The Great Grid Upgrade

Sea Link

Preliminary Environmental Information Report

Volume: 1

Part 4 Offshore Scheme

Chapter 4 Fish and Shellfish

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Contents

Table of Images

Table of Tables

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4.4 Fish and Shellfish

4.4.1 Introduction

4.4.1.1 This chapter of the Preliminary Environmental Information Report (PEIR) presents information about the preliminary environmental assessment of the likely significant effects on fish and shellfish identified to date, that could result from the Proposed Project (as described in **Volume 1, Part 1, Chapter 4 Description of the Proposed Project**).

4.4.1.2 This chapter describes the methodology used, the datasets that have informed the preliminary assessment, baseline conditions, mitigation measures and the preliminary fish and shellfish residual significant effects that could result from the Proposed Project.

4.4.1.3 The draft Order Limits, which illustrate the boundary of the Proposed Project, are illustrated on **Figure 1.1.1 Draft Order Limits** and the Offshore Scheme Boundary is illustrated on **Figure 1.1.4 Offshore Scheme Boundary**.

4.4.1.4 This chapter should be read in conjunction with:

- **Volume 1, Part 1, Chapter 4, Description of the Proposed Project**;
- **Volume 1, Part 1, Chapter 5, PEIR Approach and Methodology**;
- **Volume 1, Part 1, Chapter 6, Scoping Opinion and EIA Consultation**;
- **Volume 1, Part 4, Chapter 1, Evolution of the Offshore Scheme**;
- **Volume 1, Part 4, Chapter 2, Physical Environment;**
- **Volume 1, Part 4, Chapter 3, Benthic Ecology;** and
- **Volume 1, Part 4, Chapter 9, Commercial Fisheries**

4.4.1.5 This chapter is supported by the following figures:

- **Volume 3, Figure 4.4.1. Study Area;**
- **Volume 3, Figure 4.4.2. Relevant designated sites for the protection of fish and shellfish;**
- **Volume 3, Figure 4.4.3. Rivers of known importance to migratory salmon within the study area;**
- **Volume 3, Figure 4.4.4. Herring larvae spawning and nursery grounds;**
- **Volume 3, Figure 4.4.5. Sandeel larvae spawning and nursery grounds;**
- **Volume 3, Figure 4.4.6. Abundance of Southern North Sea herring larvae and eggs recorded during the IHLS Survey Interpolated Contour Map – 2008 to 2017 (maximum number per m^2);**
- **Volume 3, Figure 4.4.7. Potential suitable herring spawning habitat within the Offshore Scheme;** and

- **Volume 3, Figure 4.4.8. Potential suitable sandeel spawning habitat within the Offshore Scheme.**

4.4.1.6 This chapter is supported by the following appendices:

- **Volume 2, Appendix 1.4.A, Outline Code of Construction Practice;**
- **Volume 2, Appendix 1.4.F, Schedule of Environmental Commitments;** and
- **Volume 2, Appendix 4.8.B, Electromagnetic Deviation Study.**

4.4.2 Regulatory and Planning Context

4.4.2.1 This section sets out the legislation and planning policy that is relevant to the preliminary fish and shellfish assessment. A full review of compliance with relevant national and local planning policy will be provided within the Planning Statement that will be submitted as part of the application for Development Consent.

4.4.2.2 Policy generally seeks to minimise effects of development on fish and shellfish and to avoid significant adverse effects. This applies particularly to designated sites, including in this case several Marine Conservation Zones (MCZ) for which fish and shellfish are qualifying features, but also to other suitable fish and shellfish habitat outside of designated areas where there is an aspiration in policy terms to conserve and enhance such habitats, particularly those for which features are of high value or particularly sensitive.

Legislation

Marine and Coastal Access Act 2009

4.4.2.3 Marine and Coastal Access Act 2009 (Ref 4.1) provides the legal mechanism to help ensure clean, healthy, safe, and productive and biologically diverse oceans and seas.

The Conservation of Habitats and Species Regulations 2017 (amended 2019)

4.4.2.4 The Conservation of Habitats and Species Regulations 2017 (Ref 4.2) (amended 2019 (Ref 4.3)) transposes the Habitats Directive (92/43/EEC) and implements provisions from the Birds Directive (2009/147/EC) into UK legislation out to the 12 nautical mile (NM) limit.

The Conservation of Offshore Marine Habitats and Species Regulations 2017

4.4.2.5 The Conservation of Offshore Marine Habitats and Species Regulations 2017(Ref 4.4) applies within the UK Offshore Marine Area (beyond the 12 NM limit).

The Wildlife and Countryside Act 1981

4.4.2.6 The Wildlife and Countryside Act 1981 (Ref 4.5) (as amended) includes provisions relating to nature conservation.

The Marine Strategy Regulations 2010

4.4.2.7 The Marine Strategy Regulations 2010 (Ref 4.6) originally implemented the Marine Strategy Framework Directive (2008) and at the end of the Brexit transition period, the Marine Strategy Framework Regulations 2010 became retained EU law.

The Water Environment (Water Framework Directive (England and Wales) Regulations 2017

4.4.2.8 The Water Environment (Water Framework Directive (England and Wales)) Regulations 2017 (Ref 4.7) was originally introduced to implement the Water Framework Directive 2000 (2000/60/EC) and now transposes the EU Water Framework Directive (2000/60/EC) into UK legislation.

Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006

4.4.2.9 Section 41 of the NERC 2006 (Ref 4.8) imposes a requirement on the Secretary of State to publish a list of species of principal importance for the purpose of conservation of biodiversity.

The Eels (England and Wales) Regulations 2009

4.4.2.10 The Eels (England and Wales) Regulations 2009 (Ref 4.9) implement Council Regulation (EC) No 1100/2007 (EC) No 1100/2007 establishing measures for the recovery of the stock of European eel including providing for the free passage of eels. This is now part of the body of retained EU law.

The Salmon and Freshwater Fisheries Act 1975

4.4.2.11 The Salmon and Freshwater Fisheries Act 1975 (Ref 4.10), which relates to the protection of salmon and freshwater fisheries, as well as preventing the obstruction of fish migration routes.

Environment Act 2021

4.4.2.12 Environment Act 2021 (Ref 4.11) sets clear statutory targets for the recovery of the natural world in four priority areas: air quality, biodiversity, water and waste, and includes the introduction of Biodiversity Net Gain (BNG).

National Policy

National Policy Statements

4.4.2.13 National Policy Statements (NPSs) set out the primary policy tests against which the application for a Development Consent Order (DCO) for the Proposed Project would be considered. A review of the NPS was announced in the 2020 Energy white paper: Powering our net zero future. This review was to ensure the NPSs were brought up to date to reflect the policies set out in the white paper. The below information reflects these updates currently under consultation. Table 4.4.1, Table 4.4.2 and Table 4.4.3 below provides details of the elements of NPS (EN-1) Overarching National Policy Statement for Energy (Ref 4.12), NPS for Renewable Energy Infrastructure (EN-3) (Ref 4.13) and NPS for Electricity Networks Infrastructure (EN-5) (Ref 4.14) that are relevant to this chapter, and how and where they are covered in the PEIR or will be covered within the Environmental Statement (ES).

Table 4.4.1: NPS EN-1 requirements relevant to fish and shellfish (Update for consultation 2023).

NPS EN-1 section	Where this is covered in the PEIR
4.4.7 "... *Applicants are encouraged to approach the marine licensing regulator (MMO in England and Natural Resources Wales in Wales) in pre-application, to ensure that they are aware of any needs for additional marine licenses alongside their DCO application".*	Consultation with Natural England and the MMO was undertaken during the scoping stage and is ongoing. Relevant comments are provided in Section 4.4.3.
4.4.8…"*Applicants for a development consent order must take account of any relevant Marine Plans and are expected to complete a Marine Plan assessment as part of their project development, using this information to support an application for development consent*"	Marine Plans are identified in Table 4.4.5 and considered in Section 4.4.9 Preliminary Assessment of Effects.
4.4.9…"*Applicants are encouraged to refer to Marine Plans at an early stage, such as in preapplication, to inform project planning, for example to avoid less favourable locations as a result of other uses or environmental constraints*".	Marine Plans are identified in Table 4.4.5 and considered in Section 4.4.9 Preliminary Assessment of Effects.
5.4.17 (part)"... *Where the development is subject to EIA the applicant should ensure that the ES clearly sets out any effects on internationally, nationally, and locally designated sites of ecological or geological conservation importance (including those outside England), on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity, including irreplaceable habitats".*	All effects to designated sites and protected species are detailed in Section 4.4.9 of this PEIR Chapter. This will be discussed further in the ES.
5.4.18…"*The applicant should provide environmental information proportionate to the infrastructure where EIA is not required to help the Secretary of State consider thoroughly the potential effects of a proposed project".*	Consultation with Natural England was undertaken during the scoping stage. Relevant comments are provided in Section 4.4.3.
5.4.19 *"… The applicant should show how the project has taken advantage of opportunities to conserve and enhance biodiversity and geological conservation interests".*	The Proposed Project will adopt a range of measures to conserve biodiversity as detailed in Section 4.4.8 Mitigation. Opportunities for enhancement will be considered where required.
5.4.22 (part)..." *The design of Energy NSIP proposals will need to consider the movement of mobile /migratory species such as birds, fish and marine and terrestrial mammals and their*	Mobile and migratory fish, including those that are features of conservation importance for designated sites and/or

NPS EN-1 section	Where this is covered in the PEIR
potential to interact with infrastructure. As energy infrastructure could occur anywhere within England and Wales, both inland and onshore and offshore, the potential to affect mobile and migratory species across the UK and more widely across Europe (transboundary effects) requires consideration, depending on the location of development."	protected species have been considered in both the initial baseline (Section 4.4.7) and preliminary assessment of effects (Section 4.4.9) and in **Part 5, Chapter 3, Habitat Regulations Screening Report.**
5.3.18 *"… The applicant should include appropriate mitigation measures as an integral part of the proposed development".*	Mitigation measures of relevance to fish and shellfish are described in section 4.4.8.
5.4.23 *"…Energy projects will need to ensure vessels used by the project follow existing regulations and guidelines to manage ballast water".*	Mitigation measures of relevance to fish and shellfish are described in section 4.4.8.

Table 4.4.2: NPS EN-3 requirements relevant to fish and shellfish (Update for consultation 2023).

NPS EN-3 section	Where this is covered in the PEIR
3.8.129 "Fish in the context of this NPS also includes elasmobranchs (sharks and rays) and shellfish (e.g., crabs)."	Elasmobranchs and shellfish are considered in the baseline (section 4.4.7) and the preliminary assessment of effects (section 4.4.9).
3.8.130 "There is the potential for the construction and decommissioning phases, including activities occurring both above and below the seabed, to impact fish communities, migration routes, spawning activities and nursery areas of particular species."	The impact of all project phases is considered in section 4.4.9.
3.8.131 "There are potential impacts associated with energy emissions into the environment (e.g. noise or electromagnetic fields (EMF)), as well as potential interaction with seabed sediments."	Impact pathways associated with energy transmission, including EMF, are considered in section 4.4.9.
3.8.132 "The applicant should identify fish species that are the most likely receptors of impacts with respect to: • *spawning grounds;* • *nursery grounds;* • *feeding grounds;* • *over-wintering areas for crustaceans;* • *migration routes; and*	All groups of fish and shellfish are considered in the baseline, with reference to the various life stages and habitats listed. (section 4.4.7).

NPS EN-3 section	Where this is covered in the PEIR
• *protected sites."*	
3.8.133 "Applicant assessments should identify the potential implications of underwater noise from construction and unexploded ordnance including, where possible, implications of predicted construction and soft start noise levels in relation to mortality, permanent threshold shift (PTS), temporary threshold shift (TTS) and disturbance and addressing both sound pressure and particle motion) and EMF on sensitive fish species."	The impacts of all noise and EMF sources are considered in relation to each of the types of impact listed. These are considered in section 4.4.9.

Table 4.4.3: NPS EN-5 requirements relevant to fish and shellfish (Update for consultation 2023).

NPS EN-5 section	Where this is covered in the PEIR
2.2.10 "...*As well as having duties under Section 9 of the Electricity Act 1989, (in relation to developing and maintaining an economical and efficient network), applicants must take into account Schedule 9 to the Electricity Act 1989, which places a duty on all transmission and distribution licence holders, in formulating proposals for new electricity networks infrastructure, to "have regard to the desirability of preserving natural beauty, of conserving flora, fauna and geological or physiographical features of special interest and of protecting sites, buildings and objects of architectural, historic or archaeological interest; and …do what [they] reasonably can to mitigate any effect which the proposals would have on the natural beauty of the countryside or on any such flora, fauna, features, sites, buildings or objects".*	All mitigation of relevance to fish and shellfish is discussed in section 4.4.8.
2.13.15 *"…The sensitivities of many coastal locations and of the marine environment as well as the potential environmental, community and other impacts in neighbouring onshore areas must be considered in the identification onshore connection points."*	Areas of high sensitivity for fish and shellfish, such as spawning grounds, are considered and assessed in the chapter.
2.14.2..."*In the assessments of their designs, applicants should demonstrate how environmental, community and other impacts have been considered and how adverse impacts have followed the mitigation hierarchy i.e. avoidance, reduction and mitigation of adverse impacts*	Mitigation, embedded measures, and control and management measure to minimise environmental impacts to fish and shellfish are discussed in section

NPS EN-5 section	Where this is covered in the PEIR
through good design; and how enhancements to the environment post construction will be achieved including demonstrating consideration of how proposals can contribute towards biodiversity net gain (as set out in Section 4.5 of EN-1 and the Environment Act 2021), as well as wider environmental improvements in line with the Environmental Improvement Plan and environmental targets (paragraph 4.2.29 of EN-1). In addition, all applicants are encouraged to demonstrate how the construction planning for the proposals has been coordinated with that for other similar projects in the area on a similar timeline".	4.4.8; a preliminary assessment of effects, which determine requirements for BNG, is covered in section 4.4.9.

National Planning Policy Framework

4.4.2.14 The National Planning Policy Framework (NPPF) has the potential to be considered important and relevant to the Secretary of State (SoS) consideration of the Proposed Project. Biodiversity is stated as one of the factors contributing to the core objectives of sustainable economic development. Table 4.4.4 below provides details of the elements of the NPPF that are relevant to this chapter, and how and where they are covered in the PEIR or will be covered within the ES.

Table 4.4.4: NPPF requirements relevant to fish and shellfish.

NPPF section	Where this is covered in the PEIR
Paragraph 175 *"Plans should: distinguish between the hierarchy of international, national and locally designated sites; allocate land with the least environmental or amenity value, where consistent with other policies in this Framework; take a strategic approach to maintaining and enhancing networks of habitats and green infrastructure; and plan for the enhancement of natural capital at a catchment or landscape scale across local authority boundaries*".	All designated sites in place for the protection of fish and shellfish in the Study Area are presented in section 4.4.7
Paragraph 179 *"To protect and enhance biodiversity and geodiversity, plans should: Identify, map and safeguard components of local wildlife-rich habitats and wider ecological networks, including the hierarchy of international, national and locally designated sites of importance for biodiversity; wildlife corridors and stepping stones that connect them; and areas identified by national and local partnerships for habitat management, enhancement, restoration or creation; [and]*	The species, habitats and relevant designated sites are detailed in section 4.4.7.

NPPF section	Where this is covered in the PEIR
promote the conservation, restoration and enhancement of priority habitats, ecological networks and the protection and recovery of priority species; and identify and pursue opportunities for securing measurable net gains for biodiversity."	
Paragraph 180 *"When determining planning applications, local planning authorities should apply the following principles: if significant harm to biodiversity resulting from a development cannot be avoided (through locating on an alternative site with less harmful impacts), adequately mitigated, or, as a last resort, compensated for, then planning permission should be refused; [and] development on land within or outside a Site of Special Scientific Interest, and which is likely to have an adverse effect on it (either individually or in combination with other developments), should not normally be permitted. The only exception is where the benefits of the development in the location proposed clearly outweigh both its likely impact on the features of the site that make it of special scientific interest, and any broader impacts on the national network of Sites of Special Scientific Interest; [and] development whose primary objective is to conserve or enhance biodiversity should be supported; while opportunities to improve biodiversity in and around developments should be integrated as part of their design, especially where this can secure measurable net gains for biodiversity or enhance public access to nature where this is appropriate."*	Potential impacts in relation to the biodiversity of fish and shellfish are considered in this chapter. With regard to SSSIs, there are none designated for the protection of fish and shellfish features.
Paragraph 181 *"The following should be given the same protection as habitats sites: possible Special Areas of Conservation; [and] listed or proposed Ramsar sites; [and] sites identified, or required, as compensatory measures for adverse effects on habitats sites, potential Special Protection Areas, possible Special Areas of Conservation, and listed or proposed Ramsar sites."*	The only sites present in the Study Area that are of relevance to fish and shellfish are Marine Conservation Zones.

National Planning Practice Guidance

4.4.2.15 This PEIR Chapter has also followed National Planning Practice Guidance for the Natural Environment (Department for Levelling Up, Housing and Communities, and Ministry of housing, Communities and Local Government, 2016), which describes how biodiversity and ecosystems should be taken into account, for the purpose of conserving biodiversity. The PEIR Chapter follows guidance on evidence required, such as location of designated sites and the distribution and consideration of protected

and priority species. In addition, guidance has been followed applying policy to avoid, mitigate or compensate for significant harm to biodiversity, to ensure that project impacts do not cause adverse effects to fish and shellfish.

Marine Planning Policy

The following marine plans are considered relevant to a study of fish and shellfish and have informed the assessment of preliminary effects in this chapter:

- The UK Marine Policy Statement (MPS), which was adopted in 2011 and provides the policy framework for the preparation of marine plans and establishes how decisions affecting the marine area should be made (Ref 4.15);
- East Inshore and East Offshore Marine Plan (Ref 4.16); and
- South-East Inshore Marine Plan (Ref 4.17).

Table 4.4.5: Marine Planning Policies relevant to fish and shellfish.

Marine Plan	Where this is covered in the PEIR
The UK MPS	In line with policy objectives in the MPS, this PEIR Chapter has taken into consideration measures that can be taken to avoid biodiversity loss and has attached appropriate weight to the designated sites (MCZs) which are at risk of impact from the Project. Species and habitats of principal importance have also been considered, in addition to those which are qualifying features of the sites listed in section 4.4.7.
East Inshore and East Offshore Marine Plan	Several policies in the East Inshore and East Offshore Marine Plan relate to fish and shellfish, and state that proposals occurring within fish or shellfish habitat, or with the potential to cause adverse impacts to fish and shellfish habitat, should avoid, minimise and mitigate adverse impacts so that they are no longer significant. All preliminary impacts associated with the Offshore Scheme have been assessed in section 4.4.9, with embedded mitigation and additional mitigation measures in place, described in section 4.4.8.
South-East Inshore Marine Plan	Several policies in the South East Inshore Marine Plan relate to fish and shellfish, and state that proposals occurring within fish or shellfish habitat, or with the potential to cause adverse impacts to fish and shellfish habitat, should avoid, minimise and mitigate adverse impacts so that they are no longer significant. All preliminary impacts associated with the Offshore Scheme have been assessed in section 4.4.9, with embedded mitigation and additional mitigation measures in place, described in section 4.4.8 to avoid, minimise and mitigate such impacts.

Local Planning Policy

4.4.2.16 The intertidal area of the Offshore Scheme lies within the jurisdiction of Suffolk County Council, East Suffolk Council, Suffolk Coastal Local Plan, Kent County Council and within the boundary of Thanet District Council Local Plan and Dover District Local Plan. There are no additional Local Plan policies which are relevant to fish and shellfish for the Offshore Scheme.

4.4.3 Scoping Opinion and Consultation

Scoping

4.4.3.1 A Scoping Report (Ref 4.18) for the Proposed Project was issued to the Planning Inspectorate (PINS) on 24 October 2022 and a Scoping Opinion (Ref 4.19) was received from the SoS on 1 December 2022. Table 4.4.6 sets out the comments raised in the Scoping Opinion and how these have been addressed in this PEIR or will be addressed within the ES. The Scoping Opinion takes account of responses from prescribed consultees as appropriate.

Table 4.4.6: Comments raised in the Scoping Opinion

ID	Inspectorate's comments	Response
5.3.1	The Scoping Report seeks to scope this matter [*Impacts on spawning grounds for Dover sole, lemon sole, whiting and sprat*] out on the grounds that these species are pelagic spawners which release eggs into the water column, leading to the eggs being transported away by water movement. The Inspectorate notes that these species have not been highlighted as being of particular concern by any of the consultees and therefore agrees that this matter can be scoped out of further assessment.	Agreed. Impacts on these species have not been considered further in this PEIR Chapter.
5.3.2	The Scoping Report seeks to scope this matter [*effect of HDD drilling fluids on marine water quality*] out because the proposed mitigation measures include a commitment to only use inert, biodegradable drilling fluids which would be disposed of at a licensed disposal site. The Inspectorate agrees that this matter can be scoped out of further assessment. However, as noted in point 2.1.6 above, the ES should provide information on the mitigation measures relied on to avoid likely significant effects, including the measures which would be employed in	Agreed. The effects on marine water quality from use of drilling fluids during construction have not been considered further in this PEIR Chapter. A full list of mitigation measures used to avoid likely significant effects has been detailed in section 4.4.84.4.7.127 and will also be included in the ES.

ID	Inspectorate's comments	Response
	the event of an accidental leak of drilling fluids.	
5.3.3	The Scoping Report seeks to scope out this matter [*leaks and spills from vessels*] on the grounds that the measures contained in the CoCP would make the risk of accidental spills/leaks negligible. The Inspectorate agrees that, provided the measures to mitigate the risks of leaks and spills are clearly described in the ES and secured in the dDCO [draft DCO], this matter can be scoped out of further assessment.	Agreed. Effects from leaks and spills from vessels during all phases have not been considered further in this PEIR Chapter. A full list of mitigation measures used to avoid likely significant effects has been detailed in section 4.4.8 and will also be included in the ES and in the dDCO.
5.3.4	The Scoping Report states that cable thermal emissions have been scoped in because of the potential to alter community structure within the sediment. However, it also then states that cables have negligible capacity to heat the overlying water column. The Inspectorate has interpreted this as meaning that effects from thermal heating of the water column would not be assessed and agrees that this matter can be scoped out of further assessment.	Agreed. Effects from thermal emissions on the water column have not been considered further in this PEIR Chapter.
5.3.5	The Scoping Report cites published research in support of the position that while benthic invertebrates (including shellfish) may be able to detect EMF changes, significant interaction is considered to be very unlikely. The Inspectorate agrees that this matter can be scoped out of further assessment.	EMF emissions in relation to shellfish (these species are benthic invertebrates) has been scoped in for further assessment in section 4.4.9.
5.3.6	The study area shown on **Figure 4.4.1 Study Area** of the Scoping Report is stated to cover the ZoI for the Proposed Development. However, the advice from the Marine Management Organisation (MMO) (see Appendix 2 of this Opinion) is that the spawning grounds of the Thames/Blackwater herring should also be included in the assessments in the ES. Accordingly, the study area for this aspect should be extended to include the spawning grounds for this species at Herne Bay	The Study Area has now been extended to cover Herne Bay, and Eagle Bank and Osea Island in the Black Water Estuary. This has been discussed in section 4.4.7. A detailed analysis of herring spawning grounds will be undertaken, and the study area for this analysis will be agreed with the

ID	Inspectorate's comments	Response
	and at the Eagle Bank and Osea Island in the Blackwater Estuary. The Applicant should seek to agree the extent of the study area with relevant stakeholders, including the MMO.	MMO and relevant stakeholders at the ES stage.
5.3.7	The Scoping Report states that in addition to a screening distance of 50km, a regional approach will also be used to scope in any designated sites beyond this distance. The Scoping Report does not explain how this regional approach would be employed to decide which additional sites could be affected. The Applicant is advised to agree which designated sites should be included with relevant stakeholders; the ES should explain how these sites have been identified. The Applicant's attention is drawn to the comments from Natural England on potential impacts on migratory fish in Appendix 2 of this Opinion.	The updated approach to screening, particularly for migratory fish species in designated sites is detailed in section 4.4.6 of this PEIR chapter. Comments from Natural England have been considered when screening in designated sites. A meeting to discuss fish and shellfish scoping opinion comments was attended on the 31 May 2023.
5.3.8	The Inspectorate notes that the advice from Natural England identifies several other species which they consider should be included in the assessment in the ES. The Applicant should seek to agree which species should be included in the assessment with relevant stakeholders; supporting evidence of this agreement should be provided in the ES.	The species identified by Natural England have been reviewed. Stakeholders will be consulted on this matter with supporting evidence provided at the ES stage. A meeting to discuss fish and shellfish scoping opinion comments was attended on the 31 May 2023.
5.3.9	The Inspectorate notes that the data referred to in identifying spawning/nursery grounds is at least 20 years old. The ES should be based on the most up to date information available – the Applicant's attention is drawn to the advice from Natural England on this point (see Appendix 2 of this Opinion). The Applicant should seek to agree the appropriate baseline data with relevant stakeholders.	Additional, more recent available data have been considered in the identification of spawning and nursery grounds in this PEIR chapter (see section 4.4.7), which identifies potential suitable herring and sandeel spawning ground using benthic characterisation studies. A meeting to discuss fish and shellfish scoping opinion comments was attended on the 31 May 2023.

ID	Inspectorate's comments	Response
5.3.10	The Applicant's attention is drawn to the advice from the EA (see Appendix 2 of this Opinion) on the potential for onshore impacts on water quality to affect the designated shellfish waters on the North Kent coast. The Inspectorate notes that the CoCP would describe mitigation measures required to avoid likely significant effects. The ES should explain how this potential impact on shellfish waters has been addressed.	Measures for mitigating against impacts on water quality and thus designated shellfish waters are detailed in section 4.4.7.127
5.3.11	Natural England's advice (see Appendix 2 of this document) identifies potential impacts on fish and shellfish populations from the colonisation of artificial substrates associated with the Proposed Development. The Inspectorate considers that these impacts should be addressed in the ES.	These impacts have been assessed in section 4.4.9.
5.3.12	The Scoping Report provides a detailed explanation of how the significance of effects would be determined, based on the relevant guidance from the Chartered Institute of Ecology and Environmental Management (CIEEM). However, no description has been provided of the methods that will be used to assess impacts and whether these will be quantitative or qualitative. The methodologies used must be described and their use justified with reference to appropriate guidance and/or agreement with relevant stakeholders. The Applicant's attention is drawn to the advice from the MMO in Appendix 2 of this Opinion in relation to assessment of effects on herring larvae (MMO response paragraph 3.5.4) and assessment of underwater noise on fish populations (MMO response paragraph 3.5.8). The assessments in the ES should address these points.	The approach and methodology of the assessment is detailed in section 4.4.4. As per MMO advice the baseline (section 4.4.7) uses 10 years (2008-2017) of International Herring Larvae Survey (IHLS) data to inform to assessment. A separate marine licence application will be made for any UXO detonation in line with MMO advice to allow for appropriate consideration of potential UXO impacts once sufficient information is available to identify any potential UXO risk. Impact pathways in relation to UXO noise are therefore not considered in the current assessment.

Consultation and Project Engagement

4.4.3.1 On 31st May 2023, a meeting was held with the MMO, Cefas, and Natural England in order to demonstrate the progress which had been made with respect to fish and shellfish matters since the Scoping Opinion was received. During this meeting, the consultees were presented with further information about the Proposed Project and the approach to the PEIR and ES fish and shellfish assessments, including the approach to herring and sandeel spawning analysis, and assessing impacts from any unexploded ordnance (UXO) detonation. Key actions arising from this meeting were:

- A detailed herring and sandeel spawning grounds assessment will be undertaken at the ES stage. This will be based on multiple data layers, including, but not limited to, BGS sediment, OneBenthic and IHLS data, for the production of 'heat maps', for inclusion in the ES; and
- An assessment of the impact of UXO will be the subject of a separate marine licence application at a later date, based on the detailed UXO survey that will need to be undertaken to identify in detail the objects that will need to be detonated prior to cable installation works. This allows a more robust cumulative assessment, based on actual UXO activities required. Spawning assessment heat mapping and underwater sound contours from UXO noise will also be undertaken at this point and are not included in this current assessment.

4.4.3.2 Further consultation and Project Engagement is scheduled to take place during the next stage once the work for the PEIR has been completed.

4.4.4 Approach and Methodology

4.4.4.1 **Volume 1, Part 1, Chapter 5, PEIR Approach and Methodology** sets out the overarching approach which has been used in developing the preliminary environmental information. This section describes the technical methods used to determine the baseline conditions, sensitivity of the receptors and magnitude of effects and sets out the significance criteria that have been used for the preliminary fish and shellfish assessment.

Guidance specific to the fish and shellfish assessment

4.4.4.2 In addition to the legislation and policies outlined in section 4.4.2, the preliminary fish and shellfish assessment has been carried out in accordance with the following good practice guidance document:

- Chartered Institute for Ecology and Environmental Management (CIEEM) Guidelines for Ecological Impact Assessment in Britain and Ireland – Terrestrial, Freshwater, Coastal and Marine (Ref 4.20).

4.4.4.3 In the absence of Environmental Quality Standards for in situ sediments in the UK, the following guidance has been used to help inform a 'Weight of Evidence' (WoE) approach to determine whether fish and shellfish are at risk from toxic contaminants:

- Centre for Environment, Fisheries and Aquaculture Science (Cefas) Chemical Action Levels (Ref 4.21) (Reviewed 2020). These values are used in conjunction with a range of other assessment methods to make management decisions regarding the fate of dredged material. The action levels are not 'pass/fail' criteria but triggers for further assessment. In general, contaminant levels in dredged material below Action

Level 1 are of no concern and are unlikely to influence the licensing decision. However, dredged material with contaminant levels above Action Level 2 is generally considered unsuitable for sea disposal. Dredged material with contaminant levels between Action Levels 1 and 2 requires further consideration and testing before a decision can be made. Action Levels are therefore, used as a guide in assessments of sediment contamination in non-dredging activities;

- UK Offshore Operators Association (UKOOA) sediment quality guidelines for the UK North Sea (Ref 4.22);
- OSPAR background concentrations and background assessment concentrations and effect range low (ERL) and effect range median (ERM) concentrations for contaminants (Ref 4.23); and
- Canadian sediment quality guidelines (Ref 4.24) are used for a number of contaminants where there are no regional quality thresholds available.

Baseline Data Gathering and Forecasting Methods

4.4.4.4 The fish and shellfish ecology baseline has been developed using several data sources. This includes results of a project specific benthic survey carried out by Ocean Infinity Company (MMT[1]) which were used to assess conditions in relation to fish spawning habitat (Ref 4.25) and a wide body of publicly available data and reports. These desk-based data sources were used to inform the understanding of the relative importance and functionality of the study area in the regional context of fish and shellfish populations in the wider central and northern North Sea. The data sources reviewed include:

- FishBase (www.fishbase.org) for general fish ecology, distribution and biological information;
- Project-specific survey data (Ref 4.25);
- The Outer Thames Estuary Regional Environmental Characterisation (Ref 4.26,);
- International Council for the Exploration of the Sea (ICES) Ecosystem Overviews Greater North Sea Ecoregion (Ref 4.27);
- UK fleet landings by rectangle stock and estimated Exclusive Economic Zone (EEZ) 2016-2020 (Ref 4.28);
- Environment Agency Transitional & Coastal (TraC) waters fish survey relational datasets (this data is hereafter referred to simply as ‘TraC data’) (Ref 4.29);
- Environment Agency freshwater fish survey datasets from the National Fish Populations Database (NFPD) (this data hereafter referred to simply as ‘freshwater fish data’) (Ref 4.30);
- Salmonid and fisheries statistics for England and Wales (Ref 4.31);
- Updated Fisheries Sensitivity Maps in British Waters (Ref 4.32, Ref 4.33);
- Spawning and nursery grounds of selected fish species in UK waters (Ref 4.34);

[1] Note that the Ocean Infinity Company acquired MMT in 2021

- ICES International Herring Larvae Survey (IHLS) data for the North Sea over a 10-year period between 2008 - 2017;
- Spatial Interactions between Marine Aggregate Application Areas and Atlantic Herring Potential Spawning Areas (Ref 4.35);
- Spatial Interactions between Marine Aggregate Application Areas and Sandeel *Ammodytidae* Habitat (Ref 4.36);
- Hydroacoustic seabed survey and grab sampling techniques to assess "local" sandeel population abundance (Ref 4.37);
- Sandeel sediment habitat preferences in the marine environment (Ref 4.38);
- Environmental Effect Pathways between Marine Aggregate Application Areas and Atlantic Herring Potential Spawning Habitat: Regional Cumulative Impact Assessments (Ref 4.39);
- Environmental Effect Pathways between Marine Aggregate Application Areas and Sandeel Habitat: Regional Cumulative Impact Assessments (Ref 4.40);
- Salmon Stocks and Fisheries in England and Wales (Ref 4.41);
- Salmonid and fisheries statistics for England and Wales (Ref 4.42);
- Cefas demersal fish data for the southern North Sea (ICES division IVc) (Ref 4.43);
- The International Convention for the Conservation of Nature (IUCN) Red List of Threatened Species (Ref 4.44);
- EMODnet biological data portal (http://www.emodnet.eu/biology) for records of rarer fish and shellfish species;
- East Coast Regional Environmental Characterisation (Ref 4.45) for a summary of the distribution and ecology of fish and shellfish on the East Coast; and
- Publicly available and relevant academic journal papers and reports.

Assessment Criteria

4.4.4.5 Several factors will be considered when assessing the impacts on fish and shellfish resulting from the Offshore Scheme including sensitivity of the receptors, magnitude of the impact, and the overall significance of effects. Several considerations should be considered when assessing the preliminary effects resulting from a project, including the scale of the impact, the duration of the impact and whether the damage caused by the impact is reversible or not.

4.4.4.6 Throughout the assessment of effects, professional judgment and knowledge of the sensitivity of fish and shellfish, to a range of activities, have been applied. The methodologies for assessing sensitivity, magnitude and significance are described in more detail below.

Sensitivity and Value

4.4.4.7 To determine sensitivity of the receptor, the vulnerability of the receptor to the impact and its ability to recover and adapt were considered. Vulnerability differs between different species of fish and shellfish, for example those that rely on demersal (seabed) environments as part of their life cycle are more vulnerable to construction work on the

seafloor than other highly mobile species that primarily live in the water column (also referred to as the pelagic zone) and are likely to swim away from an affected area for the duration of an impact, returning once the impact is removed. In addition, the ability to recover also differs between species, with some more likely to recover over a shorter timeframe due to increased fecundity for example.

4.4.4.8 The importance of the receptor on an international, national and local scale has also been considered to determine the value of the receptor.

4.4.4.9 When defining sensitivity, criteria set out in **Volume 1, Part 1, Chapter 5 PEIR Approach and Methodology** has been followed: very high, high, medium, and low.

Magnitude

4.4.4.10 The magnitude of an impact that could affect fish and shellfish is influenced by several key factors, including the scale of the change (and how much the receptor is likely to be affected), the spatial extent over which the impact is likely to occur, and the duration and frequency of the impact. When considering the duration and frequency of the impact, thresholds of fish and shellfish for withstanding changes in the marine environment were also assessed.

4.4.4.11 When defining the magnitude of the impact, criteria detailed in **Volume 1, Part 1, Chapter 5 PEIR Approach and Methodology** has been followed: large, medium, small, and negligible.

Significance of Effects

4.4.4.12 As set out in **Volume 1, Part 1, Chapter 5, PEIR Approach and Methodology** the general approach taken to determining the significance of effect in this preliminary assessment is only to state whether effects are likely or unlikely to be significant, rather than assigning significance levels.

4.4.4.13 To determine whether an effect is significant or not, the nature and anticipated timeframe of the impact has been considered, in addition to the likely sensitivity of affected receptors. The magnitude, which includes the scale of change, spatial extent, duration and frequency, of the impact have also been considered.

4.4.4.14 Where appropriate, other disciplines have used a matrix approach to determine the significance criteria. As CIEEM does not advocate a matrix approach for determining significance of effects on ecological receptors, professional judgment and knowledge from previous projects have been considered. In addition, a precautionary approach has been taken with the worst-case scenario assessed for each impact, in order to account for any uncertainty or lack of baseline survey data in the assessment. However, maintaining consistency with other disciplines, where a matrix approach is suitable, has been considered.

Assumptions and Limitations

4.4.4.15 The availability of data for fish and shellfish within the North Sea region is considered sufficient to characterise the baseline and as such provide a good understanding of the existing environment. However, due to the mobile nature of fish and some shellfish, there is potential variability in usage of the area by different species. As a result, each survey contributing to the available library of research, realistically, only provides a snapshot. Furthermore, available data is typically broad for fish and shellfish, providing

only a broad indication of where species are present or absent, often relating to ICES boundaries.

4.4.5 Basis of Assessment

4.4.5.1 This section sets out the assumptions that have been made in respect of design flexibility maintained within the Proposed Project and the consideration that has been given to alternative scenarios and the sensitivity of the preliminary assessment to changes in the construction commencement year.

4.4.5.2 Details of the available flexibility and assessment scenarios are presented in **Volume 1, Part 1, Chapter 4 Proposed Project Description** and **Part 1, Chapter 5 PEIR Approach and Methodology**.

Flexibility Assumptions

4.4.5.3 The main preliminary assessments have been undertaken based on the description of the Proposed Project provided in **Volume 1, Part 1 Chapter 4 Description of the Proposed Project.** To take account of the flexibility allowed in the Proposed Project, consideration has been given to the potential for preliminary effects to be of greater or different significance should any of the permanent or temporary infrastructure elements be moved within the Limits of Deviation (LoD) or draft order Limits.

4.4.5.4 The assumptions made regarding the use of flexibility for the main assessment, and any alternatives assumptions are set out in Table 4.4.7 below.

Table 4.4.7: Flexibility assumptions

Element of flexibility	Proposed Project assumption for initial preliminary assessment	Flexibility assumption considered
Lateral LoD marine HVDC cable	The extent of the draft Order Limits for the Proposed Project (Offshore Scheme Boundary).	The worst-case scenario assessed for the Offshore Scheme is one bundled HVDC (x2) and one fibre optic cable in once trench. This bundled scenario may be placed anywhere within the Offshore Scheme Boundary.

Coordination Including Co-Location

4.4.5.5 The Proposed Project includes an option for co-location with National Grid Ventures proposed Nautilus and LionLink interconnector projects as explained in **Volume 1, Part 1, Chapter 5, PEIR Approach and Methodology.**

4.4.5.6 Table 4.4.8 details where the option of co-location is relevant to the preliminary fish and shellfish assessment and how this option has been assessed is reported in section 4.4.9, preliminary assessment of effects.

Table 4.4.8: Consideration of co-location

Element of coordination	How it has been considered within the preliminary assessment
Suffolk landfall	**Sea Link Only** Four Horizontal Directional Drilling (HDD) ducts (one per cable and one spare). **Sea Link (with co-location)** Up to ten HDD ducts.

Sensitivity Test

4.4.5.7 It is likely that under the terms of the draft DCO, construction could commence in any year up to five years from the granting of the DCO which is assumed to be 2026. Consideration has been given to whether the preliminary effects reported would be any different if the works were to commence in any year up to year five. Where there is a difference, this is reported in section 4.4.9, preliminary assessment of effects.

4.4.6 Study Area

4.4.6.1 The Offshore Scheme extends from the Outer Thames Estuary and southern North Sea between the Suffolk and Kent coastlines. The study area was informed by stakeholder feedback and in particular, the comments raised on spawning grounds for herring (*Clupea harengus*). This fish and shellfish chapter therefore covers a study area of 15 km from the Offshore Scheme as illustrated in **Figure 4.4.1. Study Area**. Following regulator feedback the study area for spawning has been extended to include the herring spawning ground at Herne Bay and at the Eagle Bank and Osea Island in the Blackwater Estuary. This study area has been selected to encompass all likely Zones of Influence (ZoI) for fish and shellfish, as identified in section 4.4.9.

4.4.6.2 A 50 km distance has been adopted as an initial screening distance for any sites designated for migratory fish. However, to ensure any fish that may pass through the study area are considered, a regional approach has also been adopted, scoping in any sites for which an interaction may occur but is beyond this initial screening distance. For the purposes of this report, disturbance is considered to occur where the study area falls in front of a migratory route into a river. Therefore, any designated sites that lie onshore of the Offshore Scheme have also been included to consider the potential for an interaction between the Offshore Scheme and potential migration routes of migratory fish. This regional based approach takes into consideration work by ABPMer (Ref 4.46), as shown in Image 4.4.1.

4.4.6.3 MMT benthic characterisation surveys have been completed along the length of the Offshore Scheme in August to October 2021, consisting of five drop-down video (DDV) transects and 37 grab samples (using either dual Van Veen or a Hamon grab), including but not limited to the identification of some shellfish species. Further details on the MMT benthic characterisation surveys is provided in **Part 4, Chapter 3 Benthic Ecology.**

4.4.6.4

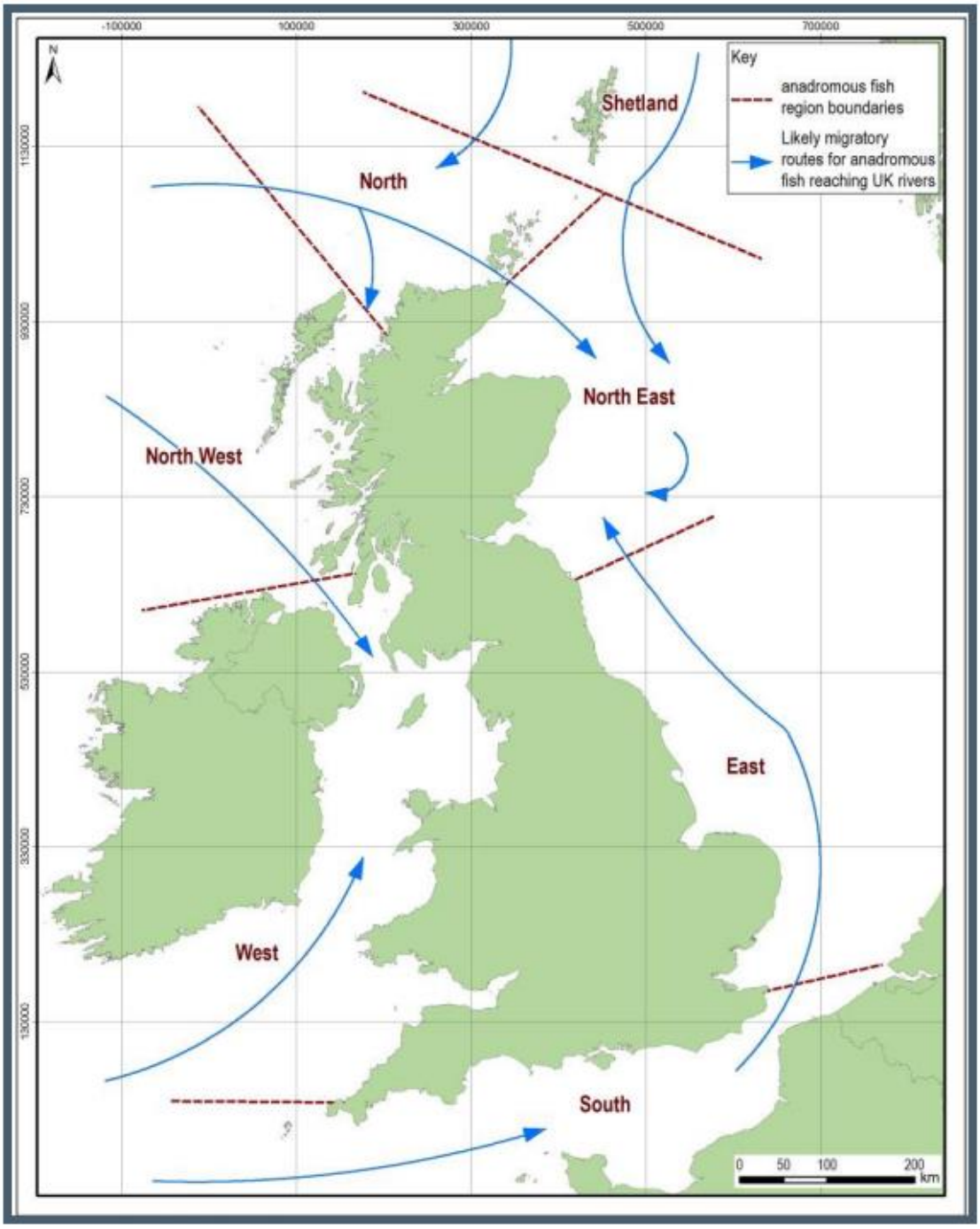

Image 4.4-1 Location and extent of coastal regions to be used for screening fish qualifying interests (provided by ABPMer 2014)

4.4.7 Baseline Conditions

4.4.7.1 This section covers the fish and shellfish ecology baseline for the Offshore Scheme, with regards to the general fish and shellfish communities in the study area including spawning and nursery grounds, potential fish migration movements, commercial fish species (from an ecology perspective only), the relevant designated sites and species-specific information.

Protected Species and Designated Sites

Protected Species

4.4.7.2 There are several fish and shellfish species known to be present in the study area that are protected under international and national conservation legislation (Table 4.4.9). All species listed are also considered to be of wider ecological value as well as commercial value within the study area except for sandeel and the migratory fish species.

Designated Sites

4.4.7.3 Three designated sites for the protection of fish and shellfish are located within 15 km of the Offshore Scheme. These are all MCZs designated for the protection of blue mussel (*Mytilus edulis*) or native oyster (*Ostrea edulis*) beds. A further four designated sites, which are designated as both MCZ and SSSIs, are located within 50 km of the Offshore Scheme. However, only one (Medway Estuary MCZ) is designated for migratory fish species, for smelt (*Osmerus eperlanus*), and is considered further based on the regional approach discussed in section 4.4.6. The other three designated sites (Dover to Folkstone MCZ; Blackwater, Crouch, Roach and Colne Estuaries MCZ; and Folkstone Warren SSSI) are not designated for the protection of migratory fish and therefore have not been considered further. There are no SACs designated for fish or shellfish within the study area. Designated sites are illustrated on **Figure 4.4.3. Relevant designated sites for the protection of fish and shellfish**. Thus, there are four designated sites located within the study area, relevant to fish and shellfish, which are:

- **Goodwin Sands MCZ** (located partially within the Offshore Scheme boundary along the south-eastern side of the Offshore Scheme). The site is designated for the protection of blue mussel beds;
- **Thanet Coast MCZ** (located < 1 km southwest of the Offshore Scheme). The site is designated for the protection of blue mussel beds;
- **Dover to Deal MCZ** (located approximately 12 km south of the Offshore Scheme). The site is designated for the protection of native oyster and blue mussel; and
- **Medway Estuary MCZ** (located approximately 42 km west of the Offshore Scheme). This site was recently designated in 2019 for smelt (*Osmerus eperlanus*), as the site is considered to provide critical habitat for this species including for feeding and post-larval development.

4.4.7.4 Further detail on designated sites screened into the Offshore Scheme assessment, relevant to fish and shellfish, are presented in **Volume 1, Part 5, Chapter 4 Marine Conservation Zone Assessment**.

Table 4.4.9: Summary of relevant fish and shellfish species protected by national and international legislation or policy

Common names	Latin names	Habitats Directive Annex II and IV species	OSPAR list of threatened and/or declining species	Bonn Convention Appendix I and II species	Bern Convention Appendix II and III species	Wildlife and Countryside Act 1981	NERC Species of Principal Importance (SPI)	Features of Conservation Interest (FOCI)	IUCN Red List*
European eel	*Anguilla anguilla*		✓	✓			✓	✓	CR (↓)
Atlantic salmon	*Salmo salar*	✓	✓				✓		LC (-)
Sea trout	*Salmo trutta*						✓		LC (?)
Sea lamprey	*Petromyzon marinus*	✓	✓		✓		✓		LC (↔)
River lamprey	*Lampetra fluviatilis*	✓					✓		LC (?)
European smelt	*Osmerus eperlanus*						✓	✓	LC (?)
Twaite shad	*Alosa fallax*	✓			✓		✓		LC (↔)
Allis shad	*Alosa alosa*	✓			✓		✓		LC (?)
Herring	*Clupea harengus*						✓		LC (↑)
Sprat	*Sprattus sprattus*								LC (?)
Mackerel	*Scomber scombrus*						✓		LC (↓)
Sandeel	*Ammodytidae*						✓[1]		LC (?)[1]
Cod	*Gadus morhua*		✓				✓		VU (-)

Poor cod	*Trisopterus minutus*						LC (?)
Mediterranean scaldfish	*Arnoglossus laterna*						LC (?)
Whiting	*Merlangius merlangus*				✓		LC (?)
Dover sole	*Solea solea*				✓		DD (↔)
Plaice	*Pleuronectes platessa*				✓		LC (↑)
Basking shark	*Cetorhinus maximus*			✓	✓		EN (↓)
Thornback ray	*Raja clavata*	✓					LC (?)
Spotted ray	*Raja montagui*	✓					LC (↔)
Spurdog	*Squalus acanthias*	✓					VU (↓)
Tope	*Galeorhinus galeus*	✓					VU (↓)
Dog whelk	*Nucella lapillus*	✓			✓		
Native oyster	*Ostrea edulis*	✓			✓	✓	
Cephalopods	*Cephalopoda*						

* IUCN Red List Status defined as ‘CR’ = Critically Endangered, ‘EN’ = Endangered, ‘VU’ = Vulnerable, ‘NT’ = Near Threatened, ‘LC’ = Least Concern and ‘DD’ = Data Deficient. Population trends are also shown in brackets (‘↑’ = increasing, ‘↓’ = decreasing, ‘↔’ = stable, ‘?’ = unknown and ‘-‘ = unspecified).

** Only A. marinus occurs offshore in sandeel species

✓[1] = Offshore waters

Species- Specific Information

Diadromous Fish Species

4.4.7.5 Diadromous fish carry out seasonal migrations between bodies of freshwater and seawater. Those species known to migrate through the Outer Thames Estuary and adjacent estuaries (such as the Blackwater and the Crouch Estuary) and coastal environments (i.e. the study area) include European eel (*Anguilla Anguilla*), Atlantic salmon (*Salmo salar*), brown trout (*Salmo trutta*), sea lamprey (*Petromyzon marinus*) and river lamprey (*Lampetra fluviatilis*), European smelt, Allis shad (*Alosa alosa*) and twaite shad (*Alosa fallax*).

European Eel

4.4.7.6 The European eel is a catadromous[2] migratory species, undertaking an extensive migration to spawn in the Sargasso Sea. The newly hatched larvae, known as leptocephali, are transported to the continental shelf of the North Atlantic by the prevailing currents of the Gulf Stream, where they metamorphose into the life stage of glass eel and subsequently, in freshwater and coastal waters become pigmented 'elvers' (Ref 4.47; Ref 4.48).

4.4.7.7 Glass eels travel across shelf seas, using tidal stream transport, rising in the water column when the tide travels inwards, and settling to the bottom as the tide returns (Ref 4.49). Eels migrate upstream into freshwater predominately during spring but may continue to do so until early Autumn.

4.4.7.8 Once within freshwater habitats, eels remain for five to 15 years, transforming into yellow eels and then finally to silver eels when they begin their downstream migration through rivers and estuaries towards spawning grounds, predominately between August and December (Ref 4.50; Ref 4.51,). Spawning in the Sargasso Sea occurs mainly in spring (Ref 4.52). However, some eels do not migrate into freshwater but instead inhabit estuaries as 'elvers' and yellow eels before returning to spawning grounds.

4.4.7.9 European eels are known to migrate into several rivers along the southeast coast of England, within the Southern North Sea. These rivers include:

- River Thames: The Thames is one of the most important rivers for European eel in the UK. A recent study by Pecorelli *et al.* (Ref 4.53) looked at citizen science data using trap surveys collected between 2011 and 2018 as part of the Thames European Eel Project to assess the annual average catch per unit effort (CPUE) within the Thames River Basin District. The results showed that in 2018 European eel were recorded across the Thames River basin, with peak CPUE values typically observed in July. The Thames River Basin includes many rivers in which European eel are known to occur, including the Thames, Medway and Colne rivers, all of which ultimately outflow into the Thames Estuary. European eel was historically abundant in the Thames Estuary but with years of anthropogenic pressure from commercial fishing and habitat loss, populations of this species have declined significantly throughout its range. (Ref 4.54). Environment Agency TraC data from 2013-2023 shows that European eel was mainly found in the Thames middle and upper regions with a max count of 13 elvers caught in the Middle Thames in 2014.

[2] A sub-category of diadromous species that migrates from freshwater to seawater to spawn

- Stour River: The Stour River is located in the east of England in the border between Suffolk and Essex and flows into the Southern North Sea. It is a relatively small river, but it is an important spawning ground for European eels with trapping and tagging surveys carried out across the Stour River in 2009 and 2010 (Ref 4.55) and while this study only assesses the behaviour of eels with respect to their interactions with man-made structures, and therefore does not provide information on where eels were found, it does at least confirm the presence of eels in the Stour River during this period. More recently, there has been evidence of European eels being present in the Stour River, as shown by the operation of a commercial glass eel fishery (Ref 4.56). In the River Stour, glass eel recruitment monitoring has been carried out to improve information on stock status (Ref 4.56) and in 2014 glass eels recruited into the river between March and August. TraC data also show that between 2013 and 2023 a total of 18 individuals were caught in the Stour River with 15 of these being caught in 2018.
- Blackwater River: The Blackwater River and Blackwater Estuary is another river system located in Essex, southeast England, where European eel is known to migrate. The estuary and surrounding rivers provide important habitat for European eel during its life cycle, including for feeding, growth, and migration. However, a study by Bark *et al.* (Ref 4.57) found that long-term data collected by the Environment Agency between 1984 and 2005 showed a statistically significant decline in population density in the Blackwater River over the 21-year period (Ref 4.57)

4.4.7.10 The TraC data recorded this species once in the Alde River in 2018. The Alde River is situated along the coast of the northern section of the Offshore Scheme.

4.4.7.11 European eel is listed as ‘critically endangered’ on the IUCN Red List since 2008 and is protected under the Eels (England and Wales) Regulations (2009) and the NERC SPI. It is also included within Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and Appendix II of the Convention on Migratory Species (CMS).

Atlantic Salmon

4.4.7.12 Atlantic salmon is an anadromous[3] migratory species, which, during its lifecycle, uses both marine and freshwater habitats. Spawning of salmon typically occurs in November or December, in the upper reaches of rivers in gravelly substrate (Ref 4.49; Ref 4.58). The resultant larvae known as ‘alevins’ remain within the interstitial gravels. The transition from larvae to parr occurs in the first summer in southern streams (Ref 4.48) or up to a year in upland systems. Following the parr life stage, salmon physically and morphologically change into ‘smolt’. This is preceding migration to the marine environment following one to five years in freshwater. The migration of smolt down-river to the ocean usually occurs from spring to early summer, generally occurring earlier in the season for larger smolt with most fish having migrated by June (Ref 4.59). Once salmon have spent another one to five years at sea, the adults then return to their spawning rivers, which in the UK usually peaks between June to August and between October to December (Ref 4.60). Salmon typically spend 72% to 86% of their

[3] Anadromous fish are diadromous fish that migrate from the sea into freshwater for spawning. This distinguishes them from catadromous fish, such as eels which migrate in the opposite direction, moving from freshwater to spawn in the sea.

time in surface waters (0 m to 5 m), but often dive, sometimes to depths of > 20 m (6% to 9% of the time).

4.4.7.13 Salmon are mainly found along the western and northern parts of England and Wales. However, relatively low numbers of salmon are also found along the southeast coast of England (Ref 4.61). Rivers considered to be of importance for Salmon within 50 km of the Offshore Scheme are shown in **Figure 4.4.4. Rivers of known importance to migratory salmon within the study area**. TraC data from 1992 to 2023 recorded a total of six individuals between 1992 and 1994 in the middle and upper River Thames. TraC data did not record salmon in any other rivers within the study area during this period. Generally, the study area which is located along the East Anglian Region is not considered to have salmon producing rivers (Ref 4.62). The nearest designated Principal Salmon River[4] is the River Itchen, which is located more than 200 km southwest of the Offshore Scheme (Ref 4.61). Salmon is protected as an Annex II species; however, there are no designated sites for which salmon is a qualifying feature (both primary and non-primary) within the study area.

Brown Trout (Sea Trout)

4.4.7.14 Brown or sea trout display a broad range of life history traits, with individuals that complete their lifecycle in freshwater, those that predominately inhabit estuarine waters, and those that exhibit full anadromy (Ref 4.63). Sea trout exhibit a similar life cycle to Atlantic salmon, though the adult marine stage of sea trout is shortened both spatially and temporally, with some migration back to freshwater environments after only a very short period of time feeding at sea, whilst ‘maidens’ only return to freshwater after a minimum of a year at sea (Ref 4.64). Adult sea trout returning to freshwater to spawn are more likely to stray from natal rivers compared to salmon.

4.4.7.15 There is limited information on swimming depths for adult sea trout, though available data suggest during the marine migration phase, they have a generally shallow swimming depth (approximately 0 m to 3 m) and make occasional deep dives (Ref 4.65). Upstream migration occurs between April and June and downstream migration through spring to early summer.

4.4.7.16 Sea trout are widely distributed across the UK; however, the limited literature suggests that sea trout populations are relatively scarce in the Anglian region (Ref 4.66). TraC data from 1998 to 2021 recorded a total of 19 individuals in the south-east and Anglian region. Overall, the TraC data recorded very low numbers of brown trout in the Adur, Medway, Stour and Thames rivers. The highest numbers of brown trout were recorded in the Upper Thames River (a total of nine individuals recorded between 1998 and 2021). Other studies have also recorded this species migrating through the tidal Thames (Ref 4.67). Freshwater fish data recorded brown trout also using the River Stour in 2021 and 2022. However, the overall low number of brown trout recordings is believed to be due to a lack of targeted trout fisheries catches in the region, which has therefore resulted in a significant underestimate of sea trout migrating into rivers along the South-east of England (Ref 4.66). Trout reported to attempt to enter most of the south coasts rivers (Ref 4.66).

[4] Principal Salmon Rivers consist of 64 rivers in England and Wales, designated as rivers which regularly support salmon. Salmon Action Plans have been developed for the conservation of these rivers and the management of rod catches.

Sea and River Lamprey

4.4.7.17 Sea lamprey and river lamprey are both anadromous migratory species. After spending several years in the marine environment, adults return to freshwater to spawn in spring and early summer (Ref 4.68).

4.4.7.18 Sea lampreys are widely dispersed in the open sea as they are solitary feeders, being rarely found in coastal and estuarine waters (Ref 4.69). The distribution of sea lamprey is chiefly defined by their host river (Ref 4.70) and they are often found at considerable depths in deeper offshore waters (Ref 4.69).

4.4.7.19 In contrast, river lampreys are usually found in coastal water, estuaries and accessible rivers and juveniles are often found in large congregations (Ref 4.71). Distribution in the UK appears to be mainly in Wales, Northern Ireland and southern Scotland (Plate 4.4.2). River lamprey generally spend one to two years in estuaries, then move upstream in the autumn, between October and December (Ref 4.72).

4.4.7.20 Sea lamprey spawn when the water temperature reaches at least 15°C and they normally migrate into freshwater from April to June and then spawn from late May to June (Ref 4.72). The migration to sea can vary from river to river, although the metamorphosis of larvae into adults occurs between July and September (Ref 4.71).

4.4.7.21 Sea lamprey and river lamprey are protected as Annex II species; however, there are no designated sites for which lamprey are a qualifying feature (both primary and non-primary) within the study area. Furthermore, while both species have been previously reported in low numbers within the Thames estuary (Ref 4.67) the TraC data did not record lamprey species in any of the rivers within the study area between 1992 and 2023. The Freshwater fish data did record lamprey within the River Stour in 2022. Image 4.4.2 also shows the limited distribution of both species within the study area.

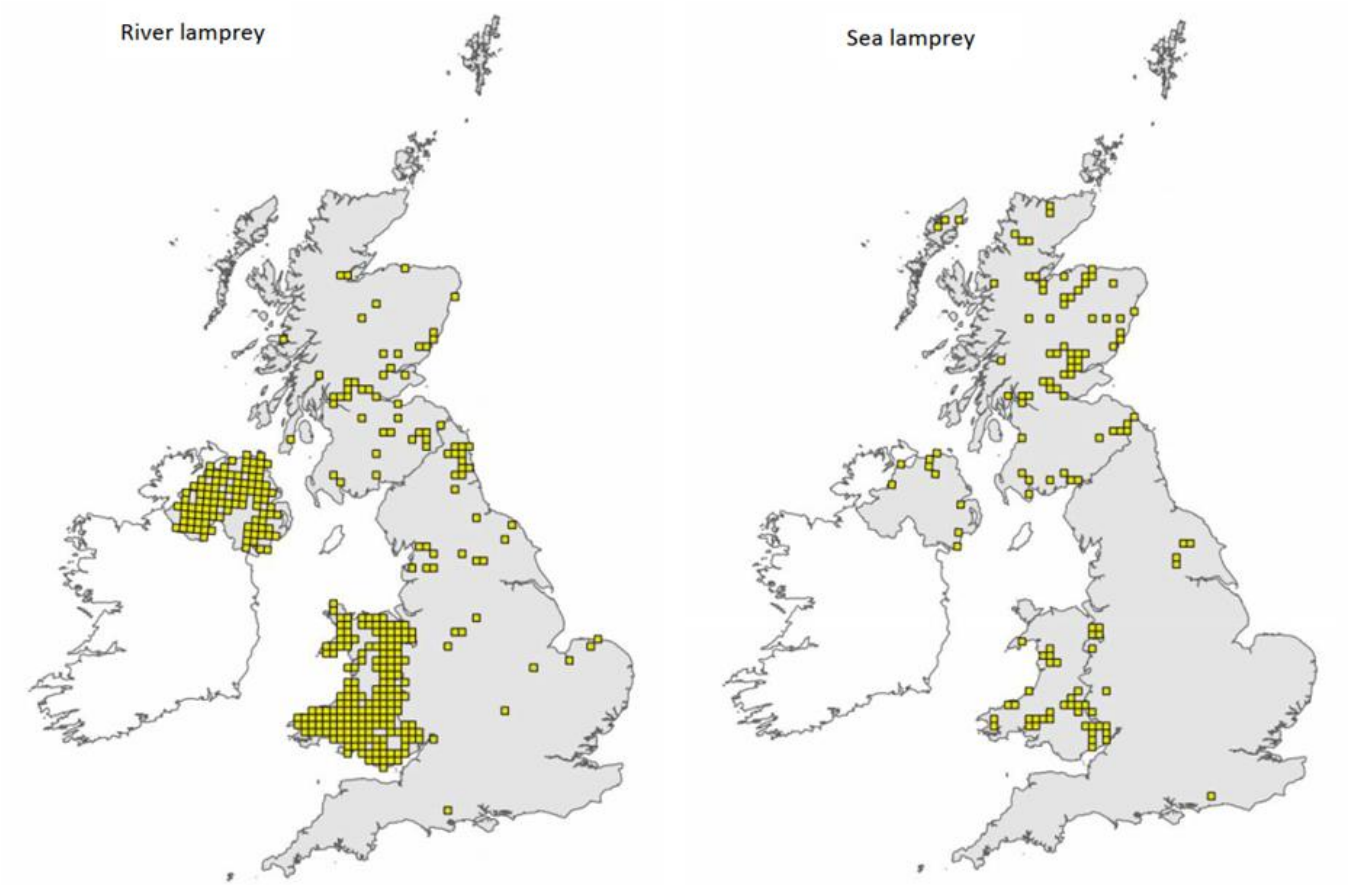

Image 4.4.2 UK distribution of river lamprey and sea lamprey (JNCC, 2018a and 2018b)

European Smelt

4.4.7.22 The European smelt is an anadromous species that is occasionally recorded in inshore waters but is most commonly found in lower river reaches and upper estuarine habitats (Ref 4.49)

4.4.7.23 Smelt migrate into estuaries where they congregate in large shoals in lower reaches of an estuary to feed before moving to freshwaters to spawn in spring (Ref 4.71); post-larval juveniles then use estuarine nursery habitats. Smelt are thought to return to their natal river to spawn, although the degree of fidelity may not be as strong as other species such as Atlantic salmon (Ref 4.73).

4.4.7.24 Once widespread in UK estuaries, smelt is now listed as a SPI and FOCI as a result of significant population declines. Smelt is a FOCI for the Medway MCZ and is also present within the wider Thames and Swale Estuary MCZ. The Medway Estuary MCZ, which is located approximately 42 km west of the Offshore Scheme, was designated in 2019 for smelt as it is considered to provide critical habitat for this species.

4.4.7.25 Furthermore, within the study area, smelt is known to occur in a number of other river systems, including the River Thames which holds one of the largest known breeding grounds of smelt in the UK (Ref 4.74). It is believed that adult smelt aggregate in the lower Thames estuary, in February and March, before commencing their upstream migration to spawn in March and April; spawning is understood to occur in the area of Wandsworth Bridge, and 600 m upstream of this, before the larvae and juveniles passively move with the tide and become distributed throughout the Thames estuary.

Other rivers known to hold smelt within the Thames estuary include River Blackwater, River Medway and River Crouch (Ref 4.74). Furthermore, TraC data from 2013 to 2023 recorded high numbers of smelt across the study area, including the rivers previously mentioned, as well as River Stour, River Alde and River Orwell.

Shad

4.4.7.26 Allis shad and twaite shad are very similar species, both members of the Clupeidae family, that are mainly found in freshwater in the UK. They occur in shallow coastal waters and estuaries but migrate further upstream to spawn during late spring (April to June) (Ref 4.75).

4.4.7.27 Spawning sites were historically recorded for allis shad in many rivers, including the Thames, although they are not thought to spawn there now (Ref 4.67). Twaite shad is recorded as migrating through the Tidal Thames (Ref 4.67). However, this species has been found in low abundance within the Outer Thames Estuary (Ref 4.76). TraC data between 1992 and 2023 showed a single Allis shad recorded in the River Stour in 2011 and a single Twite shad recorded in the River Alde in 2011. These data suggest that both shad species are present in low abundance within the study area. The presence of shad at sea is very poorly understood, but the species appears to be mainly coastal and pelagic in habit (Ref 4.71).

Pelagic Fish Species

4.4.7.28 Pelagic species are highly mobile fish that live within the water column often in large shoals. Clupeids (i.e., herring), and sprat, (*Sprattus sprattus*) are the most common species within the study area, whilst mackerel (*Scomber scombrus*) has a seasonal presence. All three species are of commercial importance with herring and mackerel also being of national conservation importance. Clupeids possess a swim bladder which is directly involved in hearing and can make them vulnerable to underwater noise. Mackerel do not have a swim bladder and are therefore less sensitive to underwater noise. Other pelagic species known to be present within the study area include scad (*Decapterus macarellus*), lesser weever fish (*Echiichthys vipera*) and horse mackerel (*Trachurus trachurus*).

Herring

4.4.7.29 Herring is an important commercial species and represents a significant prey species for many predators, including large gadoids (such as cod), dogfish, sharks, marine mammals and birds (Ref 4.77). Herring is a pelagic fish and is found mostly in continental shelf areas to depths of 200 m (Ref 4.78). Juveniles are generally distributed separately from adults, being found in shallower water, migrating into deeper waters to join the adult stock after two years. In the North Sea 1-group[5] herring are restricted within the 100 m depth contour and are most abundant in the south-east along the British east coast (Ref 4.77).

4.4.7.30 Herring are demersal spawners, which means when spawning occurs, large numbers of eggs are released (~50,000 per female) near the seafloor, which sink and attach to gravel, stones, and shells where they form a dense mat. Herring spawning takes place in areas of well-mixed waters in open seas, coastal waters, and embayments (Ref 4.49). Once they have developed into juvenile fish, herring aggregate into shoals that migrate into estuaries and shallow waters where they remain for six months to a year

[5] Fish in the second year of their lives, which are identified as having a winter (hyaline) otolith ring

(Ref 4.90). After their first year, herring move offshore, joining the adult populations as they reach maturity (Ref 4.49).

4.4.7.31 Herring exhibit a complex stock structure in the North Sea comprising of three principal stocks (Buchan/Shetland herring stock, Banks or Dogger herring stock and the Southern Bight or Downs herring stock). These stocks share foraging grounds for much of the year but are spatially and temporally differentiated by their spawning grounds and migration patterns and nursery areas (Ref 4.79). The Southern Bight or Downs herring stock is located within the study area and is known to spawn in the English Channel from November until January (Ref 4.80). These three stocks represent the bulk of the North Sea herring stock, but some spawning also occurs in spring with their spawning grounds being described on a finer scale (Ref 4.77). One of these discrete inshore herring stocks is the Blackwater and Thames stock, which is a self-contained stock located within the study area. Further details on the spawning and nurseries of these herring stocks are provided below.

Sprat

4.4.7.32 Sprat is a short-lived, small-bodied pelagic schooling species that is relatively abundant in shallow waters. Sprat is an important food resource for a number of commercially important predatory fish, as well as seabirds and marine mammals.

4.4.7.33 Sprat is thought to be an intermediate, multiple batch spawner, with batches of eggs released repeatedly throughout the spawning period (Ref 4.49). Spawning occurs in coastal waters up to 100 km offshore, and in deep basins (Ref 4.78; Ref 4. 81). Once released, the eggs and larvae, which are pelagic, move into coastal nursery areas by larval drift (Ref 4.82; Ref 4.81).

4.4.7.34 The Offshore Scheme overlaps with important spawning and nursery grounds for sprat (Ref 4.32). Sprat is particularly abundant in shallow areas in the North Sea and is fished commercially, primarily for use in fish meal and as bait (Ref 4.83). In the North Sea (ICES Subarea IIVa and IV) official landings of sprat in 2021 in the southern North Sea (ICES division IVc) totalled 3,989 tonnes which is comparatively lower than the total lands recorded in the same year in the central North Sea (75,464 tonnes in 2021) (Ref 4.84).

Mackerel

4.4.7.35 Atlantic mackerel (*Scomber scombrus*) is a widely distributed migratory fish and is one of the most abundant fish species in the North Atlantic (Ref 4.85). Mackerel spend their entire life in the pelagic environment and are an important food source for sharks, tuna and dolphins (Ref 4.86). This species is also exploited by commercial fisheries, which in the past has caused the collapse of abundant stocks in the North Sea (Ref 4.87).

4.4.7.36 Mackerel are batch spawners and have pelagic eggs and larvae (Ref 4.88). Mackerel in the eastern Atlantic is divided into three spawning components, the North Sea being one of these (Ref 4.85) however, the study area does not fall into these spawning areas (Ref 4.34). The main spawning period for mackerel occurs between mid-May to late June, taking place particularly in the central North Sea located in deep waters outside the study area (Ref 4.89). Juveniles then remain in nursery areas in the shallow waters of the Southern Bight, which is located within the study area. The study area is therefore considered to be an important nursery ground for mackerel (Ref 4.34).

Demersal Fish Species

4.4.7.37 Demersal species are defined as those species that live both on (epibenthic) and near (benthic or bentho-pelagic) the seabed. Sandeel, whiting (*Merlangius merlangus)*, Dover sole (*Solea* solea*)*, and plaice (*Pleuronectes platessa)* are all priority species listed under Section 41 of the 2006 NERC Act, whilst cod (*Gadus morhua)* is included on OSPAR's list of threatened/declining species and is also classified as 'vulnerable' on the IUCN Red List.

4.4.7.38 Whiting, Dover sole, plaice, poor cod (*Trisopterus minutus*) and European sea bass (*Dicentrarchus labrax*) are also of commercial importance. Other demersal species present within the study area include lesser weaver fish (*Echiichthys vipera*) and Mediterranean scaldfish (*Arnoglossus laterna*). Mention is also made of a number of other demersal species within the study area, including lemon sole (*Microstomus kitt)*, dab (*Limanda limanda)* and gobies *sp. (Gobiidae),* but as they are present only in low abundance a detailed baseline is not included below.

Sandeel

4.4.7.39 Five sandeel species occur in the North Sea, including Raitt's sandeel (*Ammodytes marinus)* which is the most common although the lesser sandeel (*Ammodytes tobianus)* and great sandeel (*Hyperoplus lanceolatus)* are also prevalent. Sandeels are an important element of the food chain in the north Atlantic and are prey for other fish species, sea birds and marine mammals (Ref 4.90). In the central and southern North Sea (ICES Divisions IVb and IVc) sandeel fisheries have been divided into 'Sandeel Areas'; Sandeel Area 2r, in the central and southern North Sea, overlaps with the study area (Ref 4.91).

4.4.7.40 Sandeel spend a large proportion of the year buried in the sediment, only emerging into the water column to spawn briefly in winter (between November to February), and for an extended feeding period during the spring and summer months (Ref 4.92). The distribution of sandeel (referring to all species within the genus *Ammodytes*) is highly patchy due to their preference for sandy habitats in well oxygenated waters, favouring coarse sand with fine to medium gravel and a low silt content (Ref 4.93). Populations are also associated with seabed morphological features such as subtidal sandbanks, as stated in MarineSpace *et al.* (Ref 4.39). Sandeel are demersal spawners; the presence of spawning grounds in the study area is considered below.

4.4.7.41 Great sandeel spawn from late spring to summer, Raitt's sandeel between November to February (Table 4.4.12), whilst the lesser sandeel may spawn both in spring and autumn (Ref 4.49). Once hatched, the larvae are pelagic, spending their time in the water column (undertaking vertical migrations that are influenced by light) until they develop into juveniles in the winter when they burrow into the sediment (Ref 4.94).

4.4.7.42 Much of the Outer Thames Estuary area is characterised (with medium confidence) by sediments representative of preferred sandeel habitat (Ref 4.40). These habitats include Margate and Long Sands Special Area of Conservation (SAC) which is located approximately 2 km from the Offshore Scheme and is designated for the protection of the Annex I habitat 'sandbanks which are slightly covered by sea water all the time' which is preferred sandeel habitat. However, the Offshore Scheme does not fall within the SAC. The study area has been identified as within an area of low intensity spawning and nursery grounds for sandeel (Ref 4.34). Furthermore, MMT benthic characterisation surveys carried out for the Offshore Scheme identified preferred and marginal sandeel habitat which is discussed further below, and further information on these sites are described in **Volume 1, Part 4, Chapter 3, Benthic Ecology.**

Whiting

4.4.7.43 Whiting is a bentho-pelagic species found in association with a variety of seabed types including sediment and rocky areas (Ref 4.95). Overall, whiting does not make long-distance migrations from spawning sites (Ref 4.49).

4.4.7.44 Whiting are broadcast spawners, releasing eggs to the water column from February to June (Ref 4.32), peaking in spring in shallow waters (Ref 4.96). Most whiting spawning occurs in water depths less than 100 m (Ref 4.49). González-Irusta and Wright (Ref 4.97) states that whiting shows a high plasticity in spawning ground selection, with extensive areas of spawning occurring across the North Sea. The study area is located within low intensity nursery grounds for whiting (Ref 4.34).

Dover Sole

4.4.7.45 Dover sole is a southern species whose northern limit is in the North Sea. It favours sandy and sandy muddy substrates, within which to bury, in waters of up to 50 m depth. The spatial distribution of Dover sole varies between life stages, with juveniles favouring coastal nursery grounds and older and larger individuals occupying deeper offshore waters (Ref 4.98).

4.4.7.46 Spawning in the North Sea typically occurs between March and June, peaking in April, in inshore areas such as estuaries (Ref 4.86). The pelagic eggs drift into high productivity shallow sandy nursery grounds, which provide a good feeding ground for juveniles (Ref 4.90).

4.4.7.47 The study area is considered to be an area of high intensity spawning and nursery grounds for Dover sole (Ref 4.34).

Plaice

4.4.7.48 Plaice is found on all UK coasts, normally on sandy substrata, as well as gravel and mud (Ref 4.86). Plaice generally spawn between January and April, at depths of between 20 m and 40 m, releasing high numbers of pelagic eggs. Following spawning, plaice reach their peak densities in May, and in June and July older fish tend to migrate offshore, whilst juveniles remain in the intertidal zone until autumn (Ref 4.99).

4.4.7.49 Coastal and inshore waters of the North Sea represent important nursery areas for plaice, although the study area only occurs within low intensity nursery grounds for this species. The study area does occur within high intensity spawning grounds though plaice are pelagic spawners, releasing eggs into the water column to be transported by water currents, not benthic spawners like herring and sandeel (Ref 4.34).

Cod

4.4.7.50 Cod is widely distributed throughout the North Sea, found in shallow coastal waters to the shelf edge (200 m depth). From late winter to early spring, adult cod migrate to offshore spawning grounds, typically at depths of 20 m to 100 m in the North Sea (Ref 4.90).

4.4.7.51 Modelling of spawning habitat using the abundance of spawning fish, indicated that cod spawning is widespread throughout the North Sea, associated with coarse sand and low tidal flow (Ref 4.100). Cod spawning occurs between January and May in the southern North Sea, with peak spawning in February to March (Ref 4.101). The eggs and larvae of cod remain in the water column, developing into juvenile fish within six months. Juveniles then move to the seabed, often between July and August, when

they become demersal (Ref 4.102). Juvenile cod then move into coastal nursery areas once the spawning season is over, with young cod often found in estuaries and shallow waters.

4.4.7.52 According to Ellis *et al.,* (Ref 4.34), the study area is considered to be within an area of low intensity spawning and nursery grounds for cod. However, cod in this area is not thought to constitute a significant proportion of the UK population due to substantial stock reductions in the southern North Sea over the last 30 years (Ref 4.103).

European Sea Bass

4.4.7.53 Sea bass (*Dicentrarchus labrax*) is widely distributed across the North Sea but is primarily located in the southern North Sea (Ref 4.49). This species is usually present in coastal inshore waters during the summer and uses a range of habitats including sand banks and gravel and rocky areas. In winter, seabass aggregate and migrate offshore and remain offshore throughout the winter season until they are ready to spawn in spring (between February and June). The geographic extent of spawning is thought to be bounded approximately by a minimum temperature of 9 °C and can expand as the season progresses and in warmer years (Ref 4.104). The eggs and larvae of seabass are planktonic; once released, they are carried by inshore currents to nursery grounds within estuaries and shallow coastal waters.

4.4.7.54 The south-east coast is recognised as being important nursery grounds for sea bass. A recent study carried out by Kieran *et al.,* 2018, re-assessed existing Bass Nursery Areas (BNAs) and identified additional proposed new BNAs across England and Scotland. A number of BNAs were identified within the study area including:

- Alde and Ore Estuary
- Stour and Orwell Estuary
- Crouch and Roach Estuary
- Thames and Medways Estuary
- Blackwater and Clone Estuary
- Hamford Water
- Grain Power Station Outfall

4.4.7.55 Sea bass is a key species for both commercial and recreational fisheries. TraC data from 2013 to 2023 recorded high numbers of sea bass within the southern North Sea. The TraC data identified sea bass in a number if rivers and estuaries including the Alde and Ore Estuary, Blackwater Estuary, River Crouch, River Medway, Orwell Estuary, River Stour and Thames Estuary. The highest number of sea bass was 944 individuals caught in the middle River Thames in 2007; however, this number has significantly reduced in recent years. Due to notable stock declines in recent years, sea bass is currently under special management measures that limit the recreational fishery in the Southern North Sea (ICES Division IVc) to catch and release only during the periods 1 January to 29 February and 1 December to 31 December, whilst various restrictions have been imposed on the commercial fishery (Ref 4.105).

Lesser Weever Fish

4.4.7.56 Lesser weever fish is a venomous weever of the family Trachinidae. It is widespread across the Eastern Atlantic and North Sea (Ref 4.106). Lesser weever fish can be

found in the shallow waters of the North Sea, typically at depths of up to 150 meters (Ref 4.106). They prefer sandy or muddy seabeds and can also be found near rocky areas. They are carnivorous and feed mainly on small crustaceans, such as shrimp and krill, as well as small fish and squid (Ref 4.106).

4.4.7.57 The breeding season of the lesser weever fish occurs from May to September (Ref 4.107), they are pelagic spawners; however, little is known about the location of their spawning or nursery grounds.

4.4.7.58 TraC data from 1992 to 2023 recorded a total of 172 individuals within the south-east coast of England. However, most of these individuals were recorded far north in the Lincolnshire coast near the Humber Estuary. Small numbers (1 to 2 individuals) were recorded in the Thames Estuary, River Medway, River Stour and River Alde. This suggests that lesser weever fish may be present within the study area in low numbers.

Mediterranean Scaldfish

4.4.7.59 Mediterranean scaldfish is found throughout European waters and is predominantly found along the southern and westerns coasts of UK but can also occur along the east coast of Scotland and England in smaller numbers (Ref 4.108). This species is mostly found on mixed or muddy bottoms from 10 to 200 m; however, it usually prefers the depth range of 10–100 m (Ref 4.108).

4.4.7.60 Although some studies have been carried out on this species for the same geographic area, there is very limited information on Mediterranean scaldfish movements, first maturity size and age, spawning or reproductive cycle of this species. This is likely because of its inferior commercial fisheries importance (i.e. it is a discard species).

Poor Cod

4.4.7.61 Poor cod is found all around the UK coasts, with its range extending into the northern European waters such as the Baltic Sea and the North Atlantic (Ref 4.108). This species occurs mainly from 15 m to 200 m on sandy or muddy seabeds. However, the species can also be found congregating in deeper waters around wrecks and large crevices in rocky areas (Ref 4.108). There is very limited information on the spawning and reproductive cycle of this species in the North Sea.

4.4.7.62 TraC data from the south-east coast of England recorded this species in the Orwell and Stour Estuary between 2007 and 2010, which suggests this species is likely present within the study area.

Elasmobranchs

4.4.7.63 Elasmobranchs (i.e., sharks, skates and rays) are cartilaginous fish that form part of the mixed demersal fisheries. They are slow growing, late maturing, and possess a low fecundity compared with teleost fish. Females produce limited numbers of young which means recruitment is closely related to the numbers of adult females (Ref 4.109). Many of the rajiids (skates and rays) are targeted commercially while species of the triakid sharks (e.g., tope) are important to recreational fisheries. Elasmobranchs that have been identified as being located within the study area include basking shark (*Cetorhinus maximus)*, thorrnback ray (*Raja clavate)*, spotted ray (*Raja montagui*) and blonde ray (*Raja brachyura)*, starry ray (*Amblyraja radiata),* Common skate (*Dipturus batis)*, cuckoo ray (*Laucoraja naevus)*, undulate ray (*Raja undulata)* and common stingray (*Dasyatis pastinca),* lesser-spotted dogfish (*Scyliorhinus canicular)*, spurdog

(*Squalus acanthias)*, tope (*Galeorhinus galeus)*, smooth hound (*Mustelus mustelus)* and starry smooth hound (*Mustelus asterias)*.

Basking Shark

4.4.7.64 The basking shark is large pelagic migratory species, listed under Schedule 5 of the Wildlife and Countryside Act 1981, with a distribution concentrated around the north and southwest coasts of the UK (Ref 4.110). Basking shark are present in the North Sea, but observations are relatively rare (Ref 4.111). There have been no sightings around the Southern bight, indicating negligible presence of basking shark in the study area. This agrees with a habitat suitability modelling study by Austin *et al.* (Ref 4.112) study which identifies the study area as having a very low habitat suitability (<0.5) for basking shark.

Skates and Rays

4.4.7.65 Thorrnback ray, spotted ray and blonde ray are oviparous demersal spawners, laying successive batches of eggs typically at inshore areas characterised by sandy/muddy substrates (Ref 4.49). The spawning season for these species is between February and September with peak spawning for thornback ray in May and June. Peak spawning occurs slightly later in the year for the other ray species. There is insufficient information in the literature to delineate spawning grounds for these species (Ref 4.34).

4.4.7.66 Thornback ray is one of the most abundant and commercially important elasmobranch species in UK waters with a large fishery operating in the Outer Thames Estuary. The study area overlaps with ICES rectangles 32F1, 32F2, 31F1 and 33F1 (hereafter referred to as 'relevant ICES rectangles'). UK fleet landing stock data for the relevant ICES rectangles show a total landed live weight of 148.4 tonnes of Thornback ray were recorded between 2016 and 2020. Tagging work in the Thames Estuary found adults were widely distributed across the southern North Sea during the autumn and winter and favoured 20 – 35 m depth waters with small-scale seasonal movements to shallower waters <20 m in the Inner Thames Estuary for spawning in spring (peak May/June) (Ref 4.113).

Dogfish and Small Elasmobranchs

4.4.7.67 Lesser-spotted dogfish is one of the most abundant shark species in the North Sea (Ref 4.49). Other species known to be present, but in lesser abundance, include spurdog, tope, smooth hound and starry smooth hound. Dogfish and smooth hounds are all predominately coastal species. The lesser-spotted dogfish is an oviparous demersal spawner, laying successive batches of eggs, anchoring them to macroalgae and other sessile features on the seabed. This species exhibits a protracted spawning period between November and July, peaking in June and July (Ref 4.114). The spawning and nursery grounds of lesser-spotted dogfish are difficult to report due to insufficient information in the literature.

4.4.7.68 Spurdog, tope, smooth hound and starry smooth hound are all ovoviviparous or viviparous species (i.e., rear eggs or young within the body) and are therefore not affiliated with any particular habitats. Spawning grounds for these species are not well-defined although tope is thought to use inshore areas as nursery grounds. The study area occurs within low intensity nursery grounds for tope (Ref 4.34).

Shellfish

4.4.7.69 Shellfish is a broad term used to describe a large group of marine invertebrates that possess an exoskeleton (e.g., crustaceans, molluscs, and echinoderms). Shellfish are usually benthic, demersal, subtidal and/or intertidal during their adult stages.

4.4.7.70 Fisheries landing data indicate that the study area is an important region for shellfish, notably common cockle (*Cerastoderma edule*) and common whelk (*Buccinum undatum*) which collectively comprise 57 % of the total live weight of fish and shellfish landed between 2016 and 2020 from the UK fleet landing stock data for the relevant ICES rectangles. Other commercially important and widely abundant shellfish species located within the study area include the great scallop (*Pecten maximus)*, native oyster (*Ostrea edulis)*, edible crab (*Cancer pagurus*) and blue mussel (*Mytilus edulis*) European lobster (*Homarus Gammarus*). Other less abundant and less commercially important shellfish species known to be present within the study area include queen scallops (*Aequipecten opercularis*), common razor shell (*Ensis ensis*), velvet swimming crab, (*Necora puber*), flying crab (*Liocarcinus holsatus*), spider crab (*Maja squinado*), Nephrops (*Nephrops norvegicus*) and brown shrimp (*Crangon crangon*).

4.4.7.71 No designated shellfish water protected areas[6] are located within the Offshore Scheme. However, a number of designated shellfish water protected areas are located within the study area, to the west of the Offshore Scheme: (in order of proximity) Alde (ID 8; 3.1 km), Margate (ID 29; 6.9 km), Outer Thames (ID 24; 7.8 km), Butley River (ID 9; 10.1 km) and Swalecliffe (ID 28; 11.7 km).

Common Whelk

4.4.7.72 Common whelk is common in the North Sea and is extensively distributed along the UK coastline mainly sub tidally (Ref 4.115). They are found primarily in muddy gravel or mud with mixed shell and is found either on the seabed surface or buried beneath the surface (Ref 4.116). Spawning takes place from October to May and females move to hard substrate such as rocks, shells or stones to attach eggs (Ref 4.115). UK fleet landing stock data show that a total landed weight of 5,409.9 tonnes of common whelk were recorded between 2016 and 2020 within the relevant ICES rectangles.

Common Cockle

4.4.7.73 The common cockle is an infaunal suspension feeding bivalve that is distributed widely in estuaries and sandy bays throughout the UK, inhabiting sediments to a maximum depth of 5 cm in intertidal and subtidal areas (Ref 4.117). They favour clean sand, muddy sand, mud or muddy gravel and can often be found at high population densities (Ref 4.118). Cockles reproduce by mass spawning events in late spring with spat reaching approximately 10 mm in length by the first winter.

4.4.7.74 Cockle harvesting is carried out throughout the Outer Thames Estuary and extends north along the Suffolk coastline and is divided into smaller management areas. The study area overlaps with several cockle management areas[7] including:

[6] Shellfish water protected areas designated for the protection of shellfish growth and production under Article 5 of the Shellfish Waters Directive (2006/113/EC).

[7] Cockle management areas are regulated by KEIFCA under the Thames Estuary Cockle Fishery Order (TECFO), 1994 (TECFO) and relevant byelaws. Note that there are additional cockle management areas located outside of the TECFO.

- Gunfleet Sands;
- Shingles & Long Sand
- South Margate Sands; and
- North Margate Sand & Pan Sand.

4.4.7.75 Further information regarding the cockle fishery in the Outer Thames Estuary region can be found in **Volume 1, Part 4, Chapter 9, Commercial Fisheries**.

4.4.7.76 The IFCA carried out a recent study which involved carrying out targeted annual-season cockle stock surveys within a subset of the Outer Thames Cockle Management areas (Ref 4.119). Two of the targeted survey areas fell within the study area. These targeted survey areas are not individually named but one is located just north of Margate approximately 12 km west of the Offshore Scheme and the other is located in Pegwell Bay located within the Offshore Scheme. Overall, the results in these two targeted survey areas showed relatively little cockle abundance in 2021 (Ref 4.119).

4.4.7.77 The survey results showed that cockles were mainly distributed along the Maplin sands, which are located approximately 17 km east of the Offshore Scheme. These findings agree with longer term data from annual stock surveys carried out between 2011 and 2021 which show a similar pattern of distribution with the Maplin and Foulness Sands being the most important cockle fishing areas in the district in terms of their long-term contribution to the overall stock (Ref 4.119). Margate and Long Sands SAC which is located approximately 2 km from the Offshore Scheme is also considered important areas.

Blue Mussel

4.4.7.78 Blue mussel is a commonly occurring species in the Southern North Sea and the habitat 'blue mussel beds' is a qualifying interest feature of Goodwin Sands MCZ, Thanet Coast MCZ and blue mussels themselves are a qualifying interest species for Dover to Deal MCZ. This species was recorded during the MMT benthic characterisation surveys carried out for the Offshore Scheme and was one of the top ten most abundant species recorded with a total of 4003 individuals recorded at an occurrence frequency of 15% across the survey area (Ref 4.25). Furthermore, the habitat 'blue mussel beds' was identified at grab sample site S007 and transects T001, T001A and T004. Further information on these sites is provided in **Part 4, Chapter 3, Benthic Ecology.**

Norway Lobster

4.4.7.79 Norway lobster (*Nephrops norvegicus*) is a commercially important species that is distributed according to the extent of cohesive muddy sediments, in which they construct their burrows. The type of sediment also dictates the structure of the Nephrops populations, with areas of sandy mud having higher population densities. The North Sea is identified as a core habitat for Nephrops (Ref 4.120); however, the study area does not fall within ICES Nephrops 'Functional Units' (e.g. stocks) (Ref 4.121) and the study area does not fall within the spawning or nursery groups of this species (Ref 4.34). Furthermore, this species was not recorded during the MMT benthic characterisation surveys carried out for the Offshore Scheme (Ref 4.25). Detailed information related to the MMT benthic characterisation surveys undertaken can be found in **Part 4, Chapter 3, Benthic Ecology.**

Scallop

4.4.7.80 In the North Sea, great scallop favour clean firm sand, fine or sandy gravel and depressions in the seabed but are occasionally found on muddy sand. They are active, epibenthic suspension feeders that occur at depths of between 10 m and 110 m, particularly in sheltered areas close to faster currents (Ref 4.122).

4.4.7.81 Scallop spawning times vary from spring to autumn with some populations exhibiting two spawning peaks during this time. Larvae are planktonic for 30 days and may disperse over long distances before settling onto hydrozoans and/or bryozoans until they reach a size of approximately 1 mm to 5 mm. They then detach and settle onto the seabed (Ref 4.123). Scallops are an important commercial species in the study area. Further detail is presented in **Part 4, Chapter 9, Commercial Fisheries.**

Native Oyster

4.4.7.82 Native oyster is widely distributed in UK waters and is recorded throughout the Thames Estuary and the southern North Sea. It is found within highly productive inshore waters and estuaries on firm substrates comprising of mud, muddy sand, rock, muddy gravel with shells and hard silt. Native oysters are sessile, epifaunal filter feeders found from the low intertidal to about depths of about 80 m (Ref 4.124). Within the study area oysters are a designated feature of the Dover to Deal MCZ which is an important area for this species in south-east England.

4.4.7.83 Limited studies on the distribution of native oysters within the study area have been carried out; however they have been recorded within the Colne Estuary within the Blackwater, Crouch, Roach and Colne Estuary MCZ between January and November 2007 located approximately 40 km west of the Offshore Scheme (Ref 4.125).

Crabs

4.4.7.84 The edible crab is found in water depths between 25 m and 300 m in the North Sea, with a preference for bedrock, mixed coarse grounds, and offshore in muddy sands (Ref 4.126). This species therefore has the potential to be present with the study area. Edible crabs copulate in the spring and summer, the female crabs becoming gravid, carrying their eggs under the abdomen. In the North Sea, brooding females migrate offshore to release their larvae, which once hatched remain in the water column for between 60 days and 90 days before settling. Tagging surveys off the coast of Norfolk have shown that mature females undertake long-distance northerly migrations to the Yorkshire coast, although more recent studies suggested this may be a discrete population of edible crabs.

European Lobster

4.4.7.85 The European lobster is generally found from the intertidal zone to depths of 60 m and therefore has the potential to be found in coarse habitats within the study area. This species exhibits site fidelity, although home extents can range between 2 km and 10 km (Ref 4.127). Lobsters are solitary animals and inhabit holes and tunnels that they build below rocks and boulders (Ref 4.128). Females can spawn annually or following a bi-annual pattern, with reproduction taking place during the summer (Ref 4.129). They do not make extensive migrations when berried (i.e., when carrying eggs attached to the tail or exterior part) and hatching takes place in spring and early summer on the same grounds.

4.4.7.86 UK fleet landing stock data show that a total landed weight of 80.54 tonnes of European lobster were recorded between 2016 and 2020 within the relevant ICES rectangles. Furthermore, the MMT benthic characterisation surveys carried out for the Offshore Scheme showed areas of potentially suitable habitat for lobster with the seabed between KP 14.062 to KP 30.998 and between KP 64.599 and KP 77.500 being characterised by a high reflectivity across the majority of the section interpreted to be associated with mixed and coarse sediments (i.e., cobbles and boulders). Grab sample site S031 also contained large cobbles and boulders which may be used by European lobster. Further detailed information related to the MMT benthic characterisation surveys undertaken can be found in **Part 4, Chapter 3, Benthic Ecology.**

Cephalopods

4.4.7.87 Cephalopods are divided into two superorders; the *Decapodiformes* (squid and cuttlefish) and the *Octopodiformes* (octopus). These are short-lived carnivorous invertebrates with rapid growth rates. They have only one reproductive cycle, after which they die. They play an important role in marine food webs (Ref 4.130).

4.4.7.88 The southern North Sea is not an ideal habitat for most cephalopods due to its shallow water depths (Ref 4.132). The only species that is regularly found in large numbers in this region is the long-finned European common squid (*Alloteuthis subulate)*, which typically migrates into the southern North Sea in the summer. This species is considered the dominant cephalopod species in the region (Ref 4.145).

4.4.7.89 Other species recorded in the region are:

- Long-finned squids - veined squid (*Loligo forbesii*) and European squid (*Loligo vulgaris)*;
- Short-finned squids - European flying squid (*Todaropsis eblanae)*;
- Other species of squid - clubhook squid *(Onychoteuthis banksia)*;
- Bobtail squids - Atlantic bobtail (*Sepiola atlantica)*, common bobtail (*Sepietta oweniana)* and stout bobtail (*Rossia macrosoma)*;
- Cuttlefish - common cuttlefish (*Sepia officinalis)*; and
- Octopus - curled octopus (*Eledone cirrhosa)*.

4.4.7.90 These species are the only cephalopods to have been encountered in the southern North Sea during International Bottom Trawl Surveys and International Beam Trawl Surveys between 1996-2003 (Ref 4.132).

4.4.7.91 The most commercially important cephalopod species in U.K. waters is the veined squid (Ref 4.131) but the common cuttlefish is also important (Ref 4.130). Further information in relation to commercial fisheries for cephalopods is provided in **Volume 1, Part 4, Chapter 9, Commercial Fisheries**.

Long-Finned Squids

4.4.7.92 Long-finned squids are neritic and demersal species associated with coastal waters. Four species of long-finned squid are found in northern European waters and are commercially important: European common squid (*Alloteuthis subulata*), veined squid, and European squid (*Loligo vulgaris*).

4.4.7.93 The European common squid is widely distributed in the central and southern North Sea, and it migrates into shallower water during summer and into deeper, relatively warmer waters in winter (Ref 4.132). The European common squid is morphologically similar to the common squid, and some studies suggest that they may be intra-specific forms rather than true, separate species (Ref 4.133). However, their distributions overlap significantly, and common squid is not typically found as far north as the European common squid (Ref 4.133).

4.4.7.94 The veined squid is the largest and most northerly distributed of the long-finned squids, preferring shallow, coastal waters and continental shelf areas (Ref 4.134). It tends to avoid waters cooler than 8.5°C, and it is the most commercially important squid species in UK waters (Ref 4.134). The veined squid is often confused with the similar European squid *(Loligo vulgaris)*, which is slightly smaller and has a distribution that rarely extends into northern UK regions (Ref 4.134). Maturation of veined squid takes approximately a year, and there is a single extended breeding period from December to May, usually with two pulses of recruitment during this time (Ref 4.135). They are terminal spawners, laying their eggs in batches before dying (Ref 4.136). Recent studies suggest that individuals migrate inshore from deep waters in the winter months during the peak of spawning (Ref 4.137).

4.4.7.95 The European squid is relatively scarce in the southern North Sea but is most abundant in the region in late spring to summer (Ref 4.138). It is a benthic spawner, attaching egg masses to hard substrates. The winter spawning period in the North Sea is relatively short (Ref 4.138).

Short-Finned Squids

4.4.7.96 Short-finned squid are typically found in open, oceanic waters (Ref 4.139). The European flying squid (*Todarodes eblanae*), is a predator, found in both shallow coastal and deep oceanic environments from surface waters to depths of 4,500 m (Ref 4.140). This species is known to undertake significant diurnal migrations, feeding near the surface at night, with spawning reported to occur at depths ranging from 70 to 800 meters. (Ref 4.141).

Other squids

4.4.7.97 Common clubhook squid *(Onychoteuthis banksii*) is one of the most abundant oceanic, epipelagic squid in the world. There is very little published information on the biology and ecology of this species, but it is occasionally caught around the UK. For example, this species has been recorded in the southern North Sea during International Bottom Trawl Surveys and International Beam Trawl Surveys between 1996-2003.

Bobtails

4.4.7.98 Bobtail squids, which are closely related to cuttlefish, are small and stout decapods. Even the larger species do not typically exceed 65 mm in total length. Seven species of bobtail squid are present in UK waters, and while they are abundant, they are too small to be commercially exploited. These species are typically found in shallow coastal waters and continental shelf areas over sandy or muddy seabeds and are classified as neritic, benthic species.

4.4.7.99 The bobtail squid species found in the Southern North Sea are: Atlantic bobtail (*Sepiola atlantica*), common bobtail (*Sepietta oweniana*), and stout bobtail (*Rossia macrosoma*).

Cuttlefish

4.4.7.100 Cuttlefish are advanced carnivorous decapods that consume small fish and crustaceans. They use a distinct structure called the cuttlebone to regulate their buoyancy and are economically valuable in various regions. In the UK's waters, there exist three cuttlefish species: the common cuttlefish, the elegant cuttlefish (*Sepia elegans*), the pink cuttlefish (*Sepia orbignyana*).

4.4.7.101 The common cuttlefish is both the largest (with a mantle length of up to 400 mm) and the most commonly distributed (found on all British coastlines (Ref 4.142; Ref 4.143)). It is a neritic, demersal species, typically found in warm, shallow coastal waters, with a significant number encountered in the southern North Sea. The lifespan of the common cuttlefish is approximately two years and the spawning season lasts from early spring to mid-summer, with spawning typically taking place in water shallower than 30 m (Ref 4.138). Mature individuals move inshore to spawn, with larger females migrating earlier in the season than smaller females (Ref 4.138). The black eggs are attached in bunches to substrata on the seabed, with embryo development times increasing at cooler water temperatures, taking approximately 90 days at 15°C and just 40-45 days at 20°C.

Octopuses

4.4.7.102 In UK waters, most octopuses belong to the non-finned (incirrate) category, with only a few species in the deep seas being finned (cirrate). Little is known about the biology of these deep-sea species. Unlike decapods such as squids, sepiolids, and cuttlefish, octopuses possess eight legs with suction cup suckers. Several species of octopuses are present in UK waters, with the curled octopus (*Eledone cirrhosa*) being the most prevalent.

4.4.7.103 The curled octopus, is a small bottom-dwelling octopus found in shallow coastal waters, ranging from the lower shore to depths of 300 m, and can be found on various seabed types from soft mud to rocky bottoms (Ref 4.144). The species' life cycle varies across its geographical distribution, with individuals in the North Sea displaying either a one-year or a two-year cycle depending on their growth and maturation rates (Ref 4.144). From July to September (Ref 4.144), females spawn, with death following shortly after they have laid their eggs. The eggs usually hatch between April and July (Ref 4.145).

Spawning and Nursery Grounds

4.4.7.104 The occurrence, distribution and abundance of many fish and shellfish within the study area is determined by their propensity to aggregate within specific areas to spawn. ‘Spawning grounds’ are defined either by the species behaviour and therefore may cover a wide area, or by specific habitat preferences (e.g., gravel), which may restrict spatial extent. Fish exhibit several modes of reproduction, the most common being broadcast spawning, where eggs and sperm are released into the water column (Ref 4.34). Other species deposit egg-cases or egg mats onto the seafloor making them more vulnerable to seabed disturbance.

4.4.7.105 Fisheries sensitivity maps (Ref 4.32; Ref 4.34; Ref 4.33) provide information on spawning grounds (the location where eggs are laid) and nursery grounds (the location where juveniles are common) for selected fish and shellfish species prevalent in the study area (Table 4.4.10 and Table 4.4.11). These data indicate that the Offshore Scheme is located within important spawning grounds for herring, sandeel, sprat,

whiting, plaice, Dover sole, and lemon sole. High-intensity nursery grounds of herring and Dover sole were also identified within the study area, as were important grounds for sandeel. Seabass nursery grounds are also known to be present within the study area.

4.4.7.106 The spawning and nursery grounds of these species, in the context of the Offshore Scheme are shown in **Figure 4.4.6. Herring larvae spawning and nursery grounds** and **Figure 4.4.7. Sandeel larvae spawning and nursery grounds.** Species such as sprat, whiting, plaice, plaice, Dover sole, and lemon sole are broadcast spawners, and as such eggs, once spawned, are pelagic and distributed through the water column and will therefore be carried by ocean currents, potentially distant from the Offshore Scheme and so are unlikely to be at risk of impacts. On this basis, only herring and sandeel have been taken forward for detailed appraisal and the preliminary assessment of potential impacts in section 4.4.9.

Table 4.4.10: Spawning grounds within the study area

Species	Ellis *et al.* (2012)	Coull *et al.* (1998)
Herring	Yes	Yes
Sandeel	Low intensity	Yes
Sprat	n/a	Yes
Cod	Low intensity	No
Whiting	No	Yes
Plaice	High intensity	Yes
Dover sole	High intensity	Yes
Lemon sole	n/a	Yes

Table 4.4.11: Nursery grounds within the study area

Species	Ellis *et al.* (2012)	Coull *et al.* (1998)
Herring	High intensity	Yes
Sandeel	Low intensity	Yes
Sprat	n/a	Yes
Mackerel	Low intensity	Yes
Cod	Low intensity	Yes
Whiting	Low intensity	Yes
Plaice	Low intensity	Yes
Dover sole	High intensity and low intensity	Yes
Tope shark	Low intensity	n/a
Thornback ray	Low intensity	n/a
Lemon sole	n/a	Yes

Table 4.4.12: Spawning times for sensitive demersal spawners in the study area

Fish species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Herring (Blackwater and Thames stock)		■	■	■	■							
Herring (Southern Bight or Downs herring stock)	■										■	■
Sandeel	■	■										■

Herring Spawning Grounds

4.4.7.107 Herring are demersal spawners and spawn on the seabed in specific habitat types and their eggs remain on the seabed. They are therefore, sensitive to potential seabed impacts. Spawning grounds for herring are located on gravel and similar habitats (such as coarse sand, maerl, and shell) where the water is well-oxygenated and there is a low proportion of fine sediment (Ref 4.34).

4.4.7.108 There are several geographically distinct herring stocks in UK waters (Ref 4.86), with three major populations (Buchan/Shetland herring stock, Banks or Dogger herring stock and the Southern Bight or Downs herring stock) each with different spawning times. The major population associated with the study area is the Southern Bight or Downs herring stock which spawns in the Eastern Channel and Southern Bight from November until January (Ref 4.80). At the closest point these grounds are approximately 8.5 km from the Offshore Scheme (**Figure 4.4.6. Herring larvae spawning and nursery grounds**).

4.4.7.109 Another smaller discrete spring spawning population known to be present within the study area is the Blackwater and Thames herring stock (**Figure 4.4.6. Herring larvae spawning and nursery grounds**). This population spawns between late February and early May (Ref 4.79) on Herne Bay in Kent, and at the Eagle Bank and Osea Island at the mouth of the Blackwater estuary. Adults migrate inshore in early November and aggregate within 10 miles of the coast in readiness to spawn in the spring (Ref 4.79).

4.4.7.110 There is also a small discrete herring stock on the Norfolk coast, located approximately 10 km north of the Offshore Scheme. Adult herring in the Thames Estuary are primarily composed of a mixture of individuals from the Blackwater and Thames stock and the Southern Bight or Downs herring stock. Overall, the study area is recognised as being a high intensity spawning and nursery ground for herring (Ref 4.34).

4.4.7.111 The location of the Southern Bight or Downs herring stock is evident by the areas of higher abundance of larvae and eggs outside the Offshore Scheme, sampled as part of the International Herring Larvae Surveys (IHLS) in the North Sea. The IHLS data for

the North Sea, was used to produce a contour map[8], interpolated from the maximum recorded number of larvae (number larvae per m^2) over a 10-year period (2008-2017)[9]. The IHLS result contour map is shown in **Figure 4.4.8. Abundance of Southern North Sea herring larvae and eggs recorded during the IHLS Survey Interpolated Contour Map – 2008 to 2017 (maximum number per m^2).** It should be noted that until recently the Southern North Sea and eastern English Channel (SNS) IHLS surveys for the Southern Bight or Downs herring stock were conducted as three separate sampling event surveys; one in the 3rd quarter of each year undertaken by the Netherlands between 16 to 31 December, and two in the 1st quarter of each year; between 01 to 15 January undertaken by Germany, and from 16 to 31 January undertaken by the Netherlands. However, the latter survey (from16 to 31 January) was discontinued in 2017. Therefore, the IHLS data between 2008 and 2017 was used for this assessment as it represents the latest data, which is comparable, i.e., the data are presented as numbers of larvae per m^2, with an ICES rectangle subdivision code that could be used to reference the haul ID number. It is important to note that no IHLS surveys are conducted at the Thames/Blackwater herring spawning grounds.

4.4.7.112 The IHLS result contour map (**Figure 4.4.8. Abundance of Southern North Sea herring larvae and eggs recorded during the IHLS Survey Interpolated Contour Map – 2008 to 2017 (maximum number per m^2)**) shows that the southern half of the Offshore Scheme is comprised of medium abundance (200-600 herring larvae per m^2) and a small section on the central part of the Offshore Scheme is comprised of low abundance (50 – 200 herring larvae per m^2). Furthermore, the IHLS result contour map shows that the Offshore Scheme is devoid of any areas of high abundance (i.e. 600 – 46600 herring larvae per m^2).

4.4.7.113 The subtidal benthic habitats identified along the Offshore Scheme were generally dominated by rippled sand, sand and mud, and mixed sediments (Further details can be seen in **Part 4, Chapter 3, Benthic Ecology**).

4.4.7.114 A total of 37 subtidal sampling locations were sampled within the Offshore Scheme during the MMT benthic characterisation surveys. The results of the potential herring spawning habitat study are presented in Table 4.4.13 and **Figure 4.4.9. Potential suitable herring spawning habitat along the Offshore Scheme.** Along the Offshore Scheme, only two grab sample sites (S026 and S037) were classified as "Marginal"/"Suitable" for herring spawning ground preference. The remaining sites, where particle size analysis (PSA) was analysed, were classified as "Unsuitable" for herring spawning.

[8] The contour map was produced by interpolating from the maximum recorded number of larvae (number larvae per m^2) at one location during the time period assessed. Where there were three samples or fewer, in total (per ICES rectangle sub-division[8]) over the period, these were removed. The Natural Neighbour method was applied to the point data in ArcGIS. The choice of contour intervals is based on the IHLS point data. Four percentile categories, plus zero, were determined using the ratios used within the MarineSpace (Ref 4.36 and Ref 4.37) guidance (taking consideration of the maximum IHLS point data value within the data used for this assessment). As equal interval contours were the only available option, 50 unit intervals were applied to the interpolated dataset.

[9] 10-years of data was analysed, from 2008-2017. Abundance fields were rejected, as these are dependent on the volume of water processed, which is related to water depth. Instead, the number of larvae per square metre field was selected. More recent IHLS data did not include the field 'number of larvae caught per m^2. Furthermore, there was no reference to the ICES Statistical Rectangle division for which each haul ID could be referenced to, to allow a contour plot to be produced as per MarineSpace *et al.,* (2013a and 2013b; Ref 4.36 and Ref 4.37) guidance.

Table 4.4.13: Potential herring spawning habitat in the study area

Site ID	MMT Kilometre Point	Modified Folk	Habitat Sediment Preference	Habitat Sediment Classification
S026	113.208	gravelly Sand	Suitable	Marginal
S037	120.801	Sand	Suitable	Marginal

4.4.7.115 Broadscale habitat mapping[10] has been produced by MMT for the Offshore Scheme. This broadscale habitat mapping was based on combining the grab sample data (which provided Folk (1954) classifications) with drop-down video analysis to classify the habitat types within the Offshore Scheme in terms of biotopes, in line with the EUNIS habitat classification.

4.4.7.116 This habitat mapping has indicated that there are sediment types within the central section of the Offshore scheme that are characteristic of 'preferred'/'marginal' sediment types for herring spawning (**Figure 4.4.9. Potential suitable herring spawning habitat along the Offshore Scheme**). Whilst these data broadly agree with herring spawning grounds identified by Coull *et al.,* (Ref 4.32, 1998); however Coull *et al.,* (1998) also shows herring spawning grounds along the northern section of the Offshore Scheme (see **Figure 4.4.6. Herring larvae spawning and nursery grounds**). In total the 'preferred/marginal' habitat covers an area of 19 km^2 which is 42% of the total area of the MMT benthic characterisation survey area[11] (see Table 4.4.14).

Table 4.4.14: Area considered to be preferred/marginal herring habitat sediment type resulting from the MMT benthic characterisation surveys

Habitat classification	Area (km²)	Percentage of survey area
Preferred/marginal	19.5	42.7
Other	26.1	57.3

[10] The broadscale habitats consider Folk modified 5 classifications. This means that the Folk Classifications 'gravel', 'sandy gravel', and 'gravelly sand' are grouped as 'coarse sediment', whilst 'gravelly sand' and 'sand' are grouped as 'sand'. Using herring as an example, 'marginal' and 'preferred' habitat both lie within the 'course sediment' classification and cannot be distinguished. Therefore, the lowest confidence is adopted, which in this instance would be 'marginal' habitat. 'Marginal' habitat is considered to provide a low confidence in herring spawning habitat and sandeel habitat. However, these data have been used to ground truth the MMT benthic survey characterisation data, to indicate any correlation between the presence or absence of 'preferred'/'marginal' habitat.

[11] The MMT benthic characterisation survey area is located wholly within the marine draft Order Limits however, since the MMT benthic characterisation surveys were carried out, the boundary of the marine draft Order Limits has been extended in some areas resulting in the MMT benthic characterisation survey area only covering a part of the current marine draft Order Limits.

Sandeel Spawning Grounds

4.4.7.117 Sandeel spawn on the seabed in specific habitat types and their eggs are demersal and remain on the seabed. They are therefore sensitive to potential seabed impacts. Sandbanks and other sandy areas are known to be important habitat for sandeel, which typically prefer depths between 30 m and 70 m but are known to occur at depths of 15 m and 120 m. Sandeel burrow into these sandy habitats and use interstitial water to ventilate their gills. Fine sediment has the potential to clog their gills and therefore, sandeels have a very specific habitat requirement, meaning their distribution is often patchy (Ref 4.38); (Ref 4.146).

4.4.7.118 Suitable sandeel habitat has been identified as consisting of substrate that contains a high percentage of medium to coarse sand (particle size of 0.25 mm to 2 mm), with a mud content of less than 10% (particles <63 µm). A gravel component is also considered to be suitable for sandeel habitat. The inclusion of gravel means that using Folk classifications (Ref 4.147) can often over-represent the suitability of habitat for sandeel; however, this is used as a precautionary approach. Latto *et al.,* (2013) (Ref 4.148) states that the Folk classification divisions that best describe the preferred habitat for sandeel species in UK waters, are: sand – S; slightly gravelly sand - (g)S; and gravelly sand – gS. The following Folk classification sediment divisions are considered to be marginal habitat (accorded less confidence than the preferred habitat) for sandeel species in UK waters: sandy gravel – sG.

4.4.7.119 More specific definitions of sandeel preferred grounds using sediment particle size are provided by Greenstreet *et al.,* (Ref 4.93, 2010). This method uses the sediment fraction percentage by weight of the sample, separating into two distinct fractions; silt and fine sand (particle sizes >0.25 mm) and medium to coarse sand (particles sizes 0.25 mm to 2.0 mm). Therefore, this removes the coarse >2mm fraction that can often over-represent the suitability of habitat. The results of the Greenstreet *et al.,* (Ref 4.93, 2010) are presented in Table 4.4.15 below.

4.4.7.120 The Offshore Scheme passes through areas designated as low intensity spawning grounds and low intensity nursery grounds for sandeel (Table 4.4.10 and Table 4.4.11). The Margate and Long Sands SAC is located within the study area and is designated for the protection of the Annex I habitat ‘sandbanks which are slightly covered by sea water all the time’ which is preferred sandeel habitat. However, the Offshore Scheme does not fall within the SAC.

4.4.7.121 Of the 37 subtidal sampling locations surveyed within the Offshore Scheme during the MMT benthic characterisation surveys, only six sites (S023, S025, S026, S029, S035 and S037) within the survey area were identified as “preferred” sandeel habitat and nine sites (S004, S014, S016, S019, S020, S022, S024, S030 and S036) identified as “marginal” sandeel habitat. Sandeel was also identified at grab sample sites S016 and S022 (shown in Table 4.4.15).

Table 4.4.15: Sampling stations used during the MMT benthic characterisation surveys with prime and sub-prime sandeel spawning habitat (Ref 4.93, Greenstreet *et al.,* 2010)

Station	MMT Kilometre Point	Modified Folk	Habitat Preference (Greenstreet, 2010)
S004	4.447	Sand	Marginal
S014	37.003	Sand	Marginal

Station	MMT Kilometre Point	Modified Folk	Habitat Preference (Greenstreet, 2010)
S016	55.264	Sand	Marginal
S019	80.747	Sand	Marginal
S020	93.062	Sand	Marginal
S022	110.750	Sand	Marginal
S023	111.237	Sand	Preferred
S024	111.616	Sand	Marginal
S025	112.315	Sand	Preferred
S026	113.208	gravelly Sand	Preferred
S029	114.648	Sand	Preferred
S030	115.335	Sand	Marginal
S035	2.353	Sand	Preferred
S036	118.149	Sandy Mud	Marginal
S037	120.801	Sand	Preferred

4.4.7.122 Broadscale habitat mapping shows that the 'preferred'/'marginal' habitat for sandeel is concentrated along the central section of the Offshore Scheme with large patches also presented along the southern section of the Offshore Scheme (see **Figure 4.4.10. Potential suitable sandeel spawning habitat within the Offshore Scheme.** This broadscale habitat mapping agrees with sandeel spawning grounds identified by Coull *et al.* (Ref 4.32, 1998) (see **Figure 4.4.7**). In total, 'preferred/marginal' habitat covers an area of 23.6 km^2 which is 51.6 % of the total area of the MMT benthic characterisation survey area and 'other' habitat covers 22.1 km^2 (48.4%) (Table 4.4.16).

Table 4.4.16: Area considered to be preferred/marginal herring habitat resulting from the MMT benthic characterisation surveys

Habitat classification	Area (km^2)	Percentage of survey area
Preferred/marginal	23.6	51.6
Other	22.1	48.4

Commercial Fisheries

4.4.7.123 Species of commercial importance vary along the length of the Offshore Scheme depending on location. Details on commercial fisheries within the study area, including information on ports and fishing fleet characteristics, is provided within **Volume 1, Part 4, Chapter 9 Commercial Fisheries**.

4.4.7.124 The Offshore Scheme passes through the jurisdictions of two Inshore Fisheries and Conservation Authorities (IFCA); Kent Essex IFCA (KEIFCA) and Eastern IFCA for Suffolk. Within these areas there are several closed areas for bottom towed fishing gear. These include the prohibited use of dredges and trawls due to the presence of sensitive features. These features are:

- East Margate Sands;
- Thanet Coast SAC; and
- Margate and Long Sands.

4.4.7.125 In addition, there are larger areas with partial restrictions. These partial restrictions are:

- inshore trawling restriction for vessels >15.24 m in length for 3 NM offshore along the whole Eastern IFCA boundary;
- fishing restriction, unless carried out from a beach or a vessel <17 m in length, along the whole KEIFCA boundary;
- towed gear restriction for vessels >14 m in length fishing for mussels along the whole Eastern IFCA boundary;
- fishing restriction, unless carried out from a beach or a vessel <17 m in length, along the whole KEIFCA boundary;
- inshore trawling restriction for vessels >15.24 m in length for 3 NM offshore along the whole Eastern IFCA boundary; and
- towed gear restriction for vessels >14 m in length fishing for mussels along the whole Eastern IFCA boundary.

Summary of Receptors

4.4.7.126 Fish and shellfish receptors taken forward for consideration in the appraisal along with their associated value have been determined based upon potential activity/receptor interactions and professional judgement. For the appraisal, those species considered to have the greatest sensitivity to a particular effect (high or medium sensitivity rating) have been assessed at the species level, whereas those species with lower sensitivity have been assessed either at a high taxonomic level (e.g., elasmobranchs) or by functional group (e.g., demersal, pelagic and migratory) as appropriate (Table 4.4.17).

Table 4.4.17. Fish and shellfish ecology receptors considered and their assigned value

Receptor group	Species	Rationale	Sensitivity/Value
Migratory species	European eel, Atlantic salmon, brown trout, sea and river lamprey, European smelt and shad	• Species of international or national conservation importance; • European eel listed as 'critically endangered' on the IUCN Red List; • Atlantic salmon and river and sea lamprey are qualifying features of designated SACs; • Species sensitive to underwater sound disturbance and Electromagnetic Field (EMF); and • Some species valuable economically (commercial species).	High
Pelagic fish species	Herring	• National conservation importance; • Presence of spawning and nursery grounds; • Sensitive to habitat disturbance and underwater sound; and • Commercially and ecologically (prey species) important.	Medium
	Sprat	• Presence of spawning and nursery grounds; • Sensitive to underwater sound; and • Commercially and ecologically (prey species) important	Low
	Mackerel	• Low intensity nursery grounds; and • Commercially and ecologically (prey species) important.	Low

Receptor group	Species	Rationale	Sensitivity/Value
Demersal fish species	Sandeel	• National conservation importance (lesser sandeel a PMF); • High/Low intensity spawning and nursery areas; • Sensitive to increased suspended sediment concentration (SSC), smothering and habitat disturbance and/or loss; and • Commercially and ecologically (prey species) important).	Medium
	Cod, lesser weever fish, Mediterranean scaldfish, poor cod, European seabass, European seabass, Dover sole and plaice	• International and/or national conservation importance; • Presence of spawning and nursery grounds; • Sensitive to increased SSC and underwater sound; and • Valuable economically (commercial species).	Low/Medium
Elasmobranchs	All species except basking shark	• Low intensity nursery ground for thornback ray and spurdog overlap with the Offshore Scheme; • Some species are demersal and therefore considered sensitive to increased turbidity; • Thornback ray is a demersal spawner and therefore considered sensitive to smothering and habitat disturbance and/or loss; • Sensitive to EMF effects; • Some species of national and international conservation importance, e.g., a number of ray and skate species are listed as	Medium

Receptor group	Species	Rationale	Sensitivity/Value
		an OSPAR threatened or declining species; and • Some species valuable economically (commercial species).	
	Basking shark	• Wildlife and Countryside Act 1981; and • NERC Species of Principal Importance (SPI).	High
Shellfish of commercial and/or conservation importance		• There are important shellfish areas for common cockle, common whelk within the study area, • Some species, such as mussels, and life stages are epibenthic or demersal and therefore sensitive to increased turbidity, smothering and EMF effects; and • European lobster, crabs and scallops valuable economically (commercial species).	Medium
General fish, shellfish and cephalopod communities not included above		• Common, ubiquitous and of low commercial importance; • Some species and life stages are demersal and therefore considered sensitive to increased turbidity and smothering; and • Considered to have a high tolerance to change given their distribution and abundance.	Low

Future Baseline

4.4.7.127 The fish and shellfish chapter within the ES will include an outline of the likely evolution of the baseline environment without the implementation of the development as far as natural changes from the baseline scenario can be assessed.

4.4.8 Mitigation

4.4.8.1 As set out in **Part 1, Chapter 5, PEIR Approach and Methodology**, mitigation measures typically fall into one of the three categories: embedded measures; control and management measures; and mitigation measures.

Embedded Measures

4.4.8.2 Embedded measures have been integral in reducing the fish and shellfish effects of the Proposed Project. Measures that that have been incorporated are:

- Sensitive routeing and siting of infrastructure and temporary works;
- Commitments made within **Appendix 1.4.F Outline Schedule of Environmental Commitments**.

Control and Management Measures

4.4.8.3 The following measures have been included within **Appendix 1.4.A Outline Code of Construction Practice** relevant to the control and management of impacts that could affect fish and shellfish receptors:

- GM01 - designated (and as minimal as possible) anchoring areas and protocols shall be employed during marine operations to minimise physical disturbance of the seabed;
- GM03 - an offshore Construction Environmental Management Plan (CEMP) including an Emergency Spill Response Plan and Waste Management Plan, Marine Pollution Contingency Plan (MPCP), Shipboard Oil Pollution Emergency Plan (SOPEP) and a dropped objects procedure will be produced prior to installation;
- LVS01 - all project vessels shall adhere to the International Convention for the Control and Management of Ships' Ballast Water and Sediments with the aim of preventing the spread of marine invasive non-native species (INNS);
- LVS02 - all project vessels must comply with the International Regulations for Preventing Collisions at Sea (1972) (Ref 4.149), regulations relating to International Convention for the Prevention of Pollution from Ships (the MARPOL Convention 73/78) (Ref 4.150, IMO, 1983) with the aim of preventing and minimising pollution from ships and the International Convention for the Safety of Life at Sea (Ref 4.151,);
- LVS05 - drilling fluids required for trenchless operations will be carefully managed to minimise the risk of breakouts into the marine environment. Specific avoidance measures would include:
  - the use of biodegradable drilling fluids (PLONOR substances) where practicable,

  - drilling fluids will be tested for contamination to determine possible reuse or disposal; and
  - If disposal is required drilling fluids would be transported by a licensed courier to a licensed waste disposal site.

- BE01 - a biosecurity plan will be produced for the project, following the latest guidance on INNS from the GB non-native species secretariat;
- BE02 - all project vessels will adhere to the International Maritime Organisation (IMO) Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species (Biofouling Guidelines);
- BE03 - any material introduced into the marine environment, such as rock protection material, will be from a suitable source or cleaned to ensure no INNS can be introduced;
- FSF01 - in accordance with the Department of Energy and Climate Change report (Ref 4.152) and MMO recommendations, the target depth of lowering (DOL) will be between 1.5 m to 2.5 m (subject to local geology and obstructions) to minimise the effects of EMF for fish receptors; and
- MM01 - adherence to JNCC guidelines for marine mammals, where appropriate, regarding the minimisation of impacts from underwater sound generated from geophysical surveys (Ref 4.153) and UXO detonation (Ref 4.154).

Mitigation Measures

4.4.8.4 Mitigation measures are additional topic and site-specific measures that have been applied to mitigate or offset any likely significant effects. After the application of the aforementioned embedded and control measures, no additional mitigation measures or monitoring have been recommended as a result of the impact appraisal.

4.4.9 Preliminary Assessment of Effects

4.4.9.1 The preliminary assessment of the effects of the Offshore Scheme described in this section considers the embedded, control and management and mitigation measures described in section 4.4.8.

4.4.9.1 For the sensitivity test outlined in section 4.4.5, preliminary effects reported would not be any different if the works were to commence in any year up to year five.

4.4.9.2 The preliminary fish and shellfish assessment of the effects of the Offshore Scheme is presented in Table 4.4.18.

4.4.9.3 The preliminary effects reported below are the same for the Proposed Project on its own, and the Proposed Project with co-location.

Table 4.4.18: Preliminary assessment of fish and shellfish effects.

Receptor	Fish and shellfish
Potential impact	**Permanent loss of fish and shellfish habitat due to placement of hard substrates on the seabed**: Cable protection is required where third-party assets cross the route, where burial can’t be achieved due to

	ground conditions, and at exit points (four or 10 ducts depending on co-location or not) to mitigate the effects of mobile sediments. Options for external cable protection include: • rock placement (planned berms) (10 m wide across ~13.2 km indicative pre- and post-lay rock berm – an indicative area of around 0.132 km^2); • concrete mattresses (80 mattresses, over 480 m in length – area of 0.00144 km^2); • rock/gravel/sand/grout bags (to be confirmed for ES); and • protection sleeves/cast-iron shells.
Proposed Project phase	Construction
Duration	Lifetime of project
Mitigation	N/A
Preliminary sensitivity	Migratory fish are not considered to have functional associations with seabed habitats due to their life history strategies and transient presence within the Offshore Scheme. Therefore, this receptor group has not been considered further for this impact pathway. Herring and sandeel are considered to have very high sensitivity to permanent habitat loss, as these species are demersal spawners and exhibit specific habitat requirements for spawning (i.e., gravelly sediments for herring and sandy sediments for sandeel). The adult sandeel is also sensitive to habitat loss owing to the co-location of spawning and adult habitats and sediment requirements for burrowing. Other demersal and pelagic species known to occur within the study area are highly mobile, with wide distributions and broad habitat requirements meaning they have capacity to exhibit avoidance behaviour and move into alternative available habitats nearby. Thus, this group of species are considered to have negligible sensitivity to permanent loss of habitat due to placement of hard substrates on the seabed. According to the Marine Evidence based Sensitivity Assessment (MarESA), commercially important shellfish such as brown crab and scallop are considered to be moderately sensitive to habitat loss (Ref 4.126, Neal and Wilson, 2008; Ref 4.122, Marshall and Wilson, 2008). Some crustaceans (e.g., crab and lobster) may benefit from the addition of artificial hard substrates, providing additional refuge and new potential sources of food. For example, post-installation monitoring surveys at the Horns Rev Offshore Wind Farm found artificial hard

	substrates were used as a hatchery or nursery grounds for several shellfish species, notably brown crab (Ref 4.155, Vattenfall, 2006). Thus, the overall sensitivity of shellfish is considered to be low.
Preliminary magnitude	The total indicative footprint of permanent habitat loss as a result of placement of cable protection, including rock berms and concrete mattresses is 0.13351 km^2 (0.13207 km^2 + 0.00144 km^2). The exact locations where cable protection is required are currently estimated and will be finalised for the ES stage. Therefore, it is not possible to determine how much of the habitat permanently lost is suitable for herring and sandeel (this will be considered further at the ES stage). However, in a worst-case scenario, where it is assumed that all the habitat lost is suitable for herring and sandeel, this extent is considered to be negligible in comparison to the wider available habitat for these species across the study area identified for spawning grounds. Known spawning habitat for sandeel, which overlaps with the southern section of the Offshore Scheme, is present across much of the central and southern North Sea and extends into the English Channel. Furthermore, whilst suitable habitat for herring was identified along the southern sections of the Offshore Scheme, this area falls outside of the known Southern Bight spawning area where higher levels of IHLS larvae have been recorded.
Preliminary likely significance of effect	The permanent placement of hard substrates on the seabed leading to effects to fish and shellfish is predicted to be **not significant**.
Confidence in prediction	High
Receptor	Fish and shellfish
Potential impact	**Temporary physical disturbance to fish and shellfish habitat**: A number of pre-installation and cable installation activities will temporarily disturb seabed habitats. These activities include: • boulder plough or grab (swathe of 30 to 40 m, length to be confirmed after final RPL); • pre-lay grapnel run (swathe of 1 to 3 m, length of ~116.7 km); • sandwave lowering (sidecasting/CFE) (swathe of 30 to 40 m, length of ~7.3 km); • sandwave lowering (pre-sweeping) (swathe of 20 to 25 m, length of ~25 km);

	• sea trails (not currently envisaged) (swathe of 20 to 40 m, length of 1 km minimum); and • cable trenching – may include various methods depending on seabed conditions (e.g., ploughing, jet trenching, and/or mechanical trenching) (swathe ranges from 5m to 20m, length of cable route – Up to 130 km). This will result in short term physical disturbance to, and temporary loss of, seabed habitats and in some instances physical damage to less mobile receptors (e.g., eggs, larvae and some shellfish).
Proposed Project phase	Construction
Duration	During pre-installation and installation activities.
Mitigation	N/A
Preliminary sensitivity	Sensitivity to effects of habitat disturbance varies between receptors. Mobile species and life stages have greater capacity to accommodate such changes through movement to undisturbed areas, whilst sessile or less mobile species/life stages are less tolerant of such disturbance, which may also result in physical damage in some instances. Migratory fish (e.g., European eel) are not considered to have functional associations with seabed habitats due to their life history strategies and transient presence within the Offshore Scheme. Pelagic spawners known to occur in the study area (e.g., sprat, mackerel, cod, whiting, and plaice) are also considered to have low sensitivity to temporary disturbance from cable installation activities as recruitment of these species would be largely unaffected by direct disturbance of the seabed. Therefore, potential effects for these receptor groups are not considered further for this impact pathway. Demersal species (e.g., cod, whiting, dover sole, plaice and sandeel) and demersal life stages (e.g., eggs, larvae, juveniles) are more sensitive to effects from temporary physical disturbance to seabed habitat. Displacement is considered the most likely effect to adult life stages of demersal species although some physiological damage and/or mortality of less mobile shellfish species and demersal species such as sandeel and life stages such as eggs and, to a lesser extent larva of some species which exhibit high site fidelity, is possible. Herring and sandeel are likely to have very high sensitivity to removal and degradation of spawning habitat because of their specific sediment requirements. Furthermore, the high site fidelity exhibited by sandeel also increases its potential sensitivity to benthic habitat loss at sub-population levels (Ref 4.146). The Offshore

	Scheme is known to pass through spawning grounds for both herring and sandeel. Suitable spawning habitat for herring and sandeel was also recorded sporadically within the Offshore Scheme as part of the project specific 'MMT benthic characterisation surveys'. Shellfish species including common cockle, European lobster, and crabs are more limited in their mobility than fish and in turn are often less able to avoid or move away from areas where habitat disturbance and/or loss is occurring. Some species are able to disperse over very short distances, while others are sessile. Due to these physiological constraints to dispersal, shellfish at all life stages are considered to have a medium to very high sensitivity to physical damage associated with the route preparation and cable installation works (Ref 4.118; Ref 4.126; Ref 4.124).
Preliminary magnitude	Temporary disturbance as a result of Installation Phase activities would occur along the entire Offshore Scheme (Up to 130 km in length). Boulder plough or grabs would result in the widest disturbance swathe, of up to 40 m for the bundled cable trench. The length over which this method would be employed is currently unknown. However, as a worst-case estimate and to encompass any temporary disturbance by other cable installation methods, it is assumed that this would be for the entire length of the cable. In this scenario, the total area of temporary disturbance will be 5.2 km^2. The footprint of physical disturbance to seabed habitats is considered to be localised and temporary. Recovery of any shellfish and demersal adult and spawning populations (including sandeel and herring), as well as habitat function, is expected to occur following cable burial. A degree of recovery would be expected over the short to medium term (one to five years) with individuals recolonising suitable substrates following completion of cable installation. Furthermore, the spatial extent of temporary disturbance to herring spawning and sandeel grounds is considered low in the context of alternative available habitat surrounding the Offshore Scheme and the wider North Sea. For example, although suitable habitat for herring was identified along the southern sections of the Offshore Scheme, this area falls outside of the known Southern Bight spawning area where higher levels of IHLS larvae have been recorded. The southern section of the Offshore Scheme does overlap with a known sandeel spawning area (which coincided with potential suitable sandeel habitat identified as part of the Proposed Development benthic survey). However, this spawning area covers much of the central and southern North Sea and extends into the English Channel.

	Due to the temporary and localised nature of installation activities and the small-scale installation footprint compared to wider available area of habitat, the physical disturbance and/or temporary loss of fish and shellfish habitat is predicted to be of small magnitude.
Preliminary likely significance of effect	Overall, the effect on fish and shellfish from temporary physical disturbance as a result of the Offshore Scheme installation activities is considered to be **not significant**.
Confidence in prediction	High
Receptor	Fish and shellfish
Potential impact	**Temporary increase in suspended sediment concentrations (SSC) and subsequent sediment deposition leading to contaminant mobilisation, increased turbidity and smothering effects on fish and shellfish**: Seabed disturbance from pre-installation (cable route clearance and pre-sweeping, if required) and installation activities (cable trenching) have the potential to increase SSC and turbidity, creating a sediment plume in the water column that can travel away from the Offshore Scheme before the sediment is deposited on the seabed. Potential effects to fish and shellfish include: • the clogging of respiratory apparatus such as gills; • reduced feeding success of visual predators due to decreased visibility; • the clogging of feeding apparatus; • the mortality of eggs and larvae that are less tolerant to turbid conditions; • effects related to toxic conditions if sediments in suspension are contaminated; and • potential barrier to the movement and migration of fish from increased SSC.
Proposed Project phase	Construction
Duration	During pre-installation and installation activities.
Mitigation	N/A
Preliminary sensitivity	Most fish species occupying the subtidal waters along the cable route are pelagic and of low sensitivity, with either low intensity or no spawning and nursery grounds present. Herring and sandeel are demersal spawners and are regarded as having medium sensitivity to smothering

effects from SSC, which can have implications for spawning success and recruitment (Ref 4.156).

The Offshore Scheme is located in proximity to the known Southern Bight herring stocks and discrete East Anglian spawning grounds to the north of the Suffolk landfall (Ref 4.32; and Ref 4.34). Furthermore, 'preferred' herring spawning habitat was identified sporadically along the Offshore Scheme as part of the MMT benthic characterisation surveys.

Herring larvae and eggs have been identified as very tolerant to high levels of SSC and deposition (Ref 4.157). Herring spawning grounds are located on gravel and similar coarse sediment habitats, where mobilised sediments are expected to settle rapidly. Furthermore, spawning adults and juveniles are highly adaptable to disturbance and will return to spawning grounds following the completion of the cable installation. Recoverability of herring spawning within the ZoI is expected to be high.

Increased SSC could potentially cause physiological damage and mortality to sandeel eggs in the vicinity of a sediment plume. Sediment plumes may also block filter-feeding organs used to consume plankton from the water column. However, sandeel prefer habitats of coarse sediment (Ref 4.36) where mobilised sediments are expected to settle rapidly, limiting dispersion. The species also spend most of the year burrowing (Ref 4.92), indicating smothering effects will not be of concern.

Although the Offshore Scheme passes through known spawning grounds for sandeel, the survey results indicate that suitable sandeel habitat within the Offshore Scheme is localised, sporadic and mostly located in the southernmost section of the Offshore Scheme.

The Offshore Scheme is surrounded by estuaries and rivers used by migratory fish, including European eel. The increase in SSC, turbidity and deposition associated with cable installation has the potential to act as a barrier to migration between marine and freshwater environments. However, most migratory species identified to be present in the study area have been shown to spend the majority of their time in the upper layers of the water column, so are unlikely to encounter mobilised sediment close to the bottom of the water column (roughly <5 m). Therefore, migratory fish are considered to have low sensitivity.

Berried crustaceans are likely to be more sensitive as avoidance of sediment disturbance is more difficult. Other shellfish, such as scallops, can have a low tolerance to smothering effects if they are incapable of sustaining prolonged valve closure (Ref 4.122). Despite

	this, mobile shellfish including crabs, scallops and lobsters are thought to tolerate a smothering depth of 5 cm over a month (Ref 4.126). They can exhibit avoidance behaviour when conditions become unfavourable by moving away from the affected area. Overall, the sensitivity of shellfish is considered to be medium.
Preliminary magnitude	The highest levels of SSC and largest sediment plumes will be associated with disturbance of sediments with a high proportion of fine particulate material, such as muds and clays, that will remain in suspension longest and settle to the seabed more slowly. Most of the Offshore Scheme consists of subtidal sand and mixed sediment. Areas of subtidal muds (including fine particulate material) are patchy and limited to the northernmost sections of the Offshore Scheme. Sediment contaminants such as heavy metals and PAHs, which are generally associated with finer material such as silts and clays, were elevated in the northernmost section of the Offshore Scheme. These contaminants could be mobilised at these locations. The finer fractions that are transported the furthest distance will be rapidly diluted, so that the SSC will be low and the deposition thickness on the seabed, where the sediment will settle, will be negligible and highly localised. The dilution processes over this distance will result in no detectable changes in sediment bound contaminants above background levels. Therefore, the overall magnitude of the impact is considered to be negligible. Furthermore, fish and shellfish are expected to have a natural tolerance to moderate changes in the surrounding water quality, due to temporary and localised changes during natural disturbance to the sediment, such as during storm events and periods of strong wave action and the subsequent mobilisation of sediment and contaminants. Calculations will be undertaken as part of work for the ES to estimate the extent of sediment dispersion before deposition as a result of trenching activities.
Preliminary likely significance of effect	Any sediment mobilisation as a result of construction activities for the Offshore Scheme will be highly localised (most sediments will rapidly settle within a few hundred metres) and short-term. Therefore, the overall impact is predicted to be **not significant**.
Confidence in prediction	Medium
Receptor	Fish and shellfish

Potential impact	**Underwater sound (excluding UXO):** Several activities during the construction phase will generate underwater sound, including: • pre-installation geophysical surveys comprising Multi-Beam Echo Sounder (MBES), Side-Scan Sonar (SSS), and/or Sub-Bottom Profiler (SBP); • clearance of obstacles and debris; • pre-sweeping of sand waves; • cable trenching – may include various methods depending on seabed conditions (e.g. ploughing, jet trenching, and/or mechanical trenching); • cable protection placement (e.g. rock placement, concrete mattresses, bags, protection sleeves); and • vessel movements including vessels operating with dynamic positioning (DP). A number of these sound sources have been scoped out of the preliminary assessment on the basis of their operating frequencies and source levels (with consideration of baseline noise levels). Based on this scoping exercise, the preliminary assessment addresses the impulsive sound from the operation of the SBP, the most intensive sound source scoped in, during the pre-installation geophysical survey.
Proposed Project phase	Construction
Duration	During the pre-installation geophysical survey
Mitigation	MM01 - adherence to JNCC guidelines, where appropriate, regarding the minimisation of impacts from underwater sound generated from known project activities - geophysical surveys (Ref 4.158), and UXO detonation (Ref 4.159).
Preliminary sensitivity	Fish have been grouped into three categories by Popper *et al.,* (Ref 4.160), based on their physiology (particularly the presence or absence of a swim bladder) and subsequent hearing sensitivity to underwater sound: • High hearing sensitivity fish – species in which hearing involves a swim bladder or other gas volume. These species are susceptible to barotrauma and detect sound pressure as well as particle motion and include Atlantic cod, herring and other species of the Clupidae family (e.g., allis shad and twaite shad); • Medium hearing sensitivity fish – species with swim bladders but for which hearing does not

	involve the swim bladder or other gas volume. These species are susceptible to barotrauma although hearing only involves particle motion, not sound pressure. European eel, Atlantic salmon, and sea trout are included in this category; and • Low hearing sensitivity fish – species with no swim bladder or other gas chamber are less susceptible to barotrauma detecting particle motion rather than sound pressure. This group includes lamprey, flatfish and elasmobranchs. A species sensitivity to sound varies according to the sound frequency. For most fish, sound above 1 kHz is not audible, although one sub member of the clupeiform family, the Alosinae or shads, are capable of detecting significantly higher frequencies (Ref 4.161). There are fish species from all hearing groups found within the Offshore Scheme Study Area, and therefore the preliminary sensitivity of this receptor ranges from low to very high. Shellfish are marine invertebrates which are believed to be sensitive to particle motion rather than to sound pressure (Ref 4.162), although few formal studies have been conducted on the impacts of underwater sound. At present there are no published sensitivity thresholds for invertebrates and observed responses are generally in relation to higher intensity sound sources such as from seismic surveys. Thus, shellfish are considered to have low sensitivity to sound.
Preliminary magnitude	A standard geometric spreading calculation, using a wave mode coefficient of 15 was used to determine the propagation of underwater sound from the SBP (with a sound source level of 235 dB re 1µPa @1m SPL_{peak}). The distance at which the injury and behavioural disturbance threshold for fish is met[12] is 46 m and 54 m, respectively. From these calculations, injury and disturbance ranges are extremely limited. Fish are considered more likely to be disturbed by the presence of oncoming vessels and are expected to have moved away before entering the potential injury zone.

[12] The Popper *et al.*, (2014) threshold criteria for mid-frequency sonar (1 kHz to 10 kHz) can be used as a proxy for the SBP, although it should be noted that this is highly conservative. The criteria for injury, which includes mortality and potential mortal injury, recoverable injury and Temporary Threshold Shift (TTS) (a reversible increase in the threshold of audibility) for medium to high hearing sensitivity fish is a SPLrms of 210 dB dB re. 1µPa, and for high hearing sensitivity fish only, there is a behavioural SPLrms threshold of 209 dB re. 1µPa. Also, it should be noted that these thresholds were the upper limit of the test, with actual thresholds likely to be significantly higher. In particular, no effect on the ear or non-auditory tissues was observed when the maximum received sound pressure levels were at 210 dB re 1 µPa SPLrms and injury, if it occurs, is thought to begin at higher sound levels than tested to date (Halvorsen and Zeddies, 2011). The thresholds are therefore considered to be very conservative.

	Therefore, the preliminary magnitude is predicted to be negligible.
Preliminary likely significance of effect	Due to the adherence of appropriate JNCC guidelines developed for the protection of marine mammals, particularly the soft-start, which ensures sound levels only increase gradually allowing individuals to move away, injurious impacts to fish will be avoided. Fish species may demonstrate some minor avoidance behaviour to the geophysical survey when the SBP is operating, but the vessels will be continuously moving and so the impact zone will also be transitory. As soon as the vessel has moved away normal activity would resume. Thus, the impact would be localised, temporary and reversible and so the magnitude is predicted to be negligible. When considering this, effects from underwater sound are **not significant**.
Confidence in prediction	High The below table presents the sound sources present for the Offshore Scheme

Survey or cable installation activity	Operating frequency (kHz)	Sound Pressure Level* (dB re 1µP a@1m)	Sound source data reference	Scoped into preliminary assessment
Swathe or multi-beam echo sounder (MBES)	170 - 450	221 235 (peak)	Genesis Oil and Gas Consultants (Ref 4.163, 2011)	**No** MBES operates at high frequencies that fall outside the hearing range of fish, thus it is not detectable and does not pose any risk of injury or disturbance.
Side scan sonar (SSS) (e.g., EdgeTech 4200 Series)	300 – 600	210 – 226	Genesis (Ref 4.163, 2011) and equipment specification sheet	**No** Operates at high frequency, producing sound that is outside the range of hearing of all fish and so this activity can be scoped out of the assessment.
Sub-bottom profiling (SBP)	0.5 – 12	238 (peak)	Equipment specification sheets	**Yes**

(e.g., Innomar SES-2000, Edgetech Chirp & Applied Acoustics 201 boomer)				
USBL (e.g., Kongsberg HiPAP 502)	21 – 31	207 (peak)	Equipment specification sheet	**No** Operates at high frequency (>1 kHz), producing sound that is outside the range of hearing of all fish and so this activity can be scoped out of the assessment.
Cable installation (e.g., clearance of obstacles and debris, sand wave sweeping, trenching)	1 – 15	178	Nedwell,*et al.,* (Ref 4.164, 2003); Nedwell *et al.*, (Ref 4.165, 2008); Hale (Ref 4.166, 2018)	**No** Underwater sound generated by trenching operations will be very low, and does not pose a risk of injury or significant disturbance to fish.
Rock placement	n/a	~172	Vessel Rollingstone (Ref 4.167, Barham and Mason, 2019)	**No** The SPLs associated with this activity are not of a magnitude which poses a risk of disturbance or injury to fish or shellfish, and is screened out of the assessment.
HDD (e.g., break-out)	n/a	129.5	Nedwell *et al.,* (Ref 4.168, 2012)	**No** The Offshore Scheme breakout points will be in shallow water where sound rapidly attenuates. Thus, the SPLs associated with this activity are not of a magnitude

					which poses a risk of disturbance or injury to fish or shellfish and is screened out of the assessment.
	Cable lay vessel (e.g., ~140 m in length, operating with DP)	0.005 - 3.2	180 - 197	Ross (Ref 4.169, 1993); AT&T (Ref 4.170, 2008)	**No** There will be a limited number of vessels associated with the installation of the cable. In comparison to background vessel activity in the Southern North Sea (**Volume 1, Part 4, Chapter 8: Shipping and Navigation**) the additional vessels operating to install the Offshore Scheme is not considered to be a deviation from baseline conditions. As such, sound emissions from the installation vessels will not constitute a substantive change from the baseline soundscape including existing vessel sound, and hence there is not potential for adverse effects on fish.
	Project support vessels Including medium (50 m to 100 m) and small (<50) boats	Low to high frequency	160 – 180	Genesis (Ref 4.163 2011); Richardson *et al.,* (Ref 4.171, 1995); OSPAR commission (Ref 4.172, 2009)	

* Sound Pressure Level metrics in rms unless indicated.

Receptor	Fish and shellfish
Potential impact	**Underwater sound from UXO:** a desk-based risk assessment as determined there to be a Moderate risk from encountering UXO within the Offshore Scheme. The risk is primarily due to the presence of aerial bombs, sea mines, torpedoes and depth charges. Should UXO detonation be required

	there is the potential for the underwater sound to cause injury and disturbance to fish and shellfish. Prior to installation there will be a full UXO survey to determine the need for any explosive objects to be cleared. An application for a Marine Licence in respect of UXO clearance will be made post DCO submission, when the exact number and type of detonations have been established. However, an initial impact assessment of the effect of UXO detonation is included here, together with details of the likely mitigation measures that would be adopted, so that regulator opinion can received prior to the application submission.
Proposed Project phase	Construction
Duration	At the point of UXO detonation the sound generated is a single short pulse, with a duration in the order of milliseconds. The intensity of the sound is determined by the size and nature of the UXO but this has the potential to be very high.
Mitigation	MM01
Preliminary sensitivity	There are some protected species known to be potentially present in the study area and there is potential for mortality and significant injury in fish from UXO detonation. This can occur in the immediate vicinity of the explosion from the compressive forces of the shock wave and also at more distant regions where negative pressure and the reflection of the shock wave from the water surface can cause cavitation and negative pressures low enough to cause harmful expansion of swim bladders and other barotraumas, which may result in immediate or delayed mortality (Ref 4.160). Fish without swim bladders are thought to be less likely to be affected unless in very close range of the detonation. Thus, the sensitivity of fish and shellfish to UXO detonation is considered to range from low to high.
Preliminary magnitude	Fish species are considered to be at risk of mortality or potential mortal injury at a peak SPL of 229 dB re 1µPa and sound propagation from UXO can be determined based on the formula by Soloway and Dahl (Ref 4.173). The size of likely UXO requiring clearance is unknown but based on charge sizes of 200 kg and 700 kg the distance to which mortality or injury could occur would be 580 and 880 m respectively. However, the required mitigation measures to minimise the potential risk of physical and auditory injury (PTS) to marine mammals as a result of underwater noise during UXO clearance would potentially reduce the risk to fish and shellfish species. Low order deflagration techniques will also be adopted where possible and where multiple explosive charges are present, wherever possible, the smaller

	charges shall be detonated first to maximise the 'soft-start' effect. Some behavioural disturbance is likely. However, given the mitigation measures and the short and intermittent nature of this activity (limited to instances when detonation of UXO is required) and that effects are most likely to be limited to the vicinity of the area where the detonation takes place, injury is likely to affect fish at the individual level rather than whole populations. Thus, with the measures identified above the magnitude of the effect is considered to be low.
Preliminary likely significance of effect	The significance of the effect of UXO detonation in fish and shellfish species is considered to be minor.
Confidence in prediction	Moderate – the exact detonation requirements and locations are not yet known. A full impact assessment to support a separate marine licence application for UXO clearance will be undertaken after a detailed UXO survey has been undertaken post DCO submission, prior to the construction phase.
Receptor	Fish and shellfish
Potential impact	**Potential effects on fish and shellfish due to subsea cable electromagnetic field (EMF) emissions:** EMF emissions from the cables have the potential to disturb foraging behaviour and inhibit migratory success through displacement of electro-receptive species (such as elasmobranchs) and migratory fish (such as salmon and eels). The installation scenario for the Offshore Scheme is two HVDC cables and one fibre optic cable bundled as one in one trench buried to a target depth of 1.5 m and a minimum of 0.5 m, with depth achieved depending on seabed conditions.
Proposed Project phase	Operation
Duration	Lifetime of the active cable
Mitigation	FSF01 - in accordance with the Department of Energy and Climate Change report (Ref 4.152) and MMO recommendations, the target cable burial depth will be a minimum of 1.5 m (subject to local geology and obstructions) to minimise the effects of EMF for fish receptors.
Preliminary sensitivity	Reported effects of exposure to artificially created EMFs include a reduction in swimming speed in migrating European eel (Ref 4.174), attraction to cables and reduced swimming activity for several species of elasmobranchs (Ref 4.175) and attraction to magnetic fields in free swimming trout larvae (Ref 4.176). It has been suggested that species that use electromagnetic perception for prey detection, such as elasmobranchs, may experience reduced foraging efficiency as a result of exposure to EMF. Diadromous fish and

	elasmobranchs are considered to have a very high sensitivity to EMF emissions. Pelagic species are thought to have negligible sensitivity to EMF. There is no evidence found to suggest that clupeids or scombrids for example, are able to detect EMF or are affected by it in anyway (Ref 4.177). Furthermore, the pelagic nature of these species indicates they are unlikely to come into contact with, or are able to easily avoid, any increase in EMF that would exist in only a small area around the cable. Demersal fish spend the majority of their time on or above the seabed, which could bring them into contact with the area of increased EMF generated by the Offshore Scheme (Ref 4.178). However, studies investigating EMF exposure on juvenile flounder and cod, found that long term exposure is unlikely to have adverse effects and unlikely to alter behaviour (Ref 4.179; Ref 4.180; Ref 4.181). Based on this, demersal fish are considered to have a low sensitivity to EMF emissions. Shellfish are considered to have a medium sensitivity to EMF emissions. Edible crabs and American lobster exposed to EMF were found to have limited physiological and behavioural impacts, with minimal changes in distribution and movement (Ref 4.182; Ref 4.178). However, significant differences in embryonic exposure were recorded in edible crabs and European lobster as a result of chronic exposure to EMF static (Ref 4.183). There was no evidence of negative EMF impacts to bivalve molluscs found in the literature.
Preliminary magnitude	The HVDC cables will be bundled, which are known to emit significantly lower magnetic fields due to cancellation of the magnetic fields between poles. Modelling of the predicted EMF emissions for the Offshore Scheme (**Volume 2, Appendix 4.8.B Electromagnetic Deviation Study**) shows that the geometric field for a bundled cable design buried at 1 m, was reduced to background levels within around 8 m from the cable, having only a very localised effect. The bundled cable will also meet the MMO criteria of having less than 3° compass deviation over 95% of the route. Furthermore, as part of the design controls and management measures for the Proposed Project, the cable burial depth will be a minimum of 1.5 m (subject to local geology and obstructions) to minimise the effects of EMF for fish receptors, in accordance with the Department of Energy and Climate Change report (Ref 4.152) and MMO recommendations. Where this burial depth cannot be achieved, the EMF effect distance will be higher but will be highly localised at a limited number of locations which will be defined for ES.

	Considering the localised nature of the impact, the preliminary magnitude has been assessed as small.
Preliminary likely significance of effect	Any effects to fish and shellfish would likely be highly localised to the immediate vicinity of the buried cable and only expose a very small area to EMF. Furthermore, in accordance with MMO recommendations, the cable burial depth will further minimise effects of EMF for fish receptors. Therefore, the effect to fish and shellfish is considered to be **not significant**.
Confidence in prediction	High
Receptor	Fish and shellfish
Potential impact	**Potential effects on fish and shellfish due to subsea cable thermal emissions** Subsea HVDC power cables have been shown to generate and dissipate heat when active, reaching cable surface temperatures of up to 70°C (Ref 4.184). Such heat has the potential to cause sediment dwelling and demersal mobile organisms to move away from the affected area. Increased heat may also alter physico-chemical conditions and bacterial activity (with shifts in bacterial community composition and changes in nitrogen cycling) in surrounding sediments, contributing to altered faunal composition and localised ecological shifts (Ref 4.185; Ref 4.186).
Proposed Project phase	Operation
Duration	Lifetime of the active cable
Mitigation	N/A
Preliminary sensitivity	Only species with a close association with the benthos, particularly sandeel and demersal spawning herring and shellfish species, have the potential to be affected by an increase in sediment temperature. Herring and sandeel lay their eggs on top of the seabed and are therefore not likely to come into contact with any significant sediment heating as the temperature increase is minimal in the top layers of the seabed from the buried cable. Although juvenile and adult sandeel burrow into the sediment, this is also within surface sediments, as they must not go beyond the oxic layer in order to survive (Ref 4.38). Therefore, sandeel and herring are considered to have a medium sensitivity to thermal emissions from the cable. Although there are no protected shellfish species within the Offshore Scheme[13], there are important fisheries for common whelk and common cockle located in the study

[13] Native oyster was identified within the study area, but no individuals were recorded along the marine draft Order Limits by the MMT benthic characterisation survey, nor were any native oyster beds identified as part of the baseline desk study.

	area (**Volume 1, Part 4, Chapter 9, Commercial Fisheries**). Common cockle is generally found in the mid to low intertidal and thus will not be located in areas of potential thermal emission. Common whelk is found in the subtidal on the surface of the seabed or in burrows just below surface sediments with their syphon protruding. There is unlikely to be any significant temperature changes at these depths. Although Nephrops are known to create burrow systems, which may potentially be affected by thermal emissions, the study area is not considered to be important for this species and therefore has not been considered further. Overall, shellfish are considered to have a medium sensitivity to thermal emissions from the cable.
Preliminary magnitude	Sediment particle size composition has been found to influence heat transfer, with coarse silts experiencing the greatest temperature change, but to a shorter distance from the source, while fine and coarse sands had a lower temperature change but a greater affected distance (Ref 4.184). The worst-case scenario for the Offshore Scheme is two HVDC cables and one fibre optic cable bundled as one in one trench buried to a depth of 1.5 m (subject to local geology and obstructions). Heat dissipation modelling undertaken as part of the Eastern Green Link 2 submarine HVDC transmission link (Ref 4.187) found that for bundled cables buried at a depth of 1.5 m, within 50 cm of the seabed surface the increase in sediment temperature is limited to approximately 3°C. Although thermal effects would occur for the operational lifetime of the Offshore Scheme, due to natural seasonal changes in water temperature, a temperature change of a few degrees higher than ambient is regarded as an insignificant temperature increase. Coupled with the fact that any impacts would be highly localised, and seawater at the seabed surface will have a cooling effect and will further dissipate any temperature increases. Overall, the magnitude of the effect from cable thermal emissions is considered to be negligible.
Preliminary likely significance of effect	Overall, the increase in temperature from thermal emissions as a result of the Offshore Scheme is considered to be small and is unlikely to reach depths where an interaction with fish and shellfish will occur. Thus, the predicted effect is considered to be **not significant**.
Confidence in prediction	High
Receptor	Fish and shellfish
Potential impact	**Temporary disturbance to fish and shellfish habitats**;

	Direct loss of fish and shellfish habitats due to placement of hard substrates on the seabed; **Temporary increase in SSC and sediment deposition leading to increased turbidity, smothering effects and contaminant mobilisation;** and **Disturbance, harm, and mortality to fish and shellfish due to underwater sound and vibration.**
Proposed Project phase	Maintenance
Duration	Unknown but maintenance activities likely to be intermittent and of short duration as the cable installation is designed to minimise the risk of cable exposure.
Mitigation	N/A
Preliminary sensitivity	Sensitivity of receptors during maintenance may be of similar level to cable installation.
Preliminary magnitude	Impacts during maintenance may be of a similar magnitude to cable installation
Preliminary likely significance of effect	Maintenance activity along the Offshore Scheme would generally be limited to non-intrusive inspections and cable repairs. The activities involved in cable repair (particularly jetting and rock placement) would be similar to those used for installation, and therefore the potential pathways for impact to fish and shellfish ecology would be the same as those identified for the cable installation phase of the Offshore Scheme. In mobile sand areas, periodic surveys would be undertaken to assess the continued burial of the cable and will be used to inform the necessity of any remedial works to maintain depth of cover to the cables. Cable repairs may be required at any time, however good design and installation will mitigate this. Repair works are likely to be highly localised to the area of concern and therefore the spatial extent of any impacts would be small in extent. Furthermore, any maintenance or repairs works would be of a significantly shorter duration. Maintenance and unforeseen cable repair (although unlikely) are routine, and the procedures and processes are well defined and common in the industry. Impacts of maintenance and cable repair works would be of smaller magnitude than cable installation, and the effect is predicted to be **not significant**.
Confidence in prediction	High
Receptor	Fish and shellfish
Potential impact	**Temporary disturbance to fish and shellfish habitats;**

	Temporary increase in SSC and sediment deposition leading to increased turbidity, smothering effects and contaminant mobilisation; and **Disturbance, harm, and mortality to fish and shellfish due to underwater sound and vibration.**
Proposed Project phase	Decommissioning
Duration	Unknown
Mitigation	N/A
Preliminary sensitivity	Sensitivity of receptors during decommissioning may be of similar level to cable installation.
Preliminary magnitude	Impacts during decommissioning may be of a similar magnitude to cable installation.
Preliminary likely significance of effect	If Sea Link is required to be decommissioned, the proposed subsea HVDC cable could also be decommissioned. Dependent on specific requirements, the redundant cables could either be left in-situ, or all or parts of the cable could be removed for recycling. An initial decommissioning plan will be written once the final route and installation methodology is chosen. The principal options for decommissioning are described in **Volume 1, Part 1, Chapter 4, Description of the Proposed Project**. Due consideration of the effects of removal of the cables to fish and shellfish and relevant protected areas, should be incorporated into the assessment for the best method of cable removal, or the value of the decommissioned cables remaining in situ. Should full removal from the seabed be required, this would have the potential to cause similar impacts to the cable installation phase of the Offshore Scheme. Due consideration of the effects of removal of the cables to fish and shellfish and relevant protected areas, should be incorporated into the assessment for the best method of cable removal, or the value of the decommissioned cables remaining in situ. Should full removal from the seabed be required, this would have the potential to cause similar impacts to the cable installation phase of the Offshore Scheme. Impacts during decommissioning may be of a similar magnitude to cable installation, depending upon the decommissioning option chosen. Therefore, as a worst case, the significance of the effects to fish and shellfish are predicted to be **not significant**.
Confidence in prediction	High

4.4.10 Transboundary Effects

4.4.10.1 A transboundary effect is any significant adverse effect on the environment resulting from human activity, the physical origin of which is situated wholly or in part within an area under the jurisdiction of another State.

4.4.10.2 All works associated with the Proposed Project fall within the UK jurisdiction (12 NM). Given the distance of the Proposed Project from French waters (approximately 25 km), no significant transboundary effects have been identified. Predicted disturbance from the Proposed Project is short term and local and are therefore not anticipated to be sufficient to influence fish and shellfish receptors outside UK waters, and subsequently cause transboundary effects.

4.4.10.3 Furthermore, the PEIR has concluded no significant effects for fish and shellfish receptors in UK waters.

4.4.11 Summary

4.4.11.1 In summary:

- the Offshore Scheme is located partially within the Goodwin Sands MCZ which is designated for blue mussel beds. Three additional relevant designated sites are located outside of the Offshore Scheme but within the study area. These designated sites are Thanet Coast MZC (located > 1 km southwest of the Offshore Scheme designated for blue mussel beds), Dover to Deal MCZ (located approximately 12 km south of the Offshore Scheme, designated for blue mussel beds and native oyster beds) and Medway Estuary MCZ (located approximately 42 km west of the Offshore Scheme which provides critical habitat for smelt);
- diadromous fish species known to migrate through in the study area are European eel, Atlantic salmon, brown trout, sea and river lamprey, smelt and allis shad and twite shad;
- pelagic fish species known to occur in high abundance within the study area are herring, sprat and mackerel;
- sandeel is a demersal fish species known to occur in high numbers within the study area. Other demersal fish species known to occur in lower abundance are cod, lesser weever fish, Mediterranean scaldfish, poor cod, European sea bass, whiting, dover sole and plaice;
- cephalopods (including squid, cuttlefish and octopus) are likely present within the study area;
- a number of elasmobranchs are known to occur within the study area. Thornback ray and lesser-spotted dogfish are some of the most abundant species in the North Sea and likely abundant within the study area. Basking shark is relatively rare in the Southern North Sea and is not considered to be abundant within the study area;
- common whelk, common cockle and blue mussel are abundant shellfish within the study area. Other shellfish believed to be present in lower abundance within the study area include scallop, native oyster, crabs, Norway lobster and European lobster;
- the study area is located within important spawning grounds for herring, sandeel, sprat, whiting, plaice, Dover sole, and lemon sole. High-intensity nursery grounds of

herring, and Dover sole were also identified within the study area, as were important grounds for sandeel. The MMT benthic characterisation surveys also confirm that there is preferred and marginal sandeel and herring habitat within the survey area. Seabass nursery grounds are also known to be present within the study area; and

- preliminary assessment of effects indicates that there are no likely significant effects from project activities on any fish and shellfish species present within the study area.

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National Grid plc
National Grid House,
Warwick Technology Park,
Gallows Hill, Warwick.
CV34 6DA United Kingdom

Registered in England and Wales
No. 4031152
nationalgrid.com