RWE Renewables UK Dogger Bank South (West) Limited

RWE Renewables UK Dogger Bank South (East) Limited

Dogger Bank South Offshore Wind Farms

Preliminary Environmental Information Report

Chapter 10 – Fish and Shellfish Ecology

28/04/2023

Document Reference: 004300118

Revision: 03

Unrestricted

RWE

Dogger Bank South Offshore Wind Farms

Company:	**RWE Renewables UK Dogger Bank South (West) Limited and RWE Renewables UK Dogger Bank South (East) Limited**	Asset:	**Development**
Project:	**Dogger Bank South Offshore Wind Farms**	Sub Project/Package:	**Consents**
Document Title or Description:	Preliminary Environmental Information Report – Chapter 10 – Fish and Shellfish Ecology		
Document Number:	004300118-03	Contractor Reference Number:	PC2340-RHD-OF-ZZ-RP-Z-0050

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Rev No.	Date	Status/Reason for Issue	Author	Checked by	Approved by
01	07/03/2023	First Issue	OW	HC	AP
02	28/03/2023	Second Issue	OW	HC	AP
03	28/04/2023	Third Issue	OW	HC	DB

Unrestricted

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Glossary

Term	Definition
Array Areas	The DBS East and DBS West offshore array areas, where the wind turbines and array cables will be located. The array areas do not include the offshore export cable corridor.
Array Cables	Cables which link the wind turbine generators to the offshore substation/converter/collector platform(s).
Autecology	The interactions of a given species with the surrounding environment that may influence their distribution and abundance
Dogger Bank South (DBS) Offshore Wind Farms	The collective name for the two Projects, DBS East and DBS West.
Electrical Switching Platform (ESP)	The electrical switching platform (if required) will provide a link to a co-ordinated east coast transmission system which is planned to run from Scotland to England, as per National Grid ESO's Holistic Design Network. This platform may be located either within one of the array areas (alongside a converter station) or mid-way along the export cable corridor (likely next to the Reactive Compensation Platform if required).
Fish and Shellfish Ecology Study Area	The Fish and Shellfish Ecology Study Area for the Projects is defined as ICES Rectangles 36E9; 36F0; 37E9; 37F0; 37F1; 37F2; 38F0; 38F1; and 38F2. It covers a total of 26,858km2, and includes the Offshore Development Area with a minimum buffer distance of 7km.
Inter-Platform Cables	Cables linking offshore platforms.

Term	Definition
Offshore Converter Platforms (OCPs)	Offshore Converter Platforms (OCPs) will be required for the HVDC option. The OCPs are fixed structures located within the array area that collect the AC power generated by the wind turbines and convert the power to DC, before transmission through the offshore export cables to the Project's onshore grid connection points.
Offshore Development Area	The Offshore Development Area encompasses the wind farm site and the options for the offshore transmission works.
Offshore Export Cable Corridor	This is the area which will contain the offshore export cables (and potentially the ESP and / or RCP) between the offshore substation/converter platforms and Transition Joint Bays at the landfall.
Offshore Substation Platforms (OSPs)	Offshore Substation Platforms (OSPs) will be required for the HVAC option. These are fixed structures located within the array areas that contain electrical equipment to aggregate the power from the wind turbines, followed by conversion into a more suitable voltage for transmission through the offshore export cables to the Project's onshore grid connection points.
Reactive Compensation Platform (RCP)	A Reactive Compensation Platform (RCP) will be required for a HVAC solution. The RCP will host the shunt reactors required to provide reactive compensation, in order to limit the electrical losses which occur with HVAC transmission over long distances.
Safety Zones	A statutory marine zone demarcated for the purposes of safety around a possibly hazardous installation or works/construction area.
Scoping Opinion	The report adopted by the Planning Inspectorate on behalf of the Secretary of State.
Scoping Report	The report that was produced in order to request a Scoping Opinion from the Secretary of State.

Term	Definition
The Applicant	RWE Renewables UK Dogger Bank South (West) Limited and RWE Renewables UK Dogger Bank South (East) Limited as the owners of DBS West and DBS East respectively are the named undertakers that will have the benefit of the Development Consent Order. References in this document to obligations on, or commitments by, 'the Applicant' are given on behalf of RWE Renewables UK Dogger Bank South (West) Limited and RWE Renewables UK Dogger Bank South (East) Limited.
The Projects	DBS East and DBS West (collectively referred to as the Dogger Bank South offshore wind farms).

Acronyms

Term	Definition
BGS	British Geological Survey
CEA	Cumulative Effect Assessment
CPUE	Catch per Unit Effort
DBS	Dogger Bank South
DCO	Development Consent Order
ECC	Export Cable Corridor
EEA	European Economic Area
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
EMMP	Environmental Management and Monitoring Plan
EPP	Evidence Plan Process
ES	Environmental Statement
ESP	Electrical Switching Platform
GBS	Gravity Based Structures
HDD	Horizontal Directional Drilling
HFIG	Holderness Fishing Industry Group
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IBTS	International Bottom Trawl Survey

Term	Definition
ICES	International Council for the Exploration of the Sea
IFCA	Inshore Fisheries and Conservation Authorities
IHLS	International Herring Larvae Survey
IPMP	In-Principle Monitoring Plan
JNCC	Joint Nature Conservation Committee
LAT	Lowest Astronomical Tide
LW	Landing Weight
MARPOL	International Convention for the Prevention of Pollution from Ships
MCZ	Marine Conservation Zone
MMO	Marine Management Organisation
MPA	Marine Protected Area
MPCP	Marine Pollution Contingency Plan
NPPF	National Planning Policy Framework
NPS	National Policy Statement
OSP	Offshore Substation Platform
PEIR	Preliminary Environmental Information Report
PEMP	Project Environmental Management Plan
PINS	Planning Inspectorate
PLGR	Pre-Lay Grapnel Run
PTS	Permanent Threshold Shift

Term	Definition
RMS	Route Mean Squared
SAC	Special Area of Conservation
SEL	Sound Exposure Level
SPL	Sound Pressure Level
SSC	Suspended Sediment Concentration
TTS	Temporary Threshold Shift
UXO	Unexploded Ordnance
VMS	Vessel Monitoring System

10 Fish and Shellfish Ecology

10.1 Introduction

1. This chapter of the Preliminary Environmental Information Report (PEIR) considers the likely significant effects of Dogger Bank South (DBS) East and DBS West offshore wind farms (the Projects) on Fish and Shellfish Ecology. The chapter provides an overview of the existing environment for the proposed offshore development area, followed by an assessment of likely significant effects for the construction, operation, and decommissioning phases of the Projects.

2. The assessment should be read in conjunction with the following linked chapters:

- **Chapter 8 Marine Physical Environment;**
- **Chapter 9 Benthic Habitats;** and
- **Chapter 13 Commercial Fisheries.**

3. Additional information to support the Fish and Shellfish Ecology assessment include:

- **Appendix 10-1 Fish and Shellfish Ecology;** and
- **Appendix 11-2: Underwater Noise Modelling Report.**

10.2 Consultation

4. Consultation with regard to Fish and Shellfish Ecology has been undertaken in line with the general process described in **Chapter 6 EIA Methodology**. The key element of consultation to date has included issue of the Environmental Impact Assessment (EIA) Scoping Report. The feedback received via the formal Scoping Opinion has been considered in preparing the PEIR. **Table 10-1** provides a summary of how the consultation responses received to date have influenced the approach that has been taken.

5. This chapter will be updated following consultation on the PEIR in order to produce the final assessment and chapter of the Environmental Statement (ES) that will be submitted with the Development Consent Order (DCO) application. Full details of the consultation process will also be presented in the Consultation Report that will be submitted alongside the DCO application.

Table 10-1 Consultation Responses

Comment	Project Response
The Planning Inspectorate / 02 September 2022 / Scoping Opinion: Proposed Dogger Bank South Offshore Wind Farms Case Ref: EN010125 02/09/2022	
Direct damage (crushing) and disturbance to fish and shellfish species (all phases): The Inspectorate has considered the information in the Scoping Report and does not agree that the evidence presented is sufficient to support scoping this matter out of the ES. The Inspectorate accepts that maintenance activities are likely to be of lower impact than construction, however, in the absence of any information as to the nature, duration, frequency, and extent of these activities it is not possible to rule out significant effects. The ES should assess the likely significant effects from direct impacts to fish and shellfish populations from the Proposed Development, providing an estimate of the project-specific impacts and the resulting significance of effects on species based on their value and sensitivity.	The impact of direct damage (crushing) and disturbance to fish and shellfish species has been assessed for all phases within this chapter in sections 10.6.1.1 and 10.6.2.2.
Release of sequestered contaminants (all phases): The Inspectorate notes the information in the Scoping Report including the location of dredge disposal sites shown on **Figure 2-15**. As highlighted previously, a lack of site-specific information and reasoned justification in the Scoping Report means it is not possible to exclude this matter from the ES at this stage. The ES should assess the likely significant effect or provide adequate information to demonstrate that significant effects will not occur.	The impact of release of sequestered contaminants has been assessed for all phases within this chapter in sections 10.6.1.3 and 10.6.2.4.
Pollution events resulting from the accidental release of pollutants (all project phases): Based on the information provided on the proposed mitigation and control measures, the Inspectorate agrees that significant effects from accidental release of pollution during all project phases are	Proposed embedded mitigation measures relating to pollution events are detailed in section 10.3.3.

Comment	Project Response
unlikely. The ES should detail the proposed mitigation measures for all project phases and describe how they are to be secured.	
Increase in local suspended sediment concentrations and sediment settlement (operation): The Inspectorate agrees that the potential for likely significant effects is within the construction phase, however, in the absence of more specific information on the operation and maintenance activities required it is not in a position to scope this matter out. The ES should assess any likely significant effects or provide adequate information to demonstrate that significant effects will not occur.	The impact of an increase in local suspended sediment concentrations and sediment settlement has been assessed for the operation phase within section 10.6.2.3.
Impacts on fish and shellfish species as a result of noise and vibration (operation): Paragraph 269 states that as piling and unexploded ordnance (UXO) clearances will be completed during the construction phase, no significant effects are likely. No discussion of the need for unexpected/ emergency UXO clearance during operation is provided, and no information on other operational/ maintenance activities which would be sources of underwater noise is provided. The Inspectorate advises that the ES should provide an assessment of the likely significant effects of underwater noise during operation or provide justification that significant effects are unlikely supported by the evidence highlighted above. The assessment methodology should be discussed with and agreed where possible with stakeholders, and the outcomes of any consultation (e.g., the EPP) reported in the ES.	The impact on fish and shellfish species as a result of underwater noise and vibration during the construction phase is assessed in section 10.6.1.4, and during the operational phase in section 10.6.2.5.
Habitat loss/disturbance to spawning and nursery areas (operation): In the absence of information on the likely operational activities the Inspectorate does not agree to scope this matter out. The ES should assess the likely significant effects associated with	The impact of habitat loss and disturbance has been assessed for the construction phase in section 10.6.1.1, and for the operational phase in sections 10.6.2.1 and 10.6.2.2.

Comment	Project Response
the disturbance/displacement to spawning/ nursery areas during operation. The Inspectorate notes that long-term change in fish and shellfish habitat due to substrate changes is proposed to be assessed for the operational phase and considers this approach to be appropriate.	
Electromagnetic Field (EMF) impacts arising from cables (construction and decommissioning): The Inspectorate agrees that this impact-effect pathway should be assessed for the operational phase only of the Proposed Development where likely significant effects could occur.	The impact of EMF from cables has been assessed for the operational phase in section 10.6.2.6.
Project specific surveys on fish and shellfish: The Scoping Report states that no project specific surveys are to be carried out. The ES must be based on sufficient information about the receiving environment to allow the scale of any impacts to be defined and understood. The ES should provide justification for the approach taken and explain to what extent this has been agreed with relevant stakeholders, for example via the EPP described in section 1.7 of the Scoping Report.	In the absence of site-specific surveys, multiple high-quality datasets (section 10.4.1.2) containing comprehensive information on fish and shellfish ecology within the region have been identified and used to determine the biological baseline (section 10.5.2).
Potential Impacts on Shellfish in the Dogger Bank Special Area of Conservation (SAC): Table 2-27 in Scoping Report Chapter 2.9 (Commercial Fisheries) indicates that impacts on fish and shellfish species will be assessed within the fish and shellfish ecology chapter. Paragraph 371 of Scoping Report Chapter 2.9 refers to the scallop stock within the Dogger Bank SAC which experienced a large increase in scallop dredging since early 2020 and acknowledges that a large proportion of the Array Areas overlap with the SAC. A byelaw is in place within the Dogger Bank SAC to ban the use of bottom towed fishing gear, which the Scoping Report indicates could change the baseline environment.	The impacts on shellfish from potential habitat loss and / or disturbance to spawning and nursery areas is assessed for the construction phase in section 10.6.1.1, and for the operational phase in section 10.6.2.2. Further consideration is provided within **Chapter 11 Commercial Fisheries**.

Comment	Project Response
No reference is made to this within Chapter 2.6 Fish and Shellfish Ecology. The ES should assess ecological impacts on the Dogger Bank SAC scallop stock where likely significant effects could occur.	
The Planning Inspectorate / 02 September 2022 / Scoping Opinion: Proposed Dogger Bank South Offshore Wind Farms Case Ref: EN010125 02/09/2022 Appendix 2: Respondents to Consultation and Copies of Replies	
Environment Agency:	
Depending on the chosen landfall location, could the proposed activities directly affect fish within the Humber Estuary, delay or prevent fish from entering the estuary or affect fish migrating through the estuary? If yes, potential impacts to fish in the Humber will need to be scoped into the Water Environment Regulations compliance assessment and should also be considered as part of the EIA. There is the potential for disturbance during construction phase from noise and vibration.	Migratory fish, including those within and likely to enter the Humber estuary have been identified as a receptor group for this assessment within section 10.5.3.5. Additionally, the Humber Estuary has been included within the Fish and Shellfish Ecology Study Area as indicated **Figure 10-1**.
Marine Management Organisation	
The Marine Management Organisation (MMO) notes that section 263 states that 'Atlantic herring populations within the Fish and Shellfish study area increase during the summer and autumn, with spawning peaking between April and June (JNCC 1995a; 1995b)'. Please note that Atlantic herring spawning in the central North Sea (CNS) are from the Banks population which spawn between August and October (inclusive). See Ellis *et al*. (2012) for spawning seasons of commercially important fishes. The JNCC 1995a and 1995b citations were not included in the reference list for review and comment.	Information pertinent to the Banks Atlantic herring population spawning times has been included within section 10.5.3.3.3
The MMO notes that herring spawning grounds have not been depicted in Figure 2-11, only their nursery grounds have been mapped. Nonetheless, section 263 acknowledges that Atlantic herring have spawning grounds within the Projects'	Spawning and nursery grounds of Atlantic herring as determined within Coull *et al.* (1998), and Ellis *et al.* (2012) are depicted within **Figure 10-5**. Potential Atlantic her-

Comment	Project Response
study area and that the species is highly sensitive to changes in their substrate composition. The MMO note that potential herring spawning habitat has been mapped further on in Figure 2-14, following the method described by MarineSpace (2013a) which the MMO support.	ring spawning grounds are depicted in **Figure 10-7**, following the methodology described within Reach *et al.* (2013).
The MMO notes that the commercial and ecological importance of the Dogger Bank as a sandeel habitat has been recognised in the scoping report. The report recognises that sandeel have spawning grounds within the Projects' study area and that the species is highly sensitive to changes in their substrate composition. Sandeel habitat suitability has been mapped in Figure 2-13 following the method described by MarineSpace (2013b) which the MMO support.	Potential sandeel habitat suitability is depicted in **Figure 10-6** following the methodology described within Latto *et al.* (2013).
The MMO considers that for the purpose of the PEIR and ES, details of the individual data layers that make up the herring spawning habitat and sandeel habitat 'heat' maps should be provided. For example, the temporal ranges of International Herring Larvae Survey (IHLS) data and Vessel Monitoring System (VMS) data used in the maps should be specified. The MMO recommend a minimum of ten years of IHLS data is used to inform the herring spawning 'heat map'. IHLS data up to 2021 are available to download from ICES at Eggs and larvae (ices.dk).	Information on layers used inform these figures are provided within section 10.5.3.3.2, and section 10.5.3.3.3.
Similarly, the MMO considers that information on the origins and vintage of any sediment data (e.g., Particle Size Analysis (PSA)) should be discussed and mapped to provide a visual representation of data coverage. For avoidance of duplication, appropriate sign-posting can be made to the relevant section/s of the Benthic Ecology chapter where sediment data and/or maps are presented.	Information pertaining to sediment data in relation to ecological receptors can be found within **Chapter 9 Benthic Habitats**, which has been referenced throughout this chapter where appropriate.

Comment	Project Response
The MMO notes that VMS data used to inform the sandeel heat map should be selected on the basis that the fishing gear is appropriate to target the species, i.e., VMS data for bottom trawled gear rather than pelagic gear. Please note that in 2022, the MMO introduced a new byelaw to protect important habitats and species within the Dogger Bank SAC. The byelaw prohibits bottom towed fishing across the whole SAC (MMO, 2022). With this in mind, it should be noted that the coverage of VMS data used to inform the PEIR and ES is likely to change compared to what has typically been observed over the years, as commercial fishing fleets using bottom towed gear targeting sandeel (and other demersal species) on the Dogger Bank will be excluded from the area. As the new byelaw has only just come into force, VMS data for fishing activity on the Dogger Bank in recent years will still be relevant to the assessment.	Demersal gear types only have been considered during the production of the sand eel heat map **Figure 10-6**.
In reference to section 265, the MMO notes that the correct scientific name for cuckoo ray is *Leucoraja naevus* (rather than '*Raja naevus*'). Similarly, common skate (referred to in the scoping report as '*Leucoraja batis*') is now recognised to be two different species; the flapper skate, *Dipturus intermedius*, and the blue skate, *Dipturus batis*, see Iglésias *et al.* (2010).	Updated scientific names have been used for this chapter and the associated appendix.
Tables 2-16 outline the list of existing data sources and literature that will be used to inform the fish ecology baseline. The sources are generally appropriate to characterise the study area, however the MMO have cited additional publications and peer reviewed papers within this advice which will help enhance the characterisation and inform the EIA.	Consideration to a greater range of data and literature sources has been given throughout this chapter when compared to the outline provided within the Scoping Report. Where appropriate, recommended publications and papers have been utilised.
The MMO considers that the PEIR and ES should recognise the limitations of the data collected for fish characterisation surveys for other wind farm projects (e.g., Dogger	The vintage of data collected during these fish characterisation surveys has resulted in its exclusion within this chapter. The Fish and Shellfish Ecology baseline has instead

Comment	Project Response
Bank Zone and Former Hornsea Zone) as some of the data are now in excess of ten years old. Furthermore, some of the surveys were carried out prior to the placement and operation offshore wind(OWF) infrastructure. Factors such as loss of habitat, introduction of hard substrates, and temporal and natural variations in fish assemblages may have changed over this period.	been characterised using a range of more recent datasets as described within section 10.4.1.2.
The MMO notes that when using any fisheries data collected from past surveys, it is important that the data are interpreted and presented appropriately and that all survey limitations are acknowledged. The MMO recommend that any catch data should be presented in the PEIR and ES in standardised units e.g., Catch Per Unit Effort (CPUE). The survey methods, timings and limitations of survey and gear types as well as gear selectivity should be discussed or acknowledged within the PEIR and ES, especially with regard to the influence on species and life stages captured by individual gear types/sampling methods. For example, a 2m epibenthic beam trawl will not adequately target large/adult fish, or pelagic fish; otter trawls and epibenthic beam trawls will not adequately target sandeel; and the season in which a survey is undertaken may influence species abundance in that particular area.	Fish landings data has been presented using CPUE where available (section 10.5.2.2). Where CPUE data was not available within a given source, a proxy or proxies are instead presented (section 10.5.2.1). Consideration for gear type and sampling method is given within each section.
The MMO note that despite the age of some data sources, we are generally content that there is no requirement for new fish characterisation surveys to be undertaken, as the various sources of data proposed to inform the desk-based assessment will be adequate to provide a general description of the fish species typically found in the Project study area. The MMO note that a site-specific benthic survey of the Project study area will be undertaken in 2022 which will include grab sampling of	Information pertaining to sediment data in relation to ecological receptors can be found within **Chapter 9 Benthic Habitats**, which has been referenced throughout this chapter where appropriate.

Comment	Project Response
seabed sediments which will be used for particle size analysis (PSA). PSA data can then be used to determine sandeel habitat suitability and herring spawning habitat suitability.	
The MMO notes that transboundary impacts to fisheries and fish ecology have been scoped out of the EIA on the basis that the Projects are located 40km from the Exclusive Economic Zones (EEZ) boundary, and therefore it is considered that there is no pathway for transboundary impacts. The range of effect for noise and vibration generated by piling can extend over large distances, i.e., in excess of the 40km distance between the Project sites and the EEZ boundary. On this basis the MMO recommend that transboundary impacts to fish receptors arising from underwater noise and vibration are scoped into the EIA.	An assessment of Transboundary Effects is provided within section 10.9.
The MMO do not support scoping out of the impacts arising from direct damage and disturbance to fish species during construction, operation and decommissioning stages of the development. The justification that the impact/s will be limited in spatial and/or temporal extent cannot be supported until the spatial / temporal extent of the impact/s in relation to specific species and/or habitats has been quantified and assessed. This impact should be scoped into EIA for all stages.	This impact has been assessed within sections 10.6.1.1, 10.6.2.2, and 10.6.3
The MMO do not support the scoping out of increases in local suspended sediment concentrations and sediment settlement during the operation phase of development. As per paragraph 27, the justification that the impact/s will be limited in spatial and/or temporal extent cannot be supported until the spatial / temporal extent of the impact/s in relation to specific species and/or habitats has been quantified and assessed. This impact should be scoped into EIA for all stages.	This impact has been assessed within sections 10.6.1.2, 10.6.2.3, and 10.6.3

Comment	Project Response
The MMO consider that the impact of habitat loss / disturbance to spawning and nursery areas should be scoped into the EIA for the operation phase as well as the construction and decommissioning stages. Given the location of the Project arrays within an important sandeel habitat, and the ECC cable corridor which crosses the Banks herring spawning ground at Flamborough Head, there is potential for significant impacts relating to habitat loss and/or disturbance to occur to sandeel habitat and herring spawning habitat as a result of operation and maintenance activities. The magnitude and significance of impact would depend on the scale of works required and timing of the operation and maintenance (O&M) activity.	This impact has been assessed within sections 10.6.1.1, 10.6.2.2, and 10.6.3
The MMO note that the term 'long term' should be changed to 'permanent' in the context of assessing loss of habitat or changes in habitat type from OWFs during the operation and decommissioning phases, unless the Applicant is able to commit that all infrastructure relating to the project will be removed from the seabed at the end of the Project's lifetime.	It is likely that offshore project infrastructure above the seabed will be removed at the decommissioning stage. A decommissioning programme will be agreed closer to the time. As such permanent has been used in the assessment for these scenarios.
The MMO are content that impacts arising from accidental pollution during the construction, operation, and decommissioning phases can be scoped out of further assessment, on the basis that an Environmental Management and Monitoring Plan (EMMP) will be implemented to manage and mitigate any pollution events.	Pollution Prevention Measures are described within **Table 10-3**.
The MMO note that the information provided on the proposed approach to assessing the impacts of noise and vibration on fish is quite high-level, though underwater noise modelling will be included in the EIA the MMO have provided some recommendations in points a) to g) below, to in-	a. Information on the impact of underwater noise on fish and shellfish receptors is described within section 10.5.3, and assessed within sections 10.6.1.4 and 10.6.2.5. Further details are provided within **Appendix 11.2: Underwater Noise Modelling Report**. Where available, the hearing groups of fish species are provided within **Fish and Shellfish Ecology Appendix 10-1**.

Comment	Project Response
form the approach to the EIA and underwater noise modelling for fish, particularly in respect of herring. a. The MMO would expect to see an accurate description of the physiological and behavioural impacts to fish caused by noise and vibration to be included in the PEIR and ES, and fish species relevant to the development should be assigned into one of the four categories described in Popper *et al*. (2014). b. The MMO recommend that fish are treated as a stationary receptor in any modelling used to make predictions for noise propagation on fish spawning and nursery grounds. The MMO do not support the use of a fleeing animal model for fish. c. The MMO know that fish will respond to loud noise and vibration, through observed reactions including; schooling more closely; moving to the bottom of the water column; swimming away, and; burying in substrate (Popper *et al*.,2014). However, this is not the same as fleeing, which would require a fish to flee directly away from the source over the distance shown in the modelling. The MMO are not aware of scientific or empirical evidence to support the assumption that fish will flee in this manner.	b. Fish and shellfish receptors have been assessed as stationary receptors throughout this chapter. c. See above.
d. The assumption that a fish will flee from the source of noise is overly simplistic as it overlooks factors such as fish size and mobility, biological drivers, and philopatric behaviour which may cause an animal to remain/return to the area of impact. This is of particular relevance to herring, as they are benthic spawners which require a specific substrate type on which to spawn. e. Eggs and larvae have little to no mobility, which makes them vulnerable to barotrauma and developmental effects. Accordingly, they should also be assessed and	d. See a) and b) in the row above. e. Eggs and larvae have been assessed as stationary receptors throughout this chapter. f. These figures are presented as **Figure 10-8** and **Figure 10-9** with section 10.6.1.4. g. Information pertaining to piling strategy in relation to underwater noise and vibration is provided within **Table 10-2** and in section 10.6.1.4.

Comment	Project Response
modelled as a stationary receptor, as per the Popper *et al*. (2014) guidelines. The outputs of modelling should be presented in map-form depicting the predicted noise contours. Ten years of IHLS data should be presented in the form of a 'heat map' which should be overlaid with the mapped noise contours. This will provide a better understanding of the likely extent of noise propagation into herring spawning grounds and allow for a more robust assessment of impacts to be made. g. The applicant should clearly state in their ES (and PEIR if applicable) whether they propose to undertake simultaneous piling, i.e., the installation of more than one pile at a time, for the installation of WTGs or other offshore platform structures. If simultaneous piling is proposed, then underwater noise modelling for impacts to fish should be based on this scenario.	
The MMO could not find any reference to the use of 'soft start' procedures on commencement of piling within the scoping report. This form of 'best-practice' mitigation involves the gradual ramping up of hammer energy so that sensitive marine receptors have adequate time to distances themselves away from the source of impact, thus limiting a sensitive receptor's exposure to the impact. Cefas fisheries advisors recommend a 20-minute soft-start in accordance with Joint Nature Conservation Committee (JNCC) protocol for minimising the risk of injury to marine mammals and other fauna from piling noise (JNCC, 2010). Should piling cease for a period greater than 10 minutes, then the soft-start procedure must be repeated.	Information pertaining to soft-start strategy can be found in **Table 10-2** and **Table 10-17**.
The MMO would highlight that when assessing the impacts of noise and vibration on fish for the purpose of a CIA (Cumulative Impact Assessment), given the far-reaching effects of underwater noise, projects do	A Preliminary Cumulative Effect Assessment has been included at the PEIR stage due to the potential evolution of seabed use prior to the commencement of any construction activities. A final Cumulative

Comment	Project Response
not need to be adjacent to each other for cumulative effects to arise.	Effect Assessment will be conducted as part of the ES. The approach to this is outlined in section 10.4.3.
The MMO note that inter-related impacts and effects on fisheries and fish ecology have not been discussed in the scoping report, so it is unclear if / how inter-related impacts will be assessed.	Inter-relationships are presented within section 10.11.
The MMO recommends that the applicant use of the Fisheries Sensitivity Maps developed by Coull *et al.*, 1998 to identify spawning and nursery areas for *Nephrops*. The MMO believes *Nephrops* spawning, and nursery areas fall within the Fish and Shellfish Ecology Study Area and should be considered in the future EIA.	Coull *et al.* (1998) (and Ellis *et al.* (2012)) have been analysed to identify the presence of spawning and nursery grounds within the Fish and Shellfish Ecology Study Area. Spawning and nursery grounds are identified in the relevant receptor group subsections within section 10.5.3. This includes Norway lobster *Nephrops norvegicus* which have spawning and nursery grounds within the north-eastern corner ICES rectangle 36F1 as per Coull *et al.* (1998) (and Ellis *et al.* (2012)).
The Applicant has identified a range of suitable data sources of various timescales. The MMO would expect to see data collected within the last five years as the primary data source used as this data will provide the most accurate view of current baseline conditions. This should be updated in the ES.	Data used in this chapter are outlined in section 10.4.1.2 and consideration of data identified within **Chapter 13 – Commercial Fisheries** has been given where appropriate. The majority of datasets used to inform this chapter encompass the last 5-year period.
The MMO notes that at this stage the applicant has not fully described the potential cumulative and inter-related impacts and effects on the physical and biological environment related to shellfisheries. The MMO agrees with the applicant's intention to include habitat loss and disturbance and noise impacts in conjunction with adjacent projects and cumulative changes to seabed habitat caused by changes in physical processes.	A Preliminary Cumulative Effect Assessment has been included at the PEIR stage due to the potential evolution of seabed use prior to the commencement of any construction activities. A final Cumulative Effect Assessment will be conducted as part of the ES. The approach to this is outlined in section 10.4.3.

10.3 Scope

10.3.1 Study Area

6. The Fish and Shellfish Ecology Study Area for the array areas is defined as the International Council for the Exploration of the Sea (ICES) rectangles 37F1, 37F2, 38F1 and 38F2 and the offshore export cable corridor will be located within 36E9, 37E9, 37F0, 37F1, 38F0 and 38F1. ICES Rectangle 36F0 is also included within the Fish and Shellfish Ecology Study Area due to its proximity to the offshore export cable corridor. The Fish and Shellfish Ecology Study Area covers a total of 26,858km². This Fish and Shellfish Ecology Study Area provides wider regional context to the local fish and shellfish assemblage, whilst also ensuring consideration of any effects that may occur both within and outside of the offshore development area. This includes fish and shellfish spawning and nursery grounds, feeding habitats, and migratory pathways within the region. The Fish and Shellfish Ecology Study Area is presented within **Figure 10-1**.

10.3.2 Realistic Worst Case Scenario

10.3.2.1 General Approach

7. The realistic worst case design parameters for likely significant effects scoped into the EIA for the Fish and Shellfish Ecology assessment are summarised in **Table 10-2**. These are based on the project parameters described in **Chapter 5 Project Description**, which provides further details regarding specific activities and their durations.

8. In addition to the design parameters set out in **Table 10-2**, consideration is also given to the different development scenarios still under consideration, and the possible phasing of the construction as set out in sections 10.3.2.2 to 10.3.2.5.

Table 10-2 Realistic Worst Case Design Parameters

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently (HVAC + HVDC)**	**Notes and rationale**
Construction In the instance of sequential development of the two Projects, up to a two year lag between construction activities is possible, final overall footprint would be identical to the concurrent design scenario.				
Direct damage (e.g. crushing) and disturbance; and Habitat loss and / or disturbance to spawning and nursery areas	Total Developable Array Area – 494.5km² **Cables** <u>Array Area and Inter-platform Cables</u> Array cable trench area (325km x 18m jetting disturbance width) – 5,850,000m² Inter-platform cable trench area (55km x 18m disturbance width) – 990,000m²	Total Developable Array Area – 494.5km² **Cables** <u>Array Area and Inter-platform Cables</u> Array cable trench area (325km x 18m jetting disturbance width) – 5,850,000m² Inter-platform cable trench area (99km x 18m disturbance width) – 1,782,000m² *Note –DBS West High Voltage Alternating Current (HVAC)*	Total Developable Array Area – 989km² **Cables** <u>Array Areas and Inter-platform Cables</u> Array cable trench area (650km x 18m jetting disturbance width) – 11,700,000m² Inter-platform cable trench (385km x 18m disturbance width) – 6,930,000m² *Note – Concurrent design assumes HVAC + High Voltage Direct Current (HVDC) design*	Assumes even split of the total 650km array cable length between DBS East and DBS West. Pre-lay grapnel run (PLGR) activities will fall within the footprint of the cable trench disturbance width of 18m. Two export cables required for HVDC circuit, up to four required for HVAC. Maximum export cable length assumes worst case that cables are laid and

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently (HVAC + HVDC)**	**Notes and rationale**
	Maximum seabed footprint disturbed by sandwave levelling – 950,000m² Maximum sandwave material to be dredged and relocated – 384,750m³ Maximum area disturbed – 7,790,000m² Offshore Export Cable Corridor Total offshore cable length per circuit –198km Number of cables required – two Max. offshore cable length for all cables – 396km *Note – Assuming two separate cable trenches, for each cable, 50m apart,* Maximum temporary disturbance for cable	*built in isolation would require inter-platform cables between the four offshore substation platforms (OSPs) required.* Maximum seabed footprint disturbed by sandwave levelling – 1,060,000m² Maximum sandwave material to be dredged and relocated – 429,300m³ Maximum area disturbed – 8,692,000m² Offshore Export Cable Corridor Total offshore cable length per circuit – 158km Number of cables required – four Max. offshore cable length for all cables – 632km	*scenario as the worst case. Requires inter-platform cables between the Projects to connect the OSPs, hence the increase from 99km to 385km.* Maximum seabed footprint disturbed by sandwave levelling – 2,587,500m² Maximum sandwave material to be dredged and relocated – 1,047,938m³ Maximum area disturbed – 21,217,500m² Offshore Export Cable Corridor Total offshore cable length per cable – 198km for DBS East, 158km for DBS West. Total of 356km. Corridor width of 2km for all export cables	buried in separate trenches rather than bundled.

	Parameter			
	DBS East in isolation (HVDC only)	DBS West in isolation (HVAC only)	DBS West and DBS East concurrently (HVAC + HVDC)	Notes and rationale
	installation – 7,128,000m² (based on 396km distance x 18m width of temporary disturbance) Maximum seabed footprint disturbed by sandwave levelling – 2,047,002m² Maximum sandwave material to be dredged and relocated – 33,121,800m³ Maximum total impacted area by anchoring – 22,061m² *Note – 10km stretch along the offshore export cable corridor <10m Lowest Astronomical Tide (LAT), may require use of anchoring* Total temporary area disturbed for export cable installation (trenching,	*Note – Assuming four separate cable trenches, for each cable, 50m apart,* Maximum temporary disturbance for cable installation – 11,376,000m² (based on 632km distance x 18m width of temporary disturbance) Maximum seabed footprint disturbed by sandwave levelling – 4,094,003m² Maximum sandwave material to be dredged and relocated – 66,243,600m³ Maximum total impacted area by anchoring – 44,091m² *Note – 10km stretch along the offshore export cable corridor <10m LAT, may require use of anchoring*	Number of cables required – six Max. offshore cable length for all cables – 1,028km *Note – Assuming 6 separate cable trenches, for each cable, 50m apart,* Maximum temporary disturbance for cable installation – 18,504,000m² (based on 1028km distance x 18m width of temporary disturbance) Maximum seabed footprint disturbed by sandwave levelling – 6,141,005m² Maximum sandwave material to be dredged – 99,365,402m³	

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently (HVAC + HVDC)**	**Notes and rationale**
	sandwave levelling and anchoring) – 9,197,063m²	Total temporary area disturbed for export cable installation (trenching, sandwave levelling and anchoring) – 15,514,094m²	Maximum total impacted area by anchoring – 66,136m² *Note – 10km stretch along the offshore export cable corridor <10m LAT, may require use of anchoring* Total temporary area disturbed for export cable installation (trenching, sandwave levelling and anchoring) –24,711,141m²	
	Foundations and Vessel Impacts <u>Array Areas</u> Seabed footprint for 100 small wind turbine suction bucket jacket foundations – 70,686m² Four offshore converter platforms (OCP) Gravity Based	**Foundations and Vessel Impacts** <u>Array Areas</u> Seabed preparation area for 100 small turbine suction bucket jacket foundations – 70,686m² Four OSP foundations (HVAC only, GBS foundation) and one	**Foundations and Vessel Impacts** <u>Array Areas</u> Seabed preparation area for 200 small turbine suction bucket jacket foundations – 141,372m² Eight offshore (OSP/OCP) platforms GBS seabed	In situations where a number does not divide equally between DBS East and DBS West (e.g. 95 large turbines), rounded up to higher number (e.g. 48 large wind turbines as opposed to 47.5). While the seabed footprint for the large turbine

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently (HVAC + HVDC)**	**Notes and rationale**
	Structure (GBS) and one accommodation platform seabed preparation (HVDC only) –19,242m² Vessel jack-up assuming six jack-up locations per turbine (275m² per jack up leg x four legs x six operations per turbine x 100 small turbines) – 660,000m² Vessel jack-up footprint for all platforms (1,100m² combined leg area x five operations per platform x five platforms) – 27,500m² Anchoring (116m² footprint x four anchors per activity x five activities requiring the deployment of anchors x 100 small turbines) – 232,000m²	accommodation platform – 19,242m² *Note – HVAC project in isolation requires four OSPs.* Two other platform foundations (Reactive Compensation Platform (RCP) + Accommodation Platform) (HVAC only, GBS foundation) - 7,697m² *Note – HVAC project in isolation requires a RCP accommodation platform, HVDC in-isolation does not require an RCP* Vessel jack-up assuming six jack-up locations per turbine (275m² per jack up leg x four legs x six operations per turbine x 100 small wind turbines) – 660,000m²	preparation (HVAC + HVDC) and one accommodation platform – 34,636m² *Note – HVAC/HVDC Solution = four HVAC + four HVDC = eight platforms on GBS* Vessel jack-up assuming six jack-up locations per turbine (275m² per jack up leg x four legs x six operations per turbine x 200 small wind turbines) – 1,320,000m² Vessel jack-up footprint for all platforms (1,100m² combined leg area x five operations per platform x nine platforms) – 60,500m² Anchoring (1,16m² footprint x four anchors per activity x five activities requiring the deployment of anchors x 200	scenario is greater than that of the small scenario, due to the increased vessel jack-up and anchoring footprint required for the greater number of wind turbines, the small turbine scenario has a greater seabed footprint. One project HVDC Solution = Two platforms on GBS (or four platforms on other foundation types) Anchoring events assumes four activities per wind turbine foundation installation + one activity for topside installation per turbine.

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently (HVAC + HVDC)**	**Notes and rationale**
	Maximum area disturbed in array areas – 1,010,228m² <u>Offshore Export Cable Corridor</u> Electrical Switching Platform (ESP) foundation (HVDC only, GBS foundation) - 3,848m² Vessel jack-up footprint for all platforms –5,500m² Total area disturbed by offshore platform installation activities within the offshore export cable corridor – 9,348m²	Vessel jack-up footprint for all platforms (1100m² combined leg area x five operations per platform x five platforms) – 33,000m² Anchoring (116m² footprint x four anchors per activity x five activities requiring the deployment of anchors x 100 small wind turbines) – 232,000m² Maximum area disturbed – 1,00,228m² <u>Offshore Export Cable Corridor</u> Reactive Compensation Platform (RCP) foundation (HVDC only, GBS foundation) - 3,848m² Vessel jack-up footprint for all platforms –5,500m²	small wind turbines) – 464,000m² Maximum area disturbed – 2,011,108m² <u>Offshore Export Cable Corridor</u> ESP + RCP GBS foundations – 7,697m² Vessel jack-up footprint for all platforms – 11,000m² Total area disturbed by offshore platform installation activities within the offshore export cable corridor – 18,697m²	

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently (HVAC + HVDC)**	**Notes and rationale**
		Total area disturbed by offshore platform installation activities within the offshore export cable corridor – 9,348m²		
	Landfall No. of horizontal directional drills (HDDs) – Five Indicative depth of water at drill exit – 8m Indicative HDD length – 1400m Exit pits may be located within the intertidal area	**Landfall** No. of HDDs – Five Indicative depth of water at drill exit – 8m Indicative HDD length – 1400m Exit pits may be located within the intertidal area	**Landfall** No. of HDDs – Nine Indicative depth of water at drill exit – 8m Indicative HDD length – 1400m Exit pits may be located within the intertidal area	Total HDD number includes one spare for the in isolation scenarios, and two spare for the concurrent/sequential scenario.

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently (HVAC + HVDC)**	**Notes and rationale**
	Totals Total disturbance within Array Areas – 8,800,228m² (Array and inter-platform cable trenching, sandwave levelling, foundation installation and vessel impacts) Total temporary area disturbed for export cable installation (trenching, sandwave levelling, anchoring and foundation installation) – 9,206,411m²	**Totals** Total disturbance within Array Areas – 9,702,228m² (Array and inter-platform cable trenching, sandwave levelling, foundation installation and vessel impacts) Total temporary area disturbed for export cable installation (trenching, sandwave levelling, anchoring and foundation installation) – 15,523,443m²	**Totals** Total disturbance within Array Areas – 23,228,608m² (Array and inter-platform cable trenching, sandwave levelling, foundation installation and vessel impacts) Total temporary area disturbed for export cable installation (trenching, sandwave levelling, anchoring and foundation installation) – 24,729,838m²	
Increase in local suspended sediment concentrations and sediment settlement; and	**Displaced sediment during array and inter-platform cable trenching** Array cable – 1,950,000m³ (325km length x 6m width x 1m depth)	**Displaced sediment during array and inter-platform cable trenching** Array cable – 1,950,000m³ (325km length x 6m width x 1m depth)	**Displaced sediment during array and inter-platform cable trenching** Array cable – 3,900,000m³ (650km length x 6m width x 1m depth)	

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently (HVAC + HVDC)**	**Notes and rationale**
Release of sequestered contaminants following sediment disturbance	Inter-platform cables – 330,000m³ (55km length x 6m width x 1m depth) Maximum sandwave material to be dredged and relocated (array cables) – 329,063m³ Maximum sandwave material to be dredged and relocated (inter-platform cables) – 55,688m³ **Displaced sediment during offshore export cable corridor trenching** Export cable – 2,376,000m³ (396km length x 6m width x 1m depth) *Note – 6m width based on worst case pre-lay ploughing width*	Inter-platform cables – 594,000m³ (99km length x 6m width x 1m depth) Maximum sandwave material to be dredged and relocated (array cables) – 329,063m³ Maximum sandwave material to be dredged and relocated (inter-platform cables) – 100,238m³ **Displaced sediment during offshore export cable corridor trenching** Export cable – 3,792,000m³ (632km length x 6m width x 1m depth) *Note – 6m width based on worst case pre-lay ploughing width*	Inter-platform cables – 2,310,000m³ (385km length x 6m width x 1m depth) Maximum sandwave material to be dredged and relocated (array cables) – 658,125m³ Maximum sandwave material to be dredged and relocated (inter-platform cables) – 389,813m³ **Displaced sediment during offshore export cable corridor trenching** Export cable – 6,168,000m³ (1,028km length x 6m width x 1m depth) *Note – 6m width based on worst case pre-lay ploughing width*	

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently (HVAC + HVDC)**	**Notes and rationale**
	Displaced sediment during sandwave levelling Maximum sandwave material to be dredged and relocated – 33,121,800m³ **Increase in suspended sediment concentrations due to drill arisings** Maximum volume arisings per pile (large turbines) – 17,813m³ Maximum percentage of locations using drilling – 5% Max volume of arisings (48 wind turbines) – 42,751m³ **Total displaced sediment across the offshore development area** 38,223,115m³	**Displaced sediment during sandwave levelling** Maximum sandwave material to be dredged and relocated – 66,243,600m³ **Increase in suspended sediment concentrations due to drill arisings** Maximum volume arisings per pile (large turbines) – 17,813m³ Maximum percentage of locations using drilling – 5% Max volume of arisings (48 wind turbines) – 42,751m³ **Total displaced sediment across the offshore development area** 73,069,465m³	**Displaced sediment during sandwave levelling** Maximum sandwave material to be dredged and relocated – 99,365,402m³ **Increase in suspended sediment concentrations due to drill arisings** Maximum volume arisings per pile (large turbines) – 17,813m³ Maximum % of locations using drilling – 5% Max volume of arisings (95 turbines) – 84,611m³ **Total displaced sediment across the offshore development area** 112,893,764m³	

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently (HVAC + HVDC)**	**Notes and rationale**
Impacts on fish and shellfish species as a result of noise and vibration (from piling and UXO clearance only)	**Array Area** <u>Piling</u> Max piles per day – three (two wind turbines and one OSP) Hammer energy – 7,000kJ hammer Duration per monopile – Indicative 320 minutes, up to 8 hours Number of wind turbine monopiles – 100 Monopiles for offshore platforms - 6 <u>UXO</u> Maximum UXO to be cleared in one day – two	**Array Area** <u>Piling</u> Max piles per day – three (two wind turbines and one OSP) Hammer energy – 7,000kJ hammer Duration per monopile – Indicative 320 minutes, up to 8 hours Number of wind turbine monopiles – 100 Monopiles for offshore platforms - six <u>UXO</u> Maximum UXO to be cleared in one day – two	**Array Area** <u>Piling</u> Max piles per day – five (two wind turbines per Array Area and one OSP) Hammer energy – 7,000kJ hammer Duration per monopile – Indicative 320 minutes, up to 8 hours Number of wind turbine monopiles – 200 Monopiles for offshore platforms - 11 <u>UXO</u> Maximum UXO to be cleared in one day – two	Various types and sizes of UXO may require clearance over the course of the construction phase.

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently (HVAC + HVDC)**	**Notes and rationale**
	Offshore Export Cable Corridor Maximum UXO to be cleared in one day – two	**Offshore Export Cable Corridor** Maximum UXO to be cleared in one day – two	**Offshore Export Cable Corridor** Maximum UXO to be cleared in one day – two	
Reduced fishing pressure within the Array Areas and increased fishing pressure outside of the Array Area	**Total Developable Array Area** =494.5km² **Total Offshore Export Cable Development Area** =396km²	**Total Developable Array Area** =494.5km² **Total Offshore Export Cable Development Area** =316km²	**Total Developable Array Area** =989km² **Total Offshore Export Cable Development Area** =712km²	
Operation				
Direct damage (e.g. crushing) and disturbance; and Habitat loss and / or	**Array Area** Seabed disturbance from jacking-up activities over the Projects lifetime – 306,900m² (10,230m² per year x 30 year lifespan)	**Array Area** Seabed disturbance from jacking-up activities over Projects lifetime – 306,900m² (10,230m² per year x 30 year lifespan)	**Array Areas** Seabed disturbance from jacking-up activities over Projects lifetime –613,800m² (20,460m² per year x 30 year lifespan)	

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently (HVAC + HVDC)**	**Notes and rationale**
disturbance to spawning and nursery areas as a result of operation and maintenance activities	*Note- 10,230m² is half of total 20,460m² area disturbed per year for 200 turbines)* Array cable repairs – seabed disturbance over Projects lifetime – 42,000m² (seven events x 6,000m² per event) **Offshore Export Cable Corridor** Export cable repairs – seabed disturbance over Projects lifetime – 18,000m² (three events x 6,000m² per event)	*Note- 10,230m² is half of total 20,460m² area disturbed per year for 200 turbines)* Array cable repairs – seabed disturbance over Projects lifetime – 42,000m² (seven events x 6,000m² per event) **Offshore Export Cable Corridor** Export cable repairs – seabed disturbance over Projects lifetime – 18,000m² (three events x 6,000m² per event)	Array cable repairs – seabed disturbance over Projects lifetime – 78,000m² (13 events x 6,000m² per event) **Offshore Export Cable Corridor** Export cable repairs – seabed disturbance over Projects lifetime – 36,000m² (six events x 6,000m² per event)	
Permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition	**Array Area** Total worst case wind turbine footprint with scour protection – 2,667,456m² (48 large wind turbines x 55,572m² total protection per wind turbine)	**Array Area** Total worst case wind turbine footprint with scour protection – 2,667,456m² (48 large turbines x 55,572m² total protection per wind turbine)	**Array Areas** Total worst case wind turbine footprint with scour protection – 5,279,340m² (95 large turbines x 55,572m² total protection per wind turbine)	Total scour protection per turbine includes structure footprint area. Predicted no. of cable crossings for Projects in isolation: - DBS East – 40

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently (HVAC + HVDC)**	**Notes and rationale**
	Total worst case scour protection for OCPs and other platforms in array areas – 282,052m² Total array and inter-platform cable protection – 656,512 (488,400m² array cable protection + 168,112 inter platform cable protection) Total footprint of pipeline and / or cable crossing material (array cables) – 61,310m² Total habitat loss within the Array Area – 3,667,330m²	Total worst case scour protection for OSPs and other platforms – 282,052m² Total array and inter-platform cable protection – 790,515m² (488,400m² array cable protection + 302,115m² inter-platform cable protection) Total footprint of pipeline / cable crossing material (array + inter–platform cables) – 73,539m² *Note – Four predicted inter-platform cable crossings for HVAC only scenario.* Total habitat loss within the Array Area – 3,813,562m²	Total worst case scour protection for OSP/OCPs and other platforms – 507,694m² Total array and inter-platform cable protection – 2,139,904m² (976,800m² array cable protection + 1,163,104m² inter-platform cable protection) Total footprint of pipeline / cable crossing material (array + inter–platform cables) – 244,915m² Total habitat loss within the Array Area – 8,171,853m²	- DBS West – 70

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently (HVAC + HVDC)**	**Notes and rationale**
	Offshore Export Cable Corridor Total offshore export cable protection – 1,089,660m² Total worst case scour protection for ESP in offshore export cable corridor – 56,410m² Total footprint of pipeline and / or cable crossing material – 122,611m² Total habitat loss within the offshore export cable corridor – 1,268,681m²	**Offshore Export Cable Corridor** Total offshore export cable protection – 1,642,872m² Total worst case scour protection for RCP in offshore export cable corridor – 56,410m² Total footprint of pipeline / cable crossing material – 294,267m² Total habitat loss within the offshore export cable corridor – 1,993,549m²	**Offshore Export Cable Corridor** Total offshore export cable protection – 2,701,040m² Total worst case scour protection for ESP & RCP in offshore export cable corridor – 112,821m² Total footprint of pipeline and / or cable crossing material – 441,400m² Total habitat loss within the offshore export cable corridor – 3,255,261m²	

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently (HVAC + HVDC)**	**Notes and rationale**
Increase in local suspended sediment concentrations and sediment settlement; and Release of sequestered contaminants following sediment disturbance	**Array Area** Seabed disturbance from jacking-up activities over Projects lifetime – 306,900m² (10,230m² per year x 30 year lifespan) *Note- 10,230m² is half of total 20,460m² area disturbed per year for 200 turbines)* Array cable repairs - seabed disturbance over Projects lifetime – 42,000m² (Seven events x 6,000m² per event) **Export Cable Route** Export cable repairs - seabed disturbance over Projects lifetime – 18,000m² (Three events x 6,000m² per event)	**Array Area** Seabed disturbance from jacking-up activities over Projects lifetime – 306,900m² (10,230m² per year x 30 year lifespan) *Note- 10,230m² is half of total 20,460m² area disturbed per year for 200 turbines)* Array cable repairs - seabed disturbance over Projects lifetime – 42,000m² (Seven events x 6,000m² per event) **Export Cable Route** Export cable repairs - seabed disturbance over Projects lifetime – 18,000m² (Three events x 6,000m² per event)	**Array Areas** Seabed disturbance from jacking-up activities over Projects lifetime –613,800m² (20,460m² per year x 30 year lifespan) Array cable repairs - seabed disturbance over Projects lifetime – 78,000m² (13 events x 6,000m² per event) **Export Cable Route** Export cable repairs - seabed disturbance over Projects lifetime – 36,000m² (Six events x 6,000m² per event)	

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently (HVAC + HVDC)**	**Notes and rationale**
Electromagnetic Field effects arising from cables.	**Maximum offshore export cable length** 4 x cables of 158km = 632km **Maximum array cable length** 325km **Offshore Export Cable Voltage** Up to 525kV DC **Array Cable Voltage** Up to 132kV **Minimum Burial Depth** 0.5m	**Maximum offshore export cable length** 2 x cables of 198km = 396km **Maximum array cable length** 325km **Offshore Export Cable Voltage** Up to 275kV AC **Array Cable Voltage** Up to 132kV **Minimum Burial Depth** 0.5m	**Maximum offshore export cable length** 1,028km **Maximum array cable length** 650km **Offshore Export Cable Voltage** Up to 525kV DC and 275kV AC **Array Cable Voltage** Up to 132kV **Minimum Burial Depth** 0.5m	Burial will be attempted across the full length of the array and offshore export cables. However, regions without cable burial are possible at transition points for cable crossings, or at regions of hard substrate. At these points cable protection will be utilised.

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently (HVAC + HVDC)**	**Notes and rationale**
Reduced fishing pressure within the Array Areas and increased fishing pressure outside of the Array Area	**Total footprint of infrastructure within the array area** =3.72km² **Total footprint within the offshore export cable corridor** =1.21km²	**Total footprint of infrastructure within the array area** =3.87km² **Total footprint within the offshore export cable corridor** =1.93km²	**Total footprint of infrastructure within the array area** =8.28km² **Total footprint within the offshore export cable corridor** =3.14km²	
Decommissioning				
No final decision regarding the final decommissioning policy for the onshore project infrastructure including landfall, onshore cable route and onshore substation has yet been made. It is also recognised that legislation and industry best practice change over time. However, it is likely that offshore project infrastructure will be removed above the seabed and reused or recycled where practicable. The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning and will be agreed with the regulator. It is anticipated that for the worst case scenario, the impacts will be no greater than those identified for the construction phase.				

10.3.2.2 Development Scenarios

9. There are currently two possible electrical solutions being considered for DBS West, HVAC or HVDC. Due to the distance of the Array Area offshore, DBS East will be an HVDC project. Therefore, there are two possible electrical solutions for the Projects:

- One HVDC project and one HVAC project; or
- Two HVDC projects.

10. Offshore, the most significant difference between an HVAC solution and an HVDC solution is that if an HVAC electrical solution is used an additional platform will be required along the offshore export cable. In addition, an HVAC solution will require two further offshore export cables, over and above the four export cables that would be required for two HVDC projects.

11. In order to ensure that a robust assessment has been undertaken, all development scenarios and options have been considered to ensure the realistic worst case scenario for each topic has been assessed. Further details are provided in **Chapter 5 Project Description**.

10.3.2.3 Construction Scenarios

12. The following principles set out the framework for how the Projects may be constructed (relating to both onshore and offshore works):

- DBS East and DBS West may be constructed at the same time, or at different times;
- If built concurrently, both Projects could be constructed in five years;
- If built non-concurrently, either Project could be built first;
- If built non-concurrently, each Project would require a five year period of construction;
- If built non-concurrently, it is anticipated that there would be up to a two year lag between the start of construction for the first project and the start of construction for the second project; and
- Assuming a maximum construction period per Project of five years, and taking the above into account, the maximum construction period over which the construction of both Projects could take place is seven years.

13. In order to determine which construction scenario presents the realistic worst case for each receptor and impact, the assessment considers both maximum duration effects and maximum peak effects. This is done, in addition to each Project being developed in isolation, drawing out any differences between each of the two Projects.

14. The three construction scenarios considered by the Fish and Shellfish Ecology assessment are therefore:

- Build DBS East or build DBS West in isolation;
- Build DBS East and DBS West concurrently – reflecting the maximum peak effects; and
- Build the Projects sequentially with a lag of up to two years – reflecting the maximum duration of effects.

15. The individual, concurrent and sequential construction scenarios all allow for flexibility to build out the Projects using a phased approach. This will allow the Projects to adapt to National Grid Electricity Transmission Operator's development plans for the onshore grid connection points. Under a phased approach the maximum timescales for individual elements of the construction have been assessed.

16. Any differences between the Projects, or differences that could result from the manner in which the first and the second Projects are built (concurrent or sequential, and the length of any gap) are identified and discussed where relevant in section 10.5.4. For each potential impact, only the worst case construction scenario for two Projects is presented, i.e. either concurrent or sequential. The justification for what constitutes the worst case is provided, where necessary, in section 10.5.4.

10.3.2.4 Operation Scenarios

17. Operation scenarios are described in detail in **Chapter 5 Project Description**. The assessment considers the following scenarios:

- Only DBS East in operation;
- Only DBS West in operation; and
- The two Projects operating concurrently, with a lag of two years between each Project commencing operation.

18. If the Projects are built out using a phased approach, there would also be a phased approach to starting the operational stage. The worst case scenario for the operational phases for the Projects have been assessed. See section 5.1.1 of **Chapter 5 Project Description** for further information on phasing scenarios for the Projects.

19. The operational lifetime of each Project is expected to be 30 years.

10.3.2.5 Decommissioning Scenarios

20. Decommissioning scenarios are described in **Chapter 5 Project Description**. Decommissioning arrangements will be agreed through the submission of a Decommissioning Programme prior to construction. However, for the purpose of this assessment it is assumed that decommissioning of the Projects could be conducted separately, or at the same time.

10.3.3 Mitigation Embedded in the Design

21. This section outlines the embedded mitigation relevant to the Fish and Shellfish Ecology assessment, which has been incorporated into the design of the Projects (**Table 10-3**).

Table 10-3 Embedded Mitigation Measures

Parameter	Mitigation Measures Embedded into the Project Design
Offshore export cable corridor	The offshore export cable corridor (ECC) was selected in consultation with key stakeholders to select a route which minimised impacts on designated sites and ecologically important habitats for fish and shellfish species. See **Chapter 4 Site Selection and Assessment of Alternatives**.
Scour Protection	Following industry best-practice, the Applicant will seek to minimise the use of scour protection, mitigating the habitat loss for benthic, fish and shellfish species. This will be secured through a Scour Protection and Cable Protection Plan that will be submitted for approval post consent. The Scour Protection and Cable Protection Plans will be secured within the DOC.
Underwater Noise	Ramp up and soft-start procedures will be followed during piling, and low-yield methods will be utilised for the detonation of UXO where viable, to mitigate underwater noise impacts on any fish and shellfish species sensitive to noise. Ramp up and soft-start procedures will be secured through a Marine Mammal Mitigation Protocol that will be secured within the DCO and submitted for approval post consent.
Electromagnetic Fields (EMF)	The Applicant is committed to burying offshore export cables to 0.5-1m where practicable, which reduces the effects of EMFs. The Cable Specification and Installation Plan will be secured within the DCO and submitted for approval post consent.
Pollution Prevention Measures	Due to the presence and movements of vessels and / or equipment during construction and operation and maintenance there is the potential for spills and leaks which could result in changes to water quality. All vessels working on behalf of the Projects will be required to comply with the International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78.

Parameter	Mitigation Measures Embedded into the Project Design
	An outline Project Environmental Management Plan (PEMP) will also be produced and implemented to cover the construction, operation and maintenance and decommissioning phases of the Projects. This will set out all procedures and measures (in the form of a Marine Pollution Contingency Plan (MPCP)) to be followed during the construction, operation and maintenance, and decommissioning phases, to minimise the risk of, and effects in the event of an accidental spill. The PEMP will identify all potential sources and types of accidental pollution for all project phases, and set out the proposed mitigation measures. The PEMP will be developed in consultation with key stakeholders for approval by the MMO. The requirement for a PEMP will be secured within the DCO.

10.4 Assessment Methodology

10.4.1 Policy, Legislation and Guidance

10.4.1.1 National Policy Statements

22. The assessment of potential impacts upon Fish and Shellfish Ecology has been made with specific reference to the relevant National Policy Statements (NPS) (DECC, 2011a-c). The specific assessment requirements for Fish and Shellfish Ecology, as detailed in the NPS, are summarised in **Table 10-4,** together with an indication of the section of this chapter where each is addressed.

23. It is noted that the NPS for Energy (EN-1), the NPS for Renewable Energy Infrastructure (EN-3) and the NPS for Electricity Networks Infrastructure (EN-5) are in the process of being revised. No specific provisions relevant to fish and shellfish ecology are found in NPS EN-1, NPS EN-5 or the draft versions of these NPSs. Sections of EN-3 identified as having relevance to this PEIR chapter, are summarised within **Table 10-4**. Any further changes to these draft revisions resulting from the consultation process will be considered in the ES.

24. Following the consultation in 2021 on the draft energy NPS, a new consultation opened on the 30 March 2023 on revised drafts of the energy NPSs, including EN1, EN3 and EN5. Due to the timing of this consultation, and finalisation of this PEIR we have been unable to review and take these revised draft NPS into account within these documents. However, these will be reviewed and incorporated into the final ES where relevant.

Table 10-4 NPS Assessment Requirements

NPS Requirement	NPS Reference	PEIR section Reference
EN-3 NPS for Renewable Energy Infrastructure		
There is the potential for the construction and decommissioning phases, including activities occurring both above and below the seabed, to interact with seabed sediments and therefore have the potential to impact fish communities, migration routes, spawning activities and nursery areas of particular species. In addition, there are potential noise impacts, which could affect fish during construction and decommissioning and to a lesser extent during operation.	EN-3, section 2.6.73	Construction Phase: sections 10.6.1.1, 10.6.1.2, 10.6.1.4. Operational Phase: sections 10.6.2.1, 10.6.2.2, 10.6.2.3, 10.6.2.5. Decommissioning Phase: 10.6.3

NPS Requirement	NPS Reference	PEIR section Reference
The applicant should identify fish species that are the most likely receptors of impacts with respect to feeding areas; spawning grounds; nursery grounds; overwintering areas for crustaceans and migration routes.	EN-3, section 2.6.74	Sections 10.6.1.1, 10.6.2.2.
Where mitigation measures are applied to offshore export cables to reduce electromagnetic fields (EMF) the effects on sensitive species during operation are unlikely to be a reason for PINS to have to refuse to grant consent. Once installed, operational EMF impacts are unlikely to be of sufficient range or strength to create a barrier to fish movement. EMF during operation may be mitigated by use of armoured cable for inter-array and export cables which should be buried at a sufficient depth.	EN-3, section 2.6.75 and section 2.6.76	Section 10.6.2.6.
During construction, 24 hour working practices may be employed so that the overall construction programme and the potential for impacts to fish communities are reduced in overall time.	EN-3, section 2.6.77	It is confirmed that 24 hour working practices will be employed.

25. Further detail is provided in **Chapter 3 Policy and Legislative Context**.

10.4.1.2 Data and Information Sources

26. Data sources that have been used to inform the assessment are listed in **Table 10-5** as discussed and agreed with stakeholders through the scoping and EPP processes.

Table 10-5 Available Data and Information Sources

Data Set	Spatial Coverage	Year	Notes
MMO (2022)	British Isles	2016-2021	Landings data for species by value and landed weight available for the whole Fish and Shellfish Ecology Study Area: ICES Rectangles 36E9;

Data Set	Spatial Coverage	Year	Notes
			36F0; 37E9; 37F0; 37F1; 37F2; 38F0; 38F1; and 38F2
North Sea International Bottom Trawl Survey (IBTS) (ICES, 2023a)	North Sea	2012-2022	Data available for ICES Rectangles 36F0, 37E9, 37F0, 37F1, 38F0, and 38F1
ICES International Herring Larvae Survey (IHLS) data (ICES 2023b)	North Sea	2010-2022	Used to inform potential Atlantic herring habitat within assessment
Coull *et al.* (1998)	British Isles	1998	Fish spawning and nursery grounds
Ellis *et al.* (2012)	British Isles	2012	Fish spawning and nursery grounds
Chapter 13 – Commercial Fisheries (consultation)	Fish and Shellfish Study Area and Commercial Fisheries Study Area	2022-2023	Important scallop grounds have been identified within the export cable route and Dogger Bank SAC, that have been highlighted within the Fish and Shellfish Ecology Chapter as a key point of note.

10.4.2 Impact Assessment Methodology

27. **Chapter 6 EIA Methodology** provides a summary of the general impact assessment methodology applied. The following sections describe the methods used to assess the likely significant effects on Fish and Shellfish Ecology.

10.4.2.1 Definitions

28. For each potential impact, the assessment identifies receptors sensitive to that impact, and implements a systematic approach to understanding the impact pathways and the level of impacts (i.e. magnitude) on given receptors. The definitions of sensitivity and magnitude for the purpose of the Fish and Shellfish Ecology assessment are provided in **Table 10-6** and **Table 10-7**.

Table 10-6 Definition of Sensitivity for a Fish and Shellfish Ecology Receptor

Sensitivity	Definition
High	A stock or species of national importance with an inability to adapt to, and limited to no tolerance of, a given effect. The receptor will not be able to make a permanent recovery.
Medium	A stock or species of importance within the North Sea with a limited ability to adapt to, and a limited tolerance of, a given effect. Following exposure, the receptor population is anticipated to recover to baseline levels within 7 - 12 years. OR A stock or species of national importance with a level of adaptability and tolerance to a given effect. Following exposure, the receptor population is anticipated to recover to baseline levels within 1 - 7 years.
Low	A stock or species of local importance with a limited ability to adapt to, and a limited tolerance of, a given effect. Following exposure, the receptor population is anticipated to recover to baseline levels within 1 - 12 years. OR A stock of species of importance within the North Sea with a level of adaptability and tolerance to a given effect. Following exposure, the receptor population is anticipated to recover to baseline levels within 1 - 7 years. OR A stock or species of national importance with a high level of adaptability and tolerance to a given effect. Following exposure, the receptor population is anticipated to recover to baseline levels within 1 year.
Negligible	A stock or species of national importance, or importance within the North Sea that is entirely tolerant and / or adaptable to a given effect. Following exposure, no change in the receptor population is anticipated. OR A stock or species of local importance with a high level of adaptability and tolerance to a given effect. Following exposure, the receptor population is anticipated to recover to baseline levels within 0 - 1 year.

Table 10-7 Definition of Magnitude of Impacts

Magnitude	Definition
High	An irreversible effect that is certain to occur. The effect would result in a change that is outside of the natural variation in background conditions for the given effect.
Medium	A long term (7 - 12 years) effect that is likely to occur. The effect would result in a change that is noticeable, but remains within the natural variation in background conditions for the given effect.
Low	A medium term (1 - 7 years) effect that is likely to occur. The effect would result in a change that is noticeable, but remains within the natural variation in background conditions for the given effect.
Negligible	A short term (0 - 1 year) effect that may occur. The effect would result in a change that is unnoticeable from the natural variation in background conditions for the given effect.

10.4.2.2 Significance of Effect

29. The assessment of significance of an effect is informed by the sensitivity of the receptor and the magnitude of the impact. The determination of significance is guided by the use of an impact significance matrix (**Table 10-8**) presented in **Chapter 6 EIA Methodology**. Definitions of each level of significance are provided in **Table 10-9**. For the purposes of this assessment, any effect that is of major or moderate significance is considered to be significant in EIA terms, whether this be adverse or beneficial. Any effect that has a significance of minor or negligible is not significant.

Table 10-8 Fish and Shellfish Ecology Significance of Effect Matrix

		Adverse Magnitude				Beneficial Magnitude			
		High	**Medium**	**Low**	**Negligible**	**Negligible**	**Low**	**Medium**	**High**
Sensitivity	High	Major	Major	Moderate	Minor	Minor	Moderate	Major	Major
	Medium	Major	Moderate	Minor	Minor	Minor	Minor	Moderate	Major
	Low	Moderate	Minor	Minor	Negligible	Negligible	Minor	Minor	Moderate
	Negligible	Minor	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Minor

Table 10-9 Definition of Effect Significance

Significance	Definition
Major	Very large or large change in receptor condition, which is likely to be important considerations at a regional or district level. This because they contribute to achieving national, regional, or local objectives, or could result in exceedance of statutory objectives and / or breaches of legislation.
Moderate	Intermediate change in receptor condition, which is likely to be important considerations at a local level.
Minor	Small change in receptor condition, which may be raised as local issues, but are unlikely to be important in the decision making process.
Negligible	No discernible change in receptor condition.
No change	No impact, therefore, no change in receptor condition.

10.4.3 Cumulative Effect Assessment Methodology

30. The cumulative effect assessment (CEA) considers other plans and projects that may result in cumulation with the Projects. **Chapter 6 EIA Methodology** provides details of the general framework and approach to the CEA that will be undertaken for the Projects.

31. The final assessment of cumulative effects will be undertaken during the later stages of the EIA, once further information is available on a number of projects such as the Outer Dowsing Offshore Wind Farm, Hornsea Project Four decision and the Sheringham Shoal and Dudgeon Offshore Wind Farms examination. However, for the purposes of the PEIR, it is possible to identify a number of projects and plans which are likely to feature in that assessment and consider the extent to which cumulative effects might arise. Section 10.7 presents the following preliminary information regarding cumulative effects:

- Screening for cumulative effects; and
- A preliminary short list of plans and projects considered for CEA, including a brief description as to how projects have been screened in and the initial tier level they have been assigned.

10.4.4 Transboundary Effect Assessment Methodology

32. The transboundary effect assessment, considers the potential for transboundary effects to occur on Fish and Shellfish Ecology receptors as a result of the Projects; either those that might arise within the Exclusive Economic Zone (EEZ) of the European Economic Area (EEA) member states, or arising on the interests of EEA member states e.g. a non UK fishing vessel. **Chapter 6 EIA Methodology** provides further details of the general framework and approach to the assessment of the transboundary effects.

10.4.5 Assumptions and Limitations

33. This preliminary assessment is considered to be an interim stage in the EIA process. The results presented in the following sections are based on early design assumptions and initial assessments, which will be refined and presented in the final ES to be submitted as part of the DCO application.

34. No further overarching assumptions or limitations have been identified that apply to the assessment for Fish and Shellfish Ecology. Where routine assumptions have been made in the course of undertaking the assessment, these are noted throughout.

35. No site-specific surveys have been performed for the assessment for Fish and Shellfish Ecology, but rather the assessment has been performed based on desk-based data, including peer-reviewed literature sources and governmental reports.

10.5 Existing Environment

36. This section outlines aspects of the existing environment that influence fish and shellfish ecology within the Fish and Shellfish Ecology Study Area. The existing environment has been informed using the data and information sources outlined in section 10.4.1.2 and also data presented in other relevant PEIR chapters.

10.5.1 Offshore Physical Environment

37. The Fish and Shellfish Ecology Study Area is located in the southern North Sea and covers a total area of 26,858km^2. Water depth within the Study Area decreases from a maximum of 98m offshore, to 0m at the coast (EMODnet, 2023). The minimum and maximum water depths within the array areas at the time of the site-specific geophysical survey ranged from 14.2m to 41.8m below the lowest astronomical tide (LAT).

38. The Dogger Bank area is influenced by cool Atlantic water masses originating from the north, and warmer water masses originating from the English Channel to the south. The resulting front where the two distinct water masses meet, named the Flamborough Front, gives rise to turbulence and eddies on both sides of the headland. Within the Fish and Shellfish Ecology Study Area, mean spring tide was highest close to shore, with a maximum of 1.63m/s, and progressively decreased offshore to a minimum of 0.12m/s (BERR, 2008).

39. The Fish and Shellfish Ecology Study Area straddles the 50m contour, which delineates a soft border between the two main fish communities which relate to the deeper northern and shallower southern waters (Harding *et al.*, 1986; Callaway *et al.*, 2002; Reis *et al.*, 2010). The 50m contour also reflects the Flamborough Front, where the thermally stratified waters to the north and the more or less permanently mixed waters to the south meet (Brown *et al.*, 1999). The difference in bottom water temperature on either side of the 50m contour boundary (Flamborough Front) was determined by Reis *et al.* (2010) as the most influential environmental variable on demersal fish community structure in the North Sea. The overlap of distribution of the northern and southern fish species around the Flamborough Front may be a contributory factor causing the relatively high species diversity within the Fish and Shellfish Ecology Study Area (Reis *et al.*, 2010).

40. Due to the depth of the DBS array areas, and exposure of the Fish and Shellfish Ecology Study Area to nearshore ocean processes, wave energy is relatively high. The most frequent wave movement across the offshore development area originates from the north to north-north-west sector. The nearshore area of the Fish and Shellfish Ecology Study Area is naturally more variable in wave condition, with waves approaching from the north east and consequent net sediment transport predominantly to the south. In general, the annual mean significant wave height within the Fish and Shellfish Ecology Study Area ranges from 0.92m close to shore, to 1.9m offshore (BERR, 2008).

41. Seabed sediments underpin the location of spawning grounds for focal fish species such as sandeel species of *Ammodytes* spp. (hereby referred to as sandeel) and Atlantic herring *Clupea harengus*. The seabed sediments characteristic of the Fish and Shellfish Ecology Study Area increase in gravel content with increasing distance from the landfall point, to the south of Flamborough Head. The increasing gravel component is relatively linear, with sediments within the offshore development area predominantly comprising of sand, slightly gravelly sand, and gravelly sand, with an isolated patch of sandy gravel in the DBS West array area.

42. Average annual suspended sediment concentrations (SSC) within the Dogger Bank region, including the Fish and Shellfish Ecology Study Area, are characterised by values up to 5mg/l (Cefas, 2016). These may be greater during winter periods as a result of increased turbidity resulting from storm events. Further information regarding the offshore physical environment is detailed in **Chapter 8 Marine Physical Environment** of this PEIR.

10.5.2 Offshore Biological Environment

43. Dogger Bank supports a wide variety of fish and shellfish species, many of which have high commercial importance within the region and have supported significant fisheries for over 300 years (Plumeridge and Roberts, 2017). Recent MMO landings and information outlined in section 10.4.1.2 identified numerous fish and shellfish species within the Fish and Shellfish Ecology Study Area. Alongside a range of additional sources discussed below, a list of species with likely or known presence within the Fish and Shellfish Ecology Study Area was compiled, and is presented within **Fish and Shellfish Ecology Appendix 10-1**. Details pertinent to the biology, autecology, behaviour and conservation status are also presented in **Appendix 10-1**. Where certain species have been identified as having similar or identical sensitivities to a given potential impact, they have been grouped within section 10.5.4 (receptor groups). Where individual species are identified as having significant differences in terms of their sensitivities to a given impact, these differences are highlighted, and are considered within the overall assessment of sensitivity for their respective receptor group.

10.5.2.1 Commercial Landings Data

44. Regional landings data was sourced from the MMO and included the most recent five years of data available, ranging from 2016 to 2020, as published within the MMO landings data (MMO, 2022). Data were processed to only include landings data from the ICES Rectangles included in the Fish and Shellfish Ecology Study Area (36E9; 36F0; 37E9; 37F0; 37F1; 37F2; 38F0; 38F1; and 38F2) (10.3.1).

45. Landings data for overall commercial value and landed weight of fish and shellfish species, are presented in **Table 10-10** and **Table 10-11** respectively, alongside the data specific to the five most valuable species in each category. It should be noted that the MMO landings data investigated considers landings of fish and shellfish species from all gear types. Further, these data are not collected whilst utilising a scientific sampling method. Further information on fishing gear and gear types within the region can be found in **Chapter 13 Commercial Fisheries**.

Table 10-10 Total Value of Fish and Shellfish Landings from the Fish and Shellfish Ecology Study Area (36E9; 36F0; 37E9; 37F0; 37F1; 37F2; 38F0; 38F1; and 38F2) Between 2016 and 2021. The Five Species With Greatest Associated Value From Each Category, and Total Value Across All Landed Species Within Each Category are Presented (Source: MMO, 2022).

Species	Value (GBP)
Fish	
Plaice	9,847,754.22
Atlantic herring	2,658,688.14
Turbot	870,925.32
Lemon sole	295,760.51
Atlantic cod	292,863.05
Fish Species Total	**15,527,175.78**
Shellfish	
Lobster	46,146,925.36
Brown crab	41,442,109.99
Scallop	18,977,974.82
Norway lobster	5,001,735.52
Whelk	1,742,239.31
Shellfish Species Total	**114,248,502.40**

Table 10-11 Total Landed Weight of Fish and Shellfish Landings from the Fish and Shellfish Ecology Study Area (36E9; 36F0; 37E9; 37F0; 37F1; 37F2; 38F0; 38F1; and 38F2) Between 2016 and 2021. The Five Species With Greatest Associated Landed Weight From Each Category, and Total Landed Weight Across All Landed Species Within Each Category are Presented (Source: MMO, 2022).

Species	Landed Weight (Tonnes)
Fish	
Plaice	6,414.3
Atlantic herring	3,806.7
Sandeel	463.7
Whiting	324.1
Dab	154.4
Fish Species Total	**12,245.0**
Shellfish	
Brown crab	23,580.9
Scallop	8,078.2
Lobster	3,387.9
Whelk	1,692.0
Norway lobster	1,092.4
Shellfish Species Total	**38,107.9**

10.5.2.2 International Bottom Trawl Survey

46. IBTS data is available for all ICES Rectangles within the Fish and Shellfish Ecology Study Area, with the exception of 36E9. This dataset presents species alongside a CPUE value. This metric acts as a proxy for species abundance. Between 2012 and 2022, 122 species were recorded. Many of these species are of commercial value and are therefore included within the MMO landings data (MMO, 2022) The Commercial Landings dataset is considered within section 10.5.2.1. The five species with highest mean CPUE value, over surveys undertaken in the 2012-2022 period as recorded within the dataset, are presented in **Table 10-12**. Further, it is likely that pelagic species are underrepresented within this dataset, as a bottom trawl sampling method is used that will naturally target demersal species.

Table 10-12 Species with the Highest Recorded Mean Catch Per Unit Effort Between 2012-2022 Within ICES Rectangles 36F0; 37E9; 37F0; 37F1; 37F2; 38F0; 38F1; and 38F2. (From: North Sea International Bottom Trawl Survey, 2022)

Species	Catch per Unit Effort
European sprat	490.52
Whiting	184.44
Atlantic herring	150.75
Common dab	96.38
Atlantic horse mackerel	51.23

47. In addition to commercial species, this dataset also highlights species present within the region, that whilst not commercially valuable, are likely to provide benefit to the wider ecosystem, for example as cornerstone or prey species for other species within the local environment. The top 5 in terms of CPUE) species of this type are presented in **Table 10-13**.

Table 10-13 Species With Limited to no Commercial Importance Within the North Sea Presenting the Highest Recorded Mean Catch Per Unit Effort Between 2012-2022 within ICESS Rectangles 36F0; 37E9; 37F0; 37F1; 37F2; 38F0; 38F1; and 38F2. (From: North Sea International Bottom Trawl Survey, 2022).

Species	Catch per Unit Effort
Lesser weever	15.77
Grey gurnard	9.27
Solenette	7.01
Montagu's seasnail	4.89
American plaice	4.21

10.5.3 Fish and Shellfish Ecology Receptor Groups

48. The fish and shellfish species identified as having a likely presence within the Study Area can be classified within one of five receptor groups. These receptor groups have been determined based on the similar biological and behavioural traits of the comprising species, resulting in similar or identical sensitivities to impacts identified within this assessment. The following receptor groups will therefore be utilised throughout section 10.6:

- **Elasmobranchs;**
- **Demersal fish;**
- **Pelagic fish;**
- **Migratory fish; and**
- **Shellfish.**

49. The baseline information for each of these groups is presented in the following subsections 10.5.3.1-10.5.3.5. Species considered within each of the receptor groups, alongside information on their biology and conservation status can be found in **Fish and Shellfish Ecology Appendix 10-1**.

50. Due to the specificity of species and impacts associated with underwater noise, this impact will be assessed using alternative receptor groups, as described within Popper *et al.* (2014):

- **Fish with a swim bladder used in hearing;**
- **Fish with a swim bladder not used in hearing;**
- **Fish without a swim bladder; and**
- **Fish eggs and larvae.**

51. The above receptor groups are listed in order of decreasing sensitivity to underwater noise. Species with a swim bladder using in hearing include gadids (e.g. Atlantic cod), European eel, and the clupeids shad and herring. This receptor group will be used to determine the worst case scenario assessment for underwater noise impacts. Fish with a swim bladder not used in hearing include Atlantic salmon and sea trout, and fish without a swim bladder include elasmobranchs and pleuronectiforms (Popper *et al.*, 2014). Further, all of the above receptor groups with the exception of fish eggs and larvae exhibit a degree of motility that will allow avoidance or fleeing behaviour. This response will allow for a reduction in exposure to underwater noise.

52. **Table 10-14** indicates key indicative thresholds for mortality and mortal injury, recoverable injury and temporary threshold shift (TTS), relating to underwater noise exposure for fish and shellfish receptors. This table should be considered in combination with **Appendix 11-2: Underwater Noise Modelling Report**.

Table 10-14 Key Underwater Noise Thresholds Pertaining to Fish and Shellfish Ecology (SELcum = Cumulative Sound Exposure Level (SEL); RMS = Route Mean Square *(From: Popper et al., 2014)*

Underwater Noise: Fish and Shellfish Receptor Group	Noise Source	Mortality and Potential Mortal Injury	Recoverable Injury	Temporary Threshold Shift
Fish with a swim bladder used in hearing	Continuous noise sources	N/A	170 dB RMS for 48 hrs	158 dB RMS for 12 hrs
	Pile driving	207 dB SELcum > 207 dB peak	203 dB SELcum > 207 dB peak	186 dB SELcum
	Explosions	229 – 234dB peak	NA	NA
Fish with a swim bladder not used in hearing	Pile driving	210 dB SELcum > 207 dB peak	203 dB SELcum > 207 dB peak	> 186 dB SELcum
	Explosions	229 – 234dB peak	NA	NA
Fish without a swim bladder	Pile driving	> 219 dB SELcum > 213 dB peak	> 216 dB SELcum > 213 dB peak	>> 186 dB SELcum
	Explosions	229 – 234dB peak	NA	NA
Fish eggs and larvae	Pile driving	210 dB SELcum > 207 dB peak	Moderate impact nearfield (tens of metres), low impact beyond	Moderate impact near-field (tens of metres), low impact beyond
	Explosions	> 13 mm s-1 peak velocity	NA	NA

10.5.3.1 Elasmobranchs

10.5.3.1.1 Background

53. This receptor group is inclusive of all shark and ray species, including both demersal and pelagic species. This section has been informed using the information outlined in section 10.4.1.2, supplemented by additional data

54. The Fish and Shellfish Ecology Study Area is characterised by Sand, gravelly Sand, and sandy Gravel substrates (as classified by Folk (1954)), which are less suitable for skates and rays than softer sand and muddy habitats (Martin *et al*., 2012). The areas of Sand substrates within the Fish and Shellfish Ecology Study Area are likely to be most suitable for species of skate and ray, which will reduce in areas of harder gravelly substrates.

10.5.3.1.2 Commercial Importance

55. A number of elasmobranch species of commercial importance within the Humber region are considered present within the Fish and Shellfish Ecology Study Area, including, but not limited to:

- **Thornback ray *Raja clavata*; and**
- **Spotted ray *Raja montagui*.**

56. The total catch value of thornback ray and spotted ray within the Fish and Shellfish Ecology Study Area between 2016 and 2020 was approximately £27,940 (18.19 tonnes landing weight (LW)) and £14,047 (9.26 tonnes LW) respectively (MMO, 2022). The remaining elasmobranch species recorded in MMO (2022) landings data are listed in **Fish and Shellfish Ecology Appendix 10-1** and all valued at <£2,000 in total during the 2016 - 2020 period. These species are therefore, not considered to be of commercial importance within the Fish and Shellfish Ecology Study Area.

10.5.3.1.3 Spawning and Nursery Grounds

57. As shown in **Figure 10-2**, a number of elasmobranch species have been identified as having nursery grounds within the Fish and Shellfish Ecology Study Area, these are:

- Spurdog *Squalus acanthias*; and
- Tope shark *Galeorhinus galeus*.

58. No elasmobranch spawning grounds have been identified within the Fish and Shellfish Ecology Study Area. Thornback ray nursery grounds that align with the southern boundary of the Fish and Shellfish Ecology Study Area are present, however there is no direct overlap, and therefore these nursery grounds are not considered within the assessment.

10.5.3.1.4 Conservation Importance

59. There are no elasmobranch species listed as designated features of any MPAs within the region surrounding the Fish and Shellfish Ecology Study Area. However, some species identified as present within the Fish and Shellfish Ecology Study Area are considered to be of conservation importance. Each species and its conservation status are listed in **Fish and Shellfish Ecology Appendix 10-1**. These species are:

- **Common skate *Dipturus batis*;**
- **Spotted ray;**
- **Spurdog;**
- **Thornback ray; and**
- **Tope shark.**

10.5.3.2 Demersal Fish

10.5.3.2.1 Background

60. This receptor group is inclusive of all fish species (excluding elasmobranchs) in which the seabed provides the majority of habitats utilised by species throughout their life history. The full demersal fish species list, including species-specific information on biology and nature conservation status, is presented in **Fish and Shellfish Ecology Appendix 10-1**.

10.5.3.2.2 Commercial Importance

61. The region between Flamborough head and the Humber Estuary is identified as a hotspot for commercial fishing, with catch rates of demersal fish species higher than any other region along the east-coast of England (Reiss *et al*., 2010). A number of demersal species of commercial importance within the Humber region are considered present within the Fish and Shellfish Ecology Study Area, including, but not limited to:

- Plaice *Pleuronectes platessa*;
- Turbot *Scophthalmus maximus*;
- Lemon sole *Microstomus kitt*;
- Atlantic cod *Gadus morhua*;
- Whiting *Merlangius merlangus*;
- Dover sole *Solea solea*;
- Red mullet *Mullus surmuletus*;
- Brill *Scopthalmus rhombus*; and
- Sandeel species *Ammodytidae*.

62. The demersal fish species above are listed in descending order of the sum of their total catch within the Fish and Shellfish Ecology Study Area between 2016 and 2020 (MMO, 2022) (limited to species of value >£100,000). The total catch value of plaice within the Fish and Shellfish Ecology Study Area between 2016 and 2020 was significantly higher than other demersal fish species, at approximately £9,847,754 (6,414.28 tonnes LW) (MMO, 2022). Turbot was the second most commercially valuable demersal fish species at approximately £870,925 (135.76 tonnes LW), respectively (MMO, 2022). The remaining demersal fish species of commercial importance are listed within **Fish and Shellfish Ecology Appendix 10-1**.

10.5.3.2.3 Spawning and Nursery Grounds

63. As shown in **Figure 10-3** and **Figure 10-4**, a number of demersal fish species have been identified as having known spawning and nursery grounds within the Fish and Shellfish Ecology Study Area:

- Anglerfish *Lophius piscatorius* (nursery grounds only);
- Atlantic cod;
- Blue whiting *Micromesistius poutassou* (nursery grounds only);
- Dover sole (spawning grounds only);
- European hake *Merluccius merluccius* (nursery grounds only);
- Ling *Molva* (nursery grounds only), and
- Plaice (spawning grounds only);
- Sandeel species; and
- Whiting.

64. Particular attention is given to the spawning and nursey grounds of sandeel species through this assessment. Sandeel are of high conservation importance due to both their sensitivity to seabed disturbance, and their importance as prey species for bird species present within the region.

65. Potential habitat for sandeel (considering all life stages including spawning habitat) has been assessed for the Fish and Shellfish Ecology Study Area, using the heat mapping methodology described in Latto *et al*. (2013) and utilising known spawning grounds, British Geological Society (BGS) sediment data, VMS fishing data, inshore fishing effort, and Inshore Fisheries and Conservation Authorities (IFCA) data for the east coast indicating fishing catch. Data collected during site specific surveys and presented within DBS WPM1 WPM2 WPM3 - Benthic Ecology Monitoring Report (Fugro, 2023) indicates seabed composition within the Offshore Development Area comprises majority sand and gravel components. This is similarly reflected within the BGS data used to inform the heat mapping methodology. Preferred habitat for sandeel, as classified by Folk (1954), includes Sand, slightly gravelly Sand, and gravelly Sand, with marginal habitat classified as sandy Gravel. The resulting extent of potential habitat for sandeel within the Fish and Shellfish Ecology Study Area is shown in **Figure 10-5**.

66. **Figure 10-5** indicates that the offshore development area is considered to have a medium to high spawning potential for sandeel species. The DBS West Array Area is predominantly classed as having a high potential for sandeel spawning, with a number of localised areas of medium potential – the largest of which is located in the south-eastern corner of the Array Area. The DBS East array is predominantly of a medium potential for sandeel spawning, with the exception of the north-western corner which is classed as high potential. The offshore export cable corridor consists of medium to high spawning potential, with isolated areas of very high spawning potential along the UK 12 nm limit boundary. The extent of low, medium, and high potential habitat for sandeel for the Fish and Shellfish Ecology Study Area, the offshore development area, and the DBS Array Areas are displayed in **Table 10-15**.

Table 10-15 Total Area in km² of Potential Habitat for Sandeel and the Percentages of Overlap with the Offshore Development Area and the Dogger Bank South Array Areas

Potential Habitat for Sandeel	Total Area within the Fish and Shellfish Ecology Study Area	Total Area within the Offshore Development Area	Area within the DBS Array Areas	Area within DBS East	Area within DBS West
No Potential	370.98	11.88	0.00	0.00	0.00
Low	1948.23	16.19	0.00	0.00	0.00
Medium	7209.33	827.11	481.29	458.30 (92.9%)	22.99 (4.6%)
High	14887.60	774.69	507.21	35.25 (7.1%)	471.96 (95.3%)
Very High	356.94	6.93	0.00	0.00	0.00

10.5.3.2.4 Conservation Importance

67. There are no demersal fish species listed as designated features of any MPAs within the region surrounding the Fish and Shellfish Ecology Study Area. However, some species identified as present within the Fish and Shellfish Ecology Study Area are considered to be of conservation importance, and are listed below. Each species, and its conservation status are listed in **Fish and Shellfish Ecology Appendix 10-1**.

- **Anglerfish;**
- **Atlantic cod;**
- **Atlantic halibut *Hippoglossus hippoglossus*;**
- **Blue whiting;**
- **European hake;**
- **Megrim *Lepidorhombus whiffiagonis*;**
- **Pollock *Pollachius*; and**
- **Witch flounder *Glyptocephalus cynoglossus*.**

10.5.3.3 Pelagic Fish

10.5.3.3.1 Background

68. This receptor group is inclusive of all species in which the water column provides the majority of habitats utilised by species throughout their life history. The full pelagic fish species list, including species-specific information on biology and nature conservation status, is presented in **Fish and Shellfish Ecology Appendix 10-1**.

10.5.3.3.2 Commercial Importance

69. A number of pelagic species of commercial importance within the Humber region are considered present within the Fish and Shellfish Ecology Study Area, including, but not limited to:

- **Atlantic herring *Clupea harengus*;**
- **Sprat *Sprattus*; and**
- **Atlantic mackerel *Scomber scombrus*.**

70. The pelagic fish species above are listed in descending order of the sum of their total catch within the Fish and Shellfish Ecology Study Area between 2016 and 2020 (limited to species of value >£50,000) (MMO, 2022). The total catch value of Atlantic herring within the Fish and Shellfish Ecology Study Area between 2016 and 2020 was significantly higher than other pelagic fish species, at approximately £2,658,688 (3,806 tonnes LW) (MMO, 2022). Sprat was the second most commercially valuable pelagic fish species at approximately £78,888 (108.07 tonnes LW) respectively (MMO, 2022). The remaining pelagic fish species of commercial importance are listed within **Fish and Shellfish Ecology Appendix 10-1**.

10.5.3.3.3 Spawning and Nursery Grounds

71. As shown in **Figure 10-6**, a number of pelagic fish species have been identified as having known nursery grounds within the Fish and Shellfish Ecology Study Area:

- **Atlantic mackerel; and**
- **Atlantic herring.**

72. Particular attention is given to the spawning and nursey grounds of Atlantic herring throughout this assessment. Atlantic herring are of high conservation importance due to their reliance on specific seabed substrates as spawning habitat, and the vulnerability of developing eggs to seabed disturbance. Potential spawning habitat for Atlantic herring has been assessed for the Fish and Shellfish Ecology Study Area using the heat mapping methodology described in Reach *et al*. (2013), and utilising known spawning grounds, British Geological Society sediment data, VMS fishing data, inshore fishing effort, International Herring and Larvae Survey results, and IFCA data for the east coast indicating fishing catch. Preferred spawning habitat for Atlantic herring, as classified by Folk (1954), includes Gravel and sandy Gravel, with marginal habitat classified as gravelly Sand. The resulting extent of potential spawning habitat for Atlantic herring within the Fish and Shellfish Ecology Study Area is shown in **Figure 10-7**. Atlantic herring vary in their spawning times between populations, with the Banks population present in the Central North Sea being understood to spawn over the autumn period (Dickey-Collas *et al*., 2010).

73. As shown in **Figure 10-7**, the offshore development area is considered to have a full range of no, to very high spawning potential for Atlantic herring. The DBS West Array Area is classed as having no to medium potential for Atlantic herring spawning. The DBS East Array Area is predominantly of no spawning potential for Atlantic herring, with the exception of isolated patches of low potential. The offshore export cable corridor primarily consists of no to high spawning potential, with isolated areas of very high spawning potential along the UK 12 nm limit boundary. The extent of low, medium, and high potential habitat for sandeel for the Fish and Shellfish Ecology Study Area, the offshore development area, and the DBS array areas are shown in **Table 10-16**.

Table 10-16 Total Area in km² of Potential Spawning Habitat for Atlantic Herring and the Percentages of Overlap with the Offshore Development Area and the Dogger Bank South site

Potential Spawning Habitat for Atlantic herring	Total Area within the Fish and Shellfish Ecology Study Area	Total Area within the Offshore Development Area	Area within the DBS Array Areas	Area within DBS East	Area within DBS West
No Potential	8917.12	827.30	534.04	414.94 (84.07%)	119.10 (24.06%)
Low	6714.25	448.34	326.51	78.13 (15.83%)	248.38 (50.18%)
Medium	7209.33	277.92	128.01	0.48 (0.10%)	127.52 (25.76%)
High	3551.50	60.91	0.00	0.00	0.00
Very High	462.71	22.42	0.00	0.00	0.00

10.5.3.3.4 Conservation Importance

74. There are no pelagic fish species listed as designated features of any MPAs within the region surrounding the Fish and Shellfish Ecology Study Area. However, some species identified as present within the Fish and Shellfish Ecology Study Area are considered to be of conservation importance. Each species and its conservation status are listed in **Fish and Shellfish Ecology Appendix 10-1**. These species are:

- Albacore *Thunnus alalunga*;
- Atlantic bluefin tuna *Thunnus thynnus*[1];
- Atlantic herring;
- Atlantic horse mackerel *Trachurus trachurus*; and
- Ocean sunfish *Mola*.

[1] Atlantic bluefin tuna have been absent from historical North Sea feeding grounds during the mid-20th century, however evidence suggests this species is reappearing within the North Sea and along UK coastlines (Bennema, 2018; Horton *et al.*, 2021). It has therefore been included as a species with potential presence within the Fish and Shellfish Ecology Study Area.

10.5.3.4 Shellfish

10.5.3.4.1 Background

75. This receptor group is inclusive of all shellfish species that are commercially important and have not been assessed alongside other benthic invertebrates within **Chapter 9 Benthic Habitats**. The full shellfish species list, including species-specific information on biology and nature conservation status, is presented in **Fish and Shellfish Ecology Appendix 10-1**.

10.5.3.4.2 Commercial Importance

76. A number of shellfish species of commercial importance within the Humber region are considered present within the Fish and Shellfish Ecology Study Area, including, but not limited to:

- European lobster *Homarus gammarus*;
- Brown crab *Cancer pagurus*;
- King scallops *Pecten maximus* and queen scallops *Aequipecten opercularis*;
- Norway lobster *Nephrops norvegicus*; and
- Common whelk *Buccinum undatum*.

77. The shellfish species above are listed in descending order of the sum of their total catch within the Fish and Shellfish Ecology Study Area between 2016 and 2020 (limited to species of value >£1,000,000) (MMO, 2022). The total catch value of European lobster within the Fish and Shellfish Ecology Study Area between 2016 and 2020, was the most commercially valuable shellfish species (and general fish and shellfish species), at approximately £46,146,925 (3,387.85 tonnes LW) (MMO, 2022). Brown crab was the second most commercially valuable shellfish species, at approximately £41,442,110 (23,580.87 tonnes LW) respectively (MMO, 2022). The introduction of the Dogger Bank SAC Byelaw in 2022 prohibits demersal trawling activities within the vast majority of the DBS array areas. However, there is a notable king scallop ground located within the offshore export cable corridor that is targeted by dredging vessels (**Figure 2.6-10** located in the **Commercial Fisheries Technical Report**). For more information see **Chapter 13 – Commercial Fisheries**. The remaining shellfish species of commercial importance are listed within **Fish and Shellfish Ecology Appendix 10-1**.

78. The shellfish receptor group is of the highest commercial importance compared to the other fish receptor groups within the Fish and Shellfish Ecology Study Area.

79. The Holderness Fishing Industry Group (HFIG) has supported a number of peer reviewed studies on shellfish interactions with offshore developments within the region. Sampling undertaken during the pre and post construction stages of the Westermost Rough OWF is described within Roach *et al.* (2022) on behalf of HFIG. Potting surveys conducted over a 6-year period indicated that differences in size and catch rates of European lobster were not observed between control sites and sites within both the array and export cable areas.

10.5.3.4.3 Spawning and Nursery Grounds

80. Due to the general site fidelity of shellfish species identified as present within the Fish and Shellfish Ecology Study Area, acknowledging that some shellfish (primarily cephalopod and crustacean species) undergo annual spawning migrations, all species are assumed to have spawning grounds within the Fish and Shellfish Ecology Study Area for the purposes of this assessment.

10.5.3.4.4 Conservation Importance

81. Ocean quahog *Arctica islandica* are listed as designated features of the Holderness Offshore Marine Conservation Zone (MCZ) within the region surrounding the Fish and Shellfish Ecology Study Area. European spiny lobster *Palinurus elephas* is also identified as present within the Fish and Shellfish Ecology Study Area, and considered to be of conservation importance, as listed in **Fish and Shellfish Ecology Appendix 10-1**.

10.5.3.5 Migratory Fish

10.5.3.5.1 Background

82. This receptor group is inclusive of all diadromous species that transition between marine and freshwater environments during their life history. Diadromous fish are subcategorised as either catadromous (spawn in marine environments, e.g. European eel *Anguilla anguilla*) or anadromous (spawn in freshwater environments, e.g. salmonid species). It is therefore important to determine the importance of river outlets within the vicinity of the Projects, and ensure that potential disruption to migration routes is considered. Catadromous fish species identified as potentially present within the Fish and Shellfish Ecology Study Area are limited to European eel, which migrate from UK freshwater environments to the Sargasso Sea. The Humber Estuary presents one of the furthest distances for individual European eel to migrate, and may be the reason why the population within the Anglian region is considered low in number (Defra, 2010). It is expected that the more common anadromous migratory fish species remain within coastal waters during life stages involving the marine environment, and therefore migratory species are considered to have greater presence within the offshore export cable route corridor, than the DBS array areas. The full migratory fish species list, including species-specific information on biology and nature conservation status, is presented in **Fish and Shellfish Ecology Appendix 10-1**.

10.5.3.5.2 Commercial Importance

83. The only migratory fish species of commercial importance within the Fish and Shellfish Ecology Study Area is sea trout *Salmo trutta*, although Atlantic salmon, *Salmo salar* were also landed at a low value.

84. The total catch value of sea trout within the Fish and Shellfish Ecology Study Area between 2016 and 2020 was approximately £57,416 (MMO, 2022). The only other migratory fish species recorded in MMO landings data was Atlantic salmon, valued at approximately £2,201 in total during the 2016-2020 period (MMO, 2022).

10.5.3.5.3 Migration, Spawning and Nursery Grounds

85. Due to the diadromous aspect of species within this receptor group, the Fish and Shellfish study is unlikely to represent major spawning grounds. If anadromous species were to spawn within the Fish and Shellfish Ecology Study Area, this is likely to be limited to the offshore export cable corridor, within the inshore coastal waters.

86. European eel, salmonids, river lamprey *Lampetra fluviatilis*, and sea lamprey are found within the Humber estuary, during their seasonal migrations within the marine environment (Potts and Swaby, 1993). Little is known about the direction of travel of individuals upon leaving the mouth of the Humber estuary, therefore it has been assumed that all species regularly transit through the offshore export cable corridor associated with the Projects.

10.5.3.5.4 Conservation Importance

87. Sea lamprey *Petromyzon marinus* and river lamprey are listed as a designated feature of the Humber Estuary SAC, within the region surrounding the Fish and Shellfish Ecology Study Area.

88. A total of six species identified as present within the Fish and Shellfish Ecology Study Area are considered to be of conservation importance, and are listed within the Habitats Directive. Each species and its conservation status are listed in **Fish and Shellfish Ecology Appendix 10-1**. These species include:

- **Allis shad *Alosa*;**
- **Twaite shad *Alosa fallax*;**
- **Atlantic salmon;**
- **European eel;**
- **River lamprey *Lampetra fluviatilis*; and**
- **Sea lamprey.**

10.5.4 Future Trends

89. In the event that the Projects are not developed, an assessment of future conditions for Fish and Shellfish Ecology has been carried out and is described within this section.

90. All fish and shellfish species identified within the Fish and Shellfish Ecology Study Area fundamentally depend on the existing offshore physical environment. Future changing baseline parameters such as temperature, salinity, and pH, as a result of climate change have the potential to alter interactions described within the Fish and Shellfish Ecology chapter.

91. The determinations made within this assessment are unlikely to significantly differ as a result of climate change. However, it is acknowledged that a shift in baseline species towards those more commonly found along the south coast of England (e.g. Atlantic bluefin tuna), may potentially be present currently or within the foreseeable future, unless the current rate of climate change is curtailed. The full assessment of a baseline shift over the foreseeable future is not possible within the scope of this assessment.

92. As a result of The Dogger Bank SAC (Specified Area) Bottom Towed Fishing Gear Byelaw 2022, enacted to protect the entirety of the Dogger Bank SAC from the impacts of bottom-towed fishing gear, impacts from fishing will be significantly reduced as long as the byelaw remains in place.

10.6 Assessment of Significance

10.6.1 Potential Effects During Construction

10.6.1.1 Temporary Habitat Disturbance to Fish and Shellfish Species and Spawning and /or Nursery Grounds, Including Direct Damage and Installation of Turbine Foundations, Scour Protection and Cables

93. Temporary habitat disturbance to fish and shellfish species and spawning and / or nursery grounds, including direct damage and installation of turbine foundations, scour protection, and cables, referred hereafter as "temporary habitat disturbance and direct damage", may occur during the construction phase due to seabed preparation works and/or installation of project infrastructure. Direct damage (e.g. crushing) and disturbance during the construction phase can be considered as the instantaneous loss of individuals though crushing, or entrainment by construction material or tools. This impact pathway will occur specifically during wind turbine or offshore platform foundation, scour protection, and transmission cable installation, along with rock placement activities as part of any cable stabilisation work. Seabed preparation (e.g. sandwave levelling) will also be considered within this section, due to the potential micro-environments associated with small-scale seabed morphology that may represent preferred spawning grounds for fish species.

94. It should be noted that this impact will occur episodically and highly localised to the individual locations of construction or installation over the full duration of the construction period, not as a single event. The worst cases presented below represent the combined footprints from all construction or installation events.

10.6.1.1.1 Magnitude of Impact – DBS East or DBS West in Isolation

95. The worst case scenario footprint of temporary habitat disturbance and direct damage associated with the construction phase of DBS East is approximately 18km^2. This represents approximately 0.07% of the total Fish and Shellfish Ecology Study Area. The footprint for all generation asset construction works, including the array and inter-platform cables, and offshore platforms and foundations, is 8.8km^2 for DBS East. The footprint for the construction of all transmission assets, including the offshore export cable installation, is 9.2km^2.

96. The worst case scenario footprint of temporary habitat disturbance and direct damage associated with the construction phase of DBS West is 25.2km². This represents approximately 0.09% of the total Fish and Shellfish Ecology Study Area. The footprint for all generation asset construction works, including the DBS West Array Area, array and inter-platform cables, and offshore platforms, is 9.7km². The footprint for the construction of all transmission assets, including the offshore export cable installation, is 15.5km².

97. Of the two Projects, DBS West represents the worst case scenario in isolation. The assessment of temporary habitat disturbance and direct damage in isolation will therefore assume this worst case scenario for both Projects.

98. Due to the mobile nature and high fecundity of all fish and shellfish receptor groups, exposure is considered to be short-term for any given location within the DBS West site. The loss of individuals as a result of temporary habitat disturbance and direct damage would be a medium term (1 - 7 years) effect that is likely to occur, accounting for the worst case scenario footprint. The effect would result in a change that is noticeable, but remains within the natural variation in background conditions for the given effect. Therefore, the magnitude of impact is considered low.

10.6.1.1.2 Magnitude of Impact – DBS East and DBS West Together

99. The worst case scenario footprint of temporary habitat disturbance and direct damage associated with the construction phase of both DBS Projects is 48km². This represents approximately 0.18% of the total Fish and Shellfish Ecology Study Area. The footprint for all generation asset construction works, including the array areas, array and inter-platform cables, and offshore platforms, is 23.2km². The footprint for all offshore transmission works, including the offshore export cable installation, is 24.7km².

100. The magnitude of temporary habitat disturbance and direct damage will be reduced if construction of DBS East and DBS West is staggered compared to being undertaken concurrently. This is due to the potential for local populations to be displaced into the Array Area not under construction, and then recolonisation of the disturbed array area upon commencement of construction of the second Array Area. Spill-over effects are more successful for multiple localised disturbance areas compared to single, large areas. If concurrent, local populations would be displaced from a greater area, which would take longer to recover upon completion of the construction phase.

101. Due to the mobile nature and high fecundity of receptor groups, exposure is considered to be short-term for any given position within the DBS West site. Temporary habitat disturbance and direct damage from the combined sites would be higher than the worst case for an individual site, but the effect would still be anticipated to not exceed a medium term (1 - 7 years), accounting for the worst case scenario footprint. The effect would result in a change that is noticeable but remains within the natural variation in background conditions for the given effect. Therefore, the magnitude of impact is considered low.

10.6.1.1.3 Sensitivity of Receptor Groups

102. Elasmobranch species are generally considered to have a high tolerance and adaptability to temporary habitat disturbance and direct damage due to their high mobility. Elasmobranchs may be affected by the Projects through direct effects (e.g. crushing), but may also be indirectly affected through impacts to prey species. Prey species are typically bound by the specific habitats and spatial locations in which they reside; whereas elasmobranchs have relatively large ranges that provide a degree of flexibility, should prey species become less prevalent in certain areas. Elasmobranch species have a level of tolerance to the temporary habitat disturbance and direct effects, and are anticipated to recover to baseline levels within 1 – 7 years. They are therefore considered to have a low sensitivity to temporary habitat disturbance and direct damage.

103. Both demersal and pelagic fish species have spawning grounds that overlap with the worst case scenario footprint, resulting in temporary habitat disturbance and direct damage. The likelihood of direct damage (e.g. crushing) is limited to the short-term displacement of individuals. Whilst there is likely to be an elevated stress response by individuals to direct damage, this is not likely to elicit any significant detriment to overall population health. Most species have pelagic spawning strategies that do not depend on specific substrate types, and are generally considered tolerant and adaptable to temporary habitat disturbance to spawning or nursery areas. However, species with demersal spawning strategies, particularly sandeel and Atlantic herring, have a heightened sensitivity to any disturbance of the seabed, and are therefore considered more sensitive to temporary habitat disturbance and direct damage, especially related to spawning and nursery areas.

104. Seabed morphology is considered a potentially important factor in the preferability of seabed sediments as spawning grounds for fish species, however, the loss in such features will be limited to areas in which the seabed would undergo significant disturbance (e.g. cable burial). The offshore development area is variable in its provision of potential spawning habitats for sandeel and Atlantic herring, however, there are areas of significant spawning potential for both species, particularly along the offshore export cable corridor around 12nm from the landfall site and within the array areas for sandeel. Furthermore, sandeel are known to exhibit a high habitat fidelity when settled, which makes them more susceptible to impacts on the seabed, and to direct damage, as they are less mobile. These are species of national importance that are anticipated to recover to baseline levels within 1 – 7 years. Demersal and pelagic fish species are therefore considered to have a medium sensitivity to temporary habitat disturbance and direct damage.

105. Migratory fish species are not considered to be dependent on seabed sediment composition at any stage of their life-history, and therefore no impact pathway for temporary habitat disturbance and direct damage exists for these species.

106. Once settled, and following a pelagic larval stage, shellfish species are solely reliant on the seabed for the majority of their life-history. In addition, shellfish are less mobile than the other receptor groups, and therefore have a lower tolerance and adaptability to temporary habitat disturbance and direct damage. Furthermore, the Fish and Shellfish Study Area encompasses key grounds and protected areas for commercially important shellfish species such as scallop (discussed further in **Chapter 13 Commercial Fisheries**). Shellfish generally have a higher fecundity than fish, and therefore a greater capacity for recovery following disturbance events. This is particularly relevant to the Dogger Bank SAC scallop population(s) which will benefit from exclusion of trawling, and provide a spill-over effect for bolstering the recovery of surrounding fished populations.

107. Like sandeel and Atlantic herring, certain shellfish species have an elevated sensitivity to temporary habitat disturbance and direct damage during the breeding season. For example, berried female brown crab remain buried in the sediment whilst eggs mature, and are less mobile than males or females at other stages of their life history. The shellfish species within the Fish and Shellfish Ecology Study Area are important stocks nationally with an ability to adapt to, and a tolerance of, temporary habitat disturbance and direct damage. Following exposure, they are anticipated to recover within a period of 1 - 7 years. Shellfish are therefore considered to have a medium sensitivity to temporary habitat disturbance and direct damage.

10.6.1.1.4 Significance of Effect – DBS East or DBS West in Isolation

108. The low magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the low sensitivity of effect for the elasmobranch receptor group, results in the assessment that temporary habitat disturbance and direct damage has a **negligible** effect, and is therefore not significant in EIA terms.

109. The low adverse magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the medium sensitivity of effect for the demersal fish, and pelagic fish receptor groups, results in the assessment that temporary habitat disturbance and direct damage has a **minor adverse** effect, and is therefore not significant in EIA terms.

110. The low adverse magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the medium sensitivity of effect for the shellfish receptor group, results in the assessment that temporary habitat disturbance and direct damage has a **minor adverse** effect, and is therefore not significant in EIA terms.

10.6.1.1.5 Significance of Effect – DBS East and DBS West Together

111. The low adverse magnitude of impact for both Projects together (DBS East and DBS West), combined with the low sensitivity of effect for the elasmobranch receptor group, results in the assessment that temporary habitat disturbance and direct damage has a **negligible** effect, and is therefore not significant in EIA terms.

112. The low adverse magnitude of impact for both Projects together (DBS East and DBS West), combined with the medium sensitivity of effect for the demersal fish, pelagic fish, and shellfish receptor groups, results in the assessment that temporary habitat disturbance and direct damage has a **minor adverse** effect, and is therefore not significant in EIA terms.

10.6.1.2 Increase in Local Suspended Sediment Concentrations and Sediment Settlement

113. All construction works interacting with the seabed have the potential to elevate suspended sediment concentrations (SSC) within the water column. As detailed in **Chapter 8 Marine Physical Environment**, regional mapping of seabed sediments indicates the Array Areas are dominated by sandy sediments and mixed sediment. Numerical modelling of sediment plumes undertaken for the Dogger Bank A and B offshore wind farms show that the predicted average suspended sediment concentration in the array areas is less than 3mg/l. The seabed sediments of the offshore export cable corridor transition from coarser mixed sediments (sandy Gravel and gravelly Sand) in the nearshore area, to sand-dominated sediments as the offshore export cable corridor approaches the array areas (**Chapter 8 Marine Physical Environment)**.

114. It should be noted that this impact will occur episodically and be highly localised to the individual locations of construction or installation over the full duration of the construction period, not as a single event. The worst cases presented below represent the combined volume of SSC from all construction or installation events.

10.6.1.2.1 Magnitude of Impact – DBS East or DBS West in Isolation

115. The total worst case scenario volume of sediment with the potential to cause an increase in SSC and sediment settlement associated with the construction phase of DBS East is 38,223,115 m^3. The worst case scenario volume of sediment with the potential to cause an increase in SSC and sediment settlement associated with the construction phase of DBS West is 73,069,465 m^3.

116. Based on the modelling undertaken along the export cable corridor for the Dogger Bank A and B offshore wind farms, the maximum suspended sediment concentration was 100-200mg/l at two specific locations, one near the coast and one approximately 50km offshore. The conceptual evidence-based assessment from this modelling data suggests that coarser sediment will fall rapidly (within minutes or tens of minutes) with a maximum depth of deposition of 10-50mm in localised areas adjacent to the disturbance source. Outside the direct vicinity of the disturbance, deposition is predicted to reduce to an average of 1-5mm to a distance of 10km from the source. These changes in seabed level are not predicted to last for more than seven days within the localised area and may reduce to hours to days as distance from the disturbance increases.

117. Of the two Projects, DBS West represents the worst case scenario in isolation. The assessment for an increase in SSC and sediment settlement in isolation, will therefore assume this worst case scenario for both Projects.

118. Changes in levels of suspended sediment are likely occur, however they are predicted to be indistinguishable from background conditions within a single tidal cycle. Conceptual evidence-based assessment supported by modelling for the adjacent Dogger Bank A and B and Dogger Bank C and Sofia offshore wind farms suggests that away from the immediate release location, elevations in suspended sediment would be only slightly higher than background levels (less than 10mg/l). Movement of sediments within a plume is predicted to be to the northwest or southwest, based on tidal movement. Due to the short-term and localised nature of the impact pathway, the magnitude of impact is considered low.

10.6.1.2.2 Magnitude of Impact – DBS East and DBS West Together

119. The worst case scenario volume of sediment with the potential to cause an increase in SSC and sediment settlement associated with the construction phase of both DBS Projects is 112,893,764m^3.

120. An increase in SSC and sediment settlement during concurrent construction of DBS East and DBS West would result in a greater peak in concentration (i.e. a greater density and footprint) (assuming multiple installations occurring concurrently), but would be dissipated or deposited within a shorter timeframe than if the Projects' construction were staggered. It is expected that a staggered approach would be more detrimental to Fish and Shellfish Ecology as the overall period during which SSC would be elevated and deposited would be greater and therefore increase risk of construction coinciding with spawning seasons for key spawning receptors such as sandeel and Atlantic herring.

121. Based on the conceptual assessment the peak suspended sediment concentration is not expected to exceed 100-200mg/l and suggests that coarser sediment will fall rapidly (within minutes or tens of minutes). Deposition depth is not predicted to be greater than 10-50mm in localised areas, or 1-5mm at a distance of 10km from the source. This deposition is not predicted to last for more than seven days within the localised area and may reduce to hours to days as distance from the disturbance increases.

122. Due to the short-term and highly localised nature of the impact pathway, the loss of individuals as a result of an increase in SSC and sediment settlement would be expected to fully recover within the short term (0 - 1 years), accounting for the worst case scenario volume of sediment mobilised by DBS East and DBS West together. However, the effect will be slightly noticeable compared to background condition and will remain within the range of natural variation. Therefore, as a precaution, the magnitude of impact is considered low.

10.6.1.2.3 Sensitivity of Receptor

123. The ecologically important impacts of elevated suspended sediments include reduced visibility and visual hunting strategy success, reduced photosynthetic efficiency of phytoplankton (due to reduced light intensity and altered spectrum), and smothering of filter-feeding species and eggs and / or larvae (Cloern, 1987; Henley *et al*. 2010).

124. Due to the mobility of fish receptors, it is highly unlikely that elevated suspended sediments, of the scale associated with the Projects, will significantly reduce hunting success. Fish receptors have the opportunity to move away from areas of elevated suspended sediments, and will return to the same area within –one to two tidal cycles at maximum. Elasmobranch species are more heavily reliant on electromagnetic sensors (e.g. Ampullae of Lorenzini) than visual cues when hunting prey within wide-ranging hunting grounds, and are therefore considered tolerant and adaptable to an increase in SSC and sediment settlement. Migratory fish species are not considered to be dependent on seabed sediment composition at any stage of their life-history, and are highly mobile within the coastal environment.

125. Demersal and pelagic fish species are also often highly mobile, and likely to return to the area once suspended sediments have returned to the baseline condition (ABP Research, 1999; EMU, 2004). Some demersal species are likely to increase their energy expenditure, by migrating through additional sediment deposition and / or through increased burrow maintenance. However, the short-term and localised nature of sediment deposition associated with the Projects is unlikely to cause any population-level effects due to an increase in individual energy expenditure. Adult elasmobranch, demersal fish, pelagic fish, and migratory fish species are therefore considered to have a negligible sensitivity to an increase in suspended sediment concentration and sediment settlement.

126. For demersal and pelagic species, an increase in SSC and sediment settlement will have the greatest effects upon spawning, particularly for maturing eggs and early-stage larval development. Sediment deposition can smother demersal eggs and larvae. Whereas sediments suspended within the water column, are known to adhere to pelagic eggs and increase the egg sinking rates (Westerberg *et al*., 1996c; Griffin *et al*., 2009). Both demersal and pelagic eggs and larvae are at increased risk of oxygen starvation in these scenarios, which may impact recruitment of the local population if activity overlaps spawning seasons. Whilst some evidence suggests key species such as sandeel and Atlantic herring are tolerant to increases in SSCs (Messieh *et al*., 1981; Kiørboe *et al*., 1981; Utne-Palm, 2004), sediment settlement is likely to represent a greater risk to these species. The eggs and larvae of demersal fish and pelagic fish species are therefore considered to have a medium sensitivity to an increase in SSC and sediment settlement.

127. Similarly to fish eggs and larvae, some shellfish species are at increased risk of impact from an increase in SSC and sediment settlement during the spawning season. Berried crustaceans such as brown crab may experience lower oxygen concentrations during key stages of egg development, which may reduce the success or quality of larvae within the area of effect. However, berried crustaceans have the ability to move out of areas with high sediment deposition rates, and therefore mitigate the risk of smothering of their eggs (Neal and Wilson, 2008). Filter-feeding shellfish species may experience elevated sediment accumulation on feeding apparatus as a result of an increase in SSC and sediment settlement (Pineda *et al*., 2017). However, the majority of shellfish species present within the Fish and Shellfish Ecology Study Area will be adapted to low levels of sedimentation (Essink, 1999; Sabatini and Hill, 2008; Szostek *et al*., 2013; Gibson-Hall *et al*., 2020). Shellfish species are therefore considered to have a medium sensitivity to an increase in SSC and sediment settlement.

10.6.1.2.4 Significance of Effect – DBS East or DBS West in Isolation

128. The low adverse magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the negligible sensitivity of effect for adult individuals within the elasmobranch, demersal fish, pelagic fish, and migratory fish receptor groups, results in the assessment that an increase in SSC and sediment settlement has a **negligible** effect, and is therefore not significant in EIA terms.

129. The low adverse magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the medium sensitivity of effect for eggs and/ or larvae within the elasmobranch, demersal fish, pelagic fish, and migratory fish receptor groups, results in the assessment that an increase in SSC and sediment settlement has a **minor adverse** effect, and is therefore not significant in EIA terms.

130. The low adverse magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the medium sensitivity of effect for the shellfish receptor group, results in the assessment that an increase in SSC and sediment settlement has a **minor adverse** effect, and is therefore not significant in EIA terms.

10.6.1.2.5 Significance of Effect – DBS East and DBS West Together

131. The low adverse magnitude of impact for both Projects together (DBS East and DBS West), combined with the negligible sensitivity of effect for adult individuals within the elasmobranch, demersal fish, pelagic fish, and migratory fish receptor groups, results in the assessment that an increase in SSC and sediment settlement has a **negligible** effect, and is therefore not significant in EIA terms.

132. The low adverse magnitude of impact for both Projects together (DBS East and DBS West), combined with the medium sensitivity of effect for eggs and / or larvae within the elasmobranch, demersal fish, pelagic fish, and migratory fish receptor groups, results in the assessment that an increase in SSC and sediment settlement has a **minor adverse** effect, and is therefore not significant in EIA terms.

133. The low adverse magnitude of impact for both Projects together (DBS East and DBS West), combined with the medium sensitivity of effect for the shellfish receptor group, results in the assessment that an increase in SSC and sediment settlement has a **minor adverse** effect, and is therefore not significant in EIA terms.

10.6.1.3 Release of Sequestered Contaminants following Sediment Disturbance

134. Re-mobilisation of inert sediments has the potential to release toxic substances (e.g. mercury and arsenic) into the water column, that may adversely impact fish and shellfish species.

10.6.1.3.1 Magnitude of impact – DBS East or DBS West in Isolation

135. Based on modelling undertaken along the export cable corridor for the Dogger Bank A and B offshore wind farms, the maximum suspended sediment concentration is not predicted to exceed 100-200mg/l for any single event, and will fall rapidly, with coarser sediments falling within minutes or tens of minutes. Deposition depth changes are not predicted to last more than seven days within the most heavily deposited areas (10-50mm) directly adjacent to the activity. The disturbance of sediments is therefore considered to be highly localised and short-term, with episodic rather than continuous disturbance.

136. Studies undertaken as part of the Dogger Bank A and B in 2011 and 2012 and Dogger Bank C and Sofia offshore wind farms are considered relevant to the Projects due to their close location to DBS and similarities in sediments likely to be found in the offshore development area.

137. Within these studies, one site exceeded Cefas Action Level 1 for chromium and nickel in Tranche A and a number of sites sampled along the Dogger Bank A and B export cable corridor had only a marginal exceedance of Cefas Action Level 1 (i.e. only just over Action Level 1 concentrations). There were generally higher levels of metals at Site 23, with levels of arsenic, chromium, copper and lead exceeding Action Level 1. No nearshore sites exceeded the Cefas Action Level 2 concentrations of contaminants.

138. Based on these studies, it is therefore predicted that contaminant levels would be similar in the offshore development area at DBS East and DBS West. The likely nature of sediments at DBS East and West significantly reduces the potential for accumulation of contaminants, which will be confirmed with project-specific particle size data and chemistry data incorporated into the assessment for the ES. Therefore the levels of potential contaminants are likely to be low.

139. Due to the localised, short-term disturbance of sediments, and the low likelihood of significant contamination within the offshore development area, the magnitude of impact is considered negligible.

10.6.1.3.2 Magnitude of Impact – DBS East and DBS West Together

140. Based on modelling of sediment suspension and studies of sediment types at Dogger Bank A and B in 2011 and 2012 and Dogger Bank C and Sofia offshore wind farms, it is predicted that both the level of suspended sediment release (expected to be localised, short-term, and episodic) and the levels of potential contaminants will be low. Therefore, the magnitude of impact is considered negligible.

10.6.1.3.3 Sensitivity of Receptor

141. Fish are not considered sensitive to most natural contaminants present within seabed sediments, provided the concentration of contaminants remain within environmental protection standards. There is evidence to suggest that contaminant uptake through gills is low, and that lower trophic levels are more susceptible to increased contaminant concentrations (De Gieter *et al*., 2002). Contaminants are likely to undergo biomagnification up the food chain, or bioaccumulation with age (Baeyens *et al*., 2003), however certain contaminants (e.g. arsenic) can be metabolised if present at low concentrations within the environment (Kumari *et al*., 2017).

142. Whilst it is accepted that contaminants negatively affect body condition in fish through disease, the likelihood of effect for fish and shellfish receptors within the Fish and Shellfish Ecology Study Area will be limited to short-term and localised elevation in stress responses (Henry *et al*., 2004). All fish and shellfish receptor groups are therefore considered to have a low sensitivity to the release of sequestered contaminants following sediment disturbance.

10.6.1.3.4 Significance of Effect – DBS East or DBS West in Isolation

143. The negligible magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the low sensitivity for all fish and shellfish receptor groups, results in the assessment that the release of sequestered contaminants following sediment disturbance has a **negligible** effect, and is therefore not significant in EIA terms.

10.6.1.3.5 Significance of Effect – DBS East and DBS West Together

144. The negligible magnitude of impact for both Projects together (DBS East and DBS West), combined with the low sensitivity for all fish and shellfish receptor groups, results in the assessment that the release of sequestered contaminants following sediment disturbance has a **negligible** effect, and is therefore not significant in EIA terms.

10.6.1.4 Impacts on Fish and Shellfish Species as a Result of Underwater Noise and Vibration

145. Underwater noise and vibration effects may be generated from a number of sources during the construction phase. Noise generating scenarios can be categorised in three groups:

- **Impact piling;**
- **Unexploded ordinance (UXO) clearance; and**
- **Other activities (e.g. vessel traffic, rock placement).**

146. Modelling undertaken within **Appendix 11.2: Underwater Noise Modelling Report** represents a worst case scenario through the integration of worst case piling hammer blow energies, ramp up times, strike rates, duration, and the swimming speed of receptor groups. The PEIR modelling does not take account of potential for piling within the export cable route for the installation of platforms. This will be included in the modelling used to inform the ES.

147. Soft start and ramp up periods have been incorporated within the modelling to allow for avoidance behaviour. This soft-start procedure aims to reduce nearby individuals immediately reaching thresholds for mortality, injury or TTS, and instead increases intensity gradually. The approach used in modelling is presented in **Table 10-17**. This modelling assumes each pile will require 7,500 strikes over a period of 320 minutes.

Table 10-17 Summary of the Soft Start and Ramp up Scenario Used for the Monopile Foundation Modelling for a Single Monopile

Hammer Energy	**1,050 kJ**	**1,750 kJ**	**3,500 kJ**	**5,250 kJ**	**7,000 kJ**
Number of strikes	100	800	800	800	5,000
Duration	10 mins	20 mins	20 mins	20 mins	250 mins
Strike Rate (blows per minute)	10	40	20	10	40

148. Information on the receptor groups used for the assessment of this impact is provided in section 10.5.3. The receptor group 'fish with a swim bladder used in hearing' are the most sensitive to underwater noise. It is assumed that Fish and Shellfish receptors, with the exception of eggs and larvae, have a degree of motility that will allow for avoidance behaviour following initial exposure to underwater noise and vibration. However, following comments received from the MMO during scoping (**Table 10-1**), fish have been treated as stationary receptors throughout the assessment of this impact. Therefore, the group used to determine a worst case scenario throughout the assessment of this impact is stationary fish with a swim bladder used in hearing.

149. When considering piling, Temporary Threshold Shift (TTS) for fish with a swim bladder used in hearing is determined as likely to occur at 186dB SEL_{cum}. Recoverable injury is expected at 203dB SEL_{cum}, and mortality and potential mortal injury at 207dB SEL_{cum}. Details pertaining to other receptor groups are presented within section 10.5.3.1.2.

150. Modelling has been undertaken to determine a worst case scenario for the installation of a single monopile. The underwater noise and vibration impacts will be greatest for the installation of a monopile during the construction of DBS West. In the modelled scenario, two piles are installed per 24 hours, representing the worst case scenario for in isolation (as determined within **Appendix 11.2: Underwater Noise Modelling Report**).

151. Where the Projects undergo construction together, there is the possibility for the installation of one monopile at each site, alongside the installation of an additional monopile for an offshore platform, therefore a worst case of three simultaneous piling events. In this circumstance it is possible that there will be an accumulating effect with the piling events, leading to an increase in total area over which an exposure threshold is reached. The combined area considers the total area over which a given threshold is reached when considering the worst case scenario for DBS East, DBS West, and the OSP location. **Table 10-18** presents a summary of predicted impact ranges determined using the INSPIRE model for the installation of two monopiles per 24 hours at a single location (in sequence, i.e. only one piling event at one time) alongside the combined area that might occur during three simultaneous piling events. A full breakdown as to each of these ranges is provided within **Appendix 11.2: Underwater Noise Modelling Report**.

Table 10-18 Unweighted SELcum Impact Ranges for Fish With a Bladder Used in Hearing Determined at the DBS West Location, and the Combined Area for Three Simultaneous Monopile Events, Assuming Monopile Foundations with Two Piles Installed Per 24 Hours Per Location

Popper et al. (2014) Unweighted SELcum		**Piling at a single location (DBS West)**				**Piling at three locations simultaneously**
		Area	**Maximum range**	**Minimum range**	**Mean range**	**Combined area**
Stationary	219dB (Mortality)	3.2km²	1.1km	1.0km	1.0km	8.3km²
	216dB (Mortality)	8.0km²	1.7m	1.6km	1.6km	19km²
	210dB (Mortality)	44km²	3.9m	3.8km	3.8km	100km²
	207dB (Mortality)	97km²	5.9m	5.5km	5.7km	220km²
	203dB (Injury)	560km²	9.6km	8.7km	9.1km	560km²
	186dB (TTS)	4,100km²	52km	27km	39km	9,400km²

152. It is possible that there will be a requirement for UXO clearance during the construction phase of the Projects. The underwater noise output resulting from a given charge will vary depending on both the charge weight (size of the explosive charge within the UXO), and the clearance method used. Three clearance methods are described in detail within **Appendix 11.2: Underwater Noise Modelling Report** and summarised below:

- High-order clearance (detonation of the charge using a donor charge);
- Low-order clearance (slow burning of the charge); and
- Low-yield clearance (use of the HYDRA UXO clearance system (or similar) to burn and disintegrate the charge).

153. Impact ranges for a number of UXO detonation scenarios in relation to the potential impact on Fish and Shellfish Ecology receptors is provided in **Table 10-19**. As UXO clearance is a single noise event, it is assumed that receptors will not engage in fleeing behaviour.

Table 10-19 Impact Ranges Associated with Unexploded Ordnance Clearance in Relation to Fish with a Swim Bladder Used in Hearing.

Unweighted SPLRMS (Popper et al., 2014)	Mortality and potential mortal injury	
	234dB	229dB
Low yield	130m / 0.05km²	210m / 0.14km²
Low order (0.25 kg)	40m / 0.01km²	65m / 0.01km²
25 kg + donor	170m / 0.09km²	290m / 0.26km²
55 kg + donor	230m / 0.17km²	380m / 0.45km²
120 kg + donor	300m / 0.28km²	490m / 0.75km²
240 kg + donor	370m / 0.43km²	620m / 1.21km²
525 kg + donor	490m / 0.75km²	810m / 2.01km²
698 kg + donor	530m / 0.88km²	890m / 2.49km²

154. A number of other activities are likely to be undertaken during the construction phase of the Projects. Impact ranges for a number of noise and vibration sources anticipated during the construction phase of the Projects are provided within **Table 10-20**.

Table 10-20 Impact Ranges Associated with Construction and Vessel Noise for Fish With a Swim Bladder Used in Hearing

Unweighted SPLRMS (Popper et al., 2014)	**Recoverable Injury 170dB (48 hours)**	**Temporary Threshold Shift 158dB (12 hours)**
Cable laying	< 50m / <0.01km^2	< 50m / <0.01km^2
Dredging (Backhoe)	< 50m / <0.01km^2	< 50m / <0.01km^2
Dredging (Suction)	< 50m / <0.01km^2	< 50m / <0.01km^2
Drilling	< 50m / <0.01km^2	< 50m / <0.01km^2
Rock placement	< 50m / <0.01km^2	< 50m / <0.01km^2
Trenching	< 50m / <0.01km^2	< 50m / <0.01km^2
Vessel noise (large)	< 50m / <0.01km^2	< 50m / <0.01km^2
Vessel noise (medium)	< 50m / <0.01km^2	< 50m / <0.01km^2

10.6.1.4.1 Magnitude of Impact – DBS East or DBS West in Isolation

155. **Appendix 11.2: Underwater Noise Modelling Report** determined that piling at the DBS West was likely to have the highest associated impact range as a result of the local conditions. A total of 106 monopiles will be installed across the DBS West array area, with no more than two piles being installed on a single day. Modelling assumes each pile will take up to 320 minutes of piling to install, with 250 minutes being at the full 7,000kJ. This totals 565.33 hours of piling spread across a period of no less than 53 days.

156. For fish with a swim bladder involved in hearing, TTS onset is likely to occur at an exposure to 186dB SELcum, across an area of 4,100km^2 for each pile installed. Injury is not determined as likely to occur until exposure to 203dBSELcum, and mortality until 207dB SELcum. Recoverable injury is, therefore, possible to occur across an area of up to 560km^2 (2.09% of the Fish and Shellfish Ecology Study Area) (**Table 10-18**). Mortality is likely to be limited to an area of 97km^2 (0.36% of the Fish and Shellfish Ecology Study Area). It should be noted that these values assume that no avoidance behaviour is exhibited by the receptor, however in a realistic scenario some degree of avoidance is likely. The extent of underwater noise impacts from piling at DBS West overlaid with Atlantic herring spawning potential is presented in **Figure 10-8**. This figure indicates that mortality effects will be limited to regions of seabed largely unsuitable or of low suitability for Atlantic herring spawning.

157. A small region of medium Atlantic herring spawning potential is present to the south of the 207dB SELcum mortality band in modelled results. Across the wider TTS area effects will also be limited to regions of seabed largely unsuitable or of low suitability for Atlantic herring spawning. A region of medium Atlantic herring spawning potential is present to the east of the Array Areas, and within the DBS West Array Area. As piling will be undertaken across the array area, it is possible that the impacts of 207dB SELcum exposure or greater will be experienced across the DBS West array area as piling activity takes place.

158. For UXO, a worst case scenario would represent an exposure of 229dB, potentially leading to mortality and mortal injury in fish with a swim bladder used in hearing, up to a distance of 890m (**Table 10-19**). This represents an area of 2.49km2, or <0.01% of the Fish and Shellfish Ecology Study Area. Should two UXO clearance operations be required in a single day, this value would increase to 0.019%. Further, whilst this is a worst case scenario, it is likely that low-order or low-yield methods will result in the further reduction of impact should UXO clearance operations be required during the construction phase of the Projects.

159. When considering noise associated with construction and vessel activities, the magnitude on fish and shellfish is considered negligible within the context of the Fish and Shellfish Ecology Study Area. Each of the activities presenting recoverable injury thresholds of <50m from the noise source following a minimum of 48 hours of exposure. Considering the motility of most fish and shellfish species, and that vessel movement and construction activity will move around the site over the period, it is not considered likely that this will result in notable impacts to any receptor groups.

160. Effects associated with underwater noise and vibration via all sources are likely occur. Noise and vibration associated with both piling and UXO is likely to result in a change that is outside the natural variation in background conditions. However, both noise sources pertain to discrete events, with noise and vibrations emissions occurring only in the short term (0 – 1 year). Noise and vibration associated with construction and vessel activities is likely to result in emissions that is within the natural variation of background conditions, but that may occur over the full construction period of 1 - 7 years. Therefore, the magnitude of impact for underwater noise and vibration is considered low.

10.6.1.4.2 Magnitude of Impact – DBS East and DBS West Together

161. When considering the impact of three simultaneous piling events, a total of 212 monopiles will be installed across the Array Areas, with no more than five piles being installed on a single day. Modelling assumes each pile will take up to 320 minutes of piling to install, with 250 minutes being at the full 7,000kJ. This totals 1130.67 hours of piling, spread across a period no less than 43 days.

162. The combined area of exposure to 186dB SELcum increases to a total of 9,400km². However, injury is not determined as likely to occur until exposure to 203dB SELcum, and mortality until 207dB SELcum. Impacts that will result in recoverable injury are predicted to occur across an area of up to 560km² (2.09% of the Fish and Shellfish Ecology Study Area). Mortality is likely to be limited to an area of 220km² (0.82% of the Fish and Shellfish Ecology Study Area). It should be noted that these values assume that no avoidance behaviour is exhibited by the receptor, and that in a realistic scenario some degree of avoidance is likely. The extent of underwater noise impacts from piling at DBS West, DBS East, and an Offshore Platform overlaid with Atlantic herring spawning potential is presented in Figure 10-8. This figure indicates that mortality effects will be limited to regions of seabed largely unsuitable or of low suitability for Atlantic herring spawning. A small region of medium Atlantic herring spawning potential is present to the south of the 207dB SELcum mortality band associated with DBS West. Across the wider TTS area effects will also be limited to regions of seabed largely unsuitable or of low suitability for Atlantic herring spawning. A region of medium Atlantic herring spawning potential is present to east and south west of the Array Areas, and within the DBS West Array Area. As piling will be undertaken across the Array Areas, it is possible that the impacts of 207dB SELcum exposure or greater will be experienced across the Array Areas as piling activity takes place.

163. The determination of magnitude for both UXO and other noise remains the same for both construction scenarios. Refer to section 10.6.1.1.4.

164. Effects associated with underwater noise and vibration via all sources are likely to occur. Noise and vibration associated with both piling and UXO is likely to result in a change that is outside the natural variation in background conditions, however, both noise sources pertain to discrete events, with noise and vibrations emissions occurring only in the short term (0 – 1 year). Noise and vibration associated with construction and vessel activities is likely to result in noise and vibration that is within the natural variation of background conditions, but may occur over the full construction period of 1 - 7 years. Therefore, the magnitude of impact for underwater noise and vibration is considered low.

10.6.1.4.3 Sensitivity of Receptor

165. Fish are known to have varying sensitivity to noise and vibration based on the presence or absence of a swim bladder to inner-ear connection, with fish having a swim bladder used in hearing being most intolerant to underwater noise (Popper *et al*. 2014). This receptor group also has no adaptability to underwater noise and vibration as the impact is a result of physiological traits. Many fish with a swim bladder used in hearing are of importance within the North Sea. However, recovery of this receptor group to baseline levels following exposure is likely to occur within 1 - 7 years. Fish with a swim bladder used in hearing, are therefore determined to have a medium sensitivity to underwater noise and vibration.

166. All other fish receptor groups, including fish eggs and larvae, and shellfish species, have an increased tolerance to underwater noise and vibration. European lobster, for example, showed no significant difference in size and catch rates between control sites and those exposed to the development of Westermost Rough offshore windfarm over a six-year period (Roach *et al*., 2022). Fish eggs and larvae are determined as having a similar level of sensitivity to noise and vibration, as fish with a swim bladder not used in hearing (Popper *et al*., 2014). Further, there is limited data to suggest that shellfish have greater sensitivity to noise and vibration than fish species. Whilst species within these receptor groups are of importance within the North Sea, their populations are likely to recover to baseline levels within one year due to the high fecundity of the majority of fish and shellfish species, and the limited area over which these impacts will result in individual mortalities. Therefore, all other fish and shellfish receptor groups are determined to have a low sensitivity to underwater noise and vibration.

10.6.1.4.4 Significance of Effect – DBS East or DBS West in Isolation

167. The low adverse magnitude of impact for DBS West (or DBS East), combined with the medium sensitivity of effect for fish and shellfish with a swim bladder used in hearing results in the assessment that impacts associated with noise and vibration have a **minor adverse** effect, and is therefore not significant in EIA terms.

168. All other fish and shellfish receptor groups present low sensitivity of effect, which combined with low adverse magnitude of impact, results in the assessment that impacts associated with noise and vibration have a **negligible adverse** effect, and is therefore not significant in EIA terms.

10.6.1.4.5 Significance of Effect – DBS East and DBS West Together

169. The low adverse magnitude of impact for both Projects together (DBS East and DBS West), combined with the medium sensitivity of effect for fish and shellfish with a swim bladder used in hearing results in the assessment that impacts associated with noise and vibration have a **minor adverse** effect, and is therefore not significant in EIA terms.

170. All other fish and shellfish receptor groups present low sensitivity of effect, which combined with low adverse magnitude of impact, results in the assessment that impacts associated with noise and vibration have a **negligible adverse** effect, and is therefore not significant in EIA terms.

10.6.1.5 Effect on Fish Stocks of Reduced Fishing Pressure Within the Array Areas and Increased Fishing Pressure Outside of the Array Area.

171. Commercial fishing within operational windfarms is not restricted under UK legislation. During the construction phase there will be temporary loss (up to five years per Project, seven years maximum) of fishing grounds through restriction of fishing within the offshore export cable and Array Areas. It has been assumed that all cables will be buried or have external cable protection. Therefore, there will be no material loss of fishing grounds along the offshore export cable corridor after the construction phase is complete, except around the platforms on the export cable route if they are required.

172. The Dogger Bank SAC Byelaw restricts the use of bottom towed fishing gear within the SAC to provide protection to sensitive shallow water sandbank habitats, and has been active since 13 June 2022. In order to present a worst case scenario within this assessment, impacts have been determined in the event that the Dogger Bank SAC Byelaw is revoked, and bottom trawling can continue. More details are provided within **Chapter 13 Commercial Fisheries**.

173. During construction of the DBS East and DBS West sites, it is proposed that temporary 500m safety zones will be present around foundations, wind turbines and OSPs where works are underway. Additionally, temporary 500m safety zones will also be present around pre-commissioned infrastructure, and around vessels installing array cables, offshore export cables and inter-platform cables.

174. Construction will also involve seabed preparation activities (e.g. sandwave and boulder clearance for foundations, array cables, inter platform cables and the offshore export cables). As with installation of the foundations, wind turbines, OSPs, and cables, temporary safety and/or voluntary safety zones will also be applied for around these preparatory activities.

10.6.1.5.1 Magnitude of Impact – DBS East or DBS West in Isolation

175. The impact will be of a regional spatial extent, reversible, and occur over a short- to medium-term period (maximum offshore construction period for DBS East and DBS West in isolation of up to five years; and maximum 21 months for the offshore export cable installation). Fishing activity could be excluded from the entire Offshore Development Area (inclusive of both the array area and offshore cable corridor) for the duration of works. This equates to an area excluded to fishing activity of 494.5km^2 from either the DBS East or DBS West array areas respectively and 396km^2 from the DBS East offshore export cable corridor, and 316km^2 from the DBS West offshore export cable corridor.

176. Voluntary exclusion zones of 1.5nm (2.8km) will also be present around vessels conducting seabed preparatory activities (such as sandwave and boulder clearance) and during installation of foundations, wind turbines, OSPs, inter-platform cables, inter-array cables, export cables and interconnector cables. Temporary 500m safety zones will be applied around installation of infrastructure such as foundations.

177. Of the two Projects, DBS East represents the worst case scenario in isolation, with a total exclusion area of 890.5km^2. The assessment of effect on fish stocks of reduced fishing pressure within the Array Areas, and increased fishing pressure outside of the Array Area will therefore assume this worst case scenario for both Projects.

178. The effect on fish stocks of reduced fishing pressure within the Array Areas, and increased fishing pressure outside of the Array Area would be a medium term (1-7 years) effect that is likely to occur, accounting for the worst case scenario footprint. The effect is predicted to result in a change that is noticeable, but remains within the natural variation in background conditions for the given effect. Therefore, the magnitude of impact is considered low adverse.

10.6.1.5.2 Magnitude of Impact – DBS East and DBS West Together

179. The construction period for the DBS East and DBS West concurrent scenario is assumed as up to five years (identical construction period to that of the DBS East and DBS West in isolation scenario). However, in the instance of sequential development of the two Projects, the worst case construction period increases to seven years, as up to a two year lag between the start of construction activities is possible (final overall footprint would be identical to the concurrent design scenario). As per the in isolation case, as a worst case, it is assumed that fishing could be excluded from the entire Offshore Development Area during the construction period. This comprises a total area of 989km^2 for the array areas, and 712km^2 for the offshore export cables.

180. While construction of DBS East and DBS West together covers a larger spatial footprint and a longer temporal footprint than either in isolation, construction activities will remain localised to specific construction events, and will be short- to medium-term in nature in the context of any one spatial area. Therefore, the magnitude of impact on each receptor group remains consistent with the assessment of DBS East and DBS West in isolation.

181. The effect on fish stocks of reduced fishing pressure within the Array Areas, and increased fishing pressure outside of the Array Area would be a medium term (1-7 years) effect that is likely to occur, accounting for the worst case scenario footprint. The effect is predicted to result in a change that is noticeable, but remains within the natural variation of background conditions for the given effect. Therefore, the magnitude of impact is considered low adverse.

10.6.1.5.3 Sensitivity of Receptor

182. In the adult life stage, many of the species comprising the Fish and Shellfish Ecology receptor groups exhibit a high degree of motility. Construction activities may cause temporary displacement of fish and shellfish receptors from the Array Area into adjacent waters (see section 10.6.1.3.1 for sensitivities to temporary habitat disturbance). Conversely, restrictions on fishing activity during the construction phase may result in the adjacent

areas being more heavily fished. This may lead to increased pressure on fish and shellfish receptors.

183. Fish and shellfish receptor groups are therefore considered to have a high level of tolerance and/or adaptability to the effect. Any change in fish stocks is anticipated to recover to baseline levels within one year after construction. All fish and shellfish receptor groups are therefore considered to have a low sensitivity to reduced fishing pressure within the Array Areas and increased fishing pressure outside of the Array Area.

10.6.1.5.4 Significance of Effect – DBS East or DBS West in Isolation

184. The low adverse magnitude of impact for DBS East or DBS West in isolation, combined with the low sensitivity of effect for all fish and shellfish receptor groups, results in the assessment that reduced fishing pressure within the Array Areas and increased fishing pressure outside of the Array Area has a **minor adverse** effect, and is therefore not significant in EIA terms.

10.6.1.5.5 Significance of Effect – DBS East and DBS West Together

185. The low adverse magnitude of impact for the both Projects (DBS East and DBS West), combined with the low sensitivity of effect for all fish and shellfish receptor groups, results in the assessment that reduced fishing pressure within the Array Areas and increased fishing pressure outside of the Array Area has a **minor adverse** effect, and is therefore not significant in EIA terms

10.6.2 Potential Effects During Operation

10.6.2.1 Permanent Loss of Habitat and / or Change in Habitat Type as a Result of Changes in Substrate Composition

186. Permanent loss of habitat and / or change in habitat type during the operational phase will occur due to the presence on the seabed of foundations, array cables, offshore export cables, scour and cable protection.

187. Some structures may be removed during decommissioning; however, it is not known to what extent the removal will be. It is anticipated that all structures above the seabed will be removed and it is possible that some infrastructure will remain under the seabed. As a precautionary measure, habitat loss has been considered here as permanent.

10.6.2.1.1 Magnitude of Impact - DBS East or DBS West in Isolation

188. The worst case scenario for permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition associated with the operational phase of DBS East is 4.93km². This represents approximately 0.02% of the total Fish and Shellfish Ecology Study Area. This is the worst case habitat loss for the total Array Area (3.72km²) and the total offshore export cable corridor (1.21km²).

189. The worst case scenario for permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition associated with the operational phase of DBS West is 5.51km². This represents approximately 0.02% of the total Fish and Shellfish Ecology Study Area. This is the worst case habitat loss for the total Array Area (3.87km²) and the total offshore export cable corridor (1.64km²).

190. Of the two Projects, DBS West represents the worst case scenario in isolation. The assessment of permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition, will therefore assume this worst case scenario for either Project.

191. The Fish and Shellfish Ecology Study Area covers 26,858km². The worst case scenario for permanent loss of habitat (5.51km²) represents approximately 0.02% of the total Fish and Shellfish Ecology Study Area. The permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition associated with the operational phase will occur, and the effects will not be reversed within the lifespan of the Project. However, the effect would result in a change that is unnoticeable from background conditions, due to it representing a negligible percentage of the wider Fish and Shellfish Ecology Study Area. Therefore, the magnitude of impact is considered low.

10.6.2.1.2 Magnitude of Impact – DBS East and DBS West Together

192. The worst case scenario for permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition associated with the operational phase of both Projects is 11.43km². This represents approximately 0.04% of the total Fish and Shellfish Ecology Study Area. This is the worst case habitat loss for the total Array Area (8.28km²) and the total offshore export cable corridor (3.14km²).

193. The magnitude of permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition may be slightly reduced if construction of DBS East and DBS West is staggered, and not concurrent. This may allow local populations to displace into nearby areas that are not under construction. However, as the loss of habitat is permanent , the

potential for recolonisation is removed. If concurrent, local populations would be displaced from a greater area, and changes to the sediment may be higher.

194. The total worst case scenario area is 11.43km², which represents approximately 0.04% of the total Fish and Shellfish Ecology Study Area. The permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition associated with the operational phase will occur, and the effects will not be reversed within the lifespan of the Project. However, the effect would result in a change that is unnoticeable from background conditions due to it representing a negligible percentage of the wider Fish and Shellfish Ecology Study Area. Therefore, the magnitude of impact is considered low.

10.6.2.1.3 Sensitivity of Receptor Groups

195. Habitat loss from the installation of subsea infrastructure or from changes in substrate composition is likely to affect species that are of low mobility, or those with demersal life stages of high habitat specificity. Species at a higher trophic level that do not necessarily interact with the seabed, but that prey on these impacted species, may also be impacted by this effect.

196. Elasmobranch species are present in the area, including demersal species such as thornback rays and blonde rays. However, these species are considered to have a high tolerance and adaptability to impacts of habitat loss and/ or changes in substrate due to their high mobility and wide, relatively flexible ranges. No elasmobranch spawning grounds overlap with the Fish and Shellfish Ecology Study Area, and although there are some elasmobranch nursery areas identified, these are concentrated in the southern portion, with no overlap of the Array Area or offshore export cable corridor. Elasmobranch species are generally considered to have a high tolerance and adaptability to habitat loss and /or disturbance to spawning and nursery areas due to their high mobility. Prey species are typically bound by the specific habitats and spatial locations in which they reside; whereas elasmobranchs have relatively larger ranges that provide a degree of flexibility, should prey species become less prevalent in certain areas. Elasmobranch species have a level of adaptability and tolerance to permanent loss of habitat and/or change in habitat type as a result of changes in substrate composition that are anticipated to recover to baseline levels within 1 - 7 years. Elasmobranch species are therefore considered to have a low sensitivity to permanent loss of habitat and / or change in habitat type as a result of changes in substrate.

197. Within the offshore development area, permanent loss of habitat and / or change in habitat type as a result of changes in substrate are likely to affect

demersal fish species. Demersal species common in the area include anglerfish, Atlantic cod, Dover sole, blue whiting, European hake, plaice, ling, whiting, bass, and sandeel species. Sandeel species are of particular concern as they are an important prey species for birds, and are sensitive to changes in the seabed across all life stages. As discussed in section 10.5.3.2 and section 10.5.3.3, sandeel and Atlantic herring have a heightened sensitivity to any disturbance of the seabed due to their life histories and particularly their spawning strategies, and are therefore considered more sensitive to temporary habitat disturbance and direct damage. Both Array Areas contain areas characterised as having a potential for sandeel spawning. However, DBS West is predominantly classed as having a high potential, while DBS East is predominantly medium potential, Therefore DBS West is the worst case scenario both for permanent habitat loss and also for potential sandeel spawning. There are also medium to high potential spawning areas, and isolated areas of very high spawning potential, present within the offshore export cable corridor. Demersal fish species in the area are species of national importance that are anticipated to recover to baseline levels within 1 - 7 years. Demersal fish species are therefore considered to have a medium sensitivity to permanent loss of habitat and/or change in habitat type as a result of changes in substrate composition.

198. Pelagic fish also have spawning grounds that overlap with the worst case scenario footprint for permanent loss of habitat and / or change in habitat type as a result of changes in substrate. Although most pelagic species have pelagic spawning strategies, others (including Atlantic herring) have demersal spawning strategies, that increase their sensitivity to disturbance of the seabed and habitat loss. As these fish preferentially select certain seabed types, loss of these preferred sediments for spawning, may result in negative impacts on the population. The DBS East Array Area is predominantly classed as having no potential for Atlantic herring spawning, however, the DBS West Array Area is classed as having no to medium potential. Therefore, of these two sites, DBS West represents the worst case scenario. The offshore export cable corridor is classed as having no to high herring spawning potential, as well as isolated patches of very high spawning potential. Pelagic fish species in the area are species of national importance that are anticipated to recover to baseline levels within 1 - 7 years. Pelagic fish species are therefore considered to have a medium sensitivity to permanent loss of habitat and/or change in habitat type as a result of changes in substrate composition.

199. Migratory fish species are not considered to be dependent on seabed sediment composition at any stage of their life-history, and therefore no impact pathway for permanent loss of habitat and / or change in habitat type as a result of changes in substrate exists for these species. Following exposure, no change in the receptor population is anticipated. Migratory fish species are therefore considered to have a negligible sensitivity to permanent loss of habitat and/or change in habitat type as a result of changes in substrate composition.

200. Shellfish species present in the area (including European lobster, brown crab, king and queen scallops, Norway lobster and common whelk) are likely to be impacted by permanent loss of habitat and / or change in habitat type as a result of changes in substrate. These species are predominantly reliant on the seabed habitat following their pelagic larval stage. As such, they have a lower tolerance and lower adaptability to loss of habitat or changes in the substrate. However, shellfish species may have higher fecundity compared to demersal fish species, and therefore a higher potential for population recovery following disturbance. Importantly, shellfish are of high commercial value in the area encompassing both Projects. Following exposure, shellfish populations are anticipated to recover to baseline levels within 1 - 7 years. Shellfish are therefore considered to have a medium sensitivity to permanent loss of habitat and/or change in habitat type as a result of changes in substrate composition.

10.6.2.1.4 Significance of Effect – DBS East or DBS West in Isolation

201. The low magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the low sensitivity of effect for the elasmobranch receptor group, results in the assessment that permanent loss of habitat and / or change in habitat type as a result of changes in substrate has a **negligible** effect, and is therefore not significant in EIA terms.

202. The low magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West, as well as the worst case for sandeel and Atlantic herring spawning), combined with the medium sensitivity of effect for the demersal fish, and pelagic fish receptor groups with demersal spawning, results in the assessment that permanent loss of habitat and / or change in habitat type as a result of changes in substrate has a **minor adverse** effect, and is therefore not significant in EIA terms.

203. The low magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the medium sensitivity of effect for the shellfish receptor group, results in the assessment that permanent loss of habitat and / or change in habitat type as a result of changes in substrate has a **minor adverse** effect, and is therefore not significant in EIA terms.

10.6.2.1.5 Significance of Effect – DBS East and DBS West Together

204. The low magnitude of impact for both Projects (DBS East and DBS West), combined with the low sensitivity of effect for the elasmobranch receptor group, results in the assessment that permanent loss of habitat and / or change in habitat type as a result of changes in substrate has a **negligible** effect, and is therefore not significant in EIA terms.

205. The low magnitude of impact for both Projects (DBS East and DBS West), combined with the medium sensitivity of effect for the demersal fish, and pelagic fish receptor groups with demersal spawning, results in the assessment that permanent loss of habitat and / or change in habitat type as a result of changes in substrate has a **minor adverse** effect, and is therefore not significant in EIA terms.

206. The low magnitude of impact for both Projects (DBS East and DBS West), combined with the medium sensitivity of effect for the shellfish receptor group, results in the assessment that permanent loss of habitat and / or change in habitat type as a result of changes in substrate has a **minor adverse** effect, and is therefore not significant in EIA terms.

10.6.2.2 Temporary Habitat Disturbance to Fish and Shellfish Species and Spawning and / or Nursery Grounds, Including Direct Damage From Repair and Maintenance

207. Temporary habitat disturbance to fish and shellfish species and spawning and / or nursery grounds, including direct damage from repair and maintenance, referred hereafter as “temporary habitat disturbance and direct damage”, may occur during repair and maintenance operations. Operations can include the replacement of sections of array or offshore export cables, when works interact with the seabed. This also includes the disturbance from vessels jacking up.

208. It should be noted that this impact will occur episodically and highly localised to the individual locations of operation and maintenance events over the full duration of the operational period, not as a single event. The worst cases presented below represent the combined footprints from all operation and maintenance events.

10.6.2.2.1 Magnitude of Impact – DBS East or DBS West in Isolation

209. The realistic worst case scenario for the area of seabed potentially impacted by temporary habitat disturbance and direct damage associated with the operational phase of either DBS East or DBS West is 60,000m². This represents the total seabed area with the potential to be affected through repairs of either the array or offshore export cables, and is approximately 0.0002% of the total Fish and Shellfish Ecology Study Area. At each of the two Projects, the worst case assessment is based on the potential for seven array cable repair events (7 x 6,000m²), and three offshore export cable repair events (3 x 6,000m²). The worst case scenario is therefore equal in magnitude for either Project.

210. The realistic worst case scenario for the area of seabed potentially impacted by temporary habitat disturbance and direct damage associated with the operational phase is less that assessed for the construction phase. It is expected that there would be a medium-term recovery (1 – 7 years) from any loss of habitat, disturbance to spawning and nursery areas, or the loss of individuals, as a result of activities occurring during the operational phase. The effect would result in a change that is noticeable, but remains within the natural variation of background conditions for the given effect. Therefore, the magnitude of impact is considered low.

10.6.2.2.2 Magnitude of Impact – DBS East and DBS West Together

211. The realistic worst case scenario for the area of seabed potentially impacted by temporary habitat disturbance and direct damage associated with the operational phase for both Projects is 114,000m². This represents the footprint affected by array cable repair events (13 x 6,000m²), and offshore export cable repair events (6 x 6,000m²) combined, and is approximately 0.0004% of the total Fish and Shellfish Ecology Study Area.

212. The worst case scenario for both Projects combined is less than that assessed for the construction phase. The loss of individuals as a result of temporary habitat disturbance and direct damage would be expected to fully recover within the medium-term (1 - 7 years), accounting for the worst case scenario footprint of direct damage (e.g. crushing) and disturbance. The effect would result in a change that is noticeable, but remains within the natural variation of background conditions for the given effect. Therefore, the magnitude of impact is considered low.

10.6.2.2.3 Sensitivity of Receptor

213. The sensitivity for fish and shellfish receptor groups have been assessed in section 10.6.1.3.1.

214. Elasmobranch species are considered to have a low sensitivity to temporary habitat disturbance and direct damage.

215. Demersal and pelagic fish species are considered to have a medium sensitivity to temporary habitat disturbance and direct damage.

216. Migratory fish species are not considered to be dependent on seabed sediment composition at any stage of their life-history, and therefore no impact pathway for temporary habitat disturbance and direct damage exists for these species. They are considered to have a negligible sensitivity to temporary habitat disturbance and direct damage.

217. Shellfish are considered to have a medium sensitivity to temporary habitat disturbance and direct damage.

10.6.2.2.4 Significance of Effect – DBS East or DBS West in Isolation

218. The low magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the low sensitivity of effect for the elasmobranch receptor group, results in the assessment that temporary habitat disturbance and direct damage has a **negligible** effect, and is therefore not significant in EIA terms.

219. The low magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the medium sensitivity of effect for the demersal fish, and pelagic fish receptor groups, results in the assessment that temporary habitat disturbance and direct damage has a **minor adverse** effect, and is therefore not significant in EIA terms.

220. The low magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the medium sensitivity of effect for the shellfish receptor group, results in the assessment that temporary habitat disturbance and direct damage has a **minor adverse** effect, and is therefore not significant in EIA terms.

10.6.2.2.5 Significance of Effect – DBS East and DBS West Together

221. The low adverse magnitude of impact for both Projects (DBS East and DBS West), combined with the low sensitivity of effect for the elasmobranch receptor group, results in the assessment that temporary habitat disturbance and direct damage has a **negligible** effect, and is therefore not significant in EIA terms.

222. The low adverse magnitude of impact for both Projects DBS East and DBS West), combined with the medium sensitivity of effect for the demersal fish, and pelagic fish receptor groups, results in the assessment that temporary habitat disturbance and direct damage has a **minor adverse** effect, and is therefore not significant in EIA terms.

223. The low adverse magnitude of impact for both Projects (DBS East and DBS West), combined with the medium sensitivity of effect for the shellfish receptor group, results in the assessment that temporary habitat disturbance and direct damage has a **minor adverse** effect, and is therefore not significant in EIA terms.

10.6.2.3 Increase in Local Suspended Sediment Concentrations and Sediment Settlement

224. There is the potential for temporary increases in local SSC via cable repair and / or remediation works on either the array cables, interconnector cables, and/or offshore export cables. The sediments of the offshore development area have a very low concentration of fine sediments, and therefore any suspension is predicted to be short-term, localised, and within the extent of natural variation for that area (~3mg/l).

225. It should be noted that this impact will occur episodically and be highly localised to the individual locations of operation and maintenance events over the full duration of the operational period, not as a single event. The worst cases presented below represent the combined volume of SSC from all operation and maintenance events.

10.6.2.3.1 Magnitude of Impact – DBS East or DBS West in Isolation

226. The worst case scenario for area of sediment disturbed with the potential to increase SSC, and associated sediment settlement, during the operational phase of DBS East and DBS West is 366,900m^2 (306,900m^2 for jacking-up activities, 42,000m^2 for array cable repairs, and 18,000m^2 for offshore export cable trenching).

227. Based on modelling undertaken along the export cable corridor for the Dogger Bank A and B offshore wind farms, the maximum suspended sediment concentration is not predicted to exceed 100-200mg/l for any single event, and will fall rapidly, with coarser sediments falling within minutes or tens of minutes. Deposition depth changes are not predicted to last more than 7 days within the most heavily deposited areas (10-50mm) directly adjacent to the activity.

228. Due to the short-term and localised nature of the impact pathway, the loss of individuals as a result of an increase in SSC and sediment settlement would be expected to fully recover within the short term (0 - 1 years), accounting for the worst case scenario volume of sediment mobilised by DBS East or DBS West in Isolation . However, the effect will be slightly elevated compared to background conditions and will remain within the range of natural variation. Therefore, the magnitude of impact is considered low, as a precaution.

10.6.2.3.2 Magnitude of Impact – DBS East and DBS West Together

229. The worst case scenario for area of sediment disturbed with the potential to increase SSC, and associated sediment settlement, during the operational phase of both Projects together is 727,800m² (613,800m² for jacking-up activities , 78,000m² for array cable repairs and 36,000m² for offshore export cable trenching).

230. When evaluating the two Projects combined, the total number of potential repairs is just under double that of any Project individually as this scenario considers reduction of 6,000m² for array cable repairs over the Projects lifetime. However, it is unlikely that the number of repairs at any one time would increase significantly. Therefore, although the total volume of sediment disturbed with each repair would be the same as for either Project in isolation, there is more likelihood of less time between repairs, and therefore between disturbance events.

231. Based on the conceptual assessment approach, suspended sediment peaks are not expected to exceed 200mg/l or last more than 10 days, with maximum sediment deposition predicted to range between 10-50mm at the most heavily impacted locations. At a distance from the activity, deposition and suspended sediments may return to background levels (~3mg/l) within hours to days.

232. Due to the short-term and localised nature of the impact pathway, the loss of individuals as a result of an increase in SSC and sediment settlement would be expected to fully recover within the short term (0 - 1 years), accounting for the worst case scenario volume of sediment mobilised by both Projects together. However, the effect will be slightly noticeable compared to background conditions, and will remain within the range of natural variation. Therefore, the magnitude of impact is considered low, as a precaution.

10.6.2.3.3 Sensitivity of Receptor Groups

233. The sensitivity for fish and shellfish receptor groups have been assessed in section 10.6.1.3.2.

234. Adult elasmobranch, demersal fish, pelagic fish, and migratory fish species are considered to have a negligible sensitivity to an increase in SSC and sediment settlement.

235. The eggs and / or larvae of elasmobranchs, demersal fish, and pelagic fish species are considered to have a medium sensitivity to an increase in SSC and sediment settlement.

236. Shellfish species are considered to have a medium sensitivity to an increase in SSC and sediment settlement.

10.6.2.3.4 Significance of Effect – DBS East and DBS West in Isolation

237. The low adverse magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the negligible sensitivity of effect for adult individuals within the elasmobranch, demersal fish, pelagic fish, and migratory fish receptor groups, results in the assessment that an increase in SSC and sediment settlement has a **negligible** effect, and is therefore not significant in EIA terms.

238. The low adverse magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the medium sensitivity of effect for eggs and / or larvae within the elasmobranch, demersal fish, pelagic fish, and migratory fish receptor groups, results in the assessment that an increase in SSC and sediment settlement has a **minor adverse** effect, and is therefore not significant in EIA terms.

239. The low adverse magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the medium sensitivity of effect for the shellfish receptor group, results in the assessment that an increase in SSC and sediment settlement has a **minor adverse** effect, and is therefore not significant in EIA terms.

10.6.2.3.5 Significance of Effect – DBS East and DBS West Together

240. The low adverse magnitude of impact for both Projects (DBS East and DBS West), combined with the negligible sensitivity of effect for adult individuals within the elasmobranch, demersal fish, pelagic fish, and migratory fish receptor groups, results in the assessment that an increase SSC and sediment settlement during the operational phase has a **negligible** effect, and is therefore not significant in EIA terms.

241. The low adverse magnitude of impact for both Projects (DBS East and DBS West), combined with the medium sensitivity of effect for eggs and / or larvae within the elasmobranch, demersal fish, pelagic fish, and migratory fish receptor groups, results in the assessment that an increase in SSC and sediment settlement during the operational phase has a **minor adverse** effect, and is therefore not significant in EIA terms.

242. The low adverse magnitude of impact for both Projects (DBS East and DBS West), combined with the medium sensitivity of effect for the shellfish receptor group, results in the assessment that an increase in SSC and sediment settlement in the operational phase has a **minor adverse** effect, and is therefore not significant in EIA terms.

10.6.2.4 Release of Sequestered Contaminants Following Sediment Disturbance

10.6.2.4.1 Magnitude of Impact – DBS East or DBS West in Isolation

243. Suspended sediment release has been assessed through a conceptual approach using modelling for the Dogger Bank A and B offshore wind farms. The level of SSC release is predicted to be low, as maximum suspended sediment concentration is not predicted to exceed 200mg/l, and will be highly localised, short-term, and episodic (returning to background levels ~3mg/l within hours to days).

244. The levels of potential contaminants are similarly predicted to be low, based on studies undertaken as part of the Dogger Bank A and B in 2011 and 2012 and Dogger Bank C and Sofia offshore wind farms. These studies are considered relevant to the Proposed Project due to their close proximity and similarities in sediments likely to be found within the offshore development area. The likely nature of sediments at DBS East and West reduces the potential for accumulation of contaminants. The works are not predicted to result in any change that is noticeable from the natural variation in background conditions. Therefore, the magnitude of impact is considered negligible.

10.6.2.4.2 Magnitude of Impact – DBS East and DBS West Together

245. The magnitude of impact is not predicted to be greatly higher for DBS East and West together, as the impacts will be discrete events with low predicted contaminant levels that are likely to return to background levels within a short time period. The works are not predicted to result in any change that is noticeable from the natural variation in background conditions. Therefore, the magnitude of impact is considered negligible.

10.6.2.4.3 Sensitivity of Receptor Groups

246. The sensitivity for fish and shellfish receptor groups have been assessed in section 10.6.1.3.3.

247. All fish and shellfish receptor groups are therefore considered to have a low sensitivity to the release of sequestered contaminants following sediment disturbance.

10.6.2.4.4 Significance of Effect – DBS East or DBS West in Isolation

248. The negligible adverse magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the low sensitivity of effect for all fish and shellfish receptor groups, results in the assessment that the release of sequestered contaminants following sediment disturbance has a **negligible** effect, and is therefore not significant in EIA terms.

10.6.2.4.5 Significance of Effect – DBS East and DBS West Together

249. The negligible adverse magnitude of impact for both Projects (DBS East and DBS West), combined with the low sensitivity of effect for all fish and shellfish receptor groups, results in the assessment that the release of sequestered contaminants following sediment disturbance has a **negligible** effect, and is therefore not significant in EIA terms.

10.6.2.5 Impacts on Fish and Shellfish Species as a Result of Underwater Noise and Vibration

250. During the operational phase of the Projects, noise has the potential to be produced via vibrations associated with the rotating machinery in the wind turbines. This noise may then be transmitted into the seabed and local water column. Noise produced via this mechanism is considered to be non-impulsive and continuous. Modelling undertaken within the **Appendix 11.2: Underwater Noise Modelling Report** assumes that all wind turbines associated with the Projects are operational 24 hours per day, and that receptors will not exhibit fleeing behaviour. Exposure thresholds for fish with a swim bladder used in hearing are presented in **Table 10-21**.

Table 10-21 Impact Thresholds for Fish With a Swim Bladder Used in Hearing Relating to Operational Noise of Wind Turbine (SPL_{RMS} = *Sound Pressure Level Route Mean Square)*

Unweighted SPLRMS (Popper et al., 2014)	**Wind Turbine (small)**	**Wind Turbine (large)**
Recoverable injury 170dB (48 hours) Unweighted SPL_{RMS}	< 50m	< 50m
Temporary Threshold Shift 158dB (12 hours) Unweighted SPL_{RMS}	< 50m	< 50m

251. Additional noise may be produced during the operational phase via the same impact pathways identified during the construction phase of the Projects (see section 10.6.1.4). Underwater noise scenarios that are expected to occur during operation (e.g. maintenance vessel noises), have the potential to occur during day-to-day maintenance, repair, and / or emergency works associated with the Projects following commissioning. Impact piling and UXO clearance are not anticipated post-construction. Underwater noise emissions within these categories will occur primarily during the construction phase of the Projects, and therefore the assessments provided within section 10.6.1.4 represents a worst case scenario for these impacts in the operations phase of the Projects.

10.6.2.5.1 Magnitude of Impact – DBS East or DBS West in Isolation

252. Noise exposure associated with operation of the DBS West wind turbines, at both TTS and recoverable injury, present thresholds of <50m following a minimum of 48 hours of exposure. Considering the motility of most fish and shellfish species, it is not considered likely that this will result in impacts to any receptor groups. Therefore, when considering effects associated with operational noise, the impact on fish and shellfish is considered negligible. Underwater noise associated with potential maintenance works and vessel traffic has the potential to occur during the operational phase as a result of maintenance activities. These impacts are assessed within section 10.6.1.4 and are determined to be negligible.

253. Therefore, the magnitude of impact for underwater noise and vibration during operation is considered to be negligible.

10.6.2.5.2 Magnitude of Impact – DBS East and DBS West Together

254. Noise exposure associated with operation of both DBS East and DBS West wind turbines together, at both TTS and recoverable injury present thresholds of <50m following a minimum of 48 hours of exposure. Considering the motility of most fish and shellfish species, it is not considered likely that this will result in impacts to any receptor groups. Therefore, when considering effects associated with operational noise, the impact on fish and shellfish is considered negligible. Underwater noise associated with potential maintenance works and vessel traffic has the potential to occur during the operational phase as a result of maintenance activities. These impacts are assessed within section 10.6.1.4 and are determined to be negligible.

255. Therefore, the magnitude of impact for underwater noise and vibration during operation is considered to be negligible.

10.6.2.5.3 Sensitivity of Receptor Groups

256. As presented within **Table 10-21**, the most sensitive receptor group, fish with a swim bladder used in hearing, would need to remain <50m for a wind turbine for >48 hours to experience recoverable injury. The sensitivity of the most sensitive fish and shellfish receptor group to this type of underwater noise and vibration is considered negligible.

257. Sensitivities associated with piling, UXO and other noise sources are assessed within section 10.6.1.4. Impacts resulting from underwater noise during the operations phase of the Projects are likely to be limited both spatially and temporally, and recovery of any given stock is likely to occur rapidly. Fish with a swim bladder used in hearing are determined as having a medium sensitivity to underwater noise and vibration, with all other receptor groups presenting a low sensitivity to underwater noise and vibration.

10.6.2.5.4 Significance of Effect – DBS East or DBS West in Isolation

258. The negligible magnitude of impact for DBS West (or DBS East), combined with the medium sensitivity of effect for fish and shellfish with a swim bladder used in hearing results in the assessment that impacts associated with noise and vibration at the operation phase have a **minor adverse** effect, and is therefore not significant in EIA terms.

259. All other fish and shellfish receptor groups present low sensitivity of effect, which combined with negligible magnitude of impact, results in the assessment that impacts associated with noise and vibration at the operation phase have a **negligible adverse** effect, and is therefore not significant in EIA terms.

10.6.2.5.5 Significance of Effect – DBS East and DBS West Together

260. The negligible magnitude of impact for DBS West (or DBS East), combined with the medium sensitivity of effect for fish and shellfish with a swim bladder used in hearing results in the assessment, that impacts associated with noise and vibration at the operation phase have a **minor adverse** effect, and is therefore not significant in EIA terms.

261. All other fish and shellfish receptor groups present low sensitivity of effect, which combined with negligible magnitude of impact, results in the assessment, that impacts associated with noise and vibration at the operation phase have a **negligible adverse** effect, and is therefore not significant in EIA terms.

10.6.2.6 EMF Effects Arising From Cables

262. Electromagnetic fields (EMFs) may impact fish and shellfish species within the offshore development area. EMFs are produced when electricity passes through a conductor (e.g. subsea cables), and have the potential to cause barrier/attraction effects dependent on the species, and the spatial scale of EMF. EMF comprises both an electric field (E field) and a magnetic field (B field), which may interact with or disrupt fish and shellfish species that use these phenomena for navigation or foraging (through specialised organs). E field is confined within the cable itself through the use of insulating and shielding layers. This assessment therefore relates to B fields only.

263. The strength of the EMFs produced by underwater cables is dependent on a variety of factors including distance from the cable, whether the cable is in sediment or sea water, speed and direction of water flow, and strength of the magnetic field (the electric field is confined by the insulating layer of the cable). EMF strength dissipates rapidly with increasing distance from the source; for example, the average windfarm array cable buried 1m below the seabed will decrease from 7.85 μT directly next to the cable (0m) to 1.47 μT at 4m distance (Normandeau *et al.*, 2011). Localised heating of sea water may occur, but this is limited to distances of tens of cm, and is likely to be of small magnitude, therefore no additional impact is predicted from heating effects (Boehlert and Gill, 2010; Moray Offshore Windfarm Ltd, 2018).

264. Total volume of EMF for each worst case scenario is calculated within this section. Calculations for EMF assume a worst case burial depth of 0.5m, a cable diameter of 0.3m, and that EMF remains detectable up to a distance of 4m from the cable surface. Cables laid on the seabed surface will be covered with external cable protection, therefore, no receptor species will be exposed within 0.5m of the source.

265. This EMF volume is contextualised by presenting it as a percentage of the total volume of the water column within the array areas and offshore export cable areas for each development scenario. This 'water column volume' has been calculated based on the footprint of and the array areas and offshore export cables during the construction phase, multiplied by water depth. Water depth varies across the Offshore Development Area, and therefore the following average water depths are used throughout this assessment:

- **DBS East = 23.3m;**
- **DBS West =28.4m; and**
- **Export Cable Corridor = 45.9m.**

10.6.2.6.1 Magnitude of Impact – DBS East or DBS West in Isolation

266. The worst case scenario for cable properties with the potential to cause EMF effects during the operational phase of DBS East is 957km of cable length, with a minimum burial depth of 0.5m. The worst case for offshore export cables is 632km of cable (four cables of 158km length), with a maximum voltage of 525 kV direct current (DC), whereas the worst case for array cables is 325km cable length with a maximum voltage of 132 kV.

267. The worst case scenario for cable properties with the potential to cause EMF effects during the operational phase of DBS West is 721km of cables length, with a minimum burial depth of 0.5m. The worst case for offshore export cables is 396km of cable (2 cables of 198km length) with a maximum voltage of 275 kV alternating current (AC), whereas the worst case for array cables is 325km cable length with a maximum voltage of 132 kV.

268. Of the two Projects, the DBS East represents the worst case scenario in isolation. The assessment of EMF effects arising from cables during the operational phase will therefore assume this worst case scenario.

269. Based on the cable properties for DBS East, the worst case volume of water containing detectable EMF from buried (0.5m) array cables is 7.45km^3. This represents 0.06% of the water volume within the DBS East Array Area (11,568.5km^3).

270. The worst case volume of water in the water column containing identifiable EMF from buried offshore export cables associated with DBS East is 14.48km^3. This represents 0.12% of the local water column volume associated with the offshore export cable corridor (12,516.5km^3).

271. The total worst case volume of water associated with DBS East cables is 21.93km³. This represents 0.09% of the local water column volume associated with DBS East array and offshore export cables (24,084.9km³). EMF will be present throughout the operational lifespan of the Projects. However, this would result in a change that is unnoticeable from background conditions due to it representing a negligible percentage of the wider Fish and Shellfish Ecology Study Area. Therefore, the magnitude of impact is considered negligible.

10.6.2.6.2 Magnitude of Impact – DBS East and DBS West Together

272. The worst case scenario for cable properties with the potential to cause EMF effects during the operational phase of both Projects together (DBS East and DBS West) is 1,678km of all cable with a minimum burial depth of 0.5m. The worst case for offshore export cables is 1,028km of cable length, with a maximum voltage of 525 kV DC and 275 kV AC, whereas the worst case for array cables is 650km cable length, with a maximum voltage of 132 kV.

273. Based on the cable properties for both Projects combined (DBS East and DBS West), the worst case volume of water containing detectible EMF from buried (0.5m) array cables is 14.89km³. This represents 0.06% of the local water column volume associated with the array cables of both Projects combined (25,619.4km³).

274. The worst case volume of water in the water column containing identifiable EMF from buried offshore export cables is 23.55km³. This represents 0.18% of the water column volume associated with the offshore export cables of both Projects combined (12,516.5km³).

275. The total worst case volume of EMF for all cables is 38.45km³. This represents 0.10% of the water column volume associated with the array cables and offshore export cables of both Projects combined (38,135.9km³). EMF will be present throughout the operational lifespan of the Projects. However, this would result in a change that is unnoticeable from background conditions due to it representing a negligible percentage of the wider Fish and Shellfish Ecology Study Area. Therefore, the magnitude of impact is considered negligible.

10.6.2.6.3 Sensitivity of Receptor Groups

276. Elasmobranchs are considered the most sensitive receptor group to EMF effects, due to the presence of electrosensitive sensory organs, such as the Ampullae of Lorenzini, used for navigation and to detect electric fields associated with prey species. It is not fully understood whether the detection of EMFs by elasmobranchs may cause a barrier effect, or an attractive effect, or whether this may vary dependent on EMF magnitude. In some elasmobranch species (e.g. thornback rays), EMF detection may be used by embryos within the egg case to detect potential predators and modify behaviour (Ball *et al*., 2015). In this example, EMF disruption may interrupt oxygen regulation within the egg case, or may increase predation. Although only a small total area of the wider Fish and Shellfish Study Area will be impacted by EMF effects from array cables or offshore export cables, ray species are common within the Fish and Shellfish Ecology Study Area, and elasmobranchs rely heavily on electrosensitive sensory organs. Elasmobranch species show limited tolerance to EMF effects and may be exposed throughout the duration of the operational phase. However, this group are highly mobile and are likely to move away from the source, and the receptor population is anticipated to recover to baseline levels within 1 - 7 years. Therefore, elasmobranch species are considered to have a medium sensitivity to EMF effects from cables.

277. Other fish receptor groups (e.g. pelagic, demersal, and migratory) are comparatively less reliant on electrosensitivity and are highly mobile and / or exhibit flexibility in their range of habitats. It is therefore likely that these species, if displaced by EMF effects, will find suitable habitat elsewhere in the offshore area, or in the wider Fish and Shellfish Ecology Study Area. Although barrier effects on migratory fishes are not predicted to occur for most species, European eel are thought to utilise magnetic fields for navigation and have been shown to exhibit behavioural responses to EMFs at high magnitude (Westerberg and Lagenflet, 2008). However, this response occurs at an order of magnitude greater than those planned for the Projects, and these species spend the majority of their time in the upper water column while migrating and are thus outside of the predicted spatial extent of any EMFs generated by buried cables. Demersal, pelagic, and migratory fish species therefore have a high level of adaptability and tolerance to EMF effects during the operational phase, and are anticipated to recover to baseline levels within one year following exposure. Therefore, demersal, pelagic, and migratory species are considered to have a low sensitivity to EMF effects from cables.

278. Shellfish species have been shown to react variably to EMFs, both through physiological and behavioural responses. Most research on these responses has been performed in laboratory settings, and at EMF levels orders of magnitude greater than the average windfarm array cable buried 1m below the seabed (7.85 µT) (Normandeau *et al*., 2011). For example, brown crabs exhibited responses at 500-1,000 µT, but only limited responses below 250 µT (Scott *et al*., 2021). Similarly, European lobster have been shown to modify their behaviour (proportion of large turns, and height above seabed) in response to EMFs, but only at 65.3 µT (eight times higher than average for array cables) (Hutchinson *et al*., 2020). In the same species, although EMFs were found to disrupt larval development success, this was at a magnitude 350 times greater (2.8mT) than the average for array cables. Shellfish species are therefore expected to be entirely tolerant and adaptable to EMF effects at the level anticipated for the operational phase, and no change in the receptor population is anticipated following exposure. It is therefore concluded that shellfish species are considered to have a negligible sensitivity to EMF from subsea cables.

10.6.2.6.4 Significance of Effect – DBS East or DBS West in Isolation

279. The negligible adverse magnitude of impact for DBS East (as the worst case scenario assigned to both DBS East and DBS West), combined with the medium sensitivity of effect for the elasmobranch receptor group, results in the assessment that EMF effects arising from cables during the operational phase have a **minor adverse** effect, and are therefore not significant in EIA terms.

280. The negligible adverse magnitude of impact for DBS East (as the worst case scenario assigned to both DBS East and DBS West), combined with the low sensitivity of effect for the demersal, pelagic, and migratory fish species receptor group, results in the assessment that EMF effects arising from cables during the operational phase have a **negligible** effect, and are therefore not significant in EIA terms.

281. The negligible adverse magnitude of impact for DBS East (as the worst case scenario assigned to both DBS East and DBS West), combined with the negligible sensitivity of effect for the shellfish species receptor group, results in the assessment that EMF effects arising from cables during the operational phase have a **negligible** effect, and are therefore not significant in EIA terms.

10.6.2.6.5 Significance of Effect – DBS East and DBS West Together

282. The negligible adverse magnitude of impact for both Projects together, combined with the medium sensitivity of effect for the elasmobranch receptor group, results in the assessment that EMF effects arising from cables during the operational phase have a **minor adverse** effect, and are therefore not significant in EIA terms.

283. The negligible adverse magnitude of impact for both Projects together, combined with the low sensitivity of effect for the demersal, pelagic, and migratory fish species receptor group, results in the assessment that EMF effects arising from cables during the operational phase have a **negligible** effect, and are therefore not significant in EIA terms.

284. The negligible adverse magnitude of impact for both Projects together, combined with the negligible sensitivity of effect for the shellfish species receptor group, results in the assessment that EMF effects arising from cables during the operational phase have a **negligible** effect, and are therefore not significant in EIA terms.

10.6.2.7 Effect on Fish Stocks of Reduced Fishing Pressure Within the Array Areas and Increased Fishing Pressure Outside of the Array Area.

285. Commercial fishing within operational windfarms is not restricted under UK legislation. It has been assumed that during the operational phase, all cables will be buried, or have external cable protection. Therefore, the only material loss of fishing grounds will be at locations where infrastructure is built out during the construction phase. As determined within **Chapter 13 Commercial Fisheries**, this assessment has been made on the assumption that the Dogger Bank SAC Byelaw is revoked to present a worst case assessment. Therefore, the degree to which fishing activity is restricted within the Array Area is determined primarily by gear type of individual vessels, as well as the risk tolerance of individual skippers.

286. Whilst not restricted through any legal mechanism (with the exception of any temporary 500m exclusion zones surrounding ongoing cable repair and / or remediation works), fishing activities within the Array Areas, individual decisions made by skippers with their own perception of risk will contribute to the likelihood of whether their fishing will resume within the array areas. The dimension and type of fishing gear deployed will be a significant contributor to risk perception, in addition to specific weather and tidal conditions.

287. Gear types that are both mobile and interact directly with the seabed pose the highest risk of entanglement. Therefore, dredge and otter trawl gear types are most likely to reduce in frequency within the Array Areas. However, as determined within **Chapter 13 Commercial Fisheries**, there remains the potential for resumed fishing within the Array Area and between wind turbines, where allowed by local byelaws.

10.6.2.7.1 Magnitude of Impact – DBS East or DBS West in Isolation

288. As the potential for fishing for all gear types remains throughout the operational phase of both DBS East and DBS West independently, it cannot be determined that any proportion of the Array Area will experience a reduction in fishing pressure when considering the worst case scenario. The impact is considered to be lower than that anticipated for the construction phase. The impact is not anticipated to result in any effect, and is considered short-term (0 - 1 year), with no change noticeable from natural variation. Therefore, the magnitude of impact is considered negligible.

10.6.2.7.2 Magnitude of Impact – DBS East and DBS West Together

289. As the potential for fishing for all gear types remains throughout the operational phase of DBS East and DBS West together, it cannot be determined that any proportion of the Array Area will experience a reduction in fishing pressure when considering the worst case scenario. The impact is anticipated to not result in any effect and is considered short-term (0 - 1 year), with no change noticeable from natural variation. Therefore, the magnitude of impact is considered negligible.

10.6.2.7.3 Sensitivity of Receptor

290. It is possible that a reduction in trawling activity within the region may allow for spawning and nursery grounds to establish due to the reduction in disturbance. These spawning grounds have the potential to result in an increase in fish and shellfish biomass in the Fish and Shellfish Ecology Study Area.

291. In the adult life stage, many of the species comprising the Fish and Shellfish Ecology receptor groups exhibit a high degree of motility. Whilst an area of reduced fishing pressure may reduce the mortality of individuals, individuals are unlikely to remain within an area of such limited size for a period long enough to allow for a measurable change at the population level.

292. Further, whilst it is possible that a reduction in fishing pressure within the Array Area may occur, this is dependent of the risk tolerance of individual skippers. Therefore, in a worst case scenario no given area of habitat likely to benefit from this impact can be determined. Fish and shellfish receptor groups are therefore considered to be entirely tolerant and/or adaptable to the effect, with no change anticipated. All fish and shellfish receptor groups are therefore considered to have a negligible sensitivity to reduced fishing pressure within the Array Areas and increased fishing pressure outside of the Array Area.

10.6.2.7.4 Significance of Effect – DBS East or DBS West in Isolation

293. The negligible beneficial magnitude of impact for DBS East and DBS West in isolation, combined with the negligible sensitivity of effect for all fish and shellfish receptor groups, results in the assessment that reduced fishing pressure within the Array Areas, and increased fishing pressure outside of the Array Area has a **negligible** effect, and is therefore not significant in EIA terms.

10.6.2.7.5 Significance of Effect – DBS East and DBS West Together

294. The negligible beneficial magnitude of impact for the Project (DBS East and DBS West), combined with the negligible sensitivity of effect for all fish and shellfish receptor groups, results in the assessment that reduced fishing pressure within the Array Areas and increased fishing pressure outside of the Array Area has a **negligible** effect, and is therefore not significant in EIA terms.

10.6.3 Potential Effects During Decommissioning

295. A decision regarding the final decommissioning policy is yet to be decided as it is recognised that rules and legislation change over time in line with best industry practice. The decommissioning methodology and programme would need to be finalised nearer to the end of the lifetime of the proposed Projects, to ensure it is in line within the most recent guidance, policy and legislation.

296. The scope of the decommissioning works would most likely involve removal of the accessible installed components. This is outlined in **Chapter 5 Project Description**, and the details would be agreed with the relevant authorities at the time of decommissioning. Offshore decommissioning is likely to include the removal of all of the wind turbine components and part of the foundations (those above sea level), removal of some or all of the array and offshore export cables. Scour and cable protection would likely be left in situ.

297. During the decommissioning phase, there is potential for wind turbine foundation and cable removal activities to cause effects that would be comparable to those identified for the construction phase and the operational phase, specifically:

- **Temporary habitat disturbance to fish and shellfish species and spawning and / or nursery grounds, including direct damage from removal of turbine foundations, scour protection, and cables;**
- **Increase in local SSC and sediment settlement;**
- **Release of sequestered contaminants following sediment disturbance; and**
- **Impacts on fish and shellfish species as a result of noise and vibration.**

298. Permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition, is assessed as an operational impact because it begins when the operation phase starts, following full installation of wind farm infrastructure.

299. The magnitude of decommissioning effects will be comparable to, or less than, the construction phase. Accordingly, given that the impacts were assessed to be of no greater than minor adverse significance for the identified Fish and Shellfish Ecology receptors during the construction phase, it is anticipated that the same would be true for the decommissioning phase as a reasonable worst case.

10.7 Preliminary Assessment of Cumulative Effects

300. As detailed in section 10.4.3, this section presents a preliminary assessment of cumulative effects in relation to Fish and Shellfish Ecology. The final CEA will be undertaken within the ES chapter.

10.7.1 Initial Screening for Cumulative Effects

301. **Table 10-22** below details the potential cumulative effects that may occur between the Projects and other plans, projects, and activities. Only potential impacts assessed in section 10.6 where the potential for cumulative effects has been identified (minor, moderate or major) will be taken forward to the final CEA (i.e. those assessed as 'no impact' are not taken forward as there is no potential for them to contribute to a cumulative impact).

Table 10-22 Potential Cumulative Effects

Impact	Potential for Cumulative Effects	Data Confidence	Rationale
	Construction		
Impact 1: Direct damage (e.g. crushing) and disturbance	No	High	These impacts are of limited spatial and temporal extent, relative to the identified Fish and Shellfish receptor groups within the Fish and Shellfish Ecology Study Area. Management plans will be developed to further mitigate impacts as described within **Table 10-3**.
Impact 2: Habitat loss and / or disturbance to spawning and nursery areas, including the installation of wind turbine foundations, scour protection and cables	No	High	
Impact 3: Increase in local SSC and sediment settlement	No	High	
Impact 4: Release of sequestered contaminants following sediment disturbance	No	High	
Impact 5: Impacts on fish and shellfish species as a result of noise and vibration	Yes	High	Underwater noise from other developments within the region have the potential to overlap with impacts produced during construction associated with the Projects.

Impact	Potential for Cumulative Effects	Data Confidence	Rationale
	Operation & Maintenance		
Impact 1: Permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition	Yes	High	Permanent habitat loss in combination with similar loss associated with other developments in the region may result in a significant effect.
Impact 2: Temporary Habitat Disturbance to Fish and Shellfish Species and Spawning and / or Nursery Grounds, Including Direct Damage From Repair and Maintenance	No	High	These impacts are of limited spatial and temporal extent, relative to the identified Fish and Shellfish receptor groups within the Fish and Shellfish Ecology Study Area. Management plans will be developed to further mitigate impacts as described within **Table 10-3**.
Impact 3: Increase in local SSC and sediment settlement	No	High	
Impact 4: Release of sequestered contaminants following sediment disturbance	No	High	

Impact	Potential for Cumulative Effects	Data Confidence	Rationale
Impact 5: Impacts on fish and shellfish species as a result of noise and vibration	Yes	High	Underwater noise from other developments within the region have the potential to overlap with impacts produced during operation associated with the Projects.
Impact 6: EMF effects arising from cables	Yes	High	EMF from other developments within the region have the potential to result in a cumulative impact when combined with EMF associated with the Projects.
Impact 7: Reduced fishing pressure within the Array Areas and increased fishing pressure outside of the Array Area	No	High	Impacts associated with fishing pressure are of limited spatial and temporal extent, relative to the identified Fish and Shellfish receptor groups within the Fish and Shellfish Ecology Study Area.
	Decommissioning		
Impact 1: Direct damage (e.g. crushing) and disturbance	No	High	These impacts are of limited spatial and temporal extent, relative to the

Impact	Potential for Cumulative Effects	Data Confidence	Rationale
Impact 2: Habitat loss and / or disturbance to spawning and nursery areas, including the installation of wind turbine foundations, scour protection and cables	No	High	identified Fish and Shellfish receptor groups within the Fish and Shellfish Ecology Study Area. Management plans will be developed to further mitigate impacts as described within **Table 10-3**.
Impact 3: Increase in local SSC and sediment settlement	No	High	
Impact 4: Release of sequestered contaminants following sediment disturbance	No	High	
Impact 5: Impacts on fish and shellfish species as a result of noise and vibration	No	High	Underwater noise from other developments within the region have the potential to overlap with impacts produced during decommissioning associated with the Projects.

10.7.2 Plans/Projects Considered for Cumulative Impacts

302. A high-level list of plans/projects that may result in cumulative effects with the Projects is detailed in **Table 10-23.** The Fish and Shellfish Ecology Study Area has been used to determine the initial list of projects considered for the CEA.

303. Plans / projects have been assigned a tier level between 1 and 7, based on the most recent guidance (see **Chapter 6 EIA Methodology**). For the final CEA at ES, this high-level list will be reviewed and screened to ensure all relevant plans / projects are considered in the final assessment. All listed plans / projects will be re-examined at ES to ensure each assigned tier remains accurate at the time of writing.

304. In addition to other offshore wind farms, the classes of projects that could potentially be considered for the cumulative assessment of infrastructure and other users includes:

- **Marine aggregate extraction;**
- **Oil and gas exploration and extraction;**
- **Sub-sea cables and pipelines; and**
- **Commercial shipping.**

305. With respect to these activities, the cumulative assessment considers them to be part of the baseline conditions for the surrounding area. As such, it is not expected that the Projects will contribute to cumulative effects with the existing activities in the above list, and therefore these have been have not been the subject of further assessment

Table 10-23 High-Level List of Plans/Projects Screened For Further Assessment in the Final CEA

Tier	Plan / Project	Distance to Offshore Development Area (km)
Strategic Plans		
7	East Inshore, North East Inshore, East Offshore and North East Offshore Marine Plans	Within offshore development area
Offshore Wind Farms		
2	Dogger Bank A	7
2	Dogger Bank B	17
3	Dogger Bank C	56
6	Dogger Bank D	68 (estimated)
2	Sofia	34

Tier	Plan / Project	Distance to Offshore Development Area (km)
3	Hornsea 3	20
1	Triton Knoll	73
Carbon Capture and Storage		
3	Northern Endurance CCS	2
7	CCS North Sea Leasing Round – SNS Areas 1 & 3	Within array areas
7	CCS North Sea Leasing Round – SNS Area 5	25
7	CCS North Sea Leasing Round – SNS Area 6	40
7	CCS North Sea Leasing Round – SNS Area 7	6
Subsea Cables		
2	Viking Link Interconnector	29
6	Eastern Link 2	2
7*	Third Eastern Link HVDC cable (TGDC)	Crosses offshore export cable corridor
7*	Fourth Eastern Link HVDC cable (E4L5)	Crosses offshore export cable corridor
4	Scotland England Green Link 2	3.5

**Cable route not yet finalised*

10.8 Potential Monitoring Requirements

306. Monitoring requirements will be described in the In-Principle Monitoring Plan (IPMP). The IPMP will be submitted alongside the DCO application, and is to be further developed and agreed with stakeholders, prior to construction, taking account of the final detailed design of the Projects.

307. Due to the long-term use of the Dogger Bank as a commercial fishing ground, a number of data sources relevant to Fish and Shellfish Ecology are available within the public domain. These data can be sourced from industry, regulatory, and research bodies, and relate to both commercial and non-commercial species across all Fish and Shellfish Ecology receptor groups.

308. Any monitoring requirements would therefore, only be required should a particular species or species be identified as being data deficient in the public domain. At this time no specific monitoring requirements relating to Fish and Shellfish Ecology have been identified.

10.9 Transboundary Effects

309. Transboundary effects are defined as those where the effect passes beyond the UK EEZ into the receiving environment of another European Economic Area (EEA) state or on the interests of another EEA member state (e.g. offshore infrastructure, vessels), either directly or cumulative with neighbouring projects in the area.

310. There is the potential for transboundary effects to occur with regard to Fish and Shellfish Ecology as a result of underwater noise and vibration (e.g. from piling operations or installation of infrastructure).

311. UXO clearance, for a high-order detonation with a donor charge, is not expected to cause mortality and potential mortal injury beyond 890m at 229dB (see section 10.6.1.4 and section 10.6.2.5).

312. Underwater noise with the potential to extend beyond the UK EEZ, into fish and shellfish habitats of the Netherlands, is only anticipated to be generated through piling activities. When considering piling, TTS for the most sensitive fish species (186dB; fish with a swim bladder) is expected to occur at a maximum range of 52km for a stationary receptor.

313. This impact is anticipated to be intermittent and short-term (maximum of five piles installed per 24 hours). Recovery of affected fish and shellfish populations is expected shortly after completion of piling, with a change that is unnoticeable from the natural variation. Due to the short-term nature of the transboundary effects, and that the TTS of any individuals from a given threshold area would be expected to fully recover within the short term (0-1 years), the magnitude of impact is considered negligible.

314. Fish and shellfish receptors in the Dutch EEZ, are at such a distance that exposure is anticipated to be limited and temporary. These receptors are therefore assessed as having a high level of tolerance and adaptability to the effect, and are anticipated to recover to baseline levels within one year. Fish and shellfish receptors are therefore assessed as having a low sensitivity.

315. The negligible adverse magnitude of transboundary effects, combined with the low sensitivity of effect for all receptor groups, results in the assessment that transboundary effects associated with noise and vibration have a **minor adverse** effect, and are therefore not significant in EIA terms.

10.10 Interactions

316. The effects identified and assessed in this chapter have the potential to interact with each other. The areas of potential interaction between effects are presented in **Table 10-24**, **Table 10-25**, and **Table 10-26**. This provides a screening tool for which effects have the potential to interact. **Table 10-27** provides an assessment for each receptor (or receptor group) as related to these impacts.

317. Within **Table 10-27**, the effects are assessed relative to each development phase, to see if multiple effects could increase the significance of the effect upon a receptor. Following this a lifetime assessment is undertaken which considers the potential for effect to affect receptors across all development phases.

Table 10-24 Interactions Between Construction Impacts - Screening

Potential Interactions between Impacts					
Construction					
	Direct damage (e.g. crushing) and disturbance	**Habitat loss and / or disturbance to spawning and nursery areas, including the installation of wind turbine foundations, scour protection and cables**	**Increase in local SSC and sediment settlement**	**Release of sequestered contaminants following sediment disturbance**	**Impacts on fish and shellfish species as a result of noise and vibration**
Direct damage (e.g. crushing) and disturbance		Yes	No	No	No
Habitat loss and / or disturbance to spawning and nursery areas, including the installation of wind turbine foundations, scour protection and cables	Yes		Yes	Yes	Yes
Increase in local SSC and sediment settlement	No	Yes		No	No

Potential Interactions between Impacts					
Construction					
	Direct damage (e.g. crushing) and disturbance	**Habitat loss and / or disturbance to spawning and nursery areas, including the installation of wind turbine foundations, scour protection and cables**	**Increase in local SSC and sediment settlement**	**Release of sequestered contaminants following sediment disturbance**	**Impacts on fish and shellfish species as a result of noise and vibration**
Release of sequestered contaminants following sediment disturbance	No	Yes	No		No
Impacts on fish and shellfish species as a result of noise and vibration	No	Yes	No	No	

Table 10-25 Interactions Between Operation Impacts - Screening

Potential Interactions between Impacts							
Operation							
	Permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition	**Temporary Habitat Disturbance to Fish and Shellfish Species and Spawning and / or Nursery Grounds, Including Direct Damage From Repair and Maintenance**	**Increase in local SSC and sediment settlement**	**Release of sequestered contaminants following sediment disturbance**	**Impacts on fish and shellfish species as a result of noise and vibration**	**EMF effects arising from cables**	**Reduced fishing pressure within the Array Areas and increased fishing pressure outside of the Array Area**
Permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition		Yes	Yes	Yes	Yes	Yes	Yes

Potential Interactions between Impacts							
Operation							
	Permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition	**Temporary Habitat Disturbance to Fish and Shellfish Species and Spawning and / or Nursery Grounds, Including Direct Damage From Repair and Maintenance**	**Increase in local SSC and sediment settlement**	**Release of sequestered contaminants following sediment disturbance**	**Impacts on fish and shellfish species as a result of noise and vibration**	**EMF effects arising from cables**	**Reduced fishing pressure within the Array Areas and increased fishing pressure outside of the Array Area**
Temporary Habitat Disturbance to Fish and Shellfish Species and Spawning and / or Nursery Grounds, Including Direct Damage From Repair and Maintenance	Yes		Yes	Yes	Yes	Yes	Yes

Potential Interactions between Impacts							
Operation							
	Permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition	**Temporary Habitat Disturbance to Fish and Shellfish Species and Spawning and / or Nursery Grounds, Including Direct Damage From Repair and Maintenance**	**Increase in local SSC and sediment settlement**	**Release of sequestered contaminants following sediment disturbance**	**Impacts on fish and shellfish species as a result of noise and vibration**	**EMF effects arising from cables**	**Reduced fishing pressure within the Array Areas and increased fishing pressure outside of the Array Area**
Increase in local SSC and sediment settlement	Yes	Yes		No	No	No	No
Release of sequestered contaminants following sediment disturbance	Yes	Yes	No		No	No	No

Potential Interactions between Impacts							
Operation							
	Permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition	**Temporary Habitat Disturbance to Fish and Shellfish Species and Spawning and / or Nursery Grounds, Including Direct Damage From Repair and Maintenance**	**Increase in local SSC and sediment settlement**	**Release of sequestered contaminants following sediment disturbance**	**Impacts on fish and shellfish species as a result of noise and vibration**	**EMF effects arising from cables**	**Reduced fishing pressure within the Array Areas and increased fishing pressure outside of the Array Area**
Impacts on fish and shellfish species as a result of noise and vibration	Yes	Yes	No	No		Yes	No
EMF effects arising from cables	Yes	Yes	No	No	Yes		No

Potential Interactions between Impacts							
Operation							
	Permanent loss of habitat and / or change in habitat type as a result of changes in sub-strate composi-tion	**Temporary Habi-tat Disturbance to Fish and Shell-fish Species and Spawning and / or Nursery Grounds, Includ-ing Direct Dam-age From Repair and Maintenance**	**Increase in local SSC and sedi-ment set-tlement**	**Release of seques-tered con-taminants following sediment disturb-ance**	**Impacts on fish and shell-fish spe-cies as a result of noise and vibration**	**EMF ef-fects aris-ing from cables**	**Reduced fish-ing pressure within the Ar-ray Areas and increased fishing pres-sure outside of the Array Area**
Reduced fish-ing pressure within the Array Areas and in-creased fishing pressure out-side of the Ar-ray Area	Yes	Yes	No	No	No	No	

Table 10-26 Interactions Between Decommissioning Impacts - Screening

Potential Interactions between Impacts					
Decommissioning					
	Direct damage (e.g. crushing) and disturbance	**Habitat loss and / or disturbance to spawning and nursery areas, including the installation of wind turbine foundations, scour protection and cables**	**Increase in local SSC and sediment settlement**	**Release of sequestered contaminants following sediment disturbance**	**Impacts on fish and shellfish species as a result of noise and vibration**
Direct damage (e.g. crushing) and disturbance		Yes	No	No	No
Habitat loss and / or disturbance to spawning and nursery areas, including the installation of wind turbine foundations, scour protection and cables	Yes		Yes	Yes	Yes
Increase in local SSC and sediment settlement	No	Yes		No	No

Potential Interactions between Impacts					
Decommissioning					
	Direct damage (e.g. crushing) and disturbance	**Habitat loss and / or disturbance to spawning and nursery areas, including the installation of wind turbine foundations, scour protection and cables**	**Increase in local SSC and sediment settlement**	**Release of sequestered contaminants following sediment disturbance**	**Impacts on fish and shellfish species as a result of noise and vibration**
Release of sequestered contaminants following sediment disturbance	No	Yes	No		No
Impacts on fish and shellfish species as a result of noise and vibration	No	Yes	No	No	

Table 10-27 Interaction Between Impacts - Phase and Lifetime Assessment

Receptor	Highest Significance Level				
	Construction	**Operation**	**Decommissioning**	**Phase Assessment**	**Lifetime Assessment**
Fish and Shellfish	Minor Adverse	Minor Adverse	Minor Adverse	No greater than individually assessed impacts: Permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition, may increase the potential for interactions with other impacts within the operations phase of the project, due to long-term operational period. However, all other potential impacts are of comparatively reduced duration, and are localised nature. Further, all potential impacts have been assessed as not significant (minor adverse to negligible). Therefore, none of the potential interactions identified with respect to Fish and Shellfish Ecology are expected to result in an increased significance of effect than has been assessed throughout this chapter.	No greater than individually assessed impacts: As determined within the phase assessment, all potential impacts have been assessed as not significant (minor adverse to negligible). Impacts are of limited temporal and / or spatial scale, limited the potential for inter-impact interactions across phases, including construction, operation, and decommissioning.

10.11 Inter-relationships

318. For Fish and Shellfish Ecology potential inter-relationships between other topics assessed within this PEIR including **Chapter 8 Marine Physical Environment, Chapter 9 Benthic Habitats, Chapter 11: Marine Mammals,** and **Chapter 13 Commercial Fisheries**. A summary of the potential inter-relationships between these topics is provided in **Table 10-28**.

Table 10-28 Fish and Shellfish Ecology Inter-relationships

Topic and Description	Related Chapter	Where Addressed in this Chapter	Rationale
Construction			
Benthic Habitats – Prey availability	**Chapter 9 Benthic Habitats**	This chapter informs **Chapter 9 Benthic Habitats**	The benthic environment hosts a wide range of prey species utilised by fish and shellfish receptors. Impacts on local benthic ecology may therefore lead to impacts on Fish and Shellfish Ecology.
Marine Mammals – Prey availability	**Chapter 11 Marine Mammals**	This chapter informs **Chapter 11 Marine Mammals**	Fish and shellfish species act as a prey species for a wide range of marine mammal receptors. Impacts on Fish and Shellfish Ecology may therefore lead to impacts on Marine Mammals.
Commercial Fisheries – Stock availability	**Chapter 13 Commercial Fisheries**	This chapter informs **Chapter 13 Commercial Fisheries**	Commercial fisheries rely on fish and shellfish availability. Impacts on Fish and Shellfish Ecology may therefore lead to impacts of Commercial Fisheries.
Suspended sediments and deposition	**Chapter 8 Marine Physical Environment**	Impacts as a result of suspended sediment and deposition are assessed in sections 10.6.1.2 and 10.6.2.3.	Changes in SSC are assessed in **Chapter 8 Marine Physical Environment**. Changes in SSC and associated sediment settlement could have potential impacts on Fish and Shellfish Ecology.

Topic and Description	Related Chapter	Where Addressed in this Chapter	Rationale
Re-mobilisation of contaminated sediments	**Chapter 8 Marine Physical Environment**	Re-mobilisation of contaminated sediments during construction is assessed in sections 10.6.1.3 and 10.6.2.4.	**Chapter 8 Marine Physical Environment** provides an assessment of the potential for contaminants to be present in the Study Area. Re-mobilisation of contaminated sediments and associated deposition could have potential impacts on Fish and Shellfish Ecology.
Operation			
Benthic Habitats – Prey availability	**Chapter 9 Benthic Habitats**	This chapter informs **Chapter 9 Benthic Habitats**	The benthic environment hosts a wide range of prey species utilised by fish and shellfish receptors. Impacts on local benthic ecology may therefore lead to impacts on Fish and Shellfish Ecology.
Marine Mammals – Prey availability	**Chapter 11 Marine Mammals**	This chapter informs **Chapter 11 Marine Mammals**	Fish and shellfish species act as a prey species for a wide range of marine mammal receptors. Impacts on Fish and Shellfish Ecology may therefore lead to impacts on Marine Mammals.
Commercial Fisheries – Stock availability	**Chapter 13 Commercial Fisheries**	This chapter informs **Chapter 13 Commercial Fisheries**	Commercial fisheries rely on fish and shellfish availability. Impacts on Fish and Shellfish Ecology may therefore lead to impacts of Commercial Fisheries.
Suspended sediments and settlement	**Chapter 8 Marine Physical Environment**	Impacts as a result of suspended sediment and deposition are assessed in sections 10.6.1.2 and 10.6.2.3.	Changes in SSC are assessed in **Chapter 8 Marine Physical Environment**. Changes in SSC and associated sediment deposition could have potential impacts on Fish and Shellfish Ecology.

Topic and Description	Related Chapter	Where Addressed in this Chapter	Rationale
Re-mobilisation of contaminated sediments	**Chapter 8 Marine Physical Environment**	Re-mobilisation of contaminated sediments during construction is assessed in sections 10.6.1.3 and 10.6.2.4.	**Chapter 8 Marine Physical Environment** provides an assessment of the potential for contaminants to be present in the Study Area. Re-mobilisation of contaminated sediments and associated deposition could have potential impacts on Fish and Shellfish Ecology.
Decommissioning			
Inter-relationships for impacts during the decommissioning phase will be the same as those outlined above for the construction phase.			

10.12 Summary

319. This chapter has provided a characterisation of the existing environment for Fish and Shellfish Ecology, based on existing data.

320. The assessment has determined that there will be up to **minor adverse** effects during the construction, operation and decommissioning phases of DBS East and DBS West, both in isolation, and together. Effects are generally localised in nature, being restricted to the Fish and Shellfish Ecology Study Area, and in many cases to just the area immediately surrounding project infrastructure.

321. At ES stage, consideration will be given to any changes in worst case scenario determined via further data collection and / or modelling, including but not limited to sediment plume modelling and sediment contamination data.

322. A summary of the significance of effect assessment for Fish and Shellfish Ecology is provided within **Table 10-29**.

Table 10-29 Summary of Potential Likely Significant Effects on Fish and Shellfish Ecology

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Construction						
Temporary habitat disturbance to fish and shellfish species and spawning and / or nursery grounds, including direct damage and installation of wind turbine foundations, scour protection, and cables	All	Low – Medium	Negligible	Negligible – Minor Adverse	N/A	Negligible – Minor Adverse
Increase in local SSC and sediment settlement		Negligible – Medium	Low	Negligible – Minor Adverse	N/A	Negligible – Minor Adverse
Release of sequestered contaminants following sediment disturbance		Low	Negligible	Negligible	N/A	Negligible
Impacts on fish and shellfish species as a result of noise and vibration		Low – Medium	Low	Minor Adverse	N/A	Minor Adverse

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Effect on fish stocks of reduced fishing pressure within the Array Areas, and increased fishing pressure outside of the Array Area.		Low	Low	Minor Adverse	N/A	Minor Adverse
Operation						
Permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition	All	Negligible – Medium	Low	Negligible – Minor Adverse	N/A	Negligible – Minor Adverse
Temporary habitat disturbance to fish and shellfish species and spawning and / or nursery grounds, including direct damage from repair and maintenance	All	Negligible – Medium	Low	Negligible – Minor Adverse	N/A	Negligible – Minor Adverse
Increase in local SSC and sediment settlement	All	Negligible – Medium	Low	Negligible – Minor Adverse	N/A	Negligible – Minor Adverse

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Release of sequestered contaminants following sediment disturbance		Low	Negligible	Negligible	N/A	Negligible
Impacts on fish and shell-fish species as a result of noise and vibration		Low – Medium	Negligible	Minor Adverse	N/A	Minor Adverse
EMF effects arising from cables		Negligible – Medium	Negligible	Negligible – Minor Adverse	N/A	Negligible – Minor Adverse
Effect on fish stocks of re-duced fishing pressure within the Array Areas, and increased fishing pressure outside of the Ar-ray Area		Negligible	Negligible	Negligible	N/A	Negligible

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Decommissioning						
Temporary habitat disturbance to fish and shellfish species and spawning and / or nursery grounds, including direct damage and installation of wind turbine foundations, scour protection, and cables	All	Low – Medium	Negligible	Negligible – Minor Adverse	N/A	Negligible – Minor Adverse
Increase in local SSC and sediment settlement	All	Negligible – Medium	Low	Negligible – Minor Adverse	N/A	Negligible – Minor Adverse
Release of sequestered contaminants following sediment disturbance	All	Low	Negligible	Negligible	N/A	Negligible
Impacts on fish and shellfish species as a result of noise and vibration	All	Low	Negligible	Negligible	N/A	Negligible

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Effect on fish stocks of reduced fishing pressure within the Array Areas, and increased fishing pressure outside of the Array Area.		Low	Low	Minor Adverse	N/A	Minor Adverse

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