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Offshore seabed survey of the Fladen Grounds Scottish possible MPAs

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Executive Summary

In the formal advice submitted by SNH and JNCC to Scottish Government, three Scottish nature conservation Marine Protected Areas (MPAs) were proposed in the Fladen Grounds area. Central Fladen was proposed for the 'burrowed mud' MPA search feature, and Western and South East Fladen were proposed as science based alternatives for the representation of the 'seapens and burrowing megafauna in circalittoral fine mud' component of the 'burrowed mud' habitat. All three possible MPAs (pMPAs) were assessed as being of equivalent ecological value for this feature. Central Fladen, however, was assessed as making a better contribution to the MPA network, as it was the only known location for the tall sea pen (*Funiculina quadrangularis*), which is a component species of the 'burrowed mud' MPA search feature off the east coast of Scotland. JNCC concluded that representation of the 'burrowed mud' search feature could be achieved either by taking forward the Central Fladen pMPA in its entirety; or by taking forward just the southern part of the Central Fladen pMPA (Central Fladen (core)), containing the tall sea pen. In addition, one of the two alternative locations, Western or South East Fladen pMPA, would be taken forward for the 'seapens and burrowing megafauna in circalittoral fine mud' component habitat.

This report presents the findings from analyses of the acoustic data and groundtruth samples gathered during the seabed survey of the Fladen Grounds pMPAs during January, 2013. The main aim of this survey was to confirm the presence of Priority Marine Features, namely 'burrowed mud' and its component habitats and species, within the pMPAs and provide evidence to allow comparison of benthic assemblages between the sites.

The Fladen Grounds pMPAs are located within a muddy sand and sandy mud sediment plain in the Northern North Sea, approximately 80 nautical miles east of Orkney. Western Fladen and Central Fladen comprise sub-glacial tunnel valleys, classified as the 'Fladen Deeps Key Geodiversity Area of the Quaternary of Scotland Block'. The South East Fladen includes the 'Scanner-Scotia-Challenger pockmark complex key geodiversity area', which is located within the Scanner Pockmark site of community importance (SCI).

Due to the size of the area of interest, and the potential costs associated, it was not feasible to collect full coverage multibeam echosounder data (bathymetry and backscatter) across the entire area. Acoustic data were collected during transits between ground truthing stations at all pMPAs, with two additional areas (measuring approximately 8km x 4km) located within and outside the Central Fladen (core) pMPA surveyed with 100% multibeam coverage, in an attempt to better define the distribution of *F. quadrangularis*. Multibeam bathymetry and backscatter data, along with data collected from 166 benthic grab samples, 70 video tows and 1070 still images, were used to create broadscale habitat maps and biotope point distribution maps of each pMPA.

The results of this survey showed that the Fladen Grounds pMPAs are dominated by the broadscale habitat, 'subtidal mud'. Only Central Fladen pMPA and Central Fladen (core) showed any heterogeneity in terms of broadscale habitat. A deep tunnel valley was observed in the multibeam bathymetry data at Central Fladen pMPA; with the deepest point recorded to be at 293m below chart datum. The tunnel valley was characterised by coarser sediment ('subtidal mixed sediments') and as such was characterised by a significantly different infaunal community to the surrounding area. At the edge of the valley, nearing the shallowest region of the Central Fladen pMPA, the southeastern tip was found to comprise 'subtidal sands'.

The MPA search feature *Funiculina quadrangularis*, or tall seapen, was only found within Central Fladen (core) and in an area on transit to the Western Fladen pMPA. The 'burrowed

mud' MPA search feature was found across all pMPAs, as was the component habitat 'seapens and burrowing megafauna in circalittoral fine mud'. Although the South East Fladen pMPA showed evidence of recent trawling activity, it did not differ from the other pMPAs in terms of seapen (*Pennatula phosphorea* and *Virgularia mirabilis*) distribution. Epifaunal differences between the South East Fladen and the other two pMPAs were mainly due to the absence of the anemone *Bolocera tuediae* and associated shrimp *Spirontocaris liljeborgii,* along with fewer mud encrusted polychaete tubes. Infaunal differences were due to the increased presence of species such as the bivalve *Thyasira equalis* and the polychaete *Heteromastus filiformis,* which prefer the muddier sediments found within the South East Fladen pMPA.

Two MPA search feature species, *Arctica islandica* and *Maera loveni,* were present in low abundances within all pMPAs. However, adult *A. islandica* were only found within the Central Fladen pMPA.

A summary of the SMPA search features proposed for protection, broadscale habitats and biotopes recorded at the Fladen Grounds pMPAs are presented below:

pMPA	SMPA search feature	Component habitat/species	Biotopes	Broadscale habitats
Central Fladen	Burrowed mud	Sea pens and burrowing megafauna in circalittoral fine mud*	A5.361*	Subtidal mud
		Tall seapen *Funiculina quadrangularis* (Central Fladen (core) only)	A5.3611*	
	Offshore deep sea muds	*Paramphinome jeffreysii*, *Thyasira* spp. and *Amphiura filiformis* in offshore circalittoral sandy mud	A5.37 A5.376	
			A5.441* A5.45 A5.2	Subtidal mixed sediments Subtidal sand
South East Fladen	Burrowed mud	Sea pens and burrowing megafauna in circalittoral fine mud	A5.361*	Subtidal mud
	Offshore deep sea muds	*Paramphinome jeffreysii*, *Thyasira* spp. and *Amphiura filiformis* in offshore circalittoral sandy mud	A5.37 A5.376	
Western Fladen	Burrowed mud	Sea pens and burrowing megafauna in circalittoral fine mud	A5.361*	Subtidal mud
	Offshore deep sea muds	*Paramphinome jeffreysii*, *Thyasira* spp. and *Amphiura filiformis* in offshore circalittoral sandy mud	A5.37 A5.376	

* deep circalittoral variant of the biotope.

The findings of this survey, based on acoustic and groundtruth data, were considered to provide sufficient additional evidence of the ‘burrowed mud’ MPA search features in the Fladen Grounds pMPAs to support designation of one or more of the pMPAs in offshore Scottish waters.

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1 Background

In the formal advice submitted by Scottish Natural Heritage (SNH) and the Joint Nature Conservation Committee (JNCC) to Scottish Government (SNH & JNCC 2012), three Nature Conservation Marine Protected Areas (MPAs) have been proposed in the Fladen Grounds broad search area, to represent the 'burrowed mud' MPA search feature away from the Scottish coast in OSPAR Region II. These include Central Fladen, Western Fladen and South East Fladen. The latter two have been proposed as science-based alternatives for representation of the 'seapens and burrowing megafauna in circalittoral fine mud' component habitat of the 'burrowed mud' MPA search feature. These areas, along with other areas proposed in Scottish waters by SNH and JNCC are now subject to public consultation, and have been termed possible MPAs (pMPAs) until such time as they may be designated.

All three pMPAs in the Fladen Grounds have been assessed by the Scottish MPA (SMPA) project team as being of equivalent ecological value for the 'burrowed mud' MPA search feature. However, Central Fladen pMPA has been assessed as making a better contribution to the network, as it is the only known location for the tall sea pen (*Funiculina quadrangularis*), a component species of the 'burrowed mud' MPA search feature. The JNCC concluded that representation of the 'burrowed mud' search feature could be achieved either by taking forward the Central Fladen pMPA in its entirety; or by taking forward just the southern part of the Central Fladen pMPA (Central Fladen (core)), known to contain the tall sea pen, together with one of the two alternative locations; either Western or South East Fladen pMPA for the 'seapens and burrowing megafauna' component habitat (see Appendix 1 and 2 for a full list of MPA search features in Scottish offshore waters).

Each of the pMPAs also includes marine geodiversity features recommended for protection within the Fladen Grounds. Central and Western Fladen pMPAs contain sub-glacial tunnel valleys representative of the Fladen Deeps Key Geodiversity Area. South East Fladen pMPA includes the geologically important Scanner-Scotia-Challenger pockmark complex. These 'pockmarks' or craters are formed by methane seeping from the seafloor and have unique communities associated with them. The pockmark features may also contain the Annex I habitat 'Submarine structures made by leaking gases' (methane derived authigenic carbonate (MDAC)) (see Appendix 3 for a full list of Annex I habitats).

The overall conservation aims are to conserve the proposed protected features within the possible MPAs. However, there was insufficient evidence to confirm that the features were in good condition.

Therefore, a dedicated acoustic and groudtruthing survey was undertaken by Cefas and the JNCC in January 2013 at the three Fladen Grounds pMPAs with the aims of:

1. Gathering high quality evidence to confirm the presence of the Priority Marine Features and MPA Search Features recommended for protection within the pMPAs.

2. Verifying the presence of tall sea pen within the Central Fladen pMPA.

3. Gathering sufficient groundtruth data to allow comparison of benthic assemblages between the sites, and qualitative comparison of benthic assemblages within and outside the pMPAs, to aid in site selection.

4. Recording any incidental evidence of anthropogenic activity (e.g. trawl scars).

Full survey details can be found in the survey report (Vanstaen 2013). This report delivers the findings from analyses of the data collected during the survey.

2 Introduction

2.1 Geological Context

The Fladen Grounds pMPAs are located within a muddy sand and sandy mud sediment plain in the Northern North Sea, approximately 80 nautical miles east of Orkney (JNCC–Cefas 2013) (Figure 1).

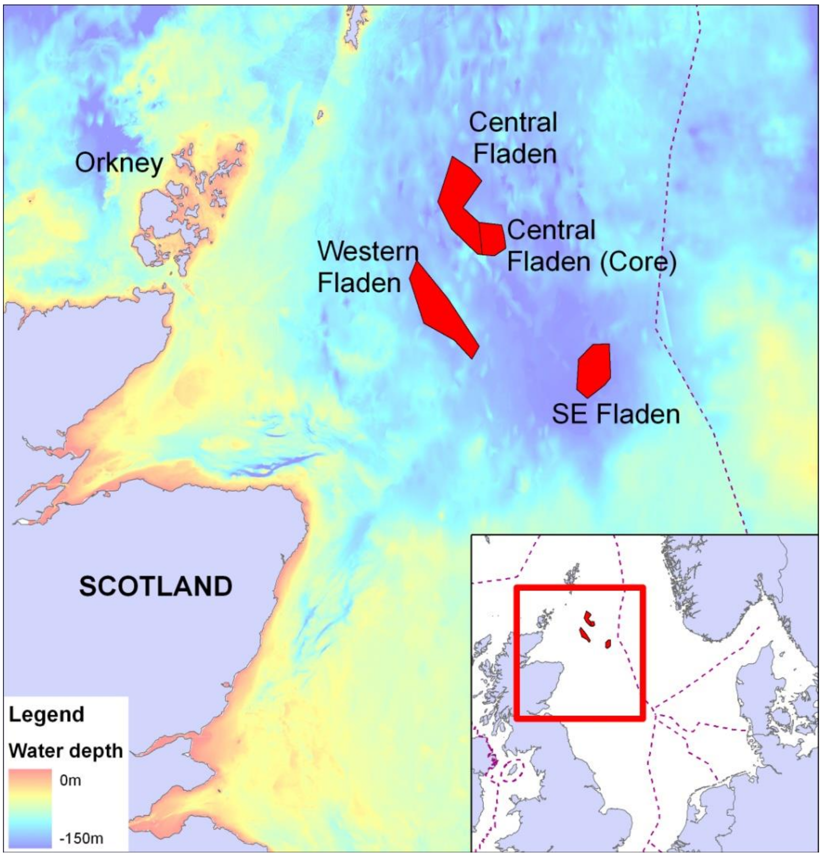

Figure 1: Location of the Fladen Grounds pMPAs.

Western Fladen and Central Fladen comprise sub-glacial tunnel valleys, classified as the Fladen Deeps Key Geodiversity Area of the Quaternary of Scotland Block[1,2]. The Fladen Deeps, also known as 'The Holes', are a series of large-scale tunnels that may reach a depth of 150m, and be 4km wide and 40km long; they have most likely been formed by pressurised melt-water flowing beneath the ice sheet (JNCC–Cefas 2013). The tunnels usually have a U-shaped cross section and therefore the slopes may be larger than about 20º (Jansen 1976). The valleys have an undulating thalweg (deepest part), without a one-directional valley gradient; furthermore, their ends stop abruptly without channel-like continuations (Jansen 1976).

The South East Fladen includes the Scanner-Scotia-Challenger pockmark complex key geodiversity area[3], which is located within the Scanner Pockmark site of community importance (SCI). A seabed survey of the Scanner Pockmark SCI was recently undertaken by Cefas and the JNCC to gather additional evidence to support the development of fisheries management measures under the Common Fisheries Policy (CFP). Findings from

[1] http://jncc.defra.gov.uk/page-6492
[2] http://jncc.defra.gov.uk/page-6476
[3] http://jncc.defra.gov.uk/page-6487

the analyses of the data gathered during the survey can be found in Rance *et al* (2013). Further information on the formation of pockmarks is detailed in Appendix 4.

According to BGS sheet 57N 00 ‘Forties’ (BGS 1989), the solid geology within the Fladen Grounds is represented by undifferentiated Eocene to Pliocene rocks that consist of interbedded siliciclastic argillaceous rocks and sandstones. These formations are covered by late Pleistocene and Holocene deposits which, in order of age, are Older Ridge Deposits, the Hills Deposits, the Fladen Deposits and the Witch Deposits (Jansen *et al* 1979). The Older Ridge Deposits and the Hills Deposits are interpreted as morainic deposits and sediments of the proglacial and glaciomarine environment. The subglacial excavation of tunnel valleys is hypothesised to have occurred, in part, simultaneously with the deposition of the glaciomarine Fladen Deposits (consisting of sandy clay) (Jansen *et al* 1979). At the boundary between the Fladen Deposits and the overlying Witch Deposits, a coastal erosion mark was found, indicating a relative North Sea level of 109-114m below the present one (Jansen *et al* 1979). The marine Witch Deposits were deposited during the postglacial sea level rise and are covered by a veneer of fine Holocene sand (Jansen *et al* 1979).
A summary of marine geodiversity features recommended for protection within the Fladen Grounds pMPAs are listed in Table 1 below:

Table 1: Marine geodiversity features recommended for protection within the Fladen Grounds pMPAs

pMPA	Marine geodiversity features
Central Fladen	Fladen Deeps Key Geodiversity Area - Quaternary of Scotland Block (Sub-glacial tunnel valleys)
South East Fladen	Scanner-Scotia-Challenger pockmark complex key geodiversity area (Seabed Fluid and Gas Seep block - pockmarks)
Western Fladen	Fladen Deeps Key Geodiversity Area - Quaternary of Scotland (Sub-glacial tunnel valleys)

2.2 Biological context

The component habitat, ‘seapens and burrowing megafauna in circalittoral fine mud’, of the ‘burrowed mud’ MPA search feature was proposed for protection at all three Fladen Ground pMPAs (with the exception of a small patch of sand and gravel habitat at the south-east tip of the Central Fladen pMPA). This was based on historical evidence gathered during the MPA assessment process. The southern part of the Central Fladen pMPA (Central Fladen (core)) was also identified as one of only two recorded areas found off the east coast of Scotland which contained the nationally uncommon seapen species *Funiculina quadrangularis*.

A summary of MPA search features and component habitats/species proposed for protection within the pMPAs are shown in Table 2 below:

Table 2: SMPA search features proposed for protection within the Fladen Grounds pMPAs

pMPA	Size	SMPA Search Feature	Component habitat/species
Central Fladen	925km^2	Burrowed mud	Sea pens and burrowing megafauna in circalittoral fine mud Tall seapen *Funiculina quadrangularis*
South East Fladen	416km^2	Burrowed mud	Sea pens and burrowing megafauna in circalittoral fine mud
Western Fladen	723km^2	Burrowed mud	Sea pens and burrowing megafauna in circalittoral fine mud

3 Survey design and methods

3.1 Existing data and information used to inform survey planning

No dedicated acoustic or groundtruthing surveys for nature conservation purposes have been undertaken in recent years at any of the Fladen Grounds pMPAs. The survey design was therefore informed by the Defra-funded bathymetry data layer (Astrium 2011), the British Geological Survey sediment seabed map (BGS 1989), UKSeaMap 2010 (McBreen *et al* 2011) (Figure 2) and information on the location and density of *Nephrops* burrows and seapens from Marine Scotland Science *Nephrops* stock assessment underwater footage from 2004 to 2010 (Figure 3 to Figure 5).

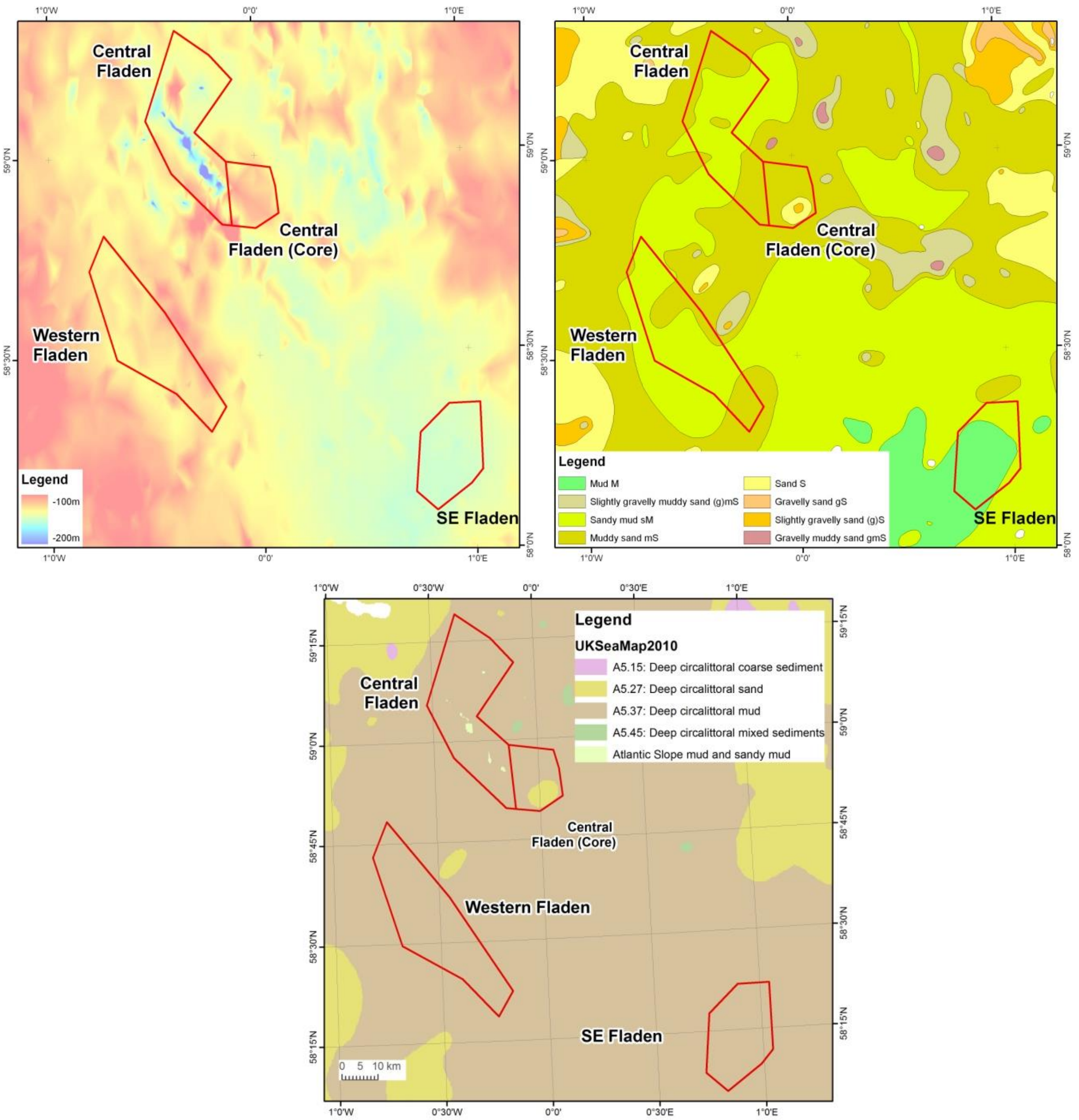

Figure 2: (Top left) Seabed bathymetry of the Fladen Grounds (From Defra DEM model, Astrium); (Top right) Seabed sediment distribution from British Geological Survey map; (Bottom) UKSeaMap 2010 predicted habitat distribution.

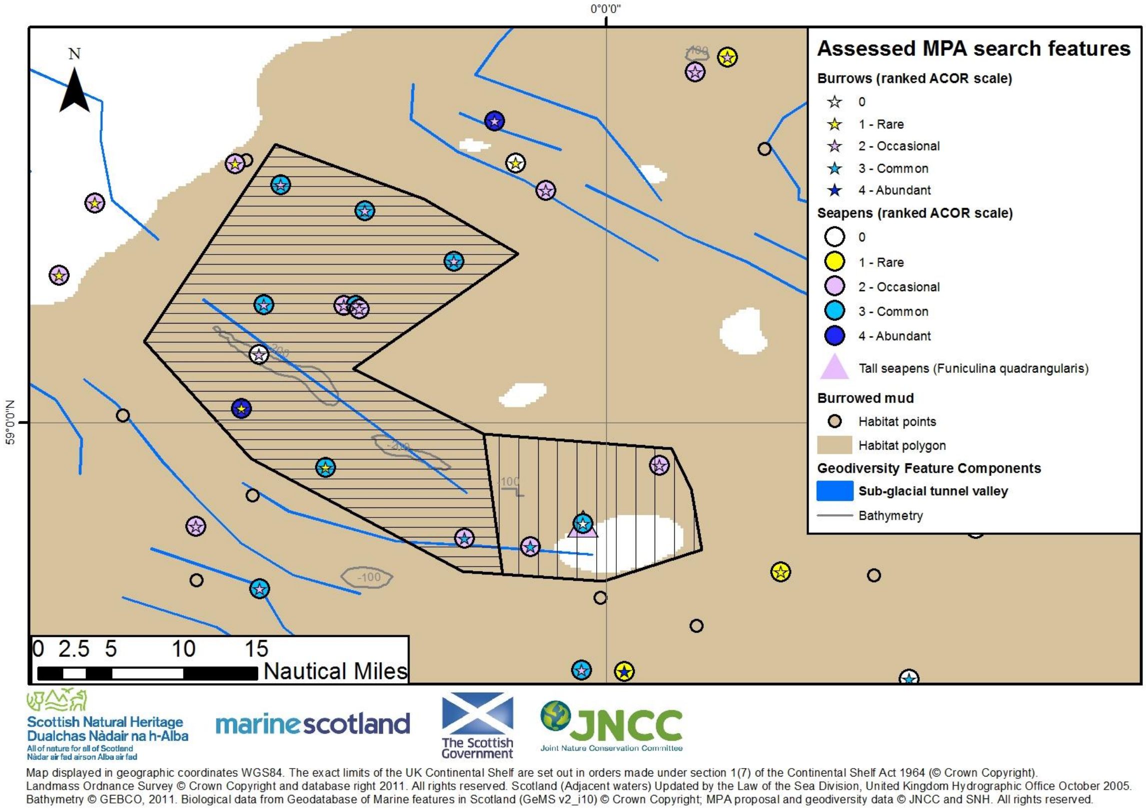

Figure 3: Distribution of geological and biological MPA search feature data (pre-survey) within the Central Fladen pMPA (JNCC-Cefas 2013).

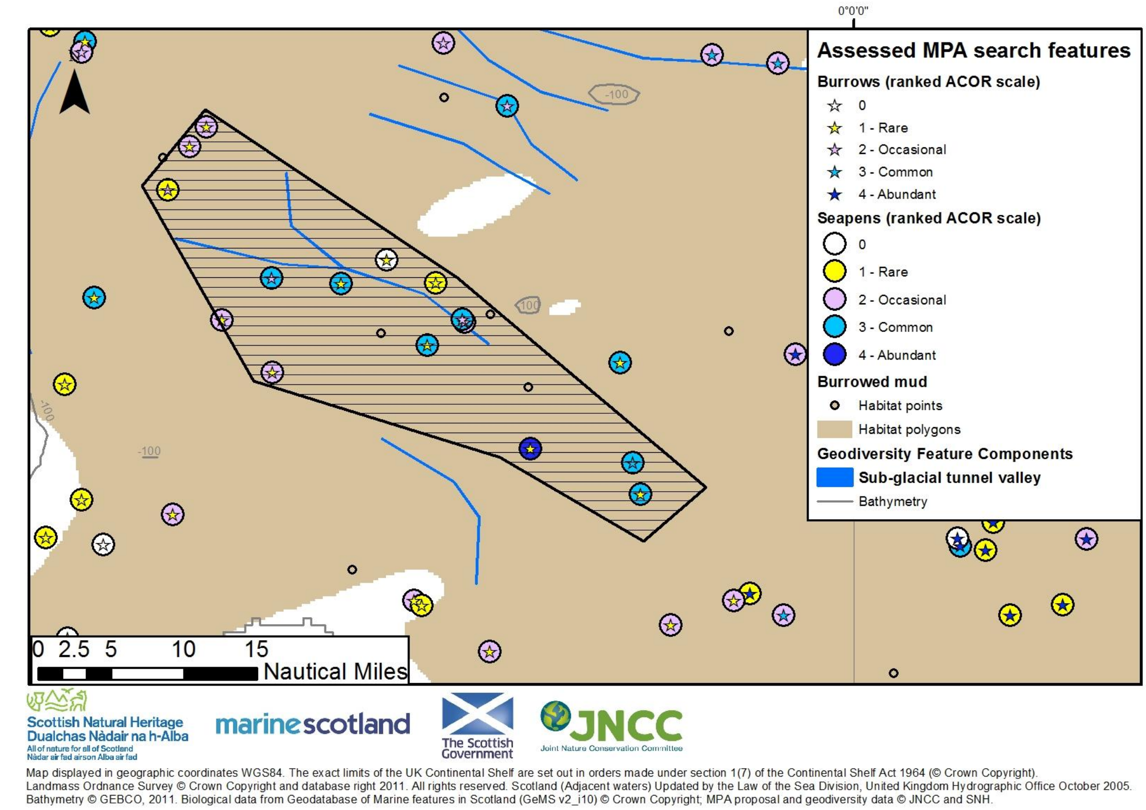

Figure 4: Distribution of geological and biological MPA search feature data (pre-survey) within the Western Fladen pMPA (JNCC-Cefas 2013).

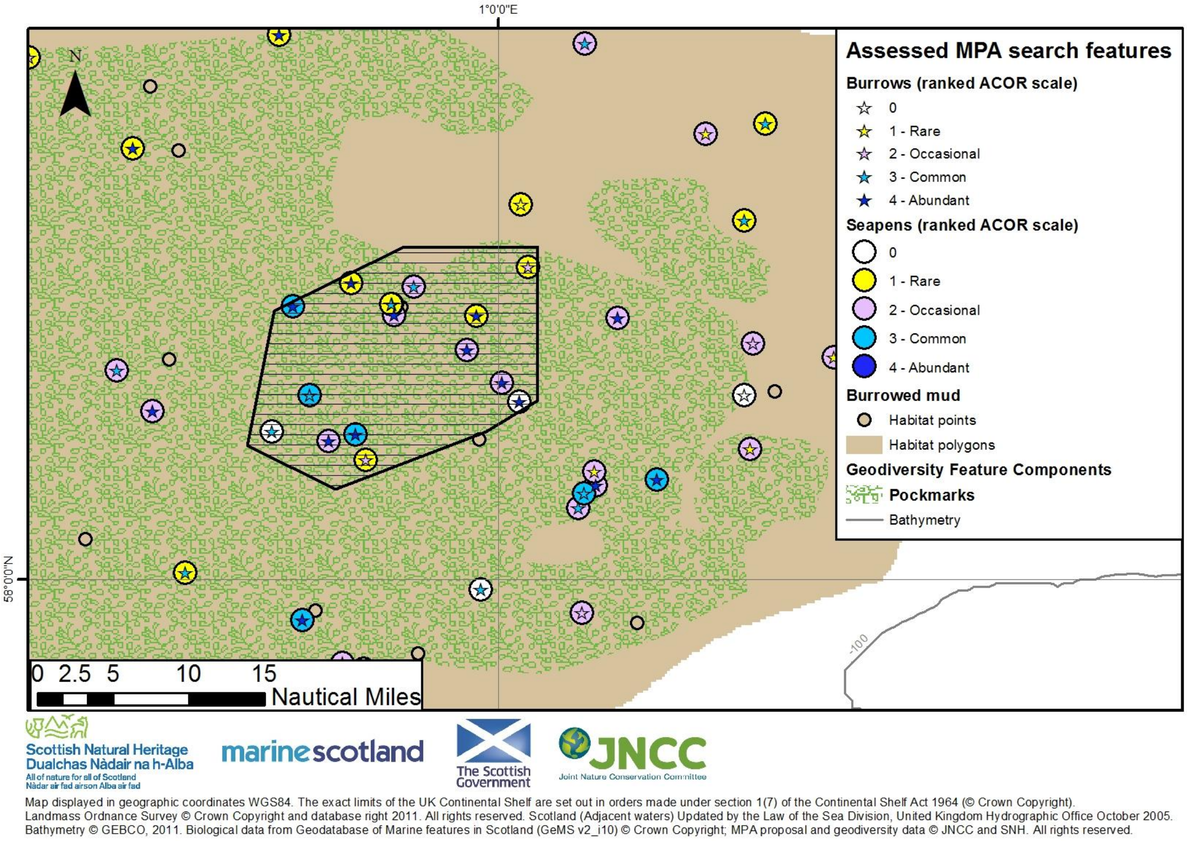

Figure 5: Distribution of geological and biological MPA search feature data (pre-survey) within the SE Fladen pMPA. The map indicates potential areas of fluid seeps (using modelled data) to predict the distribution of pockmarks (JNCC-Cefas 2013).

3.2 Survey Design

Groundtruth station selection was based on a triangular lattice pattern. Stations in the Central Fladen pMPA were placed approximately 8km apart, with two additional stations positioned within the deep valley. Within the Central Fladen (core), stations were placed approximately 4km apart. Stations in the South East Fladen pMPA were also placed approximately 4km apart. Stations in the Western Fladen pMPA were placed 5km apart. In between the three sites, a series of additional stations were visited (transit stations), providing a further 17 sampling stations (Figure 6). The rationale for this was to allow a qualitative comparison of benthic assemblages within and outside the pMPAs.

Multibeam echosounder survey lines were planned to cross through the groundtruth stations in order to develop an overview of bathymetric and backscatter changes across the pMPAs.

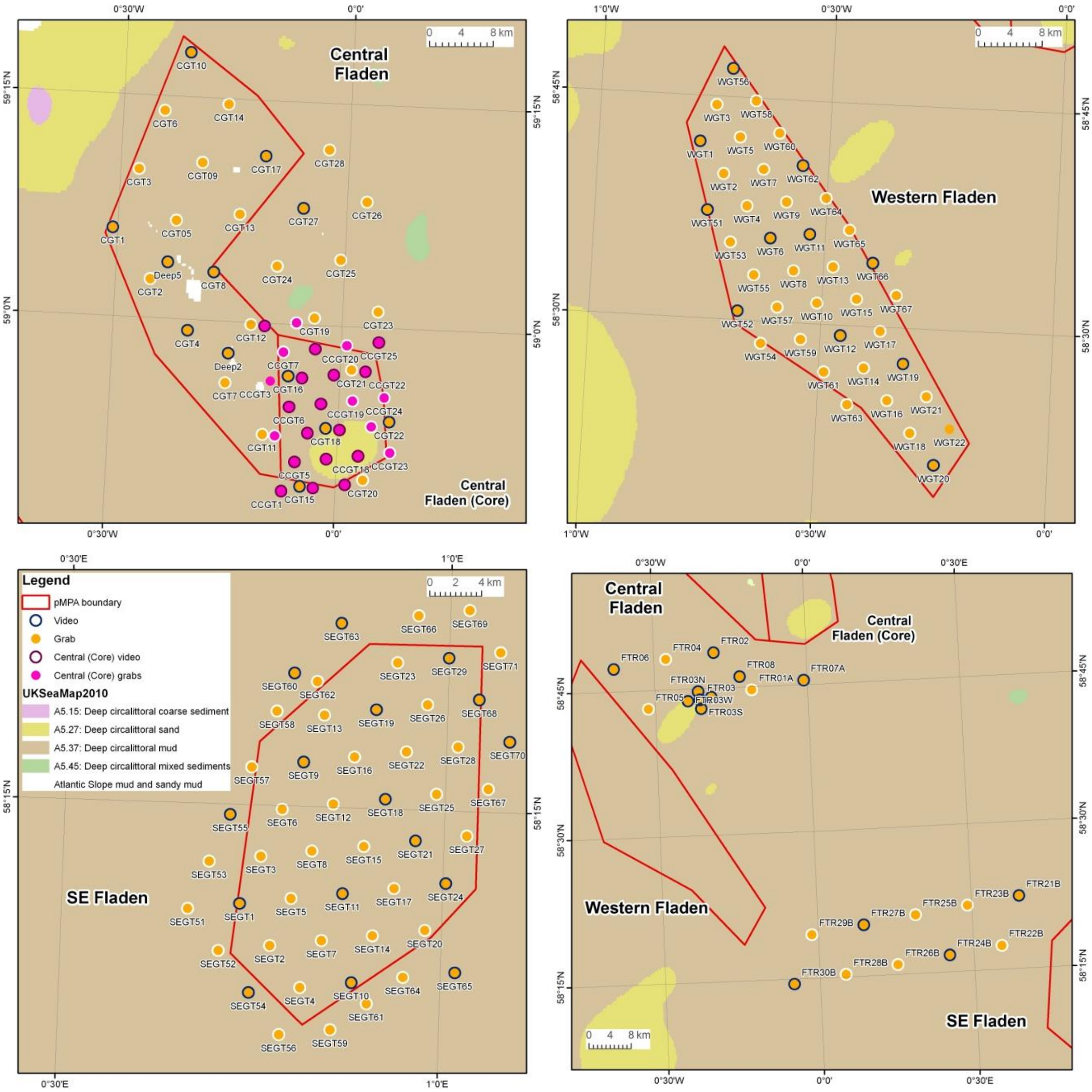

Figure 6: Location of the grab and video stations sampled at the Fladen Grounds pMPAs and at transit stations between (bottom right).

During the survey two smaller/sub-areas (one located within the Central Fladen (core) and one on the transit between Central and Western Fladen pMPAs (Figure 7), measuring approximately 8km x 4km were identified as containing highest abundances of the seapen, *Funiculina quadrangularis.* Grab and video images were taken in both of these areas, along with 100% multibeam bathymetry.

3.3 Acoustic sampling methods

Multibeam bathymetry and backscatter data were acquired using the Kongsberg EM2040 system operated at 200kHz and deployed on the drop keel of RV *Cefas Endeavour*. The keel was lowered to its full extent to minimise the effect of bad weather on the acoustic signal. Variations of sound velocity with water depth were determined using a CTD (conductivity-temperature-depth) probe and the data acquired was applied during multibeam data acquisition.

3.4 Groundtruth sampling methods

Sampling of the seabed, using underwater cameras and sediment sampling devices, was undertaken to groundtruth the acoustic data, and to enable the characterisation of habitats and resident faunal communities within the area. All seabed grab sampling was undertaken with a 0.1m^2 Day grab, with the exception of two stations located in the deep valley of the Central Fladen, where a 0.1m^2 Hamon grab was used. Seabed imagery was generally collected using a camera sledge system. The exceptions were the two stations located within the deep valley in the Central Fladen, where a drop camera and drifting HamCam (Hamon grab with attached video camera) were used. Video tows were generally collected at every third station. One station (CGT18), located within the Central Fladen (core), was revisited with the camera in order to determine the spatial extent of the tall sea pen, *F. quadranqularis*, which was found in high numbers. This station is where the species has been recorded previously.

3.4.1 Grab sampling

Sediment samples were either collected with a 0.1m^2 Day grab, or in the case of two samples, a 0.1m^2 Hamon grab (Mini Hamon grab). The sampling procedures for both types of grab are provided below. Samples were collected from within a 100m radius around the target station. For a few stations, samples were collected away from the planned station due to the presence of oil and gas installations and the exclusion zones around them (see Appendix 5 for station metadata).

<u>Day grab sampling methods</u>
On recovery of the Day grab, a photograph of the undisturbed sediment surface was taken. The sample depth in the Day grab was taken to estimate the volume of the sample. A sub-sample of sediment was taken, using a 3cm diameter corer deployed to a depth of 5cm, transferred to a plastic tub and frozen pending Particle Size Analysis (PSA) in the laboratory.

<u>Mini Hamon grab sampling methods</u>
On recovery of the mini Hamon grab, the sample was emptied into a plastic tub before photographing. Approximately 500ml of sediment was removed for particle size analysis, transferred to a plastic tub and frozen. The remaining sample was transferred to a 10L measuring bucket to provide an estimate of sample volume.

The remaining sample (taken by Day or mini Hamon grab) was emptied into a plastic box and transferred to the sample processing area onboard the vessel. Benthic fauna were collected by washing the sample with sea-water over a 5mm and a 1mm sieve. The retained >5mm fraction was photographed and then combined with the 1-5mm fraction in a labelled container. The samples were preserved in 4% buffered formaldehyde pending analysis in the laboratory.

3.4.2 Seabed imagery

The camera sledge system comprised a video camera with capability to also capture still images. Illumination was provided by four Cefas high intensity LED striplights and a dedicated flash unit. The camera was oriented to provide a forward oblique view of the seabed and was fitted with a four-spot (red) laser-scaling device which projected a 17cm x 17cm square along the axis of the lens onto the seabed. A further (green or red) horizontal laser helped to visualise the rugosity of the seabed on the moving video image (but was not always clearly visible in the still images). The drop camera system also comprised a video camera with capability to capture still images. Illumination was provided by two Cefas high intensity LED striplights and a flash unit. The camera was fitted with a four-spot laser scaling device to provide a reference scale in the video image. Set-up and operation followed the MESH 'Recommended Operating Guidelines (ROG) for underwater video and photographic imaging techniques' (Coggan *et al* 2007). A video overlay was used to provide station metadata, time and position (of the GPS antenna) in the recorded video image. A HamCam was deployed at one station due to technical issues but did not have video overlay or still image capture capacity. Video was recorded simultaneously to a Sony GV-HD700 DV tape recorder and a computer hard drive.

Camera deployments lasted a minimum of 10 minutes, with the vessel using its dynamic positioning capability to move along the planned transect at c.0.5 knots (c.0.25ms^{-1}) across a 100m 'bullring' centred on the sampling station. Still photographic images were captured at one minute intervals and opportunistically if features of interest were observed (see Appendix 6 for metadata).

3.5 Quality assurance of the data

For quality control and quality assurance of the data, all activities in the field were performed according to the recommendations in the following documents:

- Biological Monitoring: General Guidelines for Quality Assurance[4]
- Quality Assurance in Marine Biological Monitoring[5]
- Recommended operating guidelines for underwater video and photographic imaging techniques[6]

3.6 Seabed sample and data processing methodologies

3.6.1 Particle size analysis (PSA)

The sediment samples were processed by Ken Pye Associates Ltd and Cefas using the PSA methodology recommended by the National Marine Biological Analytical Quality Control (NMBAQC) scheme (Mason 2011). Particle size results were quality assured as described in the MCZ PSA Quality Statement (Mason, in prep). In total, 166 samples were analysed at half phi intervals using a combination of laser diffraction (<1mm fraction) and dry sieving techniques (>1mm). Gradistat software (Blott & Pye 2001) was used to produce all sediment statistics (e.g. mean, mode, skewness). Each sample was also assigned to one of four EUNIS sediment classes, as defined by Long (2006) (see Appendix 7 for metadata).

3.6.2 Infaunal samples from grabs

Infaunal samples were processed by Marine Ecological Surveys (MES) Ltd using inhouse laboratory practices. Results were checked following the recommendations of the National Marine Biological Analytical Quality Control (NMBAQC) scheme (Worsfold *et al* 2010). Taxa were identified to lowest taxonomic resolution and weighed. In total, 166 infaunal samples were analysed.

3.6.3 Analysis of video and still images

Video and photographic still images were processed by RSS Marine Ltd using the guidance documents developed by Cefas and the JNCC for the acquisition and processing of video and still images (Coggan & Howell 2005). In total, 70 videos and 1041 stills images were

[4] Reference URL: http://www.marbef.org/qa/documents/PKG85.pdf
[5] Reference URL: http://www.nmbaqcs.org/qa-standards/qa-in-marine-biological-monitoring.aspx
[6] Reference URL: http://www.searchmesh.net/PDF/GMHM3_Video_ROG.pdf

analysed for fauna (using the SACFOR abundance scale[7]) and sediment composition. A further 29 still images were analysed for sediment composition only due to the absence of visible fauna. A EUNIS (2012) Level 3 broadscale habitat and a Marine Nature Conservation Review (MNCR): Marine Habitat Classification v 04.05 (Connor *et al* 2004) biotope code (with corresponding EUNIS code) was assigned to all video segments and still images by the contractor. A 10% quality assurance check of both videos and still images was undertaken by RSS Marine. Further checks were undertaken by Cefas regarding Level 3 EUNIS BSH assignments, which were amended where necessary, for final reporting.

3.7 Data analysis methodologies

3.7.1 Acoustic data processing

The raw multibeam bathymetry data were processed using CARIS HIPS and QPS Fledermaus. Tidal information was extracted from a high precision CNAV 3050 DGPS receiver. Tide height data were smoothed and extracted to reduce the bathymetry data to Chart Datum. The soundings were cleaned by an experienced hydrographic surveyor using CARIS. Data collected meet IHO Order 1a requirements. Multibeam backscatter data were processed with the QPS Fledermaus Geocoder Toolbox (FMGT) software to produce floating point (FP) GeoTiff images.

3.7.2 Broadscale habitat mapping

The bathymetry data were used in conjunction with the processed backscatter data to enable the manual expert interpretation and delineation of seabed features across the Fladen area. ESRI Arc 9.3.1 GIS was used for data investigation and the visualisation of broadscale habitats. A total of 70 video tows and 166 PSA samples were used to help groundtruth and better inform seabed mapping and interpretation. Manual interpretation of data was chosen over the use of semi-automated methods due to data quality and extent (poor backscatter data was collected in some areas (due to prevailing weather conditions) and survey lines were only run between grab stations). Habitat predictions were made between stations, along multibeam transects, and extrapolated to the Fladen site boundaries where possible. It was not possible to extrapolate information in an area to the south west of the Central Fladen pMPA. This was due to a lack of data points beyond the boundary, the proximity of the tunnel valley and the associated sediment heterogeneity. Therefore, a habitat prediction could not be made with any confidence.

3.7.3 Faunal data analysis

Statistical analyses were undertaken using PRIMER 6 (Clarke & Gorley 2006) and Minitab® 15 (Minitab Inc. 2007). Standard univariate and multivariate analyses were performed on the taxon abundance-by-sample matrix produced by MES Ltd. Multivariate analyses were performed on the taxon (SACFOR) abundance-by-still image matrix created from data produced by RSS Marine Ltd.

<u>Grab samples</u>
Univariate metrics calculated for each sample include total macrofaunal abundance (N), total wet weight biomass (B), total number of taxa (S) and Hill's (1973) taxon diversity index (N1) (see Appendix 8). Boxplots were produced in Minitab® for each of the metrics.

Multivariate analyses were undertaken to determine differences in community composition within and between the pMPAs. The data were square root transformed prior to calculation

[7] http://jncc.defra.gov.uk/page-2684

of Bray-Curtis similarity matrices. Hierarchical cluster analyses using the SIMPROF routine was used to identify significantly (p= 0.05) different groups of samples within each area and between areas. Multidimensional scaling (MDS) plots were also produced from the similarity matrices and samples displayed according to pMPA and SIMPROF groups. The SIMPER routine was used to identify the taxa contributing to the similarity within and between the statistically defined groups.

Seabed imagery
The composition of epifaunal communities at each of the video stations was explored using multivariate analysis of the video taxon (SACFOR) abundance matrix. The SACFOR scale was converted to a numerical scale, where superabundant=6, abundant=5, common=4, frequent=3, occasional=2, rare=1 and present=1. No transformation of the data was undertaken prior to calculation of a Bray-Curtis similarity matrix as the scale used was equivalent to a strong data transformation. Hierarchical cluster analysis, using the SIMPROF routine, was used to identify significantly (p= 0.05) different groups of samples. SIMPER was used to identify the taxa contributing to the within and between group similarity.

Variability in epifaunal communities (and potentially biotopes) along the transects was investigated using the still image data matrix. The data were subjected to hierarchical cluster analysis and a cut-off at 30% similarity was applied to identify cluster groups. SIMPER was used to identify the taxa contributing to the within and between group similarity. As every still image was assigned to a cluster, each video segment could be checked for consistency along the tow. This ensured the final biotope assignments were accurate for each video segment.

4 Results and Data Analysis

4.1 Multibeam bathymetry and backscatter

For areas mapped in the Central Fladen pMPA and at Central Fladen (core) as part of this investigation, water depth varied between 101 and 293m (Figure 7). The shallowest regions occurred towards the centre of Central Fladen (core), in and around the region of 100% multibeam coverage. A deep tunnel valley (293m below CD at the deepest measured location) appeared to run in a NW-SE direction on the western side of the site. From the available data it was not possible to accurately delineate the boundaries of the tunnel valley, but it appeared to reach its maximum depths within the Central Fladen pMPA, and to fall entirely within the pMPA boundary.

Measured water depths at Western Fladen pMPA were more consistent than in the Central Fladen pMPA, ranging from 107 to 133m (Figure 8). Shallowest depths were found to the east of the pMPA, deepening towards the west. Tunnel valleys were not evident from the multibeam data collected during this survey of the Western Fladen pMPA.

Measured water depths at South East Fladen pMPA were also consistent and were generally deeper than those found at either Central Fladen (core) or Western Fladen pMPAs, though not to depths found within the tunnel valley of Central Fladen pMPA. Depths were shallower in the north (143m at the shallowest), deepening to the south to a maximum of 152m (Figure 9). Pockmark features were observed in the mutibeam backscatter data across the entire South East Fladen pMPA. Large pockmarks (Scanner-Scotia-Challenger pockmark complex) were not observed in the current survey as they were located between two multibeam survey lines.

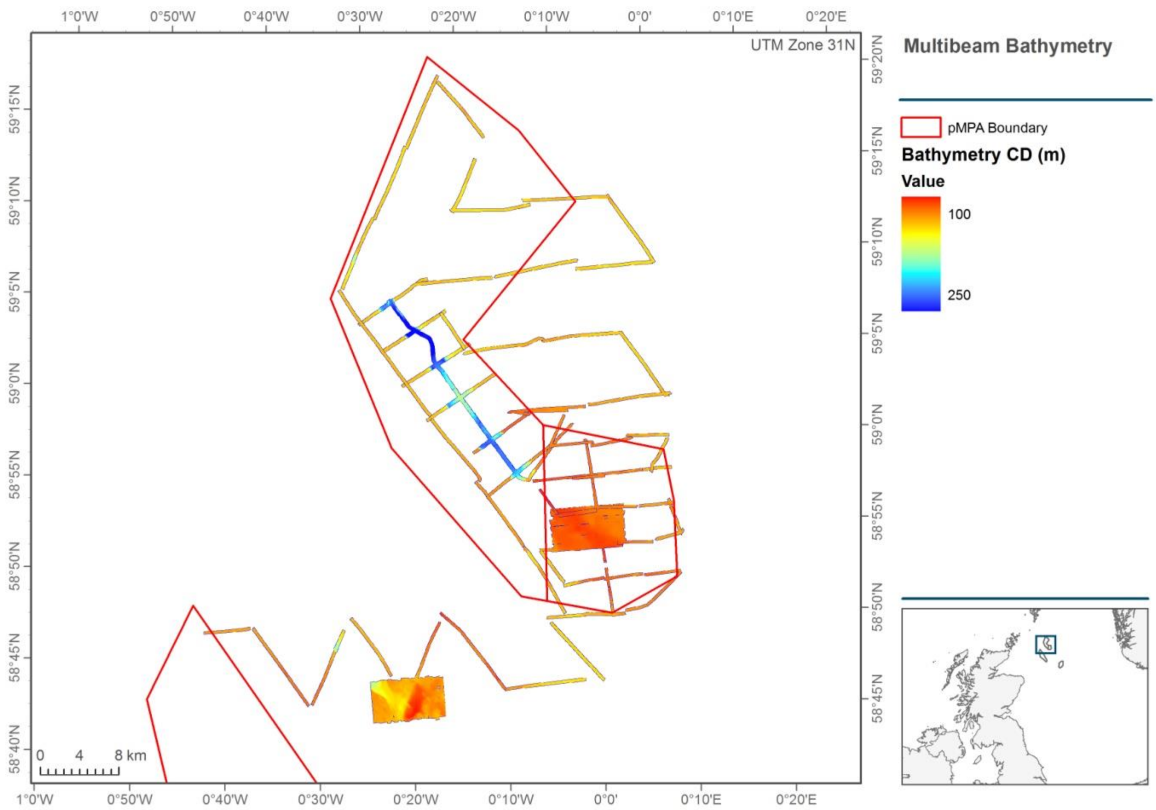

Figure 7: Multibeam bathymetry for the Central Fladen pMPA.

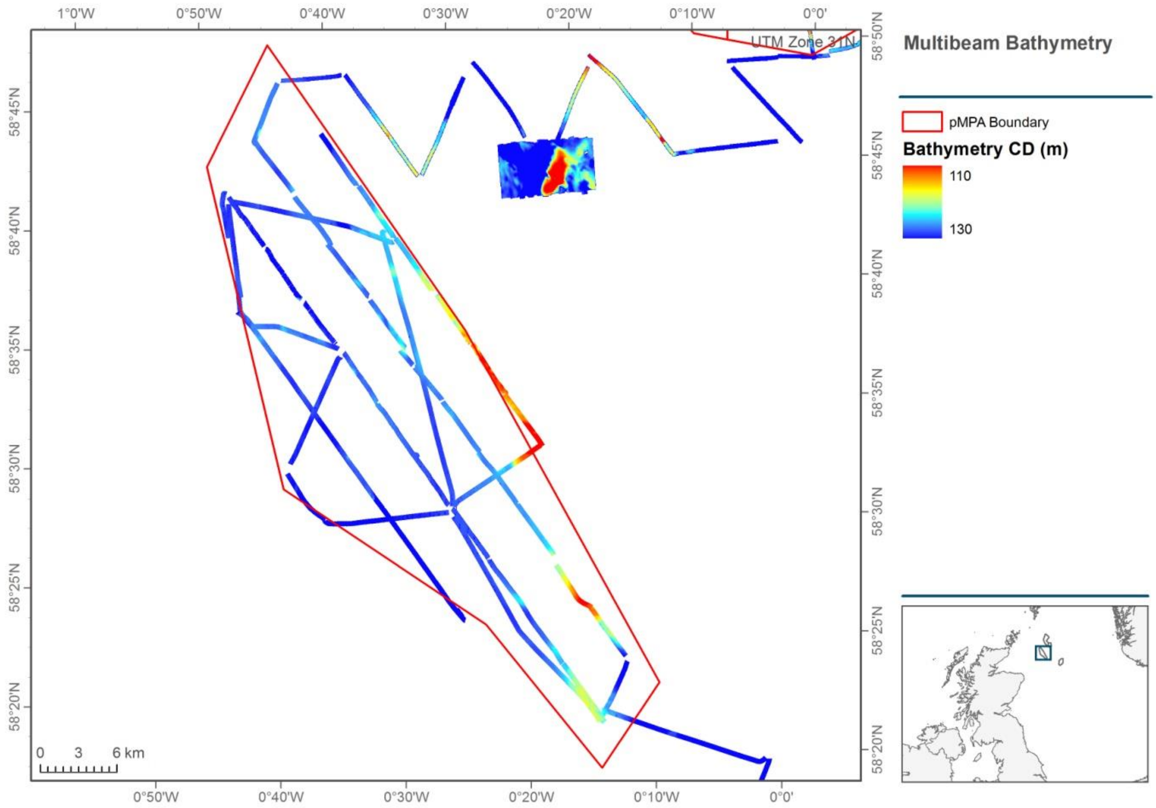

Figure 8: Multibeam bathymetry for the Western Fladen pMPA.

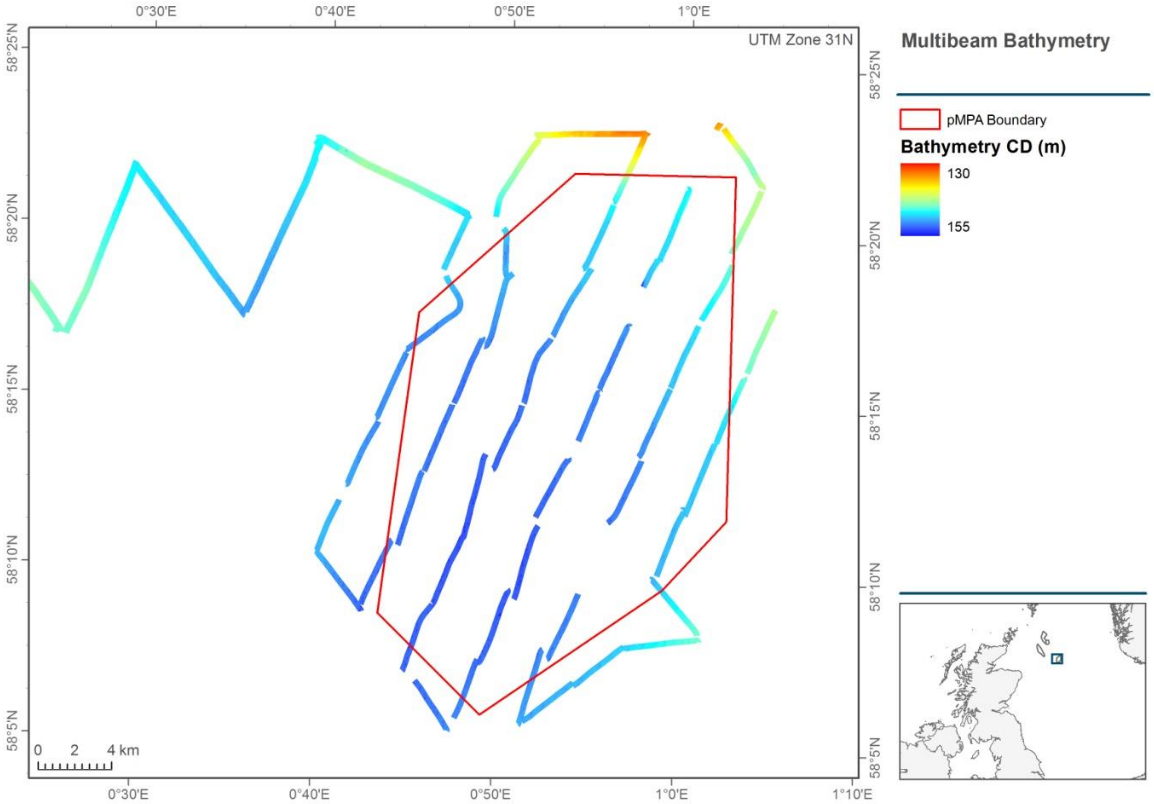

Figure 9: Multibeam bathymetry for the South East Fladen pMPA.

Backscatter at all sites was generally low (indicative of softer sediment types), with only some patches of higher reflectivity (Figure 10 to 12). Patches of higher reflectivity were found in the tunnel valley, as well as in the shallower regions of the sites. This suggested the presence of coarse sediments along the edges and bottom of the tunnel valley.

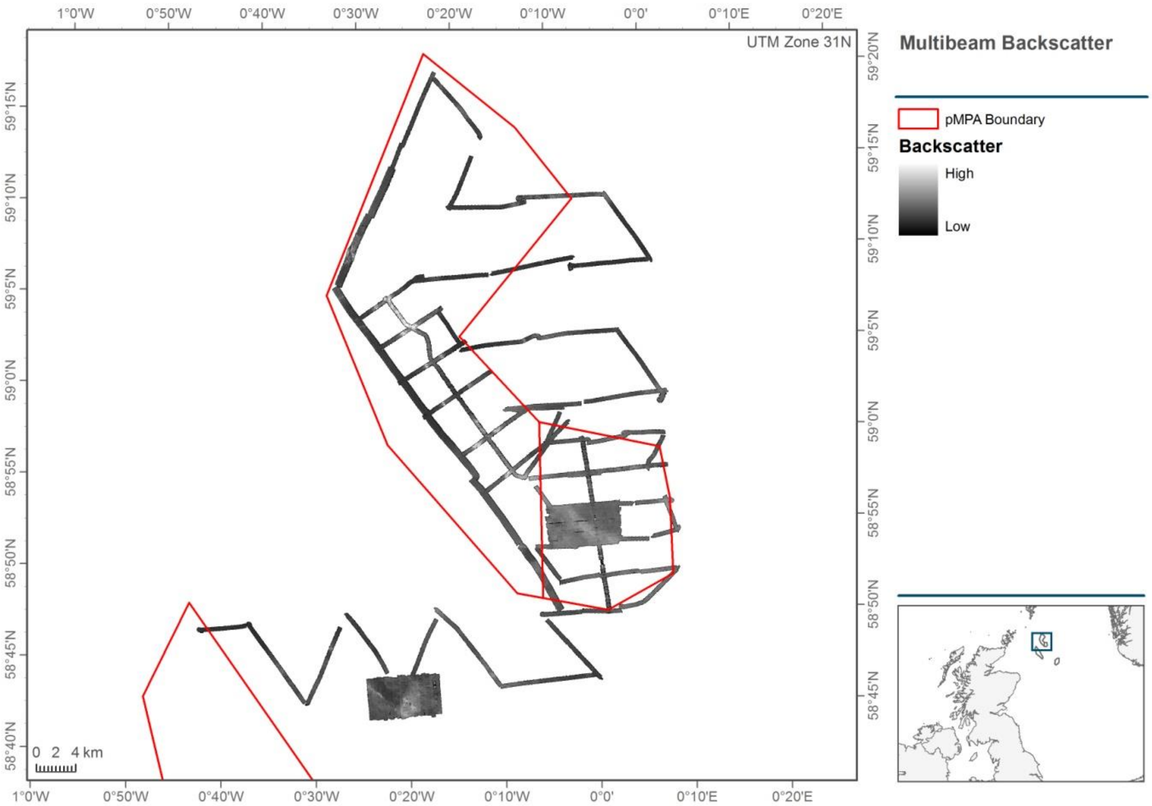

Figure 10: Multibeam backscatter for the Central Fladen pMPA.

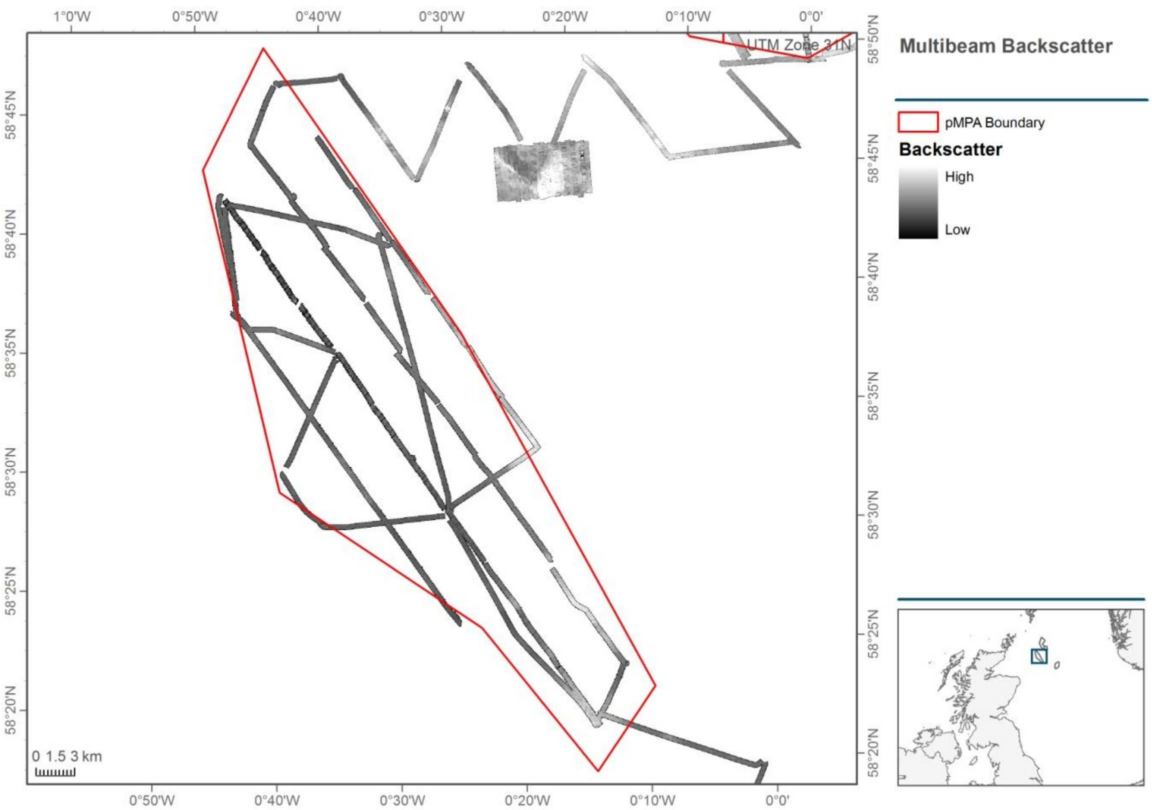

Figure 11: Multibeam backscatter for the Western Fladen pMPA.

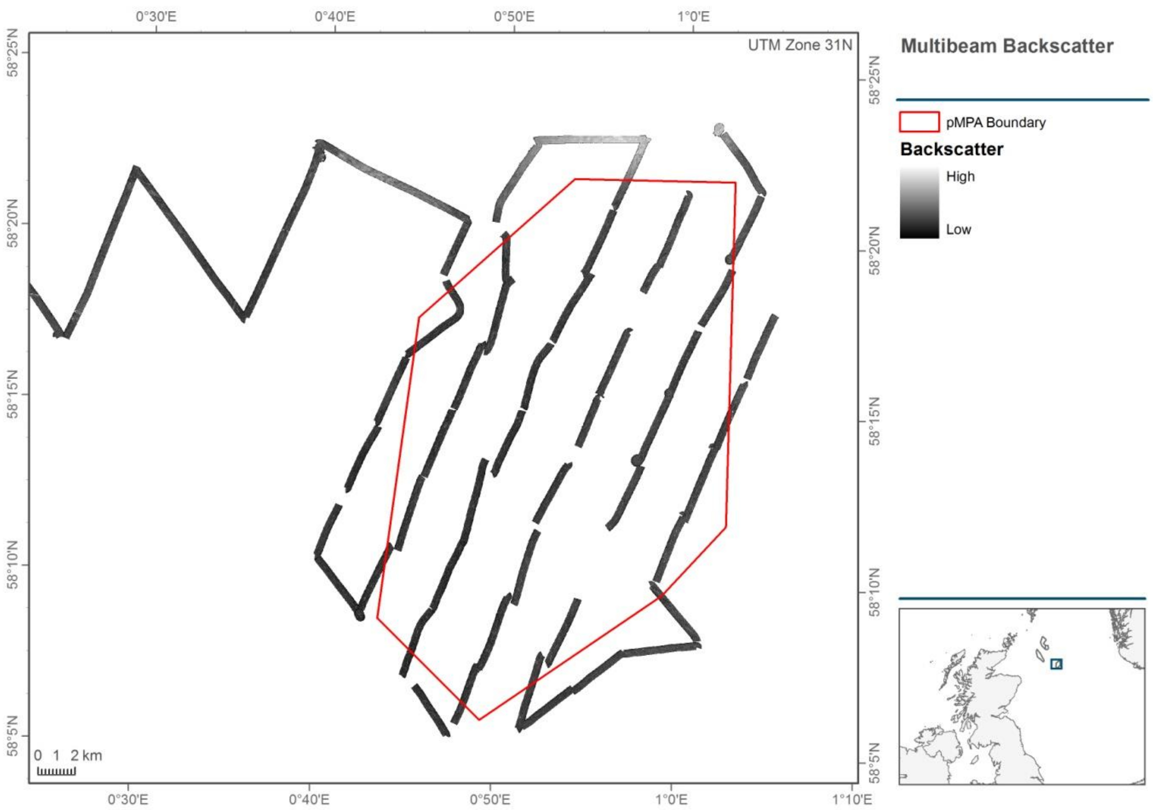

Figure 12: Multibeam backscatter for the South East Fladen pMPA.

4.2 Surficial sediments

In total, 166 grab samples were analysed for particle size. Of these, 157 were classed as mud and sandy mud, six as sand and muddy sand, and three as mixed sediment, (using the modified Folk classification by Long 2006). The relative proportions of the major sediment fractions (gravel, sand and silt/clay) for each station are presented in Figure 13 to 15.

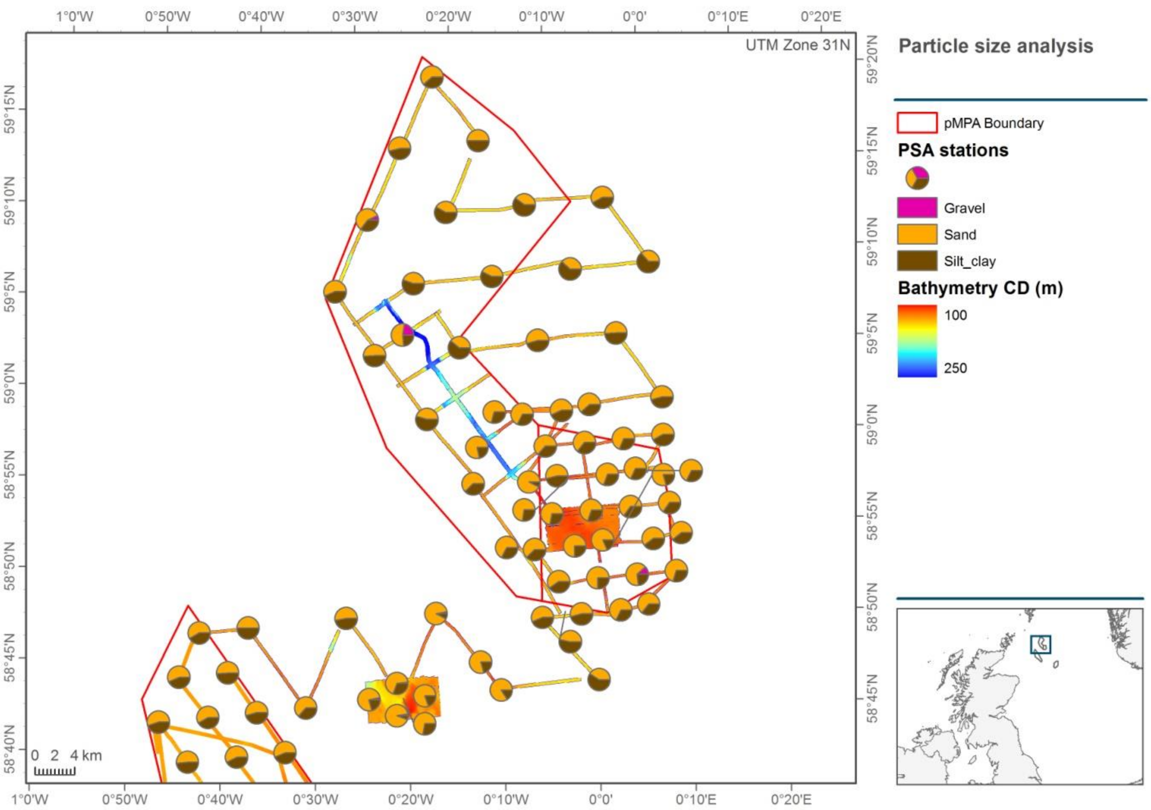

Figure 13: Proportions (as %) of gravel, sand and silt/clay from PSA of samples from the Central Fladen pMPA, overlaid on multibeam bathymetry data.

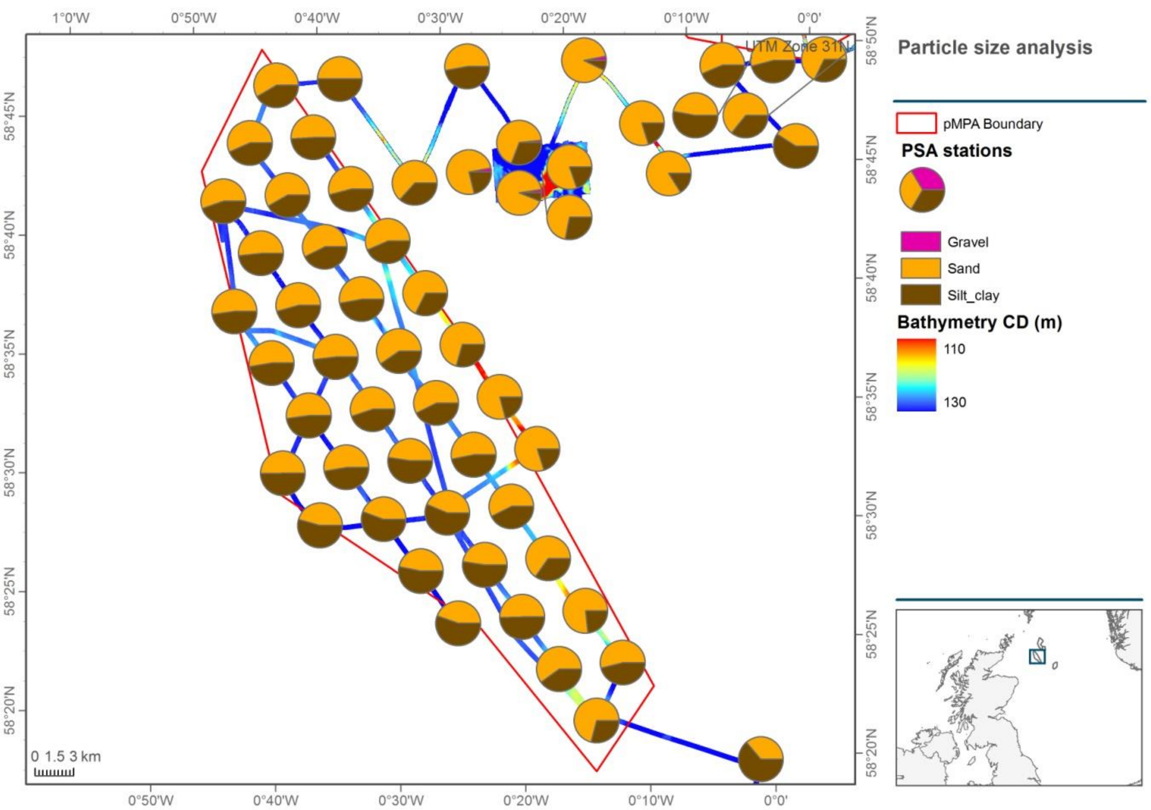

Figure 14: Proportions (as %) of gravel, sand and silt/clay from PSA samples from the Western Fladen pMPA, overlaid on multibeam bathymetry data.

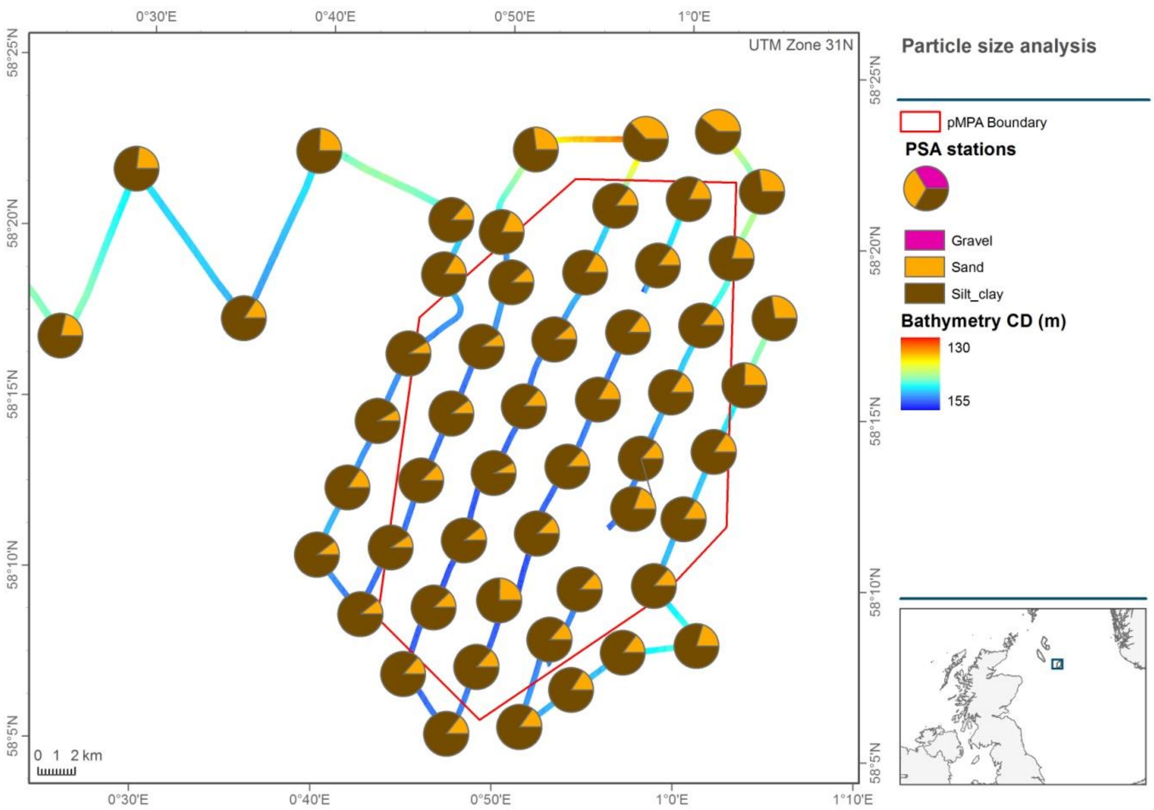

Figure 15: Proportions (as %) of gravel, sand and silt/clay from PSA samples from the South East Fladen pMPA, overlaid on multibeam bathymetry data.

In total, 70 video stations were completed successfully. Sixty-eight stations were classed as A5.3 Subtidal Mud, one as A5.4: Subtidal Mixed and one segmented into two habitats; A5.4: Subtidal Mixed and A5.2 Subtidal Sand, according to the EUNIS-based BSH classification (grab and video BSH results are presented in Figure 16).

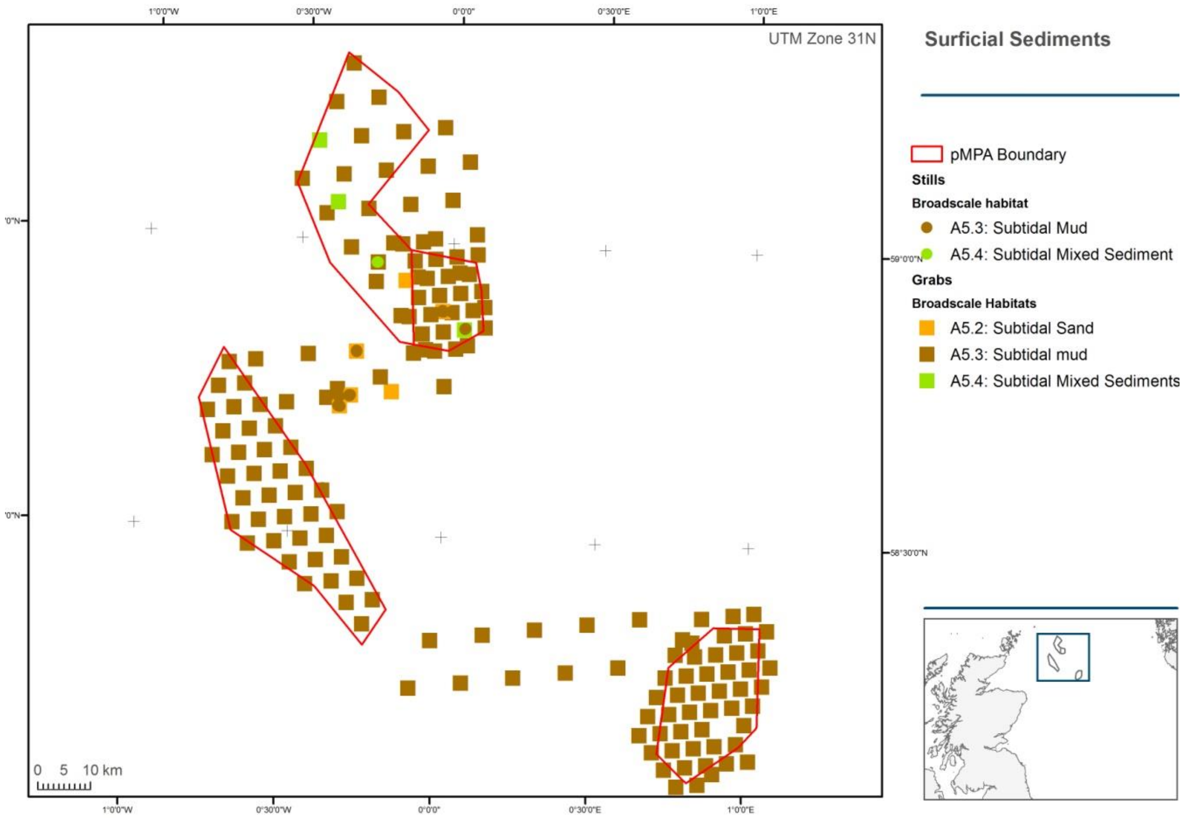

Figure 16: Broadscale habitat classifications (EUNIS Level 3) of surficial sediments from grab (PSA) and still image data.

4.3 Broadscale Habitat maps

The Fladen Grounds pMPAs (Central, Central (core), Western and South East Fladen) are all dominated by 'Subtidal mud' (Figure 17 to 19). Only the Central Fladen and Central Fladen (core) pMPAs demonstrated heterogeneity in terms of broadscale habitat. Sediments found within, and along the edges of, the tunnel valley at Central Fladen appeared to be comprised of 'Subtidal Mixed sediments'; sediments from the south-eastern tip towards the shallowest region of the site, and at the edge of the trench, were found to comprise 'Subtidal sands'.

Although little variation was seen in broadscale sedimentary habitats, there was some variation across the sites, as described in Section 3.2. Furthermore, Figure 20 demonstrates the variability between the three sites in terms of percent sand composition observed from grab samples. Samples taken within Central Fladen (core), and at the site of 100% coverage along the transect between Central Fladen and Western Fladen had the highest percentages of sand than any of the other locations. Samples taken at South East Fladen comprised a much lower proportion of sand than samples from the other sites. Samples from Central and Western Fladen were more similar to those collected in Central Fladen (core) than those collected at South East Fladen.

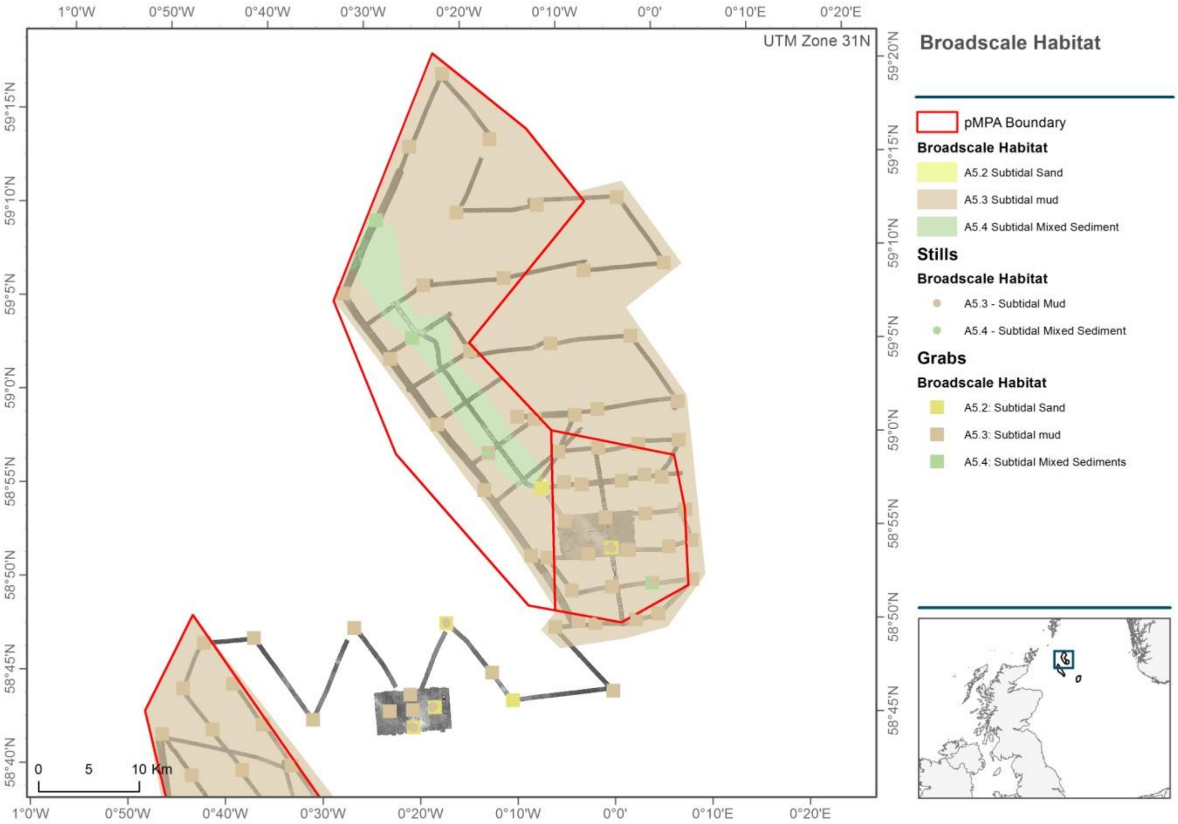

Figure 17: Map of broadscale habitat types for the Central Fladen pMPA. Classifications from still images and PSA samples are superimposed. Results for the transect to/from Western Fladen are also shown.

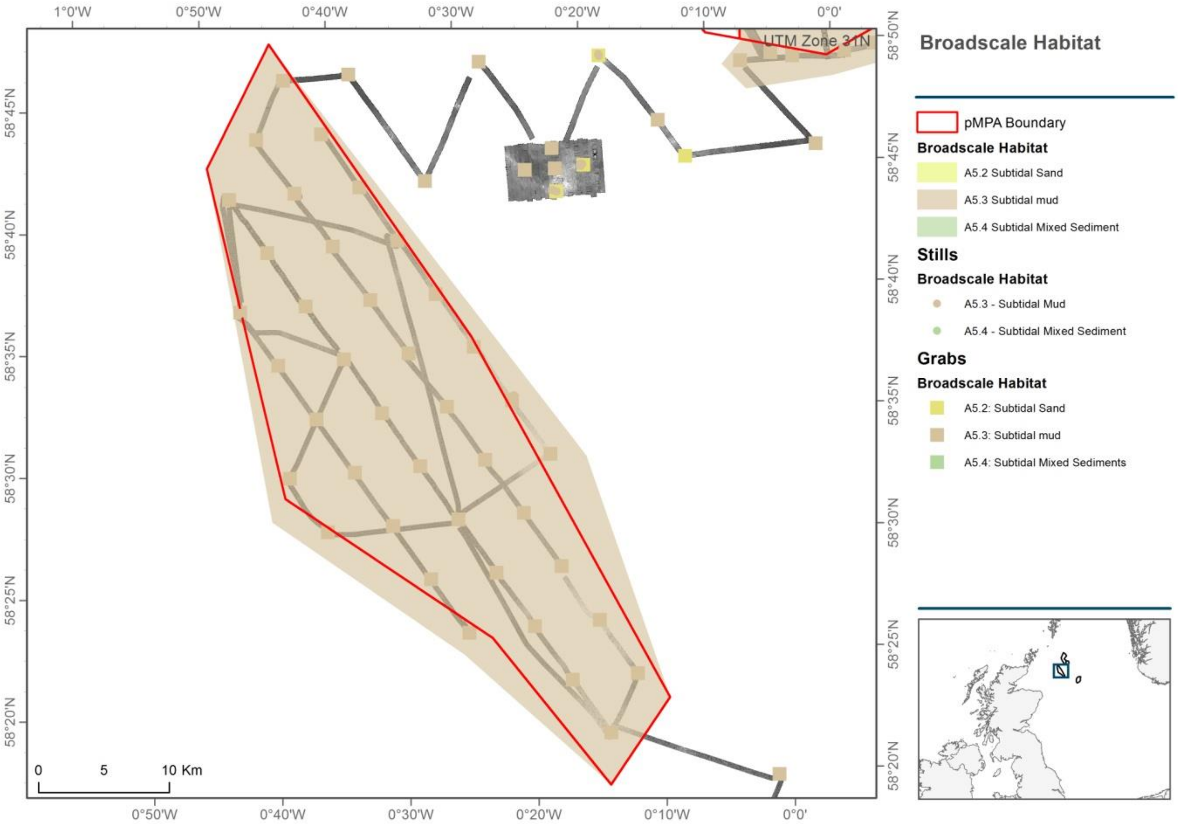

Figure 18: Map of broadscale habitat types for the Western Fladen pMPA. Classifications from still images and PSA are superimposed. Results for the transect to/from Central Fladen are also shown.

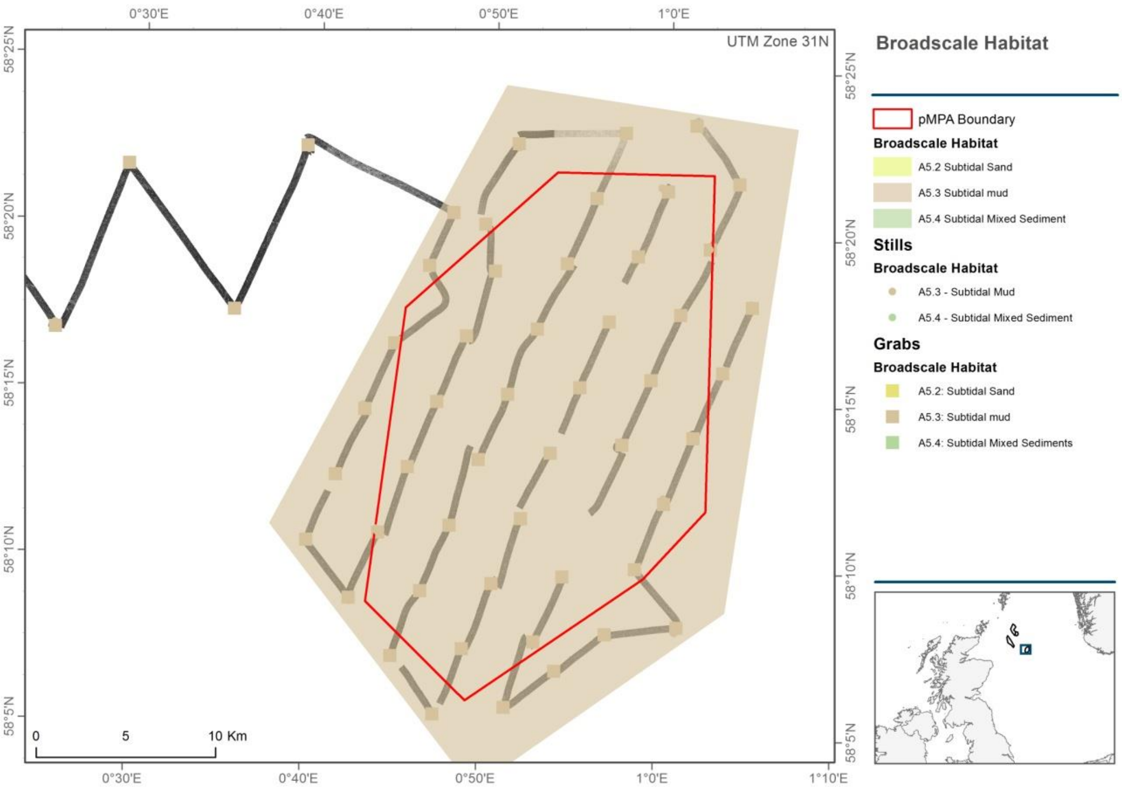

Figure 19: Map of broadscale habitat type for the South East Fladen pMPA. Classifications from still images and PSA are superimposed. Results for the transect to/from Western Fladen are also shown.

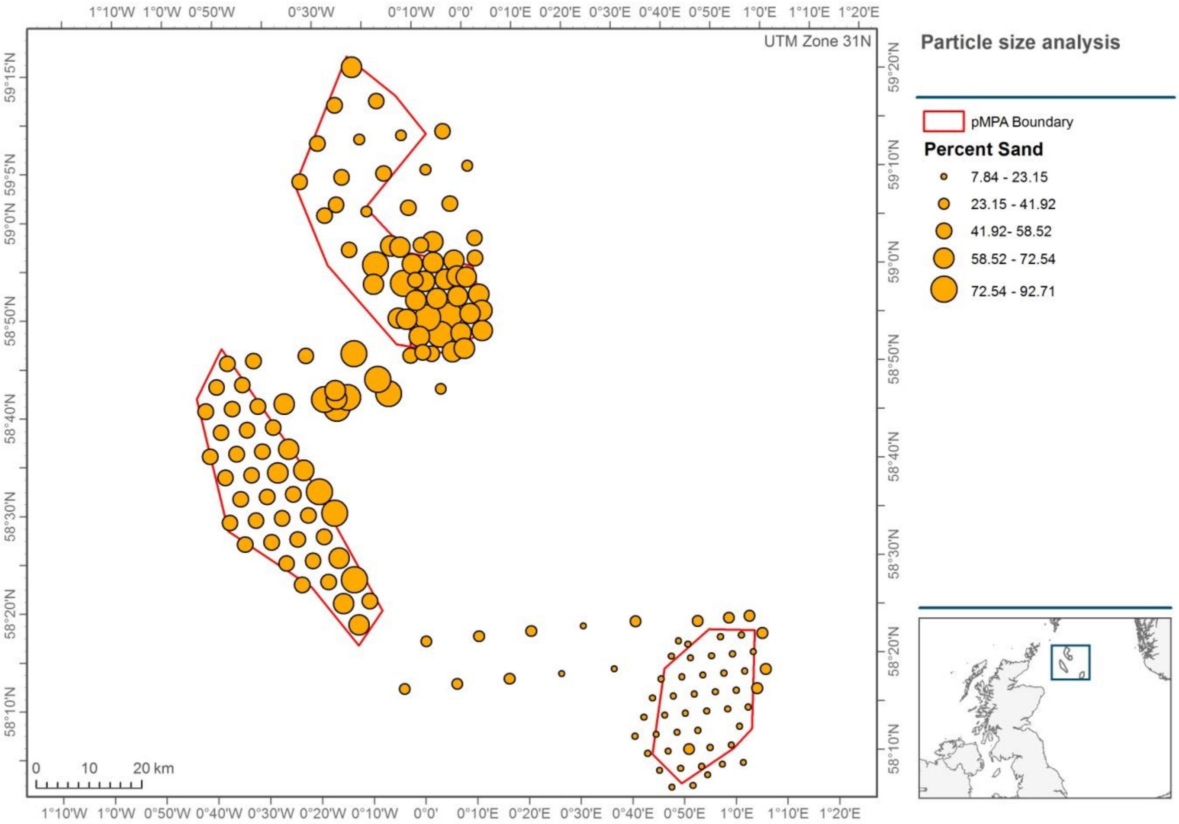

Figure 20: Bubble plots of percentage sand from grab samples collected at all Fladen Grounds pMPAs, representing variable sediment composition of samples across the area.

Figure 21 demonstrates the distribution of EUNIS habitat types and broadscale habitat over multibeam bathymetry and backscatter data for the 100% coverage site within Central Fladen (core). Data in this area were collected to investigate spatial differences or trends in the area where the tall seapens were observed to be present in the video data. Similarly, a 100% multibeam block was selected during transit from Central Fladen (core) to Western Fladen pMPA (Figure 22). In both cases, the additional survey data were collected to explore linkages between tall seapen presence and the seabed sediment composition and water depth. Although in several cases the tall seapen were found in areas of raised backscatter strength (indicative of coarser sediments) where water depths were generally shallower compared to surrounding areas, the overall evidence to support the hypothesis wasn't conclusive. A further complication in this assessment was the discrepancy between the backscatter strength and sample evidence. Figure 21 demonstrates how some of the samples within the areas of raised backscatter strength were more similar to the mud dominated samples acquired in the low backscatter strength areas, as opposed to confirming the coarse nature of the sediment in these areas as suggested by the backscatter data. This discrepancy is likely caused by the samples collected at these locations demonstrating % sand values close to the threshold set for the modified Folk classification method between 'Subtidal Mud' and 'Subtidal Sand'. The small percentage change may be enough to tip modified Folk descriptions from one to the other but not enough to necessarily be picked up as a reflectivity change in the backscatter return.

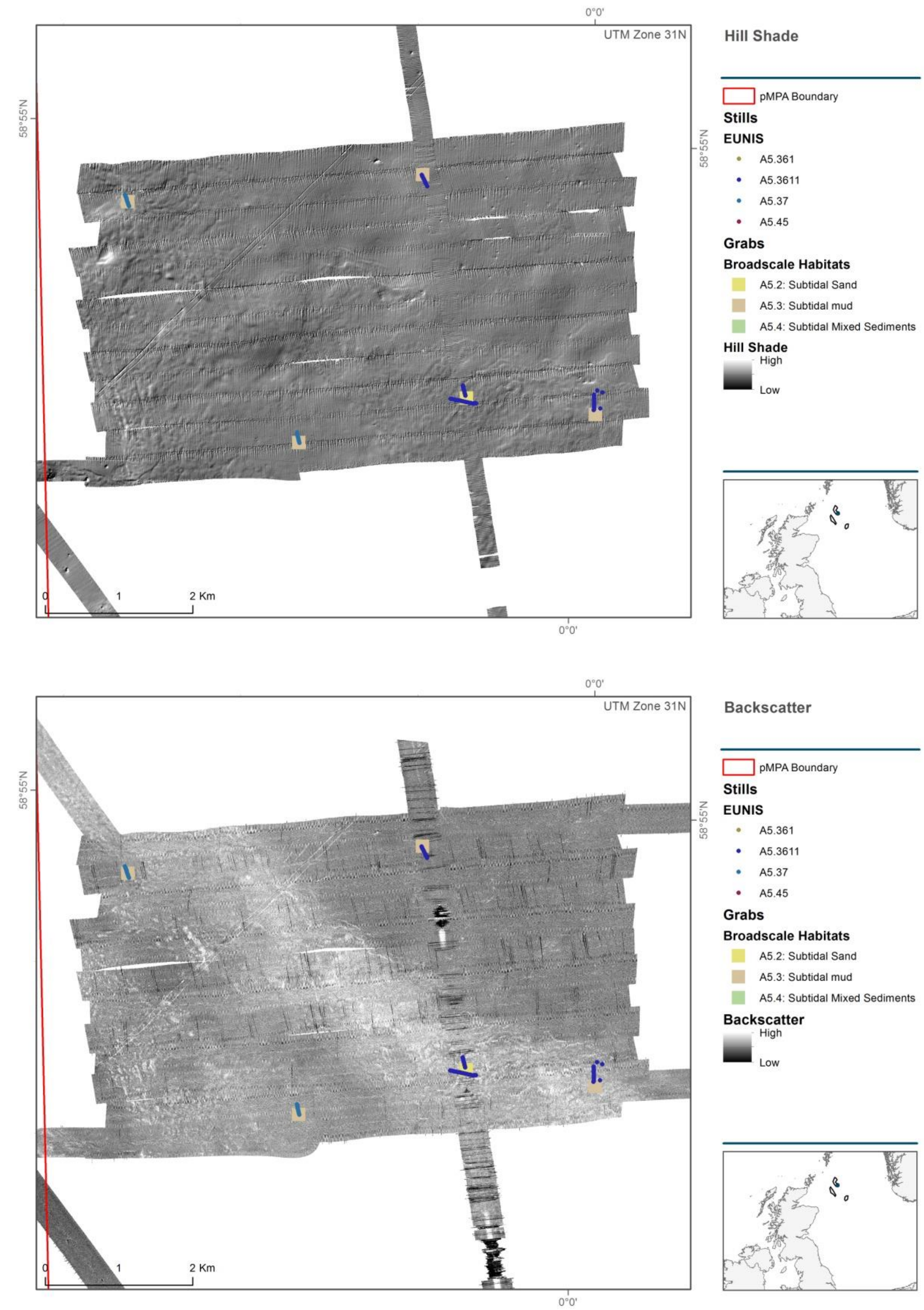

Figure 21: Multibeam bathymetry (above; data treated with ArcGIS 9.3 hill shade tool) and backscatter (below) for the area within the Central Fladen (core) pMPA with 100% sample coverage. Maps show EUNIS broadscale habitat types determined from grab sample PSA (coloured squares) and from still images (dot arrays) to demonstrate difficulty associated with mapping *F. quadrangularis*.

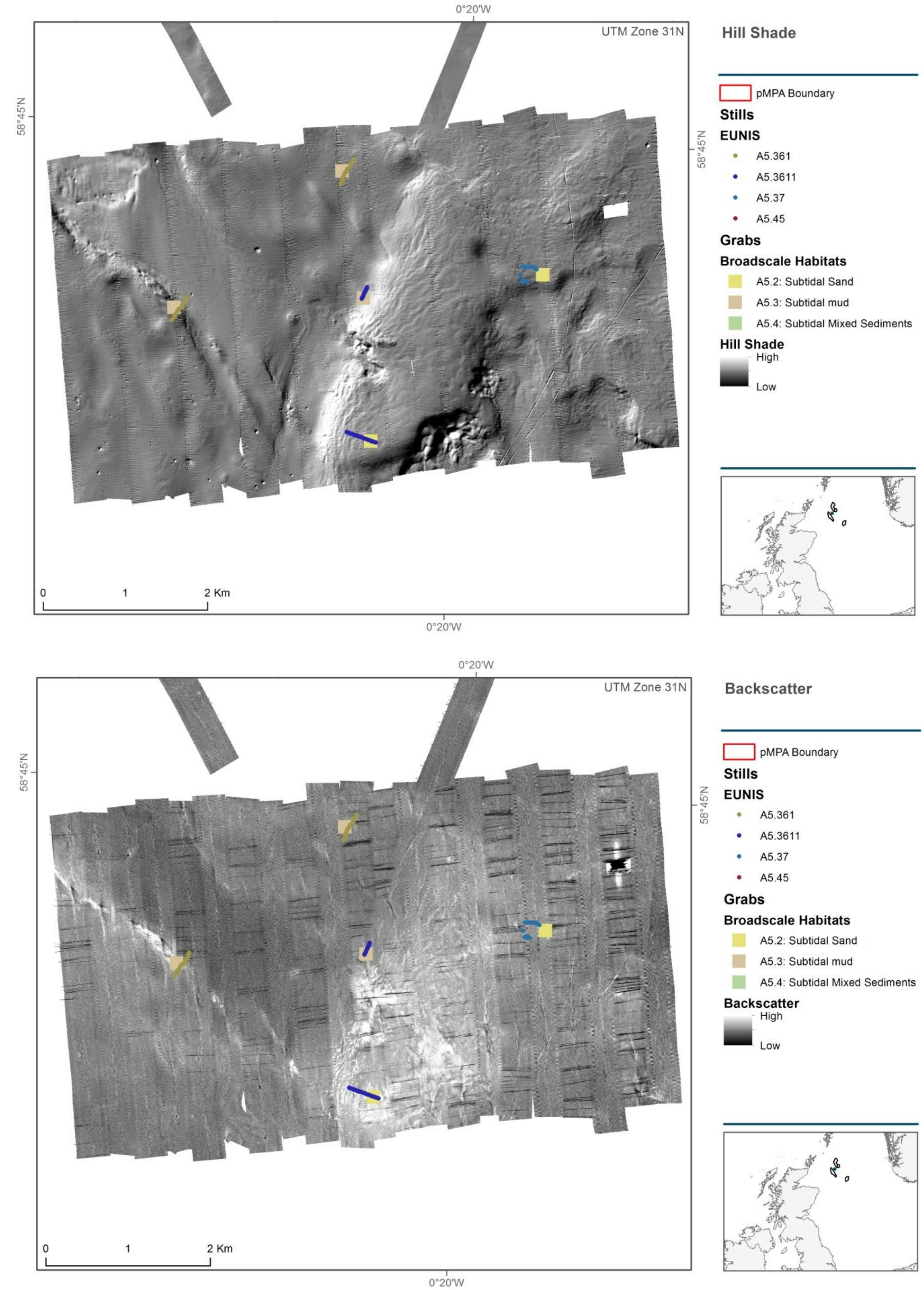

Figure 22: Multibeam bathymetry (above; data treated with ArcGIS 9.3 hill shade tool) and backscatter (below) for the area along transect between the core Central Fladen and Western Fladen pMPAs with 100% sample coverage. Maps show EUNIS broadscale habitat types determined from grab sample PSA (coloured squares) and from still images (dot arrays) to demonstrate difficulty associated with mapping *F. quadrangularis*.

4.4 Grab sample analysis

4.4.1 Univariate analyses

Comparisons between the pMPAs showed that the South East Fladen pMPA had the lowest average values for faunal abundance, number of taxa and diversity. The Western Fladen pMPA expressed highest average values for abundance and number of taxa, although average diversity was highest within the Central Fladen (core) (Figure 23).

Average biomass values were similar between all the pMPAs, with all containing several heavier than average individuals. High individual sample biomass values in the Western Fladen and South East Fladen pMPAs were due to single occurrences of the echinoderm, *Brissopsis lyfera*. In the Central Fladen pMPA and Central Fladen (core) pMPA, high individual sample biomass values were due to the presence of one or two large specimens of the ocean quahog, *Arctica islandica*.

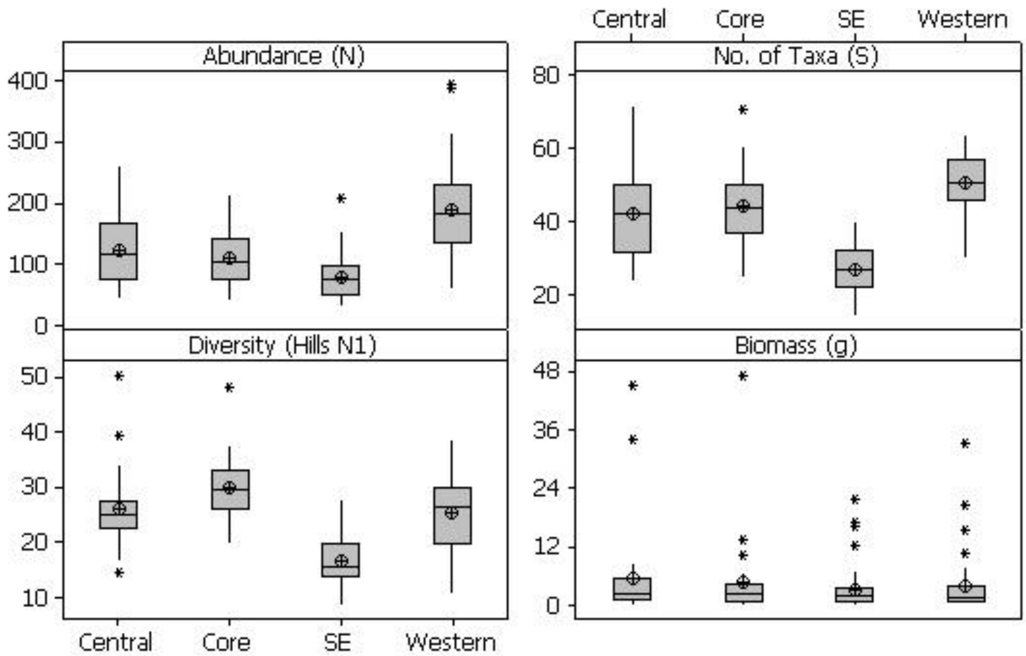

Figure 23: Box and whisker plots of the univariate metrics (abundance, number of taxa, diversity and biomass) at each of the pMPAs.

Spatial variability in the number of taxa and diversity across the pMPAs is presented in Figure 24 and 25. In the Central Fladen pMPA, variability in the numbers of taxa was high across the site, while in the Western Fladen pMPA the variability was low. Numbers of taxa were consistently low across the South East Fladen pMPA in comparison with the other sites (Figure 24). Species diversity was high within the Central Fladen (core) and within the southern part of the Western Fladen pMPA. Low diversity in the northern part of the Western Fladen pMPA was due to high abundances of the polychaete, *Galathowenia oculata* (Figure 25). All calculated metrics can be found in Appendix 9.

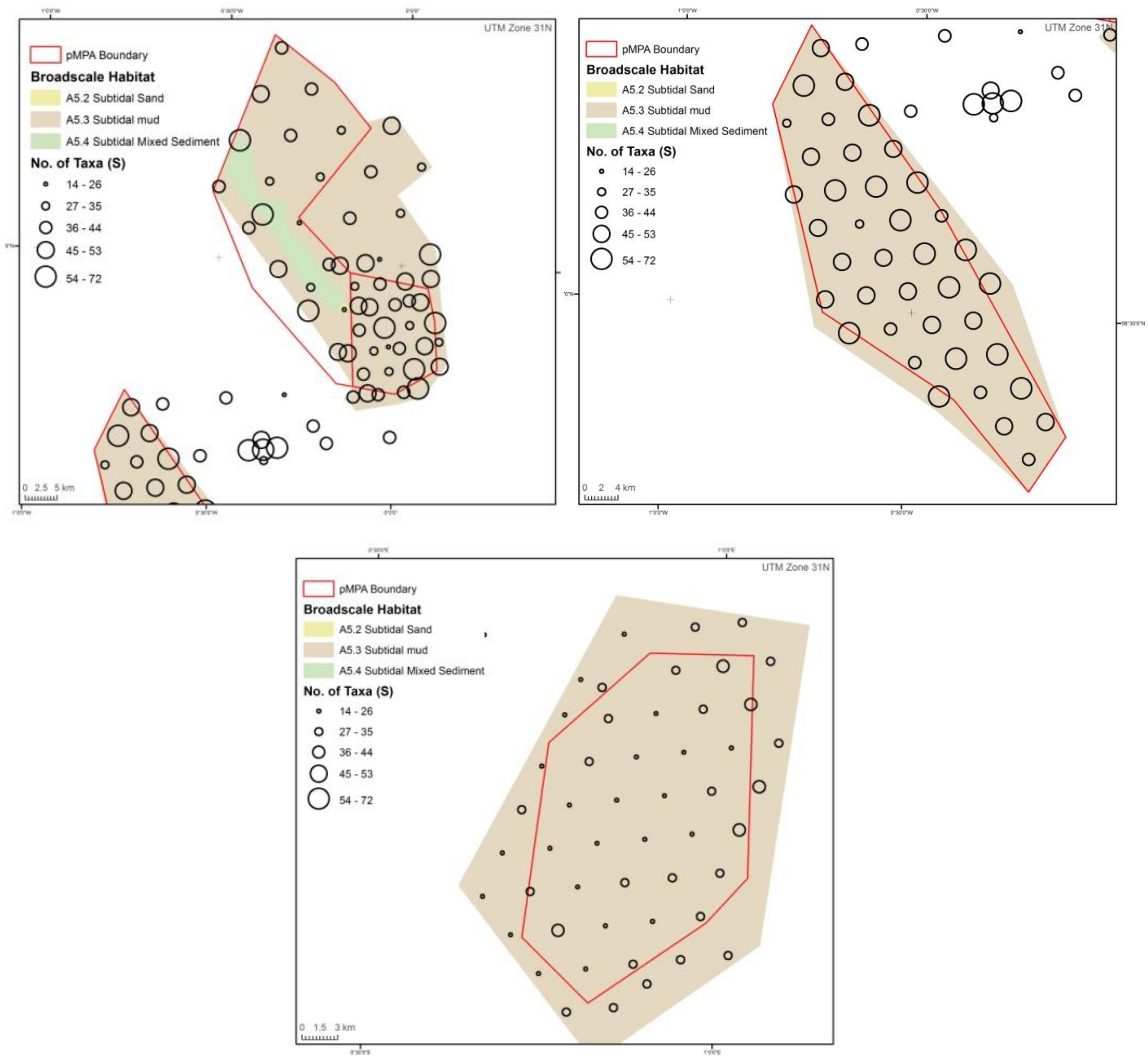

Figure 24: Total number of taxa recorded at each grab station in each pMPA. Top left: Central Fladen (and Central Fladen (core)) pMPA; top right: Western Fladen pMPA; bottom: South East Fladen pMPA. Graduated open circles represent increasing number of taxa.

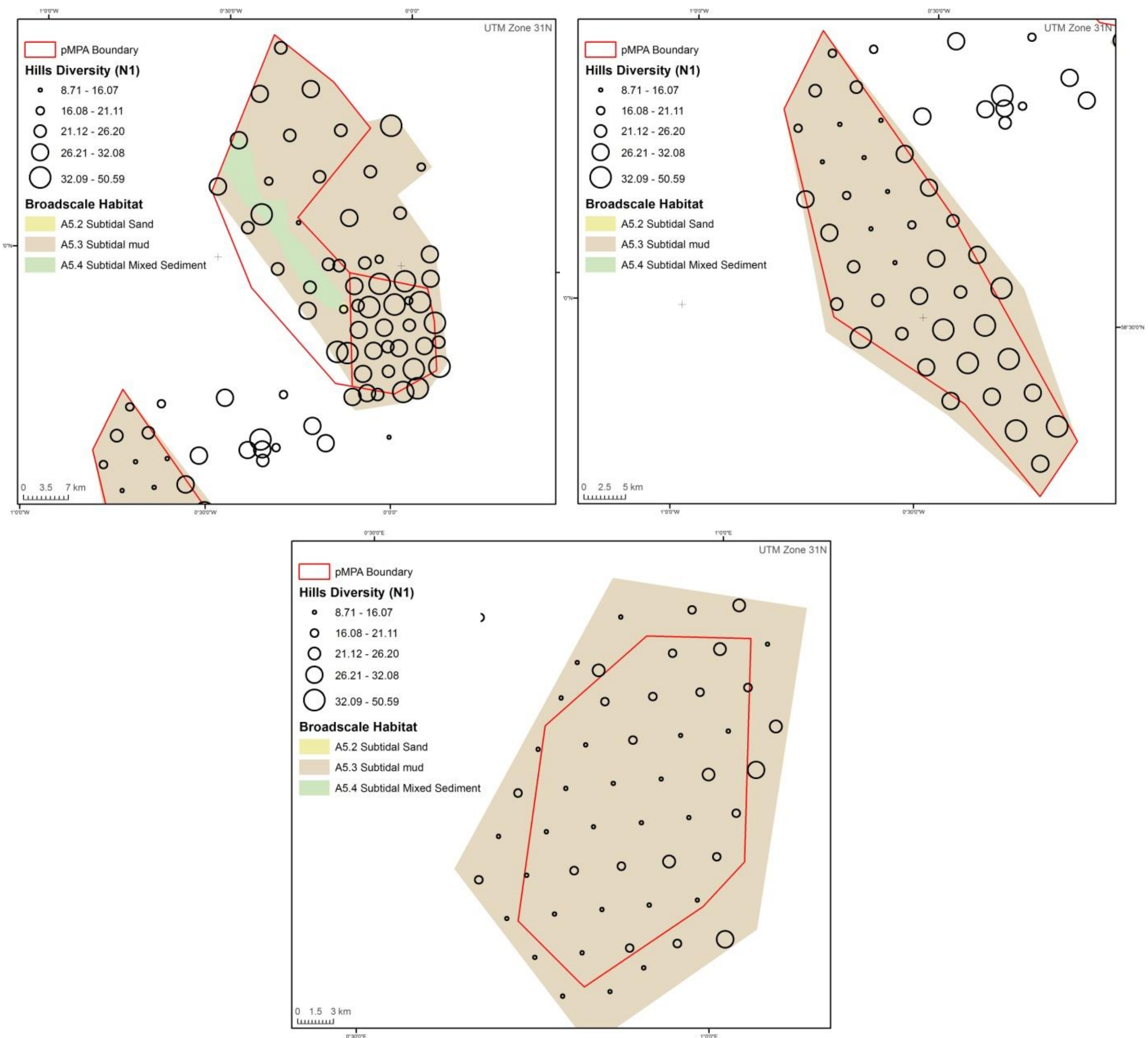

Figure 25: Species diversity at each grab station in each pMPA. Top left: Central Fladen (and Central Fladen (core)) pMPA; top right: Western Fladen pMPA; bottom: South East Fladen pMPA. Graduated open circles represent increasing diversity.

4.4.2 Multivariate analysis

An MDS ordination, displayed according to pMPA (Figure 26), shows samples from each site generally clustering together. Furthermore, the northern transit samples tended to cluster with the Western and Central Fladen pMPAs, whilst the southern transit samples clustered mainly with the South East Fladen pMPA.

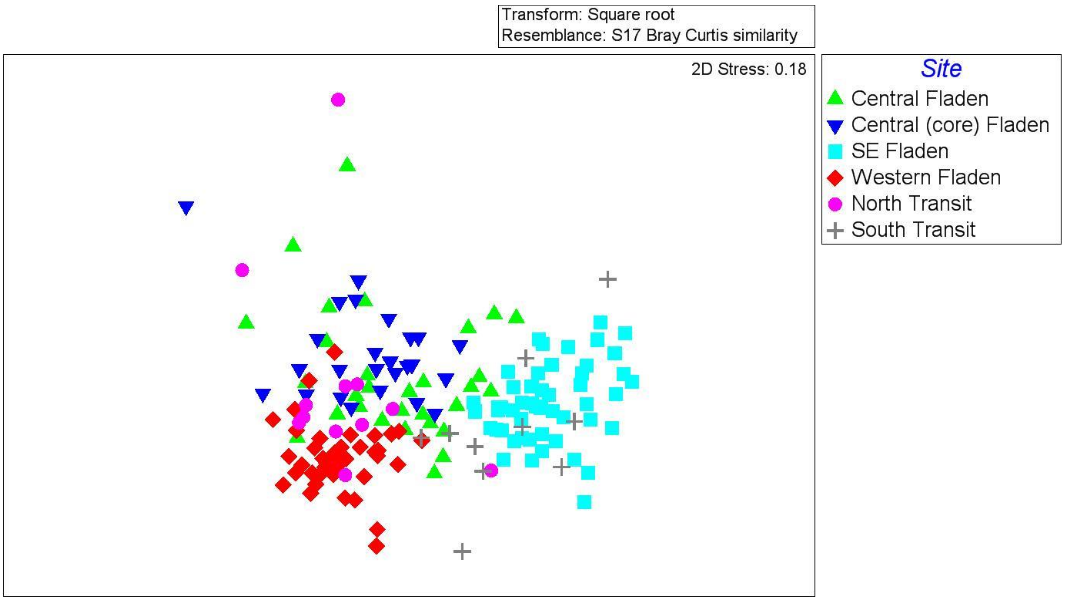

Figure 26: MDS ordination of the grab sample data displayed according to pMPA and transit stations (north and south).

Hierarchical clustering, using SIMPROF (p=0.05), revealed 17 significantly different community groups (see Appendix 9 for cluster dendrogram). Nine of the 17 cluster groups were represented by five or more grab samples each. Eight cluster groups only contained two or three samples each. Five further samples did not cluster with any of the groups and were grouped together as outliers.

Overlaying the SIMPROF clusters on the MDS shows the communities of each pMPA to be distinct from one another. For instance, cluster q (distinguished by high abundances of the polychaete, *Galothowenia oculata* and species such as *Diplocirrus glaucus, Ampharete falcata and Paramphinome jeffreysii*) is found solely within the Western Fladen pMPA; cluster i (characterised by *Thyasira equalis, Spiophanes koryeri, P. jeffreysii* and *Heteromastus filiformis*) is only found within the South East Fladen pMPA; and cluster s (characterised by *Mendicula ferruginosa, S. kroyeri* and *Lanice conchilega*) is found within the Central Fladen (core) (Figure 27 and Figure 28). Cluster r is located across both the Central and Western Fladen pMPAs and at stations on the transit between the two sites. The group is characterised by species such as *G. oculata*, *M. ferruginosa* and *S. kroyeri*. Station 'Deep5', located in the mixed sediments of the tunnel valley did not cluster with other stations due to the presence of species such as the barnacle, *Verruca stroemia,* and the brittlestar, *Amphipholis squamata,* which prefer coarse habitats. Further information on the characterising species for each group can be found in Appendix 10. Differences between clusters r (Central and Western Fladen) and i (South East Fladen) were mainly due to significantly higher average abundances of *G. oculata, L. conchilega, Eclysippe vanelli* and *A. falcata* within cluster r and significantly higher average abundances of *T. equalis* and *H. filiformis* and in cluster i. Similar species abundance differences were also apparent between cluster q (Western Fladen) and cluster i (South East Fladen). Differences between clusters within pMPAs were generally due to higher average abundances of the characteristic species of the main clusters rather than an absence of species from the clusters.

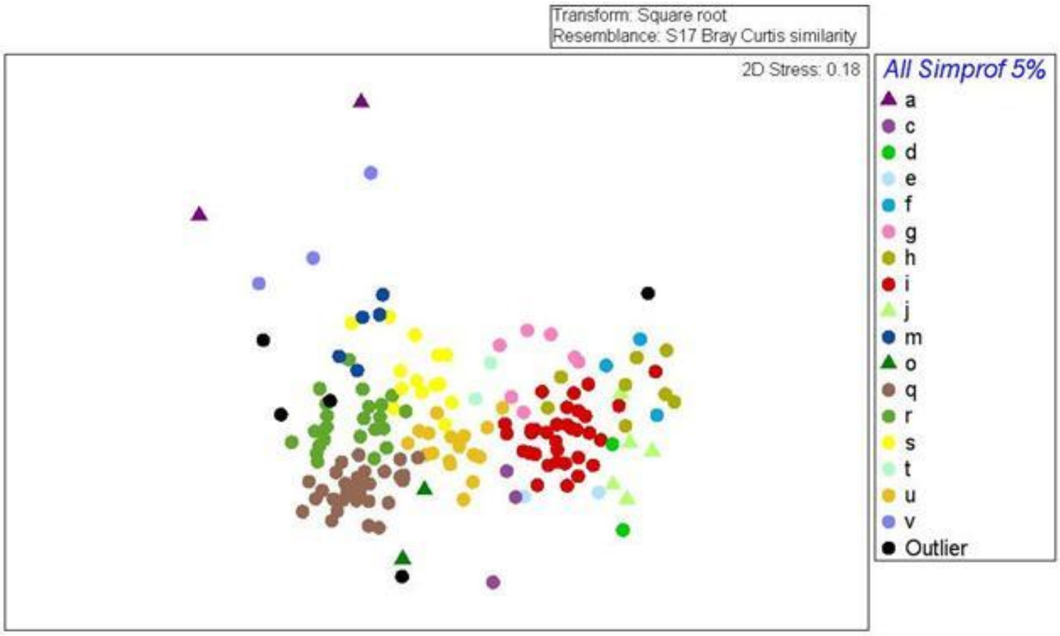

Figure 27: MDS ordination of the grab sample data displayed according to SIMPROF clusters.

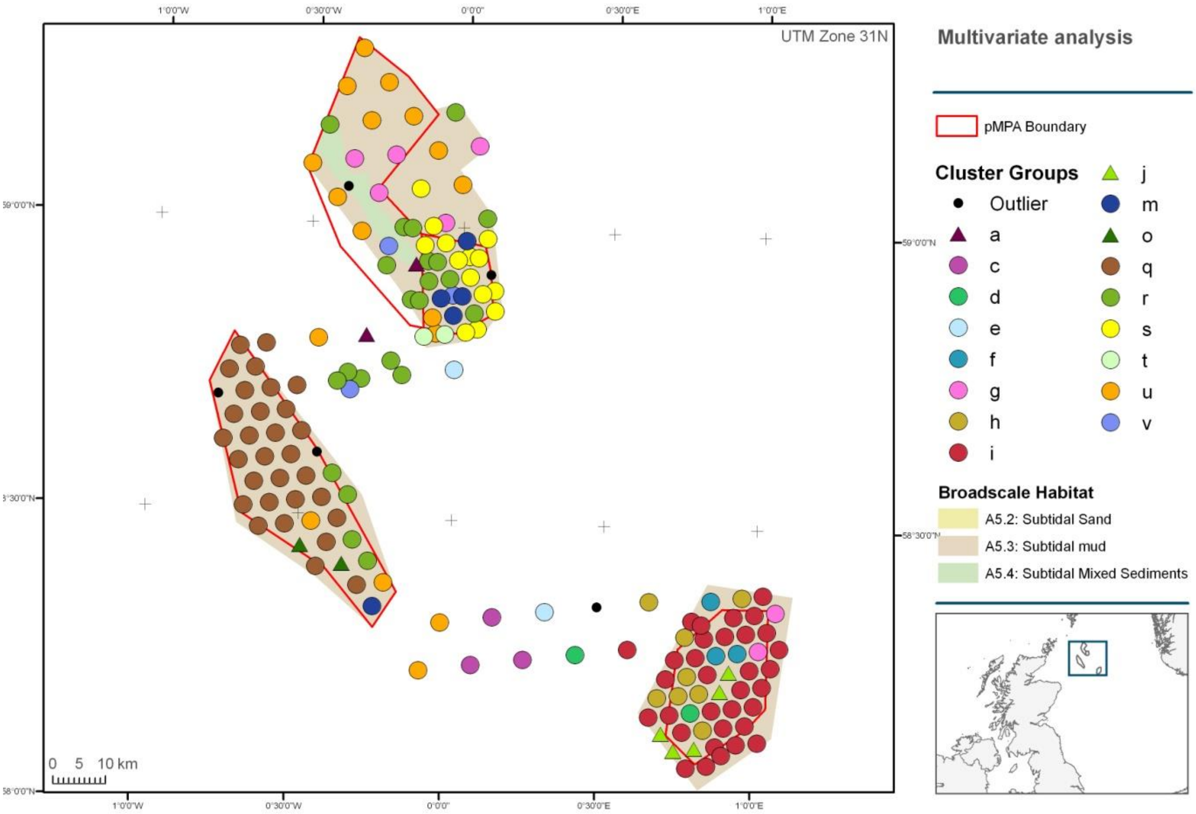

Figure 28: Location of cluster groups across the Fladen Grounds pMPAs.

4.5 Video and still image analysis

4.5.1 Multivariate analysis

Analysis of the video taxon-data-matrix revealed seven significantly different community groups (Figure 29). Viewing this information in ArcGIS showed that the clusters tended to group according to pMPA (Figure 30).

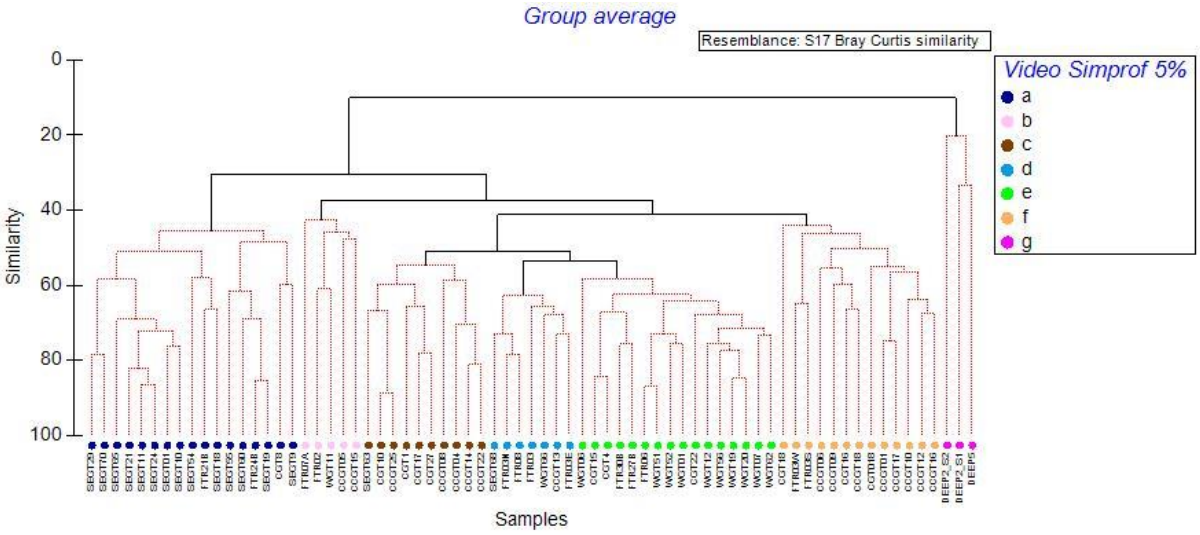

Figure 29: Hierarchical cluster analysis of species data from video tows. Red connecting lines indicate significantly different groups at p=0.05.

Groups d and f, located mainly within the Central Fladen (core) pMPA and at stations located in the 100% multibeam patch between Central and Western Fladen pMPAs, were the only groups with stations containing the tall sea pen, *Funiculina quadrangularis*. Both groups were also characterised by the deeplet sea anemone, *Bolocera tuediae*, anemone shrimp, *Spirontocaris liljeborgii*, mud encrusted polychaete tubes (species undetermined), the phosphorescent sea pen, *Pennatula phosphorea,* the echinoderm, *Echinus acutus*, and the slender sea pen, *Virgularia mirabilis*. Dissimilarity between the two groups was due to differences in the number of observations of the aforementioned characterising species. Groups c and e, located mainly in the Central and Western Fladen pMPAs, respectively, were also characterised by mud encrusted polychaete tubes, in addition to *P. phosphorea*, *E. acutus* and *V. mirabilis*. Differences between groups c and e were due to higher average abundances of *E. acutus* and *Aporrhais* sp., and lower average abundances of *P. phosphorea, V. mirabilis* and polychaete tubes in group c. Group g was represented by the two video stations located in the deep valley within the Central Fladen pMPA. No seapens were observed at either of the deep stations. Video tows from within the South East Fladen pMPA mainly clustered into group a, and were distinguished from the other groups by the absence of *B. tuediae* and *S. liljeborgii* and only rare observations of polychaete tubes (see Appendix 11 for characteristic taxa within each cluster).

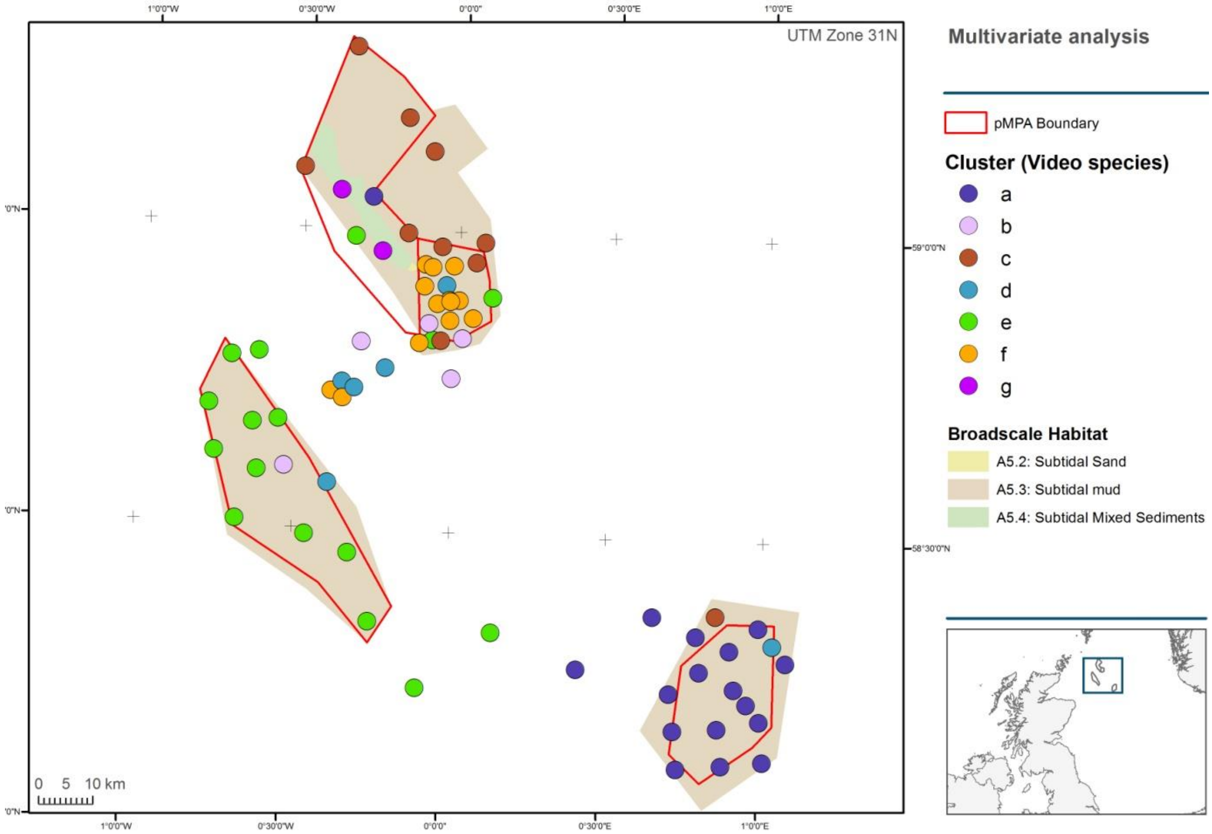

Figure 30: Significantly (p=0.05) different community groups identified from the video species data matrix.

Analysis of the still image data revealed considerable variability along each tow (see Appendices 12 and 13). This is unsurprising as epifauna are sparsely distributed on muddy sediments. The data were used to display the distribution of seapens along each video tow (see Section 4.6) and to inform the final biotope classification (see Section 4.8).

4.6 SMPA Priority Marine features and component habitats/species

4.6.1 Burrowed mud

The extent and distribution of the burrowed mud feature within each pMPA corresponds with the broadscale habitat A5.3: Subtidal mud as identified in Figure 17 to 19. Burrows were visible in the majority of videos analysed (all but three video stations).

4.6.2 Seapens and burrowing megafauna in circalittoral fine mud

The seapens *Virgularia mirabilis* and *Pennatula phosphorea* were observed in all the pMPAs and at transit stations between sites (Figure 31). As key characterising species of this biotope, the SACFOR abundance information for these species was subsequently used to inform final biotope classifications.

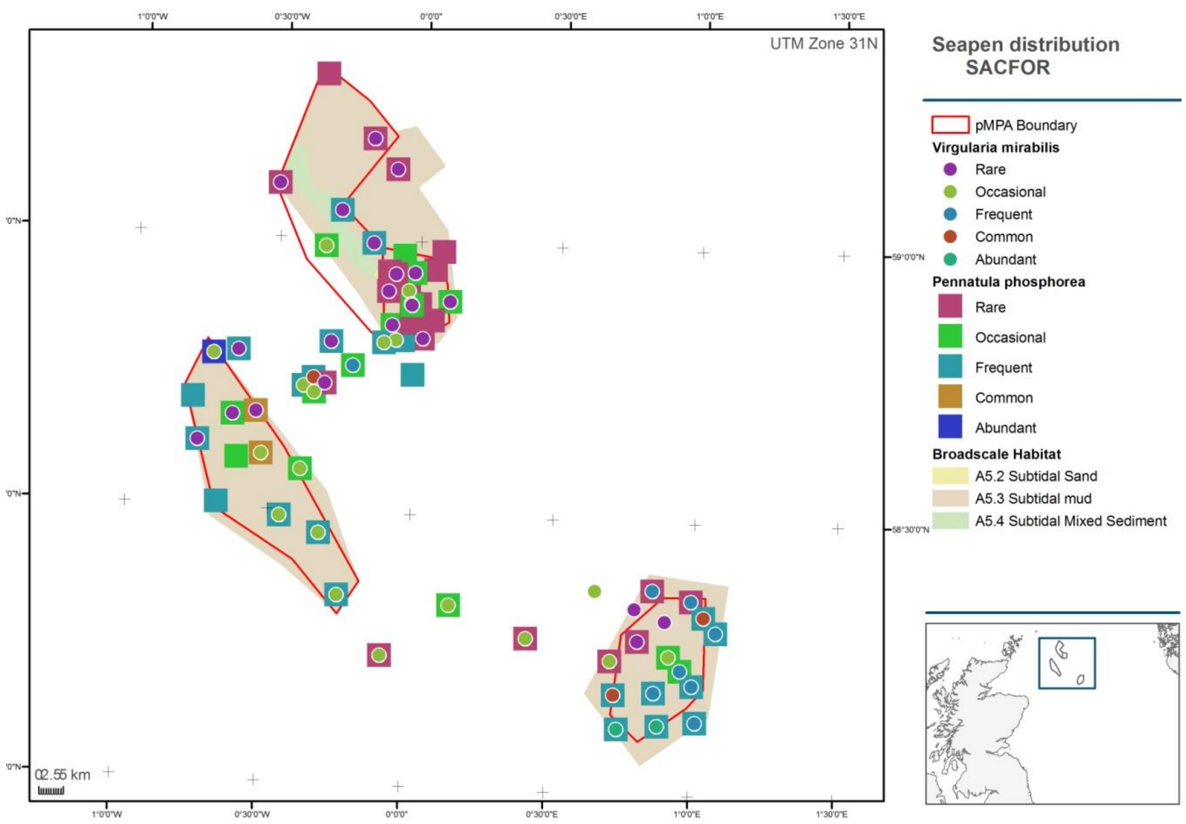

Figure 31: Distribution and SACFOR abundance scores of *Pennatula phosphorea* and *Virgularia mirabilis* across the Fladen Grounds pMPAs.

4.6.3 Tall Seapen Funiculina quadrangularis

The tall sea pen, *F. quadrangularis*, was observed at seven of the video stations, five located within Central Fladen (core) and two on the transit between the Central and Western Fladen pMPAs. The large brittlestar, *Asteronyx loveni*, was frequently observed encircling the seapen (Figure 32). Video station FTR03S, located between the Central and Western Fladen pMPAs, was identified as having the greatest abundances of *F. quadrangularis*, which were commonly observed (according to the SACFOR scale) in 23 of the 41 still images (56%) taken along the video transect (see Figure 33). *F. quadrangularis* was only observed in a maximum of 20% of the still images taken at stations located within Central Fladen (core).

Figure 32: *Funiculina quadrangularis* with the brittlestar, *Asteronyx loveni* coiled around it. Still images are from video station FTR03S.

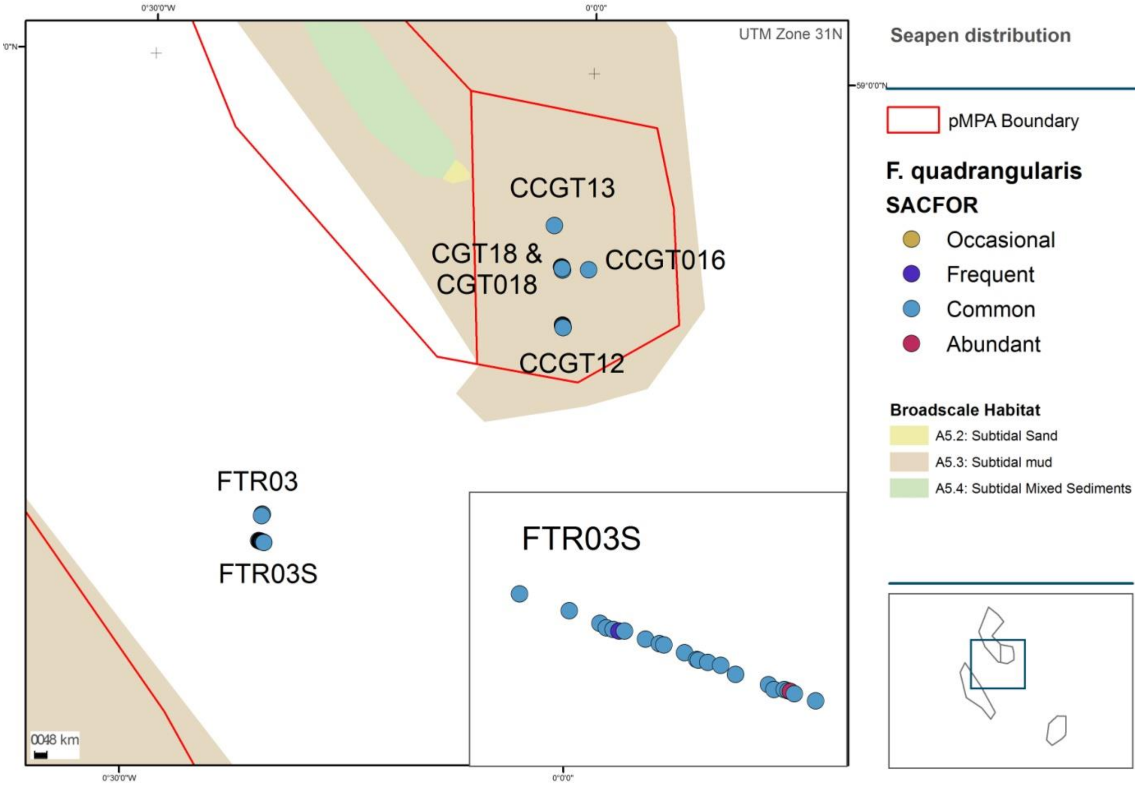

Figure 33: Distribution and SACFOR abundance scores of *Funiculina quadrangularis* across the Fladen Grounds pMPAs. Inset (within the main map) shows SACFOR scores of *F. quadrangularis* observed in still images from station FTR03S.

4.6.4 Mud burrowing amphipod, Maera loveni

The amphipod, *Maera loveni*, was identified in 31 grab samples across all pMPAs, with abundances of between 1 and 4 individuals (Figure 34). Highest abundances were found in the Western Fladen pMPA and lowest abundances were found in the Central Fladen pMPA.

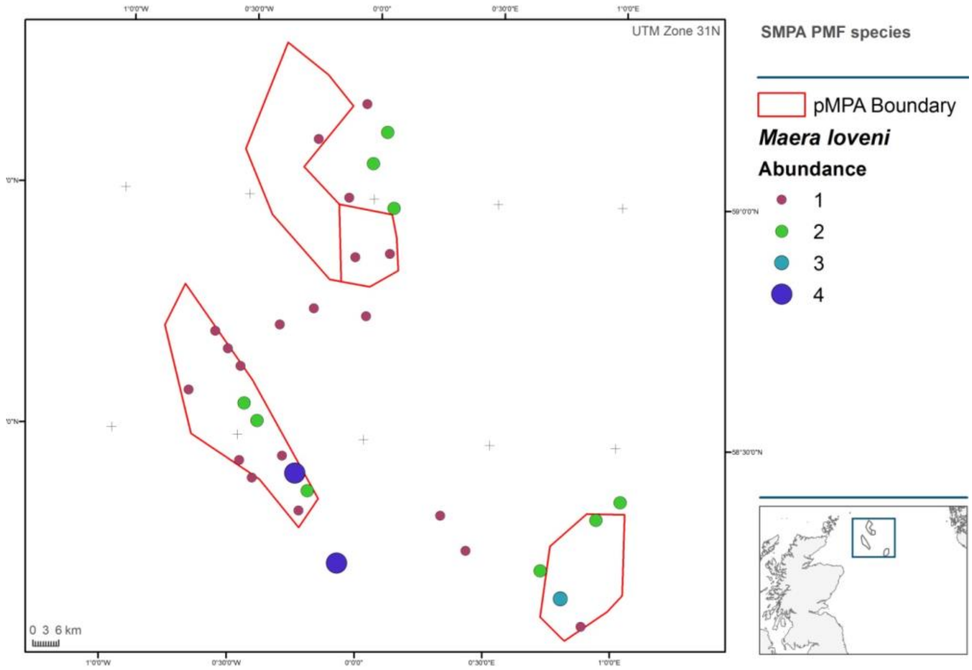

Figure 34: Distribution and abundance of the burrowing amphipod, *Maera loveni*.

4.6.5 Ocean quahog, Arctica islandica

A total of five adult *A. islandica* were identified from four grab samples solely within the Central Fladen pMPA, although juveniles of the species (mostly one individual) were found in numerous samples located across all pMPAs (Figure 35). *A. islandica* shells were also visible on the sediment surface in 10 video tows, however examination of still images revealed them to be dead.

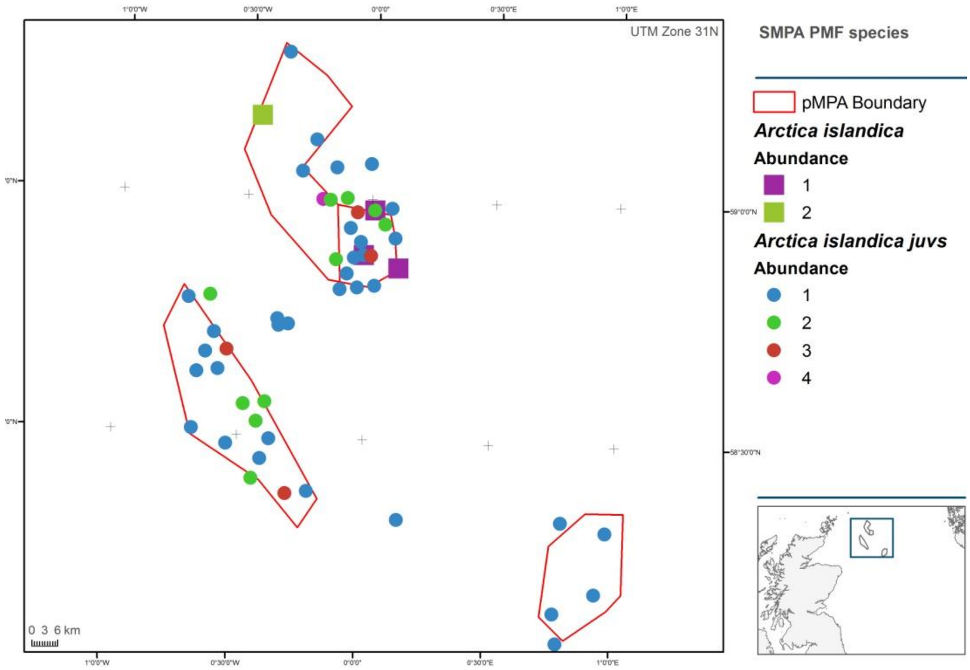

Figure 35: Distribution and abundance of the ocean quahog, *Arctica islandica* (adults and juveniles).

4.7 Other features: Pockmarks

Small pockmark features were observed in the multibeam backscatter throughout the South East Fladen pMPA. These features were also visible along the transit from the South East Fladen pMPA, but became less frequent nearer to the Western Fladen pMPA. Rance *et al* (2013), in their study of Scanner Pockmark SCI (located within South East Fladen pMPA), did not find any evidence of Methane Derived Authigenic Carbonate (MDAC) structures, which are characteristic of the Annex I habitat 'Submarine structures made by leaking gases'. However, they did find high abundances of the nematode species, *Astomonema southwardarum*, which is a characteristic species of methane seep habitats. Despite the presence of this organism, the physical evidence suggested that the methane vents were no longer active.

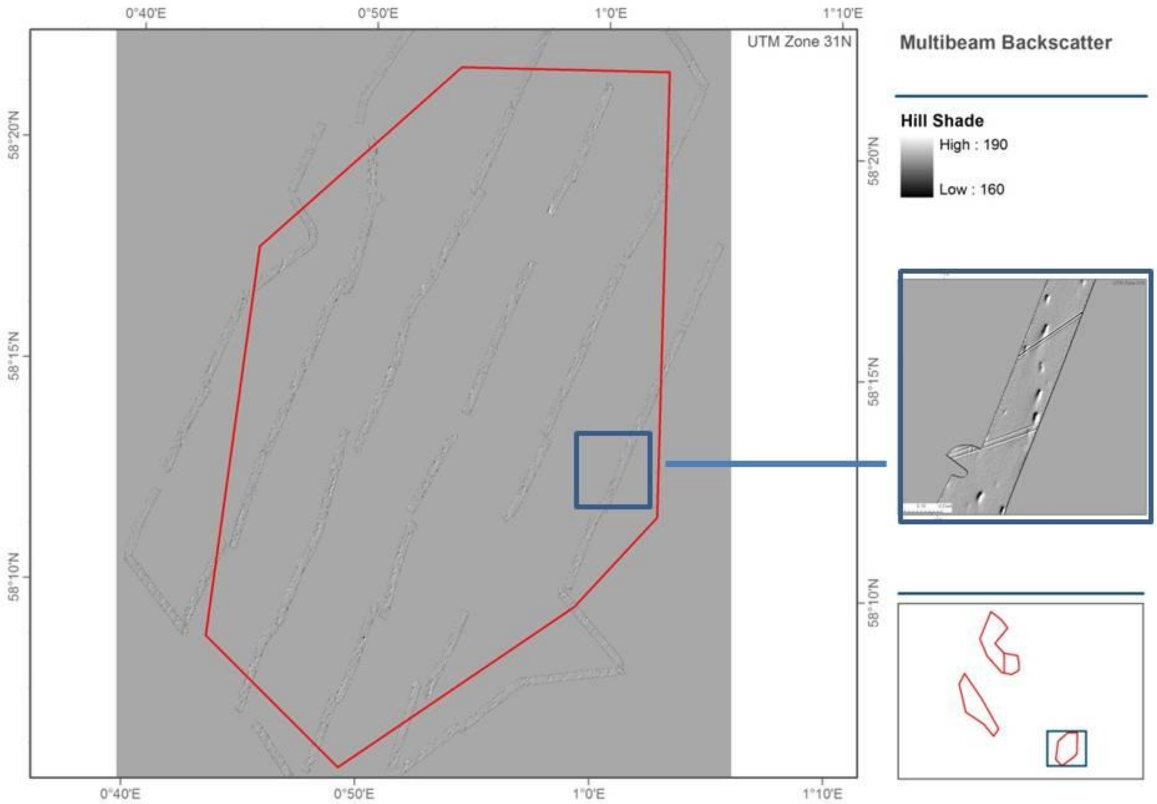

Figure 36: Pockmark features within the South East Fladen pMPA.

4.8 Biotopes

Biotopes have been assigned in all pMPAs using both the epifaunal data collected by video and infaunal data collected by grab. The infaunal clusters were mainly characterised by species that were not particular to any one EUNIS level 5 biotope, therefore only two clusters have been assigned with any confidence to a EUNIS level 5 biotope. Although epifaunal assemblages differed between sites (due to the presence/absence of certain species), seapens were the only epifaunal species present across the sites that were characteristic of EUNIS level 5 and 6 biotopes. Hence the final epifaunal biotope assignments were not pMPA site specific as per the multivariate analysis.

The EUNIS level 6 biotope 'A5.3611: Seapens, including *Funiculina quadrangularis*, and burrowing megafauna in undisturbed circalittoral fine mud' was assigned to five stations within Central Fladen (core) and two stations along the transit from Central to Western

Fladen pMPA. However, the water depths recorded across the Fladen Grounds are considerably deeper than currently documented for the biotope (see Conner *et al* 2004). Stations CTG18 (within Central Fladen (core)) and FTR03S (located on the transit from Central to Western Fladen) also contained less mud (18% and 6% (<63µm) respectively) than expected for the biotope. The habitat therefore represents a deep water, sandier variant of the biotope. The infaunal communities (represented by clusters m, v and r) were characterised by species such as the polychaetes *A. falcata*, *G. oculata* and *L. conchilega*, and the bivalve *M. ferruginosa*.

The EUNIS level 5 biotope A5.361: ‘Seapens and burrowing megafauna in circalittoral fine mud’ was assigned to 32 video stations distributed across all three pMPAs where seapen SACFOR abundance was recorded as frequent or more, in line with the typical abundance of the characterising species of this biotope (Connor *et al* 2004). Nine corresponding infaunal stations located within the South East Fladen pMPA were also assigned to the MPA component habitat and EUNIS Level 5 biotope A5.376 ‘*Paramphinome jefferysii, Thyasira* spp. and *Amphiura filiformis* in offshore circalittoral sandy mud. The remaining 23 stations were characterised by infauna from nine different clusters. Twenty-nine further video stations contained either one or both of the seapen species (*V. mirabilis or P. phosphorea*) with SACFOR abundances of rare or occasional but could not confidently be assigned to A5.361. Only three video stations in total did not contain any seapens or burrows. One station (Deep 2) was assigned to the EUNIS level 5 biotope A5.441 ‘*Cerianthius lloydii* and other burrowing anemones in circalittoral muddy mixed sediment’. Station ‘Deep 5’ was assigned A5.45: Deep circalittoral mixed sediment. Figure 37 shows the distribution of all epifaunal biotopes assigned. Where biotopes were assigned to EUNIS level 4, biotope-characteristic epifaunal species were either absent or were only less than frequently observed (see also Appendix 14 for final biotope assignments of video data).

The EUNIS level 5 biotope A5.376 ‘*Paramphinome jefferysii, Thyasira* spp. and *Amphiura filiformis* in offshore circalittoral sandy mud was assigned to 50 infaunal stations (clusters i and u) located across the pMPAs. These two infaunal clusters differed significantly according to the multivariate analysis due to the higher abundances of *T. equalis* and *H. filiformis* within South East Fladen pMPA (characteristic of muddier habitats), and higher abundances of *G. oculata* and *L. conchilega* (that use sand grains to build their tubes) in the Western and Central Fladen pMPAs, however both were dominated by key species characteristic of A5.376 (i.e. *P. jeffereysii, T. equalis and S. kroyeri),* although *A. chiajei* was more abundant than *A. filiformis*. The remaining infaunal clusters could not be matched with any EUNIS level 5 (or higher) biotope, and have therefore been assigned to EUNIS level 3 or 4 in-line with the results from the PSA (Figure 38).

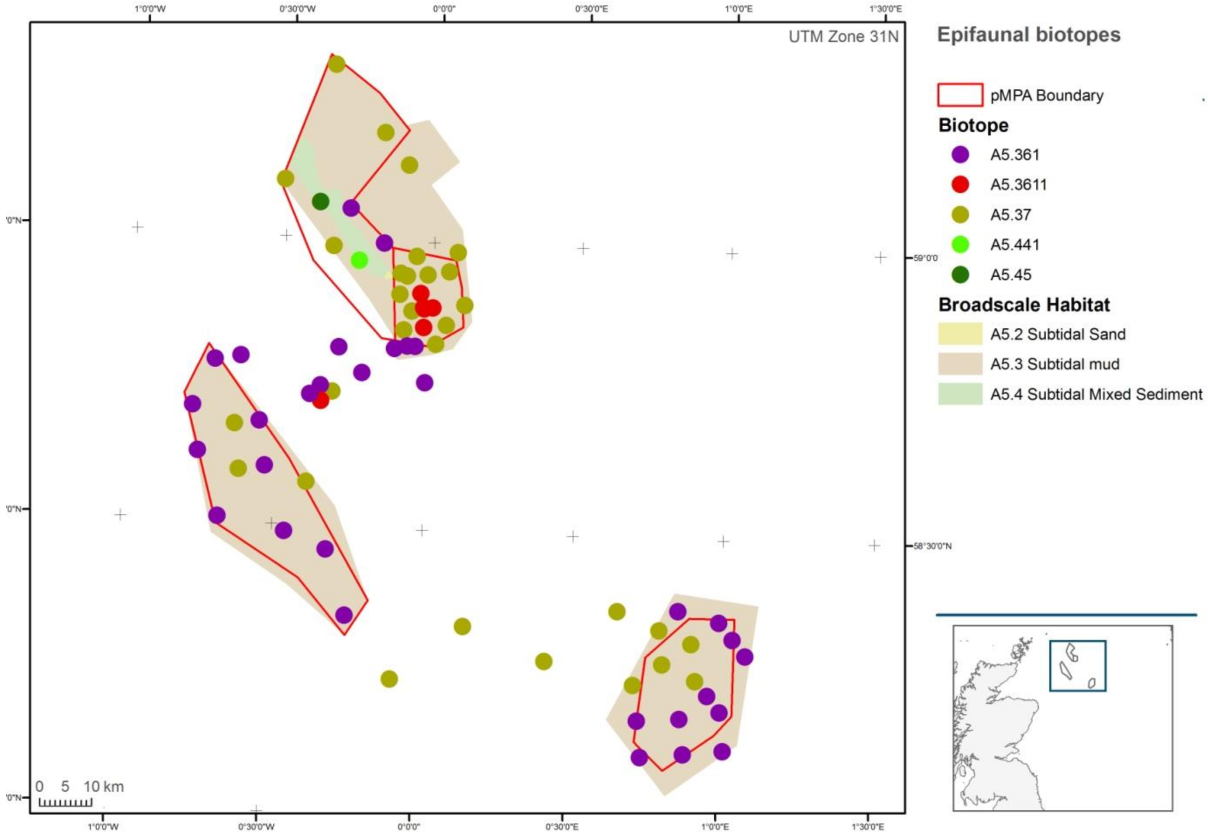

Figure 37: Biotopes assigned to video stations.

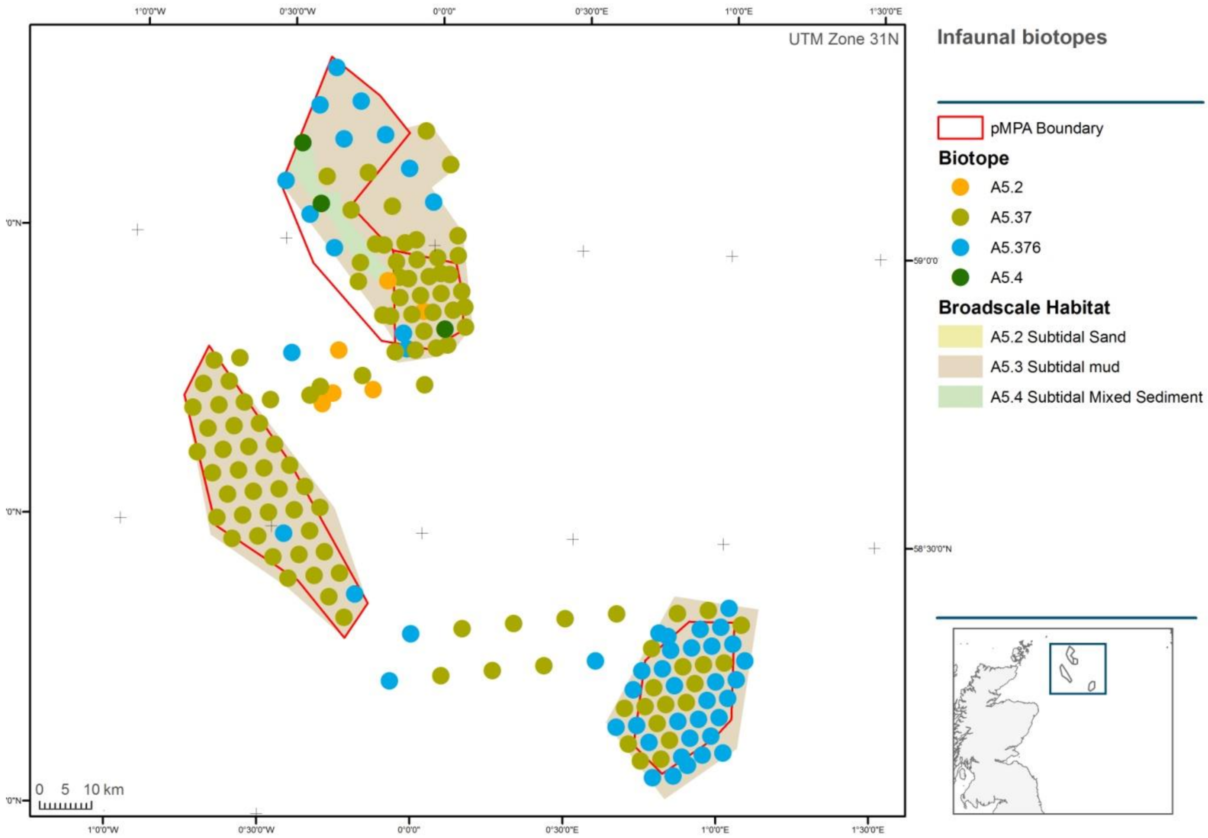

Figure 38: Biotopes assigned to grab stations.

4.9 Anthropogenic impacts

Throughout the acoustic survey, a record was kept of any apparent trawl marks that were observed in the acoustic backscatter data. Trawl marks were mainly observed within the South East Fladen pMPA and on the transit between Western Fladen and South East Fladen pMPAs (Figure 39 and Figure 40). Though trawl marks were predominantly observed in the South East Fladen area it is not possible to make any estimations of effort, nor compare between proposed sites, due to the low proportion of acoustic coverage across the Fladen area. Observations of this nature are helpful in demonstrating evidence of benthic trawling at a location but are difficult to link to impacts at the seabed as there is poor knowledge of the longevity of trawl scars on muddy habitats. A dedicated pressure-impact study could further knowledge in this area, as well as potentially exploring habitat state variability between the Fladen proposed MPA sites.

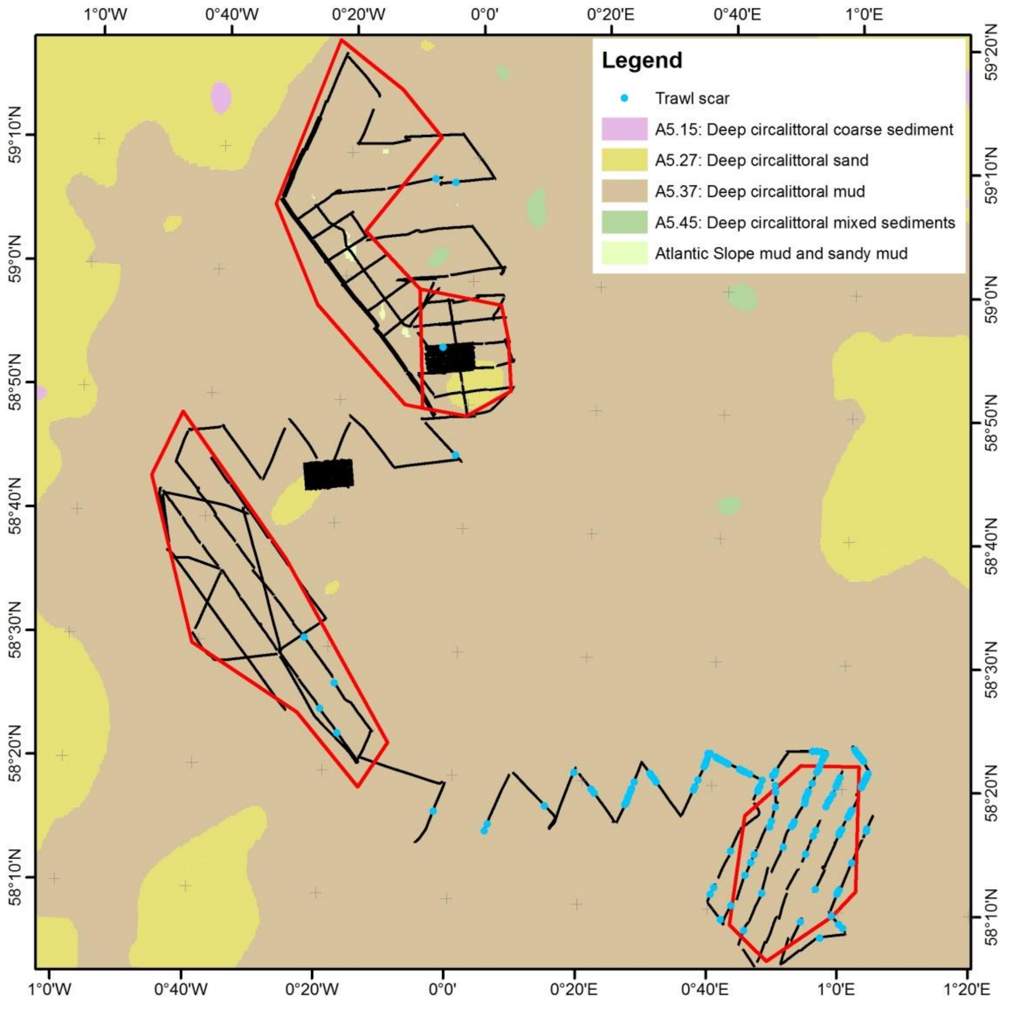

Figure 39: Location of linear ‘trawl’ marks on the seabed observed during the acoustic survey overlying UKSeaMap 2010 predictive model habitat map.

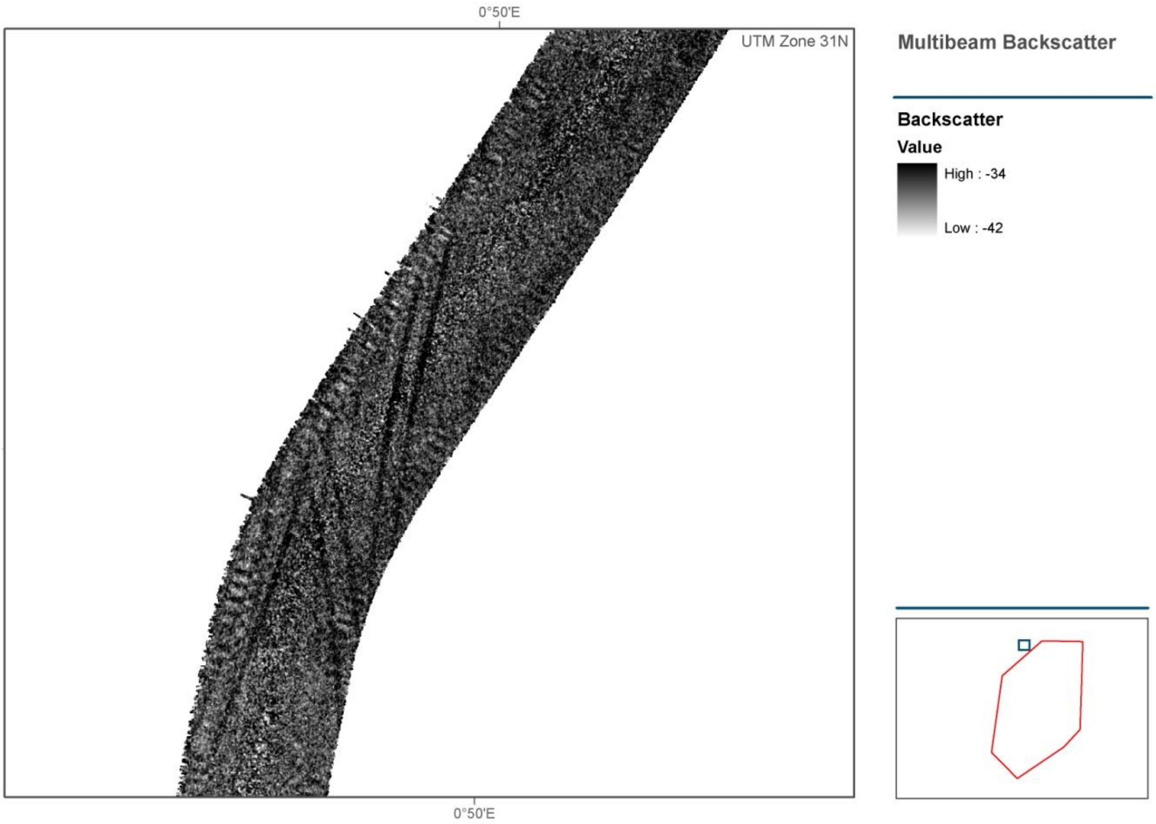

Figure 40: Detail of the multibeam backscatter data showing trawls scars on the seabed. Inset shows location of multibeam data in relation to the South East Fladen pMPA.

Linear marks of potential anthropogenic origin were recorded at 12 video stations. At six of these stations (CGT1, FTR30B, FTR27B, FTR21, SEGT01 and SEGT19) parallel linear marks were visible in the sediment which resembled marks left by dredge-type fishing gear. Still images of these marks were taken at stations CTG1 and SEGT19 (Figure 41).

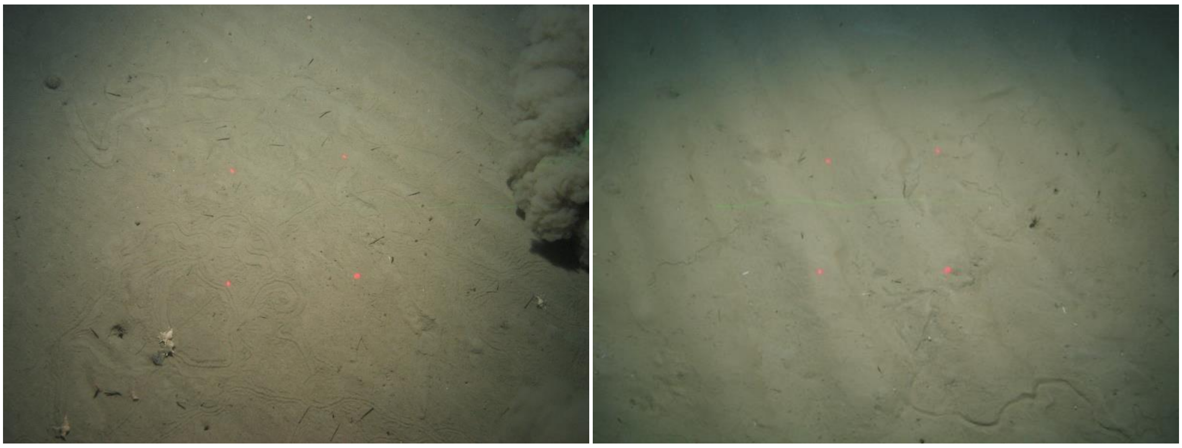

Figure 41: left; Still images from CGT1 image 004 (Linear track in top right of image) and right; SEGT19 image 009.

In addition to the impact from fishing activities, there were further anthropogenic impacts observed related to the oil and gas developments in the area. The main feature observed were pipelines running on or below the seabed. These features were observed in all three survey areas.

5 Discussion

5.1 Summary of habitats and features recorded

The MPA search features and component habitats/species proposed for designation and recorded within the Fladen pMPAs, along with biotopes and broadscale habitats recorded, are summarised in Table 3 below:

Table 3: Summary of SMPA search features proposed for protection, biotopes and BSH observed at the Fladen Grounds pMPAs.

pMPA	SMPA search feature	Component habitat/species	Biotopes	Broadscale habitats
Central Fladen	Burrowed mud	Sea pens and burrowing megafauna in circalittoral fine mud*	A5.361*	Subtidal mud
		Tall seapen *Funiculina quadrangularis* (Central Fladen (core) only)	A5.3611*	
	Offshore deep sea muds	*Paramphinome jeffreysii*, *Thyasira* spp. and *Amphiura filiformis* in offshore circalittoral sandy mud	A5.37 A5.376	
			A5.441* A5.45 A5.2	Subtidal mixed sediments Subtidal sand
South East Fladen	Burrowed mud	Sea pens and burrowing megafauna in circalittoral fine mud	A5.361*	Subtidal mud
	Offshore deep sea muds	*Paramphinome jeffreysii*, *Thyasira* spp. and *Amphiura filiformis* in offshore circalittoral sandy mud	A5.37 A5.376	
Western Fladen	Burrowed mud	Sea pens and burrowing megafauna in circalittoral fine mud	A5.361*	Subtidal mud
	Offshore deep sea muds	*Paramphinome jeffreysii*, *Thyasira* spp. and *Amphiura filiformis* in offshore circalittoral sandy mud	A5.37 A5.376	

*deep circalittoral variant of the biotope.

5.1.1 Broadscale habitats

The Fladen Grounds pMPAs are dominated by the broadscale habitat, ‘Subtidal mud’. Only Central and Central Fladen (core) demonstrated any heterogeneity in terms of broadscale habitat. A deep tunnel valley, observed in the multibeam bathymetry data at Central Fladen, was recorded at 293m below chart datum at its deepest point, while the depths across the site generally ranged between 100-150m below CD. The tunnel valley was characterised by coarser sediment (Subtidal mixed sediments) which provides suitable habitat for the colonisation of encrusting epifaunal species such as the barnacle, *Verruca stroemia* (identified in station Deep5). At the edge of the valley, nearing the shallowest region of the Central Fladen pMPA, the southeastern tip was found to comprise 'Subtidal sands'. Within Central Fladen (core) one station was classified as 'Subtidal mixed sediments' and one as 'Subtidal sands' as determined from PSA data, though this disagreed with video stills analysis at the same stations. Broadscale habitat mapping, therefore, did not discern these stations as a separate habitat within the wider context of the site. Along the transit from Central to Western Fladen, four stations were classified as 'Subtidal sand', one of which (station FTR03S) was observed with the highest frequency of the tall seapen, *Funiculina quadrangularis*.

5.1.2 Biotopes

Multivariate analysis highlighted significant differences between pMPAs for both the infaunal and epifaunal assemblages, although these differences were mainly due to shifts in average abundances of the characteristic species or absence of species not characteristic of any particular biotope. For instance, differences between the infauna of the South East Fladen and the two other pMPAs were caused by higher average abundances of species characteristic of sediments with high mud content, and reduced abundances of sand-tolerant species. Epifauna was sparse and variable along the video tows, which is typical for muddy sediments, therefore differences were due to the presence/absence of certain species. For instance, the anemone *B. tuediae* and its associated shrimp species *S. liljeborgii* was absent from South East Fladen and polychaete tubes were only rarely observed at this pMPA in comparison with Central and Western Fladen. Biotope assignment for both infauna and epifauna was based on the presence of certain characteristic species which may have been common to more than one multivariate cluster and pMPA.

The EUNIS level six biotope, A5.3611: Seapens, including *Funiculina quadrangularis*, and burrowing megafauna in undisturbed circalittoral fine mud, was assigned to five video stations within Central Fladen (core) and two between Central and Western Fladen. The level 5 biotope A5.361: Seapens and burrowing megafauna in circalittoral fine mud, was assigned to 32 video stations across the pMPAs where seapen SACFOR abundance was recorded as frequent or more in line with the typical abundance of the characterising species of this biotope (Connor *et al* 2004). The depths and sediment composition recorded across the Fladen Grounds were more characteristic of the EUNIS level 4 biotope A5.37: Deep circalittoral mud, therefore these biotopes represent deep circalittoral variants. Seapens and burrows were identified at 29 further video stations, although seapen abundances were recorded as only occasional or rare. These stations were indicative of the Seapen and burrowing megafauna habitat but could not be assigned to the level 5 biotope with any confidence due to the presence of fewer characterising species. The EUNIS level 4 biotope, A5.37: Deep circalittoral mud was therefore assigned to these stations. Records of A5.361 and A5.3611 habitats in the current classification system are largely restricted the west coast of Scotland and do not show any presence in the North Sea region. This may be a reflection of the paucity of data from offshore regions available for use in the current classification system. Work is currently being undertaken to update the classification system by incorporating more data from offshore regions. Deep North Sea variants of both habitats may be acknowledged during this process.

In addition, two stations within the tunnel valley in the Central Fladen pMPA were assigned to A5.45: Deep circalittoral mixed sediments and A5.441: '*Cerianthus lloydii* and other burrowing anemones in circalittoral muddy mixed sediment' (stations Deep5 and Deep 2 respectively).

The EUNIS level 5 biotope, A5.376: *Paramphinome jefferysii, Thyasira* spp. and *Amphiura filiformis* in offshore circalittoral sandy mud was assigned to 50 grab stations (from two clusters) located mainly in the South East Fladen and Northern part of the Central Fladen. The remaining stations could not be confidently assigned to biotopes higher than EUNIS level 3 or 4 as the dominant species and community composition did not match suitably to any of the current level 5 biotopes.

5.1.3 MPA Search Features and component habitats/species

The 'burrowed mud' MPA search feature and component habitat 'seapens and burrowing megafauna in circalittoral fine mud' were identified in all pMPAs. All but three of the video stations had evidence of seapens and burrowing fauna. The MPA component species 'the tall seapen, *F. quadrangularis',* was only observed at five video stations within Central Fladen (core) and at two stations in an area between Central and Western Fladen pMPAs. Links between the presence of *F. quadrangularis* and sediment composition and depth were inconclusive, although in several cases, the seapens were found in shallower areas containing coarser sediment (sand and shell debris).

Two SMPA search feature species were found in low numbers across the pMPAs. Adult *A. islandica*, were only found within the Central Fladen pMPA, although juveniles of the species were found across all pMPAs. The species was not, however, found in high numbers that constitute 'aggregations', as defined under the MPA search feature criteria. The mud burrowing amphipod, *M. loveni,* was found in highest numbers (4 individuals) within and to the south of the Western Fladen pMPA. Spatial distribution of the species was also highest within this pMPA.

5.1.4 Annex I habitats

No Annex I habitats were identified within any of the three pMPAs. Pockmark features were clearly visible in the multibeam bathymetry data within the South East Fladen pMPA and along the transit to Western Fladen pMPA, where the features became less abundant. However, there was no evidence of MDAC presence within the grab samples. The large pockmark features known as the Scanner-Scotia-Challenger pockmark complex were not visible at the scale of the survey.

5.1.5 Anthropogenic impacts

There was evidence in both multibeam and video data of trawl marks in the sediment across the pMPAs. Though trawl marks were predominantly observed in the South East Fladen area it was not possible to make any estimations of effort, nor compare between proposed sites, due to the low proportion of acoustic coverage across the Fladen area. A dedicated pressure-impact study could further knowledge in this area, as well as potentially exploring habitat state variability between the Fladen proposed MPA sites.

5.2 Data/survey limitations

It is important to highlight issues related to confidence levels in the habitat maps in Figure 17 to Figure 19. Multibeam Echosounder (MBES) data were only collected between sampling grab/camera stations and as such there are large acoustic data gaps across the site. With this in mind, habitat boundaries are indicative and not definitive, as habitat boundaries are rarely abrupt. Where possible, habitat boundaries were drawn to combine information on reflectivity changes (from collected backscatter) and evidence from sediment sampling. For this reason, boundaries appear linear and angular, and are unlikely to reflect a true habitat transition. As it is impractical (and undesirable) to sample the entire area of the site with grabs and video, there is the chance that a feature may exist within the site but has not been recorded, especially if it is limited in extent. The broadscale habitats were manually interpreted and therefore did not allow for confidence assessment.

As discussed previously, attempts were made to identify an environmental surrogate to aid prediction of the species *Funiculina quadrangularis.* Onboard data analysis appeared to suggest that the tall seapen may be associated with shallower, coarser habitats across the Fladen Grounds. While there was some evidence of increasing sand fractions being associated with increasing presence of *F. quadrangularis (*Figure 16*),* there was insufficient evidence to derive a robust relationship between these parameters. Results from both sites investigated with 100% multibeam coverage and camera and grab sampling indicate that *F. quadrangularis* is capable of existing at a range of depths. Plots of the presence of *F. quadrangularis* at the 100% multibeam sites (Figure 21 and Figure 22) demonstrate the difficulties in identifying an environmental surrogate for predicting the presence of this species. A further confounding issue was the % sand fractions at these sites being close to the thresholds set for the modified Folk classification method between 'Subtidal Mud' and 'Subtidal Sand'. In these instances small changes in the sand fraction of samples would be enough to tip the modified Folk descriptions from one to another, but may not necessarily demonstrate a large physical change identifiable as a reflectivity change on the backscatter return.

The biotope assignments for A5.361 and A5.3611 are indicative pending an update of the Marine Habitat Classification v 04.05 and EUNIS classification system. These classification systems currently lack information from deeper offshore regions, and as such, do not currently incorporate biotopes such as 'Seapens and burrowing megafauna' and the 'tall seapen, *F. quadrangularis*' into the 'Deep circalittoral mud' habitat that is found across the Fladen Grounds.

6 Conclusions

This report presents evidence to support the proposal of possible MPAs in the Fladen Grounds. The presence and extent of the 'Burrowed mud' MPA search feature proposed for protection through site designation was verified across all pMPAs. The majority of these records consist of the component habitat 'Seapens and burrowing megafauna in circalittoral fine mud'. The tall seapen, *Funiculina quadrangularis,* was found at stations within the Central Fladen (core) and on transects between the Central and Western Fladen pMPAs.

Biotope assignments made in this study are indicative, pending update of the Marine Habitat Classification v 04.05 and EUNIS classification system, as both the 'Seapens and burrowing megafauna in circalittoral fine mud' and 'tall seapen, *Funiculina quadrangularis*' EUNIS classifications fall within the 'Circalittoral fine mud' habitat, whereas the Fladen Grounds pMPAs generally fall within the 'Deep circalittoral mud' habitat.

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8 Appendices

Appendix 1. List of SMPA seabed habitat Search Features/Priority Marine Features in Scottish offshore waters

MPA search feature/Priority Marine Feature	Component habitats*/species
Burrowed mud	Seapens and burrowing megafauna in circalittoral fine mud
	Burrowing megafauna and *Maxmuelleria lankesteri* in circalittoral mud
	Tall seapen *Funiculina quadrangularis*
	Fireworks anemone *Pachycerianthus multiplicatus*
	Mud burrowing amphipod *Maera loveni*
Carbonate mound communities	Carbonate mound communities
Cold-water coral reefs	Coral reefs
Coral gardens	Coral gardens
Deep sea sponge aggregations	Deep sea sponge aggregations
Northern sea fan and sponge communities	Northern sea fan *Swiftia pallida*
	Deep sponge communities (circalittoral)
Offshore deep sea muds	*Ampharete falcata* turf with *Parvicardium ovale* on cohesive muddy sediment near margins of deep stratified seas
	Formaniferans and *Thyasira* sp. in deep circalittoral fine mud
	Levinsenia gracilis and *Heteromastus filiformis* in offshore circalittoral mud and sandy mud
	Paramphinome jeffreysii, *Thyasira* spp. and *Amphiura filiformis* in offshore circalittoral sandy mud
	Myrtea spinifera and polychaetes in offshore circalittoral sandy mud
Offshore subtidal sands and gravels	*Glycera lapidum*, *Thyasira* spp. and *Amythasides macroglossus* in offshore gravelly sand
	Hesionura elongata and *Protodorvillea kefersteini* in offshore coarse sand
	Echinocyamus pusillus, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand
	Abra prismatica, Bathyproeia elegans and polychaetes in circalittoral fine sand
	Maldanid polychaetes and *Eudorellopsis deformis* in offshore circalittoral sand or muddy sand
	Owenia fusiformis and *Amphiura filiformis* in offshore circalittoral sand or muddy sand
Seamount communities	Seamount communities
Submarine structures made by leaking gases	Submarine structures made by leaking gases

* Note the biotopes listed as search feature compoenents are not exhaustive, others may be considered where appropriate.

Appendix 2. List of low or limited mobility species in Scottish offshore waters

MPA search feature	Species name	Taxon group
Northern feather star aggregations on mixed substrata	*Leptometra celtica*	Starfish and feather stars
Fan mussel aggregations	*Atrina pectinata*	Snails, clams, mussels and oysters
Ocean quahog aggregations	*Arctica islandica*	Snails, clams, mussels and oysters

Appendix 3. Annex I Habitats

Annex I Habitats
Atlantic salt meadows
Estuaries
Lagoons
Large shallow inlets and bays
Mediterranean and thermo-Atlantic halophilious scrubs
Mudflats and sandflats not covered by seawater at low tide
Reefs
Salicornia and other annuals colonising mud and sand
Sandbanks which are slightly covered by seawater all the time
Spartina swards
Submerged or partially submerged caves
Submarine structures made by leaking gases

Appendix 4. Geological context: Additional pockmark information

Pockmarks are crater-like depressions with an asymmetric perimeter in the Witch Ground Basin (Judd & Hovland 2007). It is believed that they are formed by the expulsion of fluids through seabed sediments (Hovland 1989; Dando 2001). The escaping fluid is gas in the majority of cases, but may also be groundwater (Judd 2001). The gas may be microbial or thermogenic. In the first case the gas forms because of microbial decomposition of organic matter within the near-seabed sediments (Judd 2001). In the second case, the gas originates from the thermocatalytic destruction of kerogens deep within the sediments. The gas is typically composed principally by methane (>95%) and if thermogenic ethane, butane, propane and pentane may also be present (Judd 2001).

Inactive pockmarks show no signs of gas seepage (Dando 2001). However, the gas seepage observed in the so-called active pockmarks is generally a gentle bubbling and is insufficient to erode the seabed sediments (Judd 2001) and justify the presence of the crater shape. A conceptual model has been suggested by Hovland and Judd (1988) for the formation of pockmarks. During the first stage, the gas accumulates beneath the seabed and the fluid pressure may inflate the sediments to form a dome. In a second stage, the gas is released in a single event that fluidises the sediment in the water column: fine-grained sediments are drift away from the currents, while coarse sediment falls back to the pockmark floor that is often found to be covered by a lag deposit of coarse sediment (Judd 2001). The event that triggers the gas expulsion may be an earthquake or any disturbance of the seabed, e.g. iceberg ploughing (Judd 2001). If the gas continues to migrate from deeper sediments, gas seepage may continue or the gas may be periodically trapped within a sequence of inter-bedded fine and coarse sediment layers so that gas escape becomes intermittent and gives rise to polycyclic pockmarks (Judd 2001).

The Scanner pockmark complex is reported to be active with an escape of methane (Dando 2001). There is not a scientific consensus on the origin of the gas, as it could equally be that it originates from a shallow biogenic source, a deep thermogenic source, or from both. However, based on the review of isotopic analyses found in literature, Stoker and Holmes (2005) concluded that, the gas is predominantly of biological origin. Judd *et al* (1994) suggested that the Tertiary lignites are the most likely source of the gas; they also suggested that gas generation started earlier than the deposition of the Quaternary sediments in which it is accumulated and that is still forming providing a continuous supply. In the largest pockmark, the gas seepages are fed from a laterally almost continuous deposit of gas-charged sediments situated between the margins of a buried sub-glacial channel approximately 120m below seabed (Stoker & Holmes 2005).

Appendix 5. Survey metadata: Grab sample positions

Area	Stn Code	Stn No	Attempt	Gear	Date	Time	Latitude	Longitude
Central Fladen	CGT15	9	A1	DG	06/01/2013	00:03	58.818680	-0.076658
Central Fladen	CGT11	12	A1	DG	06/01/2013	02:26	58.874860	-0.162982
Central Fladen	CGT7	14	A2	DG	06/01/2013	04:05	58.931100	-0.249369
Central Fladen	CGT4	16	A1	DG	06/01/2013	05:14	58.987650	-0.336399
Central Fladen	CGT2	19	A1	DG	06/01/2013	06:51	59.043720	-0.423406
Central Fladen	CGT1	21	A1	DG	06/01/2013	08:13	59.099820	-0.510675
Central Fladen	CGT3	24	A1	DG	06/01/2013	09:41	59.166600	-0.460028
Central Fladen	CGT6	27	A1	DG	06/01/2013	10:48	59.233570	-0.409255
Central Fladen	CGT10	29	A1	DG	06/01/2013	11:41	59.300030	-0.358136
Central Fladen	CGT14	32	A1	DG	06/01/2013	13:49	59.244050	-0.270209
Central Fladen	CGT09	34	A1	DG	06/01/2013	14:42	59.177190	-0.321338
Central Fladen	CGT17	36	A1	DG	06/01/2013	15:41	59.187640	-0.182680
Central Fladen	CGT28	39	A1	DG	06/01/2013	17:17	59.197760	-0.044677
Central Fladen	CGT26	41	A1	DG	06/01/2013	18:13	59.141160	0.042289
Central Fladen	CGT27	43	A1	DG	06/01/2013	19:16	59.131110	-0.095894
Central Fladen	CGT13	46	A1	DG	06/01/2013	20:57	59.120850	-0.234123
Central Fladen	CGT05	48	A1	DG	06/01/2013	21:52	59.110870	-0.372550
Central Fladen	CGT8	50	A1	DG	06/01/2013	22:45	59.054470	-0.285508
Central Fladen	CGT24	53	A1	DG	07/01/2013	00:43	59.064580	-0.147615
Central Fladen	CGT25	55	A1	DG	07/01/2013	01:39	59.074720	-0.009488
Central Fladen	CGT23	57	A1	DG	07/01/2013	02:34	59.018270	0.076975
Central Fladen	CGT19	60	A1	DG	07/01/2013	05:27	59.008140	-0.061018
Central Fladen	CGT12	62	A1	DG	07/01/2013	06:23	58.997880	-0.198543
Core Central Fladen	CCGT4	64	A1	DG	07/01/2013	06:53	58.996640	-0.168608
Core Central Fladen	CCGT11	67	A1	DG	07/01/2013	08:14	59.001870	-0.099703
Core Central Fladen	CCGT7	69	A1	DG	07/01/2013	08:48	58.968570	-0.125189
Core Central Fladen	CCGT14	71	A1	DG	07/01/2013	09:24	58.973450	-0.056373
Core Central Fladen	CCGT20	75	A1	DG	07/01/2013	10:51	58.978680	0.012196
Core Central Fladen	CCGT25	77	A1	DG	07/01/2013	11:26	58.983970	0.081591
Core Central Fladen	CCGT22	80	A1	DG	07/01/2013	12:40	58.950380	0.055271
Central Fladen	CGT21	82	A1	DG	06/01/2013	13:47	58.951640	0.025098
Core Central Fladen	CCGT17	83	A1	DG	07/01/2013	14:19	58.945330	-0.013316
Core Central Fladen	CCGT10	85	A1	DG	07/01/2013	14:55	58.940360	-0.082225
Central Fladen	CGT16	86	A2	DG	07/01/2013	15:33	58.941670	-0.112521
Core Central Fladen	CCGT3	88	A3	DG	07/01/2013	16:51	58.935160	-0.151022
Core Central Fladen	CCGT6	90	A2	DG	07/01/2013	17:42	58.907100	-0.107786
Core Central Fladen	CCGT13	92	A1	DG	07/01/2013	18:17	58.912030	-0.038809
Core Central Fladen	CCGT19	95	A1	DG	07/01/2013	19:32	58.916990	0.029759
Core Central Fladen	CCGT24	97	A1	DG	07/01/2013	20:06	58.922180	0.098545
Central Fladen	CGT22	99	A1	DG	07/01/2013	20:42	58.895020	0.111348
Core Central Fladen	CCGT21	102	A1	DG	07/01/2013	21:55	58.888780	0.072675
Core Central Fladen	CCGT16	104	A2	DG	07/01/2013	22:33	58.883800	0.004316
Central Fladen	CGT18	105	A2	DG	07/01/2013	23:04	58.885160	-0.026140
Core Central Fladen	CCGT9	107	A1	DG	07/01/2013	00:12	58.878770	-0.065027
Core Central Fladen	CCGT2	110	A1	DG	08/01/2013	01:29	58.873750	-0.135680
Core Central Fladen	CCGT5	112	A1	DG	08/01/2013	02:10	58.845470	-0.090447
Core Central Fladen	CCGT12	115	A1	DG	08/01/2013	03:23	58.850590	-0.021822
Core Central Fladen	CCGT18	117	A1	DG	08/01/2013	03:57	58.855470	0.046992
Core Central Fladen	CCGT23	120	A1	DG	08/01/2013	05:07	58.860440	0.115723
Central Fladen	CGT20	122	A1	DG	08/01/2013	05:45	58.828540	0.059535
Core Central Fladen	CCGT15	124	A2	DG	08/01/2013	06:18	58.822320	0.021055

Area	Stn Code	Stn No	Attempt	Gear	Date	Time	Latitude	Longitude
Core Central Fladen	CCGT8	127	A1	DG	08/01/2013	07:28	58.817150	-0.047671
Core Central Fladen	CCGT1	129	A1	DG	08/01/2013	08:03	58.812210	-0.116064
Fladen Transits	FTR07A	131	A1	DG	08/01/2013	08:59	58.757760	-0.011535
Fladen Transits	FTR01A	135	A1	DG	08/01/2013	10:52	58.745090	-0.182568
Fladen Transits	FTR02	137	A3	DG	08/01/2013	12:53	58.811000	-0.303410
Fladen Transits	FTR03	140	A1	DG	08/01/2013	14:40	58.732040	-0.353430
Fladen Transits	FTR04	143	A1	DG	08/01/2013	16:49	58.802490	-0.461096
Fladen Transits	FTR05	145	A1	DG	08/01/2013	17:48	58.718860	-0.523703
Fladen Transits	FTR05	145	A1	DG	08/01/2013	17:48	58.718860	-0.523703
Fladen Transits	FTR05	145	A1	DG	08/01/2013	17:48	58.718860	-0.523703
Fladen Transits	FTR06	147	A1	DG	08/01/2013	18:56	58.788970	-0.632307
Western Fladen	WGT56	150	A1	DG	08/01/2013	20:32	58.782120	-0.717807
Western Fladen	WGT3	153	A1	DG	08/01/2013	22:09	58.740600	-0.748947
Western Fladen	WGT5	155	A1	DG	08/01/2013	22:47	58.705400	-0.694256
Western Fladen	WGT7	157	A1	DG	08/01/2013	23:26	58.670650	-0.640184
Western Fladen	WGT9	160	A1	DG	09/01/2013	00:53	58.635320	-0.587045
Western Fladen	WGT11	162	A1	DG	09/01/2013	01:43	58.600310	-0.533024
Western Fladen	WGT13	165	A1	DG	09/01/2013	03:08	58.565260	-0.479385
Western Fladen	WGT15	167	A1	DG	09/01/2013	03:59	58.530260	-0.425432
Western Fladen	WGT17	169	A1	DG	09/01/2013	04:50	58.495360	-0.371332
Western Fladen	WGT19	171	A1	DG	09/01/2013	05:34	58.460120	-0.318564
Western Fladen	WGT21	174	A1	DG	09/01/2013	07:30	58.424670	-0.265255
Western Fladen	WGT22	176	A1	DG	09/01/2013	08:09	58.389530	-0.211975
Western Fladen	WGT20	178	A1	DG	09/01/2013	08:52	58.347970	-0.243232
Western Fladen	WGT18	180	A1	DG	09/01/2013	10:05	58.382820	-0.296599
Western Fladen	WGT16	183	A1	DG	09/01/2013	11:03	58.418230	-0.349331
Western Fladen	WGT14	185	A1	DG	09/01/2013	11:49	58.453370	-0.402847
Western Fladen	WGT12	187	A1	DG	09/01/2013	12:40	58.488530	-0.456682
Western Fladen	WGT10	190	A1	DG	09/01/2013	13:54	58.523660	-0.510125
Western Fladen	WGT8	192	A1	DG	09/01/2013	14:50	58.558530	-0.564021
Western Fladen	WGT6	194	A2	DG	09/01/2013	16:20	58.593830	-0.617596
Western Fladen	WGT4	196	A1	DG	09/01/2013	17:01	58.628650	-0.671580
Western Fladen	WGT2	198	A2	DG	09/01/2013	17:55	58.663670	-0.725748
Western Fladen	WGT1	200	A1	DG	09/01/2013	18:46	58.698700	-0.780166
Western Fladen	WGT63	202	A1	DG	09/01/2013	21:07	58.411400	-0.434467
Western Fladen	WGT61	204	A1	DG	09/01/2013	21:45	58.446720	-0.488104
Western Fladen	WGT59	205	A1	DG	09/01/2013	22:16	58.481700	-0.541558
Western Fladen	WGT57	206	A1	DG	09/01/2013	22:47	58.516760	-0.595349
Western Fladen	WGT55	207	A1	DG	09/01/2013	21:36	58.551670	-0.649306
Western Fladen	WGT53	208	A1	DG	09/01/2013	23:44	58.587120	-0.703249
Western Fladen	WGT51	209	A1	DG	10/01/2013	00:20	58.621860	-0.756987
Western Fladen	WGT58	210	A1	DG	10/01/2013	01:44	58.746990	-0.663804
Western Fladen	WGT60	212	A1	DG	10/01/2013	02:21	58.712170	-0.609310
Western Fladen	WGT62	214	A1	DG	10/01/2013	03:01	58.677120	-0.555845
Western Fladen	WGT64	216	A1	DG	10/01/2013	03:36	58.641860	-0.501558
Western Fladen	WGT65	218	A1	DG	10/01/2013	04:11	58.607160	-0.448090
Western Fladen	WGT66	220	A1	DG	10/01/2013	04:48	58.571720	-0.394289
Western Fladen	WGT67	223	A1	DG	10/01/2013	06:02	58.536600	-0.340460
Western Fladen	WGT54	226	A1	DG	10/01/2013	08:23	58.475030	-0.626486
Western Fladen	WGT52	228	A1	DG	10/01/2013	09:03	58.510170	-0.680032
Fladen Transits	FTR29B	244	A1	DG	10/01/2013	22:06	58.324990	-0.021466
Fladen Transits	FTR30B	246	A1	DG	10/01/2013	23:08	58.242070	-0.084676
Fladen Transits	FTR28B	248	A1	DG	11/01/2013	00:47	58.254660	0.084010

Area	Stn Code	Stn No	Attempt	Gear	Date	Time	Latitude	Longitude
Fladen Transits	FTR27B	250	A1	DG	11/01/2013	01:51	58.337680	0.147716
Fladen Transits	FTR26B	253	A1	DG	11/01/2013	03:51	58.267160	0.252539
Fladen Transits	FTR25B	255	A1	DG	11/01/2013	04:54	58.350270	0.316880
Fladen Transits	FTR24B	257	A1	DG	11/01/2013	05:59	58.279220	0.421609
Fladen Transits	FTR23B	260	A1	DG	11/01/2013	07:43	58.362170	0.486218
Fladen Transits	FTR22B	262	A1	DG	11/01/2013	08:45	58.291130	0.590888
Fladen Transits	FTR21B	264	A1	DG	11/01/2013	09:48	58.374100	0.655275
SE Fladen	SEGT60	269	A1	DG	11/01/2013	13:22	58.342780	0.796355
SE Fladen	SEGT58	271	A1	DG	11/01/2013	13:52	58.315880	0.774954
SE Fladen	SEGT57	273	A1	DG	11/01/2013	14:38	58.276630	0.744324
SE Fladen	SEGT55	275	A1	DG	11/01/2013	15:15	58.243240	0.717952
SE Fladen	SEGT53	278	A1	DG	11/01/2013	16:29	58.210250	0.692176
SE Fladen	SEGT51	280	A1	DG	11/01/2013	17:03	58.176970	0.666036
SE Fladen	SEGT52	282	A1	DG	11/01/2013	17:46	58.148660	0.708120
SE Fladen	SEGT1	284	A1	DG	11/01/2013	18:24	58.181690	0.733979
SE Fladen	SEGT3	287	A1	DG	11/01/2013	19:39	58.214880	0.760035
SE Fladen	SEGT6	289	A1	DG	11/01/2013	20:18	58.248010	0.785943
SE Fladen	SEGT9	291	A1	DG	11/01/2013	20:56	58.281170	0.812072
SE Fladen	SEGT13	294	A1	DG	11/01/2013	22:14	58.314080	0.837473
SE Fladen	SEGT62	296	A1	DG	11/01/2013	22:47	58.337390	0.827012
SE Fladen	SEGT 63	298	A1	DG	11/01/2013	23:32	58.378180	0.856488
SE Fladen	SEGT66	301	A1	DG	12/01/2013	01:05	58.385030	0.958082
SE Fladen	SEGT23	303	A1	DG	12/01/2013	01:46	58.351970	0.931967
SE Fladen	SEGT_19	305	A1	DG	12/01/2013	02:27	58.318930	0.905723
SE Fladen	SEGT16	308	A1	DG	12/01/2013	03:34	58.285790	0.879091
SE Fladen	SEGT12	310	A1	DG	12/01/2013	04:23	58.252750	0.852961
SE Fladen	SEGT8	312	A1	DG	12/01/2013	05:00	58.219670	0.826937
SE Fladen	SEGT5	315	A1	DG	12/01/2013	06:21	58.186340	0.801463
SE Fladen	SEGT2	317	A1	DG	12/01/2013	07:03	58.153170	0.775466
SE Fladen	SEGT54	319	A1	DG	12/01/2013	07:35	58.120140	0.749419
SE Fladen	SEGT56	322	A1	DG	12/01/2013	08:59	58.091670	0.790947
SE Fladen	SEGT4	324	A1	DG	12/01/2013	09:35	58.124770	0.816747
SE Fladen	SEGT7	326	A1	DG	12/01/2013	10:12	58.157770	0.842979
SE Fladen	SEGT11	329	A1	DG	12/01/2013	11:12	58.190800	0.868656
SE Fladen	SEGT 15	332	A1	DG	12/01/2013	12:46	58.223940	0.894860
SE Fladen	SEGT18	334	A1	DG	12/01/2013	13:29	58.257160	0.921237
SE Fladen	SEGT22	337	A1	DG	12/01/2013	14:50	58.290420	0.947256
SE Fladen	SEGT26	339	A1	DG	12/01/2013	15:30	58.323460	0.973076
SE Fladen	SEGT29	341	A2	DG	12/01/2013	16:12	58.356250	0.999728
SE Fladen	SEGT69	344	A1	DG	12/01/2013	17:32	58.389630	1.025217
SE Fladen	SEGT71	346	A2	DG	12/01/2013	18:14	58.360960	1.067581
SE Fladen	SEGT68	348	A1	DG	12/01/2013	18:52	58.327920	1.041261
SE Fladen	SEGT28	351	A1	DG	12/01/2013	20:05	58.294800	1.014958
SE Fladen	SEGT25	353	A1	DG	12/01/2013	20:39	58.261710	0.988635
SE Fladen	SEGT21	355	A1	DG	12/01/2013	21:16	58.228940	0.962600
SE Fladen	SEGT17	358	A1	DG	12/01/2013	22:25	58.195400	0.936122
SE Fladen	SEGT14	359	A1	DG	12/01/2013	22:59	58.162240	0.909830
SE Fladen	SEGT10	361	A1	DG	12/01/2013	23:35	58.129330	0.883960
SE Fladen	SEGT59	364	A1	DG	13/01/2013	00:51	58.096160	0.857994
SE Fladen	SEGT61	366	A1	DG	13/01/2013	01:27	58.114990	0.904641
SE Fladen	SEGT64	368	A1	DG	13/01/2013	02:04	58.134000	0.951304
SE Fladen	SEGT65	370	A2	DG	13/01/2013	02:50	58.138260	1.019053
SE Fladen	SEGT20	373	A1	DG	13/01/2013	04:03	58.167020	0.978116

Area	Stn Code	Stn No	Attempt	Gear	Date	Time	Latitude	Longitude
SE Fladen	SEGT24	375	A1	DG	13/01/2013	04:44	58.199980	1.003791
SE Fladen	SEGT27	378	A1	DG	13/01/2013	05:59	58.233260	1.029888
SE Fladen	SEGT27	378	A1	DG	13/01/2013	05:59	58.233260	1.029888
SE Fladen	SEGT67	380	A1	DG	13/01/2013	06:32	58.266180	1.056397
SE Fladen	SEGT70	382	A1	DG	13/01/2013	07:08	58.299340	1.082705
SE Fladen	SEGT70	382	A1	DG	13/01/2013	07:08	58.299340	1.082705
Fladen Transits	FTR03W	388	A2	DG	15/01/2013	00:30	58.730000	-0.392991
Fladen Transits	FTR03N	390	A1	DG	15/01/2013	02:03	58.745780	-0.359205
Fladen Transits	FTR03S	392	A1	DG	15/01/2013	03:39	58.716500	-0.350339
Fladen Transits	FTR03E	394	A1	DG	15/01/2013	05:04	58.735560	-0.316032
Fladen Transits	FTR08	397	A1	DG	15/01/2013	06:41	58.768780	-0.221008
Central Fladen	Deep2	409	A1	HG	15/01/2013	19:44	58.964330	-0.245684
Central Fladen	Deep5	411	A1	HG	15/01/2013	21:05	59.063480	-0.387067

DG = 0.1m2 Day grab, HG = 0.1m2 Hamon grab

Appendix 6. Survey metadata: Seabed imagery

					====== START OF VIDEO =======			======= END OF VIDEO =======					
Date	Area Name	Stn Code	Stn no.	Sounded depth (m)	GPS Time (hh:mm)	DecLat WGS84	DecLong WGS84	GPS Time (hh:mm)	DecLat WGS84	DecLong WGS84	Length of video (hh.mm.ss)	BSH	No.stills
06/01/2013	Central Fladen	CGT15	10	144	01:12:17	58.81893	-0.0754	01:23:07	58.81824	-0.078017	00:10:50	Subtidal Mud	15
06/01/2013	Central Fladen	CGT4	17	134	05:39:32	58.9867	-0.33657	05:49:40	58.98796	-0.337242	00:10:08	Subtidal Mud	12
06/01/2013	Central Fladen	CGT1	22	141	08:34:12	59.09843	-0.5118	08:44:33	59.09934	-0.509881	00:10:21	Subtidal Mud	12
06/01/2013	Central Fladen	CGT10	30	138	12:42:04	59.30136	-0.35828	12:52:25	59.30003	-0.358423	00:10:21	Subtidal Mud	17
06/01/2013	Central Fladen	CGT17	37	143	16:04:05	59.18696	-0.1814	16:14:30	59.18777	-0.183519	00:10:25	Subtidal Mud	18
06/01/2013	Central Fladen	CGT27	44	143	19:47:13	59.13226	-0.09533	19:57:24	59.13406	-0.094677	00:10:11	Subtidal Mud	15
06/01/2013	Central Fladen	CGT8	51	145	23:34:32	59.0533	-0.28555	23:44:58	59.05223	-0.285743	00:10:26	Subtidal Mud	15
07/01/2013	Core Central Fladen	CCGT04	65	121	07:25:11	58.99514	-0.16803	07:35:21	58.99624	-0.168574	00:10:10	Subtidal Mud	13
07/01/2013	Core Central Fladen	CCGT14	73	123	10:00:33	58.97478	-0.05671	10:11:49	58.97332	-0.056604	00:11:16	Subtidal Mud	12
07/01/2013	Core Central Fladen	CCGT25	78	141	11:49:07	58.98436	0.081359	11:59:06	58.98312	0.081059	00:09:59	Subtidal Mud	11
07/01/2013	Core Central Fladen	CCGT22	81	135	13:02:16	58.95051	0.055215	13:13:10	58.94915	0.05481	00:10:54	Subtidal Mud	15
07/01/2013	Central Fladen	CGT16	87	118	15:53:24	58.94442	-0.10816	16:04:50	58.94327	-0.10978	00:11:26	Subtidal Mud	23
07/01/2013	Core Central Fladen	CCGT13	93	122	18:38:28	58.91062	-0.0376	18:51:18	58.91197	-0.039037	00:12:50	Subtidal Mud	17
07/01/2013	Central Fladen	CGT22	100	134	21:08:45	58.89322	0.111039	21:20:00	58.89456	0.111644	00:11:15	Subtidal Mud	13
07/01/2013	Central Fladen	CGT18	106	110	23:24:31	58.88658	-0.02707	23:34:44	58.88537	-0.026412	00:10:13	Subtidal Mud	20
08/01/2013	Core Central Fladen	CCGT09	108	116	00:33:05	58.87996	-0.06551	00:43:10	58.87871	-0.064891	00:10:05	Subtidal Mud	12
08/01/2013	Core Central Fladen	CCGT05	113	143	02:32:58	58.84639	-0.09018	02:42:13	58.84517	-0.090667	00:09:15	Subtidal Mud	13
08/01/2013	Core Central Fladen	CCGT18	118	120	04:20:47	58.85775	0.051318	04:30:50	58.85677	0.049459	00:10:03	Subtidal Mud	14
08/01/2013	Core Central Fladen	CCGT15	125	125	06:41:37	58.82375	0.018886	06:51:45	58.82263	0.020573	00:10:08	Subtidal Mud	10
08/01/2013	Fladen Transits	FTR07A	133	150	09:33:18	58.75635	-0.0114	09:44:21	58.75771	-0.010273	00:11:03	Subtidal Mud	16
08/01/2013	Fladen Transits	FTR02	138	108	13:13:50	58.81187	-0.30367	13:24:08	58.81054	-0.302797	00:10:18	Subtidal Mud	13
08/01/2013	Fladen Transits	FTR03	141	137	15:01:17	58.73322	-0.35275	15:13:04	58.73193	-0.353733	00:11:47	Subtidal Mud	16
08/01/2013	Fladen Transits	FTR06	148	134	19:18:14	58.78947	-0.62885	19:28:19	58.73247	-0.353311	00:10:05	Subtidal Mud	10
08/01/2013	Western Fladen	WGT56	151	131	21:14:05	58.78124	-0.71506	21:25:13	58.78192	-0.717135	00:11:08	Subtidal Mud	17

					====== START OF VIDEO =======			======= END OF VIDEO =======					
Date	Area Name	Stn Code	Stn no.	Sounded depth (m)	GPS Time (hh:mm)	DecLat WGS84	DecLong WGS84	GPS Time (hh:mm)	DecLat WGS84	DecLong WGS84	Length of video (hh.mm.ss)	BSH	No.stills
08/01/2013	Western Fladen	WGT07	158	129	23:46:43	58.6709	-0.63853	23:56:57	58.67052	-0.640606	00:10:14	Subtidal Mud	13
09/01/2013	Western Fladen	WGT11	163	125	02:05:53	58.60069	-0.53186	02:16:34	58.59979	-0.534286	00:10:41	Subtidal Mud	17
09/01/2013	Western Fladen	WGT19	172	120	06:29:51	58.46018	-0.31681	06:36:31	58.45988	-0.31914	00:06:40	Subtidal Mud	7
10/01/2013	Western Fladen	WGT66	221	110	05:13:12	58.57554	-0.39188	05:23:10	58.57469	-0.394374	00:09:58	Subtidal Mud	10
10/01/2013	Western Fladen	WGT52	229	134	09:38:36	58.50877	-0.68022	09:48:45	58.50994	-0.679286	00:10:09	Subtidal Mud	10
10/01/2013	Western Fladen	WGT06	232	133	11:02:04	58.59242	-0.61786	11:12:27	58.59371	-0.617523	00:10:23	Subtidal Mud	13
10/01/2013	Western Fladen	WGT51	234	131	12:43:55	58.62087	-0.75677	12:53:14	58.62191	-0.755645	00:09:19	Subtidal Mud	15
10/01/2013	Western Fladen	WGT01	236	127	14:04:38	58.69952	-0.78111	14:14:14	58.69866	-0.78	00:09:36	Subtidal Mud	12
10/01/2013	Western Fladen	WGT62	238	126	15:49:53	58.67827	-0.55698	15:59:15	58.67847	-0.560531	00:09:22	Subtidal Mud	10
10/01/2013	Western Fladen	WGT12	240	131	18:19:34	58.48904	-0.45704	18:29:59	58.48661	-0.45671	00:10:25	Subtidal Mud	17
10/01/2013	Western Fladen	WGT20	242	156	20:37:20	58.34729	-0.24337	20:48:25	58.34859	-0.242909	00:11:05	Subtidal Mud	14
10/01/2013	Fladen Transits	FTR30B	247	137	23:29:56	58.24021	-0.08459	23:40:03	58.24153	-0.084502	00:10:07	Subtidal Mud	12
11/01/2013	Fladen Transits	FTR27B	251	144	02:15:58	58.33691	0.148253	02:25:07	58.33813	0.150346	00:09:09	Subtidal Mud	10
11/01/2013	Fladen Transits	FTR24B	258	140	06:21:57	58.28139	0.421051	06:32:15	58.28005	0.421369	00:10:18	Subtidal Mud	11
11/01/2013	Fladen Transits	FTR21B	265	155	10:36:10	58.37246	0.656932	10:49:19	58.37403	0.655616	00:13:09	Subtidal Mud	17
11/01/2013	SE Fladen	SEGT60	268	146	12:46:07	58.34167	0.796735	12:56:23	58.34354	0.797231	00:10:16	Subtidal Mud	13
11/01/2013	SE Fladen	SEGT55	276	151	15:36:21	58.24539	0.715988	15:46:46	58.24408	0.717084	00:10:25	Subtidal Mud	15
11/01/2013	SE Fladen	SEGT01	285	152	18:45:06	58.18361	0.732373	18:56:22	58.18218	0.733593	00:11:16	Subtidal Mud	14
11/01/2013	SE Fladen	SEGT9	292	149	21:22:46	58.28269	0.810114	21:32:09	58.28126	0.811517	00:09:23	Subtidal Mud	13
11/01/2013	SE Fladen	SEGT63	299	142	23:58:44	58.37626	0.857189	00:09:06	58.37763	0.856686	00:10:23	Subtidal Mud	14
12/01/2013	SE Fladen	SEGT19	306	147	02:54:54	58.31955	0.903474	03:05:07	58.31932	0.907123	00:10:13	Subtidal Mud	10
12/01/2013	SE Fladen	SEGT54	320	150	08:10:13	58.12095	0.74655	08:22:12	58.1202	0.74952	00:11:59	Subtidal Mud	15
12/01/2013	SE Fladen	SEGT11	330	151	11:48:29	58.18918	0.871721	11:58:18	58.19002	0.868908	00:09:49	Subtidal Mud	16
12/01/2013	SE Fladen	SEGT18	335	153	13:50:50	58.25555	0.920261	14:01:05	58.25658	0.922272	00:10:15	Subtidal Mud	13
12/01/2013	SE Fladen	SEGT29	342	148	16:34:31	58.35811	0.993831	16:44:44	58.35723	0.996935	00:10:13	Subtidal Mud	19
12/01/2013	SE Fladen	SEGT68	349	145	19:14:48	58.32903	1.038796	19:25:42	58.32805	1.041031	00:10:54	Subtidal Mud	14

Date	Area Name	Stn Code	Stn no.	Sounded depth (m)	====== START OF VIDEO ======= GPS Time (hh:mm)	DecLat WGS84	DecLong WGS84	======= END OF VIDEO ======= GPS Time (hh:mm)	DecLat WGS84	DecLong WGS84	Length of video (hh.mm.ss)	BSH	No.stills
12/01/2013	SE Fladen	SEGT21	356	152	21:35:39	58.23067	0.961462	21:45:58	58.22938	0.962194	00:10:19	Subtidal Mud	12
12/01/2013	SE Fladen	SEGT10	362	152	23:55:58	58.12815	0.88708	00:08:42	58.12922	0.884648	00:12:44	Subtidal Mud	10
13/01/2013	SE Fladen	SEGT65	371	146	03:11:50	58.13571	1.017239	03:23:23	58.137	1.018952	00:11:33	Subtidal Mud	12
13/01/2013	SE Fladen	SEGT24	376	150	05:05:04	58.20276	1.003237	05:15:22	58.20147	1.003717	00:10:18	Subtidal Mud	16
13/01/2013	SE Fladen	SEGT70	383	143	07:28:03	58.30091	1.082125	07:37:57	58.29973	1.082436	00:09:54	Subtidal Mud	14
15/01/2013	Fladen Transits	FTR03W	389	131	01:08:41	58.72854	-0.39347	01:28:48	58.73118	-0.390462	00:20:07	Subtidal Mud	27
15/01/2013	Fladen Transits	FTR03N	391	136	02:28:05	58.74431	-0.35926	02:48:11	58.74714	-0.35677	00:20:06	Subtidal Mud	21
15/01/2013	Fladen Transits	FTR03S	393	108	04:00:12	58.71734	-0.35554	04:24:27	58.71633	-0.34924	00:24:15	Subtidal Mud	41
15/01/2013	Fladen Transits	FTR03E	395	120	05:27:01	58.7347	-0.32019	05:47:07	58.73611	-0.317366	00:20:06	Subtidal Mud	21
15/01/2013	Fladen Transits	FTR08	398	123	07:02:12	58.76943	-0.2236	07:22:10	58.76827	-0.218888	00:19:58	Subtidal Mud	20
15/01/2013	Core Central Fladen	CCGT01	400	136	08:24:04	58.81356	-0.11788	08:44:02	58.81035	-0.117472	00:19:58	Subtidal Mud	23
15/01/2013	Core Central Fladen	CCGT08	401	137	09:29:40	58.81894	-0.05	09:49:52	58.81659	-0.047386	00:20:12	Subtidal Mud	26
15/01/2013	Core Central Fladen	CCGT12	402	118	10:57:36	58.85242	-0.02314	11:18:14	58.84951	-0.021037	00:20:38	Subtidal Mud	29
15/01/2013	Core Central Fladen	CCGT16	403	113	13:03:17	58.88672	0.004471	13:17:53	58.88617	0.003754	00:14:36	Subtidal Mud	20
15/01/2013	Central Fladen	CGT18	404	111	14:05:47	58.88448	-0.02379	14:26:04	58.88491	-0.029892	00:20:17	Subtidal Mud	26
15/01/2013	Core Central Fladen	CCGT17	405	124	15:31:59	58.94359	-0.01692	15:45:45	58.94464	-0.013775	00:13:46	Subtidal Mud	17
15/01/2013	Core Central Fladen	CCGT10	406	115	16:24:56	58.94016	-0.08521	16:41:11	58.94029	-0.089123	00:16:15	Subtidal Mud	18
15/01/2013	Core Central Fladen	CCGT06	407	111	17:48:39	58.9079	-0.10857	18:00:36	58.90654	-0.107491	00:11:57	Subtidal Mud	15
15/01/2013	Central Fladen	Deep2	408	190	19:11:32	58.96383	-0.24905	19:20:16	58.96384	-0.246949	00:08:44	Subtidal Mixed	9
15/01/2013	Central Fladen	Deep5	410	207	20:50:54	59.06223	-0.38946	21:05:38	59.06348	-0.387061	00:14:44	Subtidal Mixed	0

Appendix 7. Analysis of sediment samples: classification and composition

pMPA/Area	Station code	Gravel	Sand	Silt/clay	Folk symbol	EUNIS groups	MEAN	SORTING	SKEWNESS
Central Fladen	CGT15	0	47.05	52.95	sM	mud and sandy mud	Very Coarse Silt	Very Poorly Sorted	Very Fine Skewed
Central Fladen	CGT11	0	67.34	32.66	mS	mud and sandy mud	Very Fine Sand	Very Poorly Sorted	Very Fine Skewed
Central Fladen	CGT7	0	61.88	38.12	mS	mud and sandy mud	Very Coarse Silt	Very Poorly Sorted	Very Fine Skewed
Central Fladen	CGT4	0	45.57	54.43	sM	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Central Fladen	CGT2	0	50.74	49.26	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Central Fladen	CGT1	0	56.06	43.94	mS	mud and sandy mud	Very Coarse Silt	Very Poorly Sorted	Very Fine Skewed
Central Fladen	CGT3	6.57	58.2	35.23	gmS	mixed sediments	Very Fine Sand	Very Poorly Sorted	Symmetrical
Central Fladen	CGT6	0	54.13	45.87	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Central Fladen	CGT10	0	61.33	38.67	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Central Fladen	CGT14	0	49.24	50.76	sM	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Central Fladen	CGT09	0	41.92	58.08	sM	mud and sandy mud	Coarse Silt	Poorly Sorted	Very Fine Skewed
Central Fladen	CGT17	0	39.83	60.17	sM	mud and sandy mud	Coarse Silt	Poorly Sorted	Very Fine Skewed
Central Fladen	CGT28	0.91	57.3	41.79	mS	mud and sandy mud	Very Coarse Silt	Very Poorly Sorted	Very Fine Skewed
Central Fladen	CGT26	0	36.09	63.91	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
Central Fladen	CGT27	0	38.46	61.54	sM	mud and sandy mud	Coarse Silt	Poorly Sorted	Very Fine Skewed
Central Fladen	CGT13	0	42.53	57.47	sM	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Central Fladen	CGT05	0	44.45	55.55	sM	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Central Fladen	CGT8	0	39.38	60.62	sM	mud and sandy mud	Coarse Silt	Poorly Sorted	Very Fine Skewed
Central Fladen	CGT24	0.96	53.78	45.26	mS	mud and sandy mud	Very Coarse Silt	Very Poorly Sorted	Very Fine Skewed
Central Fladen	CGT25	0	50.96	49.04	mS	mud and sandy mud	Very Coarse Silt	Very Poorly Sorted	Very Fine Skewed
Central Fladen	CGT23	0	54.43	45.57	mS	mud and sandy mud	Very Coarse Silt	Very Poorly Sorted	Very Fine Skewed
Central Fladen	CGT19	0	61.41	38.59	mS	mud and sandy mud	Very Coarse Silt	Very Poorly Sorted	Very Fine Skewed
Central Fladen	CGT12	0	70.27	29.73	mS	mud and sandy mud	Very Fine Sand	Very Poorly Sorted	Very Fine Skewed
Central Fladen (core)	CCGT4	0	67.92	32.08	mS	mud and sandy mud	Very Fine Sand	Very Poorly Sorted	Very Fine Skewed
Central Fladen (core)	CCGT11	0	56.98	43.02	mS	mud and sandy mud	Very Coarse Silt	Very Poorly Sorted	Very Fine Skewed
Central Fladen (core)	CCGT7	0	63.38	36.62	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Central Fladen (core)	CCGT14	0	64.21	35.79	mS	mud and sandy mud	Very Coarse Silt	Very Poorly Sorted	Very Fine Skewed

pMPA/Area	Station code	Gravel	Sand	Silt/clay	Folk symbol	EUNIS groups	MEAN	SORTING	SKEWNESS
Central Fladen (core)	CCGT20	0	68.97	31.03	mS	mud and sandy mud	Very Fine Sand	Very Poorly Sorted	Very Fine Skewed
Central Fladen (core)	CCGT25	0	58.01	41.99	mS	mud and sandy mud	Very Coarse Silt	Very Poorly Sorted	Very Fine Skewed
Central Fladen (core)	CCGT22	0	67.74	32.26	mS	mud and sandy mud	Very Fine Sand	Very Poorly Sorted	Very Fine Skewed
Central Fladen	CGT21	0	67.88	32.12	mS	mud and sandy mud	Very Fine Sand	Very Poorly Sorted	Very Fine Skewed
Central Fladen (core)	CCGT17	0	69.56	30.44	mS	mud and sandy mud	Very Fine Sand	Very Poorly Sorted	Very Fine Skewed
Central Fladen (core)	CCGT10	0	72.54	27.46	mS	mud and sandy mud	Very Fine Sand	Very Poorly Sorted	Very Fine Skewed
Central Fladen	CGT16	0	53.88	46.12	mS	mud and sandy mud	Very Coarse Silt	Very Poorly Sorted	Very Fine Skewed
Central Fladen (core)	CCGT3	0	92.71	7.29	S	sand and muddy sand	Medium Sand	Poorly Sorted	Very Fine Skewed
Central Fladen (core)	CCGT6	0	72.06	27.94	mS	mud and sandy mud	Very Fine Sand	Very Poorly Sorted	Very Fine Skewed
Central Fladen (core)	CCGT13	0	69.76	30.24	mS	mud and sandy mud	Very Fine Sand	Very Poorly Sorted	Very Fine Skewed
Central Fladen (core)	CCGT19	0	65.06	34.94	mS	mud and sandy mud	Very Coarse Silt	Very Poorly Sorted	Very Fine Skewed
Central Fladen (core)	CCGT24	0	65.07	34.93	mS	mud and sandy mud	Very Fine Sand	Very Poorly Sorted	Very Fine Skewed
Central Fladen	CGT22	0	60.75	39.25	mS	mud and sandy mud	Very Coarse Silt	Very Poorly Sorted	Very Fine Skewed
Central Fladen (core)	CCGT21	0	60.08	39.92	mS	mud and sandy mud	Very Coarse Silt	Very Poorly Sorted	Very Fine Skewed
Central Fladen (core)	CCGT16	0	79.4	20.6	mS	mud and sandy mud	Fine Sand	Very Poorly Sorted	Very Fine Skewed
Central Fladen	CGT18	0	81.69	18.31	mS	sand and muddy sand	Very Fine Sand	Poorly Sorted	Very Fine Skewed
Central Fladen (core)	CCGT9	0	74.32	25.68	mS	mud and sandy mud	Very Fine Sand	Very Poorly Sorted	Very Fine Skewed
Central Fladen (core)	CCGT2	0	62.36	37.64	mS	mud and sandy mud	Very Coarse Silt	Very Poorly Sorted	Very Fine Skewed
Central Fladen (core)	CCGT5	0	59.17	40.83	mS	mud and sandy mud	Very Coarse Silt	Very Poorly Sorted	Very Fine Skewed
Central Fladen (core)	CCGT12	0	74.92	25.08	mS	mud and sandy mud	Very Fine Sand	Very Poorly Sorted	Very Fine Skewed
Central Fladen (core)	CCGT18	11.72	64.94	23.34	gmS	mixed sediments	Very Fine Sand	Very Poorly Sorted	Fine Skewed
Central Fladen	CGT20	0	64.28	35.72	mS	mud and sandy mud	Very Coarse Silt	Very Poorly Sorted	Very Fine Skewed
Central Fladen (core)	CCGT15	0	67.8	32.2	mS	mud and sandy mud	Very Fine Sand	Very Poorly Sorted	Very Fine Skewed
Central Fladen (core)	CCGT8	0	54.2	45.8	mS	mud and sandy mud	Very Coarse Silt	Very Poorly Sorted	Very Fine Skewed
Central Fladen (core)	CCGT1	0	56.34	43.66	mS	mud and sandy mud	Very Coarse Silt	Very Poorly Sorted	Very Fine Skewed
Fladen Transits	FTR07A	0.14	40.87	58.99	sM	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Fladen Transits	FTR01A	0.02	83.92	16.06	mS	sand and muddy sand	Fine Sand	Poorly Sorted	Very Fine Skewed
Fladen Transits	FTR02A	2.92	89.68	7.4	(g)S	sand and muddy sand	Fine Sand	Poorly Sorted	Fine Skewed
Fladen Transits	FTR03A	0.11	71.86	28.03	mS	mud and sandy mud	Very Fine Sand	Very Poorly Sorted	Very Fine Skewed

pMPA/Area	Station code	Gravel	Sand	Silt/clay	Folk symbol	EUNIS groups	MEAN	SORTING	SKEWNESS
Fladen Transits	FTR04A	0.18	52.87	46.95	mS	mud and sandy mud	Very Coarse Silt	Very Poorly Sorted	Very Fine Skewed
Fladen Transits	FTR05A	0.08	63.35	36.57	mS	mud and sandy mud	Very Fine Sand	Poorly Sorted	Very Fine Skewed
Fladen Transits	FTR06A	0.16	49.49	50.35	sM	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT56	0	58.52	41.48	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT3	0.33	56.34	43.33	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT5	0.04	58.18	41.79	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT7	0.46	57.04	42.49	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Fine Skewed
Western Fladen	WGT9	0.03	53.03	46.93	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT11	0.16	59.55	40.29	mS	mud and sandy mud	Very Coarse Silt	Very Poorly Sorted	Fine Skewed
Western Fladen	WGT13	0	57.46	42.54	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT15	0.02	53.1	46.89	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT17	0	57.21	42.79	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT19	0.19	65.04	34.77	mS	mud and sandy mud	Very Fine Sand	Very Poorly Sorted	Very Fine Skewed
Western Fladen	WGT21	0.71	76.31	22.98	mS	mud and sandy mud	Very Fine Sand	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT22	0.13	53.93	45.94	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT20	0.75	70.45	28.79	mS	mud and sandy mud	Very Fine Sand	Very Poorly Sorted	Very Fine Skewed
Western Fladen	WGT18	0.04	60.03	39.93	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT16	0	50.39	49.61	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT14	0.04	47.54	52.42	sM	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT12	0.03	43.67	56.3	sM	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT10	0	47.49	52.51	sM	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT8	0.02	55.08	44.9	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT6	0.05	51.87	48.08	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT4	0.02	54.48	45.5	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT2	0.02	51.71	48.28	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT1	0.02	55.34	44.64	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT63	0	44.52	55.48	sM	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT61	0	46.72	53.28	sM	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT59	0.02	44.36	55.62	sM	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed

pMPA/Area	Station code	Gravel	Sand	Silt/clay	Folk symbol	EUNIS groups	MEAN	SORTING	SKEWNESS
Western Fladen	WGT57	0.27	52.47	47.26	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT55	0	52.12	47.88	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT53	0	52.58	47.42	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT51	0.02	52.19	47.79	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT58	0.02	51.12	48.86	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT60	0.05	53.98	45.97	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT62	0.08	56.48	43.45	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT64	0.05	67.59	32.36	mS	mud and sandy mud	Very Fine Sand	Poorly Sorted	Fine Skewed
Western Fladen	WGT65	0.1	70.48	29.42	mS	mud and sandy mud	Very Fine Sand	Very Poorly Sorted	Very Fine Skewed
Western Fladen	WGT66	0.02	79.09	20.88	mS	mud and sandy mud	Very Fine Sand	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT67	0.39	79.57	20.05	mS	mud and sandy mud	Very Fine Sand	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT54	0	45.74	54.26	sM	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Western Fladen	WGT52	0	50.23	49.77	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Fladen Transits	FTR29B	0.1	36.09	63.81	sM	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Fladen Transits	FTR30B	0.09	35.87	64.04	sM	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed
Fladen Transits	FTR28B	0	28.23	71.77	sM	mud and sandy mud	Coarse Silt	Poorly Sorted	Very Fine Skewed
Fladen Transits	FTR27B	0	26.62	73.38	sM	mud and sandy mud	Coarse Silt	Poorly Sorted	Fine Skewed
Fladen Transits	FTR26B	0	26.8	73.2	sM	mud and sandy mud	Coarse Silt	Poorly Sorted	Fine Skewed
Fladen Transits	FTR25B	0.29	34.02	65.69	sM	mud and sandy mud	Very Coarse Silt	Very Poorly Sorted	Fine Skewed
Fladen Transits	FTR24B	0.02	21.41	78.57	sM	mud and sandy mud	Coarse Silt	Poorly Sorted	Fine Skewed
Fladen Transits	FTR23B	0.03	23.15	76.82	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Fine Skewed
Fladen Transits	FTR22B	0.03	15.84	84.13	sM	mud and sandy mud	Coarse Silt	Poorly Sorted	Fine Skewed
Fladen Transits	FTR21B	0.05	24.39	75.56	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Fine Skewed
SE Fladen	SEGT60	0	13.73	86.27	sM	mud and sandy mud	Medium Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT58	0	16.51	83.49	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT57	0	9.05	90.95	M	mud and sandy mud	Medium Silt	Very Poorly Sorted	Fine Skewed
SE Fladen	SEGT55	0	8.43	91.57	M	mud and sandy mud	Medium Silt	Very Poorly Sorted	Fine Skewed
SE Fladen	SEGT53	0	15.45	84.55	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Fine Skewed
SE Fladen	SEGT51	0	10.46	89.54	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed

pMPA/Area	Station code	Gravel	Sand	Silt/clay	Folk symbol	EUNIS groups	MEAN	SORTING	SKEWNESS
SE Fladen	SEGT52	0	10.98	89.02	sM	mud and sandy mud	Medium Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT1	0	9.52	90.48	M	mud and sandy mud	Medium Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT3	0	12.28	87.72	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT6	0	10.71	89.29	sM	mud and sandy mud	Medium Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT9	0	9.92	90.08	M	mud and sandy mud	Medium Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT13	0	11.62	88.38	sM	mud and sandy mud	Medium Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT62	0	18.4	81.6	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT 63	0	26.97	73.03	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Fine Skewed
SE Fladen	SEGT66	0	36.88	63.12	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT23	0	14.8	85.2	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT_19	0	16.93	83.07	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT16	0	11.34	88.66	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT12	0	13.68	86.32	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT8	0	7.84	92.16	M	mud and sandy mud	Medium Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT5	0	10.94	89.06	sM	mud and sandy mud	Medium Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT2	0	12.3	87.7	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT54	0	13.62	86.38	sM	mud and sandy mud	Medium Silt	Very Poorly Sorted	Fine Skewed
SE Fladen	SEGT56	0	14.53	85.47	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT4	0	13.54	86.46	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT7	0	24.6	75.4	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT11	0	12.38	87.62	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT 15	0	13.63	86.37	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT18	0	16.7	83.3	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT22	0	14.33	85.67	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT26	0	14.9	85.1	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT29	0	17.85	82.15	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT69	0	39.03	60.97	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT71	0	27.1	72.9	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT68	0	21.16	78.84	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed

pMPA/Area	Station code	Gravel	Sand	Silt/clay	Folk symbol	EUNIS groups	MEAN	SORTING	SKEWNESS
SE Fladen	SEGT28	0	14.87	85.13	sM	mud and sandy mud	Medium Silt	Very Poorly Sorted	Fine Skewed
SE Fladen	SEGT25	0	15.93	84.07	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT21	0	19.39	80.61	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT17	0	13.54	86.46	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT14	0	13.13	86.87	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT10	0	13.82	86.18	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT59	0	14.94	85.06	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT61	0	15.99	84.01	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT64	0	14.69	85.31	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT65	0	20.35	79.65	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT20	0	13.94	86.06	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT24	0	16.19	83.81	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT27	0	15.8	84.2	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT67	0	24.69	75.31	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
SE Fladen	SEGT70	0	27.31	72.69	sM	mud and sandy mud	Coarse Silt	Very Poorly Sorted	Very Fine Skewed
Fladen Transits	FTR03W	3.07	75.83	21.1	(g)mS	mud and sandy mud	Fine Sand	Poorly Sorted	Very Fine Skewed
Fladen Transits	FTR03N	1.81	67.4	30.79	(g)mS	mud and sandy mud	Very Fine Sand	Poorly Sorted	Very Fine Skewed
Fladen Transits	FTR03S	2.39	91.6	6.01	(g)S	sand and muddy sand	Medium Sand	Poorly Sorted	Fine Skewed
Fladen Transits	FTR03E	0.02	80.28	19.69	mS	sand and muddy sand	Very Fine Sand	Poorly Sorted	Very Fine Skewed
Fladen Transits	FTR08	0.13	79.62	20.26	mS	mud and sandy mud	Fine Sand	Poorly Sorted	Very Fine Skewed
Central Fladen	Deep2	0	78.28	21.72	mS	mud and sandy mud	Very Fine Sand	Poorly Sorted	Very Fine Skewed
Central Fladen	Deep5	22.49	54.02	23.5	gmS	mixed sediments	Medium Sand	Very Poorly Sorted	Fine Skewed
Central Fladen (core)	CCGT23	0	69.82	30.18	mS	mud and sandy mud	Very Coarse Silt	Poorly Sorted	Very Fine Skewed

Appendix 8. Faunal assemblage metrics calculated for each grab sample

pMPA	Station Code	Species no. (S)	Abundance (N)	Hill's Diversity (N1)	Biomass (g)
Central Fladen	CGT05	27	59	16.62	8.7116
Central Fladen	CGT09	38	105	24.83	3.5824
Central Fladen	CGT1	44	132	27.23	0.8299
Central Fladen	CGT10	40	123	25.13	2.4389
Central Fladen	CGT11	50	116	34.43	2.7228
Central Fladen	CGT12	43	134	24.51	6.7192
Central Fladen	CGT13	32	71	22.73	1.1248
Central Fladen	CGT14	43	188	26.41	2.0535
Central Fladen	CGT15	45	115	29.17	9.0006
Central Fladen	CGT16	51	168	26.20	1.9663
Central Fladen	CGT17	33	75	25.88	1.3582
Central Fladen	CGT18	26	42	22.02	45.1482
Central Fladen	CGT19	26	48	20.69	0.3534
Central Fladen	CGT2	41	116	24.49	3.7271
Central Fladen	CGT20	55	113	39.58	7.0926
Central Fladen	CGT21	38	101	18.27	1.1691
Central Fladen	CGT22	31	68	25.53	1.6352
Central Fladen	CGT23	57	198	29.94	1.0344
Central Fladen	CGT24	42	109	26.96	1.4466
Central Fladen	CGT25	33	77	24.30	1.9299
Central Fladen	CGT26	28	81	20.02	2.7448
Central Fladen	CGT27	44	181	25.03	2.4802
Central Fladen	CGT28	52	140	33.24	5.5761
Central Fladen	CGT3	60	262	27.52	34.1429
Central Fladen	CGT4	50	137	23.91	2.3134
Central Fladen	CGT6	50	169	28.28	3.1155
Central Fladen	CGT7	55	237	26.38	3.4130
Central Fladen	CGT8	24	79	14.77	1.5005
Central Fladen	Deep2	31	64	22.94	8.5114
Central Fladen	Deep5	72	173	50.59	3.4336
Central Fladen (Core)	CCGT1	40	86	27.94	4.1695
Central Fladen (Core)	CCGT10	47	95	36.85	1.5325
Central Fladen (Core)	CCGT11	52	157	22.40	4.1675
Central Fladen (Core)	CCGT12	31	68	22.91	0.7872
Central Fladen (Core)	CCGT13	55	185	31.10	6.9706
Central Fladen (Core)	CCGT14	41	80	34.14	2.5742
Central Fladen (Core)	CCGT15	40	80	33.01	4.8245
Central Fladen (Core)	CCGT16	37	66	29.00	4.5367
Central Fladen (Core)	CCGT17	44	97	32.61	4.0446
Central Fladen (Core)	CCGT18	61	186	37.66	1.5742
Central Fladen (Core)	CCGT19	31	61	24.85	0.7591

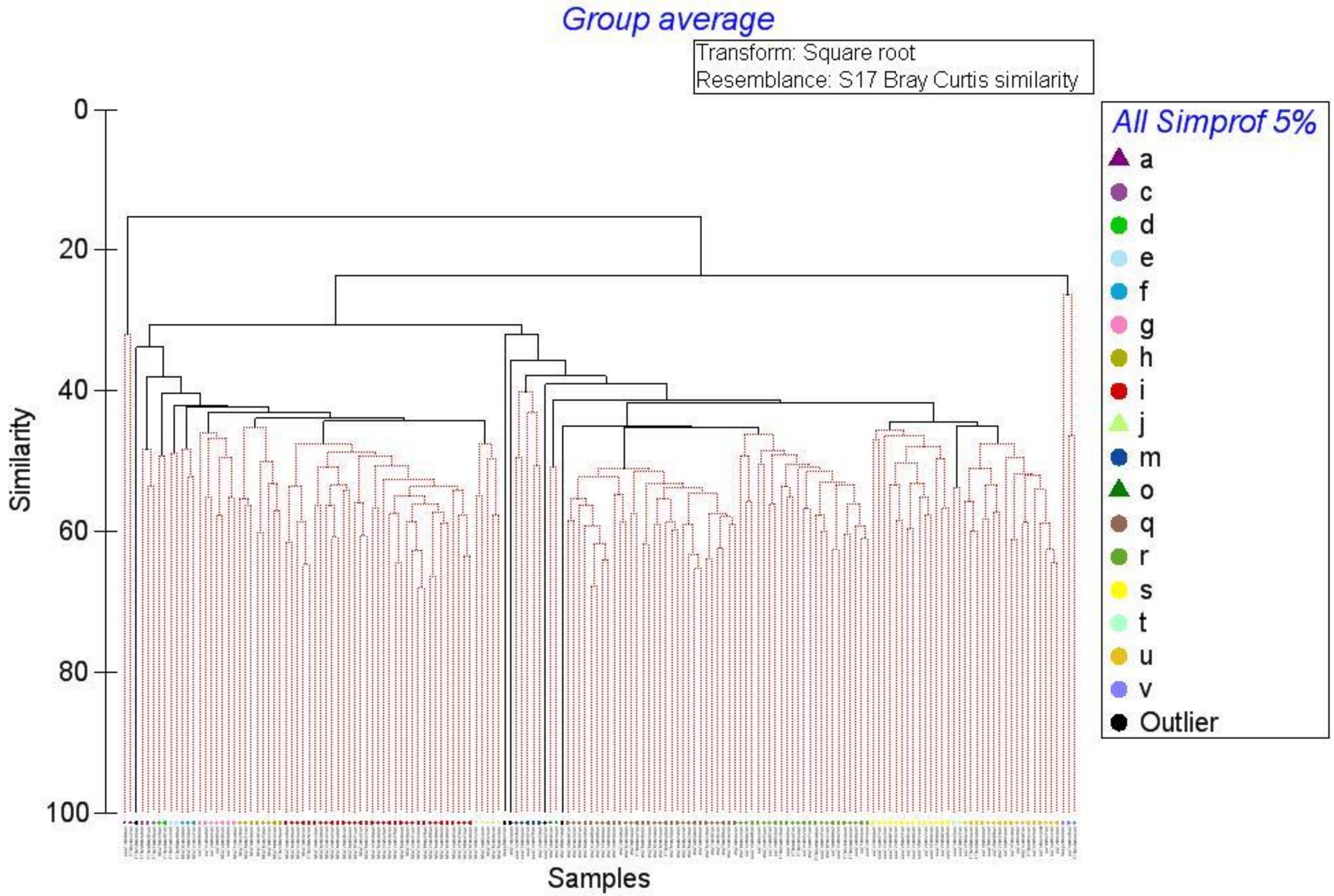
pMPA	Station Code	Species no. (S)	Abundance (N)	Hill's Diversity (N1)	Biomass (g)
Central Fladen (Core)	CCGT2	50	151	33.81	1.1290
Central Fladen (Core)	CCGT20	49	104	32.75	10.4419
Central Fladen (Core)	CCGT21	46	128	30.03	1.8281
Central Fladen (Core)	CCGT22	46	104	32.93	4.5959
Central Fladen (Core)	CCGT23	52	133	35.31	47.4237
Central Fladen (Core)	CCGT24	71	179	48.46	2.5822
Central Fladen (Core)	CCGT25	45	122	29.02	2.2469
Central Fladen (Core)	CCGT3	25	41	19.94	13.5339
Central Fladen (Core)	CCGT4	50	215	21.87	1.0927
Central Fladen (Core)	CCGT5	43	120	26.55	1.1386
Central Fladen (Core)	CCGT6	44	113	29.55	0.5847
Central Fladen (Core)	CCGT7	35	84	27.17	3.6143
Central Fladen (Core)	CCGT8	37	69	25.57	0.8809
Central Fladen (Core)	CCGT9	35	59	29.83	0.2927
SE Fladen	SEGT1	30	101	14.72	3.1670
SE Fladen	SEGT10	32	82	19.40	2.7166
SE Fladen	SEGT11	29	74	19.66	2.9796
SE Fladen	SEGT12	24	83	13.95	1.0970
SE Fladen	SEGT13	27	62	21.04	4.7880
SE Fladen	SEGT14	23	86	13.47	0.9546
SE Fladen	SEGT15	20	50	14.67	3.3954
SE Fladen	SEGT16	22	39	18.56	2.7397
SE Fladen	SEGT17	34	84	21.93	3.4380
SE Fladen	SEGT18	21	49	14.45	0.6164
SE Fladen	SEGT19	26	70	16.66	1.2698
SE Fladen	SEGT2	36	124	14.42	1.6013
SE Fladen	SEGT20	34	104	15.54	4.8807
SE Fladen	SEGT21	26	76	13.87	0.8561
SE Fladen	SEGT22	25	63	13.90	2.2924
SE Fladen	SEGT23	28	80	20.05	1.8470
SE Fladen	SEGT24	30	76	20.11	0.6223
SE Fladen	SEGT25	34	84	23.77	7.1415
SE Fladen	SEGT26	27	67	17.16	17.0140
SE Fladen	SEGT27	40	153	18.50	12.4914
SE Fladen	SEGT28	24	60	14.77	1.2165
SE Fladen	SEGT29	39	149	22.16	2.6723
SE Fladen	SEGT3	17	31	11.55	0.2238
SE Fladen	SEGT4	21	50	11.41	3.4986
SE Fladen	SEGT5	23	51	16.33	0.6633
SE Fladen	SEGT51	22	52	17.24	0.6582
SE Fladen	SEGT52	18	38	11.87	0.4598
SE Fladen	SEGT53	14	33	11.10	0.4394
SE Fladen	SEGT54	21	37	15.06	7.0764

pMPA	Station Code	Species no. (S)	Abundance (N)	Hill's Diversity (N1)	Biomass (g)
SE Fladen	SEGT55	30	97	17.20	0.8107
SE Fladen	SEGT56	30	94	14.67	1.9895
SE Fladen	SEGT57	24	208	8.71	2.7606
SE Fladen	SEGT58	18	33	12.37	0.3232
SE Fladen	SEGT59	27	84	15.11	4.9687
SE Fladen	SEGT6	16	37	14.00	0.6171
SE Fladen	SEGT60	22	54	13.62	3.5704
SE Fladen	SEGT61	28	85	15.63	16.4905
SE Fladen	SEGT62	32	77	23.95	2.1761
SE Fladen	SEGT63	20	48	11.11	1.5637
SE Fladen	SEGT64	34	106	17.39	1.2284
SE Fladen	SEGT65	35	105	26.65	1.2569
SE Fladen	SEGT66	31	72	19.92	0.8431
SE Fladen	SEGT67	37	108	27.86	22.1425
SE Fladen	SEGT68	37	110	21.11	4.7146
SE Fladen	SEGT69	32	104	22.33	2.1700
SE Fladen	SEGT7	22	51	15.09	0.7736
SE Fladen	SEGT70	34	94	24.10	3.8390
SE Fladen	SEGT71	28	103	10.10	5.3961
SE Fladen	SEGT8	24	64	14.09	0.8019
SE Fladen	SEGT9	28	88	15.49	0.9767
Western Fladen	WGT1	30	58	19.83	0.9800
Western Fladen	WGT10	46	113	30.21	5.4605
Western Fladen	WGT11	56	215	16.51	1.4585
Western Fladen	WGT12	48	119	35.14	1.4808
Western Fladen	WGT13	55	224	26.59	3.5012
Western Fladen	WGT14	59	230	32.95	2.2432
Western Fladen	WGT15	59	296	22.08	2.1299
Western Fladen	WGT16	44	104	30.45	15.7908
Western Fladen	WGT17	51	135	36.61	0.9544
Western Fladen	WGT18	51	161	37.55	1.1201
Western Fladen	WGT19	64	217	38.83	5.7789
Western Fladen	WGT2	46	240	16.07	33.4681
Western Fladen	WGT20	41	91	28.49	0.9231
Western Fladen	WGT21	60	261	28.87	7.3960
Western Fladen	WGT22	47	161	33.73	5.9995
Western Fladen	WGT3	56	222	23.30	10.8395
Western Fladen	WGT4	61	317	19.53	2.9236
Western Fladen	WGT5	41	183	11.29	1.0046
Western Fladen	WGT51	51	153	27.42	4.0708
Western Fladen	WGT52	50	197	23.73	1.2409
Western Fladen	WGT53	50	135	29.97	7.9538
Western Fladen	WGT54	62	277	35.49	20.5685

pMPA	Station Code	Species no. (S)	Abundance (N)	Hill's Diversity (N1)	Biomass (g)
Western Fladen	WGT55	48	186	24.67	3.3440
Western Fladen	WGT56	46	175	20.58	0.9594
Western Fladen	WGT57	50	194	24.78	1.3147
Western Fladen	WGT58	49	143	25.05	1.8739
Western Fladen	WGT59	44	161	23.40	2.1562
Western Fladen	WGT6	31	97	15.81	1.1172
Western Fladen	WGT60	63	394	14.79	1.7205
Western Fladen	WGT61	38	96	26.83	1.4379
Western Fladen	WGT62	53	156	29.16	0.8021
Western Fladen	WGT63	58	236	27.44	3.5105
Western Fladen	WGT64	55	143	29.04	1.4831
Western Fladen	WGT65	36	91	25.42	0.9637
Western Fladen	WGT66	56	171	29.62	1.0935
Western Fladen	WGT67	61	216	36.45	2.3764
Western Fladen	WGT7	50	192	12.15	0.9965
Western Fladen	WGT8	53	261	13.66	0.8588
Western Fladen	WGT9	57	389	10.78	2.6865
Fladen Transits	FTR01	39	98	26.41	2.2350
Fladen Transits	FTR02	20	25	18.95	0.4752
Fladen Transits	FTR03	55	149	29.96	1.4706
Fladen Transits	FTR03E	59	281	19.09	3.0937
Fladen Transits	FTR03N	53	171	35.18	1.5690
Fladen Transits	FTR03S	32	69	23.80	2.5255
Fladen Transits	FTR03W	60	195	30.57	1.2976
Fladen Transits	FTR04	37	89	26.40	0.8444
Fladen Transits	FTR05	43	146	30.50	0.7230
Fladen Transits	FTR06	39	113	19.93	1.0289
Fladen Transits	FTR07	36	131	13.20	10.2094
Fladen Transits	FTR08	44	125	29.26	16.5604
Fladen Transits	FTR21	25	58	17.65	1.0591
Fladen Transits	FTR22	27	75	17.70	3.6303
Fladen Transits	FTR23	20	46	11.79	4.0457
Fladen Transits	FTR24	28	44	22.48	0.9804
Fladen Transits	FTR25	27	63	19.82	1.2114
Fladen Transits	FTR26	36	96	26.04	2.0761
Fladen Transits	FTR27	40	142	18.10	1.0484
Fladen Transits	FTR28	31	103	14.57	1.9788
Fladen Transits	FTR29	38	96	25.10	1.0857
Fladen Transits	FTR30	51	168	32.08	3.2678

Appendix 9. Multivariate analysis: Grab samples - SIMPROF clusters

Dendrogram of grab sample similarity: significant clusters identified by SIMPROF are joined by red lines.



Appendix 10. Taxa characteristic of each faunal assemblage identified from grabs at the Fladen Ground pMPAs

	Cluster groups																
Taxa	**a**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**m**	**o**	**q**	**r**	**s**	**t**	**u**	**v**
Thyasira equalis		2.41	1.98	2.12	2.67	3.75	3.19	4.21	3.26					1.84	3.74	2.99	
Spiophanes kroyeri		1.9	2.12			1.49	1.48	1.94	2.05	1.56			2.61	2.32	2.34	2.52	1.33
Paramphinome jeffreysii		2.26	2.09					2.49	1.57	1.58	2.12	2.78	2.57			2.31	
Heteromastus filiformis		2.31	2.28	5.03		1.57	1.82	2.57	2.05							2.03	
Galathowenia oculata										1.98		7.06	4.54				1.75
Ampharete falcata		1.58								2.85	2.53	3.03	2.53	1.84			
Cerianthus lloydii		5.31		2.37							3				1.5		1.72
Mendicula ferruginosa										1.15	2.12	2.06	2.72	2.43	1.98		
OPHIUROIDEA (juv)						1.52						2.44	2.5	1.46		2.46	1.73
Abyssoninoe hibernica						2.21	1.43	1.37				1.99		1.41		1.73	
Diplocirrus glaucus											2.22	3.17			1.87	2.07	
Axinulus croulinensis								1.37		1.23			2.2		1.41	1.74	
Eclysippe vanelli												2.54	2.66			1.7	
Lanice conchilega											1.57		2.77	2.18			
Amphiura chiajei		1.87		1.41												2.14	
Eudorella emarginata											3.16	2.05					
Terebellides stroemi										1.11			1.86	1.74			
Amaeana trilobata				1.57				1.64									1
Orbinia norvegica				1.41	1.28	1.42											
Leucon nasica			1.41		1.38		1.2										
Apseudes spinosus		2.02													1.41		
Ditrupa arietina					3.25												
NEMERTEA					1.38												1.15
Lumbrineris cingulata										1.5							0.94
Praxillella affinis												2.11					
Nicomache	1.93																
Dipolydora socialis														1.88			
Harpinia antennaria														1.88			

Decipula tenella				1.73													
Phoronis													1.72				
Spiophanes bombyx																	1.14
Laonice sarsi										1.11							
Glycera lapidum															1		
Hyalinoecia tubicola	1																
Polynoidae	1																
Sthenelais limicola	1																

Values represent average abundances of square root transformed data. Colours indicate relative abundances (where red = high, yellow = medium and green = low). Taxa shown represent the top 50% characterising each group.

Appendix 11. Taxa characteristic of each faunal assemblage identified from video at the Fladen Ground pMPAs

	Cluster groups						
Taxa	**a**	**b**	**c**	**d**	**e**	**f**	**g**
Polychaeta tubes			3.6	4.71	4.94	2.62	
Pennatula phosphorea	1.88	2.6	1.5	2	2.75	1.46	
Echinus acutus		1	2.3	3	0.75	1.85	
Virgularia mirabilis	2.59	1	0.7	2.29	1.31	0.92	
Bolocera tuediae		1	0.9	1.29	0.63	3.08	0.67
Paguroidea sp.		0.8		2.14	0.75	1.69	
Aequipecten opercularis	0.76	0.6		1.57		0.69	1.33
Spirontocaris liljeborgi		0.6		1		2.38	
Aporrhais sp.	2.18		1.1				
Asteroidea sp.		1.2			0.56	1.38	
Dendrophylliidae sp.				2.86			
Crangon crangon	2.12					0.62	
Anthozoa							2.33
Crustacea sp.			0.5	0.86		0.85	
Buccinum undatum						0.54	1
Actinauge sp.				1.14			
Funiculina quadrangularis						1.08	
Asteronyx loveni						1	
Pectinidae sp.			0.9				
Arthropoda (suspended)	0.82						
Bryozoa sp. (filamentous)						0.69	
Bivalvia sp.		0.4					

Values represent average abundances of un-transformed data (SACFOR converted to numerical scale 1-6). Colours indicate relative abundances (where red = high, yellow = medium and green = low). Taxa shown represent the top 50% characterising each group.

Appendix 12. Taxa characteristic of each faunal assemblage identified from stills at the Fladen Ground pMPAs

	Cluster groups																
Taxa	aa	ab	ac	ad	ae	j	m	n	p	r	s	t	v	w	x	y	z
Polychaete tubes	1.73	2.25	2.5	2.39	2.09							1.58	1.48	1.79	1.82	1.67	1.5
Pennatula phosphorea															3.35	2.39	
Paguroidea					2.66	0.83						1.18					
Anthozoa																4.39	
Bryozoa erect									1.67	2.5							
Buccinidae			4														
Callionymus lyra																	4
Caryophyllia smithii										4							
Funiculina quadrangularis												4					
Bolocera tuediae														3.92			
Cerianthus lloydii						3.5											
Virgularia mirabilis													3.47				
Ophiuroidea						3.42											
Aporrhais sp.											3.15						
Crangon crangon								2.98									
Anthozoa - Actinaria		2.96															
Asteronyx loveni												2.95					
Echinus acutus				1.08												1.78	
Pectinidae	2.8																
Spirontocaris liljeborgi														2.32			
Scaphopoda							1.38										

Appendix 13. Number of stills within each video tow assigned to clusters

	Cluster groups																		
Video station	**aa**	**ab**	**ac**	**ad**	**ae**	**j**	**m**	**n**	**p**	**r**	**s**	**t**	**v**	**w**	**x**	**y**	**z**	**Outlier**	**Grand Total**
CCGT01				12	2								2		7				23
CCGT016	1	1		8	1	1					2	1		3	1			1	20
CCGT04				4	1			1						2	5				13
CCGT05		1		8									1		3				13
CCGT08				11				1						1	12				25
CCGT09				6	1									5					12
CCGT10	1			11	3									2				1	18
CCGT12	2			15	3							6		2	1				29
CCGT13				8	1							1		1		6			17
CCGT14				5	4										3				12
CCGT15	2			7											1				10
CCGT17				11	2									2	2				17
CCGT18				9	2								1	2					14
CCGT22	1			10	2			1							1				15
CCGT25				7									1		3				11
CCGT6	2			4	5								1	3					15
CGT018		2		5	7		1		3			2		1	3			1	25
CGT08				6	1						4		1		3				15
CGT1				4	3						5								12
CGT10	1	2		10	2									1	1				17
CGT15		1		8									2		3				14
CGT16		3	1	8	1			1						4	5				23
CGT17	1	1		8	2			1							2			1	16
CGT18	1	1		2	2	1		1				5	3	3				1	20
CGT22		1		8	2								1		1				13

Cluster groups

Video station	aa	ab	ac	ad	ae	j	m	n	p	r	s	t	v	w	x	y	z	Outlier	Grand Total
CGT27		1		10	2										1				14
CGT4				7									4		1				12
DEEP2						9													9
FTR02		1		1	8								1		2				13
FTR03		1		6	4							4			1				16
FTR03E				16	1											4			21
FTR03N				5	2								5		9				21
FTR03S		1		2	15					1		19		2	1				41
FTR03W		2		9	4	1				1			1		8			1	27
FTR06				5											4	1			10
FTR07	1			11							2				2				16
FTR08				4									8		1	7			20
FTR21							1	13										1	15
FTR24				1			1	5							1			1	9
FTR27				8									1						9
FTR30				10	1									1					12
SEGT1		1						5			3		3					1	13
SEGT10											1		6		3				10
SEGT11											6		7		1				14
SEGT18				1			1	6			5								13
SEGT19				5	2		1												8
SEGT21				1							4		3		3				11
SEGT24								2			5		6		2			1	16
SEGT29	2			6				4			1		4						17
SEGT54				2				5					4		3				14
SEGT55				1				5			3		2		1			1	13
SEGT60				6			4	2							1				13

Cluster groups

Video station	aa	ab	ac	ad	ae	j	m	n	p	r	s	t	v	w	x	y	z	Outlier	Grand Total
SEGT63		1		7	1		2						3						14
SEGT65											3		1		3			1	8
SEGT68				1	2			3					5		3				14
SEGT70				1	1						1		5		6				14
SEGT9				3	1		2	2			1				1			1	11
WGT06				8	1						1				2		1		13
WGT07			1	7	1									1	2				12
WGT1				5				1							6				12
WGT11				6	2								1		8				17
WGT12				11	1								2		2			1	17
WGT19				5	1									1					7
WGT20		2		4	3			1					1	1	2				14
WGT51				7											7		1		15
WGT52				6									1		3				10
WGT56		1		5									1		10				17
WGT62				1											9				10
WGT66				7	2										1				10

Appendix 14. Broadscale habitat, MPA search feature component habitats/species and biotope description derived from video analysis

pMPA/area	Station code	Broadscale Habitat	EUNIS code	MNCR code	Classification (Exact copy of MNCR descriptor)	MPA search feature component habitat/species
Central Fladen	CGT15	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Seapens and burrowing megafauna in circalittoral fine mud
Central Fladen	CGT4	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
Central Fladen	CGT1	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
Central Fladen	CGT10	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
Central Fladen	CGT17	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
Central Fladen	CGT27	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
Central Fladen	CGT8	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Seapens and burrowing megafauna in circalittoral fine mud
Central Fladen (core)	CCGT04	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Seapens and burrowing megafauna in circalittoral fine mud
Central Fladen (core)	CCGT14	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
Central Fladen (core)	CCGT25	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
Central Fladen (core)	CCGT22	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
Central Fladen	CGT16	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
Central Fladen (core)	CCGT13	A5.3 - Subtidal Mud	A5.3611	SS.SMu.CFiMu.SpnMeg.Fun	Seapens, including [*Funiculina quadrangularis*], and burrowing megafauna in undisturbed circalittoral fine mud	Seapens and burrowing megafauna in circalittoral fine mud
Central Fladen	CGT22	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)

pMPA/area	**Station code**	**Broadscale Habitat**	**EUNIS code**	**MNCR code**	**Classification (Exact copy of MNCR descriptor)**	**MPA search feature component habitat/species**
Central Fladen	CGT18	A5.3 - Subtidal Mud	A5.3611	SS.SMu.CFiMu.SpnMeg.Fun	Seapens, including [*Funiculina quadrangularis*], and burrowing megafauna in undisturbed circalittoral fine mud	Burrowed mud
Central Fladen (core)	CCGT09	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	-Burrowed mud (indicative)
Central Fladen (core)	CCGT05	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
Central Fladen (core)	CCGT18	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
Central Fladen (core)	CCGT15	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
Fladen Transits	FTR07A	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
Fladen Transits	FTR02	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
Fladen Transits	FTR03	A5.3 - Subtidal Mud	A5.3611	SS.SMu.CFiMu.SpnMeg.Fun	Seapens, including [*Funiculina quadrangularis*], and burrowing megafauna in undisturbed circalittoral fine mud	Burrowed mud
Fladen Transits	FTR06	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
Western Fladen	WGT56	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
Western Fladen	WGT07	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
Western Fladen	WGT11	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
Western Fladen	WGT19	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
Western Fladen	WGT66	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)

pMPA/area	Station code	Broadscale Habitat	EUNIS code	MNCR code	Classification (Exact copy of MNCR descriptor)	MPA search feature component habitat/species
Western Fladen	WGT52	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
Western Fladen	WGT06	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
Western Fladen	WGT51	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
Western Fladen	WGT01	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
Western Fladen	WGT62	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
Western Fladen	WGT12	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
Western Fladen	WGT20	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
Fladen Transits	FTR30B	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
Fladen Transits	FTR27B	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
Fladen Transits	FTR24B	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
Fladen Transits	FTR21B	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
SE Fladen	SEGT60	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
SE Fladen	SEGT55	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
SE Fladen	SEGT01	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
SE Fladen	SEGT9	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
SE Fladen	SEGT63	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
SE Fladen	SEGT19	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)

pMPA/area	Station code	Broadscale Habitat	EUNIS code	MNCR code	Classification (Exact copy of MNCR descriptor)	MPA search feature component habitat/species
SE Fladen	SEGT54	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
SE Fladen	SEGT11	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
SE Fladen	SEGT18	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
SE Fladen	SEGT29	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
SE Fladen	SEGT68	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
SE Fladen	SEGT21	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
SE Fladen	SEGT10	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
SE Fladen	SEGT65	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
SE Fladen	SEGT24	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
SE Fladen	SEGT70	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
Fladen Transits	FTR03W	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
Fladen Transits	FTR03N	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
Fladen Transits	FTR03S	A5.3 - Subtidal Mud	A5.3611	SS.SMu.CFiMu.SpnMeg.Fun	Seapens, including [*Funiculina quadrangularis*], and burrowing megafauna in undisturbed circalittoral fine mud	Burrowed mud

pMPA/area	**Station code**	**Broadscale Habitat**	**EUNIS code**	**MNCR code**	**Classification (Exact copy of MNCR descriptor)**	**MPA search feature component habitat/species**
Fladen Transits	FTR03E	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
Fladen Transits	FTR08	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
Central Fladen (core)	CCGT01	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
Central Fladen (core)	CCGT08	A5.3 - Subtidal Mud	A5.361	SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Burrowed mud
Central Fladen (core)	CCGT12	A5.3 - Subtidal Mud	A5.3611	SS.SMu.CFiMu.SpnMeg.Fun	Seapens, including [*Funiculina quadrangularis*], and burrowing megafauna in undisturbed circalittoral fine mud	Burrowed mud
Central Fladen (core)	CCGT16	A5.3 - Subtidal Mud	A5.3611	SS.SMu.CFiMu.SpnMeg.Fun	Seapens, including [*Funiculina quadrangularis*], and burrowing megafauna in undisturbed circalittoral fine mud	Burrowed mud
Central Fladen	CGT18	A5.3 - Subtidal Mud	A5.3611	SS.SMu.CFiMu.SpnMeg.Fun	Seapens, including [*Funiculina quadrangularis*], and burrowing megafauna in undisturbed circalittoral fine mud	Burrowed mud
Central Fladen (core)	CCGT17	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
Central Fladen (core)	CCGT10	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
Central Fladen (core)	CCGT06	A5.3 - Subtidal Mud	A5.37	SS.SMu.OMu	Offshore circalittoral mud	Burrowed mud (indicative)
Central Fladen	Deep2_S1	A5.4 - Subtidal Mixed Sediment	A5.441	SS.SMx.CMx.ClloMx	*Cerianthus lloydii* and other burrowing anemones in circalittoral mixed sediment	Offshore Subtidal Sands and Gravels
Central Fladen	Deep2_S2	A5.2 - Subtidal Sand	A5.441	SS.SMx.CMx.ClloMx	*Cerianthus lloydii* and other burrowing anemones in circalittoral mixed sediment	Offshore Subtidal Sands and Gravels

pMPA/area	Station code	Broadscale Habitat	EUNIS code	MNCR code	Classification (Exact copy of MNCR descriptor)	MPA search feature component habitat/species
Central Fladen	Deep5	A5.4 - Subtidal Mixed Sediment	A5.45	SS.SMx.Omx	Offshore circalittoral mixed sediments	Offshore Subtidal Sands and Gravels

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Cefas

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