The Great Grid Upgrade

Sea Link

Sea Link

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Herring and Sandeel Assessment

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3.1 Introduction

3.1.1 The aim of this report is to provide analytical support to the main fish and shellfish assessment found in **Application Document 6.2.4.3 Part 4 Marine Chapter 3 Fish and Shellfish Ecology**. It presents work associated with analysis and mapping of the potential spawning habitat for herring (*Clupea harengus*) and sandeel (*Ammodytes* spp.) species in relation the Offshore Scheme.

Project Overview

3.1.2 The Proposed Project would comprise the following elements:

The Suffolk Onshore Scheme

- A connection from the existing transmission network via Friston Substation, including the substation itself. Friston Substation already has development consent as part of other third-party projects. If Friston Substation has already been constructed under another consent, only a connection into the substation would be constructed by the Sea Link project.
- A high voltage alternating current (HVAC) underground cable of approximately 1.9 km in length between the proposed Friston Substation and a proposed converter station (below).
- A 2 GW high voltage direct current (HVDC) converter station (including permanent access from the B1121 and new bridge over the River Fromus) approximately 26 m high plus external equipment (such as lightning protection, safety rails for maintenance works, ventilation equipment, aerials, similar small scale operational plant, or other roof treatment) near Saxmundham.
- A HVDC underground cable connection of approximately 10 km in length between the proposed converter station near Saxmundham, and a transition joint bay (TJB) approximately 900 m inshore from a landfall point (below) where the cable transitions from onshore to offshore technology.
- A landfall on the Suffolk coast (between Aldeburgh and Thorpeness).

The Offshore Scheme:

- Approximately 122 km of subsea HVDC cable, running between the Suffolk landfall location (between Aldeburgh and Thorpeness), and the Kent landfall location at Pegwell Bay.

The Kent Onshore Scheme:

- A landfall point on the Kent coast at Pegwell Bay.

- A Transition Joint Bay (TJB) approximately 800 m inshore to transition from offshore HVDC cable to onshore HVDC cable, before continuing underground for approximately 1.7 km to a new converter station (below).
- A 2 GW HVDC converter station (including a new permanent access off the A256), approximately 26m high plus external equipment (such as lightning protection, safety rails for maintenance works, ventilation equipment, aerials, and similar small scale operational plant, or other roof treatment), near Minster. A new substation would be located immediately adjacent.
- Removal of approximately 2.2 km of existing HVAC overhead line, and installation of approximately 3.5 km of new HVAC overhead line from the substation near Minster and the existing Richborough to Canterbury overhead line.

3.1.3 The Proposed Project also includes modifications to sections of existing overhead lines in Suffolk (only if Friston Substation is not built by SPR) and Kent, diversions of third-party assets, and land drainage from the construction and operational footprint. It also includes opportunities for environmental mitigation, compensation and enhancement (which could include hedgerow creation, native tree planting, or habitat creation). The construction phase will involve various temporary construction activities including overhead line diversions, use of temporary towers or masts, working areas for construction equipment and machinery, site offices, parking spaces, storage, accesses, bellmouths, and haul roads, as well as watercourse crossings and the diversion of public rights of way (PROWs).

Purpose of the Report

3.1.4 The **Application Document 6.2.4.3 Part 4 Marine Chapter 3 Fish and Shellfish Ecology** provides a comprehensive description of the baseline environment for fish and shellfish, including the potential overlap of the Proposed Project with spawning and nursery areas. Herring and sandeel have been identified as being of particular concern as they are dependent on the seabed across different stages of their lifecycle, particularly in relation to their spawning and nursery areas as they are demersal spawners (i.e. spawn in or on the seabed).

3.1.5 This report includes an analysis and mapping of potential spawning habitats for herring and sandeel in relation to the Offshore Scheme. This report has been produced to address the relevant stakeholder consultation responses (i.e. Marine Management Organisation (MMO), the Environment Agency and Centre for Environment, Fisheries and Aquaculture Science (Cefas)) which was received between 8 July and 14 December 2023. Key actions arising from the consultation feedback are listed in Table 3.1 and can also be found in section 4.3 of **Application Document 6.2.4.3 Part 4 Marine Chapter 3 Fish and Shellfish Ecology**.

3.1.6 Further details on how consultation responses have informed the assessment can also be found in **Application Document 5.1 Consultation Report and Application Document 5.1.9 Appendix H.** A number of data sources (Table 3.2 and Table 3.3) have been used to provide a comprehensive analysis of herring and sandeel spawning to inform the impact assessment (section 4.9 of **Application Document 6.2.4.3 Part 4 Marine Chapter 3 Fish and Shellfish Ecology**).

Proposed Project Design and Embedded Mitigation

3.1.7 The Proposed Project has been designed, as far as possible, following the mitigation hierarchy in order to, in the first instance, avoid or minimise fish and shellfish impacts (including spawning impacts) and effects through the process of design development, and by embedding measures into the design of the Proposed Project.

3.1.8 As set out in **Application Document 6.2.1.5 Part 1 Introduction Chapter 5 EIA Approach and Methodology**, mitigation measures typically fall into one of the three categories: embedded measures; control and management measures; and mitigation measures.

Relevant Embedded Measures

3.1.9 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; and
- Commitments made within **Application Document 7.5.3.2 Construction Environmental Management Plan (CEMP) Appendix B Register of Environmental Actions and Commitments**.

Control and Management Measures

3.1.10 The following measures have been included within **Application Document 7.5.3.1 Appendix A Outline Code of Construction Practice** relevant to the control and management of impacts that could affect herring and sandeel spawning 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, 2004 (BWM Convention).
- LVS02 - all project vessels must comply with the International Regulations for Preventing Collisions at Sea (1972) (International Maritime Organisation (IMO), 1972) regulations relating to International Convention for the Prevention of Pollution from Ships (the MARPOL Convention 73/78) (IMO, 1983) with the aim of preventing and minimising pollution from ships and the International Convention for the Safety of Life at Sea (IMO, 1974).
- 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 (DECC, 2011c) and MMO recommendations, the target depth of lowering (DOL) will be between 1 m to 2.5 m (subject to local geology and obstructions).
- MM01 - adherence to JNCC guidelines for marine mammals, where appropriate, regarding the minimisation of impacts from underwater sound generated from geophysical surveys (JNCC, 2017a) and UXO detonation (JNCC, 2017b).

Additional Mitigation and Enhancement Measures

3.1.11 Aside from the embedded mitigation measures, as aforementioned above, no additional mitigation measures or monitoring have been recommended for herring and sandeel spawning as a result of the impact appraisal. Further information on the impact appraisal in relation to herring and sandeel spawning can be found in **Application Document 6.2.4.3 Part 4 Marine Chapter 3 Fish and Shellfish Ecology.**

3.1.12 However, as part of the ornithology chapter the following additional mitigation measure has been proposed, which states

- For red-throated diver, a full seasonal restriction (1st November – 31st March) in the Outer Thames Estuary (OTE) Special Protection Area (SPA). This restriction is relevant to all offshore cable installation activities, excluding the pre-lay grapnel run (PLGR).A reduced seasonal restriction (1st January – 31st March) for landfall cable installation activities at the Suffolk landfall in Aldeburgh. Therefore, the Proposed Project will avoid the seasonal period for spawning herring and sandeel of November – January and November – February (respectively) within the OTE SPA with regards to cable burial activities (excluding PLGR). Although PLGR activity is discounted from the seasonal restrictions, the impact will be highly temporary and limited to the 1 - 3 m PLGR swathe.

Relevant Statutory Consultation

3.1.13 A summary of the key consultation and technical engagement undertaken following submission of the Preliminary Environmental Information Report (PEIR) for the Offshore Scheme in relation to herring and sandeel spawning assessment in provided in Table 3.1.

Table 3.1 Key stakeholder Issues raised following the PEIR in relation to herring and sandeel spawning assessment

Date	Consultee	Issue (s) Raised	Response to issue raised and/or where it is Considered in this Report
14 December 2023	MMO	ID 4.1. The MMO agree with the proposed approach to the assessment set out in the PEIR, however there are some concerns in respect to herring and sandeel. Cable laying is currently proposed to be carried out year-round from 2028 to 2029 so there is potential for the proposed works to occur during the herring and sandeel spawning seasons. Some additional information and data are required in order to better interrogate the mapped data layers and more accurately determine whether the cable route crosses herring spawning habitat and sandeel habitat, and if so, to what degree. This will enable the MMO to consider in more detail the likelihood of potential impacts to herring and sandeel, and whether any additional temporal or spatial mitigation is necessary. Details of the presentation of data required for the final Environmental Statement (ES) are outlined in points 4.3 – 4.6 for herring and 4.7 – 4.8 for sandeel below. Details regarding the preferred methods of determining potential herring spawning habitat and sandeel habitat are outlined in points 4.9 – 4.10 below.	A full herring and sandeel spawning assessment, including potential effects to these receptors has been undertaken in this appendix. Potential suitable herring and sandeel spawning ground using benthic characterisation studies and other data recommended by MarineSpace. Furthermore, in the ornithology chapter (**see Application Document 6.2.4.5 Part 4 Marine Chapter 5 Ornithology**) a seasonal restriction in the Outer Thames Estuary SPA has been proposed (1st November – 31st March). This restriction is relevant to all offshore cable installation activities, excluding the PLGR. This is considered relevant to the fish and shellfish impact assessment. Responses to 4.3 - 4.10 are provided below.
		4.2 The MMO notes that sediment sampling has been carried out at 37 stations along the proposed cable corridor with particle size analysis (PSA) carried out on each sample. These were classified according to the modified Folk (1954) scale and combined with a drop-down camera to provide broadscale habitat mapping. Whilst the use of a drop-down camera can be used to	It is acknowledged that there is a limitation with using a drop down video (DDV), however the benthic habitat mapping comprises a combination of side-scan sonar (SSS), DDV, and grab samples (37 in total). The resulting backscatter from SSS, in combination with the other data collection methods, can determine the broad sediment type (i.e. the

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		make observations on general seabed sediments and habitats, it isn't effective for determining the component fractions of sediments in detail, for example whether the percentage of mud/silt present in a sand/gravel sample is greater than 5% / 10%. EMODnet seabed substrate data can provide appropriate broadscale information on the sediment types in the study area and should be used as a background layer with which to compare the ground-truthed sediment samples and make observations on correlations between the two data sets.	presence of mud, fine sand, coarse sand, and coarse sediment). This can then be used to inform the habitat mapping at locations where grab samples have not been taken. This approach follows that detailed in the JNCC (2018) monitoring guidance for marine benthic habitats. Although DDV is not effective for determining the component fractions of sediment (i.e. the presence of mud), the habitat mapping is based on the Folk classifications. Therefore, this is considered to be an over representation of the sediment present, in the context of herring and sandeel spawning. For example, an area classified as 'coarse sediment' may contain mud (0-5%) which would make it unsuitable for herring, even though it is being identified as being suitable based on the broad Folk classification sediment types. Similarly, an area classified as 'mud' would not become suitable for herring simply because of the presence of a small amount of gravel or sand (0-5%). However, in order to inform the herring and sandeel assessment, EMODnet data has been included in the assessment. The EMODnet data provides broader-scale sediment mapping that complements the ground-truthed grab samples, allowing for better observation and correlation between the datasets. This ensures a more accurate assessment of sediment types and habitat suitability, particularly for species such as herring and sandeel, whose

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			spawning is highly dependent on specific sediment compositions.
		ID 4.3 Of the 37 sediment samples collected, only 2 sites, (S026 and S037) contained sediments considered suitable as spawning habitat for herring, based on the Reach et al., (2013) criteria which classifies sediment suitability as potential herring spawning habitat. However, Figure 4.4.7 indicates that multiple sections of the cable route are comprised of 'preferred' or 'marginal' habitat. It would be useful if you could re-present these figures by using a base layer of EMODnet data, overlaid with their own ground-truthed sediment classifications, including the point data along the cable route where the grab samples consisted of 'preferred' or 'marginal' spawning habitat type sediments.	The figures presented in this appendix have been updated to include BGS data as a base layer (Figure **6.3.4.3.A.1 Herring larvae spawning grounds to Figure 6.3.4.3.A.20 Overview of sandeel spawning confidence heatmap within the study area**)). The project specific benthic survey data, and the Cefas One Benthic data, have both been groundtruthed using the EMODnet data. However, it is important to note that the EMODnet data is based on a limited number of grab samples and is interpolated. Therefore, conformity between these datasets is mixed, noting that sediment classifications in the study area can be variable. We would consider the project benthic survey data to be the most recent dataset and most representative of the current sediment conditions along the cable route. However, given the far ranging spatial extent of the OneBenthic data and the recent years in which sampling has taken place, these data are also considered to be robust.
		ID 4.4 Ten years of International Herring Larvae Survey (IHLS) data for the years 2008 – 2017 has been presented. Whilst more recent data are available (up to 2022) and would have provided a more robust assessment, the MMO accept that due to recent changes with this survey (the discontinuation of one of	Noted, 10 -years of IHLS data has been agreed and used in this assessment. Further information of the methodology can be found in Methodology section.

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		the three Downs herring surveys in 2018 which took place between 16-31 January), making direct comparisons between the pre-2017 data and 2018 onwards would be difficult. Taking into account the nature of the proposed cable laying activities and timescale for this project, the MMO is content that the 10-year data set used is adequate to provide a broadscale picture of the extent and intensity of herring larvae in the study area.	
		ID 4.6 For the ES, it is important you present the IHLS data (shown in Figure 4.4.6) as a mapped layer overlaid onto the sediment data layer (as outlined in point 13). This will help by providing a better visual representation of the areas of the cable route which have suitable sediments for herring spawning and have a consistent presence of herring larvae. Please indicate the kilometre point (KP) distances along the cable route on the map.	The IHLS data has been overlaid on the EMODnet data and project benthic survey data to provide better context of the presence of herring larvae. The KP distances have now been added, for further details please refer section 3.2 and **Figure 6.3.4.3.A.6 IHLS Survey Interpolated Contour Map (MarineSpace contours)** to **Figure 6.3.4.3.A.9 IHLS Survey Interpolated Contour Map (updated contouring)**.
		ID 4.7 Of the 37 sediment samples collected, six sites (S023, S025, S026, S029, S035 and S037) contained sediments classified as 'preferred' Sandeel habitat and nine sites (S004, S014, S016, S019, S020, S022, S024, S030 and S036) were classified as 'marginal' habitat. The MMO notes the Greenstreet et al., (2010) has been used to classify sediment suitability for sandeel. A more appropriate approach would have been to use the method from Latto et al., (2013) as this considers the strengths and limitations of Greenstreet et al., (2010) and Holland et al., (2005) and is therefore the method supported by the MMO and CEFAS Fisheries. Greenstreet et al., (2010) in isolation is considered to potentially overestimate habitat	These habitats have now been reclassified based on the methods provided by Latto et al. (2013) for better comparison. Of the 37 sediment samples, there are now 15 sites classified as 'preferred' and one site classified as 'marginal'. These sites are discussed in Table 3.2.

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		suitability, and therefore is not the method used by Latto et al., (2013). You should follow Latto et al., (2013) when characterising sediment suitability for sandeel.	
		ID 4.8 Figure 4.4.8 indicates multiple sections of the cable route are comprised of 'preferred' or 'marginal' sandeel habitat. As with herring, for the ES it would be useful if the Applicant could re-present this figure by using a base layer of EMODnet data, overlaid with their own ground-truthed sediment classifications, including the point data along the cable route where the grab samples consisted of 'preferred' or 'marginal' Sandeel habitat type sediments. Please indicate the KP distances along the cable route on the map.	The figures presented within this appendix have been updated to include EMODnet data as a base layer. The KP distances have also now been included. (**Figure 6.3.4.3.A.1 Herring larvae spawning grounds** to **Figure 6.3.4.3.A.20 Overview of sandeel spawning confidence heatmap within the study area**)
		ID 4.9 The MMO notes from paragraph 4.4.3.1 that detailed Herring and Sandeel spawning ground/habitat assessments will be undertaken for the ES, using multiple data layers including but not limited to; EMODnet , One Benthic and IHLS data for the production of 'heat maps'. The production of heat maps following the Marine Space (2013a) and (2013b) methods, for herring and sandeel respectively, was suggested by CEFAS fisheries advisors at the scoping stage and in a meeting with CEFAS on 31st May 2023. As stated in the documents these methods use a suite of data to determine potential herring spawning habitat and potential Sandeel habitat this should include PSA data, BGS data, Regional Seabed Monitoring Plan (RSMP) data, IHLS data (for herring assessments), as well as fishing fleet data and scientific publications. This data should then be methodically layered to generate a single 'heatmap' output. The result should	The herring and sandeel spawning assessment has been updated so that it follows the Marine Space (2013a; 2013b) guidance, including the production of heat maps. The data considered includes: EMODnet sediment data, IHLS data, Vessel Monitoring System (VMS) fishing data, and Coull et al. (1998) important spawning areas. Information on these data sources is described in Table 3.2. One Benthic data has been used for ground-truthing but is not included within the heat map as it only comprises point data. The Regional Seabed Monitoring Plan (RSMP) data is considered to be encompassed within the One Benthic data. The project benthic survey data has also not been included within the heat map, as it does not provide a regional perspective and provides too much weight on the cable route, without providing context

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		show areas of 'heat' which represent areas with potential herring spawning habitat, and potential Sandeel habitat. Areas of 'heat' are assigned a score based on confidence of the data. The Marine Space methods were developed in consultation with CEFAS and are considered appropriate for use for other offshore activities and have been widely used in Environmental Impact Assessments (EIA).	on other available habitats present nearby (i.e. the extension of this data).
		ID 4.10. You have calculated that 42.7% of the cable corridor is classified a suitable Herring spawning habitat and 51.6% of suitable and/or marginal Sandeel habitat (Tables 4.4.14 and 4.4.16). Please note that the MMO do not support the calculation of total spawning habitat as this approach can over or underrepresent spawning grounds and is solely based on either substrate suitability or broadscale historic spawning or nursery ground mapped data. The MMO has provided a summary of the reasons why we do not support the calculation of total spawning habitat below and recommend that the Applicant updates the ES to reflect MMO comments: • Spawning areas can change over time or become recolonised. • Whilst spawning and nursery ground maps are used to provide the most recent and appropriate information to identify spawning areas, they do not fully define/consider/identify the following: • All potential areas of spawning, • Any habituation that may occur i.e., identify areas where higher densities of spawning are present,	We acknowledge the MMOs comments on the use of quantitative calculations to inform the spawning assessment. However, calculations are used to inform 'potential spawning habitat'. These calculations represent an over-representation of potential spawning habitat. Environmental factors will generally reduce the area used within areas of preferred habitat, such as temperature, oxygenation, natural disturbance, anthropogenic disturbance etc. This is particularly true when considering the habituation of certain areas for spawning. These calculations do not inform the conclusions of the assessment but contextualise the EMODnet data analysed. We acknowledge that sediment types will vary over time (outside the EMODnet data temporal resolution) but consider these calculations to represent a worst-case. These are discussed in section 3.2 for herring and section 3.3 for sandeel.

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		• Specific substrate requirements e.g., substrates which are most suitable within the wider broadscale sediments, • More suitable topography e.g., ridges/edges of sandbanks where Sandeel may spawn or furrows where herring may spawn, • Environmental factors that may influence spawning intensity such as temperature, oxygenation, natural disturbance, anthropogenic disturbance etc.	
		ID 4.11. The mitigation measures outlined in section 4.4.8.3 and 4.9.8.3 remain the same as those provided at the scoping stage and seem appropriate given the scope of the works. The MMO notes the Applicant has now committed to a cable burial depth of between 1.5 metres (m) – 2.5m (subject to local geology and obstructions) (mitigation measure FSF01) in accordance with the Department of Energy and Climate Change Report (DECC 2011). The MMO welcome and support this measure which will reduce the effects of electric magnetic field (EMF) on fish receptors by increasing the distance between the electrical current and fish receptors. The proposed cable burial depth will also serve as mitigation for the effects of sediment heating (from heat emitted from the cables) on sandeel which burrow in the sediment and lay eggs on the sediment, and for herring eggs and larvae during their developmental stages.	This is noted - the commitment to this burial depth has not changed as part of the **Application Document 6.2.4.3 Part 4 Marine Chapter 3 Fish and Shellfish Ecology**. The assessment of this impact is included in section 4.9 of the **Application Document 6.2.4.3 Part 4 Marine Chapter 3 Fish and Shellfish Ecology**.
	Natural England	Please see our comments on Goodwin Sands MCZ and the requirement for Measures of Equivalent	The Proposed Project has had early engagement with MMO, Cefas and Natural England on the approach to the herring and sandeel spawning

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19 December 2023		Environmental Benefit (MEEB) under The Marine and Coastal Access Act 2009 (MCAA). Natural England's comments on fish and shellfish ecology should be considered alongside those of Cefas, where they are not features of designated sites or a prey species associated with the feature of a designated site. Natural England advises that it is important to establish a sound baseline, using the best available evidence for herring and sandeel, upon which to base the assessment of impacts. Furthermore, it is essential that limitations and uncertainties regarding the datasets used should be clearly laid out. Natural England defers to Cefas in relation to appropriate mitigation but note that based on the overlap of herring and sandeel spawning and nursery areas as well as the extent of priority/marginal habitats, and interaction with Outer Thames Estuary Special Area of Protection (OTE SPA) and Southern North Sea Special Area of Conservation (SNS SAC) designated features, it is possible that mitigation measures will need to be explored further.	assessments. Meetings were held on 31 May 2023 and 08 February 2024. The spawning assessment methodology was discussed and this approach has been approved by Cefas. Cable protection areas have been plotted with layers of suitable habitat and have been considered as part of the herring and sandeel assessment within the fish and shellfish impact assessment in this appendix (**Figure 6.4.4.3.8 Areas of permanent habitat loss and herring spawning habitat** and **Figure 6.4.4.3.9 Areas of permanent habitat loss and sandeel spawning habitat** in **Application Document 6.2.4.3 Part 4 Marine Chapter 3 Fish and Shellfish Ecology**). The potential effects to prey items are considered within **Application Document 6.6 Habitat Regulations Assessment**.
		We defer to Cefas in relation to the appropriate mitigation but note that, based on the overlap/proximity of herring and nursery areas, the proposal cable route interacts with sandeel spawning areas and both herring and sandeel preferred/marginal habitat (Figures 4.4.4 to 4.4.8). As the Project will also interact with the Outer Thames Estuary Special Protection Area (OTE SPA) and Southern North Sea Special Area of Conservation (SNS SAC) it is possible that mitigation measures will need to be further explored. Any mitigation proposed	The Proposed Project has had early engagement with MMO, Cefas and Natural England on the approach to the herring and sandeel spawning assessments. Meetings were held on 31 May 2023 and 08 February 2024. The spawning assessment methodology was discussed, and this approach has been approved by Cefas. Cable protection areas have been plotted and have been assessed as part of the **Application**

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		will need to be accompanied by suitable evidence to demonstrate it efficacy.	**Document 6.2.4.3 Part 4 Marine Chapter 3 Fish and Shellfish Ecology**.
		We recommend the Project take on board advice received from Cefas regarding mitigation measures for the herring and sandeel spawning and nursery habitats. Natural England advises that a map showing locations for external cable protection are provided with layers for sandeel and herring suitable habitat and in OTE SPA and SNS SAC. We advise the Applicant that impacts on prey availability in these sites, including suitable habitat availability and recoverability, will need thorough assessment and consideration at Appropriate Assessment and appropriate mitigation measures are applied.	The potential effects to prey items have been considered within **Application Document 6.6 Habitats Regulations Assessment**.
		The Worst-Case Scenario (WCS) refers permanent habitat loss of all suitable habitat for herring and sandeel due to external cable protection and concludes that the impact of this is not significant. In addition to NE Ref 3, we recommend that robust assessment is carried out in relation to the WCS of all suitable herring and sandeel habitat lost where the proposed cable route interacts with OTE SPA and SNS SAC.	Consideration of the potential indirect prey effects to the features of these designated sites from loss of potential herring and sandeel spawning habitat, has been considered with **Application Document 6.6 Habitats Regulations Assessment**
		Table 4.4.18 Within “preliminary likely significance of effect” relating to underwater sound (excluding UXO), the Applicant states that soft start procedures to any works will ensure sound levels only gradually increase	National Grid has considered the guidance on UXO detonation mitigation measures from the JNCC (2010), noting that this guidance is specific to marine mammals. We have considered the requirement for additional mitigation for fish, noting

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		to allow fish to move away from the noise source and reduce risk of injury. Natural England do not agree with soft start procedure being applicable to fish, as there is very little evidence to support any assertion that fish flee consistently and coherently away from noise sources. Ensure consistency across the submitted assessment to ensure that this method is not incorrectly portrayed as an appropriate mitigation measure for underwater noise impacts on fish.	that soft-starts are not an appropriate form of mitigation as avoidance behaviour in fish and shellfish is highly variable.
		Figures 4.4.4 to 4.4.8 Herring and sandeel spawning and nursery grounds have been mapped, along with preferred/marginal habitat along the cable route and a contour map showing IHLS from 2008 and 2017. It is unclear why the most up to date IHLS data has not been used. We defer to Cefas to comment on the appropriateness of the data presented and sufficiency of surveys mapping the preferred/marginal habitat for assessing impacts of the proposed cable route on herring and sandeel species. We therefore recommend discussing the most appropriate dataset to use with Cefas.	The Proposed Project has had early engagement with MMO, Cefas and Natural England on the approach to the herring and sandeel spawning assessments. Meetings were held on 31 May 2023 and 08 February 2024. The spawning assessment methodology was discussed, and this approach has been approved by Cefas. The methodology includes the IHLS data from 2008 and 2017 which was agreed by Cefas during consultation is described further in Table 3.2.
		Data Analysis, Modelling and Reporting Figures 4.4.4 to 4.4.5. Figure 4.4.4 indicates the known locations of herring spawning and nursery grounds in relation to the proposed cable route from Coull et al 1998 and Ellis et al 2012. Figure 4.4.5 indicates the	Indirect effects from prey items on the features of these designated sites, has been considered in **Application Document 6.6 Habitats Regulations Assessment.** This includes presentation of these designated sites in a figure.

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		known spawning and nursery grounds for sandeel from the same data sources. Both figures use Ellis et al 2012 to show estimated intensity of nursery grounds. The data presented in the figures suggests that the proposed cable route overlap with spawning habitat and low intensity nursery habitat for sandeel, as well as high intensity nursery habitat for herring. Natural England advises that the Figures also include the designated SPAs and SACs that the proposed project will interact with, as there is potential for impacts to occur on the prey species of designated features within OTE SPA and SNS SAC.	However, the herring and sandeel spawning assessment figures within this assessment also include these designated sites, for greater context.
		Figure 4.4.6 shows the results of IHLS in the North Sea as a contour map. The results presented in the contour map show that the proposed cable route includes a large portion of amber/medium abundance of herring larvae ranging from 200-600 eggs and larvae found per m^2. Although, no portion of the proposed cable route overlaps with high abundance of herring eggs and larvae (600-46600m2), a medium abundance indicates suitable conditions for eggs and larvae and requires sufficient assessment for potential impacts from the project on loss of prey availability for the OTE SPA and SNS SAC.	The ILHS data has been further analysed in section 3.2.30. This includes further analysis and consideration of the IHLS sampling points near the Offshore Scheme. Indirect effects from prey items on the features of these designated sites, has been considered in **Application Document 6.6 Habitats Regulations Assessment**.
		Figures 4.4.7 and 4.4.8 Coull et al (1998) and benthic characterisation surveys have been used to map preferred/marginal habitat for herring and sandeel.	Indirect effects from prey items on the features of these designated sites, has been considered in **Application Document 6.6 Habitats Regulations**

Date	Consultee	Issue (s) Raised	Response to issue raised and/or where it is Considered in this Report
		See comment on Figures 4.4.4 to 4.4.5 above, which also applies here.	**Assessment**. This includes presentation of these designated sites in a figure. However, the herring and sandeel spawning assessment figures within this assessment also include these designated sites, for greater context.
		Environmental Impact Assessment - Document Used: Part 4 Chapter 4 Fish and shellfish ecology; Part 1 Chapter 6 Scoping Opinion and EIA Consultation; Part 1 Chapter 5 PEIR Approach and Methodology Outer Thames Estuary Special Protection Area (OTE SPA) – as recognised in Natural England's supplementary advice on the conservation objectives for the site, species such as herring and sandeels are key prey species of red-throated diver (RTD). Impacts to these key fish species therefore have the potential to reduce prey availability for RTD. Impacts to the mortality, fitness or distribution of these species have the potential to add to existing pressures on RTD due to anthropogenic disturbance. Natural England defers to the expertise of Cefas in relation to fish and shellfish, where they are not features of designated sites or a prey species associated with the feature of a designated site. The absence of comment on aspects such as underwater noise, adequate baseline characterisation, and the impact assessment etc., should not be assumed to mean the absence of any concerns. We advise that providing an adequate baseline, utilising the best available evidence for herring and	The Proposed Project has had early engagement with MMO, Cefas and Natural England on the approach to the herring and sandeel spawning assessments. Meetings were held on 31 May 2023 and 08 February 2024. The spawning assessment methodology was discussed, and this approach has been approved by Cefas. A full herring and sandeel spawning assessment, including potential effects to these receptors has been undertaken in this appendix (section 3.2 for herring and section 0 for sandeel). The Outer Thames Estuary SPA has been included in the herring and sandeel spawning figures associated with this assessment. Indirect effects from prey items on the features of these designated sites, has been considered in **Application Document 6.6 Habitats Regulations Assessment.**

Date	Consultee	Issue (s) Raised	Response to issue raised and/or where it is Considered in this Report
		sandeel, is key to the assessment of impacts on these species. Such evidence is also required to inform the assessment of impacts on prey availability for RTD in the Ornithology Chapter and through the Habitats Regulations Assessment (HRA). We advise that Natural England's comments are read in conjunction with the advice of Cefas. It should be noted that Natural England's remit differs to that of Cefas. Natural England's role is to advise on features of designated sites in the context of the conservation objectives, to ensure that the sites fulfil their function and make their due contribution to the Marine Protected Areas network. Cefas' role is to advise on how the development might interact with the fish populations as a whole. This context should be considered when reading the advice of both organisations and is likely to be the reason for any perceived differences. Natural England's RAG rating relates to our remit, and therefore this may not fully reflect the severity significance of an issue when considered under Cefas' remit.	
		4.4.8.4 We defer to Cefas in relation to the appropriate mitigation but note that, based on the overlap/proximity of herring high intensity nursery areas, sandeel spawning and nursery areas and herring and sandeel preferred/marginal habitat, it is possible mitigation measures will need to be further explored. Any mitigation proposed will need to be accompanied by suitable evidence to demonstrate its efficacy.	The Proposed Project has had early engagement with MMO, Cefas and Natural England on the approach to the herring and sandeel spawning assessments. Meetings were held on 31 May 2023 and 08 February 2024. The spawning assessment methodology was discussed, and this approach has been approved by Cefas. The methodology used in described in the Methodology section of this appendix.

Date	Consultee	Issue (s) Raised	Response to issue raised and/or where it is Considered in this Report
		The submitted ES should fully reflect any advice received from CEFAS regarding mitigation measures for herring and sandeel spawning and nursery habitat. Natural England advises that any proposed mitigation measures to seasonally restrict the proposed works outside of herring and/or sandeel spawning periods would also be appropriate to reduce impacts on OTE SPA and SNS SAC. In addition, to reduce permanent impacts, we advise that no external cable protection is laid at locations where Cefas determine high sensitivity for herring and sandeel, where this interacts with OTE SPA and SNS SAC wherever feasible.	The relevant embedded measures and control and management measures presented in **Application Document 6.2.4.3 Part 4 Marine Chapter 3 Fish and Shellfish Ecology** section 4.8 and additional mitigation and enhancement measures if required for fish and shellfish is presented in **Application Document 6.2.4.3 Part 4 Marine Chapter 3 Fish and Shellfish Ecology** section 4.10. Impacts to herring and sandeel have be considered within the **Application Document 6.2.4.3 Part 4 Marine Chapter 3 Fish and Shellfish Ecology** section 4.9.
		Priority Habitats and Species listed under Section 41 list of the Natural Environmental and Rural Communities (NERC) Act, 2006. Overall: Natural England would like to highlight that lesser sandeel and herring are protected species as listed on Section 42 of the Natural Environmental and Rural Communities (NERC) Act 2006. The Applicant should have due regard for species listed on Section 42 of the NERC Act 2006 and provide a robust assessment of impacts both direct and indirect, prior to concluding no significant effect.	Section 42 Species of Principal Importance have been considered within **Application Document 6.2.4.3 Part 4 Marine Chapter 3 Fish and Shellfish Ecology** section 4.7.

Date	Consultee	Issue (s) Raised	Response to issue raised and/or where it is Considered in this Report
Cefas and MMO	08 February 2024	A meeting was held between AECOM, Cefas and MMO. AECOM. AECOM provided a detailed walkthrough of the analysis conducted across the cable corridor for herring and sandeel. This included outlining key statutory consultation comments raised in relation to herring and sandeel (from MMO and Cefas) Including the presentation of EMODnet data with ground-truthed sediment samples; - Mapping of IHLS data; - Production of heat maps; and - Use of quantitative calculations to assess suitability. Herring and sandeel analysis conducted by AECOM since PEIR - Additional data analysis conducted (in addition to the above); - Data sources considered; and - Conclusions and mitigation.	The Proposed Project has had early engagement with MMO, Cefas and Natural England on the approach to the herring and sandeel spawning assessments. Meetings were held on 31 May 2023 and 08 February 2024. The spawning assessment methodology was discussed, and this approach has been approved by Cefas. The methodology used in described in the Methodology section of this appendix. The full herring and sandeel spawning assessment is included in section 3.2 for herring and section 3.3 for sandeel of this document.

Methodology

3.1.14 A detailed suitability assessment of herring potential spawning habitat and sandeel habitat has been undertaken and is presented within this report. The assessment is based on the MarineSpace et al. (2013a; 2013b) guidance, which builds upon prior work by Reach et al. (2013) and Latto et al. (2013), in consultation with the MMO and Cefas.

3.1.15 Seabed sediments such as those identified by project specific surveys can be used to identify habitat suitability. However, MarineSpace et al. (2013a; 2013b) have identified a range of additional data sources to inform the mapping of potential herring spawning and sandeel habitats. Limitations associated with these data sources are discussed in detail in the MarineSpace et al. (2013a; 2013b) guidance and incorporated into the analysis with assigned confidence scores.

3.1.16 The MarineSpace guidance provides a methodology to assess spatial interactions between these data sources and the project Zone of Influence (ZoI), by producing a ‘heat map’. Each data layer is assigned a 'confidence score' (Table 3.2), which is combined and analysed within a Geographic Information System (GIS) to produce the 'heat' map. Table 3.2 shows the confidence scores assigned to each data layer for herring and sandeel, following the scoring methodology provided in the MarineSpace et al. (2013a; 2013b) guidance.

3.1.17 The confidence scores represent the total normalised value for each dataset, calculated using total weighted scores that account for the quality of evidence (considering factors such as vintage, resolution, quality standards, and dataset source) and the dataset's suitability as an indicator of herring spawning or sandeel presence. These scores are then combined to produce a ‘maximum possible data layer score’ or combined confidence (heat map) score.

3.1.18 In addition to the data used to produce the heat maps, OneBenthic data and the project specific benthic characterisation survey data have also been considered to ground-truth and further contextualise the data sources used based on MarineSpace et al. (2013a; 2013b) guidance.

3.1.19 It is important to note and clarify that habitat sediment classification is not the only parameter (datum) that indicates potential spawning habitat. There are other environmental (physico-chemical and biotic) variables which contribute to the affinity / suitability of seabed habitat to be used as spawning grounds by herring. These factors include oxygenation, temperature, salinity, siltation, overlap with range of spawning populations, micro-scale seabed morphological features (e.g. ripples and ridges); and undisturbed sediments (MarineSpace Ltd, ABPmer Ltd, ERM Ltd, Fugro EMU Ltd, & Marine Ecological Surveys Ltd, 2013a; MarineSpace Ltd, ABPmer Ltd, ERM Ltd, Fugro EMU Ltd, & Marine Ecological Surveys Ltd, 2013b). Considering the wide range of environmental parameters that determine herring spawning, it is important to note that the use of the habitat sediment classes alone will always over-represent the range of habitat with the potential to support herring spawning events.

3.1.20 Furthermore, herring and sandeel spawning behavior is not consistent across the entire potential habitat each year, with certain areas becoming habituated for spawning, while others may remain unused. As a result, these factors are not used to drive the final conclusions of the assessment but instead serve to contextualise the EMODnet data analysed, providing a broader understanding of the potential suitability of sediment types for herring spawning activity.

Table 3.2 Data sources used as part of the confidence assessment for herring and sandeel to produce heat maps

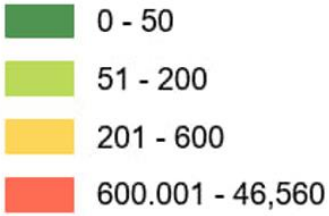
Data source	Data type	Assessment of data	Confidence score	
			Herring	Sandeel
EMODnet seabed substrate (250k) **Invalid source specified.**	Sediment data using Substrate Folk (1954) Classification	The area for which data were requested was initially based on the ICES rectangles surrounding the Offshore Scheme (31F, 32F and 33F). The area was then reduced to provide more focus on the Offshore Scheme and wider study area. The MarineSpace (2013a; 2013b) guidance categorises the preference for herring spawning and sandeel habitat on a range from 'preferred' to 'unsuitable' habitats. For herring, the Folk sediment data is classified based on Reach et al., (2013) to identify potential herring habitats. For sandeel, the Folk sediment data is classified based on Latto et al (2013) to identify potential sandeel habitats. These habitat classifications are: • Herring: – Preferred habitat sediment class: Gravel ('G') and sandy Gravel ('sG'); – Marginal habitat sediment class: gravelly Sand ('gS'); and – Unsuitable habitat sediment class: all other Folk (1954) classifications. • Sandeel: – Preferred habitat sediment class: Sand ('S'), slightly gravelly Sand ('(g)S') and gravelly Sand ('gS')	Preferred = 3 Marginal = 2	Preferred = 4 Marginal = 2

Data source	Data type	Assessment of data	Confidence score	
			Herring	Sandeel
		– Marginal habitat sediment class: sandy Gravel ('sG') – Unsuitable habitat sediment class: all other Folk (1954) classifications. There is a difference in the confidence scores for herring and sandeel, as outlined in the MarineSpace (2013a; 2013b) guidance. The 'preferred' and 'marginal' habitat classes for herring tend to overestimate the potential suitability for herring spawning because these Folk (1954) classifications allow for higher mud proportions (<10% mud) than herring actually prefer (<5% mud). Therefore, the area of potential suitable habitat for herring is considered to be highly precautionary. In contrast, the preferred Folk (1954) classifications for sandeel are considered to accurately reflect sandeel habitat preferences. Therefore, the Folk (1954) classifications for 'preferred' sandeel habitat are deemed to align well with sandeel sediment preferences, resulting in a higher confidence score. 'Marginal' habitat is considered to provide a low confidence in herring spawning habitat and sandeel habitat.		
Vessel Monitoring System (VMS) – Vessels greater than 15 m – 2017 to 2020	Fishing fleet data	VMS data were analysed to show the areas within the study area where pelagic gear types have been used for fishing. It has not been possible to crop the data for the herring spawning season as the data do not include timeframes for when fishing occurred. VMS data are derived from MMO fishing activity data, more specifically the total weight of fish that were caught by vessels greater than 15 m over the period of 2017 to 2020. In each of the VMS spatial rectangles, the total weight caught was used to	2	2

Data source	Data type	Assessment of data	Confidence score	
			Herring	Sandeel
		determine whether different types of fishing gear were used in each area from 2017 to 2020. Gear types were not defined in previous years and thus earlier data were not included. VMS data do not provide information on species caught, but can be interrogated by fishing method which can be used to broadly understand habitat resource areas. Fishing by pelagic gears (e.g. gillnets, encircling gillnets, driftnets, set gillnets, otter trawls, otter twin trawls, with purse lines, purse seine and pair trawls) are considered an indicator of herring and sandeel spawning habitat and fishing by demersal gears[1] are considered an indicator of sandeel habitat. However, it should be noted that the confidence in this data is relatively low as these fishing methods may target a range of species.		
Coull et al. (1998)	Spawning grounds	Data from Coull et al. (1998) showing important herring and sandeel spawning grounds were used. Ellis et al. (2012) has not been considered in the production of heat maps due to the following comment by Reach et al. (2013): *Ellis et al.* (2012) *updated the distribution of fish larvae and information presented in Coull et al.* (1998) *but they related the mapping of this information to the ICES sub-rectangles in which they were sampled. In effect the resolution of effective mapping of these data for environmental considerations has been reduced (although it is useful as a fisheries management tool). For assessment at a regional-scale and in relation to Atlantic Herring*	3	3

[1] Demersal gears were selected from the generic field which represented all the relevant gear types

Data source	Data type	Assessment of data	Confidence score	
			Herring	Sandeel
		the focused habitat-related data from Coull et al. (1998) *support more meaningful analysis.* However, Ellis et al. (2012) has been considered elsewhere in relation to spawning assessment for herring and sandeel, where relevant.		
International Herring Larvae Surveys (IHLS) – 2008 to 2017	Herring spawning grounds	The ICES IHLS programme in the North Sea and adjacent areas has been operating since 1967. The primary goal of this programme is to provide quantitative estimates of herring larval abundance, which serve as a relative index of changes in the herring spawning-stock biomass. This dataset also offers information about the number of larvae present in the surveyed areas during the IHLS survey campaigns. Larvae under 10 mm in length represent 'newly hatched' larvae, which can be used to determine the location or intensity of spawning grounds (ICES, 2022). A total of 10-years of data were analysed, from 2008-2017. This approach was agreed with by Cefas during the stakeholder consultation process as later data sets are not comparable (see Relevant Statutory Consultation). 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 do not include the field 'number of larvae caught per m^2'. Furthermore, there was no reference to the ICES Statistical Rectangle division to which each haul ID could be referenced, which would allow a contour plot to be produced as per MarineSpace et al., (2013a; 2013b) guidance. The 2008-2017 IHLS data were used to produce a contour map, 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	5	n/a

Data source	Data type	Assessment of data	Confidence score	
			Herring	Sandeel
		(per ICES rectangle sub-division) 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 et al. (2013a and 2013b) guidance (taking consideration of the maximum IHLS point data value within the data used for this assessment). Since the available options only allowed for equal spacing between contour intervals, we used 50-unit intervals to group the abundance of larvae in the contour map. For example, the larvae density was categorized into ranges like 0-50, 50-200, 201-600, and so on. However, for the maximum recorded larvae value, we did not use this 50-unit approach. Instead, the highest value was treated separately to ensure that it was accurately represented on the map, reflecting the actual peak abundance. The IHLS point data percentile categories are as follows:  We have provided an additional figure which has greater categorisation of the groupings to provide a better graduation between the different data points and to highlight the nuances between the data. This uses the following groupings:		

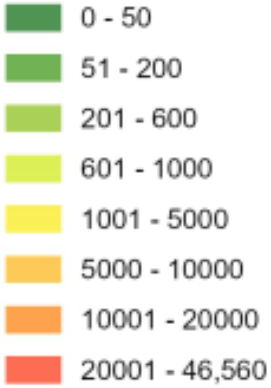
Data source	Data type	Assessment of data	Confidence score	
			Herring	Sandeel
				

Table 3.3 Additional data sources considered in the identification of potential herring and sandeel spawning habitat

Data source	Data type	Assessment of data
Project specific benthic surveys	Sediment data using Substrate Folk (1954) Classification and subtidal benthic habitats using EUNIS biotope classifications	Benthic Characterisation Survey 2021 (**Application Document 6.3.4.2.A Appendix 4.2.A Benthic Characterisation Report (Original Report)**): Benthic surveys identified subtidal broadscale habitats, habitat complexes and biotope complexes within the survey corridor. A broadscale habitat map was produced and this was based on combining the grab sample data (37 sample sites, which provided Folk (1954) classifications) with DDV analysis and SSS to classify the habitat types within the Offshore Scheme in terms of biotopes, in line with the EUNIS habitat classifications[2].

[2] The broadscale habitats consider Folk modified 5 classifications.

Data source	Data type	Assessment of data
		Remote sensing techniques are a key method in producing benthic habitat maps as per JNCC (2018) guidance. The resulting backscatter from SSS in combination with the other surveying techniques, can determine the nature of the seafloor (i.e. the presence of mud, fine sand, coarse sand, and coarse sediment), the topography of the seafloor, the compaction state of the sediment (Fournier, 2010) and is considered sufficient to identify the coarse and sand sediments that would be categorised as sediments suitable for herring and sandeel spawning. While SSS and DDV provides valuable observations of seabed sediments and habitats, it is not effective in determining finer sediment components, such as the precise percentage of mud or silt in sand or gravel samples (MarineSpace (2013a; 2013b)). This limitation is particularly relevant for distinguishing small fractions of mud/silt (e.g., greater than 5-10%) in mixed sediments, as raised during the PEIR stakeholder consultation (Table 1 A). Therefore, the classifications may overrepresent certain sediment types in the context of species-specific habitats, such as herring and sandeel spawning. For instance, if an area is identified as coarse sediment, the presence of mud (0-5%) would make it unsuitable for herring spawning. Conversely, if an area is identified as mud, the presence of small amounts of gravel or sand (0-5%) would not make it suitable for herring, as mud content must always be less than 10%. A precautionary approach has been taken, assuming that sediments are suitable for herring or sandeel despite not understanding the precise content of mud, which could make the sediment unsuitable. Habitat mapping also relies primarily on Folk 16 classifications derived from grab samples, which provide more accurate data on sediment composition. The grab samples were re-analysed following stakeholder feedback (Table 3.1) to identify if these grab sample sites contained any potential suitable spawning grounds = based on Reach et al., (2013) for herring and Latto et al., (2013) as described in MarineSpace (2013a; 2013b).

Data source	Data type	Assessment of data
		Despite this, the habitat mapping data are unable to distinguish between preferred/marginal habitat as it uses higher Folk 7 classifications (i.e. coarse sediment). These classifications are unable to identify the upper limits of sand, gravel and mud components which are required to determine Folk 16 classifications (i.e. the classifications used to define preferred vs marginal habitat as per). 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. Geophysical Survey 2024 (**Application Document 6.3.4.2.B Appendix 4.2.B Geophysical Survey Interpretation (Additional Surveys)**: Where the Offshore Scheme Boundary deviates from the Benthic Characterisation Report 2021 (**Application Document 6.3.4.2.A Appendix 4.2.A Benthic Characterisation Report (Original Report)**), a geophysical survey was commissioned to understand seabed morphology, shallow sediment structure, and to provide benthic characterisation at these locations (**Figure 6.4.4.2.5 Subtidal marine survey locations** located in **Application Document 6.4.4.2 Benthic Ecology).** However, the initial interpretations of the seabed sediments and potential sensitive habitats are based on SSS and MBES data, with further analysis anticipated[3]. Additional Benthic Survey 2024: Following consultation and a minor route change, where the Offshore Scheme Boundary deviates from the Benthic Characterisation Report 2021(**Application Document 6.3.4.2.A Appendix 4.2.A Benthic Characterisation Report (Original Report)**) survey corridor. An additional benthic survey was commissioned in 2024 to assess areas of the Offshore Scheme that were not included in the original survey. This ensured a complete understanding of the ecological conditions across the entire Offshore Scheme. The survey comprised a total of 16 transects, to ensure comprehensive coverage of the targeted areas (**Figure 6.4.4.2.5 Subtidal marine survey locations** located in **Application Document**

Data source	Data type	Assessment of data
		6.4.4.2 Benthic Ecology). At each survey station, a DDV was deployed to capture seabed imagery. These images provide detailed visual data on the substrate composition, benthic species, and habitat features which will be analysed to classify benthic habitats.
OneBenthic data	Publicly available benthic data (macrofaunal abundance, sediment particle size- % weight by sieve size)	Publicly available benthic macrofauna and sediment particle size data collected from multiple sources from 1969 to the present was analysed. This mainly involved cross-checking the OneBenthic data against the EMODnet data to ascertain any differences or similarities between data sets.

Zones of Influence

3.1.21 There are two ‘zones of influence’ (ZoI) in relation to cable installation of the Offshore Scheme, defined by the MarineSpace Guidance (2013a and 2013b) as follows:

- *Primary Impact Zone (PIZ) - the zone within which impacts resulting from the passage of the draghead* (e.g. from mechanical trencher) *over the seabed surface occur – also known as the direct impact zone; and*
- *Secondary Impact Zone (SIZ) - the footprint of effects arising as a result of the proposed cable installation activities not associated with the PIZ – also known as the indirect impact zone.*

3.1.22 The PIZ is calculated using the maximum swathe of disturbance from jet trenching. During construction of the Offshore Scheme, the maximum swathe is expected to be 25 m (12.5 m either side of the cable).

3.1.23 Herring and sandeel spawning habitats are sensitive to temporary increases in suspended sediment concentrations (SSC) and subsequent deposition, resulting in alteration of habitat and smothering effects on in-situ eggs (**Application Document 6.2.4.3 Part 4 Marine Chapter 3 Fish and Shellfish Ecology**). Therefore, the maximum distance from the Offshore Scheme at which SSC and subsequent deposition is expected to occur represents the worst-case SIZ for potential impacts to the herring and sandeel habitat.

3.1.24 Sediment dispersion modelling calculations of sediment deposition, determined that the majority of sediment is expected to be deposited within 100 m of the Offshore Scheme, with any sediment deposition beyond this distance expected to be of negligible thickness. The sediment deposition was compared against background deposition levels and the size of herring and sandeel eggs (see **Application Document 6.2.4.3 Part 4 Marine Chapter 3 Fish and Shellfish Ecology**). Therefore, a buffer distance of 100 m is considered to represent the SIZ.

3.1.25 Therefore, based on the maximum ZoI distances provided above, the total PIZ and SIZ used in this assessment is 225 m. The ‘PIZ and SIZ assessment area’ has been presented within the figures within this appendix.

3.2 Herring Spawning Assessment

Herring Sediment Preference

3.2.1 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 (Ellis, Milligan, Readdy, Taylor, & Brown, 2012). Herring lack site specific fidelity to spawning sites at a local-scale, which is driven in-part by the mobility of sediments in the nearshore. Given the location of the Offshore Scheme to the coastline, seabed sediments are expected to have a degree of instability. It is also noted (as part of MarineSpace technical input) that there may be some heterogeneity of seabed habitats between sediment classes identified by Folk (1954).

3.2.2 As per the MarineSpace et al. (2013a) guidance, spawning Atlantic herring are known to show an affinity or preference for specific seabed surface sediment types / classes (as determined by Folk, 1954). They favourably select ‘Gravel’ and ‘sandy Gravel’ sediment classes as part of their spawning habitat requirements, which are considered to be preferred spawning habitat. Marginal spawning habitat consists of the sediment class ‘gravelly Sand’, which is considered to have adequate sediment structure but is less favourable than preferred habitat.

3.2.3 According to Reach et al. (2013), sediments classified as ‘Gravel’ and ‘sandy Gravel’ on the Folk (1954) sediment classification scale should be considered as ‘preferred habitat’, while ‘gravelly Sand’ is categorized as ‘marginal habitat’. However, these classifications are not definitive indicators of actual spawning habitats but represent sediment types associated with Atlantic herring spawning grounds. Important factors like sediment aeration and elevation are not considered, meaning not all areas identified as suitable spawning habitats will necessarily support herring spawning. These sediment types are now referenced as preferred and marginal habitat sediment classes and the emphasis is on using them as a ‘basemap’ on which to layer additional data sets.

3.2.4 Thus, the mapping of grounds by sediment type only is likely to overestimate the presence of spawning. Furthermore, it is also reported that considerable variation exists in the literature as to the grain size preferred by spawning herring, although Gravel seems to generally be agreed upon (Reach et al. (2013). For this reason, it is suggested, as per the MarineSpace (2013a) guidance, that a low confidence rating should be assigned to the classification of marginal habitat.

General Herring Population within the Study Area

3.2.5 There are several geographically distinct herring stocks in UK waters (Tappin, et al., 2011) 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 (Fishsite, 2010). At the closest point these grounds are approximately 8.5 km from the Offshore Scheme (**Figure 6.4.4.3.A.1 Herring larvae spawning grounds).** Adult herring in the Thames Estuary are primarily composed of individuals from the Blackwater and Thames stock.

3.2.6 Another smaller discrete spring spawning population known to be present within the study area is the Blackwater and Thames herring stock (**Figure 6.4.4.3.A.1 Herring larvae spawning grounds**). This population spawns between late February and early May (KEIFCA, 2022) 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 (KEIFCA, 2022). There is also a small discrete herring stock on the Norfolk coast, located approximately 10 km north of the Offshore Scheme.

3.2.7 These stocks largely agree with the herring spawning grounds identified by Coull et al. (1998) **(Figure 6.4.4.3.A.1 Herring larvae spawning grounds)**. However, the Offshore Scheme does not occur within any of the spawning grounds identified by Coull et al. (1998). Furthermore, herring larvae survey data shown in Ellis et al. (2012) suggest that while herring fish larvae were recorded within the Study Area, higher numbers were located outside of the Study Area within the English Channel (**Figure 6.4.4.3.A.1 Herring larvae spawning grounds**). The Offshore Scheme does overlap with herring nursery grounds identified by Coull et al. (1998) between KP 1 and KP 42. Herring larvae spawning in the North Sea is known to drift into nearshore nursery areas.

3.2.8 The routing of the Offshore Scheme has been designed to avoid Margate and Long Sands SAC which is designated for the protection of the Annex I habitat 'sandbanks which are slightly covered by sea water all the time'. This area is also known to be a likely spawning and nursery ground for herring (Natural England, 2010).

Subtidal Benthic Characterisation

3.2.9 Broadscale habitat mapping within the MMT survey corridor, has been produced following the Benthic Characterisation Survey 2021. The broadscale benthic habitats identified were primarily composed of mud, sand, and coarse sediments (**Figure 6.4.4.3.A.2 Seabed Habitats**) (further details can also be seen in **Application Document 6.2.4.2 Part 4 Marine Chapter 2 Benthic Ecology**).

3.2.10 A total of 26 EUNIS habitats, including six habitat complexes, were identified within the MMT survey corridor (**Figure 6.4.4.3.A.2 Seabed Habitats**). Of these habitats, five were considered to be characteristic of preferred/marginal sediment types for herring spawning.

3.2.11 These characteristic habitats and habitat complexes are:

- A5.13 - Infralittoral coarse sediment
- A5.14 - Circalittoral coarse sediment
- A5.14 - Circalittoral coarse sediment/ A5.44 - Circalittoral mixed sediments
- A5.141 - *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles/ A5.14 - Circalittoral coarse sediment
- A5.142 - *Mediomastus fragilis*, Lumbrineris spp. and venerid bivalves in circalittoral coarse sand or gravel

3.2.12 These broadscale habitats have been mapped as potential preferred/marginal spawning habitat in **Figure 6.4.4.3.A.3 Potentially suitable herring spawning habitat from the Benthic Characterisation Survey 2021 within the MMT survey corridor**.

3.2.13 The MMT potential preferred/marginal spawning habitat for herring is primarily located along the central section of the Offshore Scheme, between KP31 and KP86. The total

area of potential herring preferred/marginal spawning habitat covers an area of 23.60 km^2 within the MMT survey corridor[3] and 15.67 km^2 within the Offshore Scheme (Table 3.4).

Table 3.4 Area considered to be potential preferred/marginal spawning herring habitat sediment type resulting from the Benthic Characterisation Survey 2021

Spawning Habitat classification	Area within MMT survey corridor (km^2)	Percentage of the MMT survey corridor	Area (km^2) which overlaps with the Offshore Scheme only	Percentage which overlaps with the Offshore Scheme only
Preferred/Marginal	23.60	38%	15.67	23%
Other habitats	39.25	62%	19.45	29%
Unmapped areas[4]	n/a	n/a	31.92	48%

3.2.14 A finer scale analysis was carried out on the 37 grab sample sites to identify if any of the sample sites classify as containing potential herring spawning habitat within the MMT survey corridor, using the methodology provided by Reach et al. (2013) (Table 3.5 and **Figure 6.4.4.3.A.3 Potentially suitable herring spawning habitat based on Broadscale EMODnet data within the study area**).

3.2.15 Along the Offshore Scheme, only one grab sample site (S036) was classified as preferred and three grab sample sites (S019, S026 and S037) were classified as marginal for potential herring spawning. The remaining sites, where particle size analysis (PSA) was analysed, were classified as unsuitable for herring spawning.

3.2.16 Three grab samples taken in the central section of the cable route were identified as ‘muddy sandy Gravel’. This indicates that the MMT potential preferred/marginal spawning habitat area is likely to be smaller than presented, with some areas potentially having a higher content of mud and therefore unsuitable for spawning.

[3] Note, since the Benthic Characterisation Survey 2021 was carried out, the boundary of the Offshore Scheme has been altered in some areas resulting in the MMT survey corridor only covering a part of the current Offshore Scheme Boundary.

[4] This refers to the area within the Offshore Scheme Boundary that was not covered by the MMT benthic characterisation MMT survey corridor due to route amendments following the MMT survey being completed.

Table 3.5 Sampling stations used during the Benthic Characterisation Survey 2021 with potential herring spawning habitat

Site ID	Nearest Kilometre Point	Within Offshore Scheme Boundary	Modified Folk Sediment Classification	Habitat Sediment Preference	Habitat Sediment Classification (Reach et al., 2013)
S019	75.5	Yes	gravelly Sand	Suitable	Marginal
S026	108	No	gravelly Sand	Suitable	Marginal
S036	112	Yes	sandy Gravel	Suitable	Preferred
S037	114.7	Yes	gravelly Sand	Suitable	Marginal

EMODnet Data Interpretation

3.2.17 EMODnet seabed substrate data (250k)was used to determine areas of preferred (sediment Folk classifications: ‘Gravel’ and ‘sandy Gravel’) and marginal (sediment Folk classifications: ‘gravelly Sand’) herring spawning habitat, as per Reach *et al*. (2013) guidance.

3.2.18 The addition of the EMODnet data can provide further information at a regional-scale but is not considered to be an accurate and reliable form of habitat mapping at the Project-specific-scale required for a detailed analysis of likely habitat spawning locations, due to the modelled interpolation of sediment from sporadic grab sample data points. However, both data sources (i.e. including the project specific MMT data) provide the base map from which to explore other data sources.

3.2.19 The EMODnet data shows that the Offshore Scheme passes through the outskirts of an area identified as potential preferred herring spawning habitat, between KP34 and KP57. Outside of this area, the Offshore Scheme passes through multiple patches of marginal and preferred, becoming more sporadic in the southern section of the cable route where there is more unsuitable habitat.

3.2.20 Table 3.6 shows the area and percentage of the SIZ and PIZ assessment area that is classified as potential spawning habitat, as interpolated by the EMODnet data. Within the SIZ and PIZ assessment areas, the majority of the EMODnet data was classified as unsuitable habitat, the PIZ overlapping 50.3% (1.5 km^2) and the SIZ overlapping 50.5% (11.8 km^2) (13.3 km^2 in total). Preferred habitat represented 37.0% (4.7 km^2) of the total SIZ and PIZ assessment area. The total area of suitable herring habitat within the SIZ and PIZ assessment area was 8.1 km^2 (49.6%).

Table 3.6 Proportion of suitable herring spawning habitat within the PIZ and SIZ

Potential herring spawning habitat classification	EMODnet suitable spawning habitat			
	Area (km^2) within the PIZ	Percentage (%) within the PIZ	Area (km^2) within the SIZ	Percentage (%) within the SIZ
Preferred	1.089	37.16	3.649	36.89
Marginal	0.368	12.56	2.965	12.65
Not suitable	1.473	50.27	11.831	50.46

3.2.21 The broadscale EMODnet data can also be compared to other relevant data sources (e.g. Coull et al. (1998) and MMT survey data) to determine if correlations and / or discrepancies occur between datasets.

3.2.22 Within the Offshore Scheme, the EMODnet data shows some alignment with the MMT benthic characterisation survey. Both datasets indicate preferred spawning habitat in the central section and the nearshore area in the south. However, there are areas where the EMODnet data identified suitable spawning habitat, but the MMT data considered this area to be unsuitable. This includes a large section of the Offshore Scheme in the northern end from KP5 to KP31.

3.2.23 In contrast, between KP57 and KP84, the MMT survey identifies potential spawning habitat, but EMODnet data suggests much of this area is unsuitable for spawning, except for a section between KP70.5 and KP83.5, which is classified as marginal habitat (**Figure 6.4.4.3.A.3 Potentially suitable herring spawning habitat based on Broadscale BGS data within the study area**). These differences may be due to the BGS data being interpolated over a large area using modelled data, leading to some variability and inaccuracy at the finer local scale.

3.2.24 The EMODnet data does not align well with the important spawning grounds identified by Coull et al. (1998). The Southern Bight herring stock spawning area, which is the largest and closest important spawning area to the Offshore Scheme identified by Coull et al. (1998), comprises a sparse and patchy area of marginal habitat as per the EMODnet data. A similar lack in correlation between the EMODnet data and areas of important spawning grounds, was also noted at the Blackwater Estuary and Norfolk coast spawning grounds. This was not the case for the Downs spawning area, which comprises predominantly preferred habitat.

3.2.25 It is important to note that the EMODnet data represents broadscale, modelled habitat mapping based on sporadically collected grab samples. According to the JNCC (2018) guidance on marine benthic habitats, modelled habitat distributions cannot be considered accurate when data is sparse. Therefore, the EMODnet data alone is not regarded as a reliable source for project-specific, detailed analysis of potential herring spawning locations. This evident when comparing against known historic spawning locations, as well as other data sources, such as the IHLS data (see IHLS Data).

Alternative Data Set – OneBenthic Data

3.2.26 Additional datasets have been explored to further ground-truth the EMODnet data within the Study Area. Benthic survey data and sediment data from relevant sample stations from the Cefas OneBenthic dataset have been used (**Figure 6.4.4.3.A.5 Potentially suitable herring spawning habitat based on OneBenthic survey data within the study area**). The OneBenthic data includes multiple data sources, including the Regional Seabed Monitoring Plan (RSMP) baseline dataset 2014 – 2016 and other scientific publications. The RSMP data collected macrofaunal and sediment data from the main English dredging regions (Humber, Anglian, Thames, Eastern English Channel and South Coast) and at four individual, isolated extraction sites. This data has been included in the OneBenthic dataset analysis.

3.2.27 The OneBenthic data generally conforms with the EMODnet data for areas of unsuitable habitat, which typically have a higher content of mud or sand. For EMODnet areas of potential suitable habitat, the OneBenthic data only conforms with this habitat in part. A large majority of the OneBenthic data contradicted with these BGS areas. For example, a cluster of samples taken to the east of KP16 to KP31 by RSMP surveying in 2018, showed that the large area of EMODnet identified preferred habitat, was mostly unsuitable or marginal (with small patches of preferred habitat).

3.2.28 MMT data identified suitable habitat from KP57 to KP84 but did not define whether this habitat was preferred or marginal. Along this section of the cable route the overlapping OneBenthic samples show that sediment generally comprises marginal, rather than preferred, habitat for spawning.

3.2.29 The high variability between the EMODnet , MMT, and OneBenthic datasets indicates that the content of sediment is also variable. This is a result of the strong currents and dynamic nature of sediment in this location (**Application Document 6.2.4.1 Part 4 Marine Chapter 1 Physical Processes**). Given this variability, we consider the project specific MMT data to be the most accurate, representing the most recent and relevant sampling for the Offshore Scheme.

IHLS Data

3.2.30 The IHLS data for the North Sea was used to create two contour maps, showing the abundance (maximum number per m^2) of southern North Sea herring larvae and eggs recorded during the IHLS surveys from 2008 to 2017 (**Figure 6.4.4.3.A.6. IHLS Survey Interpolated Contour Map (MarineSpace contours** and **Figure 6.4.4.3.A.7. IHLS Survey Interpolated Contour Map (detailed contouring)**). Both figures contain the same information but differ in the number of contour intervals present, the first figure being based on MarineSpace guidance (2013a), using four percentile categories. The second figure uses eight categories, offering a more detailed representation of larval distribution across the Study Area.

3.2.31 Both maps indicate some overlap between the Offshore Scheme and a small section of the IHLS contouring, with three sample sites located near the scheme (ICES rectangle codes: 32F1c, 32F1h, and 32F1f). However, these IHLS sample locations[5] are considered to be opportunistic sample locations and were only taken in select years (2008, 2009, 2010, 2011, 2016 and 2017). The abundances at these stations are considered to be low, with larvae values of 50, 260, 360 (maximum number per m^2

[5] https://www.ices.dk/data/data-portals/Pages/Eggs-and-larvae.aspx

sampled in one annum) (**Figure 6.4.4.3.A.8. The IHLS data showing peak counts of larvae, and the potentially suitable spawning habitat based on the EMODnet data**).

3.2.32 This is in comparison to stations overlapping the Southern Bight and Downs spawning grounds, where values are consistently greater than 1,000 larvae per m^2. Both figures shows that the highest recorded abundance of larvae were found to overlap with the known spawning areas of the Southern Bight or Downs herring stock, as identified by Coull et al. (1998)[6], with the highest abundances being recorded in the English Channel away from the Offshore Scheme.

3.2.33 In general, the IHLS data does not align closely with the EMODnet data near the Offshore Scheme (**Figure 6.4.4.3.A.8. The IHLS data showing peak counts of larvae, and the potentially suitable spawning habitat based on the EMODnet data**). IHLS samples taken in the southern North Sea where larvae numbers are consistently high, overlap unsuitable spawning habitat according to the EMODnet data. Most preferred habitat is located in the English Channel further to the south.

3.2.34 The movement of herring larvae from known spawning grounds or areas of suitable spawning habitat, is due to strong North Sea currents from the English Channel (see **Application Document 6.2.4.1 Part 4 Marine Chapter 1 Physical Environment** for further information on currents). The larvae collected as part of IHLS surveys are 10 days old (0-ringer/yolk sac stage), meaning they are in the water column for a few days before being caught. This was noted in the most recent IHLS report (ICES, 2019) for the survey data consisted, which stated that "*in recent years, increasing numbers of Downs larvae have drifted further north than previously observed, such as into the Skagerrak*". This statement suggests that larvae at this location have drifted over 200 – 300 km from their known spawning locations. This contributes to the discrepancies between IHLS and EMODnet data.

3.2.35 Further consideration has been given to where samples were taken consistently over the ten years of IHLS data collection. **Figure 6.4.4.3.A.9 IHLS Survey Interpolated Contour Map (Updated contouring). This** excludes opportunistic stations where samples have only been collected for 5 years or less. The majority of the samples removed, recorded zero herring larvae abundance in most years. The figure shows that, with samples removed, there is less overlap of the IHLS larvae data with the Offshore Scheme and therefore the larvae locations more closely align with known areas of potential spawning habitat and spawning areas identified by Coull et al. (1998), for example the habitat used by the Southern Bight and Downs stock.

3.2.36 In conclusions, this data suggests that the opportunistic sample locations near to the Offshore Scheme caught larvae which have drifted away from their spawning grounds further afield. Larvae sampled near the Offshore scheme are also low in abundance and indicate these areas are not key spawning sites.

[6] 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 (from 16 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 m2, 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.

VMS Data

3.2.37 The VMS data shows that there were no pelagic fishing gear areas within the Offshore Scheme, PIZ or SIZ (**Figure 6.4.4.3.A.10. VMS data of pelagic fishing gear areas within the study area**). One area where pelagic gears was used was close to the Offshore Scheme at the southern section, near the Kent landfall. However, this area is considered an anomaly and is away from other areas where pelagic gears are used. A majority of the fishing gear areas were located further afield in the English Channel, overlapping with known Southern Bight and Downs spawning grounds.

3.2.38 The VMS data only distinguish fishing locations based on gear types, which were used to determine habitat resource areas. Since a single gear type often targets multiple species, including but not limited to herring, the likelihood of this data directly indicating spawning grounds or specific habitats is low. Therefore, the VMS data is considered to be a very low confidence indicator of herring spawning in the Study Area and is not representative of important herring spawning at that location.

Heat Map

3.2.39 Following the data confidence scoring presented in Table 3.2, all relevant data layers were analysed in GIS through multi-layer mapping. This process involved overlapping the data layers and their associated confidence scores to generate 'heat maps.' The combined confidence score represents the sum of all layers at any given location. Therefore, the more data layers overlap, the higher the probability that a seabed location contains potential herring spawning habitat.

3.2.40 The heat map results (**Figure 6.4.4.3.A.11 Close-up of herring spawning confidence heatmap within the study area** and **Figure 6.4.4.3.A.12 Overview of herring spawning confidence heatmap within the study area**) indicate that the highest confidence for spawning habitat is located outside the PIZ and SIZ, in the southern North Sea and English Channel, and is classified as Very High confidence (13). High (8-10) and Very High confidence (11-13) scores were also recorded outside the PIZ and SIZ in areas corresponding to the known spawning grounds identified by Coull et al. (1998). These regions align with EMODnet preferred/marginal suitable spawning ground data and IHLS sampling sites that show higher maximum larvae counts per m^2. Additionally, these High and Very High confidence areas correspond with VMS pelagic fishing gear locations.

3.2.41 The Offshore Scheme, PIZ and SIZ, passes primarily through Low confidence potential herring spawning habitat (**Figure 6.4.4.3.A.11 Close-up of herring spawning confidence heatmap within the study area**). It also intersects a section of Medium confidence potential spawning habitat, where it overlaps with IHLS contours from three opportunistic IHLS sample sites (**Figure 6.4.4.3.A.8 The IHLS data showing peak counts of larvae, and the potentially suitable spawning habitat based on the EMODnet data**). However, these three samples are considered to overrepresent the heat scoring in this area. Table 3.7 summarizes the area and percentage of each confidence category within the PIZ and SIZ of the Offshore Scheme. The remaining study area is characterised by Low confidence herring spawning grounds**.**

3.2.42 Consideration has also been given to opportunistic samples, which could mis-represent the data. Opportunistic samples were removed in **Figure 6.4.4.3.A.13 Overview of herring spawning confidence heatmap within the study area (contour adjusted)** to indicate how IHLS data showing larvae locations can change when only focusing on data consistently collected over ten years or more. Removing opportunistic sampling

highights how larvae can drift away from spawning grounds over a short time period, resulting in unrepresentative data. Herring spawning confidence using updated contours is provided in Table 3.7.

Table 3.7 Percentage and area of herring spawning confidence values within the PIZ and SIZ Assessment Area

Herring Spawning Confidence	Area (km^2)		Percentage (%)	
	Within PIZ and SIZ		Within PIZ and SIZ	
	Original contours	Updated contours	Original contours	Updated contours
Very High	4.115	0	15.643	0
High	5.232	0	19.89	0
Medium	8.303	9.782	31.564	37.187
Low	0.667	3.304	2.536	9.641
No Score	7.987	13.219	30.363	50.253
Total	**26.305**	**26.305**	**99.999**	**97.081**

3.3 Sandeel Spawning Assessment

Sandeel Sediment Preference

3.3.1 Sandeel spawn on the seabed on specific habitat types, their eggs being demersal and remaining on the seabed. They are therefore sensitive to potential effects to the seabed. 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 (Holland, Greenstreet, Gibb , Fraser, & Robertson, 2005; Jensen, Rindorf, Wright, & Mosegaard, 2011).

3.3.2 Sandeel populations tend to be distributed unevenly and are strongly influenced by sediment type (Wright & Kennedy, 1999). These fish do not create permanent burrows and rely on interstitial water for gill ventilation. According to Holland et al. (2005), sandeels thrive in seabed environments with a high proportion of medium to coarse sand, with particle sizes ranging from 0.25 mm to less than 2 mm, and low levels of silt. Sandeels are generally scarce in sediments where silt content exceeds 4% and are virtually absent in areas where it surpasses 10% (Wright, Jensen, & Tuck , 2000; Holland, Greenstreet, Gibb , Fraser, & Robertson, 2005).

3.3.3 As per the MarineSpace et al. (2013b) guidance, spawning sandeel are known to show an affinity or preference for specific seabed surface sediment types / classes (as

determined by Folk, 1954). 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 (Folk, 1954) can often over-represent the suitability of habitat for sandeel; however, this is used as a precautionary approach. Latto *et al.,* (2013) states that the Folk classification divisions that best describe the preferred habitat for sandeel species in UK waters, are: 'Sand'; 'slightly gravelly Sand' and 'gravelly Sand'. 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 is 'sandy Gravel'.

General Sandeel Population within the Study Area

3.3.4 The Offshore Scheme overlaps with low intensity sandeel spawning grounds identified by Ellis et al (2012) and the central section of the Offshore Scheme (from KP35 to KP85) also overlaps the sandeel spawning grounds identified by Coull et al. (1998) (**Figure 6.4.4.3.A.14 Sandeel larvae spawning grounds based on Coull et al., 1998**). However, Ellis et al (2012) shows low intensity spawning grounds for sandeel is present across the whole North Sea and English Channel. 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'. This site is considered to be of importance to sandeel spawning (Natural England, 2010). However, the Offshore Scheme does not fall within the SAC (**Figure 6.4.4.3.A.21 Sandeel spawning habitat and designated sites**).

Subtidal Benthic Characterisation

3.3.5 Broadscale habitat mapping within the MMT survey corridor, has been produced following the Benthic Characterisation Survey 2021. The broadscale benthic habitats identified were primarily composed of mud, sand, and coarse sediments (Further details can be seen in **Application Document 6.2.4.2 Part 4 Marine Chapter 2 Benthic Ecology**).

3.3.6 A total of 26 EUNIS habitats, including six habitat complexes, were identified within the MMT survey corridor. Of these habitats, nine were considered to be characteristic of preferred/marginal sediment types for sandeel spawning. These characteristic habitats and habitat complexes are:

- A5.13 - Infralittoral coarse sediment
- A5.14 - Circalittoral coarse sediment
- A5.14 - Circalittoral coarse sediment/ A5.44 - Circalittoral mixed sediments
- A5.141 - *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles/ A5.14 - Circalittoral coarse sediment
- A5.142 - *Mediomastus fragilis*, Lumbrineris spp. and venerid bivalves in circalittoral coarse sand or gravel
- A5.23 - Infralittoral fine sand
- A5.231 - Infralittoral mobile clean sand with sparse fauna
- A5.233 - *Nephtys cirrosa* and Bathyporeia spp. in infralittoral sand

- A5.25 - Circalittoral fine sand

3.3.7 These characteristic broadscale habitats have been mapped as potential preferred/marginal spawning habitat in **Figure 6.4.4.3.A.15 Close-up of potentially suitable sandeel spawning habitat based on Broadscale EMODnet data within the study area**. The MMT potential suitable spawning habitat for sandeel appears to be primarily located along the central section of the Offshore Scheme, correlating well with the sections of the cable which overlaps Coull et al., (1998) important spawning grounds for sandeel.

3.3.8 The total area of potential preferred/marginal spawning habitat for sandeel covers an area of 29.03 km^2 within the MMT survey corridor[7] and only 17.37 km^2 within the Offshore Scheme (Table 3.8).

Table 3.8 Area considered to be potential preferred/marginal spawning sandeel habitat resulting from the Benthic Characterisation Survey 2021

Spawning Habitat classification	Area within original MT MMT survey corridor (km^2)	Percentage of the original MMT survey corridor	Area which overlaps with the Offshore Scheme only	Percentage which overlaps with the Offshore Scheme only
Preferred/Marginal	29.03	46%	17.37	26%
Other habitats	33.82	54%	17.74	26%
Unmapped areas[8]	n/a	n/a	31.92	48%

3.3.9 A finer scale analysis was carried out on the 37 grab sample sites to identify if any of the sample sites classify as containing potential sandeel spawning habitat within the MMT survey corridor. These grab samples were analysed based on Latto et al., (2013) guidance and are presented in below in Table 3.9 .

3.3.10 The results found fifteen sites (S004, S014, S016, S019, S020, S022, S023, S024, S025, S026, S027, S029, S030, S035, S037) within the MMT survey corridor were identified as “preferred” sandeel habitat and only one site (S036) was identified as “marginal” sandeel habitat. Sandeel were also identified within the grab samples, taken at sites S016 and S022 (shown in Table 3.9).

[7] Note, since the Benthic Characterisation Survey 2021 was carried out, the boundary of the Offshore Scheme has been altered in some areas resulting in the MMT survey corridor only covering a part of the current Offshore Scheme Boundary.

[8] This refers to the area within the Offshore Scheme Boundary that was not covered by the Benthic Characterisation Survey 2021 MMT survey corridor due to route amendments following the MMT survey being completed.

Table 3.9 Sampling stations used during the Benthic Characterisation Survey 2021 with potential sandeel spawning habitat

Station	Nearest Kilometre Point	Within Offshore Scheme Boundary	Modified Folk	Habitat Preference Latto et al., (2013)
S004	4.1	Yes	Sand	Preferred
S014	31.5	Yes	Sand	Preferred
S016	50.1	Yes	Sand	Preferred
S019	75.5	Yes	gravelly Sand	Preferred
S020	87.9	Yes	Sand	Preferred
S022	105.3	Yes	Sand	Preferred
S023	105.8	Yes	Sand	Preferred
S024	106.3	No	Sand	Preferred
S025	107.2	No	Sand	Preferred
S026	108.31	No	gravelly Sand	Preferred
S027	108.3	No	Sand	Preferred
S029	109.5	No	Sand	Preferred
S030	110	No	Sand	Preferred
S035	5	No	Sand	Preferred
S036	112	Yes	sandy Gravel	Marginal
S037	114.7	Yes	gravelly Sand	Preferred

EMODnet Data Interpretation

3.3.11 The broadscale EMODnet data was used to determine areas of 'preferred' (sediment Folk classifications: 'Sand', 'slightly gravelly Sand' and 'sandy Gravel') and 'marignal' (sediment Folk classifications: 'sandy gravel') sandeel spawning habitat, based on guidance by MarineSpace et al. (2013b).

3.3.12 The EMODnet data shows that the southern section of the Offshore Scheme passes through mainly preferred sandeel spawning habitat and the northern half of the Offshore Scheme passes mainly through marginal spawning habitat (**Figure 6.4.4.3.A.15 Close-up of potentially suitable sandeel spawning habitat based on Broadscale EMODnet data within the study area**). However, across the Offshore Scheme, the availability of suitable spawning habitat is patchy.

3.3.13 Looking at a wider context, the EMODnet data shows the southern North Sea (extending from the English Channel to north of Norfolk) to comprise a dense area of preferred spawning habitat and higher components of sand (i.e. less gravel content compared to habitat overlaying the Offshore Scheme (**Figure 6.4.4.3.A.16 Overview of potentially suitable sandeel spawning habitat based on Broadscale EMODnet data within the study area**).

3.3.14 The EMODnet data largely agrees with Ellis et al. (2012) and Coull et al (1998) data (**Figure 6.4.4.3.A.14 Sandeel larvae spawning grounds based on Coull et al., 1998**). When comparing the EMODnet data to the MMT survey data, both datasets suggests that a majority of the Offshore Scheme contains potential suitable spawning habitat. However, some discrepancies exist including for example, between KP5 to KP21 where the MMT data does not show any potential suitable spawning habitat but the EMODnet shows this area to be marginal spawning habitat.

3.3.15 Table 3.10 shows the area and percentage of the SIZ and PIZ assessment area that is classified as potential spawning habitat, as interpolated by the EMODnet data. This has then been compared to the total area of preferred and marginal spawning habitat within the Coull et al. (1998) important sandeel spawning ground (**Figure 6.4.4.3.A.16 Overview of potentially suitable sandeel spawning habitat based on Broadscale EMODnet data within the study area**). Within the SIZ and PIZ assessment area, the majority of the EMODnet data was classified as unsuitable habitat, representing 39.5% (1.2 km^2) overlapped by the PIZ and 39.6% (9.3 km^2) overlapped by the SIZ. Preferred habitat represented 36.6% (9.6 km^2) of the SIZ and PIZ assessment area. The total area of suitable sandeel habitat within the SIZ and PIZ assessment area was 15.9 km^2 (60.5%).

Table 3.10 Proportion of important sandeel spawning grounds within the PIZ and SIZ

Potential sandeel spawning habitat classification	EMODnet suitable spawning habitat			
	Area (km^2) within the PIZ	Percentage (%) within the PIZ	Area (km^2) within the SIZ	Percentage (%) within the SIZ
Preferred	1.073	36.71	8.524	36.45
Marginal	0.686	23.82	5.611	23.99
Not suitable	1.154	39.47	9.254	39.56

Alternative Data Sets – OneBenthic Data

3.3.16 Additional datasets have been explored to further ground-truth the EMODnet data within the Study Area. Benthic survey data and sediment data from relevant sample stations from the OneBenthic dataset have been used (**Figure 6.4.4.3.A.17 Potentially suitable sandeel spawning habitat based OneBenthic survey data within the study area**). The OneBenthic data includes multiple data sources, including the Regional Seabed Monitoring Plan (RSMP) baseline dataset 2014 – 2016 and other scientific publications.

3.3.17 The OneBenthic data generally conforms with the EMODnet data for areas of preferred habitat, which typically contain Sand, slightly gravelly Sand or gravelly Sand. This is clearly seen from KP35 to KP85 where there is a large area of preferred habitat shown by both datasets (overlapping in part the Margate and Longsands SAC).

3.3.18 However, for EMODnet areas of marginal habitat, the OneBenthic data only conforms with this habitat on occasion. The majority of the OneBenthic data within these

EMODnet areas of marginal habitat have a mud content of >10% and <50% sand content making them unsuitable for sandeel spawning. This discrepancy is particularly evident to the east of the northern section of the Offshore Scheme at the Suffolk landfall.

3.3.19 Overall, the OneBenthic indicates that the potential sandeel spawning habitat which the Offshore Scheme overlaps is patchy, particularly when compared to dense areas of preferred habitat elsewhere in the southern North Sea.

VMS Data

3.3.20 The VMS data, despite low confidence shows that the use of demersal gears are generally used away from the cable route, further offshore and in the English Channel.

3.3.21 The VMS data shows that there were a relatively low number of demersal fishing gear areas within the Offshore Scheme, PIZ or SIZ (**Figure 6.4.4.3.A.18 VMS data of demersal fishing gear areas within the study area**). This VMS data conforms with the known spawning grounds of sandeel identified by Coull et al., (1998), which extend to north in the southern North Sea.

Heat Map

3.3.22 Following the data confidence scoring presented in Table 3.2, all relevant data layers were analysed in GIS through multi-layer mapping. This process involved overlapping the data layers and their associated confidence scores to generate 'heat maps.' The combined confidence score represents the sum of all layers at any given location. Therefore, the more data layers overlap, the higher the probability that a seabed location contains potential sandeel spawning habitat.

3.3.23 The heat map results (**Figure 6.4.4.3.A.19 Close-up of sandeel spawning confidence heatmap within the study area** and **Figure 6.4.4.3.A.20 Overview of sandeel spawning confidence heatmap within the study area**) indicate that the highest confidence for sandeel spawning habitat is located outside the PIZ and SIZ, being widespread across the North Sea and English Channel, and is classified as very high confidence (7-8). The High and Very High confidence scores correspond to the known spawning grounds identified by Coull et al. (1998) and the EMODnet identified potential suitable sandeel spawning habitat. Additionally, these high and very high confidence areas correspond with VMS demersal fishing gear locations.

3.3.24 The Offshore Scheme, PIZ and SIZ, passes generally through Low and Medium confidence for sandeel spawning habitat. However, it also intersects a section of Medium and High confidence sandeel spawning habitat, where it overlaps with the Coull et al. (1998) known spawning grounds (from KP35 to KP85). Table 3.11 summarizes the area and percentage of each confidence category within the PIZ and SIZ of the Offshore Scheme. The remaining Study Area is characterised by Low confidence sandeel spawning grounds**.**

Table 3.11 Percentage and area of sandeel spawning confidence values within the PIZ and SIZ Assessment Area

Sandeel Spawning Confidence	Area (km^2)	Percentage (%)
	Within PIZ and SIZ	Within PIZ and SIZ
Very High	1.388	5.277
High	7.258	27.592
Medium	6.482	24.642
Low	5.455	20.738
No Score	5.722	21.752
Total	**26.305**	**100**

3.4 Summary and Conclusions

3.4.1 The summary and conclusions of the spawning analysis for herring and sandeel is proved in the below sections.

Herring

3.4.2 The MMT data shows that the Offshore Scheme is considered to contain 15.76 km^2 of potential preferred/marginal spawning herring habitat (Table 3.4).

3.4.3 The Offshore Scheme does not go through any known important spawning grounds, as identified by Coull et al. (1998). The EMODnet data shows only a small section of the Offshore Scheme passes through 'preferred' herring spawning habitats based on EMODnet data, with some alignment with the MMT data. The central and southern sections of the Offshore Scheme contain limited areas of preferred or marginal habitat. The EMODnet data also highlights that the majority of preferred herring spawning habitat lies in the southern North Sea, beyond the boundaries of the Offshore Scheme.

3.4.4 The OneBenthic data shows limited confirmation of suitable herring spawning habitat within the Offshore Scheme. However, some of the data aligns with the EMODnet results, confirming that the Offshore Scheme overlaps with areas that are largely unsuitable for herring spawning. The OneBenthic dataset largely supports the EMODnet that the broader region outside the Offshore Scheme contains more suitable spawning habitat, with some areas matching EMODnet classifications of preferred/marginal spawning grounds.

3.4.5 The IHLS data shows lower concentrations of herring larvae near the Offshore Scheme, which have come from opportunistic sampling which suggest that these areas are not key spawning grounds. Larval drift due to strong North Sea currents is understood to explain the presence of larvae in this area, rather than due to the presence of spawning habitat. The highest concentrations of herring larvae are found in established spawning grounds in the English Channel, as part of the Southern Bight and Downs spawning stocks.

3.4.6 The VMS data showed no pelagic fishing gear areas within the Offshore Scheme, indicating a low probability of spawning activity here. The VMS data shows most pelagic

fishing activity occurs in the English Channel, corresponding with established spawning grounds, further supporting the conclusion that the wider study area contains more important spawning habitats for herring.

3.4.7 When the confidence scores are compiled together from the relevant datasets to produce a heat map, it confirms that the Offshore Scheme, PIZ and SIZ, passes primarily through Low confidence potential herring spawning habitat. The highest confidence for spawning habitat is located outside the PIZ and SIZ, in the southern North Sea and English Channel, and is classified as Very High confidence.

3.4.8 Furthermore, a full seasonal restriction (1st November – 31st March) in the Outer Thames Estuary SPA. This restriction is relevant to all offshore cable installation activities, excluding the PLGR. A reduced seasonal restriction (1st January – 31st March) for landfall cable installation activities at the Suffolk landfall in Aldeburgh. Therefore, the Proposed Project will avoid the seasonal period for spawning herring from November – January and November – February (respectively) within the Outer Thames Estuary SPA with regards to cable burial activities (excluding PLGR). Although PLGR activity is discounted from the seasonal restrictions, the impact will be highly temporary and limited to the 1 - 3 m PLGR swathe.

3.4.9 Therefore, based on the comprehensive analysis presented, the data provides evidence to confirm that The Offshore Scheme is not considered an important area for herring spawning.

Sandeel

3.4.10 The MMT data shows that the Offshore Scheme is considered to contain 29.03 km^2 of potential preferred/marginal spawning sandeel habitat (Table 3.8). The central section Offshore Scheme also overlaps with important spawning grounds as identified by Coull et al. (1998), from KP35 to KP85 . These important spawning grounds are generally found within the boundary of the Outer Thames Estuary SPA from KP53 to KP83, which is known to be important for sandeel spawning.

3.4.11 The EMODnet data aligns broadly with the MMT data and Coull et al. (1998), showing the southern half of the Offshore Scheme passing through preferred habitat, while the northern half passes through marginal habitat. The majority of preferred sandeel spawning habitat which is intersected by the Offshore Scheme is located within the Outer Thames Estuary SPA between KP70 and KP83. However, discrepancies between the EMODnet and MMT datasets highlight areas of both suitable and unsuitable habitat within the Offshore Scheme. Looking more broadly, most of the wider North Sea, from the English Channel extending to the north of the Southern North Sea, consists of dense areas of preferred spawning habitats. This is in comparison to the Offshore Scheme, although encompasses only a small portion of the overall available sandeel spawning grounds within the Study Area. This area of suitable habitat is also patchy compared to elsewhere within the Study Area.

3.4.12 The OneBenthic dataset confirms the EMODnet data regarding preferred habitat but highlights that many areas classified as marginal habitat by EMODnet are unsuitable due to high mud content. The OneBenthic analysis underscores the limitations of the broadscale EMODnet data, further supporting the idea that most suitable spawning habitat lies outside the Offshore Scheme.

3.4.13 The VMS data shows that demersal fishing gear usage, an indicator of sandeel spawning, is concentrated away from the Offshore Scheme, with most activity occurring further offshore in the North Sea and English Channel.

3.4.14 When the confidence scores are compiled together from the relevant datasets to produce a heat map, it indicates that areas of highest confidence for sandeel spawning habitat are located outside the Offshore Scheme. The Offshore Scheme passes mainly through areas of low to medium confidence, with only a few sections of higher confidence. The majority of high and very high confidence areas are situated elsewhere in the North Sea and English Channel, and are widespread.

3.4.15 Furthermore, a full seasonal restriction (1st November – 31st March) in the Outer Thames Estuary SPA (and a 2 km buffer from the SPA). This restriction is relevant to all offshore cable installation activities, excluding the PLGR. A reduced seasonal restriction (1st January – 31st March) for landfall cable installation activities at the Suffolk landfall in Aldeburgh. This area is considered to be particularly important for sandeel spawning, as indicated by the EMODnet data (**Figure 6.4.4.3.A.21 Sandeel spawning habitat and designated sites**).Therefore, with regards to cable burial activities (excluding PLGR), the Proposed Project will avoid the seasonal period for spawning sandeel from November – January and November – February (respectively) within the Outer Thames Estuary SPA. Although PLGR activity is discounted from the seasonal restrictions, the impact will be highly temporary and limited to the 1 - 3 m PLGR swathe.

3.4.16 Therefore, based on the comprehensive analysis presented, the data provides evidence to confirm that the Offshore Scheme is not considered an important area for sandeel spawning.

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