Cambois Connection – Marine Scheme

Environmental Statement – Volume 3

Appendix 9.1: Herring and Sandeel Spawning Assessment (English Waters Only)

sse Renewables

Revision Information					
Rev	**Issue Status**	**Date**	**Originator**	**Checker**	**Approver**
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Approval for Issue	
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Acronyms

Acronym	Description
BBWF	Berwick Bank Wind Farm
BBWFL	Berwick Bank Wind Farm Limited
BEIS	Department for Business, Energy and Industrial Strategy
BGS	British Geographical Society
BMAPA	British Marine Aggregate Producers Association
Cefas	Centre for Environment Fisheries & Aquaculture Science
CNS	Central North Sea
EIA	Environmental Impact Assessment
ES	Environmental Statement
GIS	Geographic Information System
HVDC	High Voltage Direct Current
ICES	International Council for the Exploration of the Sea
IHLS	International Herring Larvae Survey
MHWS	Mean High Water Springs
MMO	Marine Management Organisation
MPA	Marine Protected Area
NIFCA	Northumberland Inshore Fisheries Conservation Authority
PSA	Particle size analysis
RAG	Regulatory Advisors Group
SIZ	Secondary Impact Zone
SSC	Suspended sediment concentration
SSER	SSE Renewables
SSSI	Site of Special Scientific Interest
UK	United Kingdom
UXO	Unexploded ordnance
VMS	Vessel Monitoring System
ZoL	Zone of Influence

Units

Unit	Description
kHz	Kilohertz
km	Kilometre (distance)
km^2	Kilometre squared
m	Metres
mm	Milimetre
m^2	Metre squared

1. Introduction

1.1. Project Overview

1. Berwick Bank Wind Farm Limited (BBWFL) is a wholly owned subsidiary of SSE Renewables (SSER) (hereafter referred to as 'the Applicant'). The Applicant is proposing the development of Offshore Export Cables, Onshore Export Cables, an Onshore Converter Station and associated grid connection at National Grid Substation in Blyth, Northumberland (the Cambois Connection, hereafter referred to as 'the Project'). The offshore components of the Project, seaward of mean high water springs (MHWS) comprise the Marine Scheme, which is the subject of the Environmental Statement (ES) that this Report supports.

2. The Marine Scheme will involve the construction, operation and maintenance, and decommissioning of up to four subsea High Voltage Direct Current (HVDC) cables (Offshore Export Cables) from within the Berwick Bank Wind Farm (BBWF) array area located in Scottish waters. The Offshore Export Cables will originate within the wider BBWF array area and from this point, the Offshore Export Cables will be installed along a corridor with a broad north-south alignment to the proposed Landfall location along the Cambois coastline, Northumberland, as presented in Volume 4, Figure 1.1: Fish and Shellfish Ecology Study Area.

3. The focus of this report is the section of the Marine Scheme within English waters, seaward of Mean High Water Springs (MHWS) at the Landfall to the Scotland – England median line; the reason for the focus on English waters is due to the specific feedback which the Applicant received from the Marine Management Organisation (MMO) only – this is explained in full in section 1.2 below.

1.2. Purpose of the Report

4. Volume 2, Chapter 9: Fish and Shellfish Ecology provides a comprehensive description of the baseline environment for fish and shellfish, including the potential overlap of spawning and nursery areas. Whilst most species spawn into the water column of moving water masses over extensive areas, demersal spawners (e.g. sandeel and herring) have habitat suitability requirements, and as a consequence their spawning grounds are typically more spatially limited than pelagic spawners. This report presents the analysis and mapping of potential spawning habitat for herring (*Clupea harengus*) and sandeel (*Ammodytes spp*.) species as relevant to the Marine Scheme within English waters, seaward of MHWS.

5. Herring are pelagic fish which are dependent on specific seabed habitats for spawning. As demersal spawners, they congregate together in shoals to lay dense sticky 'egg carpets' where they remain on the seabed. Eggs are typically laid on gravel and other coarse sediments (Ellis *et al.,* 2012). Due to their dependence on substrate type for spawning behaviour, herring are considered to be sensitive to habitat disturbance and changes to substrate type.

6. Sandeel are seabed dependent for the vast majority of their adult and juvenile lives and inhabit burrows except when feeding and spawning (Van Deurs *et al*., 2011; Tien *et al.,* 2017). During winter, they hibernate and remain inactive in their burrows for extended periods of time (Van Deurs *et al*., 2011). Sandeel spawning usually occurs in sandy sediments with a high proportion of medium and coarse sand and a low silt content (Holland *et al.,* 2005; BEIS, 2022). Based on their dependence on the seabed across their lifecycles, sandeel are generally considered to be sensitive to disturbance and habitat loss.

7. This report has been produced to address the MMO and Centre for Environment, Fisheries and Aquaculture Science (Cefas) comments received during Scoping of the Marine Scheme (Table 1.1) in English Waters.

8. A herring and sandeel spawning suitability assessment was not initially proposed as part of the assessments to inform the Environmental Impact Assessment (EIA) for the Marine Scheme. However, comments received from the MMO and Cefas during Scoping requested that the extent and intensity of potential herring and sandeel spawning habitat is further understood to inform the assessment of effects within the Marine Scheme ES. The Applicant considers that a full herring and sandeel assessment is disproportionate to the level of impact that may arise from the Marine Scheme. Cable burial is a transient activity and therefore spatially limited, temporary and short term and hence the levels of potential disturbance arising from the Marine Scheme are low. This was discussed in-detail with the MMO during the pre-application period, following the issue of the Scoping Opinion; for further details, please see Table 1.1 below and Volume 2, Chapter 4: Stakeholder Engagement and Consultation.

9. As a formal response from the MMO informed by Cefas advice was not received, this report has been developed and has been used to inform the impact assessment conducted within Volume 2, Chapter 9: Fish and Shellfish Ecology.

Table 1.1 Summary of key consultation and technical engagement undertaken for the Marine Scheme relevant to herring and sandeel spawning assessment

Date	Consultee and Type of Consultation	Issue(s) Raised	Response to Issue Raised and/or Where Considered in this report
Relevant consultation and engagement undertaken to date			
January 2023	Cefas	**Spawning Grounds** The scoping report has identified that the cable route overlaps sandeel (*Ammodytidae*) habitat and Atlantic herring (*Clupea harengus*) spawning grounds (as per Coull *et al*., 1998) and Ellis *et al*., 2012). Therefore, in addition to the data sources outlined in Section 9.4, I recommend that the Applicant follows the methodology described in MarineSpace (2013a,b) to determine potential spawning habitat suitability for sandeel and herring respectively. The MarineSpace method assigns confidence levels to a suite of data to provide 'heat maps' indicating suitable spawning grounds and habitat. I note that particle size analysis (PSA) data acquired during benthic surveys of the cable route will be used to inform the herring and sandeel habitat assessments. The PSA data should be included for use when following the MarineSpace methodologies. For the assessment of potential herring spawning habitat, the Applicant should use the latest 10 years of IHLS) data. IHLS data is available to download from the International Council for the Exploration of the Sea (ICES) website https://www.ices.dk/data/data-portals/Pages/Eggs-and-larvae.aspx	The methodologies described within MarineSpace (2013a and 2013b) have been followed for this assessment, as described in section 2.1. Site-specific PSA data and International Herring Larvae Survey (IHLS) have both been incorporated into the assessment (section 2.2).
January 2023	Cefas	**(MMO Question 4) Temporary Habitat and Species Disturbance or Loss** The Applicant has scoped in 'temporary habitat and species disturbance or loss' into their assessment which I agree is appropriate. As per point 11, the Applicant has stated that PSA data acquired during benthic surveys of the cable route will be used to inform the herring spawning habitat and sandeel habitat assessments. These assessments will be integral in identifying any overlaps of the cable route with herring spawning habitat and sandeel habitat, as well as any overlaps in the timing of seabed	Site-specific PSA data has been used to further understand the potential for herring and sandeel spawning, using the methods devised by Reach *et al.* (2013) and Latto *et al.* (2013). The purpose of this report is to further understand the extent and intensity of potential herring and sandeel spawning within a study area which represents the maximum extent over which direct and indirect effects on the seabed may occur.

Date	Consultee and Type of Consultation	Issue(s) Raised	Response to Issue Raised and/or Where Considered in this report
		preparation and cable installation activities with herring and sandeel spawning and hibernation periods. **Action**: The Applicant has stated that "Given the limited potential for significant fish spawning grounds along the offshore export cable route and the localised nature and small scale of direct seabed disturbance the potential for significant impacts to occur is unlikely." However, at this stage it is premature to make this assumption as an appropriate assessment to determine the extent and intensity of herring spawning habitat and sandeel habitat has not yet been undertaken. Nor has the timing of seabed preparation and cable installation activities been considered in relation to herring and sandeel spawning and hibernation periods. The likelihood of significant impacts occurring should be determined on the outcomes of the EIA.	Details on the potential mitigation requirements, including measures such as seasonal restrictions on construction works, are outlined in Volume 2, Chapter 9: Fish and Shellfish Ecology, and have been based on the outcomes of the EIA.
January 2023	Cefas	**Summary and MarineSpace references** The Applicant has provided a high-level scoping assessment identifying all major impacts and receptors that are likely to fall vulnerable to the impacts of the proposed works. I have made some recommendations regarding some impacts currently scoped out of the assessment that should be scoped in and have recommended additional sources of information (Marine Space 2013a & 2013b) to inform the habitat assessments for herring and sandeel. **Reference**s: MarineSpace Ltd, ABPmer Ltd, ERM Ltd, Fugro EMU Ltd and Marine Ecological Surveys Ltd., (2013a). Environmental Effect Pathways between Marine Aggregate Application Areas and Sandeel Habitat: Regional Cumulative Impact Assessments. A report for British Marine Aggregate Producers Association (BMAPA).	Noted, methodologies described within MarineSpace (2013a and 2013b) have been followed for this assessment, as described in section 2.1.

Date	Consultee and Type of Consultation	Issue(s) Raised	Response to Issue Raised and/or Where Considered in this report
		MarineSpace Ltd, ABPmer Ltd, ERM Ltd, Fugro EMU Ltd and Marine Ecological Surveys Ltd., (2013b). Environmental Effect Pathways between Marine Aggregate Application Areas (BMAPA) and Atlantic Herring Potential Spawning Habitat: Regional Cumulative Impact Assessments. Version 1.0. A report for the BMAPA.	
March 2023	MMO	**Determination of Spawning Grounds recommendation** The scoping report has identified that the cable route overlaps sandeel (*Ammodytidae*) habitat and Atlantic herring (*Clupea harengus*) spawning grounds (as per Coull *et al*., 1998) and Ellis *et al.*, 2012) Therefore, in addition to the data sources outlined in Section 9.4, I recommend that you follow the methodology described in MarineSpace (2013a and 2013b) to determine potential spawning habitat suitability for sandeel and herring respectively. The MarineSpace method assigns confidence levels to a suite of data to provide 'heat maps' indicating suitable spawning grounds and habitat. I note that particle size analysis (PSA) data acquired during benthic surveys of the cable route will be used to inform the herring and sandeel habitat assessments. The PSA data should be included for use when following the MarineSpace methodologies. For the assessment of potential herring spawning habitat, you should use the latest 10 years of International Herring Larvae Survey (IHLS) data. IHLS data is available to download from the International Council for the Exploration of the Sea (ICES) website; https://www.ices.dk/data/data-portals/Pages/Eggs-and-larvae.aspx	The methodologies described within MarineSpace (2013a and 2013b) have been followed for this assessment, as described in section 2.1. Site-specific PSA data and IHLS have both been incorporated into the assessment (section 2.2).
March 2023	MMO	**Temporary Habitat and Species Disturbance or Loss** You have scoped in 'temporary habitat and species disturbance or loss' into the assessment which is appropriate. You have stated that PSA data acquired during benthic surveys of the cable route will be used to inform the herring spawning habitat and sandeel habitat assessments. These assessments will be integral in identifying any overlaps of the cable route with herring spawning habitat and sandeel habitat, as well as any overlaps	Site-specific PSA data has been used to further understand the potential for herring and sandeel spawning, using the methods devised by Reach *et al.* (2013) and Latto *et al.* (2013).

Date	Consultee and Type of Consultation	Issue(s) Raised	Response to Issue Raised and/or Where Considered in this report
		in the timing of seabed preparation and cable installation activities with herring and sandeel spawning and hibernation periods.	
March 2023	MMO	**Assessment of Extent and Intensity of Herring Spawning Habitat and Sandeel Habitat** You have stated that "Given the limited potential for significant fish spawning grounds along the offshore export cable route and the localised nature and small scale of direct seabed disturbance the potential for significant impacts to occur is unlikely." However, at this stage it is premature to make this assumption as an appropriate assessment to determine the extent and intensity of herring spawning habitat and sandeel habitat has not yet been undertaken. Nor has the timing of seabed preparation and cable installation activities been considered in relation to herring and sandeel spawning and hibernation periods. The likelihood of significant impacts occurring should be determined on the outcomes of the EIA.	The purpose of this report is to further understand the extent and intensity of potential herring and sandeel spawning within a study area which represents the maximum extent over which direct and indirect effects on the seabed may occur. Details on the potential mitigation requirements, including measures such as seasonal restrictions on construction works, are outlined in Volume 2, Chapter 9: Fish and Shellfish Ecology, and have been based on the outcomes of the EIA.
April 2023	MMO (Pre-Application Clarification)	**Post-Scoping clarifications with the MMO (18 April 2023)** The Applicant met with the MMO where a number of items raised in their Scoping Opinion were discussed. During the workshop, the Applicant explained that the Project did not propose undertaking a full herring and sandeel assessment within the ES. The Applicant explained that cable burial is a transient activity and therefore spatially limited, temporary and short term over the cable route and therefore the levels of potential disturbance arising from the Marine Scheme are low. The Applicant explained the proposal that the ES would provide benthic habitat maps, would undertake PSA, and carry out an analysis of seabed substrate along the route to determine habitat suitability in a thorough / robust manner, proportionate to the scale of impact.	As detailed above, a response from the MMO, as informed by Cefas consultation was not received. On this basis the Applicant has carried out this herring and Sandeel spawning assessment.

Date	Consultee and Type of Consultation	Issue(s) Raised	Response to Issue Raised and/or Where Considered in this report
		However, the Applicant explained why it was not considered proportionate for a cable project to undertake the assessment in line with guidance developed for aggregate removal projects (which require the direct removal of large swathes of suitable sediment, potentially over repeated events; the direct removal of eggs; and the semi-permanent/permanent alteration of habitat structure). Following the meeting, the Applicant wrote to the MMO with a clarification note explaining this in further detail and supported with a detailed explanation of the proposed assessment methodology for herring and Sandeel spawning populations (Xodus, 2023); the MMO agreed to carry out consultation with Cefas so that a clear decision could be reached.	

2. Methodology

2.1. Overview

10. A detailed suitability assessment of Atlantic 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 and 2013b) guidance. The guidance expands upon existing work by Reach *et al*. (2013) and Latto *et al.* (2013), through consultation with the MMO, Cefas, and the Regulatory Advisors Group (RAG).

11. The Applicant notes the upcoming development of a second version of the MarineSpace *et al.* (2013a and 2013b) guidance, however this was not available at the time of writing, nor has it been provided to the Applicant by the MMO.

12. MarineSpace et al. (2013a and 2013b) identified a range of data sources to inform mapping of potential herring spawning and sandeel habitat. A 'confidence score' is assigned to data layers (section 2.2), and following data confidence scoring, data layers are analysed and combined in Geographic Information System (GIS) to produce a 'heat' map. The heat map represents the sum of the confidence score of all layers at any one location.

13. The study area of the assessment represents the immediate area of potential direct impact within the Marine Scheme and the extent to which smothering effects may occur from temporary increases in suspended sediment concentrations (SSC) and subsequent deposition (Volume 2, Chapter 9: Fish and Shellfish; Volume 4, Figure 9.1: Fish and Shellfish Ecology Study Area). A Zone of Influence (ZoI) of 10 km around the footprint of the proposed works is considered to represent a conservative distance for the study area (aka Secondary Impact Zone (SIZ) in accordance with the MarineSpace et al. (2013a and 2013b) guidance).

2.2. Data Sources and Confidence Assessment

14. The spatial data sources to be used are referenced within MarineSpace *et al*. (2013a and 2013b) and applied to this assessment as detailed in Table 2.1. Limitations associated with these data sources are discussed in detail in the MarineSpace *et al.* (2013a and 2013b) guidance and incorporated into the resultant confidence scores.

15. Table 2.1 provides the herring and sandeel confidence scores assigned to each data layer for the purposes of the assessment. The scoring methodology is provided within the MarineSpace *et al.* (2013a and 2013b) guidance.

16. The confidence scores represent the total normalised value for each dataset which is calculated using total weighted scores for the quality of evidence that each dataset represents (considering vintage, resolution, quality standards, and dataset source) and the suitability of the dataset as an indicator of herring spawning/sandeel presence. The 'maximum possible data layer scores' are 16 and 13, for herring and sandeel respectively.

Table 2.1 Summary of data

Data Source and Type	Assessment of Data	Confidence Score	
		Herring	Sandeel
Data screened in to the assessment			
Sediment data – British Geological Survey (BGS) – 1:250,000 scale (BGS, 2023)	BGS sediment data was acquired for the study area[1], encompassing a 10 km buffer around the Marine Scheme Offshore Export Cable Corridor as a precautionary distance for any secondary impacts which may occur from potential deposition and smothering effects.The BGS data categorises sediment types according to Folk (1954) classifications. The MarineSpace (2013a and 2013b) guidance categorises the preference for herring spawning and sandeel habitat on a range from 'preferred' to 'unsuitable' based on Folk (1954) classifications: • Herring: – Preferred habitat sediment class: Gravel and sandy Gravel; – Marginal habitat sediment class: gravelly Sand; and – Unsuitable habitat sediment class: all other Folk (1954) classifications. • Sandeel: – Preferred habitat sediment class: Sand, slightly gravelly Sand and gravelly Sand – Marginal habitat sediment class: sandy Gravel – Unsuitable habitat sediment class: all other Folk (1954) classifications.	Preferred = 3 Marginal = 2	Preferred = 4 Marginal =2

[1] To help provide wider context for the assessment and to aid with the Cefas review of this Report, the Applicant procured BGS sediment data for the wider UK region, as represented in Volume 4, Figure 9.1.

Data Source and Type	Assessment of Data	Confidence Score	
		Herring	Sandeel
	It is important to note the difference in the confidence scores for herring and sandeel, as described in the MarineSpace (2013a and 2013b) guidance. The 'preferred' and 'marginal' habitat classes for herring all over-represent the potential suitability for herring spawning due to the potential for higher mud proportions (<10% muds) in these Folk (1954) classifications than the sediment preferences (< 5% muds). Whereas, the preferred Folk (1954) classifications for sandeel are all considered to accurately represent the preferences for sandeel habitat. Therefore, the Folk (1954) classifications for 'preferred' sandeel habitat are considered to better align with sandeel sediment preferences.		
Fisheries data – Vessel Monitoring System (VMS) data (2017 – 2020) (MMO, 2022)	Satellite tracking data (Vessel Monitoring System (VMS) recorded in 0.05° by 0.05° grids from UK vessels in UK and European waters. VMS data is combined with log book data with values assigned to each cell in the grid in terms of effort and value (£). VMS data does not provide information on species caught, and therefore, has been interrogated by fishing method which can be used to broadly understand habitat resource areas. Fishing by pelagic gears are considered an indicator of herring spawning habitat and fishing by demersal gears are considered an indiactor 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. VMS data is processed in terms of presence / absence of activity with no consideration of intensity, in line with the MarineSpace (2013a and 2013b) guidance.	2	2
Spawning grounds - Coull *et al*. (1998)	Indicative spawning and nursery ground locations and timings around UK waters for sandeel and herring. Subsequent to the publication of the MarineSpace (2013a,b) guidance, Ellis *et al.* (2012) provide updated indicative spawning and nursery ground locations to map these to an ICES sub-rectangle scale. However, in accordance with Reach et al. (2013), this dataset has not been included within this assessment due as the "*resolution of effective mapping of these data for environmental considerations has been reduced (although it is useful as a fisheries management tool).*"	3	3
International Herring Larvae Survey (IHLS) data (2008 – 2017) (ICES, 2023)	The ICES programme of IHLS in the North Sea and adjacent areas has been in operation since 1967. The main purpose of this programme is to provide quantitative estimates of herring larval abundance, which are used as a relative index of changes of the herring spawning-stock biomass. This dataset also provides information regarding the number of larvae present within the areas surveyed during the IHLS survey campaigns. The number of larvae < 10 mm in length represent the number of 'newly hatched' larvae, and this can be used to inform the location or intensity of spawning grounds (ICES, 2022).	5	n/a

Data Source and Type	Assessment of Data	Confidence Score	
		Herring	Sandeel
	IHLS data from 2008 – 2017 has been analysed in accordance with the Marine Space (2013a) guidance to create a contour plot by interpolating the maximum number of larvae per m^2 at each sample station and assigning values between sample points. Four percentiles categories were used for the contour plots (plus zero). More recent IHLS data after 2017 does not include the 'number of larvae caught per m^2', and thus cannot be analysed in the same way.		
Data screened out of the assessment			
Fisheries data – Northumberland Inshore Fisheries Conservation Authority (NIFCA) sightings (2012 – 2021) (NIFCA, 2023)	Data collected by NIFCA sea patrol officers of sighted vessels in and in proximity to the NIFCA district. Fishing density data from 2012– 2021 provided by gear type using a 1 km^2 grid. The NIFCA district extends out to the 6 NM limit and observations of fishing vessels by NIFCA patrol vessels are predominantly concentrated within the boundaries of the district. The lack of records in offshore areas is not indicative of a lack of fishing activity. As this data source only covers the territorial area of the Marine Scheme Offshore Export Cable Corridor in English waters and the distribution of fishing activity by vessels using pelagic (for herring) and demersal (for sandeel) gears is adquately represented by the VMS data, this data source has been screened out.	n/a	n/a
Fisheries data – MMO vessel sightings (2011 – 2018) (MMO, 2023)	The data provides a good indication of key methods and nationalities potentially active in a given area. It is noted that surveillance patrols are not carried out at regular time intervals and therefore the level of surveillance effort may vary significantly between years. As the distribution of fishing activity by vessels using pelagic (for herring) and demersal (for sandeel) gears is adquately represented by the VMS data, this data source has been screened out.	n/a	n/a

17. The BGS data were compared against site-specific Particle Size Analysis (PSA) sediment data to assess if the two datasets provide an analogous representation of seabed sediment character and to ground-truth the classification of 'preferred' and 'marginal' habitats derived from the BGS sediment data alone. PSA was conducted for the 58 grab samples collected along the Marine Scheme (55 in English waters) and each sampling location was assigned a Folk (1954) classification (further details available in Volume 3, Appendix 8.1: Phase 1 and Phase 2 Benthic Reporting).

18. In addition, the potential presence of 'preferred' and 'marginal' herring and sandeel habitat can be further understood by analysing the PSA data using the methods devised by Latto *et al*. (2013) and Reach *et al*., (2013). As noted in Table 2.1, assigning habitat preferences using Folk (1954) classifications alone is likely to over-represent the suitability of the sediment due to the percentage components within the sediment divisions. However, the particle size distribution at each sampling location can be assessed against the sediment preferences devised by Latto *et al*. (2013) and Reach *et al*. (2013) to categorise the sediments as being 'unsuitable', 'suitable', 'sub-prime' and 'prime' habitat. 'Sub-prime' and 'prime' habitat are both assessed as 'preferred' spawning habitat, and 'suitable' habitat is indicative of 'marginal' spawning habitat.

19. Reach *et al*., (2013) describes the partition of herring spawning habitat preferences based on particle size distribution as follows:

- Prime habitat (preferred): < 5% muds, > 50% gravel;
- Sub-prime habitat (preferred): < 5% muds, >25% gravel;
- Suitable habitat (marginal): <5% muds, >10% gravel; and
- Unsuitable habitat: >5% muds, <10% gravel.

20. For sandeel, Latto *et al.* (2013) describes the partition of sandeel habitat preferences based on particle size distribution as follows:

- Prime habitat (preferred): <1% muds, >85% sand;
- Sub-prime habitat (preferred): <4% muds, >70% sand;
- Suitable habitat (marginal): <10% muds, >50% sand; and
- Unsuitable habitat: >10% muds, <50% sand.

3. Herring Spawning Suitability Assessment

3.1. Data Layer Overview

21. Several herring spawning stocks exist within UK waters. The study area overlaps with the spawning grounds likely associated with the Banks or Dogger herring stock, which spawn in the Central North Sea (CNS) and off the English coast from August until October, or the Buchan herring stock which spawns further north in Scottish waters in August and September (Coull et al., 1998; Ellis et al., 2012). The study area overlaps with indeterminate intensity spawning grounds according to Coull *et al.* (1998).

22. Table 3.1 and Figure 3.1 outline the herring spawning habitat classifications derived from publicly available BGS sediment data in accordance with the MarineSpace (2013a) guidance. Most of the study area (81.9%) is classified as unsuitable herring spawning habitat, with more suitable sediments located further inshore, overlapping the Coull *et al*., (1998) spawning grounds. There is only a small area (2.4%) of preferred herring spawning habitat (i.e Gravel or sandy Gravel) within the study area, distributed mostly in the central area of the Marine Scheme Offshore Export Cable Corridor in English waters at the point where the corridor diverges into two.

Table 3.1 BGS sediment data: habitat classification

Classification	Area (km^2)	Percentage of study area (%)
Preferred	131.3	2.4
Marginal	875.3	15.8
Other / unsuitable	4,548.0	81.9
Total Area	5,554.6	100.0

23. In general, the PSA data (Volume 3, Appendix 8.1: Phase 1 and 2 Benthic Reporting) also show a low suitability for herring spawning within the Marine Scheme in English waters. Based on the Folk (1954) classifications derived from the PSA data, only one sample location was classified as 'preferred' herring spawning habitat (sandy Gravel) and only one as 'marginal' herring spawning habitat (gravelly Sand). As noted in Table 2.1, Folk (1954) classifications are likely to over-represent preferred herring spawning habitat due to the potential for higher mud proportions (<10% muds) than the sediment preferences by herring (< 5% muds). Therefore, the potential for herring spawning has been further examined using site-specific PSA data and the methodology devised by Reach *et al.* (2013), as described in section 2.2 (Figure 3.1). The PSA data demonstrates that all but one of the grab samples taken within the Marine Scheme in English waters contained > 5% mud, and are therefore, deemed unsuitable for herring spawning according to the Reach *et al.* (2013) criteria. The one sample assessed as being of 'prime (preferred)' herring spawning habitat contained a particle size distribution of 4.2% mud and 52.29% gravel.

24. The PSA data has been compared against the BGS sediment data to identify any discrepancies between these two datasets. The sampling location assessed as prime (preferred) herring spawning habitat based on the PSA data is located in the eastern branch of the Marine Scheme in English waters on the approach to the Scotland-England border. This area is assessed as 'unsuitable' herring spawning habitat based on the BGS data alone, indicating a slight discrepancy

between these two datasets. However, considering the limited number of 'preferred' herring spawning locations within the Marine in English waters, any increase in spawning habitat preference is unlikely to affect the overarching trends and conclusions derived from the heat map.

25. Average VMS value (2017-2020) for pelagic fishing gears is displayed in Figure 3.2. There was no VMS data recorded for vessels operating pelagic gears in the study area between 2017 and 2020 (described in further detail in Volume 2, Chapter 12: Commercial Fisheries). Furthermore, as discussed in Volume 2, Chapter 12: Commercial Fisheries, herring account for a low proportion of the landings values (0.33%; 2015 - 2019) in the commercial fisheries study area.

26. The abundance of newly hatched larvae (<10 mm in length) can also provide an indication as to whether spawning grounds are in use. The IHLS survey data from 2008 – 2017 has been analysed to produce a contour plot based on an interpolation of the maximum number of larvae per m^2 at each sample station within this time period, shown in Figure 3.3. The abundance of newly hatched larvae, presented as a maximum per sampling station between 2008 and 2017, is higher in the north of the study area on the approach to the Scotland – England border with a southward trend of lower abundance.

3.2. Extent of Interaction with Potential Spawning Habitat

27. In accordance with MarineSpace (2013a), a heat map has been produced to categorise areas of the study area as being of 'low', 'medium', 'high' and 'very high' herring spawning confidence. The heat map (Figure 3.4) shows the sum of the confidence scores assigned to each individual data layer screened into the assessment (discussed in section 2.2).

28. The spatial extents of the herring spawning confidence values (i.e. heat categories) within the study area are outlined in Table 3.2. The majority (98.2%) of the study area is assessed to be of 'medium' heat (5 – 8 confidence score) with regions of 'high' heat (10 confidence score) in areas overlapping Coull *et al*. (1998) herring spawning grounds and 'preferred' herring spawning habitat determined from the BGS sediment data. Areas of 'high' heat are mostly distributed in English territorial waters and in patches of English offshore waters.

Table 3.2 Herring spawning habitat suitability area values

Category	'Heat' (confidence) score	Area (km^2)	Percentage of study area (%)
No potential	0	4.0	0.07
Low	3	0.4	0.01
Medium	5	3,932.2	70.8
Medium	7	781.3	14.1
Medium	8	742.6	13.4
High	10	94.0	1.7
Very high	11	0.08	<0.1
Total	n/a	5,554.6	100.0

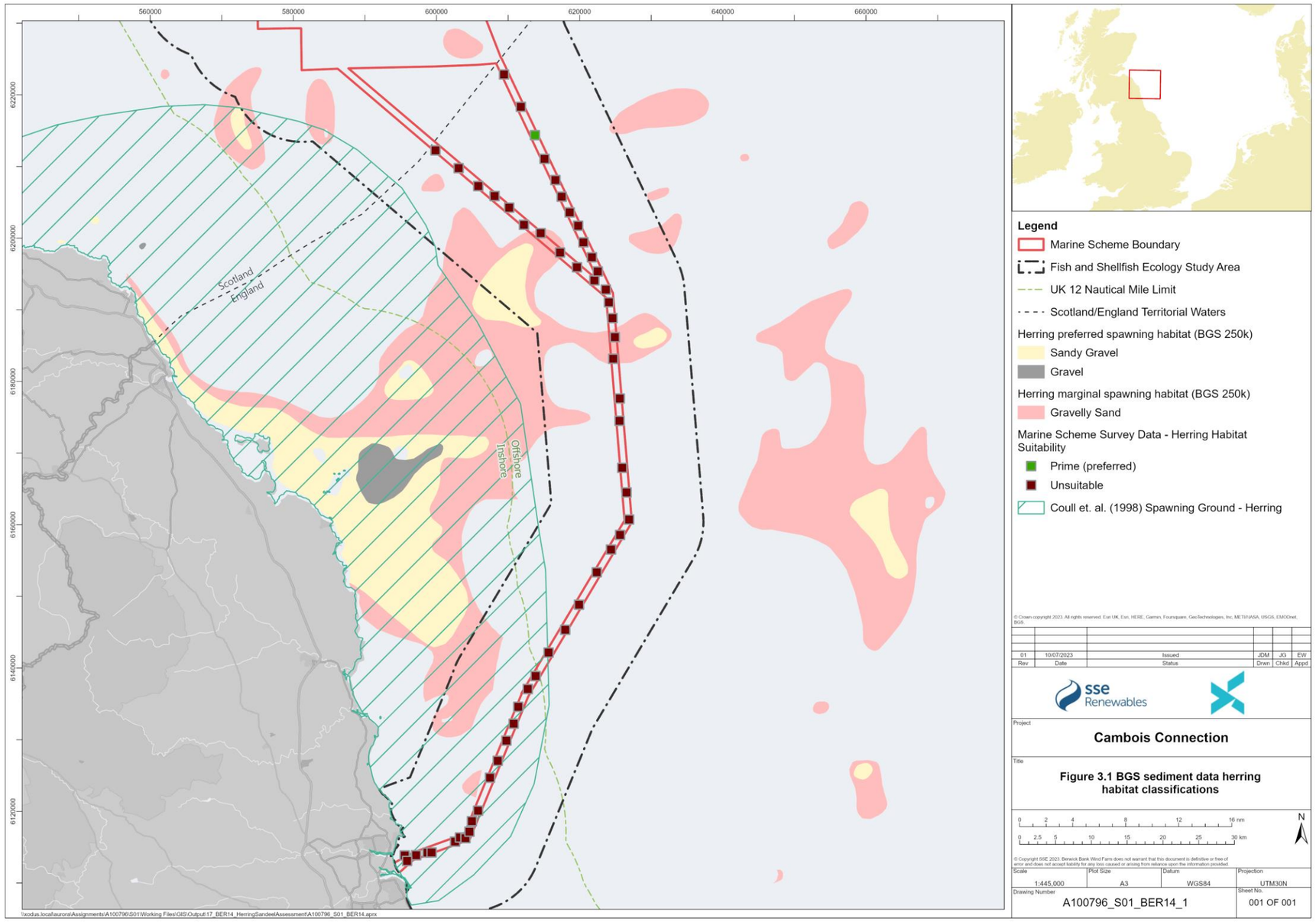

Figure 3.1 BGS sediment data herring habitat classification

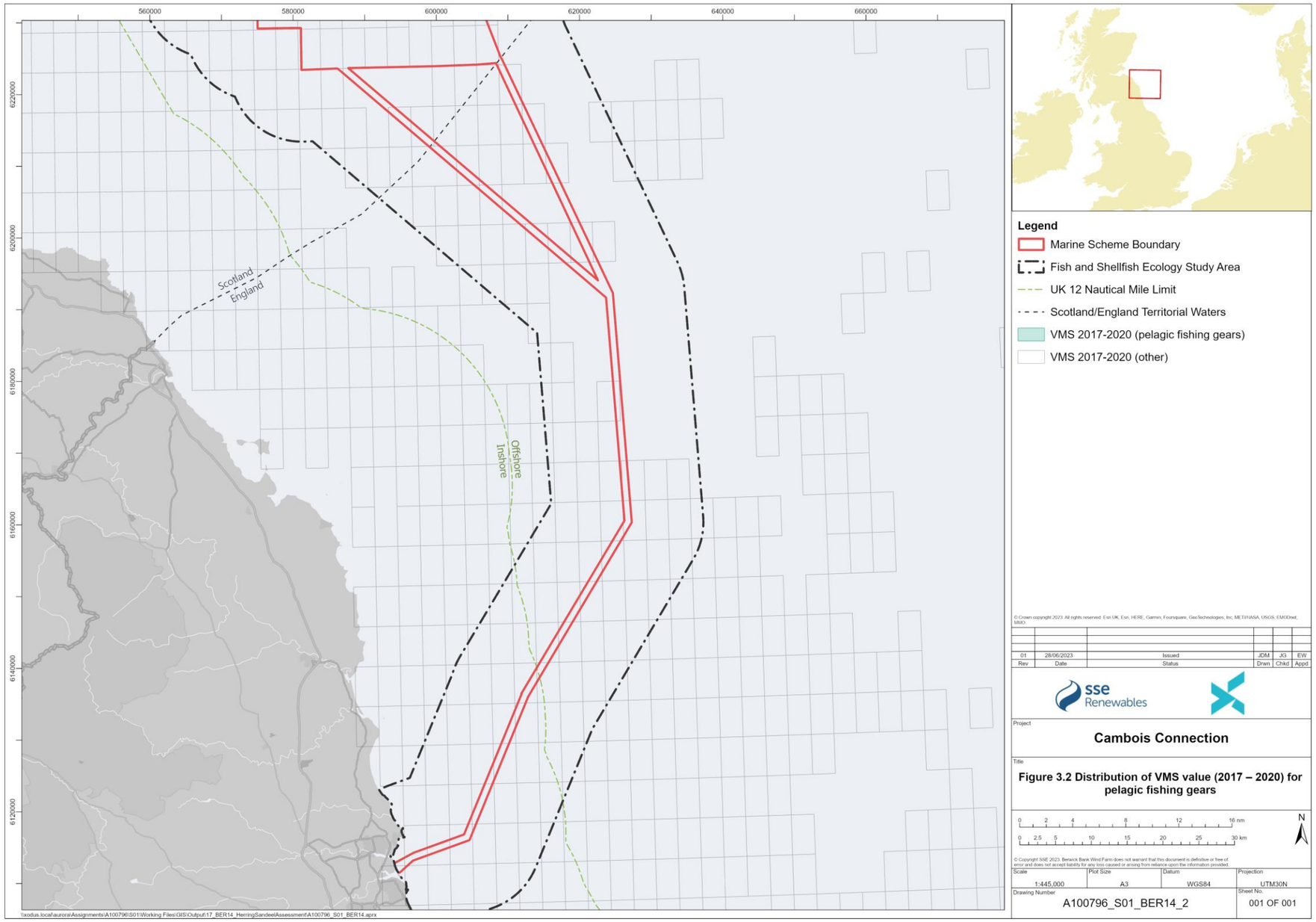

Figure 3.2 Distribution of VMS value (2017 – 2020) for pelagic fishing gears

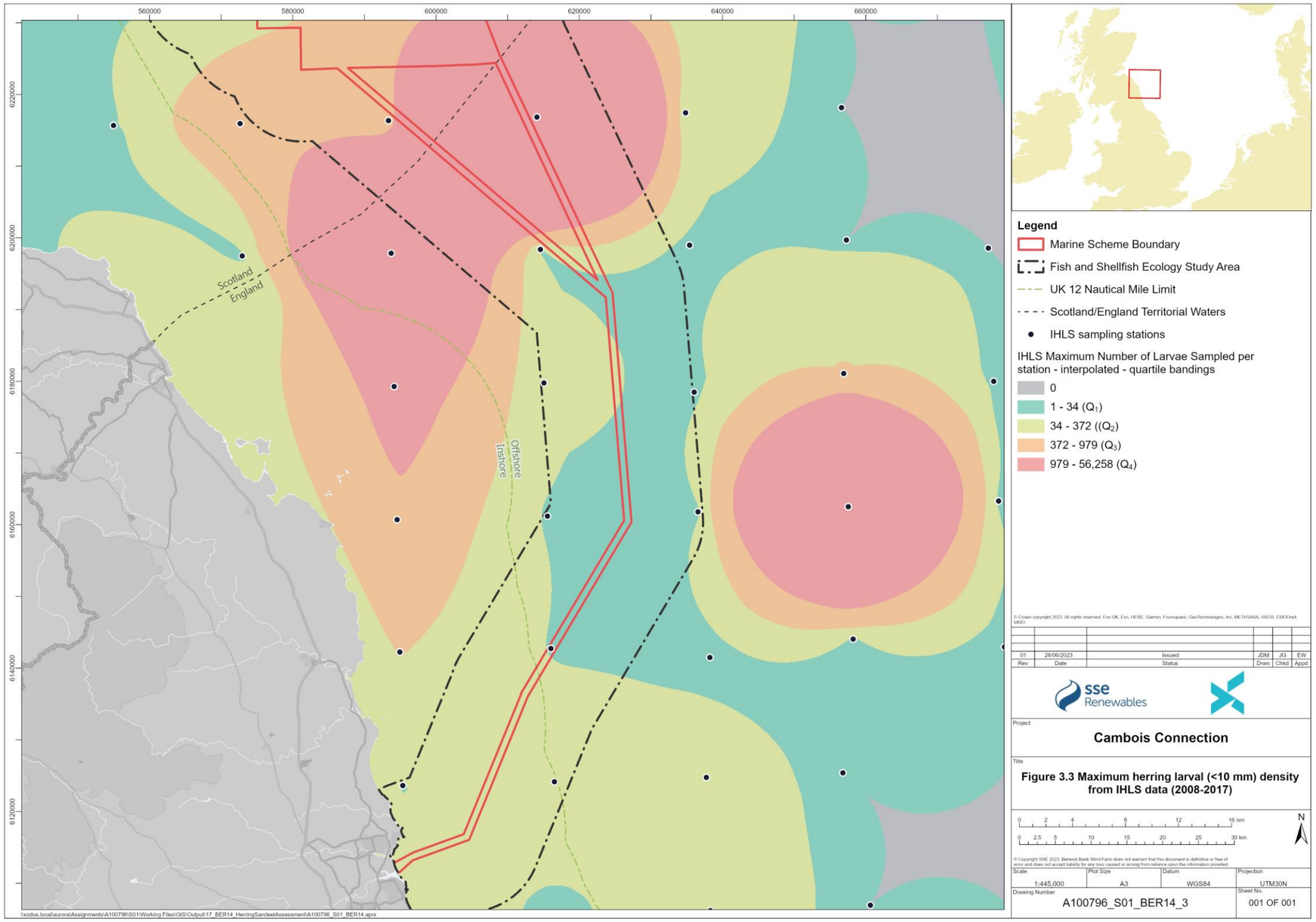

Figure 3.3 Maximum herring larval (<10 mm) density from IHLS data (2008-2017)

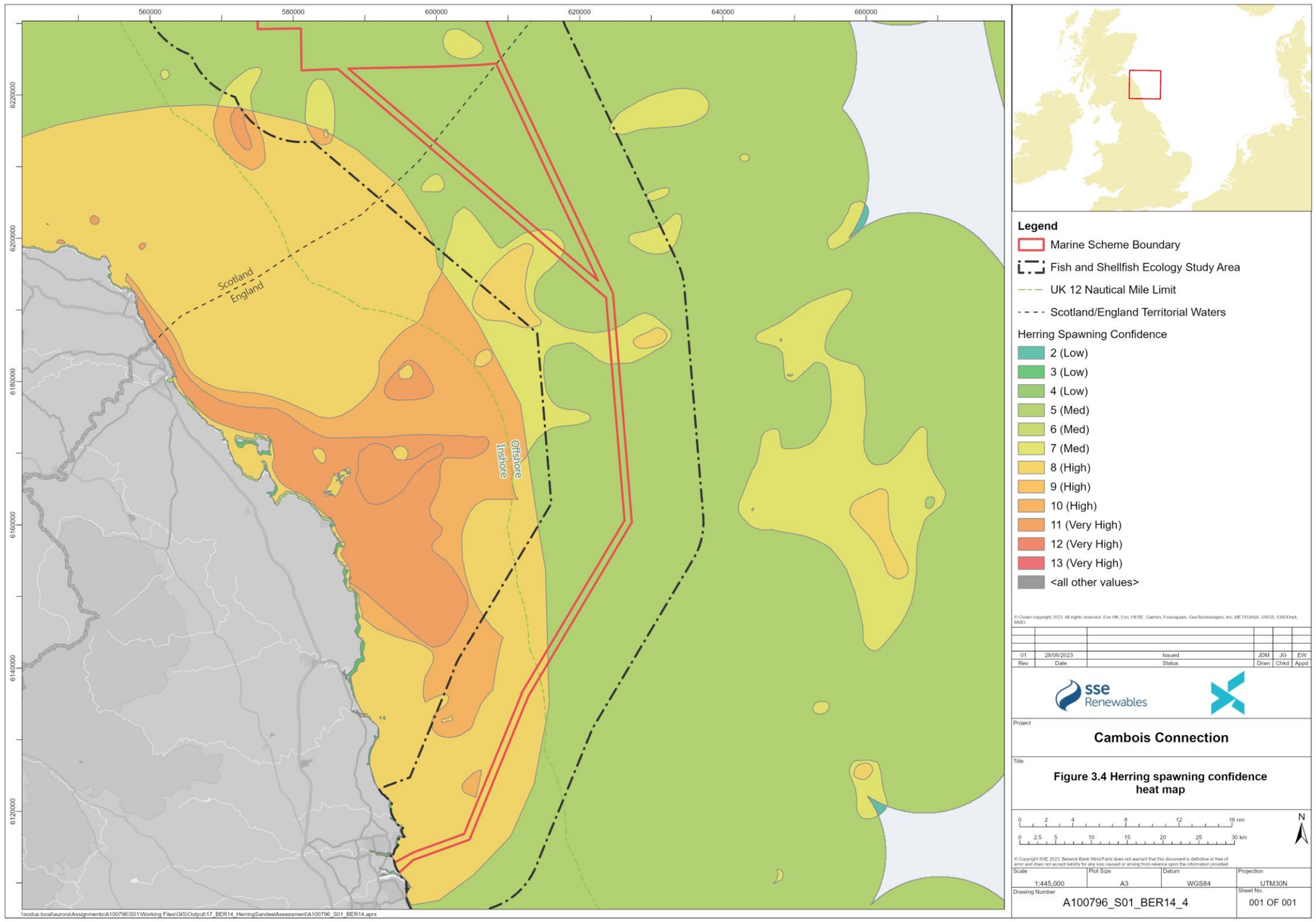

Figure 3.4 Herring spawning confidence heat map

4. Sandeel Habitat Suitability Assessment

4.1. Data Layer Overview

29. Sandeel are seabed dependent for most of their life cycle, with the greatest association with the seabed during winter hibernation when sandeels remain inactive within their burrows for extended periods of time as a response to reduced prey availability, day length and temperature (Van Deurs *et al.,* 2010). Sandeel are also dependent on specific seabed habitats for spawning and lay demersal eggs on substrates with a low silt content between November and February. The majority of the Marine Scheme in English waters overlaps with low intensity sandeel spawning grounds and spawning occurs between November and February (Coull *et al.*, 1998; Ellis *et al.*, 2012).

30. Table 4.1 and Figure 4.1 outline the sandeel habitat classifications derived from publicly available BGS sediment data in accordance with the MarineSpace (2013b) guidance. The majority of the study area is categorised as 'Preferred' sandeel habitat (i.e. Gravelly Sand, slightly gravelly Sand and Sand), mostly distributed in the north of the Marine Scheme in English waters. There is a decreasing preference for sandeel habitat in the south of the study area which contains mostly 'unsuitable' sandeel habitat with a patchy distribution of 'preferred' sandeel habitat.

Table 4.1 BGS sediment data: habitat classification

Classification	Area (km^2)	Percentage of study area (%)
Preferred	4,295.4	77.3
Marginal	129.8	2.3
Other / unsuitable	1,129.4	20.3
Total Area	5,554.6	100.0

31. At only five sample locations, the assigned Folk (1954) classifications derived from the site-specific PSA data (Volume 3, Appendix 8.1: Phase 1 and Phase 2 Benthic Reporting) were considered to represent 'preferred' sandeel habitat (three Sand, one slightly gravelly Sand and one gravelly Sand) and only one sampling location was considered to represent 'marginal' sandeel habitat (sandy Gravel). The Folk (1954) classifications at all other sampling locations were deemed 'unsuitable' for sandeel.

32. The potential for sandeel habitat has been further examined using the site-specific PSA data and the methodology devised by Latto *et al.* (2013), as described in section 2.2 (Figure 4.1). The PSA data demonstrates that the majority of the grab samples taken within the Marine Scheme Offshore Export Cable Corridor in English waters contained > 10 % mud, and are therefore, deemed unsuitable sandeel habitat according to the Latto *et al*. (2013) criteria. None of the grab samples contained <1% muds and therefore none were assigned as 'prime habitat (preferred)'. At seven sample locations, the sediment was considered to be 'suitable habitat (marginal)' for sandeel with <10% muds and >50% sand. These samples were located in areas of seabed with a higher proportion of sand and lower proportion of mud, either within English territorial waters on the approach to the cable Landfall or in areas of seabed further offshore, close to the England – Scotland border.

33. The PSA data has been compared against the BGS data to identify any discrepancies between these two datasets. The BGS data indicates a prevalence of the 'preferred' gravelly Sand, slightly Gravelly Sand and Sand sediments in the north of the Marine Scheme in English waters, whereas the PSA data indicates a higher proportion of mud in the majority of sample locations. Therefore, it is possible that the BGS sediment data alone over-represents the suitability for sandeel habitat in this area. Contrary to this, on the approach to the Landfall, the PSA data indicates the potential presence of 'marginal' sandeel habitat that is not reflected in the BGS sediment data.

34. An additional data source which has been used to further understand the potential for sandeel habitat is the recent sandeel distribution model produced by Langton *et al*. (2021), which predicts the density and probability of sandeel burrows based on environmental variables including sediment data, slope and depth (see Volume 4, Figure 9.6: Sandeel spawning). This data source has not been used for heat mapping but has been compared against the classification of 'preferred' and 'marginal' habitats from the BGS sediment data and the PSA data. Across the majority of the study area, the buried sandeel density and probability of presence is low. Areas associated with a higher probability of buried sandeel presence are located in the north of the study area towards the Scotland – England border, aligning with the areas of seabed of a higher sand and lower mud content identified through the PSA analysis. The areas of 'marginal' sandeel habitat identified through the PSA data on the approach to the Landfall are not reflected in this dataset.

35. Average VMS value (2017-2020) for demersal fishing gears is displayed in Figure 4.2. In general, the average VMS value (2017 – 2020) is concentrated in the south of the study area (described in further detail in Volume 2, Chapter 12: Commercial Fisheries). The VMS data cannot be interrogated by species, and as discussed in Volume 2, Chapter 12: Commercial Fisheries, *Nephrops norvegicus* account for the majority of landings values (2015 – 2019) by demersal fishing gears in the commercial fisheries study area. It is also important to note that fishing for sandeels is prohibited across the much of the study area with the exception of the most southerly sections of the Marine Scheme Offshore Export Cable Corridor in English waters, overlapping ICES rectangles 39E8 and 40E9[2] (Volume 4, Figure 12.15: Fishing Restricted Areas). Therefore, VMS data may over-represent sandeel spawning / burrowing activity in the study area.

4.2. Extent of Interaction with Potential Sandeel Habitat

36. In accordance with MarineSpace (2013b), a heat map has been produced to categorise areas of the study area as being of 'low', 'medium', 'high' and 'very high' sandeel habitat confidence. The heat map shows the sum of the confidence scores assigned to each individual data layer screened into the assessment (discussed in section 2.2).

37. The spatial extents of the sandeel habitat confidence values (i.e. heat categories) within the study area are outlined in Table 4.2. The majority of the study area is assessed to be of 'medium' (46.2%) or 'high' (40.5%) heat with 9.4% assessed as 'very high' heat. The distribution of very high corresponding to areas overlapping with Coull *et al*. (1998) sandeel spawning grounds, 'preferred' sandeel habitat determined from the BGS sediment data, and VMS activity by demersal trawling. The areas of higher confidence are distributed in the central and northern sections of the study area with the areas of 'very high' heat in the central area being associated with VMS activity by demersal trawling which is not as prevalent in the north.

[2] In the UK, fisheries data are collected and analysed based on ICES statistical rectangles which are approximately 900 m^2 (30° latitude by 1° longitude). The Marine Scheme Offshore Export Cable Corridor overlaps with ICES rectangles 39E8, 40E8 and 40E9 in English waters.

Table 4.2 Sandeel habitat suitability area values

Category	'Heat' (confidence) score	Area (km^2)	Percentage of study area (%)
No potential	0	26.4	0.5
Low	2	187.9	3.4
Low	3	1.9	0.04
Medium	4	1,548.8	27.9
Medium	5	1,016.4	18.3
High	6	35.1	0.6
High	7	2,214.0	39.9
Very High	9	524.1	9.4
Total	n/a	5,554.6	100.0

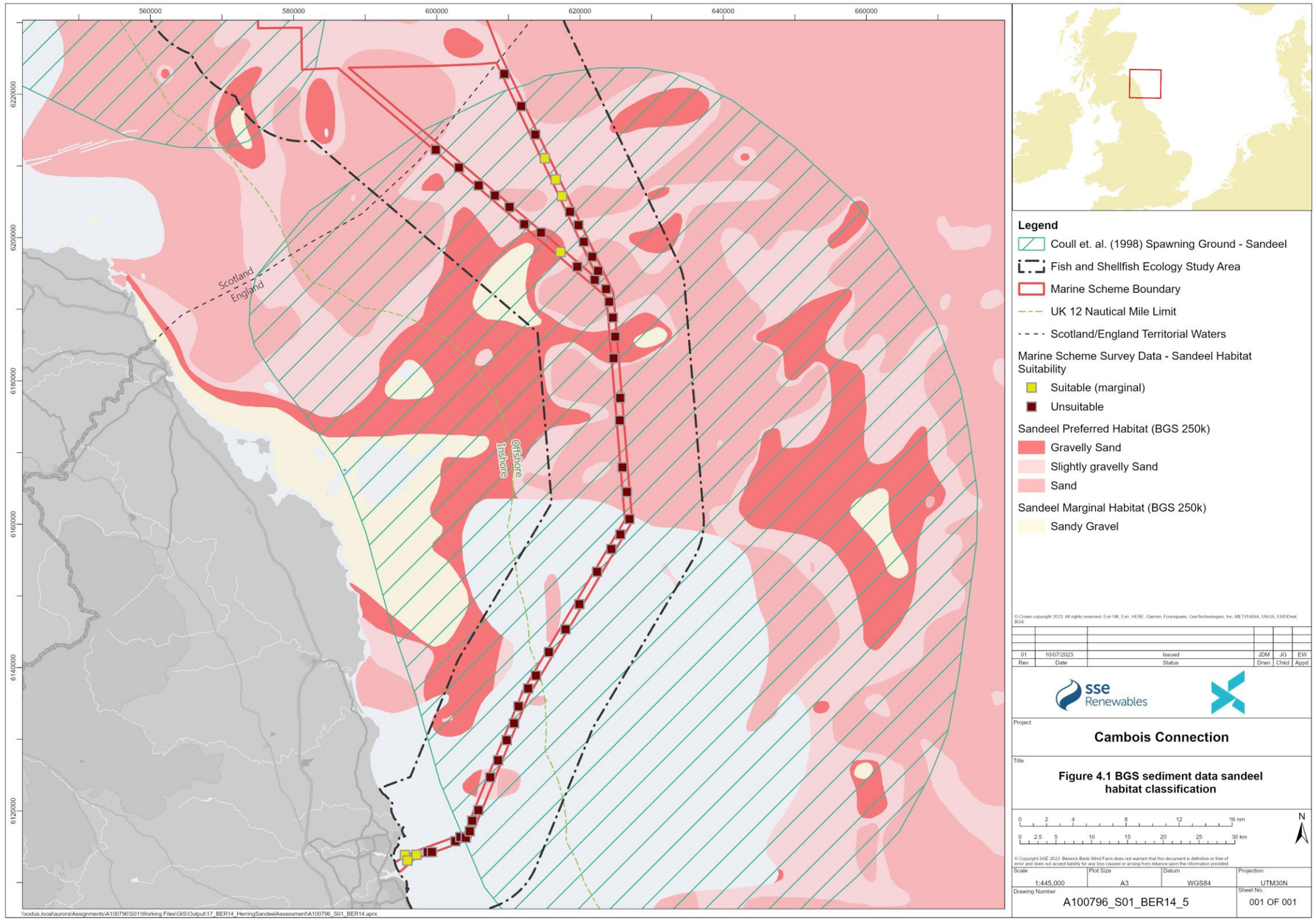

Figure 4.1 BGS sediment data sandeel habitat classification

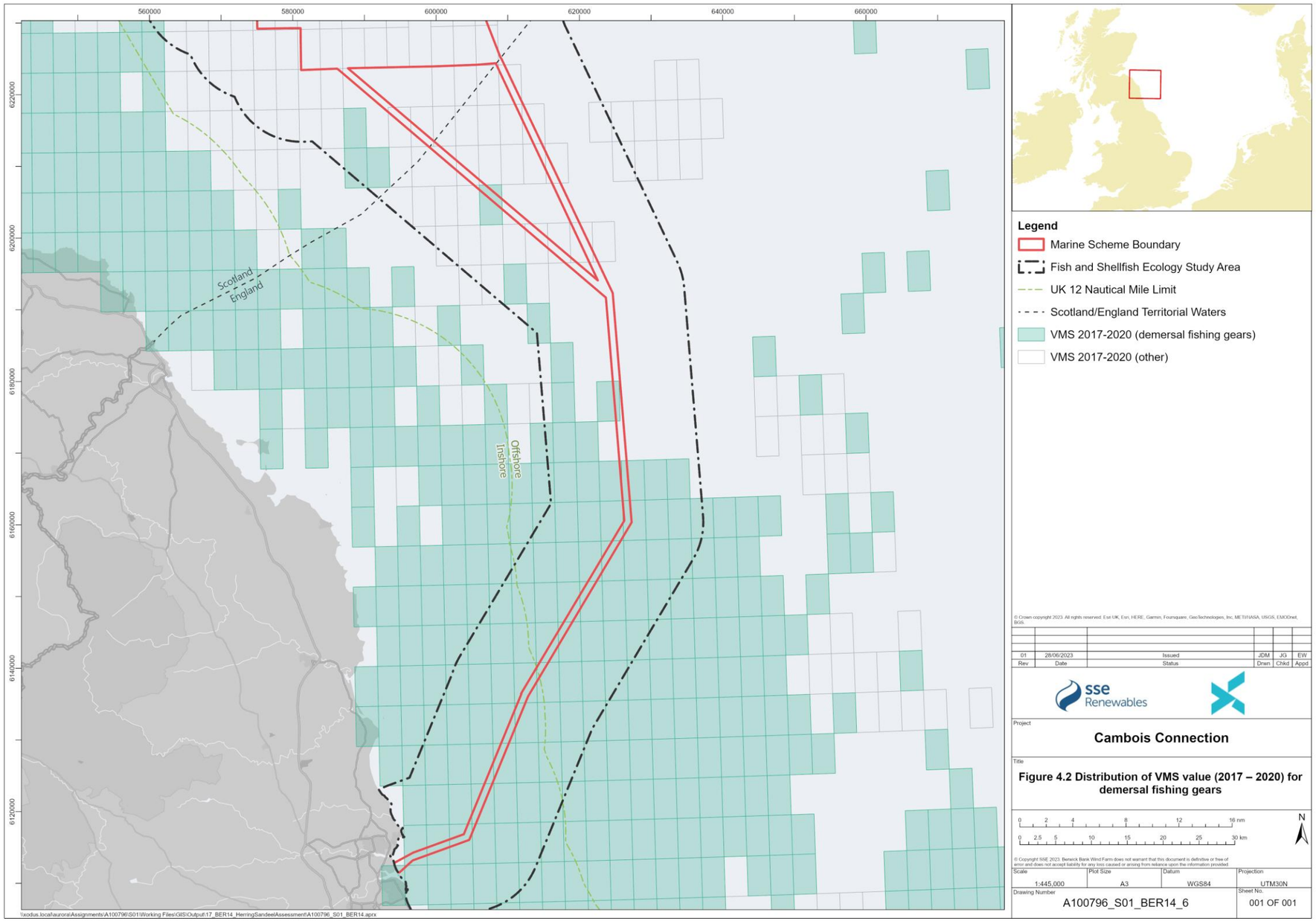

Figure 4.2 Distribution of VMS value (2017 – 2020) for demersal fishing gears

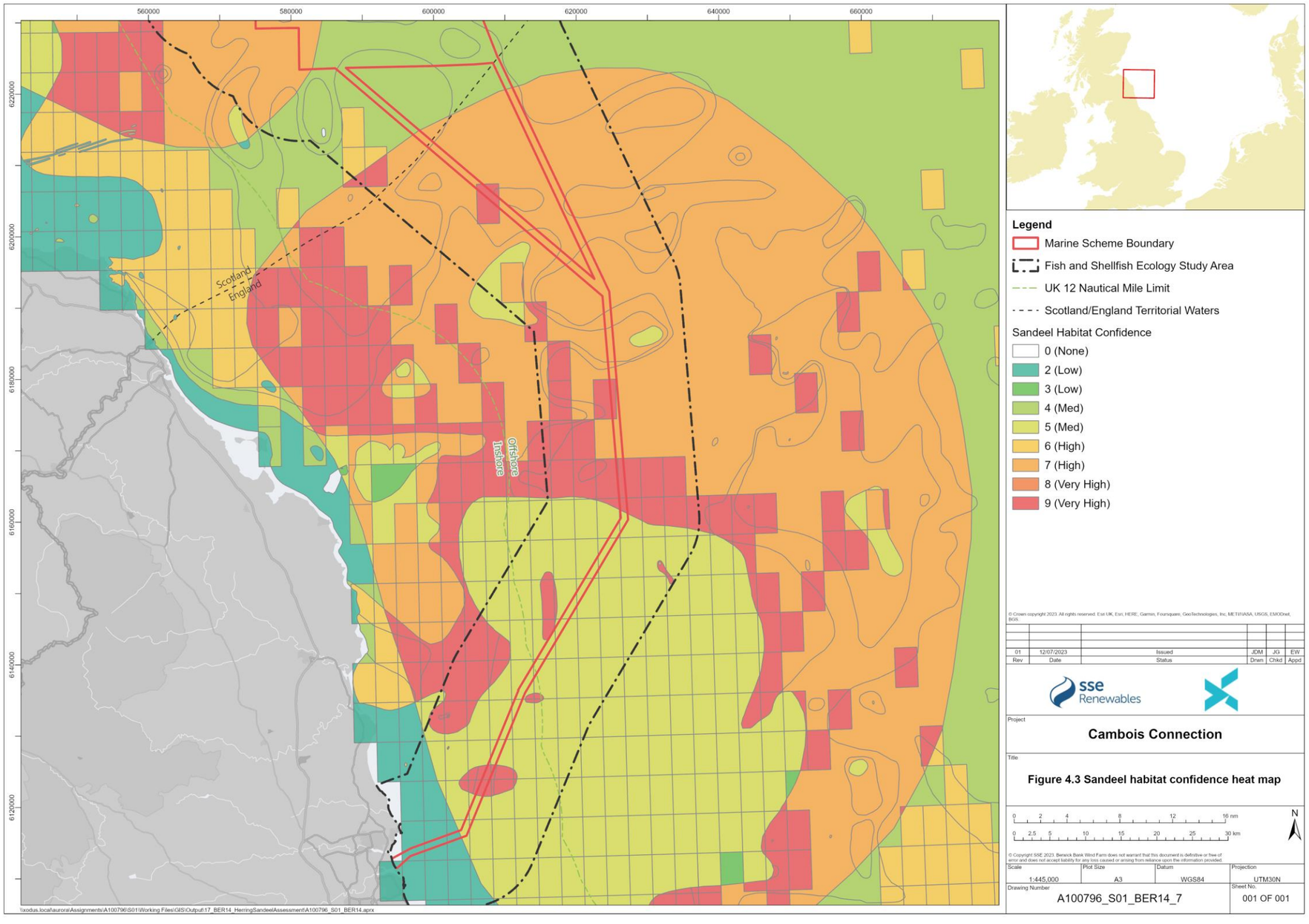

Figure 4.3 Sandeel habitat confidence heat map

5. Conclusions

5.1. Herring

38. The heat map, produced by summing the confidence scores assigned to each individual data layer, shows areas of 'very high' and 'high' heat over a small proportion of the study area (~1.7%) with the majority of the study area being assessed as 'medium' heat for herring spawning. The key drivers behind the distribution of confidence values (i.e. heat) are the overlap with Coull *et al.* (1998) herring spawning grounds and 'preferred' herring spawning habitat determined from the BGS sediment data.

39. A comparison of the BGS and PSA data indicated that both of these datasets reflect a low suitability of the sediments within the Marine Scheme in English waters for herring spawning. Slight discrepancies between the datasets were identified (e.g. areas where the PSA data indicate a 'prime (preferred)' herring spawning habitat that is not reflected in the BGS sediment data). However, this was only identified at one location and is not considered to alter the overall conclusions of this report.

40. Overall, the Marine Scheme is considered to overlap with a small extent of herring spawning grounds in the context of the wider distribution of suitable habitats in the North Sea.

5.2. Sandeel

41. The heat map for sandeel habitat shows that Marine Scheme Offshore Export Cable Corridor in English waters mostly overlaps areas of 'medium' or 'high' heat, with increasing confidence (i.e. heat) in the north of the study area. The key drivers behind the distribution of the heat map are the overlap with Coull *et al.* (1998) sandeel spawning grounds, 'preferred' sandeel habitat determined from the BGS sediment data, and VMS activity by demersal trawling. However, it is important to highlight once more that demersal trawlers within the region mainly target *Nephrops*, and therefore, these 'very high' heat areas may over-represent sandeel spawning and burrowing activity.

42. Some slight discrepancies were identified between the PSA and BGS sediment data, indicating that the BGS sediment data may over-represent 'preferred' sandeel habitat in the north of the study area where the PSA data identified proportions of mud higher than those preferred by sandeel. On the contrary, the PSA data showed potential 'suitable (marginal)' sandeel habitat in the sandy sediments on the approach to the Landfall that was not reflected in the BGS sediment data, indicating that the BGS sediment data may under-represent the suitability for sandeel habitat in this location. Overall, on balance, these discrepancies are not considered to alter the overall conclusions of this Report.

43. Overall, the Marine Scheme Offshore Export Cable Corridor in English waters is considered to overlap with a small extent of sandeel habitat in the context of the wider distribution of suitable habitats in the North Sea.

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