TotalEnergies E&P North Sea UK Ltd

Culzean Floating Offshore Wind Turbine Pilot Project

Environmental Impact Assessment Report – Chapter 9 - Fish & Shellfish Ecology

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GLOSSARY

TERMINOLOGY	DESCRIPTION
Culzean Floating Offshore Wind Turbine Pilot Project ("the Project")	The entire Development including all offshore components and all project phases from pre-construction to decommissioning.
Demersal	Living on or near the seabed.
Diadromous fish	Fish that migrate between freshwater and marine environments to fulfil their lifecycle.
eDNA	DNA that accumulates in the environment (e.g. through excretions or secretions), rather than through direct sampling of an organism.
EIA Regulations	The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2007 (as amended).
Elasmobranch	Cartilaginous fish.
Environmental Impact Assessment (EIA)	The procedure to predict, minimise, measure and, if necessary, correct and compensate the impacts produced by any human action.
Export Cable	Cable connecting the Floating Wind Turbine to the Culzean Platform.
Floating Wind Turbine Generator (WTG)	Device that converts the kinetic energy of wind into electrical energy. Can be functionally divided into four parts: wind turbine, tower and transition piece, floating foundation, and mooring system.
Gadoid	Fish from the Gadiformes order (e.g. cod, haddock and whiting).
Habitats Regulations Assessment (HRA)	Under the Habitats Regulations, all competent authorities must consider whether any plan or project could affect a European site before it can be authorised or carried out. This includes considering whether it will have a 'Likely Significant Effect' (LSE) on a European site, and if so, they must carry out an 'Appropriate Assessment' (AA). This process is known as Habitats Regulations Appraisal (HRA).
ICES rectangle	International Council for the Exploration of the Sea (ICES) rectangles are a spatial unit used for the collection and analysis of fisheries statistics by the European Commission Member States, and the UK.
Innovation and Targeted Oil and Gas (INTOG)	The Initial Plan Framework Sectoral Marine Plan for Offshore Wind for INTOG encompasses spatial opportunities and a strategic framework for future offshore wind developments within sustainable and suitable locations that will help deliver the wider United Kingdom (UK) and Scottish Government Net Zero targets. The 'IN' component of INTOG consists of small-scale innovative projects of 100 Megawatts (MW) or less. The aim of the 'TOG' component is to supplying renewable electricity directly to oil and gas infrastructure. The Culzean project falls under the TOG component of INTOG.
Marine Licence Application ("the Application")	A Marine Licence is granted under the Marine and Coastal Access Act 2009 for projects between 12-200 Nautical Miles (nm) from shore, or the Marine (Scotland) Act 2010 for projects between Mean High-Water Springs (MHWS) out to 12 nm from shore. The Application includes Habitats Regulations Appraisal (HRA) supporting documentation (where required), an application letter, Marine Licence application form and this Environmental Impact Assessment Report (EIAR).

TERMINOLOGY	DESCRIPTION
Net Zero	Refers to a government commitment to ensure the UK reduces its greenhouse gas emissions by 100% from 1990 levels by 2050 and in Scotland, the same target is set for 2045. If met, this would mean the amount of greenhouse gas emissions produced by the UK would be equal to or less than the emissions removed by the UK from the environment.
Pelagic marine finfish	Fish that live in the water column.
Project Area	The extent of the immediate area surrounding the floating Wind Turbine Generator (WTG) and cable route as characterised by the extent of the seabed environmental and habitat surveys. Also referred to as the Survey Area where specifically relating to survey activities.
Project Design Envelope	The maximum range of design parameters of all infrastructure assessed as part of the EIA.
Study Area	Receptor specific area used to characterise the baseline.
Survey Area	The area surveyed during site-specific surveys.
Swim bladder	Gas filled sac present in teleost fish.
Teleost fish	Bony fishes with a ray-finned skeleton.

ACRONYMS AND ABBREVIATIONS

ACRONYM/ ABBREVIATION	DEFINITION
BEIS	Department for Business, Energy and Industrial Strategy
CaP	Cable Plan
CBD	Convention on Biological Diversity
CBRA	Cable Burial Risk Assessment
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CEMP	Construction Environmental Management Plan
CIEEM	Chartered Institute of Ecology and Environmental Management
CMS	Construction Method Statement
CNSE	Central North Sea Electrification
CoCP	Code of Construction Practice
DDV	Drop-Down Video
DTU	Technical University of Denmark
eDNA	Environmental Deoxyribonucleic Acid (DNA)
EEA	European Environment Agency
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EMF	Electromagnetic Field

ACRONYM/ ABBREVIATION	DEFINITION
EMP	Environmental Management Plan
EUNIS	European Nature Information System
FeAST	Feature Activity Sensitivity Tool
HRA	Habitats Regulations Appraisal
Hz	Hertz
IBTS	International Bottom Trawl Survey
ICES	International Council for Exploration of the Sea
IHLS	International Herring Larvae Survey
INNS	Invasive Non-Native Species
IUCN	International Union for Conservation of Nature
km	Kilometre
LSE	Likely Significant Effect
m	Metre
MAG	Magnetometer
MarLIN	Marine Life Information Network
MASTS	Marine Alliance for Science and Technology for Scotland
MBES	Multibeam Echosounder
MD-LOT	Marine Directorate – Licensing Operations Team
MDS	Maximum Design Scenario

ACRONYM/ ABBREVIATION	DEFINITION
MHWS	Mean High-Water Springs
MMO	Marine Management Organisation
MPCP	Marine Pollution Contingency Plan
NCMPA	Nature Conservation Marine Protected Area
NID	Nature Inclusive Design
nm	Nautical Miles
OEMP	Operational Environmental Management Plan
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
OSPAR	Convention for the Protection of the Marine Environment of the North East Atlantic
PDE	Project Design Envelope
PEMP	Project Environmental Monitoring Programme
PMF	Priority Marine Feature
PSA	Particle Size Analysis
R&D	Research and Development
SAC	Special Area of Conservation
SBP	Sub-Bottom Profiler
ScotMER	Scottish Marine Energy Research
SFF	Scottish Fishermen's Federation
SSS	Side Scan Sonar

ACRONYM/ ABBREVIATION	DEFINITION
TAC	Total Allowable Catch
TEPNSUK	TotalEnergies E&P North Sea UK Ltd
UK	United Kingdom
USBL	Ultra-short baseline
UXO	Unexploded Ordnance
WTG	Wind Turbine Generator
ZoI	Zone of Influence

9 FISH AND SHELLFISH ECOLOGY

9.1 Introduction

This chapter of the Environmental Impact Assessment Report (EIAR) presents the Fish and Shellfish Ecology receptors of relevance to the Culzean Floating Offshore Wind Turbine Pilot Project (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 impacts are also considered while transboundary impacts have been scoped out with the agreement of Scottish Ministers, as described in Section 9.3.

Xodus Group Limited (Xodus) have drafted and carried out the impact assessment. Further competency details of the Project Team including lead authors for each chapter are provided in Chapter 1: Introduction. Table 9-1 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.

Table 9-1 Supporting studies

DETAILS OF STUDY	LOCATIONS OF SUPPORTING STUDY
Habitat Assessment Report – Culzean WT Site Survey June 2nd, 2023. 104728-TOT-OI-SUR-REP-HABASRE	Appendix C: Habitat Assessment Survey Report (2023)
Environmental Baseline Survey Report – Culzean WT Site Survey September 1st, 2023. 104728-TOT-OI-SUR-REP-ENVBASRE	Appendix D: Environmental Baseline Survey Report (2023)
Environmental DNA Report – Analysis of eDNA samples in water and sediment (NatureMetrics, 2023)	Appendix E: Environmental DNA Report

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

- Chapter 7: Marine Physical Processes
- Chapter 8: Benthic Ecology;
- Chapter 10: Marine Mammals and Other Megafauna;
- Chapter 11: Ornithology; and
- Chapter 12: Commercial Fisheries.

Where information is used to inform the impact assessment, reference to the relevant EIAR chapter is given.

Impacts relating to commercial fisheries are discussed in Chapter 12: Commercial Fisheries and are not considered within this chapter. Any indirect effects as a result in a change of fish and shellfish prey species for marine mammals and ornithology receptors are discussed in Chapter 10: Marine Mammals and Other Megafauna and Chapter 11: Ornithology, respectively.

An assessment under the Habitats Regulations for Europeans Sites designated for Diadromous Fish and Associated Features has also been undertaken for the Project within the Habitat Regulations Appraisal (HRA) Report (Document ID GB-CZN-00-XODUS-000023) submitted alongside the Marine Licence Application (the 'Application').

9.2 Legislation, policy and guidance

The following legislation, policy and guidance are relevant to the assessment of impacts from the Project on Fish and Shellfish Ecology:

- Legislation:
  - International:
    - 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);
    - United Nations Environmental Programme Convention on Biological Diversity ('CBD') (1992);
    - The Convention on the Conservation of Migratory Species of Wild Animals ('the Bonn Convention'; 1979);
  - National:
    - Nature Conservation (Scotland) Act 2004;
    - The Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended) (known as "the Offshore Marine Regulations");
    - The Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended);
    - Wildlife and Natural Environment (Scotland) Act 2011;
    - Nature Conservation (Scotland) Act 2004;
    - Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003;
- Policy:
  - Scotland's Biodiversity: a route map to 2020 (Scottish Government, 2015a);
  - Priority Marine Features (PMFs) (Tyler-Walters *et al.*, 2016);
  - Scotland's National Marine Plan (Scottish Government, 2015b):
    - GEN9 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 PMFs; and (c) Protect and, where appropriate, enhance the health of the marine area;
    - 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;
  - Scottish Wild Salmon Strategy (Scottish Government, 2022);

- Guidance:
  - Guidance on Environmental Considerations for Offshore Wind Farm Development (OSPAR, 2008a);
  - Guidelines for Ecological Impact Assessment in the United Kingdom (UK) and Ireland. Terrestrial, Freshwater, Coastal and Marine (Chartered Institute of Ecology and Environmental Management (CIEEM), 2022); and
  - Offshore Wind Farms Guidance Note for Environmental Impact Assessment (EIA) (Centre for Environment, Fisheries and Aquaculture Science (Cefas), 2004).

9.3 Scoping and consultation

Stakeholder consultation has been ongoing throughout the 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 Scoping Report was submitted to Scottish Ministers (Via Marine Directorate – Licensing Operations Team (MD-LOT)), on 14th April 2023, who then circulated the report to relevant consultees. The Scoping Opinion was received on 20th July 2023. Relevant comments from the Scoping Opinion and other consultation specific to Fish and Shellfish Ecology are provided in Table 9-2 below, which provides a high-level response on how these comments have been addressed within the EIAR.

Table 9-2 Summary of consultation responses specific to Fish and Shellfish Ecology

CONSULTEE	COMMENT	RESPONSE
Scoping Opinion		
Scottish Ministers (via MD-LOT and NatureScot)	The Scottish Ministers, in line with the NatureScot representation, are content that the International Council for the Exploration of the Sea (ICES) rectangle that the Proposed Development is located within is used as the Study Area.	Noted, no further response required
	The Scottish Ministers are broadly content with the key datasets and reports summarised within Table 7-5 of the Scoping Report. In addition to those already included, the Scottish Ministers advise the Developer to include the recently published Essential Fish Habitat Maps for Fish and Shellfish Species in Scotland report developed by the Scottish Marine Energy Research ("ScotMer") programme.	The habitat maps published by Franco *et al.* (2023) have been reviewed and used to inform the baseline distribution of fish and shellfish species within the Study Area in Section 9.4
	In line with section 5.4.3 of this Scoping Opinion, the Scottish Ministers welcome the inclusion of PMFs but highlight an error in section 8.2.5.5 of the Scoping Report which references 'Primary' instead of 'Priority'.	PMFs are referenced correctly throughout this EIAR chapter.
	The Scottish Ministers, in line with the NatureScot representation, advise that increased sediment concentrations should be scoped in for fish and shellfish interests, as the eggs of certain fish species may be sensitive to smothering and/or burial.	An assessment of the potential effects on fish and shellfish receptors of 'increased sediment concentrations' for the construction and decommissioning phases of the Project are assessed in Sections 9.9.1 and 9.9.3, respectively.
	Additionally, the Scottish Ministers advise that effects on Fish and Shellfish Ecology due to 'accidental release of pollutants' and 'subsea noise from wind turbine operation impacting fish and shellfish receptors' during operation and maintenance should be scoped in and monitored. This is supported by the SFF.	An assessment of the potential effects on fish and shellfish receptors of 'accidental release of pollutants' and 'subsea noise from wind turbine operation' are assessed in Section 9.9.2.1.

CONSULTEE	COMMENT	RESPONSE
	The Scottish Ministers are content with the proposed mitigation and monitoring presented in Table 7-7 of the Scoping Report. As mentioned in Table 6-2, the Scottish Ministers acknowledge that the requirements for scour protection will be included in the Construction Method Statement.	Noted, no further response required
	The Scottish Ministers are content with the cumulative impact approach presented in sections 5.4 and 7.2.8 of the Scoping Report. Additionally, the Scottish Ministers agree with the Developer that transboundary impacts can be scoped out from further consideration in the EIA Report.	Transboundary impacts have not been assessed in this chapter.
NatureScot	Study area: We are content that the ICES rectangle that the project is located within is used as the study area."	This has been used as the Study Area for Fish and Shellfish Ecology.
	Baseline: Table 7-5 summarises the key datasets and reports, however this should also include the recently published Essential Fish Habitat Maps for Fish and Shellfish Species in Scotland developed by the Scottish Marine Energy Research (ScotMER) programme."	The habitat maps from the Scottish Marine Energy Research (ScotMER) programme have been reviewed and used to understand the distribution of fish and shellfish species within the Study Area in Section 9.5.3.
	Priority Marine Features (PMFs): We support the inclusion of Priority Marine Features (PMFs) and highlight an error in section 8.2.5.5 where they are incorrectly referred to as 'Primary' Marine Features."	PMFs are referenced correctly throughout this EIAR chapter.
	Key impact pathways to consider: We are broadly content with the impacts proposed to be scoped into the assessment as per Table 7-8 of the Scoping Report. However, we advise there are elements that require further consideration as outlined below. Increased suspended sediment concentrations is a key impact pathway captured for construction and decommissioning activities across other receptors (e.g. marine physical processes and benthic ecology) and should also be scoped in for fish and shellfish interests, as the eggs of certain fish species may be sensitive to smothering and/or burial.	An assessment of the potential effects on fish and shellfish receptors of 'increased sediment concentrations' for the construction and operation and maintenance phases of the Project are assessed in Sections 9.9.1 and 9.9.3, respectively.

CONSULTEE	COMMENT	RESPONSE
	Approach to impact assessment: The proposed assessment approach is set out in section 7.2.10 and we are content with this as detailed. Cumulative impacts: We are content with the approach to the cumulative impact approach, as outlined in section 5.4 and 7.2.8. Mitigation and monitoring: The embedded mitigation measures are discussed in Table 7-7 and we note that whilst not mentioned in this chapter, the marine physical processes section states that requirements for scour protection will be included in the Construction Method Statement. Thus, we are content with what is proposed. Transboundary impacts: We agree that transboundary impacts are scoped out from further consideration in the EIAR.	Noted, no further response required
NatureScot	Positive effects for biodiversity and nature inclusive design We recommend early consideration of potential inclusion of positive effects for biodiversity as well as nature inclusive design. Whilst not a current policy requirement, as part of the need to address both the climate and biodiversity crises, we encourage developers to consider this as part of their application.	The project will utilise the pilot to implement a scientific Research and Development (R&D) programme in conjunction with the Technical University of Denmark (DTU) and the Marine Alliance for Science and Technology for Scotland (MASTS). This programme will provide knowledge and experience on offshore wind turbine construction, integration, installation, operations and maintenance. In line with NatureScot (2022a) Guidance on securing positive effects for biodiversity from local development, this project will also provide vital information to inform Nature Inclusive Design (NID) and the impacts on the biodiversity of fish and shellfish populations around Wind Turbine Generators (WTGs) and cable routes.

CONSULTEE	COMMENT	RESPONSE
Scottish Fishermen's Federation (SFF)	Electromagnetic Field (EMF) Effects: Both, 7.1 Benthic Ecology, and 7.2 Fish and Shellfish Ecology parts of the report have scoped out the EMF effects on benthic and fish and shellfish ecologies. SFF appreciates the developer's argument which are based on some publication cited in the report; however, we would argue that other studies such as St Abbs Marine Station's show the impact of EMF on brown crab. In addition, the report itself acknowledges lack of proper scientific evidence of EMF effects on marine environment. Therefore, as the development site sits in spawning and nursery ground for some fish as well as pelagic, dredging and demersal fishing ground, we would like to see the EMF effects of the development on marine environment scoped in.	As per the Scoping Response from MD-LOT, the Scottish Ministers, along with the NatureScot representation, are content for Electromagnetic Fields (EMFs) to be scoped out of the EIA report for fish and shellfish receptors. The evidence to support this, which considered scientific reports including the St Abbs Marine Station studies, was discussed in the Scoping Report. EMF recorders will also be implemented as part of the scientific R&D programme in conjunction with DTU and MASTS. As such, EMF impacts are scoped out of this assessment.
	Pollutant and noise effects: SFF believe that the 'Effects to Fish and Shellfish Ecology due to accidental release of pollutants' and 'Subsea noise from wind turbine operation impacting fish and shellfish receptors' during operation and maintenance should be scoped in and monitored.	Noted. An assessment of the potential effects on fish and shellfish receptors of 'accidental release of pollutants' and 'subsea noise from wind turbine operation' are assessed in Section 9.9.2.
SFF	Pollutant and noise effects: SFF believe that the 'Effects to fish and shellfish ecology due to accidental release of pollutants' and 'Subsea noise from wind turbine operation impacting fish and shellfish receptors' during operation and maintenance should be scoped in and monitored.	An assessment of the potential effects on fish and shellfish receptors of 'accidental release of pollutants' and 'subsea noise from wind turbine operation' are assessed in Section 9.9.2.

In line with the Scoping Opinion, aspects relevant to Fish & Shellfish Ecology but scoped out of further assessment in this EIAR include:

- The impacts of EMFs on fish and shellfish receptors during operation and maintenance;
- Temporary habitat loss or disturbance due to the presence of the cable and the anchors during operation and maintenance;
- Long-term habitat loss due to the presence of WTG anchors and the export cable on the seabed and associated scour protection during operation and maintenance; and
- Fish aggregations around infrastructure during operation and maintenance.

9.4 Study Area

The Fish and Shellfish Ecology Study Area is defined as the International Council for Exploration of the Sea (ICES) rectangle within which the Project is located (hereafter referred to as the 'Study Area'). The Study Area is located within a single ICES rectangle 43F1, as shown on Figure 9-1. This includes the extent of the Project Area which is shown on Figure 9-2.

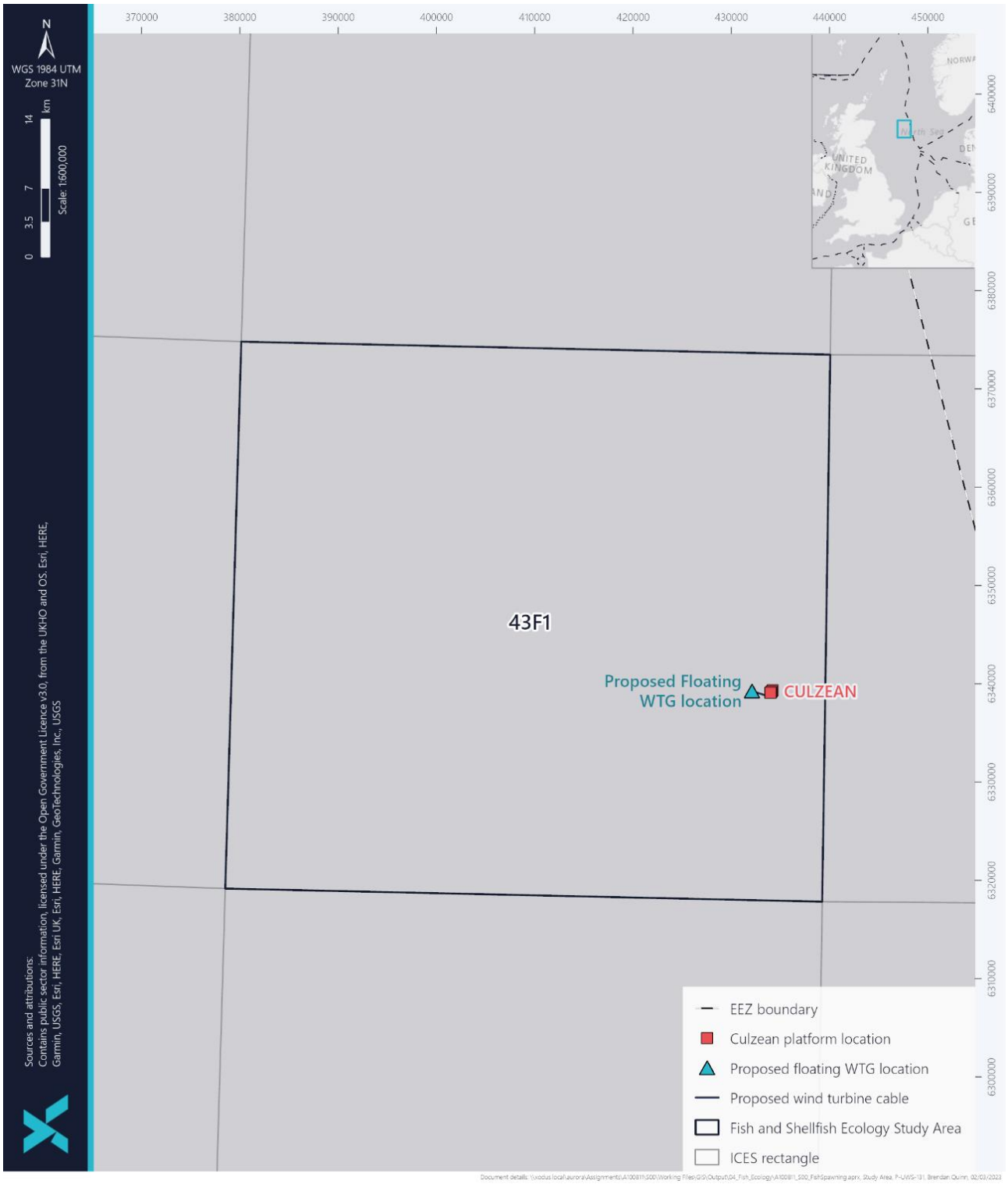

Figure 9-1 Fish and Shellfish Ecology Study Area

9.5 Baseline Environment

9.5.1 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 9-3.

Table 9-3 Summary of key datasets and reports

TITLE	SOURCE	YEAR	AUTHOR
Updated fisheries sensitivity maps in British waters	https://data.marine.gov.scot/dataset/updating-fisheries-sensitivity-maps-british-waters	2014	Aires *et al.*
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 (Ellis - key species only)	https://www.cefas.co.uk/publications/techrep/techrep147.pdf	2012	Ellis *et al.*
Developing Essential Fish Habitat maps for fish and shellfish species in Scotland	https://www.gov.scot/publications/developing-essential-fish-habitat-maps-fish-shellfish-species-scotland-report/	2023	Franco *et al.*
Spawning grounds of Atlantic cod	https://marine.gov.scot/maps/1912	2016a	Gonzalez-Irusta and Wright
Spawning grounds of Atlantic haddock	https://marine.gov.scot/maps/1913	2016b	Gonzalez-Irusta and Wright
Spawning grounds of Atlantic whiting	https://marine.gov.scot/maps/1914	2017	Gonzalez-Irusta and Wright
Survey data / reports available through ICES, including International Herring Larvae Survey (IHLS) and the International Bottom Trawl Survey (IBTS) (North Sea)	https://www.ices.dk/data/data-portals/Pages/default.aspx	2023	ICES
Verified distribution model for lesser sandeel	https://marine.gov.scot/information/lesser-sandeel-habitat	2021	Langton *et al.*,
The Marine Life Information Network (MarLIN)	https://www.marlin.ac.uk /	2023	MarLIN

TITLE	SOURCE	YEAR	AUTHOR
Landing's data (value and weight) by species and UK fleet landings by rectangle stock port and Exclusive Economic Zones (EEZ) (2022)	https://www.gov.uk/government/statistics/uk-sea-fisheries-annual-statistics-report-2022https://www.gov.uk/government/statistics/uk-sea-fisheries-annual-statistics-report-2021	2023	Marine Management Organisation (MMO)
Feature Activity Sensitivity Tool (FeAST)	https://www.marine.scotland.gov.uk/feast/	2013	Marine Scotland
Nature Conservation Marine Protected Areas (NCMPAs) in Scotland	https://marine.gov.scot/maps/844	2020	Marine Scotland
Special Areas of Conservation (SAC) in Scotland	https://www.nature.scot/professional-advice/protected-areas-and-species/protected-areas/international-designations/european-sites/special-areas-conservation-sacs	2020	NatureScot
List of threatened and/or declining species and habitats	https://www.ospar.org/work-areas/bdc/species-habitats/list-of-threatened-declining-species-habitats	2008b	OSPAR
2022 Scottish Sea Fisheries Statistics	https://www.gov.scot/publications/scottish-sea-fisheries-statistics-2022/documents/	2023	Scottish Government
Scottish PMFs	https://marine.gov.scot/sma/content/descriptions-scottish-priority-marine-features-pmfs	2016	Tyler-Walters *et al.*

9.5.2 Project site-specific surveys

Offshore benthic ecology surveys were undertaken across the Project Area from 21st March 2023 to 10th April 2023 (Figure 9-2). This included environmental sampling (grab sampling for faunal analysis and Environmental Deoxyribonucleic Acid (eDNA) (dual van Veen and Hamon Grab), geophysical surveys (Multibeam Echosounder (MBES), Side Scan Sonar (SSS), Magnetometer (MAG), and Sub-Bottom Profiler (SBP)), and drop-down camera records. Geophysical surveys were conducted to identify the seabed features and the geology of the Survey Area, which were used in combination with the environmental data to assess potential areas and species of conservation importance, and as the basis for the European Nature Information System (EUNIS) habitat classifications. Further details on these surveys are provided in the Appendix D.

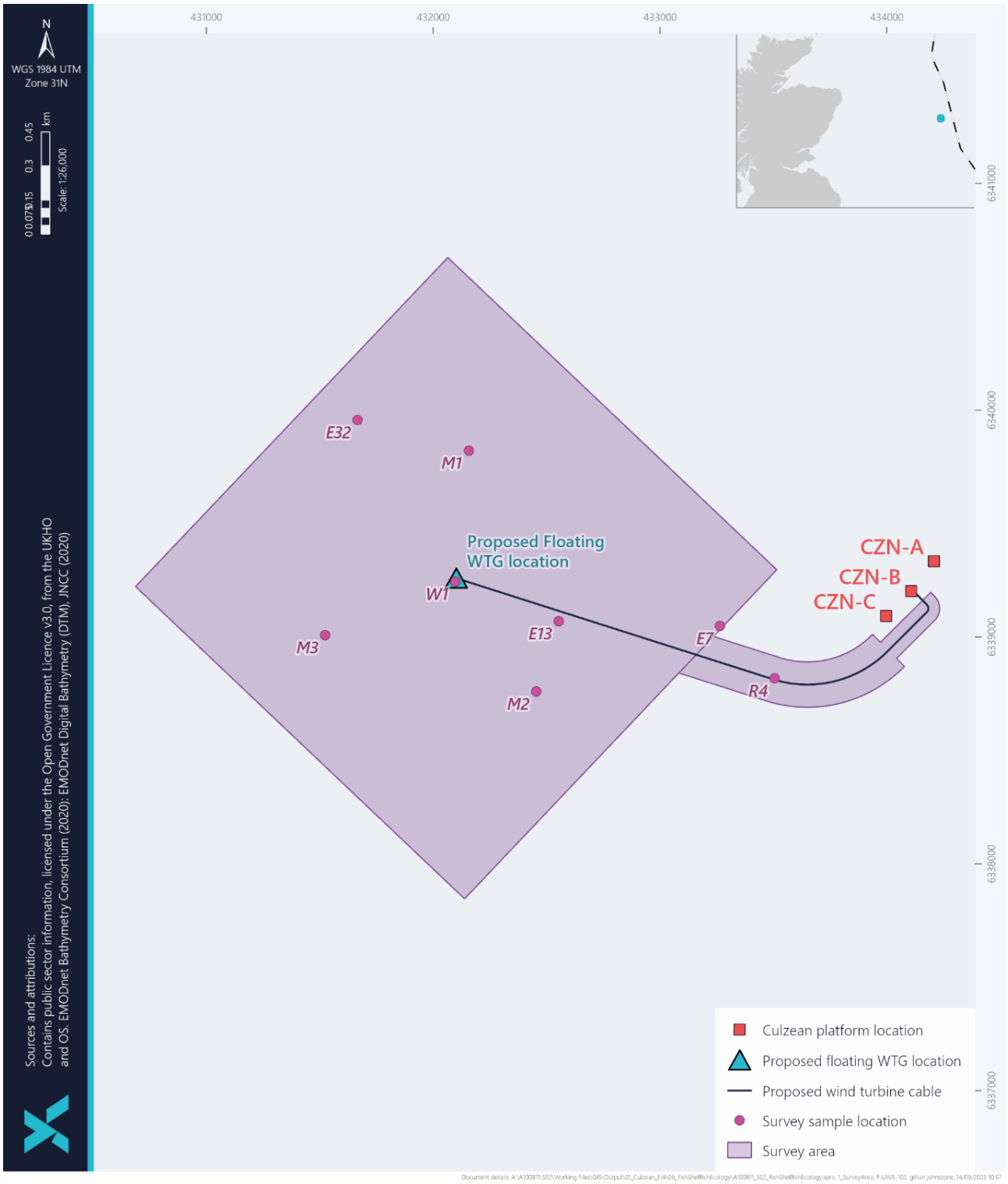

Figure 9-2 Environmental (benthic, sediment and water) sampling locations across the Project Area (Appendix C and Appendix D)

9.5.2.1 eDNA surveys

eDNA surveys can be used to determine the presence or absence of species present based on the DNA in water or sediment samples, providing a non-invasive sampling method to identify the presence of fish, vertebrates, marine mammals, invertebrates, and eukaryotes.

Two water samples were collected at eight locations within the Survey Area (using a Vampire Sampler), one at the sea surface and one near the seabed, giving a total of 40 samples, as shown in Figure 9-2.

9.5.2.2 Benthic surveys

The offshore benthic ecology surveys included grab sampling (primarily using 0.1 m^2 dual van Veen grabs and 0.1 m^2 Hamon grabs in areas of coarse sediment), Drop-Down Video (DDV; to acquire five still images per sample site and continuous video), and video transects (of length 100 m). Four grab samples were acquired per sample site, including three for benthic faunal analyses and one for Particle Size Analysis (PSA) and contaminant analysis. DDV and grab samples (PSA) were used to inform the seabed sediment characteristics that may potentially be suitable fish and shellfish habitat (e.g. spawning and nursery habitat for sandeels (*Ammodytes* spp.) and herring (*Clupea harengus)*.

9.5.3 Existing baseline

A review of literature and available data sources, augmented by Project site-specific surveys, has been undertaken to describe the current baseline environment for Fish and Shellfish Ecology.

9.5.3.1 Overview

Fish receptors relevant to the Project within the Study Area include marine fish (pelagic and demersal), elasmobranchs, and shellfish such as the Norway lobster (*Nephrops norvegicus*). There is little evidence to suggest that diadromous fish (such as Atlantic salmon, *Salmo salar*) will occur within the Study Area, however these species are still considered below. In the absence of site-specific fish survey data, sea fisheries landings data have been used to help characterise the fish and shellfish assemblage. However, it is acknowledged that commercial landings do not provide an accurate representation of species composition, as landings will be influenced by the fishing methods used, seasonality, quotas and Total Allowable Catch (TAC) limits, and could be influenced by discarding practices. To account for these limitations, ICES trawl survey data was also reviewed, as required.

Of the species identified within the waters of the Study Area, two are listed on the OSPAR (2008) List of Threatened and/or Declining Species and Habitats: cod (*Gadus morhua)* and spurdog (*Squalus acanthias*). Ten species are listed as Scottish PMFs: these are sandeel, cod, whiting *(Merlangius merlangus*), herring, Norway pout (*Trisopterus esmarkii)*, blue whiting (*Micromesistius poutassou*), ling (*Molva molva*), anglerfish (*Lophius* spp.), mackerel (*Scomber scombrus*) and spurdog (Tyler-Walters *et al.*, 2016). One species is listed on the International Union for Conservation of Nature (IUCN) Red List as *Threatened*, the sandy ray (*Leucoraja circularis)* (McCully *et al.*, 2015).

The EBS Report (Appendix D) identified five species and two families of conservation importance within the Survey Area:

- A Norway lobster burrow was identified on video survey at sample site E13 in an area of seabed habitat classified as the PMF *Burrowed Mud*, and occasional burrows were noted along the western section of the export cable corridor route. Although not protected by legislation, they have high commercial value and are considered regionally important;
- A possible sandy ray was identified on video survey at sample site E32. Sandy rays are commercially caught in the UK although they are classified as *Endangered* on the IUCN Red List (McCully *et al.*, 2015); and
- eDNA surveys identified large reads of the cod family *Gadidae*, including Norway pout and haddock, and of the ling fish family *Lotidae*. Norway pout and ling are PMFs and on the Scottish Biodiversity List. Whiting was also identified and is a PMF and on the Scottish Biodiversity list.

9.5.3.2 Spawning and nursery grounds

The North Sea to the east of the Scottish mainland, including the Study Area, are potential spawning and nursery grounds for several commercially important species, as characterised by Coull *et al.* (1998) and Ellis *et al.* (2012). It should be noted that the spawning and nursery grounds are based on predictions, and therefore may be spatially and temporally variable. Species including sandeels, mackerel, cod, Norway pout, and lemon sole (*Microstomus kitt*; Coull *et al.*, 1998; Ellis *et al.*, 2012) all have potential spawning and nursery grounds overlapping with the Project (Figure 9-3 and Figure 9-4).

Table 9-4 Spawning and nursery grounds of fish and shellfish species within the Fish and Shellfish Ecology Study Area (Coull et al., 1998; Ellis et al., 2012)

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Anglerfish	N	N	N	N	N	N	N	N	N	N	N	N
Blue Whiting	N	N	N	N	N	N	N	N	N	N	N	N
Cod	SN	S*N	S*N	SN	N	N	N	N	N	N	N	N
European hake	N	N	N	N	N	N	N	N	N	N	N	N
Haddock	N	N	N	N	N	N	N	N	N	N	N	N
Herring	N	N	N	N	N	N	N	N	N	N	N	N
Lemon Sole				S	S	S	S	S	S			
Ling	N	N	N	N	N	N	N	N	N	N	N	N
Mackerel	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	SN	S*N	S*N	SN	N	N	N	N	N	N	N	N
Plaice	N	N	N	N	N	N	N	N	N	N	N	N
Sandeels	SN	SN	N	N	N	N	N	N	N	N	SN	SN
Spurdog	N	N	N	N	N	N	N	N	N	N	N	N
Whiting	N	N	N	N	N	N	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 concentration spawning as per Coull *et al.*, (1998)

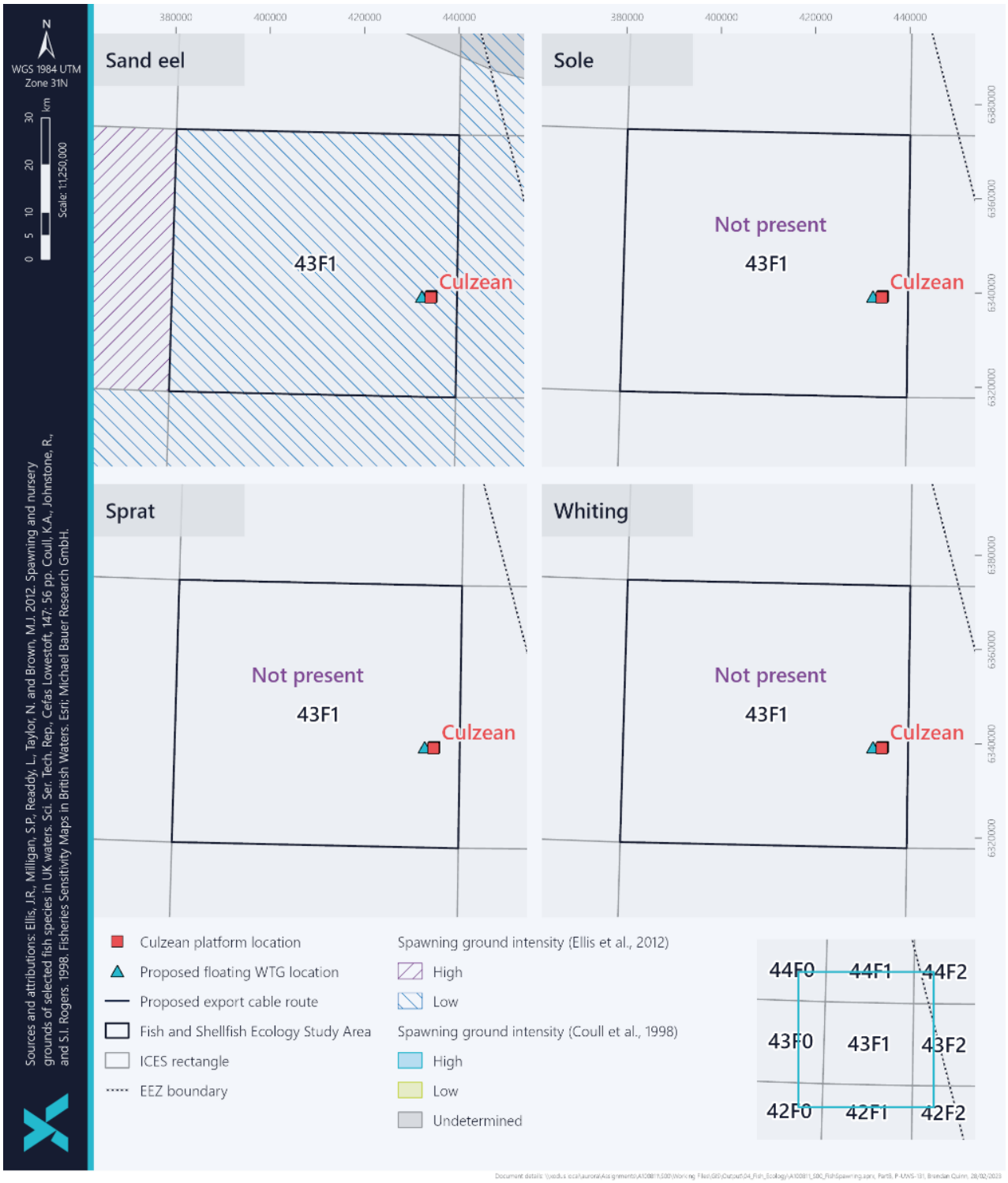

Figure 9-3 Spawning grounds

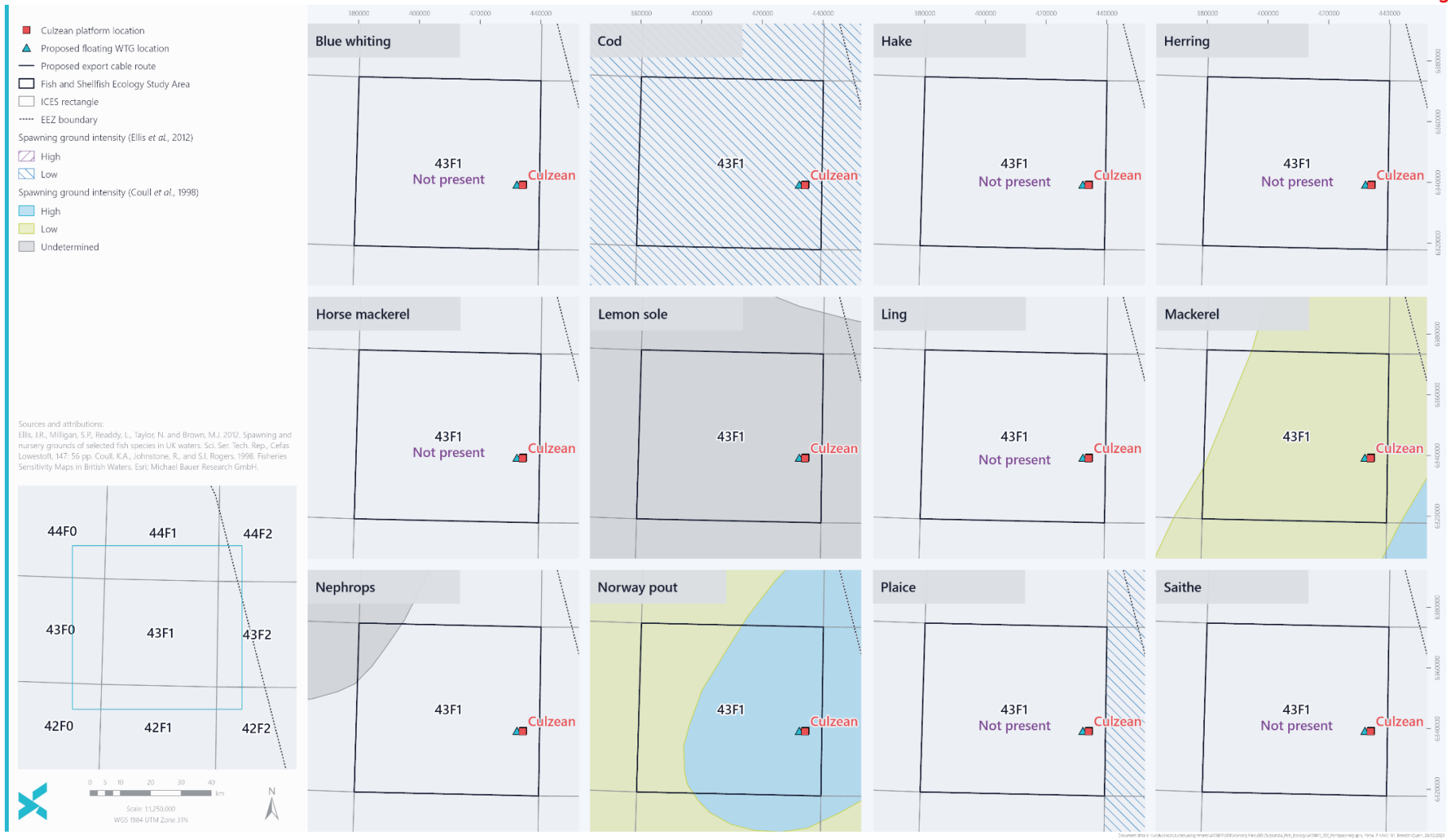

Figure 9-3 (cont.) Spawning grounds

Spawning grounds

Potential spawning grounds for cod, lemon sole, mackerel, Norway lobster, Norway pout, and sandeel overlap with the Project Area.

Spawning grounds for whiting, haddock, and cod have been further updated by González-Irusta and Wright (2016a; 2016b; 2017). González-Irusta and Wright (2016b) produced distribution models for spawning whiting in the North Sea that characterised the preference for spawning[1]. The Study Area is mostly considered as unsuitable spawning ground for whiting, with some patches of less and moderately important grounds. Distribution models were also produced for spawning haddock (González-Irusta and Wright, 2016b), with the data indicating that the Study Area overlaps with spawning grounds that are moderately important spawning grounds, with patches of spawning grounds with greater importance. Areas in the North Sea were characterised as "unfavourable", "rare", "occasional", and "recurrent" grounds for spawning cod (González-Irusta and Wright, 2016a). The Study Area mostly overlaps with areas of "unfavourable" grounds for spawning cod, with some patches of "occasional" and "recurrent" spawning grounds. The Scottish Government recently released a new report on Essential Fish Habitat for fish and shellfish species in Scotland (Franco *et al.*, 2023), detailing the potential for aggregations (presence or absence, high or low confidence). The Study Area is considered to be Essential Fish Habitat for haddock, as potential for aggregations was identified with high confidence (Franco *et al.*, 2023). Potential for aggregations with low confidence was identified for Norway lobster, plaice, common sole, whiting, and sprat (*Sprattus sprattus*).

Norway lobster has potential spawning and nursery grounds overlapping with the Project (Figure 9-3 and Figure 9-4), but the intensities are undetermined (Coull *et al.*, 1998; Ellis *et al.*, 2012). They spawn year-round with a peak between April and June. The predicted spawning and nursery grounds of Norway lobster are of undetermined intensity (Coull *et al.*, 1998), and overlaps with the northwest part of the Study Area (Figure 9-3).

Benthic spawners, such as sandeels, have specific habitat suitability requirements. Unlike pelagic spawners which spawn into the water column of moving water masses over extensive areas, benthic spawners rely on the seabed conditions, and consequently will be more spatially limited. Sandeels are seabed dependent, and spend the majority of their juvenile and adult life in the sandy substrate of the seabed, inhabiting burrows except when feeding and spawning (Van Deurs *et al.*, 2011; Tien *et al.*, 2017). According to Coull *et al.* (1998) and Ellis *et al.* (2012), the Project Area overlaps with sandeel spawning grounds. However, according to the recent distribution model developed by Langton *et al.* (2021), the Survey Area has a zero probability of sandeel burrow presence, with no predicted density of buried sandeels. As such, it is unlikely that sandeel burrowing habitat is present in the Project Area. As Coull *et al.* (1998) and Ellis *et al.* (2012) is spatially and temporarily variable, the Project Area is unlikely to be suitable for sandeel spawning.

[1] *The criteria refers to the 'Index of Persistence' of whiting spawning, where a value of 0 means that that the cell was not classified as suitable for any year during the study period and a value of 1 means that the cell was classified as suitable for all the years studied.*

Herring is a PMF and a Scottish Biodiversity List species due to its role as a key prey species for top predators (Franco *et al.*, 2023), and is the most commercially exploited species in the Study Area. The larval stage from autumn spawning passively drifts away from spawning grounds to nursery areas that may be far away, although this drift is variable and, in some years, larvae may not reach traditional nursery grounds (ICES, 2005). Herring will typically move away from nursery grounds to offshore deeper waters after two years to join the feeding and spawning migrations of adult herring (MacKenzie, 1985; ICES, 2005). No presence of spawning grounds for herring have been identified in the Study Area (Coull *et al.* 1998; Ellis *et al.* 2012).

Grab samples reported in the EBS Report from the benthic survey (Appendix D) found that at all eight sample sites, the average particle size distribution was fine sand (76.12%) followed by silt (20.49%). Sandeel spawning usually occurs in sandy sediments which higher proportions of coarse or medium sand and a low silt content, which indicates that the sediment in the Study Area is unsuitable for sandeel spawning. Similarly, herring prefer coarse substrate for spawning, such that the seabed is unlikely to be suitable.

Nursery grounds

Identified fish and shellfish nursery grounds within the Study Area are shown in Figure 9-4. The Study Area also overlaps with nursery grounds for a number of ecologically important and commercially valuable species. The Study Area overlaps with a high intensity nursery ground for cod. Low intensity nursery ground species include anglerfish, blue whiting, ling, herring, mackerel, plaice (*Pleuronectes platessa*), sandeel and spurdog (Ellis *et al.*, 2012). Haddock, Norway lobster, and Norway pout nursery grounds are also present within the Study Area, but the intensities are undetermined (Coull *et al.*, 1998; Figure 9-4).

Fish sensitivity maps

Aires *et al.* (2014) used data from trawl surveys and the ICES programme of IHLS, in combination with the findings of Coull *et al.* (1998) and Ellis *et al.* (2012), to create fish sensitivity maps that summarise the probability of aggregations of 0-group fish (i.e., in the first year of life) and/or larvae of key commercial species. Anglerfish, haddock, hake (*Merluccius merluccius*) and Norway pout are the species with the highest probability of juvenile (<1 year old fish) aggregation within the waters of the Study Area. Herring, cod and whiting were modelled at a moderate probability of juvenile aggregation (Figure 9-5). Lemon sole demonstrate an extended (six-month) spawning period of undetermined intensity within the Study Area (Figure 9-3).

Certain species present in the Study Area, like cod and herring, are sensitive to underwater sound due to the presence of a swim bladder (Popper *et al.*, 2014), and could be sensitive to impacts caused by the installation, operation and maintenance, and decommissioning of the Project

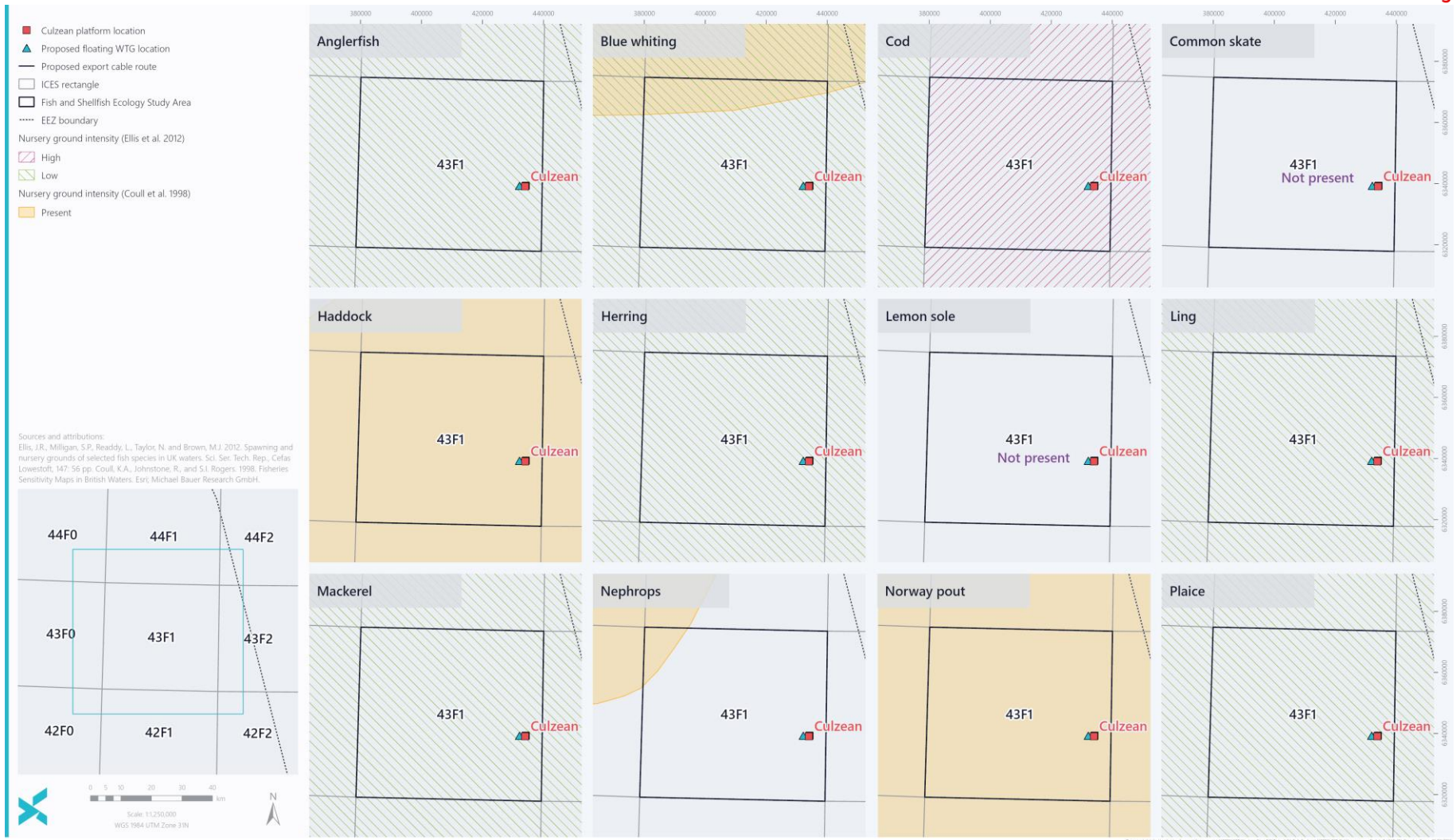

Figure 9-4 Nursery grounds

Figure 9-4 (cont.) Nursery grounds

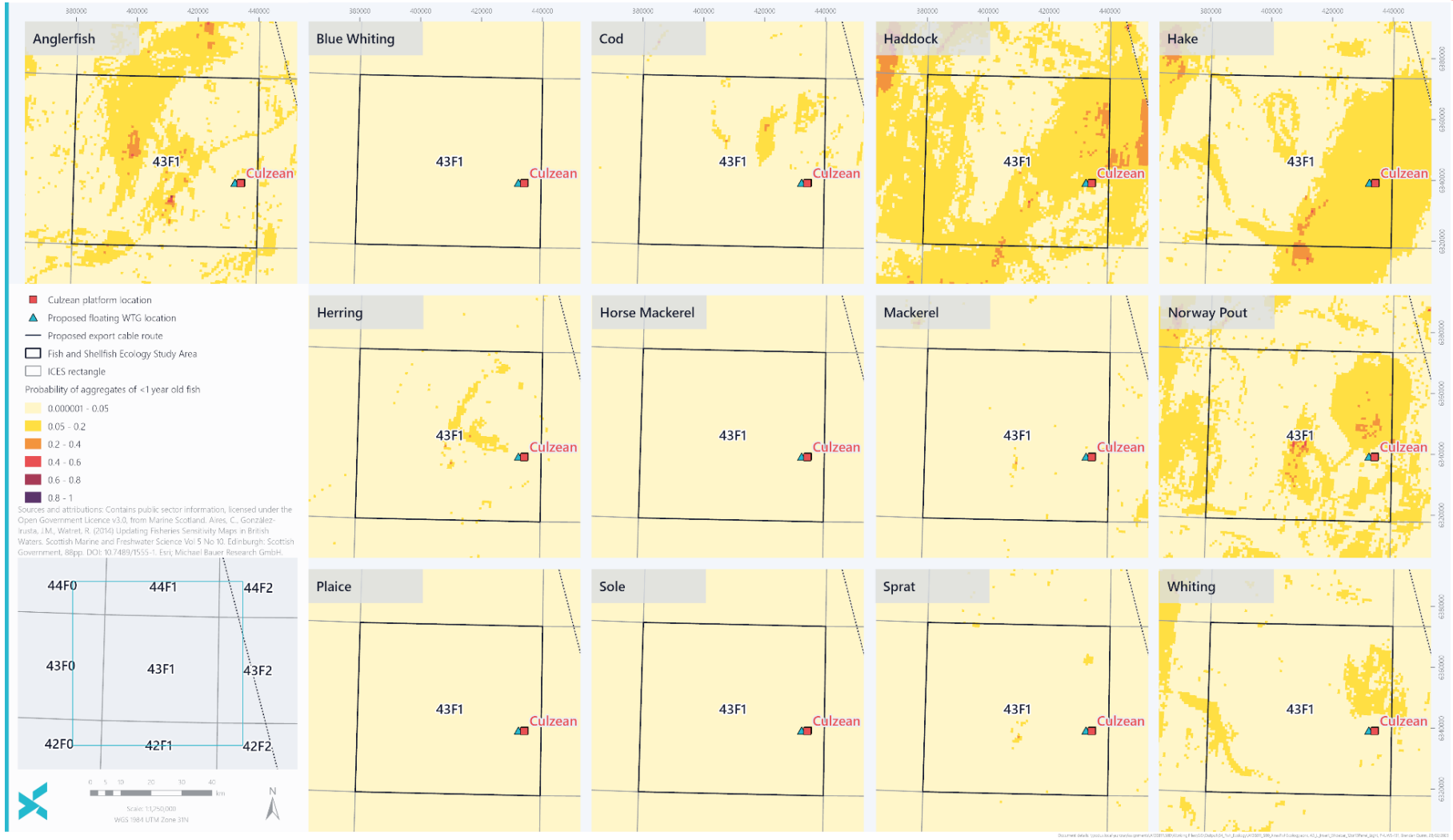

Figure 9-5 Probability of aggregation of juvenile fish (Aires et al., 2014)

9.5.3.3 Marine finfish

In this chapter, marine finfish are defined as non-diadromous marine teleosts, including demersal teleost fish (bottom dwelling) and pelagic teleost fish (fish that inhabit the water column). Demersal teleost fish are further categorised into flatfish, gadoids and 'other' demersal teleost fish species.

Commercially important species

Sixteen different marine finfish species were caught and landed within the Fish and Shellfish Ecology Study Area between 2017 and 2021, presented in Table 9-5 as the average live weights and its value between 2018 and 2022 caught in ICES rectangle 43F1. Species are presented in descending order in terms of total live weights, and only the top 10 marine finfish species are listed (by weight). Commercial landings do not provide an accurate representation of species composition, as landings will be influenced by the fishing methods used, seasonality, quotas, bycatch, discards, and TAC limits. The potential impacts of the Project on commercial fisheries are assessed in detail within Chapter 12: Commercial Fisheries.

Table 9-5 Average live weights and value (2018-2022) of commercially exploited marine finfish within the Fish and Shellfish Ecology offshore Study Area (ICES rectangle 43F1) (MMO, 2023)

SPECIES	AVERAGE LIVE WEIGHT (TONNES)	AVERAGE VALUE (£)
Herring	171.7	125,370.0
Haddock	63.4	68,361.4
Plaice	7.2	7,165.4
Whiting	6.3	7,043.7
Lemon sole	3.7	7,072.2
Monks or anglers	3.4	8,107.4
Norway pout	3.4	2,506.1
Witch (*Glyptocephalus cynoglossus*)	2.6	2,548.7
Cod	1.6	3,709.1
Gurnards – Grey (*Eutrigla gurnardus*)	1.6	808.6

The project-specific eDNA survey results have been used to further inform the baseline characterisation of the Survey Area (Appendix E). *Gadidae* spp. were the most frequently identified taxa (89% of the read counts), including Norway pout and haddock, which is generally consistent with the landings data described above. *Lotidae* spp. was the second most frequently recorded family (5% of read counts). Targeted sequence reads of three sample sites showed a high proportion of long rough dab (*Hippoglossoides platessoides*), which are not landed in the Fish and Shellfish Ecology offshore Study Area. Gurnards (*Triglidae*) were also identified in a quarter of the samples, followed by whiting, haddock, and Norway pout, all of which are identified in the landings data (Table 9-5).

9.5.3.4 Other fish species

An Atlantic hagfish (*Myxine glutinosa*) was identified in the EBS Report (Appendix D) during the video surveys of the western section of the export cable corridor route (site E13). Hagfish are a demersal species that prefer muddy seabed where they hide in the mud (Barnes, 2008). Hagfish are recorded across the North Sea and is listed as *Least Concern* on the IUCN Red List (Mincarone, 2011).

9.5.3.5 Elasmobranchs

Over 30 species of elasmobranchs are known to occur in Scottish waters, encompassing sharks, rays and skates. Basking sharks (*Cetorhinus maximus*) are not included within this chapter and are instead considered within Chapter 10: Marine Mammals and Other Megafauna. The spiny dogfish, or spurdog can be found in the Study Area, determined by catch records. The Study Area also overlaps with low intensity nursery grounds for spurdog. Figure 9-4; Ellis *et al.*, 2012). Spurdog are widely distributed through British and Irish waters and are classified as a PMF in Scotland (Marine Scotland, 2023). Other elasmobranchs in the commercial landings data from ICES rectangle 43F1 include cuckoo ray (*Leucoraja naevus*), spotted ray (*Raja montagu*) and "unidentified dogfish".

Video surveys have identified a possible sandy ray in the Study Area, belonging to the commercially designated family Rajidae (Appendix C). This species is classified as *Endangered* on the IUCN Red List (McCully *et al.*, 2015) due to bycatch and overfishing. Sandy rays are generally found along continental shelves, often on sandy muddy bottoms at depths of 70-275 m (Barnes, 2008; Franco *et al.*, 2023).

9.5.3.6 Diadromous fish

Diadromous fish are species that migrate between freshwater and marine environments during their lifecycle, such as salmonids and European eel (*Anguilla anguilla*).

Some species of diadromous fish have the potential to use or migrate through the Project Area, in particular, Atlantic salmon and European eel. The closest European sites for relevant diadromous fish species are listed in Table 9-7.

Atlantic salmon

Atlantic salmon is an Annex II species under the Habitats Directive, on the OSPAR List of Threatened and/or Declining Species and Habitats, on the Scottish Biodiversity List, a Scottish PMF species, and is of cultural, recreational and commercial importance in Scotland. Atlantic salmon spawn in freshwater environments, where the juveniles will remain for around two to three years until they mature and undergo smolting, which enables them to survive in salt water (Heard, 2007; NatureScot, 2023). Adult Atlantic salmon, known as post-smolts once they enter the marine environment, migrate to deep-water offshore feeding grounds. Current knowledge of Atlantic salmon migratory

routes is limited, although tagging studies suggest an offshore migratory route across the North Sea (Main, 2021). Trawling studies have shown high densities of post-smolts in the north and northwest coast of Scotland, dispersing through the Norwegian Sea (Holm *et al.*, 2000). Analyses of tagging studies of Scottish salmon indicate that 50% of tagged salmon were recovered within 15 kilometre (km) of release, and 90% were within hundreds of kilometres (Downie *et al.*, 2018). The proposed Project location is 222 km from the coast. Tagged individuals in Denmark showed northern movements through the centre of the North Sea, continuing on further north towards Iceland, Greenland and the Barents Sea (Rikardsen *et al.*, 2021).

Freshwater pearl mussel (*Margaritifera margaritifera*) is considered in parallel to Atlantic salmon, and although they only inhabit freshwater habitats, they rely on salmonids for juvenile recruitment and population sustainability (NatureScot, 2022b). The closest European sites for these species are listed in Table 9-7.

European eel

European eel are considered a Scottish PMF species, listed as *Critically Endangered* on the IUCN Red List, and on the OSPAR List of Threatened and/or Declining Species and Habitats. They spend most of their life in freshwater, and will migrate to spawn in the Sargasso Sea (Aarestrup *et al.*, 2009). Migratory routes are largely unknown, despite many European rivers with potential eel habitat discharging into the North Sea. However, a meta-tracking study has found some adult migratory stage eels (silver eels) leaving the North Sea to the north of the British Isles (Verhelst *et al.*, 2022), passing through Scottish waters.

Significant knowledge gaps remain on the migratory routes of Atlantic salmon, European eel, and other diadromous fish (Malcom *et al.*, 2010), and so the potential abundance of these species in the Project Area is unknown. However, the distance of the Study Area from coastlines of Britain and Europe makes it unlikely that any diadromous fish species occurs within the Study Area at notably high densities.

Through the HRA screening process no European Sites with relevant diadromous fish species were identified as overlapping with the Project boundary, due to its distance from the coastline. The HRA screening process, undertaken in consultation with NatureScot and MD-LOT, concluded there was no potential for Likely Significant Effect (LSE) on these features and therefore no further assessment was required under the HRA process.

The eDNA surveys did not identify any diadromous fish (Appendix E), although eDNA surveys only provide a snapshot of species present at the time of sample collection.

9.5.3.7 Shellfish

The shellfish species considered within this chapter include larger crustaceans and molluscs, primarily those of commercial importance. Smaller crustaceans, including ocean quahog (*Arctica islandica*), are considered within Chapter 8: Benthic Ecology. Shellfish have a more limited mobility when compared to fish. Although they are not protected by legislation, they are of commercial importance and are judged to be regionally important and are subject to fisheries management regulations such as TAC or maximum landing size.

Table 9-6details the commercially exploited shellfish species in terms of the annual average landed live weight in the Study Area between 2017 and 2021.

Table 9-6 Average live weight and value (2018-2022) of commercially exploited shellfish within the Fish and Shellfish Ecology offshore Study Area (ICES rectangle 43F1) (MMO, 2023)

SPECIES	AVERAGE LIVE WEIGHT (TONNES)	AVERAGE VALUE (£)
Nephrops (Norway lobster)	23.105	74,566.4
Squid (*Loligo* spp.)	0.438	1,686.4
Mixed squid and octopuses	0.134	434.7
Octopuses (*Octopodidae*)	0.036	42.7
Cuttlefish (*Sepiidae*, *Sepiolidae*)	0.007	12.0
Lobster – squat (*Galatheidae*)	0.002	9.9

The most economically important commercial shellfish species in the Study Area is Norway lobster. The potential impacts on commercial fisheries are assessed in detail within Chapter 12: Commercial Fisheries. Norway lobster typically do not undertake long migrations, nor do they seem to abandon their habitat at any stage in their life cycles (Aguzzi and Sardà, 2008; Merder *et al.*, 2020). Norway lobster can be found in the sublittoral zone, commonly in depths between 200-800 m (Franco, *et al.*, 2023), although considerable populations exist at depths of less than 200 m. Norway lobster live in shallow burrows, preferring soft sediment of fine cohesive mud stable enough to support a burrow (Hill and Sabatini, 2008). During reproduction, the eggs are carried on the female's abdomen, during which time they will tend to remain in their burrows. A Norway lobster burrow was identified in the EBS Report on video survey, and occasional burrows were noted along the western section of the export cable corridor route (Appendix D).

Squid are the second most valuable commercial shellfish species group, and generally includes the common squid (*Loligo vulgaris*) and the long-finned squid (*Loligo forbesii*). Due to the lack of reporting on individual species in landings, little information about the seasonal distribution of spawning and nursery grounds is known. Both species reproduce during multiple months of the year with the timing of eggs being highly variable (Laptikhovsky *et al.*, 2022). Analysis of research survey data and landings between 1990 and 2021 showed that long-finned squid was found much more frequently in the Northern North Sea, with potential nursery grounds occurring near to the Study Area (Laptikhovsky *et al.*, 2022). However, as squid are highly mobile species, identification of nursery grounds was done using a combination of egg masses and presence of mature squid. Common squid generally spawn in waters from 25 to 50 m deep (Jereb *et al.*, 2015), whereas long-finned squid generally spawn inshore during winter and gradually migrate to offshore feeding grounds as juveniles (Collins *et al.*, 1995; Franco *et al.*, 2023). Based on the results contained within the Essential Fish Habitat for Fish and Shellfish Species in Scotland report (Franco *et al.*, 2023), immature long-finned squid are not predicted to aggregate in or near the Study Area.

9.5.3.8 Designated sites

There are no designated sites that overlap with the Study Area or the Project Area for Fish and Shellfish Ecology receptors. The closest relevant site to the Project Area, the River Dee SAC, is located approximately 238 km west of the proposed operations (Figure 9-6).

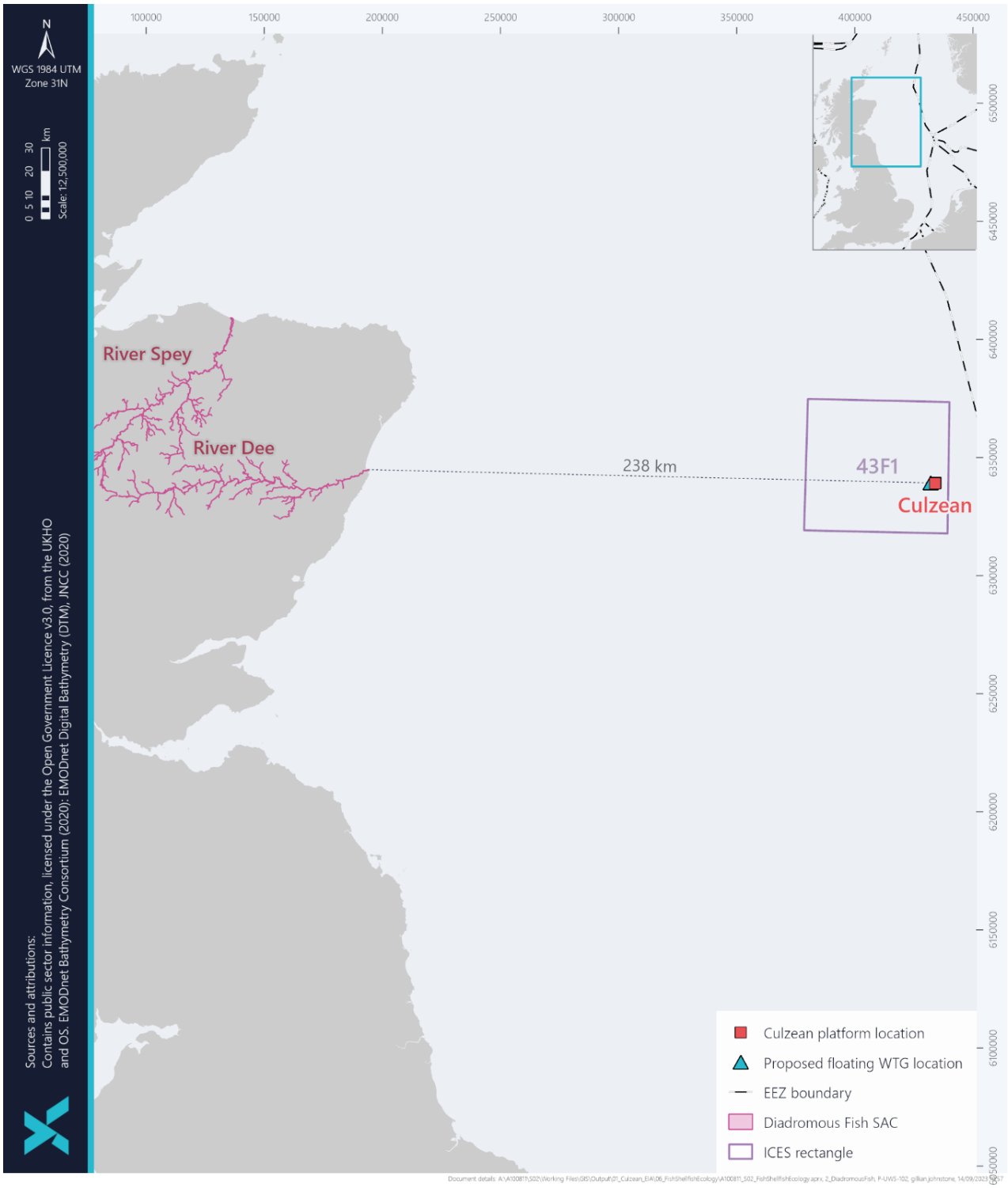

Figure 9-6 Relevant designated sites for diadromous fish

Due to the intervening distance between the proposed operations and the designated interest features within the designated sites, as well as the scale of operations, it is considered that there is little to no pathway for interaction or impacts to designated features. Table 9-7 identifies rivers and sites of importance for Atlantic salmon and freshwater pearl mussel, but where the potential connectivity with designated sites and all qualifying features have not been taken forward for consideration of no LSE and have been screened out of the HRA process. The EIAR assesses the effects of the Project on the protected features of these designated sites in EIA terms.

Table 9-7 Summary of European sites designated for qualifying interests with potential connectivity with the Project

SITE NAME	QUALIFYING INTEREST / FEATURES	DISTANCE FROM PROJECT (KM)
River Dee SAC	Atlantic salmon; freshwater pearl mussel	~ 238
River Tay SAC	Atlantic salmon	~ 288
River Tweed SAC	Atlantic salmon	~ 290
Dornoch Firth & Cromarty Bay	Designated Shellfish Water Protected Areas	~ 300
River Spey SAC	Sea Lamprey; Atlantic salmon; Freshwater pearl mussel	~ 303
Berriedale and Langwell SAC	Atlantic salmon	~ 338
River Thurso SAC	Atlantic Salmon	~ 356
River Evelix SAC	Freshwater pearl mussel	~ 364
River Oykel SAC	Atlantic salmon; and Freshwater pearl mussel	~ 380

9.5.4 Future baseline

The fish and shellfish ecological baseline is continuously evolving over time due to natural variation, climate change, changes in predator-prey interactions, and fishing activities. The future baseline for commercial fisheries is described in Chapter 12: Commercial Fisheries.

Evidence of change in fish and shellfish distributions has been observed due to changing sea temperatures, which is likely to be the most prominent driver is the structure of marine fish communities (Rutterford *et al.*, 2023). North Sea population boundaries for both fish and shellfish species are showing shifts in northerly and southerly range margins, largely linked to temperature increases and habitat loss (Perry *et al.*, 2005; Hiddink, *et al.* 2015; Weiner, *et al.*, 2016). The distribution changes of warm-water and cold-water species has been documented, where warm-water (Lusitanian) fish species are increasingly appearing in UK waters, whilst cold-affinity species are experiencing local declines (Wright *et al.*, 2020; European Environment Agency (EEA), 2022). It is expected that north western European waters are likely to become unsuitable for certain species, while becoming more suitable for others (Townhill *et al.*, 2023).

Shifts in the timing of spawning, hatching and migration, where the mismatch between the timing of fish spawning and algal blooms may have an effect on the recruitment of winter-spring hatching fish larvae (e.g. sandeel, cod, and sole) that prey on plankton (Wright *et al.*, 2020). For example, sole stocks have exhibited significant long-term trends towards earlier spawning since 1970 (Lacroix *et al.*, 2018), which is likely to be experienced in other species. Similarly, shifts in other life history stages that are influenced by environmental cues, such as migration timing and choice of migratory routes, may also occur (Department for Business, Energy and Industrial Strategy (BEIS), 2022).

Climate change effects are difficult to predict, and there is limited confidence in interpreting evidence and the level of contribution of climate change to the observed changes in the fish and shellfish communities, particularly with natural variation of populations (Wright *et al.*, 2020; BEIS, 2022). This complex relationship between anthropogenic impacts and natural variation, as well as the difficulty to predict future impacts of the rapidly changing climate on fish and shellfish populations, an accurate future Fish and Shellfish baseline for the Study Area cannot be provided.

9.5.5 Summary and key issues

Table 9-8 Summary and key issues for Fish and Shellfish Ecology

SUMMARY AND KEY ISSUES	PROJECT AREA
	• Potential for diadromous fish to migrate through the Project Area, including Atlantic salmon, and European eel; • Presence of preferred sandeel, cod, mackerel, lemon sole, and Norway pout spawning habitat; • Overlap with nursery habitat for a number of ecologically and commercially important species; • Potential interaction with species of commercial or conservation importance (e.g. PMF species) that have spawning and/or nursery grounds that overlap the offshore Project Area (e.g. herring and haddock); • Potential overlap with Norway lobster habitat; and • Potential presence of key prey species such as sandeel, herring, and mackerel.

9.5.6 Data gaps and uncertainties

An extensive desk-based study was carried out to characterise the baseline. The spawning and nursery ground data from Coull *et al.* (1998) and Ellis *et al.* (2012) provides an indication of the presence of species in the Study Area, and only provide the maximum spatial extents and duration of spawning. The actual spawning and nursery grounds could be smaller. Information from other sources, including stock data, fisheries statistics, and modelling studies (Aires *et al.*, 2014; González-Irusta and Wright, 2017; González-Irusta and Wright, 2016b; González-Irusta and Wright, 2016a; Franco *et al.*, 2023) has been used to supplement these data.

As the majority of studies on diadromous fish have been carried out in coastal environments, key uncertainties for diadromous fish include the migratory routes for Atlantic salmon and European eel adults through the North Sea, as well as the specific timings of migrations.

9.6 Key Parameters for Assessment

As detailed in Chapter 4: Project Description, this assessment considers a Project Design Envelope (PDE), which encompasses a Maximum Design Scenario (MDS) or a worst-case scenario. The MDS scenario represents, for any given receptor and potential impact on that receptor that would result in the greatest potential for change.

Given that the MDS 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 9-9 presents the worst-case scenario for potential impacts on Fish and Shellfish Ecology during construction, operation and maintenance and decommissioning.

Table 9-9 Worst case scenario specific to Fish and Shellfish Ecology receptor impact assessment

POTENTIAL IMPACT	WORST CASE SCENARIO	JUSTIFICATION
Construction and decommissioning		
Disturbance or damage to sensitive species due to underwater sound	The proposed operations will result in a total of 54 working vessel days visiting during construction operations., with a maximum of four vessels at any one time.	Construction will require a maximum number of vessels in the Project Area for cable laying, dredging, trenching, and rock placement. The construction is expected to occur over one month in Q3 2025. The cable trenching and rock placement has the greatest potential for noise disturbance.
Habitat loss or disturbance during the installation of the export cable, mooring lines and the anchors	During export cable burial activities, mooring line and anchor installation activities, interaction with the seabed may temporarily disturb and remove benthic habitats and species in a seabed sediment disturbance footprint. Mooring lines = 0.018 km^2 Anchors = 0.00411 km^2 Cable = 0.03 km^2 **Total temporary seabed disturbance = 0.052 km^2** During construction, the addition of anchor scour protection and cable protection may result in loss of seabed sediments and a habitat change for benthic communities present in the Project Area (0.024 km^2). Anchor scour = 0.00042 km^2 Cable protection = 0.007 km^2 **Total worst-case habitat change = 0.007 km^2**	Benthic habitats and species located within this footprint may be subject to temporary disturbance during construction operations (e.g., excavation and cable laying) which are estimated to last a maximum of one month. <u>Mooring line impact:</u> There will be three initial catenary mooring lines used as part of the Project. Installation of the mooring lines will involve connecting them to the anchors. Therefore, there will be no temporary impacts associated with installation. Within the MDS, each mooring line is 600 metres (m), with a maximum of 490 m in contact with the seabed following installation. The lines may be subject to a maximum of 10 m lateral movement (5 m in either direction). **3 Catenary mooring lines temporary footprint:** [3 x 490 m x 10 m = 14,700 m^2 = **0.0147 km^2**]. Approximately one year into the Project, TotalEnergies E&P North Sea UK Ltd (TEPNSUK) plan to install either a taut or semi-taught mooring system. The MDS for this will be a semi-taut mooring system (which would be the additional option with the highest seabed impact). This will involve 3 mooring lines, each with a length of 610 m. Of this approximately 110 m will be in contact with the seabed. The lines may be subject to a maximum of 10 m lateral movement (5 m in either direction). The footprint has therefore been calculated based on this assumption: **3 Semi-taut mooring lines temporary footprint:** [3 x 110 m x 10 m = 3,330 m^2 = 0.0033 km^2] **Total mooring line temporary footprint:** [0.0147 km^2 + 0.0033 km^2 = **0.018 km^2**]

POTENTIAL IMPACT	WORST CASE SCENARIO	JUSTIFICATION
		Anchoring impact: Each mooring line will have an associated anchor. Six drag anchors have been assumed to assess the worst-case scenario. Each anchor is approximately 11.2 m long and 11.2 m at its widest point (worst-case of 125m^2 per anchor). The anchors will be secured in place by dragging them across the seabed. A maximum worst-case drag length of 50 m has been assumed. Drag anchors temporary footprint [6 x 125 m^2 = 750 m^2 = 0.00075 km^2] Post-installation drag temporary footprint [6 x 11.2 m x 50 m = 3,360 m^2 = 0.00336 km^2] Total anchor seabed temporary footprint: [0.00075 km^2 + 0.00336 km^2 = **0.00411 km^2**] The anchors will penetrate approximately 10 m to 15 m into the seabed. Post-installation, there may be a requirement for up to 70 m2 of rock to be deposited as a form of scour protection at each anchor site. The maximum long-term footprint from anchoring would therefore be equivalent to: Total long-term impact footprint (Anchor scour): [6 x 70 m^2 = 420 m^2= **0.00042 km^2**] Export cable impact: The export cable will be 2,500 m long in total, with a maximum of 2,045 m in contact with the seabed. Prior to installation, a pre-lay grapnel run will be undertaken along the length of the cable route. The trenching of the export cable will involve the temporary disturbance of the surrounding seabed. A maximum seabed disturbance corridor width of 15 m has been assumed due to trenching activities and associated disturbance and site preparation works, including pre-lay grapnel run. Cable lay total temporary footprint: [15 m x 2,045 m = 30,675 m^2= **0.03 km^2**] Once the cable is installed, under a best-case scenario it will be 100% trenched and buried, resulting in no long-term impacts to the seabed. However, there may be contingency requirement for additional cable protection (likely rock dump) along approximately 50% (1,000 m worst case) of the cable route. The cable protection will be no more than 7 m wide and will remain in place for the operational lifetime of the Project. Therefore, the long-term footprint will be equivalent to: Total long-term impact footprint (cable lay): [7 m x 1,000 m^2 = 7,000 m^2= **0.007 km^2**]

POTENTIAL IMPACT	WORST CASE SCENARIO	JUSTIFICATION
Temporary increases in suspended sediment concentrations and potential sedimentation / smothering on fish	During construction activities, interaction with the seabed may result in a temporary increase in suspended sediment concentrations. This may result in increased sediment deposition, causing smothering to benthic spawning species and fish in the water column.	The proposed operations will result in minor excavation and burial around the export cable corridor. This will result in sediment suspension and deposition of sediments in the Project Area.
Operation and maintenance		
Impact to habitats or species as a result of pollution or accidental discharge	• One WTG installed within the Project Area; and • One vessel associated with operation and maintenance.	Maximum number of vessels operating during operation and maintenance that have the potential to release pollutants.
Disturbance or damage to sensitive species due to underwater sound	• One WTG installed within the Project Area; and • One vessel associated with operation and maintenance.	Maximum number of vessels operating during operation and maintenance that have the potential to release noise.
Decommissioning		
The MDS for decommissioning will be the same or less than during construction.		

9.7 Methodology for Assessment of Effects

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

The assessment for Fish and Shellfish Ecology is undertaken following the principles set out in Chapter 6: 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 9-10 and Table 9-11.

Table 9-10 Sensitivity criteria

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 9-11 Magnitude criteria

MAGNITUDE CRITERIA	DEFINITION
High	• Total change or major alteration to key elements / features of the baseline conditions, impacting a large proportion of key spawning or nursery grounds; • Impact is permanent or long-term (temporary but occurs over an entire reproductive cycle, i.e. a year or longer); 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, impacting a part of key spawning or nursery grounds; • Impact is temporary but occurs over a relatively long period of time, potentially overlapping with some of the mating/spawning season (i.e. months); and/or • Medium to high frequency (occurring repeatedly or continuously for a moderate length of time) and/or at moderate intensity or occurring occasionally / intermittently for short periods of time but at a moderate to high intensity.
Low	• Minor shift away from the baseline conditions, impacting a limited proportion of key spawning or nursery grounds; • Impact is temporary and occurs over a relatively short period of time, with little overlap with the mating / spawning season (i.e. weeks); 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, with very little to no impact on key spawning or nursery grounds; • Impact is short-term (i.e. days) and has very little or no overlap with mating / spawning seasons; and/or • The impact is very unlikely to occur and if it does will occur at very low frequency or intensity.

The consequence and significance of effect is then determined using the matrix provided in Chapter 6: EIA Methodology.

9.8 Embedded Mitigation

As described in Chapter 6: EIA Methodology, certain measures have been adopted as part of the Project development process to reduce the potential for impacts to the environment, as presented in Table 9-12. These 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.

Table 9-12 Embedded mitigation measures relevant to Fish and Shellfish Ecology

MITIGATION MEASURE	DESCRIPTION	FORM (PRIMARY OR TERTIARY)	HOW MITIGATION WILL BE SECURED
Reducing localised habitat loss	Best practice will be followed to ensure that potential habitat loss is minimised throughout the proposed works (e.g. Micro-siting and minimising the benthic footprint of the Project). The amount of rock used to protect the offshore export cable or as scour protection will be kept to a minimum where possible.	Primary	Secured through conditions attached within the Marine Licence.
Cable Plan (CaP) and Cable Burial Risk Assessment (CBRA)	A CaP will be provided for the Project which will detail the location/route and cable laying techniques of the export cable and detail the methods for cable surveys during its operational life. A CBRA will also be undertaken and included within the CaP to determine required cable protection measures[2]with an aim to minimise volume and spatial extent of protection.	Primary	Secured through conditions attached within the Marine Licence.
Environmental Management Plan (EMP)	The EMP will provide the over-arching framework for on-site environmental management during the phases of development as follows: • All construction as required to be undertaken before the commissioning of the Project • The operational lifespan of the Project from Commissioning until the cessation of electricity generation (environmental management during decommissioning is addressed by the Decommissioning Programme). The EMP will be in accordance with the Application insofar as it relates to environmental management measures. The EMP will set out the roles, responsibilities and chain of command in respect of environmental management for the protection of environmental interests during the construction and operation of the Project. It will address (but not be limited to) the following overarching requirements for environmental management during construction: • Mitigation measures as identified in the Application, pre-consent and pre-construction monitoring or data collection; • A pollution prevention and control method statement, including contingency plans;	Tertiary	Secured through conditions attached within the Marine Licence.

[2] Export cable will be routed to avoid sensitive features wherever practicable and buried as the primary cable protection method. Additional export cable protection may be used where adequate burial cannot be achieved and this will be minimised as far as is practicable. This will be informed by a CBRA*, completed to determine the suitable cable protection measures, and implemented through relevant project plans.*

MITIGATION MEASURE	DESCRIPTION	FORM (PRIMARY OR TERTIARY)	HOW MITIGATION WILL BE SECURED
	• Management measures to prevent the introduction of Invasive Non-Native Species (INNS); • A site waste management plan (dealing with all aspects of waste produced during the construction period), including details of contingency planning in the event of accidental release of materials which could cause harm to the environment. Wherever possible the waste hierarchy of reduce, reuse and recycle will be referred to; and • The reporting mechanisms that will be used to provide the Scottish Ministers and relevant stakeholders with regular updates on construction activity, including any environmental issues that have been encountered and how these have been addressed. The EMP will be regularly reviewed by the Company at intervals agreed by the Scottish Ministers and will be updated based on current information on construction methods and operations.		
Project Environmental Monitoring Programme (PEMP)	A PEMP to provide further evidence to support the conclusions of the EIA and provide information for future offshore wind farm developments.	Tertiary	Secured through conditions attached within the Marine Licence.
Construction Method Statement (CMS)	A CMS will be developed in accordance with the EMP and detail how project activities and plans identified within the EMP will be carried out, whilst also highlighting any possible dangers / risks associated with specific Project activities. The CMS will include the Code of Construction Practice (CoCP) which will set out the approach to how construction activities will be managed and controlled in order to deliver the commitments and mitigation arising from Project.	Tertiary	Secured through conditions attached within the Marine Licence.
Decommissioning Programme	A Decommissioning Programme will be provided pre-construction to address the principal decommissioning measures for the Project, this will be written in accordance with applicable guidance and detail the management, environmental management, and schedule for decommissioning.	Tertiary	Secured through conditions attached within the Marine Licence.

9.9 Assessment of Impacts

9.9.1 Potential effects during construction

9.9.1.1 Disturbance or damage to sensitive species due to underwater sound

Underwater sound from anthropogenic sources is recognised as an internationally concerning pollutant, and can cause physical injury, mortality, or behavioural effects on fish and shellfish receptors. Behavioural effects include displacement or avoidance of the area near the source of noise, impacts to reproductive success (de Jong *et al.*, 2020), foraging, predator avoidance and navigation (Hawkins and Myrberg, 1983), as well as acoustic communication (Radford *et al.*, 2014). Several species within the vicinity of the Study Area, namely cod and herring, are sensitive to the impacts of underwater noise from activities in relation to offshore construction. Sound pressures and particle motion can have pronounced impacts on the swim bladder of these species which is closely connected to the ear, and these "hearing specialists" show a more extended hearing range of up to 500 Hertz (Hz) (Popper and Hawkins, 2019).

During construction, sources of noise are generated from vessel activity, export cable laying, dredging, trenching, and rock placement. The installation of sub-sea cables is considered to have the highest potential noise impact and can potentially disturb fish, but there is no clear indication that this source of noise poses a significant risk (OSPAR, 2012). An increase in vessel activity in the area associated with construction works can also result in increased underwater noise levels. The maximum number of vessels expected on site during construction at any one time is four vessels. As this area is located in a well-developed area for oil and gas infrastructure (Chapter 18: Other Sea Users) and experiences a moderate amount of vessel traffic (Chapter 13: Shipping and Navigation), it is expected that fish and shellfish would be habituated to vessel noise. There is no direct evidence of potential mortal injury or mortality to fish from vessel sounds (Popper *et al.*, 2014). Fish behaviour may be affected by vessels, such as induced avoidance, and altering swim speeds and direction (De Robertis and Handegard, 2013; Sarà *et al.*, 2007). However due to the short-term and transient (mobile) nature of vessel operations associated with the Construction stage, together with the small number of vessels engaged in construction activities, any disturbance impacts to fish will be localised and of a short duration (days/weeks).

Pin-piling is considered the greatest source of noise during the construction of offshore windfarms, but pin-piling is not required for the installation of the WTG. Pre-construction noise, such as from geophysical surveys, have already occurred for this Project and so are not considered further in this assessment. Unexploded Ordnance (UXO) have been identified and one detonation has occurred following pre-construction surveys of the Culzean platform under a Marine Licence issued by the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED). No further UXOs were discovered during the 2023 geophysical Project surveys (Appendix J). Pre-construction visual surveys with the use of ultra-short baseline (USBL) positioning subsea positioning equipment will introduce underwater noise of relatively high intensity but of a short duration (expected survey duration is no longer than one day) at a frequency of ca. 20-30 kHz. This frequency is above the hearing range of most acoustically-sensitive fish species (Popper *et al.*, 2014) apart from three species of herring-like fishes (but not herring). The use of USBL is thus unlikely to constitute a major disturbance to fish during pre-construction.

Many of the fish predicted to utilise the area are protected and considered of regional or national importance, but with low vulnerability due to their mobility and capability to move away from the source of sound. However, less mobile species, including shellfish, eggs and larvae, are less capable to move away. Therefore, fish and shellfish species are assessed to have low sensitivity. Based on the limited spatial extent of the impact in comparison to the wide distribution ranges of fish and shellfish species, and the temporary nature of the impact, it is defined as being of negligible magnitude.

Evaluation of significance

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

Sensitivity	Magnitude of impact	Consequence
Low	Negligible	Negligible
Impact significance - NOT SIGNIFICANT		

9.9.1.2 Habitat loss or disturbance during the installation of the export cable and the anchors

During construction and installation, habitat loss or disturbance may occur because of export cable installation activities, including trenching, laying and burial and protection. The habitat loss may affect individuals directly through injury or physical harm, or indirectly through the loss or disturbance of nursery and spawning grounds.

Up to 0.052 km^2 of temporary habitat loss or disturbance may occur during installation over one month. The extent of habitat loss will depend on the equipment used. Disturbance is likely to be temporary and localised and may occur during the installation of the export cable. Up to 0.007 km^2 of longer-term habitat loss or disturbance may also occur due to the installation of the mooring lines, scour protection and cable protection.

The effect on spawning grounds is greater than nursery grounds, as juvenile fish can flee from disturbance whereas larvae and eggs are only mobile via currents. The Site may provide spawning areas for cod, lemon sole, mackerel, Norway lobster, Norway pout, and sandeel. There is a particular focus on sandeels as they are benthic spawners, and as such are considered separately below.

Sandeels

Sandeels are benthic spawners, where they burrow into the sediment and require specific habitat to be able to spawn on the seabed. According to Coull *et al.* (1998) and Ellis *et al.* (2012), the Project Area overlaps with sandeel spawning grounds. However, the Study Area has a zero probability of sandeel burrow presence, with no predicted density of buried sandeels (Langton *et al.*, 2021). As such, it is unlikely that sandeel burrowing habitat is present in the Project Area.

Sandeels are considered to have medium sensitivity to surface abrasion and high sensitivity to sub-surface abrasion or penetration based on the Scottish Government Feature Activity Sensitivity Tool (FeAST) (Marine Scotland, 2013). Sandeels are also a nationally important receptor, as they are considered a PMF. As such, having a high vulnerability to habitat loss or disturbance, sandeels are assessed to have a **high sensitivity**, although the Project Area is not expected to overlap with sandeel habitat.

Preferred sandeel habitat and spawning grounds are widely distributed across Scottish and English waters, such that potential impacts from construction and installation would only affect a very small proportion of available habitat. Only a very small proportion of habitat would be disturbed at any one time, considering the scale of the Project. The temporary habitat loss or disturbance would be highly localised and intermittent for a period of one month throughout the construction and installation stage. Based on the localised spatial and temporal change, combined with the low frequency and temporary nature of the impact, it is unlikely to affect long term functioning of the sandeel population and as such the impact is defined as being of **negligible magnitude**.

Evaluation of significance

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

Sensitivity	Magnitude of impact	Consequence
High	Negligible	Negligible
Impact significance - NOT SIGNIFICANT		

All other fish species

All other fish species, apart from sandeels, are pelagic spawners. These species are less vulnerable to habitat loss or disturbance, as they are not dependent on the seabed to spawn and have a wider availability of spawning grounds. Many other fish species are predicted to utilise the Study Area, but any temporary habitat loss or disturbance is unlikely to affect the long-term functioning of these species. As these species are mobile, they are able to avoid injury or mortality associated with the temporary habitat loss or disturbance.

Many of the fish predicted to utilise the area are protected and considered of regional or national importance, but with low vulnerability. Therefore, all other marine fish species (excluding sandeels) are assessed to have **low sensitivity**. Any temporary habitat loss or disturbance is expected to affect only a small portion of available habitat and will be highly localised. Based on the spatial extent, low-frequency, and temporary nature of the impact, it is defined as being of **negligible magnitude**.

Evaluation of significance

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

Sensitivity	Magnitude of impact	Consequence
Low	Negligible	Negligible
Impact significance - NOT SIGNIFICANT		

Shellfish

Shellfish are potentially vulnerable to habitat loss and disturbance from construction and installation due to their more limited mobility when compared to fish. There are no boundaries for shellfish spawning and nursery grounds in the data from Coull *et al.* (1998) and Ellis *et al.* (2012), except for Norway lobster which is considered separately.

During the breeding season, female crabs and lobster are 'berried', where they carry their eggs under their abdomen and remain buried in the sediment or under rocks, and so have limited mobility during this time (Neal and Wilson, 2008). Other species, such as squid and octopus, are highly mobile and would be able to avoid injury or mortality associated with the temporary habitat loss or disturbance. As there is little to no predicted density of shellfish in the area, and the disturbance is highly localised, a very small portion of available habitat would be impacted. As shellfish are judged to be regionally important due to their commercial importance, and of moderate vulnerability due to their low mobility, shellfish are assessed as being of **medium sensitivity**. Additionally, spawning and nursery grounds are in a very small portion of the Study Area and of undetermined significance, meaning it is unlikely to have an overlap with the Project. Based on the spatial extent, low-frequency, and temporary nature of the impact, it is defined as being of **negligible magnitude.**

Evaluation of significance

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

Sensitivity	Magnitude of impact	Consequence
Medium	Negligible	Negligible
Impact significance - NOT SIGNIFICANT		

Norway lobster

Norway lobster has a very small overlap of breeding and spawning grounds within the Study Area (Coull *et al.*, 1998; Ellis *et al.*, 2012), but the intensities are undetermined. They spawn year-round with a peak between April and June.

The predicted spawning and nursery grounds of Norway lobster are of undetermined intensity (Coull *et al.*, 1998), and is in the northwest part of the Study Area over a very small area. However, Norway lobster are the most economically important commercial shellfish species, and so remain a key species.

Norway lobster live in shallow burrows, preferring soft sediment of fine cohesive mud stable enough to support a burrow (Hill and Sabatini, 2008). During reproduction, the eggs are carried on the female's abdomen, during which time they will tend to remain in their burrows. During this time of reduced mobility, any disturbance could result in disturbance or damage to females and/or their egg masses.

Norway lobster are regionally and commerciality important and are moderately vulnerable due to their low mobility. Therefore, Norway lobster are assessed as being of medium sensitivity. Any temporary habitat loss or disturbance is expected to affect only a small portion of available habitat and will be highly localised. Additionally, spawning and nursery grounds are in a very small portion of the Study Area and of undetermined significance, meaning it is unlikely to have an overlap with the Project. Based on the spatial extent, low-frequency, and temporary nature of the impact, it is defined as being of negligible magnitude.

Evaluation of significance

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

Sensitivity	Magnitude of impact	Consequence
Medium	Negligible	Negligible
Impact significance - NOT SIGNIFICANT		

9.9.1.3 Effects of increased sedimentation / smothering on fish and shellfish

Increased sedimentation associated with the installation of subsea infrastructure, such as the export cable, anchors, and scour protection, may lead to localised increases in suspended sediments that can potentially smother species located within the installation area. The composition of the seabed in the Project Area is classified as 'Deep Circalittoral Sand', varying from muddy sand to slightly gravelly mud (see Chapter 8: Benthic Ecology).

The laying of anchors and chains, as well as dredging the export cable trenches, may lead to displacement and disturbance of the seabed, potentially creating plumes which could transport sediment through the water column and increase smothering in the area. As mentioned in Section 9.5.3.2, the site lies within potential spawning grounds for cod, lemon sole, mackerel, Norway lobster, Norway pout, and sandeel. Sandeel are seabed dependent species, requiring specific habitat to spawn. Additionally, the site serves as potential nursery grounds for twelve species. However, these species spawning and nursery areas extend widely beyond the Study Area, and as such any disturbance from the construction activities will affect a very small portion of available habitat. Additionally, it is unlikely that suitable sandeel habitat occurs within the site based on updated modelling by Langton *et al.* (2021). Other species are less vulnerable to increases in suspended sediments, as they are more mobile and generally display an avoidance response to increased turbidity (Robertson *et al.*, 2006). Pelagic spawners, unlike sandeels, will have buoyant eggs

that will be less vulnerable to smothering. Norway lobster have reduced mobility during reproduction and may be more vulnerable to smothering during this time. However, spawning and nursery grounds are in a very small portion of the Study Area and of undetermined significance, meaning it is unlikely to have an overlap with the Project.

The fish and shellfish species in the area will have **moderate sensitivity** based on the reliance on the seabed of sandeels and Norway lobster. Considering the small, localised area where the impact may occur, the species that are likely to be present and susceptible to smothering of eggs, and the intensive commercial fishing taking place in the region which will have a larger impact at a much greater spatial scale compared to the single WTG and export cable, the impact is defined as being of **negligible** magnitude.

Evaluation of significance

Taking the medium sensitivity of fish and shellfish and negligible magnitude of impact, the overall effect of increased sedimentation / smothering is considered to be **negligible** and **not significant** in EIA terms.

Sensitivity	Magnitude of impact	Consequence
Medium	Negligible	Negligible
Impact significance - NOT SIGNIFICANT		

9.9.2 Potential effects during operation and maintenance

9.9.2.1 Impact to habitats or species from pollution or accidental discharge

Leakage of pollutants from vessels could occur at any stage of the Project's operational life. An accidental event, such as a vessel collision, could result in the spillage or release of fuel or other contaminants from the vessels. Both of these could have a physical disturbance effect at the discharge location, and could damage the Fish and Shellfish Ecology receptors and the habitats on which they rely on. However, it is highly unlikely that accidental releases of fuel would mix within the water column in sufficient quantities and depths to interact with the seabed. Chemical leakages or spills could have an impact on plankton in the immediate area, particularly during a period of bloom or fish spawning, which can lead to contamination of the food chain and an accumulation of hydrocarbons (Almeda et al., 2013). This can have long-term chronic effects on plankton, fish, bird, and cetacean populations, such as a reduction in mating success, behavioural disturbance, and health conditions (Dirksen *et al.*, 1995; Benejam *et al.*, 2010; Seuront, 2011).

Accidental release of pollutants can occur from pollutants contained within the WTG and oil and fluid emissions from Project vessels. The potential for full inventory release for an individual WTG is considered extremely rare. The potential slow release of fluids is considered the only avenue through which pollution or discharge would enter the water column and sediment from the WTG. The impacts to Fish and Shellfish Ecology receptors are considered the same as those described above.

Many of the fish predicted to utilise the area are protected and considered of regional or national importance, but with medium vulnerability to localised accidental pollution events, as impacts are unlikely to affect the long-term

functioning of the fish and shellfish populations. Therefore, all marine fish species are assessed to have moderate sensitivity. It is unlikely that an accidental pollution event will take place as the general meteorological conditions in the central North Sea mean that any pollutants would likely disperse rapidly through wind, wave and current action, and the magnitude of an accidental spill is limited by the size of the chemical or oil inventory on maintenance vessels. Additionally, embedded mitigation measures will be adopted to ensure that the potential for accidental release of pollutants is limited, including strict controls on vessel activities and procedures and an OEMP. As a result, fish and shellfish are extremely unlikely to be adversely affected by such an incident, therefore the impact is considered of negligible magnitude.

Evaluation of significance

Taking the medium sensitivity of fish and shellfish and negligible magnitude of impact, the overall effect of pollution or accidental discharge to habitats or species is considered to be negligible and not significant in EIA terms.

Sensitivity	Magnitude of impact	Consequence
Medium	Negligible	Negligible
Impact significance - NOT SIGNIFICANT		

9.9.2.2 Disturbance or damage to sensitive species due to underwater sound generated during the operation and maintenance phase.

Vessel activity during the operation and maintenance phase will be lower than during the construction phase. In comparison with the background noise from commercial fishing vessels, vessels from other offshore developments, and transportation vessels, the presence of vessels for the maintenance of this Project is considered negligible and is not considered further for assessment.

Sources of operational noise include WTG vibration and the contact of waters with the offshore infrastructure, all of which could increase noise above baseline levels. Noise emissions from floating WTGs are concentrated in frequencies below 500 Hz with distinct tonal features related to rotational speeds (Burns *et al.*, 2022; Risch *et al.*, 2023). Sound levels for operational WTGs range between 154-149 re 1µPa, assuming a 15 m/s wind speed, and can remain above median ambient noise levels in the North Sea for distances up to 4 km away (Burns *et al.*, 2022; Risch *et al.*, 2023). Considering these studies are for large offshore developments with WTG arrays, so the noise generated from a single floating WTG is not expected to raise noise levels significantly above baseline levels.

Many of the fish predicted to utilise the area are protected and considered of regional or national importance, but with low vulnerability due to their mobility and capability to move away from the source of sound. Although the Study Area mostly overlaps with areas of "unfavourable" grounds for spawning cod (González-Irusta and Wright, 2016a), it is possible that cod may be present and experience masking of sounds produced to communicate during spawning, although this is highly unlikely to occur.

However, less mobile species, including shellfish, eggs and larvae, are less capable to move away. Therefore, fish and shellfish species are assessed to have low sensitivity. Based on the limited spatial extent of the impact in comparison

to the wide distribution ranges of fish and shellfish species, and the temporary nature of the impact, it is defined as being of **negligible magnitude**.

Evaluation of significance

Taking the medium sensitivity of fish and shellfish species and negligible magnitude of impact, the overall effect of underwater sound during operation and maintenance is considered to be **negligible** and **not significant** in EIA terms.

Sensitivity	Magnitude of impact	Consequence
Low	Negligible	Negligible
Impact significance - NOT SIGNIFICANT		

9.9.3 Potential effects during decommissioning

The targeted scenario for decommissioning is a clear seabed. Given the nature of the decommissioning activities, which will largely be a reversal of the installation process, the impacts during decommissioning are expected to be similar to or less than those assessed for the construction stage. It should be noted that the decommissioning options for the export cable removal will be subject to comparative assessment of options at the end of the installation life. This will also involve assessing the potential removal of artificial hard structures associated with the Project.

A Decommissioning Programme will be developed pre-construction to address the principal decommissioning measures for the Project. This will be developed in accordance with applicable guidance and detail the management, environmental management, and schedule for decommissioning. The Decommissioning Programme will be reviewed and updated throughout the lifetime of the Project to account for changing best practices.

Given the nature of the decommissioning activities, which will largely be a reversal of the installation process, the impacts during decommissioning are expected to be similar to, or less than those assessed for the construction phase. Therefore, the magnitudes of impact assigned to Fish and Shellfish Ecology receptors during the construction stage are also applicable to the decommissioning stage. It is also assumed that the receptor sensitivities will not materially change over the lifecycle of the offshore Project. Therefore, the decommissioning effects are not expected to exceed those assessed for construction.

9.9.4 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 9-13.

No significant effects on Fish and Shellfish Ecology receptors were identified. Therefore, mitigation measures in addition to the embedded mitigation measures listed in Section 9.8 are not considered necessary.

Table 9-13 Summary of potential effects

POTENTIAL EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF IMPACT	CONSEQUENCE (SIGNIFICANCE OF EFFECT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF EFFECT)
Construction and Decommissioning						
Disturbance or damage to sensitive species due to underwater sound	All fish and shellfish species	Low	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
Habitat loss or disturbance during the installation of the export cable, mooring lines and anchors	Sandeel	High	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	All other fish species	Low	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	Norway Lobster	Medium	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
	All other shellfish	Medium	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
Effects of increased sedimentation / smothering on fish and shellfish	All fish and shellfish species	Medium	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)

POTENTIAL EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF IMPACT	CONSEQUENCE (SIGNIFICANCE OF EFFECT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF EFFECT)
Operation and maintenance						
Impact to habitats or species from pollution or accidental discharge	All fish and shellfish receptors	Medium	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)
Disturbance or damage to sensitive species due to underwater sound generated during the operation and maintenance phase	All fish and shellfish receptors	Low	Negligible	Negligible (not significant)	None required above existing embedded mitigation measures.	Negligible (not significant)

9.10 Proposed Monitoring

With consideration of the embedded mitigation measures for the Project, the assessment has concluded no significant impacts to any marine mammal species, and therefore there is no requirement for additional mitigation over and above the embedded measures.

The project will, however, implement a scientific R&D programme in conjunction with the DTU and MASTS. This programme will provide knowledge and experience on offshore wind turbine construction, integration, installation, operations and maintenance. In line with NatureScot (2022a) Guidance on securing positive effects for biodiversity from local development, this project will also provide vital information to inform NID and the impacts on the biodiversity around WTGs and cable routes.

A full list of sub-projects is provided in Chapter 1: Introduction. Aspects relevant to Fish and Shellfish Ecology include:

- eDNA-based monitoring;
- Biodiversity and ecosystem indicators; and
- Active acoustics and optics monitoring development.

The programme provides an opportunity for real-time environmental monitoring in the offshore environment and will provide a basis from which to assess the functionality of the floating WTG and the overall design of the project in the environmental setting of the CNS, which will inform similar developments in the future.

9.11 Cumulative Effects Assessment

Any potential impacts from the Project could interact with impacts from other developments, plans and activities, resulting in a cumulative effect on Fish and Shellfish Ecology receptors. The general approach to the cumulative effects' assessment is described in Chapter 6: EIA Methodology and further detail is provided below.

The Fish and Shellfish Zone of Influence (ZoI) has been defined by a 10 km buffer around the Project. The closest offshore development to the Project will be the Central North Sea Electrification (CNSE) Project, elements of which are located approximately 11 km from the proposed operations, outwith the ZoI. All other activities within the 10 km ZoI have been considered in the existing baseline impact assessment (Section 9.9). Any potential impacts from the Project would be localised and temporary, occurring within the Study Area. Therefore, no significant change to the cumulative effects on Fish and Shellfish Ecology are expected to result from the Project cumulatively with other developments.

9.12 Inter-Related Effects

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 9-14.

Table 9-14 Fish and Shellfish Ecology inter-relationships

CHAPTER	IMPACT	DESCRIPTION
Marine Physical Processes	Impact of suspended sediments and deposition on fish and shellfish species.	The impact pathway of suspended sediment and deposition is characterised within Chapter 7: Marine Physical Processes.
Benthic Ecology	Indirect impacts to Fish and Shellfish Ecology from changes to spawning and nursery ground habitats from loss / disturbance of benthic habitats.	Changes in benthic habitats can lead to an in- direct impact on fish spawning and nursery grounds which relay on these habitats. Direct impacts to benthic habitats from the Offshore Project are assessed within Chapter 8: Benthic Ecology. Habitat loss of spawning and nursery grounds due to presence of the Project infrastructure are assessed within Section 9.9.1 of this chapter.
	Indirect impacts to fish and shellfish from changes in the availability and distribution of benthic prey species.	Changes in the availability of benthic prey species may indirectly impact Fish and Shellfish Ecology receptors.
Marine Mammals and Other Megafauna	Indirect impacts to marine mammals and other megafauna through changes in fish and shellfish prey species abundance or distribution.	Changes in fish and shellfish habitats can lead to an indirect impact on marine mammals and other megafauna due to changes in prey availability of fish, which may be impacted due to loss / disturbance of the habitat on which they rely. Direct impacts to fish and shellfish habitat from the offshore Project are assessed within Section 9.9.1.2 and 9.9.2.1 of this chapter.
Ornithology	Indirect impacts to offshore ornithology through changes in fish and shellfish prey species abundance or distribution.	Changes in fish and shellfish habitats can lead to an indirect impact on marine ornithology due to changes in prey availability of fish, which may be impacted due to loss / disturbance of the fish and shellfish habitat on which they rely. Direct impacts to fish and shellfish habitats from the offshore Project are assessed within Sections 9.9.1.2 and 9.9.2.1 of this chapter. Impacts on marine ornithology from potential change in benthic habitat and prey availability are assessed within Chapter 11: Ornithology.
Commercial Fisheries	Impacts on commercially important fish and shellfish species.	The impacts considered in this chapter includes consideration of potential effects on species of commercial importance. Impacts on fish and shellfish receptors could indirectly impact commercial fisheries.

9.13 Summary of Impacts and Mitigation Measures

Potential impacts resulting from the Project include:

- Disturbance or damage to sensitive species due to underwater sound;
- Temporary and long-term habitat loss or disturbance;
- Increased sedimentation and smothering of fish and shellfish; and
- Impacts to habitats or species from pollution or accidental discharge.

However, given the small-scale of the Project, all associated impacts are expected to be low biodiversity or negligible consequence and therefore not significant. No secondary mitigation, over and above the embedded mitigation measures proposed in Section 9.8 is either required or proposed in relation to the potential effects of the Project on Fish and Shellfish Ecology as no significant impacts are predicted.

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