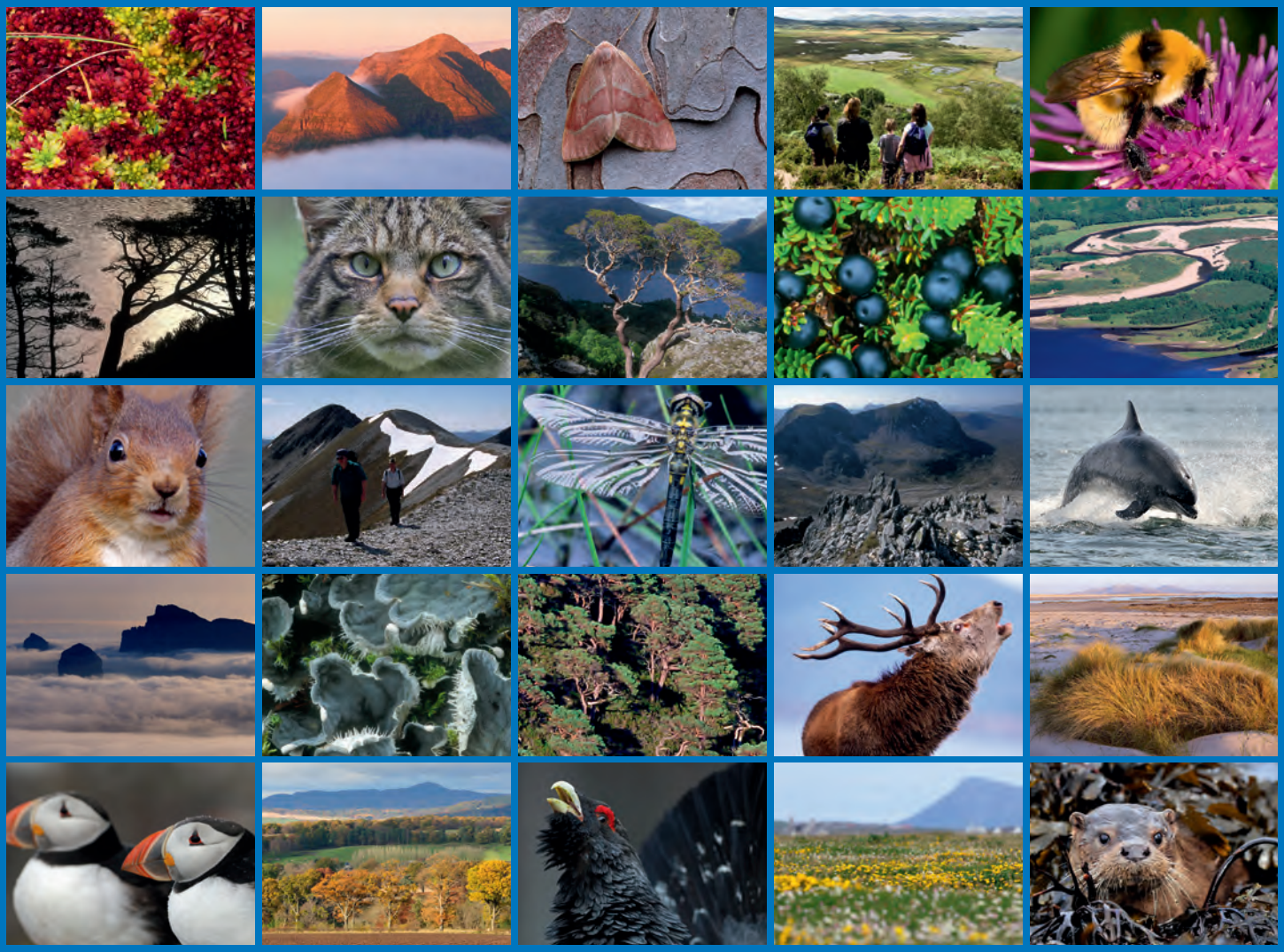
Scottish Natural Heritage
Commissioned Report No. 693

Infaunal and PSA analyses of grab samples collected from the Shiant East Bank and Wester Ross in September 2013



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COMMISSIONED REPORT

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Infaunal and PSA analyses of grab samples collected from the Shiant East Bank and Wester Ross in September 2013

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COMMISSIONED REPORT

Summary

Infaunal and PSA analyses of grab samples collected from the Shiant East Bank and Wester Ross in September 2013

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Contractor: Precision Marine Survey Limited
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Keywords

Marine survey; MPA; Wester Ross; Shiant East Bank; proposed protected features; PMF; seabed habitats; infauna; PSA.

Background

In July 2014 Scottish Ministers designated 30 Nature Conservation Marine Protected Areas (MPAs) in the seas around Scotland. In the same month, Scottish Natural Heritage (SNH) submitted formal advice recommending the progression of a further four MPA proposals. Subject to ministerial consideration, these additional sites may be the subject of public consultation in 2015.

The aim of the present investigation was to improve knowledge of the occurrence and distribution of seabed habitats within the Shiant East Bank MPA proposal and the Wester Ross MPA. This was achieved through the analysis of grab samples collected at 27 stations during an SNH research cruise on Marine Scotland Science's vessel *RV Alba na Mara* in September 2013. Precision Marine Survey Limited was commissioned to undertake infaunal and particle size analyses (PSA) of the seabed samples and produce a brief interpretative report to characterise the benthic communities and biotopes.

Main findings

- PSA of the seabed samples highlighted the presence of variable sediment types ranging from sandy-muds through to slightly gravelly muddy-sand and sandy gravels.

- Species diversity was variable but generally high (15 to 71 species per 0.1 m^2) with highest numbers of taxa associated with offshore habitats on Shiant East Bank; 266 species were recorded in total during the survey. Shannon's diversity values were moderately high but variable (H' values > 4.0 were recorded at 50% of the samples collected).

- Species distribution was highly variable and the most widespread taxa included polychaetes such as *Spiophanes kroyeri* along with flatworms (Nemertea spp.). The oweniid polychaetes *Galathowenia oculata* and *Owenia fusiformis* were also widespread and were the most numerous taxa (accounting for just under half the total number of animals collected). The remaining taxa were recorded in relatively modest numbers with

other important taxa (in terms of relative contribution to total abundance) including *Chaetozone gibber*, *Abra nitida*, *Spiophanes kroyeri, Mediomastus fragilis*, *Limatula subauriculata*, juvenile Amphiuridae spp. and Nemertea spp. which collectively accounted for 60% of the total abundance.

- The ocean quahog *Arctica islandica* (a PMF species but not a proposed protected feature of either MPA) was recorded at one station.

- A number of biotopes were recorded, including **SS.SMu.CFiMu** ('Circalittoral fine mud') at one station on Shiant East Bank and two stations off the Summer Isles. Full analysis of video evidence collected during the survey may identify examples of burrowing megafauna at these stations (and confirm the presence of the burrowed mud protected feature within the Wester Ross MPA).

- Other biotopes recorded include **SS.SMx.CMx** ('Circalittoral mixed sediments'), and **SS.SSa.OSa.OfusAfil** ('*Owenia fusiformis* and *Amphiura filiformis* in offshore circalittoral sand or muddy sand') which fall under the Circalittoral sands and mixed sediment communities proposed protected feature of the Shiant East Bank MPA proposal. One station on the bank included the biotope **SS.SCS.CCS.Blan** ('*Branchiostoma lanceolatum* in circalittoral coarse sand with shell gravel').

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1. INTRODUCTION

In September 2013 SNH undertook a survey in the North Minch area on board Marine Scotland Science's vessel *RV Alba na Mara* to improve knowledge of the occurrence and distribution of species and habitats of recognised conservation importance in the Shiant East Bank MPA proposal. Additional sampling also carried out in the Wester Ross MPA.

Provisions to designate new Marine Protected Areas (MPAs) within Scottish waters have been introduced through the Marine (Scotland) Act 2010 and the UK Marine and Coastal Access Act 2009. Scottish Natural Heritage (SNH) and the Joint Nature Conservation Committee (JNCC) have generated a focused list of habitats and species of importance in Scottish waters - the Priority Marine Features (PMFs) (Scottish Government, 2013), which are regarded as priorities for conservation action in territorial waters.

A subset of these biological features, together with a list of large-scale features of functional importance to Scotland's seas (collectively termed MPA search features) drove the identification and subsequent designation of 30 Nature Conservation MPAs in July 2014. To ensure that the MPA network meets UK legislative obligations and wider international commitments, other features representative of Scotland's seas have also been designated as protected features of these sites.

Precision Marine Survey Limited were contracted by SNH to undertake the infaunal analysis of the 27 grab samples collected during the 2013 Shiant East Bank and Wester Ross survey. Analyses included infaunal identification, particle size analysis (PSA), the assignment of a biotope to each sample, and determining if the sample was a record of a proposed protected feature of the MPAs. This report presents the results of these analyses and a brief interpretation of the data. Seabed video and still photographic imagery were collected during the survey as well, and results of their analysis have been reported in Moore (2014).

2. METHODS

2.1 Infaunal sample collection

The sampling was undertaken between the 21st - 24th of September 2013 and covered areas around the Shiant Bank and off Wester Ross (Figure 1) in water depths ranging from 48 m to 150 m. Infaunal and PSA samples were collected from 15 stations, and only a PSA sample was collected from station SG17_4. At each station either a single grab or a set of three replicate grab samples were collected using a 0.1 m^2 Day grab, resulting in a total of 26 infaunal samples and 27 PSA samples. This approach enabled some statistical analysis of community measures while also covering the widest possible area in the survey. Since it is still necessary to improve our knowledge on the distribution and extent of benthic habitats in the areas surveyed, coverage of a wider area was of greater importance than the ability to make statistical comparisons of community composition between all stations. Once the grab was recovered on board a small sub-sample was removed for separate particle size analysis (PSA) and stored in plastic bags before being frozen. Each infaunal sample was then passed through a 1 mm mesh sieve and the infaunal sieve residue retained and fixed with buffered formalin. The samples were then collected by Precision Marine Survey Limited for processing. A summary of the sampling details for the survey is provided in Table 1 and a map showing the locations of the sampling stations is given in Figure 1.

Table 1. Sampling details from the 2013 Shiant Bank and Wester Ross survey.

Station	Area	Date	Time	Latitude	Longitude	Depth (m CD)
SG14_2	Shiant East Bank	21/09/2013	13:46:30	58.022460	-5.932490	84
SG14_4	Shiant East Bank	21/09/2013	14:01:32	58.022290	-5.930120	84
SG14_5	Shiant East Bank	21/09/2013	14:08:28	58.021990	-5.929670	84
SG15_1	Shiant East Bank	23/09/2013	08:49:47	58.021880	-5.919610	88
SG23_2	Shiant East Bank	23/09/2013	10:27:33	57.944620	-5.970950	66
SG23_3	Shiant East Bank	23/09/2013	10:33:24	57.945950	-5.969250	66
SG23_4	Shiant East Bank	23/09/2013	10:39:52	57.947310	-5.967120	65
SG32_1	Shiant East Bank	23/09/2013	12:37:35	57.897890	-6.172390	65
SG10_1	Shiant East Bank	23/09/2013	12:58:50	57.934750	-6.190570	60
SG64_1	Shiant East Bank	23/09/2013	13:40:47	57.928270	-6.099090	69
SG26_2	Shiant East Bank	23/09/2013	14:45:25	57.985690	-6.039190	47
SG26_4	Shiant East Bank	23/09/2013	14:52:39	57.985110	-6.039580	47
SG26_6	Shiant East Bank	23/09/2013	14:59:59	57.984530	-6.040080	47
SG34_2	Shiant East Bank	23/09/2013	16:47:22	57.992130	-6.147190	66
SG16_1	Shiant East Bank	24/09/2013	06:13:19	58.022890	-6.081070	65
SG16_5	Shiant East Bank	24/09/2013	06:34:55	58.021550	-6.077370	65
SG16_6	Shiant East Bank	24/09/2013	06:40:00	58.020780	-6.077230	65
SG04_1	Shiant East Bank	24/09/2013	08:46:49	58.056130	-6.043510	65
SG05_2	Shiant East Bank	24/09/2013	09:07:50	58.074680	-6.079890	77
SG05_4	Shiant East Bank	24/09/2013	09:19:49	58.075080	-6.081010	77
SG05_5	Shiant East Bank	24/09/2013	09:27:48	58.075340	-6.081780	77
SG65_2	Shiant East Bank	24/09/2013	10:05:01	58.089710	-6.050770	69
SG17_4 #	Shiant East Bank	24/09/2013	10:30:13	58.094480	-6.028320	62
SG66_1	Shiant East Bank	24/09/2013	11:09:48	58.104320	-6.000690	66
NG43_1	Wester Ross	24/09/2013	13:11:33	58.019400	-5.686670	78
NG42_2	Wester Ross	24/09/2013	13:46:20	58.053540	-5.623900	103
NG41_1	Wester Ross	24/09/2013	14:29:22	58.071430	-5.570700	148

only PSA sample taken

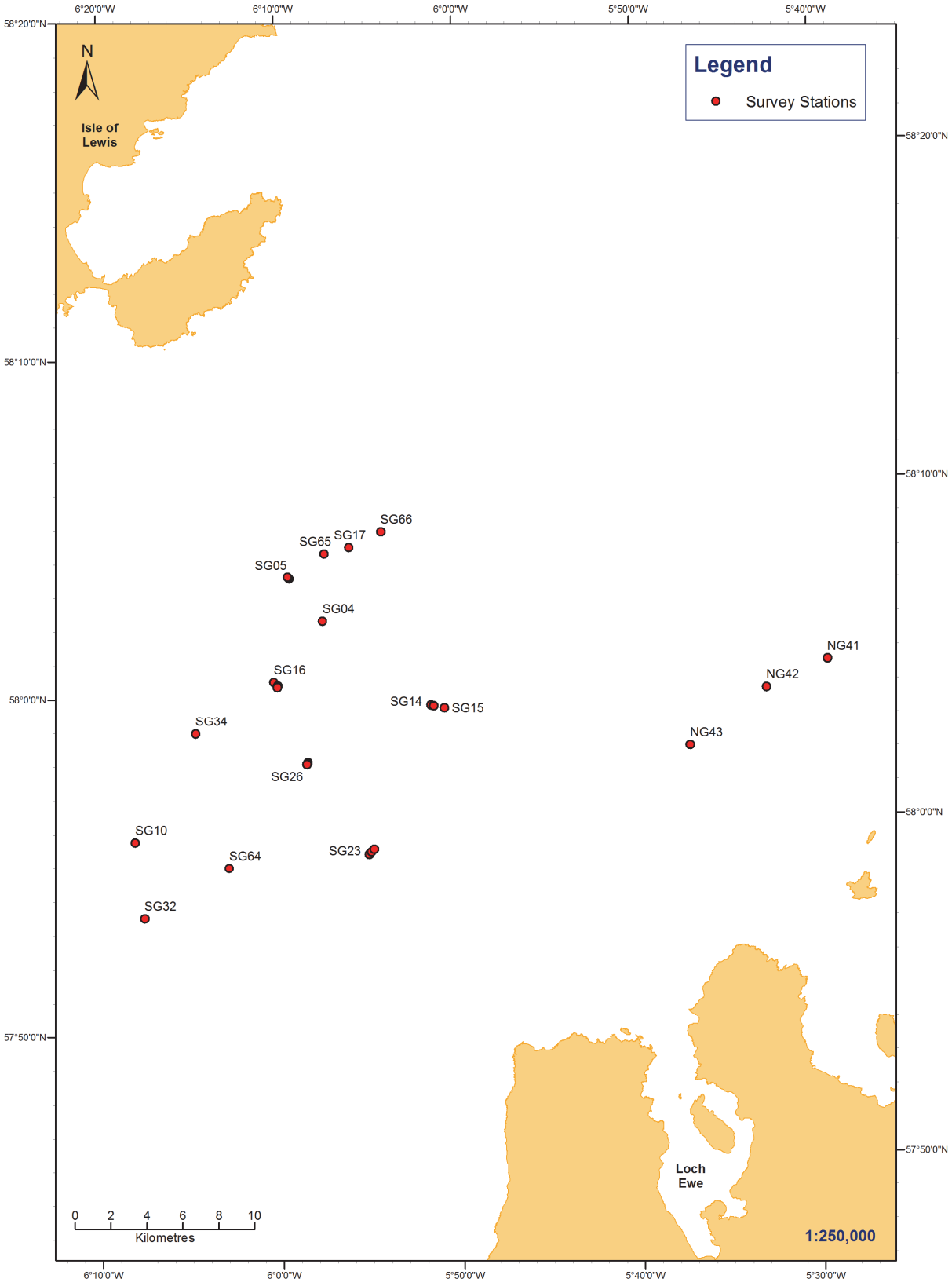

Figure 1. Map of 2013 infaunal sample stations at Shiant East Bank and off Wester Ross. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2014. All rights reserved.

2.2 Laboratory processing

All laboratory methodologies were based on best practice (Thomas, 2001; Rees *et al*., 1990; Rees 1999; Cooper & Rees 2002; Worsfold & Hall, 2010; and Ware & Kenny, 2011). In addition Precision Marine Survey Limited is a member of the National Marine Biological and Analytical Quality Control scheme (NMBAQC). Two experienced members of staff undertook all the sieving, sorting work and sample description with a further member of staff carrying out standard sorting quality control. Experienced taxonomists carried out the identification of the sorted fauna, with an additional member of staff carrying out quality control for faunal identification. A standard sample tracking procedure was followed throughout the analysis period.

Prior to species identification each sample was washed through a nest of sieves to remove the preservative and partition the sample for ease of sorting. The smallest mesh aperture was 1 mm and larger sieves (5 mm or 10 mm) were also used as required to separate larger animals or coarser sediment residue. The residue from each sieve was then gently washed into separate 100 mm petri dishes for subsequent identification. For larger samples the sieve residue was put into a separate bucket or white tray with water and the contents agitated. Immediately after agitation, the light fraction was decanted to another container. The light fraction was then decanted into petri dishes and the remaining residue put into a separate container.

The sample containers / petri dishes were marked with the appropriate sample code (relating to the client, date, specific station, sample and replicate no.). All fractions were then decanted into separate 100 mm petri dishes and examined under a stereoscopic microscope. The fauna derived were then split by phyla and placed in glass vials with 70% IMS and stored ready for identification. Each petri dish was then checked for a final time by another member of staff.

Identification was carried out using Olympus SZ40 zoom microscopes with 10X and 20X eyepieces, giving a maximum magnification of up to 80X. An additional 2X objective was occasionally used to increase the potential magnification to 160X. Olympus BX41 compound microscopes were used for further magnification, up to 800X. Identification of infaunal samples was to the lowest possible taxonomic level (i.e. species), and during identification, all individuals were initially separated into families, with part animals being assigned to families where possible. The macrofaunal specimens were identified to species level using standard taxonomic keys, low and high power stereoscopic microscopes and dissection, when necessary, for identification. Incomplete animals without anterior ends were not recorded as individuals to be included in the quantitative dataset. However, they were identified where possible and recorded as present. Similarly, motile and colonial sessile epibenthic taxa and meiofauna were only recorded as present and not included within the infaunal quantitative data set.

The taxonomic literature used was that as detailed in Rees *et al.* (1990) which includes the most recent updates in the scientific literature and newer keys provided by groups such as the NMBAQC and species reporting nomenclature used WoRMS standards (WoRMS editorial board, 2014).

Biomass analysis was performed by wet weight (tissue blotted) and carried out for individual species in each sample. Each taxon was placed on blotting paper for 30 seconds, to allow absorption of preservative into the blotting paper, following this time period the individuals were placed on the microbalance and the reading taken. The macrofaunal organisms were then placed back in their respective pots and stored. Biomass calculations included all identifiable fragments and were calculated to ± 0.0001g, and all biomass data were recorded in grams or fractions thereof.

The particle size analysis was carried out by a combination of dry sieving and laser particle size analysis (for the fraction <1 mm) using a Malvern Mastersizer 3000. Prior to analysis, photographs were taken of all samples. The sediment samples were then split with one sub-sample being passed through a 1mm sieve to remove the larger size classes of sediment if required. The <1 mm fraction of the sample was then analysed using the Malvern Mastersizer 3000 and the >1 mm fraction discarded. The second sub-sample was passed through a nest of sieves at 0.5 phi intervals. Each fraction, including the <1 mm fraction, was then oven dried at 100°C for 12 hours and weighed. Coarse and fine fractions were combined following NMBAQC guidelines and the data derived from PSA were then used to derive statistics including mean grain size, bulk sediment classes (% silt, sand & gravel), skewness and sorting coefficient using the program Gradistat. These methods are consistent with the procedures identified at the NMBAQC PSA workshop on laboratory methods, which was held at the Cefas Lowestoft laboratory in July 2009.

2.3 Analysis of biological data

A number of primary and derived biological parameters values were calculated from the species data which were subsequently tabulated and input into GIS. Standard biological parameters utilised for benthic analysis include the following:

- The total number of species at each station (S)
- The total abundance of individuals at each station (A)
- Margalef's index of species richness (d)
- Shannon's diversity index (H') - This index is a univariate measure of diversity which incorporates both the number of species and the distribution or equitability of individuals between species. High values of H' indicate a more diverse community whilst low values indicate low diversity.
- Pielou's evenness (J) - This index is a univariate measure of evenness or equitability which describes the distribution of individuals between species. High values of J (approaching 1) indicate that the abundance of animals are evenly spread between species whilst low values of J (approaching 0) indicate that the majority of animals are comprised of a few species, a situation which often occurs in low diversity areas subject to disturbance or organic enrichment.

Multivariate analysis of the abundance data was carried out in order to describe the main patterns and assemblages within the area following standard methodologies (Clarke and Warwick, 2001). Classification (cluster analysis) of the data was undertaken using the Bray-Curtis similarity coefficient and grouped average (UPGMA) clustering technique followed by a non-metric MDS (multi-dimensional scaling) ordination both using the PRIMER package. Cluster analysis is used to display graphically the similarity between stations based upon their species composition whereby the similarity between stations is calculated (in this case using the Bray-Curtis similarity coefficient) to produce a similarity matrix showing the percent similarity of stations (0% indicating no species in common and 100% indicating an identical community). These values are then used to plot a dendrogram or tree diagram in which stations are linked at their respective similarity to other stations and consequently it is possible to define groups of stations with similar species composition at a predefined level of similarity.

Non-metric MDS graphically displays the (rank) similarity between stations as a 2 dimensional plot in which the distances between stations indicates the level of similarity between them. The stress value associated with an MDS plot indicates how faithful the plot is in representing the similarity between stations, with low values (below 0.2) generally indicating a good fit. The station groupings derived from cluster analysis were subsequently superimposed onto the MDS plots and input into GIS, with the dominant species and mean

environmental and biological parameters calculated for each group. Station groupings were derived using the similarity profile test (SIMPROF) within the PRIMER package. Characteristic taxa within each group were assessed using calculations of mean abundance and the percentage of stations at which the species occurred, and by using the SIMPER routine within PRIMER. Correlations between species data and sediment parameters were undertaken using the BEST routine within PRIMER which derives a non-parametric Spearman correlation between the similarity matrices derived from the biological and environmental data. The results of this procedure give the statistic r which gives an indication of the strength of the relationships between the environmental parameters and community structure with higher values (approaching 1) indicating a strong positive correlation. This technique also derives a subset of the best combination of environmental parameters which give the highest correlation in similarity.

3. RESULTS

3.1 Sedimentary parameters

The results of particle size analysis are provided in Annex 1 with a summary of key parameters given in Table 2 which highlight that a wide range of sediments were present in the survey area ranging from sandy-muds and muddy-sands to mixed gravelly muddy-sands and sandy-gravel. Quantities of gravel at the survey stations were highly variable and ranged from 0% at stations SG05, NG41 and NG42 to 54% at sample SG15_1. Samples SG4_1, SG14_2, SG23_2 and all samples from stations SG26 and SG32 had moderate gravel contents above 20% whilst the samples from the remaining stations had values below 10%. Mud content was also highly variable with less than 10% mud in samples SG14_2, SG14_5, SG15_1, and in all samples from SG23 and SG26 whilst sandy-muds at samples SG05_4 and SG05_5, NG41_1 and NG42_2 all had in excess of 50% mud content. This variability was reflected in sediment sorting with the majority of stations exhibiting poorly or very poorly sorted sediments with the exception of the sandy-gravels at station SG26 which were moderately sorted.

The spatial distribution of sediment types is illustrated in Figures 2 and 3 which highlight sediment composition (% sand, gravel and mud) and textural group (sediment type) respectively. Whilst variable stations to the northern end of Shiant Bank and stations further inshore off Wester Ross tended to exhibit muddier sediments.

Table 2. Summary of sedimentary parameters.

Sample	Sediment Type	Median phi	Mean phi	Sorting (phi scale)		% Gravel	% Sand	% Mud
SG04_1	Gravelly Muddy-Sand	-0.17	0.91	2.97	Very Poorly Sorted	23.88	58.97	17.14
SG05_2	Muddy-Sand	3.36	3.98	2.24	Very Poorly Sorted	0.00	57.07	42.93
SG05_4	Sandy-Mud	4.94	4.86	2.06	Very Poorly Sorted	0.00	36.76	63.24
SG05_5	Sandy-Mud	4.27	4.44	2.16	Very Poorly Sorted	0.00	46.78	53.22
SG10_1	Slightly Gravelly Muddy-Sand	2.18	2.98	2.28	Very Poorly Sorted	1.49	76.93	21.58
SG14_2	Gravelly-Sand	-0.34	0.16	2.04	Very Poorly Sorted	21.04	71.31	7.65
SG14_4	Slightly Gravelly Muddy-Sand	2.11	2.21	1.49	Poorly Sorted	0.12	86.11	13.76
SG14_5	Slightly Gravelly-Sand	0.95	1.09	1.76	Poorly Sorted	0.81	91.89	7.30
SG15_1	Sandy-Gravel	-1.62	-1.11	2.58	Very Poorly Sorted	54.07	41.50	4.43
SG16_1	Gravelly Muddy-Sand	1.73	2.40	2.70	Very Poorly Sorted	7.85	71.64	20.51
SG16_5	Muddy Sandy-Gravel	-0.52	0.38	2.52	Very Poorly Sorted	30.77	55.18	14.05
SG16_6	Gravelly Muddy-Sand	1.04	1.18	2.02	Very Poorly Sorted	5.71	80.69	13.60
SG17_4	Gravelly Muddy-Sand	1.48	2.56	3.01	Very Poorly Sorted	8.19	61.64	30.17
SG23_2	Gravelly Muddy-Sand	-0.32	-0.48	2.71	Very Poorly Sorted	25.72	65.54	8.74

Sample	Sediment Type	Median phi	Mean phi	Sorting (phi scale)		% Gravel	% Sand	% Mud
SG23_3	Gravelly-Sand	-0.23	0.28	1.66	Poorly Sorted	7.75	86.08	6.16
SG23_4	Gravelly-Sand	-0.21	0.28	1.69	Poorly Sorted	9.14	84.25	6.60
SG26_2	Sandy-Gravel	-0.84	-0.87	0.89	Moderately Sorted	41.05	55.25	3.70
SG26_4	Sandy-Gravel	-0.62	-0.69	0.90	Moderately Sorted	30.08	65.86	4.06
SG26_6	Gravelly-Sand	-0.53	-0.63	0.66	Moderately Well Sorted	23.71	74.58	1.71
SG32_1	Gravelly Muddy-Sand	-0.36	0.11	2.10	Very Poorly Sorted	21.45	67.23	11.32
SG34_2	Gravelly Muddy-Sand	1.77	2.24	2.64	Very Poorly Sorted	5.15	75.71	19.14
SG64_1	Slightly Gravelly Muddy-Sand	2.29	2.30	1.47	Poorly Sorted	0.59	88.13	11.28
SG65_2	Slightly Gravelly Muddy-Sand	1.92	2.77	2.44	Very Poorly Sorted	1.52	76.37	22.11
SG66_1	Slightly Gravelly Muddy-Sand	2.16	2.60	2.17	Very Poorly Sorted	4.45	78.28	17.26
NG41_1	Sandy-Mud	4.73	4.84	1.97	Poorly Sorted	0.00	38.18	61.82
NG42_2	Sandy-Mud	4.96	5.05	1.96	Poorly Sorted	0.00	35.88	64.12
NG43_1	Slightly Gravelly Muddy-Sand	3.30	4.01	2.39	Very Poorly Sorted	1.91	54.30	43.79

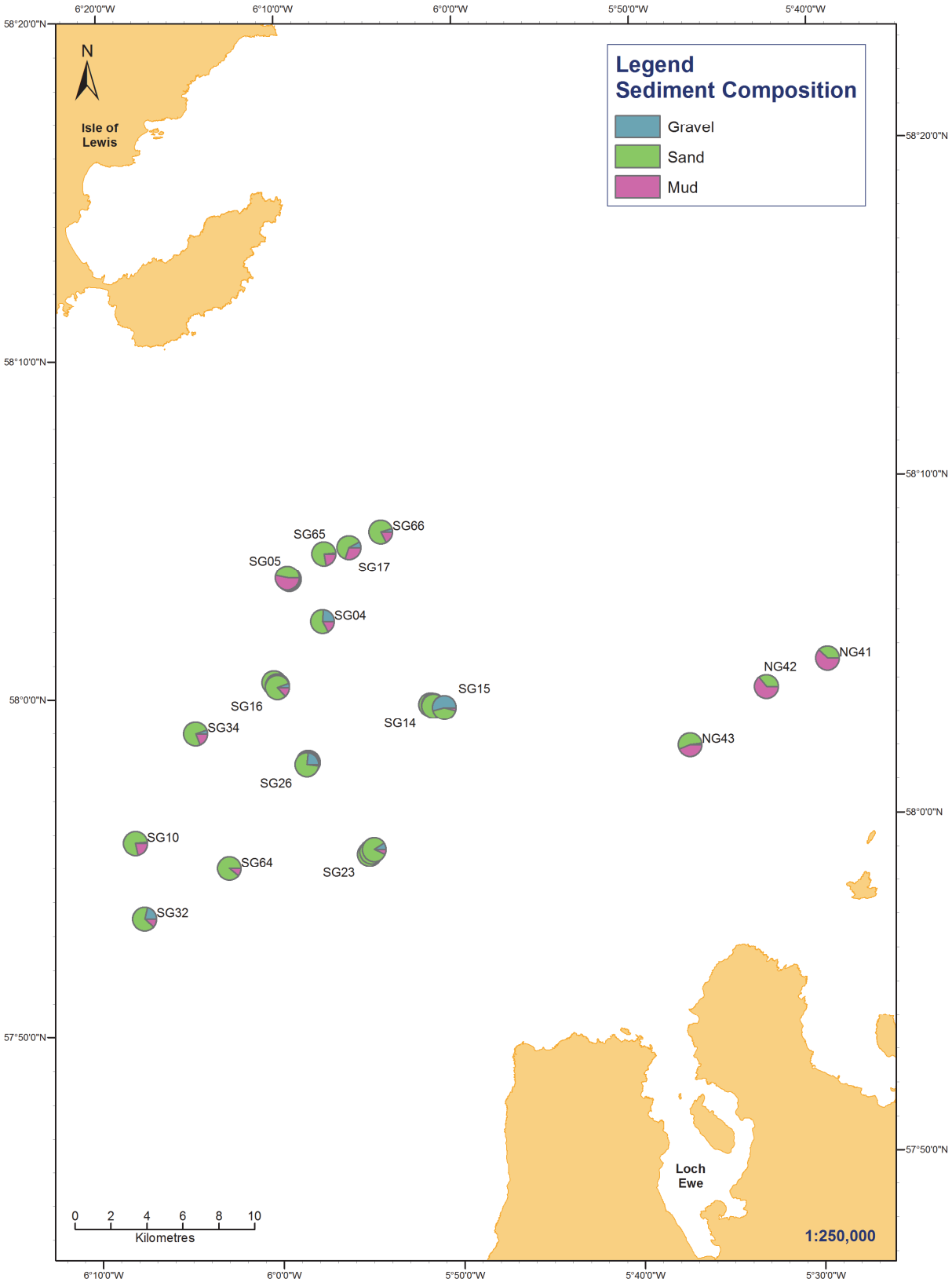

Figure 2. Sediment composition of infaunal samples collected around Shiant East Bank and Wester Ross. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2014. All rights reserved.

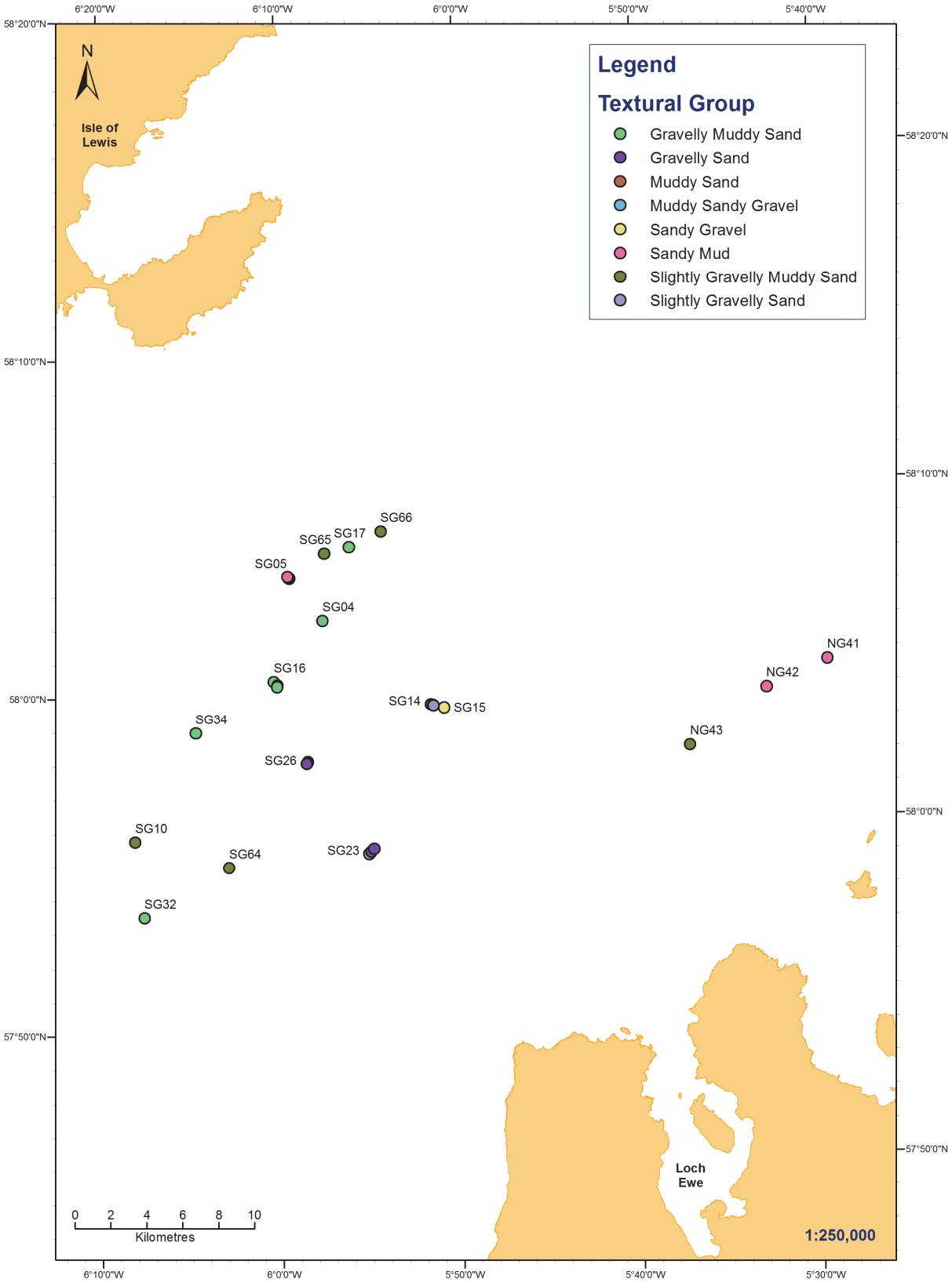

Figure 3. Sediment textural group of infaunal samples collected around Shiant East Bank and Wester Ross. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2014. All rights reserved.

3.2 Primary and derived biological parameters

The samples collected during the survey exhibited quite variable biological parameters in terms of species richness, densities, diversity and evenness. Overall they were considered to show moderate to high levels of diversity whilst the densities of infaunal organisms were moderate to low (Table 3). The numbers of species recorded per sample station ranged from 15 taxa per 0.1 m^2 at SG05_5 to 71 taxa per 0.1 m^2 at station SG64_1 and the majority of stations had between 30 to 40 taxa per 0.1m^2. Figure 4 indicates that highest number of taxa tended to occur in sites on the Shiant Bank with slightly lower numbers in muddier sediments further north or inshore. The abundances of invertebrates were generally moderate with numbers ranging from <50 individuals at stations SG05_4, SG05_5, NG41_1 and NG42_2 up to 518 individuals per 0.1 m^2 at station SG66_1. The majority of stations had between 100 to 200 individuals per 0.1 m^2 with relatively few clear spatial patterns although the stations closer inshore to Wester Ross tended to have somewhat lower densities (Figure 5). Diversity indices were also quite variable but generally showed moderate to high levels of diversity and evenness. Just under 50% of stations exhibited Shannon diversity above 4 and the majority of stations exhibited high evenness values above 0.75. Samples on the Shiant Bank and particularly those in southern or western areas of the bank tended to show slightly higher diversity although high values of Shannon's diversity were also evident at certain sites elsewhere (Figure 6.).

Table 3. Primary and derived biological parameters.

Station	Number of Species	Total Abundance (A)	Margalef's d	Pielou's Evenness J	Shannon's Diversity H'
SG04_1	36	66	8.35	0.94	4.86
SG05_2	25	75	5.56	0.77	3.58
SG05_4	18	41	4.58	0.91	3.81
SG05_5	15	34	3.97	0.88	3.44
SG10_1	47	177	8.89	0.78	4.32
SG14_2	35	154	6.75	0.67	3.44
SG14_4	35	314	5.91	0.48	2.47
SG14_5	33	425	5.29	0.40	1.99
SG15_1	40	193	7.41	0.57	3.05
SG16_1	38	92	8.18	0.84	4.41
SG16_5	43	130	8.63	0.86	4.69
SG16_6	33	56	7.95	0.94	4.76
SG23_2	39	160	7.49	0.67	3.55
SG23_3	41	183	7.68	0.67	3.57
SG23_4	36	173	6.79	0.63	3.23
SG26_2	41	210	7.48	0.84	4.48
SG26_4	36	160	6.90	0.86	4.44
SG26_6	35	109	7.25	0.88	4.51
SG32_1	39	87	8.51	0.90	4.77
SG34_2	51	183	9.60	0.73	4.13
NG41_1	18	45	4.47	0.91	3.79
NG42_2	16	47	3.90	0.86	3.44
NG43_1	35	108	7.26	0.91	4.66
SG64_1	71	220	12.98	0.79	4.89
SG65_2	37	246	6.54	0.55	2.87
SG66_1	38	518	5.92	0.40	2.11

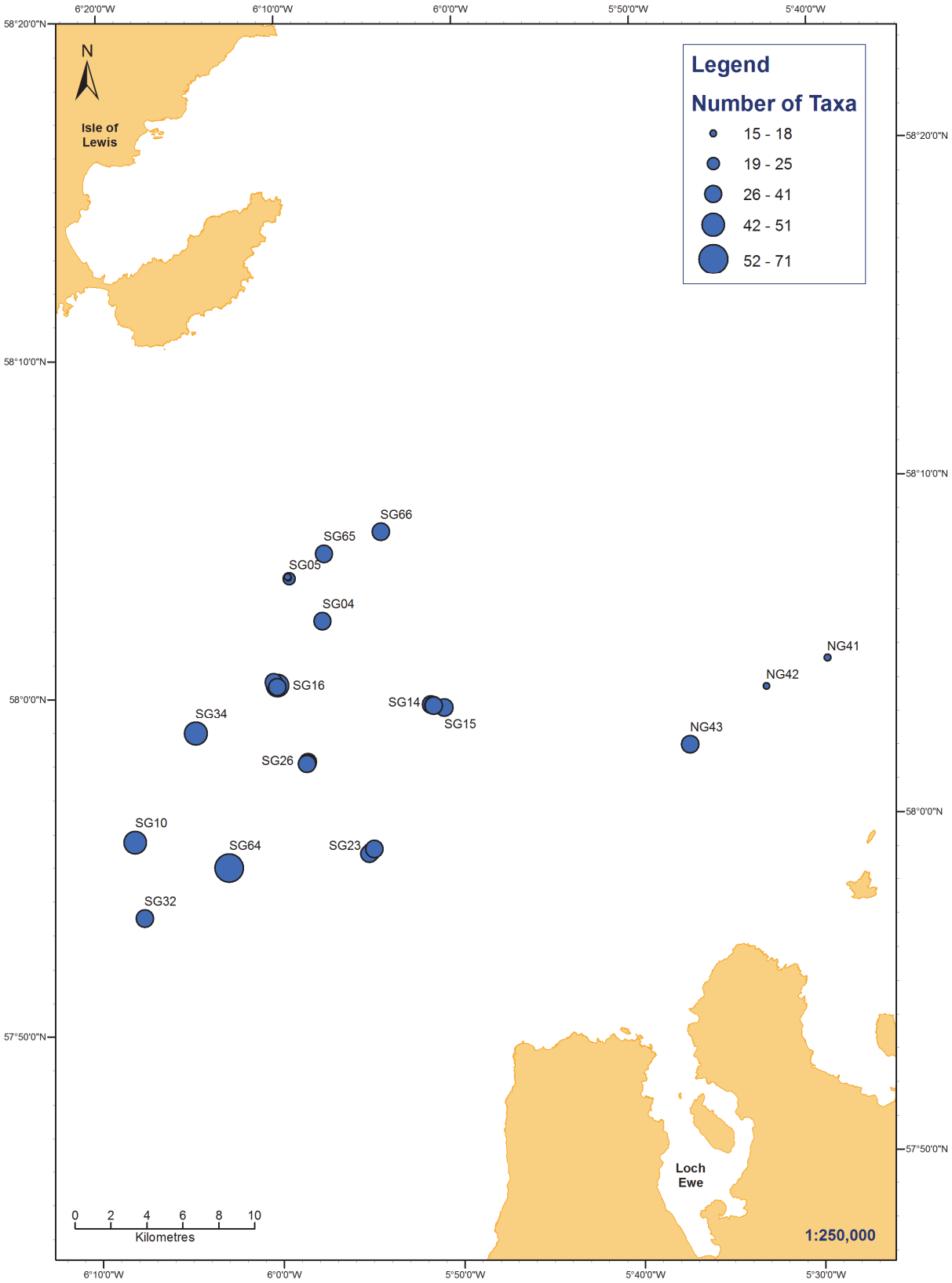

Figure 4. Total numbers of taxa (including qualitative species) collected at the survey stations. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2014. All rights reserved.

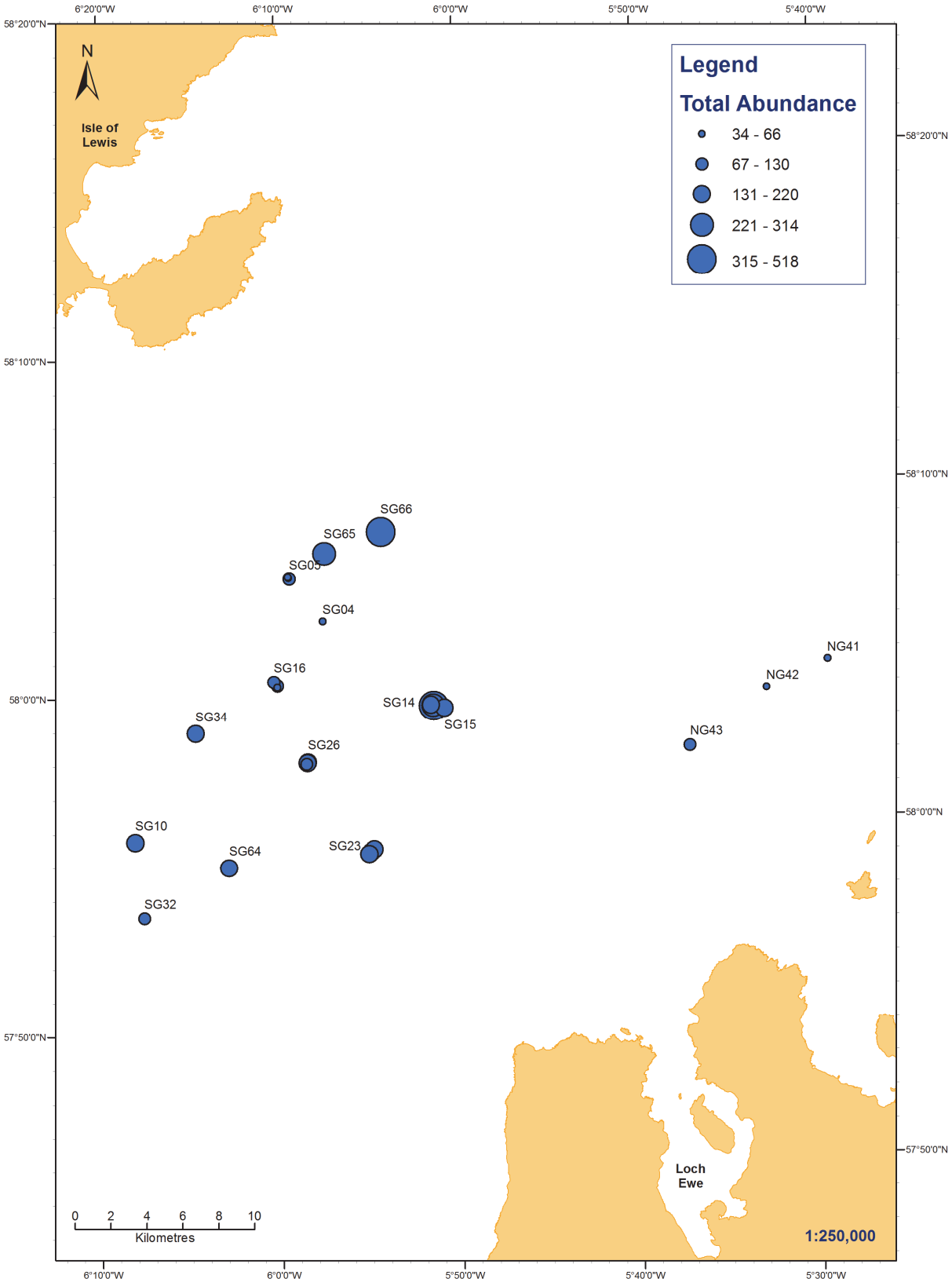

Figure 5. Total abundance (numbers of individuals) within infauna samples collected at the survey stations. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2014. All rights reserved.

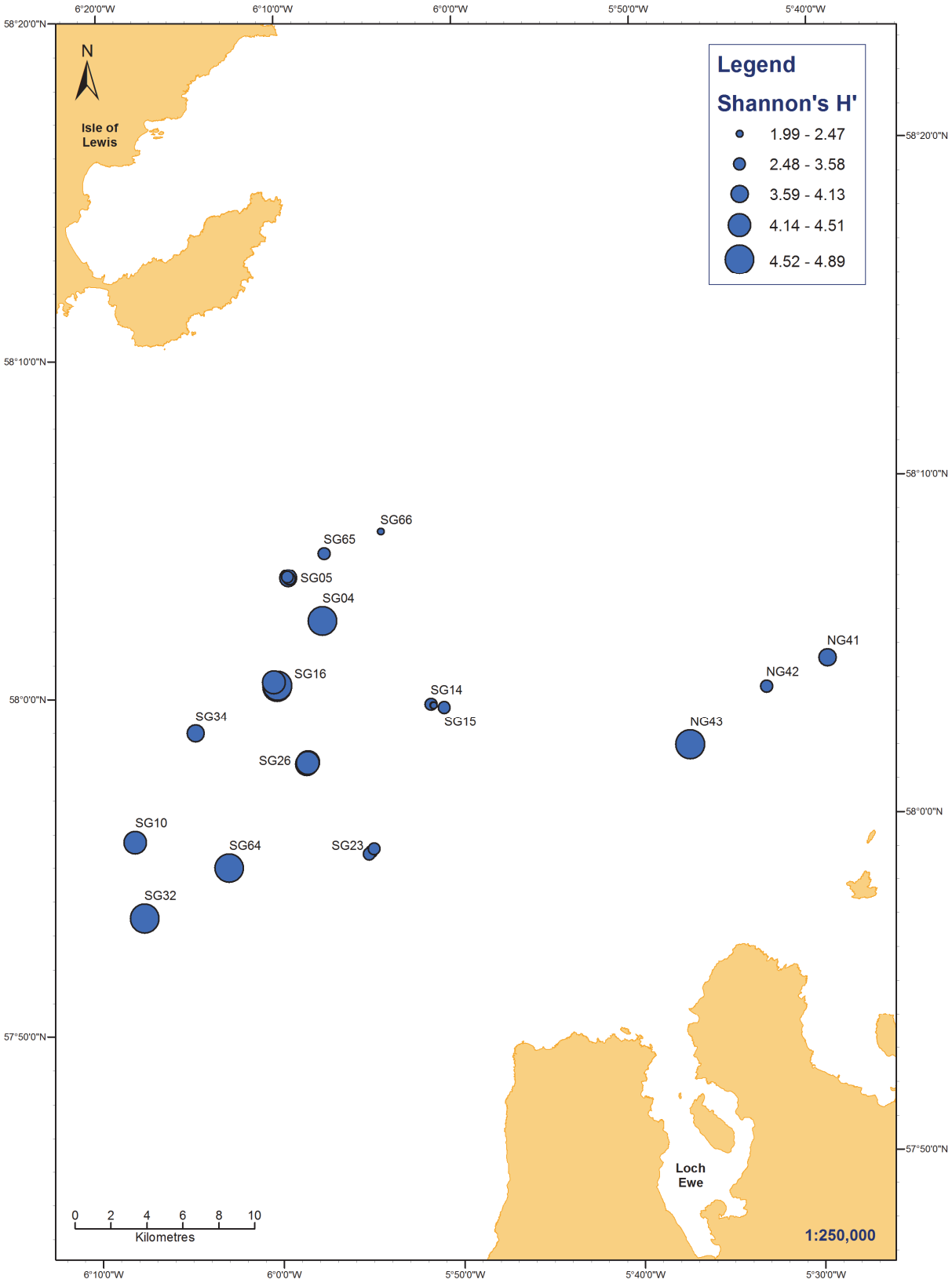

Figure 6. Shannon's diversity (H') of the infauna sample collected at the survey stations. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2014. All rights reserved.

3.3 Species composition

In total 266 taxa were recorded from the 26 samples collected and whilst many of these were present in low abundances at relatively few stations it highlights the relatively high diversity and variability of the survey area with regard to infaunal communities. A list of the most dominant taxa ranked by abundance is provided in Table 4 and this shows that few taxa were widespread throughout the area and no single taxa was collected at every station. In terms of abundance oweniid polychaetes such as *Galathowenia oculata* and *Owenia fusiformis* were most numerous and together accounted for just under half the total number of animals collected and were also present in 58 to 62% of the samples. The remaining taxa were recorded in relatively modest numbers with other important taxa (in terms of relative contribution to total abundance) including *Chaetozone gibber*, *Abra nitida*, *Spiophanes kroyeri*, *Mediomastus fragilis*, *Limatula subauriculata*, juvenile Amphiuridae spp. and Nemertea spp. which collectively accounted for 60% of the total abundance and were generally present at >50% of the stations with the exception of *Limatula subauriculata* (12% of stations) and Amphiuridae spp. (31% of stations). A wide range of other taxa were also recorded in relatively low numbers including a wide range of polychaetes such as *Abyssoninoe hibernica*, *Ampharete lindstroemi*, *Glycera lapidum*, *Chaetozone setosa* and *Aonides paucibranchiata* and a variety of robust bivalves such as and *Yoldiella philippiana* and *Moerella pygmaea*. Also present were interstitial polychaete taxa such as *Pisione remota*, *Polygordius appendiculatus*, a variety of echinoderms (primarily ophiuroids and sea cucumbers) along with amphipod, cumacean or decapod crustacea, with occasional larger types including burrowing megafauna such as *Nephrops norvegicus*, *Calocaris macandreae* and *Callianassa subterranea*.

Table 4. Dominant taxa (by abundance) recorded at the survey stations.

Taxa	Total Abundance	Mean Abundance	% of Total Abundance	No. of Samples	% of Samples
Galathowenia oculata	1148	44.15	27.29	15	58
Owenia fusiformis	860	33.08	47.74	16	62
Chaetozone gibber	149	5.73	51.28	17	65
Abra nitida	93	3.58	53.50	12	46
Spiophanes kroyeri	64	2.46	55.02	19	73
Mediomastus fragilis	61	2.35	56.47	14	54
Limatula subauriculata	60	2.31	57.89	3	12
Amphiuridae spp. juv.	57	2.19	59.25	8	31
Nemertea spp.	56	2.15	60.58	21	81
Abyssoninoe hibernica	51	1.96	61.79	12	46
Nematoda spp.	50	1.92	62.98	11	42
Ampharete lindstroemi	42	1.62	63.98	16	62
Glycera lapidum	42	1.62	64.98	11	42
Yoldiella philippiana	42	1.62	65.98	11	42
Chaetozone setosa	41	1.58	66.95	14	54
Moerella pygmaea	37	1.42	67.83	3	12
Aonides paucibranchiata	36	1.38	68.69	16	62
Pisione remota	35	1.35	69.52	3	12
Polygordius appendiculatus	34	1.31	70.33	3	12

A certain number of colonial or sessile (qualitative) taxa were also recorded attached to larger shell or stones although these tended to be relatively restricted in number or distribution and included barnacles such as *Verruca stroemi* or *Balanus crenatus*, Campanulariidae hydroids, occasional sponges (primarily *Cliona* sp.) and a variety of bryozoans such as *Crisia* spp., *Disporella hispida*, *Cellaria sinuosa*, *Phaeostachys spinifera*, *Schizomavella* sp., *Fenestrulina malusii* and *Dendrodoa grossularia*.

Table 5. Dominant qualitative (colonial/encrusting) taxa recorded at the survey stations.

Qualitative Taxa	**No. of Samples**	**% of Samples**
Porifera sp.	1	4
Cliona sp.	3	12
Campanulariidae sp.	1	4
Verruca stroemi	4	15
Balanus crenatus	3	12
Crisia spp.	1	4
Disporella hispida	1	4
Cellaria sinuosa	1	4
Phaeostachys spinifera	1	4
Schizomavella sp.	3	12
Fenestrulina malusii	1	4
Dendrodoa grossularia	1	4

3.4 Multivariate analysis

The results of multivariate analysis on the benthic samples are provided in Figure 7 whilst the spatial distribution of the groups derived from cluster analysis is provided in Figure 8. Similarities between samples range from 10% to 70% highlighting a quite varied benthic assemblage which is likely to reflect the high numbers of taxa which occur in low numbers at few stations. The SIMPROF routine in Primer identified eight groups of samples as highlighted in Figure 7. The main divisions between samples split groups a and b from the remaining samples at 10 to 20% similarity respectively whilst group h was separated from groups c to g at around 25% similarity. Groups c to g formed a series of closely related groups including some with two or less samples which were grouped together at just under 40% similarity. The results of the BEST routine (Table 6) highlight the correlation between the environmental parameters and species similarity data. All environmental parameters had correlations above 0.3 with water depth exhibiting the highest correlation (0.548) whilst mean and median phi grain size and mud content exhibited correlations above 0.4. The remaining parameters exhibited somewhat lower correlations. The best combination of parameters (water depth, mud content, mean and median grain size, sorting and skewness) produced a high correlation of 0.71 indicating that the environmental variables recorded during the survey are highly correlated to patterns in species composition.

The characteristic taxa which accounted for 90% of the similarity in sample groups are provided in Table 7 which also includes the list of samples and a summary of the sediment types and water depth. For groups with just a single station (groups d and e) just the most dominant taxa are shown. Group a consists of the three samples from a single station (SG26) in areas of sandy-gravel or gravelly-sand with low silt content and was characterised by taxa such as *Limatula subauriculata*, *Pisione remota*, *Polygordius appendiculatus*, *Moerella pygmaea*, *Goodallia triangularis*, *Gari tellinella*, Nematoda spp. and *Atylus vedlomensis*. Group b included stations in deep muddier sediments (muddy-sand or sandy-mud) namely NG41, NG42 and the three replicate samples from SG05. These samples were characterised by taxa such as *Abyssoninoe hibernica*, *Chaetozone setosa*, *Monticellina dorsobranchialis*, *Nucula sulcata*, *Abra nitida*, *Diplocirrus glaucus*, *Nephtys incisa*, *Glycera unicornis*, *Caulleriella killariensis* and *Spiophanes kroyeri*.

Groups c to f formed a series of quite similar groups in deep water with slightly gravelly muddy-sands or gravelly-sands primarily dominated by oweniid polychaetes. Group c (SG16_1 and SG23_2) was characterised by *Chaetozone gibber*, *Galathowenia oculata*, *Goniada maculata*, *Owenia fusiformis*, *Aonides paucibranchiata* and *Ampharete lindstroemi* whilst groups d and e included single samples (NG43_1 and SG4_1) characterised by *Abra nitida*, *Chaetozone gibber*, *Spiophanes kroyeri*, *Owenia fusiformis*, Nemertea spp., *Prionospio* sp., and *Mediomastus fragilis* (group d) or *Galathowenia oculata*, *Owenia fusiformis*, *Yoldiella philippiana*, *Ampelisca diadema*, *Chaetozone gibber* and *Spiophanes kroyeri* (group e).

Group f includes a larger number of samples from stations SG23, SG14, SG15 and SG66 in deep gravelly-sand or slightly gravelly muddy-sand characterised by *Galathowenia oculata*, *Owenia fusiformis*, *Chaetozone gibber*, *Ampharete lindstroemi*, *Aonides paucibranchiata*, *Phoronis* sp. and *Mediomastus fragilis* whilst group g (stations SG10_1 and SG34_2) included a similar assemblage in slightly gravelly muddy-sand characterised by taxa such as *Galathowenia oculata*, *Owenia fusiformis*, *Chaetozone gibber*, *Abra nitida*, Nemertea spp., *Spiophanes kroyeri*, *Ampharete lindstroemi* and *Terebellides stroemi*. Finally group h which is separated from groups c to g at around 25% similarity includes samples SG16_6, SG16_5, SG4_1 and SG32_1 which had slightly more mixed gravelly muddy-sand or muddy sandy-gravels and characterised by taxa such as Nemertea spp., *Glycera lapidum*, Copepoda sp., *Notomastus* sp., *Spiophanes kroyeri*, Pholoe baltica, *Eulalia mustela* and *Mediomastus fragilis*.

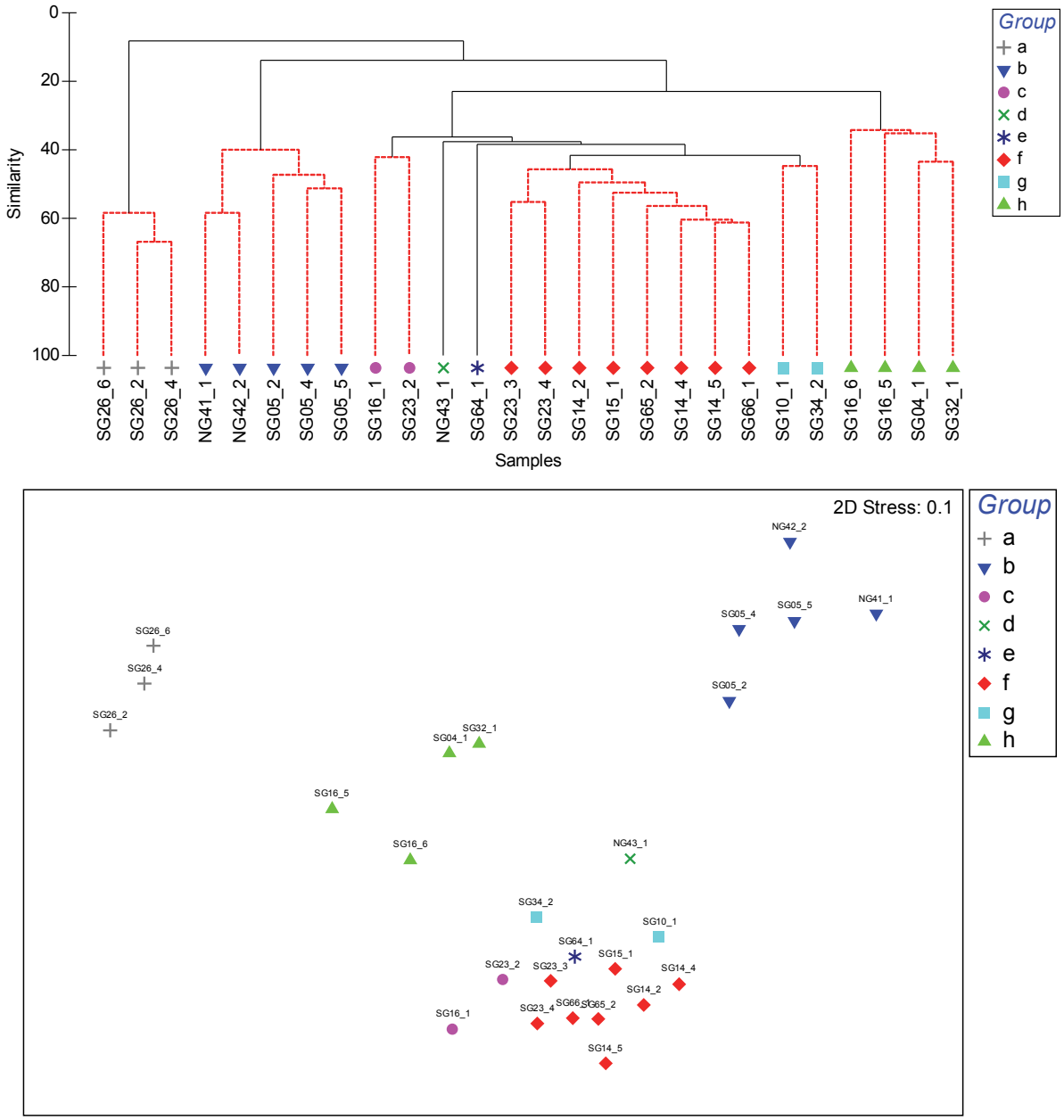

Figure 7. Results of cluster analysis and MDS.

Table 6. Results of the BEST routine.

Parameter	Correlation (r)	Best Combination (r=0.710)
Depth	0.548	✓
Mud	0.494	✓
Median Phi	0.477	✓
Mean Phi	0.472	
Skewness	0.39	✓
Sorting	0.368	✓
Sand	0.324	
Gravel	0.31	
Kurtosis	0.209	

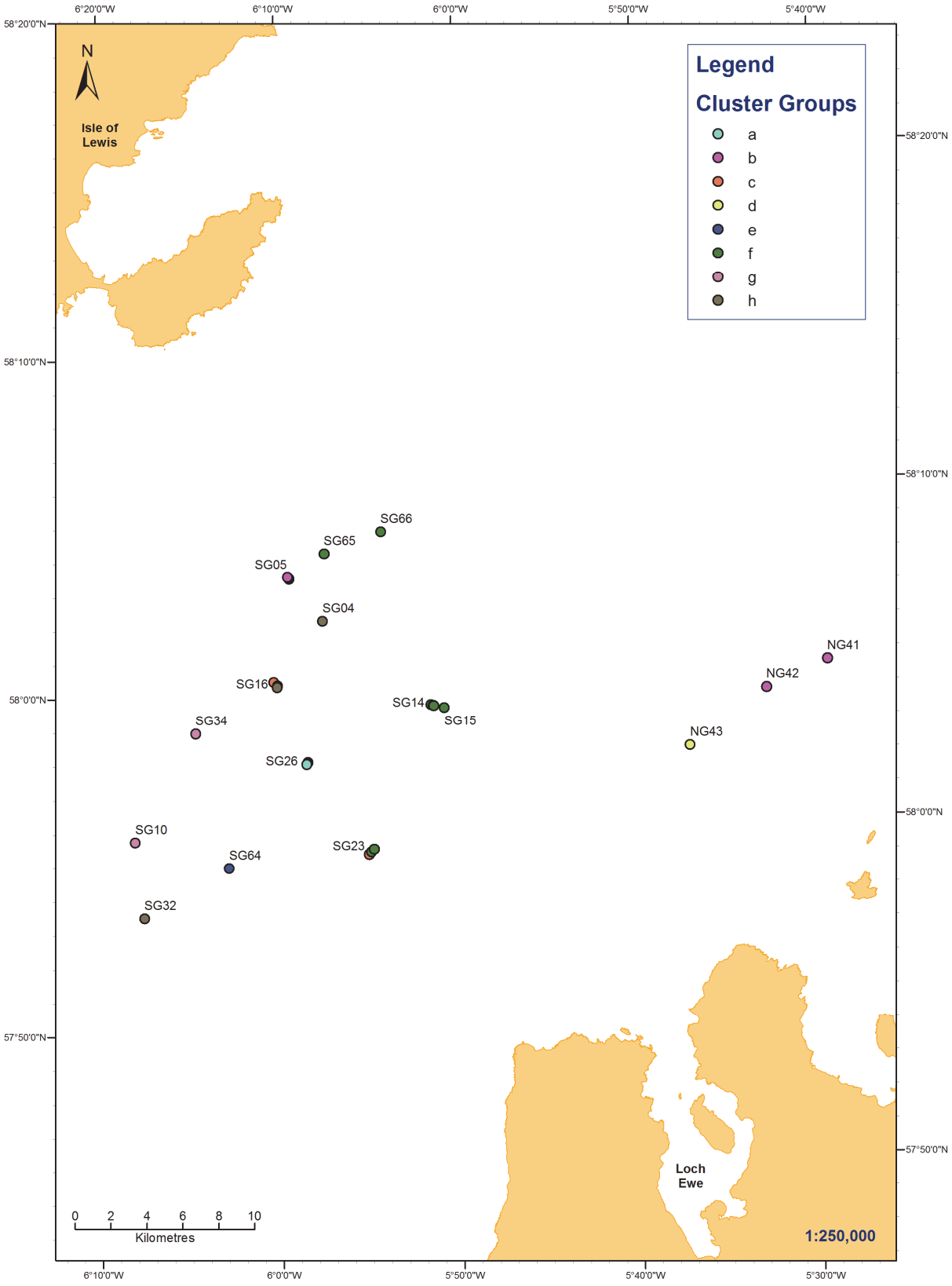

Figure 8. Groups derived from cluster analysis. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2014. All rights reserved.

Table 7. Characteristic taxa within the SIMPROF groups derived from cluster analysis.

Group A (Average similarity: 61.2%)					
Station	**Sediment Type**	**% Gravel**	**% Sand**	**% Mud**	**Depth (m CD)**
SG26_2	Sandy-Gravel	41.05	55.25	3.70	47
SG26_4	Sandy-Gravel	30.08	65.86	4.06	47
SG26_6	Gravelly-Sand	23.71	74.58	1.71	47
	Taxa	**Av. Abund**	**% of Sites**	**Contrib%**	**Cum.%**
	Limatula subauriculata	20.00	100	10.21	10.21
	Pisione remota	11.67	100	8.21	18.42
	Polygordius appendiculatus	11.33	100	8.1	26.53
	Moerella pygmaea	12.33	100	6.97	33.49
	Goodallia triangularis	6.33	100	5.46	38.96
	Gari tellinella	5.67	100	4.89	43.85
	Nematoda spp.	8.33	100	4.88	48.72
	Atylus vedlomensis	5.33	100	4.43	53.15
	Glycera lapidum	5.67	100	4.29	57.44
	Spisula sp. juv.	4.67	100	4.23	61.68
	Syllis armillaris	3.33	100	3.69	65.37
	Crenella decussata	2.67	100	3.46	68.83
	Spisula elliptica	2.67	100	2.75	71.58
	Nemertea spp.	1.33	100	2.44	74.02
	Aonides paucibranchiata	1.33	100	2.44	76.47
	Gnathia oxyuraea	1.00	100	2.44	78.91
	Ammodytidae sp.	1.00	100	2.44	81.35
	Amphiuridae spp. juv.	15.00	67	1.83	83.18
	Amphipholis squamatus	6.00	67	1.29	84.47
	Sphaerosyllis taylori	1.67	67	1.14	85.61
	Gari sp. juv.	2.67	67	1.14	86.75
	Euspira pulchella	1.67	67	1.06	87.81
	Clausinella fasciata juv.	1.67	67	1.06	88.86
	Thraciacea sp. juv.	2.67	67	1.06	89.92
	Echinocyamus pusillus	2.33	67	1.06	90.97
	Protodorvillea kefersteini	1.00	67	0.89	91.86

Group B (Average similarity: 44.39%)					
Station	**Sediment Type**	**% Gravel**	**% Sand**	**% Mud**	**Depth (m CD)**
SG05_2	Muddy-Sand	0.00	57.07	42.93	77
SG05_4	Sandy-Mud	0.00	36.76	63.24	77
SG05_5	Sandy-Mud	0.00	46.78	53.22	77
NG41_1	Sandy-Mud	0.00	38.18	61.82	148
NG42_2	Sandy-Mud	0.00	35.88	64.12	103
	Taxa	**Av. Abund**	**% of Sites**	**Contrib%**	**Cum.%**
	Abyssoninoe hibernica	5.00	100	16.14	16.14
	Chaetozone setosa	4.80	100	13.21	29.35
	Monticellina dorsobranchialis	2.20	100	11.09	40.44
	Nucula sulcata	3.60	80	8.26	48.7
	Abra nitida	8.40	80	8.22	56.92
	Diplocirrus glaucus	3.60	80	7.42	64.34
	Nephtys incisa	1.40	80	5.91	70.25
	Glycera unicornis	1.00	80	5.03	75.28
	Caulleriella killariensis	1.00	80	4.8	80.08
	Spiophanes kroyeri	2.00	60	3.26	83.34
	Nemertea spp.	1.40	60	2.88	86.22
	Nephtys sp. juv.	1.40	60	2.73	88.95
	Notomastus sp.	0.60	60	2.48	91.43

Group C (Average similarity: 42.12%)					
Station	**Sediment Type**	**% Gravel**	**% Sand**	**% Mud**	**Depth (m CD)**
SG16_1	Gravelly-Muddy Sand	7.85	71.64	20.51	65
SG23_2	Gravelly-Muddy Sand	25.72	65.54	8.74	66
	Taxa	**Av. Abund**	**% of Sites**	**Contrib%**	**Cum.%**
	Chaetozone gibber	16.50	100	13.89	13.89
	Galathowenia oculata	41.50	100	12.56	26.45
	Goniada maculata	4.00	100	8.38	34.83
	Owenia fusiformis	5.50	100	7.25	42.08
	Aonides paucibranchiata	4.50	100	5.92	48.01
	Ampharete lindstroemi	3.50	100	5.92	53.93
	Pholoe baltica	1.00	100	4.19	58.12
	Glycera fallax	1.50	100	4.19	62.31
	Glycera lapidum	2.00	100	4.19	66.5
	Caulleriella killariensis	1.00	100	4.19	70.68
	Notomastus sp.	2.00	100	4.19	74.87
	Ophelina acuminata	1.00	100	4.19	79.06
	Terebellides stroemi	1.50	100	4.19	83.25
	Pista cristata	1.50	100	4.19	87.44
	Phaxas pellucidus	1.50	100	4.19	91.62

Group D					
Station	**Sediment Type**	**% Gravel**	**% Sand**	**% Mud**	**Depth (m CD)**
NG43_1	Slightly Gravelly Muddy-Sand	1.91	54.30	43.79	78
	Taxa	**Abundance**	**Cum. %**		
	Abra nitida	16	15		
	Chaetozone gibber	8	22		
	Spiophanes kroyeri	6	28		
	Owenia fusiformis	6	33		
	Nemertea spp.	5	38		
	Prionospio sp.	5	43		
	Mediomastus fragilis	5	47		
	Ampharete lindstroemi	5	52		
	Galathowenia oculata	4	56		
	Terebellides stroemi	4	59		
	Yoldiella philippiana	4	63		
	Chaetozone setosa	3	66		
	Iphinoe serrata	3	69		
	Phoronis sp.	3	71		
	Amphiuridae spp. juv.	3	74		
	Amphiura chiajei	3	77		
	Ophiocten affinis	3	80		

Group E					
Station	**Sediment Type**	**% Gravel**	**% Sand**	**% Mud**	**Depth (m CD)**
SG64_1	Slightly Gravelly Muddy-Sand	0.59	88.13	11.28	69
	Taxa	**Abundance**	**Cum. %**		
	Galathowenia oculata	52	24		
	Owenia fusiformis	31	38		
	Yoldiella philippiana	10	42		
	Ampelisca diadema	7	45		
	Chaetozone gibber	6	48		
	Spiophanes kroyeri	5	50		
	Dodecaceria sp.	5	53		
	Dosinia sp. juv.	5	55		
	Nemertea spp.	4	57		
	Nematoda spp.	4	59		
	Antalis entalis	4	60		
	Leptosynapta bergensis	4	62		
	Lumbrineris cingulata	3	64		
	Paradoneis lyra	3	65		
	Amphitrite figulus	3	66		
	Acidostoma obesum	3	68		
	Astacilla longicornis	3	69		

Group F (Average similarity: 50.44%)					
Station	**Sediment Type**	**% Gravel**	**% Sand**	**% Mud**	**Depth (m CD)**
SG14_2	Gravelly-Sand	21.04	71.31	7.65	84
SG14_4	Slightly Gravelly Muddy-Sand	0.12	86.11	13.76	84
SG14_5	Slightly Gravelly-Sand	0.81	91.89	7.30	84
SG15_1	Sandy-Gravel	54.07	41.50	4.43	88
SG23_3	Gravelly-Sand	7.75	86.08	6.16	66
SG23_4	Gravelly-Sand	9.14	84.25	6.60	65
SG65_2	Slightly Gravelly Muddy-Sand	1.52	76.37	22.11	69
SG66_1	Slightly Gravelly Muddy-Sand	4.45	78.28	17.26	66
	Taxa	**Av. Abund**	**% of Sites**	**Contrib%**	**Cum.%**
	Galathowenia oculata	111.13	100	24.99	24.99
	Owenia fusiformis	96.75	100	20.2	45.19
	Chaetozone gibber	10.25	100	8.1	53.29
	Ampharete lindstroemi	2.63	100	4.06	57.35
	Aonides paucibranchiata	2.38	100	3.97	61.31
	Phoronis sp.	2.75	88	3.39	64.71
	Mediomastus fragilis	3.25	88	3.37	68.07
	Phaxas pellucidus	1.75	100	3.36	71.43
	Spiophanes kroyeri	2.25	88	3.21	74.64
	Goniada maculata	1.88	88	2.8	77.44
	Chaetozone setosa	1.63	88	2.63	80.07
	Nemertea spp.	1.75	88	2.45	82.52
	Yoldiella philippiana	2.38	75	2.03	84.55
	Polycirrus sp.	1.75	63	1.28	85.84
	Thyasira flexuosa	0.88	63	1.14	86.98
	Magelona alleni	1.00	63	1.13	88.11
	Leptosynapta bergensis	1.13	63	1.1	89.21
	Edwardsiidae sp.	1.38	50	0.72	89.93

Group G (Average similarity: 44.71%)					
Station	**Sediment Type**	**% Gravel**	**% Sand**	**% Mud**	**Depth (m CD)**
SG10_1	Slightly Gravelly Muddy-Sand	1.49	76.93	21.58	60
SG34_2	Gravelly Muddy-Sand	5.15	75.71	19.14	66
	Taxa	**Av. Abund**	**% of Sites**	**Contrib%**	**Cum.%**
	Galathowenia oculata	57.00	100	20.09	20.09
	Owenia fusiformis	17.50	100	11.72	31.8
	Chaetozone gibber	7.50	100	7.75	39.56
	Abra nitida	12.50	100	5.07	44.63
	Nemertea spp.	3.00	100	4.14	48.77
	Spiophanes kroyeri	2.50	100	4.14	52.92
	Ampharete lindstroemi	2.50	100	4.14	57.06
	Terebellides stroemi	2.00	100	4.14	61.2
	Westwoodilla caecula	2.00	100	4.14	65.35
	Amphiuridae spp. juv.	3.00	100	4.14	69.49
	Leptosynapta bergensis	2.50	100	4.14	73.63
	Pholoe baltica	1.50	100	2.93	76.56
	Glycera unicornis	1.50	100	2.93	79.49
	Nephtys kersivalensis	2.00	100	2.93	82.42
	Abyssoninoe hibernica	1.00	100	2.93	85.35
	Diplocirrus glaucus	2.00	100	2.93	88.28

Group H (Average similarity:36.08%)					
Station	**Sediment Type**	**% Gravel**	**% Sand**	**% Mud**	**Depth (m CD)**
SG04_1	Gravelly Muddy-Sand	23.88	58.97	17.14	65
SG16_5	Muddy Sandy-Gravel	30.77	55.18	14.05	65
SG16_6	Gravelly Muddy-Sand	5.71	80.69	13.60	65
SG32_1	Gravelly Muddy-Sand	21.45	67.23	11.32	65
	Taxa	**Av. Abund**	**% of Sites**	**Contrib%**	**Cum.%**
	Nemertea spp.	4.00	100	8.88	8.88
	Glycera lapidum	4.50	100	8.01	16.89
	Copepoda sp.	3.00	100	7	23.89
	Notomastus sp.	3.00	100	6.72	30.61
	Spiophanes kroyeri	3.00	100	6.55	37.16
	Pholoe baltica	1.50	100	5.41	42.57
	Eulalia mustela	1.50	100	5.41	47.99
	Mediomastus fragilis	3.50	75	5.23	53.22
	Terebellides stroemi	2.75	75	5.12	58.34
	Nematonereis unicornis	5.75	75	4.92	63.25
	Ampelisca spinipes	2.25	75	4.47	67.73
	Abyssoninoe hibernica	5.00	75	3.86	71.58
	Chaetozone gibber	1.25	75	2.95	74.54
	Atylus vedlomensis	1.50	75	2.84	77.37
	Echinocyamus pusillus	1.25	75	2.74	80.12
	Aonides paucibranchiata	1.00	75	2.61	82.73
	Nematoda spp.	3.00	50	1.22	83.95
	Monticellina dorsobranchialis	0.50	50	1.06	85.01
	Ampharete lindstroemi	0.75	50	1.06	86.06
	Exogone verugera	0.50	50	0.97	87.04
	Aricidea cerrutii	0.75	50	0.97	88.01
	Cheirocratus sp.	0.75	50	0.97	88.99
	Aricidea simonae	0.50	50	0.92	89.91
	Leptochiton asellus	1.50	50	0.92	90.83

3.5 Biotope composition

Biotopes were assigned to each station on the basis of species composition, sedimentary parameters, water depth and the results of multivariate analysis. A number of the stations exhibited intermediate infaunal communities or include offshore or circalittoral communities which are currently rather poorly defined by the current version of the UK biotope classification (Connor *et al*., 2004). A summary of biotope codes for the stations is provided in Table 8 and a breakdown of biotopes for stations in each of the groups derived by cluster analysis with sediment descriptions and characteristic taxa is provided in Table 9. Uncertain biotopes have been listed with a qualifier (marked with ?). The spatial distribution of biotopes is provided in Figure 9. Figure 10 shows the location of stations with MPA Protected Features within the survey area based on infaunal data. However, as discussed below there were some areas where such features may potentially be present but the infaunal data is inconclusive and video data would be required to assess this further.

Stations within group a include a range of polychaetes and bivalves in coarse sand and gravel including a number of interstitial taxa such as *Pisione remota* and *Polygordius appendiculatus* whilst bivalves include *Moerella pygmaea* and also notably the small-eared file shell *Limatula subauriculata* and the lancelet *Branchiostoma* sp. for which relatively few records exist this far north. As such this station has been assigned **SS.SCS.CCS.Blan** (*Branchiostoma lanceolatum* in circalittoral coarse sand with shell gravel) although the community also has elements of offshore coarse sediment biotopes (**SS.SCS.OCS**). Group b includes a number of stations in deep sandy-mud (or muddy-sand) with an infaunal community which resembles that from burrowed mud communities (with some megafaunal taxa also present) and stations in this group have been assigned **SS.SMu.CFiMu** (Circalittoral fine mud) and may include examples of **SS.SMu.CFiMu.SpnMeg** (Seapens and burrowing megafauna in circalittoral fine mud) or **SS.SMu.CFiMu.MegMax** (Burrowing megafauna and *Maxmuelleria lankesteri* in circalittoral mud), but would have to be identified from video footage.

Groups c to g include a closely related number of stations with muddy-sand, slightly gravelly muddy-sand or gravelly-sand with a somewhat variable infaunal community primarily characterised by oweniid polychaetes with a wide range of polychaete taxa along with bivalves such as *Yoldiella philippiana* and also occasional brittlestars including *Amphiura* spp. These communities do not correlate exactly to existing offshore or circalittoral biotopes as this area of the classification requires further review but at present the majority have been assigned **SS.SSa.OSa.OfusAfil** (*Owenia fusiformis* and *Amphiura filiformis* in offshore circalittoral sand or muddy sand) albeit with a reduced *Amphiura* component. Other stations with more muddy sediments (e.g. N43_1 in group d) have been assigned **SS.SMu.CSaMu** (Circalittoral sandy mud) and as discussed above have potential for burrowing megafauna. Those areas with more mixed sediments (muddy sandy-gravels) in groups c and h have been assigned **SS.SMx.CMx** (Circalittoral mixed sediment) and whilst they do not particularly correlate to a specific biotope given their position/depth they could also fall under the habitat complex ***SS.SMx.OMx*** (Offshore circalittoral mixed sediment).

Table 8. Biotopes at each station.

Sample	Biotope	Location	Proposed Protected Feature
SG04_1	SS.SMx.CMx	Shiant East Bank	Circalittoral sands and mixed sediment communities
SG05_2	SS.SMu.CFiMu	Shiant East Bank	
SG05_4	SS.SMu.CFiMu	Shiant East Bank	
SG05_5	SS.SMu.CFiMu	Shiant East Bank	
SG10_1	SS.SSa.OSa.OfusAfil ?	Shiant East Bank	Circalittoral sands and mixed sediment communities
SG14_2	SS.SSa.OSa.OfusAfil ?	Shiant East Bank	Circalittoral sands and mixed sediment communities
SG14_4	SS.SSa.OSa.OfusAfil ?	Shiant East Bank	Circalittoral sands and mixed sediment communities
SG14_5	SS.SSa.OSa.OfusAfil ?	Shiant East Bank	Circalittoral sands and mixed sediment communities
SG15_1	SS.SSa.OSa.OfusAfil ?	Shiant East Bank	Circalittoral sands and mixed sediment communities
SG16_1	SS.SMx.CMx	Shiant East Bank	Circalittoral sands and mixed sediment communities
SG16_5	SS.SMx.CMx	Shiant East Bank	Circalittoral sands and mixed sediment communities
SG16_6	SS.SMx.CMx	Shiant East Bank	Circalittoral sands and mixed sediment communities
SG23_2	SS.SMx.CMx	Shiant East Bank	Circalittoral sands and mixed sediment communities
SG23_3	SS.SSa.OSa.OfusAfil ?	Shiant East Bank	Circalittoral sands and mixed sediment communities
SG23_4	SS.SSa.OSa.OfusAfil ?	Shiant East Bank	Circalittoral sands and mixed sediment communities
SG26_2	SS.SCS.CCS.Blan	Shiant East Bank	
SG26_4	SS.SCS.CCS.Blan	Shiant East Bank	
SG26_6	SS.SCS.CCS.Blan	Shiant East Bank	
SG32_1	SS.SMx.CMx	Shiant East Bank	
SG34_2	SS.SSa.OSa.OfusAfil ?	Shiant East Bank	Circalittoral sands and mixed sediment communities
SG64_1	SS.SSa.OSa.OfusAfil ?	Shiant East Bank	Circalittoral sands and mixed sediment communities
SG65_2	SS.SSa.OSa.OfusAfil ?	Shiant East Bank	Circalittoral sands and mixed sediment communities
SG66_1	SS.SSa.OSa.OfusAfil ?	Shiant East Bank	Circalittoral sands and mixed sediment communities
NG41_1	SS.SMu.CFiMu	Wester Ross	
NG42_2	SS.SMu.CFiMu	Wester Ross	
NG43_1	SS.SMu.CSaMu ?	Wester Ross	

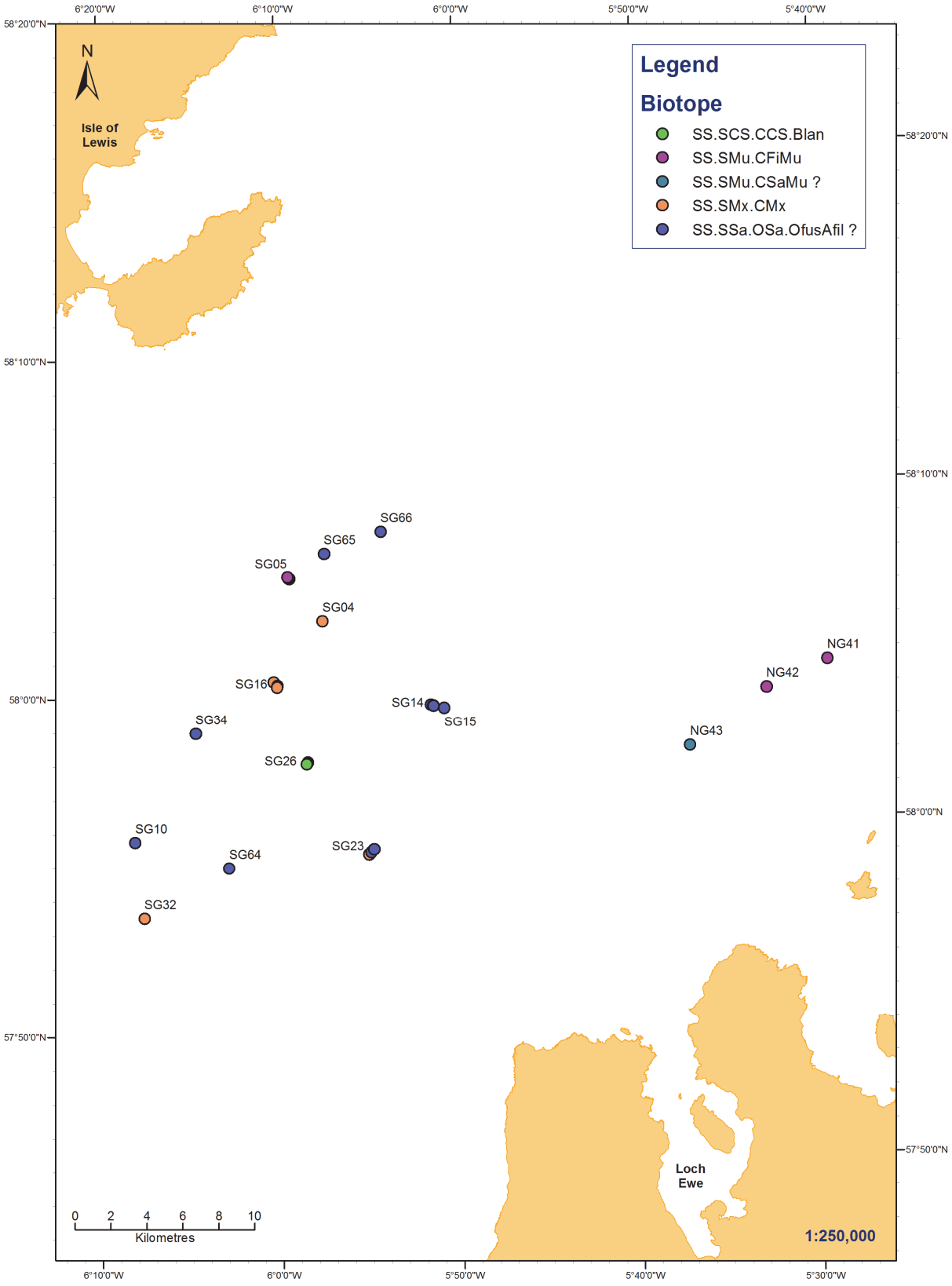

Figure 9. Biotopes at the survey stations. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right [2014]. All rights reserved. Ordnance Survey Licence number 100017908.

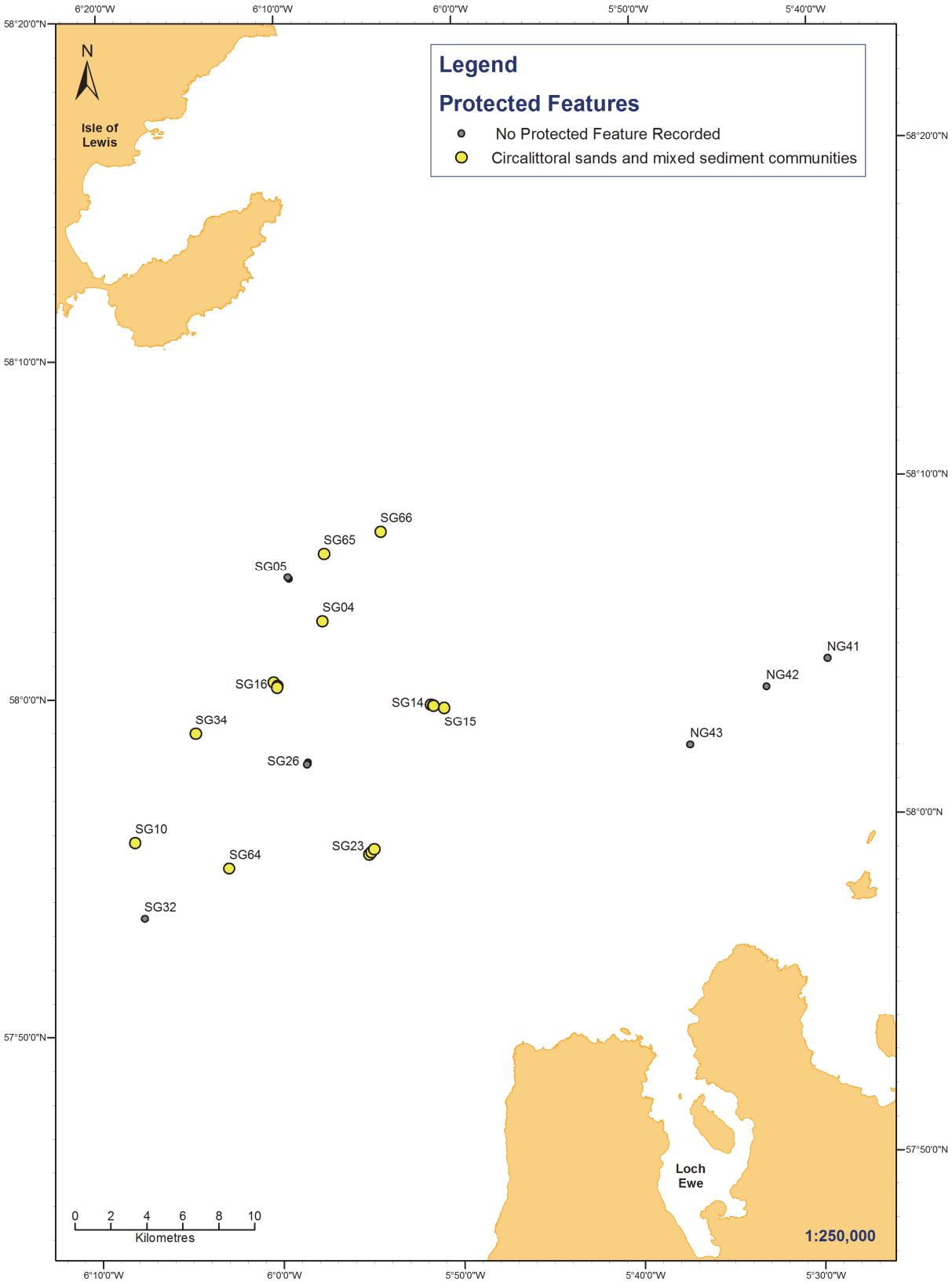

Figure 10. Proposed Protected Features at the survey stations. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right [2014]. All rights reserved. Ordnance Survey Licence number 100017908.

Table 9. Biotopes, sediment descriptions and dominant taxa within cluster groups.

Group	Station	Biotope	Sediment Type	Depth (m CD)	Dominant Taxa
a	SG26_2	SS.SCS.CCS.Blan	Sandy-Gravel	47	Amphiuridae spp. juv., *Limatula subauriculata, Moerella pygmaea*, Nematoda spp., *Pisione remota*
	SG26_4	SS.SCS.CCS.Blan	Sandy-Gravel	47	*Limatula subauriculata, Amphipholis squamatus, Pisione remota, Polygordius appendiculatus*, Nematoda spp.
	SG26_6	SS.SCS.CCS.Blan	Gravelly-Sand	47	*Limatula subauriculata, Pisione remota, Polygordius appendiculatus, Glycera lapidum, Moerella pygmaea*
b	SG05_2	SS.SMu.CFiMu	Muddy-Sand	77	*Abra nitida, Diplocirrus glaucus, Abyssoninoe hibernica, Spiophanes kroyeri*, Nemertea spp.
	SG05_4	SS.SMu.CFiMu	Sandy-Mud	77	*Chaetozone setosa, Diplocirrus glaucus, Abyssoninoe hibernica*, Nemertea spp., *Monticellina dorsobranchialis*
	SG05_5	SS.SMu.CFiMu	Sandy-Mud	77	*Abra nitida, Spiophanes kroyeri, Odostomia turrita, Monticellina dorsobranchialis, Diplocirrus glaucus*
	NG41_1	SS.SMu.CFiMu	Sandy-Mud	148	*Nucula sulcata, Abyssoninoe hibernica, Chaetozone setosa*, *Nephtys* sp. juv., *Abra nitida*
	NG42_2	SS.SMu.CFiMu	Sandy-Mud	103	*Chaetozone setosa, Chaetozone zetlandica, Abyssoninoe hibernica, Nucula sulcata, Nephtys incisa*
c	SG16_1	SS.SMx.CMx	Gravelly Muddy-Sand	65	*Chaetozone gibber, Galathowenia oculata, Aonides paucibranchiata, Abra prismatica, Goniada maculata*
	SG23_2	SS.SMx.CMx	Gravelly Muddy-Sand	66	*Galathowenia oculata, Chaetozone gibber, Spiophanes kroyeri, Owenia fusiformis, Ampharete lindstroemi*
d	NG43_1	SS.SMu.CSaMu ?	Slightly Gravelly Muddy-Sand	78	Abra *nitida, Chaetozone gibber, Spiophanes kroyeri, Owenia fusiformis*, Nemertea spp.

Group	Station	Biotope	Sediment Type	Depth (m CD)	Dominant Taxa
e	SG64_1	SS.SSa.OSa.OfusAfil ?	Slightly Gravelly Muddy-Sand	69	*Galathowenia oculata, Owenia fusiformis, Yoldiella philippiana, Ampelisca diadema, Chaetozone gibber*
f	SG14_2	SS.SSa.OSa.OfusAfil ?	Gravelly-Sand	84	*Galathowenia oculata, Owenia fusiformis, Chaetozone gibber, Mediomastus fragilis, Ampharete lindstroemi*
	SG14_4	SS.SSa.OSa.OfusAfil ?	Slightly Gravelly Muddy-Sand	84	*Owenia fusiformis, Galathowenia oculata, Chaetozone gibber, Ampharete lindstroemi, Calyptraea chinensis*
	SG14_5	SS.SSa.OSa.OfusAfil ?	Slightly Gravelly-Sand	84	*Owenia fusiformis, Galathowenia oculata, Chaetozone gibber*, *Phoronis* sp., NEMERTEA spp.
	SG15_1	SS.SSa.OSa.OfusAfil ?	Sandy-Gravel	88	*Owenia fusiformis, Galathowenia oculata, Chaetozone gibber, Mediomastus fragilis*, *Polycirrus* sp.
	SG23_3	SS.SSa.OSa.OfusAfil ?	Gravelly-Sand	66	*Galathowenia oculata, Owenia fusiformis, Chaetozone gibber, Polycirrus* sp., *Urothoe elegans*
	SG23_4	SS.SSa.OSa.OfusAfil ?	Gravelly-Sand	65	*Galathowenia oculata, Owenia fusiformis, Chaetozone gibber, Edwardsiidae sp., Spiophanes kroyeri*
	SG65_2	SS.SSa.OSa.OfusAfil ?	Slightly Gravelly Muddy-Sand	69	*Galathowenia oculata, Owenia fusiformis, Abra nitida, Chaetozone gibber, Ampharete lindstroemi*
	SG66_1	SS.SSa.OSa.OfusAfil ?	Slightly Gravelly Muddy-Sand	66	*Galathowenia oculata, Owenia fusiformis, Chaetozone gibber, Yoldiella philippiana*, Nemertea spp.
g	SG10_1	SS.SSa.OSa.OfusAfil ?	Slightly Gravelly Muddy-Sand	60	*Galathowenia oculata, Abra nitida, Owenia fusiformis, Chaetozone gibber, Abra alba*
	SG34_2	SS.SSa.OSa.OfusAfil ?	Gravelly Muddy-Sand	66	*Galathowenia oculata, Owenia fusiformis, Mediomastus fragilis, Chaetozone gibber*, Nemertea spp.

Group	Station	Biotope	Sediment Type	Depth (m CD)	Dominant Taxa
h	SG04_1	SS.SMx.CMx	Gravelly Muddy-Sand	65	*Glycera lapidum, Mediomastus fragilis, Pholoe baltica, Nematonereis unicornis, Abyssoninoe hibernica*
	SG16_5	SS.SMx.CMx	Muddy Sandy-Gravel	65	*Lumbrineris cingulata, Nematonereis unicornis*, Nematoda spp., *Sphaerosyllis taylori, Spiophanes kroyeri*
	SG16_6	SS.SMx.CMx	Gravelly Muddy-Sand	65	*Galathowenia oculata*, *Terebellides stroemi*, Copepoda sp., Nemertea spp., *Glycera lapidum*
	SG32_1	SS.SMx.CMx	Gravelly Muddy-Sand	65	*Abyssoninoe hibernica, Nematonereis unicornis*, Nemertea spp., *Leptochiton asellus*, *Mediomastus fragilis*

4. CONCLUSIONS

The sampling stations surveyed within the Shiant East Bank MPA proposal and the Wester Ross MPA in September 2013 covered a range of seabed habitats including circalittoral sandy-muds, muddy-sands or gravelly-sands with muddier habitats generally recorded further inshore. One station (SG26) with particularly gravelly sediments was recorded at the centre of Shiant East Bank with a species assemblage characterised by robust bivalves, interstitial polychaetes and occasional lancelets (*Branchiostoma* sp.) which were representative of the biotope **SS.SCS.CCS.Blan** (*Branchiostoma lanceolatum* in circalittoral coarse sand with shell gravel).

A number of stations within the Shiant East Bank MPA proposal included potential examples of Circalittoral sands and mixed sediment communities with samples from stations SG10, SG14, SG15, SG23, SG34, SG64, SG65 and SG66 including somewhat intermediate examples of the biotope **SS.SSa.OSa.OfusAfil** (*Owenia fusiformis* and *Amphiura filiformis* in offshore circalittoral sand or muddy sand). However, there was a degree of uncertainty with regard to these designations which often appeared not to be good fits and included deeper circalittoral communities which are currently rather poorly defined by the current UK biotope classification. Other mixed sediment communities were present at stations SG04, SG16, SG23 and SG32 which were rather poorly defined and reported as **SS.SMx.CMx** (Circalittoral mixed sediment).

Three stations (station SG05 on the Shiant East Bank and stations NG41 and NG42 within the Wester Ross MPA) included examples of **SS.SMu.CFiMu** (Circalittoral fine mud) whilst one other Wester Ross station NG43_1 was classified as **SS.SMu.CSaMu** (Circalittoral sandy mud). The infauna recorded at these stations could not provide a definitive biotope designation but the dominant taxa present (particularly at stations NG41 and NG42) correlated to supporting taxa often recorded in burrowing megafaunal biotopes such **SS.SMu.CFiMu.SpnMeg** (Seapens and burrowing megafauna in circalittoral fine mud) or **SS.SMu.CFiMu.MegMax** (Burrowing megafauna and *Maxmuelleria lankesteri* in circalittoral mud), both of which are components of the burrowed mud protected feature of the Wester Ross MPA. Occasional examples of burrowing crustacea such as *Nephrops norvegicus* and *Calocaris macandreae* were present at stations NG41 and NG42 but identifying specific burrowed mud biotopes from infaunal grab data alone is often problematic as characteristic species such as seapens, *Nephrops norvegicus, Maxmuelleria lankesteri* and *Callianassa subterranea* are not usually present in sufficient densities to be sampled within single or even multiple grab samples. Examples of these biotopes have, however, previously been recorded during video survey of these areas (Moore, 2014) and also fall within the current predicted extent of burrowed mud (based on acoustic data; see Envision Mapping Ltd., 2014).

Many of these deeper circalittoral or offshore habitats are currently rather poorly defined by the current UK biotope classification and recent surveys around the Clyde Sea (Allen, 2013, 2014) included similar poorly fitting examples of biotopes such as **SS.SSa.OSa.OfusAfil** whilst SNH surveys off the Small Isles, Inner Hebrides highlighted mosaics of biotopes including **.AfilMysAnit** and **.OfusAfil** which were overlain by a muddy veneer of the burrowing mud biotopes **.SpnMeg.Fun** and **.MegMax** (Howson *et al*., 2012). In such instances an assessment of epifaunal species is often beneficial and as such a full assessment of epibiota from associated video evidence collected during the survey (Moore, 2014) may assist in biotope derivation in areas where habitat mosaics are present or where infaunal data are inconclusive with regards to finer resolution biotope assignments. Using this report in conjunction with the video data collected during this survey (see Moore, 2014) should therefore allow further refinement of this biotope assessment and also the possible identification of burrowed mud features within the Wester Ross MPA.

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ANNEX 1: SEDIMENT PARTICLE SIZE ANALYSES DATA

SAMPLE	PARAMETER	SG04_1	SG05_2	SG05_4	SG05_5	SG10_1
SAMPLE TYPE:		Trimodal, Very Poorly Sorted	Bimodal, Very Poorly Sorted	Bimodal, Very Poorly Sorted	Bimodal, Very Poorly Sorted	Bimodal, Very Poorly Sorted
TEXTURAL GROUP:		Gravelly Muddy Sand	Muddy Sand	Sandy Mud	Sandy Mud	Slightly Gravelly Muddy Sand
SEDIMENT NAME:		Very Fine Gravelly Medium Silty Very Coarse Sand	Medium Silty Fine Sand	Fine Sandy Coarse Silt	Fine Sandy Coarse Silt	Slightly Very Fine Gravelly Medium Silty Medium Sand
FOLK AND WARD METHOD (µm)	MEDIAN GRAIN SIZE D_{50} (µm)	1122.9	97.2	32.6	52.0	221.1
	MEAN GRAIN SIZE (µm)	531.91	63.45	34.4	46.1	126.9
	SORTING	7.855	4.739	4.179	4.470	4.856
	SKEWNESS	-0.514	-0.367	0.028	-0.126	-0.481
	KURTOSIS	1.470	0.730	0.743	0.730	1.652
FOLK AND WARD METHOD (ø)	MEDIAN GRAIN SIZE D_{50} (ø):	-0.167	3.363	4.938	4.266	2.177
	MEAN GRAIN SIZE (ø):	0.911	3.978	4.863	4.439	2.978
	SORTING	2.974	2.245	2.063	2.160	2.280
	SKEWNESS	0.514	0.367	-0.028	0.126	0.481
	KURTOSIS	1.470	0.730	0.743	0.730	1.652
FOLK AND WARD METHOD (Description)	MEAN:	Coarse Sand	Very Fine Sand	Very Coarse Silt	Very Coarse Silt	Fine Sand
	SORTING:	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted
	SKEWNESS:	Very Fine Skewed	Very Fine Skewed	Symmetrical	Fine Skewed	Very Fine Skewed
	KURTOSIS:	Leptokurtic	Platykurtic	Platykurtic	Platykurtic	Very Leptokurtic
BULK GRAIN SIZE	% GRAVEL:	23.88	0.00	0.00	0.00	1.49
	% SAND:	58.97	57.07	36.76	46.78	76.93
	% MUD:	17.14	42.93	63.24	53.22	21.58
	% V COARSE GRAVEL:	0.00	0.00	0.00	0.00	0.00
	% COARSE GRAVEL:	0.00	0.00	0.00	0.00	0.00
	% MEDIUM GRAVEL:	2.74	0.00	0.00	0.00	0.00
	% FINE GRAVEL:	9.48	0.00	0.00	0.00	0.22
	% V FINE GRAVEL:	11.67	0.00	0.00	0.00	1.27
	% V COARSE SAND:	31.96	0.00	0.00	0.00	3.00
	% COARSE SAND:	11.53	1.80	0.00	0.61	9.68
	% MEDIUM SAND:	9.64	18.60	6.56	12.39	29.82
	% FINE SAND:	3.76	24.03	16.93	19.86	28.34
	% V FINE SAND:	2.09	12.64	13.27	13.92	6.08
	% V COARSE SILT:	2.90	8.69	14.16	12.46	2.44
	% COARSE SILT:	4.32	10.17	16.34	13.37	4.73
	% MEDIUM SILT:	4.63	10.61	15.45	12.55	6.02
	% FINE SILT:	3.83	9.45	12.45	10.55	5.95
	% V FINE SILT:	1.42	3.82	4.65	4.11	2.35
	% CLAY:	0.05	0.18	0.18	0.18	0.08

SAMPLE	PARAMETER	SG14_2	SG14_4	SG14_5	SG15_1	SG16_1
SAMPLE TYPE:		Unimodal, Very Poorly Sorted	Unimodal, Poorly Sorted	Bimodal, Poorly Sorted	Polymodal, Very Poorly Sorted	Bimodal, Very Poorly Sorted
TEXTURAL GROUP:		Gravelly Sand	Slightly Gravelly Muddy Sand	Slightly Gravelly Sand	Sandy Gravel	Gravelly Muddy Sand
SEDIMENT NAME:		Very Fine Gravelly Very Coarse Sand	Slightly Fine Gravelly Medium Silty Fine Sand	Slightly Very Fine Gravelly Very Coarse Sand	Sandy Medium Gravel	Very Fine Gravelly Medium Silty Medium Sand
FOLK AND WARD METHOD (μm)	MEDIAN GRAIN SIZE D_{50} (μm)	1269.31	231.0	517.31	3075.5	301.6
	MEAN GRAIN SIZE (μm)	894.62	215.8	470.8	2151.5	189.9
	SORTING	4.114	2.809	3.39	5.976	6.487
	SKEWNESS	-0.522	-0.337	-0.322	-0.317	-0.329
	KURTOSIS	1.722	2.098	1.084	0.617	1.593
FOLK AND WARD METHOD (ø)	MEDIAN GRAIN SIZE D_{50} (ø):	-0.344	2.114	0.951	-1.621	1.729
	MEAN GRAIN SIZE (ø):	0.161	2.212	1.087	-1.105	2.396
	SORTING	2.040	1.490	1.763	2.579	2.697
	SKEWNESS	0.522	0.337	0.322	0.317	0.329
	KURTOSIS	1.722	2.098	1.084	0.617	1.593
FOLK AND WARD METHOD (Description)	MEAN:	Coarse Sand	Fine Sand	Medium Sand	Very Fine Gravel	Fine Sand
	SORTING:	Very Poorly Sorted	Poorly Sorted	Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted
	SKEWNESS:	Very Fine Skewed	Very Fine Skewed	Very Fine Skewed	Very Fine Skewed	Very Fine Skewed
	KURTOSIS:	Very Leptokurtic	Very Leptokurtic	Mesokurtic	Very Platykurtic	Very Leptokurtic
BULK GRAIN SIZE	% GRAVEL:	21.04	0.12	0.81	54.07	7.85
	% SAND:	71.31	86.11	91.89	41.50	71.64
	% MUD:	7.65	13.76	7.30	4.43	20.51
	% V COARSE GRAVEL:	0.00	0.00	0.00	0.00	0.00
	% COARSE GRAVEL:	0.00	0.00	0.00	0.00	0.00
	% MEDIUM GRAVEL:	0.00	0.00	0.00	37.31	0.28
	% FINE GRAVEL:	4.70	0.07	0.00	9.98	1.63
	% V FINE GRAVEL:	16.34	0.06	0.81	6.78	5.93
	% V COARSE SAND:	50.46	0.98	43.55	17.25	7.78
	% COARSE SAND:	3.51	8.73	6.05	1.97	15.40
	% MEDIUM SAND:	8.25	35.09	18.79	9.67	26.25
	% FINE SAND:	7.48	36.19	20.11	10.50	17.99
	% V FINE SAND:	1.60	5.11	3.40	2.11	4.23
	% V COARSE SILT:	1.02	1.53	0.69	0.41	2.80
	% COARSE SILT:	1.66	3.29	1.72	0.96	4.37
	% MEDIUM SILT:	2.10	3.84	2.01	1.20	5.65
	% FINE SILT:	2.04	3.71	2.04	1.30	5.42
	% V FINE SILT:	0.80	1.38	0.82	0.54	2.17
	% CLAY:	0.04	0.01	0.02	0.01	0.09

SAMPLE	PARAMETER	SG16_5	SG16_6	SG17_4	SG23_2	SG23_3
SAMPLE TYPE:		Unimodal, Very Poorly Sorted	Bimodal, Very Poorly Sorted	Bimodal, Very Poorly Sorted	Trimodal, Very Poorly Sorted	Unimodal, Poorly Sorted
TEXTURAL GROUP:		Muddy Sandy Gravel	Gravelly Muddy Sand	Gravelly Muddy Sand	Gravelly Muddy Sand	Gravelly Sand
SEDIMENT NAME:		Coarse Silty Sandy Very Fine Gravel	Very Fine Gravelly Medium Silty Medium Sand	Very Fine Gravelly Medium Silty Medium Sand	Medium Gravelly Medium Silty Very Coarse Sand	Very Fine Gravelly Very Coarse Sand
FOLK AND WARD METHOD (μm)	MEDIAN GRAIN SIZE D_{50} (μm)	1437.6	487.9	357.8	1252.09	1175.7
	MEAN GRAIN SIZE (μm)	766.5	442.6	168.995	1393.01	821.21
	SORTING	5.746	4.069	8.062	6.530	3.166
	SKEWNESS	-0.597	-0.298	-0.408	-0.145	-0.643
	KURTOSIS	1.817	1.640	0.863	1.922	2.071
FOLK AND WARD METHOD (ø)	MEDIAN GRAIN SIZE D_{50} (ø):	-0.524	1.035	1.483	-0.324	-0.234
	MEAN GRAIN SIZE (ø):	0.384	1.176	2.565	-0.478	0.284
	SORTING	2.522	2.025	3.011	2.707	1.663
	SKEWNESS	0.597	0.298	0.408	0.145	0.643
	KURTOSIS	1.817	1.640	0.863	1.922	2.071
FOLK AND WARD METHOD (Description)	MEAN:	Coarse Sand	Medium Sand	Fine Sand	Very Coarse Sand	Coarse Sand
	SORTING:	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Poorly Sorted
	SKEWNESS:	Very Fine Skewed	Fine Skewed	Very Fine Skewed	Fine Skewed	Very Fine Skewed
	KURTOSIS:	Very Leptokurtic	Very Leptokurtic	Platykurtic	Very Leptokurtic	Very Leptokurtic
BULK GRAIN SIZE	% GRAVEL:	30.77	5.71	8.19	25.72	7.75
	% SAND:	55.18	80.69	61.64	65.54	86.08
	% MUD:	14.05	13.60	30.17	8.74	6.16
	% V COARSE GRAVEL:	0.00	0.00	0.00	0.00	0.00
	% COARSE GRAVEL:	0.00	0.00	0.00	0.00	0.00
	% MEDIUM GRAVEL:	0.76	0.00	2.15	16.29	0.39
	% FINE GRAVEL:	6.40	0.70	2.37	0.19	0.00
	% V FINE GRAVEL:	23.61	5.01	3.67	9.24	7.36
	% V COARSE SAND:	38.86	19.19	8.11	43.13	64.53
	% COARSE SAND:	6.37	24.08	20.74	5.82	3.70
	% MEDIUM SAND:	4.23	25.94	23.58	10.38	9.58
	% FINE SAND:	3.35	9.83	7.12	5.48	7.38
	% V FINE SAND:	2.37	1.65	2.09	0.72	0.89
	% V COARSE SILT:	2.76	2.11	4.93	1.01	0.70
	% COARSE SILT:	3.73	3.05	7.27	1.71	1.26
	% MEDIUM SILT:	3.64	3.84	8.11	2.49	1.73
	% FINE SILT:	2.86	3.35	6.97	2.47	1.74
	% V FINE SILT:	1.03	1.23	2.76	1.01	0.70
	% CLAY:	0.03	0.02	0.13	0.05	0.03

SAMPLE	PARAMETER	SG23_4	SG26_2	SG26_4	SG26_6	SG32_1
SAMPLE TYPE:		Bimodal, Poorly Sorted	Unimodal, Moderately Sorted	Unimodal, Moderately Sorted	Unimodal, Moderately Well Sorted	Unimodal, Very Poorly Sorted
TEXTURAL GROUP:		Gravelly Sand	Sandy Gravel	Sandy Gravel	Gravelly Sand	Gravelly Muddy Sand
SEDIMENT NAME:		Very Fine Gravelly Very Coarse Sand	Sandy Very Fine Gravel	Sandy Very Fine Gravel	Very Fine Gravelly Very Coarse Sand	Very Fine Gravelly Medium Silty Very Coarse Sand
FOLK AND WARD METHOD (μm)	MEDIAN GRAIN SIZE D_{50} (μm)	1153.93	1792.98	1534.13	1445.64	1279.3
	MEAN GRAIN SIZE (μm)	826.26	1822.71	1612.14	1552.41	928.402
	SORTING	3.230	1.856	1.862	1.580	4.293
	SKEWNESS	-0.615	-0.111	0.011	0.227	-0.517
	KURTOSIS	1.640	1.493	1.582	1.270	2.518
FOLK AND WARD METHOD (ø)	MEDIAN GRAIN SIZE D_{50} (ø):	-0.207	-0.842	-0.617	-0.532	-0.355
	MEAN GRAIN SIZE (ø):	0.275	-0.866	-0.689	-0.635	0.107
	SORTING	1.692	0.892	0.897	0.660	2.102
	SKEWNESS	0.615	0.111	-0.011	-0.227	0.517
	KURTOSIS	1.640	1.493	1.582	1.270	2.518
FOLK AND WARD METHOD (Description)	MEAN:	Coarse Sand	Very Coarse Sand	Very Coarse Sand	Very Coarse Sand	Coarse Sand
	SORTING:	Poorly Sorted	Moderately Sorted	Moderately Sorted	Moderately Well Sorted	Very Poorly Sorted
	SKEWNESS:	Very Fine Skewed	Fine Skewed	Symmetrical	Coarse Skewed	Very Fine Skewed
	KURTOSIS:	Very Leptokurtic	Leptokurtic	Very Leptokurtic	Leptokurtic	Very Leptokurtic
BULK GRAIN SIZE	% GRAVEL:	9.14	41.05	30.08	23.71	21.45
	% SAND:	84.25	55.25	65.86	74.58	67.23
	% MUD:	6.60	3.70	4.06	1.71	11.32
	% V COARSE GRAVEL:	0.00	0.00	0.00	0.00	0.00
	% COARSE GRAVEL:	0.00	0.00	0.00	0.00	0.00
	% MEDIUM GRAVEL:	0.00	1.14	1.90	1.55	0.57
	% FINE GRAVEL:	1.08	4.74	4.35	3.02	5.22
	% V FINE GRAVEL:	8.06	35.16	23.82	19.14	15.66
	% V COARSE SAND:	57.42	50.07	56.77	67.56	49.69
	% COARSE SAND:	6.68	3.23	7.34	6.19	7.91
	% MEDIUM SAND:	12.80	1.01	0.92	0.32	5.25
	% FINE SAND:	6.79	0.29	0.29	0.21	2.68
	% V FINE SAND:	0.55	0.65	0.54	0.29	1.71
	% V COARSE SILT:	0.94	1.05	0.77	0.32	1.85
	% COARSE SILT:	1.41	1.26	1.16	0.45	2.81
	% MEDIUM SILT:	1.82	0.86	1.14	0.46	3.08
	% FINE SILT:	1.71	0.45	0.79	0.37	2.54
	% V FINE SILT:	0.69	0.09	0.20	0.11	0.99
	% CLAY:	0.03	0.00	0.00	0.00	0.05

SAMPLE	PARAMETER	SG34_2	SG64_1	SG65_2	SG66_1	NG41_1
SAMPLE TYPE:		Polymodal, Very Poorly Sorted	Unimodal, Poorly Sorted	Bimodal, Very Poorly Sorted	Bimodal, Very Poorly Sorted	Bimodal, Poorly Sorted
TEXTURAL GROUP:		Gravelly Muddy Sand	Slightly Gravelly Muddy Sand	Slightly Gravelly Muddy Sand	Slightly Gravelly Muddy Sand	Sandy Mud
SEDIMENT NAME:		Very Fine Gravelly Medium Silty Medium Sand	Slightly Very Fine Gravelly Medium Silty Fine Sand	Slightly Very Fine Gravelly Medium Silty Medium Sand	Slightly Medium Gravelly Medium Silty Fine Sand	Very Fine Sandy Very Coarse Silt
FOLK AND WARD METHOD (μm)	MEDIAN GRAIN SIZE D_{50} (μm)	293.9	204.3	264.99	224.1	37.8
	MEAN GRAIN SIZE (μm)	211.639	202.746	147.10	165.305	34.868
	SORTING	6.230	2.777	5.441	4.515	3.909
	SKEWNESS	-0.297	-0.225	-0.471	-0.314	-0.083
	KURTOSIS	1.248	1.992	1.549	1.999	0.791
FOLK AND WARD METHOD (ø)	MEDIAN GRAIN SIZE D_{50} (ø):	1.766	2.292	1.916	2.158	4.726
	MEAN GRAIN SIZE (ø):	2.240	2.302	2.765	2.597	4.842
	SORTING	2.639	1.473	2.444	2.175	1.967
	SKEWNESS	0.297	0.225	0.471	0.314	0.083
	KURTOSIS	1.248	1.992	1.549	1.999	0.791
FOLK AND WARD METHOD (Description)	MEAN:	Fine Sand	Fine Sand	Fine Sand	Fine Sand	Very Coarse Silt
	SORTING:	Very Poorly Sorted	Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Poorly Sorted
	SKEWNESS:	Fine Skewed	Fine Skewed	Very Fine Skewed	Very Fine Skewed	Symmetrical
	KURTOSIS:	Leptokurtic	Very Leptokurtic	Very Leptokurtic	Very Leptokurtic	Platykurtic
BULK GRAIN SIZE	% GRAVEL:	5.15	0.59	1.52	4.45	0.00
	% SAND:	75.71	88.13	76.37	78.28	38.18
	% MUD:	19.14	11.28	22.11	17.26	61.82
	% V COARSE GRAVEL:	0.00	0.00	0.00	0.00	0.00
	% COARSE GRAVEL:	0.00	0.00	0.00	0.00	0.00
	% MEDIUM GRAVEL:	1.48	0.00	0.00	2.80	0.00
	% FINE GRAVEL:	1.73	0.06	0.74	0.57	0.00
	% V FINE GRAVEL:	1.95	0.52	0.78	1.08	0.00
	% V COARSE SAND:	15.73	0.97	5.95	3.17	0.00
	% COARSE SAND:	14.16	9.02	15.03	9.50	0.10
	% MEDIUM SAND:	19.80	26.78	30.18	27.36	4.97
	% FINE SAND:	18.95	40.20	21.39	30.43	14.57
	% V FINE SAND:	7.08	11.15	3.82	7.82	18.53
	% V COARSE SILT:	2.41	0.78	2.88	1.98	16.03
	% COARSE SILT:	4.21	2.89	4.73	3.96	15.14
	% MEDIUM SILT:	5.33	3.20	6.15	4.71	14.36
	% FINE SILT:	5.09	3.14	5.91	4.69	11.67
	% V FINE SILT:	2.02	1.26	2.35	1.89	4.44
	% CLAY:	0.08	0.01	0.10	0.05	0.18

SAMPLE	PARAMETER	NG42_2	NG43_1
SAMPLE TYPE:		Bimodal, Poorly Sorted	Bimodal, Very Poorly Sorted
TEXTURAL GROUP:		Sandy Mud	Slightly Gravelly Muddy Sand
SEDIMENT NAME:		Very Fine Sandy Medium Silt	Slightly Fine Gravelly Medium Silty Fine Sand
FOLK AND WARD METHOD (μm)	MEDIAN GRAIN SIZE D_{50} (μm)	32.0	101.7
	MEAN GRAIN SIZE (μm)	30.230	62.072
	SORTING	3.886	5.249
	SKEWNESS	-0.062	-0.372
	KURTOSIS	0.744	0.688
FOLK AND WARD METHOD (ø)	MEDIAN GRAIN SIZE D_{50} (ø):	4.964	3.297
	MEAN GRAIN SIZE (ø):	5.048	4.010
	SORTING	1.958	2.392
	SKEWNESS	0.062	0.372
	KURTOSIS	0.744	0.688
FOLK AND WARD METHOD (Description)	MEAN:	Coarse Silt	Very Coarse Silt
	SORTING:	Poorly Sorted	Very Poorly Sorted
	SKEWNESS:	Symmetrical	Very Fine Skewed
	KURTOSIS:	Platykurtic	Platykurtic
BULK GRAIN SIZE	% GRAVEL:	0.00	1.91
	% SAND:	35.88	54.30
	% MUD:	64.12	43.79
	% V COARSE GRAVEL:	0.00	0.00
	% COARSE GRAVEL:	0.00	0.00
	% MEDIUM GRAVEL:	0.00	0.00
	% FINE GRAVEL:	0.00	1.11
	% V FINE GRAVEL:	0.00	0.80
	% V COARSE SAND:	0.00	1.24
	% COARSE SAND:	0.00	1.87
	% MEDIUM SAND:	2.42	17.60
	% FINE SAND:	14.47	23.47
	% V FINE SAND:	19.00	10.11
	% V COARSE SILT:	14.61	6.41
	% COARSE SILT:	14.61	9.37
	% MEDIUM SILT:	15.48	11.68
	% FINE SILT:	13.72	11.35
	% V FINE SILT:	5.46	4.74
	% CLAY:	0.24	0.25

ANNEX 2: SPECIES DATA

Taxa (abundance per 0.1m^2)	SG 04_ 1	SG 05_ 2	SG 05_ 4	SG 05_ 5	SG 10_ 1	SG 14_ 2	SG 14_ 4	SG 14_ 5	SG 15_ 1	SG 16_ 1	SG 16_ 5	SG 16_ 6	SG 23_ 2	SG 23_ 3	SG 23_ 4	SG 26_ 2	SG 26_ 4	SG 26_ 6	SG 32_ 1	SG 34_ 2	NG 41_ 1	NG 42_ 2	NG 43_ 1	SG 64_ 1	SG 65_ 2	SG 66_ 1
Virgularia mirabilis															2											
Cerianthus lloydii										1				1					1			1				
Edwardsiidae sp.		1						2	1	1				1	7	2		1					1			
NEMERTEA spp.	2	3	3		2		1	4	2		6	3		1	1	1	1	2	5	4		1	5	4	1	4
Nematoda spp.										1	10	2		2		12	11	2		4				4	1	1
Golfingia elongata						1																			1	
Thysanocardia procera					2				2						1											1
Phascolion strombus																				1						
POLYCHAETA																					P					
Pisione remota																12	12	11								
Aphrodita aculeata juv.						1		1											1							
Polynoidae sp.	1									1	2													1		
Gattyana cirrhosa					1				1					1			1									
Harmothoe spp.			1										1	1		1			1		1					
Harmothoe extenuata											1										1					
Harmothoe impar																								2		
Malmgreniella lunulata																1		2								
Malmgreniella mcintoshi											1															
Pholoe baltica	3				1					1	1	1	1						1	2				1		
Sthenelais limicola							1		1																1	1
Eteone longa											1	1			1											
Hypereteone foliosa																			1							
Chaetoparia nilssoni									1																	
Eulalia expusilla											1															
Eulalia mustela	1										3	1				1	1		1							
Eumida sanguinea									1										2					1		
Glycera alba						1							1							1					1	1
Glycera fallax										2	1		1		1											
Glycera lapidum	8									1	6	3	3		1	6	2	9	1	2						
Glycera unicornis		1		1	1	1	2													2	2	1	1	1		
Goniadidae sp.									1										2							
Goniada maculata	2	1				2	1		2	4	1		4	4	1					1			1	2	2	3
Nereimyra punctata																								1		
Ophiodromus flexuosus					1																					
Podarkeopsis capensis						1		1																		
Psamathe fusca																	1									
Ancistrosyllis groenlandica			1	1																						
Syllis cornuta										1	2									2						1
Syllis armillaris											1					3	5	2								
Syllis variegata											1															
Pionosyllis compacta																1										
Exogone dispar																								1		
Exogone verugera										1		1		1	2				1	1						
Sphaerosyllis sp.	1																									
Sphaerosyllis taylori											8					3		2								
Eunereis longissima																		1								

Taxa (abundance per 0.1m^2)	SG 04_ 1	SG 05_ 2	SG 05_ 4	SG 05_ 5	SG 10_ 1	SG 14_ 2	SG 14_ 4	SG 14_ 5	SG 15_ 1	SG 16_ 1	SG 16_ 5	SG 16_ 6	SG 23_ 2	SG 23_ 3	SG 23_ 4	SG 26_ 2	SG 26_ 4	SG 26_ 6	SG 32_ 1	SG 34_ 2	NG 41_ 1	NG 42_ 2	NG 43_ 1	SG 64_ 1	SG 65_ 2	SG 66_ 1
Nereis zonata													1													
Nephtys sp. juv.		2		1			2												1		4		1			
Nephtys hombergii								1																		
Nephtys incisa			1	1		1															2	3				
Nephtys kersivalensis					1			1	1										1	3				1	2	
Aglaophamus agilis																1										
Onuphidae sp.																			1							
Hyalinoecia tubicola						1		1			1															
Aponuphis bilineata											1	1			1											
Nothria conchylega																				2						
Marphysa bellii																										1
Nematonereis unicornis	3										14			1					6	1						
Lumbrineridae						1			P																	
Lumbrineris cingulata											18			3						2				3		1
Scoletoma fragilis																1				1						
Abyssoninoe hibernica	3	5	5	2	1		2				2								15	1	6	7	2			
Schistomeringos rudolphi																1										
Notocirrus scoticus										1					1											
Protodorvillea kefersteini																	1	2								
Aricidea minuta									1															1		
Aricidea albatrossae												1														
Aricidea cerrutii												1							2							
Aricidea laubieri					1																					
Aricidea simonae	1						1	1		1					1				1							
Levinsenia gracilis		1																								
Paradoneis lyra	1								1															3		
Poecilochaetus serpens					1	2									1											
Spionidae sp.						2	2					1														2
Aonides oxycephala											1															
Aonides paucibranchiata						3	3	4	1	7	1	1	2	2	1	1	1	2	2						3	2
Laonice sp. juv.											1		1				1	1					1	1		
Laonice bahusiensis	1															1	1			1				2		
Polydora caeca																			1							
Polydora caulleryi																			1							
Prionospio sp.		2															2						5			
Prionospio fallax			1	1					1															1		
Scolelepis bonnieri							1	1																		
Scolelepis squamata		2	1																	1						
Spio decorata														1												
Spiophanes bombyx							1							1												
Spiophanes kroyeri	2	5	1	4	3	2		2	1		7	2	8	3	4				1	2			6	5	3	3
Magelona alleni					3	1	1	2	3															1		1
Magelona minuta		1						1																	1	
Caulleriella alata																									1	
Chaetozone zetlandica					1		2	1	1			1									2	8				
Chaetozone gibber	1				7	15	6	7	7	22		1	11	19	11				3	8			8	6	4	13
Chaetozone setosa		2	6	1		3	3		1					1	2						6	9	3	1	1	2
Dodecaceria sp.							2					1			4					3				5		
Monticellina dorsobranchialis	1	1	3	3	1							1		1	1						2	2				

Taxa (abundance per 0.1m^2)	SG 04_ 1	SG 05_ 2	SG 05_ 4	SG 05_ 5	SG 10_ 1	SG 14_ 2	SG 14_ 4	SG 14_ 5	SG 15_ 1	SG 16_ 1	SG 16_ 5	SG 16_ 6	SG 23_ 2	SG 23_ 3	SG 23_ 4	SG 26_ 2	SG 26_ 4	SG 26_ 6	SG 32_ 1	SG 34_ 2	NG 41_ 1	NG 42_ 2	NG 43_ 1	SG 64_ 1	SG 65_ 2	SG 66_ 1
Aphelochaeta sp. A											1															
Caulleriella killariensis		1	2			1			2	1			1	1					3		1	1	2	2		
Diplocirrus glaucus		8	6	3	3								1							1		1				1
Diplocirrus stopbowitzi											4								1							
Mediomastus fragilis	5					7	1		6	1	5			3	4				4	14			5	1	1	4
Notomastus sp.	3	1	1	1					2	1	6	1	3	2				2	2	1			2	1		1
Maldanidae sp.		2											1													
Praxillura longissima																				1						
Clymenura johnstoni					1																					
Euclymene droebachiensis														1										1		
Euclymene oerstedii					1		2		3														1	2		
Praxillella affinis																							1			
Praxillella gracilis		1																								
Ophelina acuminata										1			1													
Scalibregma inflatum				1			1	1															1			
Polygordius appendiculatus																11	12	11								
Galathowenia oculata					47	60	125	182	25	9		6	74	76	83					67			4	52	109	229
Owenia fusiformis					19	26	127	190	103	3	1		8	21	22				2	16			6	31	70	215
Amphictene auricoma														1												
Lagis koreni					1								1													
Melinna elisabethae																								1		
Ampharete lindstroemi	2		1		3	4	4	1	1	2		1	5	2	2					2			5		4	3
Amphicteis gunneri										3										1						1
Eupolymnia nesidensis	1																	3								
Terebellides stroemi	3				2			1		2		5	1						3	2		1	4			
Amphitrite cirrata																	2									
Amphitrite figulus																								3		
Lanice conchilega	1				2										1											
Pista sp.											1															
Pista cristata										1			2							1					1	
Polycirrus sp.					1			1	4			2		6	2	4	1						1	1		1
Sabellidae sp. juv./indet																								2		
Paradialychone filicaudata						1														1						
Jasmineira caudata										1		1														
Hydroides norvegicus																										1
Anoplodactylus petiolatus						1						1													2	
Copepoda sp.	1	1							1	1	5	4							2						3	
Monoculodes carinatus											1															
Pontocrates altamarinus															2											
Pontocrates arenarius																		1								
Westwoodilla caecula	1				2		1													2						
Leucothoe incisa																	4	1					1			
Urothoe elegans														5	2									2		
Harpinia antennaria		1																								
Acidostoma obesum									1	1														3		
Hippomedon denticulatus																1		1								
Orchomene humilis																								1		
Orchomene nana												1														
Atylus vedlomensis	1										3		1			4	9	3	2							

Taxa (abundance per 0.1m^2)	SG 04_1	SG 05_2	SG 05_4	SG 05_5	SG 10_1	SG 14_2	SG 14_4	SG 14_5	SG 15_1	SG 16_1	SG 16_5	SG 16_6	SG 23_2	SG 23_3	SG 23_4	SG 26_2	SG 26_4	SG 26_6	SG 32_1	SG 34_2	NG 41_1	NG 42_2	NG 43_1	SG 64_1	SG 65_2	SG 66_1
Ampelisca sp.										1					1											
Ampelisca brevicornis												1														
Ampelisca diadema					2		1		1				1											7	4	
Ampelisca spinipes	3			1		1						2	3				1		4					1	1	
Cheirocratus sp.												2							1							
Eriopisa elongata															1							1	1			
Othomaera othonis														2										1		
Gammaropsis maculata																								1		
Aoridae sp.										1				1											1	
Leptocheirus hirsutimanus											1															
Corophiidae sp.					1																					
Pariambus typicus																								1		
Phtisica marina																								1		
Gnathia sp.														1		2								1		
Gnathia oxyuraea																1	1	1	1	1				1		
Eurydice pulchra																		1								
Astacilla longicornis																								3		
Tanaopsis graciloides						1								1												
Bodotria scorpioides											1	1														
Iphinoe serrata					3				1														3			
Eudorella truncatula																					1					
Diastylis cornuta					1																					
Diastylis tumida													2											1		
Diastyloides biplicata									1											1			1			
Caridion gordoni													1													
Pontophilus spinosus													1													
Nephrops norvegicus																						1				
Calocaris macandreae																					2	3				
Callianassa subterranea															1											
Anapagurus laevis							1																			
Galathea intermedia	1													1												
Galathea nexa																								1		
Munida sp.																								1		
Ebalia cranchii																		1								
Ebalia tuberosa																			1							
Corystes cassivelaunus juv.																							1		1	1
Atelecyclus rotundatus juv.										2					1											
Chaetoderma nitidulum			3		1															1	1			1		
Leptochiton asellus	1												2						5							
Emarginula fissura																								1		
Turritella communis			1																							
Calyptraea chinensis							4																			
Euspira montagui	1										1							2		1						
Euspira pulchella					2								1			3	2							1		1
Odostomia plicata							1																			
Odostomia turrita				4																		1				
Acteon tornatilis																									1	
Cylichna cylindracea									1	1																
Philine aperta																				1					1	

Taxa (abundance per 0.1m^2)	SG 04_ 1	SG 05_ 2	SG 05_ 4	SG 05_ 5	SG 10_ 1	SG 14_ 2	SG 14_ 4	SG 14_ 5	SG 15_ 1	SG 16_ 1	SG 16_ 5	SG 16_ 6	SG 23_ 2	SG 23_ 3	SG 23_ 4	SG 26_ 2	SG 26_ 4	SG 26_ 6	SG 32_ 1	SG 34_ 2	NG 41_ 1	NG 42_ 2	NG 43_ 1	SG 64_ 1	SG 65_ 2	SG 66_ 1
Onchidoridídae sp. juv.																								1		
Antalis entalis					4	1																		4		
Nucula nitidosa	1	1						1																	1	
Nucula nucleus														1										1		
Nucula sulcata		2	3																		7	6				
Ennucula tenuis								1													1					
Yoldiella philippiana		1			4		1	1	4				4	2									4	10	4	7
Glycymeris glycymeris juv.																2		1								
Modiolus sp. juv.																								2		
Crenella decussata																4	2	2								
Limatula subauriculata																21	23	16								
Palliolum furtivum																		2								
Thyasira sp.								1																		
Thyasira flexuosa		1				2	1		1											1	1				2	1
Axinulus croulinensis					1																					
Mendicula ferruginosa							1	1																		
Tellimya ferruginosa						1		2												3						1
Kurtiella bidentata					1	1		1			1			1												
Goodallia triangularis																9	5	5								
Parvicardium scabrum																								1		
Spisula sp. juv.																8	3	3								
Spisula elliptica															1	2	5	1								
Phaxas pellucidus					2	1	2	2	1	1			2	1	2									1	4	1
Arcopagia crassa																	1									
Moerella pygmaea																19	11	7								
Gari sp. juv.																6		2								
Gari tellinella																4	9	4								
Abra alba	1				7	2	2		1												1					1
Abra nitida		28	1	9	22		2	1	1											3	4		16	1	5	
Abra prismatica										6		2	1	1	1									1		
Arctica islandica																								2		
Clausinella fasciata juv.																3	2									
Timoclea ovata											1		1						2				1	1		1
Tapes rhomboides																1										
Dosinia sp. juv.					2	1		2						1										5		
Corbula gibba					4					1													2	2		
Hiatella arctica																								1		
Thraciacea sp. juv.					1	1										6	2			1						
Thracia phaseolina																2										
Phoronis sp.					1	3	4	5		2	1			2	1					1			3		3	4
Ophiothrix fragilis																								2		
Ophiactis balli													2													
Amphiuridae spp. juv.					2					1						39	6		1	4			3		1	
Amphiura chiajei															2								3	1		
Amphiura filiformis	2				4				2	3									1					2		2
Amphipholis squamatus	1												2			3	15									
Ophiuridae sp. juv.													2							1						
Ophiocten affinis	1																			1			3	1		2
Ophiura ophiura																				1						

Taxa (abundance per 0.1m^2)	SG 04_ 1	SG 05_ 2	SG 05_ 4	SG 05_ 5	SG 10_ 1	SG 14_ 2	SG 14_ 4	SG 14_ 5	SG 15_ 1	SG 16_ 1	SG 16_ 5	SG 16_ 6	SG 23_ 2	SG 23_ 3	SG 23_ 4	SG 26_ 2	SG 26_ 4	SG 26_ 6	SG 32_ 1	SG 34_ 2	NG 41_ 1	NG 42_ 2	NG 43_ 1	SG 64_ 1	SG 65_ 2	SG 66_ 1
Psammechinus miliaris juv.	2																									
Echinocyamus pusillus	1										3	1				5	2							2	1	1
Echinocardium sp. juv.					1			1		1	1	2	1	2						3						1
Echinocardium cordatum																									2	
Pseudothyone raphanus						1																				
Thyone fuscus																1				1						
Thyonidium drummondii													1							1				2		
Leptosynapta bergensis					2		2		1					4						3				4	1	1
Leptosynapta decaria	2																									
Branchiostoma sp.																	1	1								
Ammodytidae sp.																1	1	1								
Porifera sp.																								P		
Cliona sp.	P												P				P									
Campanulariidae sp.					P																					
Verruca stroemi	P										P		P											P		
Balanus crenatus	P																							P		P
Crisia spp.																								P		
Disporella hispida																	P									
Cellaria sinuosa																				P						
Phaeostachys spinifera																								P		
Schizomavella sp.											P						P							P		
Fenestrulina malusii																								P		
Cnemidocarpa mollis											1															
Dendrodoa grossularia	P																									

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