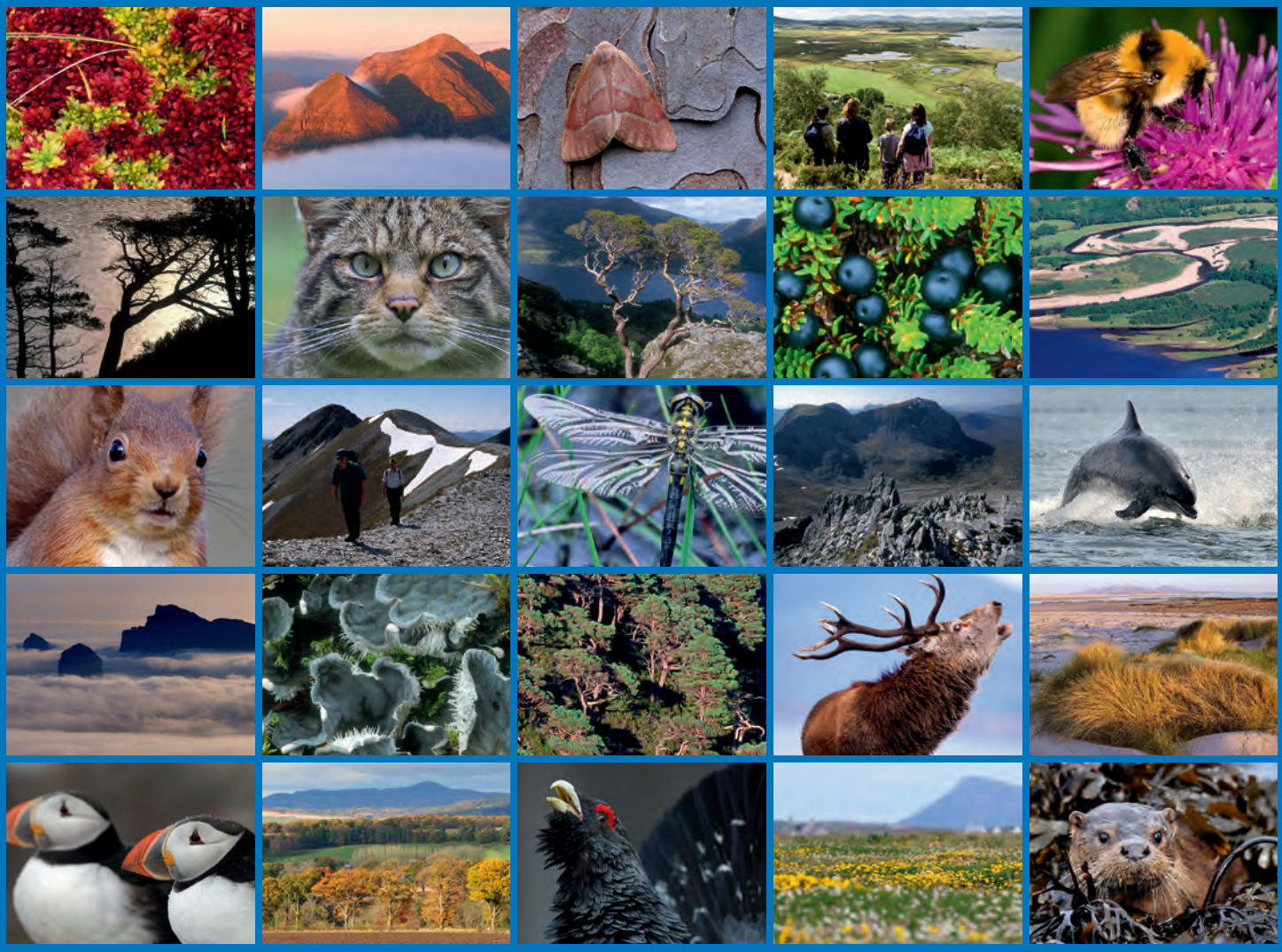
Scottish Natural Heritage
Commissioned Report No. 504

Infaunal analysis of grab samples collected from Canna, Small Isles, June 2011



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COMMISSIONED REPORT

Commissioned Report No. 504

Infaunal analysis of grab samples collected from Canna, Small Isles, in June 2011

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COMMISSIONED REPORT

Summary

Infaunal analysis of grab samples collected from Canna, Small Isles, in June 2011

Commissioned Report No. 504
Contractor: Seastar Survey Ltd.
Year of publication: 2012

Background

Scottish Natural Heritage (SNH) and the Joint Nature Conservation Committee (JNCC) have generated a draft list of important habitats and species in Scottish waters in order to help guide the selection of Marine Protection Areas (MPAs). A number of ongoing research projects are collating existing data on the distribution of Priority Marine Features (PMFs). A modest programme of new survey work began in 2010 to validate the continued presence of PMFs and to supplement existing records, including a survey conducted by SNH in the Sound of Canna. As part of this survey a number of grab samples were collected.

Seastar Survey Ltd. was contracted by SNH to undertake the infaunal analysis of the grab samples taken during the survey of the Sound of Canna, including identifying all the faunal components within the grab samples, sediment particle size analysis (PSA), and assigning a biotope to each sample. This report presents the results from these analyses, and a brief interpretation of the data.

Main findings

- A total of 21 Day grab sediment samples were collected during the 2011 Canna survey.
- The sediment at the majority of stations was classified as 'sand' with > 50 % sand fraction. Only one location (G01) was classified as 'sandy mud'.
- The macrofauna was dominated by Annelida (48.8 %) followed by Mollusca (18.9 %) and Crustacea (15.7 %).
- The bivalve *Abra nitida* and the polychaete *Lumbrineris gracilis* were the most abundant species. Other relatively abundant taxa were *Amphiura filiformis, Pholoe synophthalmica* and *Stenothoe marina*.
- Species diversity was low to medium but equitability was found to be high overall;
- Six biotope complexes / biotopes were identified: **SS.SBR.SMus.ModMx**, **SS.SMu.CSaMu.AfilMysAnit**, **SS.SSa.OSa**, **SS.SSa.OSa.OfusAfil**, **SS.SMu.OMu** and **SS.SCS.CCS.MedLumVen**.
- The following PMFs and MPA search features were found; **SS.SBR.SMus.ModMx** and **SS.SSa.OSa.OfusAfil** as well as *Leptometra celtica* and *Arctica islandica*, the former biotope with medium to high abundance of *Modiolus modiolus*.

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TABLE OF CONTENTS

1 INTRODUCTION 1
1.1 Background and objectives 1

2 METHODS 1
2.1 Infaunal sample collection 1
2.2 Sediment sample analysis 4
2.2.1 Sediment Particle Size Analysis (PSA) 4
2.2.2 Macrofaunal processing and analysis 5
2.2.3 Assignment of biotopes 5

3 RESULTS 6
3.1 Particle size analysis 6
3.2 Macrofaunal analysis 14
3.2.1 Macrofaunal abundance 14
3.2.2 Diversity 16
3.2.3 Macrofaunal composition 18
3.2.4 Limitations 20
3.3 Designation of biotopes 21
3.4 Comparisons between macrofaunal trends and the abiotic data 26

4 DISCUSSION 29
4.1 The main habitats and comparisons with the 2010 survey 29
4.2 Limitations 31

5 REFERENCES 32

This work was funded by Marine Scotland as part of the Scottish MPA project.

1 INTRODUCTION

1.1 Background and objectives

The Marine (Scotland) Act 2010 provides a framework that will help balance competing demands on our maritime environment, integrating the economic growth of industry with the need to protect Scotland's seas. Where necessary, suitable conservation measures may be implemented at the wider seas level (e.g. through marine planning); targeted at specific species (e.g. improved protection for seals); or delivered within key locations (e.g. through the identification of new Marine Protected Areas – MPAs).

To help target action under each of these three pillars, Scottish Natural Heritage (SNH) and the Joint Nature Conservation Committee (JNCC) have generated a draft focused list of habitats and species of importance in Scottish waters – the Priority Marine Features (PMFs) (see Appendix 01). To underpin the development of formal Nature Conservation MPA proposals, a number of research projects have collated existing data on the distribution of PMFs within Scotland's marine environment. In addition, a modest programme of survey work was begun in 2010 to validate the continued presence of PMFs and to supplement existing records. As part of this programme the Sound of Canna was surveyed by SNH in July 2011 aboard the SEPA vessel *Sir John Murray*, a survey which included the collection of sediment grab samples.

During 2011 a survey was undertaken by Scottish Natural Heritage (SNH) within the sound of Canna to collect video and grab samples. The analysis of video samples can be seen in Commissioned report 507 (Moore 2012). Seastar Survey Ltd. was contracted by SNH to undertake the infaunal analysis of the grab samples taken during this survey, including identifying all the faunal components within the grab samples, sediment particle size analysis (PSA), and assigning a biotope to each sample. This report presents the results from these analyses, and a brief interpretation of the data.

2 METHODS

2.1 Infaunal sample collection

The collection of infaunal samples was carried out by SNH on board the Scottish Environmental Protection Agency (SEPA) vessel the SV *Sir John Murray*. Sample stations were selected during the planning phase based on the presence of historical records of PMFs and MPA search features within the sound. Samples were collected using a 0.1 m^2 Day grab. A total of 21 grab stations were sampled between 19th – 20th June 2011 in the Sound of Canna (Table 2.1 and Figures 2.1 and 2.2 as well as the field logs in Appendix 02). The samples (examples in Figure 2.3) each had a 5 cm core subsample retrieved for particle size analysis (PSA), before being washed through a Wilson's autosieve set with a 0.5 mm mesh size. Any material retained on the sieve was transferred to a labelled container before being fixed with a buffered 4% formaldehyde solution.

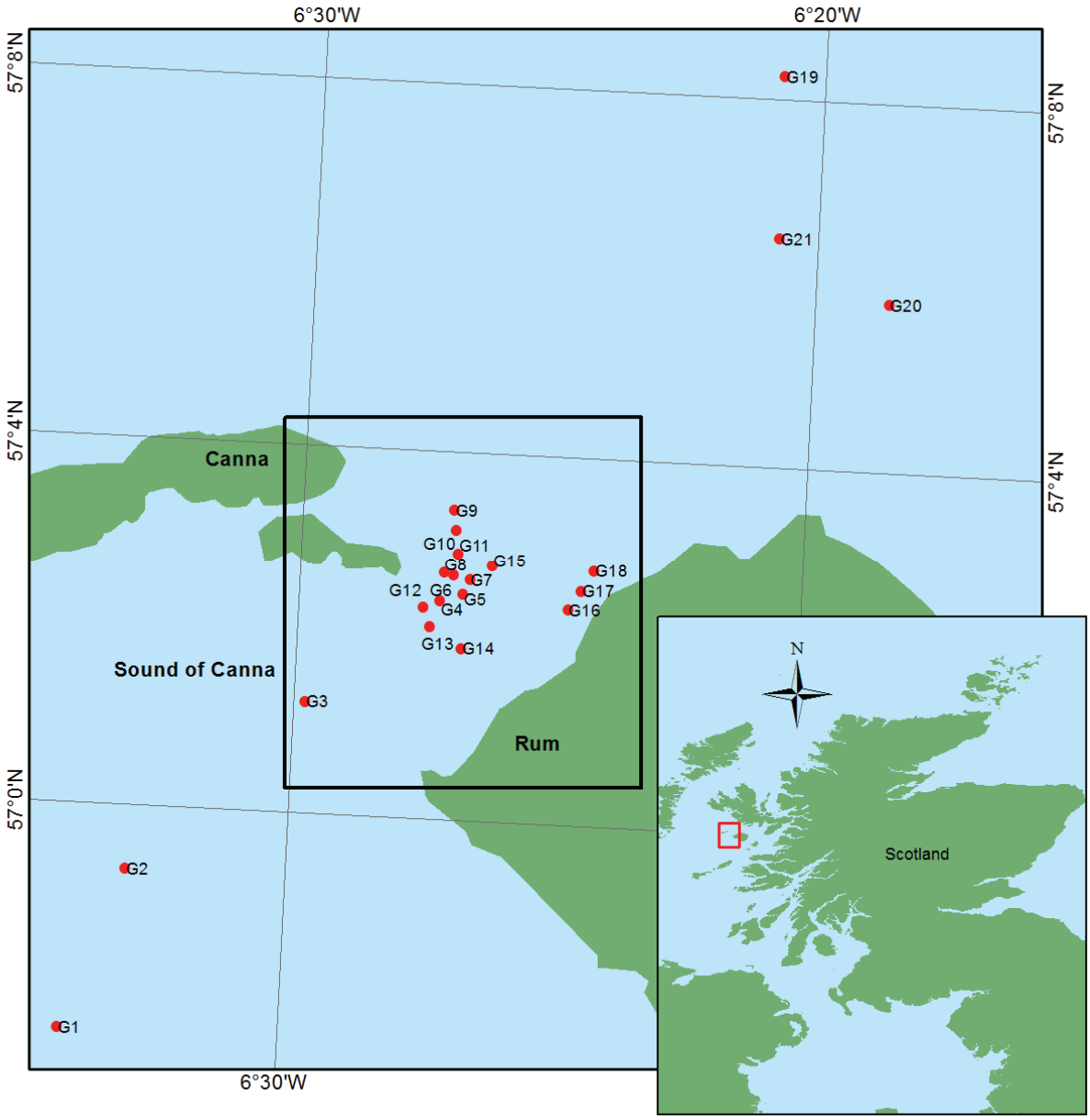

Figure 2.1. Locations of grab sampling stations for the Canna infaunal survey 2011 (black rectangle illustrating approximate size and position of figure 2.2 below).

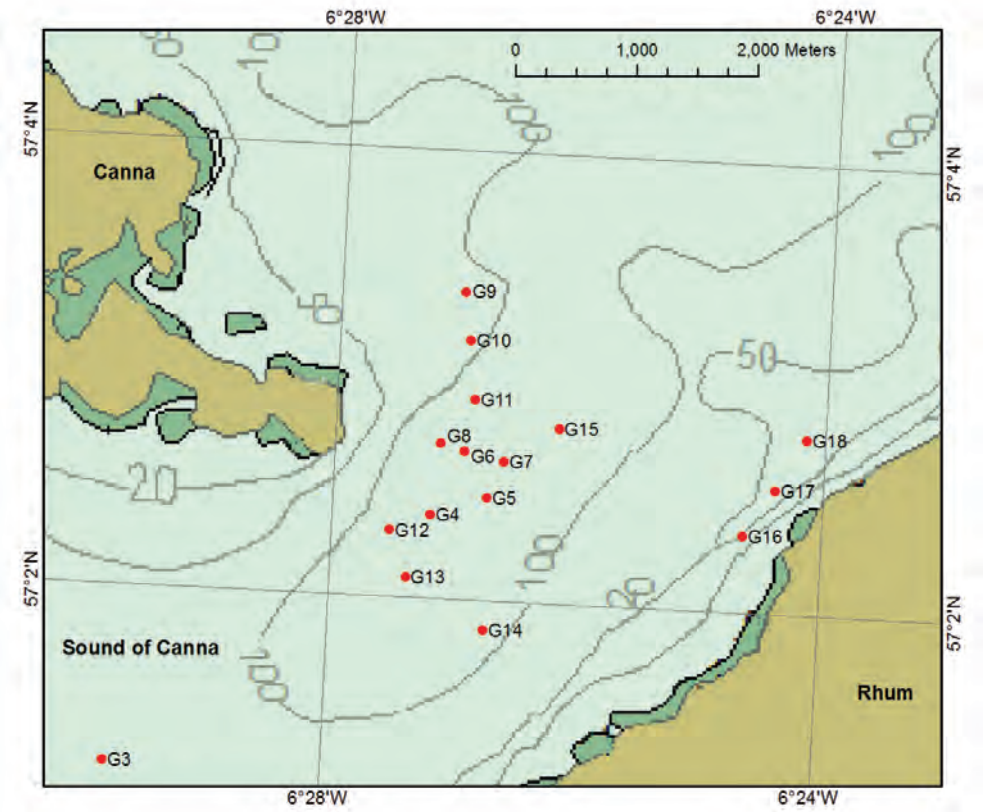

Figure 2.2. Grab sampling stations in the Sound of Canna (exclude G1, G2, G19, G20 and G21).

Table 2.1. Location of grab sites, Sound of Canna infaunal survey 2011.

Date	Station	Location	Position		Depth (m)
			Latitude	Longitude	
19/06/2011	G1	Sound of Canna	56.9592	6.5728	90
19/06/2011	G2	Sound of Canna	56.9884	6.5529	86
19/06/2011	G3	Sound of Canna	57.0202	6.4961	120
19/06/2011	G4	Sound of Canna	57.0395	6.4531	245
19/06/2011	G5	Sound of Canna	57.0409	6.4456	196
19/06/2011	G6	Sound of Canna	57.0443	6.4488	234
19/06/2011	G7	Sound of Canna	57.0437	6.4435	225
19/06/2011	G8	Sound of Canna	57.0449	6.4521	238
20/06/2011	G9	Sound of Canna	57.0562	6.4497	184
20/06/2011	G10	Sound of Canna	57.0526	6.4487	210
20/06/2011	G11	Sound of Canna	57.0483	6.4478	242
20/06/2011	G12	Sound of Canna	57.0383	6.4586	250
20/06/2011	G13	Sound of Canna	57.0348	6.4561	212
20/06/2011	G14	Sound of Canna	57.0312	6.4452	190
20/06/2011	G15	Sound of Canna	57.0463	6.4361	210
20/06/2011	G16	Sound of Canna	57.0391	6.4105	99
20/06/2011	G17	Sound of Canna	57.0425	6.4064	28
20/06/2011	G18	Sound of Canna	57.0463	6.4023	51
20/06/2011	G19	Sound of Canna	57.1376	6.3472	206
20/06/2011	G20	Sound of Canna	57.0972	6.3088	205
20/06/2011	G21	Sound of Canna	57.1082	6.3462	230

Figure 2.3. Examples of sediment grab samples collected by SNH during the Canna infaunal sampling survey 2011 (image A – station G09; image B – G16; image C – G17 and D – G18).

2.2 Sediment sample analysis

2.2.1 Sediment Particle Size Analysis (PSA)

Particle size analysis (PSA) was undertaken at Seastar Survey's laboratory, using a combination of wet and dry sieving techniques at half phi intervals as per standard protocols. The PSA followed the sediment grades used by the Marine Nature Conservation Review (MNCR) as described below (JNCC, 2012):

Pebble – medium (>8 mm)	Sand, medium (250-500 µm)
Pebble – small (4-8 mm)	Sand, fine (125-250 µm)
Granule (2-4 mm)	Sand, very fine (63-125 µm)
Sand, very coarse (1000-2000 µm)	Silt and clay (mud) (<63 µm)
Sand, coarse (500-1000 µm)	

For each sediment sample, the dry weight of the whole sediment sample was determined and any muddy samples were disaggregated using a suitable method (e.g. sodium hexametaphosphate). The sample was wet sieved on a 63 µm mesh, then dried (at 100 °C) and re-weighed to establish the weight percentage of the <63 µm fraction. The remainder of the sample was dry sieved with a nest of sieves in the range of -4 to 4 phi of mesh sizes to yield weight percentage data for particle size fractions at half phi intervals, with 63 µm being the smallest sieve size and 16 mm the maximum. The sub 63 µm fraction was then measured using a Mastersizer 2000 laser granulometer, which can analyse particles in the size range of 0.04 µm – 2000 µm. Sediment statistics were calculated using Gradistat v.4.0 (Blott and Pye, 2001).

The phi ( ) grain size measure is based on the Wentworth sediment class divisions but using $\log_2$ rather than $\log_{10}$ (see Leeder, 1982), thus = - $\log_2$ mm. The Wentworth grain size (sieve mesh size) series of 8 mm, 4 mm, 2 mm, 1 mm, 0.5 mm, 0,25 mm and 0.125 mm

are therefore calculated as 2^3, 2^2, 2^1, 2^0, 2^{-1}, 2^{-2} and 2^{-3}; giving units of -3, -2, -1, 0, 1, 2 and 3.

2.2.2 Macrofaunal processing and analysis

The processing of the macrofaunal sediment samples took place at Seastar Survey's laboratory in Southampton. Formalin was removed from the sediment samples by gentle re-sieved on 1 mm sieves. Any fauna present in the sample was sorted and picked out using trays and low-magnification microscopes. The fauna were subsequently identified to the lowest practical taxonomic level with reference to WoRMS (Appletans *et al*., 2011) for species nomenclature, and assigned an MCS biocode according to Howson and Picton (1997) were applicable. A full list of taxa encountered and abundances per sample were recorded on a standard species/ sample matrix (Appendix 03). A reference collection was created and a Quality Control exercise was carried out by Artoo Marine Ecological Consultants to check the identification results. The invertebrate specimens collected were separated by species and station, preserved in alcohol and stored in glass sample vials with polyethylene closures to facilitate their incorporation into the collections of The National Museums of Scotland.

The macrofaunal sediment data are given in number of individuals/0.1 m^2. The data analyses comprised both univariate and multivariate analyses all of which were calculated using Primer (Plymouth Routines in Multivariate Ecological Research) v 6 (Clarke and Warwick, 2001). The univariate analysis included the total number of individuals (N), total number of species (S), species diversity where the Shannon-Wiener (H'), Pielou's (J), Margalef's (d) diversity and Simpson's Dominance indices (see e.g. Gage and Tyler, 1991; Fowler and Cohen, 1992; Clarke and Warwick, 2001) were used with the natural log ($\log_e$) being the chosen parameter in the case of the Shannon-Wiener diversity index.

The multivariate analysis was carried out using cluster analysis and ordination (non-metric multi-dimensional scaling, MDS). These data were then transformed to square root to down-weigh the importance of common types of macrofauna in relation to rarer types. The transformed data were then analysed using the Bray-Curtis similarity coefficient (using Primer v.6) followed by a cluster analysis where the sites were group averaged and the resultant dendrogram plotted. Non-metric multi-dimensional scaling (MDS) was then carried out to further assess the presence of any similarities between sites (Clarke and Warwick, 2001). The SIMPER routine in PRIMER was subsequently used to assess the difference in characteristic species/ taxa in the sample clusters. Spearman's rank correlation coefficient (see e.g. Fowler and Cohen, 1992) was then used to assess any correlations with the particle size analysis variables and depth. The BIOENV routine in PRIMER was used to carry out this task on untransformed but normalised abiotic data.

2.2.3 Assignment of biotopes

A biotope was assigned to each grab station according to the Marine Biotope Classification for Britain and Ireland (Connor *et al*., 2004). The sediment type derived from the PSA results and the characteristic species identified from each sample were used to categorize the biotope for each sample. Where insufficient fauna (i.e. characterising fauna not available) were collected to adequately categorise a biotope, then the sediment type from the PSA analysis was primarily used.

3 RESULTS

3.1 Particle size analysis

The results from the particle size analysis are given in Table 3.1. The majority of samples had a low gravel component (0 – 5% by weight), with two samples composed of ~18% gravel (G5 and G18), and two samples with almost 30% gravel (G16 and G17). All the samples had a sand fraction >54%, apart from G1, which only had 48% sand. Over 50% of the sediment by weight at G1 was mud, and was the only sample to be classified as sandy mud. Mud fractions ranged from between 3 – 51%. In total, six samples were classified as muddy sand (G2, G3, G14, G19, G20 and G21), and eight samples were classified as muddy sand with some degree of gravel component (G4, G5, G6, G7, G9, G12, G13, and G15). Five samples were classified as sand with a gravel component (G8, G10, G16, G17, and G18), and one sample was classified as pure sand (G11). In general, the sediment samples were either very poorly or poorly sorted, with the exception of G11, which was moderately sorted. There was no relationship between the depth that samples were collected from and the type of sediment found. The sediment samples have been displayed on a modified Folk triangle (Folk, 1954) in Figure 3.1.

Table 3.1. Summary of the Particle Size Analysis (sediment weight by percentage) from grab samples collected by SEPA from the Sound of Canna (mud, sand and gravel refer to all size fractions within each category).

Sample	Gravel (%)	Sand (%)	Mud (%)	Depth (m)	Classification (Folk system adapted by BGS)	Sorting Index
	(Wentworth Scale)					
G1	0.00	48.58	51.42	90	Sandy Mud	Poorly Sorted
G2	0.00	62.33	38.07	86	Muddy Sand	Poorly Sorted
G3	0.46	82.55	17.43	120	Muddy Sand	Poorly Sorted
G4	1.68	83.93	14.71	245	Slightly Gravelly Muddy Sand	Poorly Sorted
G5	18.86	71.59	9.55	196	Gravelly Muddy Sand	Very Poorly Sorted
G6	2.94	84.69	12.64	234	Slightly Gravelly Muddy Sand	Poorly Sorted
G7	3.45	85.02	11.93	225	Slightly Gravelly Muddy Sand	Poorly Sorted
G8	3.29	88.04	9.15	238	Slightly Gravelly Sand	Poorly Sorted
G9	1.43	87.71	11.29	184	Slightly Gravelly Muddy Sand	Poorly Sorted
G10	4.70	87.40	9.02	210	Slightly Gravelly Sand	Poorly Sorted
G11	0.24	94.52	5.57	242	Sand	Moderately Sorted
G12	6.89	76.89	16.69	250	Gravelly Muddy Sand	Very Poorly Sorted
G13	1.45	85.93	12.64	212	Slightly Gravelly Muddy Sand	Poorly Sorted
G14	0.08	89.34	10.63	190	Muddy Sand	Poorly Sorted
G15	2.16	73.99	24.22	210	Slightly Gravelly Muddy Sand	Very Poorly Sorted
G16	28.30	68.26	3.16	99	Gravelly Sand	Very Poorly Sorted
G17	29.39	65.36	5.39	28	Gravelly Sand	Very Poorly Sorted
G18	18.19	74.09	7.69	51	Gravelly Sand	Very Poorly Sorted
G19	0.00	71.64	28.46	206	Muddy Sand	Poorly Sorted
G20	0.00	55.61	44.56	205	Muddy Sand	Very Poorly Sorted
G21	0.00	54.17	45.69	230	Muddy Sand	Very Poorly Sorted

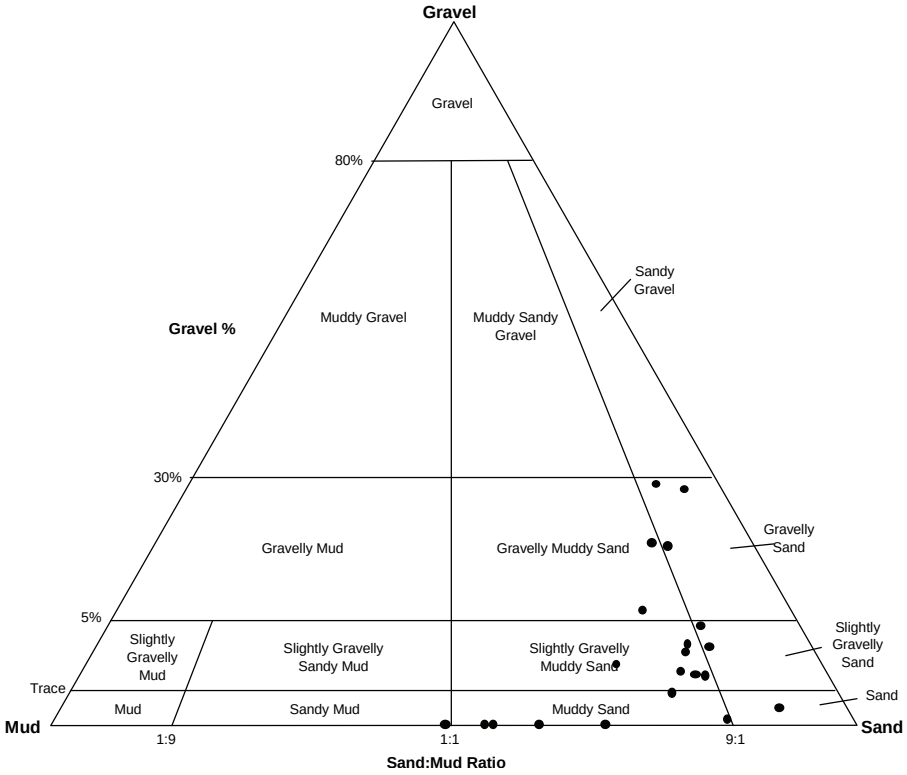

Figure 3.1. Modified Folk triangle showing classification of the Sound of Canna sediment samples (c.f. Table 3.1 and Figures 3.4 and 3.5).

Table 3.3 shows the total percentage weight for each sample for every half phi interval. The sub 63 µm fraction was further examined by laser granulometry, and the results are summarised in Table 3.2 with the clay and silt values expressed as percentages of total weight of the whole sediment samples. All samples had ~1 % or less clay, with silt representing the majority of the sub 63 µm fraction.

Table 3.2. Summary table of sub 63 µm fraction from Canna sediment samples (NB. Values for clay and silt are expressed as a percentage of the total weight of the whole sediment sample).

Station	Clay (%)	Silt (%)		
		Fine	Medium	Coarse
G1	0.90	7.22	12.63	30.67
G2	0.69	6.92	11.77	18.69
G3	0.35	4.18	6.62	6.27
G4	0.36	3.59	6.10	4.66
G5	0.21	2.49	4.36	2.49
G6	0.42	3.37	5.69	3.16
G7	0.21	3.14	5.23	3.35
G8	0.21	2.73	4.21	2.00
G9	0.23	2.94	5.20	2.94
G10	0.21	2.73	4.19	1.89
G11	0.14	1.57	2.57	1.29
G12	0.25	3.93	7.36	5.15
G13	0.21	3.52	6.01	2.90
G14	0.33	2.66	4.65	2.99
G15	0.60	6.28	10.76	6.58
G16	0.10	0.86	1.44	0.77
G17	0.08	1.26	2.70	1.35
G18	0.18	2.01	3.48	2.01
G19	0.53	6.85	11.60	9.49
G20	0.95	9.96	18.96	14.70
G21	1.14	10.85	21.13	12.56

Figures 3.2 and 3.3 (see more detailed sediment statistical descriptors in Appendix 04) illustrate the cumulative percentage sediment weight for each sample for every half phi interval (separated into two figures to simplify analysing the results). The majority of samples showed a similar cumulative frequency curve, with 70% or more of the sediment between 0.125 – 1 mm particle size. Samples from sites G1, G2, G15, G19, G20 and G21 were dominated by particles sizes of 0.125 mm or less, which represented 70% or more of the sediment by weight. Four sites (G5, G16, G17 and G18) were composed of at least 30% sediment greater than 1 mm particle size.

Figures 3.4 and 3.5 illustrate the relative positions of the sampling locations with the sediment descriptions. The results show a mixed sediment environment in the centre of the Sound of Canna with coarse sediments along the coastal fringe of the Isle of Rum. Finer sediment (sandy muds) are dominant at the stations outside (north and south) the Sound of Canna.

Table 3.3. Total percentage sediment weight of grab samples from the Sound of Canna (grey indicates 'gravel' fraction, light yellow 'sand' fraction, and brown the 'mud' fraction - NB. Processing differential results in the total percentage for each location to be excess of/less than 100%).

Location	Sieve Size (mm)															
	16	8	4	2.8	2	1.4	1	0.71	0.5	0.355	0.25	0.18	0.125	0.09	0.063	< 0.063
G1	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.19	0.68	1.86	4.06	7.99	8.67	10.06	15.02	51.42
G2	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.76	1.06	1.72	3.20	5.96	10.52	17.41	21.25	38.07
G3	0.00	0.00	0.06	0.14	0.26	1.05	3.33	5.04	6.27	7.82	11.69	16.49	16.47	8.75	5.62	17.43
G4	0.00	0.00	0.35	0.55	0.77	1.64	2.90	5.23	9.58	16.05	21.38	13.09	7.79	3.49	2.78	14.71
G5	0.00	7.20	4.54	2.86	4.27	5.65	5.88	6.93	8.44	11.06	12.64	9.72	6.62	2.66	1.98	9.55
G6	0.00	1.30	1.11	0.42	0.11	1.30	2.75	5.19	9.43	14.59	18.17	16.30	10.92	3.59	2.44	12.64
G7	0.00	0.75	0.79	0.83	1.07	3.01	4.75	6.85	9.79	12.88	15.17	14.78	11.17	3.88	2.73	11.93
G8	0.00	0.00	2.42	0.28	0.59	1.15	3.33	10.38	18.34	19.17	15.72	9.62	6.30	2.38	1.66	9.15
G9	0.00	0.00	0.35	0.46	0.62	1.64	2.70	4.37	7.92	12.53	19.92	20.05	11.59	4.23	2.75	11.29
G10	0.00	1.29	1.42	1.16	0.82	2.46	3.54	5.00	8.71	14.15	20.28	18.72	9.32	3.02	2.20	9.02
G11	0.00	0.00	0.00	0.00	0.24	0.24	0.79	2.81	7.20	14.43	29.18	29.91	8.36	0.97	0.63	5.57
G12	0.00	1.73	3.68	0.63	0.84	1.44	2.79	5.37	8.91	13.56	18.04	12.55	7.14	3.97	3.13	16.69
G13	0.00	0.00	0.40	0.43	0.63	2.08	6.25	15.12	18.59	14.90	11.74	7.42	4.99	2.68	2.16	12.64
G14	0.00	0.00	0.00	0.06	0.02	0.63	1.62	3.12	6.65	12.24	20.74	22.87	14.54	4.15	2.79	10.63
G15	0.00	0.00	0.58	0.62	0.96	1.58	1.70	2.29	3.70	6.65	11.05	15.04	16.54	9.39	6.07	24.22
G16	0.00	7.35	8.26	5.91	6.78	8.65	6.82	5.45	5.24	5.83	9.07	14.27	10.19	2.04	0.70	3.16
G17	0.00	14.01	7.86	2.81	4.71	6.22	7.42	7.66	8.88	11.23	9.59	8.79	3.32	1.32	0.93	5.39
G18	0.00	2.27	3.97	4.55	7.40	8.75	7.32	6.69	5.84	4.89	5.55	10.34	15.68	6.21	2.83	7.69
G19	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.10	1.20	4.74	10.89	22.11	19.64	8.06	4.87	28.46
G20	0.00	0.00	0.00	0.00	0.00	0.35	0.58	1.07	2.97	7.12	11.45	11.83	9.60	5.80	4.85	44.56
G21	0.00	0.00	0.00	0.00	0.00	0.09	0.50	0.73	1.56	3.70	6.83	13.51	14.32	7.61	5.31	45.69

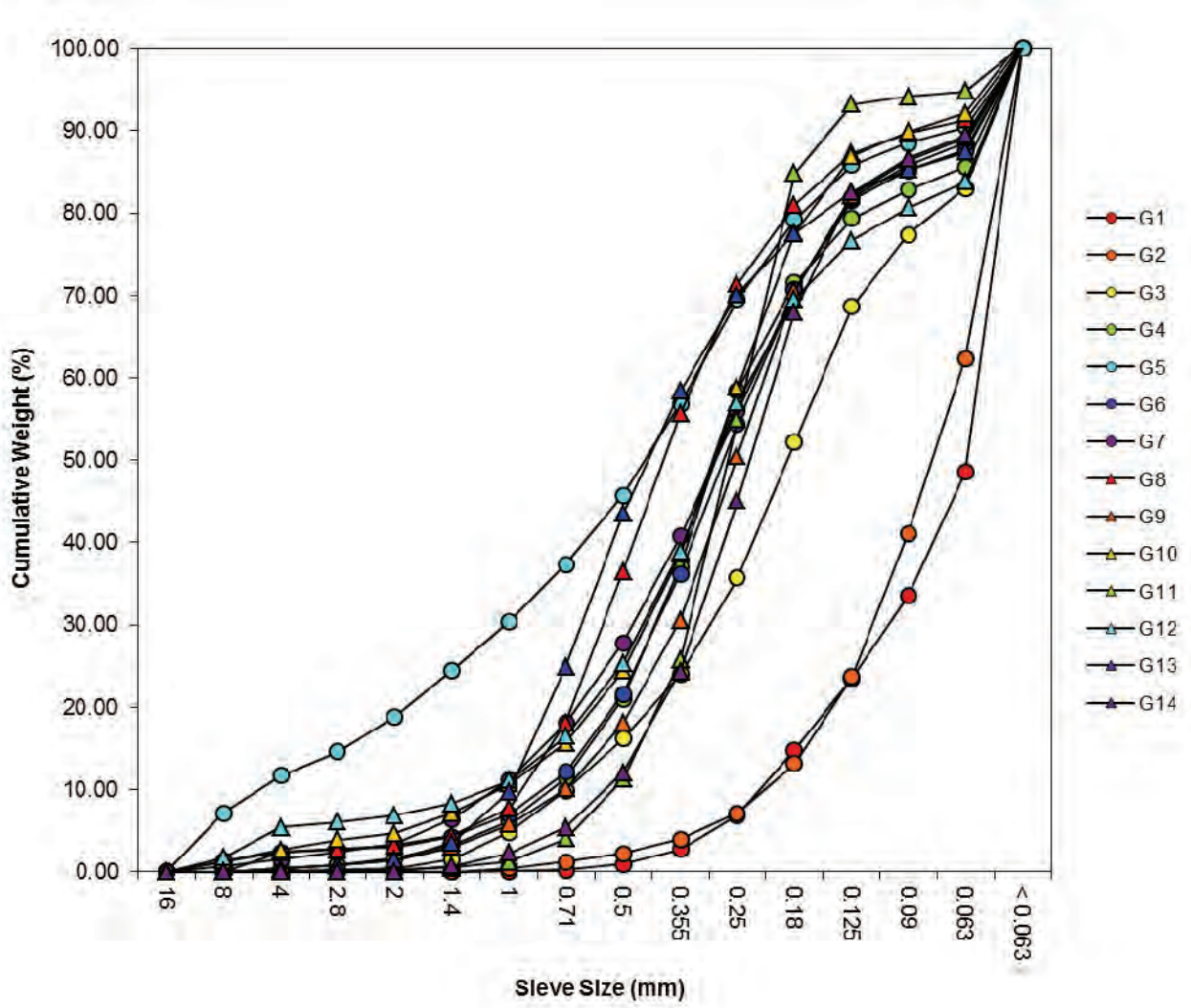

Figure 3.2. Cumulative percentage sediment weight for grab samples from the Sound of Canna (= - $\log_2$ mm).

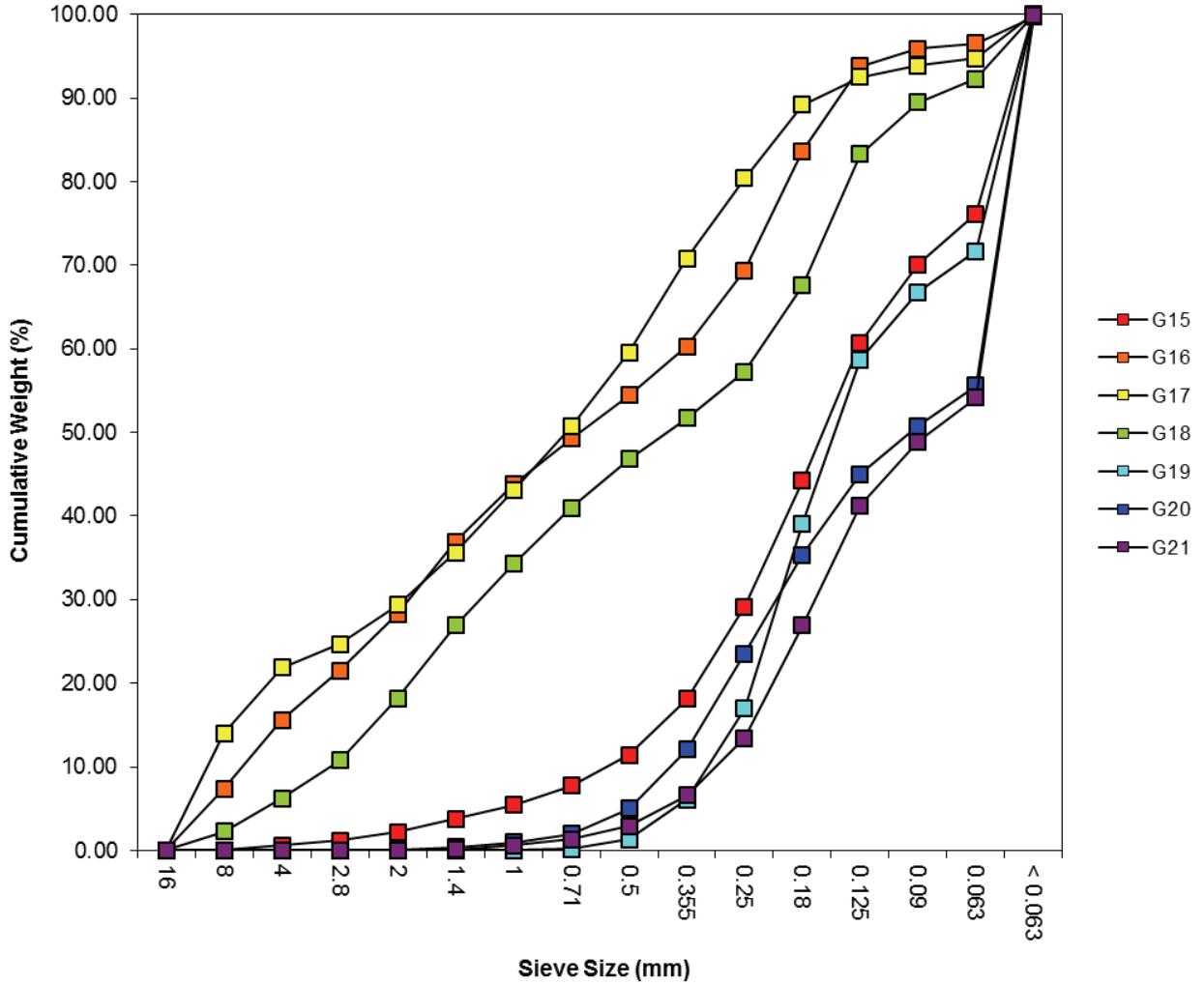

Figure 3.3. Cumulative percentage sediment weight for grab samples from the Sound of Canna (= - $\log_2$ mm).

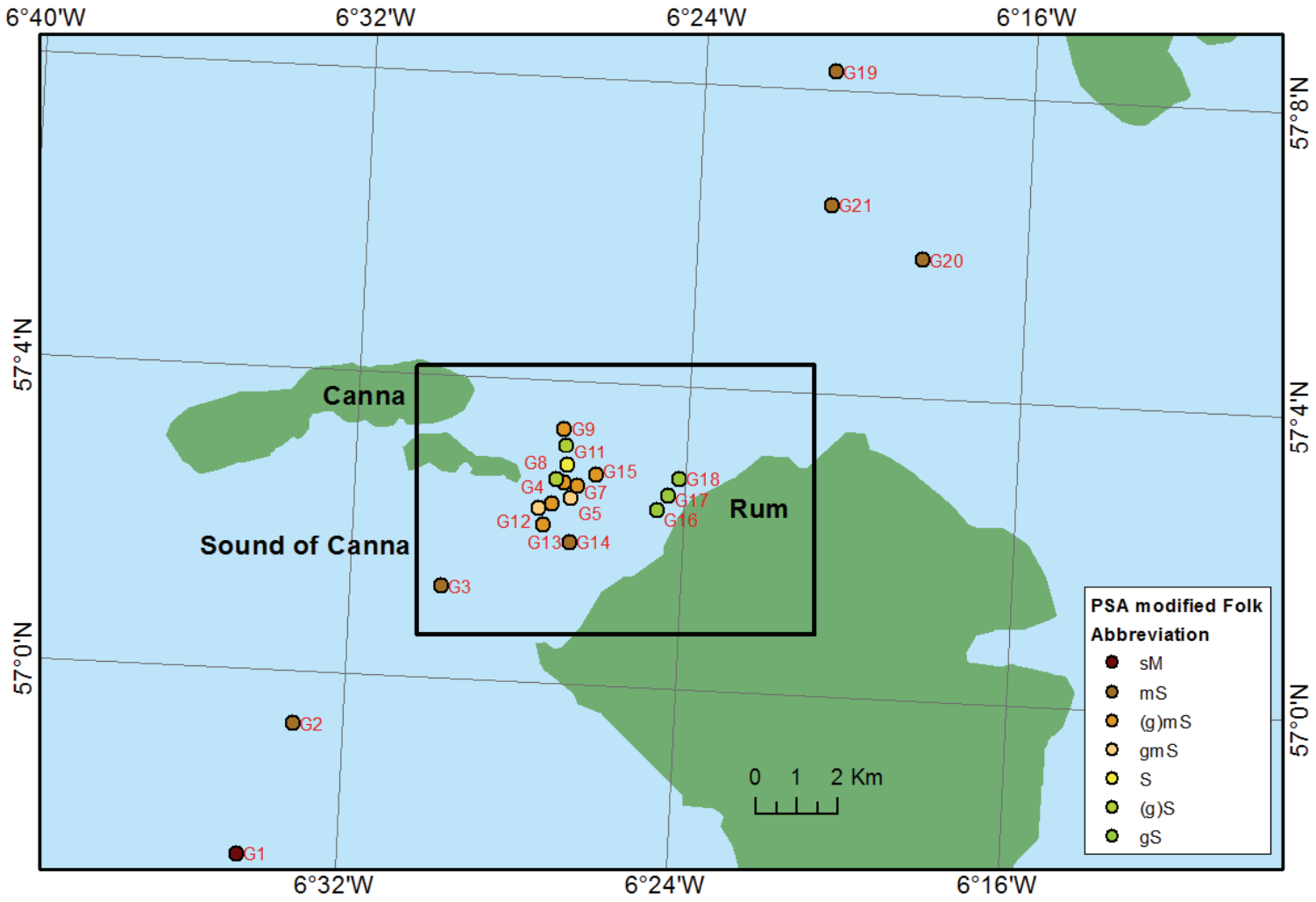

Figure 3.4. Particle Size Analysis results for the Canna 2011 survey (black rectangle illustrating approximate size and position of figure 3.5 below).

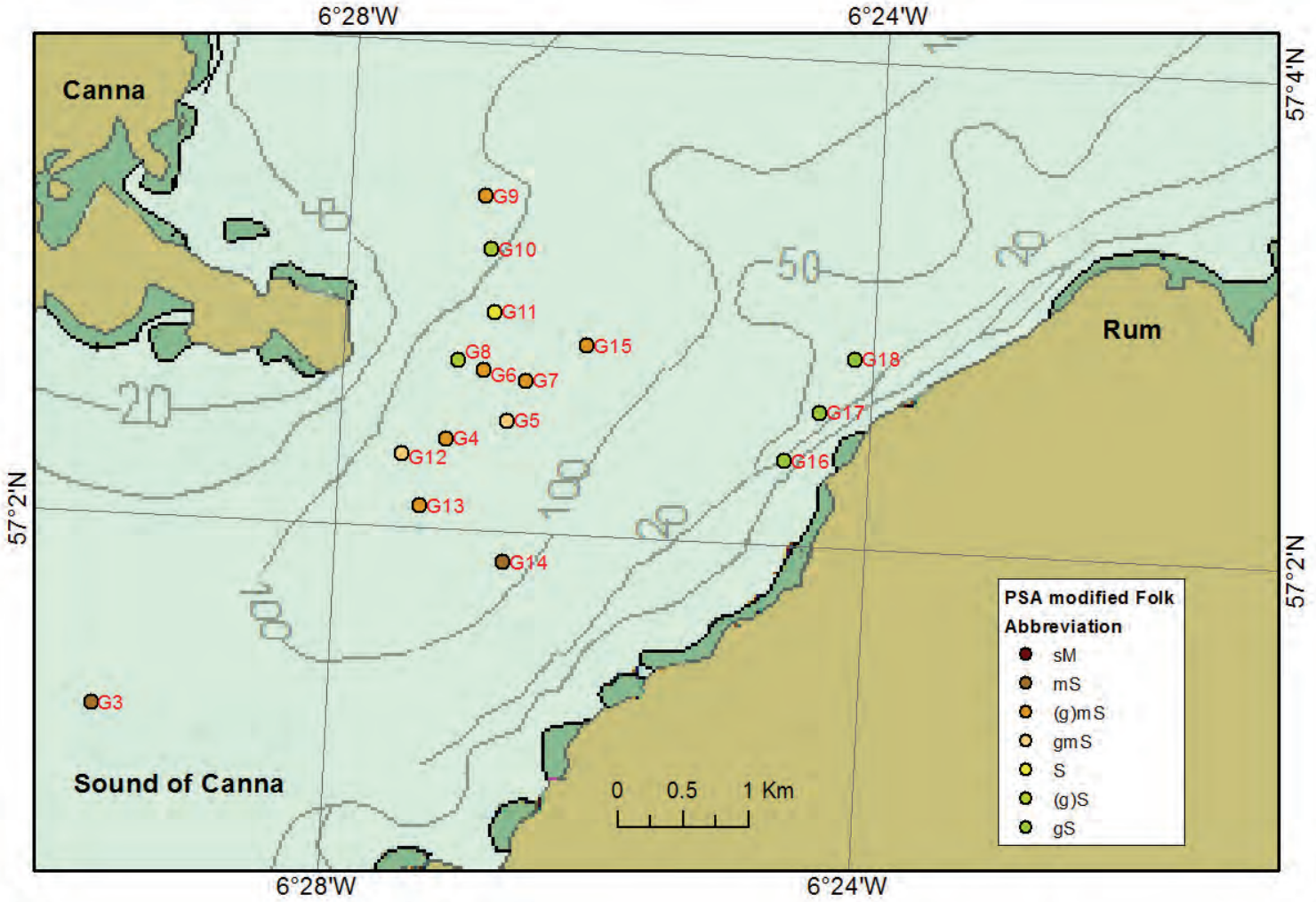

Figure 3.5. Particle Size Analysis results for the Sound of Canna 2011 sampling locations (excluding G1, G2, G19, G20 and G21).

3.2 Macrofaunal analysis

The macrofaunal analysis revealed a total of 3761 individuals and 279 taxa (see Appendix 02) in the Canna Day grab samples (including meiofauna, epi-fauna and one Osteichthyes individual). Overall the macrofauna was dominated by Annelida (48.8 %) followed by Mollusca (18.9 %) and Crustacea (15.7 %), the latter excluding the Cirripedia. The Echinoderms contributed 11.5 %, Nemertea 2.3 % and Nematoda 1.4 % with the remaining groups (Porifera, Anthozoa, Turbellaria, Sipuncula, Ascidiacea, Cirripedia, Pycnogonida and Osteichthyes) contributing the final 1.4 %. The meiofauna, epi-fauna and the Cephalochordate were all excluded from the univariate and multivariate analyses.

Of particular note was the presence of *Modiolus modiolus, Leptometra celtica* and *Arctica islandica*, two Priority Marine Feature (PMF) search features (habitats and species respectively).

Modiolus modiolus was recorded at six locations in the Canna 2011 study. *M. modiolus* is found off all British coasts and extensive beds are most common on northern or western coasts. It is typically found part buried in soft sediments or coarse grounds or attached to hard substrata, forming clumps or extensive beds or reefs. It has been recorded subtidally to c. 280 m (MarLin, 2012c). *M. modiolus* can live for as long as 30-50 years and although the recoverability is good, this taxon is vulnerable to dredging activities (MES, 2008).

Leptometra celtica was recorded at station G3 in this study. This species has been recorded from the continental shelf to west and south west of Britain and it can be found on shell gravel from 40 to over 1000 m depth. It has also been recorded at 20 m in the Scottish sea lochs and sheltered conditions (MarLin, 2012d).

Arctica islandica (Ocean quahog) was recorded at stations G3, G14 and G17 in this study. *A. islandica* can found at extreme low water level but predominately on sub-littoral firm sediments including level offshore areas, buried (or part buried) in sand and muddy sand (MarLin, 2012e). *A. islandica* has a heavy, thick, oval to rounded shell up to 13 cm in length and it t is brown in smaller individuals, becoming greenish-brown to black in larger specimens.

It is also worth noting the presence of a snapping shrimp (Alpheidae sp.) and an isopod in the *Gnathia* genus in the Canna 2011 samples. The latter appears closely related (affiliated) to *Gnathia oxyuraea* (hence recorded as *Gnathia aff. Oxyuraea* in the species matrix) but the species is not recognised and therefore remains unknown.

The individual of the Alpheidae found in the sample lacks the characteristic identifying features and this taxon can therefore not be identified to genus or species level. However, it is worth noting that this group has a southern distribution in British waters but some species have also been recorded off the west and east coasts of Ireland (Smaldon *et al*., 1993).

3.2.1 Macrofaunal abundance

The abundance of the identified macrofauna (excluding meiofauna, epi-fauna and the Cephalochordata) are given in Appendix 03 with a summary of the most abundant taxa overall given in Table 3.4. Unlike the overall data, where Annelida were the most abundant, *Abra nitida* is the most abundant taxon overall but *Lumbrineris gracilis* and *Amphiura filiformis* are also relatively abundant.

- *Abra nitida* is widespread on the coasts of Britain and it inhabits self-made burrows in mud, sandy mud, silty sand and muddy gravel in the sublittoral zone to 183 metres (MarLin, 2012a). *A. nitida* is reportedly tolerant to enriched sediments in areas of enhanced hydrocarbons (Hiscock *et al*., 2005).
- *Lumbrineris gracilis* belongs to the Lumbrineris are a free-living burrowing genus that lives in mucus-lined burrows in gravel, muddy sand and shelly substrata (Hayward and Ryland, 1990). *L. gracilis* has been shown to be intolerant to hydrocarbons, synthetic chemicals and substratum loss (Hiscock *et al*., 2005).
- *Amphiura filiformis* is found on most British and Irish coasts although records have not been found for the south east of England. This species lives buried in the surface of fine muddy sands, mostly at depths greater than 15 m although can be found at extreme low water.

Table 3.4. Abundance (ind./0.1 m^2) of the main macrofaunal taxa in the Canna 2011 survey.

MCS A	MCS N	Taxon	Species	Abundance
W	2061	*Abra*	*nitida*	284
P	579	*Lumbrineris*	*gracilis*	125
ZB	154	*Amphiura*	*filiformis*	125
P	94	*Pholoe*	*synophthalmica*	106
S	98	Gammaridea	sp.	96
S	213	*Stenothoe*	*marina*	89
G	1	NEMERTEA	spp.	87
P	-	*Cirratulus*	*cf. caudatus*	87
P	921	*Notomastus*	*latericeus*	85
ZB	152	*Amphiura*	*chiajei*	76
ZB	124	*Ophiothrix*	*fragilis*	73
P	822	Cirratulidae	sp.	64
P	25	Polynoidae	spp.	63
P	1098	*Owenia*	*fusiformis*	62
P	1099	TEREBELLIDA	spp.	62
S	892	*Janira*	*maculosa*	61
P	834	*Chaetozone*	*setosa*	59
P	-	*Euclymene*	sp. A	59
P	823	*Aphelochaeta*	sp.	55
P	796	*Spiophanes*	*kroyeri*	54
HD	1	NEMATODA	sp.	52
P	1235	*Polycirrus*	sp.	50
P	271	*Goniada*	*maculata*	49
P	833	*Chaetozone*	*gibber*	47
W	1702	*Modiolus*	*modiolus*	47
P	569	Lumbrineridae	sp.	43

3.2.2 Diversity

The results for the species diversity analyses are given in Table 3.5. The total number of individuals at each station range from 58 to 493 individuals per sample with the total number of taxa ranging from 21 to 96 taxa per sample indicating that there some differences between the samples, and potentially between the stations.

The species diversity (Shannon-Wiener diversity index) overall is low to medium with diversity being highest at station G06 but relatively high values are also found at stations G04, G05, G07, G08, G12, G17 and G18. The lowest species diversity value is found (in order) at stations G19 and G20, followed by G11, G02, G21 and G01. Species richness is highest among the Sound of Canna sample locations and the lowest outside the Sound (Figures 3.6 and 3.7).

The equitability (J) results suggest an equal distribution between species at most of the stations. Most values are close to 0.9 with the lowest equitability found at station G11, indicating a relatively higher dominance by a smaller number of different species but even at 0.71 equitability has to be considered medium to high.

Table 3.5. Total number of individuals (N), number of species (S), Margalef's species richness (d), Pielou's equitability index (J), Shannon-Wiener diversity index (H') and Simpson's Dominance Index for all the samples in the 2011 Canna Day grab survey.

Location	S	N	d	J	H(log_e)	Simpson's
G01	23	58	5.42	0.85	2.68	0.92
G02	20	65	4.55	0.87	2.61	0.91
G03	53	152	10.35	0.87	3.46	0.96
G04	72	254	12.82	0.87	3.70	0.97
G05	63	203	11.67	0.91	3.76	0.97
G06	88	388	14.59	0.89	3.99	0.98
G07	95	493	15.16	0.82	3.74	0.95
G08	63	155	12.29	0.93	3.85	0.98
G09	52	103	11.00	0.91	3.61	0.97
G10	51	170	9.74	0.86	3.39	0.95
G11	31	109	6.39	0.71	2.44	0.83
G12	80	275	14.07	0.87	3.80	0.96
G13	52	121	10.63	0.93	3.66	0.97
G14	57	172	10.88	0.79	3.19	0.90
G15	69	220	12.61	0.80	3.38	0.90
G16	61	198	11.35	0.88	3.60	0.96
G17	69	237	12.44	0.91	3.84	0.98
G18	54	138	10.76	0.93	3.70	0.98
G19	22	65	5.03	0.78	2.40	0.83
G20	17	71	3.75	0.85	2.41	0.89
G21	20	41	5.12	0.88	2.63	0.92

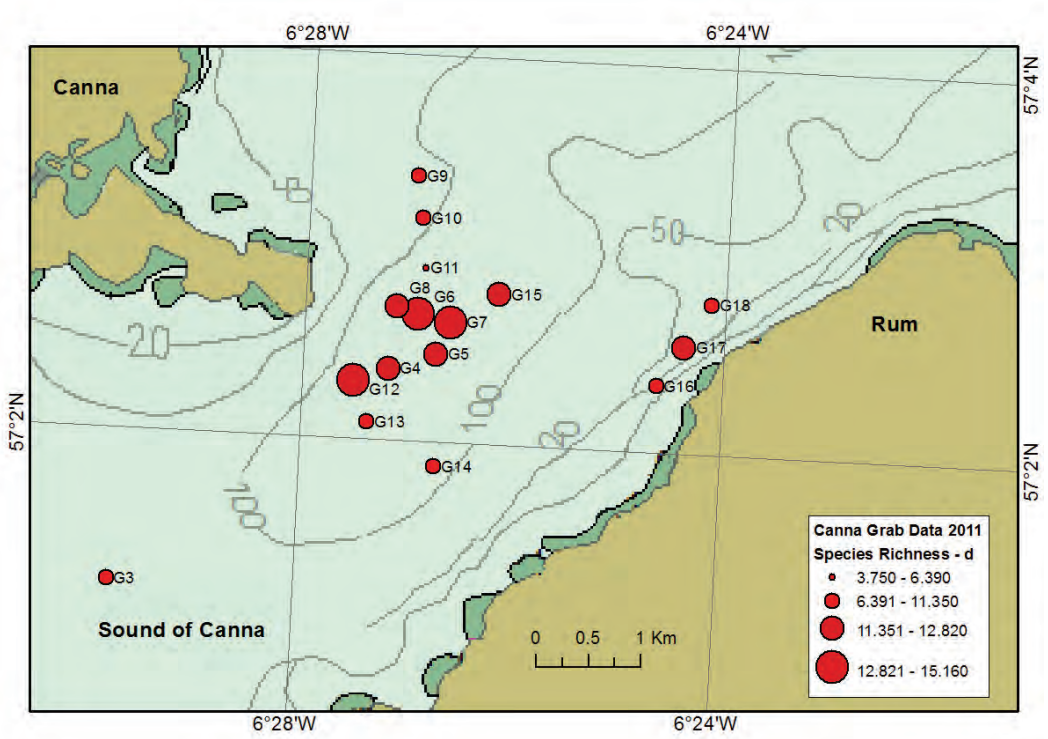

Figure 3.6. Margalef's species richness (Table 3.5) across the Canna 2011 survey locations (black rectangle illustrating approximate size and position of figure 3.7 below).

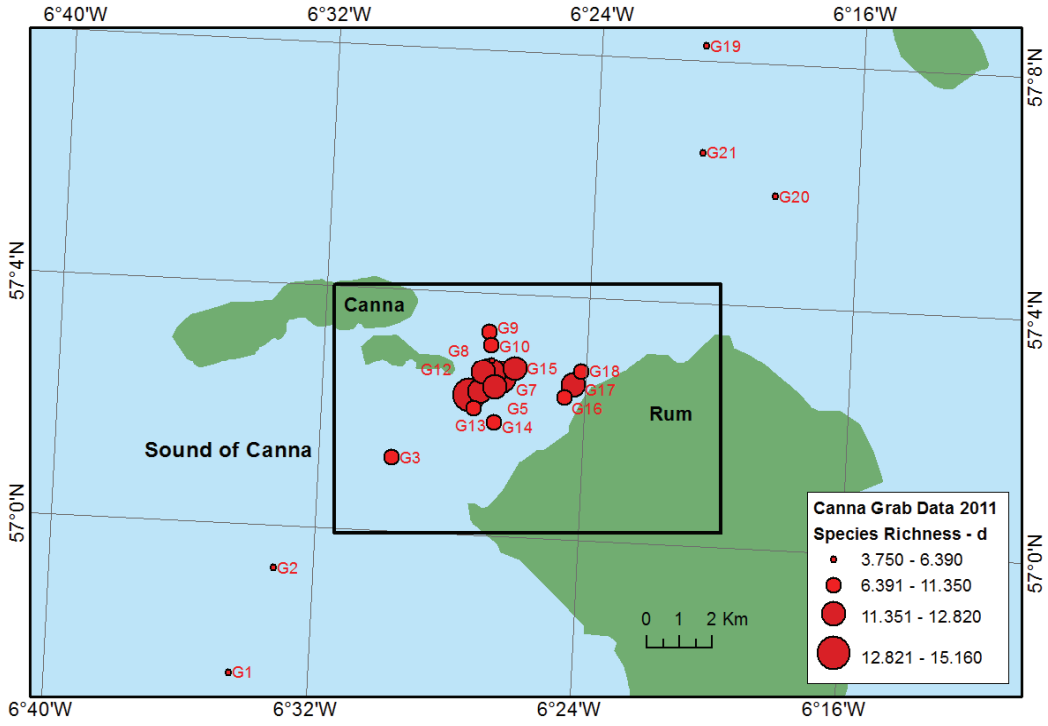

Figure 3.7. Margalef's species richness (Table 3.5) at the Sound of Canna 2011 survey locations (exclude G1, G2, G19, G20 and G21).

3.2.3 Macrofaunal composition

The results from the cluster and ordination analyses are given in Figures 3.8 and 3.9. The results from the cluster analysis suggest two main clusters which have been subdivided further into four main clusters together with a number of less certain clusters. These clustered communities are also apparent in the ordination analysis but perhaps with less certainty. Of particular note is the grouping of G15 in relation to the other stations in clusters A and B, a grouping suggesting similarities between all of these samples overall. The grouping of G18 suggests some similarities with G16 and G17 but overall there is some uncertainty in these clusters.

The clustering of stations G11, G16 and G17 and those in cluster B is particularly uncertain but there appear to be similarities between these stations and those in cluster A in particular. Several different statistical attempts were made in order to explain the clustering and groupings further but these attempts resulted in no additional apparent explanations.

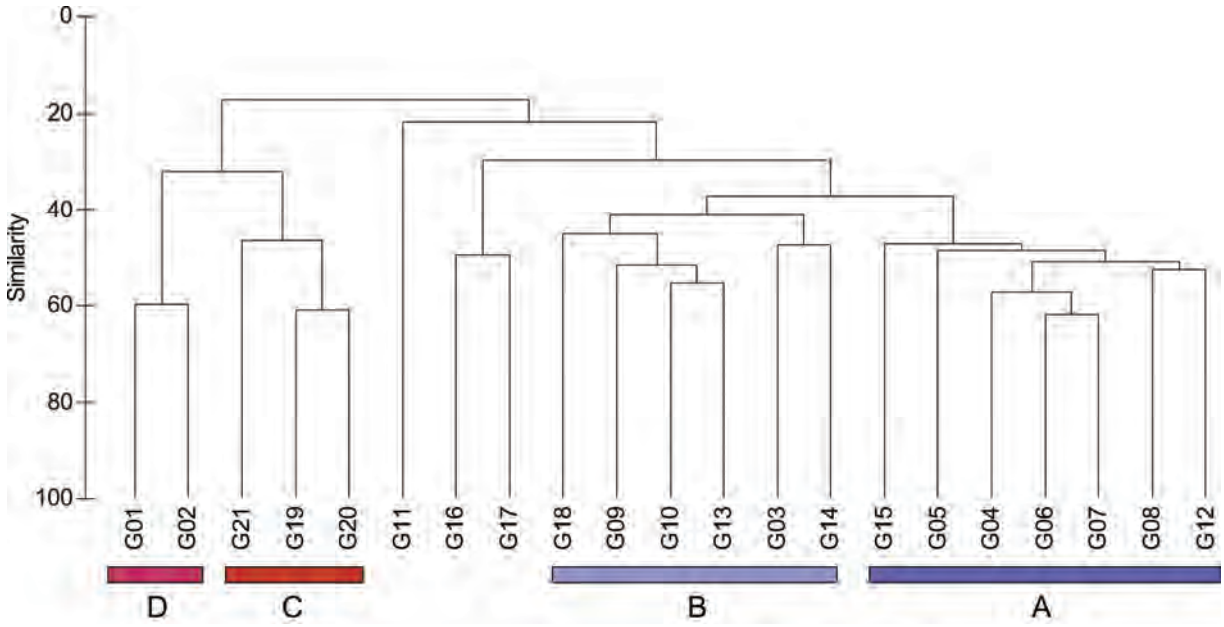

Figure 3.8. Cluster analysis of the Canna 2011 macrofaunal sample data.

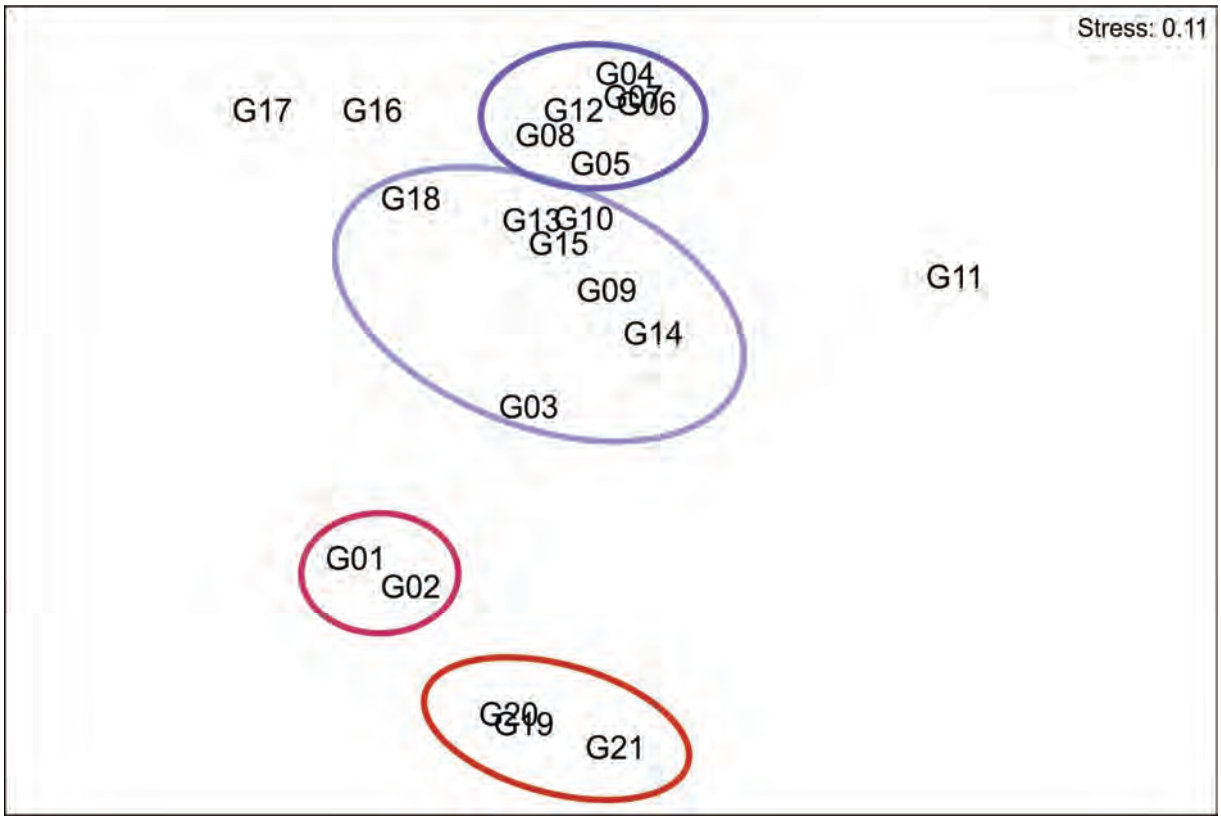

Figure 3.9. Ordination analysis of the Canna 2011 macrofaunal sample data.

A SIMPER analysis was undertaken to assess any similarities between the different clusters (see Table 3.6). The characteristic fauna in cluster A and B are similar whilst the fauna in clusters C and D are different, suggesting these clusters are related to actual community and abiotic differences when compared to A and B. Of note is also the relatively low percentage contribution of the different taxa in clusters A and B, suggesting high equitability among the taxa in these clusters (supported by the species diversity indices in Table 3.5).

Table 3.6. SIMPER analysis of the Canna 2011 macrofaunal samples.

Cluster	Taxa / Species	Contribution (%)
A	*Abra nitida*	5.38
	Pholoe synophthalmica	4.08
	Lumbrineris gracilis	3.69
	Polynoidae spp.	3.36
	NEMERTEA spp.	3.27
	TEREBELLIDA spp.	2.96
	Gammaridea sp.	2.93
	Cirratulidae sp.	2.59
	Janira maculosa	2.43
	Notomastus latericeus	2.41
	Spiophanes kroyeri	2.40
	Stenothoe marina	2.37
	Amphitrite cirrata	2.29
	Modiolus modiolus	2.28
B	*Chaetozone setosa*	6.26
	Pholoe synophthalmica	5.11
	Goniada maculata	5.03
	Abra nitida	4.43
	Cirratulidae sp.	4.25
	Notomastus latericeus	4.24
	Lumbrineris gracilis	4.12
	Spiophanes kroyeri	4.08
	Chaetozone gibber	3.98
	Amphiura filiformis	3.85
	Glycera unicornis	3.71
	Amphiura chiajei	3.59
	Owenia fusiformis	3.12
C	*Cirratulus cf. caudatus*	22.00
	Chaetoderma nitidulum	15.44
	NEMERTEA spp.	10.37
	Minuspio cf. multibranchiata	7.43
	Nephtys incisa	6.49
	Diplocirrus glaucus	6.49
	Notomastus latericeus	6.49
D	*Polycirrus* sp.	16.15
	Notomastus latericeus	15.32
	Scoletoma impatiens	10.22
	TEREBELLIDA spp.	10.22
	NEMERTEA spp.	7.22

3.2.4 Limitations

The macrofaunal identification was slightly hampered by the large number of damaged animals making this process challenging. In particular, the Crustacea, Terebellids and many of the polychaete taxa were difficult to identify to a low taxonomic level (see Appendix 03) but overall the results are believed to be representative for the samples taken. However, note that these difficulties will also affect the biotope classification process.

3.3 Designation of biotopes

A total of six biotopes / biotope complexes were designated. All but two (G17 and G18 at 28 m and 51 m respectively) of the locations sampled during the Canna survey are from a depth greater than 80 m. The dominant fauna and the sediment classification of the samples together with depth were used to define the most appropriate biotope for each station. Of note is that the depth readings at G16 and G18 seem incorrect when comparing the positions to the bathymetry in this area. The depth range appears to be 30 – 40 m in this section of the Sound of Canna. Assigning biotopes for these stations have therefore been particularly challenging and may need further consideration.

The classification process was completed prior to any statistical analyses of the data. Table 3.7 and Figure 3.10 summaries the biotopes assigned to the sites sampled around Canna. Two biotopes (**SS.SBR.SMus.ModMx**; **SS.SSa.OSa.OfusAfil;** were Priority Marine search features with **SS.SSa.OSa.OfusAfil** also being an offshore Priority Marine Features and Marine Protected Area search feature.

Table 3.7. Summary of biotopes assigned to samples taken during the Canna survey 2011.

Station	Depth (m)	Sediment	Characterising/dominant fauna	Biotope
Canna G1	90	sM	*Polycirrus* sp., Lumbrineridae sp., *Notomastus latericeus*	SS.SMu.OMu
Canna G2	86	mS	*Polycirrus* sp., *Notomastus latericeus, Chaetozone gibber, Scoletoma impatiens*	SS.SMu.OMu
Canna G3	120	mS	*Cirratulus cf. caudatus, Amphiura chiajei, Goniada maculata,* Cirratulidae sp., *Notomastus latericeus*	SS.SSa.OSa
Canna G4	245	(g)mS	*Pholoe synophthalmica,* Gammaridea sp., *Monia squama, Stenothoe marina Amphiura chiajei, Ophiothrix fragilis*	SS.SBR.SMus.ModMx
Canna G5	196	gmS	*Abra nitida, Euclymene* sp. A Polynoidae spp., *Aphelochaeta* sp., *Notomastus latericeus*	SS.SMu.CSaMu.AfilMysAnit
Canna G6	234	(g)mS	*Janira maculosa, Stenothoe marina Modiolus modiolus, Ophiothrix fragilis Abra nitida, Lumbrineris gracilis*	SS.SBR.SMus.ModMx
Canna G7	225	(g)mS	*Abra nitida, Ophiothrix fragilis, Pholoe synophthalmica,* Gammaridea sp., *Nucula nitidosa*	SS.SBR.SMus.ModMx
Canna G8	238	(g)S	*Lumbrineris gracilis, Pholoe synophthalmica,* NEMERTEA spp., *Leptochiton asellus, Modiolus modiolus*	SS.SBR.SMus.ModMx

Table 3.7 cont. Summary of biotopes assigned to samples taken during the Canna survey 2011.

Station	Depth (m)	Sediment	Characterising/dominant fauna	Biotope
Canna G9	184	(g)mS	*Abra nitida, Owenia fusiformis, Lumbrineris gracilis, Goniada maculata, Chaetozone setosa*	SS.SMu.CSaMu.AfilMysAnit
Canna G10	210	(g)S	*Euclymene* sp. A, *Abra nitida, Lumbrineris gracilis, Spiophanes kroyeri, Owenia fusiformis*	SS.SMu.CSaMu.AfilMysAnit
Canna G11	242	S	*Amphiura filiformis, Owenia fusiformis, Abra nitida, Kurtiella bidentata*	SS.SSa.OSa.OfusAfil
Canna G12	250	gmS	*Stenothoe marina, Gammaridea sp., Velutina plicatilis, Abra nitida, Nucula nitidosa*	SS.SBR.SMus.ModMx
Canna G13	212	(g)mS	*Euclymene* sp. A, *Lumbrineris gracilis, Spiophanes kroyeri, Pholoe synophthalmica*	SS.SMu.CSaMu.AfilMysAnit
Canna G14	190	mS	*Amphiura filiformis, Abra nitida, Owenia fusiformis, Goniada maculata, Chaetozone setosa, Amphiura chiajei*	SS.SMu.CSaMu.AfilMysAnit
Canna G15	210	(g)mS	*Abra nitida, Pholoe synophthalmica, Amphiura chiajei, Polynoidae* spp. *Lumbrineris gracilis*	SS.SBR.SMus.ModMx
Canna G16	99	gS	*Galathea intermedia, Lumbrineris gracilis, Sabellidae* sp., *Liocarcinus pusillus*	SS.SCS.CCS.MedLumVen
Canna G17	28	gS	*Sabellidae* sp., *Trypanosyllis coeliaca, Galathea intermedia, Echinocyamus pusillus, Lumbrineris gracilis*	SS.SCS.CCS.MedLumVen
Canna G18	51	gS	*Lumbrineris gracilis, Chaetozone setosa, Mediomastus fragilis, Aphelochaeta* sp., *Amphiura filiformis*	SS.SCS.CCS.MedLumVen
Canna G19	206	mS	*Cirratulus cf. caudatus, Chaetoderma nitidulum,* NEMERTEA spp., *Nephtys incisa, Notomastus latericeus*	SS.SSa.OSa
Canna G20	205	mS	*Cirratulus cf. caudatus, Minuspio cf. multibranchiata, Diplocirrus glaucus, Chaetoderma nitidulum,* NEMERTEA spp.	SS.SSa.OSa
Canna G21	230	mS	*Cirratulus cf. caudatus, Chaetoderma nitidulum, Caridea* sp., NEMERTEA spp.	SS.SSa.OSa

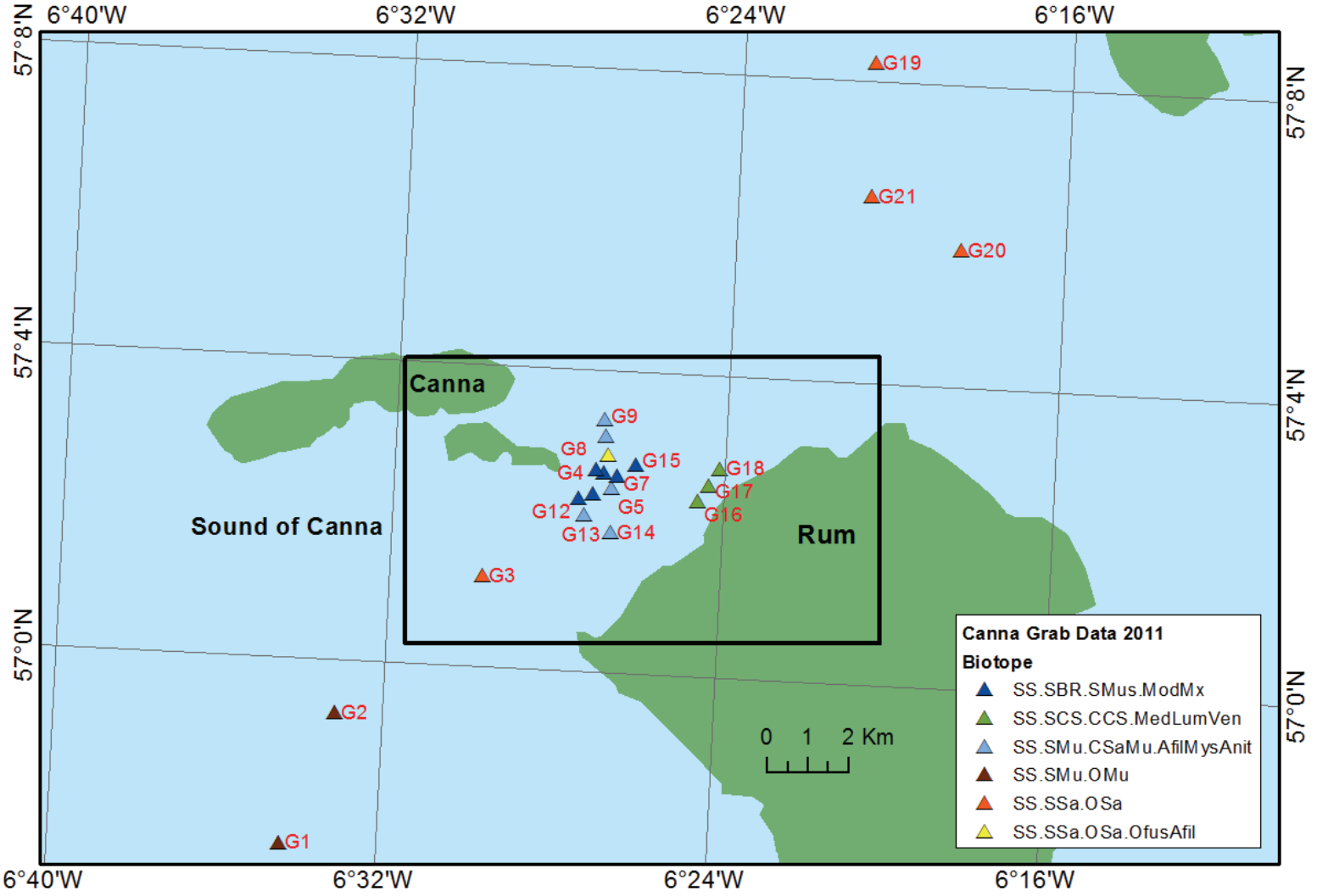

Figure 3.10. Biotope complexes and biotopes of all the samples collected during the Canna 2011 survey (black rectangle illustrating approximate size and position of figure 3.11 below).

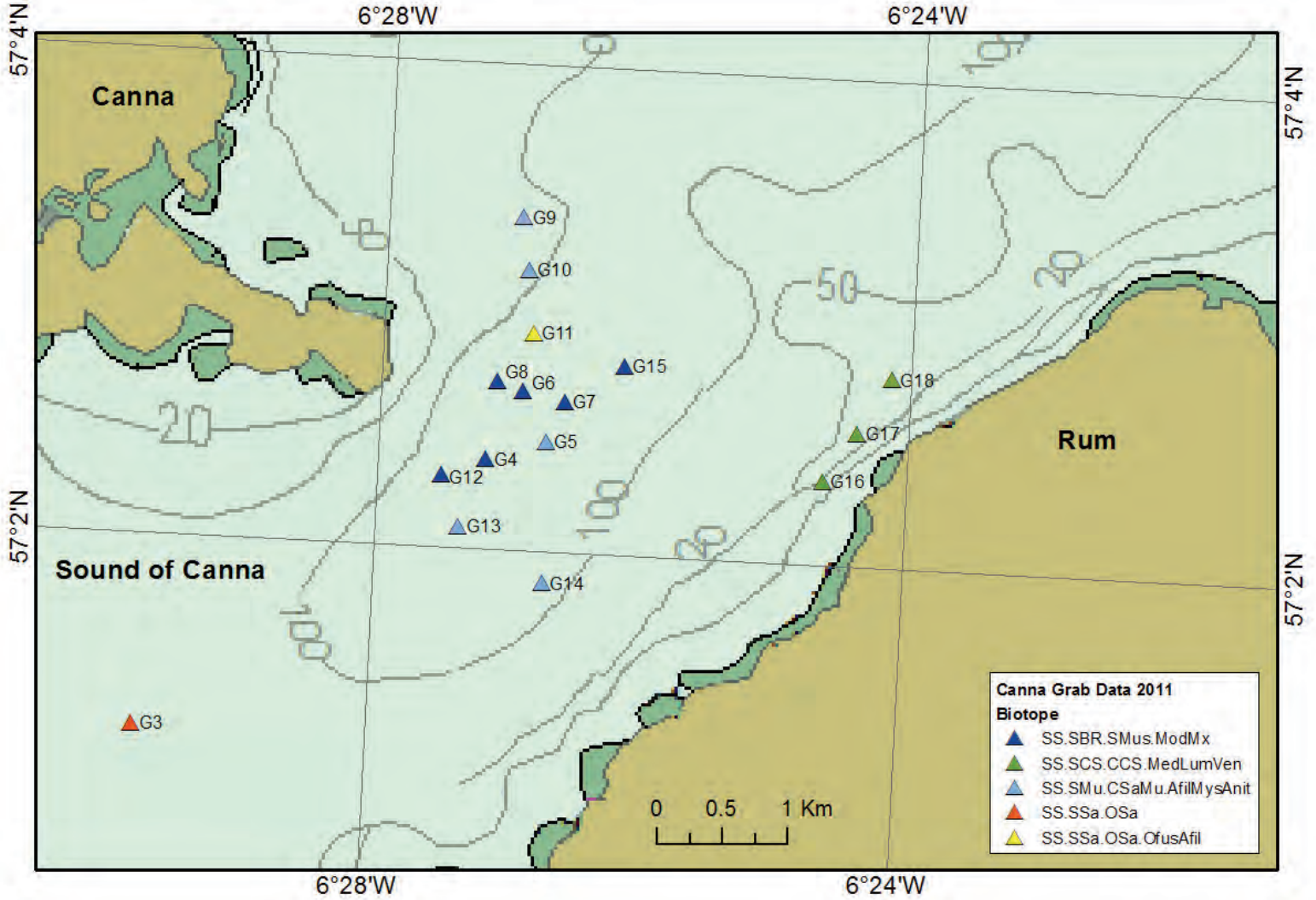

Figure 3.11. Biotope complexes and biotopes of the samples collected from the Sound of Canna 2011 (exclude G1, G2, G19, G20 and G21).

The habitat at six stations (G4, G6, G7, G8, G12 and G15), has been classified as **SS.SBR.SMus.ModMx**. This biotope is described as muddy gravels and coarse sands in deeper water of continental seas, which is similar to the description from the Canna stations (gravelly, muddy sand). The biotope may contain venerid bivalves with beds of *Modiolus modiolus* and the clumping of the byssus threads of the *M. modiolus* creates a stable habitat that attracts a very rich infaunal community with a high density of polychaete species. The polychaete taxa include *Glycera lapidum*, *Paradoneis lyra*, *Aonides paucibranchiata*, *Laonice bahusiensis*, *Protomystides bidentata*, *Lumbrineris* spp., *Mediomastus fragilis* and syllids such as *Exogone* spp. and *Sphaerosyllis* spp. and bivalves such as *Spisula elliptica*, *Timoclea ovata* and other venerid species are also present.

The presence, size and health of any *M. modiolus* bed are difficult to assess from the infaunal samples. However, as the numbers of *Modiolus* present are medium to high (3-20 individuals/0.1 m^2) in comparison to the biotope classification assessment (see Connor *et al*., 2004), these stations are believed to consist of *Modiolus* beds and therefore designated as **SS.SBR.SMus.ModMx**.

The stations designated as the **SS.SMu.CSaMu.AfilMysAnit** biotope are G5, G9, G10, G13 and G14 largely as a result of the fauna present. The sediment in the Canna samples is characterised by gravelly muddy sand which does not quite agree with the **SS.SMu.CSaMu.AfilMysAnit** biotope description (muddy sands) and all else considered these habitats could fall within the SS.SMx.OMx.PoVen biotope. However, as the fauna (both in this study and in the biotope description) is characterised by abundant *Amphiura filiformis* and *Abra nitida* with some *Kurtiella bidentata*, together with polychaetes such as *Nephtys* spp., *Pholoe* sp., and cirratulids and other taxa including *Nucula nitidosa*, this biotope is appropriate. The **SS.SMu.CSaMu.AfilMysAnit** biotope occurs in moderately deep water (~200 m in the Canna samples) and may be related to the 'off-shore muddy sand association' (Connor *et al*., 2004).

There are three stations (G16, G17 and G18) classified as **SS.SCS.CCS.MedLumVen**. All of these stations are found along the coastal fringe of the Isle of Rum at depths recorded as 28 m, 51 m and 99 m. The depth band for this biotope encompasses the Canna sample range but there is some uncertainty as to the actual depths at these locations when referring to the charts of the area. The sediment and faunal communities present in the Canna samples from these locations are comparable to those described for the **SS.SCS.CCS.MedLumVen** biotope, a biotope described as ‘circalittoral gravels, coarse to medium sands, and shell gravels, sometimes with a small amount of silt and generally in relatively deep water (generally over 15-20m)’. The **SS.SCS.CCS.MedLumVen** biotope has previously been described as the 'Deep *Venus* Community' and the 'Boreal Off-Shore Gravel Association' (Connor *et* al., 2004) and it may be quite variable over time. The fauna is characterised by polychaetes such as *Mediomastus fragilis, Lumbrineris* spp., *and Glycera lapidum* as well as the pea urchin *Echinocyamus pusillus*, all of which were found in the Canna samples at these locations. Other taxa found and included in the biotope include Nemertea spp., *Owenia fusiformis, Ampelisca* spinipes and *Amphipholis squamata* together with the presence of conspicuous venerid bivalves, particularly *Timoclea ovata*.

The offshore (deep) circalittoral **SS.SSa.OSa** biotope complex is characterised by fine sands or non-cohesive muddy sands. Very little data is available on these habitats however they are likely to be more stable than their shallower counterparts and characterised by a diverse range of polychaetes (e.g. cirratulds, terebellids), amphipods, bivalves and echinoderms. The classification of G3, G19, G20 and G21 as **SS.SSa.OSa** is largely based on the depth and sediment present but the overall fauna was also considered. Stations G20 and G21 had a

relatively large mud component and could be considered within the **SS.SMu.OMu** biotope complex but the faunal community present did not merit such an inclusion. Of particular note for these stations is the presence of *Leptometra celtica* at station G3, a PMF species and an MPA search feature when found in aggregations.

The designation of G11 as the **SS.SSa.OSa.OfusAfil** biotope is based more specifically on the fauna and the tube building *Owenia fusiformis* with the brittlestar *Amphiura filiformis* in particular. Other fauna present include *Goniada maculata*, *Pholoe* sp., *Diplocirrus glaucus*, cirratulds and *Spiophanes kroyeri*, all of which were found in these Canna samples.

Stations G1 and G2 are located south of Canna and these stations have been classified as **SS.SMu.OMu**. This biotope complex is characterised as mud and cohesive sandy mud in the offshore circalittoral zone, typically below 50-70 m. Stations G1 and G2 closely match this description. The high percentage of mud is the important fraction in these samples but there is a relatively large sand fraction in the samples but no gravel. A variety of faunal communities may develop, depending upon the level of silt/clay and organic matter in the sediment, but the described communities are typically dominated by polychaetes, often with high numbers of bivalves. Whilst the former group is characteristic of these Canna samples the latter is not. Replicate sampling may have elucidated on this point and made the interpretation clearer.

3.4 Comparisons between macrofaunal trends and the abiotic data

In this study the abiotic parameters available include sediment particle size data and depth records but other parameters are also likely to influence the biological communities in the survey area. The available data were compared to the cluster and ordination analyses results (see Table 3.8 and Figure 3.6 as well as Appendix 05).

Table 3.8 illustrates that all the samples in cluster A, apart from G5, have been classified as **SS.SBR.SMus.ModMx**, most of the samples in cluster B have been classified as **SS.SMu.CSaMu.AfilMysAnit**; the samples in cluster C have been classified as **SS.SSa.OSa** whilst the samples in cluster D have been classified as either **SS.SMu.OMu**. The remaining stations have a variety of biotope designations including **SS.SSa.OSa**, **SS.SSa.OSa.OfusAfil** and **SS.SCS.CCS.MedLumVen**.

Further analyses of the data using the ordination data suggest a correlation between macrofaunal community and both sediment grain size and depth. The visual analysis of the MDS plots (abiotic bubble plots) suggest that the strongest correlations between the macrofaunal ordination results and abiotic parameters are with the sediment size fractions 4.0 mm, 1.0 mm and <0.063 mm (see Figure 3.12 and Appendix 05) in particular (see vectors in Figure 3.12). The ‘gravel’ and ‘mud’ sediment fractions (see Appendix 05) support these suggestions further. Depth presumably has some influence but is less important than sediment grain size. There are no apparent trends with latitude or longitude (in terms of the MDS data).

In attempt to assess these results further the Spearman rank correlation coefficient (r_s) was used and the strongest correlation was with a combination of the < 0.063 mm, 0.25 and 1.0 mm size fractions (r_s = 0.73). As individual parameters the largest correlations were (in order) < 0.063 mm (r_s = 0.661), 0.063 mm (r_s = 0.483), 1.0 mm (r_s = 0.422) and 0.09 mm (r_s = 0.440). The correlation with depth was low (r_s = 0.09). With the abiotic data available it therefore appears as if sediment grain size is the primarily controller of the distributions of the faunal communities seen. However, there are many other potential parameters that are likely to influence these distributions and compositions.

Table 3.8. Summary of results for each sample and cluster group (colours as Figures 3.10 and 3.11).

Sample no.	Gravel (%)	Sand (%)	Mud (%)	Depth (m)	Biotope classification	Sediment descriptions		Field notes
Canna G4	1.68	83.93	14.71	245	SS.SBR.SMus.ModMx	Slightly Gravelly Muddy Sand	(g)mS	Live *Modiolus*
Canna G6	2.94	84.69	12.64	234	SS.SBR.SMus.ModMx	Slightly Gravelly Muddy Sand	(g)mS	Live *Modiolus*
Canna G7	3.45	85.02	11.93	225	SS.SBR.SMus.ModMx	Slightly Gravelly Muddy Sand	(g)mS	Live *Modiolus*
Canna G8	3.29	88.04	9.15	238	SS.SBR.SMus.ModMx	Slightly Gravelly Sand	(g)S	Live *Modiolus*
Canna G12	6.89	76.89	16.69	250	SS.SBR.SMus.ModMx	Gravelly Muddy Sand	gmS	2 x live *Modiolus*
Canna G15	2.16	73.99	24.22	210	SS.SBR.SMus.ModMx	Slightly Gravelly Muddy Sand	(g)mS	2 x live *Modiolus*
Canna G5	18.86	71.59	9.55	196	SS.SMu.CSaMu.AfilMysAnit	Gravelly Muddy Sand	gmS	*Modiolus* shell
Canna G9	1.43	87.71	11.29	184	SS.SMu.CSaMu.AfilMysAnit	Slightly Gravelly Muddy Sand	(g)mS	Shelly mud
Canna G10	4.70	87.40	9.02	210	SS.SMu.CSaMu.AfilMysAnit	Slightly Gravelly Sand	(g)S	*Modiolus* shells
Canna G13	1.45	85.93	12.64	212	SS.SMu.CSaMu.AfilMysAnit	Slightly Gravelly Muddy Sand	(g)mS	*Modiolus* shells
Canna G14	0.08	89.34	10.63	190	SS.SMu.CSaMu.AfilMysAnit	Muddy Sand	mS	
Canna G16	28.30	68.26	3.16	99*	SS.SCS.CCS.MedLumVen	Gravelly Sand	gS	Muddy shelly sand
Canna G17	29.39	65.36	5.39	28	SS.SCS.CCS.MedLumVen	Gravelly Sand	gS	
Canna G18	18.19	74.09	7.69	51*	SS.SCS.CCS.MedLumVen	Gravelly Sand	gS	Shelly gravel
Canna G3	0.46	82.55	17.43	120	SS.SSa.OSa	Muddy Sand	mS	Muddy sand
Canna G19	0.00	71.64	28.46	206	SS.SSa.OSa	Muddy Sand	mS	
Canna G20	0.00	55.61	44.56	205	SS.SSa.OSa	Muddy Sand	mS	
Canna G21	0.00	54.17	45.69	230	SS.SSa.OSa	Muddy Sand	mS	
Canna G11	0.24	94.52	5.57	242	SS.SSa.OSa.OfusAfil	Sand	S	
Canna G1	0.00	48.58	51.42	90	SS.SMu.OMu	Sandy Mud	sM	Mud
Canna G2	0.00	62.33	38.07	86	SS.SMu.OMu	Muddy Sand	mS	Mud

** = these depths may need verification.*

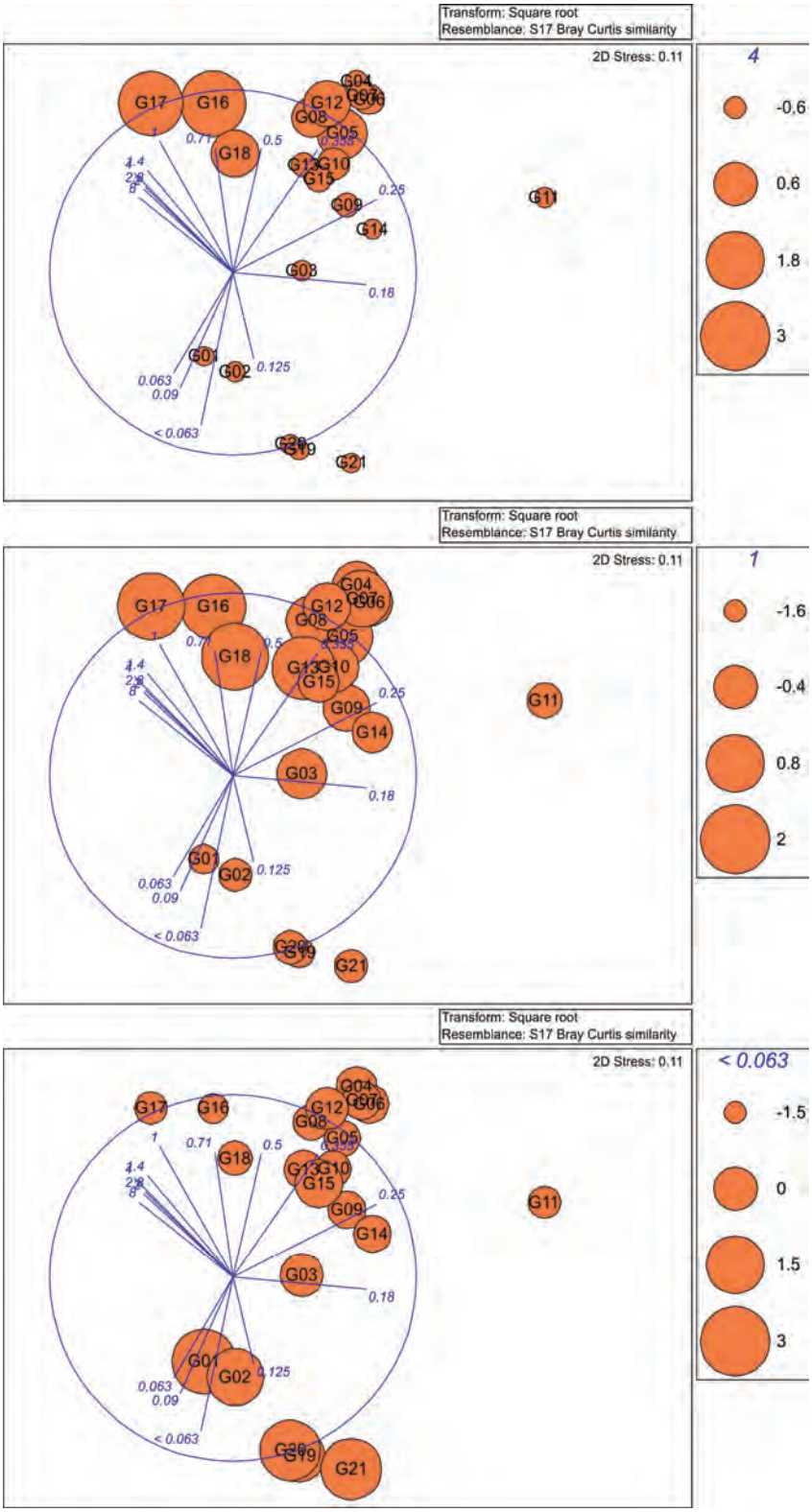

Figure 3.12. Macrofaunal community MDS plot with abiotic bubble analysis.

4 DISCUSSION

The Marine (Scotland) Act 2010 provides a framework that will help balance competing demands on our maritime environment, integrating the economic growth of industry with the need to protect Scotland's seas. A draft list of habitats and species of importance in Scottish waters – the Priority Marine Features (PMFs) (see Appendix 01). The Sound of Canna 2011 survey work is part of a modest programme of survey work which begun in 2010 in order to validate the continued presence of PMFs and supplement existing records. In 2010 a more extensive survey was completed in the Sound of Canna and some comparisons have been made between the current and the 2010 survey.

4.1 The main habitats and comparisons with the 2010 survey

In the 2011 Canna survey a total of six main biotope complexes / biotopes were identified; **SS.SBR.SMus.ModMx**, **SS.SMu.CSaMu.AfilMysAnit**, **SS.SSa.OSa**, **SS.SSa.OSa.OfusAfil**, **SS.SMu.OMu** and **SS.SCS.CCS.MedLumVen**. These biotopes compare well with the results of the 2010 survey results overall (see Figure 4.1). The main difference between the two surveys in the presence of *Modiolus modiolus* and the **SS.SBR.SMus.ModMx** in 2011, a species not believed to have been found and biotope not recorded in 2010.

As mentioned above, the presence, size and health of any *M. modiolus* bed are difficult to assess from the infaunal samples alone. However, as the numbers of *Modiolus* present within the samples collected in 2011 are relatively high (30-200 individuals/1.0 m^2) and compare well with those recorded in the biotope classification assessment (see Connor *et al*., 2004), these stations are believed to consist of *Modiolus* beds and these stations have therefore designated as **SS.SBR.SMus.ModMx**. However, drop-down camera as well as acoustic data would be required to assess these beds in more detail.

Of note is also the presence of **SS.SSa,OSa.OfusAfil**, an offshore PMF and MPA search feature. This habitat was found at station G11 and therefore needs particular attention during any further reporting from this area. This biotope was recorded in several locations in 2010 and it may be more widely distributed across the Sound of Canna.

The analysis of the data from stations G5, G9, G10 and G13 was challenging as the sediment classification (PSA results) suggested a coarse habitat (gravelly muddy sand) and a different biotope to the one designated for these stations (**SS.SMu.CSaMu.AfilMysAnit**). Any drop-down survey work would most likely identify a different biotope but considering the fauna present at these locations, the **SS.SMu.CSaMu.AfilMysAnit** biotope was the most logical designation. However, further assessment may be required of these stations to assess the habitats fully.

The stations classified as **SS.SCS.CCS.MedLumVen** also agree well with the 2010 survey results but whilst *Limaria hians* was recorded in 2010, this taxon was not recorded in 2011. These cryptic animals are notoriously difficult to identify on any footage and usually scuba-diving is required to find the nests. The nests are furthermore typically small in size and although easy to identify, the likelihood of successfully sampling the nests during a remote sampling programme may be limited. It would furthermore be inappropriate as the nest would be damaged during such a process.

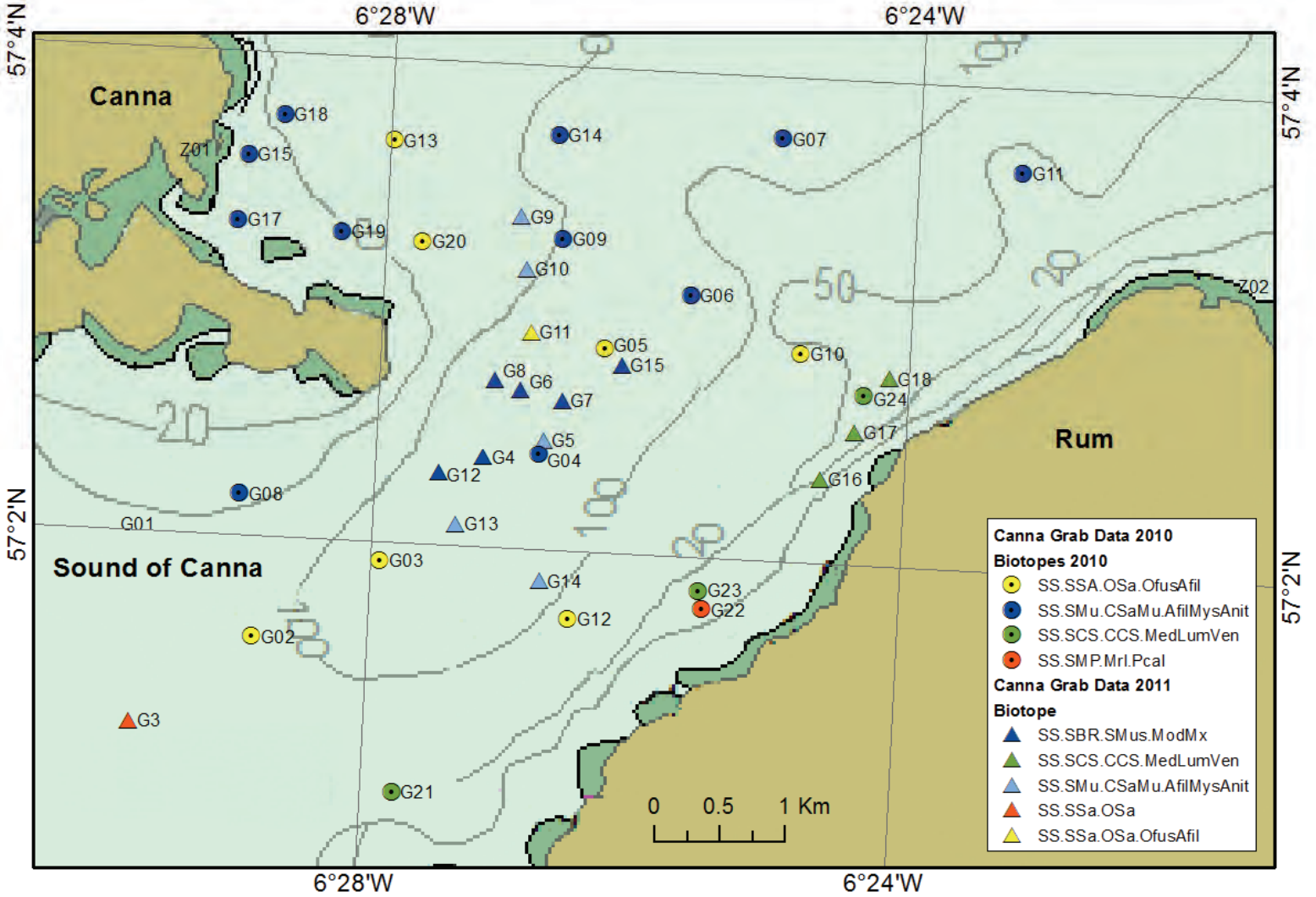

Figure 4.1. Biotopes in the Sound of Canna from the 2010 (circles) and 2011 (triangles) surveys (N.B. stations G1, G2, G19, G20 and G21 from the 2011 survey are missing from this image).

Finally, the presence of *Leptometra celtica* at station G3 and *Arctica islandica* at stations G3, G14 and G17 is worth highlighting as these taxa are PMFs and threatened and / or declining in Scottish waters (OSPAR, 2008; Howson *et al*., 2012). Considering the status of these species, additional drop-down camera surveys would therefore be beneficial to further assess the distribution of these taxa in the area.

4.2 Limitations

The seabed environment around the Sound of Canna is complex with deep channels and deeper troughs as well as several banks and steep coastal fringes on either side of the Sound making any analysis of the relatively low number of sediment samples challenging. The lack of any available drop-down camera footage or any acoustic data made conclusions regarding the presence of substantial *Modiolus* beds uncertain. Such data would greatly aid any detailed analysis of the infaunal data to allow large-scale features to be identified.

A final consideration is the lack of detail in the biotope classification system in terms of the biological communities found in the deeper and offshore areas around the United Kingdom (see Connor *et al*., 2004). It has therefore been challenging to classify the samples at a high level (5 or 6). The remit for this brief study does not include a detailed analysis in terms of the broader biological communities present in Canna but the data should aid any reviews or broad-scale studies in the area.

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APPENDIX 01. List of Priority Marine Features

Habitats

Priority Marine Feature (PMF)	Component biotopes/ species (biotope/ common name)	Component biotopes/ species (biotope code/ species name)
Blue mussel beds	*Mytilus edulis* beds on littoral sediments	LS.LBR.LMus.Myt
	Mytilus edulis and *Fabricia sabella* in littoral mixed sediment	LS.LSa.St.MytFab
	Mytilus edulis beds on sublittoral sediment	SS.SBR.SMus.MytSS
	Mytilus edulis beds on reduced salinity infralittoral rock	IR.LIR.IFaVS.MytRS
Burrowed mud	Seapens and burrowing megafauna in circalittoral fine mud	SS.SMu.CFiMu.SpnMeg
	Burrowing megafauna and *Maxmuelleria lankesteri* in circalittoral mud	SS.SMu.CFiMu.MegMax
	Tall seapen	*Funiculina quadrangularis*
	Fireworks anemone	*Pachycerianthus multiplicatus*
	Mud burrowing amphipod	*Maera loveni*
Cold-water coral reefs	*Lophelia* reefs	SS.SBR.Crl.Lop
Flame shell beds	*Limaria hians* beds in tide-swept sublittoral muddy mixed sediment	SS.SMx.IMx.Lim
Horse mussel beds	*Modiolus modiolus* beds with hydroids and red seaweeds on tide-swept circalittoral mixed substrata	SS.SBR.SMus.ModT
	Modiolus modiolus beds on open coast circalittoral mixed sediment	SS.SBR.SMus.ModMx
	Modiolus modiolus beds with fine hydroids and large solitary ascidians on very sheltered circalittoral mixed substrata	SS.SBR.SMus.ModHAs
	Modiolus modiolus beds with *Chlamys varia*, sponges, hydroids and bryozoans on slightly tide-swept very sheltered circalittoral mixed substrata	SS.SBR.SMus.ModCvar
Inshore deep mud with burrowing heart urchins	*Brissopsis lyrifera* and *Amphiura chiajei* in circalittoral mud	SS.SMu.CFiMu.BlyrAchi
Intertidal mudflats	Littoral mud	LS.LMu
Kelp and seaweed communities on sublittoral sediment	Kelp and seaweed communities on sublittoral sediment[1]	SS.SMp.KSwSS
Low or variable salinity habitats	Faunal communities on variable or reduced salinity infralittoral rock	IR.LIR.IFaVS
	Kelp in variable or reduced salinity	IR.LIR.KVS
	Submerged fucoids, green or red seaweeds (low salinity infralittoral rock)	IR.LIR.Lag
	Sublittoral mud in low or reduced salinity (lagoons)	SS.SMu.SMuLS
	Bird's nest stonewort	*Tolypella nidifica*
	Baltic stonewort	*Chara baltica*
	Foxtail stonewort	*Lamprothamnium papulosum*
	Small brackish water snail	*Hydrobia acuta neglecta*

[1] The following sub-biotopes are specifically excluded: Mats of *Trailliella* on infralittoral muddy gravel (SS.SMp.KSwSS.Tra); and Filamentous green seaweeds on low salinity infralittoral mixed sediment or rock (SS.SMp.KSwSS.FilG)'

Priority Marine Feature (PMF)	Component biotopes/ species (biotope/ common name)	Component biotopes/ species (biotope code/ species name)
Maerl beds	Maerl beds	SS.SMp.Mrl
Maerl or coarse shell gravel with burrowing sea cucumbers	*Neopentadactyla mixta* in circalittoral shell gravel or coarse sand	SS.SCS.CCS.Nmix
Native oysters	*Ostrea edulis* beds on shallow sublittoral muddy mixed sediment	SS.SMx.IMx.Ost
	Native oyster	*Ostrea edulis*
Northern sea fan and sponge communities	*Caryophyllia smithii* and *Swiftia pallida* on circalittoral rock	CR.MCR.EcCr.CarSwi
	Mixed turf of hydroids and large ascidians with *Swiftia pallida* and *Caryophyllia smithii* on weakly tide-swept circalittoral rock	CR.HCR.XFa.SwiLgAs
	Deep sponge communities (circalittoral)	CR.HCR.DpSp
	Northern sea fan	*Swiftia pallida*
Seagrass beds	*Zostera noltii* beds in littoral muddy sand	LS.LMp.LSgr.Znol
	Zostera marina/angustifolia beds on lower shore or infralittoral clean or muddy sand	SS.SMp.SSgr.Zmar
	Ruppia maritima in reduced salinity infralittoral muddy sand	SS.SMp.SSgr.Rup
Sea loch egg wrack beds	*Ascophyllum nodosum* ecad *mackaii* beds on extremely sheltered mid eulittoral mixed substrata	LR.LLR.FVS.Ascmac
Serpulid aggregations	*Serpula vermicularis* reefs on very sheltered circalittoral muddy sand[2]	SS.SBR.PoR.Ser
Shallow tide-swept coarse sands with burrowing bivalves	*Moerella* spp. with venerid bivalves in infralittoral gravelly sand	SS.SCS.ICS.MoeVen
Submarine structures made by leaking gases	Submarine structures made by leaking gases	No code
Tide-swept algal communities	Fucoids in tide-swept conditions	LR.HLR.FT
	Halidrys siliquosa and mixed kelps on tide-swept infralittoral rock with coarse sediment	IR.HIR.KSed.XKHal
	Kelp and seaweed communities in tide-swept sheltered conditions[3]	IR.MIR.KT
	Laminaria hyperborea on tide-swept, infralittoral mixed substrata	IR.MIR.KR.LhypTX

[2] As well as the serpulid reefs biotope this PMF specifically includes smaller aggregations of *Serpula vermicularis*

[3] The following sub-biotopes are specifically excluded: *Laminaria saccharina* with foliose red seaweeds and ascidians on sheltered tide-swept infralittoral rock (IR.MIR.KT.LsacT); and Filamentous red seaweeds, sponges and *Balanus crenatus* on tide-swept variable-salinity infralittoral rock (IR.MIR.KT.FilRVS)

Species

Priority Marine Feature (PMF)	Taxon group	Species name
Burrowing sea anemone	Sea anemones, sea fans and seapens	*Arachnanthus sarsi*
Pink sea fingers	Sea anemones, sea fans and seapens	*Alcyonium hibernicum*
White cluster anemone	Sea anemones, sea fans and seapens	*Parazoanthus anguicomus*
Northern feather star	Starfish and feather stars	*Leptometra celtica*
Fan mussel	Snails, clams, mussels and oysters	*Atrina fragilis*
Heart cockle	Snails, clams, mussels and oysters	*Glossus humanus*
Ocean quahog	Snails, clams, mussels and oysters	*Arctica islandica*
European spiny lobster	Lobsters and sand hoppers	*Palinurus elephas*
Eel (*marine part of life cycle)*	Bony fish (catadromous)	*Anguilla anguilla*
Atlantic salmon (*marine part of life cycle*)	Bony fish (anadromous)	*Salmo salar*
European river lamprey (*marine part of life cycle*)	Bony fish (anadromous)	*Lampetra fluviatilis*
Sea lamprey (marine part of life cycle)	Bony fish (anadromous)	*Petromyzon marinus*
Sea trout *(marine part of life cycle)*	Bony fish (anadromous)	*Salmo trutta*
Anglerfish (*juveniles*)	Bony fish	*Lophius piscatorius*
Atlantic herring (*juveniles and spawning adults*)	Bony fish	*Clupea harengus*
Atlantic mackerel	Bony fish	*Scomber scombrus*
Cod	Bony fish	*Gadus morhua*
Ling	Bony fish	*Molva molva*
Norway pout	Bony fish	*Trisopterus esmarkii*
Saithe (*juveniles*)	Bony fish	*Pollachius virens*
Sandeels	Bony fish	*Ammodytes marinus* and *Ammodytes tobianus*
Sand goby	Bony fish	*Pomatoschistus minutus*
Whiting (*juveniles*)	Bony fish	*Merlangius merlangus*
Basking shark	Sharks, skates and rays	*Cetorhinus maximus*
Common skate	Sharks, skates and rays	Formerly *Dipturus batis* now split provisionally into *D.* cf. *flossada* and *D.* cf. *intermedia*
Spiny dogfish	Sharks, skates and rays	*Squalus acanthias*
Bottlenose dolphin	Whales, dolphins and porpoises	*Tursiops truncates*
Harbour porpoise	Whales, dolphins and porpoises	*Phocoena phocoena*
Killer whale	Whales, dolphins and porpoises	*Orcinus orca*
Minke whale	Whales, dolphins and porpoises	*Balaenoptera acutorostrata*
Risso's dolphin	Whales, dolphins and porpoises	*Grampus griseus*
Short-beaked common dolphin	Whales, dolphins and porpoises	*Delphinus delphis*
White-beaked dolphin	Whales, dolphins and porpoises	*Lagenorhynchus albirostris*
Harbour/common seal	Seals	*Phoca vitulina*
Grey seal	Seals	*Halichoerus grypus*
Otter	Otter	*Lutra lutra*

APPENDIX 02. SNH field sample log – Canna infaunal survey 2011.

DATE	GENERAL LOCATION	STATION NUMBER	LAT	LONG	DEPTH (m)	Notes
19/06/2011	South of Canna sound	G1	56.9592	-6.57278	90	Mud
19/06/2011	South of Canna sound	G2	56.98837	-6.55294	86	Mud
19/06/2011	South of Canna sound	G3	57.02017	-6.49608	120	Muddy sand
19/06/2011	South of Canna sound	G4	57.03952	-6.45313	245	Live Modiolus
19/06/2011	South of Canna sound	G5	57.04093	-6.44557	196	Modiolus shell
19/06/2011	South of Canna sound	G6	57.04435	-6.44885	234	Live Modiolus
19/06/2011	South of Canna sound	G7	57.04367	-6.44345	225	Live Modiolus
19/06/2011	South of Canna sound	G8	57.04486	-6.45211	238	Live Modiolus
20/06/2011	South of Canna sound	G9	57.05621	-6.4497	184	Shelly mud
20/06/2011	South of Canna sound	G10	57.05261	-6.44873	210	Modiolus shells
20/06/2011	South of Canna sound	G11	57.04826	-6.44781	242	
20/06/2011	South of Canna sound	G12	57.03828	-6.4586	250	2 x live Modiolus
20/06/2011	South of Canna sound	G13	57.03481	-6.45608	212	Modiolus shells
20/06/2011	South of Canna sound	G14	57.03116	-6.44521	190	
20/06/2011	South of Canna sound	G15	57.04632	-6.43613	210	2 x live Modiolus
20/06/2011	South of Canna sound	G16	57.03906	-6.41049	99	Muddy Shelly sand and pebble
20/06/2011	South of Canna sound	G17	57.04252	-6.40637	28	
20/06/2011	South of Canna sound	G18	57.04633	-6.40235	51	Shelly gravel
20/06/2011	South of Canna sound	G19	57.13761	-6.34719	206	
20/06/2011	South of Canna sound	G20	57.09716	-6.3088	205	
20/06/2011	South of Canna sound	G21	57.10818	-6.34619	230	

APPENDIX 03. Macrofaunal species matrix – Canna infaunal survey 2011.

Seastar Survey Ltd.
Job No. J/11/269
Canna Macrofaunal Samples
Macrofaunal ID. Results

NB. MCS A and MCS N according to Howson & Picton (1997).
Species nomenclature according to WoRMS (Appletans *et al.*, 2011)

						Site											
MCS A	MCS N	Taxon	Species	Authority	Qualifier	G01	G02	G03	G04	G05	G06	G07	G08	G09	G10	G11	G12
C	1	PORIFERA	sp.								1						
D	583	ANTHOZOA	sp.									1		2		3	
F	2	TURBELLARIA	sp.					1									
F	87	*Stylochoplana*	*maculata*	(Quatrefages, 1845)													
G	1	NEMERTEA	spp.		Dam./Indet.	2	3	7	2	7	5	8	7	3	2	1	7
HD	1	NEMATODA	sp.		indet.			18	3	7	3	3	1	3	6		
N	1	SIPUNCULA	sp.		Dam.			3	1		2	1			3		
N	17	*Golfingia*	*vulgaris*	(de Blainville, 1827)				1									
N	47	*Aspidosiphon*	*muelleri*	Diesing, 1851	Dam						1						
P	17	APHRODITOIDEA	sp.									13				1	
P	19	*Aphrodita*	*aculeata*	Linnaeus, 1758						2	1	1					
P	25	Polynoidae	spp.		Dam.				2	8	12	5	4	2	6		9
P	49	*Gattyana*	*cirrosa*	(Pallas, 1766)						2	1						
P	50	*Harmothoe*	spp.		Dam.				9	4	6	7			1	1	
P	59	*Harmothoe*	*fragilis*	Moore, 1910					1								
P	80	*Lepidonotus*	sp.	Leach, 1816	Dam.												1
P	91	*Pholoe*	sp.	Johnston, 1839							5	8					2
P	94	*Pholoe*	*synophthalmica*	Claparède, 1868				3	21	4	8	18	8	2	5	1	6
P	107	*Sthenelais*	*boa*	(Johnston, 1839)								1					
P	114	Phyllodocidae	sp.		Dam./juv.				1			1	1				
P	150	*Eulalia*	spp.	Savigny, 1817	Dam.												
P	155	*Eulalia*	*expusilla*	Pleijel, 1987													
P	164	*Eumida*	*bahusiensis*	Bergstrom, 1914				1	1					1			
P	176	*Paranaitis*	*kosteriensis*	(Malmgren, 1867)		1	1										
P	255	*Glycera*	sp.	Savigny, 1818	Dam. / Juv.			1	1	1	1	2	1	1	1		
P	260	*Glycera*	*lapidum*	Quatrefages, 1866						1		1	2		1		2
P	-	*Glycera*	*unicornis*	Lamarck, 1818		1		3				1	2	1	1		
P	266	Goniadidae	sp.		Juv.			1					1				
P	268	*Glycinde*	*nordmanni*	(Malmgren, 1866)													1
P	271	*Goniada*	*maculata*	Oersted, 1843				10	3	5	2	2	1	4	5	2	1
P	293	Hesionidae	sp.		Dam./Indet.				1		2	2			1		
P	311	*Nereimyra*	*punctata*	(O F Müller, 1788)					5		6	11	5				4
P	313	*Ophiodromus*	*flexuosus*	(Chiaje, 1827)		2		2									
P	340	*Glyphohesione*	*klatti*	Friedrich, 1950						1		1					
P	346	*Syllidae*	sp.		Dam. / Juv.								1				2
P	349	*Syllis*	*cornuta*	(Rathke, 1843)				1				1		1		2	
P	355	*Eurysyllis*	*tuberculata*	Ehlers, 1864								1				2	
P	362	*Trypanosyllis*	*coeliaca*	Claparède, 1868													
P	371	*Syllis*	*variegata*	Grube, 1860					1	1	2	2					
P	372	*Syllis*	*cf. vittata*	(Grube, 1840)					1				1				
P	380	*Eusyllis*	*blomstrandi*	Malmgren, 1867							1						
P	418	*Exogone*	sp.	Oersted, 1845				1									
P	421	*Exogone*	*hebes*	(Webster & Benedict, 1884)				2									
P	424	*Sphaerosyllis*	sp.	Claparède, 1863													
P	425	*Sphaerosyllis*	*bulbosa*	Southern, 1914													
P	437	*Myrianida*	*brachycephala*	(Marenzeller, 1874)	Syn. Autolytus brachycephalus				3	1							4
P	475	*Nereis*	*longissima*	Johnston, 1840						1	1			1		1	
P	494	*Nephtys*	spp.	Cuvier, 1817	Dam.					2	2					1	1

P	498	*Nephtys*	*cirrosa*	Ehlers, 1868													1	
P	501	*Nephtys*	*incisa*	Malmgren, 1865		1												
P	502	*Nephtys*	*kersivalensis*	McIntosh, 1908				2	1	1	4	1		1	2	1	2
P	539	*Aponuphis*	*bilineata*	(Baird, 1870)														
P	564	*Marphysa*	*bellii*	(Audouin & Milne-Edwards, 1833)					1									
P	568	*Nematonereis*	*unicornis*	(Grube, 1840)														
P	569	Lumbrineridae	sp.	de Blainville, 1828	Dam.	9		1		2	5	1	4	1	1		1
P	571	*Lumbrineriopsis*	*paradoxa*	(Saint-Joseph, 1888)					1									
P	579	*Lumbrineris*	*gracilis*	(Ehlers, 1868)					5	3	15	11	12	8	12	1	7
P	584	*Scoletoma*	*impatiens*	(Claparède, 1868)	Dam.	4	5	4		1	1				1		2
P	591	*Drilonereis*	*filum*	(Claparède, 1868)														
P	597	*Notocirrus*	*scoticus*	McIntosh, 1869				1							1			
P	643	*Schistomeringos*	*rudolphi*	(Chiaje, 1828)							3		2	1	1			
P	661	*Orbinia*	sp.	Quatrefages, 1865														
P	665	*Orbinia*	*sertulata*	(Savigny, 1820)														
P	674	Paraonidae	sp.		Dam./ juv.													
P	683	*Aricidea (Acmira)*	sp.	Hartley, 1981	Dam.			1										
P	684	*Aricidea (Acmira)*	*catherinae*	Laubier, 1967														
P	685	*Aricidea (Acmira)*	*cerrutii*	Laubier, 1966														
P	690	*Cirrophorus*	*branchiatus*	Ehlers, 1908				2		3		1	1		1			
P	699	*Paradoneis*	*lyra*	(Southern, 1914)								2		1				
P	718	*Poecilochaetus*	*serpens*	Allen, 1904														
P	720	Spionidae	sp.		Dam./Indet.	1	1	3		1	1	4	1				1
P	723	*Aonides*	*paucibranchiata*	Southern, 1914							1							
P	731	*Laonice*	sp.	Malmgren, 1867														
P	733	*Laonice*	*bahusiensis*	Soderstrom, 1920										1	2		1
P	735	*Laonice*	*sarsi*	Soderstrom, 1920				1	1									
P	745	*Minuspio*	sp.	Foster, 1971														
P	746	*Minuspio*	cf. multibranchiata	(Berkeley, 1927)			2											
P	747	*Minuspio*	*cirrifera*	(Wiren, 1883)								2	1	1			1
P	768	*Prionospio*	*steenstrupi*	Malmgren, 1867		1												
P	774	*Pseudopolydora*	*pulchra*	(Carazzi, 1895)														
P	793	*Spiophanes*	sp.	Grube, 1860	Dam./juv.						1	1					1
P	795	*Spiophanes*	*cf. wigleyi*	Pettibone, 1962														
P	796	*Spiophanes*	*kroyeri*	Grube, 1860		1	1	1	5	3	6	5	3	2	10		1
P	803	*Magelona*	sp.	F Müller, 1858	Dam.	1												
P	804	*Magelona*	*alleni*	Wilson, 1958			1											
P	806	*Magelona*	*minuta*	Eliason, 1962		1	2	1										
P	822	Cirratulidae	sp.		Dam./Indet.		1	10	1	7	2	6	5	2	1		4
P	823	*Aphelochaeta*	sp.	Blake, 1991		2		1	4	8		6	2		1		6
P	824	*Aphelochaeta*	*marioni*	(Saint-Joseph, 1894)		1	1	1		2	4	2	1				3
P	828	*Caulleriella*	sp.	Chamberlin, 1919									1					
P	829	*Caulleriella*	*alata*	(Southern, 1914)						1							2
P	832	*Chaetozone*	sp.	Malmgren, 1867	Dam./Indet.			1						1				
P	833	*Chaetozone*	*gibber*	Woodham & Chambers, 1994			6	2	2	7		2	2	1	6		1
P	834	*Chaetozone*	*setosa*	Malmgren, 1867				7	4	1	8	3		4	8		2
P	-	*Cirratulus*	*cf. caudatus*	Levinsen, 1893			3	20						4			1
P	873	Flabelligeridae	sp.												1			
P	878	*Diplocirrus*	*glaucus*	(Malmgren, 1867)	Dam.			1	1	2	5	4				1		
P	885	*Pherusa*	*plumosa*	(O F Müller, 1776)					1									
P	906	*Capitella*	sp.	de Blainville, 1828				1					1					
P	919	*Mediomastus*	*fragilis*	Rasmussen, 1973						1		1			1			
P	921	*Notomastus*	*latericeus*	M Sars, 1851		9	10	8	2	8	6	6	1	1	6		3
P	938	Maldanidae	spp.		Dam.			1	1					1	1			
P	963	*Euclymene*	*lumbricoides*	(Quatrefages, 1866)				1										
P	-	*Euclymene*	sp. A	(Claparède, 1863)					2	10	2	1		3	22		1
P	970	*Praxillella*	sp.	Verrill, 1881										1				
P	971	*Praxillella*	*affinis*	(M Sars, 1872)					1	3								

P	1012	*Ophelina*	sp.	Oersted, 1843	Dam.										1		
P	1027	*Scalibregma*	*inflatum*	Rathke, 1843					1		3	1					
P	1090	Oweniidae	sp.		Dam./Indet.												
P	1098	*Owenia*	*fusiformis*	Chiaje, 1842						1	1		1	9	9	31	
P	1099	TEREBELLIDA	spp.		Dam./Indet.	5	4	5	7	3	8	9	5	1	1		9
P	1100	Pectinariidae	sp.		Juv.							1					
P	1102	*Amphictene*	*auricoma*	(O F Müller, 1776)					1		2		1				
P	1107	*Lagis*	*koreni*	(Malmgren, 1866)						1	1			2			
P	1111	*Petta*	*pusilla*	Malmgren, 1866													
P	1117	*Sabellaria*	*spinulosa*	Leuckart, 1849					1								1
P	1125	Ampharetinae	spp.		Indet.			2				1					
P	1175	*Terebellides*	*stroemi*	M Sars, 1835						1	1	3			1		1
P	1176	*Trichobranchus*	sp.	Malmgren, 1866									1				1
P	1182	*Amphitrite*	*cirrata*	O F Müller, 1771					3	7	4	9	2	1	5		1
P	1189	*Eupolymnia*	*nebulosa*	(Montagu, 1819)					1	2	9	4	1		1		2
P	1210	*Nicolea*	*zostericola*	(Oersted, 1844)							1		1				1
P	1235	*Polycirrus*	sp.	Grube, 1850	Dam./Indet.	10	14	1	3	3	7	1		2	2		1
P	1254	*Thelepus*	*cincinnatus*	(Fabricius, 1780)							1						
P	1257	Sabellidae	sp.		Dam./Indet.							2					2
P	1334	*Hydroides*	*norvegica*	Gunnerus, 1768					1	1							
P	1343	*Serpula*	*vermicularis*	Linnaeus, 1767					1			1					
P	1402	Oligochaeta	sp.									1					
Q	5	*Nymphon*	*brevirostre*	Hodge, 1863	Dam.										1		
Q	33	*Callipallene*	*brevirostris*	(Johnston, 1837)	Dam.							1	1				
Q	44	*Anoplodactylus*	*petiolatus*	(Kröyer, 1844)					1			1		1		1	1
R	15	Thoracica	sp.		Dam/ indet									P			
R	74	*Balanus*	sp.	Costa, 1778													
R	2422	*Philomedes*	*lilljeborgi*	(G O Sars, 1865)	Dam.					1							
S	8	*Nebalia*	*herbstii*	Leach, 1814	Dam												
S	31	Mysidae	sp.		Dam/ indet							1					1
S	92	*Heteromysis*	*formosa*	S I Smith, 1874	Dam.					1							2
S	98	Gammaridea	sp.		Dam./indet.				18	1	15	27	2				21
S	109	*Eusirus*	*longipes*	Boeck, 1861	Dam			1									
S	120	*Arrhis*	*phyllonyx*	(M Sars, 1858)	Dam									1			
S	128	*Deflexilodes*	*subnudus*	(Norman, 1889)	Dam												
S	133	*Pontocrates*	*altamarinus*	(Bate & Westwood, 1862)	Dam												
S	152	Amphilochidae	sp.		Dam./indet.								1				
S	158	*Amphilochus*	*manudens*	Bate, 1862	Dam						3						
S	170	*Paramphilochoides*	*odontonyx*	(Boeck, 1871)	Dam												
S	180	*Leucothoe*	*spinicarpa*	(Abildgaard, 1789)	Dam						1						
S	213	*Stenothoe*	*marina*	(Bate, 1856)	Dam				16	1	20	7	4		1		40
S	255	*Harpinia*	*crenulata*	(Boeck, 1871)	Dam.			1		2	3	5			2		
S	262	*Metaphoxus*	*pectinatus*	(A O Walker, 1896)	Dam												1
S	301	*Lepidepecreum*	*longicornis*	(Bate & Westwood, 1861)	Dam												
S	307	*Menigrates*	*obtusifrons*	(Boeck, 1861)	Dam						1						
S	320	*Orchomene*	*humilis*	(Costa, 1853)	Dam												1
S	357	*Tiron*	*spiniferus*	(Stimpson, 1853)	Dam												
S	413	*Atylus*	*vedlomensis*	(Bate & Westwood, 1862)	Dam									1			
S	423	*Ampelisca*	sp.	Kröyer, 1842	Dam/ indet												
S	438	*Ampelisca*	*spinipes*	Boeck, 1861						6							
S	442	*Ampelisca*	*typica*	(Bate, 1856)	Dam										2		
S	448	*Haploops*	*tubicola*	Liljeborg, 1855	Dam				4	4	1	2	1	1	4		
S	519	*Othomaera*	*othonis*	(H Milne-Edwards, 1830)	1 very large male (*)				1	3*	9	2	5				
S	537	Isaeidae	sp.		Dam./indet.					2							
S	538	*Gammaropsis*	sp.	Liljeborg, 1855	Dam/ indet							5					
S	541	*Gammaropsis*	*maculata*	(Johnston, 1828)	Dam										3		4
S	558	Ischyroceridae	sp.		Dam./indet.											1	
S	562	*Erichonius*	*difformis*	H Milne-Edwards, 1830	Dam					1		1	3				

S	577	Aoridae	sp.		Dam./indet.					3						1	
S	584	*Lembos*	sp.	Bate, 1857	Dam							1					
S	585	*Lembos*	*websteri*	Bate, 1857	Dam						3	3					
S	588	*Leptocheirus*	*hirsutimanus*	(Bate, 1862)	Dam					3		5					4
S	629	*Dyopedos*	*porrectus*	(Bate, 1857)	Dam												
S	653	*Parvipalpus*	*capillaceus*	(Chevreux, 1888)	Dam.					1							
S	657	*Phtisica*	*marina*	Slabber, 1769	Dam.					1	1	2	1			1	4
S	796	*Gnathia*	aff. *oxyuraea*	(Liljeborg)	Dam												
S	854	*Eurydice*	*pulchra*	Leach, 1815	Dam												
S	892	*Janira*	*maculosa*	Leach, 1813	Dam				12	7	26	8	2				6
S	903	*Munna*	*boeckii*	Kröyer, 1839	Dam				6	2		11					3
S		*Astacilla*	*dilatata*		Dam												
S	1140	*Pseudoparatanais*	*batei*	(G O Sars, 1882)	Dam							1					
S	1208	*Eudorella*	*truncatula*	(Bate, 1856)							1	1			1		
S	1257	*Diastyloides*	*biplicata*	(G O Sars, 1865)	Dam.					2							
S	1255	*Diastylis*	*tumida*	(Liljeborg, 1855)	Dam				1	3			2				3
S	1276	Decapoda	sp.		juv. indet.	1											
S	1293	Caridea	sp.		juv. indet.												
S	1293	Caridea	sp.		Dam/ indet							1					
S	1328	Alpheidae	sp.		Dam./indet.			1									
S	1338	*Caridion*	*gordoni*	(Bate, 1858)	Dam						3						
S	-	*Eualus*	*cranchii*		Dam						7						
S	1409	*Calocaris*	*macandreae*	Bell, 1846	Dam									1			
S	1445	Paguridae	sp.		Dam/ indet												
S	1470	*Galathea*	sp.	Fabricius, 1793	Indet juv							1					
S	1471	*Galathea*	*dispersa*	Bate, 1859	Dam. Some indi. infected with parasitic barnacle Sacculinidae				3	4	7*	1	3				6
S	1472	*Galathea*	*intermedia*	Liljeborg, 1851	Dam												
S	1523	*Inachus*	*phalangium*	(Fabricius, 1775)	Dam				1	1	2		3				1
S	1584	*Liocarcinus*	*pusillus*	(Leach, 1815)	Dam												
S	1606	*Goneplax*	*rhomboides*	(Linnaeus, 1758)	Dam												
S	1609	*Monodaeus*	*couchii*	(Couch, 1851)	Dam. Some indi. Infected with parasitic barnacles Sacculinida				1	1*	1*		2		1*		3
W	9	*Chaetoderma*	*nitidulum*	Lovén, 1844		1	4				1			2			
W	11	*Falcidens*	*crossotus*	Salvini-Plawen, 1968				1				4	1				2
W	31	*Neomenia*	*dalyelli*	(Koren & Danielssen, 1877)													
W	35	*Eleutheromenia*	*sierra*	(Pruvot, 1890)					1								
W	50	*Leptochiton*	sp.	J E Gray, 1847					1								2
W	53	*Leptochiton*	*asellus*	(Gmelin, 1791)					1		1		6	2			
W	71	cf *Ischnochiton*	*albus*	(Linnaeus, 1767)								2					
W	81	*Tonicella*	*marmorea*	(O Fabricius, 1780)					1		2						
W	82	*Tonicella*	*rubra*	(Linnaeus, 1767)								4					
W	237	*Lepeta*	*caeca*	(O F Müller, 1776)													
W	368	*Onoba*	*aculeus*	(Gould, 1841)													
W	443	*Capulus*	*ungaricus*	(Linnaeus, 1758)					1		1	3	1				1
W	480	*Velutina*	*velutina*	(O F Müller, 1776)					1								13
W	638	*Melanella*	*frielei*	(Jordan, 1895)					2								1
W	708	*Buccinum*	*undatum*	Linnaeus, 1758										1			
W	952	*Odostomia*	*conoidea*	(Brocchi, 1814)													
W	1059	*Diaphana*	*minuta*	Brown, 1827													5
W	1319	Onchidoridae	sp.														
W	1325	*Onchidoris*	*muricata*	(O F Müller, 1776)					1			1					
W	1569	*Nucula*	*nitidosa*	Winckworth, 1930		1	1	1			3	16			1	1	10
W	1571	*Nucula*	*sulcata*	Bronn, 1831			2		1		2	3	2	1			
W	1595	*Nuculana*	*minuta*	(O F Müller, 1776)							1	1					
W	1627	*Yoldiella*	*philippana*	(Nyst, 1844)							1						
W	1702	*Modiolus*	*modiolus*	(Linnaeus, 1758)					5		20	9	6				3
W	1708	*Modiolula*	*phaseolina*	(Philippi, 1844)					2		7	6	3				1
W	1718	*Musculus*	*marmoratus*	(Forbes, 1838);								3					2
W	1743	*Limaria*	*loscombi*	(G B Sowerby I, 1823)								1	1	1			2

W	1768	Pectinidae	sp.		Indet juv													
W	1774	*Mimachlamys*	sp.	Röding, 1798	Indet juv													2
W	1779	*Mimachlamys*	*varia*	(Linnaeus, 1758)					1		2	4						
W	1805	Anomiidae	sp.								1							
W	1814	*Monia*	*squama*	(Linnaeus, 1761)	Present on *Modiolus* shells				17	2	3	3	1	1				
W	1827	*Myrtea*	*spinifera*	(Montagu, 1803)														
W	2072	*Arctica*	*islandica*	(Linnaeus, 1767)	Dam			1										
W	1837	*Thyasira*	*flexuosa*	(Montagu, 1803)	Dam										2	1		
W	1906	*Kurtiella*	*bidentata*	(Montagu, 1803)	Dam	1		1								4		
W	1951	*Parvicardium*	*pinnulatum*	(G B Sowerby II, 1840)							1		1	1				1
W	1952	*Parvicardium*	*scabrum*	(Philippi, 1844)					1						1			2
W	2006	*Phaxas*	*pellucidus*	(Pennant, 1777)	Dam			1								2		
W	2095	*Gouldia*	*minima*	(Montagu, 1803)														
W	2021	*Tellina*	*donacina*	Linnaeus, 1758														
W	2023	*Angulus*	*pygmaea*	(Lovén, 1846)														
W	2056	*Azorinus*	*chamasolen*	(da Costa, 1778)														
W	2061	*Abra*	*nitida*	(O F Müller, 1776)	Dam			3	9	24	17	96	5	11	18	5	12	
W	2100	*Clausinella*	*fasciata*	(da Costa, 1778)													1	
W	2104	*Timoclea*	*ovata*	(Pennant, 1777)										1				
W	2112	*Venerupis*	*aurea*	(Gmelin, 1791)														
W	2157	*Corbula*	*gibba*	(Olivi, 1792)				5										
W	2166	*Hiatella*	*arctica*	(Linnaeus, 1767)	Dam				2		1	2	1			1	1	
W	2247	*Lyonsia*	*norwegica*	(Gmelin, 1791)									1					
ZA	3	*Phoronis*	sp.	Wright, 1856				2										
ZB	15	*Leptometra*	*celtica*	(Barrett & McAndrew, 1858)	Dam			1										
ZB	105	Ophiuroidea	sp.		Indet juv				2	4	6	8		1		3	1	
ZB	124	*Ophiothrix*	*fragilis*	(Abildgaard, 1789)	Dam				14		18	35	1			3		
ZB	128	*Ophiocomina*	*nigra*	(Abildgaard, 1789)	Dam							1						
ZB	143	*Ophiactis*	*balli*	(Thompson, 1840)	Dam				4		6	6	3				4	
ZB	151	*Acrocnida*	*brachiata*	(Montagu, 1804)	Dam		1					1						
ZB	152	*Amphiura*	*chiajei*	Forbes, 1843	Dam	1	2	14	15		8	7	4	2	2		1	
ZB	154	*Amphiura*	*filiformis*	(O F Müller, 1776)	Dam					2	4	6	4	3	5	32	1	
ZB	161	*Amphipholis*	*squamata*	(Chiaje, 1829)	Dam	1		3	2		10	3		1				
ZB	176	*Ophiocten*	*affinis*	(Forbes, 1852)	Dam											2		
ZB	181	Echinoidea	sp.	Brandt, 1835	Indet juv													
ZB	212	*Echinocyamus*	*pusillus*	(O F Müller, 1776)					2		3	2		3	1	1	1	
ZB	222	*Echinocardium*	sp.	J E Gray, 1825	Indet juv						1				1		3	
ZB	224	*Echinocardium*	*flavescens*	(O F Müller, 1776)							1		1					
ZB	229	Holothurioidea	sp.		Dam/ indet						1			1		1	1	
ZB	252	*Psolus*	*phantapus*	(Strussenfeldt, 1765)														
ZB	264	*Thyone*	cf. *roscovita*	Hérouard, 1889							1							
ZB	262	*Thyone*	*fusus*	O F Müller, 1776)							1	1		1				
ZB	257	*Pseudothyone*	*raphanus*	(Duben & Koren, 1845)												2		
ZB	272	*Paracucumaria*	*hyndmani*	(Thompson, 1840)					1									
ZD	2	ASCIDIACEA	sp.								3	1				1		
ZD	81	*Corella*	*parallelogramma*	(O F Müller, 1776)								1						
ZD	88	*Ascidia*	*conchilega*	O F Müller, 1776							1							
ZG		Rockling juv	sp	(Walbaum, 1792)	Dam												1	
						58	65	170	259	208	388	500	156	108	175	113	276	

Seastar Survey Ltd.
Job No. J/11/269
Canna Macrofaunal Samples
Macrofaunal ID. Results

NB. **MCS A and MCS N according to Howson & Picton (1997).**
Species nomenclature according to WoRMS (Appletans *et al.*, 2011)

MCS A	MCS N	Taxon	Species	Authority	Qualifier	G13	G14	G15	G16	G17	G18	G19	G20	G21
C	1	PORIFERA	sp.					1						
D	583	ANTHOZOA	sp.			1				1	5			1
F	2	TURBELLARIA	sp.											
F	87	*Stylochoplana*	*maculata*	(Quatrefages, 1845)						1				
G	1	NEMERTEA	spp.		Dam./Indet.	3	3	4	3	9		4	5	2
HD	1	NEMATODA	sp.		indet.	5		2		1				
N	1	SIPUNCULA	sp.		Dam.			1						
N	17	*Golfingia*	*vulgaris*	(de Blainville, 1827)							1			
N	47	*Aspidosiphon*	*muelleri*	Diesing, 1851	Dam									
P	17	APHRODITOIDEA	sp.			1								
P	19	*Aphrodita*	*aculeata*	Linnaeus, 1758			1					1		
P	25	Polynoidae	spp.		Dam.	4	1	8	2					
P	49	*Gattyana*	*cirrosa*	(Pallas, 1766)										
P	50	*Harmothoe*	spp.		Dam.			1		3				
P	59	*Harmothoe*	*fragilis*	Moore, 1910										
P	80	*Lepidonotus*	sp.	Leach, 1816	Dam.									
P	91	*Pholoe*	sp.	Johnston, 1839			2							
P	94	*Pholoe*	*synophthalmica*	Claparède, 1868		6	5	9	1	5	4			
P	107	*Sthenelais*	*boa*	(Johnston, 1839)										
P	114	Phyllodocidae	sp.		Dam./juv.	1			1					
P	150	*Eulalia*	spp.	Savigny, 1817	Dam.					2	1			
P	155	*Eulalia*	*expusilla*	Pleijel, 1987						1				
P	164	*Eumida*	*bahusiensis*	Bergstrom, 1914										
P	176	*Paranaitis*	*kosteriensis*	(Malmgren, 1867)		1								
P	255	*Glycera*	sp.	Savigny, 1818	Dam. / Juv.	1			2	2	3			
P	260	*Glycera*	*lapidum*	Quatrefages, 1866		2		1	3	7	4			
P	-	*Glycera*	*unicornis*	Lamarck, 1818		4	3	3		1	3	1	2	
P	266	Goniadidae	sp.		Juv.									
P	268	*Glycinde*	*nordmanni*	(Malmgren, 1866)						1				
P	271	*Goniada*	*maculata*	Oersted, 1843		2	9			1	2			
P	293	Hesionidae	sp.		Dam./Indet.				1	2				
P	311	*Nereimyra*	*punctata*	(O F Müller, 1788)				1				1		1
P	313	*Ophiodromus*	*flexuosus*	(Chiaje, 1827)			1			5				
P	340	*Glyphohesione*	*klatti*	Friedrich, 1950				1						
P	346	*Syllidae*	sp.		Dam. / Juv.									
P	349	*Syllis*	*cornuta*	(Rathke, 1843)		1		1		3				
P	355	*Eurysyllis*	*tuberculata*	Ehlers, 1864				1						
P	362	*Trypanosyllis*	*coeliaca*	Claparède, 1868					4	13				
P	371	*Syllis*	*variegata*	Grube, 1860						1				
P	372	*Syllis*	*cf. vittata*	(Grube, 1840)				1		3				
P	380	*Eusyllis*	*blomstrandi*	Malmgren, 1867		1			1		1			
P	418	*Exogone*	sp.	Oersted, 1845							1			
P	421	*Exogone*	*hebes*	(Webster & Benedict, 1884)				3			1			
P	424	*Sphaerosyllis*	sp.	Claparède, 1863						3				
P	425	*Sphaerosyllis*	*bulbosa*	Southern, 1914						2				
P	437	*Myrianida*	*brachycephala*	(Marenzeller, 1874)	Syn. Autolytus brachycephalus									
P	475	*Nereis*	*longissima*	Johnston, 1840										
P	494	*Nephtys*	spp.	Cuvier, 1817	Dam.									

P	498	*Nephtys*	*cirrosa*	Ehlers, 1868									1		
P	501	*Nephtys*	*incisa*	Malmgren, 1865									3	1	1
P	502	*Nephtys*	*kersivalensis*	McIntosh, 1908		1		2							
P	539	*Aponuphis*	*bilineata*	(Baird, 1870)							2	2			
P	564	*Marphysa*	*bellii*	(Audouin & Milne-Edwards, 1833)											
P	568	*Nematonereis*	*unicornis*	(Grube, 1840)				1			3	3			
P	569	Lumbrineridae	sp.	de Blainville, 1828	Dam.	3	1	2	6	5	1				
P	571	*Lumbrineriopsis*	*paradoxa*	(Saint-Joseph, 1888)											
P	579	*Lumbrineris*	*gracilis*	(Ehlers, 1868)		8	1	6	16	11	9				
P	584	*Scoletoma*	*impatiens*	(Claparède, 1868)	Dam.			2				2	3		
P	591	*Drilonereis*	*filum*	(Claparède, 1868)		1									
P	597	*Notocirrus*	*scoticus*	McIntosh, 1869											
P	643	*Schistomeringos*	*rudolphi*	(Chiaje, 1828)				1	1	3					
P	661	*Orbinia*	sp.	Quatrefages, 1865			1								
P	665	*Orbinia*	*sertulata*	(Savigny, 1820)						1					
P	674	Paraonidae	sp.		Dam./ juv.	1									
P	683	*Aricidea (Acmira)*	sp.	Hartley, 1981	Dam.								1		
P	684	*Aricidea (Acmira)*	*catherinae*	Laubier, 1967			1								
P	685	*Aricidea (Acmira)*	*cerrutii*	Laubier, 1966						1					
P	690	*Cirrophorus*	*branchiatus*	Ehlers, 1908		1	1	1	1			1			
P	699	*Paradoneis*	*lyra*	(Southern, 1914)			1								
P	718	*Poecilochaetus*	*serpens*	Allen, 1904						2					
P	720	Spionidae	sp.		Dam./Indet.	2		4	5	1	1				
P	723	*Aonides*	*paucibranchiata*	Southern, 1914				2	1	8	3				
P	731	*Laonice*	sp.	Malmgren, 1867					1						
P	733	*Laonice*	*bahusiensis*	Soderstrom, 1920			2		2	4	1	1			
P	735	*Laonice*	*sarsi*	Soderstrom, 1920											
P	745	*Minuspio*	sp.	Foster, 1971				1	2	1					1
P	746	*Minuspio*	cf. multibranchiata	(Berkeley, 1927)								1	9		2
P	747	*Minuspio*	*cirrifera*	(Wiren, 1883)		1		2		1	2				1
P	768	*Prionospio*	*steenstrupi*	Malmgren, 1867											
P	774	*Pseudopolydora*	*pulchra*	(Carazzi, 1895)				1	1	2					
P	793	*Spiophanes*	sp.	Grube, 1860	Dam./juv.	2	1	2			1				
P	795	*Spiophanes*	*cf. wigleyi*	Pettibone, 1962		1	1								
P	796	*Spiophanes*	*kroyeri*	Grube, 1860		8	2	2		1	3				
P	803	*Magelona*	sp.	F Müller, 1858	Dam.										
P	804	*Magelona*	*alleni*	Wilson, 1958											
P	806	*Magelona*	*minuta*	Eliason, 1962											
P	822	Cirratulidae	sp.		Dam./Indet.	4	5	4	6	1	3		1	1	
P	823	*Aphelochaeta*	sp.	Blake, 1991		1	1	1	5	2	7	2	6		
P	824	*Aphelochaeta*	*marioni*	(Saint-Joseph, 1894)			1	1				2	3		
P	828	*Caulleriella*	sp.	Chamberlin, 1919											
P	829	*Caulleriella*	*alata*	(Southern, 1914)											
P	832	*Chaetozone*	sp.	Malmgren, 1867	Dam./Indet.		1				1				
P	833	*Chaetozone*	*gibber*	Woodham & Chambers, 1994		3	2	2	4	1	6				
P	834	*Chaetozone*	*setosa*	Malmgren, 1867		3	7	2			8				2
P	-	*Cirratulus*	*cf. caudatus*	Levinsen, 1893			5	1				26	18		9
P	873	Flabelligeridae	sp.				1	1		1					
P	878	*Diplocirrus*	*glaucus*	(Malmgren, 1867)	Dam.		1	1			1	1	7		1
P	885	*Pherusa*	*plumosa*	(O F Müller, 1776)											
P	906	*Capitella*	sp.	de Blainville, 1828						1					
P	919	*Mediomastus*	*fragilis*	Rasmussen, 1973							8				
P	921	*Notomastus*	*latericeus*	M Sars, 1851		2	2	3	2	5	6	3	1		1
P	938	Maldanidae	spp.		Dam.						2				
P	963	*Euclymene*	*lumbricoides*	(Quatrefages, 1866)											
P	-	*Euclymene*	sp. A	(Claparède, 1863)		11		4	1		2				
P	970	*Praxillella*	sp.	Verrill, 1881			2								
P	971	*Praxillella*	*affinis*	(M Sars, 1872)			1	1	1	1	3				

P	1012	*Ophelina*	sp.	Oersted, 1843	Dam.		1							
P	1027	*Scalibregma*	*inflatum*	Rathke, 1843				3	1					1
P	1090	Oweniidae	sp.		Dam./Indet.					2	1			
P	1098	*Owenia*	*fusiformis*	Chiaje, 1842		1	6		1		2			
P	1099	TEREBELLIDA	spp.		Dam./Indet.		1	1	1	1	1			
P	1100	Pectinariidae	sp.		Juv.									
P	1102	*Amphictene*	*auricoma*	(O F Müller, 1776)										
P	1107	*Lagis*	*koreni*	(Malmgren, 1866)										
P	1111	*Petta*	*pusilla*	Malmgren, 1866						1				
P	1117	*Sabellaria*	*spinulosa*	Leuckart, 1849		1								
P	1125	Ampharetinae	spp.		Indet.									
P	1175	*Terebellides*	*stroemi*	M Sars, 1835							4			
P	1176	*Trichobranchus*	sp.	Malmgren, 1866										
P	1182	*Amphitrite*	*cirrata*	O F Müller, 1771		2		2						
P	1189	*Eupolymnia*	*nebulosa*	(Montagu, 1819)				2						
P	1210	*Nicolea*	*zostericola*	(Oersted, 1844)										
P	1235	*Polycirrus*	sp.	Grube, 1850	Dam./Indet.	1	1	2	2					
P	1254	*Thelepus*	*cincinnatus*	(Fabricius, 1780)										
P	1257	Sabellidae	sp.		Dam./Indet.				10	16				
P	1334	*Hydroides*	*norvegica*	Gunnerus, 1768					1					
P	1343	*Serpula*	*vermicularis*	Linnaeus, 1767				1						
P	1402	Oligochaeta	sp.					4				3	4	
Q	5	*Nymphon*	*brevirostre*	Hodge, 1863	Dam.									
Q	33	*Callipallene*	*brevirostris*	(Johnston, 1837)	Dam.									
Q	44	*Anoplodactylus*	*petiolatus*	(Kröyer, 1844)										
R	15	Thoracica	sp.		Dam/ indet									
R	74	*Balanus*	sp.	Costa, 1778					P	P	P			
R	2422	*Philomedes*	*lilljeborgi*	(G O Sars, 1865)	Dam.									
S	8	*Nebalia*	*herbstii*	Leach, 1814	Dam	1				1				
S	31	Mysidae	sp.		Dam/ indet						1			
S	92	*Heteromysis*	*formosa*	S I Smith, 1874	Dam.									
S	98	Gammaridea	sp.		Dam./indet.	2		1	4	4	1			
S	109	*Eusirus*	*longipes*	Boeck, 1861	Dam									
S	120	*Arrhis*	*phyllonyx*	(M Sars, 1858)	Dam									
S	128	*Deflexilodes*	*subnudus*	(Norman, 1889)	Dam					1				
S	133	*Pontocrates*	*altamarinus*	(Bate & Westwood, 1862)	Dam						1			
S	152	Amphilochidae	sp.		Dam./indet.			1	1	1				
S	158	*Amphilochus*	*manudens*	Bate, 1862	Dam									
S	170	*Paramphilochoides*	*odontonyx*	(Boeck, 1871)	Dam				1					
S	180	*Leucothoe*	*spinicarpa*	(Abildgaard, 1789)	Dam									
S	213	*Stenothoe*	*marina*	(Bate, 1856)	Dam									
S	255	*Harpinia*	*crenulata*	(Boeck, 1871)	Dam.		1							
S	262	*Metaphoxus*	*pectinatus*	(A O Walker, 1896)	Dam									
S	301	*Lepidepecreum*	*longicornis*	(Bate & Westwood, 1861)	Dam				1					
S	307	*Menigrates*	*obtusifrons*	(Boeck, 1861)	Dam									
S	320	*Orchomene*	*humilis*	(Costa, 1853)	Dam									
S	357	*Tiron*	*spiniferus*	(Stimpson, 1853)	Dam			1						
S	413	*Atylus*	*vedlomensis*	(Bate & Westwood, 1862)	Dam				1		4			
S	423	*Ampelisca*	sp.	Kröyer, 1842	Dam/ indet				1					
S	438	*Ampelisca*	*spinipes*	Boeck, 1861		3				2				
S	442	*Ampelisca*	*typica*	(Bate, 1856)	Dam		2				4			
S	448	*Haploops*	*tubicola*	Liljeborg, 1855	Dam	1		2						
S	519	*Othomaera*	*othonis*	(H Milne-Edwards, 1830)	1 very large male (*)				5	10				
S	537	Isaeidae	sp.		Dam./indet.									
S	538	*Gammaropsis*	sp.	Liljeborg, 1855	Dam/ indet									
S	541	*Gammaropsis*	*maculata*	(Johnston, 1828)	Dam	4								
S	558	Ischyroceridae	sp.		Dam./indet.									
S	562	*Ericthonius*	*difformis*	H Milne-Edwards, 1830	Dam				2					

S	577	Aoridae	sp.		Dam./indet.									
S	584	*Lembos*	sp.	Bate, 1857	Dam									
S	585	*Lembos*	*websteri*	Bate, 1857	Dam									
S	588	*Leptocheirus*	*hirsutimanus*	(Bate, 1862)	Dam									
S	629	*Dyopedos*	*porrectus*	(Bate, 1857)	Dam		1							
S	653	*Parvipalpus*	*capillaceus*	(Chevreux, 1888)	Dam.									
S	657	*Phtisica*	*marina*	Slabber, 1769	Dam.				1					
S	796	*Gnathia*	aff. *oxyuraea*	(Liljeborg)	Dam					3				
S	854	*Eurydice*	*pulchra*	Leach, 1815	Dam				1					
S	892	*Janira*	*maculosa*	Leach, 1813	Dam									
S	903	*Munna*	*boeckii*	Kröyer, 1839	Dam			1						
S		*Astacilla*	*dilatata*		Dam		1							
S	1140	*Pseudoparatanais*	*batei*	(G O Sars, 1882)	Dam									
S	1208	*Eudorella*	*truncatula*	(Bate, 1856)				1						
S	1257	*Diastyloides*	*biplicata*	(G O Sars, 1865)	Dam.		1							
S	1255	*Diastylis*	*tumida*	(Liljeborg, 1855)	Dam	1			1					
S	1276	Decapoda	sp.		juv. indet.				1					1
S	1293	Caridea	sp.		juv. indet.									4
S	1293	Caridea	sp.		Dam/ indet									
S	1328	Alpheidae	sp.		Dam./indet.									
S	1338	*Caridion*	*gordoni*	(Bate, 1858)	Dam									
S	-	*Eualus*	*cranchii*		Dam	1								
S	1409	*Calocaris*	*macandreae*	Bell, 1846	Dam							1		1
S	1445	Paguridae	sp.		Dam/ indet				4	3				
S	1470	*Galathea*	sp.	Fabricius, 1793	Indet juv									
S	1471	*Galathea*	*dispersa*	Bate, 1859	Dam. Some indi. infected with parasitic barnacle Saccu			1						
S	1472	*Galathea*	*intermedia*	Liljeborg, 1851	Dam				28	12				
S	1523	*Inachus*	*phalangium*	(Fabricius, 1775)	Dam									
S	1584	*Liocarcinus*	*pusillus*	(Leach, 1815)	Dam				9	4				
S	1606	*Goneplax*	*rhomboides*	(Linnaeus, 1758)	Dam								1	
S	1609	*Monodaeus*	*couchii*	(Couch, 1851)	Dam. Some indi. Infected with parasitic barnacles Sacculinidae sp. (*)									
W	9	*Chaetoderma*	*nitidulum*	Lovén, 1844								5	7	7
W	11	*Falcidens*	*crossotus*	Salvini-Plawen, 1968		3	2	3			2	2		1
W	31	*Neomenia*	*dalyelli*	(Koren & Danielssen, 1877)							1			
W	35	*Eleutheromenia*	*sierra*	(Pruvot, 1890)										
W	50	*Leptochiton*	sp.	J E Gray, 1847										
W	53	*Leptochiton*	*asellus*	(Gmelin, 1791)		2		4	6		2			
W	71	cf *Ischnochiton*	*albus*	(Linnaeus, 1767)						5				
W	81	*Tonicella*	*marmorea*	(O Fabricius, 1780)										
W	82	*Tonicella*	*rubra*	(Linnaeus, 1767)						1				
W	237	*Lepeta*	*caeca*	(O F Müller, 1776)				1						
W	368	*Onoba*	*aculeus*	(Gould, 1841)				1				2		
W	443	*Capulus*	*ungaricus*	(Linnaeus, 1758)				1						
W	480	*Velutina*	*velutina*	(O F Müller, 1776)										
W	638	*Melanella*	*frielei*	(Jordan, 1895)				3						
W	708	*Buccinum*	*undatum*	Linnaeus, 1758										
W	952	*Odostomia*	*conoidea*	(Brocchi, 1814)								1		
W	1059	*Diaphana*	*minuta*	Brown, 1827										
W	1319	Onchidorididae	sp.							10				
W	1325	*Onchidoris*	*muricata*	(O F Müller, 1776)										
W	1569	*Nucula*	*nitidosa*	Winckworth, 1930		1				1				2
W	1571	*Nucula*	*sulcata*	Bronn, 1831			1	1	5					
W	1595	*Nuculana*	*minuta*	(O F Müller, 1776)										
W	1627	*Yoldiella*	*philippana*	(Nyst, 1844)										
W	1702	*Modiolus*	*modiolus*	(Linnaeus, 1758)				4						
W	1708	*Modiolula*	*phaseolina*	(Philippi, 1844)					1					
W	1718	*Musculus*	*marmoratus*	(Forbes, 1838);										
W	1743	*Limaria*	*loscombi*	(G B Sowerby I, 1823)										

W	1768	Pectinidae	sp.		Indet juv		1							
W	1774	*Mimachlamys*	sp.	Röding, 1798	Indet juv				3	2				
W	1779	*Mimachlamys*	*varia*	(Linnaeus, 1758)										
W	1805	Anomiidae	sp.											
W	1814	*Monia*	*squama*	(Linnaeus, 1761)	Present on *Modiolus* shells									
W	1827	*Myrtea*	*spinifera*	(Montagu, 1803)			1							
W	2072	*Arctica*	*islandica*	(Linnaeus, 1767)	Dam		1			3				
W	1837	*Thyasira*	*flexuosa*	(Montagu, 1803)	Dam		1	1	1					
W	1906	*Kurtiella*	*bidentata*	(Montagu, 1803)	Dam		5	2						
W	1951	*Parvicardium*	*pinnulatum*	(G B Sowerby II, 1840)										
W	1952	*Parvicardium*	*scabrum*	(Philippi, 1844)		1			4		4			
W	2006	*Phaxas*	*pellucidus*	(Pennant, 1777)	Dam	1	2							
W	2095	*Gouldia*	*minima*	(Montagu, 1803)					6		1			
W	2021	*Tellina*	*donacina*	Linnaeus, 1758							1			
W	2023	*Angulus*	*pygmaea*	(Lovén, 1846)					1	1	1			
W	2056	*Azorinus*	*chamasolen*	(da Costa, 1778)			1							
W	2061	*Abra*	*nitida*	(O F Müller, 1776)	Dam	4	11	66	1				1	1
W	2100	*Clausinella*	*fasciata*	(da Costa, 1778)					9	6				1
W	2104	*Timoclea*	*ovata*	(Pennant, 1777)					2	5	1			
W	2112	*Venerupis*	*aurea*	(Gmelin, 1791)					1					
W	2157	*Corbula*	*gibba*	(Olivi, 1792)			1				1			
W	2166	*Hiatella*	*arctica*	(Linnaeus, 1767)	Dam									
W	2247	*Lyonsia*	*norwegica*	(Gmelin, 1791)										
ZA	3	*Phoronis*	sp.	Wright, 1856										
ZB	15	*Leptometra*	*celtica*	(Barrett & McAndrew, 1858)	Dam									
ZB	105	Ophiuroidea	sp.		Indet juv	1	2	1	2		1			
ZB	124	*Ophiothrix*	*fragilis*	(Abildgaard, 1789)	Dam		1	1						
ZB	128	*Ophiocomina*	*nigra*	(Abildgaard, 1789)	Dam			3						
ZB	143	*Ophiactis*	*balli*	(Thompson, 1840)	Dam			5						
ZB	151	*Acrocnida*	*brachiata*	(Montagu, 1804)	Dam									
ZB	152	*Amphiura*	*chiajei*	Forbes, 1843	Dam	1	7	9	1		1		1	
ZB	154	*Amphiura*	*filiformis*	(O F Müller, 1776)	Dam	4	51	6			7			
ZB	161	*Amphipholis*	*squamata*	(Chiaje, 1829)	Dam					2		1		
ZB	176	*Ophiocten*	*affinis*	(Forbes, 1852)	Dam									
ZB	181	Echinoidea	sp.	Brandt, 1835	Indet juv					3				
ZB	212	*Echinocyamus*	*pusillus*	(O F Müller, 1776)		1			5	12				
ZB	222	*Echinocardium*	sp.	J E Gray, 1825	Indet juv		1		1	1				
ZB	224	*Echinocardium*	*flavescens*	(O F Müller, 1776)			1							
ZB	229	Holothurioidea	sp.		Dam/ indet	2	1			1	1			
ZB	252	*Psolus*	*phantapus*	(Strussenfeldt, 1765)		2		1						
ZB	264	*Thyone*	cf. *roscovita*	Hérouard, 1889										
ZB	262	*Thyone*	*fusus*	O F Müller, 1776)							1			
ZB	257	*Pseudothyone*	*raphanus*	(Duben & Koren, 1845)										
ZB	272	*Paracucumaria*	*hyndmani*	(Thompson, 1840)										
ZD	2	ASCIDIACEA	sp.			2	1							
ZD	81	*Corella*	*parallelogramma*	(O F Müller, 1776)										
ZD	88	*Ascidia*	*conchilega*	O F Müller, 1776										
ZG		Rockling juv	sp	(Walbaum, 1792)	Dam									
						129	173	224	199	239	143	65	71	42

APPENDIX 04. SEDIMENT SAMPLE STATISTICS

NB. See Blott and Pye (2001) for details on statistical formulae used in the calculation of grain size parameters

SAMPLE: G1	SIEVING ERROR:	0.0%
	SAMPLE TYPE:	Bimodal, Poorly Sorted
	TEXTURAL GROUP:	Sandy Mud
	SEDIMENT NAME:	Very Fine Sandy Coarse Silt
METHOD OF MOMENTS Arithmetic (mm)	MEAN:	95.81
	SORTING:	104.6
	SKEWNESS:	3.142
	KURTOSIS:	19.36
METHOD OF MOMENTS Geometric (mm)	MEAN:	31.29
	SORTING:	4.370
	SKEWNESS:	0.273
	KURTOSIS:	1.380
METHOD OF MOMENTS Logarithmic (φ)	MEAN:	4.998
	SORTING:	2.128
	SKEWNESS:	-0.273
	KURTOSIS:	1.380
FOLK AND WARD METHOD (mm)	MEAN:	45.26
	SORTING:	3.828
	SKEWNESS:	-0.232
	KURTOSIS:	0.803
FOLK AND WARD METHOD (φ)	MEAN:	4.465
	SORTING:	1.937
	SKEWNESS:	0.232
	KURTOSIS:	0.803
FOLK AND WARD METHOD (Description)	MEAN:	Very Coarse Silt
	SORTING:	Poorly Sorted
	SKEWNESS:	Fine Skewed
	KURTOSIS:	Platykurtic
	MODE 1 (mm):	76.50
	MODE 2 (mm):	215.0
	MODE 3 (mm):	
	MODE 1 (φ):	3.731
	MODE 2 (φ):	2.237
	MODE 3 (φ):	
	D_{10} (mm):	6.708
	D_{50} (mm):	58.33
	D_{90} (mm):	219.6
	(D_{90} / D_{10}) (mm):	32.73
	(D_{90} - D_{10}) (mm):	212.8
	(D_{75} / D_{25}) (mm):	7.885
	(D_{75} - D_{25}) (mm):	103.9
	D_{10} (φ):	2.187
	D_{50} (φ):	4.100
	D_{90} (φ):	7.220
	(D_{90} / D_{10}) (φ):	3.301
	(D_{90} - D_{10}) (φ):	5.033
	(D_{75} / D_{25}) (φ):	1.970
	(D_{75} - D_{25}) (φ):	2.979

SAMPLE: G2	SIEVING ERROR:	-0.4%
	SAMPLE TYPE:	Unimodal, Poorly Sorted
	TEXTURAL GROUP:	Muddy Sand
	SEDIMENT NAME:	Medium Silty Very Fine Sand
METHOD OF MOMENTS Arithmetic (mm)	MEAN:	110.9
	SORTING:	135.8
	SKEWNESS:	4.339
	KURTOSIS:	28.05
METHOD OF MOMENTS Geometric (mm)	MEAN:	43.94
	SORTING:	4.139
	SKEWNESS:	-0.139
	KURTOSIS:	1.605
METHOD OF MOMENTS Logarithmic (φ)	MEAN:	4.508
	SORTING:	2.049
	SKEWNESS:	0.139
	KURTOSIS:	1.605
FOLK AND WARD METHOD (mm)	MEAN:	54.14
	SORTING:	3.489
	SKEWNESS:	-0.358
	KURTOSIS:	1.029
FOLK AND WARD METHOD (φ)	MEAN:	4.207
	SORTING:	1.803
	SKEWNESS:	0.358
	KURTOSIS:	1.029
FOLK AND WARD METHOD (Description)	MEAN:	Very Coarse Silt
	SORTING:	Poorly Sorted
	SKEWNESS:	Very Fine Skewed
	KURTOSIS:	Mesokurtic
	MODE 1 (mm):	76.50
	MODE 2 (mm):	
	MODE 3 (mm):	
	MODE 1 (φ):	3.731
	MODE 2 (φ):	
	MODE 3 (φ):	
	D_{10} (mm):	8.132
	D_{50} (mm):	77.22
	D_{90} (mm):	213.7
	(D_{90} / D_{10}) (mm):	26.27
	(D_{90} - D_{10}) (mm):	205.5
	(D_{75} / D_{25}) (mm):	4.981
	(D_{75} - D_{25}) (mm):	97.25
	D_{10} (φ):	2.227
	D_{50} (φ):	3.695
	D_{90} (φ):	6.942
	(D_{90} / D_{10}) (φ):	3.118
	(D_{90} - D_{10}) (φ):	4.716
	(D_{75} / D_{25}) (φ):	1.762
	(D_{75} - D_{25}) (φ):	2.316

SAMPLE: G3	SIEVING ERROR:	-0.4%
	SAMPLE TYPE:	Unimodal, Poorly Sorted
	TEXTURAL GROUP:	Slightly Gravelly Muddy Sand
	SEDIMENT NAME:	Slightly Very Fine Gravelly Very Coarse Silty Fine Sand
METHOD OF MOMENTS Arithmetic (mm)	MEAN:	300.1
	SORTING:	360.3
	SKEWNESS:	3.789
	KURTOSIS:	29.03
METHOD OF MOMENTS Geometric (mm)	MEAN:	138.0
	SORTING:	4.421
	SKEWNESS:	-0.857
	KURTOSIS:	2.918
METHOD OF MOMENTS Logarithmic (φ)	MEAN:	2.857
	SORTING:	2.144
	SKEWNESS:	0.857
	KURTOSIS:	2.918
FOLK AND WARD METHOD (mm)	MEAN:	168.3
	SORTING:	3.633
	SKEWNESS:	-0.218
	KURTOSIS:	1.538
FOLK AND WARD METHOD (φ)	MEAN:	2.571
	SORTING:	1.861
	SKEWNESS:	0.218
	KURTOSIS:	1.538
FOLK AND WARD METHOD (Description)	MEAN:	Fine Sand
	SORTING:	Poorly Sorted
	SKEWNESS:	Fine Skewed
	KURTOSIS:	Very Leptokurtic
	MODE 1 (mm):	215.0
	MODE 2 (mm):	
	MODE 3 (mm):	
	MODE 1 (φ):	2.237
	MODE 2 (φ):	
	MODE 3 (φ):	
	D_{10} (mm):	19.40
	D_{50} (mm):	187.1
	D_{90} (mm):	703.7
	(D_{90} / D_{10}) (mm):	36.28
	(D_{90} - D_{10}) (mm):	684.3
	(D_{75} / D_{25}) (mm):	3.529
	(D_{75} - D_{25}) (mm):	245.9
	D_{10} (φ):	0.507
	D_{50} (φ):	2.418
	D_{90} (φ):	5.688
	(D_{90} / D_{10}) (φ):	11.22
	(D_{90} - D_{10}) (φ):	5.181
	(D_{75} / D_{25}) (φ):	2.179
	(D_{75} - D_{25}) (φ):	1.819

SAMPLE: G4	SIEVING ERROR:	-0.3%
	SAMPLE TYPE:	Unimodal, Poorly Sorted
	TEXTURAL GROUP:	Slightly Gravelly Muddy Sand
	SEDIMENT NAME:	Slightly Very Fine Gravelly Very Coarse Silty Medium Sand
METHOD OF MOMENTS Arithmetic (mm)	MEAN:	402.2
	SORTING:	496.7
	SKEWNESS:	4.528
	KURTOSIS:	32.12
METHOD OF MOMENTS Geometric (mm)	MEAN:	195.3
	SORTING:	4.437
	SKEWNESS:	-1.158
	KURTOSIS:	3.615
METHOD OF MOMENTS Logarithmic (φ)	MEAN:	2.356
	SORTING:	2.150
	SKEWNESS:	1.158
	KURTOSIS:	3.615
FOLK AND WARD METHOD (mm)	MEAN:	234.2
	SORTING:	3.449
	SKEWNESS:	-0.352
	KURTOSIS:	1.752
FOLK AND WARD METHOD (φ)	MEAN:	2.094
	SORTING:	1.786
	SKEWNESS:	0.352
	KURTOSIS:	1.752
FOLK AND WARD METHOD (Description)	MEAN:	Fine Sand
	SORTING:	Poorly Sorted
	SKEWNESS:	Very Fine Skewed
	KURTOSIS:	Very Leptokurtic
	MODE 1 (mm):	302.5
	MODE 2 (mm):	
	MODE 3 (mm):	
	MODE 1 (φ):	1.747
	MODE 2 (φ):	
	MODE 3 (φ):	
	D_{10} (mm):	26.01
	D_{50} (mm):	286.4
	D_{90} (mm):	778.5
	(D_{90} / D_{10}) (mm):	29.93
	(D_{90} - D_{10}) (mm):	752.5
	(D_{75} / D_{25}) (mm):	3.028
	(D_{75} - D_{25}) (mm):	307.1
	D_{10} (φ):	0.361
	D_{50} (φ):	1.804
	D_{90} (φ):	5.265
	(D_{90} / D_{10}) (φ):	14.58
	(D_{90} - D_{10}) (φ):	4.903
	(D_{75} / D_{25}) (φ):	2.421
	(D_{75} - D_{25}) (φ):	1.598

SAMPLE: G5	SIEVING ERROR:	0.0%
	SAMPLE TYPE:	Trimodal, Very Poorly Sorted
	TEXTURAL GROUP:	Gravelly Muddy Sand
	SEDIMENT NAME:	Medium Gravelly Very Coarse Silty Medium Sand
METHOD OF MOMENTS Arithmetic (mm)	MEAN:	1509.2
	SORTING:	2518.7
	SKEWNESS:	2.421
	KURTOSIS:	7.844
METHOD OF MOMENTS Geometric (mm)	MEAN:	444.0
	SORTING:	5.949
	SKEWNESS:	-0.581
	KURTOSIS:	3.418
METHOD OF MOMENTS Logarithmic (φ)	MEAN:	1.171
	SORTING:	2.573
	SKEWNESS:	0.581
	KURTOSIS:	3.418
FOLK AND WARD METHOD (mm)	MEAN:	533.4
	SORTING:	5.338
	SKEWNESS:	0.081
	KURTOSIS:	1.366
FOLK AND WARD METHOD (φ)	MEAN:	0.907
	SORTING:	2.416
	SKEWNESS:	-0.081
	KURTOSIS:	1.366
FOLK AND WARD METHOD (Description)	MEAN:	Coarse Sand
	SORTING:	Very Poorly Sorted
	SKEWNESS:	Symmetrical
	KURTOSIS:	Leptokurtic
	MODE 1 (mm):	302.5
	MODE 2 (mm):	9600.0
	MODE 3 (mm):	4800.0
	MODE 1 (φ):	1.747
	MODE 2 (φ):	-3.243
	MODE 3 (φ):	-2.243
	D_{10} (mm):	68.32
	D_{50} (mm):	438.5
	D_{90} (mm):	4549.0
	(D_{90} / D_{10}) (mm):	66.59
	(D_{90} - D_{10}) (mm):	4480.7
	(D_{75} / D_{25}) (mm):	6.566
	(D_{75} - D_{25}) (mm):	1154.1
	D_{10} (φ):	-2.186
	D_{50} (φ):	1.189
	D_{90} (φ):	3.872
	(D_{90} / D_{10}) (φ):	-1.771
	(D_{90} - D_{10}) (φ):	6.057
	(D_{75} / D_{25}) (φ):	-5.098
	(D_{75} - D_{25}) (φ):	2.715

SAMPLE: G6	SIEVING ERROR:	-0.3%
	SAMPLE TYPE:	Unimodal, Poorly Sorted
	TEXTURAL GROUP:	Slightly Gravelly Muddy Sand
	SEDIMENT NAME:	Slightly Medium Gravelly Very Coarse Silty Medium Sand
METHOD OF MOMENTS Arithmetic (mm)	MEAN:	528.7
	SORTING:	1194.2
	SKEWNESS:	6.241
	KURTOSIS:	45.08
METHOD OF MOMENTS Geometric (mm)	MEAN:	211.7
	SORTING:	4.382
	SKEWNESS:	-0.887
	KURTOSIS:	4.138
METHOD OF MOMENTS Logarithmic (φ)	MEAN:	2.240
	SORTING:	2.132
	SKEWNESS:	0.887
	KURTOSIS:	4.138
FOLK AND WARD METHOD (mm)	MEAN:	254.1
	SORTING:	3.216
	SKEWNESS:	-0.224
	KURTOSIS:	1.759
FOLK AND WARD METHOD (φ)	MEAN:	1.977
	SORTING:	1.685
	SKEWNESS:	0.224
	KURTOSIS:	1.759
FOLK AND WARD METHOD (Description)	MEAN:	Medium Sand
	SORTING:	Poorly Sorted
	SKEWNESS:	Fine Skewed
	KURTOSIS:	Very Leptokurtic
	MODE 1 (mm):	302.5
	MODE 2 (mm):	
	MODE 3 (mm):	
	MODE 1 (φ):	1.747
	MODE 2 (φ):	
	MODE 3 (φ):	
	D_{10} (mm):	35.46
	D_{50} (mm):	271.3
	D_{90} (mm):	818.4
	(D_{90} / D_{10}) (mm):	23.08
	(D_{90} - D_{10}) (mm):	782.9
	(D_{75} / D_{25}) (mm):	2.979
	(D_{75} - D_{25}) (mm):	306.3
	D_{10} (φ):	0.289
	D_{50} (φ):	1.882
	D_{90} (φ):	4.817
	(D_{90} / D_{10}) (φ):	16.66
	(D_{90} - D_{10}) (φ):	4.528
	(D_{75} / D_{25}) (φ):	2.410
	(D_{75} - D_{25}) (φ):	1.575

SAMPLE: G7	SIEVING ERROR:	-0.4%
	SAMPLE TYPE:	Unimodal, Poorly Sorted
	TEXTURAL GROUP:	Slightly Gravelly Muddy Sand
	SEDIMENT NAME:	Slightly Very Fine Gravelly Coarse Silty Medium Sand
METHOD OF MOMENTS Arithmetic (mm)	MEAN:	548.0
	SORTING:	1008.8
	SKEWNESS:	6.285
	KURTOSIS:	51.83
METHOD OF MOMENTS Geometric (mm)	MEAN:	233.0
	SORTING:	4.456
	SKEWNESS:	-0.937
	KURTOSIS:	3.936
METHOD OF MOMENTS Logarithmic (φ)	MEAN:	2.102
	SORTING:	2.156
	SKEWNESS:	0.937
	KURTOSIS:	3.936
FOLK AND WARD METHOD (mm)	MEAN:	283.1
	SORTING:	3.495
	SKEWNESS:	-0.145
	KURTOSIS:	1.574
FOLK AND WARD METHOD (φ)	MEAN:	1.821
	SORTING:	1.805
	SKEWNESS:	0.145
	KURTOSIS:	1.574
FOLK AND WARD METHOD (Description)	MEAN:	Medium Sand
	SORTING:	Poorly Sorted
	SKEWNESS:	Fine Skewed
	KURTOSIS:	Very Leptokurtic
	MODE 1 (mm):	215.0
	MODE 2 (mm):	
	MODE 3 (mm):	
	MODE 1 (φ):	2.237
	MODE 2 (φ):	
	MODE 3 (φ):	
	D_{10} (mm):	40.59
	D_{50} (mm):	285.2
	D_{90} (mm):	1086.5
	(D_{90} / D_{10}) (mm):	26.77
	(D_{90} - D_{10}) (mm):	1046.0
	(D_{75} / D_{25}) (mm):	3.564
	(D_{75} - D_{25}) (mm):	397.0
	D_{10} (φ):	-0.120
	D_{50} (φ):	1.810
	D_{90} (φ):	4.623
	(D_{90} / D_{10}) (φ):	-38.608
	(D_{90} - D_{10}) (φ):	4.743
	(D_{75} / D_{25}) (φ):	3.138
	(D_{75} - D_{25}) (φ):	1.834

SAMPLE: G8	SIEVING ERROR:	-0.5%
	SAMPLE TYPE:	Unimodal, Poorly Sorted
	TEXTURAL GROUP:	Slightly Gravelly Sand
	SEDIMENT NAME:	Slightly Fine Gravelly Medium Sand
METHOD OF MOMENTS Arithmetic (mm)	MEAN:	562.6
	SORTING:	762.8
	SKEWNESS:	4.343
	KURTOSIS:	23.73
METHOD OF MOMENTS Geometric (mm)	MEAN:	297.0
	SORTING:	3.891
	SKEWNESS:	-1.406
	KURTOSIS:	5.277
METHOD OF MOMENTS Logarithmic (φ)	MEAN:	1.752
	SORTING:	1.960
	SKEWNESS:	1.406
	KURTOSIS:	5.277
FOLK AND WARD METHOD (mm)	MEAN:	352.8
	SORTING:	2.887
	SKEWNESS:	-0.311
	KURTOSIS:	1.682
FOLK AND WARD METHOD (φ)	MEAN:	1.503
	SORTING:	1.530
	SKEWNESS:	0.311
	KURTOSIS:	1.682
FOLK AND WARD METHOD (Description)	MEAN:	Medium Sand
	SORTING:	Poorly Sorted
	SKEWNESS:	Very Fine Skewed
	KURTOSIS:	Very Leptokurtic
	MODE 1 (mm):	427.5
	MODE 2 (mm):	
	MODE 3 (mm):	
	MODE 1 (φ):	1.247
	MODE 2 (φ):	
	MODE 3 (φ):	
	D_{10} (mm):	76.39
	D_{50} (mm):	391.0
	D_{90} (mm):	927.3
	(D_{90} / D_{10}) (mm):	12.14
	(D_{90} - D_{10}) (mm):	851.0
	(D_{75} / D_{25}) (mm):	2.848
	(D_{75} - D_{25}) (mm):	403.1
	D_{10} (φ):	0.109
	D_{50} (φ):	1.355
	D_{90} (φ):	3.710
	(D_{90} / D_{10}) (φ):	34.10
	(D_{90} - D_{10}) (φ):	3.602
	(D_{75} / D_{25}) (φ):	3.199
	(D_{75} - D_{25}) (φ):	1.510

SAMPLE: G9	SIEVING ERROR:	-0.4%
	SAMPLE TYPE:	Unimodal, Poorly Sorted
	TEXTURAL GROUP:	Slightly Gravelly Muddy Sand
	SEDIMENT NAME:	Slightly Very Fine Gravelly Very Coarse Silty Medium Sand
METHOD OF MOMENTS Arithmetic (mm)	MEAN:	376.1
	SORTING:	476.9
	SKEWNESS:	4.883
	KURTOSIS:	36.51
METHOD OF MOMENTS Geometric (mm)	MEAN:	200.6
	SORTING:	3.804
	SKEWNESS:	-1.244
	KURTOSIS:	4.473
METHOD OF MOMENTS Logarithmic (φ)	MEAN:	2.317
	SORTING:	1.928
	SKEWNESS:	1.244
	KURTOSIS:	4.473
FOLK AND WARD METHOD (mm)	MEAN:	243.6
	SORTING:	2.940
	SKEWNESS:	-0.194
	KURTOSIS:	1.843
FOLK AND WARD METHOD (φ)	MEAN:	2.037
	SORTING:	1.556
	SKEWNESS:	0.194
	KURTOSIS:	1.843
FOLK AND WARD METHOD (Description)	MEAN:	Fine Sand
	SORTING:	Poorly Sorted
	SKEWNESS:	Fine Skewed
	KURTOSIS:	Very Leptokurtic
	MODE 1 (mm):	215.0
	MODE 2 (mm):	
	MODE 3 (mm):	
	MODE 1 (φ):	2.237
	MODE 2 (φ):	
	MODE 3 (φ):	
	D_{10} (mm):	46.30
	D_{50} (mm):	251.3
	D_{90} (mm):	715.1
	(D_{90} / D_{10}) (mm):	15.44
	(D_{90} - D_{10}) (mm):	668.8
	(D_{75} / D_{25}) (mm):	2.661
	(D_{75} - D_{25}) (mm):	257.4
	D_{10} (φ):	0.484
	D_{50} (φ):	1.992
	D_{90} (φ):	4.433
	(D_{90} / D_{10}) (φ):	9.163
	(D_{90} - D_{10}) (φ):	3.949
	(D_{75} / D_{25}) (φ):	2.105
	(D_{75} - D_{25}) (φ):	1.412

SAMPLE: G10	SIEVING ERROR:	-1.1%
	SAMPLE TYPE:	Unimodal, Poorly Sorted
	TEXTURAL GROUP:	Slightly Gravelly Sand
	SEDIMENT NAME:	Slightly Very Fine Gravelly Medium Sand
METHOD OF MOMENTS Arithmetic (mm)	MEAN:	608.9
	SORTING:	1247.6
	SKEWNESS:	5.471
	KURTOSIS:	36.66
METHOD OF MOMENTS Geometric (mm)	MEAN:	260.7
	SORTING:	3.987
	SKEWNESS:	-0.861
	KURTOSIS:	4.901
METHOD OF MOMENTS Logarithmic (φ)	MEAN:	1.940
	SORTING:	1.995
	SKEWNESS:	0.861
	KURTOSIS:	4.901
FOLK AND WARD METHOD (mm)	MEAN:	300.4
	SORTING:	3.039
	SKEWNESS:	-0.056
	KURTOSIS:	1.954
FOLK AND WARD METHOD (φ)	MEAN:	1.735
	SORTING:	1.604
	SKEWNESS:	0.056
	KURTOSIS:	1.954
FOLK AND WARD METHOD (Description)	MEAN:	Medium Sand
	SORTING:	Poorly Sorted
	SKEWNESS:	Symmetrical
	KURTOSIS:	Very Leptokurtic
	MODE 1 (mm):	302.5
	MODE 2 (mm):	
	MODE 3 (mm):	
	MODE 1 (φ):	1.747
	MODE 2 (φ):	
	MODE 3 (φ):	
	D_{10} (mm):	75.25
	D_{50} (mm):	288.5
	D_{90} (mm):	1057.4
	(D_{90} / D_{10}) (mm):	14.05
	(D_{90} - D_{10}) (mm):	982.1
	(D_{75} / D_{25}) (mm):	2.639
	(D_{75} - D_{25}) (mm):	304.1
	D_{10} (φ):	-0.081
	D_{50} (φ):	1.793
	D_{90} (φ):	3.732
	(D_{90} / D_{10}) (φ):	-46.357
	(D_{90} - D_{10}) (φ):	3.813
	(D_{75} / D_{25}) (φ):	2.359
	(D_{75} - D_{25}) (φ):	1.400

SAMPLE: G11	SIEVING ERROR:	-0.3%
	SAMPLE TYPE:	Unimodal, Moderately Sorted
	TEXTURAL GROUP:	Slightly Gravelly Sand
	SEDIMENT NAME:	Slightly Very Fine Gravelly Medium Sand
METHOD OF MOMENTS Arithmetic (mm)	MEAN:	316.2
	SORTING:	218.3
	SKEWNESS:	3.626
	KURTOSIS:	27.44
METHOD OF MOMENTS Geometric (mm)	MEAN:	236.6
	SORTING:	2.571
	SKEWNESS:	-2.367
	KURTOSIS:	9.804
METHOD OF MOMENTS Logarithmic (φ)	MEAN:	2.079
	SORTING:	1.362
	SKEWNESS:	2.367
	KURTOSIS:	9.804
FOLK AND WARD METHOD (mm)	MEAN:	277.6
	SORTING:	1.873
	SKEWNESS:	-0.066
	KURTOSIS:	1.845
FOLK AND WARD METHOD (φ)	MEAN:	1.849
	SORTING:	0.905
	SKEWNESS:	0.066
	KURTOSIS:	1.845
FOLK AND WARD METHOD (Description)	MEAN:	Medium Sand
	SORTING:	Moderately Sorted
	SKEWNESS:	Symmetrical
	KURTOSIS:	Very Leptokurtic
	MODE 1 (mm):	215.0
	MODE 2 (mm):	
	MODE 3 (mm):	
	MODE 1 (φ):	2.237
	MODE 2 (φ):	
	MODE 3 (φ):	
	D_{10} (mm):	141.6
	D_{50} (mm):	264.6
	D_{90} (mm):	531.2
	(D_{90} / D_{10}) (mm):	3.751
	(D_{90} - D_{10}) (mm):	389.6
	(D_{75} / D_{25}) (mm):	1.802
	(D_{75} - D_{25}) (mm):	160.4
	D_{10} (φ):	0.913
	D_{50} (φ):	1.918
	D_{90} (φ):	2.820
	(D_{90} / D_{10}) (φ):	3.090
	(D_{90} - D_{10}) (φ):	1.907
	(D_{75} / D_{25}) (φ):	1.577
	(D_{75} - D_{25}) (φ):	0.850

SAMPLE: G12	SIEVING ERROR:	-0.5%
	SAMPLE TYPE:	Bimodal, Very Poorly Sorted
	TEXTURAL GROUP:	Gravelly Muddy Sand
	SEDIMENT NAME:	Fine Gravelly Fine Silty Medium Sand
METHOD OF MOMENTS Arithmetic (mm)	MEAN:	701.4
	SORTING:	1504.5
	SKEWNESS:	4.330
	KURTOSIS:	23.21
METHOD OF MOMENTS Geometric (mm)	MEAN:	208.1
	SORTING:	5.634
	SKEWNESS:	-0.579
	KURTOSIS:	3.126
METHOD OF MOMENTS Logarithmic (φ)	MEAN:	2.265
	SORTING:	2.494
	SKEWNESS:	0.579
	KURTOSIS:	3.126
FOLK AND WARD METHOD (mm)	MEAN:	227.7
	SORTING:	4.789
	SKEWNESS:	-0.195
	KURTOSIS:	1.890
FOLK AND WARD METHOD (φ)	MEAN:	2.134
	SORTING:	2.260
	SKEWNESS:	0.195
	KURTOSIS:	1.890
FOLK AND WARD METHOD (Description)	MEAN:	Fine Sand
	SORTING:	Very Poorly Sorted
	SKEWNESS:	Fine Skewed
	KURTOSIS:	Very Leptokurtic
	MODE 1 (mm):	302.5
	MODE 2 (mm):	4800.0
	MODE 3 (mm):	
	MODE 1 (φ):	1.747
	MODE 2 (φ):	-2.243
	MODE 3 (φ):	
	D_{10} (mm):	20.83
	D_{50} (mm):	285.1
	D_{90} (mm):	1137.1
	(D_{90} / D_{10}) (mm):	54.58
	(D_{90} - D_{10}) (mm):	1116.3
	(D_{75} / D_{25}) (mm):	3.778
	(D_{75} - D_{25}) (mm):	371.6
	D_{10} (φ):	-0.185
	D_{50} (φ):	1.810
	D_{90} (φ):	5.585
	(D_{90} / D_{10}) (φ):	-30.133
	(D_{90} - D_{10}) (φ):	5.770
	(D_{75} / D_{25}) (φ):	2.948
	(D_{75} - D_{25}) (φ):	1.918

SAMPLE: G13	SIEVING ERROR:	0.0%
	SAMPLE TYPE:	Unimodal, Poorly Sorted
	TEXTURAL GROUP:	Slightly Gravelly Muddy Sand
	SEDIMENT NAME:	Slightly Very Fine Gravelly Very Coarse Silty Coarse Sand
METHOD OF MOMENTS Arithmetic (mm)	MEAN:	532.1
	SORTING:	516.1
	SKEWNESS:	3.517
	KURTOSIS:	24.81
METHOD OF MOMENTS Geometric (mm)	MEAN:	274.3
	SORTING:	4.557
	SKEWNESS:	-1.406
	KURTOSIS:	4.092
METHOD OF MOMENTS Logarithmic (φ)	MEAN:	1.866
	SORTING:	2.188
	SKEWNESS:	1.406
	KURTOSIS:	4.092
FOLK AND WARD METHOD (mm)	MEAN:	339.1
	SORTING:	3.464
	SKEWNESS:	-0.435
	KURTOSIS:	1.532
FOLK AND WARD METHOD (φ)	MEAN:	1.560
	SORTING:	1.792
	SKEWNESS:	0.435
	KURTOSIS:	1.532
FOLK AND WARD METHOD (Description)	MEAN:	Medium Sand
	SORTING:	Poorly Sorted
	SKEWNESS:	Very Fine Skewed
	KURTOSIS:	Very Leptokurtic
	MODE 1 (mm):	605.0
	MODE 2 (mm):	
	MODE 3 (mm):	
	MODE 1 (φ):	0.747
	MODE 2 (φ):	
	MODE 3 (φ):	
	D_{10} (mm):	35.26
	D_{50} (mm):	430.4
	D_{90} (mm):	995.0
	(D_{90} / D_{10}) (mm):	28.22
	(D_{90} - D_{10}) (mm):	959.8
	(D_{75} / D_{25}) (mm):	3.520
	(D_{75} - D_{25}) (mm):	507.3
	D_{10} (φ):	0.007
	D_{50} (φ):	1.216
	D_{90} (φ):	4.826
	(D_{90} / D_{10}) (φ):	669.2
	(D_{90} - D_{10}) (φ):	4.819
	(D_{75} / D_{25}) (φ):	4.654
	(D_{75} - D_{25}) (φ):	1.815

SAMPLE: G14	SIEVING ERROR:	0.0%
	SAMPLE TYPE:	Unimodal, Poorly Sorted
	TEXTURAL GROUP:	Slightly Gravelly Muddy Sand
	SEDIMENT NAME:	Slightly Very Fine Gravelly Very Coarse Silty Fine Sand
METHOD OF MOMENTS Arithmetic (mm)	MEAN:	295.9
	SORTING:	255.7
	SKEWNESS:	3.258
	KURTOSIS:	23.77
METHOD OF MOMENTS Geometric (mm)	MEAN:	182.7
	SORTING:	3.392
	SKEWNESS:	-1.554
	KURTOSIS:	5.044
METHOD OF MOMENTS Logarithmic (φ)	MEAN:	2.452
	SORTING:	1.762
	SKEWNESS:	1.554
	KURTOSIS:	5.044
FOLK AND WARD METHOD (mm)	MEAN:	226.0
	SORTING:	2.579
	SKEWNESS:	-0.237
	KURTOSIS:	1.911
FOLK AND WARD METHOD (φ)	MEAN:	2.146
	SORTING:	1.367
	SKEWNESS:	0.237
	KURTOSIS:	1.911
FOLK AND WARD METHOD (Description)	MEAN:	Fine Sand
	SORTING:	Poorly Sorted
	SKEWNESS:	Fine Skewed
	KURTOSIS:	Very Leptokurtic
	MODE 1 (mm):	215.0
	MODE 2 (mm):	
	MODE 3 (mm):	
	MODE 1 (φ):	2.237
	MODE 2 (φ):	
	MODE 3 (φ):	
	D_{10} (mm):	53.55
	D_{50} (mm):	232.9
	D_{90} (mm):	558.3
	(D_{90} / D_{10}) (mm):	10.43
	(D_{90} - D_{10}) (mm):	504.8
	(D_{75} / D_{25}) (mm):	2.329
	(D_{75} - D_{25}) (mm):	200.3
	D_{10} (φ):	0.841
	D_{50} (φ):	2.102
	D_{90} (φ):	4.223
	(D_{90} / D_{10}) (φ):	5.023
	(D_{90} - D_{10}) (φ):	3.382
	(D_{75} / D_{25}) (φ):	1.808
	(D_{75} - D_{25}) (φ):	1.220

SAMPLE: G15	SIEVING ERROR:	-0.4%
	SAMPLE TYPE:	Unimodal, Very Poorly Sorted
	TEXTURAL GROUP:	Slightly Gravelly Muddy Sand
	SEDIMENT NAME:	Slightly Very Fine Gravelly Very Coarse Silty Fine Sand
METHOD OF MOMENTS Arithmetic (mm)	MEAN:	302.0
	SORTING:	551.0
	SKEWNESS:	5.102
	KURTOSIS:	34.77
METHOD OF MOMENTS Geometric (mm)	MEAN:	104.5
	SORTING:	5.099
	SKEWNESS:	-0.457
	KURTOSIS:	2.355
METHOD OF MOMENTS Logarithmic (φ)	MEAN:	3.259
	SORTING:	2.350
	SKEWNESS:	0.457
	KURTOSIS:	2.355
FOLK AND WARD METHOD (mm)	MEAN:	115.3
	SORTING:	4.297
	SKEWNESS:	-0.287
	KURTOSIS:	1.423
FOLK AND WARD METHOD (φ)	MEAN:	3.117
	SORTING:	2.103
	SKEWNESS:	0.287
	KURTOSIS:	1.423
FOLK AND WARD METHOD (Description)	MEAN:	Very Fine Sand
	SORTING:	Very Poorly Sorted
	SKEWNESS:	Fine Skewed
	KURTOSIS:	Leptokurtic
	MODE 1 (mm):	215.0
	MODE 2 (mm):	
	MODE 3 (mm):	
	MODE 1 (φ):	2.237
	MODE 2 (φ):	
	MODE 3 (φ):	
	D_{10} (mm):	12.36
	D_{50} (mm):	157.6
	D_{90} (mm):	570.3
	(D_{90} / D_{10}) (mm):	46.12
	(D_{90} - D_{10}) (mm):	558.0
	(D_{75} / D_{25}) (mm):	4.284
	(D_{75} - D_{25}) (mm):	217.8
	D_{10} (φ):	0.810
	D_{50} (φ):	2.666
	D_{90} (φ):	6.338
	(D_{90} / D_{10}) (φ):	7.823
	(D_{90} - D_{10}) (φ):	5.527
	(D_{75} / D_{25}) (φ):	2.156
	(D_{75} - D_{25}) (φ):	2.099

SAMPLE: G16	SIEVING ERROR:	0.3%
	SAMPLE TYPE:	Polymodal, Very Poorly Sorted
	TEXTURAL GROUP:	Gravelly Sand
	SEDIMENT NAME:	Very Fine Gravelly Fine Sand
METHOD OF MOMENTS Arithmetic (mm)	MEAN:	1880.0
	SORTING:	2583.9
	SKEWNESS:	1.965
	KURTOSIS:	6.096
METHOD OF MOMENTS Geometric (mm)	MEAN:	704.4
	SORTING:	4.726
	SKEWNESS:	-0.406
	KURTOSIS:	3.327
METHOD OF MOMENTS Logarithmic (φ)	MEAN:	0.505
	SORTING:	2.241
	SKEWNESS:	0.406
	KURTOSIS:	3.327
FOLK AND WARD METHOD (mm)	MEAN:	781.2
	SORTING:	4.222
	SKEWNESS:	0.151
	KURTOSIS:	0.763
FOLK AND WARD METHOD (φ)	MEAN:	0.356
	SORTING:	2.078
	SKEWNESS:	-0.151
	KURTOSIS:	0.763
FOLK AND WARD METHOD (Description)	MEAN:	Coarse Sand
	SORTING:	Very Poorly Sorted
	SKEWNESS:	Coarse Skewed
	KURTOSIS:	Platykurtic
	MODE 1 (mm):	215.0
	MODE 2 (mm):	4800.0
	MODE 3 (mm):	1700.0
	MODE 1 (φ):	2.237
	MODE 2 (φ):	-2.243
	MODE 3 (φ):	-0.743
	D_{10} (mm):	144.6
	D_{50} (mm):	679.8
	D_{90} (mm):	5032.0
	(D_{90} / D_{10}) (mm):	34.81
	(D_{90} - D_{10}) (mm):	4887.4
	(D_{75} / D_{25}) (mm):	10.71
	(D_{75} - D_{25}) (mm):	2142.8
	D_{10} (φ):	-2.331
	D_{50} (φ):	0.557
	D_{90} (φ):	2.790
	(D_{90} / D_{10}) (φ):	-1.197
	(D_{90} - D_{10}) (φ):	5.121
	(D_{75} / D_{25}) (φ):	-1.757
	(D_{75} - D_{25}) (φ):	3.421

SAMPLE: G17	SIEVING ERROR:	-0.1%
	SAMPLE TYPE:	Trimodal, Very Poorly Sorted
	TEXTURAL GROUP:	Gravelly Sand
	SEDIMENT NAME:	Medium Gravelly Medium Sand
METHOD OF MOMENTS Arithmetic (mm)	MEAN:	2346.2
	SORTING:	3193.8
	SKEWNESS:	1.535
	KURTOSIS:	3.839
METHOD OF MOMENTS Geometric (mm)	MEAN:	794.4
	SORTING:	5.510
	SKEWNESS:	-0.656
	KURTOSIS:	3.761
METHOD OF MOMENTS Logarithmic (φ)	MEAN:	0.332
	SORTING:	2.462
	SKEWNESS:	0.656
	KURTOSIS:	3.761
FOLK AND WARD METHOD (mm)	MEAN:	934.4
	SORTING:	4.891
	SKEWNESS:	0.113
	KURTOSIS:	0.981
FOLK AND WARD METHOD (φ)	MEAN:	0.098
	SORTING:	2.290
	SKEWNESS:	-0.113
	KURTOSIS:	0.981
FOLK AND WARD METHOD (Description)	MEAN:	Coarse Sand
	SORTING:	Very Poorly Sorted
	SKEWNESS:	Coarse Skewed
	KURTOSIS:	Mesokurtic
	MODE 1 (mm):	9600.0
	MODE 2 (mm):	427.5
	MODE 3 (mm):	4800.0
	MODE 1 (φ):	-3.243
	MODE 2 (φ):	1.247
	MODE 3 (φ):	-2.243
	D_{10} (mm):	162.3
	D_{50} (mm):	730.0
	D_{90} (mm):	8805.7
	(D_{90} / D_{10}) (mm):	54.27
	(D_{90} - D_{10}) (mm):	8643.5
	(D_{75} / D_{25}) (mm):	8.996
	(D_{75} - D_{25}) (mm):	2425.6
	D_{10} (φ):	-3.138
	D_{50} (φ):	0.454
	D_{90} (φ):	2.624
	(D_{90} / D_{10}) (φ):	-0.836
	(D_{90} - D_{10}) (φ):	5.762
	(D_{75} / D_{25}) (φ):	-1.188
	(D_{75} - D_{25}) (φ):	3.169

SAMPLE: G18	SIEVING ERROR:	0.0%
	SAMPLE TYPE:	Trimodal, Very Poorly Sorted
	TEXTURAL GROUP:	Gravelly Sand
	SEDIMENT NAME:	Very Fine Gravelly Fine Sand
METHOD OF MOMENTS Arithmetic (mm)	MEAN:	1165.4
	SORTING:	1748.0
	SKEWNESS:	2.933
	KURTOSIS:	13.27
METHOD OF MOMENTS Geometric (mm)	MEAN:	404.2
	SORTING:	5.323
	SKEWNESS:	-0.570
	KURTOSIS:	3.196
METHOD OF MOMENTS Logarithmic (φ)	MEAN:	1.307
	SORTING:	2.412
	SKEWNESS:	0.570
	KURTOSIS:	3.196
FOLK AND WARD METHOD (mm)	MEAN:	473.5
	SORTING:	4.573
	SKEWNESS:	0.048
	KURTOSIS:	0.931
FOLK AND WARD METHOD (φ)	MEAN:	1.079
	SORTING:	2.193
	SKEWNESS:	-0.048
	KURTOSIS:	0.931
FOLK AND WARD METHOD (Description)	MEAN:	Medium Sand
	SORTING:	Very Poorly Sorted
	SKEWNESS:	Symmetrical
	KURTOSIS:	Mesokurtic
	MODE 1 (mm):	152.5
	MODE 2 (mm):	1700.0
	MODE 3 (mm):	9600.0
	MODE 1 (φ):	2.737
	MODE 2 (φ):	-0.743
	MODE 3 (φ):	-3.243
	D_{10} (mm):	84.25
	D_{50} (mm):	399.7
	D_{90} (mm):	2978.5
	(D_{90} / D_{10}) (mm):	35.35
	(D_{90} - D_{10}) (mm):	2894.2
	(D_{75} / D_{25}) (mm):	10.00
	(D_{75} - D_{25}) (mm):	1363.9
	D_{10} (φ):	-1.575
	D_{50} (φ):	1.323
	D_{90} (φ):	3.569
	(D_{90} / D_{10}) (φ):	-2.267
	(D_{90} - D_{10}) (φ):	5.144
	(D_{75} / D_{25}) (φ):	-4.540
	(D_{75} - D_{25}) (φ):	3.322

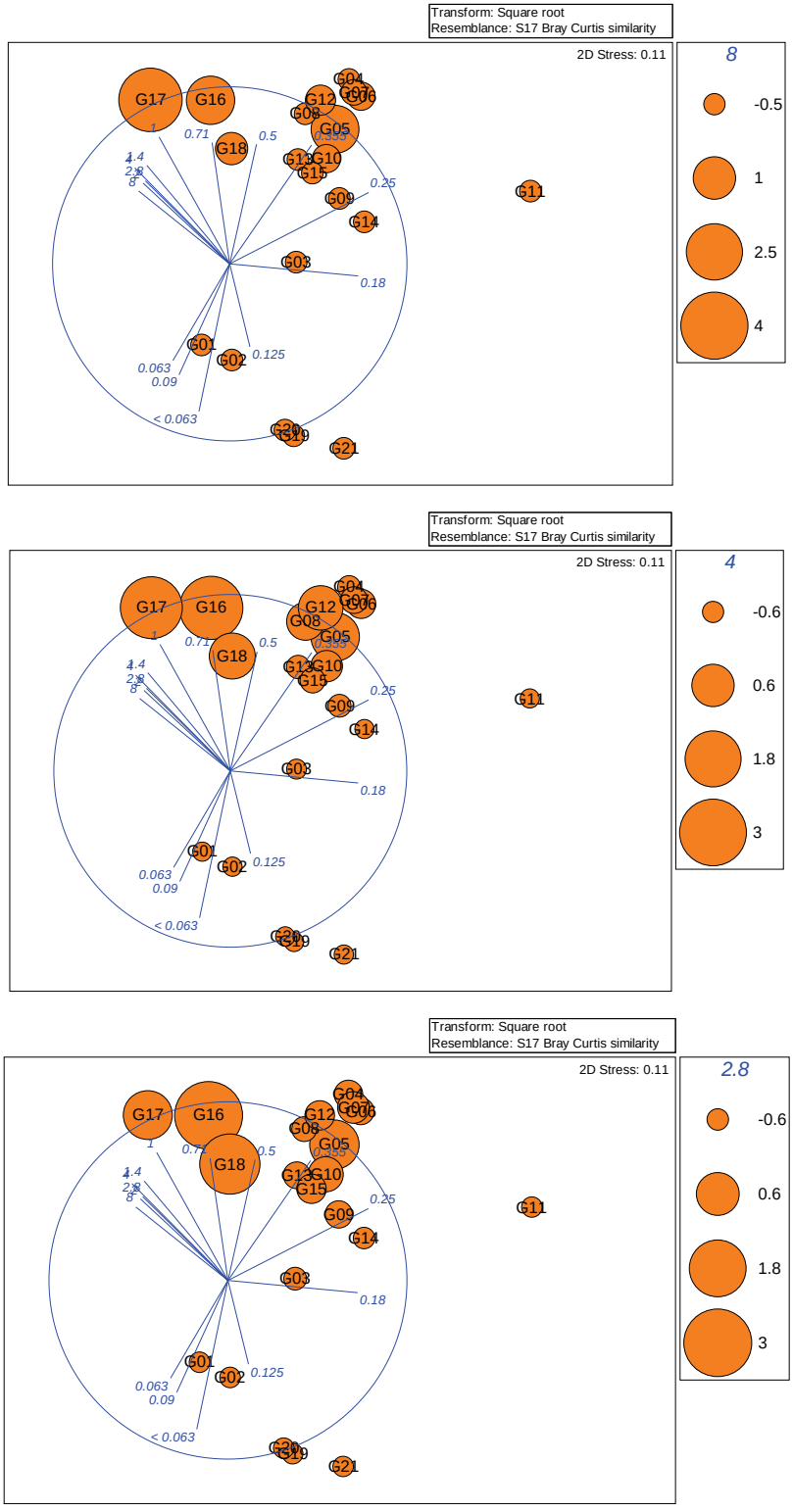
SAMPLE: G19	SIEVING ERROR:	-0.1%
	SAMPLE TYPE:	Unimodal, Poorly Sorted
	TEXTURAL GROUP:	Muddy Sand
	SEDIMENT NAME:	Coarse Silty Fine Sand
METHOD OF MOMENTS Arithmetic (mm)	MEAN:	160.5
	SORTING:	121.2
	SKEWNESS:	1.334
	KURTOSIS:	7.001
METHOD OF MOMENTS Geometric (mm)	MEAN:	75.88
	SORTING:	4.407
	SKEWNESS:	-0.728
	KURTOSIS:	1.837
METHOD OF MOMENTS Logarithmic (φ)	MEAN:	3.720
	SORTING:	2.140
	SKEWNESS:	0.728
	KURTOSIS:	1.837
FOLK AND WARD METHOD (mm)	MEAN:	89.07
	SORTING:	3.586
	SKEWNESS:	-0.551
	KURTOSIS:	1.053
FOLK AND WARD METHOD (φ)	MEAN:	3.489
	SORTING:	1.842
	SKEWNESS:	0.551
	KURTOSIS:	1.053
FOLK AND WARD METHOD (Description)	MEAN:	Very Fine Sand
	SORTING:	Poorly Sorted
	SKEWNESS:	Very Fine Skewed
	KURTOSIS:	Mesokurtic
	MODE 1 (mm):	215.0
	MODE 2 (mm):	
	MODE 3 (mm):	
	MODE 1 (φ):	2.237
	MODE 2 (φ):	
	MODE 3 (φ):	
	D_{10} (mm):	10.39
	D_{50} (mm):	146.8
	D_{90} (mm):	312.7
	(D_{90} / D_{10}) (mm):	30.11
	(D_{90} - D_{10}) (mm):	302.3
	(D_{75} / D_{25}) (mm):	4.924
	(D_{75} - D_{25}) (mm):	176.7
	D_{10} (φ):	1.677
	D_{50} (φ):	2.768
	D_{90} (φ):	6.589
	(D_{90} / D_{10}) (φ):	3.929
	(D_{90} - D_{10}) (φ):	4.912
	(D_{75} / D_{25}) (φ):	2.059
	(D_{75} - D_{25}) (φ):	2.300

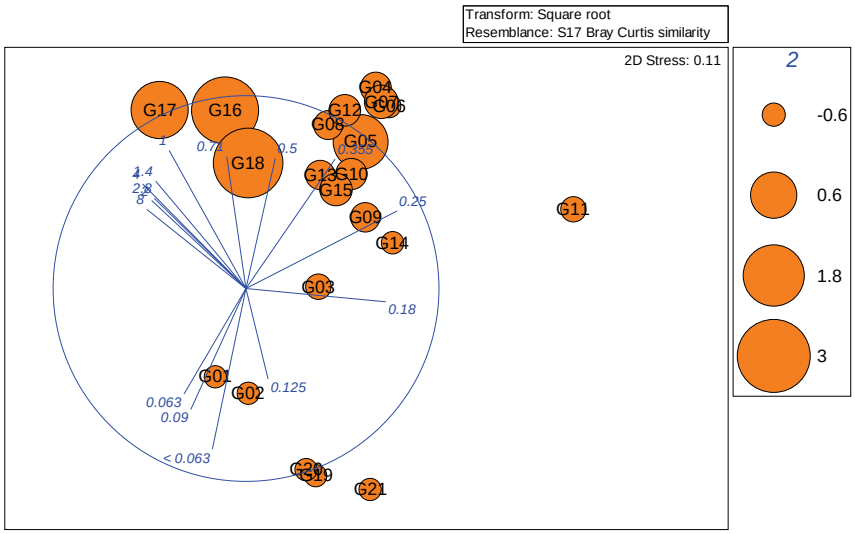
SAMPLE: G20	SIEVING ERROR:	-0.2%
	SAMPLE TYPE:	Unimodal, Very Poorly Sorted
	TEXTURAL GROUP:	Muddy Sand
	SEDIMENT NAME:	Fine Silty Fine Sand
METHOD OF MOMENTS Arithmetic (mm)	MEAN:	169.0
	SORTING:	202.3
	SKEWNESS:	3.011
	KURTOSIS:	17.58
METHOD OF MOMENTS Geometric (mm)	MEAN:	50.24
	SORTING:	5.626
	SKEWNESS:	0.001
	KURTOSIS:	1.284
METHOD OF MOMENTS Logarithmic (φ)	MEAN:	4.315
	SORTING:	2.492
	SKEWNESS:	-0.001
	KURTOSIS:	1.284
FOLK AND WARD METHOD (mm)	MEAN:	67.86
	SORTING:	4.640
	SKEWNESS:	-0.273
	KURTOSIS:	0.728
FOLK AND WARD METHOD (φ)	MEAN:	3.881
	SORTING:	2.214
	SKEWNESS:	0.273
	KURTOSIS:	0.728
FOLK AND WARD METHOD (Description)	MEAN:	Very Fine Sand
	SORTING:	Very Poorly Sorted
	SKEWNESS:	Fine Skewed
	KURTOSIS:	Platykurtic
	MODE 1 (mm):	215.0
	MODE 2 (mm):	
	MODE 3 (mm):	
	MODE 1 (φ):	2.237
	MODE 2 (φ):	
	MODE 3 (φ):	
	D_{10} (mm):	7.298
	D_{50} (mm):	93.52
	D_{90} (mm):	392.1
	(D_{90} / D_{10}) (mm):	53.73
	(D_{90} - D_{10}) (mm):	384.8
	(D_{75} / D_{25}) (mm):	12.86
	(D_{75} - D_{25}) (mm):	221.1
	D_{10} (φ):	1.351
	D_{50} (φ):	3.419
	D_{90} (φ):	7.098
	(D_{90} / D_{10}) (φ):	5.255
	(D_{90} - D_{10}) (φ):	5.748
	(D_{75} / D_{25}) (φ):	2.789
	(D_{75} - D_{25}) (φ):	3.685

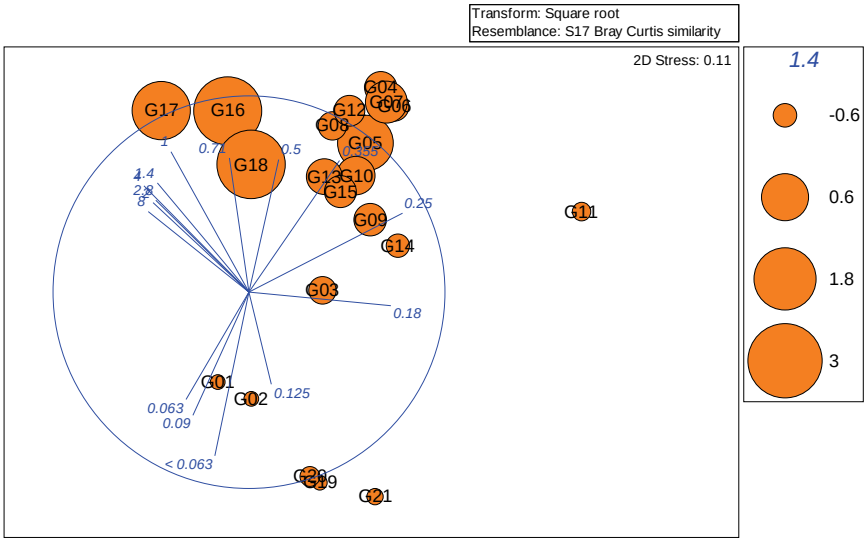
SAMPLE: G21	SIEVING ERROR:	0.1%
	SAMPLE TYPE:	Unimodal, Very Poorly Sorted
	TEXTURAL GROUP:	Muddy Sand
	SEDIMENT NAME:	Medium Silty Fine Sand
METHOD OF MOMENTS Arithmetic (mm)	MEAN:	137.7
	SORTING:	162.3
	SKEWNESS:	3.421
	KURTOSIS:	21.72
METHOD OF MOMENTS Geometric (mm)	MEAN:	43.66
	SORTING:	5.111
	SKEWNESS:	0.037
	KURTOSIS:	1.294
METHOD OF MOMENTS Logarithmic (φ)	MEAN:	4.517
	SORTING:	2.354
	SKEWNESS:	-0.037
	KURTOSIS:	1.294
FOLK AND WARD METHOD (mm)	MEAN:	58.80
	SORTING:	4.224
	SKEWNESS:	-0.304
	KURTOSIS:	0.756
FOLK AND WARD METHOD (φ)	MEAN:	4.088
	SORTING:	2.078
	SKEWNESS:	0.304
	KURTOSIS:	0.756
FOLK AND WARD METHOD (Description)	MEAN:	Very Coarse Silt
	SORTING:	Very Poorly Sorted
	SKEWNESS:	Very Fine Skewed
	KURTOSIS:	Platykurtic
	MODE 1 (mm):	215.0
	MODE 2 (mm):	
	MODE 3 (mm):	
	MODE 1 (φ):	2.237
	MODE 2 (φ):	
	MODE 3 (φ):	
	D_{10} (mm):	7.173
	D_{50} (mm):	83.78
	D_{90} (mm):	298.2
	(D_{90} / D_{10}) (mm):	41.57
	(D_{90} - D_{10}) (mm):	291.0
	(D_{75} / D_{25}) (mm):	10.58
	(D_{75} - D_{25}) (mm):	171.0
	D_{10} (φ):	1.746
	D_{50} (φ):	3.577
	D_{90} (φ):	7.123
	(D_{90} / D_{10}) (φ):	4.081
	(D_{90} - D_{10}) (φ):	5.378
	(D_{75} / D_{25}) (φ):	2.415
	(D_{75} - D_{25}) (φ):	3.403

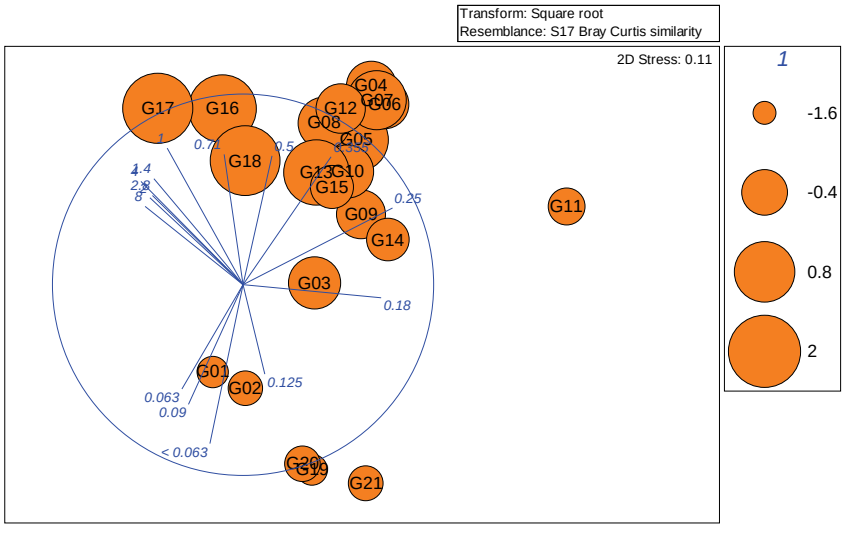
APPENDIX 05. MDS analysis results - abiotic bubble analysis

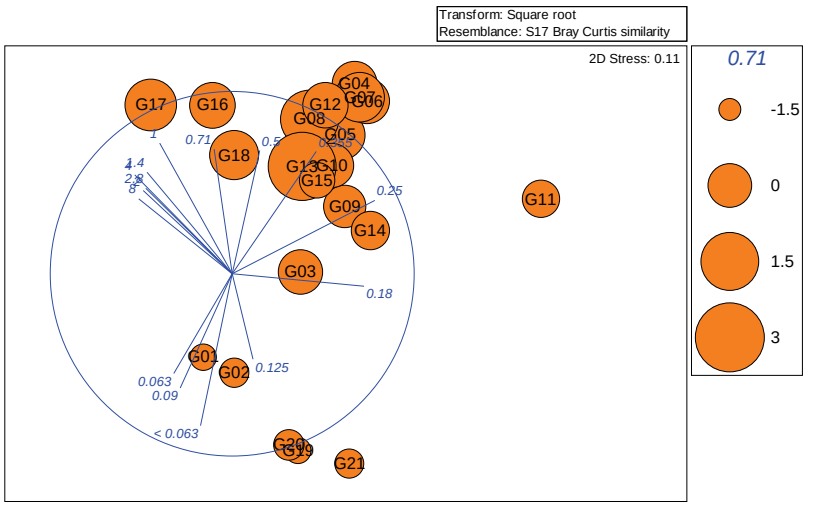
Normalised PSA data

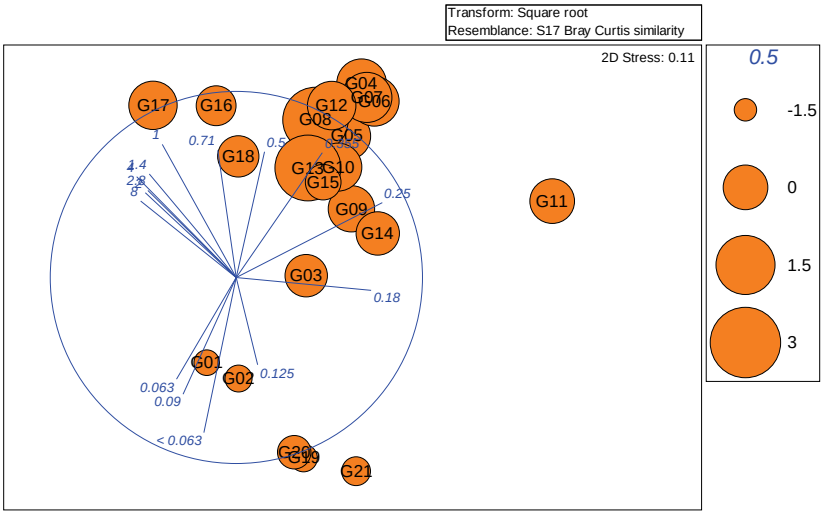


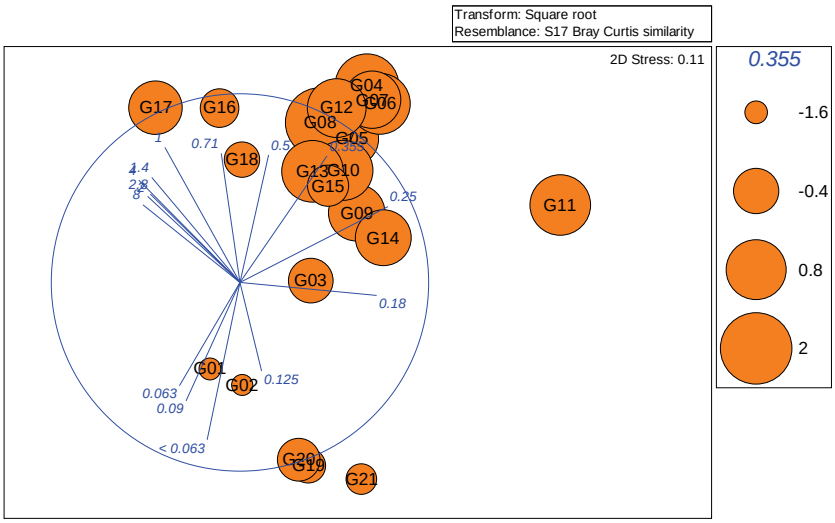

Transform: Square root
Resemblance: S17 Bray Curtis similarity
2D Stress: 0.11
2
-0.6
0.6
1.8
3
G17
G16
G04
G07
G06
G12
G08
G05
G18
G13
G10
G15
G09
G14
G03
G11
G01
G02
G21
1
0.71
0.5
0.355
1.4
2.8
8
0.25
0.18
0.125
0.063
0.09
< 0.063

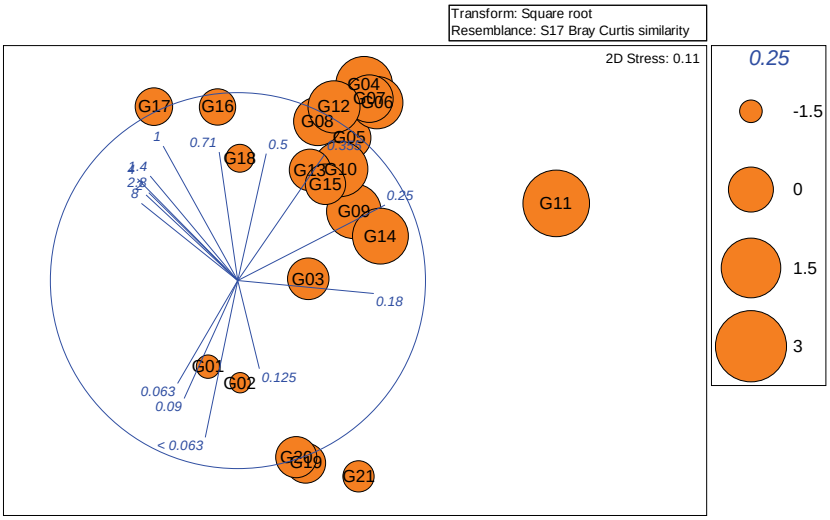

Transform: Square root
Resemblance: S17 Bray Curtis similarity
2D Stress: 0.11
1.4
-0.6
0.6
1.8
3
G17
G16
G04
G07
G06
G12
G08
G05
G18
G13
G10
G15
G09
G14
G03
G11
G01
G02
G21
1
0.71
0.5
0.355
1.4
2.8
8
0.25
0.18
0.125
0.063
0.09
< 0.063

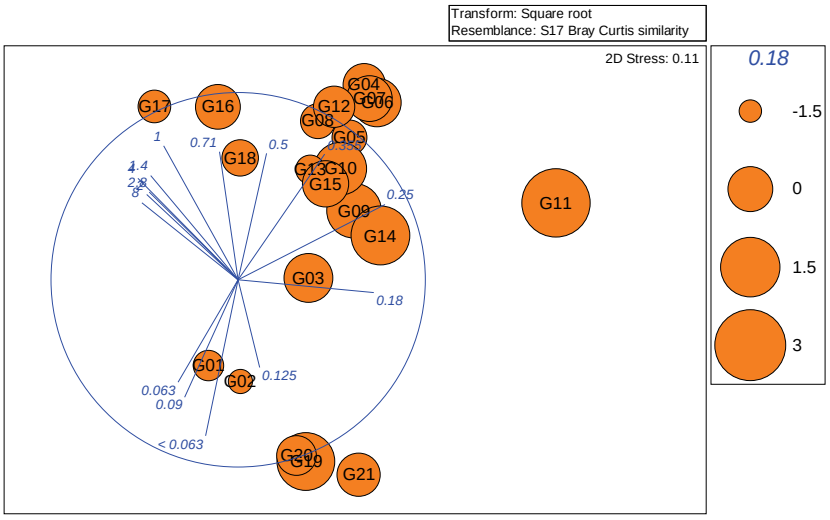

Transform: Square root
Resemblance: S17 Bray Curtis similarity
2D Stress: 0.11
1
-1.6
-0.4
0.8
2
G17
G16
G04
G07
G06
G12
G08
G05
G18
G13
G10
G15
G09
G14
G03
G11
G01
G02
G21
1
0.71
0.5
0.355
1.4
2.8
8
0.25
0.18
0.125
0.063
0.09
< 0.063

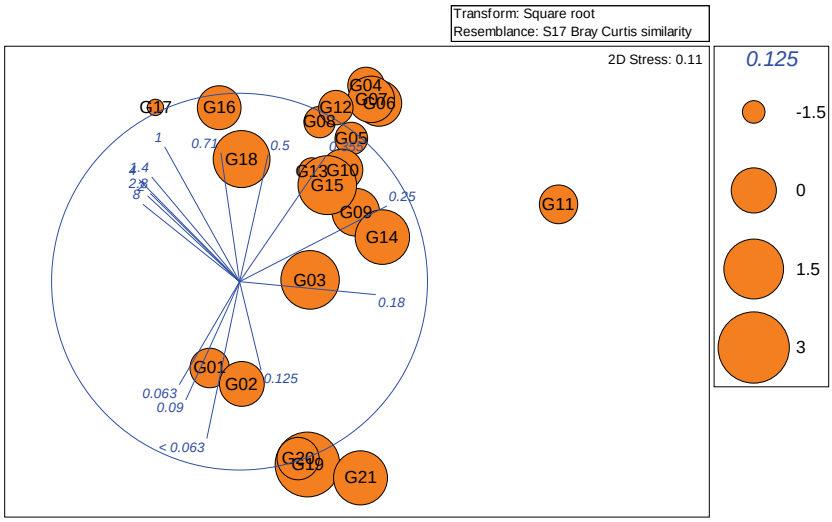

Transform: Square root
Resemblance: S17 Bray Curtis similarity
2D Stress: 0.11
0.71
-1.5
0
1.5
3
G17
G16
G04
G07
G06
G12
G08
G05
G18
G13
G10
G15
G09
G14
G03
G11
G01
G02
G21
1
0.71
0.5
0.25
0.18
0.125
0.063
0.09
< 0.063

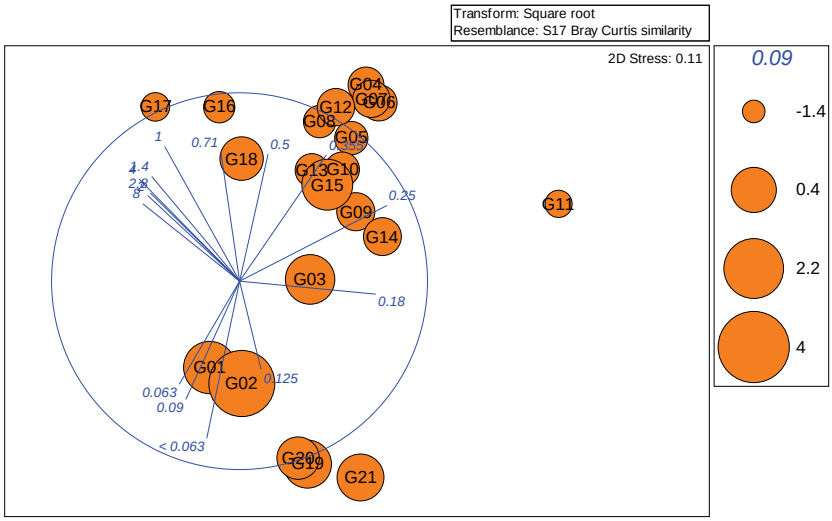

Transform: Square root
Resemblance: S17 Bray Curtis similarity
2D Stress: 0.11
0.5
-1.5
0
1.5
3
G17
G16
G04
G07
G06
G12
G08
G05
G18
G13
G10
G15
G09
G14
G03
G11
G01
G02
G21
1
0.71
0.5
0.25
0.18
0.125
0.063
0.09
< 0.063

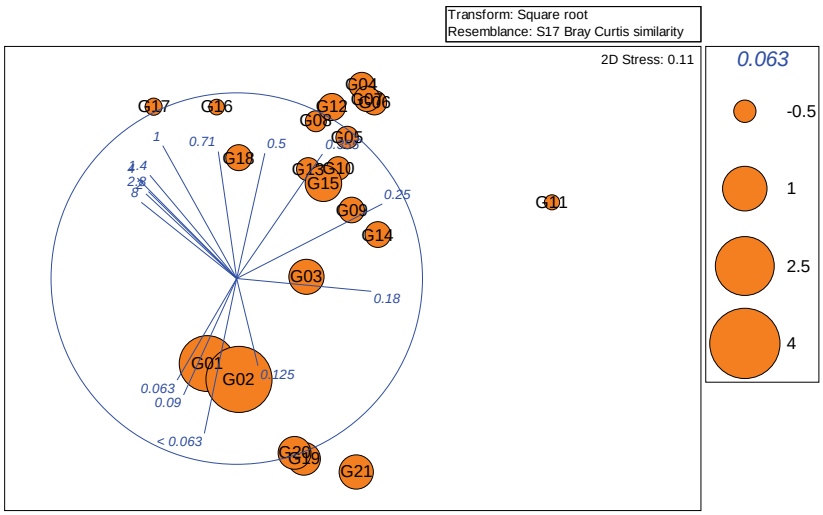

Transform: Square root
Resemblance: S17 Bray Curtis similarity
2D Stress: 0.11
0.355
-1.6
-0.4
0.8
2
G17
G16
G04
G07
G06
G12
G08
G05
G18
G13
G10
G15
G09
G14
G03
G11
G01
G02
G21
1
0.71
0.5
0.25
0.18
0.125
0.063
0.09
< 0.063

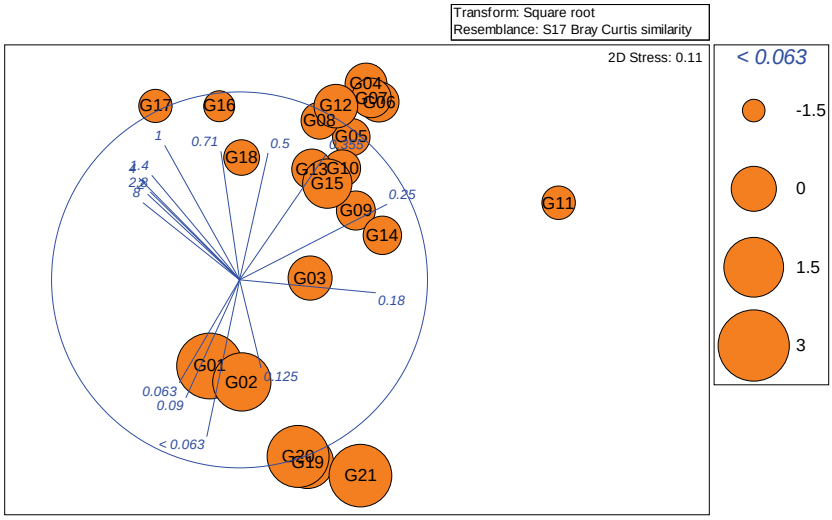

Transform: Square root
Resemblance: S17 Bray Curtis similarity
2D Stress: 0.11
0.25
-1.5
0
1.5
3
G17
G16
G04
G07
G06
G12
G08
G05
G18
G13
G10
G15
G09
G14
G03
G11
G01
G02
G20
G19
G21
1
0.71
0.5
0.25
0.18
0.125
0.063
0.09
< 0.063


Transform: Square root
Resemblance: S17 Bray Curtis similarity
2D Stress: 0.11
0.18
-1.5
0
1.5
3
G17
G16
G04
G07
G06
G12
G08
G05
G18
G13
G10
G15
G09
G14
G03
G11
G01
G02
G20
G19
G21
1
0.71
0.5
0.25
0.18
0.125
0.063
0.09
< 0.063

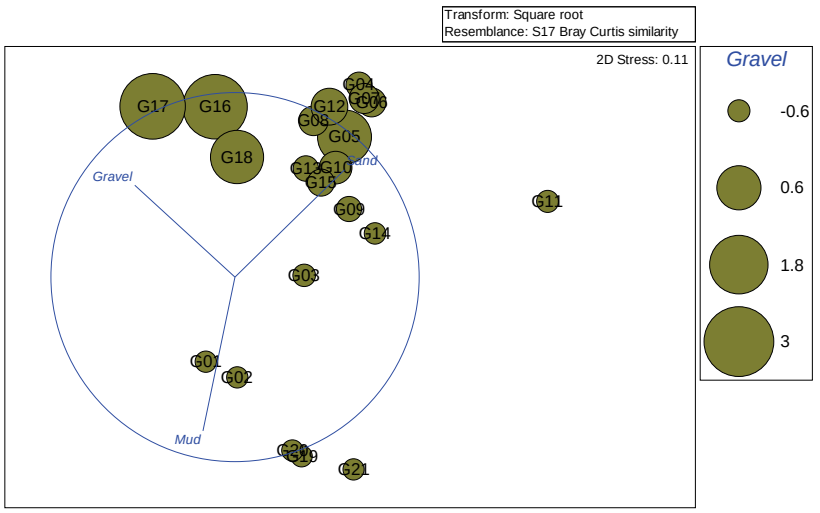

Transform: Square root
Resemblance: S17 Bray Curtis similarity
2D Stress: 0.11
0.125
-1.5
0
1.5
3
G17
G16
G04
G07
G06
G12
G08
G05
G18
G13
G10
G15
G09
G14
G03
G11
G01
G02
G20
G19
G21
1
0.71
0.5
0.25
0.18
0.125
0.063
0.09
< 0.063

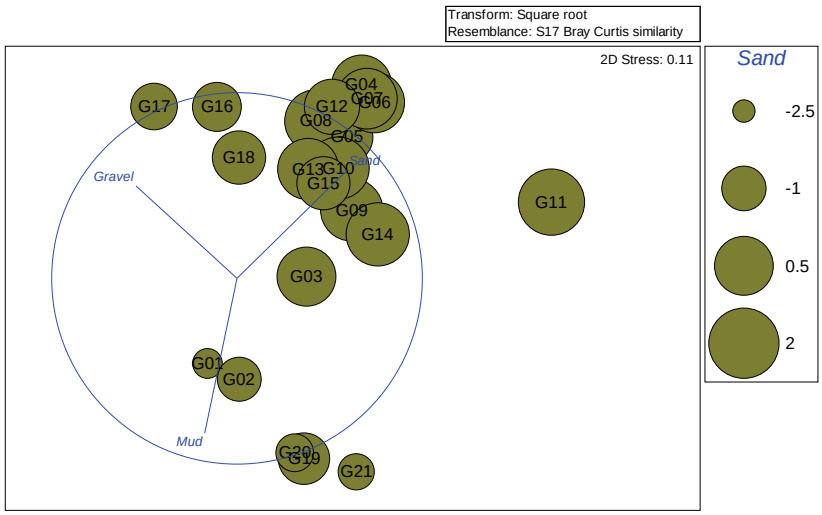

Transform: Square root
Resemblance: S17 Bray Curtis similarity
2D Stress: 0.11
0.09
-1.4
0.4
2.2
4
G17
G16
G04
G07
G06
G12
G08
G05
G18
G13
G10
G15
G09
G14
G11
G03
G01
G02
G20
G19
G21
1
0.71
0.5
0.25
0.18
0.125
0.063
0.09
< 0.063

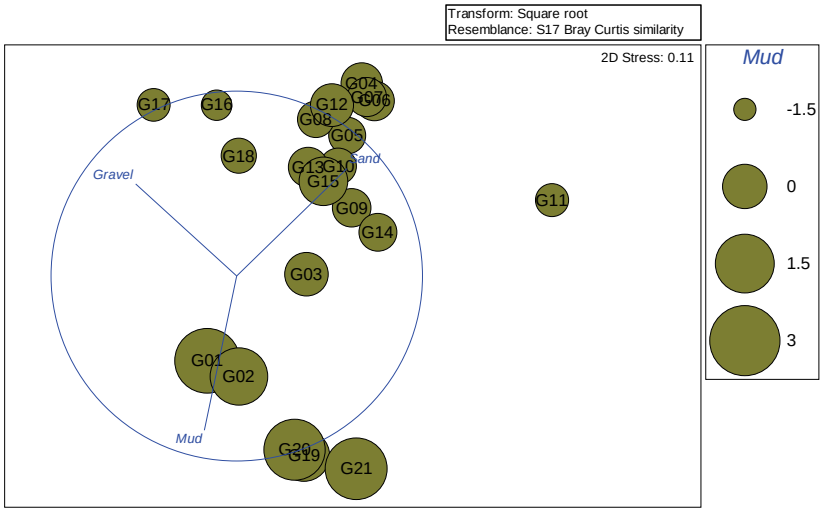

Transform: Square root
Resemblance: S17 Bray Curtis similarity
2D Stress: 0.11
0.063
-0.5
1
2.5
4
G17
G16
G04
G07
G06
G12
G08
G05
G18
G13
G10
G15
G09
G14
G11
G03
G01
G02
G20
G19
G21
1
0.71
0.5
0.25
0.18
0.125
0.063
0.09
< 0.063


Transform: Square root
Resemblance: S17 Bray Curtis similarity
2D Stress: 0.11
< 0.063
-1.5
0
1.5
3
G17
G16
G04
G07
G06
G12
G08
G05
G18
G13
G10
G15
G09
G14
G11
G03
G01
G02
G20
G19
G21
1
0.71
0.5
0.25
0.18
0.125
0.063
0.09
< 0.063

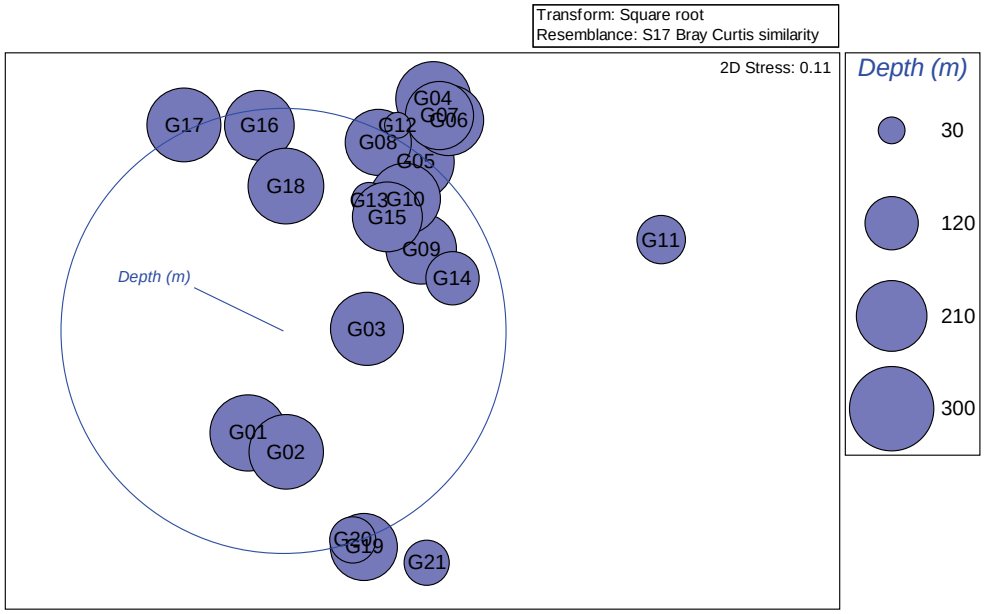
Sediment (%) fractions (gravel, sand and mud)







Depth (m)


Transform: Square root
Resemblance: S17 Bray Curtis similarity
2D Stress: 0.11
Depth (m)
30
120
210
300
G17
G16
G04
G07
G06
G12
G08
G05
G18
G13
G10
G15
G09
G14
G11
Depth (m)
G03
G01
G02
G20
G19
G21

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