N = Nursery, SN = Spawning and Nursery; * = peak spawning; Species = High intensity nursery ground as per Ellis *et al.*, 2012; Species = High intensity spawning as per Ellis *et al.*, (2012); and Species = High concentration spawning as per Coull *et al.* (1998).

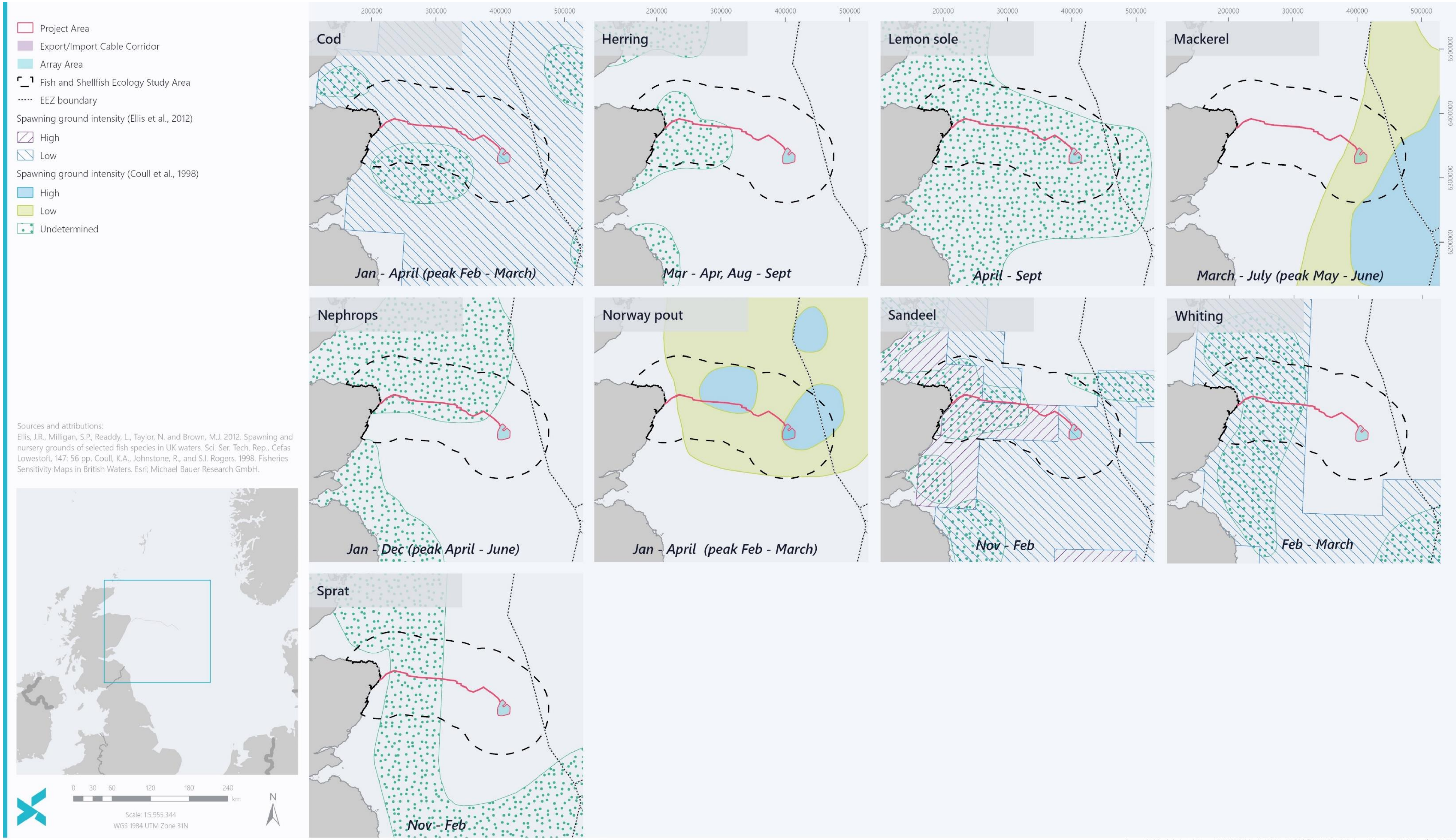

Figure 13-3 Spawning grounds within the Study Area (Ellis et al., 2012 and Coull et al., 1998) (Note: Spawning period for each species is inclusive of the months listed)

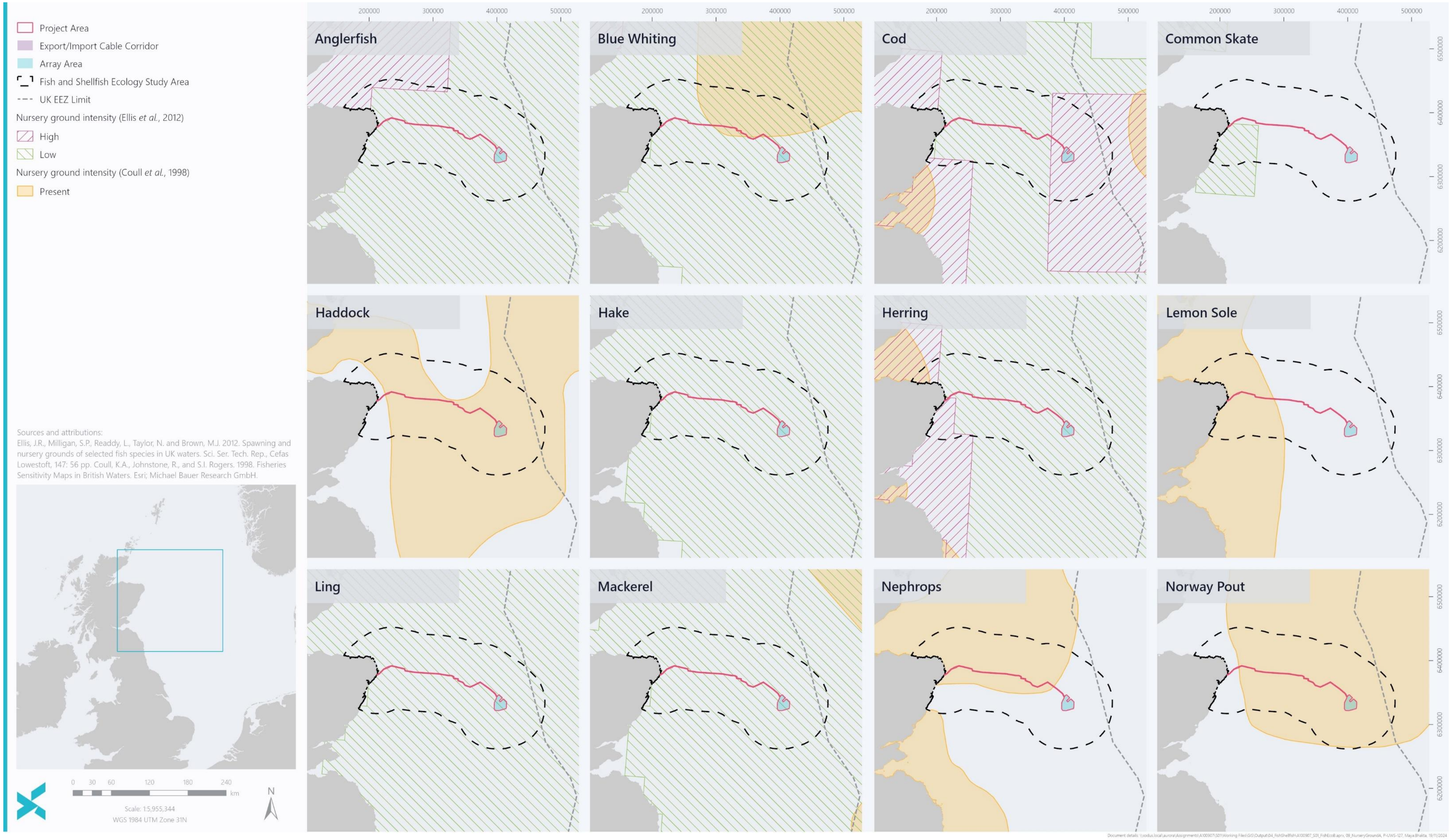

Figure 13-4 Nursery grounds within the Study Area (Ellis et al., 2012 and Coull et al., 1998) (1 of 2)

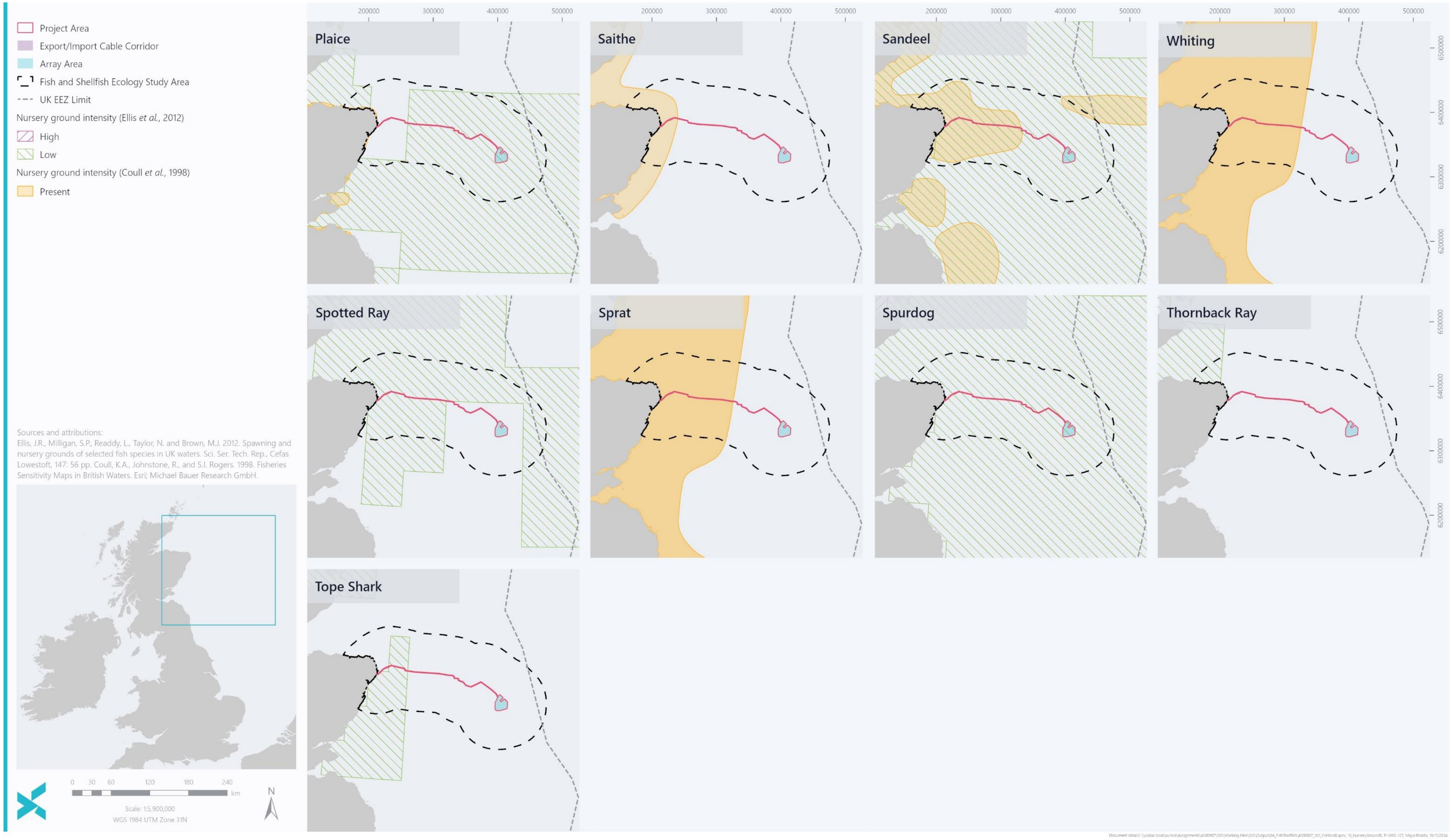

Figure 13-5 Nursery grounds within the Study Area (Ellis et al., 2012 and Coull et al., 1998) (2 of 2)

13.4.4.2.1 Spawning grounds

The Fish and Shellfish Study Area overlaps with high intensity spawning grounds (Figure 13-3) for cod (*Gadus morhua*), sandeel, Norway pout (*Trisopterus esmarkii*), and whiting (*Merlangius merlangus*) along the EICC and Array Area, and mackerel (*Scomber scombrus*) from the Array Area seaward. The Study Area overlaps with low intensity or undetermined intensity spawning grounds for cod, herring, lemon sole (*Microstomus kitt*), *Nephrops (Nephrops norvegicus)*, Norway pout, sandeel (*Ammodytes* spp.), and sprat (*Sprattus sprattus*) which intersects the Project Area along the EICC and the Array Area, and whiting in the inshore section of the EICC.

Spawning grounds for cod, haddock (*Melanogrammus aeglefinus*) and whiting have been further updated by González-Irusta and Wright (2016a; 2016b; 2017 (Figure 13-6). The Study Area coincides with large areas of grounds with relatively lower importance, with sporadic areas that are slightly more suitable for spawning haddock along the EICC (Figure 13-6). There is a region of relatively higher importance for whiting spawning ground that spans the east coast of Scotland, which is intersected by the EICC (Figure 13-6). There is a large area of 'occasional' grounds for spawning cod closer to shore along the east coast of Scotland and 'unfavourable' grounds for spawning cod closer to the Array Area (Figure 13-6). A small area of 'recurrent' spawning grounds for cod is also present, which is intersected by the EICC (González-Irusta and Wright, 2016a (Figure 13-6)).

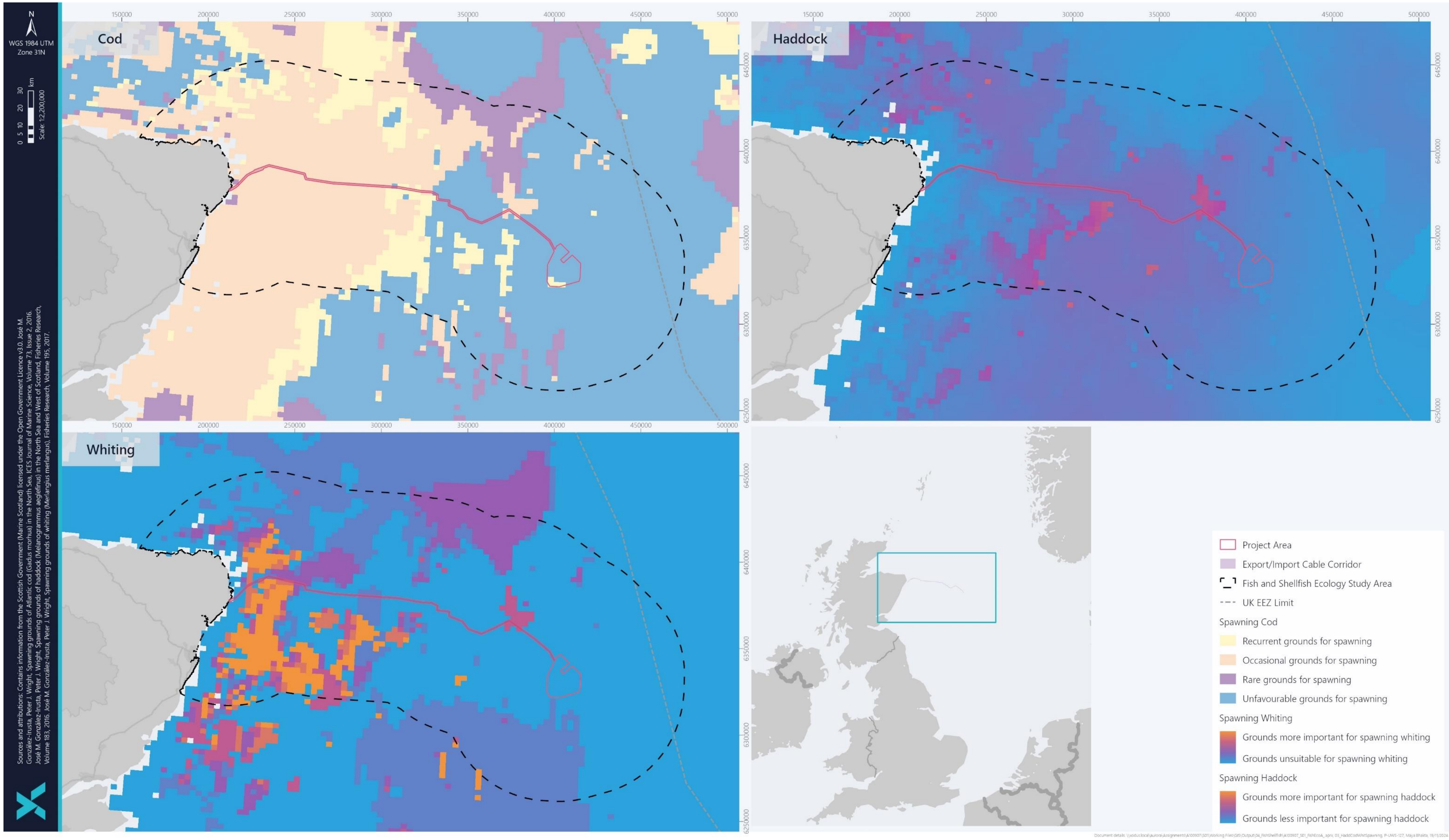

Figure 13-6 Spawning grounds for cod, haddock, and whiting (González-Irusta and Wright, 2016a; 2016b; 2017)

Herring spawning habitat

Herring spawn on the seabed and gather in shoals in shallow water (less than 40 m depth) or offshore banks (up to 200 m depth), in areas of coarse sediments, gravel, and shells, to deposit their sticky eggs (Ellis *et al.*, 2012).

The management of North Sea Autumn Spawning (NSAS) herring is treated as a single stock, divided into four spawning subcomponents based on their spawning area and timing. The Buchan subcomponent, in which spawning occurs between August and September (Barreto and Bailey, 2014), overlaps with the Study Area. Herring spawn once per annum, over a short timeframe, across multiple waves. Herring gather together and each female produces a single clutch of eggs, resulting in an 'egg carpet' which may have several layers and may cover a large area. The timeframe for eggs to hatch is dependent on the temperature of the sea but will usually last two to three weeks. Newly hatched herring larvae are dependent on reserves in the yolk sac and, as a result, stay on the seabed for a period between 3 and 20 days, until the yolk is absorbed. The yolk sac absorption rate is dependent on sea temperature (Russell, 1976). Once the yolk sac is absorbed, the larvae then become pelagic and utilise the surface currents to move towards nursery grounds (Dickey-Collas, 2004). Larvae experience a metamorphosis into juvenile herring between April and July (Dickey-Collas, 2004), maturing into adults at around 2-3 years (Frost and Diele, 2022).

The potential for herring spawning has been looked at in more detail by using the results from site-specific (PSA) data from the EBS reports (EIAR Vol. 4, Appendix 10: Environmental Baseline and Habitat Assessment Report – Inshore EICC, EIAR Vol. 4, Appendix 11: Environmental Baseline Report – OWF, EIAR Vol. 4, Appendix 12: Environmental Baseline Report – EICC). Methodology was devised by Reach *et al.* (2013) and recently updated by Kyle-Henney *et al.* (2024). Using the sediment composition, locations were classified as either 'preferred', 'marginal' or 'unsuitable' habitat for herring spawning, as presented in Table 13-5. The suitability of the sediments in the Study Area for herring spawning habitat is shown in Figure 13-7.

Table 13-5 Partitioning of herring spawning habitat using sediment characteristics (Reach et al.*, 2013; Kyle-Henney et al., 2024)*

% PARTICLE CONTRIBUTION (MUDS = <63 µM; GRAVEL = 63-2000 µM)	HABITAT PREFERENCE	FOLK SEDIMENT UNIT	HABITAT CLASSIFICATION
<5% mud, >50% gravel	Prime	Gravel and part sandy; gravel	Preferred
<5% mud, >25% gravel[5]	Sub-prime	Part sandy gravel and part gravelly sand	Preferred
<5% mud, >10% gravel	Suitable	Part gravelly sand	Marginal
>5% mud, <10% gravel	Unsuitable	Everything excluding gravel, part sandy gravel and part gravelly sand	Unsuitable

An overview of the sediment fractions identified during the Project-specific surveys is provided in EIAR Vol. 3, Chapter 8: Marine Geology, Oceanography and Coastal Processes. Overall, the results from the PSA indicated high levels of muds (>5% of the sediment composition) and low proportions of gravels (<10% of the sediment composition) across the majority of samples within the EICC and Array Area. The percentage of muds ranged from 2.1% to 82.43% (average 32.93%). Gravels ranged from 0.03% to 34.69% (average 1.67%). Consequently, most sample locations were classified as muddy sand under the modified Folk classification system (EIAR Vol. 4, Appendix 10: Environmental Baseline and Habitat Assessment Report – Inshore EICC, EIAR Vol. 4, Appendix 11: Environmental Baseline Report – OWF, EIAR Vol. 4, Appendix 12: Environmental Baseline Report – EICC). Overall, conditions were considered to be 'unsuitable' for herring spawning at all sample locations across the EICC and Array Area, as reported in EIAR Vol. 4, Appendix 10: Environmental Baseline and Habitat Assessment Report – Inshore EICC, EIAR Vol. 4, Appendix 11: Environmental Baseline Report – OWF, EIAR Vol. 4, Appendix 12: Environmental Baseline Report – EICC.

BGS data for the Study Area also indicates that the majority of the Study Area comprises of sediments unsuitable for herring spawning (Figure 13-7). The sediments along the EICC are a mixture of sand, gravelly sand and slightly gravelly sand, and therefore, indicate potential suitability for herring spawning ('marginal' habitat sediment classification), which contradicts the Project-specific surveys. It is important to note that the BGS sediments maps are interpolated from data from sporadic surveys (some of which may be decades old). Although a valuable resource, the Project-specific data is considered a more accurate representation of the seabed sediments present across the Project Area.

The suitability of sediments for herring spawning within the Study Area, using Benthic Solutions data and BGS broadscale seabed sediment data is shown in Figure 13-7 (EIAR Vol. 4, Appendix 10: Environmental Baseline and

[5] *Please note the Kyle-Henney et al. (2024) guidance (Appendix B) states a 'sub-prime' habitat preference of >10% gravel and 'suitable' habitat preference of >25% gravel content. However, the Applicant assumes this is an error and that the values in Reach et al (2013) should be retained. It is stated in Appendix B of Kyle-Henney et al. (2024) that the partitioning of herring spawning habitat using sediment characteristic remains unchanged from Reach et al (2013).*

Habitat Assessment Report – Inshore EICC, EIAR Vol. 4, Appendix 11: Environmental Baseline Report – OWF, EIAR Vol. 4, Appendix 12: Environmental Baseline Report – EICC, BGS, 2024).

The NorthConnect survey campaign, comprising of grab sampling and seabed imagery has been used to supplement the understanding of the inshore section of the EICC (MMT, 2018). No herring and/or eggs from herring were identified in the inshore section of the EICC. The inshore survey was conducted at the start of the spawning season, and before hatching, which generally occurs between August and September (ICES, 2017). Although preferred substrates, i.e. coarse sand and gravel, were found within the survey corridor between KP 1.39 and KP 4.95 (NorthConnect, 2018; MMT, 2018). The timing of the survey and the absence of herring spawning suggests that the inshore section of EICC is not currently utilised by herring.

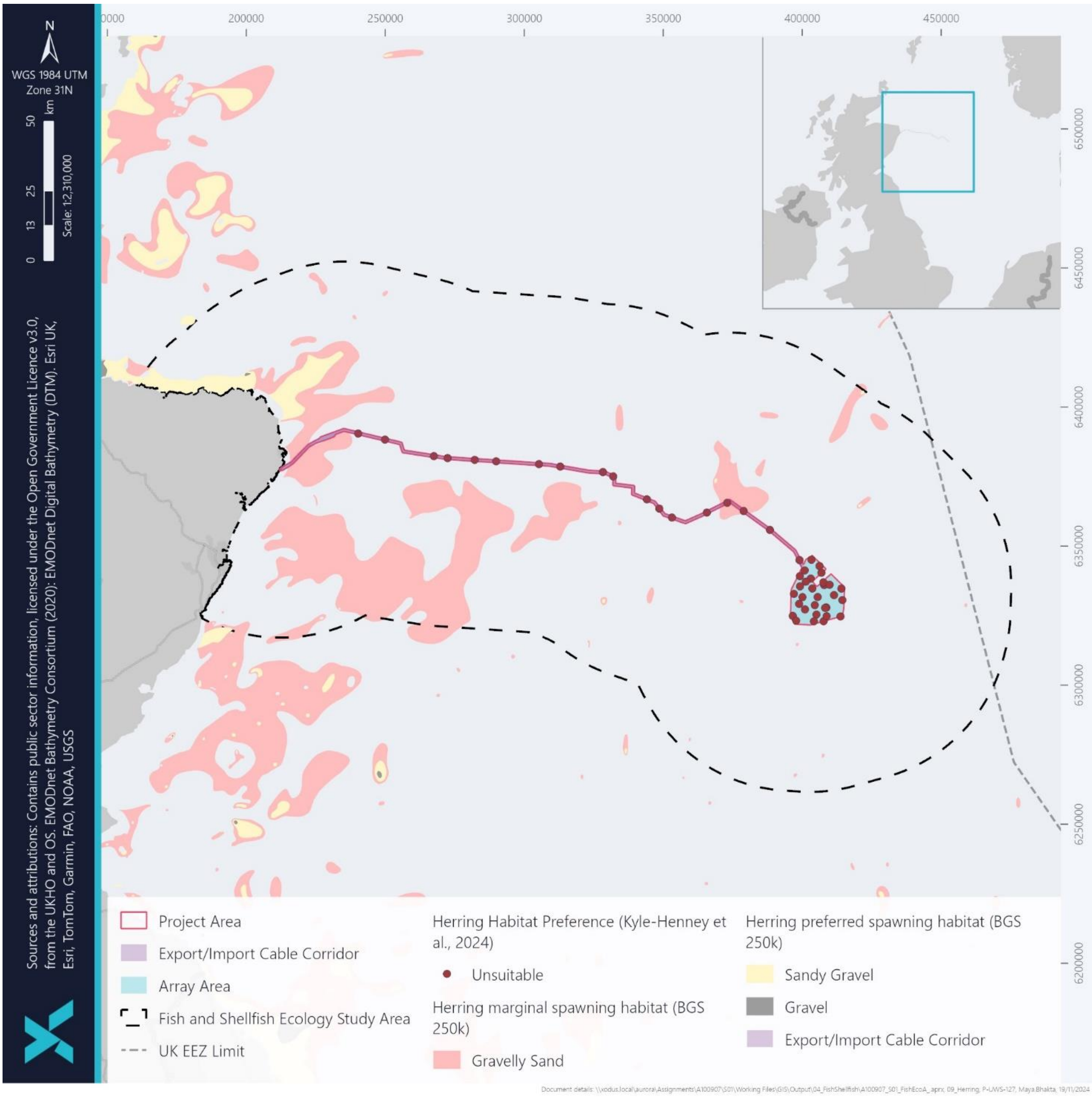

Figure 13-7 Herring spawning habitat suitability

Sandeel habitat

Sandeel are dependent on the seabed for the majority of their juvenile and adult life cycles and inhabit burrows, except when feeding and spawning (Van Deurs *et al.*, 2011; Tien *et al.*, 2017). Sandeel spawning usually occurs in sandy sediments with a high proportion of medium and coarse sand, and a low silt content (Holland *et al.*, 2005;

BEIS, 2022). Based on their dependence on the seabed, sandeel are generally considered to be sensitive to disturbance and habitat loss. The Scottish Government FEAST states that sandeel have a high sensitivity to sub-surface abrasion or penetration and a medium sensitivity to surface abrasion (Scottish Government, 2023).

As described in Latto *et al.* (2013) and Reach *et al.* (2024), there is a substantial amount of broadscale suitable habitat for sandeel throughout the North Sea. Sandeel species prefer sand, slightly gravelly sand and gravelly sand sediment habitats (Holland *et al.*, 2005; Reach *et al.*, 2024).

Sandeel are thought to use the seabed in the vicinity of the Study Area as both nursery grounds and during spawning (see Figure 13-3 and Figure 13-5; Coull *et al.*, 1998; Ellis *et al.*, 2012). Langton *et al.* (2021) developed a distribution model for the lesser sandeel (*Ammodytes marinus*), aiming to predict the probability and density of buried sandee4l across the North Sea. Using this model, sandeel are predicted to be patchily present throughout the Study Area as shown in Figure 13-8 (Langton *et al.*, 2021). Both the probability and density of buried sandeel is predicted to be low across the Array Area and the majority of the EICC, with the exception of areas close to shore. Generally, the probability for buried sandeel is higher north and south of the Project Area within the Moray Firth and Forth and Tay regions.

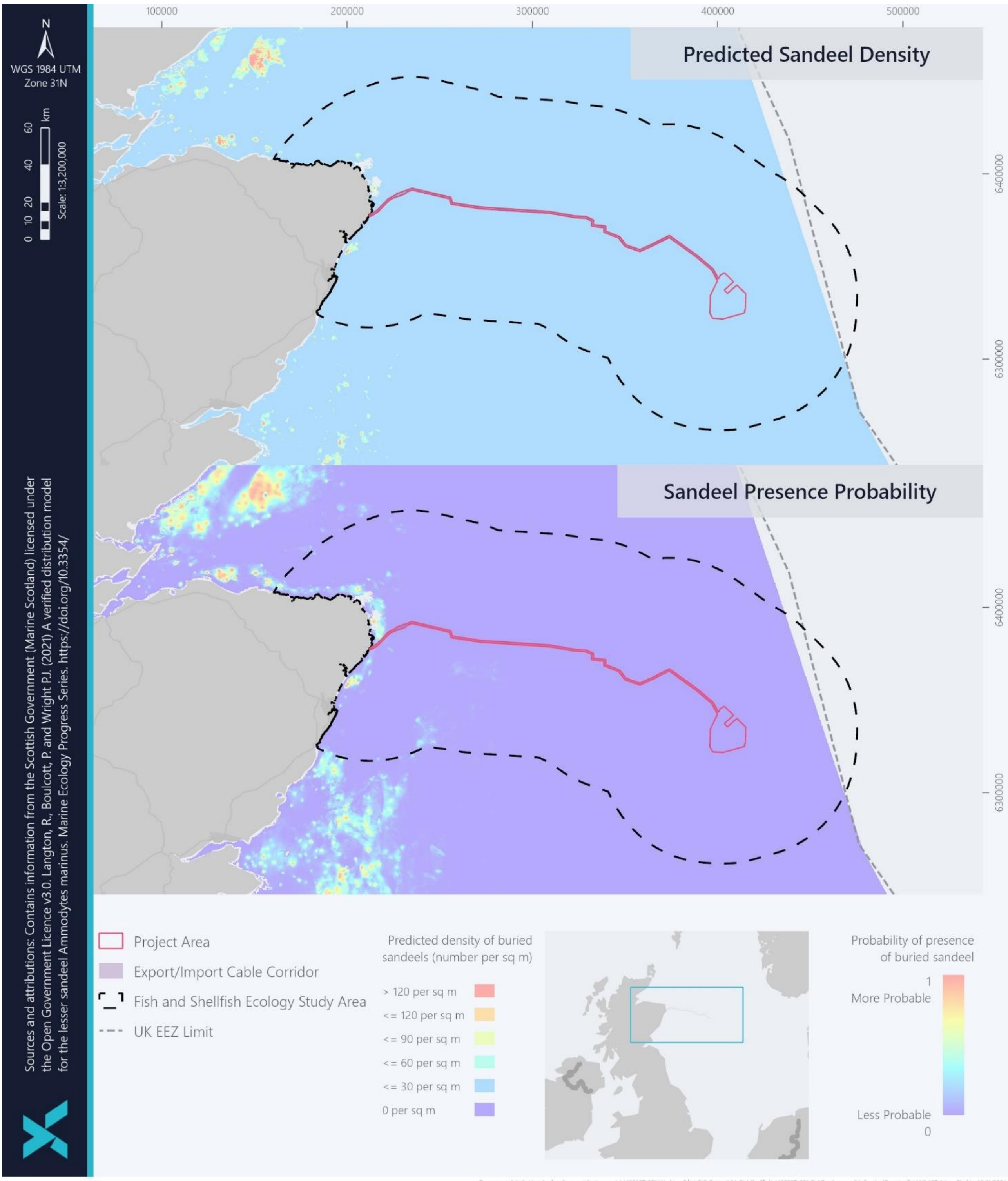

Figure 13-8 Predicted sandeel habitat from Langton et al. *(2021) (top panel = predicted sandeel density and bottom panel = sandeel presence probability)*

Sandeel prefer habitats with a substrate that is comprised of a low percentage of fines (<10% mud) (Wright *et al.*, 2000; Holland *et al.*, 2005). Holland *et al.* (2005) and Greenstreet *et al.* (2010) also identified that suitable sediments could also contain a gravel content. Holland *et al.* (2005) concluded that suitable sediments could contain up to 80% gravel (with<30% being prime habitat and 30-50% being sub-prime habitat), whereas Holland *et al.* (2005) concluded that a gravel content of <25% was preferred and that any sediments containing >35% gravel were likely unsuitable. Accordingly, Table 13-6 presents the Folk sediment divisions classed as 'preferred', 'marginal' or 'unsuitable' in accordance with Reach et al. (2024). Sandy gravel is identified by Reach *et al.* (2024) as 'marginal' sandeel habitat, representing sediments which contain an adequate sediment structure for sandeel spawning that are unlikely to support high numbers of sandeel. This Folk sediment division contains a gravel content of 30-80% and therefore exceeds the 'preferred' categories identified by Holland *et al.* (2005) and Greenstreet *et al.* (2010). It should be noted that Reach et al. (2024) does not include sediment fractions to identify 'prime' or 'sub-prime' or 'suitable' sandeel habitat preferences. This is a deviation from the previous guidance on sandeel suitability assessments (MarineSpace, 2013) and also from the equivalent updated guidance for herring suitability assessments (Kyle-Henney *et al.*, 2024).

As detailed in the EBS reports, the proportion of muds in the sediment ranged from 2.1% to 82.43% (average 32.93%), gravel content between 0.03% and 34.69% (average 1.67%) and a sand content between 0.25% to 96.45% (average 64.29%) (EIAR Vol. 4, Appendix 10: Environmental Baseline and Habitat Assessment Report – Inshore EICC, EIAR Vol. 4, Appendix 11: Environmental Baseline Report – OWF, EIAR Vol. 4, Appendix 12: Environmental Baseline Report – EICC).

Table 13-6 Partitioning of sandeel habitat using sediment characteristics (Reach et al., 2024)

FOLK CLASSIFICATION	HABITAT CLASSIFICATION
Sand, slightly gravelly sand and gravely sand	Preferred
Sandy gravel	Marginal
All other Folk sediment divisions	Unsuitable

The PSA results from the EBS indicated that the habitat along the EICC and within the Array Area was mainly 'unsuitable' for sandeel spawning due to most samples containing >10% mud and classified as muddy sand. Two sediment samples located along the EICC, closer to the Array Area, were classified as sand and therefore represent 'preferred' sandeel habitat. These 'preferred' locations are approximately 70 km from the Turbot Bank Nature Conservation Marine Protected Area (NCMPA) (designated for sandeel). The other 48 sample locations were all considered to be 'unsuitable' for sandeel spawning. The suitability of the sediments in the Project Area for sandeel spawning habitat using Benthic Solutions data (EIAR Vol. 4, Appendix 10: Environmental Baseline and Habitat Assessment Report – Inshore EICC, EIAR Vol. 4, Appendix 11: Environmental Baseline Report – OWF, EIAR Vol. 4, Appendix 12: Environmental Baseline Report – EICC) is shown in Figure 13-9.

Sandeel were identified in the grab samples taken along the inshore section of the EICC. These instances coincided with pockets of coarse sediment which comprised 80-90% sand and 8-18% gravel (MMT, 2018). Sediment potentially suitable for sandeel was found within the inshore EICC, between KP 3.50 and KP 17.50 (MMT, 2018).

BGS data for the Study Area indicates potential presence of preferred and marginal sandeel habitat within the Study Area, contradicting the Project-specific survey data. However, as noted for herring above, Project-specific survey data is considered to provide a more accurate representation of seabed sediment within the Project Area.

In summary, the above datasets show that although sandeel have a broad range of suitable habitat across the North Sea, including within the Study Area, the Project does not overlap with a large area of preferred sandeel habitat, although some locations along the EICC appear to have a greater probability of being suitable habitat.

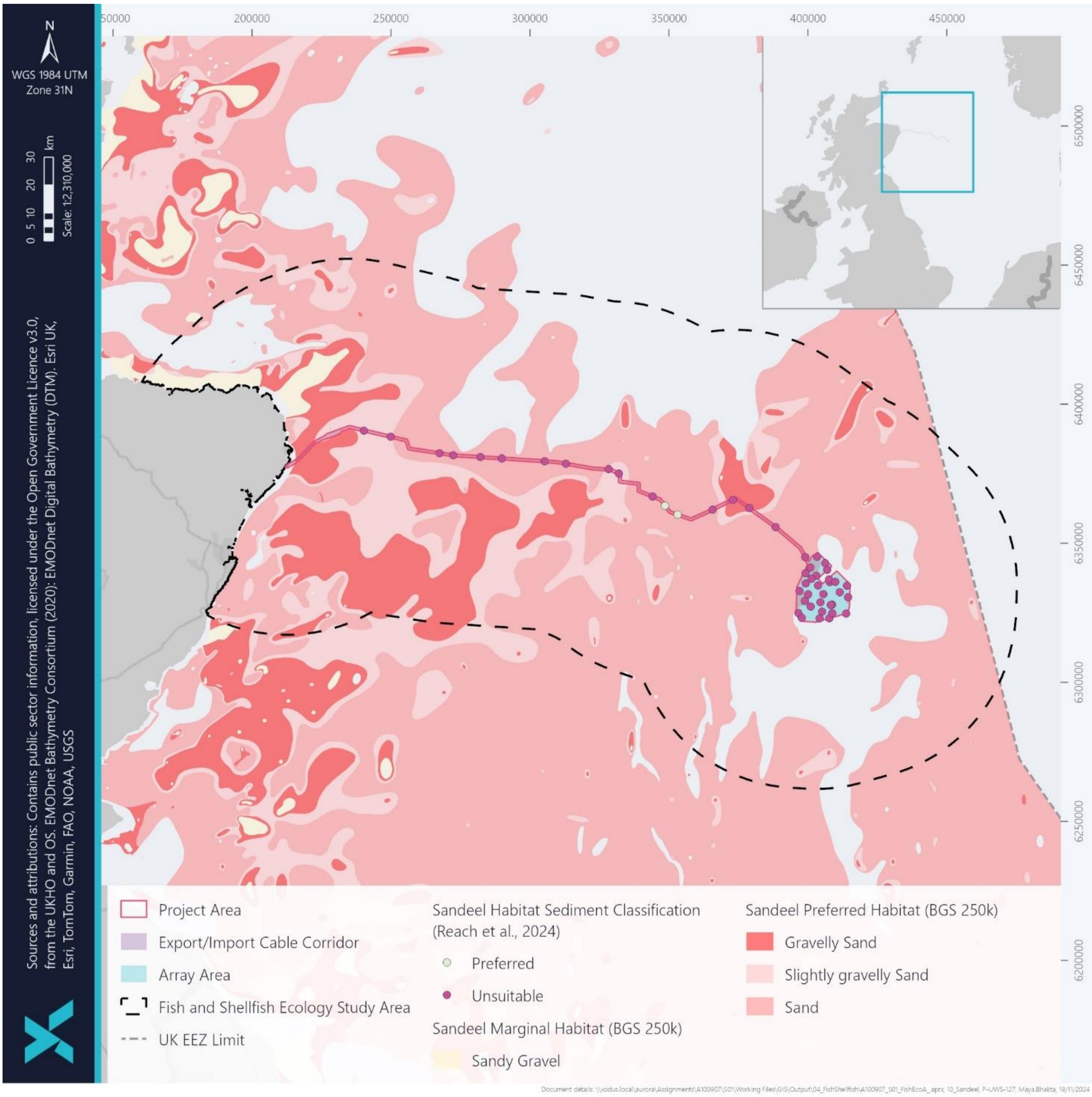

Figure 13-9 Sandeel spawning habitat suitability

13.4.4.2.2 Nursery grounds

As discussed in Section 13.4.4.2, there are nursery grounds present within the Study Area, which are presented in Table 13-4, Figure 13-4 and Figure 13-5 (Coull *et al.* 1998; Ellis *et al.* 2012). The Study Area overlaps with high intensity nursery grounds for anglerfish (*Lophius piscatorius)*, cod, and herring, and low intensity nursery grounds for anglerfish, blue whiting (*Micromesistius poutassou*), cod, common skate[6] (*Dipturus intermedius* and *Dipturus flossada*), hake, herring, ling (*Molva molva*), mackerel, plaice (*Pleuronectes platessa*), sandeel, spotted ray (*Raja montagui*), spurdog (*Squalus acanthias*), thornback ray (*Raja clavata*), and tope shark (*Galeorhinus galeus*). Coull *et al.* (1998) notes nursery grounds present (undetermined intensity) for sandeel, blue whiting, herring, haddock, lemon sole, *Nephrops*, Norway pout, saithe (*Pollachius virens*), sprat , and whiting (Figure 13-4 and Figure 13-5).

The Scottish Government released an Essential Fish Habitats report in May 2023, which details the potential for aggregations (either presence or absence, lower or higher confidence) for fish and shellfish species around Scotland (Franco *et al.* 2023). The highest potential for aggregations is represented by the ranking 'presence (higher confidence)'. Lesser sandeel is the only species recorded as 'presence (higher confidence)' within the Study Area, notably around Turbot Bank. There is potential for aggregations of *Nephrops*, common sole, whiting, hake and sprat; however, the potential for aggregations is less likely ('presence, lower confidence'). All other species are considered less probable for potential aggregations, recorded as 'absence (lower or higher confidence)'.

Aires *et al.* (2014) use the findings of Coull *et al.* (1998) and Ellis *et al.* (2012) together with International Bottom Trawl Survey (IBTS) data, beam trawl survey data, IHLS and other standalone surveys to summarise the probability of aggregations of individuals in the first year of their life, referred to as 0-group, and/or larvae of key commercial species. The probability of 0-group aggregations occurring within the Study Area is presented in Figure 13-10. The probability of 0-group aggregations is low to moderate for anglerfish, blue whiting, cod, herring, horse mackerel, mackerel, place, sole, and sprat, and moderate to high for haddock, hake, Norway pout, and whiting (Aires *et al.* 2014).

[6] *In 2010, common skate was identified as containing two distinct species, flapper skate (Dipturus intermedius) and* blue skate (*Dipturus flossada*). Further details are available here: https://www.nature.scot/plants-animals-and-fungi/fish/sea-fish/flapper-skate.

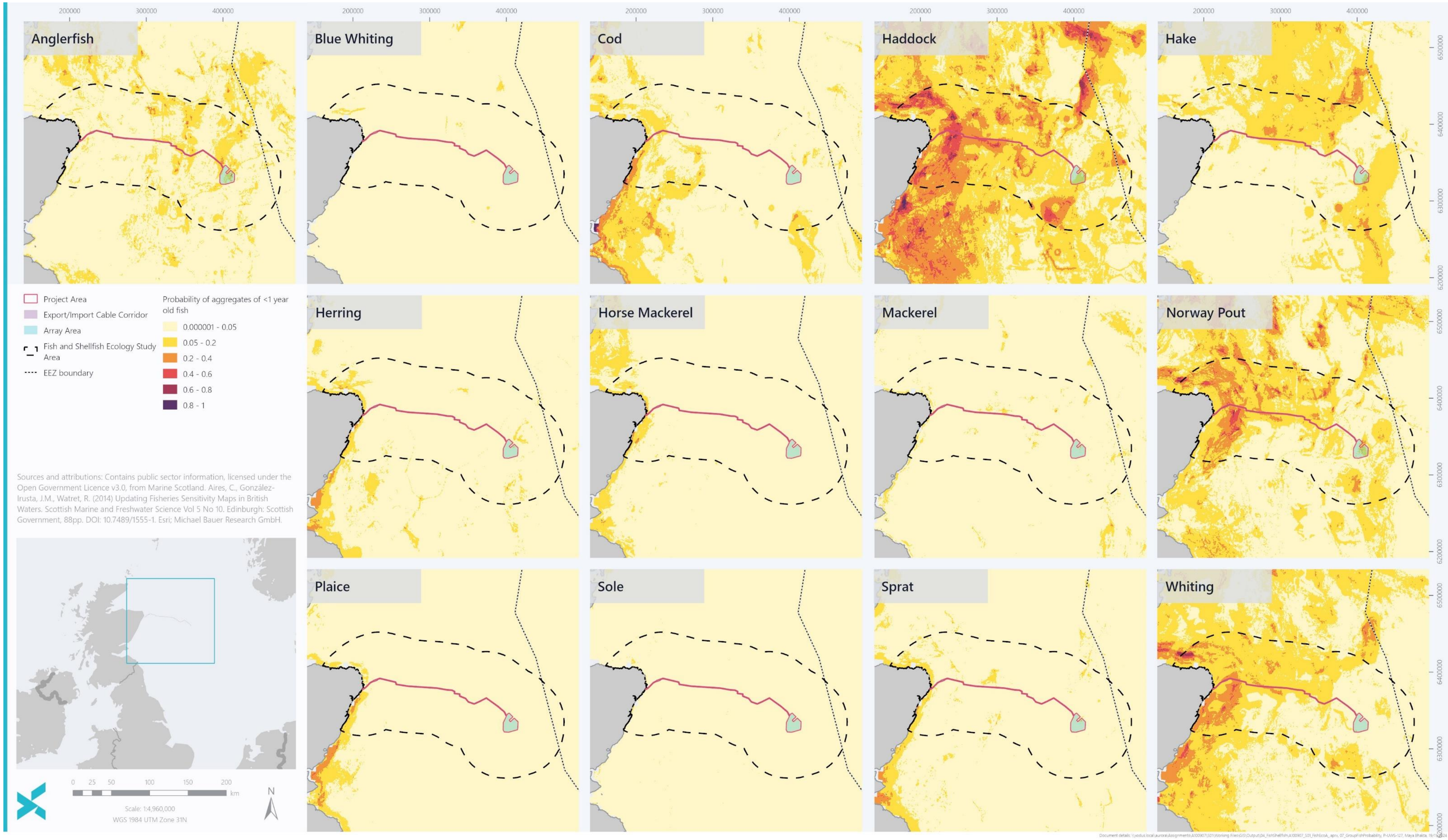

Figure 13-10 Probability of aggregations of 0-group fish (Aires et al., 2014)

13.4.4.3 Marine finfish

Marine finfish are defined in this chapter as non-diadromous marine teleosts and include pelagic marine finfish (fish that inhabit the water column) and demersal teleost fish (bottom dwelling fish that are found near or on the seabed). Demersal marine finfish are further classified into flatfish, gadoids, and 'other' demersal marine finfish species.

Analysis of the conspicuous fauna within the Array Area showed free-swimming megafauna mainly consisted of flatfish (order Pleuronectiformes), gadoid fish (family Gadidae) and the hagfish (*Myxine glutinosa*); with gurnards (family Triglidae), squid (class Cephalopoda) and rays (family Rajidae) also observed on occasion (EIAR Vol. 4, Appendix 10: Environmental Baseline and Habitat Assessment Report – Inshore EICC, EIAR Vol. 4, Appendix 11: Environmental Baseline Report – OWF, EIAR Vol. 4, Appendix 12: Environmental Baseline Report – EICC). Conspicuous fauna in the EICC revealed a moderate diversity and density for an overarchingly sand dominated seabed, with comparable fauna assemblages across most stations. Free-swimming megafauna mainly consisted of unidentified flatfish, lemon sole, gadoid fish and the hagfish; with gurnards, and rays also observed on occasion (EIAR Vol. 4, Appendix 10: Environmental Baseline and Habitat Assessment Report – Inshore EICC, EIAR Vol. 4, Appendix 11: Environmental Baseline Report – OWF, EIAR Vol. 4, Appendix 12: Environmental Baseline Report – EICC).

Site specific surveys using grabs (stations S01, S02, S03, S04 and S05) and cameras (transects T04 and T05) were carried out in the section of the EICC within 12 NM (MMT, 2018). The MMT (2018) report findings on benthic species for this section of the EICC are in line with the Benthic Solutions findings (EIAR Vol. 4, Appendix 10: Environmental Baseline and Habitat Assessment Report – Inshore EICC, EIAR Vol. 4, Appendix 11: Environmental Baseline Report – OWF, EIAR Vol. 4, Appendix 12: Environmental Baseline Report – EICC). Mobile species observed included vertebrates, such as unidentified fish (class Actinopterygii), plaice (*Pleuronectes platessa*) and common dragonettes (*Callionymus lyra*). Sandeel species were also potentially identified, however, reduced visibility due to water column turbidity limited the conclusion of their presence across the EICC (EIAR Vol. 4, Appendix 12: Environmental Baseline Report – EICC).

Commercially important marine finfish

An indication of the characteristic commercial marine finfish species within the Study Area can be obtained from commercial landings data from the ICES statistical rectangles displayed on Figure 13-1. However, it is acknowledged that an accurate representation of species composition cannot be provided by commercial landings data alone, as the data is influenced by factors, such as the fishing methods used, seasonality, quotas, bycatch, and Total Allowable Catch (TAC) limits.

Thirty-eight different marine finfish species were recorded as landed from the ICES statistical rectangles that are listed in Section 13.4.1 between 2018-2022 (MMO, 2023). Table 13-7 presents the average live weights (2018 – 2022) for marine finfish within the Study Area. The species listed in the table are presented in descending order in terms of total live weights, and only the top ten marine finfish species are listed. Haddock (*Melanogrammus aeglefinus*) account for the majority of the marine finfish average live weights (39% of all marine finfish average live weights), followed by herring and whiting.

Table 13-7 Average live weights (tonnes, 2018 – 2022) of commercially exploited marine finfish from the ICES statistical rectangles displayed on Figure 13-1 (MMO, 2023)

SPECIES	AVERAGE LIVE WEIGHTS (tonnes)									
	44E8	44E9	44F0	44F1	43E8	43E9	43F0	43F1	42F1	Total
Haddock	671.25	836.43	575.16	448.31	265.91	945.77	333.12	63.20	20.00	20.795.82
Herring	301.97	277.33	18.26	0.06	0.00	2338.51	650.83	34.35	6.29	18.137.99
Whiting	144.51	264.50	169.06	46.26	8.97	41.61	36.02	6.31	18.05	3.676.38
Sandeel	0.00	0.00	0.00	0.00	145.04	449.55	133.73	0.00	0.00	3.641.61
Mackerel	188.84	23.44	173.96	0.81	28.76	10.27	0.93	0.30	0.21	2.137.64
Monks or Anglers (*Lophius* spp.)	97.62	145.80	130.64	25.02	3.42	3.04	6.31	3.36	12.25	2.137.27
Plaice	24.59	17.02	15.54	25.12	7.31	23.96	27.81	7.23	5.30	769.39
Cod	25.81	25.44	45.83	16.11	2.11	3.12	5.87	1.51	0.59	631.96
Grey gurnard (*Eutrigla gurnardus*)	14.06	25.00	14.09	8.84	1.35	1.92	6.35	1.64	10.28	417.68
Witch (*Glyptocephalus cynoglossus*)	12.54	21.41	26.52	8.57	0.61	0.90	1.50	2.60	5.01	398.28

13.4.4.4 Shellfish

The shellfish species considered within this chapter include larger crustaceans and molluscs, primarily those of commercial importance, such as velvet swimming crab (*Necora puber*), *Nephrops*, and king scallops. Smaller crustaceans and clam species, including ocean quahog (*Arctica islandica*), are considered within EIAR Vol. 3, Chapter 10: Benthic Ecology.

Analysis from the conspicuous fauna within the Array Area showed mobile fauna, such as whelks (family Buccinidae), *Nephrops*, squat lobster (family Munididae), and spider crab (family Majidae) to be present (EIAR Vol. 4, Appendix 11: Environmental Baseline Report – OWF). Conspicuous fauna in the EICC revealed a moderate diversity and density for an overarching sand dominated seabed, with comparable fauna assemblages across most stations. Mobile fauna included hermit crabs (*Pagurus sp.*), sea stars (Asteroidea), brittlestars (*Ophiuroidea*), sea-urchins, whelk, *Nephrops*, squat lobster, spider crab and sea slugs (EIAR Vol. 4, Appendix 10: Environmental Baseline and Habitat Assessment Report – Inshore EICC, EIAR Vol. 4, Appendix 11: Environmental Baseline Report – EICC).

The MMT (2018) report identified crustacean species, such as the rugose squat lobster (*Munida rugosa*), along with common starfish (*Asterias rubens*) and common urchin (*Echinus esculentus*), which have been discussed in more detailed in EIAR Vol. 3, Chapter 10: Benthic Ecology.

13.4.4.4.1 Nephrops

Nephrops is a lobster which can grow up to 25 cm long and is considered to be the most commercially valuable crustacean in Europe (Hill *et al*., 2008). The species predominantly inhabits muddy seabed sediments and shows a strong preference for sediments with more than 40% silt and clay (Bell *et al*,. 2006), which determines the distribution of the species. *Nephrops* are opportunistic predators and target crustaceans, molluscs, and worms. They spend a significant amount of time in semi-permanent burrows at around 20 to 30 cm in depth and 10 cm in diameter (Hill *et al*., 2008).

Mating typically begins in the early summer, with spawning occurring in September. The females are fully matured by three years old, and they carry their eggs from September until April or May, when the eggs begin to hatch. The larvae develop into plankton before settling into the seabed six to eight weeks later (Coull *et al*., 1998). *Nephrops* have spawning and nursery grounds of undetermined intensity located within the Study Area (Figure 13-3 and Figure 13-5).

As mentioned in Section 13.4.4.2.1, PSA results from the EBS Reports (EIAR Vol. 4, Appendix 10: Environmental Baseline and Habitat Assessment Report – Inshore EICC, EIAR Vol. 4, Appendix 11: Environmental Baseline Report – OWF, EIAR Vol. 4, Appendix 12: Environmental Baseline Report – EICC) indicate that the sediment within the Array Area and the EICC contain high proportions of mud, which is a preferred habitat for *Nephrops* (see EIAR Vol. 3, Chapter 8: Marine Geology, Oceanography, and Coastal Processes for a summary of the sediments recorded across the Project Area). Both the EICC and the Array Area intersect with areas of suitable *Nephrops* habitat managed under Functional Units (FUs) known as FU9 (Moray Firth), FU7 (Fladen), and FU34 (Devil's Hole) (Figure 13-11) (Scottish Government, 2017). These FUs are targeted predominantly by commercial fisheries vessels (see EIAR Vol. 3, Chapter 14: Commercial Fisheries).

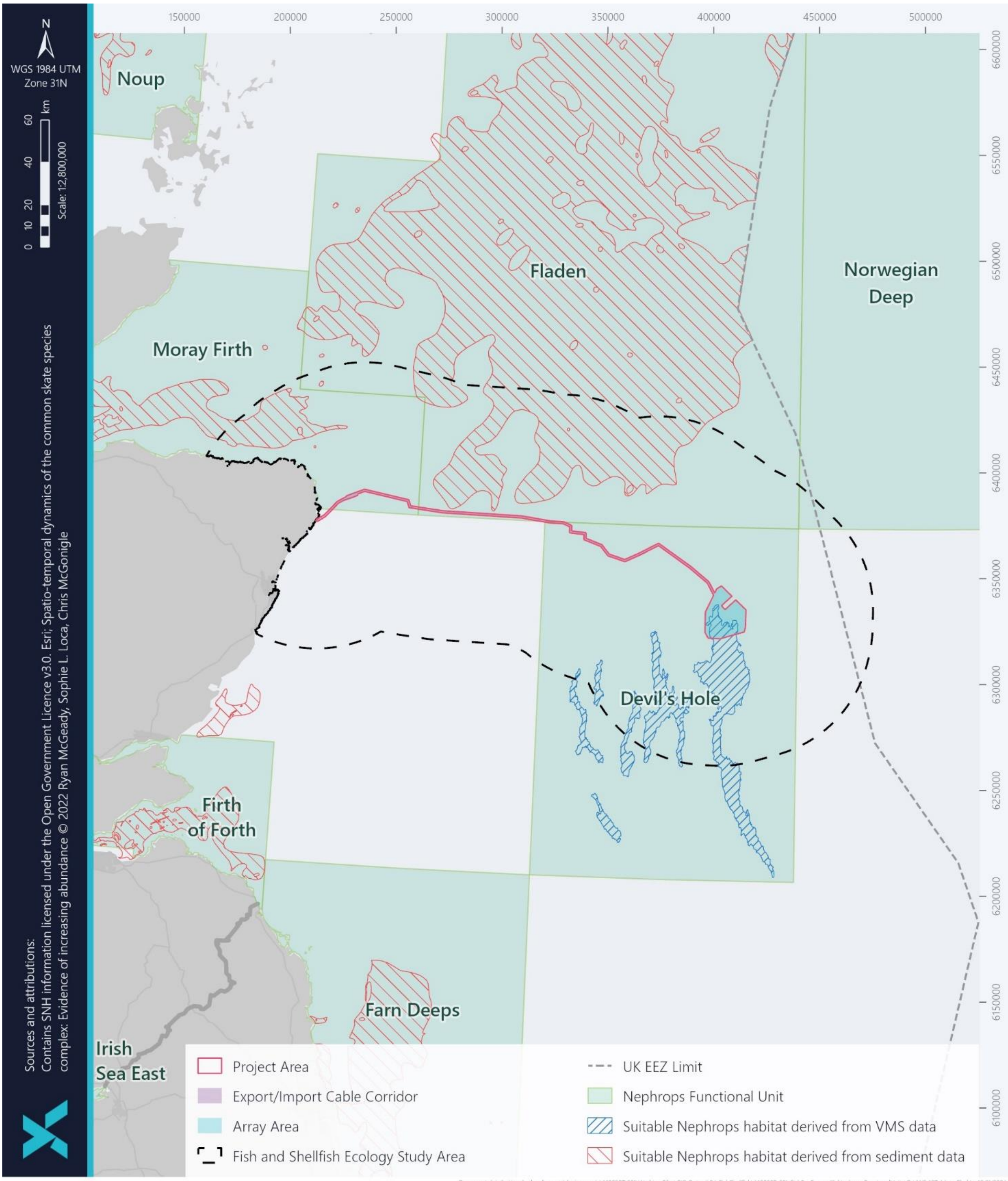

Figure 13-11 Nephrops functional units

13.4.4.4.2 King scallops

King scallops (*Pecten maximus*) show a habitat preference for clean, firm sand, fine or sandy gravel, and may occasionally be found on muddy sand. There is no clear distribution pattern of scallops (Marshal and Wilson, 2008; Carter, 2009), but areas with a lower mud composition and a strong current show the greatest abundance. Given the PSA results for the Project Area (EIAR Vol. 4, Appendix 10: Environmental Baseline and Habitat Assessment Report – Inshore EICC, EIAR Vol. 4, Appendix 11: Environmental Baseline Report – OWF, EIAR Vol. 4, Appendix 12: Environmental Baseline Report – EICC), the high proportions of mud in the sediment samples suggests that the Project Area is likely to be less suitable for scallops. Scallops are commercially fished in ICES rectangles 44E8 and 43E8 at an average annual live weight > 100 tonnes (Table 13-8).

13.4.4.4.3 Lobster

Lobster (*Homarus gammarus*) is predominantly found throughout the British coast on rocky substrata, down to water depths of 60 m. Lobsters are solitary species and inhabit holes and tunnels that they build within rocks and boulders (Wilson, 2008). Lobsters are commercially fished at the Project Area (Table 13-8).

13.4.4.4.4 Crab species

Brown crab (*Cancer pagurus*) is a relatively long-lived species that can grow a carapace of up to 25 cm. Typically found along Britain's coasts ranging from the intertidal zones to water depths of 100 m. They inhabit rocky, gravelly substrate, which they are able to burrow into (Neal and Wilson, 2008). Following spawning, there is a larval dispersal phase that lasts between 30 to 50 days. Similarly, to the lobster, brown crab are commercially fished at the Project and will likely be found within the Study Area (Table 13-8).

Velvet swimming crabs are found along the coast in Britain and reside on stony/rocky intertidal substrate up to depths of 100 m (Howson and Picton, 1997). The landings data show that velvet swimming crab are commercially fished in the Study Area (Table 13-8), alongside brown crab and therefore, are assumed to be present within the Study Area.

13.4.4.4.5 Squid

Squid species are found over areas of sand and muddy seabed (Wilson, 2006). They are predominantly demersal by nature, therefore, are often caught as bycatch in demersal fisheries with research determining they are most likely batch spawners (Bellido-Milan *et al*., 2001). However, this can vary depending on species, with others utilising hard substrate for spawning purposes (Guerra and Rocha, 1994). Some squid species (e.g. *Loligo forbesii*) are targeted by commercial fisheries and have been caught within the Study Area (Table 13-8).

13.4.4.4.6 Commercially important shellfish

Twelve shellfish species were landed from the ICES rectangles within the Study Area. Table 13-8 presents the average live weights (2018 – 2022) for shellfish within these ICES statistical rectangles. The species listed in the table are presented in descending order in terms of total live weights, and only the top 10 shellfish species are listed in Table 13-8.

Nephrops account for the majority of the shellfish average live weights (34% of all shellfish average live weights), followed by scallops and brown crabs.

Table 13-8 Average live weights (tonnes, 2018 – 2022) of commercially exploited shellfish from the ICES statistical rectangles displayed on Figure 13-1(MMO, 2023)

SPECIES	AVERAGE LIVE WEIGHTS (tonnes)									
	44E8	44E9	44F0	44F1	43E8	43E9	43F0	43F1	42F1	Total
Nephrops	281.80	869.71	889.28	139.19	11.38	10.56	19.83	23.05	241.78	12,432.86
King scallop	296.93	1.72	0.00	0.00	297.77	31.76	0.92	0.00	0.36	3,147.30
Brown crab (mixed sexes)	451.42	0.50	0.68	0.00	68.50	2.81	0.06	0.00	0.00	2,619.87
Velvet swimming crab	49.03	0.10	0.06	0.00	4.74	0.00	0.03	0.00	0.00	269.84
Lobster	22.75	0.02	0.03	0.00	5.00	0.03	0.01	0.00	0.00	139.20
Mixed squid and octopi	8.62	4.32	2.82	1.81	0.29	0.75	2.24	0.13	0.72	108.58
Octopus (*Octopus vulgaris*)	0.84	2.63	2.19	0.37	0.07	0.02	0.03	0.04	0.31	32.42
Green crab (*Carcinus maenas*)	0.37	0.00	0.02	0.00	0.11	0.00	0.00	0.00	0.00	2.49
Cuttlefish (*Sepia officinalis*)	0.03	0.03	0.05	0.01	0.00	0.01	0.02	0.00	0.06	1.04
Shortfin squid (*Illex coindetii*)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.84

13.4.4.5 Elasmobranchs

Elasmobranchs are a group of cartilaginous fish that include sharks, rays, and skates. Over 30 species of elasmobranchs have been recorded in Scottish waters, including basking shark, spurdog (*Squalus acanthias*), nursehound (*Scyliorhinus stellaris*) and tope shark (*Galeorhinus galeus*) (Marine Scotland, 2020).

Fisheries landings data from 2018-2022 showed presence of cuckoo ray (*Leucoraja naevus*), small spotted catshark (*Scyliorhinus canicula*), thornback ray (*Raja clavate*), spotted ray (*Raja montagui*), nursehound (*Scyliorhinus stellaris*), blonde ray (*Raja brachyura*), starry smoothhound (*Mustelus asterias*), common skate (*Dipturus intermedius*) (i.e. flapper skate), smoothhound (*Mustelus mustelus*), angel shark (*Squatina squatina*), and starry skate (*Raja stellulata*) within the Study Area. However, over the past five years, the landings data indicate that these elasmobranch species were inconsistently landed across all ICES statistical rectangles mentioned in Section 13.4.1, with very low numbers and, in some rectangles, none at all (MMO, 2023).

Spotted ray and tope shark have small areas of low intensity nursery grounds that overlap with the EICC, closer to the shore (Figure 13-4 and Figure 13-5). Thornback ray have a small area of low intensity grounds close to shore, near the north Angus coast, with a small overlap with the Study Area, and spurdog have low intensity spawning grounds throughout the whole Study Area, intersecting the Array Area and EICC. Thornback ray are oviparous and lay paired eggs on shallow sand, mud, pebble, or gravel seabed (Fishbase, 2024a). Therefore, it is anticipated that these elasmobranch species are present throughout the Study Area in very low abundances (Figure 13-6).

13.4.4.5.1 Basking shark

The basking shark is the largest fish species found in UK waters, with individuals reaching up to 10 metres (m) in length (Scottish Natural Heritage (SNH), 2014). Due to their large size, basking sharks are sometimes assessed alongside other large marine megafauna species (e.g. marine mammals). However, for the purpose of this EIAR, basking sharks are assessed within this Fish and Shellfish Ecology chapter.

Historic over-exploitation throughout the northeast Atlantic has resulted in a decline in the basking shark population, and this, combined with slow growth rate, late maturation and small litter sizes, results in very slow species recovery (Wilson *et al.*, 2020). This species is now listed as Endangered by the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (Rigby *et al.*, 2021) and is also a Scottish PMF (NatureScot, 2020a). Basking sharks are included in several key international conventions, such as Appendix II of the Berne Convention, Appendix I/II of the Convention on Migratory Species (Bonn Convention), and Annex V of the OSPAR Convention. In the UK, they are protected under Schedule 5 of the Wildlife and Countryside Act 1981 (as amended), the Nature Conservation (Scotland) Act 2004, and the Wildlife and Natural Environment (Scotland) Act 2011, which provides a mechanism for licensing potential offences (e.g. disturbance) within Scottish waters. They are also recognised in several conservation policy documents, including their designation as a Scottish PMF and their inclusion in the Scottish Biodiversity List (NatureScot, 2020b).

Basking sharks are filter-feeders with a global distribution (Doherty *et al.*, 2017). In the open ocean, they opportunistically forage for planktonic prey (Bloomfield and Solandt, 2008; Gore *et al.*, 2008). When not in deep-ocean waters, they target oceanic and tidal fronts, such as those in the English Channel and along the west coast of Scotland, which offer stable foraging opportunities (Sims *et al.*, 2000; Priede and Miller, 2008). Basking shark foraging activity increases in the summer months due to higher zooplankton abundance (Sims *et al.*, 2005). Elevated seasonal densities of basking sharks in these foraging hotspots lead to increased social activity during the summer, with groups engaging in courtship behaviour along thermal fronts (Sims *et al.*, 2000).

Basking sharks are commonly sighted in Scottish waters during the summer months and are more frequently observed on the west coast (Paxton *et al.*, 2014; Witt *et al.*, 2012). Basking sharks show strong site fidelity near the Hebrides on the west coast of Scotland and exhibit southerly migrations during winter and have been observed traveling as far as Madeira (Witt *et al.*, 2014; 2016). Austin *et al.* (2019) identified several key factors influencing basking shark habitat suitability, including chlorophyll concentration (a proxy for zooplankton abundance) and sea surface temperature, which are correlated with feeding and migratory patterns.

Marine Directorate's NMPi (2024) indicate basking shark incidental sightings and distribution in Scotland's seas and shows that there have been very few sightings of basking shark off the Aberdeen coast, and no sightings within the Study Area. The Whale Track sighting map (Hebridean Whale and Dolphin Trust, 2024) indicate that over the last ten years, there have been no sightings in the vicinity of the Project, even though in some years there are regular sightings in the Moray Firth. Other publicly-available data sets list occasional shore-based observations off the Aberdeenshire coast (Sea Watch Foundation, 2024). According to records listed in the National Biodiversity Network (NBN) Atlas, the most recent verified sighting of basking shark in Aberdeenshire occurred in 2012 just offshore and north of Peterhead (NBN Atlas, 2024).

Pikesley *et al.* (2024) analysed over 33 years of sightings data from the Basking Shark Watch dataset managed and operated by the Marine Conservation Society and Shark Trust. The review identified hotspots for basking shark surface sightings in western Scotland, the Isle of Man and southwest England, consistent with the sources described above. Sightings on the east coast of Scotland were low.

Based on the above information on patterns of distribution, basking shark are more likely to occur within the Study Area during the summer foraging season. Since the annual foraging season may also serve as a breeding season, the summer months are likely to be particularly sensitive for this species.

13.4.4.5.2 Common skate

The common skate species complex includes both flapper skate (*Dipturus intermedius*) and blue skate (*Dipturus flossada*). Flapper skate are distributed across the Northeast Atlantic Ocean, particularly around the British Isles, including the North Sea (McGeady *et al.*, 2022). Both species are categorised as Critically Endangered by the IUCN (Ellis *et al.*, 2024a; Ellis *et al.*, 2024b). There is a high concentration of flapper skate around the west coast of Scotland, with the Inner Sound of Skye being particularly notable for having a large, known flapper skate egg-laying site (Scottish Wildlife Trust, 2021). In contrast, blue skate have a more southerly distribution, although there is an overlap with the flapper skate geographical range (Delaval *et al.*, 2022). Considering the more southerly distribution of blue skate, the predominant species expected to be present within the Study Area is expected to be flapper skate. However, for simplicity, and in line with the terminology recommended by MD-LOT and NatureScot, the term 'common skate' has been used within this document.

A recent distribution model by McGeady *et al.* (2022) indicates that there is higher relative abundance of common skate located in the north-west of Scotland and low relative abundance in the North Sea. Figure 13-12 indicates that the relative probability of common skate occurring within the Study Area is very low. Consequently, it is considered that the Study Area is of negligible importance to common skate.

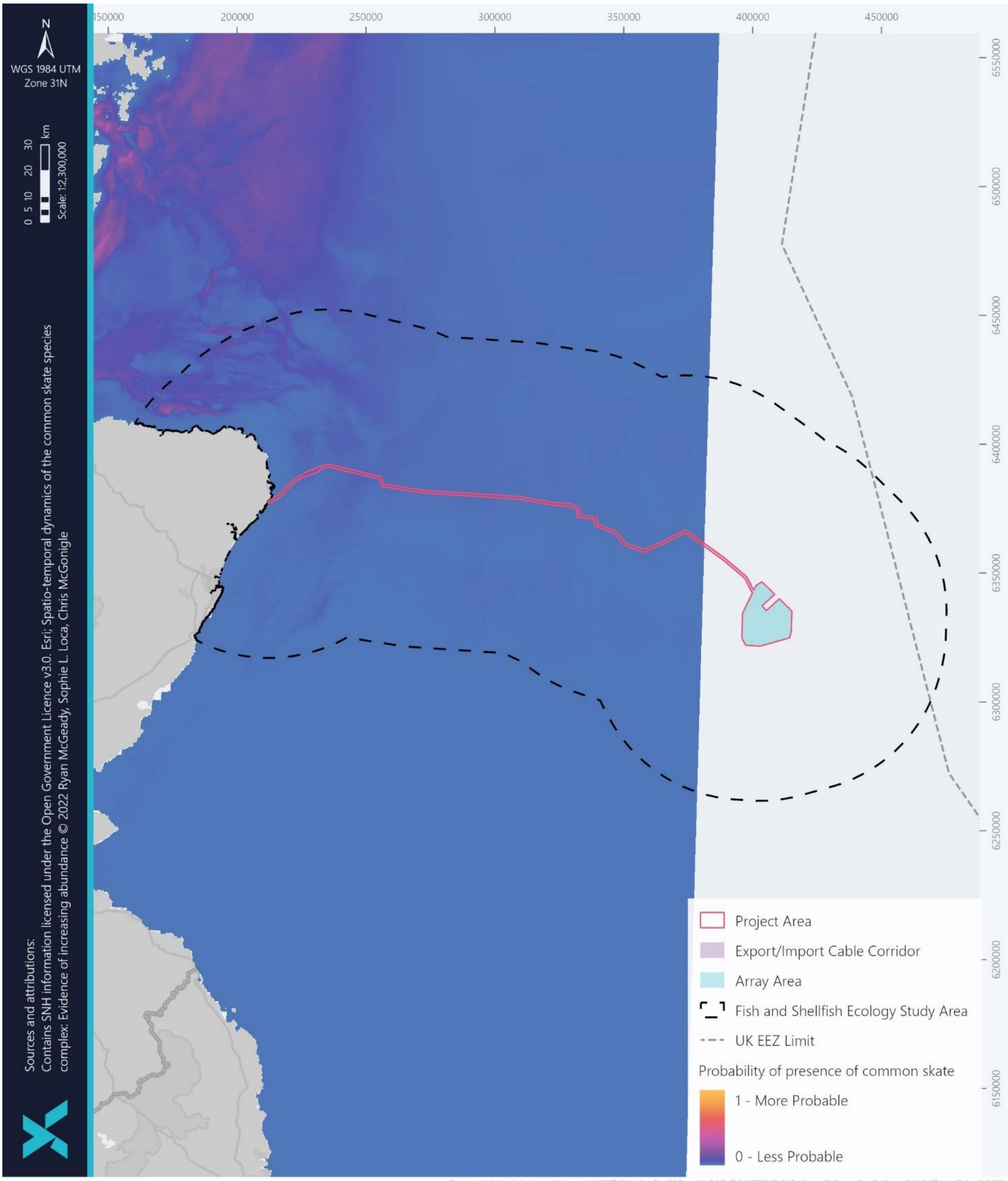

Figure 13-12 Probability of common skate presence (2018-2020) (McGeady et al., *2022) Note that the eastern section of the EICC and the Array Area are located outside the species distribution model domain for McGeady et al (2022)*

13.4.4.6 Diadromous fish

Diadromous fish migrate between freshwater and marine environments to fulfil their lifecycle. Diadromy takes several forms; this chapter focuses on anadromy, which characterises species migrations from marine waters to freshwater to spawn (e.g. salmonids and lamprey), and catadromy, in which a species migrates from freshwater to spawn in marine waters (e.g. European eel *Anguilla anguilla*).

13.4.4.6.1 Atlantic salmon

Atlantic salmon is an Annex II species under the Habitats Directive, is on the OSPAR List of Threatened and/or Declining Species and Habitats, and is a Scottish PMF species. In Scotland, the species is also of cultural, recreational and commercial importance. Atlantic salmon spawn in riverine environments, such as springs, streams, or rivers, and after the juveniles develop into parr at approximately 10 cm, the salmon then undergoes a transformation, called smoltification, which allows the species to survive in saline conditions. Once in the marine environment, juvenile Atlantic salmon are known as post-smolts.

The post-smolt migration occurs principally between April and June, where the salmon leave rivers and enter the sea, and spend either one (one sea-winter (1SW) or grilse) or multiple winters at sea (multi sea-winter (MSW)). Malcolm *et al*. (2015) used existing smolt migration data across a number of locations in Scotland to characterise the "sensitive window" for development where it would be expected that large densities of post-smolts would be migrating in the coastal zone. The sensitive window was identified by determining the start and end of migration as the days of year on which 25% and 75% of smolts had migrated, respectively. There was no geographical variation in the migration timings identified by Malcolm *et al*. (2015), although variation with elevation and year was identified. The sensitive window was defined as day 103 to 145 of the year (i.e. mid-April to late May). The majority of studies suggest that post-smolt migrations were most likely to occur during hours of darkness (e.g. McIlvenney *et al*., 2021). However, in a recent tracking study by Lilly *et al.* (2023), post-smolts were detected exiting the Irish Sea during all hours of the day, contradicting previous evidence.

Current tracking findings from Rodger *et al.* (2024) show that, overall, post-smolts from the rivers Solway, Clyde, Boyne, Bush, and Foyle, which enter the Irish Sea and Firth of Clyde, tended to migrate in a northerly direction, being detected passing through the North Channel at the northern end of the Irish Sea. Post-smolt tracking on the east coast of Scotland in the River Dee indicate that in their initial stage of migration, post-smolts travel in an easterly direction, and the interim results of epipelagic trawling conducted by Marine Directorate on the north and east coasts of Scotland also indicate that post-smolts are widely distributed across offshore areas, with higher Catch Per Unit Effort (CPUE) off the east Grampian coast and lower catch rates in the outer Moray Firth (Main, 2021; Newton, 2021; Newton, 2023, *personal communication*).

The Wick Smolt Tracking Project (Del Villar-Guerra *et al.*, 2016) analysed the movement of salmon post-smolts in relation to marine renewable energy developments in northern Scotland. The study applied acoustic tagging to track migration patterns, revealing that post-smolts from different tributaries migrated at varying times and speeds, with most moving at night to avoid predators. The findings indicate that local tidal flows significantly influence smolt movement, but the fish were able to move away from these currents within a tidal cycle. The report emphasizes the need for ongoing monitoring to understand the impacts of environmental changes and development on salmon populations. The West Coast Tracking Project (Atlantic Salmon Trust, 2022) indicates that post-smolts from the west coast of Scotland disperse widely to reach the continental shelf to then travel towards the northeast Atlantic feeding grounds in a west-to-east direction. More recent studies have also indicated that passive drifting is unlikely to be used for the entirety of the migration out to sea, and active directing swimming is likely to be utilised for at least part of the migration (Ounsley *et al*., 2020; McIlvenny *et al*., 2021).

Atlantic salmon return to their natal river as adults to spawn, which usually occurs from November to December, but in some areas, it can extend from October to February (NatureScot, 2024).

13.4.4.6.2 Anadromous brown trout (sea trout)

Sea trout (*Salmo trutta*) is a Scottish PMF species and is also of cultural, recreational and commercial importance in Scotland. Similar to Atlantic salmon, sea trout display outward marine migrations from freshwater and returning as adults after spending a period at sea (NatureScot, 2022), with smolts migrating to marine environments between April and June (Ferguson *et al.*, 2019).

Sea trout make the homeward migrations as adults, but there is variation in timing and duration of these migrations. 'Finnock' return to their native rivers in the same year as their seaward migration, usually in July and September. Whereas 'maidens' make the homeward migration after a duration of 12 months at sea (NatureScot, 2022). Typically, sea trout migrations are more coastal than Atlantic salmon. However, sea trout migratory routes of hundreds of kilometres have been observed around the east coast of Scotland (Malcolm *et al.*, 2010).

13.4.4.6.3 Lamprey species

Lamprey species are listed as Annex II species under the Habitats Directive, are a Scottish PMF species, and are also listed on the OSPAR threatened and/or declining habitats and species. Three species of lamprey occur within the UK, which include river lamprey, sea lamprey, and brook lamprey (*Lampetra planeri)*. Lamprey skeletons are not bony, but are formed of strong, flexible cartilage. Lamprey species are found in temperate waters in the northern and southern hemisphere (NatureScot, 2023a).

River and sea lamprey spawn in freshwater and display outward migrations to marine environments as juveniles, making the species diadromous. River lamprey are typically found in coastal and estuarine habitats with spawning occurring in the spring and autumn months and migration occurring from late Autumn (Maitland, 2003). Sea lamprey tend to migrate further offshore than river lamprey and return to freshwater rivers after around 18 to 24 months at sea to spawn in spring / early summer (NatureScot, 2023).

13.4.4.6.4 European eel

European eel are widely distributed in Europe and inhabit freshwater and estuarine habitats. According to IUCN Red List of Threatened Species, European eel is Critically Endangered and are also listed on the OSPAR List of Threatened and/or Declining Species and Habitats. The European eel is also listed as a Scottish PMF species.

European eel have four life stages:

1. Glass eel;
2. Elver;
3. Yellow eel; and
4. Silver eel.

European eel migrate to the Sargasso Sea, a region in the Atlantic Ocean, to spawn, where the eggs are assumed to drift along with the Gulf Stream eastward to Europe (NatureScot, 2023b). Whilst drifting, the eggs hatch into young larvae (referred to as 'leptocephalus') and metamorphose into the typical cylindrical eel shape (glass eel) on reaching the European continental shelf. Glass eel darken in colour on entering freshwater (known as elvers), where they migrate to freshwater and estuarine habitats. Yellow eel refers to the life stage when the eel is a fresh-water resident, where they can remain for more than 20 years on a diet of invertebrates and fish (NatureScot, 2023b). Once European eel are ready to reproduce, they become silver eel and migrate 5,000 to 10,000 km to the Sargasso Sea to spawn and die (Aarestrup *et al.*, 2009; Wright *et al.*, 2022).

The migratory patterns of eel in Scottish waters are not well known, however, a proportion of the total European eel population, at the glass eel and silver eel life stages, are likely to pass through Scottish coastal waters (Malcom *et al.*, 2010).

13.4.4.7 Freshwater pearl mussel

FWPM is listed as Endangered on the IUCN Red List, which can be found in rivers throughout the UK, with the majority of the population found in Scotland (Moorkens *et al*., 2024; NatureScot, 2023b). FWPM live on the beds of freshwater rivers with coarse sand or fine gravel so they can be buried partly of wholly. FWPM are reliant on salmonids (such as Atlantic salmon and sea trout) during the microscopic larval stage (or the glochidial stage) of the mussel's life cycle, when they attach to the gills of sea trout or Atlantic salmon as parasites, without causing harm to the fish (NatureScot, 2023b). Therefore, the Project only has potential to cause an impact to FWPM indirectly through the potential effects on Atlantic salmon and/or sea trout.

13.4.4.8 Fish and shellfish species of conservation importance

There are several species known to be present within the Study Area, which are protected under international and national conservation legislation or policy. These species are listed in Table 13-9 below.

Table 13-9 Summary of relevant fish and shellfish species identified as species of conservation concern

COMMON NAME	LATIN NAME	Habitats Directive Annex II and Annex IV Species	OSPAR List of Threatened and/ or Declining Species	Wildlife And Countryside Act 1981	UK Post-2010 Biodiversity Framework	IUCN Red List[7]*	Scottish PMF[8]*
Atlantic salmon	*Salmo salar*	✓	✓		✓	LC (-)	✓+
Sea trout	*Salmo trutta*				✓	LC (?)	✓+
Sea lamprey	*Petromyzon marinus*	✓	✓		✓	LC (↔)	✓+
River lamprey	*Lampetra fluviatilis*	✓			✓	LC (?)	
European eel	*Anguila anguila*		✓		✓	CR (↓)	✓+
Herring	*Clupea harengus*				✓	LC (↑)	
Mackerel	*Scomber scombrus*				✓	LC (↓)	
Haddock	*Melanogrammus aeglefinus*					VU (-)	
Cod	*Gadus morhua*		✓		✓	VU (-)	✓±
Whiting	*Merlangius merlangus*				✓	LC (?)	✓±

[7] *IUCN Red List defined as 'CR'= Critically Endangered, 'EN' = Endangered, 'VU' = Vulnerable, 'NT' = Near Threatened, 'DD' = Data Deficient, and 'LC' = Least Concern. Population trends are defined in brackets as '↑' = increasing, '↓' = decreasing, '↔' = stable, '-' = unspecified, '?' = unknown.*

[8] *✓- = Offshore waters; ✓+ = Territorial waters; and ✓± = Both*

COMMON NAME	LATIN NAME	Habitats Directive Annex II and Annex IV Species	OSPAR List of Threatened and/ or Declining Species	Wildlife And Countryside Act 1981	UK Post-2010 Biodiversity Framework	IUCN Red List[7*]	Scottish PMF[8*]
Plaice	*Pleuronectes platessa*				✓	LC (↑)	
Sandeel	Ammodytidae species				✓	LC (?)	✓[±]
Spotted ray	*Raja montagui*		✓			LC(↔)	
Thornback ray	*Raja clavata*		✓			LC (↓)	
Spurdog	*Squalus acanthias*		✓		✓	EN (↓)	✓[+]
Sprat	*Sprattus sprattus*					LC (?)	
Tope shark	*Galeorhinus galeus*				✓	CR (↓)	✓[+]
Common skate	*Dipturus flossada;* *Dipturus intermedius*		✓	✓	✓	CR (↓)	✓[±]
Basking shark	*Cetorhinus maximus*		✓[+]	✓[+]	✓[+]	EN (↓)	✓[+]
Freshwater pearl mussel	*Margaritifera margaritifera*	✓				EN (↓)	

13.4.4.9 Designated sites

The Project Area does not directly overlap with any sites designated for the protection of fish and shellfish species. However, the Study Area overlaps with two protected sites with fish and shellfish as designated features: Turbot Bank NCMPA and River Dee SAC. The Diadromous Fish Study Area also overlaps with a number of designated sites. The designated sites which are located within, or partially within, the Study Area and Diadromous Fish Study Area are included in Table 13-10 and Figure 13-13. The designated features of each site are listed in Table 13-10.

Please note, only designated sites which have designated features relevant to fish and shellfish species are listed in Table 13-10.

Table 13-10 Designated sites with fish and shellfish designated features that have potential connectivity with the Project

DESIGNATED SITE	DESIGNATED FEATURE(S)	DISTANCE TO PROJECT AREA (kilometre (km))
Designated sites with fish and shellfish receptors		
Turbot Bank NCMPA	• Sandeel.	5.9
River Dee SAC	• FWPM; and • Atlantic salmon.	36.8
River Spey SAC	• FWPM; • Sea lamprey; and • Atlantic salmon.	76.0
River South Esk SAC	• FWPM; and • Atlantic salmon.	92.9
River Tay SAC	• Sea lamprey; • Brook lamprey; • River lamprey; and • Atlantic salmon.	112.7
Berridale and Langwell Waters SAC	• Atlantic salmon.	129.8
River Tweed SAC	• Atlantic salmon; • Sea lamprey; • Brook lamprey; and • River lamprey.	180.9
River Teith SAC	• Atlantic salmon; • Sea lamprey; • Brook lamprey; and • River lamprey.	192.0

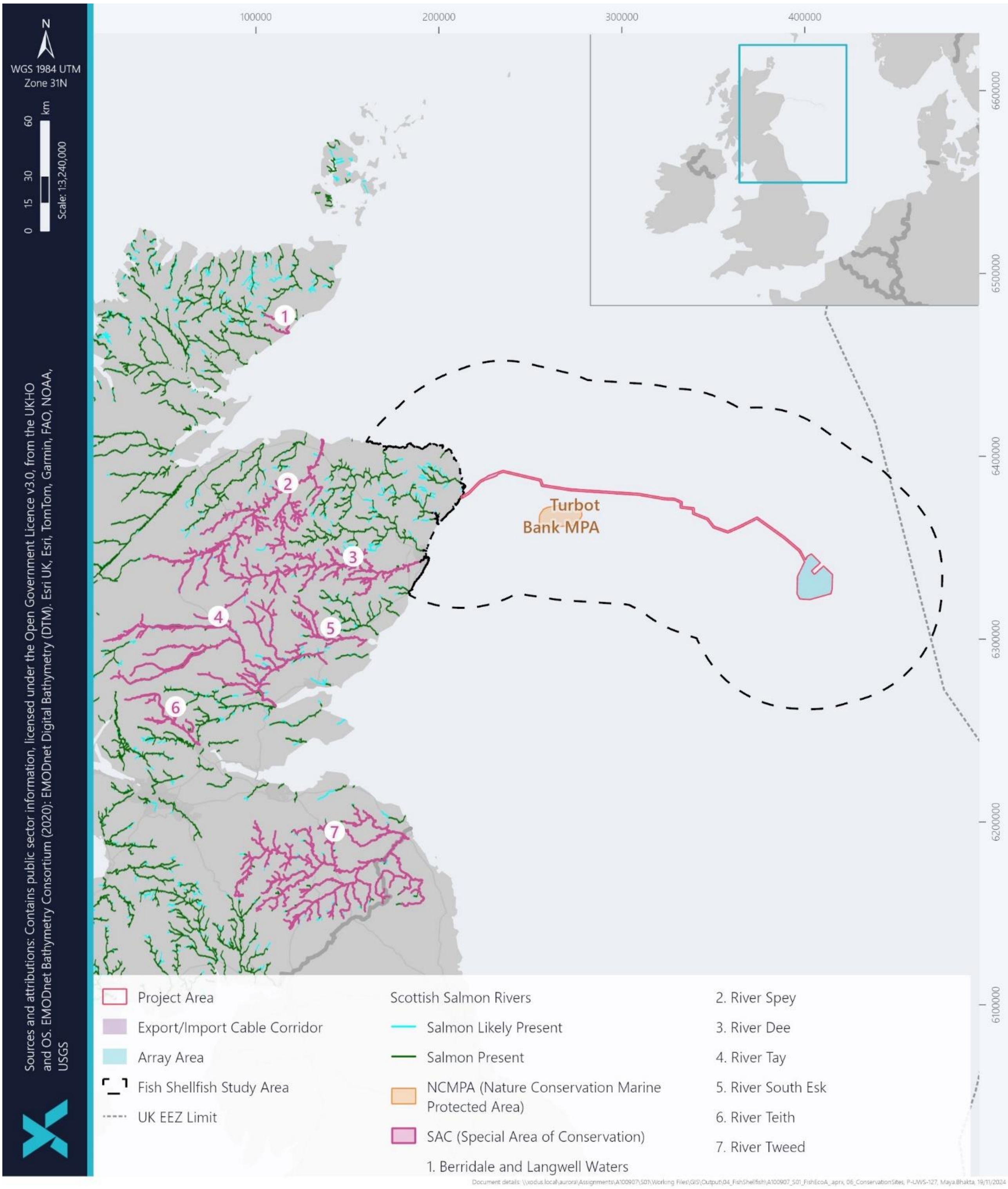

Figure 13-13 Designated sites with fish and shellfish qualifying features

13.4.5 Future baseline

The Fish and Shellfish Ecology baseline will continue to evolve over time as a result of various influences, including climate change, predator-prey interactions, and commercial fishing. Evidence of climate change and warming waters affecting fish and shellfish species distribution have already been observed, including northward shifts of population boundaries for a number of species (Perry *et al.*, 2005; Wright *et al.*, 2020). An example of this is the analysis of trawl survey data over a 45-year period, which has demonstrated that the number of warmer-water species has increased in the North Sea, Baltic Sea and Celtic Seas, whereas the number of colder-water species has decreased (EEA, 2022).

As a result of these shifts, declines in recruitment may result if these environments do not contain the specific habitat requirements of some species (e.g. sandeel spawning grounds). Additionally, a variance in the timing of fish spawning periods and algal blooms may have subsequent effects on recruitment success for species with fish larvae that prey upon plankton (Wright *et al.*, 2020). Other life history stages may also experience a shift (e.g. migratory timings), that are influenced by environmental cues such as temperature (BEIS, 2022; Wright *et al.*, 2020).

It is important to note that, due to natural variation, and uncertainties in long-term changes to the climate, there is limited confidence in linking observed alterations in fish and shellfish species communities definitively to climate change (Wright *et al.*, 2020). Predicting the impact of climate change on fish and shellfish species populations is extremely challenging, making it difficult to provide an accurate future baseline for the Fish and Shellfish Ecology baseline.

Modifications in fishing practices could also impact fish and shellfish species populations within the Study Area. Elasmobranchs, which exhibit slow growth rates and low fecundity, are especially vulnerable to overfishing. These fishing practices themselves may be driven by variation in stocks or by demand.

13.4.6 Summary and key issues

Table 13-11 Summary and key issues for Fish and Shellfish Ecology

SUMMARY AND KEY ISSUES	PROJECT AREA
	• The Study Area overlaps with the River Dee SAC (designated for freshwater pearl mussel and Atlantic salmon) and the Turbot Bank Nature Conservation Marine Protected Area (NCMPA) (designated for sandeel). • A number of species utilise the Study Area as a spawning or nursery ground, including species of commercial or conservation importance (e.g. PMF species) (e.g. mackerel, cod and haddock). • Site-specific survey PSA determined that sediments sampled along the EICC and within the Array Area were 'unsuitable' for herring spawning. • Similarly, PSA found the Project Area was 'unsuitable' for sandeel spawning at all but three locations, which were otherwise 'sub-prime (preferred)' or 'suitable (marginal)'. • Much of the Study Area is located within areas of muddy sediments which indicates preferred *Nephrops* habitat. • Haddock, herring and whiting were the marine finfish species which made up the majority of catch by weight across the Study Area. With regards to shellfish, *Nephrops*, king scallops and brown crabs dominate landings. • No basking shark have been sighted in the vicinity of the Project in the past 10 years. Generally, within Scottish waters they are more prevalent on the west coast and not within the North Sea. • Due to a lack of evidence on migratory pathways, there is potential for diadromous fish to migrate through the Study Area, including Atlantic salmon, sea trout, lamprey species and European eel.

13.4.7 Data gaps and uncertainties

A number of data gaps for Fish and Shellfish Ecology have been outlined in the two recently updated ScotMER evidence maps: fish and fisheries and diadromous fish (ScotMER, 2024a; ScotMER, 2024b). This includes:

- Electromagnetic Fields (EMF):
  - There is currently a lack of understanding on current levels of EMF emissions from in-situ cables and relevance of some literature describing effects and impacts;
  - There are no policies or regulations related to EMF;
  - Lack of understanding how pelagic and migratory species (e.g. sharks, fish) may react to dynamic cables (i.e. sections of cables suspended in the water column) (Copping *et al.*, 2020; Garavelli *et al.*, 2024); and
  - Sensitivity ranges for magnetic and electric field detection in general is better understood for some taxa, such as elasmobranchs, but less so compared to others, such as shellfish (Hutchison *et al.*, 2020).
- Diadromous fish migrations:

- Recent tagging studies, such as the West Coast Tracking Project[9] and the Wick Smolt Tracking Project[10], have been conducted on the east and west coasts of Scotland. The majority of studies have however been conducted in coastal environments, providing an indication of smolt behaviour / movement from freshwater to coastal environments. These studies provide an indication of the origins / destinations of adult migrating salmon at the coast. Despite these studies, there is still limited available information on sea trout, European eel, and sea lamprey migration. Tagging studies have been conducted in rivers in the east of Scotland (e.g. Main, 2021), and data is also available via Marine Directorate's epipelagic trawl surveys for post-smolts at sea, yet the migratory patterns of Atlantic salmon remain relatively unknown and research is ongoing (ScotMER, 2024b).
- Key uncertainties for diadromous fish also include:
  - Migratory routes for Atlantic salmon, sea trout, European eel, river lamprey and sea lamprey juveniles and adults;
  - Specific timing of migrations;
  - The abundance / proximity of migratory fish to the Project;
  - Salmon and sea trout post-smolt migratory behaviour (beyond the coastal environment) and migratory routes; and
  - River of origin of diadromous fish within the Study Area.

- The commercial landings data acquired from selected ICES statistical rectangles cannot provide an accurate representation of species composition, as the data is influenced by factors, such as the fishing methods used, seasonality, quotas, bycatch, and TAC limits.

13.5 Impact assessment methodology

13.5.1 Impacts requiring assessment

The impacts identified as requiring consideration for Fish and Shellfish Ecology are listed in Table 13-12. These impacts were scoped in for assessment within the EIA, as documented within the 2024 Scoping Report and incorporate feedback received in the Scoping Opinion based upon responses from consultees. Information on the nature of impact (i.e. direct or indirect) is also described.

Table 13-12 Impacts requiring assessment for Fish and Shellfish Ecology

POTENTIAL IMPACT	NATURE OF IMPACT
Construction and decommissioning	
Long-term impacts to the seabed and sensitive fish habitats (e.g. spawning and/or nursey habitats)	Direct

[9] *https://atlanticsalmontrust.org/our-work/west-coast-tracking-project/*
[10] *https://www.fcrt.org/wp-content/uploads/2021/04/Smolt-tracking-Report-FCRT-2016.pdf*

POTENTIAL IMPACT	NATURE OF IMPACT
Temporary impacts to the seabed and sensitive fish habitats (e.g. spawning and/or nursery habitats)	Direct
Underwater noise and vibration	Direct
Potential changes to Suspended Sediment Concentrations (SSC)	Direct
Basking shark collision with vessels	Direct
Operation and maintenance	
Temporary impacts to the seabed and sensitive fish habitats (e.g. spawning and/or nursery habitats)	Direct
Long-term impacts to the seabed and sensitive fish habitats (e.g. spawning and/or nursey habitats)	Direct
Underwater noise and vibration	Direct
Potential effects from EMF and heat generated by cables	Direct
Operational windfarm may act as a Fish Aggregation Device (FAD)	Direct
Secondary entanglement	Direct
Basking shark collision with vessels	Direct
Decommissioning	
In the absence of detailed information regarding decommissioning works, and unless otherwise stated, the impacts during decommissioning are considered analogous with, or likely less than, those of the construction phase.	

13.5.2 Impacts scoped out of the assessment

The impacts scoped out of the assessment during EIA scoping, and the justification for this, are listed in Table 13-13. Scoping was based on the information contained within the 2024 Scoping Report and incorporates feedback received in the Scoping Opinion, including consultee responses.

Table 13-13 Impacts scoped out for Fish and Shellfish Ecology

IMPACT SCOPED OUT	JUSTIFICATION
Construction	
Potential effect from EMF and heat generated by cables	Subsea cables emit localised EMF. EMF may interfere with navigation, feeding and predator or conspecific detection and/or may provoke an attraction, avoidance, stress, or alarm behaviour response in electro- or magneto-sensitive fish species (or their prey species). As EMF only poses a potential effect on fish and shellfish species when the subsea cable is in-situ, the impact pathway has been scoped out of the construction phase.
Operational windfarm may act as a FAD	Offshore windfarm floating infrastructure may act as FADs, increasing habitat complexity and positively influencing biodiversity by providing refuge and nursery grounds. Smaller species and juveniles may use FADs strictly for predator avoidance, while predatory species may be drawn to feed on aggregating prey items. Changing spatial distribution of prey may therefore influence the distribution of higher trophic predators such as piscivorous fish and sharks which may change interactions between prey species and predatory species. However, it is unlikely that this impact would affect fish and shellfish species during the construction phase due to the continuous construction activities within the Project Area, causing potential disturbance and displacement. Furthermore, as this is an ongoing effect, this is assessed for the operation and maintenance phase only.
Decommissioning	
Potential effect from EMF and heat generated by cables	During the decommissioning phase of the Project, impacts from EMF are generally not considered to affect fish and shellfish species. This is mainly due to the temporary nature of EMF exposure associated with subsea cables, which reduces once the cables are removed. The subsea cables may be removed during decommissioning or if they remain in-situ, they will not be in use. Therefore, will not continue to emit EMF and heat into the environment. For this reason, this impact pathway has been scoped out of the decommissioning phase of the Project.

IMPACT SCOPED OUT	JUSTIFICATION
All phases	
Accidental releases to the marine environment	Accidental releases to the marine environment will be limited to the chemical or hydrocarbon inventory on construction vessels. All vessels involved in the Project will be required to comply with best practice management. This includes the application of strict environmental controls through the implementation of the Environmental Management Plan (EMP), which will include a Marine Pollution Contingency Plan (MPCP), to be secured through Section 36 and Marine Licence conditions. These plans will detail procedures in the event of an accidental release, characterise all sources for potential contaminant releases and provide key emergency contact details for use in the event of a release. Measures detailed in the EMP and MPCP will be in accordance with OSPAR Convention and Marine Pollution (MARPOL) Convention guidelines for preventing pollution at sea. Individual vessels will also have a Ship Oil Pollution Emergency Plan (SOPEP) in place. For these reasons, the potential for accidental release of contaminants from vessels is extremely unlikely and any incidents would be responded to quickly, with strict controls to effectively minimise the scale and impact of any accidental release on the marine environment. As this embedded mitigation minimises the likelihood of a significant effect to negligible, accidental releases to the marine environment has been scoped out of the EIA as a potential impact pathway.
Subsea mooring systems may cause entanglement resulting in injury and/or mortality (pelagic; demersal; elasmobranchs; and migratory fish)	To date, there have been no recorded instances of fish entanglement from mooring systems of renewable devices, or for anchored Floating Production Storage and Offloading vessels in the oil and gas industry which have similar or more complex mooring systems compared to those proposed for the Project's Floating Turbine Units (FTUs). Given the number, size and physical characteristics of mooring lines associated with FTUs it is considered highly unlikely that any fish species with potential to occur in the Study Area would be of greater enough size to become directly entangled in the mooring lines or associated structures.

13.5.3 Assessment methodology

An assessment of potential impacts is provided separately for the construction, operation and maintenance and decommissioning phases.

The assessment for Fish and Shellfish Ecology is undertaken following the principles set out in EIAR Vol. 2, Chapter 7: EIA Methodology. The sensitivity of the receptor is combined with the magnitude to determine the impact significance. Topic-specific sensitivity and magnitude criteria are assigned based on professional judgement, as described in Table 13-14 and Table 13-15.

Table 13-14 Sensitivity criteria for Fish and Shellfish Ecology

SENSITIVITY OF RECEPTOR	DEFINITION
High	• Receptor with no capacity to accommodate a particular effect and no ability to recover or adapt (i.e. high vulnerability); and • Receptor of conservation value to an extent that is internationally or nationally important (e.g. species on the OSPAR List of Threatened and Declining Species and Habitats, IUCN Red List of Threatened Species ('Red List') (near threatened, vulnerable, endangered or critically endangered), PMF species, species listed on Annex II of the Habitats Directive and / or a qualifying interest of a SAC or NCMPA).
Medium	• Receptor with low capacity to accommodate a particular effect with low ability to recover or adapt (i.e. medium vulnerability); and/or • Receptor of conservation or commercial value to an extent that is regionally important.
Low	• Receptor has some tolerance to accommodate a particular effect or will be able to recover or adapt (i.e. low vulnerability); and/or • Receptor of conservation / commercial value to an extent that is locally important.
Negligible	• Receptor is generally tolerant and can accommodate a particular effect without the need to recover or adapt (i.e. not vulnerable); and/or • Receptor is widespread / common and is of low conservation / commercial value.

Table 13-15 Magnitude criteria for Fish and Shellfish Ecology

MAGNITUDE CRITERIA	DEFINITION
High	• Total change or major alteration to key elements / features of the baseline conditions; • Impact occurs over a large or spatial geographical extent and/or is long-term or permanent in nature; and/or • High frequency (occurring repeatedly or continuously for a long period of time) and/or at high intensity.
Medium	• Partial change or alteration to one or more key elements / features of the baseline conditions; • Impact occurs over a medium scale/spatial extent and/or has a medium-term duration; and/or • Medium to high frequency (occurring repeatedly or continuously for a moderate length of time) and/or at moderate intensity or occurring

MAGNITUDE CRITERIA	DEFINITION
	occasionally/intermittently for short periods of time but at a moderate to high intensity.
Low	• Minor shift away from the baseline conditions; • Impact occurs over a local to medium scale/spatial extent and/or has a short to medium-term duration; and/or • Impact is unlikely to occur or at a low frequency (occurring occasionally / intermittently for short periods of time at a low intensity).
Negligible	• Very slight change from baseline conditions; • Impact is highly localised and short-term with full rapid recovery expected to result in very slight or imperceptible changes to baseline conditions or receptor population; and/or • The impact is very unlikely to occur and if it does will occur at very low frequency or intensity.
No change	• No change from baseline conditions.

The consequence and significance of effect is then determined using the matrix provided in EIAR Vol. 2, Chapter 7: EIA Methodology.

13.5.4 Embedded mitigation

As described in EIAR Vol. 2, Chapter 7: EIA Methodology, certain measures (primary and tertiary mitigation) have been adopted as part of the Project development process to reduce the potential for impacts to the environment, as presented in Table 13-16. These measures have been accounted for in the assessment presented below. The requirement for additional mitigation measures (secondary mitigation) will be dependent on the significance of the effects on Fish and Shellfish Ecology receptors. The Management Plans listed below in Table 13-16 form elements of tertiary mitigation (i.e., measures that are implemented in accordance with industry standard practice or to meet legislative requirements and are independent of the EIA).

Table 13-16 Embedded mitigation measures relevant to Fish and Shellfish Ecology

CODE	MITIGATION MEASURE	TYPE	DESCRIPTION	SECURED BY
MM-002	Mooring and anchor design to ensure reduction of habitat loss and disturbance	Primary	FTU mooring designs considered for the project have excluded the catenary mooring which was identified as the design with the largest seabed footprint, therefore minimising footprint within the East of Gannet and Montrose Field NCMPA. Semi-taut and taut mooring designs options for semi-submersible substructure and tendon mooring designs for Tension Leg Platform (TLP) substructures have been retained as mooring design options for the Project because these design options produce the least disturbance and minimise potential for habitat loss. Additionally, anchor designs considered for the Project have excluded the drag embedment anchor, which was identified as the design with the greatest potential for seabed disturbance and habitat loss. Suction and driven pile anchor designs have been retained as anchor design options for the Project because they have the smallest footprint and minimise potential seabed disturbance during installation. Anchors will be installed through suction embedment or piling, rather than drilling, in order to minimise sediment disturbance. Novel anchor solutions with equivalent or similar seabed footprint have also been retained as options. Localised habitat loss during the installation phase is an unavoidable consequence of the Project. Best practices will be followed to ensure that potential habitat loss is reduced (e.g. micro-siting and reducing the benthic footprint of the Project), including during the operational phase (e.g. from mobile mooring chains on the seabed). The amount of rock armour, grout bags, and concrete mattresses used to protect the Export/Import Cable and the IACs will be kept to a minimum where possible, especially in the NCMPAs.	Commitment made within Project design. The final design will be detailed within the Construction Method Statement (CMS), required under Section 36 Consent and/or Marine Licence conditions.
MM-004	Micro-siting of FTUs and associated	Primary	Pre-construction cable route survey to confirm the condition of the seabed and that no significant changes have occurred from previous surveys, confirm the presence of	Final layout will be captured in the DSLP, required under

CODE	MITIGATION MEASURE	TYPE	DESCRIPTION	SECURED BY
	offshore infrastructure, including cable routes		morphological features and the requirement for micro-siting around these or completion of seabed preparation works. The final Array Area layout (including IACs) and Import/Export Cable Route will be presented within the Development Specification and Layout Plan (DSLP) and will include micro-siting of infrastructure to avoid sensitive habitats or features. Where possible, the Export/Import Cable Route will aim to avoid sensitive habitats and, where this is not practicable, the route will be designed to achieve the least impact to sensitive habitats or features.	Section 36 Consent and/or Marine Licence conditions.
MM-005	Target Depth of Lowering (DoL)	Primary	Static cables will be trenched and buried to a minimum depth of 0.4 m. Where this cannot be achieved, remedial cable protection will be applied. The cable burial target depth is informed by a Cable Burial Risk Assessment (CBRA) and implemented through the Cable Plan (CaP), which will be produced post-consent. EMF emissions associated with the cabling will be reduced by burial of between 90-100% of the cables at the depth between 0.4 – 1.5 m.	Final cable design will be informed by the CBRA and detailed within the CaP, required under Section 36 Consent and/or Marine Licence conditions.
MM-006	Environmental Management Plan (EMP)	Tertiary	The EMP will set out procedures to ensure all activities with the potential to affect the environment are appropriately managed and will include a description of planned activities and procedures, roles and responsibilities, pollution control and spillage response plans, incident reporting, chemical usage requirements, waste management plans, plant service procedures, communication and reporting structures, and programme of work. It will detail the final design selected and take into account Marine Licence conditions and commitments. The EMP will additionally include an Invasive Non Native Species (INNS) Management Plan (INNSMP) and a MPCP and will be developed in consultation with stakeholders.	The EMP, including the INNSMP and MPCP, will be required under Section 36 Consent and/or Marine Licence conditions. An outline EMP is provided as part of the Application EIAR Vol. 4 Appendix 32: Outline EMP.

CODE	MITIGATION MEASURE	TYPE	DESCRIPTION	SECURED BY
MM-007	CMS	Tertiary	A CMS will be developed to manage the construction process so as to avoid harm to construction personnel and third parties. The CMS will specify the Project's construction methods, setting out good practice construction measures and how agreed mitigation measures from the EIAR, associated documents, Section 36 Consent, Marine Licences and those stated within the EMP are implemented during construction.	The CMS will be required under Section 36 and/or Marine Licence conditions.
MM-008	Cable Plan (CaP)	Tertiary	The CaP will be provided post-consent and will detail the location / route and cable laying techniques of the IACs and Export/Import Cable and detail the methods for cable surveys during the operational life of the cables for the Project. This will be supported by survey results from the geotechnical, geophysical and benthic surveys. The CaP will also detail EMF of the cables deployed and methods to mitigate against any effects of EMF. A CBRA will also be undertaken and results included within the CaP which will detail cable specifications, cable installation, cable protection, target burial depths / depth of lowering and any hazards the cable will present during the lifespan of the cable. The CaP will also include methodologies of post construction and operational surveys and methodologies for cable inspection with measures to address and report any exposure of cables.	Final cable design will be informed by the CBRA and detailed within the CaP, required under Section 36 Consent and/or Marine Licence conditions.
MM-009	Decommissioning Programme	Tertiary	The development of, and adherence to, a Decommissioning Programme, approved by Scottish Ministers prior to construction and updated throughout the Project's operational life. This will be written in accordance with applicable guidance and will detail the required activities, programme and environmental management for decommissioning.	The Decommissioning Programme will be required under Section 105 of the Energy Act 2004 (as amended) and a condition of the Section 36 Consent.
MM-010	Marine Pollution Contingency Plan (MPCP)	Tertiary	Accidental releases to the marine environment will apply strict environmental controls through the implementation of the EMP, which will include a MPCP. These plans will detail procedures in the event of an accidental release, characterise all sources for potential contaminant releases and provide key emergency contact details for use in the event of a release. Measures detailed	The MPCP will be required under Section 36 Consent and/or Marine Licence

CODE	MITIGATION MEASURE	TYPE	DESCRIPTION	SECURED BY
			in the EMP and MPCP will be in accordance with Oslo-Paris Convention (OSPAR) and Marine Pollution (MARPOL) Convention guidelines for preventing pollution at sea. Individual vessels will also have a SOPEP in place. For these reasons, the potential for accidental release of contaminants is extremely unlikely and any incidents would be responded to quickly, with strict controls to effectively minimise the scale and impact of any accidental release on the marine environment.	conditions as part of the EMP. An outline EMP is provided as part of the Application EIAR Vol. 4, Appendix 32: Outline EMP.
MM-018	Unexploded Ordnance (UXO) clearance approach.	Primary	In the event that a UXO is identified within the Project construction area, a hierarchy of mitigation will be applied: 1. Micro-siting/micro-rerouteing will be used to avoid UXO in the first instance. 2. Where micro- siting/micro-rerouting is not possible, the UXO will be moved to a safe location out with the corridor or working area; 3. In cases where UXO cannot be avoided or pose a safety concern, Low Order clearance methods, such as deflagration will be applied. 4. In cases where UXO cannot be avoided or pose a safety concern and Low Order clearance methods have not been successful, High Order (i.e. detonation) may be required. However, this method will only be used where absolutely necessary, in agreement with Scottish Ministers.	Any clearance activity will be subject to a separate Marine Licence and European Protected Species (EPS) Licence, which will be accompanied by supporting environmental information.
MM-019	Piling Strategy (PS) (if impact piling is required)	Tertiary	If impact piling is selected as the optimal installation mechanism for the FTUs/OSCPs, a PS will be produced for the Project and implemented in line with relevant guidance. The strategy will provide details on the piling activities and parameters, expected noise levels, duration of activities and any required mitigations associated with this installation technique. The PS will delineate the requirement for and nature of noise mitigation measures to be implemented (documented in the Marine Mammal Mitigation Protocol (MMMP), see below) during piling activities (including soft-start and ramp-up procedures).	The PS will be required under Section 36 Consent and/or Marine Licence conditions, An outline MMMP is provided as part of the Application EIAR Vol. 4 Appendix 33: Outline MMMP.

CODE	MITIGATION MEASURE	TYPE	DESCRIPTION	SECURED BY
MM-022	Removal of debris from floating lines and cables to minimise potential for secondary entanglement.	Primary	Mooring lines and dynamic IACs will be inspected with a risk-based frequency using a Service Operations Vessel (SOV) which may be equipped with Remotely Operated Vehicles (ROV) used for subsea inspections. Over the operational life-cycle of the Project, inspections will be completed, starting at a higher frequency and likely declining after a number of years, based on evidence gathered during inspections. Any observed / detected debris on the floating lines and cables will be recovered based on a risk assessment which considers impact on environment, risk to asset integrity, risk to personnel and equipment, and cost of intervention.	This measure will be secured through production and approval of an EMP and OMP required under Section 36 Consent and/or Marine Licence conditions.

13.5.5 Worst-case scenario

As detailed in EIAR Vol. 2, Chapter 7: EIA Methodology, this assessment considers the worst-case scenario for the Project parameters which are predicted to result in the greatest environmental impact, known as the 'realistic worst-case scenario'. The worst-case scenario represents, for any given receptor and potential impact, the scenario that would result in the greatest potential for change.

Given that the worst-case scenario is based on the design option (or combination of options) that represents the greatest potential for change, confidence can be held that development of any alternative options within the design parameters will give rise to no worse effects than assessed in this impact assessment. Table 13-17 presents the worst-case scenario for potential impacts on Fish and Shellfish Ecology during construction, operation and maintenance and decommissioning.

Table 13-17 Worst-case scenario specific to Fish and Shellfish Ecology impact assessment

POTENTIAL IMPACT	WORST-CASE SCENARIO	JUSTIFICATION
Construction		
Temporary impacts to the seabed and sensitive fish habitats (e.g. spawning and/or nursery habitats)	Up to 10.63 km^2 of temporary impacts to the seabed and sensitive fish habitats associated with: • Disturbance over 10.25 km^2 from cable installation across the 510 km of IACs and the Export/Import Cable associated with: – Maximum width of seabed disturbance for IACs and Export/Import Cable installation tool of 20 m (5.6 km^2 for IACs and 4.6 km^2 for Export / Import Cable); – Seabed preparations (Pre-Lay Grapnel Run (PLGR) and boulder clearance) across the Project Area, including: ▪ PLGR across the entire length of all cables (230 km for Export/Import Cable and 280 km of IACs on the seabed) at a maximum disturbance width of 0.01 km; ▪ Boulder clearance disturbance width of 20 m along 59.9 km of the Export/Import Cable and the entire length of the IACs on the seabed (280 km). • Temporary mattresses for IACs pre-lay: – Disturbance over 0.054 km^2 for the installation of up to 3,000 temporary mattresses for cable pre-lay (18 m^2 seabed footprint per mattress, up to 60 mattresses per cable installation for up to 50 IACs). • Mooring line pre-lay (worst-case area): 3,960 m of mooring line per FTU of 1 m disturbance width totalling 376,200 m^2; • Unexploded Ordnance (UXO) detonation:	These areas represent the largest spatial area and duration of temporary impacts to the seabed and sensitive fish habitats during construction. The maximum area of temporary impacts associated with cable installation has been calculated based on the 0.02 km width of cable installation, 510 km total length of IACs and Export/Import Cable (where the PLGR will be used), deployment of 3,000 temporary mattresses for cable pre-lay and the deployment of 10 temporary mattresses for the HDD exit point. Any seabed disturbance associated with the boulder clearance (20 m width) and PLGR (10 m width) would be located within the areas where cable installation occurs. The seabed disturbance associated with the pre-lay of mooring lines will be located within the swept area of seabed disturbance (1.44 km^2) associated with the mooring lines once the Project is operational. Therefore, the temporary disturbance resulting from the pre-lay of mooring lines is not included within

POTENTIAL IMPACT	WORST-CASE SCENARIO	JUSTIFICATION
	– Clearance of up to 51 UXO's within the Project Area, with 50 cleared by Low Order Deflagration (LOD) with a donor charge of 0.08 kg and one High Order Detonation (HOD), with a charge weight of 227 kg and 5 kg donor charge; and – Up to 706 m^2 temporary seabed disturbance (assuming a crater with 30 m diameter) due to one detonation. • Landfall Horizontal Directional Drilling (HDD) one exit point with three boreholes in a water depth of approximately 26.5 m below MHWS: – Up to 0.0005 km^2 of temporary mattresses to be positioned in the exit point (assuming 10 mattresses, 50 m^2 seabed footprint for each mattress).	the overall footprint of temporary disturbance for construction. It is expected that, where possible, all UXO clearance will be undertaken using LOD methods, such as deflagration, and all efforts will be made to avoid HOD where possible. It has been assumed that all vessels will use Dynamic Positioning. It has been assumed that the Export/Import Cable and IACs will be trenched and buried along the majority of their length and will therefore incur a temporary disturbance. Sections of these cables that are proposed to be protected with rock material are considered under long-term impacts. 26.5 m water depth below MHWS of HDD exit point is assumed worst-case in the event as that will have the highest potential to affect inshore benthic habitats.
Underwater noise and vibration	• UXO detonation: – Clearance of up to 51 UXO's within the Project Area, with 50 cleared by LOD with a donor charge of 0.08 kg and one HOD, with a charge weight of 227 kg and 5 kg donor charge; • FTU anchor piling: – Up to nine piles per FTU (855 piles in 15 MW Tension Leg Platform; TLP scenario);	These parameters represent the maximum duration and number of piles which will be installed as part of the Project. Further piling parameters are defined in Vol. 4, Appendix 15: Underwater Noise Modelling Report.

POTENTIAL IMPACT	WORST-CASE SCENARIO	JUSTIFICATION
	– Maximum 4.5 m diameter pile, maximum 57 m pile penetration depth; – Maximum strike rate of 30 strikes per minute; – Maximum hammer energy of 2,500 kJ; – Maximum of three piles installed over 24 hours; and – Maximum of 285 days (average of 95 days of piling per year), over three years. • OSCPs piling: – Up to 12 piles per OSCP (up to 24 piles in total); – Maximum 3.05 m diameter pile, maximum 57 m pile penetration depth; – Maximum strike rate of 30 strikes per minute; – Maximum hammer energy of 4,400 kJ; – Maximum of 12 piles installed over 24 hours (average of 4); and – Maximum of 14 days duration as 7 days per OSCP foundation, completed in separate years.	
Potential changes to suspended sediment concentrations	Within the Array Area: • For up to 95 FTUs, construction of: – Moorings for semi-submersible only as this would interact with the seabed: ▪ Up to six per FTU, with a maximum semi-taut mooring length of 4,541 m per FTU; ▪ Mooring line pre-lay (worst-case area): 3,960 m of mooring line per FTU of 1 m disturbance width totalling 376,200 m^2; ▪ Mooring installation to take one-week per FTU. – Suction or driven pile anchors for semi-submersible and TLP: ▪ For semi-submersible, a total of six anchors per FTU, with a maximum seabed footprint of 198 m^2 per FTU and 15,840 m^2 for Array Area; and ▪ For TLP, a total of three clusters of piles, up to nine piles, with a maximum seabed footprint of 297 m^2 per FTU and 28,215 m^2 for Array Area.	This covers the largest spatial area of impact associated with seabed preparation activities, OSCP, and cable installation activities. Which in turn has the greatest potential to result in increases in SSC. The worst-case scenario with regards to this impact is presented in full in EIAR Vol. 3, Chapter 8: Marine Geology, Oceanography and Coastal Processes.

POTENTIAL IMPACT	WORST-CASE SCENARIO	JUSTIFICATION
	• For OSCPs, construction of: – Up to two OSCPs, with a seabed footprint per jacket foundation of 1,209 m^2, total seabed footprint of 2,418 m^2. • For IACs, construction of: – Up to 120 IACs with a total length of 280 km (on the seabed). Maximum trench width of 2 m and maximum trench depth of 1.8 m. Installation via jet trenching, mechanical trenching and/or ploughing; and – Maximum width of seabed disturbance for IACs installation tool of 20 m corridor: any disturbance from boulder clearance (grab and plough) and Pre-Lay Grapnel Run (PLGR) within this corridor. Total seabed disturbance area of 5.6 km^2 (20 m width x 280 km length) although little to no disturbance volume is anticipated associated with this width and only through the trenching process. Within the EICC: • For Export/Import Cable, construction of: – A bundle of two High Voltage Directional Current (HVDC) cables and one fibre-optic cable in a single trench with a total route length of 230 km; – Maximum trench width of up to 2 m and trench depth of 1.8 m, based on a minimum Depth of Burial (DoB) of 0.4m and a maximum DoL of 1.5 m. Exception is within 12 NM where maximum trench width of up to 3 m for pre-lay trenching via a plough. Installation via ploughing, trenching or jetting and assumes: ▪ 100% cable buried within the East of Gannet and Montrose Fields NCMPA (except for cable/pipeline crossings) ▪ 95% cable buried between 12 NM and the East of Gannet and Montrose Fields NCMPA NCMPA (except for cable/pipeline crossings); and – Associated with the Export/Import Cable installation is a maximum 20 m corridor width of seabed disturbance from the installation tool, with any disturbance from PLGR and boulder clearance (grab and plough) within this corridor. Total seabed	

POTENTIAL IMPACT	WORST-CASE SCENARIO	JUSTIFICATION
	disturbance area of 4.6 km^2, although little to no disturbance volume is anticipated associated with this width and only through the trenching process. • For landfall – Maximum of one exit point with three boreholes, with a total maximum of 3,000 m^3 in fluid losses which will contain 18 m^3 in solid losses (most likely bentonite) to the sea at the HDD pop-out. The three boreholes will be drilled individually, not concurrently, and therefore there will be a maximum of 1,000m^3 of fluid loss (containing 6m3 of drilling solids) discharged at any one time.	
Basking shark collision with vessels	• A maximum offshore construction period of six calendar years; and • Up to 22 vessels operating simultaneously during construction, making a total of 319 transits per year (across the six year construction period).	These parameters represent the expected maximum worst-case scenario with regards to vessel movement during construction.
Operation and maintenance		
Temporary impacts to the seabed and sensitive fish habitats (e.g. spawning and/or nursery habitats)	The temporary impact during operation and maintenance will be less than construction as the footprint for all seabed preparatory work and infrastructure installation is captured under construction. Operation and maintenance activities will include: • Routine inspections of FTUs, OSCPs, foundations and cables; • Up to two major component exchanges per FTU involving a tow back to shore (i.e. up to 190 operations); • Up to three major component exchanges per FTU conducted in-situ; • Re-tensioning of each mooring line twice over the operational lifetime with up to 10% of mooring lines requiring replacement; • Up to 10% of IACs requiring repair (e.g. deburial and reburial) and up to 10% of IACs requiring replacement; and	See justification for construction phase.

POTENTIAL IMPACT	WORST-CASE SCENARIO	JUSTIFICATION
	• Up to four Export / Import Cable repairs. The worst-case scenario has been assessed as the same impact as construction as the footprint of operation and maintenance activities has not been quantified.	
Long-term impacts to the seabed and sensitive fish habitats (e.g. spawning and/or nursery habitats)	Up to 1.90 km^2 of long-term impacts to the seabed and sensitive fish habitats associated with: • Mooring chains within the Array Area: – The maximum excursion of the FTU within an allowable radius results in a maximum swept area of seabed disturbance of 1.44 km^2 for 95 FTU each with 6 mooring lines. This area includes the mooring chain seabed footprint i.e. per FTU, a maximum proportion of 34% of the 3,960 m semi-taut mooring chain on the seabed. • OSCPs: – Up to two OSCPs with foundations of 0.0024 km^2 (incorporates footprint of mudmats and piles); • Piles for FTUs: – Up to 0.0282 km^2 for 95 FTU (nine piles per FTU, 33 m^2 seabed footprint per pile). • Anchors for tethering dynamic sections of IACs: – Up to 0.0023 km^2 (190 anchors, 12 m^2 per anchor). • Hubs: – Up to 0.0017 km^2 (19 hubs, 90 m^2 per hub). • IACs protection: – Up to 0.0325 km^2 for IACs protection, including: ▪ Up to 0.0154 km^2 for IACs protection at the OSCP base (22 cables, 0.1 km length of each cable, 7 m width of cable protection);	This represents the largest spatial area and duration of long-term impacts to the seabed during operation and maintenance. Conservative assumptions have been made to estimate the cable protection requirements for the Project, as detailed in EIAR Vol. 2, Chapter 5: Project Description. This area differs from temporary impacts to the seabed and benthic habitats as it only considered areas where habitats and species will be impacted in the long-term through the installation of infrastructure.

POTENTIAL IMPACT	WORST-CASE SCENARIO	JUSTIFICATION
	▪ Up to 0.0171 km^2 of mattresses for IACs protection at the touchdown points (5 mattresses at each touchdown point, 18 m^2 seabed footprint of each mattress, 190 touchdown points). • Export/Import Cable protection: – Up to 0.1679 km^2 for Export/Import Cable protection; • Cable/pipeline crossings: – Up to 0.2177 km^2 for protection for up to 20 cable/pipeline crossings with the EICC and eight within the Array Area; and • Operational life of 35 years.	
Underwater noise and vibration	• Low level continuous noise generated by gearbox; • Maximum of up to 95 floating FTUs; – 570 mooring lines, with a total length of 376,200 m; and • Operational life of 35 years.	These parameters represent the expected maximum worst-case scenario with regards to generation of underwater noise during operation and maintenance, which is limited to low level continuous noise generated by WTG gearbox mechanics and impulsive transient noises generated by mooring line movement.
Potential effects from EMF and heat generated by cables	• IACs: – Cable voltage up to 132 kV; – Up to 350 km of cables in total: ▪ Of which, 280 km are static, and 70 km are dynamic (have no contact with the seabed); ▪ Burial is the preferred protection method; ▪ Up to 0.0154 km^2 for IACs protection at the OSCPs base (22 cables, 0.1 km length of each cable); – Maximum target burial depth of 1.5 m;	The maximum length of IACs and the Export/Import Cable will result in the greatest potential for EMF/thermal effects. The minimum target burial depth represents the worst-case scenario as EMF/heat exposure will be minimised by increased burial depths. EMF strengths are reported in EIAR Vol. 2, Chapter 5: Project Description, EIAR Vol. 4, A14A: EMF

POTENTIAL IMPACT	WORST-CASE SCENARIO	JUSTIFICATION
	– Minimum target burial depth of 0.4 m; • Export/Import Cable: – Cable voltage up to 525 kV; – Cable route of up to 230 km length: ▪ Of which, 26.35 km will require cable protection within 12 NM out to a width of 7 m and height of 1 m (166,850 m^2); ▪ Of which 95% buried between 12 NM and East of Gannet and Montrose Fields NCMPA (except for cable/pipeline crossings); ▪ Of which 100% buried within East of Gannet and Montrose Fields NCMPA (except for cable/pipeline crossings); ▪ 0.0007 km at OSCPs bases at a height of 1 m (700 m^2); – Maximum target burial depth of 1.5 m; – Minimum target burial depth of 0.4 m; • Up to 20 crossings of the EICC associated with 181,260 m^2 of protection at a maximum height of 3.5 m; • Up to eight crossings within the Array Area associated with 36,480 m^2 of protection at a maximum height of 2.25 m; and • Operational life of 35 years.	Assessment Report Vol.1, and EIAR Vol. 4, A14B: EMF Assessment Report Vol.2
Operational windfarm may act as a FAD	The worst-case scenario here is the same as defined for long-term impacts to the seabed and sensitive fish habitats (e.g. spawning and/or nursery habitats), with the following addition: • Maximum of 95 FTUs; – Footprint per FTU at the surface of up 5,600 m^2, total surface footprint of 532,000 m^2; – 570 mooring lines, with a total length of 376,200 m; • Up to two OSCPs, each will occupy a spatial footprint of 3,000 m^2;	Subsea infrastructure from offshore wind farms can act as FADs. The area occupied by infrastructure both on the seabed and in the water column may have this effect therefore the primary parameters for defining this impact are based on the surface area of the Project infrastructure.

POTENTIAL IMPACT	WORST-CASE SCENARIO	JUSTIFICATION
	• Up to 70 km of dynamic cabling for IACs; and • Operational life of 35 years.	

Secondary entanglement	• Maximum of 95 FTUs;
	  – Footprint per FTU at the surface of up 5,600 m^2, total surface footprint of 532,000 m^2;
	  – 570 mooring lines, with a total length of 376,200 m;
	• Up to 70 km of dynamic IACs; and
	• Operational life of 35 years.
		Secondary entanglement relates to the potential entanglement of marine life in debris, such as fishing gear, that has been snagged on a mooring line or IACs. The relative probability of entanglement will be dependent the number of mooring lines and number / length of dynamic cabling for IACs within the water column. There are a number of contributing variables which cannot be quantified, predominantly the prevalence of debris within the Project Area, which then snags on Project infrastructure. Quantification of this risk is not possible; therefore, this assessment is largely qualitative in nature.
		
		Please note, the mooring lines themselves do not represent a direct entanglement hazard – this impact has been scoped out of further assessment (per Section 13.5.2).

Basking shark collision with vessels	• Operational life of 35 years; and • Up to 10 vessels operating simultaneously during operation and maintenance phase; and • Temporary statutory 500 m safety zones around heavy maintenance vessels and while Restricted in Ability to Manoeuvre is engaged and 50 m advisory clearance	These parameters represent the expected maximum worst-case scenario with regards to vessel movement during operation and maintenance.

POTENTIAL IMPACT	WORST-CASE SCENARIO	JUSTIFICATION
	distances from all other maintenance vessels during operations within the marine environment	
Decommissioning		
In the absence of detailed information regarding decommissioning works, the implications for Fish and Shellfish Ecology are considered analogous to or likely less than those of the construction phase. Therefore, the worst-case parameters defined for the construction phase also apply to decommissioning. The decommissioning approach is set out in EIAR, Vol. 2, Chapter 5: Project Description.		

13.6 Assessment of potential effects

This section assesses the effects of the Project on Fish and Shellfish Ecology through the potential impact pathways listed in Table 13-12. Where the nature of the impact and sensitivity of receptor does not differ between fish and shellfish species, a grouped assessment is provided, informed by expert judgement with consideration of the source-pathway-effect model.

Please note, per Table 13-12, long-term impacts to the seabed and sensitive fish habitats (e.g. spawning and/or nursey habitats) are scoped in for assessment under the construction phase. While this impact is scoped in for all Project phases, to avoid duplication of text/assessment for one pathway, this impact is assessed in the operation and maintenance phase only, as this is the Project phase where this impact has the greatest potential magnitude (longevity) (Section 13.6.2.2). Therefore, the assessment in Section 13.6.2.2 represents the worst-case.

Similarly, basking shark collision with vessels may occur during both the construction and operation and maintenance phases of the Project. However, collisions (though rare) are more likely to occur during instances of increased vessel presence. In relative terms, vessels will be infrequently present during the operational and maintenance phase of the Project, compared to the increased number of vessels associated with the construction phase. Therefore, though this impact is scoped in for all Project phases, to avoid duplication of text/assessment for one pathway, basking shark collision with vessels is assessed in the construction phase only (Section 13.6.1.4). The assessment in Section 13.6.1.4 represents the worst-case.

In addition, Table 13-12 indicates the windfarm acting as a FAD has been scoped in for assessment under the decommissioning phase. The final Decommissioning Programme will outline the proposed activities with regards to decommissioning of Project infrastructure. The operational windfarm as an FAD has been assessed in Section 13.6.2.5, under the operation and maintenance phase. To avoid duplication of text/assessment for one pathway, and due to the uncertainty surrounding activities at the time of decommissioning, this impact is assessed in the operation and maintenance phase only. It is anticipated that any subsequent FAD effects during decommissioning will be reduced compared to effects during the assessed operation and maintenance phase. Therefore, the assessment in Section 13.6.2.5 represents the worst-case.

13.6.1 Potential effects during construction

13.6.1.1 Temporary impacts to the seabed and sensitive fish habitats (e.g. spawning and/or nursery habitats)

There is potential for temporary habitat loss or disturbance to occur during the construction phase of the Project, due to site preparation, the placement of anchors, installation of mooring lines (including pre-lay), and installation of the Export/Import Cable and IACs. While non-spawning adult finfish may be affected by the construction activities, they are highly mobile and able to avoid the area for the limited duration of activity and thus any effects on non-spawning adult fish will be inconsequential. Instead, seabed disturbance could result in loss of deposited eggs or larvae and spawning habitat, displacement of fish that live in the sediment (e.g. sandeel) as well as loss of shellfish on (e.g. king scallop) or buried in (e.g. *Nephrops*) the seabed.

As detailed in Table 13-17, the area that will be temporarily disturbed during the installation of IACs (inclusive of temporary mattress placement) is 5.65 km^2. A further 4.6 km^2 will be disturbed due to installation of the Export/Import Cable and an area of 0.0005 km^2 will be disturbed by temporary mattress placement at the HDD point of exit. Additionally, up to 0.37 km^2 may be disturbed from the temporary pre-lay of mooring lines.

As described in Section 13.4.4.2, the Study Area may overlap spawning areas for cod, herring, lemon sole, mackerel, *Nephrops*, Norway pout, plaice, sandeel, sprat and whiting, and may provide nursery grounds for anglerfish, herring, mackerel, sandeel, haddock, cod, lemon sole, sandeel, European hake (*Merluccius merluccius*), *Nephrops*, blue whiting, Norway pout, saithe, hake, ling, common skate, spurdog, sprat, spotted ray, tope shark, and whiting (Table 13-4). Specifically, herring are seabed dependent during spawning and egg maturation and are an important commercially exploited species. Sandeel are also demersal spawners which rely on sandy sediment for spawning (Wright and Bailey, 1996).

Spawning grounds are considered to be more sensitive than nursery grounds: while larvae and eggs are not motile, whereas motile juvenile fish are able to move away from disturbance. As herring and sandeel are demersal (rather than pelagic) spawners, they are considered separately below.

13.6.1.1.1 Herring

Herring spawn on the seabed, and it has been noted that their eggs are sensitive to substratum loss (Faber *et al.*, 2007). According to Coull *et al.* (1998) and Ellis *et al.* (2012), the Study Area overlaps with herring spawning grounds along the EICC and mostly with 'low' intensity nursery areas (a small overlap with high intensity nursery grounds occurs near the landfall) (Figure 13-3 and Figure 13-5). The PSA results from the EBS reports (EIAR Vol. 4, Appendix 10: Environmental Baseline and Habitat Assessment Report – Inshore EICC, EIAR Vol. 4, Appendix 11: Environmental Baseline Report – OWF, EIAR Vol. 4, Appendix 12: Environmental Baseline Report – EICC) conducted across the EICC and Array Area contributed to the determination of habitat suitability for herring spawning. As discussed in Section 13.4.4.2.1, all the sediment samples were considered to be 'unsuitable' for herring spawning. For this reason, it is anticipated that herring larvae and eggs are expected to be scarce at the Project Area, and effects of temporary disturbance of the seabed will be minimal.

Furthermore, unlike sandeel, herring are only dependent on the seabed during the spawning, egg development and early larval phases of their lifecycle. As adults, herring are comparatively more mobile than sandeel and thus are able to avoid direct disturbance impacts. As a PMF species, herring are considered to be a nationally important receptor and of a high value as a prey species. However, they are considered to have a medium vulnerability to habitat loss and disturbance. Therefore, they are considered to be of medium sensitivity to temporary impacts to the seabed.

Furthermore, based on the sediments present, the Project Area does not intersect with areas that are key for herring spawning, and no long-term impact on the functioning of spawning herring populations would be anticipated. The impact is assessed as being highly localised and of a short duration, reversible, and of a low frequency (intermittent over construction), and therefore is defined as being of negligible magnitude.

Evaluation of significance

Taking the medium sensitivity and negligible magnitude of effect, the overall impact of temporary habitat loss and disturbance on herring during construction is considered to be negligible and not significant in EIA terms

Sensitivity	Magnitude of effect	Consequence
Medium	Negligible	Negligible
Impact significance – NOT SIGNIFICANT		

13.6.1.1.2 Sandeel

The Study Area overlaps with low intensity, high intensity, and undetermined spawning grounds for sandeel (Coull *et al.*, 1998 Ellis *et al.*, 2012). However, as discussed in Section 13.4.4.2.1, the analysis of the PSA data indicates that 48 out of 50 sediment sample locations were 'unsuitable' for sandeel spawning, and two sediment samples were assigned a Folk classification representative of 'preferred' sandeel habitat.

The Scottish Government FeAST tool categorises sandeel as having a high sensitivity to sub-surface abrasion or penetration, and a medium sensitivity to surface abrasion (Scottish Government, 2023). Sandeel spawning habitats are spatially restricted and combined with their demersal egg phase, this makes them susceptible to temporary disturbances or habitat loss. Both adult and juvenile sandeel may be at risk from habitat loss or disturbances that could reduce their burrowing habitats or directly affect immobile sandeel in burrows during their overwintering period. Due to their high site fidelity once settled, sandeel populations are vulnerable to local impacts (Jensen *et al.*, 2011). However, monitoring before and after construction at the Beatrice Offshore Wind Farm and Horns Rev has shown that sandeel populations can recover once construction and installation activities have ceased (Beatrice Offshore Windfarm Ltd (BOWL), 2021; Jensen *et al.*, 2004).

Sandeel are considered to be of nationally important being listed as a PMF and protected within the Turbot Bank NCMPA (located approximately 6 km from the EICC) and a high value prey species and are also considered to have a high vulnerability to habitat loss and disturbance. Therefore, sandeel are assessed to have a high sensitivity. However, preferred sandeel habitats and spawning grounds are widely distributed in UK waters, including the central North Sea (Langton *et al.*, 2021). Therefore, localised, temporary habitat disturbance and loss will likely only affect a very small proportion of the habitat available for this species. Furthermore, as described in Section 13.4.4.2.1, the substrate across much of the Project Area is 'unsuitable' for sandeel spawning, with a few localised exceptions, only two sample stations were assessed as 'preferred'. This further reduces the opportunity for any Project disturbance to affect sandeel habitat.

It is anticipated that the temporary habitat disturbance or loss will be highly localised and intermittent for a period of up to six years throughout the construction phase, and in most cases will be for a short duration. Furthermore, only a small proportion of habitat would be disturbed at any one time., A degree of recovery would be expected following any disturbance, with sandeel recolonising the area (e.g. larvae settling from adjacent spawning grounds).

The Turbot Bank NCMPA is located within the 60 km Project Area, but it is not anticipated that there will be a direct impact on the sandeel present in the NCMPA, which is located approximately 6 km from the EICC. If any buried sandeel are present at the Project Area, it is possible that adults or juveniles disturbed during construction could relocate and recolonise areas within this NCMPA or their adjacent sandeel grounds. It is expected that a degree of spatial mixing between sandeel grounds already occurs, as this has been recorded out to 28 km (Jensen *et al.*, 2011). Overall, the impact is considered to highly localised and of a short duration, reversible and of a low frequency (intermittent over the construction), and the impact is defined as being of negligible magnitude with only a small area of sandeel habitat likely to be disturbed or lost, which will likely recover. An assessment of the potential effects of the Project on the Turbot Bank NCMPA is detailed within the MPA Assessment.

Evaluation of significance

Taking the high sensitivity of sandeel and the negligible magnitude of effect, the overall impact of temporary habitat disturbance and loss on sandeel during construction is considered to be negligible and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
High	Negligible	Negligible
Impact significance – NOT SIGNIFICANT		

13.6.1.1.3 Pelagic-spawning marine finfish

With the exception of sandeel and herring, all other marine finfish species that are likely to occur within the Study Area are pelagic (midwater) spawners. Pelagic spawners have a wider availability of spawning grounds that are not dependent on specific seabed substrates. This factor means that these species are less vulnerable to habitat disturbance and/or loss to spawning grounds.

The indicative construction period is expected to last up to six years, which will consist of intermittent construction activities, including seabed preparation (e.g. PLGR), installation of FTUs, installation of up to two OSCPs, and IACs and Export/Import Cable installation. Therefore, there is potential for construction works to overlap temporally with the spawning seasons of fish species listed in Table 13-4. However, as pelagic spawners, the temporary impacts to the seabed are unlikely to affect the spawning or the development of eggs and larvae of these species.

Amongst the pelagic-spawning marine finfish species that are thought to utilise the Study Area (presented in Table 13-4), some are regionally or internationally important being as PMFs or other biodiversity lists (e.g. OSPAR list of threatened and/or declining species). As these species spawn into the pelagic environment, temporary disturbance impacts on seabed habitat will be of minimal consequence to their eggs, larvae and juveniles, and therefore have a low vulnerability to this impact. Overall, pelagic-spawning marine finfish species are considered to have a low sensitivity to direct habitat loss due to disturbance of spawning and nursery grounds during construction activities within the Project Area.

The construction works will take place over a period of up to six years, however, construction activities will take place intermittently across a large area, and therefore the total area of disturbance/loss will not occur across the whole Project Area at the same time. Any impacts are likely to be localised and temporary, therefore, unlikely to affect long-term functioning of pelagic-spawning marine finfish populations. Any effects on feeding habitat and prey items are expected to affect only a small proportion of the available habitat in the vicinity of the Project (as described in EIAR Vol. 3, Chapter 10: Benthic Ecology), and given the large geographic range and distribution of most pelagic-spawning marine finfish species, these effects are not anticipated to have an extensive impact on feeding opportunities. Overall, the impact is assessed as being of a highly localised and of a short duration, reversible, and of a low frequency (intermittent over construction). Therefore, the impact is defined as being of negligible magnitude.

Evaluation of significance

Taking the low sensitivity of pelagic-spawning marine fish and negligible magnitude of effect, the overall impact of temporary habitat loss and disturbance pelagic-spawning marine finfish during construction is considered to be negligible and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Low	Negligible	Negligible
Impact significance – NOT SIGNIFICANT		

13.6.1.1.4 Shellfish

Many shellfish species have a more limited mobility in comparison to marine finfish and are therefore potentially vulnerable to habitat loss and disturbance during the construction phase. As described in Section 13.4.4.4.6, landings data from the relevant ICES statistical rectangles shows that the key shellfish species are *Nephrops*, brown crab, king scallops, and lobster. Furthermore, the Project intersects three FUs which have been established for the purposes of management and stock assessment for *Nephrops*.

Some shellfish display a degree of mobility, such as king scallop jet propulsion, depending on the life-cycle stage, whereas others are predominantly immobile (e.g. 'berried' female crabs and lobsters). These predominantly immobile shellfish may be more vulnerable to disturbance on the seabed. 'Berried' female crabs and lobsters carry their eggs under their abdomen and are often found buried under sediment. Any direct physical disturbance during construction could result in the damage or mortality to these females and/or their egg masses (Neal and Wilson, 2008).

Other shellfish, such as *Nephrops*, are dependent on burrows or shelter within fine sediments. While *Nephrops* are mobile, it is likely that if disturbed they will seek refuge within their burrows (Sabatini and Hill, 2008). As burrowing species, they can avoid and accommodate immediate disturbance, although their burrows are also likely to be damaged by seabed preparation and other construction activities. However, Marrs *et al.* (1998) reported that burrows were re-established within two days of disturbance providing that the occupant had remained unharmed (Hill and Sabatini, 2008). The MarLIN tool advises *Nephrops* exhibit intermediate tolerance to abrasion and physical disturbance (Sabatini and Hill, 2008).

Shellfish and benthic communities associated with mud habitats, i.e. sediments typical of much of the Project Area, have been shown to return to baseline species abundance after a period of short-term disturbance over a period of up to eight months, with a longer recovery time (up to three years) for coarser sediments containing sands and gravels (Newell *et al.*, 1998). The recoverability of *Nephrops* is dependent on the recovery of the sediment, however, muddy sand sediments are expected to exhibit a rapid recover over several months. Timescales of recovery for the species are likely to align approximately with the recovery of sediments in the wake of construction impacts. No shellfish species have protected status but are classed as being regionally important due to their commercial importance in the region, and of moderate vulnerability, due to their low mobility. Therefore, shellfish are assessed as being of medium sensitivity.

Any habitat loss or disturbance during the construction phase will be temporary (over a six-year construction period) and localised in nature, representing a small proportion of the available habitat in the wider region. It is expected that individuals will recolonise the area as the seabed recovers after construction activities have ceased and only a small proportion of available habitat would be disturbed at any one time. Overall, it is expected that some disturbance to individuals may occur, however, this is unlikely to affect the long-term functioning of the shellfish populations which cover a large geographical area. The impact is considered to be highly localised, of a short duration, reversible and of a low frequency (intermittent over construction). Therefore, the impact is defined as being of **negligible magnitude**.

Evaluation of significance

Taking the medium sensitivity of shellfish and negligible magnitude of effect, the overall impact of temporary habitat loss and disturbance on shellfish during construction is considered to be **negligible** and **not significant** in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Medium	Negligible	Negligible

Impact significance – **NOT SIGNIFICANT**

13.6.1.1.5 Elasmobranchs

Spawning grounds for elasmobranchs were not established by Coull *et al.* (1998) and Ellis *et al.* (2012) due to a lack of data on egg laying grounds. The Study Area overlaps with nursery grounds of tope shark, common skate, spotted ray, thornback ray, and spurdog (Section 13.4.4.2.2). With the exception of tope, which give birth to live young, these elasmobranch species deposit egg cases on the seabed, therefore, making these species vulnerable to seabed disturbance. However, after hatching they become mobile and are subsequently considered to be less vulnerable. Tope shark, spotted ray, thornback ray, and spurdog and are listed as PMFs and some are Endangered or Critically Endangered on the IUCN Red List, and therefore these species are of national to international importance, but assessed as having a medium vulnerability to this impact. Therefore, this group of species has been assessed as of **medium sensitivity**. Tope shark, thornback ray, spotted ray, and spurdog also have a wide distribution throughout UK waters (Barnes, 2008a; Snowden, 2008; Gibson-Hall, 2018; Barnes, 2008b), therefore any localised, temporary seabed disturbance is unlikely to have long-term affects to the functioning of these elasmobranch populations. Overall, this impact on these elasmobranch species is of a local spatial extent and short-duration, reversible and of a low frequency (intermittent over construction), and has been assessed as being of a **negligible magnitude**.

Common skate are Critically Endangered on the IUCN Red List and extinct over large extents of their natural range. This species is considered separately to other elasmobranchs owing to the selective nature of egg laying grounds within areas of hard substrate which increases the potential vulnerability to seabed disturbance (Phillips *et al.*, 2021). This species is of conservation value to an extent that is internationally important and is assessed to have **high sensitivity**. However, they are considered to be of low sensitivity to substratum loss and are expected to exhibit high recoverability (Neal and Pizzolla, 2006). The FeAST tool categorises common skate (prior to the recognition of flapper skate and blue skate as two separate species) as having a medium sensitivity to surface abrasion due to the potential disturbance to egg cases (Scottish Government, 2023) It is also expected that the presence of common skate within the Study Area is relatively unlikely (Figure 13-12; McGeady *et al.* 2021). Therefore, no impact to common skate populations would be expected. The impact is considered to be of a local spatial extent and short-duration, reversible and of a low frequency (intermittent over construction). Therefore, the impact is assessed as being of **negligible magnitude**.

Based on the information in Section 13.4.4.5.1, basking shark are more likely to occur in the Study Area during the summer foraging and breeding season. Basking sharks are ovoviviparous, meaning eggs are not deposited on the seabed and they hatch inside the uterus of the female (Wilson *et al.*, 2020). In the last ten years, there have been very few sightings of basking shark in the vicinity of the Project (Hebridean Whale and Dolphin Trust, 2024; Sea Watch Foundation, 2024l; NMPI, 2024). They are large, mobile animals but are not known to occur in high numbers or notable aggregations within the Project Area. This species is endangered on the IUCN Red List and is therefore of international importance but has a negligible vulnerability to temporary habitat disturbance or loss. Therefore, this species has been assessed to be of **negligible sensitivity** and the impact is of **negligible magnitude,** owing to it being highly localised, of a short-duration, reversible, and of a low frequency (intermittent over construction).

Typically, elasmobranchs reach sexual maturity after a number of years, exhibit relatively low fecundity, and have long gestational periods. Therefore, it is likely that elasmobranchs have slow recovery times following disturbance or loss of spawning grounds. However, there is little evidence that the Project Area is important for spawning of any species, and they are likely to recover and return to the area once construction activities have ceased.

Evaluation of significance

Common skate, spotted ray, thornback ray, spurdog, tope shark, and basking shark are all defined as having different levels of sensitivity to temporary impacts to the seabed. However, in light of the negligible magnitude of effect, the overall impact of temporary habitat loss and disturbance on elasmobranchs during construction is considered to be **negligible** and **not significant** in EIA terms.

Species	Sensitivity	Magnitude of effect	Consequence
Common skate	High	Negligible	Negligible
Spotted ray, thornback ray, spurdog and tope shark	Medium	Negligible	Negligible
Basking shark	Negligible	Negligible	Negligible

Impact significance – **NOT SIGNIFICANT**

13.6.1.1.6 Diadromous fish

All diadromous fish species are considered to be of conservation concern and of international importance. They may have connectivity with the Project during migration to/from rivers along the east coast of Scotland, including the Scottish Salmon Rivers and SACs (Figure 13-13). The diadromous species most likely to occur in the Study Area is Atlantic salmon.

Diadromous fish are deemed to be of low vulnerability to temporary disturbance, as they exhibit high recoverability. Furthermore, Atlantic salmon are known to occur largely within the top few metres of the water column during their marine phase (Newton *et al.*, 2021; Godfrey *et al.*, 2015), therefore, they are not likely to encounter disturbance at the seabed. Combined with their international importance, diadromous fish are assessed to be of **negligible sensitivity**.

The habitats within the Project Area are not expected to be particularly important to diadromous species and the seabed disturbance from the construction activities is likely to be highly localised with respect to the occurrence of diadromous fish in the Diadromous Fish Study area or indeed the wider NE Atlantic Ocean. The construction activities will occur intermittently over the construction period over highly localised areas and therefore the potential interaction with migrating diadromous fish is considered low. The impact is defined as being highly localised, of a short-duration, reversible and of a low frequency (intermittent over construction). Therefore, the impact is assessed as **negligible magnitude**.

Evaluation of significance

Taking the low sensitivity of diadromous fish and the negligible magnitude of effect, the overall impact of temporary habitat loss and disturbance on diadromous fish during construction is considered to be **negligible** and **not significant** in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Negligible	Negligible	Negligible

Impact significance – **NOT SIGNIFICANT**

13.6.1.2 Underwater noise and vibration

Anthropogenic noise is generated in the marine environment, including from offshore construction activities such as impact piling. An increase in underwater noise can affect acoustic communication in fish (Radford, Kerridge and Simpson, 2014) and reproductive success (De Jong *et al.*, 2020) as well as having behavioural effects on foraging, predator avoidance and navigation (Hawkins and Myrberg, 1983). In addition, underwater noise can also cause physical injury, and even mortality, to fish and shellfish species depending upon the characteristics of the sound source and the proximity of an individual to the source.

Underwater noise has both a pressure and particle motion component. The majority of research on the impact of underwater noise on marine species focuses on the effects of sound pressure (Nedelec *et al.*, 2016); however, it is known that both physical properties of sound can be relevant to how fish detect sound (Popper *et al.*, 2014; Popper and Hawkins, 2018). All fish species are able to detect particle motion using otolithic organs in their inner ear, with species which possess a lateral line additionally being able to detect particle motion via the sensory hair cells contained within this structure (Popper and Hawkins, 2018). The auditory system of shellfish is comparatively poorly understood, but it is believed they are primarily sensitive to particle motion, likely through sensory cells linked to hairs or statocysts, or via vibrations of their exoskeletons (Popper and Hawkins, 2018).

Fish with a swim bladder may also be able to detect sound pressure changes, as the gas within the swim bladder expands and contracts as a result of the sound pressure waves. Where the swim bladder is connected to the hearing system, or is in close proximity to it, this can result in greater hearing sensitivity as the swim bladder radiates additional particle motion (Popper *et al.*, 2014). Possession of a swim bladder also makes fish more prone to injury and, potentially, mortality via sound pressure-induced barotrauma. Fish without a swim bladder are generally not considered sensitive to sound pressure.

This section focuses on the impacts of underwater noise from impact piling and UXO clearance activities on sensitive fish and shellfish species as these will be the highest amplitude noise sources during construction. Consideration of underwater noise from construction vessels is also considered in Section 13.6.1.2.4. Other installation activities such as geophysical surveys, cable laying, dredging, trenching, and rock placement also result in highly localised underwater noise impacts. However, geophysical survey activity is largely out with the hearing range of fish, and therefore, is not considered further within this assessment. Furthermore, vessel noise is considered to dominate over the noise impacts of other installation activities such as cable laying, dredging, trenching and rock placement, and therefore, these sound sources have not been considered within this assessed (see Vol. 4, Appendix 15: Underwater Noise Modelling Report for further details).

13.6.1.2.1 Impact criteria

The most relevant criteria for assessing potential impacts on fish species are considered to be those provided in the Sound Exposure Guidelines for Fishes and Sea Turtles (Popper *et al.*, 2014). Fish species can be categorised by their hearing sensitivity (Hawkins and Popper, 2017), which is defined by a number of factors such as their hearing anatomy, particle motion detection, the use of sound during navigation or mating and the presence or absence of a swim bladder.

Popper *et al.* (2014) established impact criteria for assessing mortal injury, recoverable injury, and Temporary Threshold Shift (TTS), as well as masking and behavioural effects. The Popper *et al*. (2014) threshold criteria for impact piling (13.6.1.2.4) is provided in Table 13-18. For non-impulsive noises such as those generated by vessels (Section 13.6.1.2.4), the Popper *et al.* (2014) threshold criteria for non-impulsive noises is provided in Table 13-19, and these are largely qualitative based upon proximity to the noise source. The Popper *et al.* (2014) threshold criteria for explosives has been used for the modelling of impact ranges associated with UXO clearance (Table 13-20).

When quantitative guideline values are unavailable, risks are categorized qualitatively as “high”, “moderate,” or “low” at three distances from the source: “near” (tens of meters), “intermediate” (hundreds of meters), and “far” (thousands of meters). It is important to note that these qualitative criteria do not distinguish between different sound levels, meaning all sound sources, regardless of their level, would theoretically yield the same assessment result.

Currently, there are no criteria for assessing impact ranges related to changes in particle motion. Therefore, the criteria outlined by Popper *et al.*, (2014) remain the most reliable for evaluating underwater noise impacts on fish. At present, there are also no generalised auditory threshold criteria available for shellfish.

Noise criteria are detailed further within the underwater noise assessment (refer to EIAR, Vol. 4, Appendix 15: Underwater Noise Modelling Report).

Table 13-18 Fish impact thresholds for piling noise (Popper et al., 2014)

TYPE OF ANIMAL	PARAMETER	MORTALITY AND POTENTIAL INJURY	IMPAIRMENT			BEHAVIOUR[11]	SPECIES EXAMPLES
			Recoverable injury	TTS	Masking[11]		
Group 1: Fish with no swim bladder (particle motion detection)	SELcum dB re 1 µPa2·s	>219	>216	186	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low	Flatfish (such as such as plaice, sole and lemon sole), elasmobranchs (such as common skate, thornback ray, spurdog, tope shark, basking shark), and mackerel and horse mackerel.
	SPLpeak dB re 1 µPa	>213	>213	-			
Group 2: Fish with swim bladder not involved in hearing (particle motion detection)	SELcum dB re 1 µPa2·s	210	203	186	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low	Salmonids. Such as Atlantic salmon and sea trout.
	SPLpeak dB re 1 µPa	>207	>207	-			
Group 3 and 4: Fish with swim bladder involved in hearing (primarily sound pressure detection)	SELcum dB re 1 µPa2·s	207	203	186	(N) High (I) High (F) Moderate	(N) High (I) High (F) Low	Gadoids (such as such as cod, ling, saithe, whiting, blue whiting, haddock and hake), and European eel. Clupeids (e.g. herring and sprat).
	SPLpeak dB re 1 µPa	>207	>207	-			

[11] N = Near (i.e. tens of metres); I = Intermediate (i.e. hundreds of metres); F = Far (thoudands of metres) (Popper et al., 2014)

TYPE OF ANIMAL	PARAMETER	MORTALITY AND POTENTIAL INJURY	IMPAIRMENT			BEHAVIOUR[11]	SPECIES EXAMPLES
			Recoverable injury	TTS	Masking[11]		
Basking shark	SELcum dB re 1 µPa2·s	219	216	186	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low	Please note, these parameters are based on elasmobranchs being Group 1 more generally.
	SPLpeak dB re 1 µPa	>213	>213	-			
Eggs and larvae	SELcum dB re 1 µPa2·s	210	-	-	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	
	SPLpeak dB re 1 µPa	>207	-	-			

Table 13-19 Fish impact thresholds to non-impulsive sounds (Popper et al., 2014)

TYPE OF ANIMAL	MORTALITY AND POTENTIAL INJURY	IMPAIRMENT			BEHAVIOUR[11]	SPECIES EXAMPLES
		Recoverable injury	TTS	Masking[11]		
Group 1: Fish with no swim bladder (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	N) Moderate (I) Moderate (F) Low	Flatfish (such as such as plaice, sole and lemon sole), elasmobranchs (such as common skate, thornback ray, spurdog, tope shark, basking shark), and mackerel and horse mackerel.
Group 2: Fish with swim bladder not involved in hearing (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	N) Moderate (I) Moderate (F) Low	Salmonids. Such as Atlantic salmon and sea trout.
Group 3 and 4: Fish with swim bladder involved in hearing (primarily sound pressure detection)	(N) Low (I) Low (F) Low	170 dB re 1 uPa (rms) for 48 h	158 dB re 1 uPa (rms) for 48 h	(N) High (I) High (F) High	(N) High (I) Moderate (F) Low	Gadoids (such as such as cod, ling, saithe, whiting, blue whiting, haddock and hake), and European eel. Clupeids (e.g. herring and sprat)
Basking shark	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	N) Moderate (I) Moderate (F) Low	
Eggs and larvae	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low	N) Moderate (I) Moderate (F) Low	

Table 13-20 Fish impact thresholds to explosive sounds (Popper et al., 2014)

TYPE OF ANIMAL	PARAMETER	MORTALITY AND POTENTIAL MORTAL INJURY	RECOVERABLE INJURY	TTS
Group 1 Fish: no swim bladder (particle motion detection)	Peak, dB re 1µPa	2–9 – 234	(Near) High (Intermediate) Low (Far) Low	(Near) High (Intermediate) Moderate (Far) Low
Group 2 Fish: where swim bladder is not involved in hearing (particle motion detection)	Peak, dB re 1µPa	2–9 – 234	(Near) High (Intermediate) High (Far) Low	(Near) High (Intermediate) Moderate (Far) Low
Group 3 and 4 Fish: where swim bladder is involved in hearing (primarily pressure detection)	Peak, dB re 1µPa	2–9 – 234	(Near) High (Intermediate) High (Far) Low	(Near) High (Intermediate) High (Far) Low
Basking shark	Peak, dB re 1µPa	2–9 – 234	(Near) High (Intermediate) High (Far) Low	(Near) High (Intermediate) Moderate (Far) Low
Eggs and larvae	Peak, dB re 1µPa	>13 mm s^{-1} peak velocity	(N) High (I) Low (F) Low	(N) High (I) Low (F) Low

13.6.1.2.2 Noise modelling and assessment assumptions

Seiche undertook underwater noise modelling to determine the extent of underwater noise from the worst-case project scenarios. The accompanying noise modelling report can be seen in Vol. 4, Appendix 15: Underwater Noise Modelling Report. This model was used to determine the impact radius ranges of noise for key fish species. The underwater noise assessment considered the potential effects on fish attributed to various project activities, including impact piling, UXO clearance and vessel presence. Piling associated with installation of both the FTU anchors, and the OSCPs foundations was modelled (Vol. 4, Appendix 15: Underwater Noise Modelling Report).

Impact piling

The durations for piling of the anchors and foundations will differ over the construction phase of the Project, with the FTU anchors being installed over a maximum of 285 days (average of 95 days of piling per year), over a period of three years. Comparatively, the OSCPs foundations will be installed over a maximum of 14 days (as 7 days per OSCP foundation, completed in separate years). However, a greater number of piles may be installed per day for the OSCPs (up to 12 piles over 24 hours, instead of three for the FTU anchors; Section 13.5.5).

For the context of the assessment of impact piling, consecutive impact piling of the OSCPs foundations has been selected as the worst-case scenario based upon the sound source levels, hammer energy and the number of piles which might be installed within a 24-hour period (see EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report). Although installation of the FTU anchors will occur over a longer duration, the range of impact is expected to be lower. Accounting for the OSCPs foundations piling will provide potential area of effect, whilst the potential duration of impacts can be extrapolated to match the duration of the FTU anchor installation. This is highly conservative but is in keeping with the worst-case scenario approach as defined in Section 13.5.5. The worst-case impact ranges were reported in EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report. This information is presented herein. Overall, the water depths across the Array Area range from 82 mLAT to 105 mLAT. The range in water depth across the Array Area is unlikely to result in any perceptible difference in terms of underwater noise impacts to fish.

Potential impact ranges for impact piling have been reported against both SPL_{peak} and SEL_{cum} criteria. For SEL_{cum}, impact ranges are presented in EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report for two scenarios assuming 1) receptors are static; 2) that receptors are highly mobile and have the capacity to move away from excessive noise. Although most fish species are highly mobile, as a conservative approach to assessing effects resulting from SEL_{cum} impact ranges assumes static receptors throughout. Due to their smaller size and reduced mobility, eggs and larvae are considered static and assessed as such.

Construction vessel noise

The assessment of underwater noise from construction vessels has been based on non-impulsive threshold criteria (Table 13-19) (Popper *et al.*, 2014).

UXO clearance

The risk associated with UXO has been independently assessed through a UXO Threat and Risk Assessment (EIAR Vol. 4, Appendix 5: UXO Threat and Risk Assessment)). The findings of the assessment state the risk of UXO as being 'low' within the Array Area, and 'medium' toward the western end of the EICC. Given the degree of flexibility afforded by both the Array Area and the width of the EICC, it is anticipated that it will be possible to avoid UXO through micro-siting / micro-routeing. However, where UXO are identified in the Project Area which cannot be avoided or which pose a threat to safe completion of construction works, clearance will be undertaken as necessary. The worst-case scenario for the Project has been considered within the assessment below based on clearance of up to 50 UXO via LOD with a donor charge of 0.08 kg followed by a maximum of one HOD of a 227 kg UXO, if necessary. The modelling of underwater noise impacts from UXO clearance uses the Popper et al. (2014) threshold criteria for explosives (Table 13-20).

13.6.1.2.3 Impact piling

Piling will be required to anchor the moorings and secure the OSCPs foundations. The impulsive sounds produced are characterized by a rapid rise to a maximum pressure value, followed by a decay period that may include a period of diminishing, oscillating maximal and minimal pressures (Popper *et al.*, 2014). The peak sound levels from impact piling vary significantly based on factors such as pile type, diameter, material, hammer size, water depth, and seabed substrate.

The modelling results for the worst-case scenario are summarised in Table 13-21 based the threshold criteria presented in Table 13-18. Table 13-21 represents the parameters associated with OSCPs foundations piling. Any impact ranges for FTU anchor piling will be within those modelled for the OSCPs foundations (see Section 13.6.1.2.2 and EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report).

*Table 13-21 Modelled impact distances of OSCPs foundations piling[12] (**EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report**)*

TYPE OF ANIMAL	PARAMETER	MEAN IMPACT RANGE (m)					SPECIES EXAMPLES
		MORTALITY AND POTENTIAL INJURY	IMPAIRMENT			BEHAVIOUR[11]	
			RECOVERABLE INJURY	TTS	MASKING[11]		
Group 1: Fish with no swim bladder (particle motion detection)	SELcum dB re 1 µPa²·s	Moving: N/E[13]	Moving: N/E	Moving: 25,200 m	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low	Flatfish (such as such as plaice, sole and lemon sole), elasmobranchs (such as common skate, thornback ray, spurdog, tope shark, basking shark), mackerel, horse mackerel, and sandeel
		Static: 378 m	Static: 571 m	Static: 39,500 m			
	SPLpeak dB re 1 µPa	100 m	100 m	-			
Group 2: Fish with swim bladder not involved in hearing (particle motion detection)	SELcum dB re 1 µPa²·s	Moving: N/E	Moving: 21 m	Moving: 25,200 m	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low	Salmonids. Such as Atlantic salmon and sea trout
		Static: 1,340 m	Static: 3,620 m	Static: 39,500 m			
	SPLpeak dB re 1 µPa	250 m	250 m	-			
Group 3 and 4: Fish with swim bladder involved in hearing	SELcum dB re 1 µPa²·s	Moving: N/E	Moving: 21 m	Moving: 25,200 m	(N) High (I) High (F) Moderate	(N) High (I) High (F) Low	Gadoids (such as such as cod, ling, saithe, whiting, blue whiting, haddock and hake), and European eel.
		Static: 1,570 m	Static: 3,620 m	Static: 39,500 m			

[12] As explained in Section 13.6.1.2.2, OSCPs foundations piling has been assessed as the worst-case scenario. The impact ranges for FTU anchor impact piling will be within the worst-case of OSCPs foundations piling.
[13] N/E = threshold not exceeded.

TYPE OF ANIMAL	PARAMETER	MEAN IMPACT RANGE (m)					SPECIES EXAMPLES
		MORTALITY AND POTENTIAL INJURY	IMPAIRMENT			BEHAVIOUR[11]	
			RECOVERABLE INJURY	TTS	MASKING[11]		
(primarily sound pressure detection)	SPLpeak dB re 1 µPa	250 m	250 m	-			Clupeids (e.g. herring and sprat)
Basking shark	SELcum dB re 1 µPa^2·s	Moving: N/E	Moving: N/E	Moving: 16,900 m	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low	Please note, these parameters are based on elasmobranchs being Group 1 more generally.
		Static: 378 m	Static: 571 m	Static:39,500 m			
	SPLpeak dB re 1 µPa	100 m	100 m	-			
Eggs and larvae	SELcum dB re 1 µPa^2·s	1,340 m	-	-	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	
	SPLpeak dB re 1 µPa	250 m	-	-			

Mortality, potential mortal injury and recoverable injury

This assessment considers three classes of potential injury to individual fish: mortality, potential mortal injury and recoverable injury. Mortal injuries are severe injuries resulting from a noise source that results in death to an individual. The threshold for mortality and for potential mortal injury will differ between species, hence the fish hearing groups (Popper *et al*., (2014) criteria) detailed in Section 13.6.1.2. A recoverable injury is a survivable injury, where the individual will fully recover with time following the exposure to noise. However, during recovery, a temporary decrease in fitness may result which can increase the individual's susceptibility to predation. The assessment utilises the results from modelling the worst-case scenario as presented in the EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report, which equates to underwater noise generated by piling of the OSCP foundations.

Group 3 and 4 fish

Herring

The noise modelling results suggest that the threshold was exceeded for mortality and potential mortal injury for stationary herring. Mortality, potential mortal injury and recoverable injury may occur up to 250 m away from the source based on SPL_{peak} criteria (Table 13-21). Based on the SEL_{cum} criteria, mortality or potential mortal injury could occur out to 1,570 m and recoverable injury out to 3,620 m.

According to Coull *et al*. (1998) and Ellis *et al*. (2012), the distribution of herring spawning grounds are closer towards the coast, along the EICC. The Array Area does not overlap with any herring spawning grounds and only overlaps with 'low' intensity nursery areas. Therefore, it is not expected that piling within the Array Area will affect significant herring populations.

Additionally, it is anticipated that herring larvae and eggs are unlikely to occur in the vicinity of the Array Area. The PSA results from the EBS reports (EIAR Vol. 4, Appendix 10: Environmental Baseline and Habitat Assessment Report – Inshore EICC, EIAR Vol. 4, Appendix 11: Environmental Baseline Report – OWF, EIAR Vol. 4, Appendix 12: Environmental Baseline Report – EICC) confirmed that all of the sediment samples within the Project Area were considered to be 'unsuitable' for herring spawning. Therefore, the range of impact is highly unlikely to come close to any possible herring spawning areas.

As herring are a PMF and an important prey to a range of predators, they are considered to be nationally important receptors and a high value prey species. Herring are highly sensitive to underwater noise; however, they are mobile and capable of moving away from the affected area. Furthermore, as the Array Area does not overlap with any key spawning or nursery ground for this species, it is considered that there is no likely impact of spawning and early development, nor any reproductive motivation for adult herring to unnecessarily remain in proximity to high noise levels. Therefore, herring have been assessed to have medium sensitivity to underwater noise generated from construction activities. The impact is defined as being of a medium spatial extent and short-duration, reversible and of a low frequency (average 95 days per year for three years for FTU anchors and 14 days for OSCPs foundations, i.e. seven days in each of two separate years), the impacts are unlikely to have long-term effects on the functioning of herring populations. Therefore, the impact is assessed as low magnitude.

Evaluation of significance

Taking the medium sensitivity and low magnitude of effect, the overall impact of mortality, potential mortal injury and recoverable injury for impact piling on herring during construction is considered to be minor and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Medium	Low	Minor
Impact significance – NOT SIGNIFICANT		

All other Group 3 and 4 fish

This assessment is provided in the 'Other fish species' section below.

Group 2 fish (i.e. salmonids)

The noise modelling results suggest that the threshold was exceeded for mortality and potential mortal injury for stationary salmonids (i.e. Group 2 fish). Mortality, potential mortal injury and recoverable injury may occur up to 250 m away from the source based on SPL_{peak} criteria (Table 13-21). Based on the SEL_{cum} criteria, mortality or potential mortal injury could occur out to 1,340 m and recoverable injury out to 3,620 m.

Empirical studies investigating the effect of underwater noise on salmonids are lacking. Harding *et al.* (2016) exposed Atlantic salmon post-smolts and adults to piling noise and showed no significant physiological response. However, this study was conducted in a laboratory environment and the relevance to wild salmon is not clear (Harding et al., 2016). Available evidence for caged sea trout exposed to pile driving at a range of distances in Southampton water indicated that fish with a received sound pressure level of 134 dB re 1µPa at 400 m from the pile did not respond (Nedwell *et al.*, 2003). Therefore, the risk of mortality or injury to salmonids as a result of impact of impact piling is considered to be low.

Salmonids are considered to be of international importance. Overall, Atlantic salmon and sea trout are considered to have a low vulnerability to mortality, potential mortal injury and recoverable injury to the underwater noise generated from piling activities. Therefore, European eel, Atlantic salmon and sea trout are assessed to have a medium sensitivity.

The impact is defined as being of a medium spatial extent and short-duration, reversible and of a low frequency (average 95 days / year for three years for FTU anchors and 14 days for OSCPs foundations, i.e. seven days in each of two separate years), the impacts are unlikely to have long-term effects on salmonid populations. Therefore, the impact is assessed as low magnitude.

Evaluation of significance

Taking the medium sensitivity of shellfish and low magnitude of effect, the overall impact of mortality potential mortal injury and recoverable injury for impact piling on salmonids during construction is considered to be minor and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Medium	Low	Minor
Impact significance – NOT SIGNIFICANT		

Group 1 fish

Sandeel

Sandeel are demersal spawners and are known to burrow into the sediment and are considered to be stationary receptors. They are classed as a Group 1 species and have the lowest sensitivity to sound pressure. The noise modelling results suggest mortality, potential mortal injury for and recoverable injury sandeel may occur up to 100 m away based on the SPL_{peak}. Based on the SEL_{cum} criteria, mortality and potential mortal injury may occur out to 378 m and recoverable injury may occur out to 571 m (Table 13-21).

Additionally, post-construction monitoring of sandeel populations within the Beatrice Offshore Windfarm, showed that the number of sandeel increased between 2014 and 2020 (pre- and post-construction; Beatrice Offshore Windfarm, 2021). Therefore, there was no evidence to suggest that windfarm construction impacts (including pilling) negatively affected the local sandeel population (Beatrice Offshore Windfarm, 2021). The Beatrice Offshore Windfarm would have been associated with more piling for the fixed foundation WTGs compared to the Cenos OSCP foundations. Comparatively, the Beatrice Offshore Windfarm area was heavily utilised by sandeel, unlike the Project Area.

The Study Area overlaps with low intensity, high intensity and undetermined spawning grounds for sandeel (Ellis *et al*., 2012). However, the analysis of the PSA data indicates that a majority of sample locations were 'unsuitable' for sandeel spawning. The Turbot Bank NCMPA is located 122 km from the Array Area, therefore sandeel within the site will not be affected by the piling activities. Outside the NCMPA, the relative unsuitability of the substrate within the Project Area suggests that only low levels of sandeel will be present within the Array Area at any given time.

Sandeel are a PMF and are important prey to a range of predators and are therefore considered to be nationally important receptors. Sandeel are considered to have medium vulnerability to underwater noise generated from construction activities. According to Popper *et al*., (2014) criteria, the hearing sensitivity of Group 1 fish is low, however, sandeel are relatively immobile during prolonged periods of burial, and are therefore, assessed as having a medium sensitivity.

Based on the likely low presence of sandeel at the Array Area and the post-construction monitoring at existing operational offshore wind farms, any impacts are unlikely to affect long-term functioning of sandeel populations. The impact is defined as being of a medium spatial extent and short-duration, reversible and of a low frequency (average 95 days / year for three years for FTU anchors and 14 days for OSCPs foundations, i.e. seven days in each of two separate years). Therefore, the impact is assessed as low magnitude.

Evaluation of significance

Taking the medium sensitivity of sandeel and the low magnitude of effect, the overall impact of mortality potential mortal injury and recoverable injury for impact piling on sandeel is considered to be minor and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Medium	Low	Minor
Impact significance – NOT SIGNIFICANT		

Elasmobranchs

Elasmobranchs are categorised as Group 1 species as they do not possess a swim bladder and are therefore less vulnerable to trauma from extreme sound pressure changes compared to fish with swim bladders. The Study Area overlaps with nursery grounds for common skate, spotted ray, thornback ray, and tope shark. Skates and rays are associated with the seabed, therefore, may be more sensitive to particle motion transmitted through the seabed caused by impact piling vibrations, in comparison to pelagic species, such as tope shark and basking shark. However, these species are all highly mobile and can move away from the noise source.

Elasmobranchs that may occupy the Study Area and therefore intersect the Project Area are considered to be of national to international importance. However, considering their limited hearing capabilities, elasmobranchs are assessed to have a low vulnerability and low sensitivity to underwater noise. The underwater noise impacts from impact piling will be of a medium spatial extent and a short duration, reversible and intermittent (average 95 days per year for three years for FTU anchors and 14 days for OSCPs foundations, i.e. seven days in each of two separate years). Therefore, the impact is assessed as being of low magnitude.

Evaluation of significance

Taking the low sensitivity of elasmobranch species and the low magnitude of effect, the overall impact of mortality, potential mortal injury and recoverable injury for impact piling on all elasmobranch species during construction is considered to be minor and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Low	Low	Minor
Impact significance – NOT SIGNIFICANT		

All other Group 1 fish

This assessment is provided in the 'Other fish species' section below.

Other fish species

All other marine finfish and non-salmonid diadromous fish are listed in Table 13-18, grouped according to the criteria set by Popper *et al.*, (2014). The majority of these species which occur within the Study Area are Group 1 receptors, i.e. do not have swim bladders and therefore have a lower sensitivity to underwater noise. Exceptions include gadoids (e.g. cod) and European eel (Group 3), and sprat (Group 4). Due to their smaller size and reduced mobility, eggs and larvae are also potentially vulnerable to underwater noise (Popper *et al.*, 2014).

Based upon SPL_{peak} noise levels, the potential for mortality or potential mortality for Group 1 fish species extends up to 100 m from the noise source (Table 13-21). This range increases to 250 m for Group 2, 3 and 4 fish, and eggs and larvae (Popper *et al.*, 2014). Assuming individuals are stationary, when exposed to SEL_{cum} noise levels, Group 1 fish may experience mortality and potential injury up to 378 m from the impact source. For Group 2, this extends out to 1.34 km. Group 3 and 4 may experience mortality and potential injury out to 1.57 km from the source (Table 13-21). For recoverable injury, the range increases further to 571 m for Group 1 fish and 3.62 km for Group 2, and 2.74 km for Group 3 and 4 fish (SEL_{cum}; Table 13-21). A threshold for recoverable injury is not available for eggs and larvae. However, Popper *et al.* (2014) assesses the relative risk for eggs and larvae as moderate at distances near to the source (tens of metres), and low at distances intermediate (hundreds of metres) or far (thousands of metres) from the source (Table 13-21).

Although these mortality and injury extents are representative of static individuals, fish are typically highly mobile (possibly excepting during spawning). When an individual is moving away from the noise source, the range for mortality, potential mortality injury or recoverable injury decreases. The results from the underwater noise modelling (EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report) has stated that the threshold was not exceeded on moving fish from Groups 1, 2, 3 and 4 based on SEL_{cum}. Owing to their mobile nature, fish are not likely to be exposed to higher levels of noise for a prolonged period (Maes *et al.*, 2004), although the likelihood of fish fleeing from high-amplitude sounds has not yet been quantified in the published literature. An exception to this would be demersal eggs and larvae which are unable to move area from areas experiencing higher levels of noise and are potentially vulnerable to barotrauma. There are few studies investigating the potential impact of underwater noise on eggs and larvae. An investigation of mortality impacts of impact piling on common sole larvae was conducted by Bolle *et al.* (2012) which found now significant difference in the mortality rate between groups of larvae exposed to impulsive sound and control groups. These findings cannot be extrapolated to other species due to inter-specific differences in hearing sensitivity.

Many of the fish species predicted to utilise the Study Area are of a national (e.g. PMF species) or international (e.g. Critically Endangered on IUCN Red List) importance. The Study Area does directly overlap with areas of high intensity nursery grounds for cod, which are classed as Group 3 fish species and, therefore, are potentially sensitive to noise. Other than cod, the Study Area is not located within large areas of high concentration spawning grounds for any species. The Study Area overlaps with low density spawning and/or nursery grounds for anglerfish, lemon sole, Norway pout, mackerel, plaice, (Group 1), blue whiting, haddock, hake, ling, saithe, and whiting (Group 3), and sprat (Group 4), but is not considered to be a key spawning and / or nursery grounds for these species.

Non-salmonid diadromous fish (e.g. lamprey species (Group 1) and European eel (Group 3)) may also interact with the Project Area and are considered to be nationally to internationally important. The potential for a spatial and temporal overlap with impact piling would depend on the migratory timings and routes which are not well known. However, considering the area available for migration, it is expected that only a limited number of individuals would be exposed to the worst-case underwater noise levels.

In the interest of taking a conservative approach to assessment, and in order to capture the range in sensitivity and importance across the groups, marine finfish are considered to have medium sensitivity.

The assessment has been based on a precautionary worst-case approach, and therefore, the injury ranges presented are expected to be less in reality. The impact is defined as being of a medium spatial extent and short-duration, reversible and of a low frequency (average 95 days per year for three years for FTU anchors and 14 days for OSCPs foundations, i.e. seven days in each of two separate years). Therefore, the impact is assessed as low magnitude.

Evaluation of significance

Taking the medium sensitivity of other fish species and the low magnitude of effect, the overall impact of mortality, potential mortal injury and recoverable injury for impact piling on other fish during construction is considered to be minor and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Medium	Low	Minor
Impact significance – NOT SIGNIFICANT		

Shellfish

There are no published generalised thresholds for the assessment of potential underwater noise impacts on shellfish.

The potential impacts of underwater noise on shellfish are comparatively poorly understood, but there is a growing body of evidence that various species have differing levels of receptivity and/or sensitivity to underwater noise. Shellfish do not possess a swim bladder; therefore, it is assumed that they are primarily sensitive to particle motion, similar to Group 1 fish species. Lacking any gas-filled chambers, shellfish are considered to be resilient against noise-induced barotrauma. However, shellfish are less mobile than fish, and less able to flee from underwater noise.

Many crustaceans are known to be sensitive to underwater noise, including hermit crab (*Pagurus bernhardus*), American lobster (*Homarus americanus*), and *Nephrops* (Roberts *et al.*, 2016; Miller *et al.*, 2016; Goodall *et al.*, 1990). Sound sensitivity has also been established in several bivalve species, such as blue mussels (*Mytilus edulis*), Pacific oysters (*Magallana gigas*), and Japanese scallops (*Mizuhopecten yessoensis*) (Roberts *et al.*, 2015; Charifi *et al.*, 2017; Zhadan, 2005). Therefore, it is assumed that the shellfish present within the Study Area, which include crabs, lobster, and king scallops could potentially detect particle motion. However, the available evidence suggests that sound sensitivity in shellfish is commonly limited to a narrow frequency range at frequencies <3 kHz.

Potential impacts of underwater noise on shellfish range from behavioural changes, reduced fecundity, physical damage to hearing structures, and mortality etc, with larvae appearing to be at greater risk to more serious impacts than adults (Solé *et al.*,2023). However, as many of these potential impacts have been established in laboratory settings, using noise playbacks, or in response to sound sources not relevant to this assessment, their relevance is uncertain. Moreover, there is limited to no understanding of the implications of these potential impacts at a population level.

Considering their regional importance as a commercially valuable species, and assuming that shellfish have similar characteristics to Group 1 fish, with limited acoustic receptivity, shellfish are considered to be of low sensitivity to underwater noise. Shellfish are judged to be of regional importance, as they are not protected, but are of commercial importance within the Study Area. The impact is defined as being of a medium spatial extent and short-duration, reversible and of a low frequency (average 95 days per year for three years for FTU anchors and 14 days for OSCPs foundations, i.e. seven days in each of two separate years). Therefore, the impact is assessed as low magnitude.

Evaluation of significance

Taking the low sensitivity of shellfish and the low magnitude of effect, the overall impact of mortality potential mortal injury and recoverable injury for impact piling on shellfish during construction is considered to be minor and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Low	Low	Minor
Impact significance – NOT SIGNIFICANT		

TTS, masking and behavioural disturbance

Exposure to intense noise can produce TTS, which is a temporary reduction in hearing sensitivity, with hearing ability returning shortly after the emitted noise ceases. Individuals experiencing TTS may experience a temporary decrease in fitness and ability to detect prey.

Fish and shellfish species will have varying reactions and sensitivities to piling noise. There is potential for receptor responses to lead to significant effects at an individual level (e.g. reduced fitness, susceptibility to predation) or potentially at a larger population level (e.g. avoidance of or delayed migration to key spawning grounds), depending on the duration and scale of the impact.

The overall spatial extent of the Array Area is relatively small, compared to the large surrounding area of available habitat. It is, therefore, reasonable to assume that fish and shellfish would move out of the zone of effect if disturbed by the piling noise (e.g. if vocalisations were masked).

Group 3 and 4 fish

Herring

The Array Area is not located in a key herring spawning ground and only overlaps with low intensity nursery areas. As shown in Figure 13-3, herring spawning areas are concentrated closer to the coast. As detailed in Section 13.4.4.2.1, herring are considered to be a mobile species, and it is not anticipated that herring larvae and eggs will occur in high numbers in the vicinity of the Array Area. As noted above for mortality, potential mortal injury and recoverably injury, herring are assessed as having a medium sensitivity to underwater noise

The potential for TTS of static herring may occur up to 39.5 km from the noise source. The assumptions for the noise modelling are considered to represent a highly conservative worst-case scenario, however, in reality, the effects are assumed to be less. Herring possess swim bladders and are therefore more sensitive to sound, and at a greater risk of potential behavioural effects and masking over larger distances.

As the Array Area does not overlap with key herring spawning or nursery grounds, it is more likely that herring present within the vicinity of the Array Area are adult herring, which are mobile and have the ability to flee from the noise, reducing the likelihood of behavioural effects or masking. The qualitive data provided by Popper *et al.*, (2014), suggest that behavioural effects or auditory masking in herring from impact piling are expected to be moderate in the far field, and high within the intermediate field (Table 13-21).

The piling of FTU anchors is expected to average 95 days per year for three years and the piling of the two OSCPs foundations is expected to occur over 14 days (seven days in each of two separate years). Although behavioural effects or auditory masking in herring from piling are expected to be moderate in the far field, and high within the intermediate field (see Table 13-21), owing to their mobile nature, herring are considered to have low vulnerability to TTS, masking and behavioural disturbance associated with piling noise. Furthermore, herring present in this area likely spawn during the autumn months (Frost *et al.*, 2022), which is unlikely to overlap with the piling season.

The impact is defined as being of a medium spatial extent and short-duration, reversible and of a low frequency (average 95 days per year for three years for FTU anchors and 14 days for OSCPs foundations, i.e. seven days in each of two separate years). Therefore, the impact is assessed as low magnitude. Any effects are unlikely to affect long-term functioning of the herring populations.

Evaluation of significance

Taking the medium sensitivity of herring to underwater noise and the low magnitude of effect, the overall impact of underwater noise from impact piling on TTS, masking and behavioural disturbance on herring during construction is considered to be minor and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Medium	Low	Minor
Impact significance – NOT SIGNIFICANT		

Other Group 3 and 4 fish

This assessment is provided in the 'Other fish species' section below.

Group 2 fish (i.e. salmonids)

It is possible that salmonids (Atlantic salmon and sea trout) may be displaced for a short period of time during construction as a result of underwater noise impacts. For Atlantic salmon and sea trout, this impact may be greatest during the post-smolt migratory period which occurs during late spring to June and in hours of darkness when post-smolt migrations are most likely to occur (Moore *et al.*, 1995, although see opposing evidence from Lilly *et al*. 2023).As noted above for mortality, potential mortal injury and recoverably injury, salmonids are assessed as having a medium sensitivity to underwater noise. The potential for TTS of Group 2 fish may occur up to 39.5 km from the noise source. The assumptions for the noise modelling are considered to represent a highly conservative worst-case scenario, The qualitive data provided by Popper *et al.* (2014), suggest that behavioural effects in salmonids from impact piling are expected to be moderate in the near field, and low within the intermediate field and masking effects are expected to be high in the near field and moderate in the intermediate field (Table 13-21).

The Array Area is located in offshore waters and not in close proximity to coastal waters where post-smolts conduct their rapid coastal migration and where adults are returning to rivers to spawn. Therefore, it is unlikely that the underwater noise during construction would result in substantial barrier effects or interruptions to migration that would hinder migratory success or result in any other significant survival or fitness impairment. The impact is defined as being of a medium spatial extent and short-duration, reversible and of a low frequency (average 95 days per year for three years for FTU anchors and 14 days over two years for OSCPs foundations). Therefore, the impact is assessed as low magnitude.

Evaluation of significance

Taking the medium sensitivity of salmonids and the low magnitude of effect, the overall impact of underwater noise from impact piling on TTS, masking and behavioural disturbance on salmonids during construction is considered to be minor and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Medium	Low	Minor
Impact significance – NOT SIGNIFICANT		

Group 1 fish

Sandeel

As detailed in Section 13.6.1.2.1, sandeel are considered a stationary species for this assessment. The potential for TTS of stationary sandeel may occur up to 39.5 km from the noise source (Table 13-21). The assumptions for the noise modelling are considered to represent a highly conservative worst-case' scenario, however, and in reality, the effects are assumed to be less. As sandeel lack a swim bladder, the potential for behavioural effects on this species from noise are considered to be low. However, as this species is relatively immobile during periods of prolonged burial, they are considered to be potentially vulnerable to underwater noise impacts. As noted above for mortality, potential mortal injury and recoverably injury, sandeel are assessed as having a medium sensitivity to underwater noise.

The Project Area overlaps with low intensity, high intensity, and undetermined spawning grounds for sandeel (Ellis *et al.*, 2012) and a majority of the sediment samples from the PSA data (EIAR Vol. 4, Appendix 10: Environmental Baseline and Habitat Assessment Report – Inshore EICC, EIAR Vol. 4, Appendix 11: Environmental Baseline Report – OWF, EIAR Vol. 4, Appendix 12: Environmental Baseline Report – EICC) indicate that the seabed composition is 'unsuitable' for sandeel spawning. One sample was considered to be 'sub-prime (preferred)', and two sediment samples showed 'suitable (marginal)'. The pilling activity taking place will be in a small proportion of a wider available habitat and the qualitive data provide by Popper *et al.* (2014), suggests that auditory masking in sandeel from piling activity are expected to be low, except close to the source (i.e. tens of metres) from the piling locations and behavioural effects are low to moderate, except near to the source, resulting in a localised effect. Furthermore, as noted above for mortality, potential mortality and recoverable injury, sandeel have been shown to be present in high densities within an offshore wind farm array area following cessation of piling (Beatrice Offshore Windfarm, 2021), indicating that any effects are likely reversible.

Note that Turbot Bank NCMPA, designated for sandeel, is >120 km from the closest piling activities in the Array Area, and as a result there is no likelihood of impact on this protected site as a result of piling noise, and so the status of this protected area is not taken into account when considering the sensitivity of sandeel to piling noise.

The impact is defined as being of a medium spatial extent and short-duration, reversible and of a low frequency (average 95 days per year for three years for FTU anchors and 14 days for OSCPs foundations, i.e. seven days in each of two separate years). Therefore, the impact is assessed as low magnitude.

Any effects are unlikely to affect long-term functioning of the sandeel populations.

Evaluation of significance

Taking the medium sensitivity of sandeel and the low magnitude of effect, the overall impact of underwater noise from impact piling on TTS, masking and behavioural disturbance on sandeel during construction is considered to be minor and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Medium	Low	Minor
Impact significance – NOT SIGNIFICANT		

Elasmobranchs

As noted above for mortality, potential mortal injury and recoverable injury, elasmobranchs lack swim bladders and are therefore less vulnerable to sound pressure than other fish species with swim bladders. Although these species range from being nationally to internally important, owing to their low vulnerability to underwater noise, elasmobranchs are assessed as having a low sensitivity.

The potential for TTS of stationary elasmobranchs may occur up to 39.5 km from the noise source. Popper *et al.* (2014), suggests that auditory masking in Group 1 fish from piling activities are expected to be low, except close to the source (i.e. tens of metres) from the piling locations and behavioural effects are low to moderate, except near to the source.

The impact is defined as being of a medium spatial extent and short-duration, reversible and of a low frequency (average 95 days per year for three years for FTU anchors and 14 days for OSCPs foundations, i.e. seven days in each of two separate years). Therefore, the impact is assessed as low magnitude.

Evaluation of significance

Taking the low sensitivity of elasmobranch species and the low magnitude of effect, the overall impact of underwater noise from impact piling on TTS, masking and behavioural disturbance on all elasmobranch species during construction is considered to be minor and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Low	Low	Minor
Impact significance – NOT SIGNIFICANT		

Other Group 1 fish

This assessment is provided in the 'Other fish species' section below.

Other fish species

All other marine finfish and non-salmonid diadromous fish are listed in Table 13-18, grouped according to the criteria set by Popper *et al.*, (2014). The potential of TTS for all fish species may occur up to 39.5 km from the noise source for Groups 1, 2, 3 and 4, when individuals are assumed to be static (Table 13-21). For eggs and larvae, the relative risk to individuals, as assessed by Popper *et al.*, (2014), is moderate at distances near to the source (tens of metres), and low at distances intermediate (hundreds of metres) or far (thousands of metres) from the source (Table 13-21).

The assumptions for noise modelling are considered to represent a highly conservative worst-case scenario, however, in reality, the effects are assumed to be less. All other fish species are considered to be mobile receptors and have the ability to move from the area with the onset of pilling activity to avoid masking and behavioural effects. The only exception to this would be eggs and larvae which are less mobile and potentially more vulnerable to impact. Considering the Popper *et al.*, (2014) criteria, behavioural effects or auditory masking in fish species from impact piling are expected to be moderate in the far field (i.e. thousands of metres), and high within the intermediate field (i.e. hundreds of metres) for Group 3 and 4 species. For Group 1 species, the behavioural effects range from high at distances near to the source, moderate at distances intermediate to the source and low at distances far from the source. Masking effects range from moderate near the source to low at intermediate and far distances from the source for Group 1 species (Popper *et al.*, 2014). Finally, for eggs and larvae, the risk of masking and behavioural effects is moderate in the near field and reduces to low in the intermediate field (Table 13-21).

Many of the fish predicted to utilise the Study Area are considered to be nationally or international important receptors. Other fish species not already assessed (including marine finfish, non-salmonid diadromous fish and eggs and larvae) have a **medium sensitivity** to underwater noise generated from impact piling activities, as outlined in the section above for mortality, potential mortal injury and recoverable injury.

The impact is defined as being of a medium spatial extent and short-duration, reversible and of a low frequency (average 95 days per year for three years for FTU anchors and 14 days for OSCPs foundations, i.e. seven days in each of two separate years). Therefore, the impact is assessed as **low magnitude**.

Evaluation of significance

Taking the medium sensitivity of all other fish and the low magnitude of effect, the overall impact of underwater noise from impact piling on TTS, masking and behavioural disturbance on other fish species during construction is considered to be **minor** and **not significant** in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Medium	Low	Minor
Impact significance – **NOT SIGNIFICANT**		

Shellfish

As described above, there is no threshold criteria available for the assessment of potential underwater noise impacts on shellfish. Shellfish do not possess a swim bladder; therefore, it is assumed that they are only able to detect particle motion, similarly to Group 1 fish species, which have been assessed above. However, shellfish are not as mobile as fish and are less able to flee the area affected by underwater noise impacts.

Shellfish are considered to be of **low sensitivity** to masking or behavioural effects associated with underwater noise, on the basis that they are regionally important but do not possess a swim bladder, and therefore, have a reduced hearing sensitivity. The impact is defined as being of a medium spatial extent and short-duration, reversible and of a low frequency (average 95 days / year for three years for FTU anchors and 14 days for OSCPs foundations, i.e. seven days in each of two separate years). Considering the widespread presence of the shellfish species throughout UK waters, the impact is defined as being of low magnitude.

Evaluation of significance

Taking the low sensitivity of shellfish and the low magnitude of effect, the overall impact of underwater noise from impact piling on TTS, masking and behavioural disturbance on shellfish during construction is considered to be minor and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Low	Low	Minor
Impact significance – NOT SIGNIFICANT		

13.6.1.2.4 Construction vessel noise

The most well-known and frequently-studied continuous sounds in the oceans are those produced by ships, as well as smaller vessels. However, other sources, such as vibratory pile drivers and vessels dredging for aggregates, also produce continuous sounds (Robinson *et al.*, 2011). Popper *et al.* (2014) states that there is no direct evidence of mortality or potential mortal injury to fish from ship noise. However, continuous noise of any level that is detectable by fish can mask signal detection and thus may have a pervasive effect on fish behaviour. Nonetheless, the consequences of this masking and any attendant behavioural changes for the survival of fish are unknown. Popper *et al.* (2014) concludes that lack of quantification of exposure sound levels that elicit responses to ships makes it impossible to provide numerical guidelines for behavioural responses of fish to sounds from ships. The modelled ranges of impacts are given in Table 13-22. It should be noted that fish would need to be exposed to vessel noise 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.

*Table 13-22 Modelled impact distances of non-impulsive construction activities (**EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report**)*

SOURCE	RECOVERABLE INJURY 170 DB (48 HOURS)	TTS 158 DB (12 HOURS)
Sandwave clearance	< 10	33
Boulder clearance, offshore construction vessel, excavator, backhoe dredger	N/E	N/E
Main installation vessels (Barge/DP vessel)	< 10	33
Jack up rig	N/E	N/E
Tug/anchor handlers	< 10	19
Cable laying, installation vessels	< 10	33
Rock placement vessels	< 10	33
Guard vessels, workboats	< 10	19

SOURCE	RECOVERABLE INJURY 170 DB (48 HOURS)	TTS 158 DB (12 HOURS)
Survey vessels, geophysical/geotechnical survey vessels	N/E	< 10

As noted above for impact piling (Section 13.6.1.2.3), the highest sensitivity afforded to fish species for underwater noise is a **medium sensitivity** for herring, salmonids, sandeel and other fish species.

Shellfish may also be sensitive to continuous sound sources, such as vessel noise. Shellfish do not have a swim bladder and are therefore only able to detect particle motion, and therefore, underwater noise modelling for shellfish have not been conducted. Overall, shellfish are assessed as having a **medium sensitivity** to underwater noise, as described in Section 13.6.1.2.3.

It is important to note, based on Automatic Identification System (AIS) there are existing shipping lanes that intersect with the Project Area, therefore, the baseline noise within the region will already include noise produced from these vessels. Further detail on shipping routes through the area is provided in **EIAR Vol. 3, Chapter 15: Shipping and Navigation**. Based on likely existing levels of background noise, the magnitude of effect attributed to noise exclusively from vessels, is deemed **negligible**.

Evaluation of significance

Considering the medium sensitivity and negligible magnitude of impact, the overall impact of construction vessel noise on all fish and shellfish species during construction is considered to be **negligible** and **not significant** in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Medium	Negligible	Negligible
Impact significance – NOT SIGNIFICANT		

13.6.1.2.5 UXO clearance

As described in Section 13.6.1, although there is only a small probability of locating UXO, UXO clearance has been identified as a possible noise source with the potential to impact Fish and Shellfish Ecology. The overall impact of UXO clearance would be a very short-term (seconds) increase in underwater noise (i.e. sound pressure levels and particle motion). During this time, injury or behavioural effects may occur to fish and shellfish species. The worst-case scenario considered with respect to UXO clearance is:

- Up to 50 clearances using a low-noise technique, such as LOD with a donor charge of 0.08 kg; and
- A single HOD of a UXO with a charge weight of 227 kg, plus a 5 kg donor charge, capturing accidental or (very unlikely) necessary detonation.

Any required clearance would be subject to a separate Marine Licence and associated risk assessment provided to MD-LOT and associated stakeholders. Whilst subject to future licensing requirements, it is anticipated that LOD would be employed, with high-order (i.e. detonation) only used where absolutely necessary. This approach is consistent with the advice from MD-LOT and stakeholders and allows for a meaningful assessment of UXO clearance based on actual locations, seabed conditions and actual potential impacts to relevant receptors.

The potential impact radii associated with the worst-case HOD, detailed within Vol. 4, Appendix 15: Underwater Noise Modelling Report, have been taken forward into this assessment.

The Popper *et al.* (2014) threshold for mortality and potential mortal injury due to explosion, for all hearing groups of fish, is expected to occur between 229–234 dB re 1 µPa (Table 13-20). This range exists due to highly variable methodologies and data on fish species in relation to explosions. The guidelines provided by Popper *et al.* (2014) for explosions use the lowest amplitude in the literature available that have caused consistent mortality. Based on these thresholds, there is potential for mortality and potential mortal injury impacts to fish at up to a radius of 375-620 m from the source (Vol. 4, Appendix 15: Underwater Noise Modelling Report).

No particle motion modelling for mortality and potential mortal injury due to explosion has been undertaken for eggs and larvae. Popper *et al.* (2014) states that risk of mortality and potential mortality could occur at a peak particle motion velocity greater than 13 mm s^{-1} in a spawning bed during the egg incubation period. A study by Thomsen *et al*. (2015) investigated particle motion around the installation of piles at offshore wind sites. The study concluded that, for most fish, particle motion levels at 750 m from the pile driving are high enough to be detected. It can be assumed that eggs and larvae will experience the effects of particle motion generated by a detonation event across a greater range, due to the high-amplitude sound emissions from the explosion. However, it is likely that the potential for physical damage to eggs and larvae due to particle motion will be confined to a smaller range than disturbance and detectability.

Fish

For all fish species and groups, the maximum mortality and potential mortality impact radius for UXO clearance, based on a 227 kg UXO, is 375-620 m from the noise source (Vol. 4, Appendix 15: Underwater Noise Modelling Report). The explosion will be instantaneous, with a short-term impact, which will occur over a few seconds. It is conservatively assumed that the impact radius for mortality and potential mortal injury for eggs and larvae would be similar to those presented for all other fish species.

There is a lack of data available for the effects from UXO detonations, therefore Popper *et al.* (2014) provides only qualitative risk levels for recoverable injury and TTS. For fish Groups 2, 3, and 4 (e.g. those that possess a swim bladder), the risk of recoverable injury and TTS impacts are expected to be high in the near field (tens of metres) and intermediate field (hundreds of metres) and low in the far field (thousands of metres). For Group 1 fish species (i.e. those that do not possess a swim bladder), the recoverable injury impacts are expected to be high in the near field and low in the intermediate and far field. For Group 1 fish species, TTS impacts are expected to be high in the near field, moderate in the intermediate field and low in the far field. For eggs and larvae, a qualitative risk-based approach is also presented in Popper *et al.* (2014). The risk of impacts for recoverable injury for eggs and larvae are high in the near field and low in the intermediate and far field. It is acknowledged that UXO clearance may lead to disturbance, but it will be an isolated explosion (i.e. not continuous) and impacts are anticipated to be very short lived (e.g. a matter of seconds) (Table 13-20).

For all fish species considered (including eggs and larvae), sensitivity to mortal injury and potential injury impacts from UXO clearance is based on the value of the receptor, rather than sensitivity to noise as used for other noise related construction activities assessed. Many of the fish identified as present within the Study Area are judged to be nationally or internationally important (such as Atlantic salmon, sandeel, herring etc.) based on their conservation status and presence/distribution of spawning or nursery grounds. As a result of the risk of mortality, high sensitivity is assumed for all fish species present within the vicinity of the Project.

The noise impact ranges for mortality and potential mortality for explosion are the same across all the fish groups assessed with a maximum impact radius of 375-620 m. For TTS and recoverable injury, all impacts will be localised within the near and intermediate fields. The impact will be a single explosion, highly localised and extremely short lived (a matter of seconds). As the event will be instantaneous, the consequences will be limited to the individual fish located within the maximum impact radius area. As only a small proportion of each fish population is likely to be affected (and/or a small number of individual fish), a detonation event will not affect long-term functioning of whole fish populations. As such, the impact is assessed as being highly localised and of a short-duration, reversible, and of a low frequency. Therefore, the magnitude of effect from UXO clearance for all fish species, including eggs and larvae, are assessed at this stage as being of negligible magnitude.

Evaluation of significance

Considering the high sensitivity for all fish species and the negligible magnitude of effect, the overall impact of UXO clearance underwater noise during is considered to be negligible and not significant in EIA terms

Sensitivity	Magnitude of effect	Consequence
High	Negligible	Negligible

Impact significance – NOT SIGNIFICANT

Shellfish

There are no set impact thresholds for the assessment of potential underwater noise impacts on shellfish (Section 13.6.1.2.1). As such, no modelling has been undertaken for shellfish to inform impact ranges for mortality or potential mortal injury. Crustaceans have been recorded as being able to detect particle motion, therefore, it is assumed that the shellfish present in the Study Area, including crabs, lobster, and king scallops could potentially detect particle motion, similar to Group 1 fish species previously assessed in the section above.

Given the sensitivity of aquatic invertebrates to particle motion, benthic invertebrates including shellfish such as *Nephrops* are almost certainly sensitive to substrate vibration (Hawkins *et al*., 2021; Roberts and Elliott, 2017). However, if and how *Nephrops* differentiate between waterborne particle motion and substrate vibration is uncertain. Impacts of sediment-borne vibration are more poorly understood than water-borne particle motion and share the same limitations around any lack of any established disturbance thresholds.

In terms of sensitivity to mortality and potential mortal injury impacts from UXO clearance, this is based on the value of the receptor rather than sensitivity to noise as used for other noise related construction activities assessed. The shellfish species that have been identified as present within the Study Area, which are judged as commercially important are detailed in Table 13-8. As they are collectively considered to be a receptor of regional importance, shellfish are classed as being of medium sensitivity.

Based on modelling undertaken for all fish species (including Group 1 fish species), UXO clearance will be a single explosion, localised, and instantaneous (lasting seconds). The impact is assessed as being highly localised and of a short-duration, reversible, and of a low frequency. Taking this into consideration, as well as the widespread presence of the commercially important shellfish species present in Study Area and throughout UK waters, the impact is defined as being of low magnitude.

Evaluation of significance

Considering the medium sensitivity of shellfish and the low magnitude of effect, the overall impact of UXO clearance underwater noise during construction is considered to be minor and not significant in EIA terms

Sensitivity	Magnitude of effect	Consequence
Medium	Low	Minor
Impact significance – NOT SIGNIFICANT		

13.6.1.3 Potential changes to Suspended Sediment Concentrations

Fish and shellfish species may be temporarily disturbed by the suspension of sediment and deposition during the installation of Project infrastructure. This has been subject to desk-based analyses which are detailed in EIAR Vol. 3, Chapter 8: Marine Geology, Oceanography and Coastal Processes. The outputs of this analysis have been used to inform the impact assessment for Fish and Shellfish Ecology.

The proportion of the total disturbed sediment volume across the Array Area and EICC which will enter suspension and be distributed in a temporary plume is dependent on the local composition of the sediment (see EIAR Vol. 3, Chapter 8: Marine Geology, Oceanography and Coastal Processes for further details). The rest of the sediment volume that will be disturbed and will not enter in suspension, will instead be deposited more locally. The impact of suspended sediment and the deposition of the sediment within the Array Area and EICC are considered here for Fish and Shellfish Ecology.

The seabed preparation (e.g., undertaking PLGR), construction and installation of infrastructure such as the IACs, Export/Import Cable, anchors and mooring lines (including pre-lay) on the seabed, and rock placement will disturb seabed sediments and result in a temporary increase in SSC. Of these, the worst-case SSC will be generated by cable burial by ploughing, trenching and jetting. The results presented herein are with specific reference to the cable installation activities. The extent of SSC and deposition will be determined by the nature of the sediments within the Project Area. Assumptions regarding tool parameters and aspects of the physical environment (e.g. flows and sediments), which all affect SSC and deposition, are fully described in EIAR Vol. 3, Chapter 8: Marine Geology, Oceanography and Coastal Processes.

The maximum extent of the plume within the Array Area associated with installation of IACs could be up to the tidal excursion extent of around 4.5 km. The tidal excursion extent is defined as the path followed by tidal currents, and the maximum distance that tidal currents might displace water in one flood or ebb cycle from a given location. This is a limiting factor in the maximum spatial extent of sediment plume effects. The maximum SSC for the cable trenching activities is very locally hundreds of thousands of mg/l, which then reduces to low thousands of mg/l between 50 m and 500 m from the disturbance. Should the plume reach the tidal excursion extent of around 4.5 km, between one to six hours after disturbance, SSC would be at tens of mg/l. A return to background levels characteristic of the Array

Area also occurs rapidly with the cessation of activity with concentrations of around <10 mg/l occurring over longer durations (at approximately six to 24 hours). Therefore, elevated SSC concentrations will only last over a matter of hours, up to a maximum of a day. Therefore, water column SSC impacts to fish and shellfish species are limited to this timeframe.

With regards to cable installation within the EICC, the maximum extent of the plume will be the tidal excursion distance of up to 12 km. Very locally, the maximum SSC for the cable trenching activities is hundreds of thousands of mg/l, which then reduces to hundreds to low thousands of mg/l between 50 m and 500 m from the disturbance. Should the plume reach the tidal excursion extent, which ranges between 5 km and 12 km along the EICC, between one to six hours after disturbance, SSC would be at tens of mg/l. A return to background levels would also occur rapidly as the trenching tool moves on, with concentrations of <10 mg/l occurring over longer durations (at approximately at approximately six to 24 hours).

In the case of sediment deposition, cable installation will result in direct deposits of sediment on the seabed. The greatest zone of increased SSC and thickest deposition will be within 50 m of the disturbance. This is applicable to installation of the Export/Import Cable within the EICC and the IACs within the Array Area. All gravel sized sediment will likely be deposited in this zone, along with a large proportion of any coarser sand grains that are not resuspended high into the water column. Here, these coarser sediments may be deposited to local thicknesses of tens of centimetres to several metres. Beyond 50 m, deposition thickness will decrease. Here, SSC will be measurable but significantly reduced and deposition will only last within an hour of the activity taking place. Deposition of coarser sediments (sands and gravels) will be on the scale of tens of centimetres and finer sediments will be deposited at negligible thicknesses. Beyond 500 m, there will be no measurable thickness of deposition of any sediments. In terms of impacts on fish and shellfish species, sedimentation will be localised to within 500 m of the cable installation and any smothering effects will be highly localised to within 50 m of the activity.

Additionally, the release of drilling fluid during HDD punch out at the landfall will also result in temporary increase in SSC. As described in EIAR, Vol. 4, Appendix 7: Marine & Physical Processes Modelling Report, the release of bentonite and drill cuttings in the form of drilling fluid from the planned HDD operations will result in a localised and temporary plume of elevated SSC specifically comprising bentonite clay (a natural non-toxic mineral). Any plume will be small in absolute and relative terms (tens to low hundreds of mg/l over footprints less than 500 m over a period of minutes to one hour). It is expected that the plume would be dispersed to relatively low concentrations within hours of release and to background concentrations within a few tidal cycles (i.e. 1 day) and any bentonite in the drilling fluid will be widely dispersed to very low concentrations before settling. If any bentonite and/or drill cuttings did accumulate in or around the HDD exit point, the accumulated material is expected to be reworked and redistributed to not-measurable concentrations and thicknesses over time by wave and tidal action.

13.6.1.3.1 Herring

The Array Area does not overlap with any herring spawning grounds and only overlaps with low intensity nursery areas. For this reason, it is anticipated that herring larvae and eggs are expected to be scarce in the vicinity of the Array Area. While the EICC does partly overlap with a herring spawning area, the PSA results from the EBS reports (EIAR Vol. 4, Appendix 10: Environmental Baseline and Habitat Assessment Report - Inshore EICC, EIAR Vol. 4, Appendix 11: Environmental Baseline Report – OWF, EIAR Vol. 4, Appendix 12: Environmental Baseline Report - EICC) conducted along the EICC and Array Area found that a majority of the sediment samples were considered to be ‘unsuitable’ for herring spawning.

The opportunity for the SSC plume and subsequent deposition to affect herring spawning, eggs and larvae is only likely to occur along the EICC closer to the coast. However, this will be extremely spatially limited considering the thickest deposits will occur within 50 m of the cable installation. Beyond this, the negligible extent and thickness of sedimentation is unlikely to materially affect fish species.

Herring are considered to be nationally important and have a medium vulnerability as a result of their dependence on the seabed for spawning and their demersal egg phase. Therefore, herring are assessed as having a **medium sensitivity** to increases in SSC and smothering. The impact is assessed as occurring over a local spatial extent and of a short duration, reversible, and of a low frequency (intermittent over construction). Overall, the impact will only affect a small area of the seabed (the majority of which is unlikely to be important to herring populations), and the impact is therefore defined as being of **low magnitude**.

Evaluation of significance

taking the medium sensitivity of herring and the low magnitude of effect, the overall impact of potential changes to SSC on herring during construction consequence is considered to be **minor** and **not significant** in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Medium	Low	Minor

Impact significance – NOT SIGNIFICANT

13.6.1.3.2 Sandeel

Sandeel are demersal spawners. Analysis of PSA data across the Project Area indicates that a majority of sample locations were 'unsuitable' for sandeel spawning and only two sediment samples showed 'preferred)' (**EIAR Vol. 4, Appendix 10: Environmental Baseline and Habitat Assessment Report - Inshore EICC, EIAR Vol. 4, Appendix 11: Environmental Baseline Report – OWF, EIAR Vol. 4, Appendix 12: Environmental Baseline Report - EICC**) (see Section 13.4.4.2.1).

Sandeel are a protected species (PMF) and are therefore considered to be of national importance. Sandeel have a medium vulnerability to SSC and smothering owing to their dependence on specific sediment characteristics for the majority of their life-cycle. However, sandeel and their eggs tend to inhabit areas with a high energy environment, where sediment resuspension and deposition are frequent. Therefore, overall sandeel are assessed as having a **medium sensitivity** to increases in suspended sediments and smothering as a result of construction activities associated with the Project.

The majority of sediment deposited will be within 50 m of the activity, and the majority of the deposition will occur within the first hour of disturbance. SSC levels will likely reduce to background within 24 hours. Therefore, any impacts on sandeel will be limited in duration. Impacts on spawning behaviour will be limited to within 24 hours which is minimal in the context of the sandeel spawning season (from November to February).

Based on the local spatial extent and reversible nature of the impact, combined with the short-duration and low frequency nature of the construction activities, the impact is defined as being of **low magnitude**. Any impacts are unlikely to affect the functioning of the sandeel populations.

The Turbot Bank NCMPA (designated for sandeel) is located approximately 6 km from the EICC. the site (as the receptor) is considered to be of high sensitivity.

The location of the NCMPA in relation to the EICC is approximately in line with where the tidal ellipses are in the region, approximately 10 km. This means that, at worst, sediment plumes can travel up to this distance prior to settling out of suspension. Therefore, the finest sediments disturbed during installation of the EICC may travel into the NCMPA. However, as stated in Section 13.6.1.3, the deposition of sediments is greatest within the initial 50 m of the activity. Beyond 500 m, deposition beyond baseline conditions is not detectible. Therefore, with regards to sandeel populations within the NCMPA, although there is a potential pathway for impact, the impact is considered to be of low magnitude.

Evaluation of significance

taking the medium sensitivity of sandeel and the low magnitude of effect, the overall impact of potential changes to SSC on sandeel during construction is considered to minor and not significant in EIA terms.

As a designated site, the turbot bank NCMPA is of high sensitivity. However, the impact remains, as above, of low magnitude, and therefore, the overall effect of potential changes in SSC on this NCMPA is minor and not significant in EIA terms.

Species	Sensitivity	Magnitude of effect	Consequence
Sandeel	Medium	Low	Minor
Turbot Bank NCMPA	High	Low	Minor
Impact significance – NOT SIGNIFICANT			

13.6.1.3.3 Pelagic-spawning marine finfish

Pelagic-spawning finfish do not spawn on the seabed and are therefore less reliant on the seabed than herring and sandeel. The construction activities will generate localised increases in SSC within the Array Area and along the EICC. Adult finfish are highly mobile species and have been known to display avoidance behaviour within affected areas of increased SCC (EMU, 2004). Juvenile marine finfish may also be present within the Study Area (Section 13.4.4.1).

The buoyant eggs from pelagic spawners are less vulnerable to increased SSC, however, in some cases, the eggs may sink if sediment adheres to the surface. This can result in reduced oxygen diffusion rates which can ultimately impact larvae. In these instances, the larvae could be subject to damaged gill tissue (Robertson *et al.*, 2006; Wenger *et al.*, 2017). This would only have an effect on eggs or larvae located in close proximity to the construction activities (largely within 50 m of the disturbance). Tidal currents can also rapidly disperse any disturbed sediment. Deposition of the sediments once they fall out of suspension is unlikely to affect those species which spawn pelagically. As their eggs are released into the water column, they will not be affected by processes occurring on the seabed. Overall, although pelagic-spawning marine finfish may be of regional to international importance, they are considered to have a low vulnerability to this impact. Therefore, pelagic-spawning marine finfish are considered to be of low sensitivity to increased SSC and smothering.

As noted previously, elevated SSC will be localised and temporary in duration (up to 24 hours). Sediments deposited out of suspension will be primarily within 50 m of the disturbance, therefore the impact is considered to occur over a local spatial extent and of a short duration, reversible and of a low frequency (intermittent over construction). Therefore, the impact is defined as being of a low magnitude.

Evaluation of significance

Taking the low sensitivity of pelagic-spawning marine finfish and the low magnitude of effect, the overall impact of potential changes to SSC on pelagic-spawning marine finfish during construction is deemed minor and therefore not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Low	Low	Minor
Impact significance – NOT SIGNIFICANT		

13.6.1.3.4 Shellfish

Mobile crustaceans have the ability to move away from areas of increased SSC and mortality as a result of the impact, is considered unlikely (Neal and Wilson, 2008). However, less mobile shellfish species, such as berried crabs and lobsters, and king scallops are more vulnerable to increases SSC as they are less able to migrate away from affected areas. As described in Section 13.6.1.1.4, berried crabs and lobsters are potentially vulnerable to sediment deposition as their eggs need regular aeration (Neal and Wilson, 2008).

Increased SSC may also adversely impair the feeding capabilities of king scallops, although they are a mobile species and individuals are capable of moving away from areas with higher sediment loads. Smothering impacts may be avoided by king scallops as individuals can lift themselves clear of the newly deposited sediment layer (Marshall and Wilson, 2008).

Nephrops, which are likely to be found in the Project Area, are considered tolerant of increases in SSC and smothering. As scavengers, they are not dependent on suspended sediment for food availability (Sabatini and Hill, 2008). Furthermore, as a burrowing species, they will be able to excavate any sediment deposited as a result of Project construction activities.

Shellfish are deemed to be of regional importance, as they are not protected but are of commercial importance in the Study Area. Due to their relative immobility, they have been assessed as being of medium vulnerability to increased SSC and/or smothering, either throughout the life cycle or during the breeding season. Therefore, shellfish are judged to have a medium sensitivity. Any increases in SSC and associated smothering during the construction phase will be short-term, and localised in nature, representing a small proportion of the available habitat in the area. Overall, the impact is considered to be of a local spatial extent and short-duration, reversible and of a low frequency (intermittent over construction). Therefore, the impact is defined as being of low magnitude.

Evaluation of significance

Taking the medium sensitivity of shellfish and the low magnitude of effect, the overall impact of potential changes to SSC on shellfish during construction is deemed to be of minor consequence and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Medium	Low	Minor
Impact significance – NOT SIGNIFICANT		

13.6.1.3.5 Elasmobranchs

Elasmobranchs are highly mobile and are not considered to be vulnerable to increases in SSC and subsequent deposition. Species with demersal reproductive strategies may be more susceptible to SSC and associated deposition impacts.

Common skate or other oviparous elasmobranchs are not thought to be present in significant numbers within the Study Area and are also not considered to be sensitive to smothering from increases in SSC as adults. Neal and Pizzolla (2006) suggest that common skate might experience some stress due to loss of food and energetic costs of migrating to new foraging areas. Heavy rates of sedimentation may smother egg cases, and therefore, oviparous elasmobranchs are considered to have a medium vulnerability to this impact, although species are considered relatively tolerant of low sediment loads (Scottish Government, 2023). Furthermore, considering the limited spatial extent of potential sediment plumes and associated deposition, the degree of avoidance by elasmobranchs is unlikely to be significant. Therefore, elasmobranchs have been assessed as medium sensitivity.

As described in Section 13.4.4.5.1, several ovoviviparous elasmobranchs may also be present at the Project Area. Basking sharks are more likely to occur in the Study Area during the summer foraging and breeding season but there have been very few sightings, so the species is not thought to be present in significant numbers within the Study Area. Basking sharks are ovoviviparous and are not reliant on the seabed for reproduction (Wilson *et al.*, 2020). They are also filter feeders and during the summer months, when they are most likely to be present, spend most of their lives in the water column close to the surface, and therefore, they are unlikely to be affected by increased SSC due to construction activities on the seabed. Tope shark also have nursery grounds which overlap the Project Area and give birth to live young. Overall, these species have been assessed as having a negligible vulnerability to SSC, and therefore, is judged to have a negligible sensitivity to increased SSC.

The impact is considered to be of a local spatial extent and short-duration, reversible and of a low frequency (intermittent over construction). Considering the limited spatial extent of potential sediment plumes and associated deposition, the impact is of low magnitude.

Evaluation of significance

Taking the medium sensitivity of viviparous elasmobranchs and the low magnitude of effect, the overall impact of potential changes to SSC on viviparous elasmobranchs during construction is assessed as minor and not significant in EIA terms.

Taking the negligible sensitivity of ovoviviparous elasmobranchs and the low magnitude of effect, the overall impact of potential changes to SSC on ovoviviparous elasmobranchs during construction is assessed as negligible and not significant in EIA terms.

Species	Sensitivity	Magnitude of effect	Consequence
Viviparous elasmobranchs (e.g common skate)	Low	Low	Minor
Ovoviviparous elasmobranchs (e.g. basking shark)	Negligible	Low	Negligible

Impact significance – NOT SIGNIFICANT

13.6.1.3.6 Diadromous fish

Salmonids can be sensitive to increases in SSC as the impact can reduce the ability to visually detect prey species (Abbotsford, 2021). However, the impact on adult fish will be limited to times when they pass through the Project Area during migration. While species may migrate through the Project Area, the specific footprint of the Project itself is unlikely to be of significance to diadromous species and exposure to increased SSC will be limited in duration.

Generally, diadromous fish species are expected to have some tolerance to elevated SSC, as they occur within rivers (often with significant suspended sediment) and their migration routes typically pass through estuarine habitats, which are known to have more turbid waters. Migratory salmonids also tend to swim within the top 5 m of the water column (Godfrey *et al.*, 2014) rather than closer to the seabed, therefore will unlikely be affected by the disturbed seabed sediment. Therefore, Atlantic salmon are unlikely to encounter any plumes (the highest SSC will be closest to the location of the activity). Other diadromous species, such as eels and lamprey, tolerate silty turbid and poor light conditions (Behrmann-Godel and Eckmann, 2003; Hansen *et al.*, 2016; Christoffersen *et al.*, 2018). As these species are all highly mobile and pelagic then there is also no risk of smothering or burial.

Diadromous fish are deemed to be of low vulnerability and of national to international importance. As highly mobile species, diadromous fish are capable of moving to avoid an area of elevated SSC. Overall, diadromous fish are considered to have low sensitivity to increased changes in SSC as a result of Project construction activities. While migrating, diadromous fish e.g. Atlantic salmon could feasibly cross the Project Area during migration to or from freshwater during the construction phase, this will be of a short duration. Therefore, the likelihood of migrating or marine resident individuals of these diadromous species encountering an area of increased SSC is low.

The impact is considered to be of a local spatial extent and short-duration, reversible and of a low frequency (intermittent over construction). Given the limited spatial extent of potential sediment plumes and associated deposition, and the highly mobile nature of diadromous fish species, the impact is deemed to be of low magnitude.

Evaluation of significance

taking the low sensitivity of diadromous fish and the low magnitude of effect, the overall impact of potential changes to SSC on diadromous fish during construction is deemed **minor** and therefore **not significant** in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Low	Low	Minor
Impact significance – NOT SIGNIFICANT		

13.6.1.4 Basking shark collision with vessels

Basking sharks typically feed very close to the surface and at slow speeds (Sims *et al.*, 2000) and are therefore at risk from collision with vessel traffic. However, there have not been any recorded observations of basking shark within the Study Area in the past 10 years (Hebridean Whale and Dolphin Trust, 2024; NMPi, 2024). In the absence of density or abundance data for basking shark, a qualitative impact assessment has been conducted under the precautionary assumption that individuals may be present in very low numbers within the Project Area during the lifecycle of the Project.

Basking sharks have a global distribution and are widespread along the west coast of the UK. However, they are classed as Endangered on the IUCN Red List of Threatened Species (Rigby *et al.*, 2021). At a national level, they are a PMF (NatureScot, 2020) and are protected in waters <12 NM from the coast under Schedule 5 of the Wildlife and Countryside Act 1981.

While there is literature on the recovery of some elasmobranch species to instances of injury from collision with vessels, there is no evidence on healing rates in basking sharks. Though not comparable to injury resulting from ship strike, healing of smaller injuries and abrasions associated with hooks and harpoons is regularly evidenced in other elasmobranch species (Wilson *et al.*, 2020). The body of literature on this topic indicates that healing rates may be slower in cooler waters (Wilson *et al.*, 2020). Photo-identification and observational studies of basking sharks regularly record injuries, scars, notches in fins, propeller injuries, ship-strikes, and marks from nets or ropes (Speedie and Johnson, 2008; Speedie *et al.*, 2009; Solandt and Chassin, 2013), suggest basking sharks can heal and recover from a range of injuries (Wilson *et al.*, 2020).

There have been numerous accounts of basking shark ship strikes (Kelly *et al.*, 2004; Speedie and Johnson, 2008). The Marine Conservation Society (MCS) reported 63 sharks suffering from ship strike or entanglement in fishing gear between 1992 and 2013 (Solandt and Chassin, 2013). In more severe cases, these collisions can result in fatal wounds (Chilton and Speedie, 2008). This is most likely to occur with fast moving vessels.

The slow growth rate, slow maturation, long gestational period, and small litter sizes of basking sharks results in very slow species recovery (Wilson *et al.*, 2020). Where a ship strike is fatal to the individual, it is unknown what the consequence of this would be at a population level. The consequence of a rare collision resulting in death of a mature individual is the removal of a breeding shark from the population. However, there is no evidence of delayed or long-term effects on feeding and reproductive success (Wilson *et al.*, 2020). There is considerable uncertainty regarding population-level consequences of basking sharks because little is known about them, especially in the North Sea.

Overall, evidence from other elasmobranch species suggests that minor injuries in basking sharks might heal within a few months. More significant (but not fatal) injuries might heal within a year (Wilson *et al.*, 2020). Ship strike could result in death of individual basking sharks, however the wider implications of this at the population-level are little understood. The loss of an individual under the rare circumstances of a collision is unlikely to affect the population more widely. The MarLIN sensitivity assessment for basking shark concludes they have medium resistance and resilience, representing the potential for mortality while acknowledging the lack of evidence for delayed or long-term effects on feeding and reproductive success. Therefore, MarLIN concludes the species is of medium sensitivity (Wilson *et al.*, 2020). On this basis, this assessment judges basking sharks to have a medium vulnerability to vessel collision. Combined with the international importance of this species, basking sharks are judged to have a medium sensitivity to vessel collision.

While there is potential for collision during the construction phase of the Project, most of the vessels during this time will be slow moving, and a low-speed ship strike is less likely to result in serious injury or death. Furthermore, the potential for interaction between Project vessels and basking sharks will likely be limited to certain times of year when the sharks are foraging at the surface (i.e. in summer) and potentially breeding. Otherwise, they are more likely to be found at depths below the hull or propulsion system of most vessels. Finally, given the limited presence of basking shark in the North Sea (relative to the seas off western Scotland), the likelihood of a vessel collision is very low. Overall, the impact is considered to be highly localised, of a short-duration, reversible and of a low frequency (intermittent over construction). Therefore, the potential for basking shark collision with a Project vessel is considered to be of negligible magnitude.

Evaluation of significance

Taking the medium sensitivity of basking shark and the negligible magnitude of effect, the overall impact of vessel collision on basking sharks during construction is considered to be negligible and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Medium	Negligible	Negligible

Impact significance – NOT SIGNIFICANT

13.6.2 Potential effects during operation and maintenance

13.6.2.1 Temporary impacts to the seabed and sensitive fish habitats (e.g. spawning and/or nursery habitats)

Temporary habitat loss and disturbance will also occur during the operation and maintenance phase as a result of seabed disturbance during major cable repair or replacement activities. This temporary disturbance would occur intermittently over the 35-year operation and maintenance phase. However, the spatial extent would be highly localised and is not expected to exceed the effects assessed for the construction phase. Therefore, the sensitivity and magnitude ratings for temporary impacts to the seabed during the construction phase (Section 13.6.1.1) is also considered applicable to the operation and maintenance phase.

Evaluation of significance

Taking the negligible to high sensitivity of fish and shellfish species and the negligible magnitude of effect, the overall impact of temporary habitat loss / disturbance to fish and shellfish species during the operation and maintenance phase ranges is **negligible** for all species and **not significant** in EIA terms.

Species	Sensitivity	Magnitude of effect	Consequence
Herring	Medium	Negligible	Negligible
Sandeel	High	Negligible	Negligible
Pelagic-spawning marine finfish	Low	Negligible	Negligible
Shellfish	Medium	Negligible	Negligible
Common skate	High	Negligible	Negligible
Spotted ray, thornback ray, spurdog and tope shark	Medium	Negligible	Negligible
Basking shark	Negligible	Negligible	Negligible
Diadromous fish	Negligible	Negligible	Negligible
Impact significance - NOT SIGNIFICANT			

13.6.2.2 Long-term impacts to the seabed and sensitive fish habitats (e.g. spawning and/or nursery habitats)

There is potential for long-term impacts on spawning and nursery grounds as a result of the placement of OSCPs foundations, FTU anchors, mooring lines, IACs and the Export/Import Cable. The presence of anchors, cables and associated protection, will result in the loss of available habitat which may currently be utilised as spawning and nursery grounds by the species listed in Table 13-4.

The total maximum seabed footprint consists of FTU mooring chains and anchors (including associated piles), IACs and Export/Import Cable remedial protection, and OSCP footprints (inclusive of piles and mudmats). As per Table 13-17, the total permanent footprint is 1.90 km^2. The intention is to bury the IACs within the Array Area to a minimum depth of 0.4 m. However, where this is not possible in localised areas, remedial protection may be required, and external protection will also be required at touchdown points. Along the IACs, no rock placement is anticipated to be required, except at crossing locations and at the OSCPs, and alternative remedial protection measures will be used. This will prevent lateral movement of the cables and thus remove the potential for formation of scour during the operational phase.

Within the Array Area, and included within the total maximum seabed footprint, there will be a footprint associated with the lateral movement of the FTU mooring lines on the seabed. This swathe area will affect up to 1.44 km^2 in total, across all the whole Array Area. The movement will be continuous over the operational phase of the Project therefore this area will be constantly subject to disturbance. It is important to note that this is a worst-case and will depend on the final design chosen.

The Array Area may overlap spawning areas for cod, herring, lemon sole, mackerel, *Nephrops*, Norway pout, plaice, sandeel, sprat and whiting, and may provide nursery grounds for anglerfish, herring, mackerel, sandeel, haddock, cod, lemon sole, sandeel, European hake, *Nephrops*, blue whiting, Norway pout, saithe, hake, ling, common skate, Spurdog, sprat, spotted ray, tope shark, and whiting (Table 13-4).

Spawning and nursery grounds are extensive and extend widely beyond the Project Area, the proportion of spawning and nursery ground that may be affected by the Project and associated infrastructure on the seabed is very small in relation to the available spawning and nursery grounds.

13.6.2.2.1 Herring

As previously described, although the Project Area overlap with herring spawning grounds the PSA results (EIAR Vol. 4, Appendix 10: Environmental Baseline and Habitat Assessment Report - Inshore EICC, EIAR Vol. 4, Appendix 11: Environmental Baseline Report – OWF, EIAR Vol. 4, Appendix 12: Environmental Baseline Report - EICC) indicated that all of the sediment samples were considered to be 'unsuitable' for herring spawning.

Herring are considered to be a nationally important receptor due to their importance as a prey species for many marine predators, and their listing as a PMF. Due to their specific habitat requirements, herring are considered to have a medium vulnerability to substratum loss and overall are deemed to be of a medium sensitivity.; However, the sediments in the Project Area indicate that there is no overlap with key herring spawning grounds. Ultimately, the long-term loss of spawning habitat will be highly localised within an area thought to experience low levels of herring spawning. Furthermore, this is limited to the operational life of the Project (35 years), before the infrastructure is removed during decommissioning. Overall, the impact is considered to be highly localised, long-term (but of a finite duration) and continuous. In the context of the importance of the Project Area for herring spawning, the impact is defined as being of negligible magnitude.

Evaluation of significance

Taking the medium sensitivity of herring and the negligible magnitude of effect, the overall impact of long-term habitat loss and disturbance on herring during the operation and maintenance is considered to be **negligible** and **not significant** in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Medium	Negligible	Negligible
Impact significance – NOT SIGNIFICANT		

13.6.2.2.2 Sandeel

As a result of the specific habitat requirements preferred for demersal spawning and for burrowing adult and juvenile sandeel, the Scottish Government FeAST tool categorises sandeel as having a high sensitivity to a physical change in seabed type. Therefore, sandeel are considered to have a high vulnerability to this impact (Scottish Government, 2023). Combined with the national importance of this species, sandeel are assessed to have a **high sensitivity**.

The placement of long-term infrastructure on the seabed, represents a physical change in the seabed type over a maximum area of 1.90 km^2 for the duration of the operation and maintenance phase (35 years). For context, the Array Area is approximately 333 km^2 and the EICC is approximately 230 km in length. The area of seabed affected long-term by the presence of Project infrastructure will equate to <0.5% of the entire Project Area. Given the PSA results have shown that most of the Project Area is largely unsuitable for sandeel spawning, it is unlikely that this area represents an important area of spawning habitat lost to sandeel. Furthermore, the seabed footprint associated with the Project infrastructure represents a small proportion of the available habitat in the wider central North Sea (CNS). Overall, the impact is considered to be highly localised, long-term (but of a finite duration) and continuous. The Project Area also does not overlap with important sandeel grounds, and therefore, the impact is defined as being of **negligible magnitude.**

As mentioned in Section 13.4.4.9, the Turbot Bank NCMPA is located approximately 6 km from the EICC. There is no direct overlap between the proposed Project infrastructure and the site. Therefore, the NCMPA will not be affected by long-term impacts to the seabed.

Evaluation of significance

Taking in the high sensitivity of sandeel and the negligible magnitude of effect, the overall impact of long-term habitat disturbance and loss on sandeel during operation and maintenance is considered to be **negligible** and **not significant** in EIA terms.

Sensitivity	Magnitude of effect	Consequence
High	Negligible	Negligible
Impact significance – NOT SIGNIFICANT		

13.6.2.2.3 Pelagic-spawning marine finfish

While some pelagic-spawning marine finfish species are nationally or internationally important, those which are not reliant on the seabed during their lifecycle are considered to be of low vulnerability to habitat loss and disturbance. Hence these marine finfish are assessed as having a **low sensitivity**.

The spatial extent of the long-term habitat loss and disturbance during the operation and maintenance phase (1.90 km^2), represents a small area in comparison to the availability of habitat for pelagic-spawning marine finfish species out with the Project Area. Therefore, long-term habitat loss will only affect a small proportion of the available habitat for these species. Overall, the impact is considered to be highly localised, long-term (but of a finite duration) and continuous. Therefore, the impact is defined as being of **negligible magnitude.**

Evaluation of significance

Taking the low sensitivity of all pelagic-spawning marine finfish and negligible magnitude of effect, the overall impact of long-term habitat loss and disturbance on pelagic-spawning marine finfish during operation and maintenance is considered to be **negligible** and **not significant** in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Low	Negligible	Negligible
Impact significance – NOT SIGNIFICANT		

13.6.2.2.4 Shellfish

Shellfish receptors with restricted mobility, such as *Nephrops*, brown crab, lobster, and king scallops, are vulnerable to long-term habitat loss and disturbance.

Species such as brown crab and lobster prefer harder substrates. Brown crab are typically found under boulders, mixed coarse grounds, and offshore in muddy sand (Neal and Wilson, 2008). Therefore, placement of hard substrate such as rock, will not affect them adversely. Within windfarms in Belgian waters, Degraer *et al*. (2020) found evidence of increased numbers of species associated with hard substrates, including crustaceans (brown crab). This suggests that an introduction of hard substrate can be beneficial to some species.

Larger crustacea (e.g. *Nephrops* and 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 (or the disturbance has ceased). Thus, the MarLIN tool advises that *Nephrops* are highly intolerant of substratum loss (Sabatini and Hill, 2008). Larvae of *Nephrops* also generally remain in the hatching areas of adults and are not transported long distances by hydrographic processes. Consequently, recoverability of *Nephrops* populations to substratum loss is reliant on the continued presence of a wider mature population. Overall, MarLIN considers the ability of *Nephrops* to recover from changes in substrate to be moderate and so their overall sensitivity to this impact is moderate (Sabatini and Hill, 2008). The East of Gannet and Montrose Fields NCMPA overlaps with the Array Area and is designated for offshore deep-sea muds. Due to the high mud composition, this is potentially prime *Nephrops* habitat as discussed in Section 13.4.4.4.1. The impacts on the East of Gannet and Montrose Fields NCMPA is assessed in the MPA Assessment. Considering the regional importance of shellfish and their medium vulnerability, shellfish are assessed as having **medium sensitivity** to long-term impacts to the seabed.

Based on the spatial extent of the long-term habitat loss and disturbance during the Project's operation and maintenance phase equating to 1.90 km^2, long-term habitat loss will only affect a small proportion of the available habitat for these species. In addition, this proportionately small area should not impede the ability for unaffected populations to replenish the area, in spite of any lost habitat. Furthermore, the introduction of hard substrate may act as an area of refuge for smaller species and a potential source of food for shellfish. Overall, the impact is considered to be highly localised, long-term and continuous. Therefore, the impact is defined as being of negligible magnitude.

Evaluation of significance

Taking the medium sensitivity of shellfish and negligible magnitude of effect, the overall impact of long-term habitat loss and disturbance on shellfish during operation and maintenance is considered to be negligible and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Medium	Negligible	Negligible
Impact significance – NOT SIGNIFICANT		

13.6.2.2.5 Elasmobranchs

The Study Area overlaps with nursery grounds of tope shark, common skate, spotted ray, thornback ray and spurdog (Section 13.4.4.2). All of these elasmobranch species, except tope shark and basking shark, deposit egg cases on the seabed (i.e. viviparity), making these species vulnerable to seabed disturbance. However, in their later lifecycles, they become mobile and are less vulnerable. The main impact associated with long-term habitat loss and disturbance during the operation and maintenance phase would be the loss of suitable egg laying grounds for oviparous (produces eggs that hatch outside their body) elasmobranchs, including spurdog, thornback ray, spotted ray, and common skate. The Scottish Government FeAST tool categorises common skate as having a low sensitivity to physical change to any other seabed type (Scottish Government, 2023) which suggests they are not likely to be affected by the placement of any infrastructure and associated remediation. Combined with the national to international importance of elasmobranchs, the sensitivity to long-term impacts to the seabed is assessed as low.

Egg laying habitat may be lost due to the placement of long-term infrastructure associated with the Project. However, this would represent a localised area, with alternative egg laying grounds present in the wider region, out with the Project Area and including areas within the Array Area where no infrastructure is present on the seabed. Overall, the impact is considered to be highly localised, long-term, and continuous. Therefore, the impact is defined as being of negligible magnitude.

Evaluation of significance

Taking the low sensitivity of all elasmobranch species and the negligible magnitude of effect, the overall impact of long-term habitat loss and disturbance during operation and maintenance is considered to be negligible and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Low	Negligible	Negligible
Impact significance – NOT SIGNIFICANT		

13.6.2.2.6 Diadromous fish

Diadromous fish are national to internationally important receptors but have a negligible vulnerability to seabed disturbance, as diadromous fish are not reliant on specific seabed habitats. They are also highly mobile species;

therefore, diadromous fish are assessed as having a low vulnerability to this impact. In conjunction with diadromous fish being nationally to internationally important, they are assessed as having a low sensitivity to long-term impacts to the seabed.

Considering the localised extent of any habitat disturbance and the introduction of infrastructure, along with the wide availability of habitat available to diadromous fish out with the Project Area, the impact is not expected to have an adverse effect on migrating diadromous fish passing through the Project Area. Overall, the impact is considered to be highly localised, long-term, and continuous. Therefore, the impact is defined as being of negligible magnitude.

Evaluation of significance

Taking the low sensitivity of diadromous fish and negligible magnitude of effect, the overall impact of long-term habitat loss and disturbance on diadromous fish during operation and maintenance is considered to be negligible and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Low	Negligible	Negligible
Impact significance – NOT SIGNIFICANT		

13.6.2.3 Underwater noise

Underwater noise generated during the operational phase will predominantly be mechanically-generated vibration from the rotating machinery in the FTUs, which is subsequently transmitted into the water column. It has also been suggested that floating offshore windfarms generate additional operational noise due to the flexible mooring lines that consist of steel cables, chains or wired ropes, which may produce 'snaps' or 'bangs' during short periods of tension (Risch *et al.*, 2023). Underwater noise may also result from the presence of vessels, as described for construction.

The 'pinging' noise due to the snapping of mooring lines in the water column has been identified as a potential source of underwater noise, generating a sound of approximately 160 dB re 1 µPa (SPL_{peak}) but rarely exceeding 170 dB re 1 µPa (SPL_{peak}) (JASCO, 2011). The occurrence of this underwater noise source is characterised by discrete events, which are not likely to exceed the TTS SPL_{peak} threshold for Group 3 and 4 fish with a swim bladder-inner ear connection at 186 dB re 1 µPa (Popper *et al.*, 2014). JASCO (2014) has identified that the expected rate of pinging from mooring lines is 0.958 events per hour, although this is likely dependent on weather conditions and the motion (pitch, heave and roll) of the FTUs.

Risch *et al.* (2023) noted that during a study of two operational floating offshore windfarms, the operational noise is concentrated below 200 Hz, with median 1/3 octave band sound pressure levels between 95 and 100 dB re 1 µPa. Overall, the operational broadband source sound pressure levels from the floating offshore windfarms monitored by Risch *et al.* (2023) were above expected ambient noise levels (Wenz, 1962), and were similar to the operational noise generated from fixed offshore turbines (Tougaard *et al.*, 2020, Stöber and Thomsen 2021).

13.6.2.3.1 All fish

Operational vessel presence will be reduced in comparison to activities during the construction phase. It is likely that vessel presence will be limited to ad hoc maintenance activities. The outputs of the noise modelling documented the injury zone radii associated with various vessels which may be present over the operation and maintenance phase of the Project. For Group 3 and 4 fish (i.e. those with a swim bladder involved in hearing), the recoverable injury threshold (per Popper *et al*., 2014, shown in Table 13-9) was only exceeded within 10 m from the source. In some instances, the threshold was not exceeded at all (Table 13-22). With regards to TTS, the threshold for Group 3 and 4 fish was only exceeded within 33 m of the source (Table 13-22). This is only applicable to larger vessels (i.e. those which would be used for installation activities), which are likely to be infrequently required over the operation and maintenance phase of the Project. The radii were <33 m for smaller vessels (e.g. survey vessels). It is important to note that these radii are also highly conservative. 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. In reality, given the mobility of fish, this level of exposure will not occur. Further details on the noise modelling are available in EIAR Vol. 4, Appendix 15: Underwater Noise Modelling Report

The effects of operational noise on fish is deemed significantly less than noise generated during the construction phase (Section 13.6.1.2). Continuous noise generated from mechanically generated vibration is likely to be slightly above ambient noise levels , but not much more than fixed offshore wind turbines, with some louder 'snaps' or 'bangs' during periods of mooring tension. Popper *et al*. (2014) assesses that the threshold at which individuals will experience TTS for 12 hours is 158 dB and recoverable injury (recoverable after 48 hours) is 170 dB. Both of these thresholds are higher than the broadband source sound pressure levels recorded at floating wind farms and reported by Risch *et al.* (2023).

Many of the fish predicted to utilise the Study Area are regionally to internationally important As assessed in Section 13.6.1.2, fish receptors have a medium sensitivity to the high-amplitude underwater noise generated from construction activities and would likely have low sensitivity to relatively low amplitude operational noise within the Array Area. Fish are also mobile and have the ability to flee the area if they are disturbed. Based on the local spatial extent, long-term and continuous nature of this impact on fish species (<50 m), it is defined as being of low magnitude.

Evaluation of significance

Taking the low sensitivity and the low magnitude of effect, the overall impact of underwater noise on all fish species during the operation and maintenance phase is considered to be minor and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Low	Low	Minor

Impact significance – NOT SIGNIFICANT

13.6.2.3.2 Shellfish

There are no threshold criteria available for the assessment of potential underwater noise impacts on shellfish. Shellfish do not possess a swim bladder; therefore, it is assumed that they are only able to detect particle motion, similarly to Group 1 fish species, which have been assessed in Section 13.6.1.2 above for construction. However, shellfish are not as mobile as fish and are less able to flee the area affected by the underwater noise impacts.

As mentioned in Section 13.6.1.2, some crustacean species (Roberts *et al.*, 2016; Miller *et al.*, 2016), have been recorded as being able to detect particle motion. Therefore, it is assumed that the shellfish present within the Study Area, which include crabs, lobster, *Nephrops*, and king scallops could potentially detect particle motion.

Due to their regional importance and the assumption that shellfish have similar characteristics to Group 1 fish, therefore, have reduced hearing sensitivity, they are considered to be of negligible sensitivity to underwater noise generated during the operation phase of the Project. The impact will be localised (<50 m) and is not expected to be noisier than a fixed-bottom windfarm, other than the transient snapping sounds generated by mooring lines. Overall, the impact from continuous operational noise will be of a local spatial extent, long-term and continuous and is defined as being of low magnitude.

Evaluation of significance

Taking the negligible sensitivity of shellfish and the low magnitude of effect, the overall impact of underwater noise on shellfish during the operation and maintenance phase is considered to be negligible and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Negligible	Low	Negligible

Impact significance – NOT SIGNIFICANT

13.6.2.4 Potential effects from Electromagnetic Fields (EMF) and heat generated by cables

The Project cables, including for the IACs (static and dynamic cabling) and the Export/Import Cable in the EICC will result in emission of localised EMFs. Elasmobranchs, diadromous fish, and lobsters and crabs in particular are known to have the potential to detect EMFs (CMACS, 2003; Hutchison *et al.*, 2021). Additionally, it is understood that power cables in the marine environment generate and dissipate heat (Taormina *et al.*, 2018). These two impact pathways are addressed herein.

EMF comprise electrical fields (E-fields), measured in volts per metre (V per m), and magnetic fields (B-fields), measured in microtesla (µT). E-fields are blocked by conductive sheathing and are not emitted from the cables. However, B-fields penetrate most materials and so are emitted into the marine environment and can result in an induced electric field (iE-field).

The Earth has its own natural geomagnetic field, with associated B and iE-fields, which species rely on for navigation (Winklhofer, 2009; Gill and Desender, 2020). In the North Sea, background measurements of the magnetic field are approximately 50 µT, and the naturally occurring electric field in the North Sea is approximately 25 microvolts per metre (µV per m) (Tasker *et al.*, 2010).

Marine renewable energy researchers, developers and regulators, widely agree that EMFs emitted via cables are likely to be of relatively low intensities. The strength of B-fields (and iE-fields) decreases with distance from the source, so burying a cable results in a reduced B-field at the seabed (Nordmandeau *et al.*, 2011; CSA, 2019; Hutchison *et al.*, 2021). While the separation between source and receptor due to the burial of cables and use of cable protection reduces the maximum EMF strength likely to be encountered by marine species on or near the seabed (Copping *et al.*, 2020), it does not wholly mitigate the presence of B-fields associated with subsea cables (Hutchison *et al.*, 2021).

Design parameters and installation methods are expected to conform to industry standard specifications which includes shielding technology to reduce the direct emission of B-fields (and iE-fields).

B-fields associated with Direct Current (DC) cables are typically higher than those associated with Alternating Current (AC) cables because DC cables transmit electricity using a static current (as opposed to alternating polarity) which enables formation of a static EMF. Both AC and DC cables will be used in the Project: the IACs will be AC while the Export/Import Cable will be DC. Generally, electrosensitive species are mainly responsive to both DC and AC, low intensity IE-fields between 0.02 µV per cm and 100 µV per cm and frequencies of 0–15 Hertz (Hz) (Tricas and Sisneros, 2004; Stoddard, 2010; Hutchison et al., 2020). The FeAST tool presents a 'benchmark' level for EMF changes and sets a pressure benchmark as a change in the local iE-field of 1 V/m or local B-field of 10 µT (Scottish Government, 2023).

EMF modelling has been completed for the Project Export/Import Cable and IACs EIAR Vol. 4, Appendix 14A: EMF Assessment Report Vol. 1 and EIAR Vol. 4, Appendix 14B: EMF Assessment Report Vol. 2. The results from these studies are summarised in EIAR Vol. 2, Chapter 5: Project Description.

The Export/Import Cable will be comprised of up to 230 km of bundled HVDC cables. The cables will have a maximum voltage of up to 525 kV. EMF calculations were performed at KPs along the EICC at seabed level and at heights of 0.5 m, 1.0 m and 5.0 m above the cables, assuming these are representative of those expected for the Project, whereby DoL will range between 0.4 – 1.5 m. The B-fields were subsequently averaged across the length of the EICC. At the minimum burial depth (0.4 m), the B-fields at the seabed predicted to be 363.7 µT for the 525 kV Export/Import Cable. For cables carrying a lower voltage of 320 kV[14], the EMF at the seabed is 451.0 µT. This is above baseline levels for the North Sea and exceeds the FeAST tool benchmark for EMF changes. This is considerably lower when cables are buried to a depth of 1.5 m.

Additionally, the intensity-fields attenuate rapidly with distance from the Export/Import Cable. At a distance of 5 m from the 525 kV cable, at a depth of burial of 0.4 m, an EMF of 52.4 µT can be expected. Using the same distance and burial depth parameters, the 320 kV cable results in an EMF intensity of 52.8 µT, therefore, a return to 52.4 µT or 52.8 µT within 5 m can be taken to indicate a return to baseline EMF levels at this distance. Thus, the greatest effects will be felt within the most immediate surroundings of the Export/Import Cable.

The Project will also include up to 350 km of IACs with a voltage of up to 132 kV. Of the IACs, up to 280 km will be buried static cables, and the remaining 70 km will be dynamic in the water column and will have no contact with the seabed. The static buried sections of high voltage alternating current (HVAC) IACs exhibit much lower B-fields compared to the HVDC Export/Import Cable, as would be expected. The B-fields associated with the static 132 kV IACs is 34.4 µT at the seabed, assuming a minimum depth of burial of 0.4 m. Comparatively, the 66 kV cables generate B-fields of 64.9 µT. This exceeds baseline levels of EMF for the North Sea and exceeds the FeAST tool benchmark for EMF changes; however, the EMF intensity decays rapidly with increasing distance from the cable such that, at 1 m from the seabed, the EMF intensity has reduced by an order of magnitude, well below background geomagnetism. At 5 m from the seabed, the field strength is almost completely diminished.

[14] *EMF modelling was conducted using a lower and higher voltage for the Export/Import Cable. The lower voltage Export/Import Cable results in higher B-fields around the cable due to the higher current required for this voltage (see EIAR Vol. 2, Chapter 5: Project Description).*

From the calculations undertaken, a B-field strength of 211.8 μT occurs at the surface of the dynamic portions of the 132 kV cables. In comparison, an intensity of 360.6 μT occurs at the surface of the 66 kV dynamic cables. This is reduced by several orders of magnitude within 1 m of the cable surface and attenuates further with distance; at 10 m from the cable surface, the EMF intensity is reduced to 0.1 μT for both cable voltages, below the FeAST tool benchmark for EMF changes.

With respect to thermal emissions, water has a high specific heat capacity, meaning it is able to absorb and dissipate thermal energy originating from infrastructure such as subsea cables. Therefore, thermal emissions from the IACs and Export/Import Cable will not substantially heat the surrounding seawater, other than immediately adjacent to the cable surface where heat will rapidly dissipate. With regards to buried sections of cables, sediments within the Array Area, adjacent to the IACs and along the EICC may be subject to localised heating (Taormina *et al.* 2018), meaning only species which depend on the seabed for spawning or shelter could have the potential to be affected by thermal emissions.

Even within seabed sediments, thermal emissions are highly localised to the immediate surroundings of the cable. Taormina *et al*. (2018) found that a maximum increase of 2.5°C occurs 50 cm directly below an AC cable buried at 1 m deep. Sediment temperature increases above the cables were reduced, due to the influence of the seawater interacting with the seabed. Additionally, Emeana *et al*. (2016) determined that heat transfer was dependent on sediment type, with coarse silts experiencing the greatest temperature change. Coarser sediments had a lower temperature change but were affected over a greater distance. As sediment types change throughout the Project Area, the extent of thermal emissions within the sediments may vary across the Project Area. However, as cable thermal emissions are relatively low, the degree of heating is not likely to change perceptibly throughout the Array Area and along the EICC and is not likely to represent a significant impact on seabed sediments.

13.6.2.4.1 Marine finfish (including herring and sandeel)

Pelagic and demersal species will encounter EMF and thermal emissions associated with the Export/Import Cable and IACs. Pelagic species are more likely to encounter this through proximity to the dynamic cabling for the IACs. Comparatively, demersal fish species, including eggs and larvae of species which exhibit demersal reproductive strategies, may overlap with the EMF associated with the static cabling for the IACs and the Export/Import Cable, including burrowing species such as sandeel, and to a lesser extent place. Sandeel burrow into the seabed overnight and for prolonged periods over winter to depths of approximately 0.5 m. Herring and sandeel are demersal-spawning species, but the Project Area does not represent extensive high quality spawning habitat for these species (Section 13.4.4.2).

The evidence base for EMF effects on fish is limited and uncertain. In particular, *in situ* evidence is limited to a small number of studies. The existing knowledge base on EMF suggests that, under laboratory conditions, potential developmental, genetic and physiological implications of exposure to B-fields only occur when exposure levels are in the range of several milli Tesla (mT), rather than μT (Gill and Desender, 2020; Copping *et al*. 2021). These levels are considerably higher than would be expected to be emitted by either the IACs or Export/Import Cable (see Section 13.6.2.4). Generally, EMF associated with offshore renewable developments are unlikely to result in broad-scale or acute impacts on fish species (Gill and Desender, 2020; Copping *et al*., 2021). Furthermore, the range over which most marine finfish can detect EMF of the magnitude of those emitted by the IACs and Export/Import Cable infrastructure is limited to centimetres, rather than metres (CSA, 2019). This suggests that fish would have to be in very close proximity to the cables for relatively extended periods of time to be affected. Even then, the effects on these fish are highly uncertain and based on the current body of evidence, effects are not likely to have significant ecological consequences.

Similarly, thermal emissions are limited in extent so only those species which spend time within the sediment are expected to be affected. Due to the high heat capacity of water, thermal emissions in the water column associated with dynamic cables will not result in a discernible increase in surrounding water temperatures. Therefore. burrowing species such as sandeel and plaice are most likely to encounter elevated temperatures. Sandeel burrow into the seabed during times of low light intensity (i.e. at night and in winter; Fishbase, 2024b) and plaice burrow during the day (Fishbase, 2024c).

Sandeel productivity is understood to be affected by temperature in multiple life stages including during their reproductive cycle (Wright *et al*., 2017a, 2017b) and during their egg development (Régnier *et al*., 2018). However, the available research largely focuses on wider temperature increases associated with warming seas, whereas heating of seabed sediments due to cable thermal emissions will be so highly localised that it is unlikely demersal species will experience any effects.

Sandeel, and to a lesser extent, plaice, are shallow burrowers (Ruiz, 2007; Rowley, 2008). Although sandeel can bury to 0.5 m, therefore there is the potential for overlap with thermal emissions from the Project cables, as the minimum depth of burial will is 0.4 m. However, as noted previously in Section 13.4.4.2.1, the Project Area is not likely to constitute an important area for sandeel. Per Figure 13-8, the predicted density of buried sandeel across the Project Area is very low.

Overall, marine finfish are deemed not to be vulnerable to EMF and thermal emissions. They are highly mobile and therefore exhibit the capacity to adapt and recover to any disturbance as may be generated by EMF or thermal emissions. However, acknowledging the lack of concrete evidence on fish responses to EM and also the regional to international importance of marine finfish receptors, a conservative approach has been taken, and the receptor is considered to be of medium sensitivity.

As explained above the spatial extent of any EMF and/or thermal emissions will be minimal in the uppermost layers of sediment and to the immediate surroundings of the cable. Overall, the impact is considered to be highly localised, long-term and continuous and assessed as being of a negligible magnitude.

Evaluation of significance

Taking the medium sensitivity of marine finfish and the negligible magnitude of effect, the overall impact of EMF and heat generated from cables on marine finfish during the operation and maintenance is assessed as being negligible and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Medium	Negligible	Negligible
Impact significance – NOT SIGNIFICANT		

13.6.2.4.2 Diadromous fish

Diadromous fish contain magnetically sensitive material within their skeletons which allow them to use EMFs as a navigational tool during migration (Gill and Bartlett, 2010). Consequently, the introduction of anthropogenic EMF into the marine environment has the potential to alter these migratory behaviours (Gill and Bartlett, 2010). Due to the highly mobile nature of diadromous species in the marine environment, and the rapid dissipation of heat originating from the Export/Import Cable and the IACs, there is not thought to be any pathway for connectivity between these species and thermal emissions. Therefore, the assessment below focusses on EMF effects.

Atlantic salmon, sea trout, sea lamprey, river lamprey, and European eel may pass through the Project Area during migrations (Section 13.4.4.6). While exact migration pathways are little understood, they are likely to be diffuse across the Diadromous Fish Study Area.

No field studies are available on the response of Atlantic salmon to EMF. A study on Chinook salmon migration indicated that the presence of an energised HVDC cable did not affect the probability of successful salmon migration through a river estuary, although the EMF appeared to have limited and localised effect on the migration path and timing (Wyman *et al.*, 2018). In a laboratory setting, Armstrong *et al*. (2015) also did not find any physiological or behavioural response of Atlantic salmon to B-fields at intensities of 95 μT and below. However, this was the greatest intensity that was tested so it is not possible to deduce if any physiological or behavioural response can be expected above this B-field intensity level.

Most migratory salmonids swim within the top 5 m of the water (Godfrey *et al*., 2014; Newton *et al*., 2021). Therefore, they would be unlikely to perceive EMF emitted from buried cables, given the limited influence of EMF within a matter of metres of the seabed and the intervening distance through the water column. However, it is possible that EMF emitted from the IACs could be detected by salmon, although this will be highly localised, and EMF would only be detectable for a short period of time as they swim through the field associated with the dynamic cabling for the IACs. Similarly, other species such as eels, may be found throughout the water column, including near the seabed, but would likely only be within detectable range of any EMF for a short time as they swim through the field associated with Export/Import Cable and IACs.

Studies on European eel have concluded that subsea cables did not pose a prohibitive barrier to crossing (Hvidt *et al*., 2003); however, some individuals did show limited effects on directional movement (Westerberg and Begout-Anras, 2000) and speed (Westerberg and Langenfelt, 2008). However, these were not strong avoidance behaviours, nor were they judged likely to influence an overall migration (Westerberg and Begout-Anras, 2000; Westerberg and Langenfelt, 2008). Under laboratory conditions, Orpwood *et al*. (2015) observed no change in the movement or behaviour of European eels as a result of EMF. Overall, it is recognised that high levels of EMF emissions may have the potential to impact the behaviour and migration of diadromous fish. However, diadromous fish are considered to have low vulnerability to the levels being emitted by the Project. Combined with the international importance due to their conservation value, diadromous fish are deemed to exhibit low sensitivity to EMF effects.

While EMF will be emitted over the operational life of the Project, this will have a highly localised impact which varies depending on the current load in the cables and will be long-term and continuous. Therefore, the impact is considered to have a negligible magnitude.

Evaluation of significance

Taking the low sensitivity of diadromous fish and the negligible magnitude of effect, the overall impact of EMF and heat generated from cables on diadromous fish during the operation and maintenance phase is considered to be negligible and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Low	Negligible	Negligible
Impact significance – NOT SIGNIFICANT		

13.6.2.4.3 Shellfish

The body of literature on responses in shellfish to EMF is varied. Recent evidence suggests that crustaceans, including lobster and crab, have been shown to demonstrate a response to B-fields (CSA, 2019). Recent research on brown crab in laboratory conditions (Scott *et al.*, 2021), found that there were no adverse physiological or behavioural impacts at B-fields of 250 µT. At B-field levels of 500 µT and above attraction to the areas emitting EMF and increased time spent roaming was observed. It is important to note that while responses were observed, the proposed Export/Import Cable for would not emit B-fields exceeding 500 µT. Only at the surface of the dynamic sections of IACs would B-fields exceed 500 µT (see EIAR Vol. 2, Chapter 5: Project Description). However, there will be rapid decay of B-fields emitted by the dynamic cabling for the IACs with increasing distance from the cable, with intensities well below this 500 µT value at 1 m.

Furthermore, Love *et al.*, (2017) concluded that the attraction of crabs to EMF sources is not thought to impact overall crab movements. Research undertaken by Hutchison *et al*. (2018; 2020) on American lobster observed behavioural response to EMF associated with a HVDC cable. However, the response was subtle (Hutchison *et al.*, 2018; 2020).

While shellfish could be susceptible to EMF exposure at the seabed, the pelagic larval stages of some species may encounter the dynamic cabling for the IACs. Exposure to EMF during embryonic development was found to lead to physiological deformities and reduced swimming test success rates in lobster and brown crab larvae; however, these deformities arose in response to exposure of EMF levels of 2,800 µT over extended periods (Harsanyi *et al.*, 2022). These levels are far higher than, and therefore not comparable to, EMF levels expected for the IACs and Export/Import Cables and are considered unrealistic for comparison with the Project's EMF emissions. In reality, any larvae exposure times to dynamic cabling for the IACs will be of short duration, i.e. as they drift by in the water column. Scott (2019) also found that EMF exposure during development resulted larvae which were significantly smaller than the controls. However, there were no difference in the number of hatched larvae, mortality or fitness. Overall, recent research concerning invertebrates generally supports previous studies that demonstrated no or localised, minor effects of exposure to EMFs (Albert *et al.*, 2020).

Shellfish which burrow into sediments have limited potential for experiencing elevated temperatures due to cable thermal emissions, *Nephrops* in particular are known for burrowing into muddier sediments to depths of 20 to 30 cm (Hill *et al.*, 2008). Similarly, brown crab have been known to dig large pits in softer sediments to access molluscs (Neal and Wilson, 2008), but the depth of such pits is likely to be limited to the uppermost layer of sediments. Therefore, these species are unlikely to encounter the buried cable (buried to a minimum depth of 0.4 m). Furthermore, these excavations will be filled with water which will act to further dissipate heat, given the thermal conductivity of sea water and the relatively low ambient water temperature of the CNS.

Considering the above, shellfish species are considered to have low vulnerability EMF and heat levels associated with the Export/Import Cable and IACs. Combined with the regional importance of this receptor, shellfish are deemed to have a low sensitivity to EMF and heat emissions.

The influence of EMF and heat generated by the Export/Import Cable and IACs on shellfish is limited to those cables at, or within, the seabed. As shellfish are not mobile in the water column, the exposure to EMF and thermal emissions associated with the dynamic cabling of the IACs will be limited. The spatial extent of EMF and thermal emissions is highly localised and, given the relatively narrow zone of influence affected by EMF, as it attenuates quickly it is reasonable to expect an insignificant proportion of shellfish populations within the North Sea will come into contact with EMF levels higher than the natural geomagnetic range. B-field strengths associated with the Export/Import Cable and IACs will be essentially indistinguishable from the earth's own magnetic field intensity within a matter of metres from the cable. Therefore, the impact is defined as highly localised, long-term and continuous and is judged to be of a negligible magnitude.

Evaluation of significance

Taking the low sensitivity of shellfish and the negligible magnitude of effect, the overall impact of EMF and heat generated from cables on shellfish during the operation and maintenance phase is considered to be negligible and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Low	Negligible	Negligible

Impact significance – NOT SIGNIFICANT

13.6.2.4.4 Elasmobranchs

Elasmobranchs detect B-fields directly, due to their possession of specialist magnetic receptor cells. It is widely accepted that they are more responsive to B-fields in comparison to other species (Gill *et al.*, 2005; Hutchison *et al.*, 2020).

Gill *et al.* (2009) reported that several species of elasmobranchs showed some attraction to cables and reduced swimming activity. Gill *et al.* (2009) found that lesser spurdog and thornback ray responded to B-fields of 8 μT and iE-fields of 2.2 μV/m, but noted that the observed response was unpredictable and, in some instances, did not occur altogether. Hutchison *et al.* (2018; 2020) also demonstrated that little skate, a north American species, showed an increased exploratory behaviour in response to EMF exposure. But ultimately, the cable did not represent a barrier to skate movement (Hutchison *et al.*, 2018). Whilst evidence suggests that EMFs may attract large elasmobranchs, the magnitude of effect is currently unknown (Sims and Quale, 1998; Kempster and Collin, 2011). Elasmobranchs are also highly mobile, and able to roam across large distances, with any behavioural response only likely to occur within meters of the cable where B-field strength is observable above background.

Overall, the extent of EMF influence on elasmobranchs is variable. However, the literature appears to indicate that EMF levels higher than those expected of the Project would be required to cause behavioural change in individuals. With regard to thermal emissions, these will be limited to the buried cables in the sediment (due to the rapid dissipation of any heat energy in water). Thermal emissions will dissipate rapidly with distance from the cable, so there is limited opportunity for elasmobranchs to encounter elevated temperatures. A precautionary approach has been taken and so elasmobranchs are considered to have a low to medium vulnerability to EMF and thermal emissions. Combined with the national to international importance of this group, elasmobranchs are assessed as having a **medium sensitivity** to EMF and thermal emissions.

The literature indicates that EMF associated with cables are relatively localised. The Export/Import Cable and IACs will be insulated, sheathed and armoured to reduce EMF and thermal emissions, particularly in the water column where the dynamic cabling for the IACs is more exposed. Consequently, the impact is considered to be highly localised, long-term and continuous and is therefore assessed as being of **negligible magnitude**.

Evaluation of significance

Taking the medium sensitivity of elasmobranchs and the negligible magnitude of effect, the overall impact of EMF and a heat generated from cables on elasmobranchs during the operation and maintenance is assessed as **negligible** and **not significant** in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Medium	Negligible	Negligible
Impact significance – **NOT SIGNIFICANT**		

13.6.2.5 Operational windfarm may act as a FAD

Subsea infrastructures associated with offshore wind farms may provide shelter and new habitats for fish and shellfish species as they can act as artificial reefs. The introduction of hard infrastructure in the marine environment alters previously soft sediment habitat areas with hard structures, which can attract new species to the area, therefore, potentially increasing habitat complexity and biodiversity of the area (Degraer *et al.*, 2020).

Similarly, floating structures, associated moorings, and OSCP jacket foundations- have the potential to act as artificial reefs and FADs, which attract fish from other areas and group individuals together into a smaller area. The introduction of hard structures in the marine environment will likely become inhabited by marine organisms, creating new habitats and demonstrating an artificial reef effect. These hard structures become known as a FAD, if fish become attracted to these artificial reefs. It is thought that fish stocks concentrate around FADs, rather than actually increasing productivity and biodiversity (Inger *et al.*, 2009). Evidence suggests, however, that hard structures, which may act as artificial reefs, provide food and refuge, and therefore may increase the productivity of an area (Langhamer and Wilhelmsson, 2009; Wilhelmsson *et al*. 2006; Linley *et al.* 2007). Early results of the PrePARED project, which consisted of BRUV monitoring at operational offshore wind farms on the east coast of Scotland in 2022 to assess the presence, abundance and size of demersal fish species close to offshore wind farm turbines, indicate an increased abundance, size and mean energy content of fish near to turbines when compared to reference sites further from turbine foundations. The results indicated 2.5 times more flatfish within 30 m of turbines at the Beatrice Offshore Wind Farm and 3 times more haddock. Results at the Moray East Offshore Wind Farm were less pronounced with no increase in flatfish and two times more haddock (PrePARED, 2024). It is not possible to say whether similar changes to those observed in the PrePARED project monitoring would be reflected at this Project, or whether those effects would be significant, or even whether there would be positive, negative or neutral effects on the fish and shellfish community.

The installation of the OSCP jacket foundations (including mud mats), IACs, anchors, mooring lines, clump weights and remedial protection on the seabed within the Array Area, will provide surfaces that have the potential to be colonised. As detailed in Table 13-17, the combined seabed footprint of the infrastructure associated with the Project is 1.90 km^2. The static cabling for IACs will be buried, where possible, to reduce the footprint of additional remedial protection. Along the IACs, no rock placement is anticipated to be required, except at crossing locations and at the OSCPs, and alternative remedial protection measures will be used. External protection will also be required at touch-down points. Biofouling will occur on hard surfaces, if there is no antifouling treatment applied to the OSCP foundations, floating substructures, mooring lines, anchors or IACs. Furthermore, biofouling will also occur on any remedial protection along the cable route.

Within the Array Area, the submerged exterior surface of the FTU floating substructures and OSCP jacket foundations will provide additional colonisable hard surfaces in the water column and may provide new habitat for some benthic species. The worst-case total surface area coverage of each of the FTUs at the sea surface is 5,600 m^2 (532,000 m^2 across the Array Area), associated with a maximum mooring line length of 376,200 m across the Array Area. There will also be up to 70 km of dynamic cabling for the IACs across the Project Area. Furthermore, each OSCP will occupy a spatial footprint of 3,000 m^2. The potential impact regarding benthic species colonising the installed structures has been assessed in EIAR Vol. 3, Chapter 10: Benthic Ecology. Comparatively, the scale of the fish aggregation effect is expected to be lower for floating offshore wind developments, than other offshore industries which are characterised by foundations on the seabed (Linley *et al.*, 2007).

In sand-dominated environments, fish aggregation around hard substrate and structures is likely to boost local biodiversity and have positive impacts upon populations of key fish species such as Atlantic cod and pouting (Reubens *et al.*, 2013). However, given the scale of the Project in the context of the wider CNS, aggregations as a result of the Project are not expected to result in population-level effects. For well-established artificial reef structures, aggregation of predatory species may have a localised negative impact upon small prey species (Leitão *et al.*, 2008). However, the potential for aggregation is dependent on a number of variables relating to the size, complexity, material, location, and age of the artificial structure, in addition to seasonal distributions of fish driven by abiotic conditions (Glarou *et al.*, 2020; Wright *et al.*, 2020).

Many of the fish predicted to utilise the Study Area (as shown in Table 13-4) are of a high conservation status and therefore considered to be nationally or internationally important. Generally, pelagic, demersal and diadromous fish species have a high degree of mobility and agility. While they may aggregate in areas of high productivity (around FADs), they are considered to exhibit a level of adaptability to aggregation effects. Therefore, the receptor is deemed to be of low vulnerability and overall, a low sensitivity to this impact.

The surfaces provided by the FTU floating substructures, anchors, mooring lines, dynamic cabling for IACs and OSCP jacket foundations will provide minimal surface area for colonisation, when compared with the larger area over which substructures will be deployed, representing a very small proportion of the wider CNS. With regard to the artificial reef effect, it is likely to be a highly localised impact and unlikely to significantly increase the productivity of the area. The total area of potential new habitat is small, but this still represents a minor shift away from baseline conditions. Overall, the impact is defined as being of a local spatial extent, long-term and continuous and is judged to be of a low magnitude. Any impacts are unlikely to affect long-term functioning of the baseline fish and shellfish species.

Evaluation of significance

Taking the medium sensitivity of fish and shellfish species and low magnitude of effect, the overall impact of the operational windfarm acting like a fad is considered to be minor and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Medium	Low	Minor
	Impact significance – NOT SIGNIFICANT	

13.6.2.6 Secondary entanglement

Secondary entanglement results when marine life, such as fish, becoming entangled in debris, such as fishing gear, that has been snagged on a mooring line or dynamic sections of cable. Abandoned, Lost or Discarded Fishing Gear (ALDFG) is a recognised global issue, with fishing equipment entanglement on marine infrastructure presenting a potential pathway for injury and/or mortality of a range of marine species, including marine mammals. While commercial fisheries have a legal obligation to retrieve lost gear (e.g. MMO, 2016), it is not possible to retrieve all lost gear in every situation. The full extent of the risk secondary entanglement poses in floating offshore windfarms is limited because of the relative infancy of the industry and lack of entanglement and marine debris monitoring for existing floating development (SEER, 2022).

Experience from the oil and gas and offshore wind industries suggest that there is a low risk of entanglement to marine fauna from mooring lines and cables associated with floating offshore windfarms (Garavelli *et al.*, 2024). The Project infrastructure represents a small spatial footprint in comparison to the large spatial extent of the North Sea, which reduces the likelihood of discarded fishing gear snagging and contributing to secondary entanglement. The mooring lines and dynamic cabling for IACs will also be subject to regular maintenance work, in line with engineering requirements, where any snagged fishing gear would be routinely removed, eliminating the potential for impact further.

Within the Array Area, there will be up to 70 km of dynamic cabling for the IACs present within the water column. Additionally, the total length of mooring lines across the Array Area will be 376,200 m which introduces the additional potential for derelict fishing gear to snag.

13.6.2.6.1 All fish species

Pelagic species and demersal species may be affected by secondary entanglement, depending on where in the water column fishing gear snags on Project infrastructure including the dynamic cabling for the IACs or mooring lines within the Array Area. Therefore, the risk of secondary entanglement is not likely to be materially different between pelagic and demersal species. With respect to larger species, namely basking shark, there have been no reports of secondary entanglement with abandoned fishing gear and other marine debris in marine renewable energy systems since 2020 (Garavelli *et al.*, 2024).

As described in EIAR Vol. 3, Chapter 15: Commercial Fisheries, fishing activity within the ICES rectangles in which the Array Area sits (43F1), occurs at low levels and is dominated by demersal trawling for *Nephrops*. Low levels of demersal seine and pelagic trawls make up the remaining gear types. There is no reported gill or trammel netting within the ICES rectangles adjacent to the Array Area and lost nets from these fisheries are typically recovered in the location in which they were lost (Oliveira *et al.*, 2015). The risk of demersal trawl and seine nets being lost or fouled within the

Array Area is exceptionally low due to the fact that these are weighted nets which are dragged along the seabed and would likely remain on the seabed, should they come loose or become ensnared on obstructions on the seabed. Pelagic trawl nets are unweighted, but the scale and material used in these nets still makes them negatively buoyant and it is not anticipated that they would remain within the pelagic water column long enough to be carried by currents into the Array Area. Studies indicate that buoyant plastic fishing gear is a type of marine debris that poses a high risk of secondary entanglement and tends to remain near the surface (Gilman *et al.*, 2021). The risk of secondary entanglement may therefore be highest in the first few meters of the water column close to floating platforms; however, this type of fishing gear (set and fixed gillnets and trammel nets, drift gillnets) is not common at the Project Area. Additionally, floats and polypropylene ropes associated with static fishing (creeling) could drift into the Project Area and become snagged on Project infrastructure. This type of fishing gear has been known to entangle marine mammals in Scottish waters, and it is plausible that through a similar mechanism, it could entangle other marine megafauna such as basking sharks. However, as with other types of fishing gear, this would likely be a rare occurrence

The fishing gear types utilised in the Project Area do not lend themselves to becoming snagged on infrastructure and instead would remain on the seabed. Coupled with the low likelihood of such events occurring, it is reasonable to assume that the implications on fish and shellfish species is limited. In addition, maintenance activities will be required to regularly remove any debris on the infrastructure and cables. Furthermore, the snagged fishing gear would be static and would not be actively moving through the water column catching fish. Regular maintenance of the Project infrastructure should ensure that the potential for secondary entanglement is low. Both demersal and pelagic fish species are assessed as **medium sensitivity** to this impact. Some are nationally or internationally important due to their conservation value. However, the impact is considered to be highly localised, long-term and continuous, affecting a small spatial extent of a large maritime area used by fish species. Therefore, the impact is defined as being of **negligible magnitude**.

Evaluation of significance

Taking the medium sensitivity of all fish receptors and the negligible magnitude of effect, the overall impact of secondary entanglement on all fish species during operation and maintenance is considered to be **negligible** and **not significant** in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Medium	Negligible	Negligible
Impact significance – **NOT SIGNIFICANT**		

13.6.2.6.2 Shellfish

Shellfish have reduced mobility and typically found in close proximity to the seabed. Therefore, snagged fishing gear on the mooring lines or dynamic cabling for the IACs would have little effect on shellfish species, except for where the gear is hanging down to touch the seabed. Demersal gear types, which are prevalent in the Array Area, once lost, will remain on the seabed due to the weight of the gear. However, the proportion of seabed likely to be affected by ALDFG will be extremely small relative to the availability of shellfish habitat in the Study Area and wider CNS.

Some shellfish species, such as king scallops and 'berried' crabs and lobster, can bury themselves into the sediment, avoiding the potential dangers of secondary entanglement. Furthermore, the impact of secondary entanglement reduces further as the ALDFG is static. Other less mobile shellfish, particularly those which are filter feeders (e.g. bivalves), are unlikely to be affected by entanglement as their life strategies are not reliant on movement.

Shellfish are not protected but are classed as being regionally important due to their commercial importance in the Study Area. However, due to the reasons provided above, shellfish are assessed as being of low sensitivity. Overall, the impact is considered to be of a highly localised spatial extent, long-term and continuous but will affect a very small portion of a large maritime area used by shellfish species. Therefore, the impact is defined as being of negligible magnitude.

Evaluation of significance

Taking the low sensitivity of shellfish and negligible magnitude of effect, the overall impact of secondary entanglement on shellfish during operation and maintenance is considered to be negligible and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Low	Negligible	Negligible
Impact significance – NOT SIGNIFICANT		

13.6.2.7 Basking shark collision with vessels

As per construction, during operation and maintenance, there will be a small localised increased in vessel activity associated with operation and maintenance activities at the Array Area and EICC.

The impact for the operation and maintenance phase will occur over a longer duration than construction (see Section 13.6.1.4). However, in general due to the greater number of vessels present at the Project Area, and the temporary and intermittent nature of vessel presence during the operation and maintenance phase, the impact during operation and maintenance is considered analogous to or likely less than that of construction. Therefore, basking shark are assigned as having a medium sensitivity and the impact is considered to be of a negligible magnitude.

Evaluation of significance

Taking the medium sensitivity of basking shark and the negligible magnitude of effect, the overall impact of vessel collision on basking sharks during operation and maintenance is considered to be negligible and not significant in EIA terms.

Sensitivity	Magnitude of effect	Consequence
Medium	Negligible	Negligible
Impact significance – NOT SIGNIFICANT		

13.6.3 Potential effects during decommissioning

Effects on Fish and Shellfish Ecology receptors associated with decommissioning are anticipated to result from the full removal of the Project components. Decommissioning activities will be subject to consultations and further assessments closer to the time of decommissioning to understand technical feasibility, safety and risk, and environmental considerations in detail. These details will be included in a Decommissioning Programme which will be developed post-consent and updated over the life of the Project.

The decommissioning of the Project intends to complete the full removal of offshore infrastructure to below the mudline (where safe/practicable to do so), in line with the OSPAR Convention and forthcoming guidance from OSPAR's North-East Atlantic Environmental Strategy 2030. The majority of decommissioning works are likely to be undertaken in reverse to the sequence of construction works and involve similar or lesser levels of effects to construction.

A Decommissioning Programme will be prepared prior to construction, in line with the requirements of Section 105 of the Energy Act 2004 (as amended) and any applicable guidance available at the time. Currently it is assumed that:

- FTU substructure and WTG components will be removed and towed to port;
- Mooring lines will be removed, and where possible piles will be removed or cut to a suitable distance below the mudline such that the upper portion is removed;
- Cables no longer required will be removed where safe to do so; where they cross live third-party assets, they may be cut and left in situ to prevent damage to third-party operations; and
- The OSCPs will be decommissioned and the jacket and topside(s) will be towed to shore. The piles will be cut a suitable distance below the mudline.

The sensitivities and effect magnitudes for decommissioning are considered to be comparable to those identified for the construction phase. Therefore, in the absence of detailed information regarding decommissioning works, the effects during the decommissioning of the Project are considered analogous with, or likely less than, those of the construction phase.

13.6.4 Summary of potential effects

A summary of the outcomes of the assessment of potential effects from the construction, operation and maintenance and decommissioning of the Project is provided in Table 13-23.

No significant effects on Fish and Shellfish Ecology receptors were identified. Therefore, mitigation measures in addition to the embedded mitigation measures listed in Section 13.5.4 are not considered necessary.

As requested by NatureScot, the Applicant has also considered the potential for the Project to result in a significant impact to the national status of relevant PMFs, in line with NatureScot's Priority Marine Features Guidance (SNH, 2017). This assessment considers the distribution and status of PMFs (see Section 13.4.4), the sensitivity of the PMF to Project impacts and the magnitude of effect, as described within Sections 13.6.1 to 13.6.3.

Although there are several fish and shellfish species PMFs potentially present within the Study Area, including some which are assessed as potentially vulnerable or critically endangered on the IUCN Red List and/or listed on the OSPAR list of threatened and/or declining species, the Project Area is not considered to represent a disproportionately large or valuable portion of the population of any fish and shellfish species PMF. Furthermore, no significant long-term regional or national population level impacts are predicted to result from the Project on any fish and shellfish species.

Therefore, it is concluded that although the Project may impact PMFs, this will not result in a significant impact on the national status of any fish and shellfish species PMF.

Table 13-23 Summary of potential effects

POTENTIAL EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF IMPACT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF IMPACT)
Construction						
Temporary impacts to the seabed and sensitive fish habitats (e.g. spawning and/or nursery habitats	Herring	Medium	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
	Sandeel	High	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Pelagic-spawning marine finfish	Low	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Shellfish	Medium	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)

POTENTIAL EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF IMPACT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF IMPACT)
	Common skate	High	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Spotted ray, thornback ray, spurdog and tope shark	Medium	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Basking shark	Negligible	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Diadromous fish	Negligible	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
Underwater noise and vibration	Herring	Medium	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)

POTENTIAL EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF IMPACT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF IMPACT)
(mortality, potential mortal injury and recoverable injury)	Salmonids	Medium	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
	Sandeel	Medium	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
	Elasmobranchs	Low	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
	All other fish species	Medium	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
	Shellfish	Low	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)

POTENTIAL EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF IMPACT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF IMPACT)
Underwater noise and vibration (TTS, masking and behavioural disturbance)	Herring	Medium	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
	Salmonids	Medium	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
	Sandeel	Medium	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
	Elasmobranchs	Low	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
	All other fish species	Medium	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)

POTENTIAL EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF IMPACT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF IMPACT)
	Shellfish	Low	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
Underwater noise and vibration (construction vessel noise)	All fish and shellfish species	Medium	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
Underwater noise and vibration (UXO)	All fish species	High	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Shellfish	Medium	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
Potential changes to Suspended	Herring	Medium	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)

POTENTIAL EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF IMPACT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF IMPACT)
Sediment Concentrations (SSC)	Sandeel	Medium	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
	Turbot Bank NCMPA	High	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
	Pelagic-spawning marine finfish	Low	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
	Shellfish	Medium	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
	Viviparous elasmobranchs	Medium	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)

POTENTIAL EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF IMPACT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF IMPACT)
	Ovoviviparous elasmobranchs	Negligible	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
	Diadromous fish	Low	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
Basking shark collision with vessels	Basking shark	Medium	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
Operation and maintenance						
Temporary impacts to the seabed and sensitive fish habitats (e.g. spawning	Herring	Medium	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Sandeel	High	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)

POTENTIAL EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF IMPACT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF IMPACT)
and/or nursery habitats	Pelagic-spawning marine finfish	Low	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Shellfish	Medium	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Common skate	High	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Spotted ray, thornback ray, spurdog and tope shark	Medium	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Basking shark	Negligible	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)

POTENTIAL EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF IMPACT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF IMPACT)
	Diadromous fish	Negligible	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
Long-term impacts to the seabed and sensitive fish habitats (e.g. spawning and/or nursery habitats)	Herring	Medium	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Sandeel	High	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Pelagic-spawning marine finfish	Low	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Shellfish	Medium	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)

POTENTIAL EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF IMPACT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF IMPACT)
	Elasmobranchs	Low	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Diadromous fish	Low	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
Underwater noise and vibration	All fish species	Low	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Shellfish	Negligible	Low	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
Potential effects from Electromagnetic	Marine finfish (including herring and sandeel)	Medium	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)

POTENTIAL EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF IMPACT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF IMPACT)
Fields (EMF) and heat generated by cables	Diadromous fish	Low	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Shellfish	Low	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Elasmobranchs	Medium	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
Operational windfarm may act as a Fish Aggregation Device (FAD)	All fish and shellfish species	Medium	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
Secondary entanglement	All fish species	Medium	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)

POTENTIAL EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF IMPACT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF IMPACT)
	Shellfish	Low	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
Basking shark collision with vessels	Basking shark	Medium	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
Decommissioning						
The sensitivity of receptors and the magnitude of effect to Fish and Shellfish Ecology receptors concluded as part of the assessment of potential effects during the construction phase (Section 13.6.1) are also applicable to the decommissioning phase.						

13.7 Assessment of cumulative effects

13.7.1 Introduction

Potential impacts from the Project have the potential to interact with those from other projects (developments), plans and activities, resulting in cumulative effects on Fish and Shellfish Ecology receptors. The general approach to the cumulative effects assessment is described in EIAR Vol. 2, Chapter 7: EIA Methodology and in EIAR Vol. 4, Appendix 31: Cumulative Effects Assessment Methodology and further detail is provided below. As part of the cumulative process, a long list of plans, activities and projects (developments) is first defined. Upon review of this long list, the construction period of some of the identified developments did not overlap with the construction phase of the Project, so these plans, activities and projects (developments) will not be considered further in this cumulative assessment.

Subsequent topic/receptor-specific Zones of Influence (ZoIs) were also defined in order to narrow down the long list further to a shortlist of those plans, activities and projects (developments) relevant for assessment.

For Fish and Shellfish Ecology, the ZoI used was 60 km. This is based on the modelled maximum range of disturbance of fish due to underwater noise originating from impact piling at 150 dB SPL_{rms}. However, it is important to note that for most impacts (e.g. potential changes to SSC), the ZoI will be less than 60 km due to the more localised nature of the impact, therefore a 60 km buffer is considered to be highly precautionary.

The short list of relevant plans, activities and projects (developments) for inclusion within the cumulative effects assessment (i.e. those within the Fish and Shellfish ZoI) are in Table 13-24.

Table 13-24 List of developments considered for the Fish and Shellfish Ecology cumulative impact assessment

LOCATION	PROJECT TYPE	PROJECT NAME	DISTANCE TO PROJECT (KM)	STATUS	CONFIDENCE[15]
United Kingdom	Offshore Wind	Bowdun Offshore Wind Farm	47.49	Pre-application (Scoping)	Low
United Kingdom	Offshore Wind	MarramWind	0	Pre-application (Scoping)	Low

[15] *Confidence ratings have been applied to each cumulative development where: 'Low' = pre-application or application, 'Medium' = consented and 'High' = under construction or operational. Disposal sites are an exception to this; despite being operational, they are marked as 'Low' owing to uncertainty over frequency of use.*

LOCATION	PROJECT TYPE	PROJECT NAME	DISTANCE TO PROJECT (KM)	STATUS	CONFIDENCE[15]
United Kingdom	Offshore Wind	Muir Mhòr Offshore Wind Farm	0	Application	Low
United Kingdom	Offshore Wind	Eastern Green Link 3	0	Pre-application (Scoping)	Low
United Kingdom	Offshore Wind	Bellrock Offshore Wind Farm	53.46	Pre-application (Scoping)	Low
United Kingdom	Disposal	North Buchan Ness	1.56	Operational	Low
United Kingdom	Disposal	Peterhead	1.57	Operational	Low
United Kingdom	Disposal	Peterhead Harbour	4.06	Operational	Low
United Kingdom	Disposal	Fraserburgh	21.04	Operational	Low
United Kingdom	Disposal	Aberdeen	36.99	Operational	Low
United Kingdom	Disposal	Macduff	54.86	Operational	Low
United Kingdom	Disposal	Banff Harbour	59.08	Operational	Low

The following impacts have been taken forward for the cumulative effects assessment:

- Construction and decommissioning:
  - Temporary impacts to the seabed and sensitive fish habitats (e.g. spawning and/or nursery habitats);
  - Long-term impacts to the seabed and sensitive fish habitats (e.g. spawning and/or nursery habitats);
  - Underwater noise and vibration;
  - Potential changes to SSC; and
  - Basking shark collision with vessels.
- Operation and maintenance:
  - Long-term impacts to the seabed and sensitive fish habitats (e.g. spawning and/or nursery habitats);
  - Underwater noise and vibration;
  - Potential effects from EMF and heat generated by cables;
  - Operational windfarm may act as a FAD;
  - Secondary entanglement; and
  - Basking shark collision with vessels.

13.7.2 Cumulative construction effects

13.7.2.1 Temporary impacts to the seabed and sensitive fish habitats (e.g. spawning and/or nursery habitats)

All of the activities/developments listed in Table 13-24, with the exception of the disposal sites, are relevant to this impact as they will all generate some degree of temporary disturbance to the seabed which may interact cumulatively with the Project. Use of the disposal sites will not result in disturbance at the seabed.

The Eastern Green Link (EGL) 3 Project involves a 2 GW HVDC system connecting Aberdeenshire to Lincolnshire in England. This project includes the construction of new infrastructure such as the English Onshore Scheme, the Scottish Onshore Scheme, and the Marine Scheme (i.e. the offshore section of cable; Collaborative Environmental Advisers, 2023). The Marine Scheme features approximately 575 km of subsea HVDC cable from a proposed landfall at either Anderby Creek or Theddlethorpe, Lincolnshire, to Sandford Bay, Peterhead. The submarine cable system will consist of two HVDC cables and a fibre optic cable (Collaborative Environmental Advisers, 2023).

EGL 3, though located 163.47 km from the Array Area, will cross the EICC relatively close to the coast, near to the EGL 3 and EICC landfall locations close to Peterhead. Aside from this crossing, the EGL 3 cable travels almost in a north-south orientation and does otherwise not lie in close proximity to other Project activities and infrastructure. As a cable, the parameters dictating the extent of disturbance associated with EGL 3 is assumed to be comparable to that of the EICC. Seabed preparatory works and cable installation activities will likely be similar in scope between the two. The construction timeline of EGL 3 coincides with that of the Project; therefore, it is possible that these activities will be occurring in tandem. However, the scale of overlap, combined with the temporary duration of disturbance will be minimal.

The MarramWind Offshore Wind Farm will be located 75-110 km offshore of the northeast Aberdeenshire coast. It will consist of between 126 – 225 WTGs, anticipated to be connected at, or near, Peterhead or New Deer (MarramWind, 2023). The offshore elements will include WTGs with FTUs and mooring systems within the Option Agreement Area, as well as offshore transmission infrastructure, including array export cables between the Option

Agreement Area and landfall locations. The project will also include onshore transmission infrastructure to connect the MarramWind Offshore Wind Farm to the National Electricity Transmission System (MarramWind, 2023).

The MarramWind Offshore Wind Farm and associated export cable infrastructure are due to be constructed within the same window as the Project. The array for the windfarm is located approximately 51.65 km from the Project at the closest point. Given the distance between the MarramWind Offshore Wind Farm and the Array Area, there will be considerable undisturbed space between the two to allow passage of fish and shellfish species during times of construction disturbance.

However, the MarramWind Offshore Wind Farm export cable will cross the EICC. As for EGL 3, the scale of disturbance associated with the export cable is likely to be similar to that of the Export/Import Cable. Furthermore, it is highly unlikely that the cables associated with the Project and MarramWind would be installed at the same time, thereby allowing time for recovery between periods of disturbance.

The Muir Mhòr Offshore Wind Farm export cable corridor may also cross the EICC and the array area of this offshore wind farm is approximately 3.3 km from the EICC. The Muir Mhòr Offshore Wind Farm may be constructed in the same window as the Project. As per Marram Wind, the scale of the disturbance of the export cable will likely be similar to that of the Export/Import Cable, whereas the offshore wind farm, which will comprise of FTUs and associated cabling, will be more akin to the disturbance associated with the Array Area.

In addition to MarramWind Offshore Wind Farm and Muir Mhòr Offshore Wind Farm, the Bowdun Offshore Wind Farm and Bellrock windfarm are located 47.49 km and 53.46 km from the EICC respectively. The construction of these two developments are also due to coincide with the construction of the Project.

Bowdun Offshore Wind Farm will comprise up to 67 floating WTGs, up to 156 km of inter-array cables, up to 35 km of interconnector cables, up to 3 substations, up to four export cables approximately 320 km in length, and associated protection measures (Thistle Wind Partners, 2024).

Bellrock Offshore Wind Farm is located 120 km east of Stonehaven (116 km southeast of Peterhead) and covers an area of 280 km^2. The development will comprise of between 42 and 80 WTGs (depending on the size of the WTGs) with floating substructures and (if used) fixed bottom substructures (Bellrock Offshore Windfarm ,2024).

Of these developments, the four offshore windfarms will potentially all be floating. Muir Mhòr Offshore Wind Farm, Bowdun Offshore Wind Farm, and Bellrock Offshore Wind Farm are set to be slightly smaller in scope than the Project. However, MarramWind Offshore Wind Farm will be the largest of the developments, potentially by some margin (depending on the final development parameters). While footprints of disturbance are not available for any of these developments, they are anticipated to involve similar activities to the Project. Due to the relatively similar scales, and the nature of the developments, activities will be comparable between Muir Mhòr Offshore Wind Farm, Bowdun Offshore Wind Farm, Bellrock Offshore Wind Farm and the Project.

It is extremely unlikely that, despite overlapping timelines, specific construction activities will occur at the same time. Furthermore, as established for the Project alone, the magnitude of effect is highly localised and temporary in duration. This is expected to be applicable to other offshore windfarm developments. The four windfarm developments are located within 50 km of the Project, with the MarramWind and Muir Mhòr Offshore Wind Farm export cables crossing the EICC. Across the entirety of the CNS, the temporary areas of disturbance attributed to these developments in combination with the Project are unlikely to result in a cumulatively widespread area of impact. As described in Section 13.6.1.1, sandeel, herring, common skate, and shellfish are the most sensitive fish and shellfish species to disturbance due to their reliance on the seabed. The sensitivities presented for this impact pathway for the Project alone is also relevant for the cumulative effects assessment. Taking into consideration the sensitivity of all fish and shellfish species to temporary impacts on the seabed, the impact has been classed as high sensitivity (in order to be conservative and capture the most sensitive of receptors – common skate). Fish and shellfish lay many eggs, so populations are naturally able to recover relatively quickly to disturbance.

For these developments, any temporary disturbance to fish and shellfish species is expected to be highly localised, with some recovery once installation activities are completed. Despite overlapping schedules, in reality the temporal overlap in construction activities is likely to be limited. Muir Mhòr Offshore Wind Farm is set to start construction first in in 2027, followed by Bowdun Offshore Wind Farm in 2029, EGL 3 in 2033, with MarramWind Offshore Wind Farm and Bellrock Offshore Wind Farm expected in 2034. Overall, the temporary impacts to fish and shellfish species from the cumulative projects will not significantly increase those associated with the Project. Therefore, the impact is assessed as being of a low magnitude for all fish and shellfish species, and the overall impact is assessed to be minor and not significant in EIA terms.

13.7.2.2 Underwater noise and vibration

It is anticipated that for some of the developments listed in Table 13-24, pre-construction surveys (such as geotechnical and geophysical surveys, boulder and UXO surveys and clearance) may be required. Piling activities may also be required to install anchor points on the seabed for the MarramWind Offshore Wind Farm, Muir Mhòr Offshore Wind Farm for Bellrock Offshore Wind Farm. Additionally, piling of the wind turbines and offshore substation foundations, moorings and anchors for Bowdun Offshore Wind Farm may be required.

Underwater noise will also be generated from construction and supporting vessels involved in all the developments/activities in Table 13-24.

With regards to modelled impact distances associated with non-impulsive construction activities, TTS thresholds for many of the Project activities are not exceeded. In instances where they are, this is limited to within tens of metres from the source (Section 13.6.1.2.4). The distance between the developments and the Project is such that non-impulsive sources of underwater noise will not overlap and as a result fish and shellfish species will be unaffected. Consequently, this is not a pathway that will result in cumulative impacts. Therefore, this cumulative impact assessment will focus on underwater noise as generated by piling activities and UXO. Therefore, of the developments/activities in Table 13-24, the disposal sites are not considered further as they will not involve piling or UXO activities.

Bellrock Offshore Wind Farm will be comprised of up to 80 turbines. Both fixed and floating designs have been included within the Scoping Report (Bellrock Offshore Wind Farm Ltd, 2024). Construction is due to start in the early years of 2030s, and is anticipated to last two to four years. Bellrock Offshore Wind Farm is located 59.64 km from the Array Area and 53.46 km from the EICC.

Bowdun Offshore Wind Farm will consist of up to 67 WTGs, including associated supporting structures, which may be fixed or floating and up to three OSCPs. Construction is planned to commence from 2029 and will continue for a period of five years. Bowdun is located 145.13 km from the Array Area and 47.49 km from the EICC.

Muir Mhòr Offshore Wind Farm will consist of up to 67 WTGs with associated structures and cabling. Construction is planned to commence in 2027 and end in 2030. The Muir Mhòr Offshore Wind Farm is located 102.7 km from the Array Area and 3.3 km from the EICC. The EICC, where UXO clearance may also occur, overlaps with the development.

MarramWind Offshore Wind Farm will consist of between 126 and 225 floating turbines and an unconfirmed number of fixed substation platforms. The construction period is anticipated to commence in 2034 and continue for a period of eight years. The MarramWind Offshore Wind Farm is located approximately 132.45 km from the Array Area, where the piling activities and UXO clearance may occur. However, the EICC, where UXO clearance may also occur, overlaps with the development.

As a cable, no piling activities will be required for EGL 3. The cable will directly overlap with the EICC, where UXO clearance may be required.

With regards to Project piling, TTS impact ranges on static fish (of all groups) were calculated to be up to 39.5 km from the source. Mortality and potential injury for static Group 3 and 4 (i.e. more sensitive) fish was up to 1.57 km. For the purposes of this assessment, it is assumed that piling requirements and parameters for the three nearby windfarms will be comparable to that of the Project.

The distance from each of the developments to the Project exceeds the mortality and potential injury impact ranges from the Project; all developments are >1.34 km away from the Project. With regards to TTS, there may be some overlap between these ranges (assuming static individuals). Fish within 39.5 km of Project piling may experience TTS. In the highly unlikely scenario that piling for Muir Mhòr Offshore Wind Farm, MarramWind Offshore Wind Farm, Bellrock Offshore Wind Farm, Bowdun Offshore Wind Farm occurs at the same time as the Project, and assuming that piling impacts are comparable, there may be some overlap in TTS distances. However, within this distance, impacts are recoverable and fish, being highly mobile and of variable sensitivity to underwater noise, will likely be able to accommodate this disturbance.

UXO detonation for the Project indicates that impact ranges for mortality and potential mortality for explosion are the same across all the fish groups and reach a maximum impact radius of 375-620 m. Given this limited range of impact, this is only relevant where other development cables will come within 375 m of the EICC (namely at crossings). Both EGL 3, Muir Mhòr Offshore Wind Farm cable and MarramWind Offshore Wind Farm cable cross the EICC. However, the chance of UXO being detonated within this distance simultaneously as part of the Project, EGL 3, Muir Mhòr Offshore Wind Farm, and the MarramWind Offshore Wind Farm cable is extremely low. Such events are unlikely and also instantaneous, as opposed to periods of piling activity which generate ongoing noise.

As impacts associated with piling represent a worst-case, they form the basis of consideration within this assessment. It is important to note that the developments have varying construction start dates. Therefore, it is unlikely that other piling activities will be concurrent with those of the Project. Should there be an overlap in piling schedules, it is unlikely that this will occur over an extended period of time. Furthermore, the noise emitted from piling will be temporary and intermittent. Therefore, the potential for the cumulative impacts from the developments remains is assessed as low magnitude for all fish and shellfish species., When accounting for more sensitive receptor groups, (e.g. herring) with a medium sensitivity, the impact is assessed to remains as minor and therefore not significant in EIA terms.

13.7.2.3 Potential changes to SSC

The expected construction period for the Project is in 2030, while the start date for Muir Mhòr Offshore Wind Farm is 2027, Bowdun Offshore Wind Farm is scheduled for 2029, EGL 3 in 2033, and MarramWind Offshore Wind Farm and Bellrock in 2034. All of these developments, excepting EGL 3, Muir Mhòr Offshore Wind Farm, and the MarramWind Offshore Wind Farm export cable, are located in the region of 50 km from the Project. Based on the tidal excursion distances within the Project Area, these developments are sufficiently far from the Project that there is no opportunity for sediment plumes to combine. Therefore, of the developments listed in Table 13-24, only EGL 3, Muir Mhòr Offshore Wind Farm, and MarramWind Offshore Wind Farm export cable, and the seven disposal sites have the potential to cause a combined localised increase in SSC and sediment deposition during construction.

As described above for the Project alone assessment, herring, sandeel, and some shellfish, such as berried crabs and lobsters are more sensitive to SSC. On this basis, in order to approach assessment conservatively, all fish and shellfish receptors have been assumed to have a medium sensitivity to potential changes to SSC.

The output of EIAR Vol. 4, Appendix 7: Marine and Physical Processes Modelling Report have shown highly localised SSC with limited duration and (very) low sediment deposition thicknesses. The highest SSC levels and the majority of deposited sediment will take place within 50 m of the site of disturbance. Based on these outputs, it can be assumed that plumes generated from EGL 3, Muir Mhòr Offshore Wind Farm and the MarramWind Offshore Wind Farm export cable will also be highly localised, limited in duration and will be accompanied by thin sediment deposition thicknesses.

The seven disposal sites are also relevant in the context of changes to SSC. Though these sites are operational, they are included here as the nature of disposal sites means they are visited on a (assumed) regular basis in order to deposit typically dredged material. It is likely that these disposal sites are utilised by the ports and harbours along the Aberdeenshire coast to facilitate capital and maintenance dredging measures within harbours.

The disposal sites are located between 1.56 km and 59.08 km from the EICC. The operational disposal sites have the potential to cause increased SSC occasionally when used; however, this is an intermittent impact and is not anticipated to be a frequent occurrence. As described in Section 13.6.1.3, SSC and deposition attributed to Project construction activities will be limited to within a tidal excursion of the activity. At the coast, this corresponds to tidal excursion extents of up to 12 km. However, disposal of dredged material being from the surface can generate a more extensive plume than impacts at the seabed (as for the Project). The closest disposal sites being <12 km from the EICC may therefore generate sediment plumes which extend within the Project Area. In spite of this, the increases to SSC attributed to the Project are so localised that it is unlikely that they will interact with plumes generated by disposed material within the disposal sites. Furthermore, at the coast flows are higher and it can be assumed that any suspended sediments will be readily reincorporated into the local sediment transport regime. Thus, it is not anticipated that the operation disposal sites will cause an extensive increase in SSC cumulatively.

All the developments in Table 13-24 are >12 km from the Turbot Bank NCMPA, with the exception of the Muir Mhòr Floating Offshore Wind Farm. As per the Project alone, only localised and temporary changes to SSC would be expected during construction and these would only combine with those of the Project's if construction activities within the region of the Turbot Bank NCMPA were to overlap, which is considered highly unlikely. Therefore, there is not anticipated to be a significant increase in the changes to SSC caused by the Project in-combination with the Muir Mhòr Floating Offshore Wind Farm. The NCMPA is not considered further.

Overall, the impacts associated with the other developments will be intermittent, of a short duration and are not likely to modify the impact of the Project alone. The cumulative impact remains consistent with the assessment for the Project alone. Therefore, the impact remains as being at a low magnitude for all fish and shellfish receptors, with the overall impact assessed to be minor for all receptors and not significant in EIA terms.

13.7.2.4 Basking shark collision with vessels

The construction phase of offshore windfarms poses a risk of collisions with slow-moving basking sharks due to increased vessel traffic, as detailed in Section 13.6.1.4. Therefore, all the developments in Table 13-24 are relevant for assessment here, assuming they will all require vessels.

As noted in Section 13.4.4.5.1, sightings of basking shark on the east coast of Scotland are low. Basking shark are considered to be of medium sensitivity to vessel collision.

As described previously, is likely that there will be an overlap to some extent of construction/use periods for the developments in Table 13-24, resulting in locally increased numbers of vessels present in the area at the same time.

It is anticipated that the construction phase of the Project will take up to six years, commencing in 2030. The construction of the proposed projects listed in Table 13-24 are scheduled to begin in the next 10 years. The Muir Mhòr Floating Offshore Wind Farm, 3.3 km from the EICC is expected to commence construction in 2027, completing in 2030. The Bowdun Offshore Wind Farm, located 47.49 km from the EICC, will commence construction in 2029 and is scheduled to continue for five years. The Bellrock Offshore Wind Farm, located 53.46 km from the EICC route, is set to commence in the early 2030s, with a construction period of two four years. The MarramWind Offshore Wind project construction period is planned for 2034. The cable of the MarramWind Offshore Windfarm will directly overlap with the EICC from this Project. Additionally, the EGL 3 development will directly overlap the EICC and will begin construction in 2033, with an expected duration of six years.

Although the construction periods of these projects may overlap, construction vessel traffic will likely be variable over the respective construction periods. The CNS is a large area, and basking sharks are highly mobile, allowing them to avoid and move away from disturbances. Therefore, the impact remains negligible magnitude for basking shark, and the overall impact is assessed to be negligible and not significant in EIA terms.

13.7.3 Cumulative operation and maintenance effects

13.7.3.1 Temporary impacts to the seabed and sensitive fish habitats (e.g. spawning and/or nursery habitats)

Muir Mhòr Floating Offshore Wind Farm is set to start construction first in 2027, followed by Bowdun Offshore Wind Farm in 2029, EGL 3 in 2033, with MarramWind Offshore Wind Farm and Bellrock Offshore Wind Farm expected in 2034. Therefore, the operational phase of these developments will overlap with the Project.

There may be temporary seabed disturbance during any maintenance work undertaken at the developments listed above and in Table 13-24. However, it is anticipated that any temporary habitat loss will be significantly less than that occurring during construction. It is also unlikely that all cumulative projects will require maintenance works simultaneously.

As described above for the Project alone, the most sensitive Fish Ecology receptor to temporary effects to the seabed and benthic habitats has high sensitivity.

Overall, the temporary habitat loss of the cumulative projects will not substantially increase that which is associated with the Project. Therefore, the effect remains as being at a negligible magnitude for all receptors. Therefore, the overall effect is assessed to be negligible for all receptors and not significant in EIA terms.

13.7.3.2 Long-term impacts to the seabed and sensitive fish habitats (e.g. spawning and/or nursery habitats)

Only the activities/developments listed in Table 13-24 which will have a long-term impact on the seabed are relevant to this assessment. Due to the nature of activities which take place within disposal sites and based on the assumption that disposal events will occur relatively infrequently and intermittently, these sites are not considered within the scope of this assessment.

As noted above, all relevant developments listed in Table 13-24 will be in operation at the time of the Project's operation and maintenance phase.

There are limited specific details on the developments included within this assessment with regard to seabed footprint and introduction of infrastructure and hard substrate due to their being early in the pre-consent process. However, EGL 3 will consist of approximately 575 km of subsea cable, which will be buried, where possible, at a target burial depth of between 1-2.5 m. If it is not possible to bury the cable then external protection, such as rock placement and concrete mattresses will be required, introducing hard substrate to the seabed (NationalGrid, 2024).

Muir Mhòr Offshore Wind Farm will consist of up to 67 WTGs with associated structures and cabling. Construction is planned to commence in 2027 and end in 2030. The Muir Mhòr Offshore Wind Farm is located 102.7 km from the Array Area and 3.3 km from the EICC. Cable protection may be required at unburied sections of cable and at cable/pipeline crossings (Fred.Olsen, Seawind & Vattenfall, 2023).

Bowdun Offshore Wind Farm will comprise up to 67 floating WTGs, up to 156 km of inter-array cables, up to 35 km of interconnector cables, up to 3 substations, up to four export cables approximately 320 km in length, and associated protection measures (Thistle Wind Partners, 2024). It is anticipated the cables will be buried, where possible, at a target burial depth of between 1-3 m with external cable protection material, such as rock bags and rock berms, used if required (Thistle Wind Partners, 2024).

Bellrock Offshore Wind Farm cover an area of 280 km^2 and will comprise of between 42 and 80 WTGs (depending on the size of the WTGs) with floating substructures and (if used) fixed bottom substructures (Bellrock Offshore Windfarm, 2024). The development will base the target burial depth of subsea cables on the outcome of the CBRA, which will also highlight instances where alternative external protection is needed. Abrasion protection is also anticipated at the touchdown point, where the dynamic cable comes in to contact with the seabed (Bellrock Offshore Wind Farm, 2024).

MarramWind will consist of between 126 and 225 floating turbines. As detailed in the development's Scoping Report, the cables will be buried, where possible, at a suggested a target cable burial depth of between 1-2 m. It is anticipated that external rock protection will be used if cables cannot reach target burial depth (MarramWind, 2024).

The worst-case long-term seabed disturbance footprint for the Project is outlined in Section 13.5.5.

Although long-term habitat loss associated with the developments will occur in areas of cable protection and where other infrastructure is installed on the seabed, it is anticipated to be highly localised for all developments. As discussed in Section 13.7.2.1 above, the developments are located at varying distances from the Project. It is anticipated that each of the development will have an impact on different habitats and will likely not affect the same receptors and/or sensitive areas (e.g., spawning and nursery grounds). Furthermore, the developments occupy a small spatial footprint relative to the entire area available in the CNS.

As previously mentioned in Section 13.7.2.1, sandeel, herring, common skate, and shellfish are the most sensitive fish and shellfish receptors to habitat loss due to their reliance on the seabed. Taking into consideration the sensitivity of all fish and shellfish species to long-term impacts on the seabed, the impact has been classed as **high sensitivity**. This sensitivity designation is conservative and based on common skate, which are unlikely to occur at high density across the Project Area but is very sensitive to habitat loss.

Temporary disturbances to fish and shellfish habitats may occur during maintenance work on offshore wind farms and cables throughout their operational lifetimes as a result of major cable repair or replacement activities. However, it is expected that temporary habitat loss during maintenance will be significantly less than during construction.

Additionally, it is unlikely that all cumulative projects will require maintenance simultaneously. Overall, the temporary habitat loss from cumulative projects will not substantially increase the impact associated with the Project. Therefore, the impact is assessed as low magnitude.

The overall impact is assessed to be minor and not significant in EIA terms.

13.7.3.3 Underwater noise and vibration

The level of underwater noise generated during the operational phase will be less than the noise generated during construction (addressed in Section 13.6.1.2). Operational noise associated with the developments in Table 13-24 will be limited to vessels and mooring line tension noises. This is relevant to Muir Mhòr Offshore Wind Farm, MarramWind Offshore Wind Farm, Bowdun Offshore Wind Farm, and Bellrock which are all confirmed, or possible, floating wind farms.

The 'pinging' noise due to the snapping of tension lines in the water column has been identified as a potential source of underwater noise, generating a sound of approximately 160 dB re 1 µPa (SPL_{peak}) (JASCO, 2011). The occurrence of this underwater noise source is characterised by discrete events, which are unlikely to exceed the TTS SPL_{peak} threshold for Group 3 and 4 fish with a swim bladder-inner ear connection at 186 dB re 1 µPa (Popper *et al.*, 2014). JASCO (2014) has identified that the expected rate of pinging from mooring lines is 0.958 events per hour.

Many of the fish and shellfish receptors have low sensitivity to underwater noise that arises from construction activities. Although some species of Group 3 and 4 fish, such as cod, whiting, and haddock, are most sensitive to noise due to the swim bladder-inner ear connection, JASCO (2011) indicate that the noise generated from the tension lines do not exceed the underwater noise threshold. Taking into consideration that the magnitude of underwater noise associated with operational activities is reduced in comparison to construction, all fish and shellfish receptors have been deemed to be of low sensitivity to underwater noise. As mentioned in Section 13.6.2.3, continuous noise generated from mechanically generated vibration is suggested to be above ambient noise, with some louder 'snaps' or 'bangs' during periods of mooring tension. However, these noises will be intermittent and are unlikely to exceed thresholds for TTS in fish.

Given the distances between the developments and the Project, and the low levels of operational noise (i.e. 'pinging'), it is highly unlikely that the operational noise from the developments will significantly exceed ambient noise levels. Therefore, the impact remains as being at a low magnitude for all fish and shellfish receptors. The overall impact is assessed to be negligible for all receptors and not significant.

13.7.3.4 Potential effects from EMF and heat generated by cables

Subsea cables have the potential to emit EMF and heat into the marine environment, which can have an impact on electrosensitive species. This impact pathway is only relevant to developments that involve cable infrastructure. Therefore, of the developments listed in Table 13-24, only Muir Mhòr Offshore Wind Farm, MarramWind Offshore Wind Farm, Bowdun Offshore Wind Farm, Bellrock Offshore Wind Farm, and EGL 3 are considered within this assessment. The inter-array, interconnector and export cables associated with the developments have the potential to emit EMF and heat and are considered. The disposal sites are not assessed herein.

As these developments are in the early pre-application stage, there are limited specific details on the developments with regard to effects from EMF and generation of heat. However, parallels can be drawn between the expected EMF and thermal outputs of the Project and the other developments. As these windfarms may all be floating, there will be sections of dynamic cables within the water column.

As discussed in Section 13.6.2.4, from the calculations undertaken in EIAR Vol. 4, Appendix 14A: EMF Assessment Report Vol. 1 and EIAR Vol. 4, Appendix 14B: EMF Assessment Report Vol. 2, an EMF strength of 211.8 μT would be given off at the surface of the dynamic portions of the 132 kV cables. In comparison, an intensity of 360.6 μT would be given off by the 66 kV dynamic cables. This attenuates rapidly with distance; at 10 m from the cable surface, the EMF intensity is reduced to 0.1 μT for both cable voltages.

Beyond the dynamic sections of cables, EMF emissions associated with the EICC are greater. At the minimum burial depth, the EMF intensity at the seabed is 363.7 μT for cables of 525 kV. For a lesser voltage of 320 kV, the EMF at the seabed is 451.0 μT. While this is considerably above baseline levels for the North Sea, at increased burial depths this is reduced. Furthermore, EMF intensity attenuates rapidly with distance from the cable. Within 5 m of the Export/Import Cable, EMF will have returned to background levels.

As the EMF intensity associated with the Project reduces all but completely to a distance of 10 m from the cables, there is only potential for cumulative effects to occur between the Project and crossings with other cables. Only EGL 3, Muir Mhòr Offshore Wind Farm export cable, and the MarramWind Offshore Wind Farm export cable will directly overlap the EICC. The target burial depths of these developments, range from 1 m to 4 m. Therefore, the potential for any overlap in EMF fields is unlikely. In areas where it is not possible to bury the cable, rock placement will be used to protect the cable. This will further reduce the range of EMF.

Thermal emissions are limited to within centimetres of the cable (Taormina *et al*., 2018). Considering the proposed depths of burial associated with the Project and the other developments, and the potential application of rock placement, the opportunity for cumulative thermal impacts is highly limited. In the water column, thermal emissions attenuate even faster owing to the specific heat capacity of water. Therefore, dynamic sections of cables associated with the Project and other developments will not result in any cumulative effect on fish and shellfish.

As described above for the Project alone assessment, the most sensitive fish and shellfish receptors are elasmobranchs, diadromous fish, lobsters and crabs. Elasmobranchs have been identified as having medium sensitivity to EMF. All other fish and shellfish receptors have been assessed to have a low sensitivity to EMF effects.

The range of EMF from subsea cables is very localised, therefore, only the EGL 3 cable and the MarramWind Offshore Wind Farm cable have been considered as having the potential to act cumulatively as there is a direct overlap with the Project. The cable burial depth for EGL 3 will be dependent on seabed conditions, perceived risk and probability of potential hazards, but it is currently anticipated that burial depth will be 1-2.5 m (NationalGrid, 2024). MarramWind has stated in the Scoping Report that cables will be buried, where possible, and has suggested a target cable burial depth of between 1-2 m (MarramWind, 2024).

Any EMF levels are anticipated to be highly localised in the case of each development. Therefore, the impact is considered to be low magnitude, making the overall impact negligible all Fish and Shellfish Ecology receptors. Therefore, the cumulative effect is not significant in EIA terms.

13.7.3.5 Operational windfarm may act as a FAD

The introduction of hard structures in the marine environment can act as a FAD. Therefore, of the developments listed in Table 13-24, those which involve installation of infrastructure are relevant to the assessment here. The seven disposal sites are not considered.

The potential areas of artificial reef or fish aggregation will be localised to discreet areas around installed infrastructure and associated protection measures. Further research is needed to better understand whether this fish aggregation effect represents a redistribution of existing biomass, or higher productivity in the vicinity of FTUs.

Elasmobranchs can swim through and around infrastructure with a minor energy burden. Furthermore, elasmobranch species are tolerant and adaptable to fish aggregation effects. Pelagic, demersal, and diadromous fish species generally exhibit high mobility and agility, making them likely to aggregate in areas of high productivity or habitat quality. Diadromous fish species are more likely to transit through the Project Area rather than aggregate around structures. Shellfish species have limited mobility and are confined to the immediate area where they have settled. Overall, fish and shellfish receptors have a low sensitivity to potential FAD effects.

There are limited specific details on the developments included within this assessment (Muir Mhòr Offshore Wind Farm, Bowdun Offshore Wind Farm, MarramWind Offshore Wind Farm and export cable, EGL 3, and Bellrock Offshore Wind Farm), with regard to seabed footprint and introduction of infrastructure and hard substrate due to their being early in the pre-consent process. However, it is anticipated that the FAD effect of the cumulative developments will be highly localised and are not expected to substantially increase that which is associated with the Project. Therefore, the impact is considered to be of low magnitude. Overall, the impact of the operational Project in combination with other developments acting as FADs is considered to be minor and not significant.

13.7.3.6 Secondary entanglement

ALDFG is a global issue that poses the threat of secondary entanglement, which may cause injury and/or mortality of a range of marine species. Secondary entanglement becomes an issue when ALDFG becomes caught on infrastructure. Similar to the assessment of FADs in Section 13.6.2.5, this impact relates to developments which will involve physical installation of infrastructure in the marine environment. Therefore, of the developments listed in Table 13-24, the disposal sites are not considered further.

Commercial fishing effort around the Muir Mhòr Offshore Wind Farm targets demersal fish and shellfish (mainly *Nephrops*, king scallops and brown crab). MarramWind Offshore Windfarm mainly targets *Nephrops*. The most used fishing gear type within this area (ICES Rectangle 44E9) is demersal trawlers. Bellrock Offshore Windfarm is located within ICES Rectangles 42E9 and 42F0 where demersal seine nets are the primary fishing gear (Bellrock Offshore Windfarm, 2024). However, the number of vessels operating within the ICES Rectangles where Bellrock Offshore Windfarm is located is significantly lower than the surrounding rectangles. Fishing effort within these rectangles is described fully in EIAR Vol. 3, Chapter 15: Commercial Fisheries.

Fisheries along the northern extent of EGL 3 (in ICES Rectangles 40E8, 41E9, and 41E9), where it will cross the EICC, primarily use pots and traps to target shellfish species, followed by pelagic and demersal trawling (NationalGrid, 2024). Bowdun Offshore Windfarm is located in ICES Rectangles 42E7, 42E8, and 43E8. Fisheries in this area also target shellfish species, such as king scallop and brown crab, using pots and traps (Thistle Wind Partners, 2024). Gear types such as pots and traps are unlikely to cause secondary entanglement.

As there are some trawling nets used within the vicinity of the projects, secondary entanglement may occur due to lost or fouled nets. Therefore, as with the Project alone assessment, all fish species have a medium sensitivity and shellfish species have a low sensitivity to secondary entanglement.

As discussed in Section 13.6.2.6, the full extent of the impact is limited due to the infancy of the offshore windfarm industry. However, from experience from oil and gas infrastructures, secondary entanglement on marine megafauna is a low risk (Garavelli *et al.*, 2024). The full extent of the risk secondary entanglement poses in floating offshore windfarms is limited because of the infancy of the industry and lack of entanglement and marine debris monitoring for existing floating development (SEER, 2022).

Regular maintenance will ensure any debris is removed from the development's infrastructure, and the static nature of snagged fishing gear means it will not actively catch fish. Given the mobility of fish species and the low likelihood of secondary entanglement, the impact on fish and shellfish species is limited. The impact remains low magnitude and the overall impact is considered negligible due to its temporary and small spatial extent and not significant in EIA terms.

13.7.3.7 Basking shark collision with vessels

Due to the timelines of the developments listed in Table 13-24, it is likely that there will be an overlap in operation period. This is inclusive of the seven disposal sites which are currently open. Therefore, vessels transiting to/from the disposal sites and maintenance vessels for the other developments may be present at the same time as maintenance vessels for the Project.

As with the Project alone assessment, basking shark have medium sensitivity to collision with vessels.

However, due to the availability of space between the developments and disposal sites, it is not anticipated that the number of vessels in the area pose a risk to basking shark. Again, it is important to emphasise that the North Sea is not an important area for basking shark which are infrequently observed. Therefore, the impact remains negligible magnitude for basking shark. The overall impact is assessed to be negligible and not significant in EIA terms.

13.7.4 Cumulative decommissioning effects

The decommissioning of the Project intends to complete the full removal of offshore infrastructure to below the mudline (where safe/practicable to do so). The majority of decommissioning works are likely to be undertaken in reverse to the sequence of construction works. However, there is limited information on the details around decommissioning of the Project and around the lifecycle of other developments. Considering this, it is assumed that decommissioning involves similar or lesser levels of effects to construction.

A Decommissioning Programme will be prepared prior to construction, in line with the requirements of Section 105 of the Energy Act 2004 (as amended) and any applicable guidance available at the time.

13.7.5 Summary of cumulative effects

A summary of the outcomes of the assessment of cumulative effects for the construction, operation and maintenance and decommissioning phases of the Project is provided in Table 13-25.

In relation to the impact on the national status of fish and shellfish species PMFs, although the magnitude of effect has increased when considering the effects of the Project combined with other projects, plans and activities, as no significant effects have been identified, no significant impact on the national status of fish and shellfish species PMFs is expected.

Table 13-25 Summary of assessment of cumulative effects

POTENTIAL IMPACT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF IMPACT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF IMPACT)
Construction						
Temporary impacts to the seabed and sensitive fish habitats (e.g. spawning and/or nursery habitats)	All fish and shellfish species	High	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
Underwater noise and vibration	All fish and shellfish species	Medium	Low	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
Potential changes to SSC	All fish and shellfish species	Medium	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)

POTENTIAL IMPACT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF IMPACT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF IMPACT)
Basking shark collision with vessels	Basking shark	Medium	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
Operation and maintenance						
Temporary impacts to the seabed and sensitive fish habitats (e.g. spawning and/or nursery habitats)	All fish and shellfish species	High	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
Long-term impacts to the seabed and sensitive fish habitats (e.g. spawning and/or nursery habitats)	All fish and shellfish species	High	Low	Minor (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
Underwater noise and vibration	All fish and shellfish species	Low	Low	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)

POTENTIAL IMPACT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF EFFECT	CONSEQUENCE (SIGNIFICANCE OF IMPACT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF IMPACT)
Potential effects from EMF and heat generated by cables	All fish and shellfish species	Medium	Low	Negligible (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
Operational windfarm may act as a FAD	All fish and shellfish species	Low	Low	Negligible (not significant)	None required above existing embedded mitigation measures.	Minor (not significant)
Secondary entanglement	All fish and shellfish species	Medium	Low	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
Basking shark collision with vessels	Basking shark	Medium	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)

13.8 Inter-related effects

Inter-related effects are the potential effects of multiple impacts, effecting one receptor or a group of receptors. Inter-related effects include interactions between the impacts of the different phases of the Project (i.e. interaction of impacts across construction, operation and maintenance and decommissioning), as well as the interaction between impacts on a receptor within a Project phase. The potential inter-related effects for Fish and Shellfish Ecology receptors are described below.

13.8.1 Inter-related effects between Project phases

Each phase of the Project can affect different aspects of Fish and Shellfish Ecology. However, impacts related to EMF and heat, secondary entanglement and the FAD effects are specific to the operation and maintenance phase. Consequently, these impacts will not overlap with those from the construction or decommissioning phases.

Long-term and short-term impacts to the seabed and fish habitats during the operation and maintenance phase will occur in the same areas as construction and decommissioning. For example, the anchors, associated piles, IACs and Export/Import Cable remedial protection, and OSCP foundations) will be located in areas disturbed by seabed preparation and cable installation. However, the majority of habitat disturbance and loss during the construction phase will be temporary and localised, with a recovery of the seabed once construction activities have ceased. Therefore, there is considered to be a limited potential for an interaction between the habitat loss and disturbance during the construction, operation and maintenance and decommissioning phases to result in a greater effect than when each phase is assessed in isolation.

13.8.2 Inter-related effects within a Project phase

The greatest disturbance from underwater noise and vibration is predicted to result from UXO clearance pre-construction and impact piling during the construction phase. Underwater noise during the operation and maintenance phase has been assessed in Section 13.6.2.3 and it was concluded that it will be highly localised. Noise during construction will be intermittent and temporary. Therefore, the potential for cumulative impacts from underwater noise across the construction, operation and maintenance, and decommissioning phases is considered limited, as each phase's impacts are primarily evaluated independently.

The spatial extent associated with EMF and heat effects, secondary entanglement and potential fish aggregation from FAD effects, will be similar during the operation and maintenance phase. However, as concluded in Sections 13.6.2.4 and 13.6.2.5, these impacts are considered to be highly localised, the combined effect of these impacts during the operation and maintenance phase is not expected to result in a greater effect than the assessment of these impacts in isolation.

13.8.3 Inter-relationships

Inter-relationships are defined as the interaction between the impacts assessed within different topic assessment chapters on a receptor. The other chapters and impacts related to the assessment of potential effects on Fish and Shellfish Ecology are provided in Table 13-26.

Table 13-26 Fish and Shellfish Ecology inter-relationships

Chapter	Impact	Description
EIAR Vol. 3, Chapter 8: Marine Geology, Oceanography, and Coastal Processes	Impacts on SSC and associated sediment deposition.	Impacts on sediment properties that can impact fish and shellfish species resulting in disturbance or indirectly for their prey species.
EIAR Vol. 3, Chapter 9: Marine Water and Sediment Quality	Impacts associated with changes in water quality.	These changes can result in indirect impacts on fish and shellfish species, including spawning habitats, which may be sensitive to water quality, sediment disturbance, and contamination
EIAR Vol. 3, Chapter 10: Benthic Ecology	Impacts on benthic habitats.	These changes may lead to an indirect impact on fish spawning and nursery grounds.
EIAR Vol. 3, Chapter 11: Marine Mammal Ecology	Impacts on spawning and nursery grounds.	Impacts on spawning and nursery grounds may lead to an indirect impact on prey availability or distribution.
EIAR Vol. 3, Chapter 12: Ornithology	Impacts on spawning and nursery grounds. Operational windfarm may act as a FAD	Impacts on spawning and nursery grounds, and the potential for the operational windfarm to act as a FAD may lead to an indirect impact on prey availability or distribution.
EIAR Vol. 4, Chapter 13: Commercial Fisheries	Impacts on commercially important fish and shellfish species.	These impacts may have an indirect effect on species availability for commercial fisheries.

13.9 Whole Project assessment

Please refer to EIAR Vol. 2, Chapter 7: EIA Methodology for the full description of the Whole Project assessment. These onshore aspects have therefore not been assessed as part of the Project. The key receptor which could be impacted by the onshore Project would be diadromous fish during their freshwater life-cycle stages. However, the onshore Project area does not overlap any river systems, and therefore, it is not anticipated that there will be any additional impacts from the onshore Project on Fish and Shellfish Ecology receptors, including diadromous fish. An overall description of the Project is detailed in EIAR Vol. 2, Chapter 5: Project Description.

13.10 Ecosystem assessment

Fish and shellfish species occupy various positions within the food chain, serving as both predators and prey, and are crucial in the transfer of energy across trophic levels within ecosystems, and even between terrestrial and marine ecosystems, as is the case for diadromous fish (BEIS, 2022). A comprehensive approach has been adopted to identify impacts, considering potential ecosystem-wide effects, particularly across trophic levels (e.g., how impacts on prey species might affect their availability to predators). Variations in the availability or distribution of fish and shellfish species can trigger cascading effects on other species within the ecosystem, indirectly influencing those that feed on them (such as piscivorous fish, marine mammals, and birds) and those they consume (including other fish, shellfish, and benthic species).

The monitoring being conducted as part of the PrePARED project aims to improve the understanding of the value of offshore wind farms in terms of food availability and prey quality for marine predators. Only preliminary results are currently available based on the first two years of surveys. However, notable results in relation to the presence, distribution and size of fish include increased abundance and size around turbine foundations (as described in Section 13.7.3.5). Additionally, monitoring at offshore wind farms in the Forth and Tay Region via acoustic surveys, trawl sampling, BRUV monitoring and fish traps, indicated no small scale effect (i.e. at the scale of the OWF site) on sandeel, a key prey species (PrePARED, 2024).

Benthic species, along with other fish and shellfish, can serve as prey for fish and shellfish receptors. Consequently, the impacts discussed in EIAR Vol. 3, Chapter 10: Benthic Ecology may indirectly affect certain Fish and Shellfish Ecology receptors.

Marine mammals and megafauna, being generalist feeders, highly mobile, and wide-ranging, are considered to have low sensitivity to changes in prey availability. Several offshore bird species, including kittiwakes, guillemots, razorbills, and gannets, are deemed to have medium sensitivity to indirect effects on prey species.

Changes in predator distribution and abundance can potentially impact fish and shellfish prey species, for example via predator aggregation around subsea infrastructure at the Project Area (as assessed in Section 13.6.2.5). However, no significant effects on predator species, including piscivorous fish, marine mammals, or bird species, were identified, even in relation to predator aggregation (EIAR Vol. 3, Chapter 11: Marine Mammal Ecology, and EIAR Vol. 3, Chapter 12: Ornithology for more details).

Ecosystem effects have been considered holistically throughout the ecological chapters of the EIAR. The Fish and Shellfish Ecology assessment concluded that there are no significant effects on fish and shellfish species. Therefore, there will be no significant implications for prey species due to changes in predators, and no significant effects on predator species due to changes in prey availability. No ecosystem effects have been concluded.

13.11 Transboundary effects

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

Fish, particularly diadromous fish, are mobile species and may extend beyond Scottish or UK waters. Therefore, there is the potential for transboundary impacts upon Fish and Shellfish Ecology receptors due to construction, operation and maintenance, and decommissioning of the Project. The potential transboundary impacts for Fish and Shellfish Ecology receptors include:

- Long-term impacts to the seabed and sensitive fish habitats (e.g. spawning and/or nursery habitats);
- Temporary impacts to the seabed and sensitive fish habitats (e.g. spawning and/or nursery habitats);
- Underwater noise and vibration;
- Potential changes to SSC;
- Basking shark collision with vessels;
- Potential effects from EMF and heat generated by cables; and
- Operational windfarm may act as FAD.

The following impacts have no potential for transboundary impacts upon Fish and Shellfish Ecology receptors:

- Secondary entanglement.

The assessment of potential effects from the Project, both alone and in combination with other developments, has been conducted based on the distribution of Fish and Shellfish Ecology Receptors, which are not confined by national geographical boundaries. As a result, there are no potential significant transboundary effects on fish and shellfish receptors due to the construction, operation and maintenance and decommissioning of the Project. The potential impacts are localised and are not expected to affect other EEA states (other than insignificantly).

13.12 Summary of mitigation and monitoring

No secondary mitigation, over and above the embedded mitigation measures proposed in Section 13.5.4, is either required or proposed in relation to the potential effects of the Project on Fish and Shellfish Ecology as no adverse significant impacts are predicted.

No monitoring is currently proposed for Fish and Shellfish Ecology.

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