METHIL OFFSHORE WIND DEMONSTRATOR BENTHIC SUB-TIDAL ECOLOGY SURVEY FINAL REPORT

Report No: 15/J/3/03/2590/1782

Prepared for:

2-B Energy Limited
Scott Harper
Quayside House
Dock Road
Methil Dock
Methil
KY8 3SR

Client Reference Number:

Rev.	Description	Prepared	Checked	Approved	Date
2	Final	Luke Betteridge Evelina Capasso	Peter Barfield	Richard Walters	24th April 2015
1	Draft	Luke Betteridge Evelina Capasso	Peter Barfield	Richard Walters	2nd March 2015

Fugro EMU Limited
Trafalgar Wharf (Unit 16), Hamilton Road, Portchester, Portsmouth, Hampshire, PO6 4PX, United Kingdom
Tel: +44 (0)2392 205 500, Fax: +44 (0)2392 205 555, http://www.fugroemu.com

AMENDMENTS PAGE

This table contains a record of amendments.

Issue Number	Amendment Number	Section/Paragraph	Date	Authoriser's Signature

SIGN OFF PAGE

Document Release and Authorisation Record			
Fugro EMU Document No.	15/J/3/03/2590/1782		
Issue Number	2		
Hard Copy	-		
Issued To	Scott Harper		
Date Issued	24 April 2015		
This Version Authorised By	**Name**	**Date**	**Signature**
Author(s)	Luke Betteridge	02/03/15	[redacted]
	Evelina Capasso	16/02/15	
Technical Checker	Peter Barfield	02/03/15	
QA Proof Reader	Heather Shepherd	02/03/15	
Project Manager	Tom Morris	02/03/15	
Group Manager/Director	Richard Walters	24/04/15	

Contact Details

Fugro EMU Limited
Trafalgar Wharf (Unit 16)
Hamilton Road
Portchester
Portsmouth
Hampshire
PO6 4PX
United Kingdom

[redacted]

[redacted]

www.fugroemu.com

CONTENTS

		Page
1.	**INTRODUCTION**	**1**
1.1	Aims and Objectives	1
2.	**METHODS**	**2**
2.1	Survey design	2
2.2	Sampling and site positioning	2
2.2.1	Seabed Drop Down Video (DDV)	2
2.2.2	Grab Sampling	3
2.2.3	Sediment Chemistry Sampling	3
2.2.4	Epibenthic Beam Trawling	4
2.3	Video Data Analysis	6
2.3.1	Assessment of Annex I Reef	6
2.4	Grab Data Analysis	8
2.4.1	Particle size distribution (PSD) analysis	8
2.4.2	Macrobenthic analysis	8
2.4.3	Statistical analysis of the data	9
2.4.4	Biotope classification	10
2.4.5	Sediment Chemistry	10
2.4.6	Total Organic Content	11
3.	**RESULTS**	**12**
3.1	Overview	12
3.2	Seabed video data	12
3.2.1	Assessment of Annex I Reef	15
3.3	Sediment Grab Sample Data	17
3.4	Macrofaunal grab sample data	24
3.4.1	Faunal abundance	24
3.4.2	Biomass	29
3.4.3	Diversity Index	29
3.4.4	Multivariate Analysis	32
3.5	Biotopes	38
3.6	Epibenthic Trawl	43
3.7	Sediment Chemistry	46
4.	**DISCUSSION**	**47**
4.1	Subtidal benthic ecology	47
4.1.1	Features on conservation importance	49
4.2	Sediment Chemistry	50
4.2.1	PAH	50
4.2.2	Metals	50
4.2.3	Organotins	51
4.2.4	PCBs	51

4.2.5 Total Petroleum Hydrocarbons 51

5. REFERENCES 52

6. APPENDICES 56

TABLES

Table 1.1: Benthic Sub-tidal Ecology Sampling Techniques 1
Table 2.1: Parameters for Recording the Length of Fish and Shellfish. 4
Table 2.2: Marine Nature Conservation Review (MNCR) SACFOR* Abundance Scale 6
Table 2.3: The Main Characterising Features of a Stony Reef (from Irving 2009) 7
Table 3.1: Total Sites Successfully Sampled 12
Table 3.2: Most Frequent Species Recorded from DDV Survey 12
Table 3.3: Biotopes Assigned at Each Site Following Video Data Analysis 14
Table 3.4: Summary of the Measure of Reefiness of Rocky Substrates Encountered within the Vicinity of the Methil Benthic Survey Area 16
Table 3.5: The Proportions of Folk Sediment Classification from the Sediment Samples for the Methil Benthic Survey Area 18
Table 3.6: Top 10 Most Abundant and Most Frequently Recorded Species in the Grab Samples 26
Table 3.7: Diversity Indexes 30
Table 3.8: Species Composition of Each SIMPER Group 34
Table 3.9: Biotopes Described for the Survey Area 38
Table 3.10: Total Abundance and Frequency of the Top Ten Most Abundant Enumerated Taxa, and Frequency of the Non–enumerated Taxa Recorded from the 2 m Beam Trawl Survey 45
Table 3.11: Total Abundance and Frequency of the Top Ten Fish Taxa Recorded from the 2 m Beam Trawl Survey 45
Table 3.12: Integrated Assessment Classes Linking TBT Effects in Gastropod Species with Concentrations of TBT In Water and Sediment 46
Table 4.1: Summary Table 48

FIGURES

Figure 2.1 Actual sample positional data. 5
Figure 3.1 Sediment components with folk classifications 19
Figure 3.2 Dendrogram showing the statistically significant clusters for the sediment in the survey area (a) and the distribution of the Folk 1954 classification within the clusters (b). 21
Figure 3.3 Sorting categories overlaid on the Folk 1954 classification, indicating the variability of the sediment composition in the survey area. 22
Figure 3.4 Principal components analysis ordination of percentage fractional weight particle size distribution data collected from grab samples and their distribution across the survey sites 23
Figure 3.5 Summary of the percentage number of taxa (a) and individuals (b) recorded in the grab samples and presented per major groups 25
Figure 3.6 Distribution of number of individuals across the survey area 27
Figure 3.7 Distribution of number of taxa across the survey area 28
Figure 3.8 Contribution to biomass by all major groups (AFDW). Epifauna is included in ‘Other’ taxa 29

Figure 3.9 Shannon -Weiner diversity index across the survey area 31
Figure 3.10 Cluster analysis dendrogram and Multidimensional Scaling plot of the multivariate statistical analysis of the macrofaunal grab data 33
Figure 3.11 Faunal primer groupings 36
Figure 3.12 MDS plots with species highlighted as driving SIMPER group differences 37
Figure 3.13 Biotopes from grab faunal assemblages 41
Figure 3.14 Predicted habitat distribution based on geophysical and grab/trawl data 42
Figure 3.15 Percentage contributions of major taxonomic groups to the total number of taxa recorded (a) to the total abundance for enumerated only (b) 44

1. INTRODUCTION

Fugro EMU Limited (Fugro EMU) were commissioned by 2-B Energy to undertake a sub-tidal ecological survey in the Firth of Forth. The work is in support for the 2-B Energy Offshore Wind Turbine Demonstrator project at Methil, Fife. The purpose of this survey was to acquire sufficient data to characterise the seabed habitats and associated communities within and in the vicinity of the proposed development area to inform the EIA.

1.1 Aims and Objectives

The sub-tidal benthic ecology survey was conducted following Cefas Guidelines (Cefas, 2004) and based on updated sampling methods described in Ware and Kenny (2011) as well as JNCC Procedural Guidance No. 3.9 (Davies et al., 2001). Following receipt of advice from Marine Scotland, the benthic subtidal survey included the techniques and proposed number of samples listed in Table 1.1:

Table 1.1: Benthic Sub-tidal Ecology Sampling Techniques

Sampling Technique	No. of Samples	Purpose
Drop down seabed video and photographic stills at each benthic sub-tidal sample station.	19	Assessment of benthic habitat and epibenthic communities.
Stainless steel grab sample at each soft sediment benthic sub-tidal sample station.	19	Quantitative sampling of sediment fauna and particle size distribution (PSD).
Stainless steel grab sampling at selected soft sediment benthic sub-tidal sample stations.	3	Seabed sediment chemical analyses.
Epibenthic scientific beam trawling at selected benthic sub-tidal sample stations	5	Assessment of mobile epibenthic assemblages.

2. METHODS

2.1 Survey design

19 sites were selected within and around the site boundary in the Firth of Forth with Drop down videos and Faunal grab samples taken at each. Three of the sites within the site boundaries were also selected for sediment chemistry samples using a stainless steel grab. Five trawl sites were selected across the survey array for 2 m scientific beam trawling.

2.2 Sampling and site positioning

All survey work was carried out between the 9th October and 13th October 2014 on board the MV Conserver. The actual sample locations are presented in Figure 2.1.

Sample positioning was achieved using EMU's Hemisphere Crescent V110 DGPS which has a stated horizontal accuracy of <0.6 m (95% confidence). Navigation and position recording was achieved using Trimble's HYDROPro software version 2.4.

A list of target site positions was used to guide the vessel to the planned sampling locations. At each site, the actual position of each sampling event was recorded at the moment the winch wire went slack, indicating that the sampling device reached the seabed.

2.2.1 Seabed Drop Down Video (DDV)

Drop down video footage was successfully collected at all 19 sites. Five of the sites were of extended length due to trawl locations present at the same site; these were site numbers 4, 5, 10, 16 and 18. At these sites the video was extended to cover the full length of the proposed trawl transects.

At site 3 the video was extended due to the substrate observed being deemed to be sufficiently obstructive that the grab sample was not attempted. The proposed site had contained both grab samples for benthic fauna and PSD as well as a sediment chemistry sample.

The seabed at each benthic sub-tidal sample station was initially surveyed using a Kongsberg 208 video and stills camera mounted on a drop down frame. Seabed habitat types and epibenthic communities were recorded for the duration of the seabed video deployment together with any additional observations of seabed features, such as burrows or tubes. The duration of the seabed video was a minimum of five minutes, although this was extended up to 15 minutes in areas of high local substrate complexity or where the substrate was observed to be sufficiently obstructive that a grab sample was not attempted. The duration of video surveillance was also extended where any feature of interest was encountered. In addition, a minimum of five photographic stills was taken per deployment.

All video footage was overlaid with dGPS positions and all stills images geo-referenced. Field recordings include the time and date of each deployment and the different seabed habitats present (sediment descriptions), characterising epibenthic species and seabed features at each benthic sub-tidal sample location.

The drop down video logs are presented in Appendix B. The video analysis descriptions and associated images are presented in Appendix F**.**

2.2.2 Grab Sampling

Grab samples were attempted at 18 of the 19 sites with site 3 not attempted due to the obstructive sediment observed. Grab samples were successfully collected at 17 sites using a 0.1m^2 mini Hamon grab for determination of particle size distribution and invertebrate faunal content. Up to three attempts were made to retrieve an acceptable sample. A minimum grab sample size of 5 litres volume was deemed acceptable with no further attempts required.

At site 2 only indicative benthic fauna and no PSD samples were collected due to repeated small sample sizes significantly below the acceptable amount.

Upon recovery of each sample, the sediment within the grab bucket was viewed to assess whether the sample was acceptable (i.e., has not been subject to partial washout during retrieval and is of sufficient volume relating to the depth of bite). Smaller samples were accepted at sites 6 and 12 where three attempts were made resulting in three low volume samples. Low volume samples were not pooled, therefore the benthic fauna and PSD samples were taken from separate attempts at these two sites.

On receipt of an acceptable sample, the sample was released into a suitable container. An assessment of the sample volume (in litres) was then made and a visual description recorded including basic sediment description, quantity of shell, conspicuous fauna and/or flora and evidence of any anoxia. A photograph of the sediment was taken prior to sample processing which is displayed in Appendix A.

A sub-sample for PSD analysis was then taken. The volume of the sub-sample was approximately 500 ml, although the exact volume depended on the nature of the sediment. The PSD sub-sample was then transferred into a pre-labelled heavy duty container and sealed to ensure no loss of fine material.

The remaining sample was sieved on a 1 mm aperture mesh sieve to remove the finer sediment fractions. The contents of the sieve were transferred into a pre-labelled bucket with internal label and fixed on-site using 4% buffered saline formaldehyde solution.

The grab sampling logs are presented in Appendix C**.**

2.2.3 Sediment Chemistry Sampling

Sediment chemistry samples were attempted at two of the three sites with site 3 not attempted due to the obstructive sediment. A sediment chemistry sample was successfully collected at site 5, within the proposed development area, using a stainless steel Day grab. The Day grab was cleaned with Acetone between stations to prevent cross contamination. At site 12 a successful sample was not taken due to the grab being prevented from closing fully due to obstructive substrate being trapped in the jaws of the grab on all attempts.

Sediment was collected from the top five centimetres of the sample, with a cleaned metal scoop used for hydrocarbon samples and a plastic scoop for metals. The sample obtained was placed in appropriate pre-labelled container then frozen and stored at the Edinburgh office.

The sediment chemistry sampling log is presented in Appendix D**.**

2.2.4 Epibenthic Beam Trawling

Epibenthic beam trawling was attempted at three of the five sites due to obstructive substrate being observed at T3 and T5. T2 was also shortened to prevent the trawl from being deployed across an area of obstructive substrate. At all of the sites attempted a successful sample was recovered.

The Epibenthic beam trawling was carried out using an industry standard (Lowestoft design) 2 m scientific beam trawl fitted with a knotless cod end liner (5 mm mesh). The trawl was fitted with a chain mesh to prevent cobbles and boulders entering the trawl. A dispensation was given by Marine Scotland for the use of a 5 mm mesh cod end liner. The length of each trawl tow was approximately 500 m and collected at a speed of 1-2 knots, except for Trawl 2 which was reduced to approximately 250 m. Start and end dGPS positions of each trawl were recorded.

At the end of each trawl, the catch was brought on board the vessel and emptied into a trawl processing tray. Records of the catch, including species identities and abundance as well as photographs were taken. The trawl photographs are displayed in Appendix A. This includes notes of any substrate material and conspicuous sessile epifauna. The catch was processed on-site including the identification and enumeration of fish, prawns and crabs, prior to its return to the sea. However, where the field identification was uncertain, a representative of that species was returned to the laboratory for confirmation. Any sub-sampling of large catches was recorded.

The length of fish was measured to the nearest centimetre (rounded down), with shellfish measured to the nearest millimetre according to the parameters outlined in Table 2.1. The sex, carapace length and shell softness of macro-crustaceans was also recorded where possible, including the presence of any berried females. The sex of elasmobranch species was recorded where possible.

Table 2.1: Parameters for Recording the Length of Fish and Shellfish.

Taxon	Measurement
Fish	Total length (TL)
Rajids	Disk width and TL
Lobster, spider crab, edible crab	Carapace length
Squid, cuttlefish	Mantle length
Bivalves (scallop)	Shell width
Gastropod (whelk)	Shell length

The epibenthic beam trawling logs are presented in Appendix E.

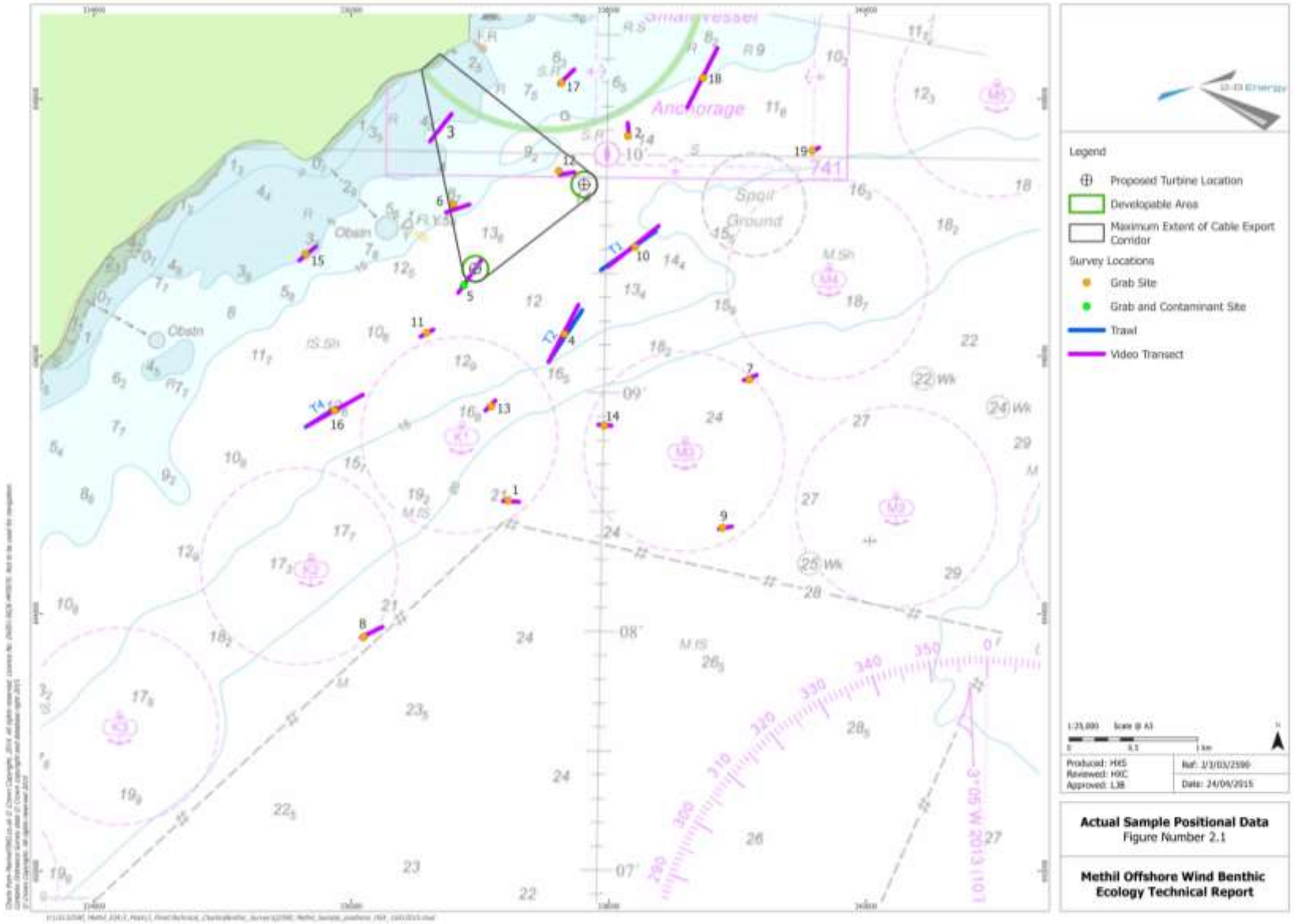


Figure 2.1: Actual sample positional data

2.3 Video Data Analysis

Seabed video data collected in the field were reviewed upon return to Fugro EMU's office to identify and describe the characterising habitat types and associated epifauna for each transect.

Substrate types for each video station were recorded as % cover of the seabed whilst the species abundance was calculated using the industry standard SACFOR abundance scale (Hiscock, 1996) which uses the average species size and abundance to classify the population (Table 2.2). In addition, the digital still images were used to assist identification of species and improve habitat descriptions. Biotopes were classified based on the Marine Biotope Classification for Britain and Ireland Version 04.05 (Connor et al., 2004) and was aided by the use of the biotope decision support tool BioScribe (Hooper et al., 2011).

Table 2.2: Marine Nature Conservation Review (MNCR) SACFOR* Abundance Scale

Growth Form			Size of Individuals / Colonies				Density
%cover	Crust /Meadow	Massive /Turf	<1 cm	1-3 cm	3-15 cm	>15 cm	
>80%	S		S				>1/0.001 m^2
40-79%	A	S	A	S			1-9/0.001 m^2
20-39%	C	A	C	A	S		1-9/0.01 m^2
10-19%	F	C	F	C	A	S	1-9/0.1 m^2
5-9%	O	F	O	F	C	A	1-9/1 m^2
1-5% or density	R	O	R	O	F	C	1-9/10 m^2
<1% density	R	R		R	O	F	1-9/100 m^2
					R	O	1-9/1000 m^2
						R	<1/1000 m^2

*Key: S=Superabundant, A=Abundant, C=Common, F=Frequent, O=Occasional, R=Rare, P=present (used when the abundance of an organism could not be estimated accurately)

2.3.1 Assessment of Annex I Reef

Where rocky and stony substrates were encountered they were compared with the existing criteria for defining geogenic reef for the purposes of Annex I of the EC Habitats Directive.

Clarification of geogenic reef as 'stony reef' under the Habitats Directive was attempted during an inter-agency workshop and subsequent discussions in 2008 (Irving, 2009). Table 2.3 presents several key parameters of 'reefiness' that were proposed to assess the main characterising features of a stony reef. Using these criteria, a measure of the resemblance of the stony and rocky seabed habitats observed at Methil with Annex I geogenic reef criteria has been attempted.

Table 2.3: The Main Characterising Features of a Stony Reef (from Irving 2009)

Measure of 'reefiness'	NOT a REEF	LOW	MEDIUM	HIGH
Composition Diameter of cobbles / boulders being greater than 64 mm. Percentage cover relates to a minimum area of 25 m^2. This 'composition' characteristic also includes 'patchiness'.	<10%	10-40% Matrix supported	40-95%	>95% Clast supported
Elevation Minimum height (64 mm) relates to minimum size of constituent cobbles. This characteristic could also include 'distinctness' from the surrounding seabed. Note that two units (mm and m) are used here.	Flat seabed	<64 mm	64 mm-5 m	>5 m
Extent	<25 m^2	>25 m^2		
Biota	Dominated by infaunal species			>80% of species present composed of epifaunal species

2.4 Grab Data Analysis

2.4.1 Particle size distribution (PSD) analysis

PSD analysis was undertaken at Fugro EMU's sediment laboratory using in house methods based on BS1377: Parts 1 3: 1990 (dry sieving), and BS 13320:2009 (laser diffraction). The latter method was used when the fine fraction of sediment (<63 µm) was greater than 5% of the total sample by weight. Representative sub-samples of each sediment sample were oven dried to constant weight at 105 ± 5°C before routinely wet sieving to remove silt and clay-sized particles of <63 µm (unless there was no sample cohesion after drying, where dry sieve analysis only is undertaken). The remaining coarser material was again oven dried to constant weight at 105 ± 5°C followed by dry sieving through a series of mesh apertures corresponding to units as described by the Wentworth scale. The weight of the sediment fraction retained on each mesh was subsequently measured and recorded and merged with the laser diffraction data where appropriate. Sediments were then classified according to the Folk sediment classification system (Folk, 1954) (Appendix I).

2.4.2 Macrobenthic analysis

Grab and beam trawl samples were returned to Fugro EMU's benthic laboratory for analysis. Fugro EMU's benthic lab are long time participants in the National Marine Biological Analytical Quality Control (NMBAQC) scheme which provides a source of external Quality Assurance (QA) for laboratories engaged in the production of marine biological data.

Samples were re-sieved over a 1 mm mesh to remove all remaining fine sediment and fixative. Fauna were sorted from the sediment by elutriation and subsequent examination under a stereomicroscope.

Macro-invertebrates were identified to the lowest practical level (species level, when possible) and enumerated. Any colonial, encrusting epifaunal species were recorded as present (P). A reference collection was prepared with one individual of each species identified retained. Nomenclature used is consistent with the World Register of Marine Species (WoRMS, 2015).

Fugro EMU undertook quality control (QC) checks on a representative number of whole samples, as well as the entire reference collection in compliance with internal analytical QC criteria.

Faunal biomass analysis was based on a wet-blot method with estimates of ash-free dry weight (AFDW) based on conversion factors provided by Eleftheriou and Basford (1989). Mollusc biomass included the weight of the flesh plus shell. The retained infauna was then separated into the following phyla and weighed to 0.0001 g:

- Polychaeta;
- Crustacea;
- Echinodermata;
- Mollusca; and
- Others.

Specimens caught in the 2 m beam trawls were identified and enumerated on site prior to being returned to the sea. Specimens returned to the laboratory were identified to species levels, where possible and enumerated and added to the field list. Sessile epifauna was recorded as P (present).

2.4.3 Statistical analysis of the data

For multivariate statistical analyses the Plymouth Marine Laboratories PRIMER v6 (Plymouth Routines in Multivariate Ecological Research) suite of programs was used (Clarke and Warwick, 2001; Clarke and Gorley, 2006). The recorded macro-invertebrate assemblages were also analysed using univariate measures (Shannon-Wiener diversity index, Pielou's evenness and Simpson's dominance index). Univariate analyses are used to extract features of communities which are not the function of specific taxa, i.e. these methods are species independent and therefore assemblages with no species in common can theoretically have equal values.

The Shannon-Wiener diversity index is a measure of biodiversity based on the number of species present and the number of individuals of each species. If a few species dominate, the index value is low. A greater number of species and a more even distribution of species both result in an increase in Shannon's diversity. Pielou's evenness is a measure of how the numbers of individuals are distributed across the number of species found in a sample. If the numbers of individuals are equally spread amongst the species then the community is considered to be even. The closer Pielou's evenness is to 1, the more even the distribution of abundance is amongst the species. The nearer the value is to 0, the less even the community is with some species having much higher abundances than others. Simpson's dominance index is a measure of the probability that two individuals randomly selected from a sample will belong to the same species. Simpson's dominance index ranges from 0 (all taxa are equally present) to 1.0 (one taxon dominates the community completely).

Faunal data for multivariate analysis were imported into PRIMER and initially subjected to a square root (grab samples) transformation to reduce the influence of any highly abundant taxa allowing less abundant species a greater role in driving the emergent multivariate patterns. The transformed data were then subjected to hierarchical clustering to identify sample groupings based on the Bray-Curtis index of similarity. This process combines samples into groups starting with the highest mutual similarities and then gradually lowers the similarity level at which groups are formed. The process ends with a single cluster containing all stations and is best expressed as a dendrogram diagram showing the sequential clustering of stations against relative similarity. The SIMPROF (similarity profile analysis) routine was used to identify statistically significant groupings.

The MDS (Multi-dimensional Scaling) procedure uses the same similarity matrix as that used by the cluster analysis to produce an ordination of stations which is multi-dimensional. This attempts to satisfy all of the between-samples relationships indicated by the similarity matrix. This multi-dimensional ordination is then reduced to a two-dimensional representation that is a more accessible and useable representation. The representativeness of this two-dimensional version, in comparison to the multi-dimensional array, is indicated by a stress level. The closer this stress level is to zero, the better, and more useful, is the representation.

SIMPER analysis was then applied to the data to rank species in terms of their contribution to both the internal group similarity and "between" group dissimilarity and thereby assist the assessment of the distinctiveness of each community identified and the identification of the characterising taxa.

Sediment data were also imported into PRIMER and subjected to hierarchical clustering using Euclidean distance as the similarity measure. In addition, Principal Components Analysis (PCA) ordination analysis was performed on the sediment data. PCA is a multivariate statistical technique principally used to investigate variability in environmental data through the ordination of the results of sediment analyses. The analysis identifies a reduced set of 'principal components' that account for most of the variance of the original variables.

2.4.4 Biotope classification

Biotope code allocations were made using the current UK Marine Classification System v4.05 (Connor et al., 2004). Biotopes were allocated to faunal composition at individual grab sites.

Biotopes were assigned with the aid of the biotope decision support tool BioScribe (Hooper et al., 2011). The tool matches the species list from a sample to the biological communities usually recorded with potential biotope matches. Confidence indicators and direct links to habitat descriptions from the Marine Habitat Classification for Britain and Ireland are provided to facilitate the process. The tool was used by an experienced ecologist practised in matching UK biotopes to field survey data with codes applied through expert judgement informed by outputs from BioScribe and knowledge of the current biotope classification system. All survey data were used to inform the biotope allocation process including the PSD analysis results and the video ground truthing data.

2.4.5 Sediment Chemistry

The sediment samples for analysis included the following:

- Metals – Aluminium (Al), Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Iron (Fe), Lithium (Li) Mercury (Hg), Nickel (Ni), Lead (Pb), Zinc (Zn);
- Polychlorinated biphenyls (PCB) (ICES 7 and 25);
- Organotins (TBT, DBT);
- Polycyclic aromatic hydrocarbons (PAHs) – Acenaphthene, Acenaphtylene, Anthracene, Fluorene, Naphthalene, Phenanthrene, Benzo[a]anthracene, Benzo[b]fluoranthene, Benzo[k]fluoranthene, Benzo[a]pyrene, Benzo[g, h, i]perylene, Dibenzo[a, h]anthracene, Chrysene, Fluoranthene, Pyrene, Indeno (1, 2, 3cd) pyrene;
- Total PAH;
- Total petroleum hydrocarbons (TPH); and
- Total organic carbon (loss of ignition).

Polychlorinated biphenyls were analysed at Fugro EMU's UKAS accredited Sediment Laboratory in Edinburgh. The rest of the analysis, apart from the Total organic carbon, was subcontracted to the UKAS accredited National Laboratory Service (NLS).

NLS use Ekofisk crude oil both for the standards and calibration when analysing total petroleum hydrocarbon.

The results of the analyses and notes on analysis methods are presented in Appendix J and are compared against the Scottish Guidelines for Assessment of Disposal of Dredged Sediments and any elevated concentrations highlighted.

2.4.6 Total Organic Content

The method for the Determination of the Mass Loss on Ignition (Fugro EMU MET/01) is based on BS1377: 1990 Part 3 Clause 4.1 and describes the procedure for determining the proportion by mass that is lost from a sediment sample by ignition at a specific temperature. The mass Loss on Ignition (LOI) can be used as a rough estimate of the organic matter content of certain sediments, such as sand, provided that the sediment contains little, or none, of the following: clay, chalky material, peats and organic clays which may contain more that 10% organic matter. It must be recognised that, in sediments where such components may be present, factors unrelated to the organic content could be responsible for a proportion of the mass loss on ignition.

A representative sub-sample is oven dried at 50 ±5°C and weighed to constant mass. The sample is then subjected to ignition in a muffle furnace at 440 ±250 C for 4 hours (or subject to client specific requirements). The organic matter content is then calculated from the subsequent loss in mass.

3. RESULTS

3.1 Overview

Table 3.1 presents the total number of sites successfully sampled for each sample type.

Table 3.1: Total Sites Successfully Sampled

Sampling Technique	Number of Samples Successfully Collected	Purpose
Drop down seabed video and photographic stills at each benthic sub-tidal sample station.	19	Assessment of benthic habitat and epibenthic communities.
Grab sample at each soft sediment benthic sub-tidal sample station.	17	Quantitive sampling of sediment fauna and particle size distribution (PSD).
Stainless steel grab sampling at selected soft sediment benthic sub-tidal sample stations.	1	Seabed sediment chemical analyses.
Epibenthic scientific beam trawling at selected benthic sub-tidal sample stations	3	Assessment of mobile epibenthic assemblages.

3.2 Seabed video data

A total of 19 sites were investigated by DDV. These included five extended transects (4, 5, 10, 16 and 18) carried out to assess the full length of a proposed trawl site and one transect (3) extended due to the nature of the sediment obstructing grab sampling from taking place. *Asterias rubens*, the common sea star, was the most frequently occurring species being observed in 18 out of 19 of the videos. This was closely followed by Gobiidae and *Liocarcinus* which were observed in 17 out of 19 videos. Table 1.1 presents the species recorded at more than 50% of the sites surveyed.

Table 3.2: Most Frequent Species Recorded from DDV Survey

Conspicuous Species	Common Name	No. of Sites	Frequency (%)
Asterias rubens	Common Sea Star	18 out 19	94.7%
Gobiidae	Goby	17 out 19	89.5%
Liocarcinus	Swimming crab	17 out 19	89.5%
Alcyonium digitatum	Dead – man's fingers	11 out 19	57.9%
Astropecten irregularis	Sand star	11 out 19	57.9%
Echinus esculentus	Edible sea urchin	11 out 19	57.9%
HYDROZOA/BRYOZOA turf		10 out 19	52.6%
Paguridae	Hermit crab	10 out 19	52.6%
PLEURONECTIFORMES	Flat fish	10 out 19	52.6%

The highest number of conspicuous species recorded from a single transect was 21 at site 5, in the centre of the survey array. At this site substrate was observed to be mainly coarse sediment with boulders, interspersed with some open patches of shelly sand, although this was obscured for about the last 100 m of the transect by the presence of an *Ophiothrix* bed.

The lowest number of conspicuous species recorded was eight and this occurred at two sites; Site 9, the most offshore site in the survey array and one of the sites adjacent to this, site 14. At site 9 the sediment was observed to consist of slightly shelly sand whilst at site 14 slightly shelly rippled sand was recorded. The presence of visible holes and burrows at both sites indicated the presence of a hidden, more infaunal component to the communities at these locations.

After being analysed and the observed species abundances converted into SACFOR the video data were used to determine biotopes visible at each site.

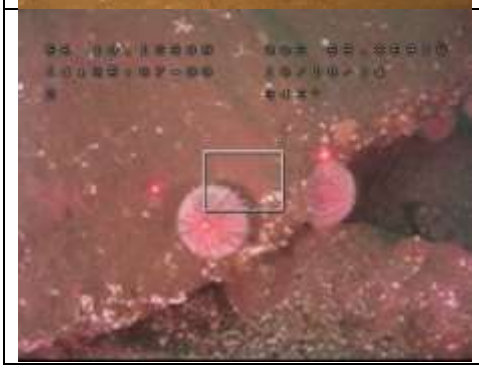
Seapens and burrowing megafauna in circalittoral fine mud (**SS.SMU.CFiMu.SpnMeg**) at 6 out of 19 sites, and circalittoral mixed sediment (**SS.SMx.CMx**), at 6 out of 19 sites, were the two joint most commonly occurring biotopes, observed in the survey area. The former encountered from the central survey area and continued out to the southern offshore sites and the latter spread across the middle to inshore and northern edge of the survey area.

Ophiothrix fragilis and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment (**SS.SMx.CMx.OphMx**), characterised by dense brittlestar beds were observed at five sites within the survey area. The sites were aligned with the coarser substrate described for the area (more details in the following PSD section) and were located within the proposed development site, extending out to the most northerly point at site 18.

The Echinoderms and Crustose communities (**CR.MCR.EcCr**) biotope was observed at three sites including the two most inshore ones. Due to the rocky nature of the substrate grabbing was not attempted at one of the sites and was unsuccessful at another. Therefore these two sites, sites 2 and 3, are described by the video data only.

Details and examples of the biotopes described are presented in Table 3.3 whilst full video data analysis results are presented in Appendix F.

Table 3.3: Biotopes Assigned at Each Site Following Video Data Analysis

Biotope Image	Biotope	Description	Sites Observed
	SS.SMx.CMx	Circalittoral mixed sediment	5, 10, 15, 16, 18 and 19
	SS.SMU.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	1, 4, 8, 9, 13 and 14
	SS.SMx.CMx.OphMx	*Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment	2, 5, 6, 12, and 18
	SS.SSa.CMuSa	Circalittoral muddy sand	2, 7, 11, 15 and 17
	CR.MCR.EcCr	Echinoderms and crustose communities	2, 3 and 17

Biotope Image	Biotope	Description	Sites Observed
	CR.HCR.XFa	Mixed faunal turf communities	15
	SS.SMu.CSaMu.VirOphPmax.HAs	*Virgularia mirabilis* and *Ophiura* spp. with *Pecten maximus*, hydroids and ascidians on circalittoral sandy or shelly mud with stones	16
	SS.SSa	Sublittoral sands and muddy sands	17

3.2.1 Assessment of Annex I Reef

Table 3.4 presents the results of the measure of reefiness of the rocky substrates encountered within the survey area. A full assessment of the attributes of these substrates in terms of resemblance to Annex I criteria is provided in Appendix M.

Table 3.4: Summary of the Measure of Reefiness of Rocky Substrates Encountered within the Vicinity of the Methil Benthic Survey Area

Site	Seabed description	Reef	Representative Image	Biotope
2	<25°m^2 cobbles and/or boulders/bedrock	Not a Reef		**CR.MCR.EcCr**
3	50% cobbles and/or boulders/bedrock	Medium		**CR.MCR.EcCr**
6	50% cobbles and/or boulders	Medium		**SS.SMx.CMx.OphMx**
15	30% bedrock	Low		**CR.HCR.XFa**
17	40% cobbles and/or boulders/bedrock	Low		**CR.MCR.EcCr And SS.SSa.CMuSa**

As indicated in the Table above, the rocky substrate at site 2 was considered to not have a resemblance to Annex I geogenic reef. Although this site contained some large boulders the overall area of rocky substrate was less than the extent required to be given Low to High reef resemblance.

Site 3 and 6 had Medium geogenic reef resemblance. Site 3 consisted of a large area of boulders and bedrock covered with encrusting and mobile epifauna interspersed with pebbles, cobbles and occasional patches of sand, thus fulfilling the Medium reef requirements. Site 6 featured brittlestar beds on slightly shelly sand with cobbles and boulders.

Sites 15 and 17 were given a low measure of reefiness. Site 15 was determined to have patches of bedrock (including areas of sand/mudstone ledging) mixed with slightly shelly silty sand, resulting in a 30% composition of bedrock. Site 17 was determined to have patches of cobbles and boulders with mud/sandstone ledging (including areas with relatively large holes bored in the surface) interspersed with slightly pebbly gravelly sand.

Typical fauna associated with the rocky and stony habitats included encrusting and sessile species (e.g. Corallinaceae, *Spirobranchus*, *Alcyonium digitatum,* Hydroid/Bryozoan turf species), grazers (*Echinus esculentus*) and mobile fauna (e.g. *Asterias rubens*, *Liocarcinus, Cancer pagurus*). Dense aggregations of the epifaunal brittlestar *Ophiothrix fragilis* were observed on cobbles and boulders at one of the medium reef resembling sites.

The biotopes associated with the potential Annex I habitats included, either on their own or as a mosaic with another biotope, **CR.MCR.EcCr** (Echinoderms and crustose communities)**SS.SMx.CMx.OphMx** (*Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment) and **CR.HCR.XFa** (Mixed faunal turf communities).

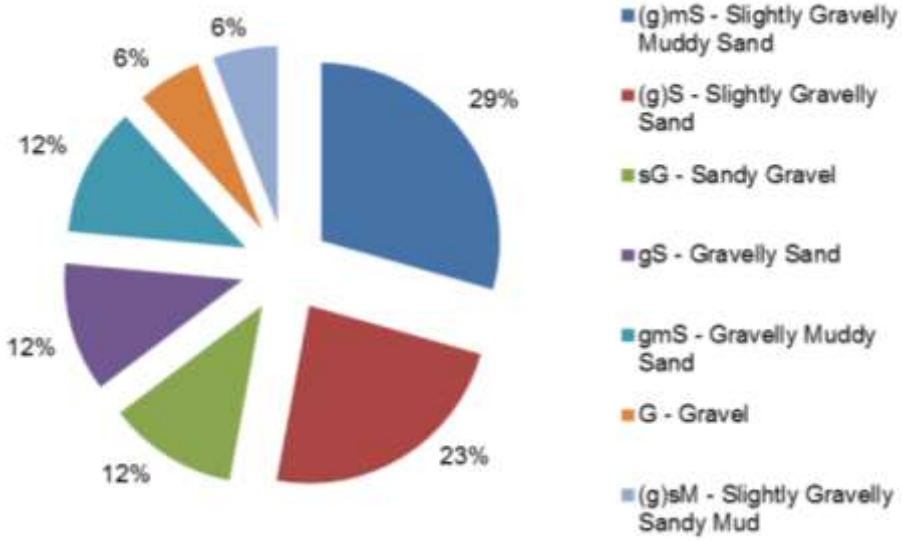
3.3 Sediment Grab Sample Data

Results of the sediment particle size analysis of the 17 acquired grab samples, including fractional weight and percentage data and Folk sediment classifications, are presented in Appendix I.

A total of seven different Folk Classifications have been recorded across the benthic survey area, the relative proportions of which are presented in Table 3.5. The dominant fraction was slightly gravelly muddy sand ((g)mS) which accounted for 29% of the results (five sites), followed by slightly gravelly sand ((g)S) which accounted for 24% of the results (four sites).

Figure 3.1 shows the distribution of the sediment classifications and the distribution of principal sediment components (%mud, %sand, %gravel).

Table 3.5: The Proportions of Folk Sediment Classification from the Sediment Samples for the Methil Benthic Survey Area



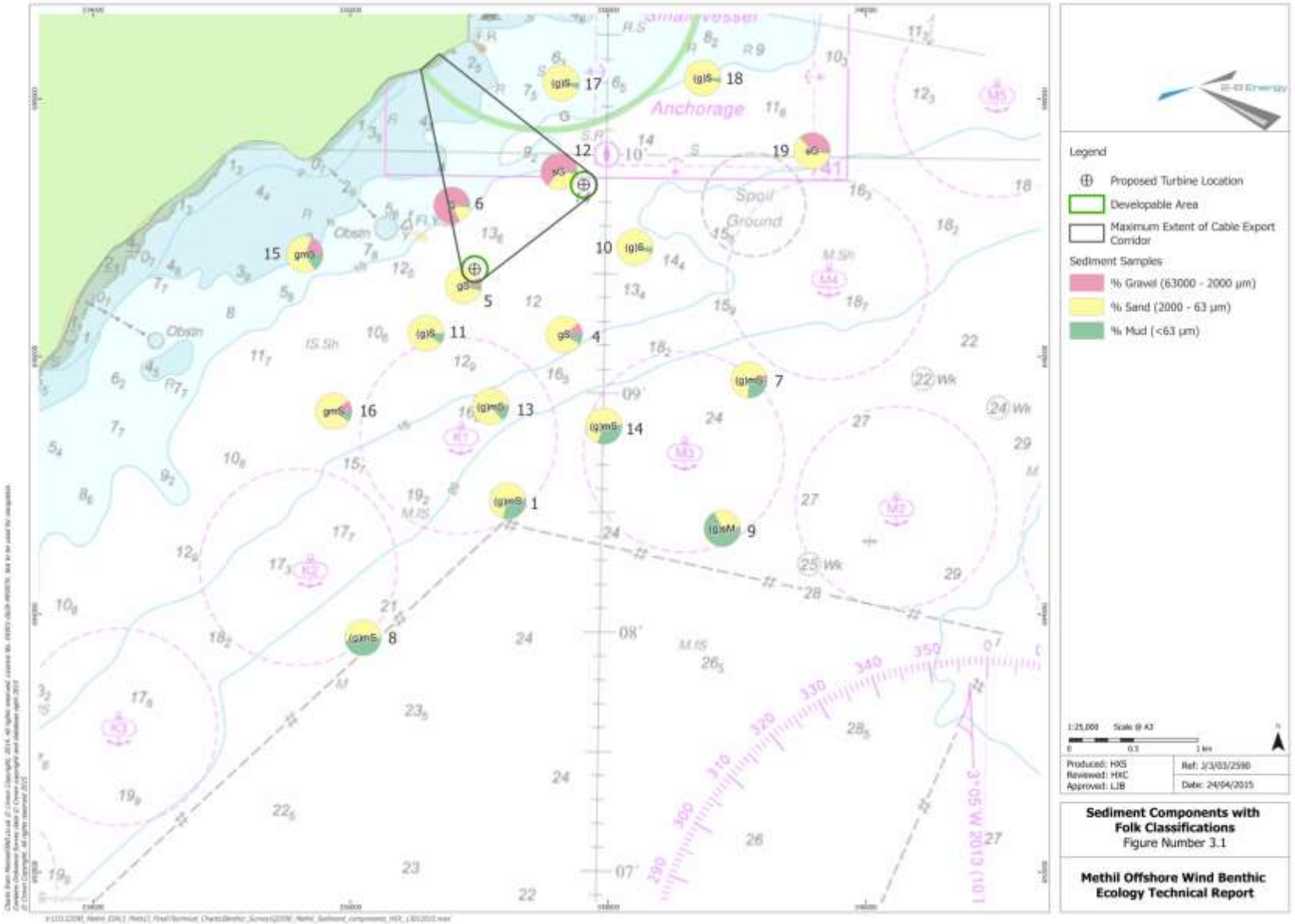


Figure 3.1: Sediment components with folk classifications

Data were further analysed using multivariate techniques, presenting the ordinations of percent fractional weight sediment data based on a Euclidean distance resemblance matrix. Application of the PRIMER SIMPROF routine, (Figure 3.2a) highlighted seven statistically significant groups. The Folk 1954 classification for the sites is overlaid on the clusters in Figure 3.2b.

Group e is the largest group and encompasses 8 sites out of 17. The sites were characterised by high percentage of the fine sand fraction. This group was dominated by samples categorised as slightly gravelly sand ((g)S) according to the Folk 1954 classification'.

Group c includes 3 sites out of 17 and they are characterised by very fine sand. This group is distinguished by a slightly 'finer' nature as captured by the Folk 1954 classification with each of the three samples categorised as slightly gravelly muddy sand ((g)mS).

Group g includes only 2 sites out of 17 and they are characterised by a higher percentage of gravel. This coarser component is also highlighted by the Folk 1954 classification for the two sites concerned as being composed of gravel (G) and sandy gravel (sG) substrates.

Groups a, b, d and f are each formed by a single site. Although the sediments at these sites do not differ greatly, in overall terms, from the sites in the other groups, the different proportions of gravel, sand and mud vary enough such that the SIMPROF routine has not grouped them with any of the other sites. Site 9 (group a) is the most offshore location and has a higher component of 'fines' (<63µm fraction); site 19 (group d) is located to the east of the survey array and has higher coarse, medium and fine gravel fractions; site 15 (group f) is located inshore to the west of the survey array and has higher coarse sand fraction; and finally, site 8 (group b) is located offshore to the south of the survey array and has the highest very fine sand fraction.

The degree of variability in the sediment distribution is also indicated by the sorting coefficient (Figure 3.3). Sorting indicates the spread of the grain sizes around the average and it provides a proxy measure of the energy of the environment (Blott and Pye 2001; Garrison, 2009). Sorting categories for the sites varied from extremely poorly sorted (eps), with very high sorting coefficients, to moderately well sorted (mws), with low sorting coefficients. Other sorting categories present were very poorly sorted (vps), poorly sorted (ps) and moderately sorted (ms). Well sorted sediments can indicate a consistent input of energy with little fluctuation; on the contrary poorly sorted sediments can indicate the reverse, i.e. an inconsistent energy input and a consequently wide fluctuation in the sediment matrix (Garrison, 2009).

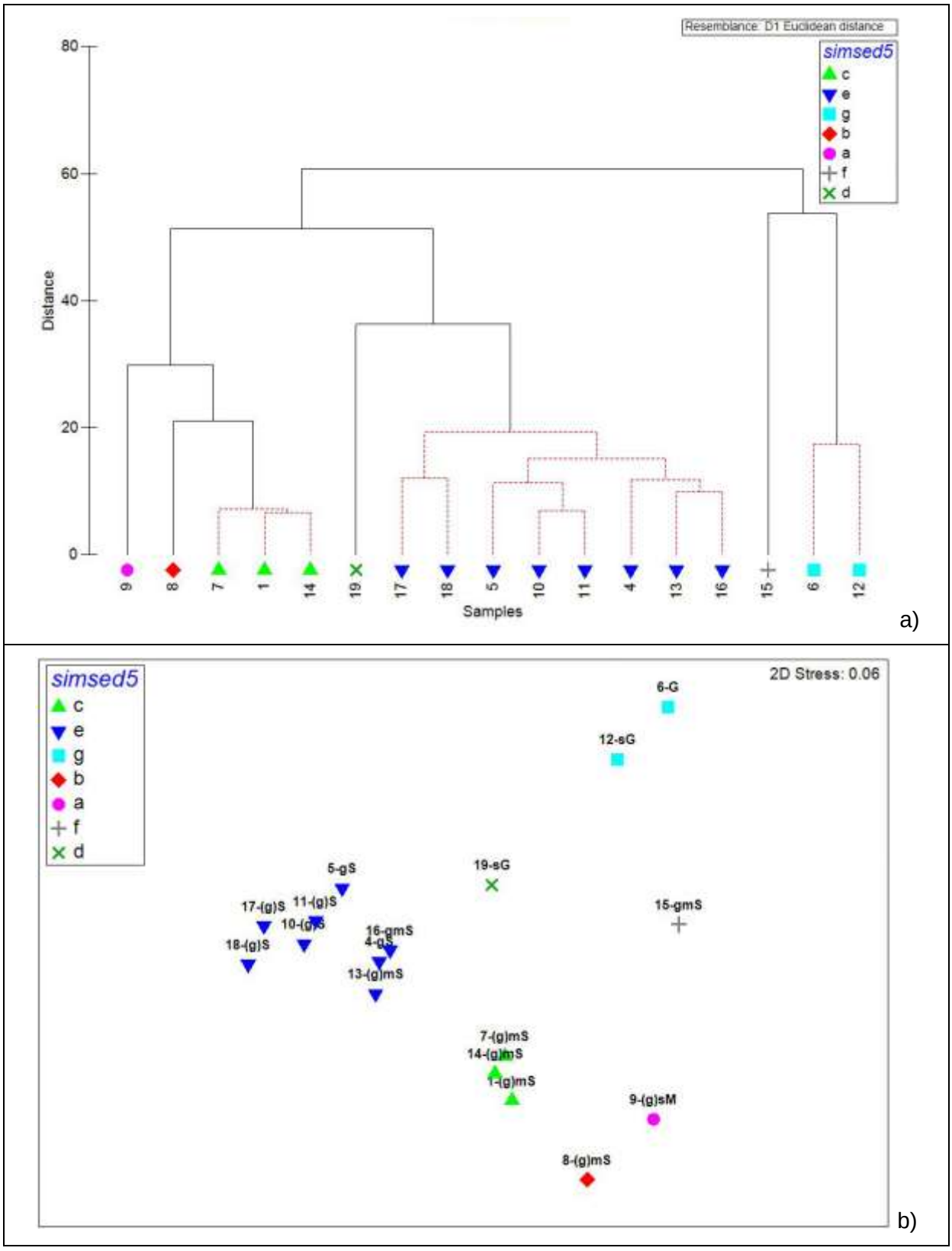


Figure 3.2: Dendrogram showing the statistically significant clusters for the sediment in the survey area (a) and the distribution of the Folk 1954 classification within the clusters (b)

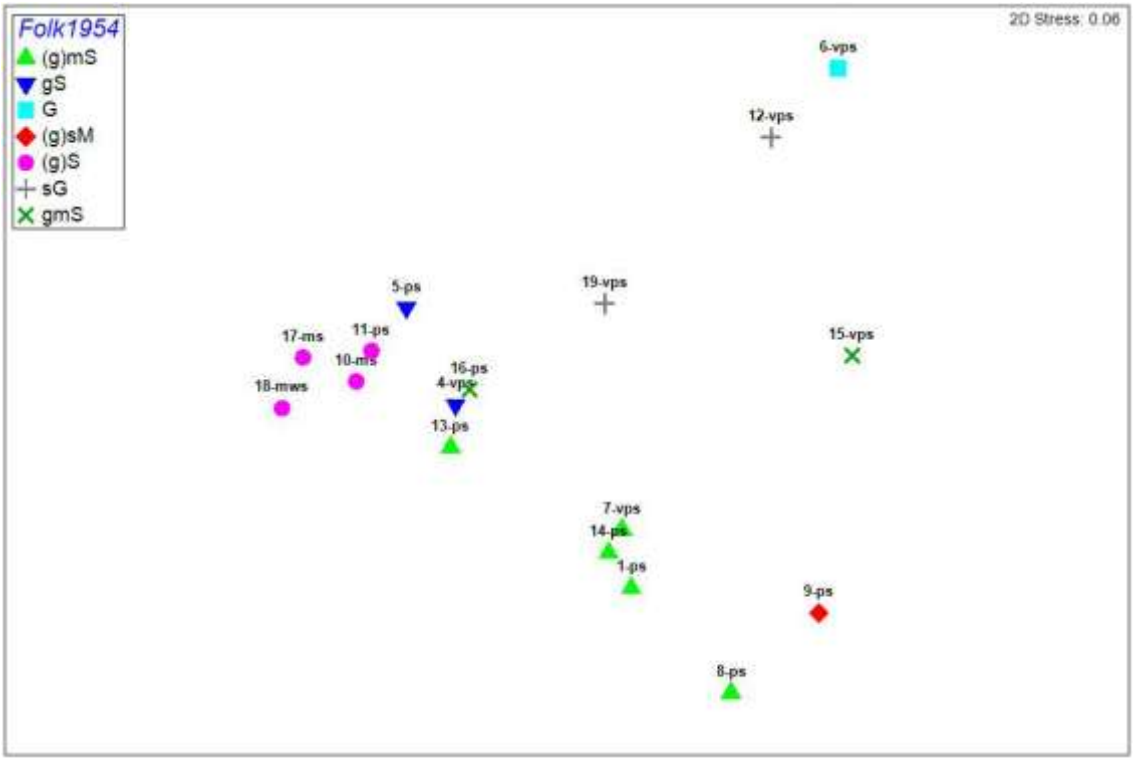


Figure 3.3: Sorting categories overlaid on the Folk 1954 classification, indicating the variability of the sediment composition in the survey area

Figure 3.4a below presents a PCA ordination plot for percentage fractional sediment data used to identify the sediment fractions driving the variability of the sediment composition amongst the sites. The principal component axis (PC1) is very strongly positively correlated with percentage fine sand (250 µm) and accounts for 53.4% of the variation. The second principal component axis (PC2) is strongly correlated with the percentage of very fine sand (125 µm) and accounts for a further 31.8% of the variation. The 2-dimensional PCA can be considered a good description of the higher multi-dimensional space with PC1 and PC2 together accounting for 85.3% of the variability. The importance of the percentage of these fractions in structuring the multivariate patterns observed is visible from the bubble plots in Figure 3.4b, and c.

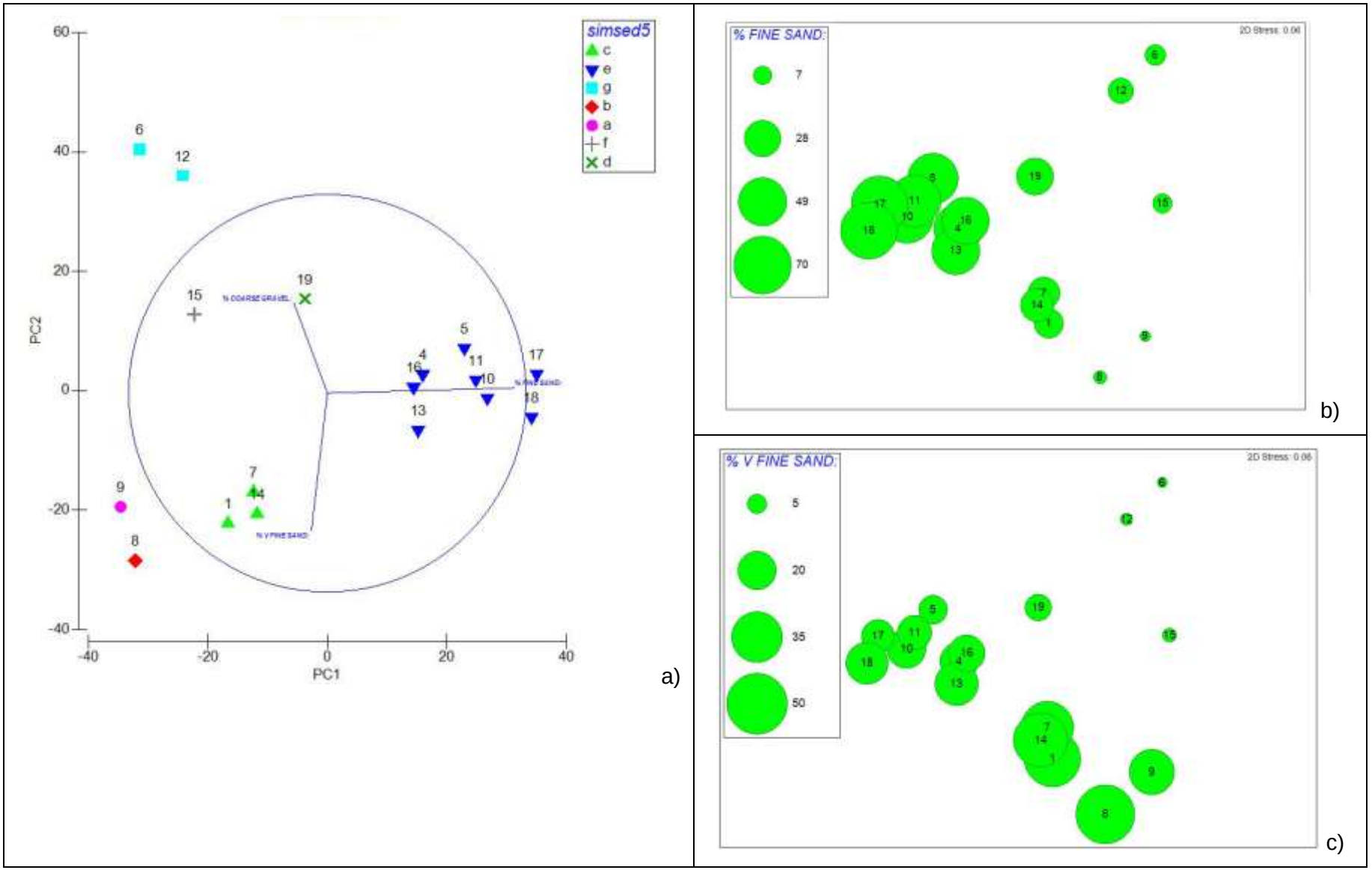


Figure 3.4: Principal components analysis ordination of percentage fractional weight particle size distribution data collected from grab samples and their distribution across the survey sites

3.4 Macrofaunal grab sample data

Seventeen grab samples were successfully collected for macrofaunal analysis. Raw data including infaunal and epifaunal species abundance generated from the analysis of the faunal samples are available in Appendix G. The data are presented with the relevant AphiaID included as a reference to names currently accepted by the World Register of Marine Species (WoRMS) (WoRMS Editorial Board (2015).

Biomass (as blotted wet weight) per major phyla was also recorded and the results presented in Appendix H.

3.4.1 Faunal abundance

A total of 233 quantitative taxa (including juveniles) were recorded from the grab samples collected. As no juveniles were listed in the top 20 most abundant species, they were included in the statistical analysis as their recorded presence was very unlikely to skew any assessment of the pattern of site relatedness. An additional 16 non-quantitative taxa were identified from the grab samples and recorded as present (P). These were not included in the statistical analysis. One fish taxon (*Ammodytes* sp. – sand eel) was recorded in the grab sample. It was included in the descriptive analysis of the grab sample data, but removed for the statistical analysis of the benthic invertebrate macrofaunal species.

The total number of individuals recorded was 4,320.

Quantitative taxa were split into the five major taxonomic groups:

- **Annelida**, mainly including polychaetes, or bristle worms, but also including some oligochaetes;
- **Mollusca**;
- **Crustacea**;
- **Echinodermata**; and
- '**Others**', which includes a range of minor phyla such as anemones, flatworms, ribbon worms, acorn worms, horseshoe worms and sipunculids or peanut worms.

The percentage contribution by each of the major taxonomic groups in terms of number of species and abundance is presented in Figure 3.5a and b respectively. The distribution of these across the survey area is presented in Figure 3.6 and Figure 3.7.

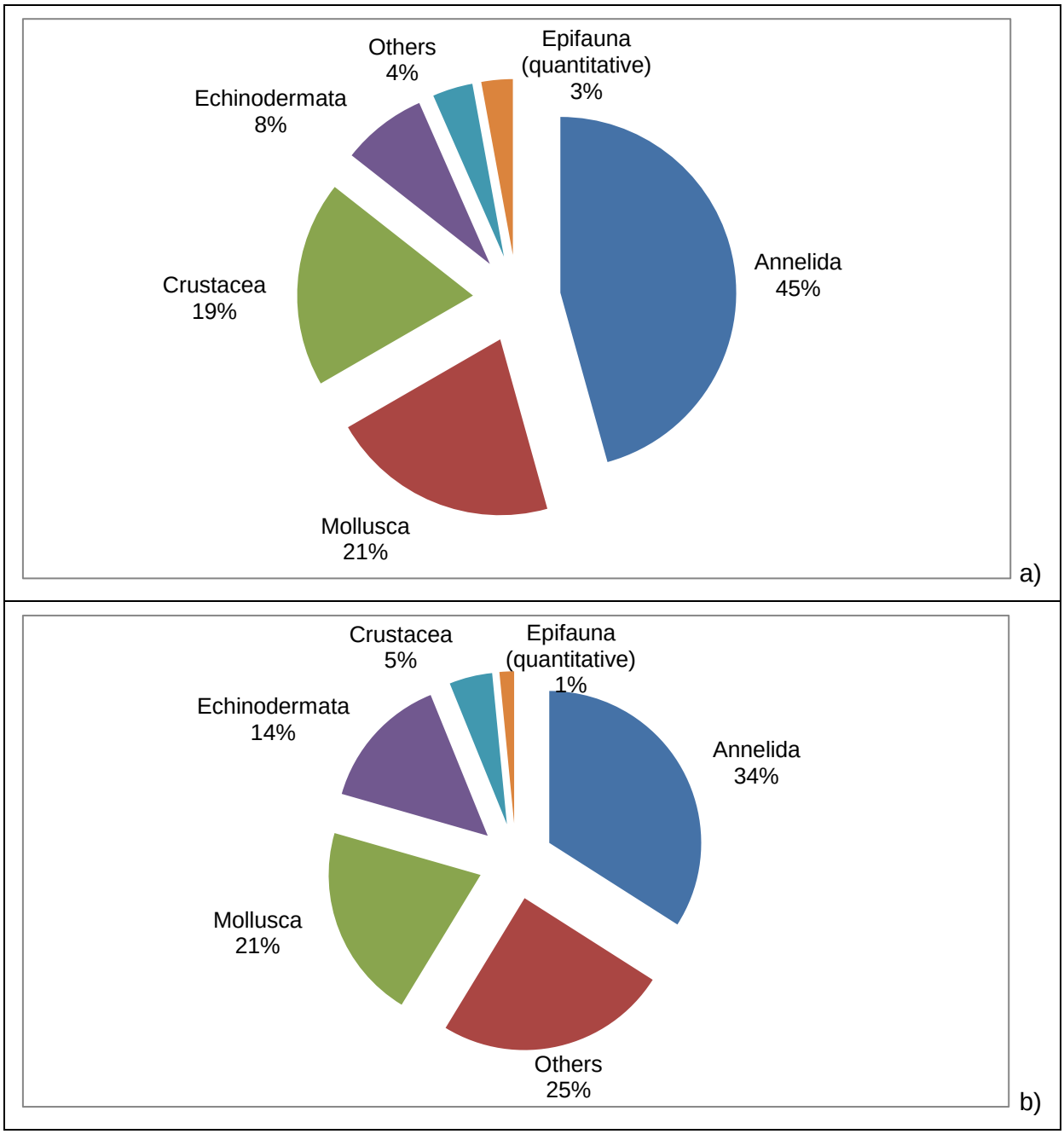


Figure 3.5: Summary of the percentage number of taxa (a) and individuals (b) recorded in the grab samples and presented per major groups

As expected, polychaetes are the most abundant and the most taxonomically diverse group in the macrobenthic communities sampled in the survey area constituting 45% of the recorded species (Figure 3.5a) and 34% of the individuals forming the benthic communities (Figure 3.5b). The group with the second highest number of recorded taxa was molluscs (21%) followed by crustaceans (19%), Echinodermata (8%) and Others (3%).

The group with the highest abundance was Annelida (34%). This was due to the high abundance of *Magelolona filiformis* and *Magelona johnstoni* particularly at sites 17 and 18 both located close to the shore to the north of the survey area and described as slightly gravelly sand. The second highest abundant group was 'Others', due to the large abundance of the genus *Phoronis* with a total number of 935 individuals across the survey area. These animals are commonly found in soft substrates such

as mud or sand. The abundance of molluscs (21%) was third highest with *Kurtiella bidentata* and *Tellina fabula* being relatively abundant. Echinoderm abundance at 14% was determined by the high numbers of *Amphiura filiformis* present at many sites across the survey area and *Ophiothrix fragilis* being particularly abundant at Site 6 and Site 12. As shown by the drop down video analysis (Section 2.3) *Ophiothrix* beds were observed at Site 6 and site 12. Crustacea at 5% were recorded in limited abundances in the grab samples.

Amongst the top ten most abundant species recorded from the grab samples there are four species which are also amongst the most frequently recorded (Table 3.6). The most abundant species found in 76% of the samples (13 sites) was the taxon *Phoronis*. The second most abundant species, recorded in 65% of samples (11 sites) was the brittlestar *Amphiura filiformis*. The bivalve *Kurtiella bidentata* was the third most abundant species, and was the most frequently occurring species being found in 88% of samples (15 sites).

Table 3.6: Top 10 Most Abundant and Most Frequently Recorded Species in the Grab Samples

Most abundant species			**Most frequently occurring species (n=17)**		
Scientific Name	Common Name	Total	Scientific Name	Common Name	%
Phoronis	Polychaete worm	935	*Kurtiella bidentata*	Bivalve	88
Amphiura filiformis	A brittlestar	224	*Owenia borealis*	Polychaete worm	82
Kurtiella bidentata	Bivalve	219	NEMERTEA	Ribbon worm	82
Ophiothrix fragilis	Common brittlestar	177	*Phoronis*	Polychaete worm	76
Magelona filiformis	Polychaete worm	128	*Lumbrineris cingulata*	Polychaete worm	71
Magelona johnstoni	Polychaete worm	118	*Spiophanes bombyx*	Polychaete worm	71
NEMERTEA	Ribbon worm	113	*Pholoe baltica*	Polychaete worm	65
Tellina fabula	Bean-like tellin	100	*Ampelisca tenuicornis*	An amphipod	65
Rodhine	Polychaete worm	93	*Amphiura filiformis*	A brittlestar	65
Phaxas pellucidus	Razor shell	86	*Glycinde nordmanni*	Polychaete worm	59

In 10 of the 17 grab samples collected in the survey area a total of 16 species and higher taxa of non-quantitative colonial epifaunal animals were identified. The dominant taxa present was Bryozoa (8 taxa), followed by Cnidaria (5 taxa), Porifera (2 taxa) and Entoprocta (1 taxa).

The full record of the epifaunal (non-enumerated) species identified from the grab samples is presented in Appendix G.

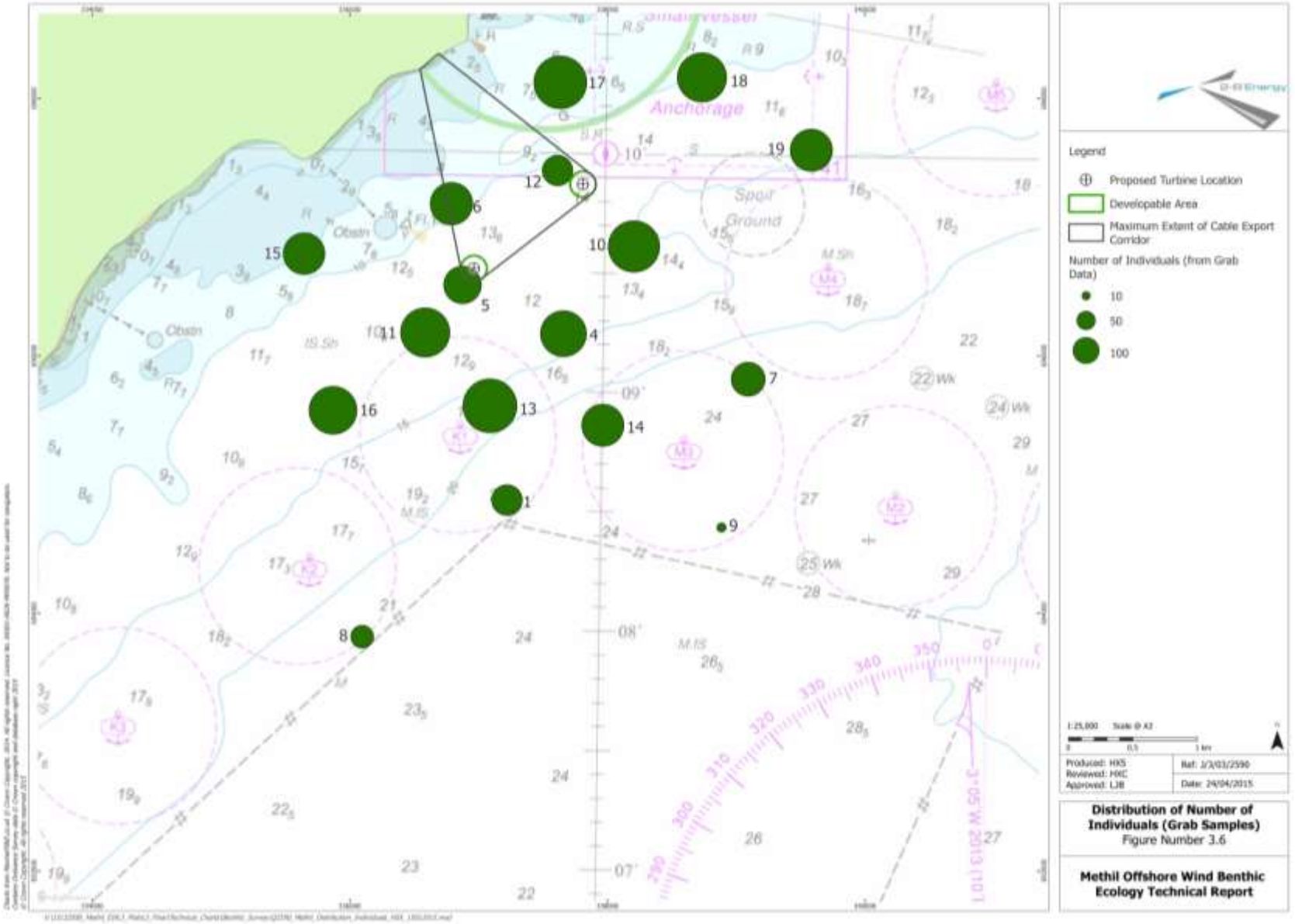


Figure 3.6: Distribution of number of individuals across the survey area

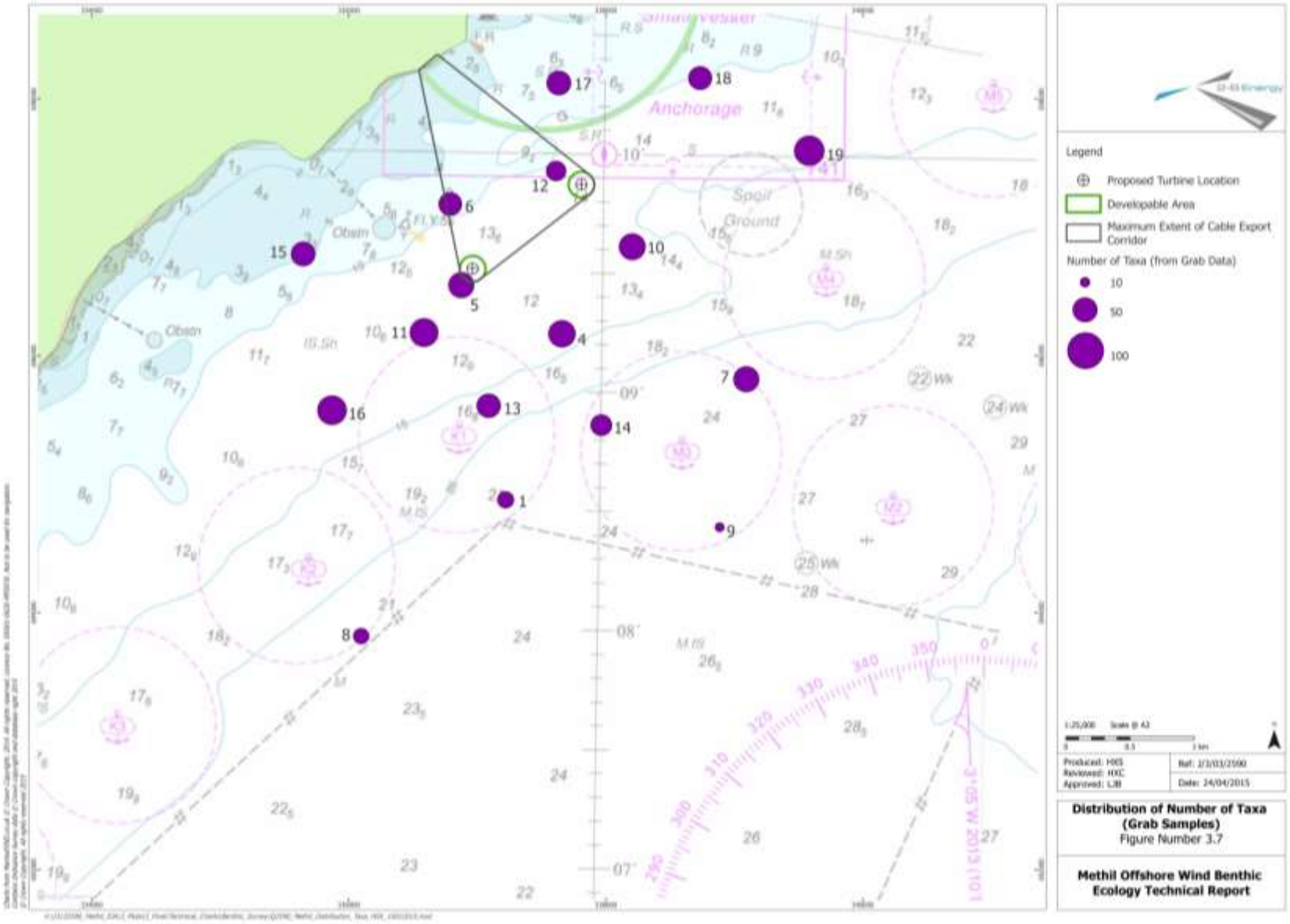


Figure 3.7: Distribution of number of taxa across the survey area

3.4.2 Biomass

Biomass weight for Mollusca included shells. The phylum contributing the most (Figure 3.8) was the Echinodermata which accounted for 40% of the total AFDW. This was mainly due to the presence of large specimens of the brittlestar *O. fragilis* with a smaller contribution from *A filiformis* at sites 6 and 12. The particularly high abundance of these two brittlestars is due to the presence of extensive brittlestar beds at these sites. Mollusca contributed 38%, Annelida and Other taxa contributed 10% each and Crustacea accounted for 2% of the total AFRW. Biomass data are presented in Appendix I.

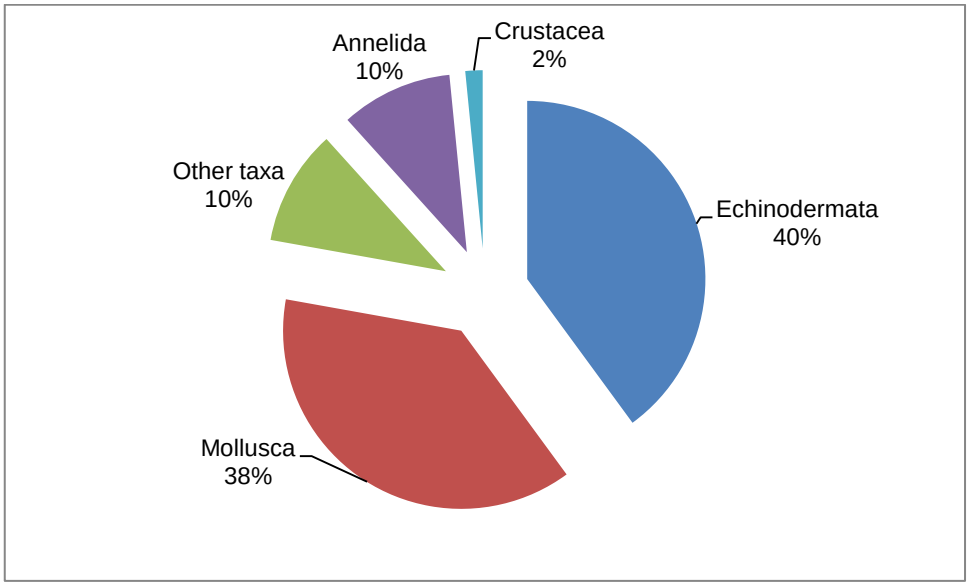


Figure 3.8: Contribution to biomass by all major groups (AFDW). Epifauna is included in 'Other' taxa

3.4.3 Diversity Index

The number of species recorded in the survey area ranged from 9 species at Site 9 to 71 species at Site 19. The site where species richness was less than 10 was characterised by a high percentage of very fine sand and various fractions of silt. This type of habitat can typically, be species poor. The video survey also found a paucity of fauna at this location which was the most offshore site in the survey array. The Shannon-Weiner diversity index combines species richness and their abundances, giving high values where the numbers of individuals are evenly distributed across the species recorded. Figure 3.9 shows the distribution of the index across the survey area, reflecting the variations of species richness and abundance at the sites described.

Table 3.7summarises the diversity indexes for the study area.

Table 3.7: Diversity Indexes

Site	No of Species (N)	No of Individuals (N)	Pielou's Evenness (J')	Simpsons Dominance (1-Lambda')	Shannon-Wiener (H'(loge))
1	25	137	0.588	0.6955	1.893
4	59	309	0.7576	0.9045	3.089
5	54	205	0.8752	0.959	3.491
6	45	261	0.6374	0.8019	2.426
7	54	168	0.7365	0.8464	2.938
8	23	75	0.7954	0.8771	2.494
9	9	12	0.9206	0.9091	2.023
10	57	385	0.7276	0.8731	2.942
11	65	354	0.7843	0.929	3.274
12	35	134	0.611	0.7101	2.172
13	48	421	0.5782	0.7282	2.238
14	39	258	0.473	0.5472	1.733
15	49	251	0.836	0.9432	3.254
16	68	334	0.7456	0.8911	3.146
17	49	405	0.7554	0.9086	2.94
18	46	351	0.8096	0.9301	3.1
19	71	260	0.8168	0.934	3.482

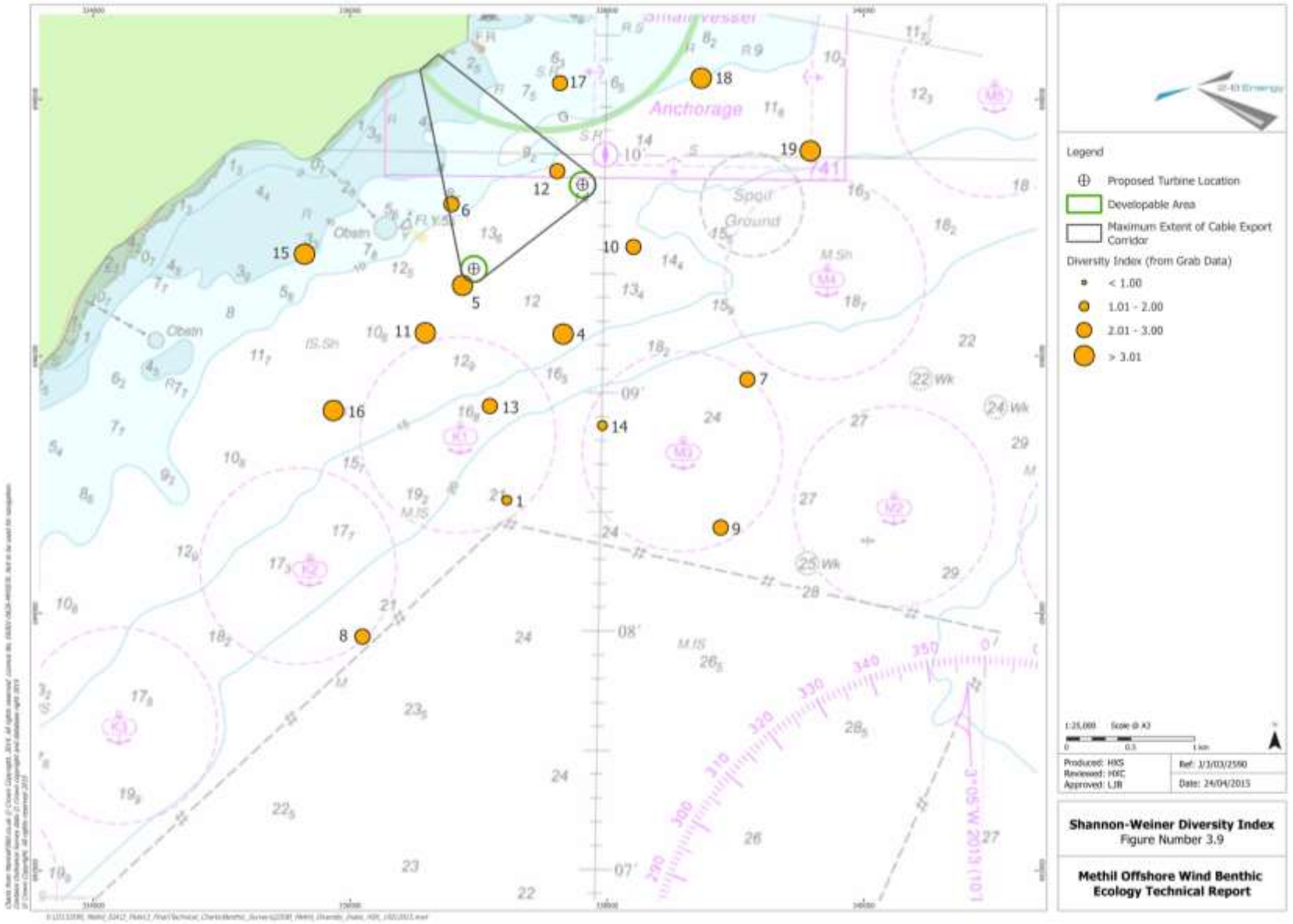


Figure 3.9: Shannon -Weiner diversity index across the survey area

3.4.4 Multivariate Analysis

The multivariate statistical analysis returned eight statistically significant groups. The cluster analysis dendrogram and the MDS plot are presented in Figure 3.10. The SIMPROF (Figure 3.10a) groupings are based on the 5% significance levels. The ordination of grab faunal samples (Figure 3.10b) has labelled sites with the Folk sediment classifications, indicating how faunal groupings may be related to sediment characteristics.

The SIMPER routine aided in the identification of the species characterising each group it also highlighted those species determining their difference. The species composition of each group, contributing to up to 50% of the similarity within the group, is presented in Table 3.8.

Groups f, d and e show comparable species suits and the differences between these groups are mostly due to differences in relative abundance of particular species as well as differences in species composition. Species such as *Phoronis* sp., *K. bidentata*, *A. filiformis* and *Owenia borealis* were found amongst the species contributing to the within group similarity of each of these groups. Buchanan et al (1978) considered *Phoronis* to be associated with *A. filiformis – A. chiajei* communities, in particular on muddy sand with *A. filiformis* sub-communities off the coast of Northumberland, just south of the Firth of Forth.

These species are typically found on fine sediment such as sand or mud (MarLIN, 2006). The sediment type of the groups was slightly gravelly Sand ((g)S) with a proportion of mud.

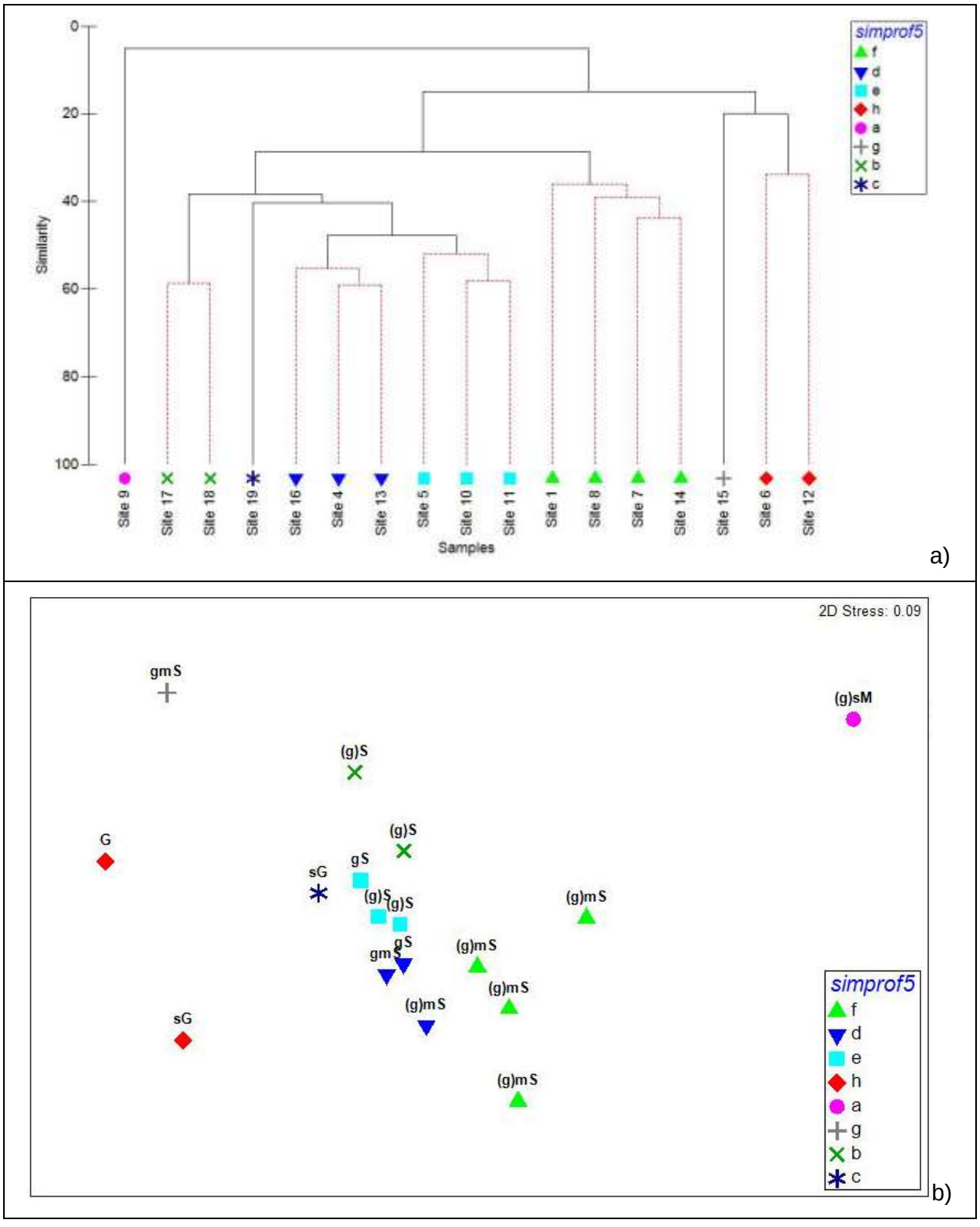


Figure 3.10: Cluster analysis dendrogram and Multidimensional Scaling plot of the multivariate statistical analysis of the macrofaunal grab data

The two species contributing to 50% of the similarity within Group h were the common brittlestar *O. fragilis* and the polychaete worm *Subadyte pellucida*. The former being quite abundant resulting in brittlestar beds (see video analysis – 3.2), on coarser grounds. These two species have shown to be

commensal with *S. pellucida* previously being reported on the discs and arms of *O. fragilis* (Pettibone, 1969 and 1993).

Group b was characterised by the presence of high abundance of *M. filiformis* and *M. johnstoni* as well as the mollusc bivalve molluscs *T. fabula* and *K. bidentata*.

The other groups included single samples only. It is worth mentioning the high abundance of the bivalve *Musculus subpictus* at site 19 (group c). This is the only site where the grab samples collected the taxa Ascidiidae, *Ascidiella* and *Ascidiella aspersa* and *M. subpictus* is known to frequently occur embedded in the flesh of tunicates (Neal, 2004).

Table 3.8: Species Composition of Each SIMPER Group

Group	Sites in Group and Dominant Sediment Characteristics	Species	Av. Abundance	Cum %
▲ f Average similarity: 38.36 %	1, 7, 8 and 14 **slightly gravelly muddy Sand** poorly sorted	*Phoronis* *Kurtiella bidentata* *Owenia borealis* *Ampelisca tenuicornis* *Glycera unicornis*	8.38 2.7 1.49 1.47 1.35	28.02 36.77 43.65 49.59 54.78
▼ d Average similarity: 56.61 %	4, 13, and 16 **slightly gravelly muddy Sand** poorly sorted	*Phoronis* *Amphiura filiformis* *Rhodine* *NEMERTEA* *Melinna palmata* *Magelona alleni* *Owenia borealis* *Anobothrus gracilis* *Lucinoma borealis*	10.94 5.51 4.34 3.16 3.6 3.64 2.88 2.31 2.2	14.46 21.3 26.64 31.64 36.26 40.49 44.43 48.09 51.22
■ e Average similarity: 54.03%	5, 10 and 11 **slightly gravelly Sand** poorly sorted	*Amphiura filiformis* *Kurtiella bidentata* *Phoronis* *Phaxas pellucidus* *Acrocnida brachiata* *Thracia (juv.)* *Cylichna cylindracea* *Thracioidea (juv.)* *Ophiuridae (juv.)* *Pholoe baltica* *Owenia borealis*	5.52 5.27 7 3.36 3.44 3.22 2.29 2.23 2.39 2.55 2.72	8.33 15.46 21.85 27.26 31.74 35.29 38.78 42.28 45.57 48.86 52.07
◆ h Average similarity: 33.87%	6 and 12 **Sandy Gravel** Very poorly sorted	*Ophiothrix fragilis* *Subadyte pellucida*	9.34 2.74	38.39 50.44
✕ b Average similarity: 58.67%	17 and 18 **slightly gravelly Sand** moderately (well) sorted	*Magelona filiformis* *Magelona johnstoni* *Tellina fabula* *Kurtiella bidentata* *Spio symphyta* *NEMERTEA* *Thracia phaseolina*	7.58 7.51 6.7 4.74 3.97 3.41 3.5	11.6 22.98 30.39 37.62 43.09 47.56 51.73

Group	Sites in Group and Dominant Sediment Characteristics	Species	Av. Abundance	Cum %
+ g	15 **gravelly muddy Sand** very poorly sorted	*Scoloplos armiger* *Glycera lapidum* *Pholoe baltica* NEMERTEA *Mediomastus fragilis*		
● a	9 **slightly gravelly sandy Mud** Poorly sorted	*Nephtys incisa* NEMERTEA *Abra nitida* *Aphelochaeta marioni* *Crangon allmanni*		
* c	19 **sandy gravel** Very poorly sorted	*Musculus subpictus* *Kurtiella bidentata* *Amphiura filiformis* NEMERTEA *Phoronis*		

Note: The single site groups g, a and c do not have species identified by SIMPER which requires a minimum of two sites within a group. Instead the top five species by abundance have been included in the Table for comparative purposes.

The distribution of faunal groupings across the survey area is shown in Figure 3.11 and reflects the natural environment variability of the survey area.

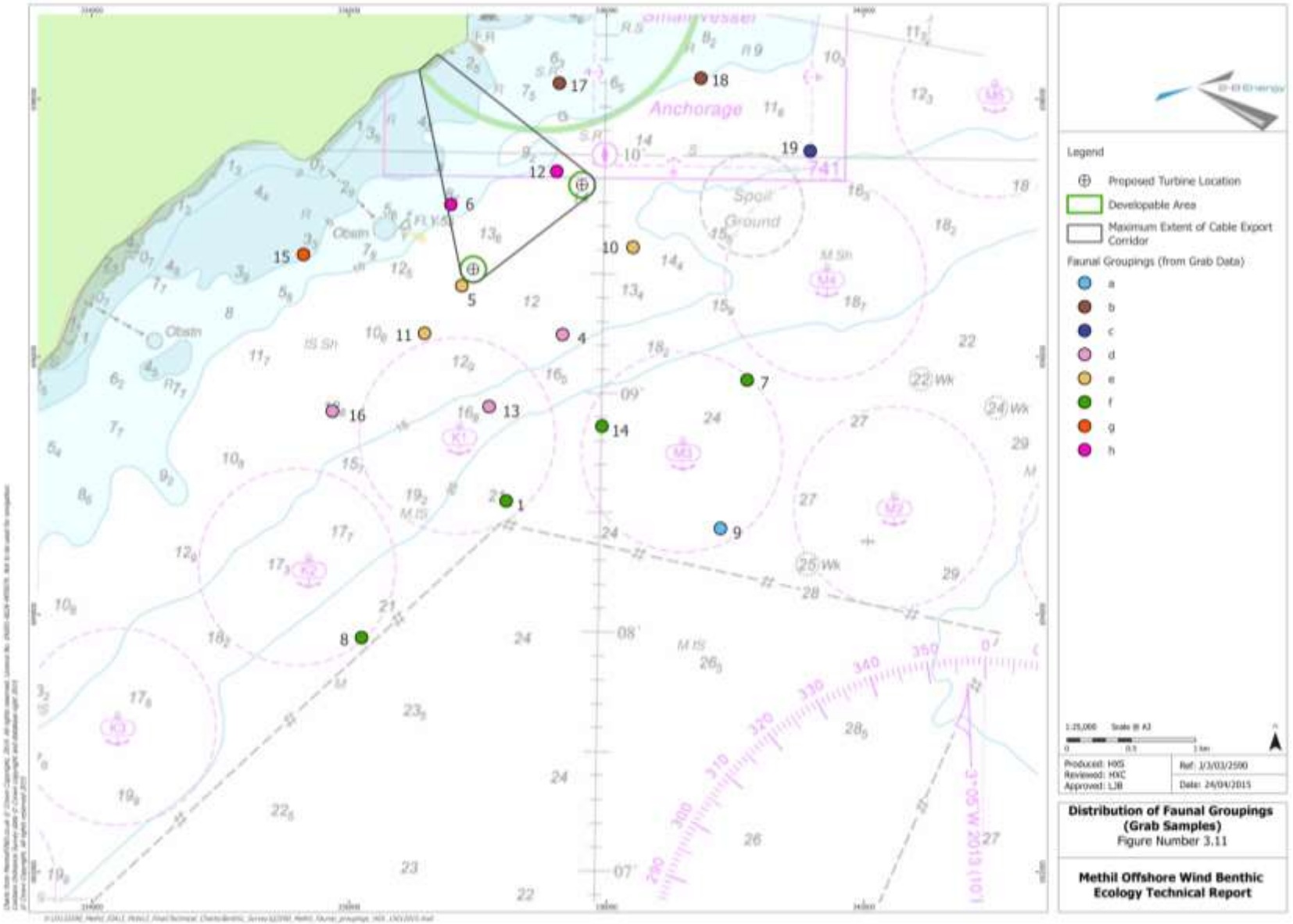


Figure 3.11: Faunal primer groupings

As well as describing the species forming each statistical group, SIMPER also returns the list of species driving the differences between groups. These were mainly related to variation in the density of *Phoronis* sp., but in some cases also to the high abundance of species such as *O. fragilis*, *Turritella communis*, *Magelona filiformis* and *Magelona johnstoni* at some locations and the lack of them at other sites. Details are presented in Figure 3.12.

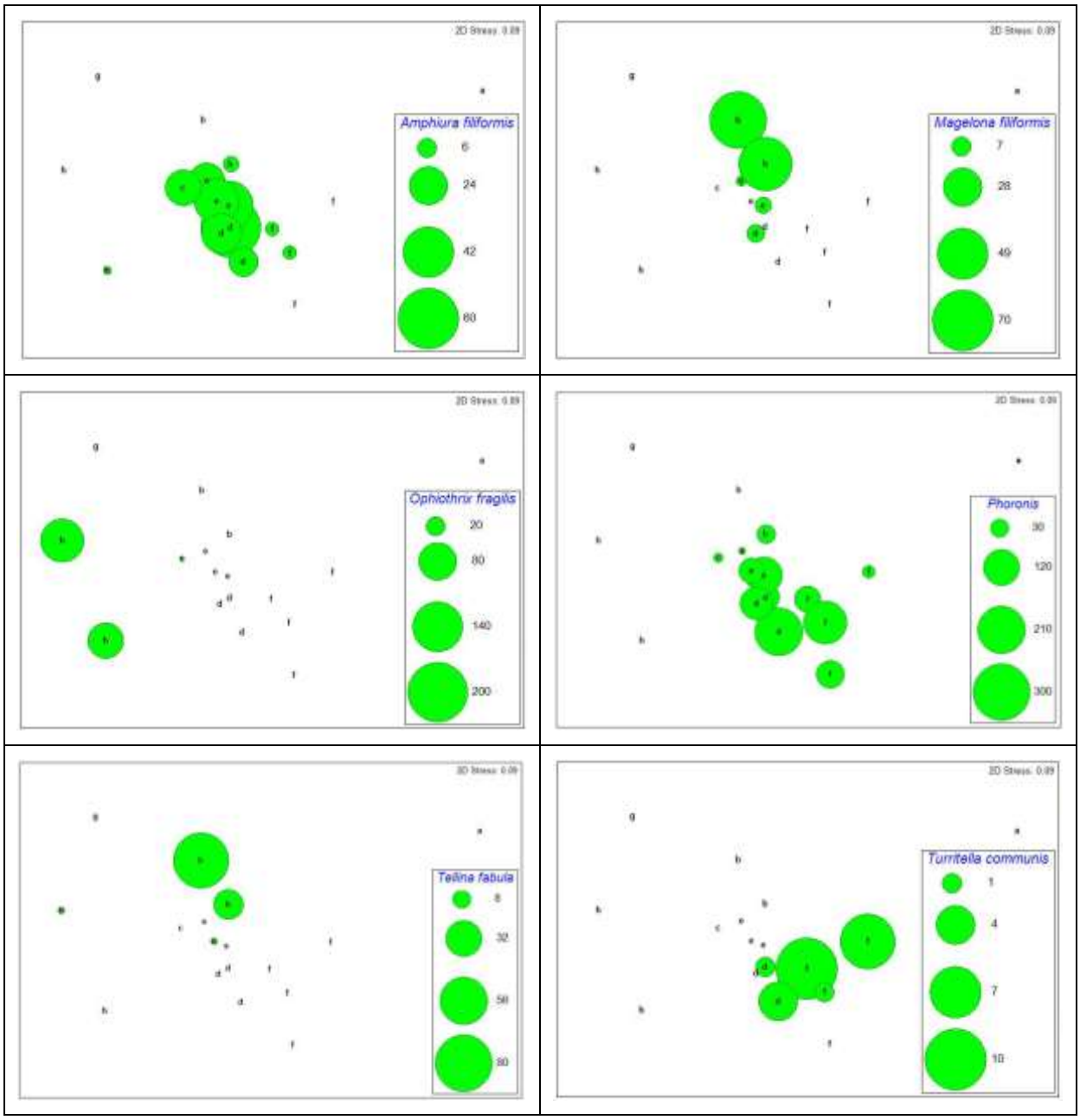


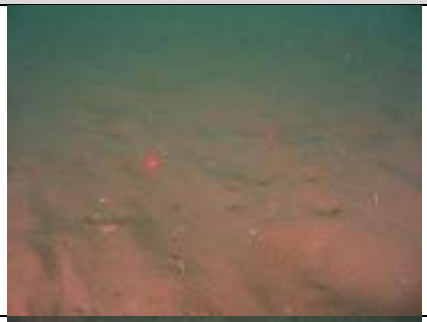
Figure 3.12: MDS plots with species highlighted as driving SIMPER group differences

3.5 Biotopes

Macrofaunal species abundance data and sediment particle size data were analysed together to determine the biotopes present in the survey area. Data from the seabed imagery analysis and depth of the sites were also used to support the defined biotopes. The list of species for each site was run through BioScribe, the biotope decision support tool, to cross-check whole community data against the reference samples used by the JNCC to originally describe the habitats in the marine classification system (Hooper et al., 2010, Connor et al., 2004). Finally, a biotope was allocated to each of the 17 sites included in the analysis. A total of six biotopes were identified in the survey area and they were consistent with Connor et al. (2004) and the EUNIS habitat Classification 2012. Of these, two were described as full Level 5 biotopes and four were described as Level 4 biotope complexes. Details related to these biotopes are presented in Table 3.9.

Table 3.9: Biotopes Described for the Survey Area

Biotope	EUNIS Code	Sites	Faunal Groups	Example Image
SS.SSA.OSa	A5.27	1, 4, 5, 10, 11, 13, 14 and 16	d, e, f	
SS.SMu.CSaMu	A5.35	8 and 9	a, f	
SS.SMU.CFiMu	A5.36	7	f	
SS.SMx.CMx	A5.44	15 and 19	g and c	

Biotope	EUNIS Code	Sites	Faunal Groups	Example Image
SS.SSA.IMuSa.FfabMag	A5.242	17 and 18	b	
SS.SMx.CMx.OphMx	A5.445	6 and 12	h	

Based on the biotopes described, the survey area can be divided in four blocks following the sediment gradient from the offshore sites to the inshore ones (Figure 3.13 and Figure 3.14). This confirms the pattern already noticed in the faunal groupings (Figure 3.11).

As will become clear from the description below, it is considered important to note here that work is being carried out by the JNCC in order to update the marine classification system. The area of main concern, due to lack of data, is the offshore coarse sediments, in particular the circalittoral coarse and mixed sediments (JNCC, 2014). Communities associated with offshore mixed sediments are believed to be found in the survey area and the biotope allocations described are based on the best available current evidence. Alternatives that were considered but then discarded are also discussed briefly within the text.

Biotopes such as **SS.SMx.CMx.OphMx** indicating the presence of *Ophiothrix* beds and the biotope complex **SS.SMx.CMx** indicating mixed coarse substrate were confirmed by the video analysis and were located in the inshore part of the survey area. The biotope **SS.SSA.IMuSa.FfabMag** was also found at two locations close to shore where the species *Tellina fabula*[1] and two species of *Magelona* were abundant and the sediment observed as muddy sand matches the one characteristic for this biotope.

Careful consideration was given to the selection of the biotopes in the central part of the survey area particularly with regard to the possible presence of two Level 5 biotopes **SS.SMU.AfilMysAnit** and **SS.SSA.OSa.OfusAfil**. The presence of species such as *Amphiura filiformis*, *Kurtiella bidentata* [2], which characterise this biotope, although in variable abundances at most of the sites, suggested the

[1] Please note change of name *Fabulina fabula* is now called *Tellina fabula* as per the World Register of Marine Species (WoRMS) (Appeltans et al., 2012).

[2] Please note change of name *Mysella bidentata* is now called *Kurtiella bidentata* as per the World Register of Marine Species (WoRMS) (Appeltans et al., 2012).

former biotope. However, the low percentage of mud present in no way supported selection of this biotope. Therefore the second option was considered. This observation was supported by a recent study carried out in Scottish waters, SNH (2013), highlighting that in areas where burrowed mud habitat was observed from video footage (**SS.SMU.CFiMu.SpnMeg**) grab samples collected were classified as either **SS.SSa.OSa.OfusAfil**, which comprise coarse sandy sediments or **SS.SMu.CSaMu.AfilMysAnit** which comprise sandy mud sediments. The former one was reported as found in muddier conditions (between 10% and 30%) (Howson et al., 2012). The data behind the description of SS.SMu.CSaMu.AfilMysAnit provided by Connor et al. (2004) indicates this biotope was defined from very muddy sediments with a silt/clay (i.e. mud) fraction of over 50%. Moreover, in this biotope, the brittlestar *A. filiformis* is expected to be found in large numbers (SNH, 2013) and, although definitely present in the communities observed in this study, its abundance is not considered to support this description. **SS.SMu.CSaMu.AfilMysAnit** was therefore not selected.

Similar consideration was given to those sites (Site 1 and Site 13) where higher abundance of *Phoronis* (horseshoe worm) and *Rhodine* (bamboo worm) where recorded. The high abundance observed for these species at few sites suggested the biotope **SS.SSA.OSa.MalEdef** Maldanid polychaetes and *Eudorellopsis deformis* in offshore circalittoral sand or muddy sand. Although sufficient data are not available, and therefore there is high degree of uncertainty (e.g. contribution of *Phoronis* spp. is unknown), maldanid polychaetes such as *Rhodine* contribute significantly to the classification of this assemblage, but are not considered as important in the alternative biotopes considered.

It was clear that a definite decision could not be made to describe the habitat to biotope level with confidence (for the currently described full Level 5 biotopes); therefore the final choice was to attribute the biotope complex **SS.SSA.OSa** to the sites in question, as evidence strongly suggests that the type of biotopes hierarchically below this complex are good candidates in describing the communities and the environment.

For the offshore area, two biotope complexes were identified: **SS.SMu.CSaMu** and **SS.SMU.CFiMu**. As the species assemblages did not indicate any clear biotope, but rather an impoverished area, these were left at complex level and derived largely, on the basis of the sediment composition and depth. However, some observations on the faunal composition were made. The presence of *Turritella communis* on this ground is possibly indicative of transitional communities. As highlighted by the video analysis, the area is characterised by the presence of the biotope **SS.SMU.CFiMu.SpnMeg** whose infaunal composition is described as very similar to the one occurring beneath another biotope called **SS.SMU.CFiMu.BlyrAchi** *Brissopsis lyrifera* and *Amphiura chiajei* in circalittoral mud. Although described as occurring in deeper and siltier muds, it is worth mentioning this biotope as it is also similar to the biotope called **SS.SMU.AfilMysAnit** which was also considered for other sites within the present study. High numbers of *T. communis* are found in communities which are considered transitional between the two (SS.SMU.CFiMu.BlyrAchi and SS.SMU.AfilMysAnit) (Connor et al., 2004).

The biotopes from the video and grab data described above have been viewed in conjunction with the Geophysical data provided in order to produce a broad indicative habitat map (Figure 3.14).

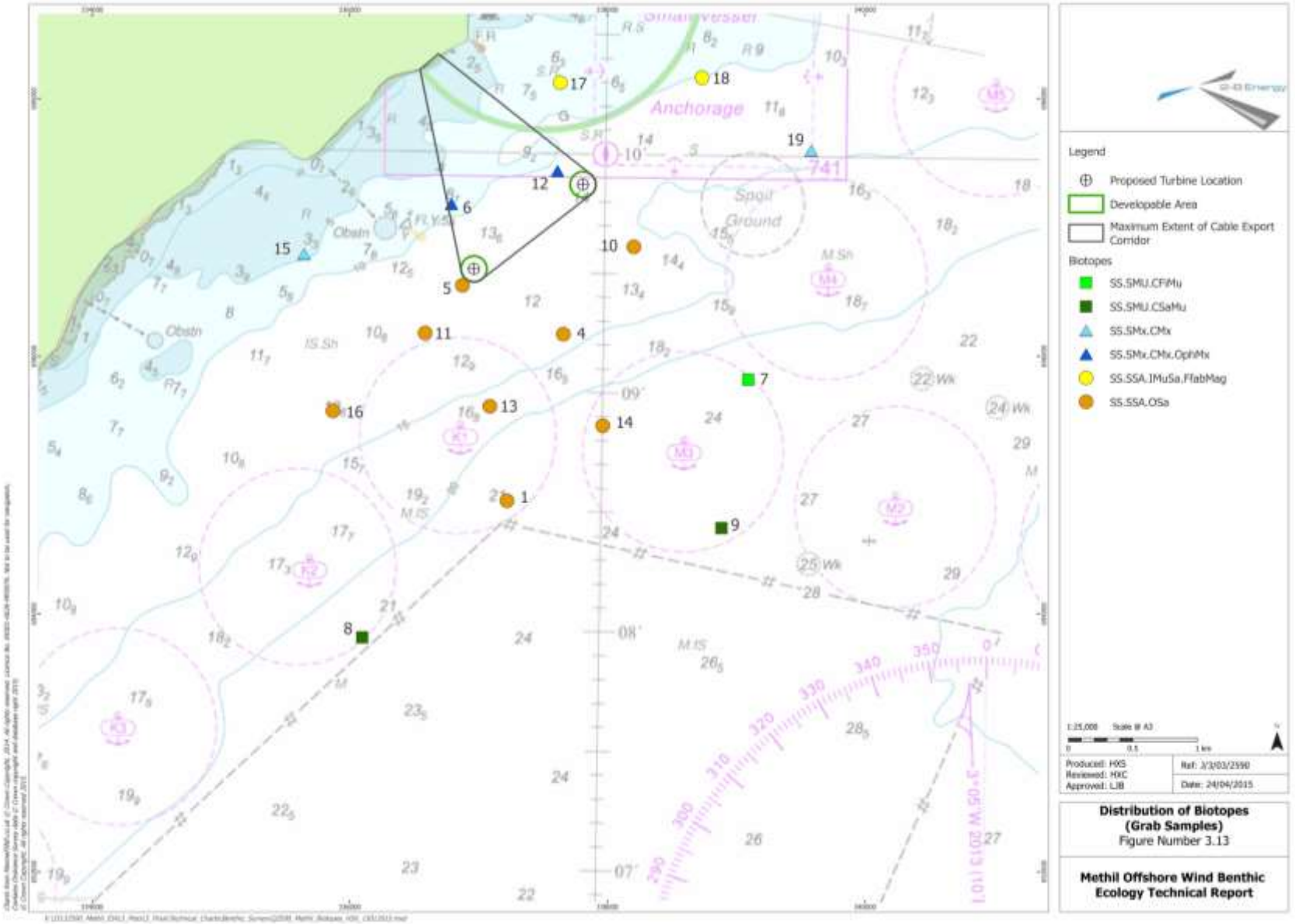


Figure 3.13: Biotopes from grab faunal assemblages

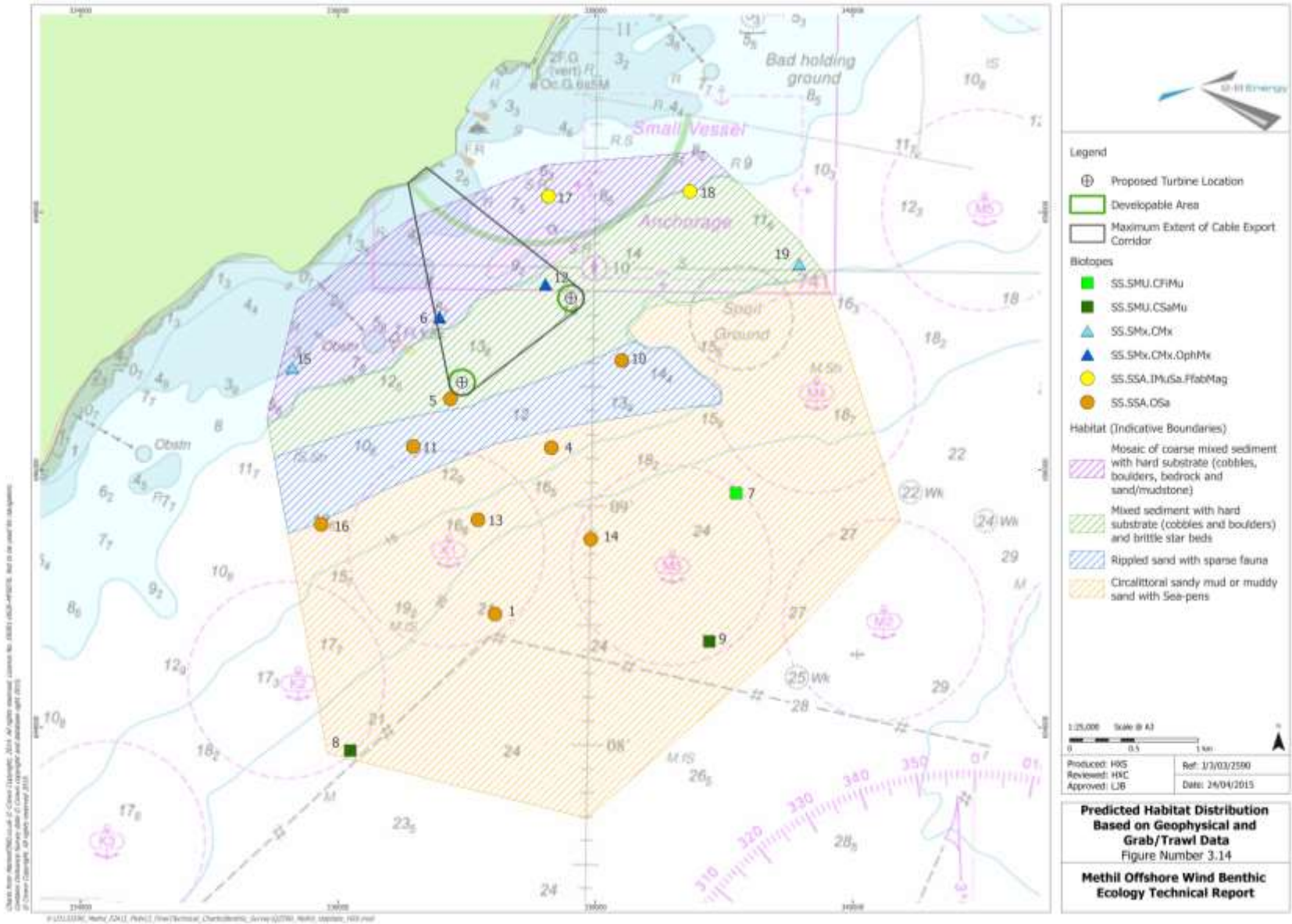


Figure 3.14: Predicted habitat distribution based on geophysical and grab/trawl data

3.6 Epibenthic Trawl

Large and more mobile epibenthic communities were investigated by a series of 2 m beam trawls (see Appendix K for raw data).

The most common epibenthic group sampled was that of bony fish in the Class Actinopterygii (21%), followed by Crustacea and Mollusca (19%), Echinodermata (14%) and Annelida (11%). All the other major groups accounted for less than 10% each (Figure 3.15a)

The non-enumerated taxa included all of the colonial organisms. The abundance calculations only included numerable taxa, therefore colonial organisms, such as Porifera, Bryozoa and some Cnidaria were excluded. A total of 2,636 individuals were recorded. Of these, Echinodermata were the most abundant group (36%), due mainly to the very high abundance of *Astropecten irregularis* and the high abundance of *Asterias rubens*. Other major taxa contributing to the total abundance included Tunicata (24%), Crustacea (14%), Mollusca (13%) and Actinopterygii (12%). Annelida counted for 1% of the total abundance with Cnidaria counting for less than 1% (Figure 3.15b).

The high abundances of sand star *Astropecten irregularis* present in some trawls and of *Acrocnida brachiata* in the grab data indicate the potential presence of **SS.SSA.CMuSa.AbrAirr** *Amphiura brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand as an epifaunal overlay. Site 10 (T1) and site 11 appear to have **SS.SSA.CMuSa.AbrAirr** present as an overlay, as well as at site 4 (T2) and site 5 although more marginally. This fits with the description of this biotope which states that in some areas it forms an epifaunal overlay which may cover a wide range of biotopes in years of good recruitment but does not develop into a settled or established community (Connor et al., 2004). The presence of *Kurtiella bidenta*, a characteristic species of **SS.SSA.CMuSa.AbrAirr** which may have a commensal association with *A. brachiata* (Southward and Campbell, 2006) supports this as its highest abundance was found at site 11 and picked out by SIMPER for group e (sites 5, 10 and 11).

Amongst the enumerated taxa, the most abundant species and their frequency are presented in Table 3.10; the table also presents the most frequent taxa amongst the non-enumerated species. The sea squirt *Ascidiella* was the most numerous species overall, being the most abundant in Trawl 4 and the second most abundant in Trawl 1 and 2. *Ascidiella* was mainly composed of *Ascidiella aspersa* (counting for 509 out of 634 individuals), with *Ascidiella* (juv.) (96 individuals), *Ascidiella scabra* (21 individuals) and *Ascidiella* (8 individuals). The sea star *Astropecten irregularis* was the second most abundant species overall, with only nine less individuals than *Ascidiella*, being the most abundant species in Trawls 1 and 2 but only seventh most abundant in Trawl 4. All of the ten most abundant species were recorded at all three trawl sites.

Amongst the non–enumerated colonial sessile taxa the Bryozoan *Alcyonidium parasiticum* was the most frequently recorded species found in all three trawls (Table 3.10). The hydroid *Hydrallmania falcata* and cnidaria *Alcyonium digitatum* were present in two of the trawls.

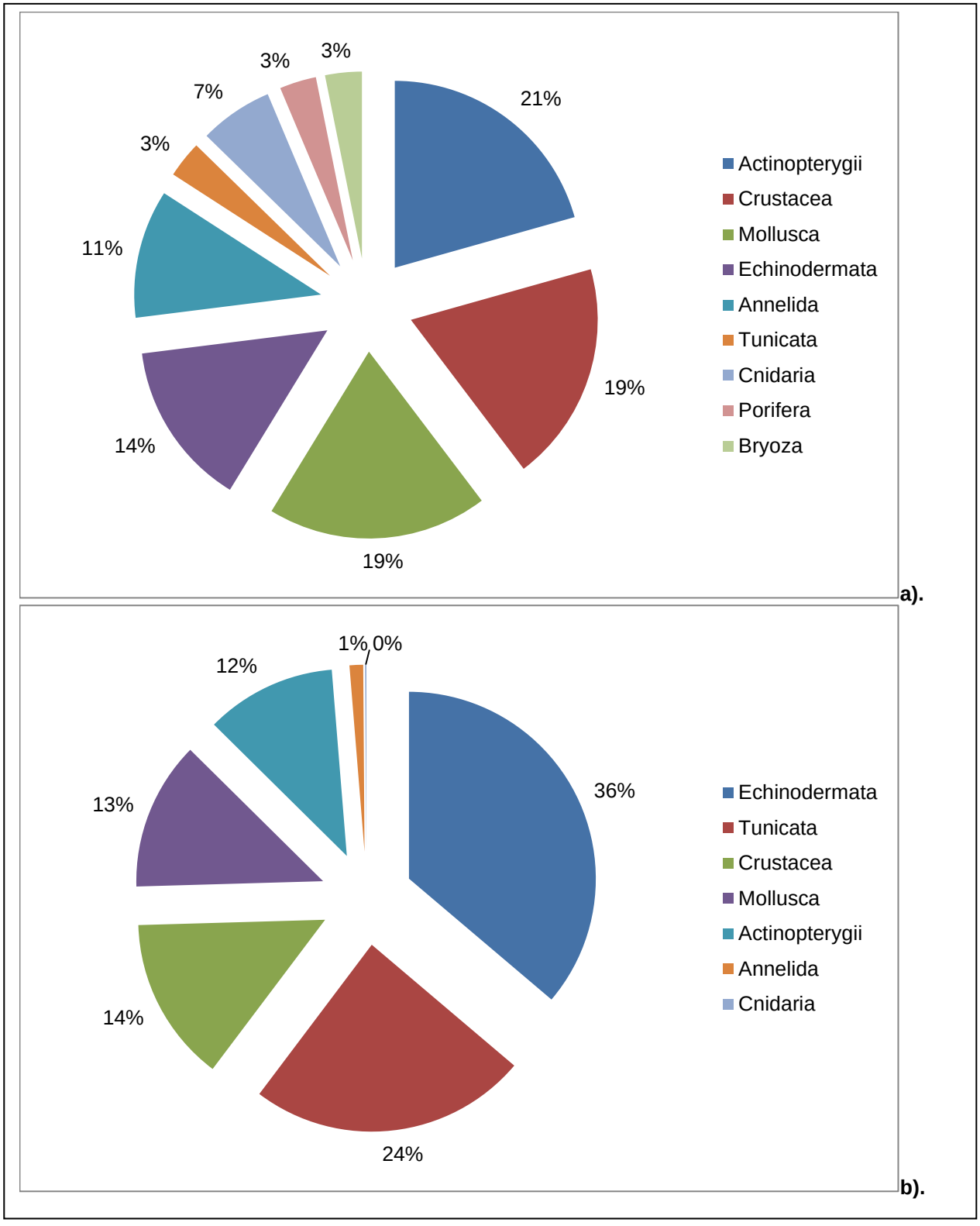


Figure 3.15: Percentage contributions of major taxonomic groups to the total number of taxa recorded (a) to the total abundance for enumerated only (b)

At the three trawling sites, a total of 13 fish taxa were recorded. Of these, 11 were identified to species level with the remaining two identified to a higher level. Abundance and frequency recorded for the top ten most abundant taxa are presented in

Table 3.11. The flat fish *Pleuronectes platessa* accounted for 34% of the total abundance of fish taxa and were recorded at all sites. This was followed by the sand goby *Pomatoschistus minutus* (27%) and dab *Limanda limanda* (15%), both of which were found at all three sites.

Table 3.10: Total Abundance and Frequency of the Top Ten Most Abundant Enumerated Taxa, and Frequency of the Non–enumerated Taxa Recorded from the 2 m Beam Trawl Survey

Species (enumerated)	Total abundance	No. of trawls	Species (non - enumerated)	No. of trawls
Ascidiella	634	3	*Alcyonidium parasiticum*	3
Astropecten irregularis	500	3	*Hydrallmania falcata*	2
Asterias rubens	229	3	*Alcyonium digitatum*	2
Philine aperta	181	3	*Suberites ficus* (agg.)	1
Liocarcinus depurator	176	3	*Halichondria*	1
Ophiothrix fragilis	167	3	*Abietinaria abietina*	1
Crangon crangon	136	3	*Eucratea loricata*	1
Aequipecten opercularis	111	3		
Pleuronectes platessa	102	3		
Pomatoschistus minutus	81	3		

Table 3.11: Total Abundance and Frequency of the Top Ten Fish Taxa Recorded from the 2 m Beam Trawl Survey

Fish species	Total abundance	Frequency	% of total abundance
Pleuronectes platessa	102	3	34
Pomatoschistus minutus	81	3	27
Limanda limanda	46	3	15
Syngnathus acus	22	3	7
Agonus cataphractus	15	3	5
Callionymus lyra	8	3	3
Pomatoschistus	8	1	3
Gadus morhua	6	1	2
Myoxocephalus scorpius	4	3	1
Pholis gunnellus	2	2	1

3.7 Sediment Chemistry

Contaminant samples for the analysis of total PAH, metals, PCB, organotin (TBT, DBT) compounds, TPH and total organic carbon (loss of ignition) were successfully sampled at site 5 (within the application boundary), one of the three sediment chemistry sample locations in the survey area. The results of these analyses are presented in Appendix J and are compared against the Marine Scotland pre-dredge guidelines and other criteria where relevant.

PAHs

Total PAH levels at site 5 were 169 µg/kg. All of the single PAH concentrations were below the revised Marine Scotland Action Levels as described in the Marine Scotland pre-dredge guidelines (Marine Scotland, 2011).

When compared against the OSPAR assessment criteria all of the individual PAH concentrations are below the Effects Range Low (ERL). The ERL values used by OSPAR were developed by the United States Environmental Protection Agency for assessing the ecological significance of sediment concentrations. Concentrations below the ERL rarely cause adverse effects in marine organisms (MERMAN, 2015).

Metals

All metal concentrations were below the revised Marine Scotland Action Levels (Marine Scotland, 2011). All of the metal concentrations are also all below the OSPAR ERLs except for Arsenic, which had a concentration of 9.25 mg / kg against an ERL of 8.2 mg / kg.

A summary of the concentrations is presented in Appendix J.

Organotins

Tributyltin concentration was below the Marine Scotland revised action limit. The level of TBT fell within class C of the OSPAR reference levels, which is a six class assessment scheme for TBT specific biological effects in the reproductive capability of sensitive gastropod species (OSPAR, 2009a). Other organotins had similar levels, <4 µg / kg or lower except for Dibutyltin which had a level of 7.04 µg / kg.

Table 3.12: Integrated Assessment Classes Linking TBT Effects in Gastropod Species with Concentrations of TBT In Water and Sediment

Assessment Class	TBT Sediment (µg TBT / kg dw)
A	n.d.
B	<2
C	2 - <50
D	50 - <200
E	200 - 500
F	>500

PCB (ICES 7 and 25)

Polychlorinated biphenyls (PCB) concentrations for PCB (ICES 7) was 1.2 µg / kg and the concentration for PCB (CEN 25) was 2.68 µg / kg. There were no Action Levels in the Marine Scotland pre-dredge guidelines to compare against; however when compared against the OSPAR Environmental Assessment Criteria (EAC) all of the individual PCB concentrations analysed were below the assessment concentration. EACs were developed by OSPAR and the International Council for the Exploration of the Sea (ICES) for assessing the ecological significance of sediment concentrations with concentrations below the EAC not expected to cause any chronic effects in marine organisms (MERMAN, 2015).

Total petroleum hydrocarbons

The TPH concentration was 370 mg / kg, which is above the existing and revised Marine Scotland Action Levels of 100 mg / kg. Ahmed et al. (2006) reported that the Forties crude oil equivalent concentrations for Firth of Forth sediments varied between samples from 47.1 to 351.5 mg/kg dry weight with a mean concentration of 161.8 mg/kg dry weight. The TPH analysis reported here was carried out using an Ekofisk crude oil standard for calibration.

Total organic content

Total organic content after loss on ignition at site 5 was 2.52 %. The mean background organic matter content reported for central North Sea sediments by UKOOA (2001) was 1.63% and the 95th percentile value was 4.48% (UKOOA 2001).

4. DISCUSSION

4.1 Subtidal benthic ecology

The survey area was mainly circalittoral with the offshore part characterised by silty sediments, the middle part characterised by sandy sediments and the more inshore area characterised by mixed sediment and an infralittoral sandy element in the most northerly inshore sites. These zonations were evident from the analysis presented in the results, and were consistent across the sampling methodologies employed. They also reflected the natural variations of the physical characteristics of the seabed.

Multivariate analysis of the grab faunal data showed that there were eight statistically different groups across the survey area, as illustrated in Figure 3.11. Each group was determined by the composition of the species that each site contained (Table 3.8), which is influenced by the physical characteristics encountered at each site. The faunal groupings reflected the gradient shown by sediment characterisation and a summary is presented in Table 4.1.

The analysis of the biotopes also reflected the zonation observed by the sediment analysis and the faunal groupings derived by the multivariate biological analysis. Biotopes are determined by their physical habitat conditions together with the community of characteristic benthic species found within them although these defining attributes, such as what species are present and in what numbers have a degree of flexibility. The process of assigning biotopes from grab data to some of the locations investigated was, therefore, not straight forward and a number of considerations were made. Based

on the grab data the area was then described by two level 5 biotopes, namely **SS.SMx.CMx.OphMx** and **SS.SSA.IMuSa.FfabMag**, and four level 4 biotope complexes, namely **SS.SMx.CMx**, **SS.SSA.OSa**, **SS.SMu.CSaMu**, **SS.SMU.CFiMu**. These biotopes are similar to biotopes previously encountered in the Firth of Forth by Fugro EMU (Fugro EMU, 2013).

The biotopes assigned divided the survey area into an offshore area consisting of circalittoral sandy mud (**SS.SMu.CSaMu)** and circalittoral fine mud (**SS.SMU.CFiMu**), a central offshore area of circalittoral sand (**SS.SSA.OSa**), a near shore circalittoral mixed sediment (and with brittlestar beds) (**SS.SMx.CMx** and **SS.SMx.CMx.OphMx**) and a nearshore infralittoral muddy sand area (**SS.SSA.IMuSa.FfabMag**).

The analysis suggested that offshore sand sediments are found in the survey area and the biotope allocations described are based on the best available current evidence. The biotope complex **SS.SSA.OSa** was chosen as best describing the habitats for a large part of the survey area. Data analysis highlighted the need of some careful considerations with respect to assigning biotopes and in this way **SS.SMU.AfilMysAnit, SS.SSA.OSa.OfusAfil**, and **SS.SSA.OSa.MalEdef** were considered and rejected. The **SS.SMU.AfilMysAnit** has, with a degree of uncertainty, been recorded further offshore in deeper water within the Firth of Forth (MESH Atlantic, 2015). Both **AfilMysAnit** and **OfusAfil** have also been found underlying borrowed mud habitats described by video data analysis in other locations in Scottish waters (SNH, 2013). However this was not considered to appropriately describe the sites in question as muddier conditions should be present (SNH, 2013; Connor et al., 2004)

The biotope analysis of the video data highlighted coarser sediment close to shore which were well described by the biotope complex **SS.SMx.CMx** and by the biotope **SS.SMx.CMx.OphMx**. Also **CR.MCR.EcCr** and **CR.HCR.XFa** were described for inshore sites. **SS.SSa** was a biotope complex describing the northern part of the inshore area, characterised by finer sediment. Moving offshore, finer sediments were noticed and described by biotope complexes (such as **SS.SSa.CMuSa**) with a prevalence of burrowed mud to which the biotope **SS.SMU.CFiMu.SpnMeg** was mainly assigned. This is in accordance with the distribution of the burrowed mud MPA search feature (SNH, 2013 and documents mentioned within).

Video data is useful for describing broad picture epifaunal biotopes and grab data fills in the detail describing the infaunal, underlying communities. Table 4.1 summarises the biological communities described for the area by the sampling methodologies employed.

Table 4.1: Summary Table

Site	Faunal Groupings	Sediment Groupings	Biotope (Grab Data)	Biotope (Video Data)
1	f	c	**SS.SSA.OSa**	**SS.SMU.CFiMu.SpnMeg**
2	no data	no data	**not suitable data**	**SS.SMx.CMx.OphMx** **SS.SSa.CMuSa** **CR.MCR.EcCr**

Site	Faunal Groupings	Sediment Groupings	Biotope (Grab Data)	Biotope (Video Data)
3	no data	no data	**no data**	**CR.MCR.EcCr**
4	d	e	**SS.SSA.OSa**	**SS.SMu.CFiMu.SpnMeg**
5	e	e	**SS.SSA.OSa**	**SS.SMx.CMx** **SS.SMx.CMx.OphMx**
6	h	g	**SS.SMx.CMx.OphMx**	**SS.SMx.CMx.OphMx**
7	f	c	**SS.SMU.CFiMu**	**SS.SSa.CMuSa**
8	f	b	**SS.SMu.CSaMu**	**SS.SMu.CFiMu.SpnMeg**
9	a	a	**SS.SMu.CSaMu**	**SS.SMu.CFiMu.SpnMeg**
10	e	e	**SS.SSA.OSa**	**SS.SMx.CMx**
11	e	e	**SS.SSA.OSa**	**SS.SSa.CMuSa**
12	h	g	**SS.SMx.CMx.OphMx**	**SS.SMx.CMx.OphMx**
13	d	e	**SS.SSA.OSa**	**SS.SMu.CFiMu.SpnMeg**
14	f	c	**SS.SSA.OSa**	**SS.SMu.CFiMu.SpnMeg**
15	g	f	**SS.SMx.CMx**	**CR.HCR.XFa** **SS.SMx.CMx** **SS.SSa.CMuSa**
16	d	e	**SS.SSA.OSa**	**SS.SMu.CSaMu.VirOphPmax.HAs** **SS.SMx.CMx**
17	b	e	**SS.SSA.IMuSa.FfabMag**	**SS.SSa** **CR.MCR.EcCr** **SS.SSa.CMuSa**
18	b	e	**SS.SSA.IMuSa.FfabMag**	**SS.SMx.CMx.OphMx** **SS.SMx.CMx**
19	c	d	**SS.SMx.CMx**	**SS.SMx.CMx**

4.1.1 Features on conservation importance

Burrowed mud is a Priority Marine Feature (PMF) in Scotland's seas. One of the component biotopes identified for this PMF is **SS.SMu.CFiMu.SpnMeg** Seapens and burrowing megafauna in circalittoral fine mud'. This biotope was observed within the Methil survey area. This habitat is also on the OSPAR

list of threatened and declining habitats as 'Sea-Pen and burrowing megafauna communities' (OSPAR, 2010).

Both rocky biotopes encountered (**CR.MCR.EcCr** and **CR.HCR.XFa**) were only described to level 4 due to the data available as further precision would have been less accurate and therefore not suitable. It should be noted that some of the level 5 biotopes for these classifications are included on the Scottish Natural Heritage list of PMFs. However, both require the presence of the Northern sea fan, *Swiftia pallida,* the known distribution of which is restricted to the west coast of Scotland (Marine Scotland 2015).

Rocky features identified in the Video analysis were identified to have medium resemblance to being classed as stony reef at two sites. These were sites 3 and 6 in the inshore area which were assigned to **CR.MCR.EcCr** and **SS.SMx.CMx.OphMx** respectively. Sites 15 and 17 were identified to have low resemblance to stony reef and were assigned to **CR.HCR.XFa and CR.MCR.EcCr** (as a mosaic with **SS.SSA.CMuSa)**. The rest of the sites were considered to be not reef. Sites 15 and 17 were also found to have areas of mud/sandstone with the latter site also having relatively large holes bored in the surface. This would appear to be consistent with the biotope **CR.MCR.SfR** Soft rock communities which is illustrative of the UK BAP habitat 'Peat and Clay Exposures with Piddocks'. However, it is worth noting that this habitat was not included in the Scottish biodiversity list.

Three fish species listed as SNH PMF's were identified during this survey, Sandeel *Ammodytes*, Sand goby *Pomatoschitus minutus* and Cod *Gadus morhua*. A Sandeel was found at site 15 to the north west inshore survey area. Sand goby were found at all three trawl sites and were the second most abundant fish species caught. The Firth of Forth is a known nursery ground of Cod (Ellis et al., 2012). During this survey six juvenile cod were caught in the 2 m beam trawl T1 at site 10 within the application boundary.

4.2 Sediment Chemistry

4.2.1 PAH

PAHs in the marine environment have both natural and anthropogenic sources. They are natural components of coal and oil and are also found during the combustion of fossil fuels and organic material (OSPAR, 2009a and OSPAR, 2010). All PAHs analysed were detected as being below the Marine Scotland Action Levels (Marine Scotland, 2011). Naphthalene and Anthracene were above the OSPAR background concentrations although they did not exceed the upper assessment criterion (ERL) (OSPAR, 2009a).

At the majority of stations around the UK the concentrations of PAHs exceed the ERL suggesting, where this is the case that there may be some potential for adverse biological effects. However where two or more are still significantly below the ERL the concentrations of contaminants are at levels where it can be assumed that little or no risks are posed to the environment (OSPAR, 2009a)

4.2.2 Metals

All metals analysed were below the Marine Scotland revised action limits as well as the OSPAR ERLs except for Arsenic which had a concentration just above the ERL.

Arsenic occurs naturally in the environment from natural diffuse sources as well as anthropogenic point and diffuse sources (UK Marine SACs Project, 2001).

4.2.3 Organotins

The level of TBT in the sediment was below the level of the Marine Scotland Revised Action Limit. It fell into class C of the OSPAR assessment classes which means that it would not be expected to affect the reproductive capability of sensitive gastropod species (OSPAR, 2009a).

4.2.4 PCBs

Polychlorinated biphenyls (PCBs) have varied harmful effects on marine organisms. Contamination from PCBs is widespread and there are a few areas where concentrations are close to zero (OSPAR, 2010). The results show that the concentrations of PCB total ICES 7 was above the BAC, although when compared against the Environmental Assessment Criteria (EAC) all of the individual PCB concentrations were lower. The EAC represents the contaminant concentration in the environment below which no chronic effects are expected to occur in marine species, including the most sensitive species (OSPAR 2009b).

4.2.5 Total Petroleum Hydrocarbons

Although Ekofisk equivalent concentrations of TPH were above the existing and revised Marine Scotland Action levels with a value of 370 mg / kg against 100 mg / kg, Forties crude oil equivalent concentrations as high as 351.5 mg/kg dry weight have been recorded in the Firth of Forth previously (Ahmed et al., 2006). As there is no absolute measure of fluorescence emission spectrofluorimeters must first be calibrated with solutions of reference standards (Cefas 2000). Commonly used standards include both Ekofisk and Forties crude oil. It should be noted that different standards were used for the above reported values and therefore direct comparison is hampered. Nevertheless, the results from Ahmed et al. (2006) indicate that similarly high values of total hydrocarbons have been reported from the Firth of Forth more broadly.

It is also worth noting that multivariate statistical analysis showed the infaunal community sampled at Site 5 grouping with Sites 10 and 11 (rather than grouping out individually for example). All these sites had high numbers of the brittlestar *Amphiura filiformis* compared to the majority of sites sampled during the survey. *A. filiformis* is a species known to be highly intolerant of oil pollution (Olsgard and Gray 1995). On this basis the high value of total hydrocarbons reported at Site 5 would seem not to be having a negative effect on the biological community sampled. This site also had the highest Shannon-Wiener diversity index reported from the survey.

5. REFERENCES

Ahmed, A. S., Webster, L., Pollard, P., Davies, I. M. and Moffat, C. F. (2006). Description and evaluation of a sampling system for monitoring hydrocarbons in sediments. Fisheries Research Services Internal Report No 09/06

Blott, S.J. and Pye, K. (2001). GRADISTAT: a grain size distribution and statistics package for the analysis of unconsolidated sediments. Earth Surface Processes and Landforms, 26, 1237-1248.

Buchanan, J. B., Sheader, M. and Kingston, P. F. (1978). Sources of Variability in the Benthic Macrofauna off the South Northumberland Coast, 1971–1976 *JMBA UK* **58** 191-209.

Cefas (2000). Methods for the analysis for hydrocarbons and polycyclic aromatic hydrocarbons (PAH) in marine samples. *Sci. Ser. Aquat. Environ. Prot.: Analyt. Meth.*, CEFAS, Lowestoft, (12), 18pp.

Cefas (2004). Offshore Wind Farms: Guidance note for Environmental Impact Assessment In respect of FEPA and CPA requirements. Version 2 – June 2004

Clarke, K.R., Gorley, R.N., 2006. PRIMER v6: User Manual/Tutorial. PRIMER-E, Plymouth.

Clarke, K.R., Warwick R.M. (2001). Change in marine communities: an approach to statistical analysis and interpretation, 2nd edition. PRIMER-E, Plymouth.

Connor, D. W., Allen, J. H., Golding, N., Howell, K. L, Lieberknecht, L. M., Northen, K. O. and Reker, J. B., (2004) The Marine Habitat Classification for Britain and Ireland Version 04.05 JNCC, Peterborough ISBN 1 861 07561 8 (internet version) www.jncc.defra.gov.uk/MarineHabitatClassification

Davies, J., Baxter, J., Bradley, M., Connor, D., Khan, J., Murray, E., Sanderson, W., Turnbull, C. & Vincent, M. 2001. Marine Monitoring Handbook. Available online: http://jncc.defra.gov.uk/page-2430#download

Eleftheriou, A. Basford, D.J. 1989. The macrobenthic infauna of the offshore northern North Sea. Journal of Marine Biological Association 69: 123-143

Ellis, J.R., Milligan, S.P., Readdy, L., Taylor, N. and Brown, M.J. (2012). Spawning and nursery grounds of selected fish species in UK waters. Sci. Ser. Tech. Rep., Cefas Lowestoft, 147: 56 pp.

EMODnet, 2015. Seabed Habitats. www.searchmesh.net/webGIS

Folk, R.L., 1954. The distinction between grain size and mineral composition in sedimentary rock nomenclature. Journal of Geology 62 (4), 344-359

Fugro EMU Limited (2013). Report for Inch Cape Offshore Limited. Appendix 12C, Benthic Ecology Baseline Offshore Export Cable Corridor, Technical Report

Garrison, T. (2009). Oceanography: An Invitation to Marine Science. Cengage Learning. 582 pages.

Hiscock, K. (ed.) (1996) Marine Nature Conservation Review: rationale and methods. Coasts and seas of the United Kingdom MNCR Series, Peterborough, Joint Nature Conservation Committee.

Hooper, G.J., Barfield, P.D., Thomas N.S. and Capasso, E (2011). Redefining biotopes at a regional scale and development of a new MNCR biotope decision support tool. First published 2011. ISBN No. 978 0 907545 58 3. Published by the MALSF. Emu Ltd Report No. 1/J/1/03/1552/1103.

Howson, C.M., Clark, L., Mercer, T.S. and James, B. (2012). Marine biological survey to establish the distribution and status of fan mussels Atrina fragilis and other Marine Protected Area (MPA) search features within the Sound of Canna, Inner Hebrides. Scottish Natural Heritage Commissioned Report No. 438

Irving, R., (2009) The identification of the main characteristics of stony reef habitats under the Habitats Directive. JNCC Report No. 432. ISSN 0963-8091

JNCC, 2014. The Marine Habitat Classification for Britain & Ireland (v04.05). http://jncc.defra.gov.uk/MarineHabitatClassification last updated: 23/07/2014; last visited: 23/01/2015

de Kluijver, M.J., Ingalsuo, S.S., and de Bruyne, R.H., – Mollusca of the North Sea http://species-identification.org/about.php

Marine Scotland (2011), Guidance for the sampling and analysis of sediment and dredged material to be submitted in support of applications for sea disposal of dredged material. Marine (Scotland) Act 2010, Available at: http://www.scotland.gov.uk/Resource/0044/00443832.pdf. Accessed 14-01-2015

Marine Scotland (2015). National marine plan interactive. Available online at: http://marinescotland.atkinsgeospatial.com/nmpi/

MarLIN, 2006. BIOTIC - Biological Traits Information Catalogue. Marine Life Information Network. Plymouth: Marine Biological Association of the United Kingdom. [Cited 21/01/2015] Available from www.marlin.ac.uk/biotic

MERMAN, (2015). CSEMP — assessment criteria for Polycyclic Aromatic Hydrocarbons (PAH) in sediments. Available online: http://www.bodc.ac.uk/projects/uk/merman/assessments_and_data_access/csemp/help/assessment_criteria/sediment/polycyclic_aromatic_hydrocarbons.html Accessed 10/02/2015

MESH Atlantic (2015). Mapping European Seabed Habitats - Interactive mapping portal. Available online at: http://www.emodnet-seabedhabitats.eu/default.aspx?page=1974

Neal, K. (2004). Modiolarca tumida. Marbled crenella. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the

United Kingdom. [cited 12/02/2015]. Available from: http://www.marlin.ac.uk/speciesinformation.php?speciesID=3814

Olsgard, F. & Gray, J.S., (1995). A comprehensive analysis of the effects of offshore oil and gas exploration and production on the benthic communities of the Norwegian continental shelf. *Marine Ecology Progress Series*, **122**, 277-306.

OSPAR (2009a). CEMP assessment report: 2008/2009 Assessment of trends and concentrations of selected hazardous substances in sediments and biota Monitoring and Assessment Series. Publication Number: 390/2009. ISBN 978-1-906840-30-3 http://qsr2010.ospar.org/media/assessments/p00390_2009_CEMP_assessment_report.pdf Accessed: 23/01/2015

OSPAR (2009b). Background Document on CEMP assessment criteria for the QSR 2010. OSPAR Commission Monitoring and Assessment Series. ISBN 978-1-907390-08-1. Publication Number: 461/2009.

OSPAR (2010). OSPAR Recommendation 2010/11 on furthering the protection and restoration of sea-pen and burrowing megafauna communities in the OSPAR Maritime Area. OSPAR 10/23/1-E, Annex 33.

OSPAR (2013). Levels and trends in marine contaminants and their biological effects – CEMP Assessment report 2012. Monitoring and Assessment Series. ISBN 978-1-909159-29-7. Publication Number: 596/2013. Available at: http://www.ospar.org/documents/dbase/publications/p00596/p00596_assessment_report_2012_cemp.pdf

Pettibone, M. H. (1969) Review of some species referred to Scalisetosus McIntosh (Polychaeta, Polynoidae). Proceedings of the Biological Society of Washington, 82: 1-30.

Pettibone, M. H. (1993) Scaled Polychaetes (Polynoidae) Associated with Ophiuroids and Other Invertebrates and Review of Species Referred to Malmgrenia McIntosh and Replaced by Malmgreniella Hartman, with Descriptions of New Taxa. Smithsonian Contributions to Zoology NUMBER 538

Scottish Biodiversity List http://www.biodiversityscotland.gov.uk/advice-and-resources/scottish-biodiversity-list/

SNH, 2013. Scottish MPA Project. Assessment against the MPA Selection Guidelines. Small isles possible nature conservation MPA. SNH web publication [B1209026 / 27(#27)].

Southward, E.C.; Campbell, A.C. (2006). [Echinoderms: keys and notes for the identification of British species]. Synopses of the British fauna (new series), 56. Field Studies Council: Shrewsbury, UK. ISBN 1-85153-269-2. 272 pp.

UK Marine SACs Project, (2001). Available online: http://www.ukmarinesac.org.uk/activities/water-quality/wq8_9.htm Accessed 11/02/15

UKOOA, 2001. An analysis of UK Offshore oil and gas environmental surveys 1975 – 1995, Aberdeen: Heriot-Watt University, UKOOA.

Ware, S. J., and Kenny, A. J. (2011), Guidelines for the Conduct of Benthic Studies at Aggregate Dredging Sites 2nd edition. Marine Aggregate Levy Sustainability Fund. 80pp

WoRMS Editorial Board (2015). World Register of Marine Species. Available from http://www.marinespecies.org at VLIZ. Accessed 2015-01-28

6. APPENDICES

A. APPENDIX A DECK PHOTOS

Site 1

Site 2

Site 4

Site 5

Site 6

Site 7

Site 8

Site 9

Site 10

Site 11

Site 12

Site 13

Site 14

Site 15

Site 16

Site 17

Site 18

Site 19

T1

T2

T4

B. APPENDIX B VIDEO LOGS

Hyperdigital Log

Site	Date	Start Time (GMT)	Start Depth (m BCD)	WGS84 UTM Z30N			
				Start Position		End Position	
				Easting [m]	Northing [m]	Easting [m]	Northing [m]
1	11/10/2014	08:10	27.8	499342.9	6221925.8	499220.3	6221928.7
2	10/10/2014	14:20	20	500158.5	6224769.1	500147.3	6224879.0
3	10/10/2014	15:12	11.6	498776.9	6224930.1	498613.1	6224717.6
4	11/10/2014	11:05	19.2	499783.7	6223461.2	499563.6	6223025.7
5	11/10/2014	10:26	18.7	498848.8	6223542.1	499023.9	6223798.6
6	10/10/2014	15:36	15.6	498924.3	6224229.2	498745.9	6224165.2
7	11/10/2014	08:46	28.5	501177.1	6222936.3	501078.1	6222895.2
8	11/10/2014	07:48	27.6	498296.5	6220938.9	498132.8	6220854.7
9	11/10/2014	08:29	32.1	501000.9	6221758.3	500902.5	6221737.6
10	11/10/2014	11:37	21.2	500011.0	6223762.0	500398.3	6224083.7
11	11/10/2014	10:09	17.3	498658.7	6223253.1	498560.6	6223198.3
12	10/10/2014	14:55	18.9	499735.5	6224490.9	499626.1	6224471.1
13	11/10/2014	09:16	22.5	499148.5	6222709.7	499072.7	6222630.7
14	11/10/2014	09:02	28.2	500053.8	6222528.0	499954.3	6222533.3
15	10/10/2014	15:55	14.2	497735.8	6223883.4	497609.9	6223776.3
16	11/10/2014	09:38	18.8	497691.2	6222491.0	498117.0	6222738.9
17	10/10/2014	14:38	13.6	499724.1	6225289.2	499610.6	6225175.5
18	10/10/2014	13:48	18.5	500607.7	6225008.0	500834.7	6225471.3
19	10/10/2014	09:54	24.6	501636.5	6224709.9	501598.2	6224690.5

Static Image Log

Site	Stills PICT No.	Date	WGS84 UTM Z30N	
			Easting [m]	Northing [m]
1	A128	11/10/2014		
1	A129	11/10/2014	499274.6	6221929.9
1	A130	11/10/2014	499267.4	6221931.3
1	A131	11/10/2014	499263.3	6221932.0
1	A132	11/10/2014	499259.4	6221932.4
1	A133	11/10/2014	499256.5	6221932.9
1	A134	11/10/2014	499253.1	6221933.1
1	A135	11/10/2014	499249.7	6221933.1
2	A034	10/10/2014		
2	A035	10/10/2014	500158.5	6224769.1
2	A036	10/10/2014	500157.6	6224776.8
2	A037	10/10/2014	500154.8	6224785.1
2	A038	10/10/2014	500150.9	6224791.0
2	A039	10/10/2014	500147.4	6224795.8
2	A040	10/10/2014	500145.4	6224799.1
2	A041	10/10/2014	500140.9	6224818.3
3	A066	10/10/2014		
3	A067	10/10/2014	498757.2	6224945.7
3	A068	10/10/2014	498750.5	6224942.4
3	A069	10/10/2014	498741.7	6224940.7
3	A070	10/10/2014	498733.5	6224939.4
3	A071	10/10/2014	498725.0	6224938.1
3	A072	10/10/2014	498717.7	6224932.2
3	A073	10/10/2014	498698.8	6224915.0
3	A074	10/10/2014	498695.3	6224911.6
3	A075	10/10/2014	498669.7	6224886.7
3	A076	10/10/2014	498664.3	6224883.5
3	A077	10/10/2014	498659.3	6224880.3
3	A078	10/10/2014	498654.7	6224876.4
3	A079	10/10/2014	498651.3	6224871.9
3	A080	10/10/2014	498648.9	6224866.9
3	A081	10/10/2014	498632.3	6224848.2
3	A082	10/10/2014	498622.1	6224829.5
3	A083	10/10/2014	498616.0	6224810.8
3	A084	10/10/2014	498619.0	6224794.2
3	A085	10/10/2014	498619.4	6224760.3
3	A086	10/10/2014	498615.4	6224739.6
3	A087	10/10/2014	498614.8	6224730.1
4	A198	11/10/2014		
4	A199	11/10/2014	499686.3	6223245.1
4	A200	11/10/2014	499683.5	6223241.0
4	A201	11/10/2014	499681.7	6223238.4
4	A202	11/10/2014	499679.6	6223235.9
4	A203	11/10/2014	499678.3	6223234.3
4	A204	11/10/2014	499675.6	6223231.8
4	A205	11/10/2014	499672.9	6223227.8
4	A206	11/10/2014	499670.8	6223224.6
5	A186	11/10/2014		
5	A187	11/10/2014	498880.4	6223590.3
5	A188	11/10/2014	498881.9	6223594.7

Site	Stills PICT No.	Date	WGS84 UTM Z30N	
			Easting [m]	Northing [m]
5	A189	11/10/2014	498882.8	6223596.9
5	A190	11/10/2014	498883.5	6223598.9
5	A191	11/10/2014	498884.2	6223600.5
5	A192	11/10/2014	498884.9	6223601.8
5	A193	11/10/2014	498885.9	6223602.6
5	A194	11/10/2014	498887.6	6223604.6
5	A195	11/10/2014	498889.7	6223606.6
5	A196	11/10/2014	498891.3	6223608.0
5	A197	11/10/2014	498894.8	6223610.5
6	A088	10/10/2014		
6	A089	10/10/2014	498876.0	6224250.3
6	A090	10/10/2014	498843.3	6224263.1
6	A091	10/10/2014	498839.4	6224262.1
6	A092	10/10/2014	498819.7	6224246.2
6	A093	10/10/2014	498804.2	6224235.4
6	A094	10/10/2014	498797.4	6224231.1
6	A095	10/10/2014	498795.1	6224230.1
6	A096	10/10/2014	498792.5	6224229.0
6	A097	10/10/2014	498790.3	6224227.4
6	A098	10/10/2014	498788.6	6224223.6
6	A099	10/10/2014	498784.9	6224220.2
6	A100	10/10/2014	498781.4	6224217.3
6	A101	10/10/2014	498758.2	6224192.9
6	A102	10/10/2014	498751.6	6224180.7
6	A103	10/10/2014	498750.2	6224175.9
7	A144	11/10/2014		
7	A145	11/10/2014	501136.0	6222906.3
7	A146	11/10/2014	501132.0	6222905.9
7	A147	11/10/2014	501123.1	6222905.0
7	A148	11/10/2014	501120.1	6222904.7
7	A149	11/10/2014	501117.5	6222904.4
7	A150	11/10/2014	501114.2	6222904.0
7	A151	11/10/2014	501109.5	6222903.4
7	A152	11/10/2014	501104.4	6222902.7
8	A119	11/10/2014		
8	A120	11/10/2014	498164.7	6220859.2
8	A121	11/10/2014	498158.2	6220858.4
8	A122	11/10/2014	498153.8	6220858.3
8	A123	11/10/2014	498149.6	6220858.0
8	A124	11/10/2014	498146.2	6220857.7
8	A125	11/10/2014	498143.6	6220857.4
8	A126	11/10/2014	498140.7	6220856.9
8	A127	11/10/2014	498136.6	6220855.8
9	A136	11/10/2014		
9	A137	11/10/2014	500939.0	6221744.8
9	A138	11/10/2014	500929.9	6221746.6
9	A139	11/10/2014	500926.1	6221746.9
9	A140	11/10/2014	500923.8	6221746.8
9	A141	11/10/2014	500921.2	6221746.7
9	A142	11/10/2014	500918.5	6221746.4
9	A143	11/10/2014	500914.8	6221745.3

Site	Stills PICT No.	Date	WGS84 UTM Z30N	
			Easting [m]	Northing [m]
10	A207	11/10/2014		
10	A208	11/10/2014	500202.0	6223918.0
10	A209	11/10/2014	500204.9	6223920.4
10	A210	11/10/2014	500207.0	6223922.0
10	A211	11/10/2014	500209.5	6223923.6
10	A212	11/10/2014	500211.3	6223924.9
10	A213	11/10/2014	500213.5	6223926.7
10	A214	11/10/2014	500214.8	6223927.9
11	A178	11/10/2014		
11	A179	11/10/2014	498608.5	6223227.1
11	A180	11/10/2014	498605.4	6223225.2
11	A181	11/10/2014	498603.2	6223223.4
11	A182	11/10/2014	498600.3	6223221.0
11	A183	11/10/2014	498598.5	6223219.2
11	A184	11/10/2014	498596.8	6223217.6
11	A185	11/10/2014	498594.1	6223215.1
12	A055	10/10/2014		
12	A056	10/10/2014	499667.9	6224520.1
12	A057	10/10/2014	499657.0	6224519.3
12	A058	10/10/2014	499646.2	6224516.1
12	A059	10/10/2014	499636.0	6224515.3
12	A060	10/10/2014	499620.0	6224505.7
12	A061	10/10/2014	499619.5	6224499.5
12	A062	10/10/2014	499619.9	6224496.1
12	A063	10/10/2014	499620.5	6224492.6
12	A064	10/10/2014	499621.0	6224489.4
12	A065	10/10/2014	499621.5	6224485.1
13	A160	11/10/2014		
13	A161	11/10/2014	499127.4	6222674.2
13	A162	11/10/2014	499125.8	6222671.1
13	A163	11/10/2014	499124.1	6222668.3
13	A164	11/10/2014	499122.7	6222665.8
13	A165	11/10/2014	499120.8	6222663.2
13	A166	11/10/2014	499118.8	6222660.8
13	A167	11/10/2014	499117.1	6222658.9
14	A153	11/10/2014		
14	A154	11/10/2014	500014.9	6222523.9
14	A155	11/10/2014	500010.0	6222527.3
14	A156	11/10/2014	500006.3	6222529.6
14	A157	11/10/2014	500002.5	6222531.9
14	A158	11/10/2014	499998.6	6222532.9
14	A159	11/10/2014	499995.1	6222533.3
15	A104	10/10/2014		
15	A105	10/10/2014	497699.8	6223860.2
15	A106	10/10/2014	497695.6	6223858.1
15	A107	10/10/2014	497688.8	6223855.1
15	A108	10/10/2014	497679.3	6223849.5
15	A109	10/10/2014	497662.9	6223834.2
15	A110	10/10/2014	497660.9	6223831.2
15	A111	10/10/2014	497658.5	6223827.3
15	A112	10/10/2014	497656.5	6223823.4

Site	Stills PICT No.	Date	WGS84 UTM Z30N	
			Easting [m]	Northing [m]
15	A113	10/10/2014	497654.3	6223819.3
15	A114	10/10/2014	497645.8	6223809.9
15	A115	10/10/2014	497642.1	6223807.2
15	A116	10/10/2014	497637.0	6223803.3
15	A117	10/10/2014	497632.2	6223799.6
16	A168	11/10/2014		
16	A170	11/10/2014	497893.8	6222610.5
16	A171	11/10/2014	497896.4	6222611.7
16	A172	11/10/2014	497900.4	6222613.7
16	A173	11/10/2014	497904.0	6222615.4
16	A174	11/10/2014	497906.8	6222616.9
16	A175	11/10/2014	497909.4	6222618.0
16	A176	11/10/2014	497912.1	6222619.4
16	A177	11/10/2014	497915.8	6222621.8
17	A042	10/10/2014		
17	A043	10/10/2014	499698.3	6225266.5
17	A044	10/10/2014	499695.1	6225258.4
17	A045	10/10/2014	499690.5	6225250.4
17	A046	10/10/2014	499686.6	6225247.9
17	A047	10/10/2014	499662.8	6225238.6
17	A048	10/10/2014	499655.5	6225229.4
17	A049	10/10/2014	499638.3	6225205.1
17	A050	10/10/2014	499630.0	6225192.7
17	A051	10/10/2014	499628.1	6225190.0
17	A052	10/10/2014	499625.6	6225186.5
17	A053	10/10/2014	499622.7	6225182.8
17	A054	10/10/2014	499619.3	6225180.0
18	A022	10/10/2014		
18	A023	10/10/2014	500714.2	6225210.2
18	A024	10/10/2014	500721.7	6225230.1
18	A025	10/10/2014	500725.0	6225237.3
18	A026	10/10/2014	500728.5	6225243.3
18	A027	10/10/2014	500730.7	6225246.9
18	A028	10/10/2014	500733.3	6225251.9
18	A029	10/10/2014	500735.4	6225255.4
18	A030	10/10/2014	500826.5	6225433.1
18	A031	10/10/2014	500829.2	6225449.0
18	A032	10/10/2014	500830.4	6225456.8
18	A033	10/10/2014	500831.8	6225463.5
19	A010	10/10/2014		
19	A011	10/10/2014	501614.7	6224702.0
19	A012	10/10/2014	501576.3	6224692.2
19	A013	10/10/2014	501571.8	6224688.0
19	A014	10/10/2014	501570.5	6224685.8
19	A015	10/10/2014	501568.9	6224676.0
19	A016	10/10/2014	501568.4	6224672.0
19	A017	10/10/2014	501567.6	6224666.3
19	A018	10/10/2014	501566.4	6224663.7
19	A019	10/10/2014	501591.1	6224680.4
19	A020	10/10/2014	501595.4	6224686.1
19	A021	10/10/2014	501598.2	6224690.5

C. APPENDIX C GRAB LOGS

Site No.	Date	Fauna Lab. Ref. No.	PSA Lab. Ref. No.	Depth (m BCD)	WGS84 UTM Z30 N		Fauna (volume L)	PSA	*In-situ* Sediment Description	Sediment Features	Sediment Anoxia	Anthropogenic Features	Conspicuous Fauna
					Easting [m]	Northing [m]							
1	12/10/14	13187	13206	27.4	499261.5	6221935.2	15	300	Clay / Mud	-	Streaks	-	-
2	11/10/14	13188	-	19.6	500151.7	6224779.2	2	-	Pebbly gravelly sand with cobble (8cm)	-	Streaks	Broken Glass	*Ophiothrix*
3	N/A	N/A	N/A	N/A	498661.8176	6224877.904	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	12/10/14	13190	13209	19.8	499680.6	6223233.3	12	300	Sand	-	Patches	-	*Astropecten irregularis*
5	12/10/14	13191	13210	19.1	498892.3	6223601.2	8	300	Sand	-	-	-	*Ophiura*
6	11/10/14	-	13211	15.1	498794.3	6224222.9	-	300	Shelly pebbly sand	-	Streaks	-	*Ophiothrix*, *Ophiura*
6	11/10/14	13192	-	15.3	498797.6	6224230.9	3.5	-	Shelly sand with 2 cobbles (9 & 7cm)	Tubes	Streaks	-	*Ophiothrix*
7	12/10/14	13193	13212	28.6	501119.9	6222900.7	15	300	Clay / Mud	-	Patches	-	-
8	12/10/14	13194	13213	27.5	498153.0	6220858.5	15	300	Clay / Mud	-	Streaks	-	-
9	12/10/14	13195	13214	32.5	500929.2	6221746.0	15	300	Clay / Mud	-	Streaks	-	-
10	12/10/14	13196	13215	20.6	500218.3	6223918.4	9	300	Slightly shelly sand	Tubes	Patches	-	-
11	12/10/14	13197	13216	17.8	498608.2	6223227.7	14	300	Shelly mud	Tubes	Patches	-	*Nephtys*
12	11/10/14	13198	-	17.6	499617.4	6224500.3	3.5	-	Slightly shelly slightly pebbly sand with cobble (9cm)	Tubes	Streaks	-	*Ophiothrix*
12	11/10/14	-	13217	17.5	499621.8	6224496.4	-	300	Slightly shelly slightly pebbly sand with cobble (8cm)	Tubes	Streaks	-	*Ophiothrix*
13	12/10/14	13199	13218	23.7	499118.6	6222665.6	15	300	Clay / Mud	Tubes	Streaks	-	-
14	12/10/14	13200	13219	28.1	499997.7	6222526.6	15	300	Clay / Mud	-	Streaks	-	-
15	12/10/14	13201	13220	14.1	497658.6	6223825.2	13	300	Sandy shelly mud	-	Patches	-	-

Site No.	Date	Fauna Lab. Ref. No.	PSA Lab. Ref. No.	Depth (m BCD)	WGS84 UTM Z30 N		Fauna (volume L)	PSA	*In-situ* Sediment Description	Sediment Features	Sediment Anoxia	Anthropogenic Features	Conspicuous Fauna
					Easting [m]	Northing [m]							
16	12/10/14	13202	13221	18.8	497900.7	6222612.3	14	300	Shelly mud	Tubes	-	-	-
17	11/10/14	13203	13222	14.1	499628.8	6225185.0	9.5	300	Sand	-	Patches	-	*Echinocardium*
18	11/10/14	13204	13223	16.4	500728.1	6225238.8	10	300	Sand	-	Streaks	-	*Echinocardium*
19	11/10/14	13205	13224	20.4	501584.2	6224686.0	6	300	Slightly pebbly shelly sand	Tubes	Patches	-	*Ophiothrix*

Site No.	Attempts	Successful Sample Collected (Y/N)	Brief Description of Problems with Sample	Size of Sample Retained	Additional Notes on Quality of Retained Samples
2	3	Fauna only	Three attempts returned small samples	2	Indicative Fauna only obtained for first attempt
3	N/A	N	Sample not attempted due to obstructive sediment	N/A	N/A
12	4	Y	First sample water only, Second sample fauna only, third sample PSA only	3.5	Fauna taken from second attempt, PSA taken from third attempt
6	4	Y	First two samples were small volume, third was water only	3.5	PSA was taken from first attempt, Fauna was taken from forth attempt

D. APPENDIX D CONTAMINANT LOGS

Site No.	Date	Depth (m BCD)	WGS84 UTM Z30N		Sample Size	Hydro-carbons	Organotins	PCB	PAH	Metals	*In-situ* Sediment Description	Sediment features	Sediment Anoxia	Anthropogenic Features	Conspicuous Fauna
			Easting [m]	Northing [m]											
3	N/A	N/A	498661.8	6224877.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	12/10/2014	19.1	498887.6	6223597.9	3/4	Y	Y	Y	Y	-	-	-	-	-	-
5	12/10/2014	19.1	498884.7	6223595.8	1/2	-	-	-	-	Y	-	-	-	-	-
12	N/A	N/A	499620.3	6224495.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Site No.	Attempts	Successful Sample Collected (Y/N)	Brief Description of Problems with Sample	Size of Sample Retained	Additional Notes on Quality of Retained Samples
3	N/A	N	Sample not attempted due to obstructive sediment	N/A	
12	3	N	Cobble in jaw for all 3 attempts	-	
5	3	Y	second attempt grab did not fire	3/4 and 1/2	Hydrocarbons, organotins, PCB and PAH from attempt 1, Metals from attempt 2

E. APPENDIX E 2 M BEAM TRAWL LOGS

Site No	Date	Point on line	WGS84 UTM (Z30N)		Time (GMT)	Depth (BCD m)	Trawl Speed (knots)	Distance (m)	Direction of Travel	Comments
			Easting [m]	Northing [m]						
T1	12/10/14	Start End	499956 500374	6223736 6224041	14:52 15:01	20.4 21.2	1.8	517	Into Current	
T2	13/10/14	Start End	499814 499558	6223421 6223016	07:58 08:07	19.1 21.1	1.5	478	Into Current	
T3	N/A	Start End	499029 498745	6223803 6223392	N/A	N/A	N/A	N/A	N/A	Not attempted due to obstructive sediment
T4	13/10/14	Start End	497911 497679	6222634 6222483	08:47 08:52	18.5 18.8	1.6	276	Into Current	Shortened due to obstructive sediment
T5	N/A	Start End	500614 500846	6225021 6225464	N/A	N/A	N/A	N/A	N/A	Not attempted due to obstructive sediment

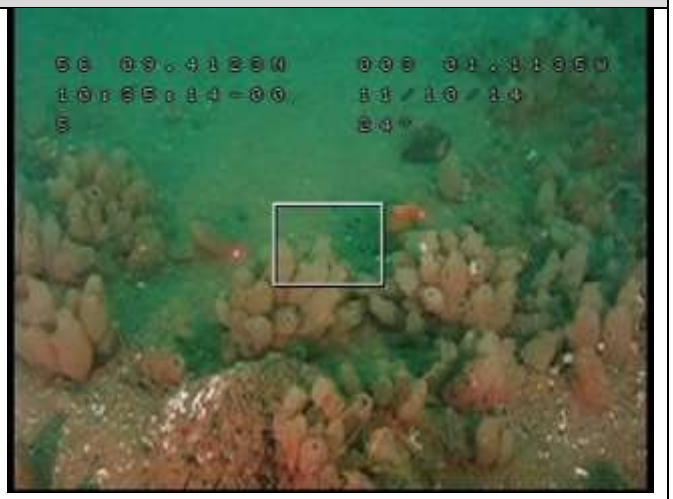
Site Number	Date	Total Volume (Litres)	Sediment Character (Percentage)							% Shell Material	% Algae	Other Features
			Mud	Sand	Granules	Pebble	Cobbles	Lge Cobbles	Boulders			
T1	12/10/14	129				20				80		Twig, fucoid algae
T2	13/10/14	31				85				15		Trawl rubber, fucoid algae, stick, dead leaves, chaetopterus tube
T4	13/10/14	115.3										

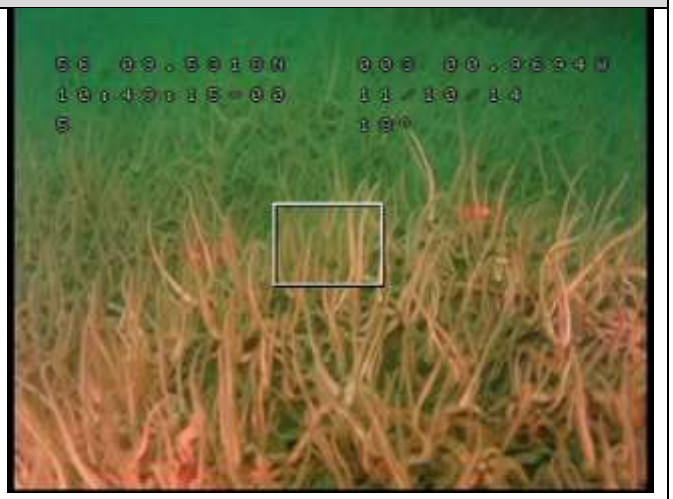
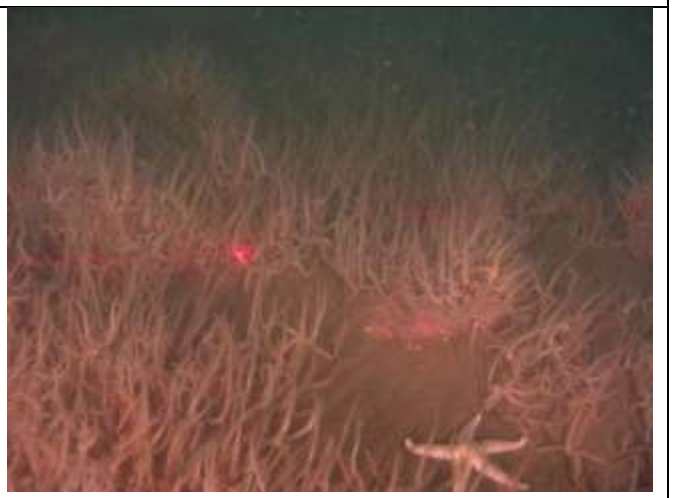
F. APPENDIX F VIDEO ANALYSIS DATA

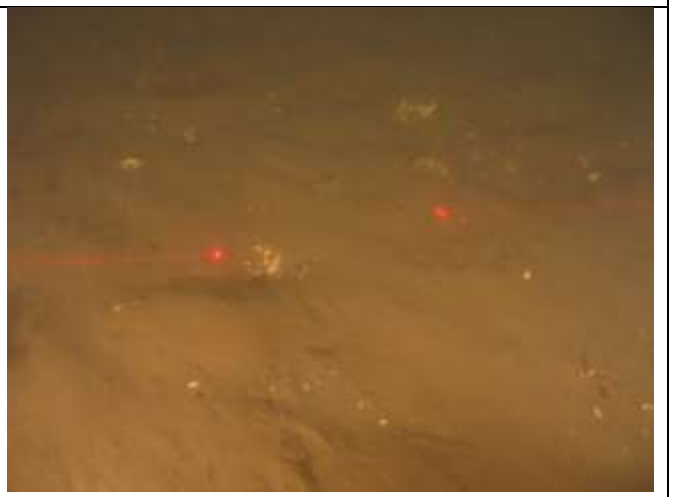
Site	General Description	Detailed Sediment Notes	Conspicuous Species	Estimated Abundance	Representative Image
1	Slightly shelly, slightly muddy rippled sand 56°08.5427 N, 003°00.6337 W To 56°08.5441 N, 003°00.7526 W (123.2m^2)	Fine muddy sand with occasional shells and shelly patches. Ripples and holes present and occasional burrows and depressions. Some tracks from mobile epifauna observed.	*Virgularia mirabilis* Paguridae *Pennatula phosphorea* *Asterias rubens* *Liocarcinus* *Astropecten irregularis* *Metridium senile* PISCES Gobiidae PLEURONECTIFORMES *?Arctica islandica* (?dead)	F O O O F O O O P O O	
2	*Ophiothrix* beds overlying rippled sand with cobbles and boulders 56°10.0750 N, 002°59.8473 W to 56°10.0951 N, 002°59.8619 W (40.2m^2)	Most detail obscured by *Ophiothrix fragilis.*	*Ophiothrix fragilis* *Asterias rubens* *Echinus esculentus* *Necora puber* Gadidae *Ophiura albida*	P F O O O O	

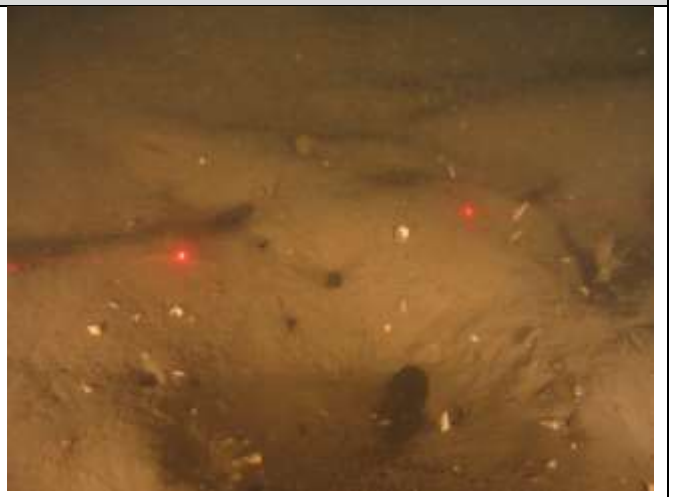
Site	General Description	Detailed Sediment Notes	Conspicuous Species	Estimated Abundance	Representative Image
	Slightly shelly, slightly gravelly rippled sand. 56°10.0951 N, 002°59.8619 W To 56°10.1277 N, 002°59.8592 W (60.5m^2)	Slightly shelly slightly gravelly fine sand. Ripples and holes present, some tubes visible.	*Asterias rubens* DECAPODA *Ophiura* *Cancer pagurus* *Henricia* *Liocarcinus* Gobiidae ACTINIARIA	F O F O O O O O	
	Slightly shelly gravelly, pebbly, cobbly sand with boulders 56°10.1277 N, 002°59.85.92 W To 56°10.1350 N, 002°59.8577 W (13.6m^2)	Large boulders covered with encrusting and mobile epifauna overlaying slightly shelly gravelly, pebbly, cobbly fine sand.	*Echinus esculentus* *Asterias rubens* *Ophiothrix fragilis?* *Alcyonium digitatum* *Spirobranchus* Corallinaceae	F F O P P P	

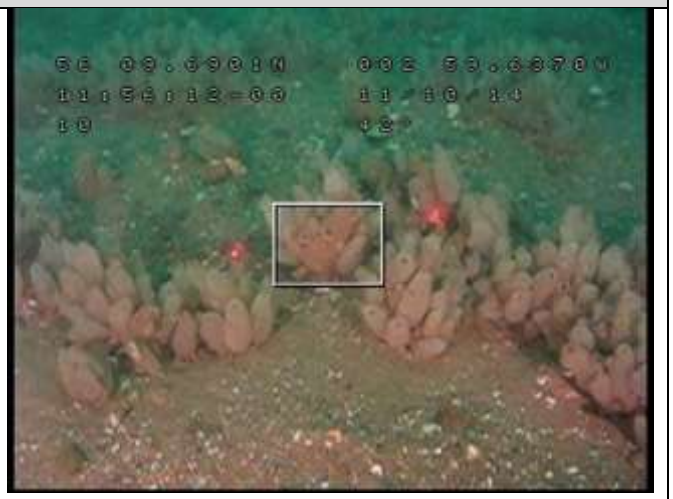
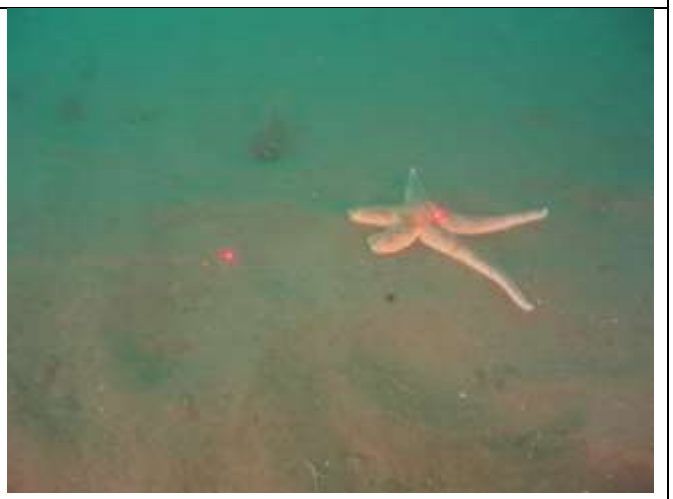
Site	General Description	Detailed Sediment Notes	Conspicuous Species	Estimated Abundance	Representative Image
3	Pebbles and cobbles with large boulders and bedrock with occasional patches of sand 56°10.1620 N, 003°01.1821 W To 56°10.0475 N, 003°01.3401 W (268m^2)	Large boulders and bedrock covered with encrusting and mobile epifauna and silt flocculation, interspersed with pebbles, cobbles and occasional sand patches.	*Echinus esculentus* *Alcyonium digitatum* *Asterias rubens* *Spirobranchus* Gobiidae LAMINARIALES *Cancer pagurus* *Necora puber* *Liocarcinus* Callionymidae	C P F P O F O O O O	
4	Slightly gravelly slightly shelly rippled sand with occasional pebble and very occasional boulder 56°09.3706 N, 003°00.2090 W To 56°09.1356 N, 003°00.4213 W (488.2m^2)	Slightly shelly fine sand. Burrows and holes present, tubes visible. Some tracks from mobile epifauna observed.	*Ascidiella aspersa* *Asterias rubens* *Metridium senile(* *Ophiura* Gobiidae Majidae *Virgularia mirabilis* *Psammechinus miliaris* *Liocarcinus* *Alcyonium digitatum* *Astropecten irregularis* PISCES *Pennatula phosphorea* *Pagurus bernhardus* *Hydractinia echinata* HYDROZOA/BRYOZOA turf PLEURONECTIFORMES Paguridae	R F O F P O F O O P O O F P R R O O	

Site	General Description	Detailed Sediment Notes	Conspicuous Species	Estimated Abundance	Representative Image
5	Slightly shelly sand mixed with patches of coarse mixed sediment including cobbles and occasional boulders. Area is soon dominated by the coarse sediment with boulders, interspersed with some open patches of the shelly sand. 56° 09.3344 N 003° 01.1914 W To 56° 09.5042 N 003° 01.0013 W (371.4m^2)	The shelly sand mixed with coarse mixed sediment and boulders is dominated by dense swathes of *Ascidiella aspersa* and the starfish *Asterias rubens*. *Echinus esculentus* become notable around larger cobbles and boulders. Small patches with ophiuroid arms (probably *Ophiothrix*) seen mixed with *Ascidiella* on the boulders. Some areas of the substrate appearing to be compacted coarse sediment. A few *Pecten maximus* and some small flat fish are seen within the more sandy sediment patches.	*Asterias rubens* *Ascidiella aspersa* HYDROZOA/BRYOZOA turf *Homarus gammarus* *Echinus esculentus* Gobiidae *Pholis gunnellus* *Pecten maximus* DECAPODA *Cancer pagurus* OPHIUROIDEA *Nemertesia antennina* PLEURONECTIFORMES *Alcyonium digitatum* *Ophiura ophiura* Paguridae *Astropecten irregularis* *Urticina* Gadidae *?Tubularia indivisa*	F F R O F P O O O O R O O R P P O O O R	

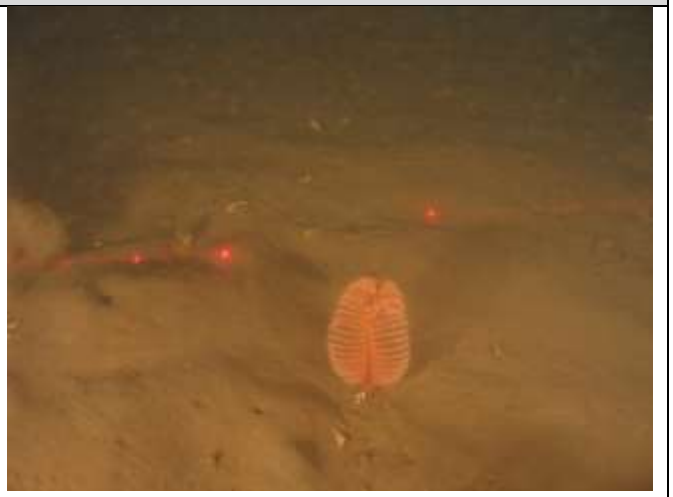
Site	General Description	Detailed Sediment Notes	Conspicuous Species	Estimated Abundance	Representative Image
	Shelly sand with patches of coarse sediment and the occasional boulder. 56° 09.5042 N 003° 01.0013 W To 56° 09.5520 N 003° 00.9436 W (106.9m^2)	Shelly sand dominates this section but with some coarse sediment present and occasional clusters of boulders. The brittlestar *Ophiothrix fragilis* covers the area, forming a dense carpet, appearing largely to exclude *Ascidiella aspersa,* which dominates the first section of the transect. *Asterias rubens* and *Echinus esculentus* are still present in notable numbers. *Urticina* and a few *Pecten maximus* are also seen.	*Ophiothrix fragilis* *Asterias rubens* *Ascidiella aspersa* HYDROZOA/BRYOZOA turf *Echinus esculentus* *Pecten maximus* DECAPODA *Urticina*	85% F O R F O O O	
6	Patches of slightly shelly sand with patches of boulders and cobbles 56°09.7840 N, 003°01.0399 W To 56°09.7500 N, 003°01.2111 W (188.1m^2)	Most detail obscured by *Ophiothrix.* Patches of slightly shelly rippled sand with patches of boulders and cobbles. Where there is a patch of clear shelly sand burrows are visible.	*Echinus esculentus* Corallinaceae *Asterias rubens* ACTINIARIA PISCES DECAPODA *Ophiothrix fragilis* *Ophiura* *Ophiura albida*	F R F O O O A O O	

Site	General Description	Detailed Sediment Notes	Conspicuous Species	Estimated Abundance	Representative Image
7	Slightly shelly sand 56° 09.0872 N 002° 58.8629 W To 56° 09.0652 N 002° 58.9581 W (106.7m²)	Slightly shelly sand with many tracks on the surface. Holes present throughout with a few burrows. *Pennatula phosphorea* scattered across the area. Lots of small pagurid crabs in Turritellidae shells.	*Pennatula phosphorea* *Asterias rubens* ASTEROIDEA Gobiidae Paguridae Majidae *Astropecten irregularis* Pectinidae HYDROZOA/BRYOZOA turf *Lanice conchilega* *Chaetopterus* tubes DECAPODA *Liocarcinus*	O O O P P O O O R R O O O	
8	Slightly shelly rippled sand 56° 08.0104 N 003° 01.6441 W To 56° 07.9651 N 003° 01.8016 W (183.5m²)	Slightly shelly rippled sand. Holes and burrows present throughout. *Nephrops norvegicus* seen in a couple of burrows. *Virgularia mirabilis* visible in patches. Crabs present throughout.	DECAPODA Paguridae Gadidae *Chaetopterus* tubes *Metridium senile* *Asterias rubens* *Nephrops norvegicus* *Virgularia mirabilis* *Liocarcinus* PLEURONECTIFORMES *Astropecten irregularis* ?*Sabella* tube	O P O P O O O O O O O O	

Site	General Description	Detailed Sediment Notes	Conspicuous Species	Estimated Abundance	Representative Image
9	Slightly shelly sand 56° 08.4522 N 002° 59.0336 W To 56° 08.4412 N 002° 59.1275 W (99.4m^2)	Slightly shelly sand with holes and burrows. *Virgularia mirabilis* seen across the site. *Nephrops norvegicus* seen within one burrow.	*Chaetopterus* tubes *Virgularia mirabilis* Gadidae Gobiidae Paguridae *Liocarcinus* *Metridium senile* *Nephrops norvegicus*	P O P P O O O	
10	Slightly shelly rippled sand. Few scattered cobbles. One small boulder seen. 56° 09.5324 N 002° 59.9894 W To 56° 09.6790 N 002° 59.6665 W (430.9m^2)	Slightly shelly rippled sand with small sparse but regular clumps of *Ascidiella aspersa* across the area. Small holes present in the sediment. One small patch of dense *Ascidiell*a. *Asterias rubens* and *Astropecten irregularis* regularly seen. Rare occurrence of *Metridium senile* and very small rare presence of *Alcyonium digitatum*.	*Ascidiella aspersa* Paguridae CARIDEA HYDROZOA/BRYOZOA turf *Asterias rubens* DECAPODA Gobiidae PLEURONECTIFORMES *Astropecten irregularis* *Metridium senile* *Aequipecten opercularis* *Liocarcinus* *Alcyonium digitatum* *Pecten maximus* *Lanice conchilega*	R O P R F O P O F O O O R O R	

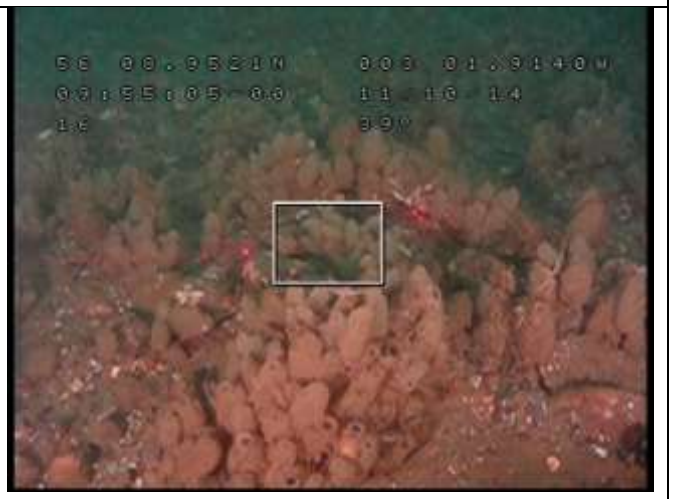
Site	General Description	Detailed Sediment Notes	Conspicuous Species	Estimated Abundance	Representative Image
	Shelly gravelly sand with pebbles and cobbles with the occasional small boulder. 56° 09.6790 N 002° 59.6665 W To 56° 09.7056 N 002° 59.6152 W (72.5m^2)	The ground becomes coarser with raised aggregated areas of sediment, supporting dense swathes of *Ascidiella aspersa*. Where *Ascidiella* clusters around a boulder, the arms of ophiuroids can be seen within the faunal mass. Starfish are still regularly seen, and *Echinus esculentus* is present.	*Echinus esculentus* OPHIUROIDEA *Ascidiella aspersa* HYDROZOA/BRYOZOA turf *Asterias rubens* Gobiidae *Astropecten irregularis* *Alcyonium digitatum* *Pecten maximus* *Lanice conchilega*	O P C R F P F R O R	
11	Slightly shelly sand with a few pebbles. 56° 09.2580 N 003° 01.2955 W To 56° 09.2285 N 003° 01.3897 W (111.8m^2)	Slightly shelly rippled sand with small holes evident in places. Sparse clumps of *Ascidiella aspersa*. Small amounts of *Lanice conchilega*. *Asterias rubens* dotted throughout, with a few *Ophiura ophiura* and *Astropecten irregularis* also seen. Very little fauna seen overall.	*Lanice conchilega* Paguridae *Asterias rubens* *Ascidiella aspersa* Gobiidae *Astropecten irregularis* Syngnathidae *Ophiura ophiura* *Liocarcinus* *Alcyonium digitatum* HYDROZOA/BRYOZOA turf	R R F R P O O O O R R	

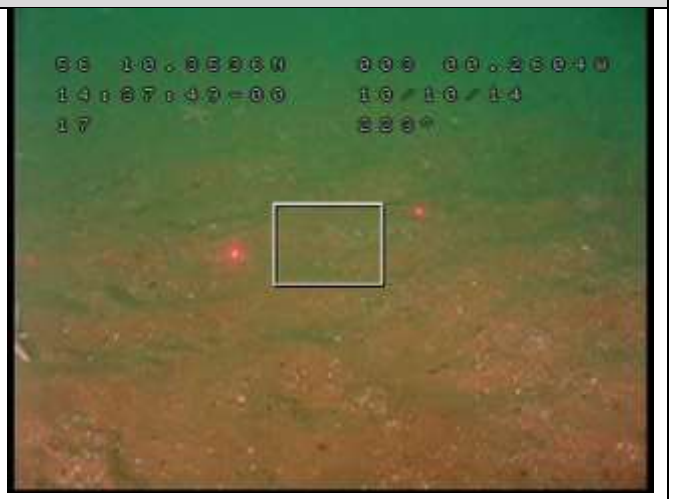
Site	General Description	Detailed Sediment Notes	Conspicuous Species	Estimated Abundance	Representative Image
12	Slightly shelly sand with occasional boulders 56°09.9252 N, 003°00.2550 W To 56°09.9142 N, 003°00.3610 W (111.6m^2)	Rippled shelly sand with pebbles and boulders. Most detail obscured by *Ophiothrix.* Camera lifted off seabed before the end of the video.	*Ophiothrix fragilis* *Asterias rubens* PISCES *Echinus esculentus* ACTINIARIA *Liocarcinus* Corallinaceae *Urticina* Gobiidae	A F O F O O R O P	
13	Very slightly shelly sand 56^o 08.9651 N 003^o 00.8221 W To 56^o 08.9228 N 003^o 00.8947 W (108.7m^2)	Sand with holes and burrows. *Pennatula phosphorea* seen regularly throughout the transect. *Asterias rubens* also very frequent, along with various small starfish that were not easily identifiable due to the visibility. Crabs and small ophiuroids were also regularly seen.	*Asterias rubens* *Pennatula phosphorea* Paguridae *Astropecten irregularis* HYDROZOA/BRYOZOA turf OPHIUROIDEA Gobiidae *Chaetopterus* tubes ASTEROIDEA Gadidae *Liocarcinus* *Virgularia mirabilis* *?Metridium senile* *Ophiura ophiura*	F F O O P P P P O O O O O P	

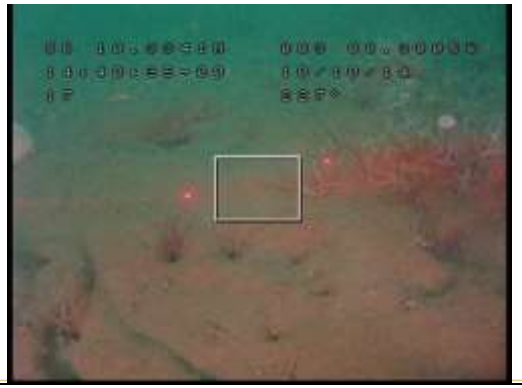
Site	General Description	Detailed Sediment Notes	Conspicuous Species	Estimated Abundance	Representative Image
14	Slightly shelly sand 56°08.8671 N 002°59.9480 W To 56°08.8700 N, 003°00.0434 W (98.9m^2)	Slightly shelly rippled sand. Mobile epifauna tracks visible. Some burrows present.	*Asterias rubens* *Liocarcinus* *Pennatula phosphorea* PISCES HYDROZOA/BRYOZOA turf *Astropecten irregularis* DECAPODA Gobiidae	F F F O R O O O	

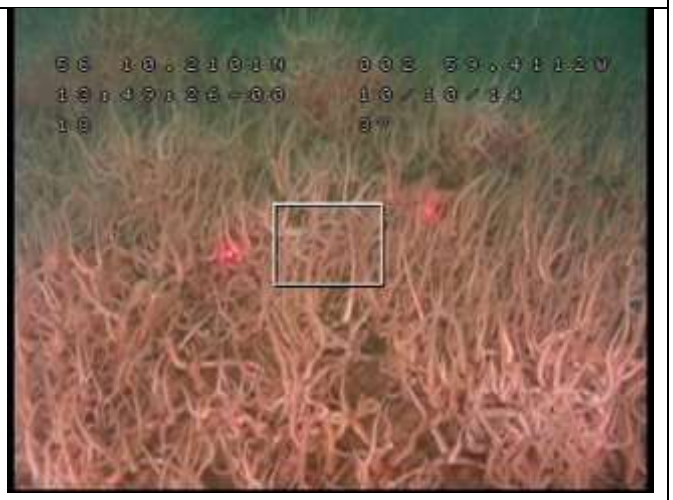
Site	General Description	Detailed Sediment Notes	Conspicuous Species	Estimated Abundance	Representative Image
15	Sand/mudstone ledging and bedrock, mixed with slightly shelly silty sand. 56°09.5977 N, 003°02.1868 W To 56°09.5800 N, 003°02.2401 W (64.2m^2)	Slightly shelly silty sand with visible burrows. Bedrock of mixed composition emerging from the sediment and forming flat ledges in places. Other areas of dropped edges appearing to be sand/mudstone, with a thick covering of shelly silty sand in some places. Some coarser sediment within the recesses.	*Ophiura* *Asterias rubens* Gobiidae *Nemertesia* *Alcyonium digitatum* Corallinaceae *Cancer pagurus* *Echinus esculentus* HYDROZOA/BRYOZOA turf PLEURONECTIFORMES	P F P P R R O F R P	  

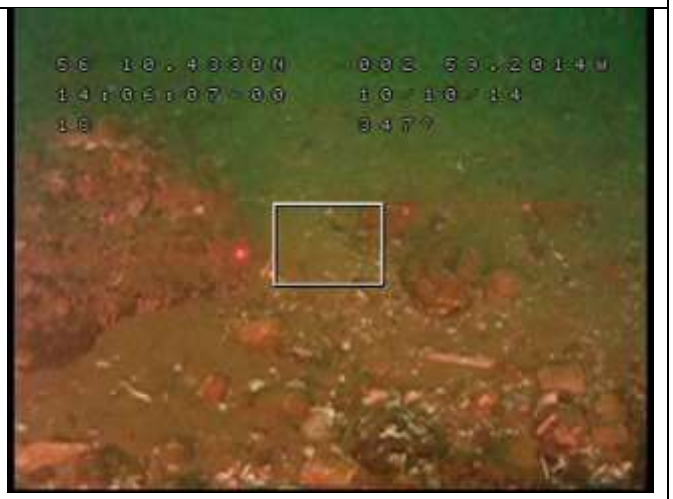
Site	General Description	Detailed Sediment Notes	Conspicuous Species	Estimated Abundance	Representative Image
	Slightly sandy pebbly shelly gravel 56°09.5800 N, 003°02.2401 W To 56°09.5585 N, 003°02.2728 W (52.3m^2)	An area of mixed coarse sediment of sandy shelly gravel, forming coarse shallow waves, with larger pebbles and a few cobbles aggregating within the recesses. Cobbles and pebbles appear in part, to comprise fragmented mud/clay.	*Asterias rubens* HYDROZOA/BRYOZOA turf *Cancer pagurus* Gobiidae *Liocarcinus* ACTINIARIA	F A O O O O	
	Slightly gravelly slightly shelly silty sand 56°09.5585 N, 003°02.2728 W To 56°09.5405 N, 003°02.3077 W (49.2m^2)	Slightly gravelly slightly shelly silty rippled sand. Mobile epifauna tracks visible.	PLEURONECTIFORMES *Asterias rubens* DECAPODA *Liocarcinus* Gobiidae	O F O O O	

Site	General Description	Detailed Sediment Notes	Conspicuous Species	Estimated Abundance	Representative Image
16	Slightly shelly sand with pebbles and cobbles. Occasionally dense aggregations of coarser substrate within the main sand matrix. Small holes evident. 56° 08.8489 N 003° 02.2297 W To 56° 08.9173 N 003° 02.0132 W (257.6m^2)	Sand with pebbles and cobbles, with dense aggregations of *Ascidiella aspersa* on the coarser fraction. Substrate varying between small coarser patches and slightly open expanses of sand with sparse pebbles and cobbles. Very occasional small boulder. *Asterias rubens* very common, rare clumps of *Nemertesia antennina*, sparse hydroid/bryozoan turf, A few *Astropecten irregularis* and *Liocarcinus* crabs. *Pecten maximus* occasionally seen within the sediment. Gastropod tracks evident.	*Ascidiella aspersa* *Asterias rubens* *Liocarcinus* *Nemertesia antennina* Paguridae *Pecten maximus* *Astropecten irregularis* Gobiidae *Alcyonium digitatum* HYDROZOA/BRYOZOA turf *Virgularia mirabilis* PLEURONECTIFORMES *Aequipecten opercularis* CARIDEA *Urticina*	O F O O O O O P R R O O O P O	
	Shelly sand with coarse mixed sediment with cobbles and pebbles and small boulders. 56° 08.9173 N 003° 02.0132 W To 56° 08.9806 N 003° 01.8188 W (233.0m^2)	Area coarser than the start of the transect forming more dense coarse sediment aggregations with fewer expanse of sand. Coarse sediment forming small raised mounds in places. Small to medium boulders regularly seen. *Ascidiella aspersa* forming dense aggregations across the site. Within some patches, ophiuroid arms seen in large numbers. *Asterias rubens* common across the area. *Echinus esculentus* now evident on the coarse areas.	*Ascidiella aspersa* *Asterias rubens* *Liocarcinus* *Nemertesia antennina* *Pecten maximus* *Astropecten irregularis* Gobiidae *Alcyonium digitatum* HYDROZOA/BRYOZOA turf CARIDEA *Urticina* *Echinus esculentus* OPHIUROIDEA *Urticina*	F F O O O O P R R P O O P O	

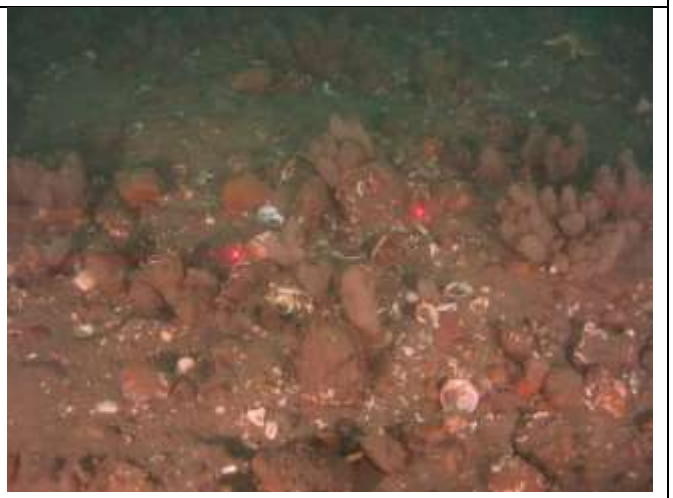
Site	General Description	Detailed Sediment Notes	Conspicuous Species	Estimated Abundance	Representative Image
17	Shelly sand with occasional boulder 56°10.3557 N, 003°00.2668 W To 56°10.3512 N, 003°00.2700 W (18.9m^2)	Rippled shelly sand with burrows. Occasional boulder visible.	*Asterias rubens* PLEURONECTIFORMES *Ophiura* *Liocarcinus*	O O F O	

Site	General Description	Detailed Sediment Notes	Conspicuous Species	Estimated Abundance	Representative Image
	Slightly pebbly gravelly shelly silty sand with boulders and sand/mudstone (compacted sediment) 56°10.3512 N, 033°00.2700 W To 56°10.3189 N, 003°00.3366 W (91.3m^2)	Slightly pebbly gravelly shelly sand with cobbles and boulders. Areas of mud/sand stone ledging, forming shallow dropped steps in some areas, and flat topped exposures in others. Relatively large holes bored in the surface. The compacted sediment areas form a mosaic with the bedrock and boulders. Patches of rippled sand fill the recesses between the various hard substrata. A thin sediment covering evident across much of the area. Large holes bored into the mud/sand stone, and small holes visible within the softer sediment. Length of rope or cable visible and possible tyre.	*Asterias rubens* *Echinus esculentus* Corallinaceae *Alcyonium digitatum* *Ophiura* *Ophiothrix fragilis* *Spirobranchus* *Liocarcinus* Gobiidae	F F R R F F R O P	  

Site	General Description	Detailed Sediment Notes	Conspicuous Species	Estimated Abundance	Representative Image
	Slightly shelly silty sand with occasional sand/mudstone outcrop 56°10.3189 N, 003°00.3366 W To 56°10.2944 N, 003°00.3760 W (61.1m^2)	Slightly shelly silty rippled sand with occasional sand/mudstone outcrop. Burrows and tubes visible.	PISCES *Ophiura* *Asterias rubens* PLEURONECTIFORMES *Liocarcinus* Gobiidae	O F F O O P	
18	Slightly gravelly shelly sand with boulders 56°10.2057 N, 002°59.4122 W To 56°10.2766 N, 002°59.3508 W (146.1m^2)	Most detail obscured by *Ophiothrix.*	*Ophiothrix fragilis* *Asterias rubens* Callionymidae *Echinus esculentus* *Alcyonium digitatum* ACTINIARIA Corallinaceae	P F O F R O R	

Site	General Description	Detailed Sediment Notes	Conspicuous Species	Estimated Abundance	Representative Image
	Slightly gravelly shelly sand with gravelly pebbly patches and occasional boulder 56°10.2766 N, 002°59.3508 W to 56°10.4194 N, 002°59.2070 W (303.8m^2)	Rippled shelly sand with gravelly and pebbly patches and occasional boulders. Occasional tube visible.	*Liocarcinus* *Asterias rubens* *Echinus esculentus* *Necora puber* Paguridae *Aequipecten opercularis* *Ascidiella aspersa* Gobiidae PISCES *Astropecten irregularis* *Ophiura* PLEURONECTIFORMES	O F F O O O R P O O P O	
	Cobbly pebbly gravelly shelly sand with boulders 56°10.4194 N, 002°59.2070 W To 56°10.4534 N, 002°59.1942 W (64.4m^2)	Cobbly pebbly gravelly shelly sand with boulders, and patches of rippled sand. Encrusting and mobile fauna visible.	*Echinus esculentus* *Asterias rubens* Corallinaceae HYDROZOA/BRYOZOA turf *Alcyonium digitatum*	F F R R R	

Site	General Description	Detailed Sediment Notes	Conspicuous Species	Estimated Abundance	Representative Image
19	Pebbly shelly gravelly rippled sand 56°10.0432 N, 002°58.4188 W To 56°10.0389 N, 002°58.4418 W (25.1m^2)	Pebbly shelly gravelly rippled sand with clumps of *Ascidiella aspersa* associated with the pebbles.	*Asterias rubens* *Ascidiella aspersa* *Liocarcinus* *Aequipecten opercularis* *Alcyonium digitatum* HYDROZOA/BRYOZOA turf	F F O O R R	
	Cobbly shelly pebbly gravelly sand 56°10.0389 N, 002°58.4418 W To 56°10.0372 N, 002°58.4599 W (19.0m^2)	Cobbly shelly pebbly gravelly sand with occasional small boulders and dense clumps of *Ascidiella aspersa.* The mixed coarse sediment becomes more consolidated in some areas and forms raised areas and occasional depressions.	*Ascidiella aspersa* *Echinus esculentus* *Aequipecten opercularis* Corallinaceae Majidae *Ophiura* *Spirobranchus* *Asterias rubens* HYDROZOA/BRYOZOA turf	C F O R O P R O C	

Site	General Description	Detailed Sediment Notes	Conspicuous Species	Estimated Abundance	Representative Image
	Slightly pebbly shelly gravelly rippled sand with occasional cobbles 56°10.0372 N, 002°58.4599 W To 56°10.0288 N, 002°58.4834 W (28.9m^2)	Slightly pebbly shelly gravelly rippled sand with occasional clumps of *Ascidiella aspersa* associated with the pebbles. Burrows visible.	*Asterias rubens* *Ascidiella aspersa* Gobiidae Callionymidae PLEURONECTIFORMES *Liocarcinus* *Spirobranchus* HYDROZOA/BRYOZOA turf	O R P O O O R R	
	Slightly cobbly pebbly shelly gravelly rippled sand with occasional cobbles 56°10.0288 N, 002°58.4834 W to 56°10.0352 N, 002°58.4533 W (75.4m^2)	Slightly cobbly pebbly shelly gravelly rippled sand with clumps of *Ascidiella aspersa* associated with the pebbles and occasional boulders. Burrows visible.	*Asterias rubens* *Ascidiella aspersa* HYDROZOA/BRYOZOA turf PISCES *Alcyonium digitatum* Gobiidae *Echinus esculentus* Majidae *Spirobranchus* *Ophiothrix fragilis*	F R O O R P O O R O	

G. APPENDIX G GRAB FAUNAL ANALYSIS DATA

Epifauna Abundance Data		Site	001	002	004	005	006	007	008	009	010
Species Name	**MCS Code**	**Aphia ID**	**TOTAL**	**TOTAL**	**TOTAL**	**TOTAL**	**TOTAL**	**TOTAL**	**TOTAL**	**TOTAL**	**TOTAL**
PORIFERA	C0001	558									
Cliona (agg.)	C0475	132026									
ANTHOATHECATAE	D0140	13551						P			
CAMPANULINOIDEA	D0338	13552			P						
Sertularia	D0433	117234									
Campanulariidae	D0491	1606									
Alcyonium digitatum	D0597	125333			P						
ACTINIARIA	D0662	1360		1							
Pedicellina	K0045	111796		P				P			
Verruca stroemia	R0041	106257		1							
CTENOSTOMATIDA	Y0070	110723			P						
Alcyonidium gelatinosum/Alcyonidioides mytili	Y0077/Y0080	110783						P			
Alcyonidium parasiticum	Y0081	111604			P				P		
Membraniporoidea	Y0167	153579									
Conopeum reticulum	Y0172	111351									
Electra monostachys	Y0177	111354									
Electra pilosa	Y0178	111355									
Cribrilina punctata/Collarina balzaci	Y0310/Y0314	110742						P			
ASCIDIACEA (juv.)	ZD0002	1839									
Ascidiidae	ZD0082	103443									
Ascidiella	ZD0083	103484									
Ascidiella aspersa	ZD0084	103718									

Epifauna abundance data			Site	011	012	013	014	015	016	017	018
Species Name	**MCS Code**	**Aphia ID**	**TOTAL**	**TOTAL**	**TOTAL**	**TOTAL**	**TOTAL**	**TOTAL**	**TOTAL**	**TOTAL**	**TOTAL**
PORIFERA	C0001	558						P			
Cliona (agg.)	C0475	132026		P			P				
ANTHOATHECATAE	D0140	13551				P		P			
CAMPANULINOIDEA	D0338	13552	P					P		P	
Sertularia	D0433	117234				P					
Campanulariidae	D0491	1606			P						
Alcyonium digitatum	D0597	125333									
ACTINIARIA	D0662	1360									
Pedicellina	K0045	111796									
Verruca stroemia	R0041	106257					4				
CTENOSTOMATIDA	Y0070	110723						P			
Alcyonidium gelatinosum/Alcyonidioides mytili	Y0077/Y0080	110783									
Alcyonidium parasiticum	Y0081	111604			P	P					
Membraniporoidea	Y0167	153579	P				P				
Conopeum reticulum	Y0172	111351								P	
Electra monostachys	Y0177	111354					P				
Electra pilosa	Y0178	111355		P							
Cribrilina punctata/Collarina balzaci	Y0310/Y0314	110742	P				P	P		P	
ASCIDIACEA (juv.)	ZD0002	1839					4				
Ascidiidae	ZD0082	103443									3
Ascidiella	ZD0083	103484									4
Ascidiella aspersa	ZD0084	103718									7

Taxon	MCS Code	Aphia ID	001.1.13187	002.1.13188	004.1.13190	005.1.13191	006.1.13192	007.1.13193	008.1.13194	009.1.13195	010.1.13196
Cerianthus lloydii	D0632	283798			2						1
Edwardsiidae	D0759	100665			5			1			13
TURBELLARIA	F0002	794						1			
NEMERTEA	G0001	152391		7	11	9	12	1		1	4
Golfingia elongata	N0014	175026									
Nephasoma minutum	N0025	136060									
Thysanocardia procera	N0028	136063						1			
Phascolion strombus	N0034	410749	1					2			
Pisione remota	P0015	130707									
Subadyte pellucida	P0032	130833		2			7				
Enipo kinbergi	P0044	130738									
Gattyana cirrhosa	P0049	130749									
Harmothoe	P0050	129491		1							
Malmgreniella darbouxi	P0050	130812		1				1			
Malmgrenia andreapolis	P0051	147008							1		
Harmothoe glabra	P0062	571832			1						
Pholoe baltica	P0092	130599			1	3	2				6
Pholoe inornata	P0094	130601					1				
Pholoe assimilis	P0091	130598									
Sigalion mathildae	P0104	131072									
Sthenelais limicola	P0109	131077									2
Eteone longa (agg.)	P0118	130616					1				
Hypereteone foliosa	P0124	152250	1								
Phyllodoce groenlandica	P0141	334506					1				
Phyllodoce rosea	P0146	334514				2					
Eumida	P0163	129446						1			
Eumida bahusiensis	P0164	130641			1	1					1
Eumida sanguinea (agg.)	P0167	130644					1				
Glycera	P0255	129296	1								

Taxon	MCS Code	Aphia ID	001.1.13187	002.1.13188	004.1.13190	005.1.13191	006.1.13192	007.1.13193	008.1.13194	009.1.13195	010.1.13196
Glycera alba	P0256	130116			1	1	1				
Glycera celtica (?)	P0257	130119									
Glycera lapidum	P0260	130123									
Glycera unicornis	P0255	130131	4					1	1		
Glycinde nordmanni	P0268	130136	1		1	1		1			1
Goniada maculata	P0271	130140		1	1	2		1	1		
Psamathe fusca	P0305	152249					1				
Oxydromus flexuosus	P0313	710680						1			
Podarkeopsis capensis	P0319	130195		1	1	2		1			1
Syllis cornuta	P0349	157583					2				
Parexogone hebes	P0421	757970									
Exogone naidina	P0422	131304						1			
Eunereis longissima	P0475	130375			1						
Nephtys assimilis	P0495	130353									1
Nephtys caeca	P0496	130355									
Nephtys hombergii	P0499	130359	1		2	2					3
Nephtys incisa	P0501	130362							3	4	
Nephtys kersivalensis	P0502	130363		2	2		2	1			
Lumbrineris	P0572	129337			1						
Lumbrineris cingulata	P0572	130240		9	2	19	3	1			1
Protodorvillea kefersteini	P0638	130041					1				
Orbinia sertulata	P0665	130523									
Scoloplos armiger	P0672	334772				5	4				1
Levinsenia gracilis	P0693	130578	1		1						
Paradoneis lyra	P0699	130585				1					
Poecilochaetus serpens	P0718	130711			1	3					2
Aonides oxycephala	P0722	131106					1				
Aonides paucibranchiata	P0723	131107									
Malacoceros girardi (?)	P0736	338471					1				

Taxon	MCS Code	Aphia ID	001.1.13187	002.1.13188	004.1.13190	005.1.13191	006.1.13192	007.1.13193	008.1.13194	009.1.13195	010.1.13196
Prionospio cirrifera	P0747	131153		1							
Dipolydora flava	P0754	131118			3	1					
Prionospio fallax	P0765	131157			2						2
Pseudopolydora paucibranchiata	P0773	131168				1					
Pseudopolydora pulchra	P0774	131169			1			1			
Spio symphyta	P0787	596189				1					6
Spiophanes	P0793	129626									
Spiophanes bombyx	P0794	131187			3	2		1			4
Spiophanes kroyeri	P0796	131188	2		2			1	1		
Magelona	P0803	129341							1		
Magelona alleni	P0804	130266	8		8	2		1			9
Magelona filiformis	P0805	130268				2					5
Magelona johnstoni	P0803	130269									2
Aphelochaeta marioni	P0824	129938								1	
Caulleriella alata	P0829	129943									
Chaetozone christiei	P0834	152217		1	1	1					
Chaetozone setosa	P0834	129955	1					6			
Chaetozone zetlandica	P0831	336485					2				
Cirratulus (juv.)	P0835	129243		2							
Cirratulus cirratus	P0836	129959					2				
Cirriformia tentaculata	P0839	129964					5				
Diplocirrus glaucus	P0878	130100			1			2	3		
Pherusa plumosa	P0885	130113		1							
Capitella	P0906	129211									
Mediomastus fragilis	P0919	129892		4			41	2	1		
Notomastus	P0920	129220	1						1		
Peresiella clymenoides	P0925	129906						1			
Maldanidae	P0938	923									

Taxon	MCS Code	Aphia ID	001.1.13187	002.1.13188	004.1.13190	005.1.13191	006.1.13192	007.1.13193	008.1.13194	009.1.13195	010.1.13196
Microclymene tricirrata	P0955	130309									2
Euclymene oerstedi	P0964	130294			5				1		
Rhodine	P0989	129363	22		10						
Ophelina acuminata	P1014	130500		1				1			1
Scalibregma inflatum	P1027	130980	1	2		1		7			
Galathowenia oculata	P1093	146950		2							1
Owenia	P1097	129427									1
Owenia borealis	P1097	329882	2		10	2		3	2		14
Amphictene auricoma	P1102	152448			1						
Lagis koreni	P1107	152367	1			1	1		1		
Sabellaria spinulosa	P1117	130867				2		1			
Melinna palmata	P1124	129808		12	7	2		3			10
Ampharete	P1133	129155							1		
Ampharete lindstroemi (agg.)	P1139	129781			1			4			2
Amphicteis gunneri	P1142	129784	1								
Anobothrus gracilis	P1147	129789		5	6			7	2		3
Terebellides stroemii	P1175	131573		1		1					
Trichobranchus roseus	P1178	131575									
Terebellinae	P1179	322588									
Neoamphitrite edwardsi	P1183	131503									
Eupolymnia nesidensis	P1190	131490					1				
Lanice conchilega	P1195	131495									
Pista mediterranea	P1216	131519									
Lysilla loveni	P1233	131500									
Polycirrus	P1235	129710			1		1	2			
Polycirrus denticulatus	P1239	131527					1				1
Streblosoma intestinale	P1251	131540									
Dialychone dunerificta	P1257	558752						2			
Hydroides norvegicus	P1334	131009						2			

Taxon	MCS Code	Aphia ID	001.1.13187	002.1.13188	004.1.13190	005.1.13191	006.1.13192	007.1.13193	008.1.13194	009.1.13195	010.1.13196
Spirobranchus (juv.)	P1339	129582									
Spirobranchus lamarcki	P1340	560033					1				
Spirobranchus triqueter	P1341	555935					1				
Tubificoides	P1487	137393					1				
Tubificoides amplivasatus	P1489	137570		3							
Tubificoides benedii	P1490	137571									
Tubificoides pseudogaster (agg.)	P1498	137582									
Tubificoides swirencoides	P1500	137584		1							
Tubificoides galiciensis	P1487	137576					25	1			
Anoplodactylus petiolatus	Q0044	134723									1
CRUSTACEA	R0001	1066								1	
Perioculodes longimanus	S0131	102915									
Synchelidium maculatum	S0138	102928				1					
Leucothoe incisa	S0177	102460									
Urothoe poseidonis	S0250	103235									
Harpinia antennaria	S0254	102960			1						
Acidostoma neglectum	S0272	102495									1
Iphimedia obesa	S0382	102347									
Atylus vedlomensis	S0413	102132									
Ampelisca	S0423	101445									1
Ampelisca brevicornis	S0427	101891			2	3		1	2		
Ampelisca diadema	S0429	101896			1	2					
Ampelisca tenuicornis	S0440	101930	2		8	1		3	1		4
Ampelisca typica	S0442	101933				1					2
Cheirocratus (female)	S0503	101669				1					
Cheirocratus sundevallii	S0506	102798					1				
Gammaropsis cornuta	S0539	148545									
Photis longicaudata	S0552	102383									10

Taxon	MCS Code	Aphia ID	001.1.13187	002.1.13188	004.1.13190	005.1.13191	006.1.13192	007.1.13193	008.1.13194	009.1.13195	010.1.13196
Ericthonius (female)	S0561	101567									
Ericthonius punctatus	S0564	102408									
Unciola crenatipalma	S0621	102057									
Phtisica marina	S0657	101864									1
Pseudoprotella phasma	S0659	101871									
Tanaopsis graciloides	S1142	136458					1				
Bodotria	S1193	110387									
Eudorellopsis (juv.)	S1209	110413									
Diastylis (juv.)	S1247	110398									
Diastylis laevis	S1251	110481									
Diastylis rugosa	S1254	110488									
CARIDEA	S1293	106674									1
Hippolytidae	S1334	106777									
Hippolyte varians	S1350	107518									
Processa	S1362	107054									
Processa nouveli	S1367	108345								1	
Crangonidae	S1380	106782									
Philocheras bispinosus	S1386	108207			1						
Crangon allmanni	S1384	107551								1	
Callianassa subterranea	S1415	107729									
Paguridae (juv.)	S1445	106738									
Pagurus bernhardus	S1457	107232					1	2			
Pagurus cuanensis	S1460	107235						1			
Pisidia longicornis	S1482	107188	2								
Liocarcinus	S1577	106925									1
Liocarcinus (juv.)	S1577	106925		2				1			
Liocarcinus depurator	S1580	107387	1								
Chaetoderma nitidulum	W0009	139106			2	1					
Gibbula (juv.)	W0157	138590					1				

Taxon	MCS Code	Aphia ID	001.1.13187	002.1.13188	004.1.13190	005.1.13191	006.1.13192	007.1.13193	008.1.13194	009.1.13195	010.1.13196
Gibbula tumida	W0161	141799									
Turritella communis	W0270	141872			1			10	8		
Hyala vitrea	W0410	140129						2	3		
Euspira nitida	W0491	151894									
Bela nebula	W0801	139217									
Philine (juv.)	W1036	138339									
Philine aperta	W1038	140744									1
Cylichna cylindracea	W1028	139476				4		4			5
Facelina	W1467	137997									
BIVALVIA	W1560	105									
Nucula (juv.)	W1565	138262									
Nucula nitidosa	W1569	140589		1	4			1			5
Mytilidae (juv.)	W1691	211					1				
Musculus subpictus	W1718	506128									
Aequipecten opercularis	W1773	140687									
Anomiidae (juv.)	W1805	214									
Lucinoma borealis	W1829	140283			7						1
Thyasiridae	W1833	219						1			
Thyasira	W1835	138552			1						
Thyasira flexuosa	W1837	141662			1						
Devonia perrieri	W1898	140365									
Kurtiella bidentata	W1906	345281	4		5	17	2	1	20		20
Tellimya ferruginosa	W1902	146952				3					
Parvicardium	W1947	137739					1				
Spisula (juv.)	W1973	138159									
Ensis	W1996	138333				1					
Ensis (juv.)	W1996	138333			1						
Ensis magnus	W1998	160539									
Phaxas pellucidus	W2006	140737			21	11		1			10

Taxon	MCS Code	Aphia ID	001.1.13187	002.1.13188	004.1.13190	005.1.13191	006.1.13192	007.1.13193	008.1.13194	009.1.13195	010.1.13196
Tellina fabula	W2019	141587					1				
Gari fervensis	W2051	140870				4					
Abra	W2058	138474						1			
Abra (juv.)	W2058	138474		1			3				
Abra alba	W2059	141433	1								
Abra nitida	W2061	141435						1		1	
Veneridae (juv.)	W2086	243			4	5		3		1	7
Dosinia (juv.)	W2126	138636				15		1	4		2
Dosinia lupinus	W2128	141912	4		1	2					
Dosinia exoleta	W2130	141911									
Polititapes rhomboides	W2113	745846					1				
Chamelea striatula	W2098	141908			3	8		1	1		
Mysia undata	W2139	140728	1					2			
Mya (juv.)	W2144	138211									1
Mya truncata	W2147	140431		1							
Corbula gibba	W2157	139410		1							
Thracioidea (juv.)	W2226	382318				4					6
Thracia (juv.)	W2227	138549				8					3
Thracia convexa	W2229	141644									
Thracia phaseolina	W2231	152378			2	3	3				1
Cochlodesma praetenue	W2239	181373				2					
Phoronis	ZA0003	128545	72		68	4		64	15	1	125
Astropecten irregularis	ZB0026	123867			3						
OPHIUROIDEA (juv.)	ZB0105	123084									
Ophiothrix fragilis	ZB0124	125131		55			105				
Amphiuridae	ZB0148	123206		1	1						3
Amphiuridae (juv.)	ZB0148	123206			2	1	1				3
Acrocnida brachiata	ZB0151	236130			6	5					20
Amphiura filiformis	ZB0154	125080			59	21		3			39

Taxon	MCS Code	Aphia ID	001.1.13187	002.1.13188	004.1.13190	005.1.13191	006.1.13192	007.1.13193	008.1.13194	009.1.13195	010.1.13196
Amphipholis squamata	ZB0161	125064									
Ophiuridae (juv.)	ZB0165	123200		2	4	3	5				9
Ophiura	ZB0166	123574					3				
Ophiura (juv.)	ZB0166	123574		2							
Ophiura albida	ZB0168	124913		20		3	4				
Ophiura ophiura	ZB0170	124929					4				
ECHINOIDEA (juv.)	ZB0181	123082									
SPATANGOIDA	ZB0213	123106									
Echinocardium	ZB0222	123426	1			1					1
Echinocardium cordatum	ZB0223	124392			3						1
Leptopentacta elongata	ZB0280	124635									
Leptosynapta inhaerens	ZB0296	124465							1		
ENTEROPNEUSTA	ZC0012	1820		1							
Ammodytes	ZG0442	125909									

Taxon	MCS Code	Aphia ID	011.1.13197	012.1.13198	013.1.13199	014.1.13200	015.1.13201	016.1.13202	017.1.13203	018.1.13204
Cerianthus lloydii	D0632	283798			3					
Edwardsiidae	D0759	100665	4		7			2	1	5
TURBELLARIA	F0002	794	1							1
NEMERTEA	G0001	152391	3	3	9		16	10	16	8
Golfingia elongata	N0014	175026	1							
Nephasoma minutum	N0025	136060								
Thysanocardia procera	N0028	136063			1	2		1		
Phascolion strombus	N0034	410749		1				1		
Pisione remota	P0015	130707					1			
Subadyte pellucida	P0032	130833		8						
Enipo kinbergi	P0044	130738				1				
Gattyana cirrhosa	P0049	130749					1			
Harmothoe	P0050	129491								
Malmgreniella darbouxi	P0050	130812						1		
Malmgrenia andreapolis	P0051	147008	1		1	3				
Harmothoe glabra	P0062	571832						1		
Pholoe baltica	P0092	130599	12			1	18	2	3	3
Pholoe inornata	P0094	130601					1			
Pholoe assimilis	P0091	130598					4			
Sigalion mathildae	P0104	131072							2	3
Sthenelais limicola	P0109	131077								
Eteone longa (agg.)	P0118	130616					1			
Hypereteone foliosa	P0124	152250								
Phyllodoce groenlandica	P0141	334506								
Phyllodoce rosea	P0146	334514								
Eumida	P0163	129446					1			
Eumida bahusiensis	P0164	130641	6		1			3	2	1
Eumida sanguinea (agg.)	P0167	130644		1						
Glycera	P0255	129296								

Taxon	MCS Code	Aphia ID	011.1.13197	012.1.13198	013.1.13199	014.1.13200	015.1.13201	016.1.13202	017.1.13203	018.1.13204
Glycera alba	P0256	130116						1		
Glycera celtica (?)	P0257	130119	1							
Glycera lapidum	P0260	130123		1			20			
Glycera unicornis	P0255	130131	1		2	2		1		
Glycinde nordmanni	P0268	130136	1	1	1			4		2
Goniada maculata	P0271	130140	1		2	3		4		1
Psamathe fusca	P0305	152249					2			
Oxydromus flexuosus	P0313	710680								
Podarkeopsis capensis	P0319	130195					1	4	1	
Syllis cornuta	P0349	157583					1	1		
Parexogone hebes	P0421	757970								
Exogone naidina	P0422	131304								
Eunereis longissima	P0475	130375			4			1		
Nephtys assimilis	P0495	130353	1						1	
Nephtys caeca	P0496	130355	1				1		1	
Nephtys hombergii	P0499	130359	3							1
Nephtys incisa	P0501	130362								
Nephtys kersivalensis	P0502	130363	1	1	1			2		
Lumbrineris	P0572	129337			1					
Lumbrineris cingulata	P0572	130240	5	10	3		3	19	2	
Protodorvillea kefersteini	P0638	130041					4			
Orbinia sertulata	P0665	130523				1		1		
Scoloplos armiger	P0672	334772					41		11	
Levinsenia gracilis	P0693	130578								
Paradoneis lyra	P0699	130585	1					6		
Poecilochaetus serpens	P0718	130711								
Aonides oxycephala	P0722	131106								
Aonides paucibranchiata	P0723	131107					7			
Malacoceros girardi (?)	P0736	338471					1			

Taxon	MCS Code	Aphia ID	011.1.13197	012.1.13198	013.1.13199	014.1.13200	015.1.13201	016.1.13202	017.1.13203	018.1.13204
Prionospio cirrifera	P0747	131153								
Dipolydora flava	P0754	131118			1	1		1		
Prionospio fallax	P0765	131157								2
Pseudopolydora paucibranchiata	P0773	131168		1				1	2	
Pseudopolydora pulchra	P0774	131169								
Spio symphyta	P0787	596189	2					1	20	12
Spiophanes	P0793	129626			1					
Spiophanes bombyx	P0794	131187	3	1	1	1		1	4	6
Spiophanes kroyeri	P0796	131188			1	1				
Magelona	P0803	129341								
Magelona alleni	P0804	130266	4		32	7		6		4
Magelona filiformis	P0805	130268						6	61	54
Magelona johnstoni	P0803	130269	1					2	61	52
Aphelochaeta marioni	P0824	129938							1	
Caulleriella alata	P0829	129943					1			
Chaetozone christiei	P0834	152217							7	6
Chaetozone setosa	P0834	129955	1			1		3		
Chaetozone zetlandica	P0831	336485								1
Cirratulus (juv.)	P0835	129243								
Cirratulus cirratus	P0836	129959								
Cirriformia tentaculata	P0839	129964								
Diplocirrus glaucus	P0878	130100				1			1	
Pherusa plumosa	P0885	130113								
Capitella	P0906	129211					1			
Mediomastus fragilis	P0919	129892	1				15		1	
Notomastus	P0920	129220								
Peresiella clymenoides	P0925	129906						2		
Maldanidae	P0938	923	1							
Microclymene tricirrata	P0955	130309								

Taxon	MCS Code	Aphia ID	011.1.13197	012.1.13198	013.1.13199	014.1.13200	015.1.13201	016.1.13202	017.1.13203	018.1.13204
Euclymene oerstedi	P0964	130294			4			2	10	
Rhodine	P0989	129363	2		41	6		12		
Ophelina acuminata	P1014	130500		2						
Scalibregma inflatum	P1027	130980	3		2			5		
Galathowenia oculata	P1093	146950	2		4			1	1	
Owenia	P1097	129427								
Owenia borealis	P1097	329882	9	2	12	2		4	4	16
Amphictene auricoma	P1102	152448	2		1				1	
Lagis koreni	P1107	152367	3		1	2				
Sabellaria spinulosa	P1117	130867								
Melinna palmata	P1124	129808	4		10	6		25	4	
Ampharete	P1133	129155		1						
Ampharete lindstroemi (agg.)	P1139	129781	3		1			6		
Amphicteis gunneri	P1142	129784								
Anobothrus gracilis	P1147	129789		1	5	2		5		
Terebellides stroemii	P1175	131573								
Trichobranchus roseus	P1178	131575						1		
Terebellinae	P1179	322588	1							
Neoamphitrite edwardsi	P1183	131503						1		
Eupolymnia nesidensis	P1190	131490								
Lanice conchilega	P1195	131495	1			1			6	
Pista mediterranea	P1216	131519					5			
Lysilla loveni	P1233	131500				1				
Polycirrus	P1235	129710				1	1	3		
Polycirrus denticulatus	P1239	131527							2	
Streblosoma intestinale	P1251	131540						1		
Dialychone dunerificta	P1257	558752								
Hydroides norvegicus	P1334	131009								
Spirobranchus (juv.)	P1339	129582								

Taxon	MCS Code	Aphia ID	011.1.13197	012.1.13198	013.1.13199	014.1.13200	015.1.13201	016.1.13202	017.1.13203	018.1.13204
Spirobranchus lamarcki	P1340	560033					13			
Spirobranchus triqueter	P1341	555935					1			
Tubificoides	P1487	137393								
Tubificoides amplivasatus	P1489	137570								
Tubificoides benedii	P1490	137571					1			
Tubificoides pseudogaster (agg.)	P1498	137582		1						
Tubificoides swirencoides	P1500	137584								
Tubificoides galiciensis	P1487	137576					3			
Anoplodactylus petiolatus	Q0044	134723	1							
CRUSTACEA	R0001	1066								
Perioculodes longimanus	S0131	102915							1	
Synchelidium maculatum	S0138	102928	1	1						
Leucothoe incisa	S0177	102460							1	
Urothoe poseidonis	S0250	103235							5	
Harpinia antennaria	S0254	102960	2		3			1		
Acidostoma neglectum	S0272	102495								
Iphimedia obesa	S0382	102347								
Atylus vedlomensis	S0413	102132		1			6			
Ampelisca	S0423	101445		1						
Ampelisca brevicornis	S0427	101891	5						8	6
Ampelisca diadema	S0429	101896	3			1		1		
Ampelisca tenuicornis	S0440	101930			6	3		2		2
Ampelisca typica	S0442	101933	1	1	2			1		2
Cheirocratus (female)	S0503	101669					8			
Cheirocratus sundevallii	S0506	102798								
Gammaropsis cornuta	S0539	148545					1			
Photis longicaudata	S0552	102383			4					
Ericthonius (female)	S0561	101567								
Ericthonius punctatus	S0564	102408								

Taxon	MCS Code	Aphia ID	011.1.13197	012.1.13198	013.1.13199	014.1.13200	015.1.13201	016.1.13202	017.1.13203	018.1.13204
Unciola crenatipalma	S0621	102057					1			
Phtisica marina	S0657	101864								
Pseudoprotella phasma	S0659	101871								
Tanaopsis graciloides	S1142	136458	1					1		
Bodotria	S1193	110387		1						
Eudorellopsis (juv.)	S1209	110413				1				
Diastylis (juv.)	S1247	110398								
Diastylis laevis	S1251	110481								
Diastylis rugosa	S1254	110488		1						
CARIDEA	S1293	106674								
Hippolytidae	S1334	106777								
Hippolyte varians	S1350	107518		1				1		
Processa	S1362	107054						1		
Processa nouveli	S1367	108345						1		
Crangonidae	S1380	106782						1		
Philocheras bispinosus	S1386	108207								
Crangon allmanni	S1384	107551								
Callianassa subterranea	S1415	107729				1				
Paguridae (juv.)	S1445	106738					1			
Pagurus bernhardus	S1457	107232		1	1	1				
Pagurus cuanensis	S1460	107235								
Pisidia longicornis	S1482	107188					3			
Liocarcinus	S1577	106925								
Liocarcinus (juv.)	S1577	106925					3			1
Liocarcinus depurator	S1580	107387		1						
Chaetoderma nitidulum	W0009	139106	1		1			2		
Gibbula (juv.)	W0157	138590								
Gibbula tumida	W0161	141799					2			
Turritella communis	W0270	141872			4	1				

Taxon	MCS Code	Aphia ID	011.1.13197	012.1.13198	013.1.13199	014.1.13200	015.1.13201	016.1.13202	017.1.13203	018.1.13204
Hyala vitrea	W0410	140129								
Euspira nitida	W0491	151894					1	1		
Bela nebula	W0801	139217	2							
Philine (juv.)	W1036	138339							2	
Philine aperta	W1038	140744		1	1				4	
Cylichna cylindracea	W1028	139476	7			2		3	3	8
Facelina	W1467	137997								
BIVALVIA	W1560	105					1		1	
Nucula (juv.)	W1565	138262	2							
Nucula nitidosa	W1569	140589	5					1	2	3
Mytilidae (juv.)	W1691	211								1
Musculus subpictus	W1718	506128								
Aequipecten opercularis	W1773	140687								
Anomiidae (juv.)	W1805	214					2			
Lucinoma borealis	W1829	140283			5			3		
Thyasiridae	W1833	219								
Thyasira	W1835	138552								
Thyasira flexuosa	W1837	141662								
Devonia perrieri	W1898	140365			1	1				
Kurtiella bidentata	W1906	345281	52		2	11	14	4	21	24
Tellimya ferruginosa	W1902	146952	2			2			2	10
Parvicardium	W1947	137739								
Spisula (juv.)	W1973	138159					3		1	1
Ensis	W1996	138333								
Ensis (juv.)	W1996	138333								
Ensis magnus	W1998	160539	2				5			2
Phaxas pellucidus	W2006	140737	13		2			5	4	13
Tellina fabula	W2019	141587	1						76	22
Gari fervensis	W2051	140870								1

Taxon	MCS Code	Aphia ID	011.1.13197	012.1.13198	013.1.13199	014.1.13200	015.1.13201	016.1.13202	017.1.13203	018.1.13204
Abra	W2058	138474								
Abra (juv.)	W2058	138474						1		
Abra alba	W2059	141433							1	1
Abra nitida	W2061	141435								
Veneridae (juv.)	W2086	243	2			1			3	1
Dosinia (juv.)	W2126	138636		1		2	13	1		
Dosinia lupinus	W2128	141912		2	1					
Dosinia exoleta	W2130	141911					1			
Polititapes rhomboides	W2113	745846					5			
Chamelea striatula	W2098	141908	1	1			2	4		3
Mysia undata	W2139	140728			4					
Mya (juv.)	W2144	138211								
Mya truncata	W2147	140431								
Corbula gibba	W2157	139410	2							
Thracioidea (juv.)	W2226	382318	5					1	3	
Thracia (juv.)	W2227	138549	26	1						
Thracia convexa	W2229	141644						1		
Thracia phaseolina	W2231	152378	3	1				2	19	7
Cochlodesma praetenue	W2239	181373	1							2
Phoronis	ZA0003	128545	61		212	173		100		32
Astropecten irregularis	ZB0026	123867								
OPHIUROIDEA (juv.)	ZB0105	123084							6	
Ophiothrix fragilis	ZB0124	125131		71						
Amphiuridae	ZB0148	123206	4					10		
Amphiuridae (juv.)	ZB0148	123206	7		1			1	7	4
Acrocnida brachiata	ZB0151	236130	13					3	3	7
Amphiura filiformis	ZB0154	125080	33	1	14	3		26		4
Amphipholis squamata	ZB0161	125064					5			
Ophiuridae (juv.)	ZB0165	123200	6	2	1				5	8

Taxon	MCS Code	Aphia ID	011.1.13197	012.1.13198	013.1.13199	014.1.13200	015.1.13201	016.1.13202	017.1.13203	018.1.13204
Ophiura	ZB0166	123574								
Ophiura (juv.)	ZB0166	123574		3						1
Ophiura albida	ZB0168	124913		6						
Ophiura ophiura	ZB0170	124929								
ECHINOIDEA (juv.)	ZB0181	123082								
SPATANGOIDA	ZB0213	123106							1	1
Echinocardium	ZB0222	123426				2				4
Echinocardium cordatum	ZB0223	124392				2				2
Leptopentacta elongata	ZB0280	124635				1		1		
Leptosynapta inhaerens	ZB0296	124465			2	4				
ENTEROPNEUSTA	ZC0012	1820	2		1					
Ammodytes	ZG0442	125909					1			

H. APPENDIX H BIOMASS DATA

TaxonName	001.1.13187	002.1.13188	004.1.13190	005.1.13191	006.1.13192	007.1.13193	008.1.13194	009.1.13195	010.1.13196	011.1.13197
Other taxa	0.9106	0.0160	2.8484	0.0910	0.0217	0.5803	0.0532	0.0023	4.9579	2.7158
Cnidaria	0.0000	0.0000	0.1097	0.0000	0.0000	0.0062	0.0000	0.0000	0.3760	0.0233
Polychaetes	1.9147	0.4944	1.5853	1.1929	0.6836	0.8860	0.5388	0.0581	2.1687	4.3280
Oligochaetes	0.0000	0.0003	0.0000	0.0000	0.0066	0.0003	0.0000	0.0000	0.0000	0.0000
Crustaceans	0.1507	0.0174	0.0221	0.0294	0.0143	0.2095	0.0104	0.0712	3.0516	0.0519
Molluscs	20.2117	0.2147	8.0193	5.3705	0.1941	8.0845	4.1104	0.0077	1.2904	3.7522
Echinoderms	0.0651	9.6652	4.1215	2.0459	55.5228	0.1043	0.1256	0.0000	2.9024	2.2131

TaxonName	012.1.13198	013.1.13199	014.1.13200	015.1.13201	016.1.13202	017.1.13203	018.1.13204	019.1.13205
Other taxa	0.0083	11.7360	1.1611	0.0140	4.2769	2.7662	0.4059	0.0635
Cnidaria	0.0000	0.4937	0.0000	0.0000	0.0252	0.0272	0.0826	0.0000
Polychaetes	0.3478	3.7716	2.2650	5.6915	2.9103	1.8863	1.8656	0.5013
Oligochaetes	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.0008
Crustaceans	0.2041	0.1385	0.7947	0.0628	0.0291	0.1034	0.0518	0.0396
Molluscs	11.6410	8.7793	1.1506	16.8298	5.7744	6.0732	3.1018	17.5631
Echinoderms	38.5677	0.6365	2.1005	0.0038	0.3123	5.7451	12.6430	1.4473

I. APPENDIX I PSD ANALYSIS DATA

SAMPLE ID:	1	4	7	8	9	10	11	13	14	15	16	17
LAB ID:	13206	13209	13212	13213	13214	13215	13216	13218	13219	13220	13221	13222
Aperture [µm]	Fractional [%]	Fractional [%]	Fractional [%]	Fractional [%]	Fractional [%]	Fractional [%]	Fractional [%]	Fractional [%]	Fractional [%]	Fractional [%]	Fractional [%]	Fractional [%]
63000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16000	0.00	9.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	0.00
8000	1.29	0.00	1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.27	0.24
4000	0.42	0.19	1.45	0.40	1.36	0.43	0.00	0.57	0.98	3.79	3.31	0.13
2000	0.42	0.53	1.68	0.46	0.21	0.44	0.22	0.83	0.19	15.12	4.57	0.42
1000	0.55	0.78	0.99	0.32	0.17	0.53	0.35	0.88	0.51	20.95	2.75	0.46
500	1.42	1.47	2.38	0.35	0.10	1.29	0.85	2.16	1.34	14.98	2.57	1.20
250	5.38	8.33	7.63	1.41	0.44	11.84	15.99	7.77	3.19	19.07	10.46	9.80
125	18.08	50.18	21.60	3.57	2.33	59.38	56.91	48.63	23.30	7.85	47.07	67.83
63	42.93	19.73	37.19	47.00	27.85	20.57	16.06	25.54	39.83	2.58	18.01	14.74
31.25	8.15	1.52	6.07	10.79	25.86	1.05	1.59	2.78	8.98	3.00	2.26	0.98
15.63	7.60	2.11	6.73	11.32	16.57	1.27	2.46	3.42	7.87	3.90	2.39	1.13
7.81	5.86	2.10	5.59	10.11	10.25	1.29	2.43	3.18	6.00	3.48	1.95	1.21
3.91	4.19	1.65	3.99	7.58	7.55	1.02	1.75	2.31	4.18	2.61	1.41	0.97
1.95	2.20	0.89	2.10	4.02	4.16	0.54	0.86	1.17	2.16	1.55	0.74	0.53
0.98	0.91	0.35	0.86	1.63	1.89	0.22	0.32	0.46	0.89	0.71	0.30	0.23
0.49	0.55	0.20	0.50	0.95	1.16	0.13	0.19	0.27	0.54	0.39	0.18	0.13
< 0.49	0.05	0.01	0.04	0.08	0.10	0.01	0.01	0.02	0.04	0.03	0.01	0.01
TOTAL:	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

SAMPLE ID:	5	6	12	18	19
LAB ID:	13210	13211	13217	13223	13224
Sieve Aperture [µm]	Fractional [%]	Fractional [%]	Fractional [%]	Fractional [%]	Fractional [%]
63000	0.00	0.00	0.00	0.00	0.00
31500	0.00	31.66	31.20	0.00	0.00
16000	0.00	35.76	25.21	0.00	14.38
8000	0.88	10.17	2.09	0.00	12.30
4000	3.88	3.38	2.80	0.27	6.93
2000	2.20	1.10	2.60	0.34	3.12
1000	1.99	0.96	2.47	0.24	2.72
500	2.86	1.42	3.09	0.59	4.57
250	18.42	3.44	13.21	2.61	15.14
125	53.98	8.91	13.56	68.03	28.82
63	11.08	1.29	1.92	24.07	9.51
< 63	4.72	1.90	1.85	3.85	2.51
TOTAL:	100.00	100.00	100.00	100.00	100.00

J. APPENDIX J SEDIMENT CHEMISTRY ANALYSIS

Analysis of Fife Energy Park Sediment Sample Analytical Report					Marine Scotland Revised AL		OSPAR ERL	
Client ID	**Sample Description**	**Analysis***	**Value****	**Units**				
STN005	**Marine Sediment**	Total hydrocarbons	370	mg/kg	100	mg/kg		
		Naphthalene	25.2	µg/kg	0.1	mg/kg	160	µg/kg
		Acenaphthylene	<1	µg/kg	0.1	mg/kg		
		Acenaphthene	3.03	µg/kg	0.1	mg/kg		
		Fluorene	<5	µg/kg	0.1	mg/kg		
		Phenanthrene	19.3	µg/kg	0.1	mg/kg	240	µg/kg
		Anthracene	6.62	µg/kg	0.1	mg/kg	85	µg/kg
		Fluoranthene	21	µg/kg	0.1	mg/kg	600	µg/kg
		Pyrene	21.3	µg/kg	0.1	mg/kg	665	µg/kg
		Benzo(a)anthracene	11.9	µg/kg	0.1	mg/kg	261	µg/kg
		Chrysene	7.66	µg/kg	0.1	mg/kg	384	µg/kg
		Benzo(b)fluoranthene	13.8	µg/kg	0.1	mg/kg		
		Benzo(k)fluoranthene	5.82	µg/kg	0.1	mg/kg		
		Benzo(a)pyrene	11.4	µg/kg	0.1	mg/kg	430	µg/kg
		Indeno(123cd)pyrene	8.41	µg/kg	0.1	mg/kg	240	µg/kg
		Benzo(ghi)perylene	11.9	µg/kg	0.1	mg/kg	85	µg/kg
		Dibenzo(ah)anthracene	1.66	µg/kg	10	mg/kg		
		Total EPA16 Priority PAHs	169	µg/kg				
		Dioctyltin	<4	µg/kg				
		Dibutyltin	7.04	µg/kg				
		Tributyltin	<4	µg/kg	0.1	mg/kg		
		Tetrabutyltin	<3	µg/kg				
		Diphenyltin	<3	µg/kg				
		Triphenyltin	<3	µg/kg				
		Aluminium	7010	mg/kg				
		Arsenic	9.25	mg/kg	20	mg/kg	8.2	mg/kg
		Cadmium	0.028	mg/kg	0.4	mg/kg	1.2	mg/kg
		Chromium	18.6	mg/kg	50	mg/kg	81	mg/kg
		Copper	3.48	mg/kg	30	mg/kg	34	mg/kg
		Iron	12800	mg/kg				
		Lithium	9.66	mg/kg				
		Lead	13	mg/kg	50	mg/kg	47	mg/kg
		Mercury	0.0199	mg/kg	0.25	mg/kg	0.15	mg/kg
		Nickel	9.54	mg/kg	30	mg/kg	21	mg/kg
		Zinc	32.6	mg/kg	130	mg/kg	150	mg/kg

Notes:

* Total hydrocarbons determined by methanol digest, pentane exchange and analysis by UV fluorescence spectrometry. Polycyclic Aromatic Hydrocarbon (PAH) content determined by solvent extraction and analysis by GC-QQQ. - Organotin content determined by ultrasonic extraction and derivatisation of extract for GC-MS analysis. - Mercury determined by aqua-regia digest, addition of stannous chloride and analysis by CV-AFS. - Metals determined by aqua-regia digest with analysis

by ICP-MS and ICP-OES ** The data presented within this report relate only to the samples as received at the laboratory. All results reported on a sediment dry weight basis.

Analysis of Fife Energy Park Sediment Sample Analytical Report						
Client ID	**Sample Description**	**Analysis***	**Value****	**Units**	**OSPAR ERL**	
STN005	**Marine Sediment**	PCB 18	0.183	µg/kg		
		PCB 28	0.284	µg/kg	1.7	µg/kg
		PCB 31	0.22	µg/kg		
		PCB 44	0.11	µg/kg		
		PCB 47	0.057	µg/kg		
		PCB 49	0.092	µg/kg		
		PCB 52	0.263	µg/kg	2.7	µg/kg
		PCB 66	0.186	µg/kg		
		PCB 101	0.216	µg/kg	3	µg/kg
		PCB 105	0.049	µg/kg		
		PCB 110	0.146	µg/kg		
		PCB 118	0.183	µg/kg	0.6	µg/kg
		PCB 128	0.068	µg/kg		
		PCB 138	0.126	µg/kg	7.9	µg/kg
		PCB 141	<0.010	µg/kg		
		PCB 149	0.045	µg/kg		
		PCB 151	0.024	µg/kg		
		PCB 153	0.132	µg/kg	40	µg/kg
		PCB 156	0.021	µg/kg		
		PCB 158	0.059	µg/kg		
		PCB 170	0.042	µg/kg		
		PCB 180	0.054	µg/kg	12	µg/kg
		PCB 183	0.042	µg/kg		
		PCB 187	0.036	µg/kg		
		PCB 194	0.035	µg/kg		
		Total ICES 7	1.26	µg/kg		
		Total CEN 25	2.68	µg/kg		

Notes:
* Polychlorinated biphenyls (PCB) determined by ultrasonic extraction and clean-up of the extract for analysis by GC-µECD. ** The data presented within this report relate only to the samples as received at the laboratory. All results reported on a sediment dry weight basis.

K. APPENDIX K 2 BEAM TRAWL ANALYSIS DATA

Taxon	MCS Code	APHIA ID	T1	T2	T4
			Total	Total	Total
Suberites ficus (agg.)	C0418	134285	0	P	0
Halichondria	C0632	131807	P	0	0
Abietinaria abietina	D0409	117870	P	0	0
Hydrallmania falcata	D0424	117890	P	P	0
Alcyonium digitatum	D0596	125333	P	P	0
ACTINIARIA	D0662	1360	1	2	0
Aphrodita aculeata	P0019	129840	2	12	7
Alentia gelatinosa	P0034	130722	0	1	0
Gattyana cirrhosa	P0049	130749	0	1	0
Lepidonotus squamatus	P0082	130801	3	1	0
Chaetopterus variopedatus	P0814	129914	0	1	0
Flabelligera affinis	P0881	130103	1	0	1
Eupolymnia nesidensis	P1190	131490	0	0	1
Balanus crenatus	R0077	106215	0	7	0
Crangon allmanni	S1384	107551	4	1	0
Crangon crangon	S1385	107552	27	79	30
Pagurus bernhardus	S1457	107232	2	0	0
Galathea dispersa	S1471	107148	0	0	1
Pisidia longicornis	S1482	107188	3	1	13
Macropodia parva/rostrata	S15??/S1532	205077	1	0	3
Hyas araneus	S1518	107322	3	2	0
Hyas coarctatus	S1519	107323	5	0	3
Cancer pagurus (female)	S1566	107276	0	0	1
Liocarcinus depurator	S1580	107387	79	57	40
Liocarcinus holsatus	S1581	107388	5	9	0
Leptochiton asellus	W0053	140199	2	0	0
Gibbula tumida	W0161	141799	1	0	0
Turritella communis	W0270	141872	0	1	0
Lamellaria perspicua	W0470	140173	3	0	4
Buccinum undatum	W0708	138878	2	1	2
Philine aperta	W1038	140744	81	25	75
Musculus subpicutus	W1718	506128	4	0	21
Pecten maximus	W1771	140712	0	1	0
Aequipecten opercularis	W1773	140687	17	3	91
Sepiola atlantica	W2329	141454	1	0	0

Taxon	MCS Code	APHIA ID	T1	T2	T4
			Total	Total	Total
Sepietta oweniana	W2333	141452	2	1	0
Eledone cirrhosa	W2398	140600	0	0	1
Alcyonidium parasiticum	Y0081	111604	P	P	P
Eucratea loricata	Y0165	111361	0	P	0
Astropecten irregularis	ZB0026	123867	255	213	32
Crossaster papposus	ZB0075	124154	1	0	0
Asterias rubens	ZB0100	123776	89	70	70
Ophiothrix fragilis	ZB0124	125131	66	3	98
Ophiocten affinis	ZB0167	124850	0	0	1
Ophiura albida	ZB0168	124913	3	0	0
Ophiura ophiura	ZB0170	124929	2	36	0
Psammechinus miliaris	ZB0193	124319	4	1	9
Echinus esculentus	ZB0198	124287	0	0	1
Ascidiidae	ZD0082	103443	1	0	0
Ascidiella	ZD0083	103484	8	0	0
Ascidiella (juv.)	ZD0083	103484	34	32	30
Ascidiella aspersa	ZD0084	103718	132	176	201
Ascidiella scabra	ZD0085	103719	19	2	0
Gadus morhua	ZG0116	126436	6	0	0
Syngnathus acus	ZG0245	127387	5	16	1
Myoxocephalus scorpius	ZG0281	127203	1	2	1
Agonus cataphractus	ZG0291	127190	2	11	2
Zoarces viviparus	ZG0437	127123	0	0	1
Pholis gunnellus	ZG0440	126996	1	0	1
Callionymus lyra	ZG0452	126792	3	3	2
Gobiidae	ZG0455	125537	0	0	1
Pomatoschistus	ZG0476	125999	0	8	0
Pomatoschistus minutus	ZG0479	126928	26	35	20
Limanda limanda	ZG0572	127139	14	30	2
Microstomus kitt	ZG0574	127140	2	0	0
Pleuronectes platessa	ZG0578	127143	36	60	6

Trawl	Fish Species Measurements	Total Lengths (cm rounded down)																				Abundance
	Agonus cataphractus	13	6																			2
	Callionymus lyra	13	7	5																		3
	Limanda limanda	17	6	5	7	6	7	7	8	7	7	8	8	8	8							14
	Microstomus kitt	16	11																			2
	Pholis gunnelis	13																				1
	Pleuronectes platessa	11	9	11	9	10	11	13	9	8	10	12	9	9	10	9	8	9	9	10	9	
		9	9	8	8	8	8	7	5	6	7	7	6	7	8	8	8					36
	Myoxocephalus scorpius	8																				1
	Pomatoschistus minutus	7	8	6	7	8	6	6	6	7	6	6	6	4	5	3	4	5	5	3	6	
		4	3	3	5	3	3															26
	Syngnathus acus	12	9	11	11	12																5
T1	*Gadus morhua*	10	10	10	9	9	15															6
	Agonus cataphractus	12	6	6	6	8	6	6	5	5	6	4										11
	Limanda limanda	12	8	7	7	8	8	7	7	8	7	6	6	6	7	6	6	6	6	7	5	
		7	5	5	7	6	6	5	7	6	6											30
	Pleuronectes platessa	14	11	11	11	9	10	8	9	10	9	8	8	9	9	9	9	8	9	8	8	
		8	8	9	9	8	10	8	9	8	8	7	7	8	8	7	7	8	7	7	6	
		7	6	6	5	6	5	5	6	6	6	7	8	8	8	7	8	8	8	7	7	60
	Myoxocephalus scorpius	13	16																			2
	Syngnathus acus	12	13	10	10	12	11	12	12	12	13	9	11	11	9	12	10					16
	Callionymus lyra	5	5	7																		3
	Pomatoschistus minutus	8	6	7	8	7	6	6	6	6	7	6	6	6	6	6	6	6	4	4	5	
		6	3	4	3	4	4	4	3	3	3	3	3	3	3	3						35
T2	*Pomatoschistus*	3	3	3	3	3	3	3	3													8
	Agonus cataphractus	11	5																			2
	Limanda limanda	14	5																			2
	Pholis gunnellus	17																				1
	Pleuronectes platessa	8	7	8	8	12	5															6
	Pomatoschistus minutus	6	7	6	5	4	4	5	5	3	3	6	6	6	7	8	5	6	5	5	8	20
	Syngnathus acus	11																				1
	Callionymus lyra	8	8																			2
	Myoxocephalus scorpius	14																				1
T4	*Zoarces viviparus*	18																				1

Trawl	Fish Species Measurements	Total Lengths (cm rounded down)																				Abundance
	Gobiidae	2																				1

Trawl	Shellfish Measurements	Total Lengths (mm)																				Abundance
	Aequipecten opercularis	63	75	76	30	31	33	44	78	39	30	35	29	66	40	7	10	10				17
	Buccinum undatum	95	25																			2
	Sepiola atlantica	17																				1
T1	*Sepietta oweniana*	29	30																			2
	Buccinum undatum	108																				1
	Aequipecten opercularis	42	34	38																		3
	Pecten maximus	123																				1
T2	*Sepietta oweniana*	27																				1
	Buccinum undatum	118	10																			2
	Cancer pagurus (female)	29																				1
	Aequipecten opercularis	70	43	48	33	29	33	34	37	31	49	30	47	33	35	40	45	41	36	69	38	91
		35	32	39	39	51	36	43	47	41	45	55	47	37	40	50	45	44	33	50	61	
		36	34	42	39	46	50	41	45	40	38	30	34	45	16	38	17	32	38	35	30	
		38	32	41	37	33	32	30	36	38	34	32	33	35	46	33	35	35	37	35	35	
		40	36	35	31	42	31	14	15	37	15	17										
T4	*Eledone cirrhosa*	13																				1

L. APPENDIX L PSD CERTIFICATE OF ANALYSIS

Certificate Number:	EP/14/4610	**Fugro EMU Job Number:**	J/3/08/2590
Job Reference:	Methil Benthic Survey		
Prepared For		**Prepared By**	
2B-Energy		**James Hutchinson** **Fugro EMU Limited** Trafalgar Wharf (Unit 16) Hamilton Road Portchester Portsmouth PO6 4PX United Kingdom	
		Phone: +44 (0) 2392 205500 **Email:** sediment@fugroemu.com **Web:** www.fugroemu.com	

Sampling Undertaken By:	Fugro EMU	**Sampling Date:**	11/10/2014 – 12/10/2014
Date of Receipt:	15/10/2014	**Date of Analysis:**	05/12/2014 – 18/12/2014
Sample Matrix:	Marine Sediments		
Method Reference:	Particle Size Distribution by Dry Sieving – Fugro EMU MET/01 based on BS1377: 1990: Parts 1 – 2. *Particle Size Distribution by Laser Diffraction – Fugro EMU MET/50 based on BS ISO 13320: 2009. *Organic Content by Loss on Ignition @ 440°C for 4 hours – Fugro EMU MET/01 based on clause 4 of BS1377: Part 3: 1990.		
Test Results:	Refer to pages 2-5 of 5		
Laboratory Comments:	**Deviating Codes:** None		
Authorised Signature:	[redacted]		
Name:	James Hutchinson		
Position:	Sediment Laboratory Manager		
Issue Date:	18/12/2014		

- Further information on methods of analysis may be obtained from the above address
- Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
- *Indicates determinand not included in UKAS accreditation
- Test results reported relate only to those items tested
- ^{Sub}indicates subcontracted test

A UKAS TESTING LABORATORY

UKAS TESTING 1272

FUGRO EMU LIMITED
CERTIFICATE OF ANALYSIS

Test Results: Particle Size Distribution by Dry Sieving (63000 - < 63 µm) @ 1 Phi Intervals
Fugro EMU Job Number: J/3/08/2590
Job Reference: Methil Benthic Survey

SAMPLE ID:	**5**	**6**	**12**	**18**	**19**
LAB ID:	**13210**	**13211**	**13217**	**13223**	**13224**
Sieve Aperture [µm]	**Fractional [%]**	**Fractional [%]**	**Fractional [%]**	**Fractional [%]**	**Fractional [%]**
63000	0.00	0.00	0.00	0.00	0.00
31500	0.00	31.66	31.20	0.00	0.00
16000	0.00	35.76	25.21	0.00	14.38
8000	0.88	10.17	2.09	0.00	12.30
4000	3.88	3.38	2.80	0.27	6.93
2000	2.20	1.10	2.60	0.34	3.12
1000	1.99	0.96	2.47	0.24	2.72
500	2.86	1.42	3.09	0.59	4.57
250	18.42	3.44	13.21	2.61	15.14
125	53.98	8.91	13.56	68.03	28.82
63	11.08	1.29	1.92	24.07	9.51
< 63	4.72	1.90	1.85	3.85	2.51
TOTAL:	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

FUGRO EMU LIMITED
CERTIFICATE OF ANALYSIS

Test Results: Particle Size Distribution by Dry Sieving (63000 - 63 µm) and Laser Diffraction (< 63 - < 0.49 µm) @ 1 Phi Intervals
Fugro EMU Job Number: J/3/08/2590
Job Reference: Methil Benthic Survey

SAMPLE ID:	1	4	7	8	9	10	11	13	14
LAB ID:	13206	13209	13212	13213	13214	13215	13216	13218	13219
Aperture [µm]	Fractional [%]	Fractional [%]	Fractional [%]	Fractional [%]	Fractional [%]	Fractional [%]	Fractional [%]	Fractional [%]	Fractional [%]
63000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16000	0.00	9.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8000	1.29	0.00	1.20	0.00	0.00	0.00	0.00	0.00	0.00
4000	0.42	0.19	1.45	0.40	1.36	0.43	0.00	0.57	0.98
2000	0.42	0.53	1.68	0.46	0.21	0.44	0.22	0.83	0.19
1000	0.55	0.78	0.99	0.32	0.17	0.53	0.35	0.88	0.51
500	1.42	1.47	2.38	0.35	0.10	1.29	0.85	2.16	1.34
250	5.38	8.33	7.63	1.41	0.44	11.84	15.99	7.77	3.19
125	18.08	50.18	21.60	3.57	2.33	59.38	56.91	48.63	23.30
63	42.93	19.73	37.19	47.00	27.85	20.57	16.06	25.54	39.83
31.25	8.15	1.52	6.07	10.79	25.86	1.05	1.59	2.78	8.98
15.63	7.60	2.11	6.73	11.32	16.57	1.27	2.46	3.42	7.87
7.81	5.86	2.10	5.59	10.11	10.25	1.29	2.43	3.18	6.00
3.91	4.19	1.65	3.99	7.58	7.55	1.02	1.75	2.31	4.18
1.95	2.20	0.89	2.10	4.02	4.16	0.54	0.86	1.17	2.16
0.98	0.91	0.35	0.86	1.63	1.89	0.22	0.32	0.46	0.89
0.49	0.55	0.20	0.50	0.95	1.16	0.13	0.19	0.27	0.54
< 0.49	0.05	0.01	0.04	0.08	0.10	0.01	0.01	0.02	0.04
TOTAL:	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

FUGRO EMU LIMITED
CERTIFICATE OF ANALYSIS

Test Results: Particle Size Distribution by Dry Sieving (63000 - 63 µm) and Laser Diffraction (< 63 - < 0.49 µm) @ 1 Phi Intervals
Fugro EMU Job Number: J/3/08/2590
Job Reference: Methil Benthic Survey

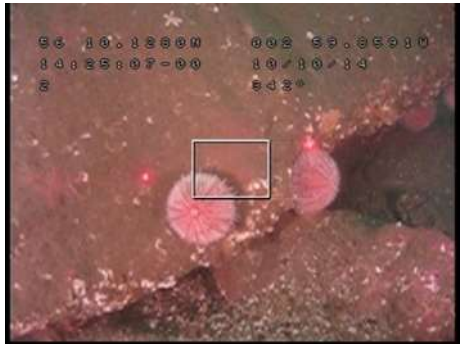
SAMPLE ID:	15	16	17
LAB ID:	13220	13221	13222
Aperture [µm]	Fractional [%]	Fractional [%]	Fractional [%]
63000	0.00	0.00	0.00
31500	0.00	0.00	0.00
16000	0.00	0.75	0.00
8000	0.00	1.27	0.24
4000	3.79	3.31	0.13
2000	15.12	4.57	0.42
1000	20.95	2.75	0.46
500	14.98	2.57	1.20
250	19.07	10.46	9.80
125	7.85	47.07	67.83
63	2.58	18.01	14.74
31.25	3.00	2.26	0.98
15.63	3.90	2.39	1.13
7.81	3.48	1.95	1.21
3.91	2.61	1.41	0.97
1.95	1.55	0.74	0.53
0.98	0.71	0.30	0.23
0.49	0.39	0.18	0.13
< 0.49	0.03	0.01	0.01
TOTAL:	100.00	100.00	100.00

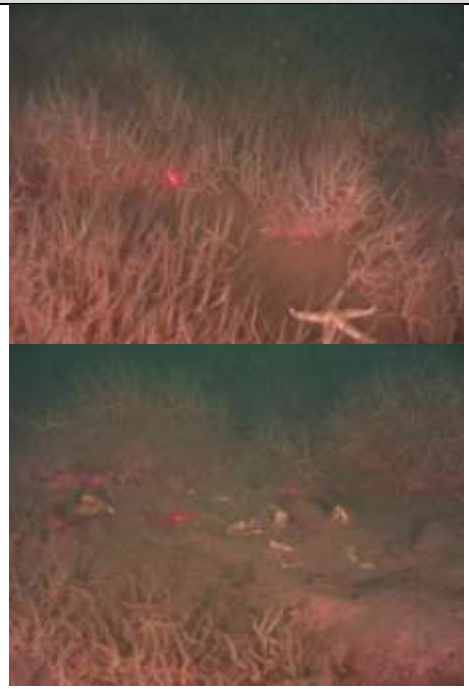
FUGRO EMU LIMITED
CERTIFICATE OF ANALYSIS

Test Results: Organic Content by Loss on Ignition @ 440°C for 4 hours
Fugro EMU Job Number: J/3/08/2590
Job Reference: Methil Benthic Survey

Sample ID	Lab ID	% Organic Content [<2mm]
5	13210	2.52

M. APPENDIX M ASSESSMENT OF RESEMBLANCE OF OBSERVED REEF FEATURES TO ANNEX I REEF CRITERIA

Site Number	Geogenic Classification				Substrate Description and Associated Species	Biotope and Representative Images
	% cobbles and / or boulders / bedrock	Elevation	% Epibiota Cover	Overall Reef Classification		
2	<25°m^2 cobbles and/or boulders/bedrock	64 mm-5 m Boulders not more than 1.5 to 2 m high at the most.	>80% of species present composed of epifaunal species	Not a reef	**Substrate:** Large boulders covered with encrusting and mobile epifauna overlaying slightly shelly gravelly, pebbly, cobbly fine sand. **Typical species:** *Echinus esculentus* *Asterias rubens* *Ophiothrix fragilis?* *Alcyonium digitatum* *Spirobranchus* Corallinaceae	 CR.MCR.EcCr Echinoderms and crustose communities
3	40-95% 50% cobbles and/or boulders/bedrock suggested	64 mm-5 m Boulders not more than 1.5 to 2 m high at the most.	>80% of species present composed of epifaunal species	Medium	**Substrate:** Large boulders and bedrock covered with encrusting and mobile epifauna and silt flocculation, interspersed with pebbles, cobbles and occasional sand patches. **Typical species:** *Echinus esculentus* *Alcyonium digitatum* *Asterias rubens* *Spirobranchus* Gobiidae LAMINARIALES *Cancer pagurus* *Necora puber* *Liocarcinus* Callionymidae	 CR.MCR.EcCr Echinoderms and crustose communities

Site Number	Geogenic Classification				Substrate Description and Associated Species	Biotope and Representative Images
	% cobbles and / or boulders / bedrock	Elevation	% Epibiota Cover	Overall Reef Classification		
6	40-95% 50% cobbles and/or boulders suggested	64 mm-5 m Boulders not more than 1.5 m high at the most.	>80% of species present composed of epifaunal species	Medium	**Substrate:** Most detail obscured by *Ophiothrix.* Patches of slightly shelly rippled sand with patches of boulders and cobbles. Where there is a patch of clear shelly sand burrows are visible. **Typical species:** *Echinus esculentus* Corallinaceae *Asterias rubens* ACTINIARIA PISCES DECAPODA *Ophiothrix fragilis* *Ophiura* *Ophiura albida*	 **SS.SMx.CMx.OphMx** Ophiothrix fragilis and/or Ophiocomina nigra brittlestar beds on sublittoral mixed sediment

Site Number	Geogenic Classification				Substrate Description and Associated Species	Biotope and Representative Images
	% cobbles and / or boulders / bedrock	Elevation	% Epibiota Cover	Overall Reef Classification		
15	10-40% 30% bedrock suggested	64 mm-5 m Boulders not more than 1 m high at the most.	>80% of species present composed of epifaunal species	Low	**Substrate:** Slightly shelly silty sand with visible burrows. Bedrock of mixed composition emerging from the sediment and forming flat ledges in places. Other areas of dropped edges appearing to be sand/mudstone, with a thick covering of shelly silty sand in some places. Some coarser sediment within the recesses. **Typical species:** *Ophiura* *Asterias rubens* Gobiidae *Nemertesia* *Alcyonium digitatum* Corallinaceae *Cancer pagurus* *Echinus esculentus* HYDROZOA/BRYOZOA turf PLEURONECTIFORMES	 **CR.HCR.XFa** Mixed faunal turf communities

Site Number	Geogenic Classification				Substrate Description and Associated Species	Biotope and Representative Images
	% cobbles and / or boulders / bedrock	Elevation	% Epibiota Cover	Overall Reef Classification		
17	10-40% 40% cobbles and/or boulders/bedrock suggested	64 mm-5 m Boulders not more than 1 m high at the most.	>80% of species present composed of epifaunal species	Low	**Substrate:** Slightly pebbly gravelly shelly sand with cobbles and boulders. Areas of mud/sand stone ledging, forming shallow dropped steps in some areas, and flat topped exposures in others. Relatively large holes bored in the surface. The compacted sediment areas form a mosaic with the bedrock and boulders. Patches of rippled sand fill the recesses between the various hard substrata. A thin sediment covering evident across much of the area. Large holes bored into the mud/sand stone, and small holes visible within the softer sediment. Length of rope or cable visible and possible tyre. **Typical species:** *Asterias rubens* *Echinus esculentus* *Corallinaceae* *Alcyonium digitatum* *Ophiura* *Ophiothrix fragilis* *Spirobranchus* *Liocarcinus* *Gobiidae*	 **CR.MCR.EcCr** And **SS.SSA.CMuSa** Echinoderms and crustose communities