Scottish Natural Heritage
Research Report No. 1037

Infaunal and PSA analyses of benthic samples collected from the South of Skye, Southannan Sands SSSI and Mousa SAC / MPA in 2016

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RESEARCH REPORT

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This report should be quoted as:

Allen, J.H. 2018. Infaunal and PSA analyses of benthic samples collected from the South of Skye, Southannan Sands SSSI and Mousa SAC / MPA in 2016. *Scottish Natural Heritage Research Report No. 1037.*

RESEARCH REPORT

Summary

Infaunal and PSA analyses of benthic samples collected from the South of Skye, Southannan Sands SSSI and Mousa SAC / MPA in 2016

Research Report No. 1037
Project No: 015846
Contractor: Precision Marine Survey Limited
Year of publication: 2018

Keywords

Marine survey; SSSI; SAC; MPA; Skye; Southannan Sands; Mousa; protected features; PMF; sandflat; seagrass; seabed habitats; maerl, infauna; PSA.

Background

Provisions to designate new Marine Protected Areas (MPAs) within Scottish waters have been introduced through the Marine (Scotland) Act 2010 and the UK Marine and Coastal Access Act 2009. Sampling at the Mousa SAC (also part of the Mousa to Boddam MPA) was undertaken in 2016 in an area to the north-west of Mousa. Southannan Sands SSSI (originally part of the Portencross Coast SSSI) was designated in 2013 under the Nature Conservation (Scotland) Act 2004. Sandflats are a protected feature of this site and component habitats here include intertidal seagrass beds and blue mussel beds (both of which are Priority Marine Features). Monitoring of the sandflats feature of the Southannan Sands SSSI was carried out in 2016. In addition, surveys were carried out in south Skye in the vicinity of lochs Eishort, Slapin, Scavaig and Soay Sound in order to fill data gaps.

Subtidal seabed surveys were conducted using drop down video and grab sampling (in the sea lochs off south Skye) and diver cores (off Mousa). Intertidal sampling in the Southannan Sands SSSI was undertaken using handheld cores, dig-overs and quadrats along a series of transects. This report presents the analysis of the samples collected during the surveys conducted by SNH and Heriot-Watt University (Mousa) and SNH and SEPA (Skye) in August 2016, whilst surveys at Southannan Sands were undertaken by SNH in July 2016. In total, four diver core samples were collected from Mousa and 10 grab samples were collected from south Skye along with 16 core samples in the Southannan Sands SSSI. Precision Marine Survey Ltd. were commissioned to undertake faunal analysis and particle size analysis (PSA) of the samples and produce a brief interpretative report to characterise the benthic infaunal communities.

Main findings

- Species diversity was highly variable but generally moderate to high with between 1 and 45 taxa per 0.08 m^2 recorded at Southannan Sands and from 28 to 44 taxa per 0.01 m^2 at the Mousa maerl bed. Highest diversities and species richness were recorded in the coarse/mixed sediments at some sites in the south Skye survey, where numbers of taxa ranged from 37 to 107 taxa per 0.1 m^2 grab sample.

- The Southannan Sand benthic samples were characterised by taxa such as *Macomangulus tenuis* and *Pygospio elegans* with *Scoloplos (Scoloplos) armiger*, *Crassicorophium crassicorne*, *Tubificoides benedii* and *Parvicardium* sp. *(pinnulatum?),* which collectively accounted for 80% of the total abundance. Seagrass beds were also recorded in the area.

- Biotopes recorded at the Southannan Sands SSSI included variants of **LS.LSa.MoSa.BarSa**, **LS.LSa.FiSa.Po.Aten**, **LS.LSa.MuSa.Lan, LS.LSa.MuSa.CerPo**, **LS.LMp.LSgr.Znol** (a Priority Marine Feature) and **LS.LMx.Mx.CirCer.**

- Specimens of maerl (a red seaweed with a hard, chalky skeleton) were collected at six stations from Skye and also from the four dive cores at Mousa. Abundances of live maerl at Mousa and at five of the ten stations from south Skye were sufficiently high to qualify as maerl bed biotopes (**SS.SMp.Mrl**). Measurements of live maerl fragments in the benthic grab and diver core samples were also undertaken. Other biotopes recorded included **SS.SMx.CMx.MysThyMx**, **SS.SCS.CCS.Blan**, **SS.SCS.ICS.MoeVen** (a Priority Marine Feature) and **SS.SCS.CCS.MedLumVen.**

- The Mousa maerl bed diver core samples were dominated by the bivalve *Modiolula phaseolina* and the tunicate *Clavelina lepadiformis* along with Nematode worms. Other key taxa included juvenile Amphiuridae sp., *Trypanosyllis (Trypanosyllis) coeliaca* the amphipods *Protomedeia fasciata* and *Othomaera othonis* along with Ophiuroidea sp., *Gari tellinella*, Nemertean worms, *Abra nitida* and *Limatula subauriculata*.

- The grab samples from the south Skye survey exhibited a diverse infauna and the most abundant taxa were nematode worms, *Balanus balanus* and *Kurtiella bidentata*. Other key inafunal taxa included *Alvania beanii, Lysidice unicornis, Hilbigneris gracilis, Acrocnida brachiata, Leptochiton cancellatus, Psamathe fusca, Aponuphis bilineata, Glycera lapidum* agg., *Echinocyamus pusillus, Pisione remota, Leptochiton asellus,, Lysianassa plumosa, Vaunthompsonia cristata* and *Modiolula phaseolina.*

- The flame shell, *Limaria hians,* was recorded at a single station in the south Skye survey (station G03), although densities were not high enough to consider this a flame shell bed.

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1. INTRODUCTION

In July and August 2016 SNH undertook a number of surveys to improve knowledge of the occurrence and distribution of species and habitats of recognised conservation importance in Scottish territorial waters. Provisions to designate new Marine Protected Areas (MPAs) within Scottish waters have been introduced through the Marine (Scotland) Act 2010 and the UK Marine and Coastal Access Act 2009. Scottish Natural Heritage (SNH) and the Joint Nature Conservation Committee (JNCC) have generated a focused list of habitats and species of importance - the Priority Marine Features (PMFs), which are regarded as priorities for conservation action in Scottish waters (Tyler-Walters *et al*., 2016).

The waters around Mousa in Shetland are a Special Area of Conservation (SAC), designated under the Habitats Directive 92/43/EEC in 2005 for reefs, submerged or partially submerged sea caves and harbour seals. This area also forms part of the Mousa to Boddam MPA, designated in 2014 for sandeels and geodiversity interests (including carbonate rich sediments). Monitoring of the Mousa SAC/MPA was undertaken between the 21st July to the 6th August by Heriot-Watt University and SNH. Although not a named feature of the SAC, a maerl bed (a PMF) considered to contribute to the geo-interests of the MPA, was surveyed to the north-west of Mousa.

Southannan Sands SSSI (originally part of the Portencross Coast SSSI) is located on the west coast of Scotland in Ayrshire and was designated in 2013 under the Nature Conservation (Scotland) Act 2004. Sandflats are a protected feature of this site and component habitats here include intertidal seagrass beds and blue mussel (*Mytilus edulis*) beds (both of which are PMFs). Monitoring of the sandflats feature of the Southannan Sands SSSI was carried out by SNH from 25th-27th July 2016.

Following discussions with local stakeholders regarding a community-led marine nature conservation initiative in south Skye, SNH carried out a survey in collaboration with SEPA on the *SV Sir John Murray* on the 23rd and 24th August. The primary objective of this survey was to fill data gaps. Drop-down video and grab samples were collected throughout lochs Eishort, Slapin, Scavaig and Soay Sound.

Precision Marine Survey Limited were contracted by SNH to undertake the analyses of the grab and core samples collected during these surveys and in total 18 core samples and 10 grab samples were provided to Precision Marine Survey Ltd for analysis. Table 1 provides a summary of the sampling regime undertaken at the three survey areas. Analyses included infaunal identification, particle size analysis (PSA) and the assignment of a biotope to each sample. The location of the survey areas for the 2015 surveys is provided in Figure 1.

Table 1. Number of infaunal replicates and PSA samples taken in the three survey areas in 2016 that require processing as part of this contract (emboldened). Information is also provided in relation to dig over replicates from each shore zone (in brackets within table) and epifaunal quadrat sampling undertaken at Southannan Sands SSSI (these are associated with additional data entry contract tasks only).

Area	Samples / Stations	Infaunal replicates	PSA samples	Epifaunal replicates
Mousa	1	**Cores: 4**	**1**	0
Southannan Sands	16	**Cores: 14** (& Dig overs: 14)	**15**	Quadrats: 80 (5 per each of 16 zones)
South Skye	10	**Grabs: 10**	**10**	0
Total	27	**28** (+14 dig-over)	**26**	80

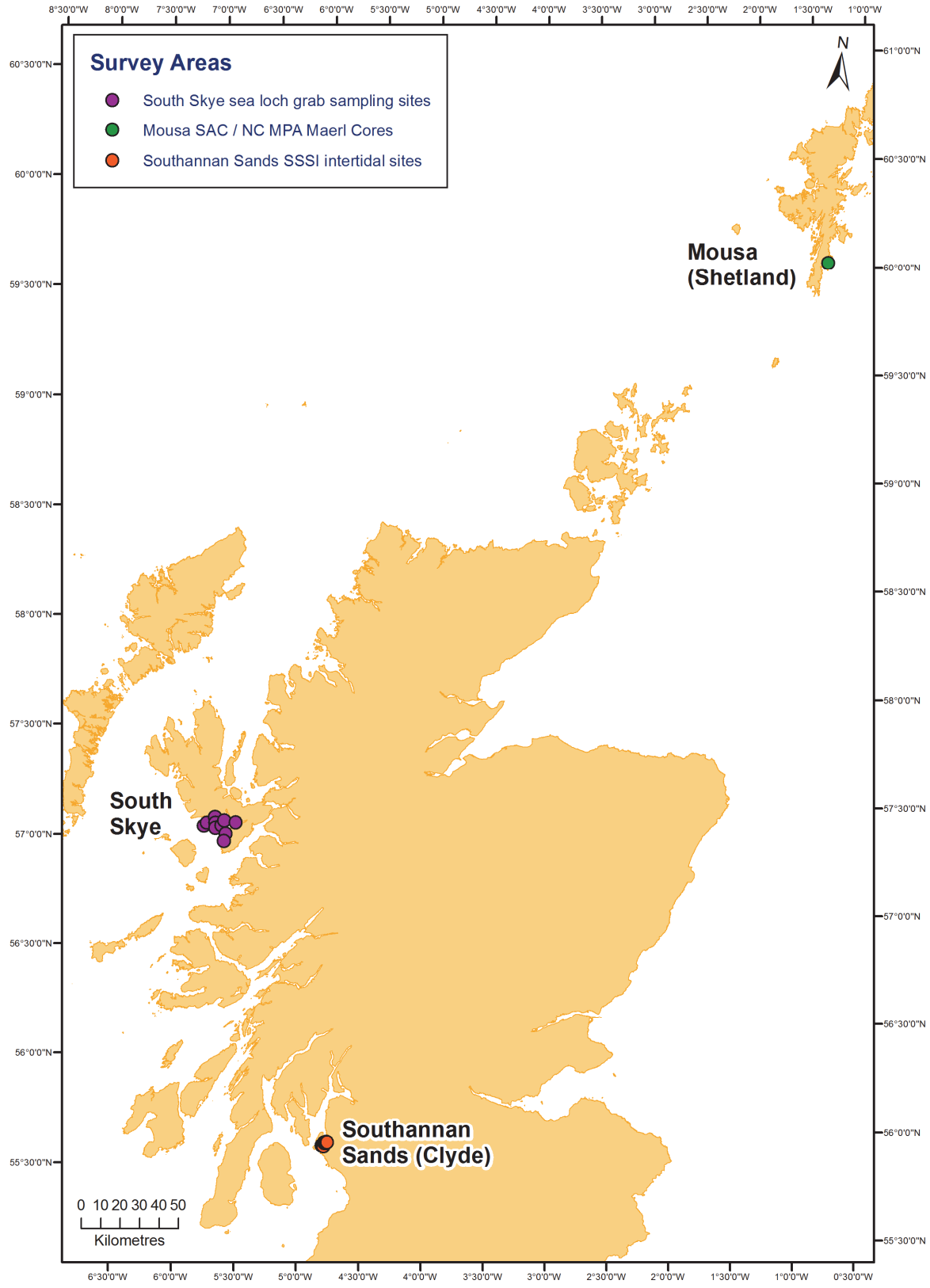

Figure 1. Map of 2016 grab sampling and core sampling areas for infauna and PSA analysis. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2018. All rights reserved. Ordnance Survey Licence number 100017908.

2. METHODS

2.1 Intertidal core sample collection (Southannan Sands SSSI)

Monitoring of the sandflats feature of the SSSI was carried out by SNH from 25 - 27 July. Eight cores of 10.3 cm diameter to a depth of approximately 15 cm were pooled from each biological zone (where practicable) on three shores. A single transect was surveyed on each shore; Hunterston Sands, Southannan Sands and Fairlie Sands (Figure 2). A total of 16 zones were identified, yet where the upper shore substrates were too coarse to core sample, samples were not taken (from this zone at two of the transects). All core samples were sieved on a 0.5mm sieve. The sieve residue was retained and fixed using buffered formalin. In addition, sediment for particle size analysis (PSA) was taken in each zone (15 in total - a PSA sample was collected from one of the upper shore zones where it was too rocky to collect infaunal cores). Additional quadrat data (5 quadrats from each of the 16 shore zones) and dig over data (one from each of the 14 zones where the sediments permitted) were also collected. Whilst the information from the quadrats/dig-overs has been used to assist in biotope determinations for the survey stations/zones this data is not formally reported here. The position of the sample transects and sample stations are provided in Figure 2 and sampling details are provided in Annex 1.

2.2 Diver sample collection (Mousa)

Monitoring of the Mousa SAC/ MPA was undertaken between the 21st July to the 6th August by Heriot-Watt University and SNH. Four core samples were taken using a 10.3 cm diameter core, collected haphazardly along a 25 m transect in the north-west corner of the SAC. These cores were not pooled and were analysed separately representing replicates from a single transect 'sample' for subsequent analyses and data entry. Each infaunal sample was passed through a 1 mm mesh sieve. The sieve residue was retained and fixed using buffered formalin. A single PSA sample was also collected at the survey station and stored in a plastic bag before being frozen. Sample locations are provided in Figure 3 and Annex 1.

2.3 Infaunal grab sample collection (south Skye)

The south Skye grab sampling was undertaken in collaboration with SEPA on the *SV Sir John Murray* on the 23rd and 24th August 2016. Both drop-down video and grab sampling was undertaken though only the latter is reported here. Ten grab samples were collected throughout lochs Eishort, Slapin, Scavaig and Soay Sound in total using a 0.1 m^2 Day grab. A small sub-sample was also removed from each grab for PSA. Water depths at the benthic grab stations ranged from 8 m to 25 m CD. Infaunal and PSA samples were collected from all 10 stations and at each station a single sample was taken. Once the grab was recovered on board a small sub-sample was removed for separate particle size analysis (PSA) and stored in a plastic bag before being frozen. Each infaunal sample was passed through a 1 mm mesh sieve. The sieve residue was retained and fixed using buffered formalin. A summary of the sampling details for the survey is provided in Annex 1 and a map showing the locations of the sampling stations is given in Figure 4.

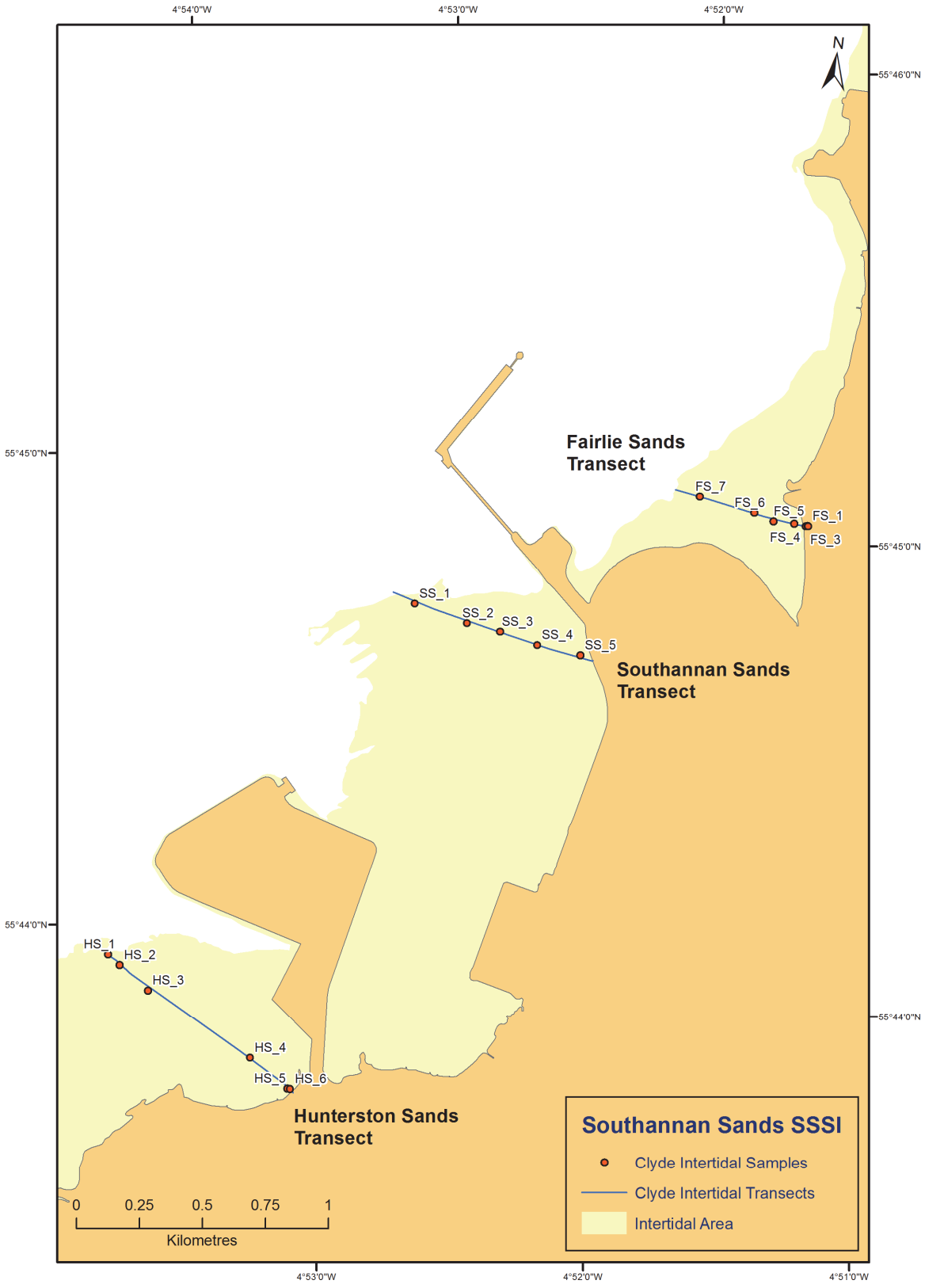

Figure 2. Map of 2016 intertidal sample stations in the Southannan Sands SSSI. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2018. All rights reserved. Ordnance Survey Licence number 100017908.

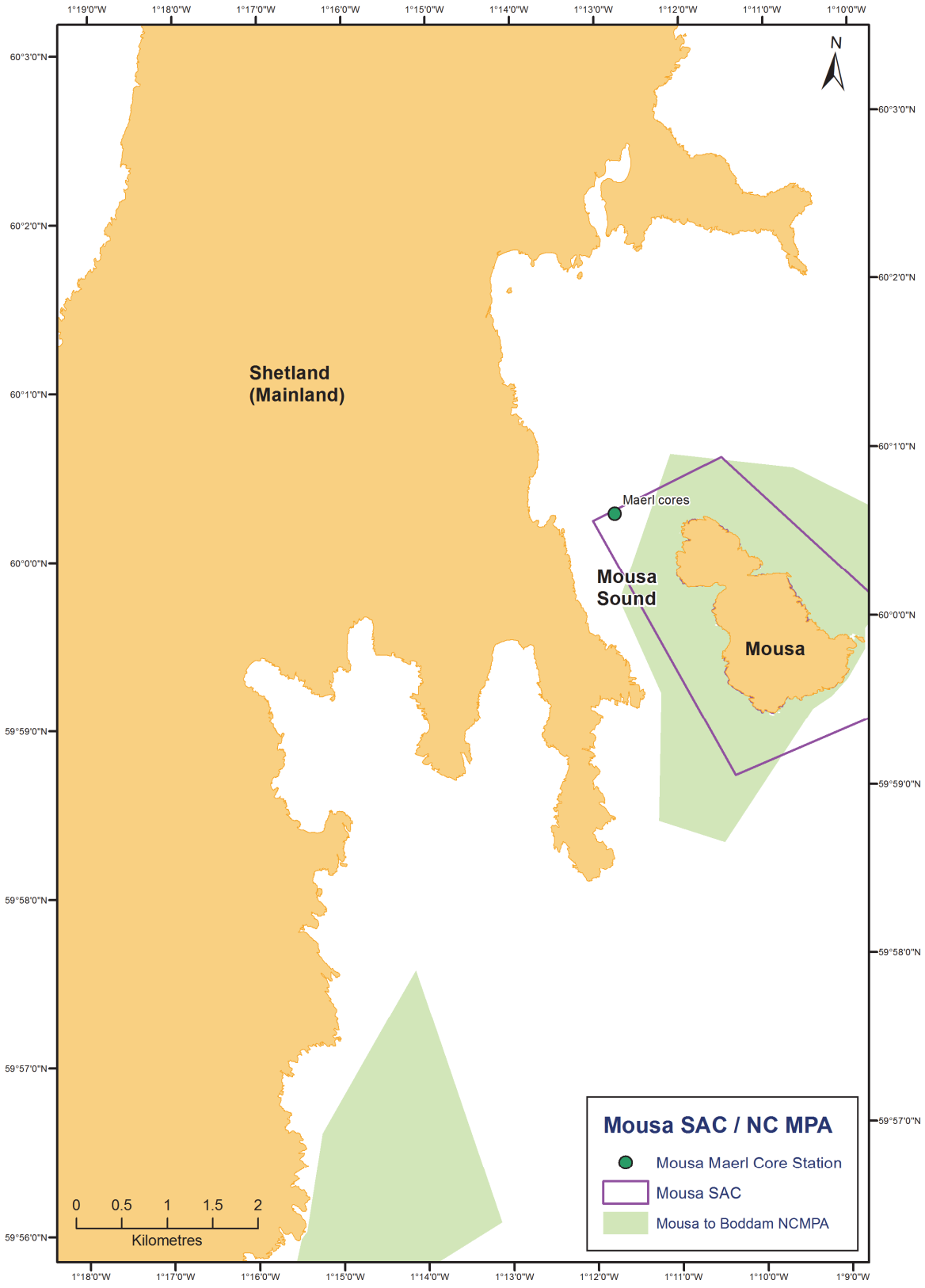

Figure 3. Map of the 2016 diver core sample station in Mousa Sound. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2018. All rights reserved. Ordnance Survey Licence number 100017908.

Figure 4. Map of 2016 infaunal sample stations within the South Skye sea lochs. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2018. All rights reserved. Ordnance Survey Licence number 100017908.

2.4 Laboratory processing

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

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

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

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

The taxonomic literature used was that as detailed in Rees *et al.* (1990) in addition to more recent updates in the scientific literature and newer keys provided by groups such as the NMBAQC. Species reporting nomenclature used WoRMS standards (WoRMS editorial board, 2016 and the WoRMS MSBIAS subset (UK Marine Environmental Data and Information Network, 2011).

Measurements of live maerl fragments were also undertaken for the four core samples from Mousa and from six grab samples from the south Skye sea lochs. In each case a subsample was randomly selected from the homogenised grab or core sample. A maximum of 50 maerl fragments were measured (max length) from each sample where live maerl was recorded. Small fragments of broken maerl <5 mm were not included as these were difficult to assess. Where present, specimens of *Limaria hians* were also measured (from one sample collected from station G03 at the south Skye sea lochs). Length, width and breadth measured to the nearest mm were taken for each *L. hians* specimen.

The particle size analysis was carried out by a combination of dry sieving and laser particle size analysis (for the fraction <1 mm) using a Malvern Mastersizer 3000 following the latest NMBAQC guidance (Mason, 2016 v18_01_2016). Prior to analysis, photographs were taken of all samples. The sediment samples were then split with one sub-sample being passed through a 1 mm sieve to remove the larger size classes of sediment if required and the <1 mm fraction of the sub-sample analysed using the Malvern Mastersizer 3000. If the PSA sample contained any material above 1mm the remainder of the PSA sample was wet sieved through a 1 mm sieve. Each fraction, including the <1 mm fraction was then oven dried at 100°C for 12 hours and weighed with >1 mm fraction passed through a nest of sieves at 0.5 phi intervals. Coarse and fine fractions were combined following NMBAQC guidelines and the data derived from PSA were then used to derive statistics including mean grain size, bulk sediment classes (% silt, sand & gravel), skewness and sorting coefficient using the program Gradistat. These methods are consistent with the procedures identified at the recent NMBAQC PSA workshop on laboratory methods, which was held at the Cefas Lowestoft laboratory in 2014.

2.5 Analysis of biological data

Univariate analysis

A number of primary and derived biological parameter values were calculated from the species data which were subsequently tabulated and input into GIS. A variety of standard biological parameters were used which summarise the species richness and diversity of the benthic communities. The following biological parameters have been used in the current study as these are widely reported in the industry and were also used for a number of recent SNH surveys (Allen 2014) and therefore allow comparison with other surveys.

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

Multivariate analysis

Multivariate analysis of the abundance data was carried out for the Southannan Sands and south Skye samples in order to describe the main patterns and assemblages within the area following standard methodologies (Clarke and Warwick, 2001; Clarke and Gorley, 2006). Given their spatial separation and the differing sampling techniques and sample sizes utilised for sample collection the data for Southannan Sands and south Skye sea lochs were analysed separately. Multivariate analysis was not undertaken on the data from Mousa as only four samples were collected. Classification (cluster analysis) of the data was undertaken using the Bray-Curtis similarity coefficient and grouped average (UPGMA) clustering technique, followed by a non-metric MDS (multi-dimensional scaling) ordination both using the PRIMER package. Cluster analysis was used to display graphically the similarity between stations based upon their species composition. The similarity between

stations was calculated (in this case using the Bray-Curtis similarity coefficient) to produce a similarity matrix showing the percent similarity of stations (0% indicating no species in common and 100% indicating an identical community).

These values were then used to plot a dendrogram or tree diagram in which stations are linked at their respective similarity to other stations and consequently it is possible to define groups of stations with similar species composition at a predefined level of similarity. This information along with available environmental data was subsequently used to assist in the assignation of biotopes.

Non-metric MDS graphically displays the (rank) similarity between stations as a two dimensional plot in which the distances between stations indicates the level of similarity between them. The station groupings derived from cluster analysis were subsequently superimposed onto the MDS plots and input into GIS, with the dominant species and mean environmental and biological parameters calculated for each group. Station groupings were derived using the similarity profile test (SIMPROF) within the PRIMER package.

Characteristic taxa within each group were assessed using calculations of mean abundance and the percentage of stations at which the species occurred, and by using the SIMPER routine within PRIMER. The most characteristic taxa for each cluster group derived from SIMPER analysis was presented along with available environmental data in tabular form to provide a summary of the biological and environmental characteristics of each group of stations, which can then be used to assist in the derivation of biotopes.

Correlations between species data and sediment parameters were undertaken using the BEST routine within PRIMER, which derives a non-parametric Spearman correlation between the similarity matrices derived from the biological and environmental data. The results of this procedure give the statistic ‘r’, which gives an indication of the strength of the relationships between the environmental parameters and community structure; higher values (approaching 1) indicate a strong positive correlation. This technique also derives a subset of the best combination of environmental parameters, which give the highest correlation in similarity.

3. RESULTS - SOUTHANNAN SANDS SSSI

3.1 Sedimentary parameters (Southannan Sands SSSI)

The results of particle size analysis are provided in Annex 2 with a summary of key parameters provided in Table 3. The spatial distribution of sediment types is illustrated in Figures 5 and 6, which highlight bulk sediment classes (% sand, gravel and mud) and sediment classification type respectively.

The intertidal sediments within the survey area are predominantly slightly gravelly sands or gravelly muddy sands, with a few stations characterised by cleaner gravelly sands or more mixed muddy sandy gravel. Along the Hunterston Sands transect, intertidal sediments were predominantly moderately well sorted, slightly gravelly sands with low gravel content (<2%) and a relatively low mud content (<6%). However, station HS2 on the low shore was a very poorly sorted gravelly sand with over 20% gravel content. At Southannan Sands, sediments ranged from moderately well sorted, slightly gravelly sand with <5% mud or gravel content at stations SS1, SS3 and SS5 to poorly sorted gravelly muddy sands at station SS4 (9% mud and 11% gravel). Cleaner, moderately sorted gravelly sands were present at station SS2 on the low shore (2% mud and 6% gravel). The Fairlie sands transect included poorly or very poorly sorted gravelly muddy sand (FS3 and FS4) on the upper shore, with gravel contents ranging from 7% to 27%, and mud contents ranging from 9.55% to 20.3%. FS5 was characterised by gravelly sand, with 8.5% gravel and 5% mud whilst FS6 on the midshore had very poorly sorted muddy sandy gravel with 39.5% gravel and 20% mud. On the low shore station FS7 was characterised by moderately well sorted slightly gravelly sand with <0.03% gravel and 2.6% mud.

Table 3. Sediment parameters at the Southannan Sands SSSI survey stations.

Station	Sediment Type	Median phi	Mean phi	Sorting		Gravel	Sand	Mud
HS_2	Gravelly Sand	1.43	0.58	2.07	Very Poorly Sorted	22.53	75.47	2.00
HS_3	Slightly Gravelly Sand	1.97	1.98	0.64	Moderately Well Sorted	0.14	98.22	1.64
HS_4	Slightly Gravelly Sand	2.12	2.15	0.70	Moderately Well Sorted	0.07	96.89	3.05
HS_5	Slightly Gravelly Sand	2.32	2.33	0.85	Moderately Sorted	0.32	95.62	4.07
HS_6	Slightly Gravelly Sand	1.83	1.94	0.98	Moderately Sorted	1.29	92.65	6.06
SS_1	Slightly Gravelly Sand	1.85	1.85	0.54	Moderately Well Sorted	0.89	96.75	2.36
SS_2	Gravelly Sand	1.69	1.68	0.99	Moderately Sorted	6.01	91.69	2.29
SS_3	Slightly Gravelly Sand	1.98	2.00	0.57	Moderately Well Sorted	0.36	96.89	2.75
SS_4	Gravelly Muddy Sand	1.68	1.68	1.88	Poorly Sorted	11.12	79.86	9.02
SS_5	Slightly Gravelly Sand	1.86	1.87	0.71	Moderately Sorted	3.43	92.13	4.45
FS_3	Gravelly Muddy Sand	2.71	1.15	3.63	Very Poorly Sorted	26.92	52.75	20.33
FS_4	Gravelly Muddy Sand	2.03	2.12	1.69	Poorly Sorted	7.03	83.42	9.55
FS_5	Gravelly Sand	1.72	1.73	1.45	Poorly Sorted	8.56	86.16	5.28
FS_6	Muddy Sandy Gravel	0.24	0.15	2.51	Very Poorly Sorted	39.46	52.48	8.06
FS_7	Slightly Gravelly Sand	2.14	2.17	0.69	Moderately Well Sorted	0.03	97.38	2.59

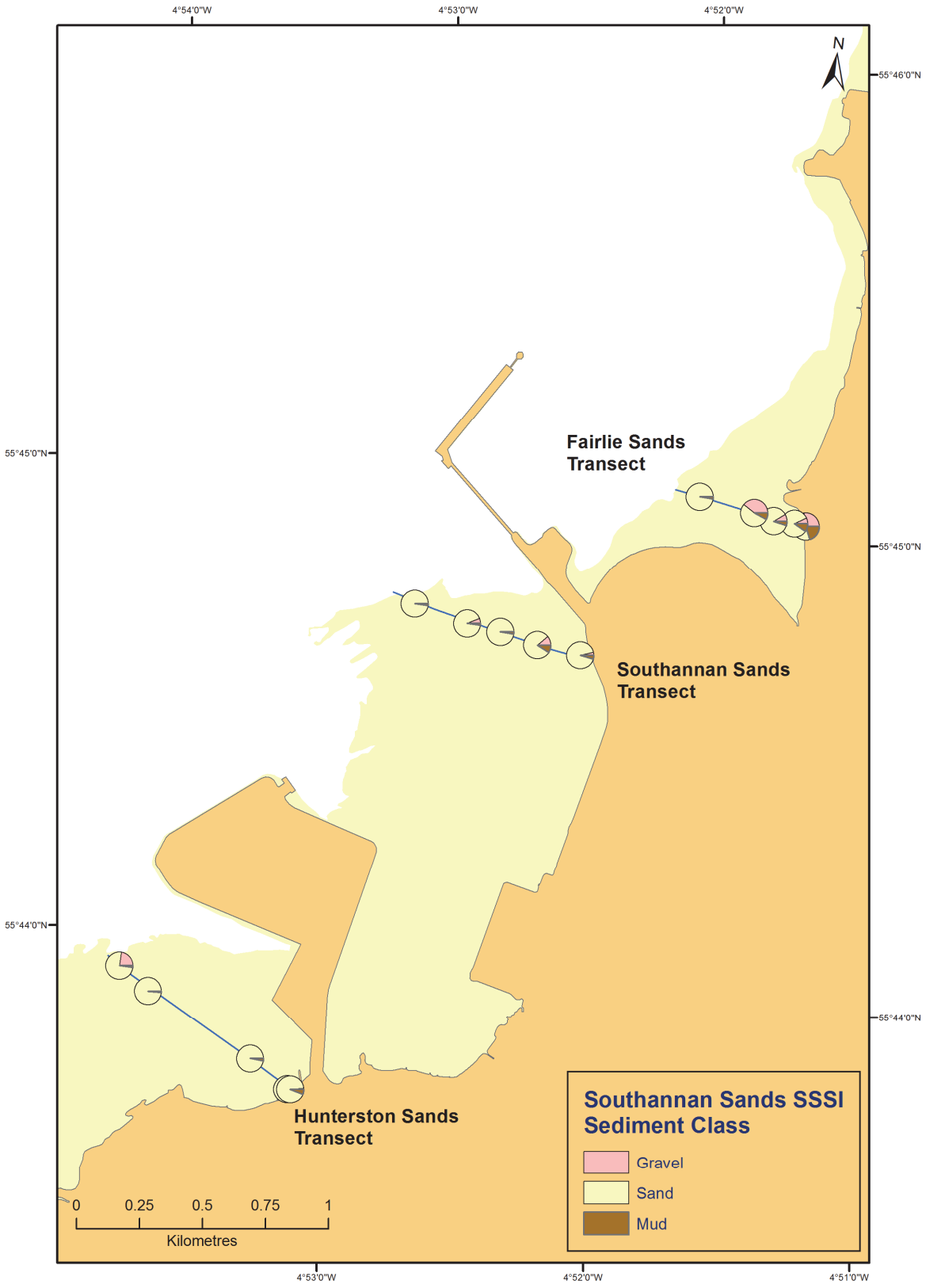

Figure 5. Sediment composition of infaunal samples collected at the Southannan Sands SSSI. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2018. All rights reserved. Ordnance Survey Licence number 100017908.

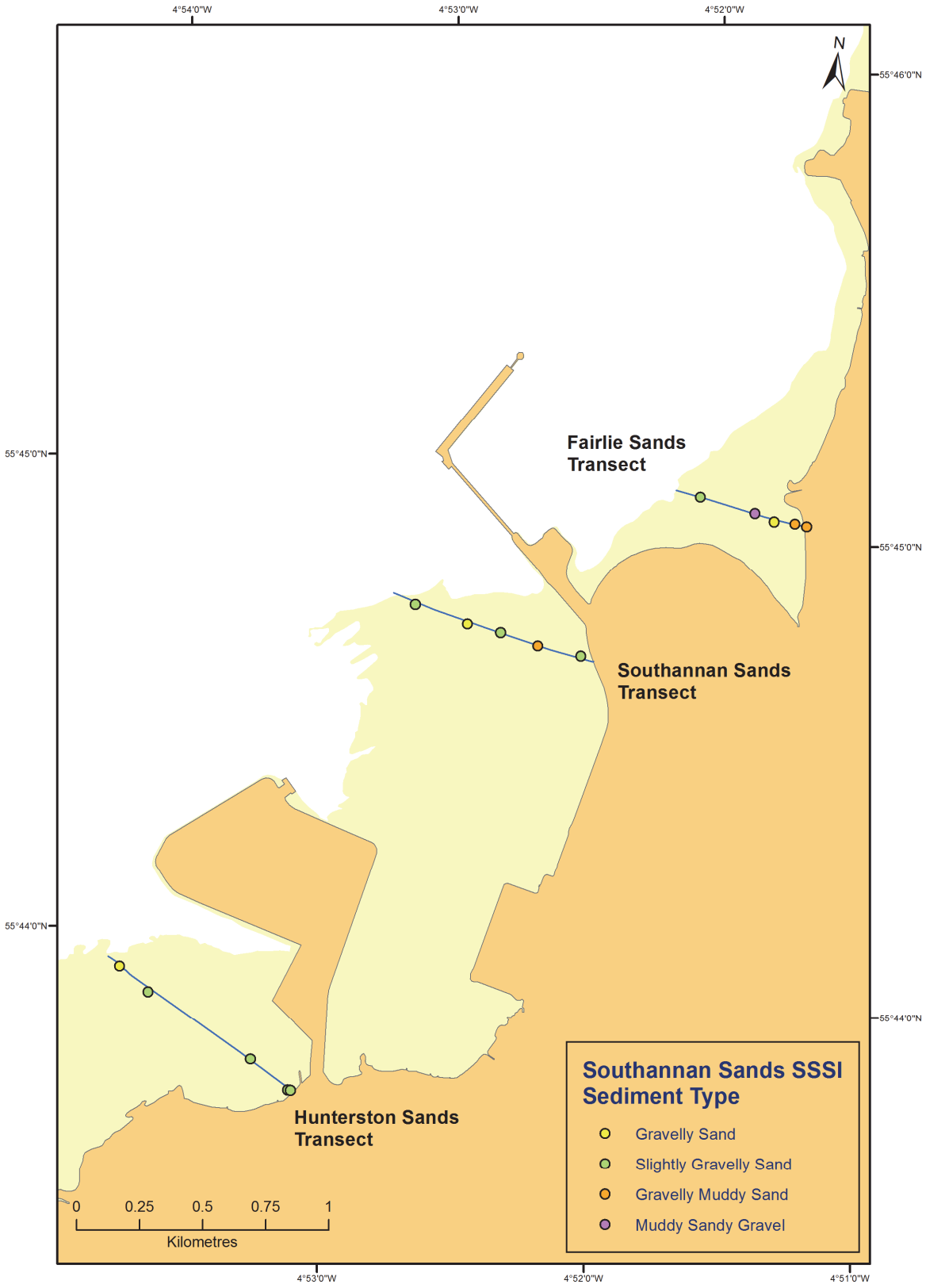

Figure 6. Sediment type of infaunal samples collected at the Southannan Sands SSSI. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2018. All rights reserved. Ordnance Survey Licence number 100017908.

3.2 Primary and derived biological parameters

The samples collected from Southannan Sands varied considerably in terms of species richness, densities, diversity and evenness and these parameters have been summarised in Table 4. The spatial distribution of the number of species, abundance and Shannon's diversity are provided in Figures 7 to 9. Overall the Southannan Sand SSSI survey stations were generally considered to exhibit moderate to high levels of species richness, whilst the abundances of infaunal organisms were variable but often relatively high (Table 4). The numbers of species recorded per sample station ranged from 21 to 40 taxa per 0.08 m^2 at Fairlie Sands and from 1 to 23 taxa per 0.08 m^2 at Hunterston Sands with very low numbers of taxa on the uppermost shore station (one taxa at FS6). Numbers of taxa at Southannan Sands ranged from 20 to 45 taxa per 0.08 m^2. In general, somewhat lower numbers of taxa were usually recorded at the upper shore stations.

The abundances of invertebrates ranged from low to rather high at Fairlie Sands and Southannan Sands (804 to 1195 individuals per 0.08 m^2 and 485 to 1559 per 0.08 m^2 respectively). Lower densities were recorded at Hunterston Sands, with numbers of individuals ranging from 1 to 335 per 0.08 m^2. Diversity indices were rather variable but generally showed moderate levels of diversity and evenness. Evenness values generally ranged from 0.44 to 0.79, although a null value was recorded at the impoverished upper shore station HS6 at Hunterston which contained a single individual. Shannon diversity indices were low to moderately high and ranged from 0 (at HS6) to 4.16 at FS6. Some relatively high Shannon diversity values (around 4) were recorded at Southannan Sands but values were generally between 2 and 3.

Table 4. Primary and derived biological parameters at the Southannan Sands SSSI survey stations (values per 0.08 m^2).

Station	Location	Number of Species	Total Abundance (A)	Margalef's d	Pielou's Evenness J	Shannon's Diversity H'
FS4	Fairlie Sands	22	1195	2.82	0.71	3.10
FS5	Fairlie Sands	21	811	2.99	0.67	2.95
FS6	Fairlie Sands	40	804	5.53	0.79	4.16
FS7	Fairlie Sands	28	937	3.95	0.44	2.13
HS2	Hunterston Sands	22	172	3.89	0.68	3.00
HS3	Hunterston Sands	23	335	3.78	0.69	3.10
HS4	Hunterston Sands	20	272	3.21	0.68	2.90
HS5	Hunterston Sands	13	131	2.26	0.77	2.75
HS6	Hunterston Sands	1	1	n/a	n/a	0.00
SS1	Southannan Sands	28	485	3.88	0.57	2.63
SS2	Southannan Sands	20	653	2.93	0.50	2.17
SS3	Southannan Sands	40	1559	5.17	0.56	2.97
SS4	Southannan Sands	44	1513	5.74	0.74	3.99
SS5	Southannan Sands	45	1028	6.34	0.73	4.00

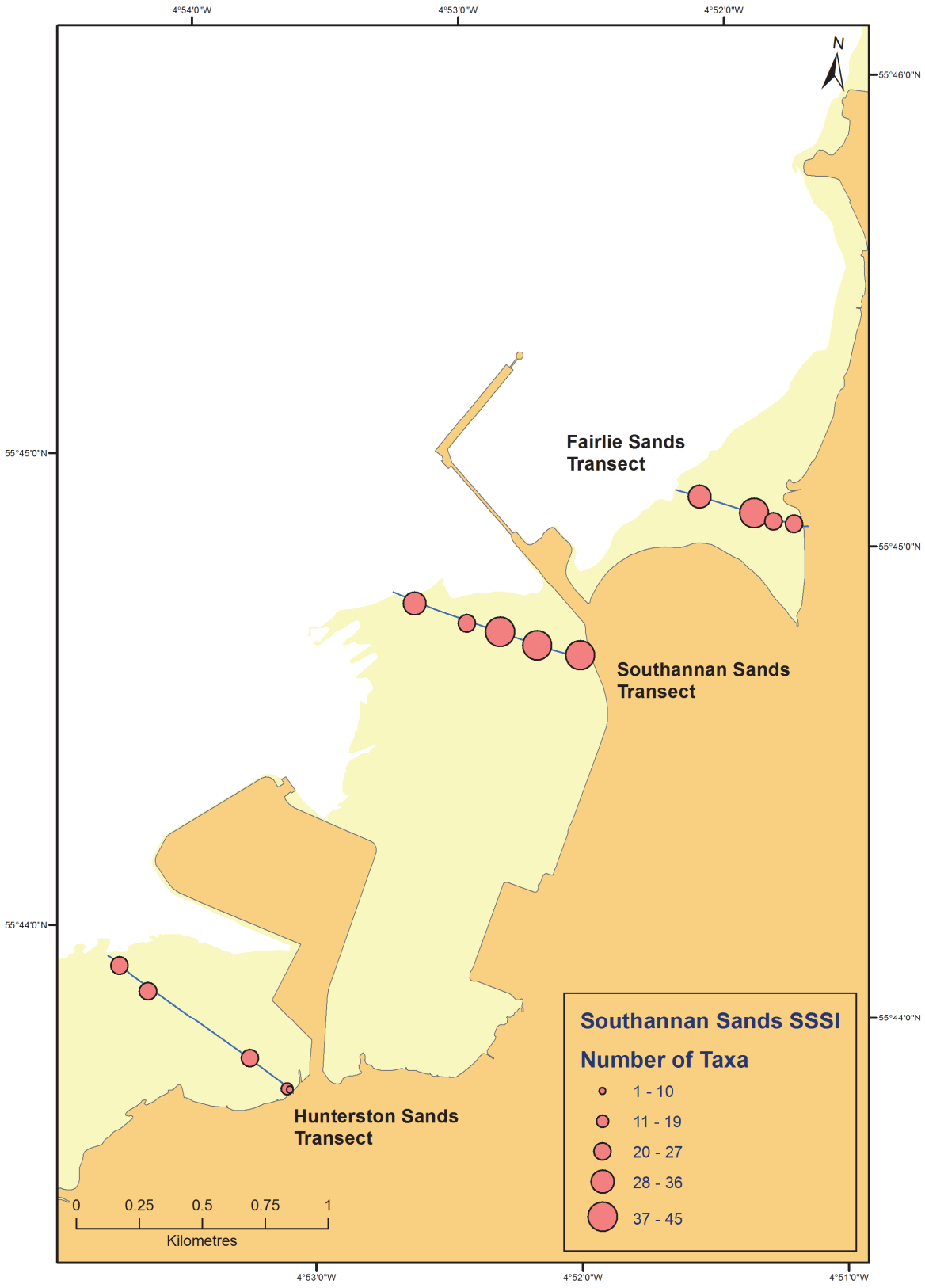

Figure 7. Total numbers of taxa per 0.08 m^2 (including qualitative species) collected at the Southannan Sands SSSI survey stations. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2018. All rights reserved. Ordnance Survey Licence number 100017908.

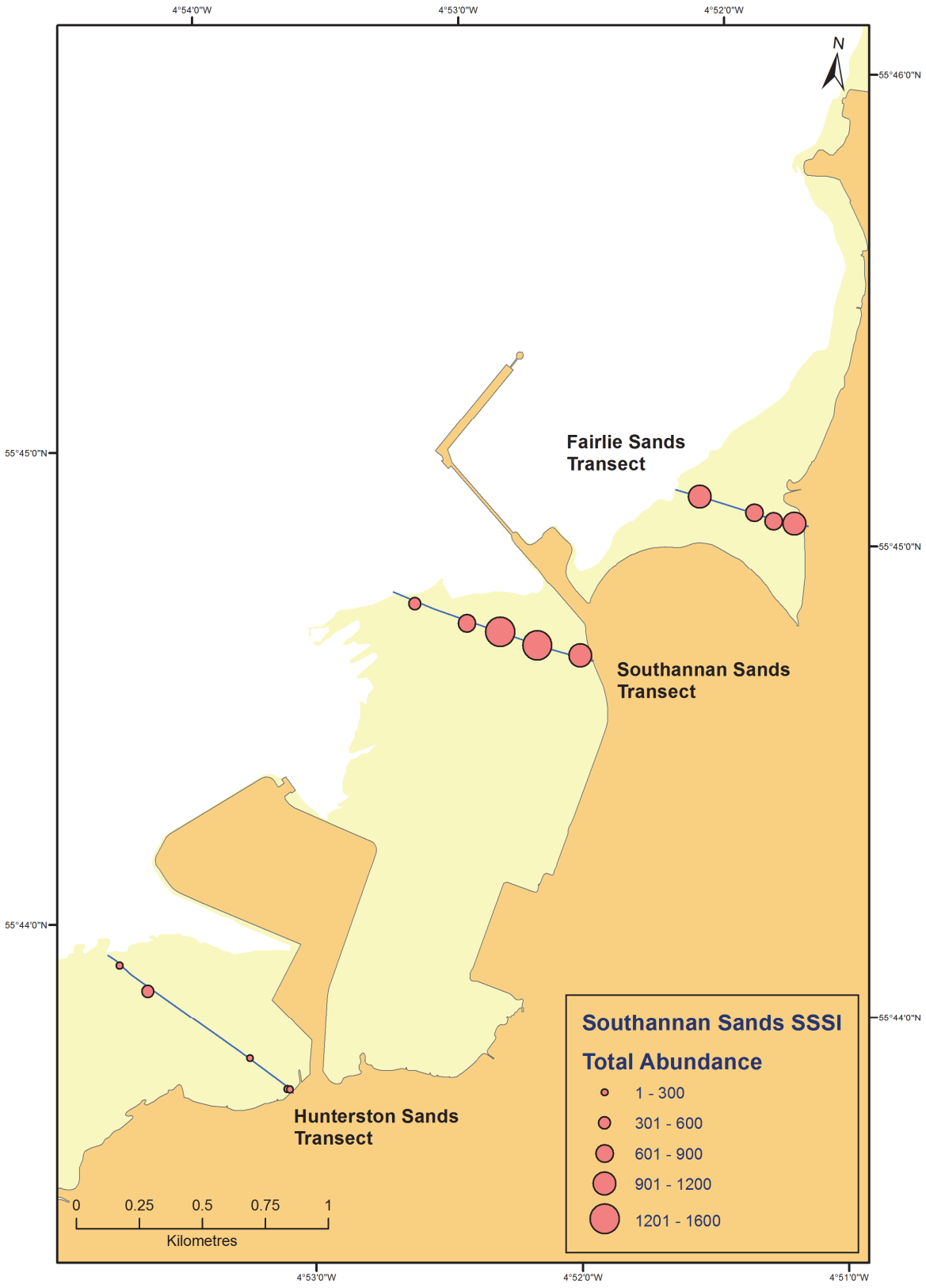

Figure 8. Total abundance (numbers of individuals) per 0.08 m^2 within infauna samples collected at the Southannan Sands SSSI survey stations. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2018. All rights reserved. Ordnance Survey Licence number 100017908.

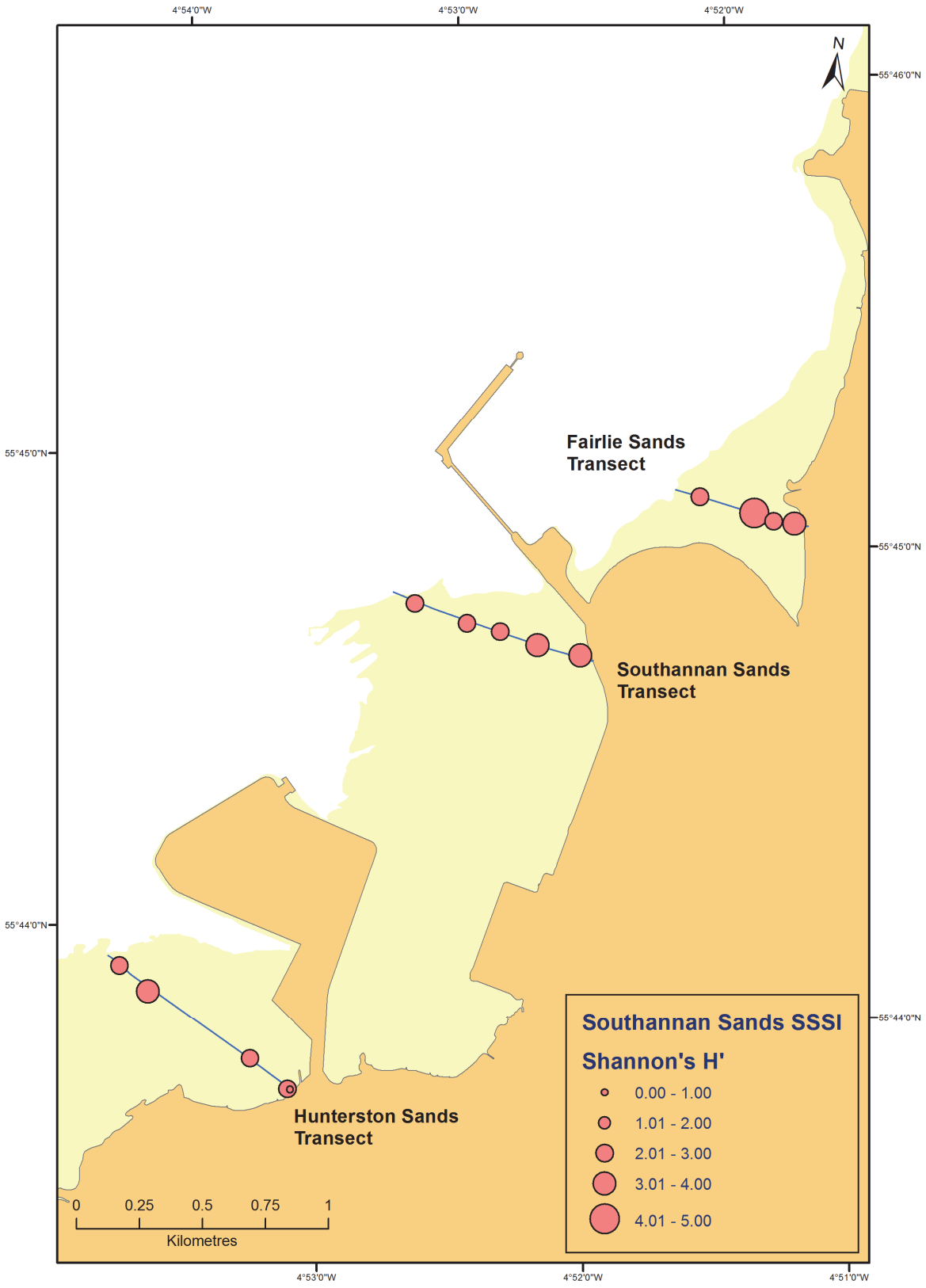

Figure 9. Shannon's diversity (H') of the infauna sample collected at the Southannan Sands SSSI survey stations. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2018. All rights reserved. Ordnance Survey Licence number 100017908.

3.3 Species composition

In total 111 taxa were recorded from the 14 samples collected at the Southannan Sands SSSI and whilst many of these were present in low abundances or at relatively few stations, it highlights the relatively high diversity of these intertidal habitats with regard to infaunal communities. A list of taxa ranked by abundance (taxa which account for 80% of total abundance) is provided in Table 5 and the full species dataset is provided in Annex 3. In terms of abundance, *Macomangulus tenuis* and *Pygospio elegans* were most abundant and these two taxa accounted for just over 34% of the animals collected during the survey. These species were also present in the majority of the samples (79% and 100% respectively). Other taxa with moderately high abundances included *Scoloplos (Scoloplos) armiger, Crassicorophium crassicorne, Tubificoides benedii* and quite high numbers of small individuals (almost juvenile) of *Parvicardium sp.* (*P. pinnulatum*?), which collectively accounted for 80% of the total abundance. A wide range of other polychaete, bivalve, gastropod and crustacean taxa were also recorded in lower numbers.

Table 5. Dominant taxa (by abundance) recorded at the Southannan Sands SSSI survey stations.

Taxa (all transects)	Total Abundance (all samples)	Mean Abundance per 0.08m^2	Cumulative % of Total Abundance	No. of Samples	% of Samples
Macomangulus tenuis	2103	150.21	21.25	11	79
Pygospio elegans	1279	91.36	34.18	14	100
Scoloplos (Scoloplos) armiger	868	62.00	42.95	10	71
Crassicorophium crassicorne	676	48.29	49.78	6	43
Tubificoides benedii	613	43.79	55.97	6	43
Parvicardium sp. *(pinnulatum?)*	564	40.29	61.67	10	71
Pseudofabricia aberrans	262	18.71	64.32	5	36
Parexogone hebes	237	16.93	66.71	10	71
Nematoda	237	16.93	69.11	6	43
Nemertea	229	16.36	71.42	13	93
Phoronis sp.	218	15.57	73.63	7	50
Dipolydora quadrilobata	212	15.14	75.77	4	29
Exogone verugera	203	14.50	77.82	8	57
Tubificoides pseudogaster agg.	201	14.36	79.85	6	43
Eteone longa/flava agg.	188	13.43	81.75	11	79

In terms of the individual survey transects (Tables 6 to 8), many of the most dominant taxa were commonly found in all three areas, although the areas differed in terms of the ranking of dominant taxa and densities of other less abundant species. Fairlie Sands samples were dominated by (in order of importance) Macomangulus tenuis, Tubificoides benedii, Pygospio elegans, Scoloplos (Scoloplos) armiger, *Nematoda*, Pseudofabricia aberrans *and* Tubificoides pseudogaster *agg. On the other hand, Hunterston Sands was dominated by* Scoloplos (Scoloplos) armiger*,* Macomangulus tenuis, *juvenile* Parvicardium *sp. (*P. pinnulatum*?)*, Pygospio elegans, Eteone longa/flava *agg.,* Tubificoides pseudogaster *agg. and* Urothoe elegans*. The Southannan Sands transect was dominated by* Macomangulus tenuis, Crassicorophium crassicorne, Pygospio elegans, Scoloplos (Scoloplos) armiger, *juvenile* Parvicardium *sp. (*P. pinnulatum*?) and* Phoronis *sp.*

Table 6. Dominant taxa (by abundance) recorded at the Fairlie Sands survey stations.

Taxa (Fairlie Sands)	Total Abundance (all samples)	Mean Abundance per 0.08m^2	Cumulative % of Total Abundance	No. of Samples	% of Samples
Macomangulus tenuis	695	173.75	18.55	3	75
Tubificoides benedii	600	150.00	34.56	3	75
Pygospio elegans	565	141.25	49.64	4	100
Scoloplos (Scoloplos) armiger	342	85.50	58.77	4	100
Nematoda	210	52.50	64.37	3	75
Pseudofabricia aberrans	169	42.25	68.88	3	75
Tubificoides pseudogaster agg.	153	38.25	72.97	2	50
Nemertea	138	34.50	76.65	4	100
Ophelia rathkei	90	22.50	79.05	3	75
Parvicardium sp. *(pinnulatum?)*	90	22.50	81.45	2	50

Table 7. Dominant taxa (by abundance) recorded at the Hunterston Sands survey stations.

Taxa (Hunterston Sands)	Total Abundance (all samples)	Mean Abundance per 0.08m^2	Cumulative % of Total Abundance	No. of Samples	% of Samples
Scoloplos (Scoloplos) armiger	188	37.60	20.64	4	80
Macomangulus tenuis	155	31.00	37.65	3	60
Parvicardium sp. *(pinnulatum?)*	140	28.00	53.02	4	80
Pygospio elegans	125	25.00	66.74	5	100
Eteone longa/flava agg.	83	16.60	75.85	3	60
Tubificoides pseudogaster agg.	26	5.20	78.70	3	60
Urothoe elegans	23	4.60	81.23	1	20

Table 8. Dominant taxa (by abundance) recorded at the Southannan Sands survey stations.

Taxa (Southannon Sands)	Total Abundance (all samples)	Mean Abundance per 0.08m^2	Cumulative % of Total Abundance	No. of Samples	% of Samples
Macomangulus tenuis	1253	250.60	23.92	5	100
Crassicorophium crassicorne	669	133.80	36.69	4	80
Pygospio elegans	589	117.80	47.94	5	100
Scoloplos (Scoloplos) armiger	338	67.60	54.39	2	40
Parvicardium sp. *(pinnulatum?)*	334	66.80	60.77	4	80
Phoronis sp.	212	42.40	64.81	5	100
Dipolydora quadrilobata	183	36.60	68.31	3	60
Parexogone hebes	178	35.60	71.71	4	80
Exogone verugera	157	31.40	74.70	5	100
Euclymene oerstedii	108	21.60	76.77	3	60
Bathyporeia guilliamsoniana	107	21.40	78.81	2	40
Eteone longa/flava agg.	97	19.40	80.66	5	100

3.4 Multivariate analysis (Core samples - Southannan Sands SSSI)

The results of multivariate analysis on the benthic samples are provided in Figure 10. Similarities between samples range from less than 10% to just over 60% highlighting a quite varied intertidal benthic assemblage which is likely to reflect (in part) the high numbers of taxa occurring in low numbers at relatively few stations. The SIMPROF routine identified five groups of samples as highlighted in Figure 14 although this included one group containing a single sample (group a – station HS6). The main division splits station HS6 in group a from the remaining samples in groups b to e at 1.4% similarity. The remaining samples/groups exhibit higher similarities ranging from around 30% to >60% similarity. The results of the BEST routine (Table 9) highlight the correlation between the environmental parameters and species similarity data. No combination of parameters provided a higher correlation than that provided by mud content (0.285) and individual correlations between the environmental parameters and species similarity data were rather low.

The characteristic taxa derived from SIMPER which accounted for the bulk of the similarity within sample groups (typically the top 90%) are provided in Annex 4. A summary of the sediment types and shore position also shown in Annex 4 were used to aid in biotope assignments. Group a (station HS6) was an impoverished upper shore station from Hunterston Sands in slightly gravelly sand with just one individual (the polychaete *Pygospio elegans*). Group b included stations from Hunsterston, Southannan and Fairlie Sands on the mid to low shore in relatively clean slightly gravelly sands and were characterised by high numbers of *Macomangulus tenuis.* Other taxa in group b included *Pygospio elegans*, *Parvicardium* sp. (P. *pinnulatum*?), *Nemertea*, *Crassicorophium crassicorne*, *Travisia forbesii*, *Eteone longa/flava* agg., *Bathyporeia sarsi* and *Bathyporeia guilliamsoniana*. Group c (sites from Hunterston Sands) was characterised by gravelly or slightly gravelly sand at a variety of shore positions and the presence of *Pygospio elegans*, *Scoloplos (Scoloplos) armiger*, *Parvicardium* sp. (*P. pinnulatum*?), Nemertea, *Macomangulus tenuis*, *Tubificoides pseudogaster* agg., *Eteone longa/flava* agg. and Nematoda spp. Two of the stations in this group also included fragments of *Zostera* sp. *(Z. noltii*?) in the core samples.

Group d included two stations on the upper or mid shore at Fairlie Sands with rather more mixed sediments (gravelly muddy sand or gravelly sand). These stations were characterised by relatively high numbers of *Tubificoides benedii*, *Pygospio elegans* and *Scoloplos (Scoloplos) armiger* along with *Tubificoides pseudogaster* agg., *Pseudofabricia aberrans*, Nemertea spp., Nematoda spp., *Peringia ulvae*, *Capitella capitata* agg. and *Cerastoderma edule*. One of these stations (FS4) also included fragments of *Zoster* sp. *(Z. noltii*?) in the core sample.

Group f included mid or upper shore stations in somewhat mixed sediment at Southannan Sands and Fairlie Sands. These stations were characterised by a fairly diverse assemblage including *Pygospio elegans*, *Scoloplos (Scoloplos) armiger*, *Macomangulus tenuis*, *Parvicardium* sp. (*P. pinnulatum*?), *Exogone verugera*, *Parexogone hebes*, *Phoronis* sp., Nemertea, *Euclymene oerstedii*, *Ophelia rathkei*, *Pseudofabricia aberrans*, *Capitella capitata* agg., *Dipolydora quadrilobata*, Enchytraeidae spp. and *Cerastoderma edule*.

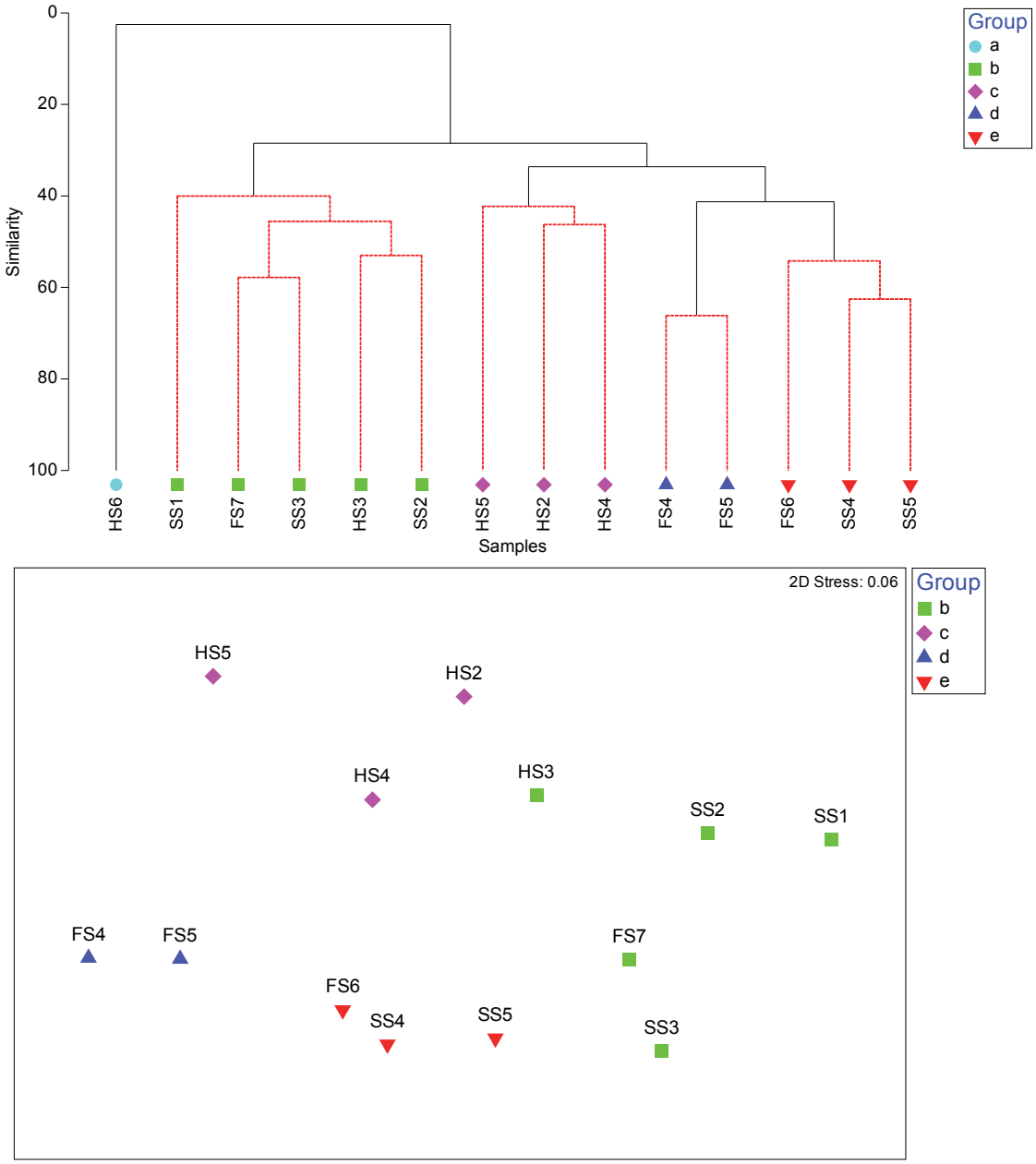

Figure 10. Results of cluster analysis and MDS for intertidal core samples collected at the Southannan Sands SSSI (station HS6 omitted from the nMDS plot).

Table 9. Results of the BEST routine for intertidal core samples collected at the Southannan Sands SSSI. Parameters with ticks highlight those parameters which in combination produced the highest correlation with species similarity data.

Parameter	Correlation (r)	Best Combination (r=0.285)
Mud	0.285	☐
Skewness	0.161	
Sorting	0.058	
Kurtosis	0.037	
Sand	-0.071	
Gravel	-0.09	
Mean Phi	-0.153	
Median Phi	-0.166	

Biotope composition (Southannan Sands)

Biotopes were assigned to each station on the basis of species composition, sedimentary parameters, shore position and the results of multivariate analysis. The information provided from the quadrat and dig-over sampling was also utilised where appropriate. A number of the stations exhibited rather intermediate infaunal communities, which are rather poorly defined by the current version of the UK biotope classification (Connor *et al.,* 2004). A summary of biotope codes for stations in each of the groups (derived by cluster analysis with sediment descriptions and characteristic taxa from core sampling, quadrat and dig-over data) is provided in Table 10. A number of stations had rather uncertain biotope classifications as described below and have been recorded with the appropriate qualifier for entry into Marine Recorder. The spatial distribution of biotopes at the core sampling stations at Southannan Sands, Hunterston Sands and Fairlie Sands is provided in Figure 11.

The station in group a (HS6) has been assigned the biotope **LS.LSa.MoSa.BarSa (Barren littoral coarse sand)** given that it was extremely impoverished, although this sample did contain a slightly higher mud content than normally found in such habitats. The stations in group b were dominated by high numbers of *Macomangulus tenuis* and have tentatively been assigned the biotope **LS.LSa.FiSa.Po.Aten (Polychaetes and *Angulus tenuis* in littoral fine sand),** although this is rather uncertain as there were a number of taxa more prevalent in sublittoral habitats. These stations often had quite high densities of small individuals (almost juvenile size) of *Parvicardium* sp. which is more common in sublittoral habitats. Occasional low/moderate numbers of *Cerastoderma edule* here also indicated some correlation to **LS.LSa.MuSa.CerPo (*Cerastoderma edule* and polychaetes in littoral muddy sand)**. It is possible that these habitats are rather intermediate between **LS.LSa.FiSa.Po.Aten** and **LS.LSa.MuSa.CerPo** and in some areas influenced by adjacent seagrass habitats. One station within this group (SS1) also had high densities of *Lanice conchilega* recorded in the quadrats so from an epifaunal perspective low shore sediments in the vicinity of SS1 may be considered examples of **LS.LSa.MuSa.Lan** (*Lanice conchilega* in littoral sand).

Group c included stations with a somewhat similar community to group b but with lower numbers of *Macomangulus tenuis* and also included *Cerastoderma edule.* Two of the stations included specimens of seagrass (*Zostera noltii*) which were also recorded in the quadrat surveys. As such one site has been assigned as **LS.LSa.FiSa.Po.Aten,** whilst the two stations with seagrass have been assigned the biotope **LS.LMp.LSgr.Znol (*Zostera noltii* beds in littoral muddy sand)**.

Group d included two mixed sediment stations with oligochaetes, polychaetes and *Cerastodrma edule*. *Zostera noltii* was present at one of these stations and was therefore classified as **LS.LMp.LSgr.Znol**, whilst the other has been assigned **LS.LSa.MuSa.CerPo (*Cerastoderma edule* and polychaetes in littoral muddy sand)**.

Group e includes mixed sediment habitats from Fairlie Sands and Southannan Sands which shows some similarity to the other groups, but with more mixed sediments a quite diverse assemblage. High numbers of syllid polychaetes such as *Exogone* or *Paraexogone* sp. were recorded in group e, along with a number of taxa more prevalent in sublittoral sediments. In addition, moderately high numbers of *Cerastoderma edule* (and *Parvicardium* sp.) were recorded in in the dig-over. As such these stations have tentatively been assigned the biotope **LS.LMx.Mx.CirCer (Cirratulids and *Cerastoderma edule* in littoral mixed sediment),** although it lacks the high numbers of cirratulids usually found in this biotope and is likely to be a variant not currently covered by the current classification.

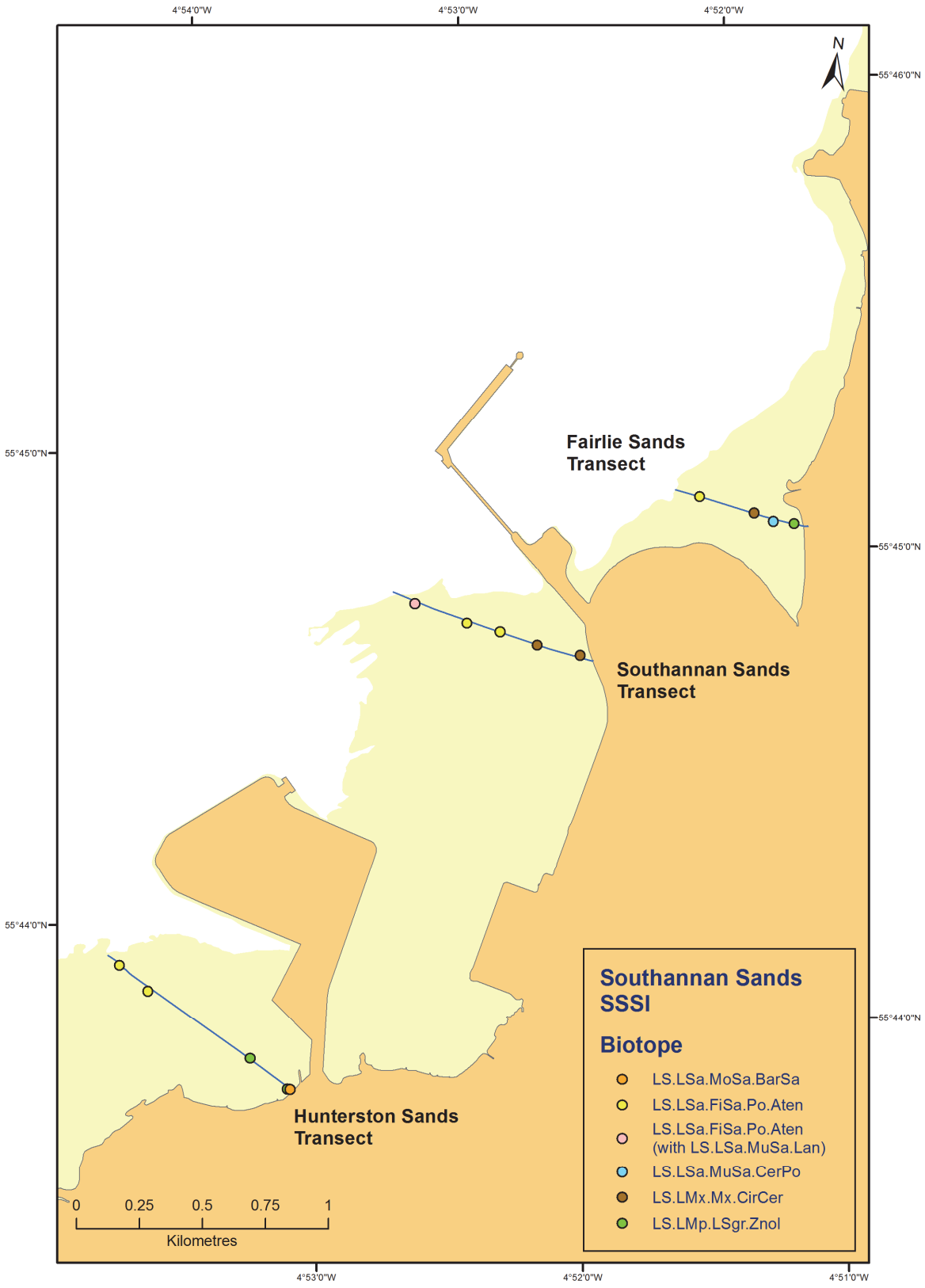

Figure 11. Infaunal biotopes at the Southannan Sands SSSI survey stations. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2018. All rights reserved. Ordnance Survey Licence number 100017908.

Table 10. Biotopes, sediment descriptions and dominant taxa within cluster groups from core sampling at the Southannan Sands SSSI. Biotopes flagged as ? indicate an uncertain match.

Group	Station	Biotope	Flag	Sediment Type	Shore Position	Dominant Taxa (Cores)	Quadrat Taxa (count data)	Quadrat Taxa (% cover data)	Dig Over Taxa
a	HS6	LS.LSa.MoSa.BarSa		Slightly Gravelly Sand	Upper	*Pygospio elegans*	-	-	-
b	FS7	LS.LSa.FiSa.Po.Aten	?	Slightly Gravelly Sand	Low	*Macomangulus tenuis, Pygospio elegans, Travisia forbesii, Parvicardium* sp. (*P. pinnulatum*?), *Dipolydora coeca, Dipolydora quadrilobata, Notomastus* sp., *Thracia villosiuscula*, Nemertea, *Capitella capitata* agg.	Small tube worm (*Pygospio elegans*), *Arenicola marina*, Un ID worm, *Littorina littorea*	Filamentous green algae	*Cerastoderma edule, Echinocardium cordatum*
b	HS3	LS.LSa.FiSa.Po.Aten	?	Slightly Gravelly Sand	Mid/Low	*Macomangulus tenuis, Parvicardium* sp. *(P. pinnulatum*?*), Scoloplos (Scoloplos) armiger, Pygospio elegans, Urothoe elegans, Eteone longa/flava* agg*., Retusa obtusa, Urothoe brevicornis,* Nemertea*, Phyllodoce mucosa*	*Arenicola marina, Littorina littorea, Cerastoderma edule*	Filamentous brown algae, *Fucus vesiculosus*	*Cerastoderma edule, Echinocardium cordatum*
b	SS1	LS.LSa.FiSa.Po.Aten or LS.LSa.MuSa.Lan (in terms of epifauna)	?	Slightly Gravelly Sand	Mid-low	*Macomangulus tenuis, Bathyporeia guilliamsoniana,* Mytiloidea sp. (juv.), *Travisia forbesii, Pygospio elegans, Bathyporeia sarsi, Nemertea, Retusa truncatula, Exogone verugera, Crassicorophium crassicorne*	*Lanice conchilega*	Filamentous brown algae, Filamentous green algae, Chorda filum, Red - UnID	*Echinocardium cordatum*
b	SS2	LS.LSa.FiSa.Po.Aten	?	Gravelly Sand	Mid-low	*Macomangulus tenuis, Parvicardium* sp. *(P. pinnulatum*?*), Crassicorophium crassicorne, Urothoe elegans, Travisia forbesii, Bathyporeia sarsi, Pygospio elegans,* Nemertea*, Ophelia rathkei, Bathyporeia pelagica*		*Enteromorpha*, *Chorda filum*, Filamentous green algae, Filamentous brown algae	

b	SS3	LS.LSa.FiSa.Po.Aten	?	Slightly Gravelly Sand	Mid-low	*Crassicorophium crassicorne, Macomangulus tenuis, Pygospio elegans, Urothoe brevicornis, Parvicardium* sp. *(P. pinnulatum*?*), Notomastus* sp.*, Bathyporeia guilliamsoniana, Dipolydora quadrilobata, Phoronis sp., Arenicola marina* (juv.)	*Arenicola marina*, Small tube worm (*Pygospio elegans*)	Filamentous brown algae, *Chorda filum*, Filamentous green algae	*Echinocardium cordatum, Cerastoderma edule*
c	HS2	LS.LSa.FiSa.Po.Aten	?	Gravelly Sand	Low	*Eteone longa/flava* agg.*, Macomangulus tenuis, Pygospio elegans, Parvicardium* sp*. (P. pinnulatum*?*), Scoloplos (Scoloplos) armiger, Parexogone hebes, Exogone verugera, Streptosyllis websteri, Urothoe brevicornis, Phyllodoce mucosa*	*Arenicola marina*	*Enteromorpha, Fucus serratus*, Barnacle, Filamentous brown algae, *Fucus vesiculosus*	
c	HS4	LS.LMp.LSgr.Znol		Slightly Gravelly Sand	Upper Mid	*Scoloplos (Scoloplos) armiger, Parvicardium* sp*. (P. pinnulatum*?*), Pygospio elegans, Macomangulus tenuis, Tubificoides pseudogaster agg., Dipolydora coeca,* Nemertea*, Cerastoderma edule, Euclymene oerstedii, Retusa obtusa*	*Mytilus edulis, Littorina littorea, Arenicola marina, Cerastoderma edule, Hydrobi*a sp.	*Z. noltii*, Filamentous green algae	*Cerastoderma edule*
c	HS5	LS.LMp.LSgr.Znol	?	Slightly Gravelly Sand	Upper	*Scoloplos (Scoloplos) armiger, Pygospio elegans, Peringia ulvae,* Nematoda*, Tubificoides benedii, Littorina saxatilis, Tubificoides pseudogaster agg., Parvicardium* sp*. (P. pinnulatum*?*), Littorina obtusata*, Nemertea	*Arenicola marina, Littorina littorea, Hydrobia* sp., *Littorina obtusata*	*Z. noltii*	*Cerastoderma edule, Mytilus edulis, Macoma balthica*
d	FS4	LS.LMp.LSgr.Znol		Gravelly Muddy Sand	Upper	*Tubificoides benedii, Pygospio elegans,* Nematoda*, Scoloplos (Scoloplos) armiger, Tubificoides pseudogaster* agg.*, Pseudofabricia aberrans,* Diptera sp. larvae*,* Nemertea*, Peringia ulvae, Capitella capitata* agg.	*Littorina littorea, Hydrobia* sp.	*Z. noltii*, Filamentous green algae, *Fucus spiralis*	
d	FS5	LS.LSa.MuSa.CerPo	?	Gravelly Sand	Mid	*Tubificoides benedii, Pygospio elegans, Scoloplos (Scoloplos) armiger, Ophelia rathkei,*	Small tube worm (*Pygospio*	Filamentous green algae, *Fucus*	*Cerastoderma edule*

						Tubificoides pseudogaster agg.*, Pseudofabricia aberrans, Aricidea (Aricidea) minuta,* Nemertea*,* Nematoda*, Peringia ulvae*	*elegans*), *Arenicola marina, Lanice conchilega, Littorina littorea*	*vesiculosus*	
e	FS6	LS.LMx.Mx.CirCer	?	Muddy Sandy Gravel	Mid	*Pygospio elegans, Macomangulus tenuis, Scoloplos (Scoloplos) armiger,* Nemertea*, Parexogone hebes, Ophelia rathkei, Peringia ulvae,* Enchytraeidae spp., *Exogone verugera, Pseudofabricia aberrans*	*Littorina littorea*, Small tube worm (*Pygospio elegans*), *Cerastoderma edule, Lanice conchilega*	Filamentous green algae, Filamentous brown algae, *Fucus spiralis, Enteromorpha*	*Cerastoderma edule*
e	SS4	LS.LMx.Mx.CirCer	?	Gravelly Muddy Sand	Mid	*Pygospio elegans, Scoloplos (Scoloplos) armiger, Parexogone hebes, Pseudofabricia aberrans, Exogone verugera, Parvicardium* sp*. (P. pinnulatum*?*), Dipolydora quadrilobata, Euclymene oerstedii, Phoronis* sp., Enchytraeidae spp.	Small tube worm (*Pygospio elegans*), *Arenicola marina*, *Lanice conchilega*	Filamentous brown algae, Filamentous green algae, *Fucus vesiculosus, Chorda filum, Enteromorpha*, Red algae - UnID	*Cerastoderma edule*
e	SS5	LS.LMx.Mx.CirCer	?	Slightly Gravelly Sand	Upper	*Pygospio elegans, Macomangulus tenuis, Phoronis* sp.*, Scoloplos (Scoloplos) armiger, Dipolydora quadrilobata, Parvicardium* sp*. (P. pinnulatum*?*), Exogone verugera, Travisia forbesii, Parexogone hebes, Euclymene oerstedii*	Small tube worm (*Pygospio elegans*), *Arenicola marina*, *Littorina saxatilis*	Filamentous green algae, Filamentous brown algae	*Cerastoderma edule*

4. MOUSA SAC / MPA MAERL BED CORES

4.1 Sedimentary parameters

The results of particle size analysis from the diver core sampling in the Mousa SAC are provided in Annex 2 and a summary of key sedimentary parameters is given in Table 11. These indicate that sediments at the Mousa sample station comprised of very poorly sorted sandy gravel with 33.8% gravel, 63.9% sand and a small amount of mud (2.26%). The majority of the gravel collected in the samples was maerl gravel.

Table 11. Sediment biological parameters recorded at the Mousa maerl bed core station.

Station	Sediment Type	Median phi	Mean phi	Sorting		Gravel	Sand	Mud
Mousa Maerl Bed	Sandy Gravel	-0.37	-0.60	2.11	Very Poorly Sorted	33.82	63.93	2.26

4.2 Primary and derived biological parameters

The biological parameters derived for each core sample from the dive transect at Mousa are provided in Table 12 and highlight a moderately diverse infaunal community. Numbers of taxa ranged from 28 to 44 taxa per 0.01 m^2 core, whilst abundance (number of individuals) ranged from 84 to 227 individuals per core. Evenness was moderately high, ranging from 0.66 to 0.82, whilst values of Shannon's diversity H' were also moderate with values ranging from 3.47 to 3.92.

Table 12. Primary and derived biological parameters recorded at the Mousa maerl core station.

Sample	Number of Species	Total Abundance per 0.01m^2	Margalef's d	Pielou's Evenness J	Shannon's Diversity H'
Maerl core 1	28	86	5.61	0.79	3.71
Maerl core 2	30	97	5.68	0.82	3.92
Maerl core 3	44	227	6.82	0.66	3.47
Maerl core 4	30	84	5.42	0.82	3.83

4.3 Species composition

The diver cores samples from the Mousa maerl bed included a total of 79 taxa (Annex 5), although many of the taxa recorded were present in relatively low numbers. The benthic communities were typified by a range of invertebrates including bivalve molluscs, ophuiroid echinoderms and a variety of polychaetes. Dominant taxa recorded during the survey (Table 13) included the bivalve *Modiolula phaseolina* and the tunicate *Clavelina lepadiformis,* which were present in moderate numbers along with Nematode worms and accounted for 47% of the total abundance and were present in all samples. Other key taxa included juvenile Amphiuridae sp., *Trypanosyllis (Trypanosyllis) coeliaca* the amphipods *Protomedeia fasciata* and *Othomaera othonis* along with other taxa such as Ophiuroidea sp., *Gari tellinella*, nemertean worms, *Abra nitida* and *Limatula subauriculata*. A wide variety of other species were also present in low numbers (see Annex 5). Numerous fragments of live maerl (*Phymatolithon* spp. and possibly *Lithothamnion* sp.) were also recorded in the core samples and as such these samples have been assigned the biotope **SS.SMp.Mrl (Maerl beds)**. Measurements of the maerl fragments (maximum 50 fragments) are provided in Annex 6.

Table 13. Dominant taxa (by abundance) recorded at the Mousa SAC diver core station.

Taxa (Mousa Maerl Cores)	Total Abundance (0.04 m^2)	Mean Abundance per 0.01 m^2	Cumulative % of Total Abundance	No. of Samples	% of Samples
Modiolula phaseolina	88	22.00	17.81	4	100
Clavelina lepadiformis	81	20.25	34.21	4	100
Nematoda	61	15.25	46.56	4	100
Amphiuridae sp. (juv.)	21	5.25	50.81	2	50
Trypanosyllis (Trypanosyllis) coeliaca	19	4.75	54.66	4	100
Protomedeia fasciata	16	4.00	57.89	1	25
Othomaera othonis	13	3.25	60.53	1	25
Ophiuroidea sp. (juv./dam.)	12	3.00	62.96	1	25
Amphiuridae sp.	11	2.75	65.18	1	25
Gari tellinella	10	2.50	67.21	3	75
Nemertea	9	2.25	69.03	4	100
Abra nitida	9	2.25	70.85	1	25
Limatula subauriculata	8	2.00	72.47	3	75
Glycera lapidum	7	1.75	73.89	3	75
Leptochiton asellus	7	1.75	75.30	3	75
Ophiocomina nigra	7	1.75	76.72	2	50
Echinocyamus pusillus	6	1.50	77.94	4	100
Polynoinae sp.	6	1.50	79.15	3	75
Aonides paucibranchiata	6	1.50	80.36	3	75

5. SOUTH SKYE SEA LOCHS

5.1 Sedimentary parameters

The results of particle size analysis for the south Skye sea loch samples are provided in Annex 2 and a summary of key sedimentary parameters is provided in Table 14. The spatial distribution of sediment characteristics are also highlighted in Figures 12 and 13, which show bulk sediment classes (gravel, sand and mud) and sediment type respectively. Sediment types at the south Skye sea loch survey stations are predominantly rather heterogeneous gravelly muddy sands, but also include more mixed muddy sandy gravel (station G15) and gravelly sand or sandy gravel (stations G07, G12 and G39). One particularly muddy station with slightly gravelly muddy sand was also recorded at station G02. Mud content ranged from 0.63 % (G12) to 46.34 % (G02), whilst gravel content ranged from 0.09 % (G02) to 34 37 % (G12). With the exception of sandy gravels at station G12, which was moderately well sorted, the remaining stations exhibited poorly or very poorly sorted sediments. The muddiest station (G02) was located further up Loch Eishort, whilst the cleanest sediments with lowest mud content were recorded further south in more exposed habitats (e.g. station G12).

Table 14. Sediment parameters recorded at the South Skye sea lochs survey stations.

Station	Sediment Type	Median phi	Mean phi	Sorting		Gravel	Sand	Mud
SSS_G02	Slightly Gravelly Muddy Sand	3.81	4.31	2.08	Very Poorly Sorted	0.09	53.57	46.34
SSS_G03	Gravelly Muddy Sand	2.30	2.36	3.38	Very Poorly Sorted	21.02	46.27	32.71
SSS_G04	Gravelly Muddy Sand	-0.25	0.31	2.15	Very Poorly Sorted	23.19	65.64	11.17
SSS_G05	Gravelly Muddy Sand	0.69	1.23	2.70	Very Poorly Sorted	20.04	63.11	16.85
SSS_G07	Gravelly Sand	-0.35	-0.26	1.51	Poorly Sorted	20.47	72.86	6.67
SSS_G10	Gravelly Muddy Sand	1.06	1.98	2.93	Very Poorly Sorted	10.46	64.58	24.97
SSS_G12	Sandy Gravel	-0.84	-0.89	0.51	Moderately Well Sorted	34.37	65.00	0.63
SSS_G15	Muddy Sandy Gravel	0.28	1.61	3.42	Very Poorly Sorted	31.73	38.63	29.64
SSS_G29	Gravelly Sand	0.36	0.40	1.84	Poorly Sorted	17.73	74.79	7.48
SSS_G39	Gravelly Muddy Sand	1.77	2.39	3.07	Very Poorly Sorted	10.49	60.05	29.46

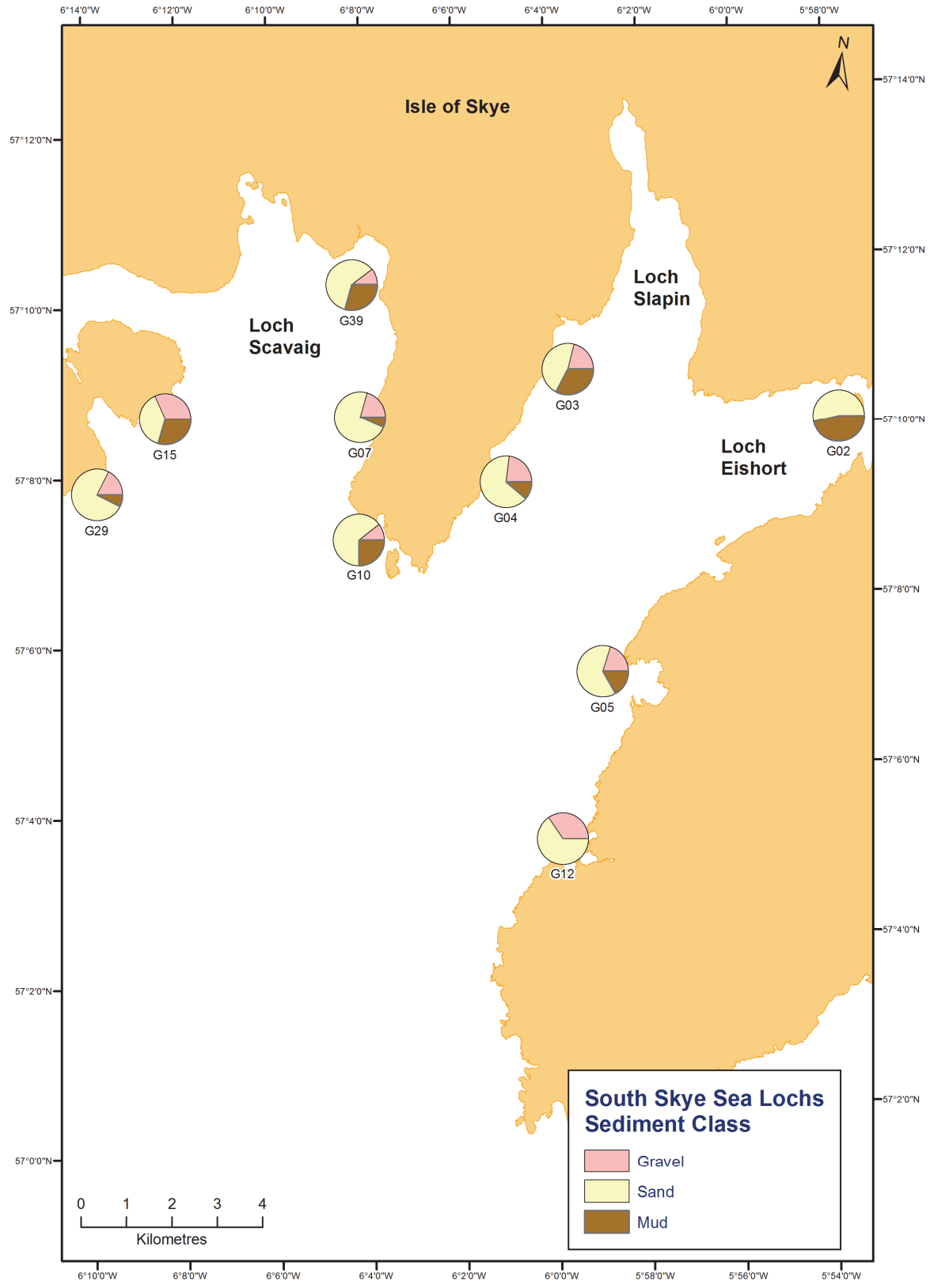

Figure 12. Sediment composition of infaunal samples collected at the south Skye sea lochs. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2018. All rights reserved. Ordnance Survey Licence number 100017908.

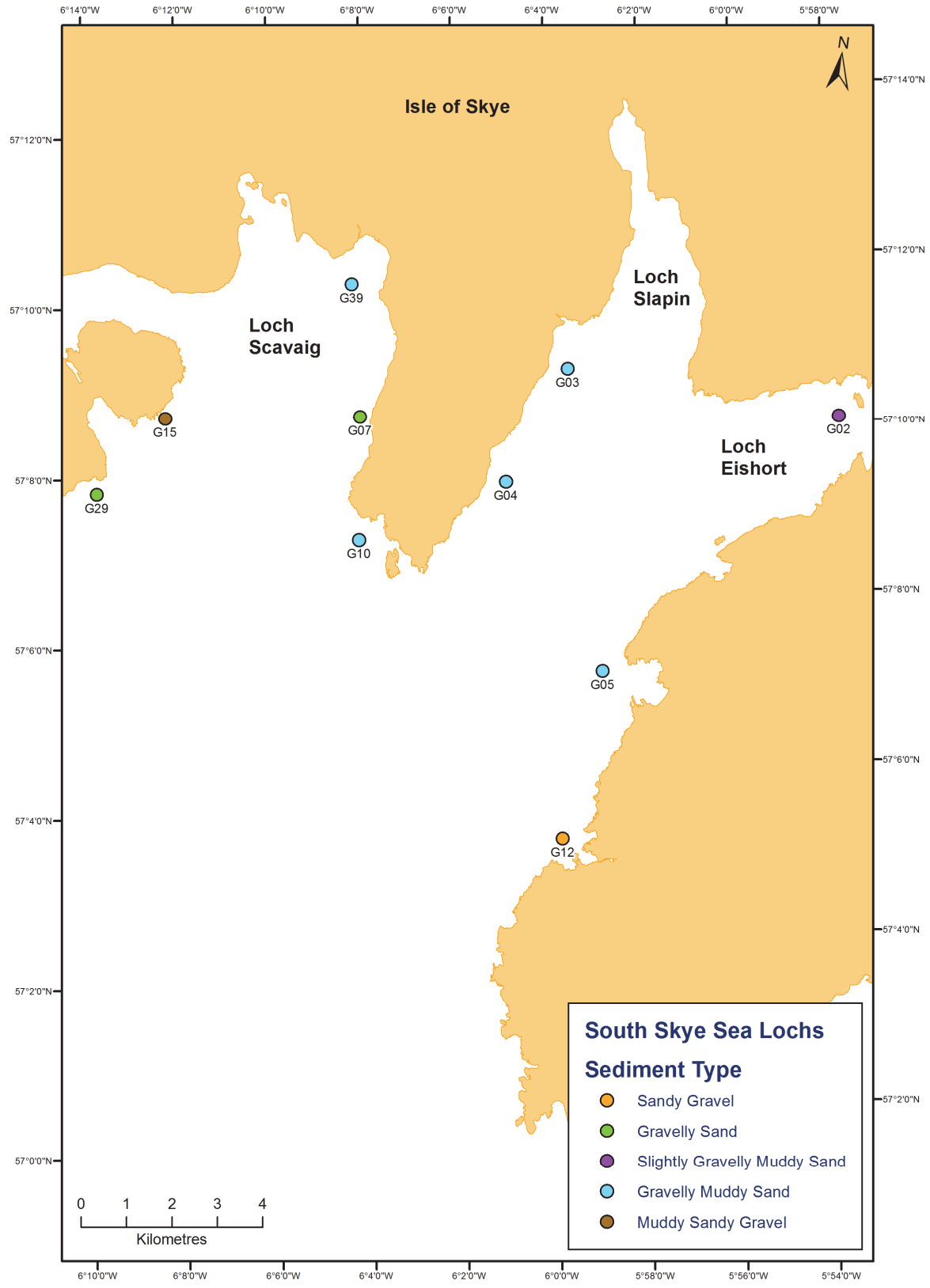

Figure 13. Sediment type of infaunal samples collected at the south Skye sea lochs. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2018. All rights reserved. Ordnance Survey Licence number 100017908.

5.2 Primary and derived biological parameters

The biological parameters recorded from grab samples in the south Skye sea loch survey (Table 15) tended to be rather variable, but generally exhibited moderate to high levels of species richness and diversity. Numbers of species ranged from 37 taxa per 0.1 m^2 at G02 to 107 per 0.1 m^2 taxa at G03. A similar pattern was evident with regard to total abundance and in general, low to moderate numbers of individuals were collected; from 84 per 0.1 m^2 (G05) to 666 individuals per 0.1 m^2 (G07). Pielou's evenness values were moderate to high, ranging from 0.61 (G02) to 0.94 (G05). Values for Shannon's diversity were generally high (>4) and ranged from 3.13 (G02) to 5.44 (G03), with a number of stations exhibiting Shannon diversity values above 5. The spatial distribution of key parameters (numbers of taxa, abundance and Shannon's diversity) are provided in Figures 14 to 16.

Table 15. Primary and derived biological parameters at the South Skye sea loch survey stations.

Station	Number of Species	Total Abundance per 0.1 m^2	Margalef's d	Pielou's Evenness J	Shannon's Diversity H'
G02a	37	264	6.10	0.61	3.13
G03	107	490	15.50	0.82	5.44
G04c	68	179	12.53	0.87	5.26
G05	42	84	9.25	0.94	5.05
G07a	83	666	12.31	0.66	4.18
G10a	61	181	11.54	0.88	5.21
G12	46	146	8.63	0.89	4.86
G15b	71	335	11.52	0.72	4.40
G29b	40	115	8.01	0.88	4.65
G39b	47	177	8.69	0.88	4.86

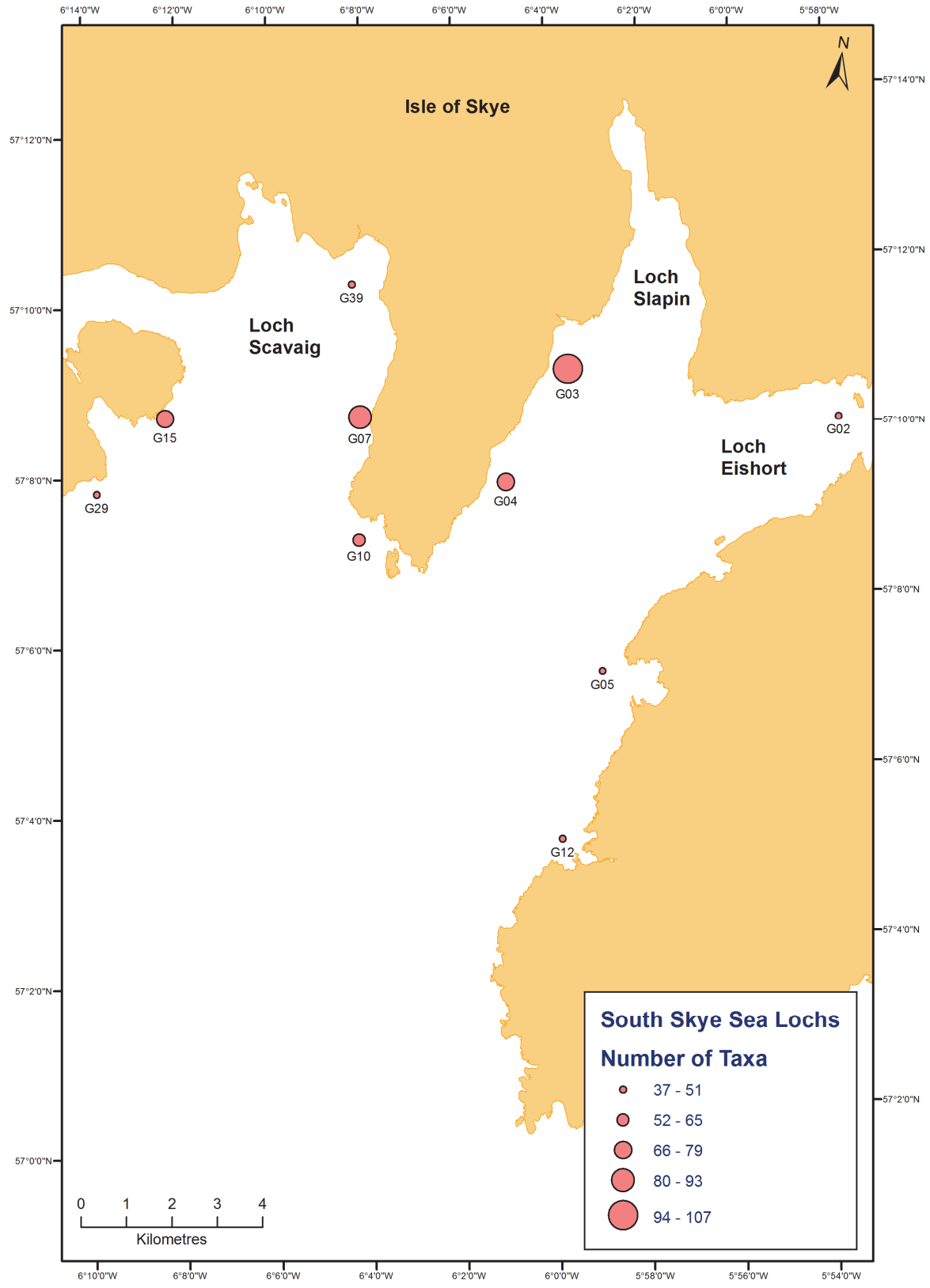

Figure 14. Total numbers of taxa (including qualitative species) collected at the south Skye sea loch survey stations. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2018. All rights reserved. Ordnance Survey Licence number 100017908.

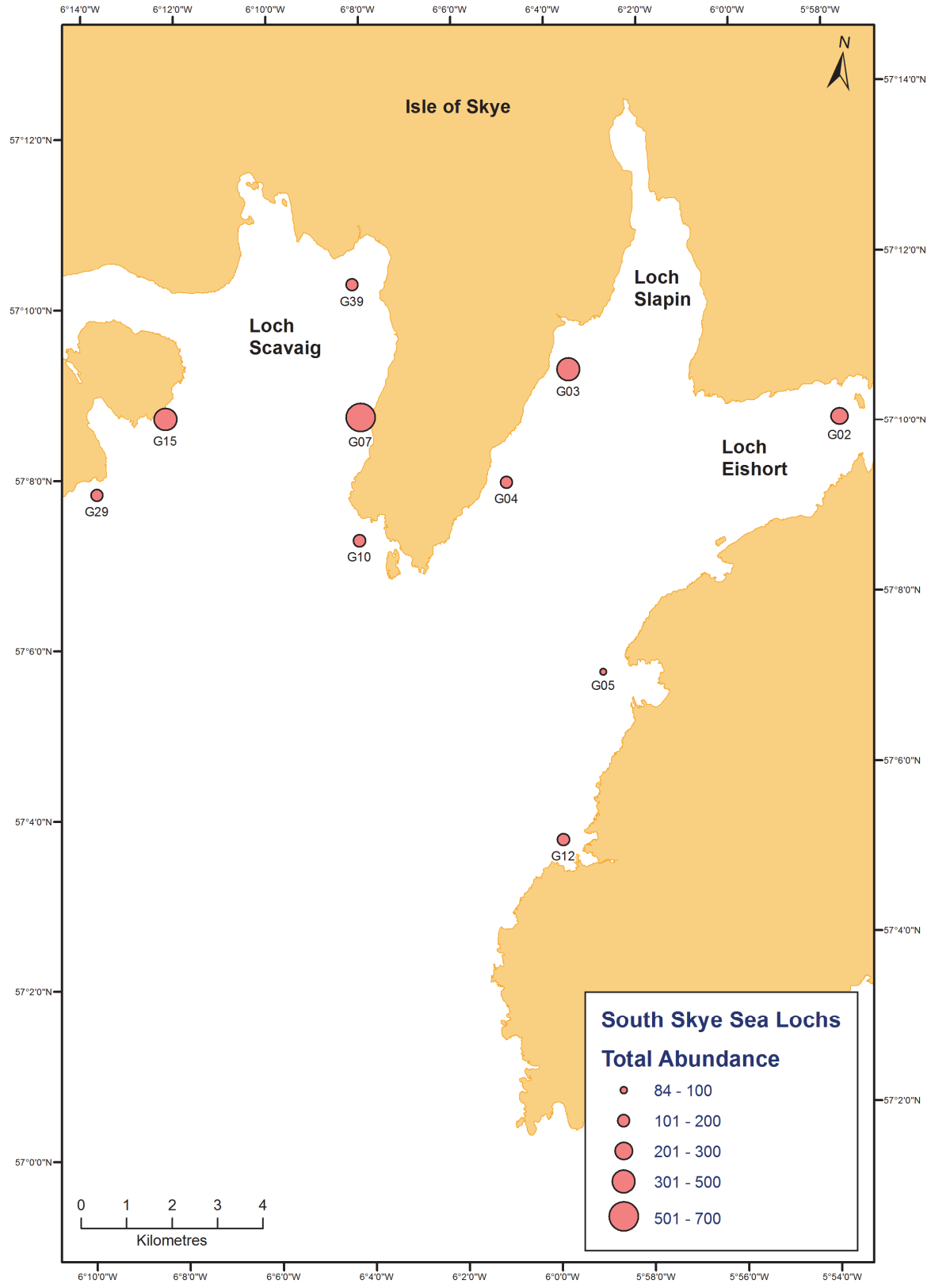

Figure 15. Total abundance (numbers of individuals) within infauna samples collected at the south Skye sea loch survey stations. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2018. All rights reserved. Ordnance Survey Licence number 100017908.

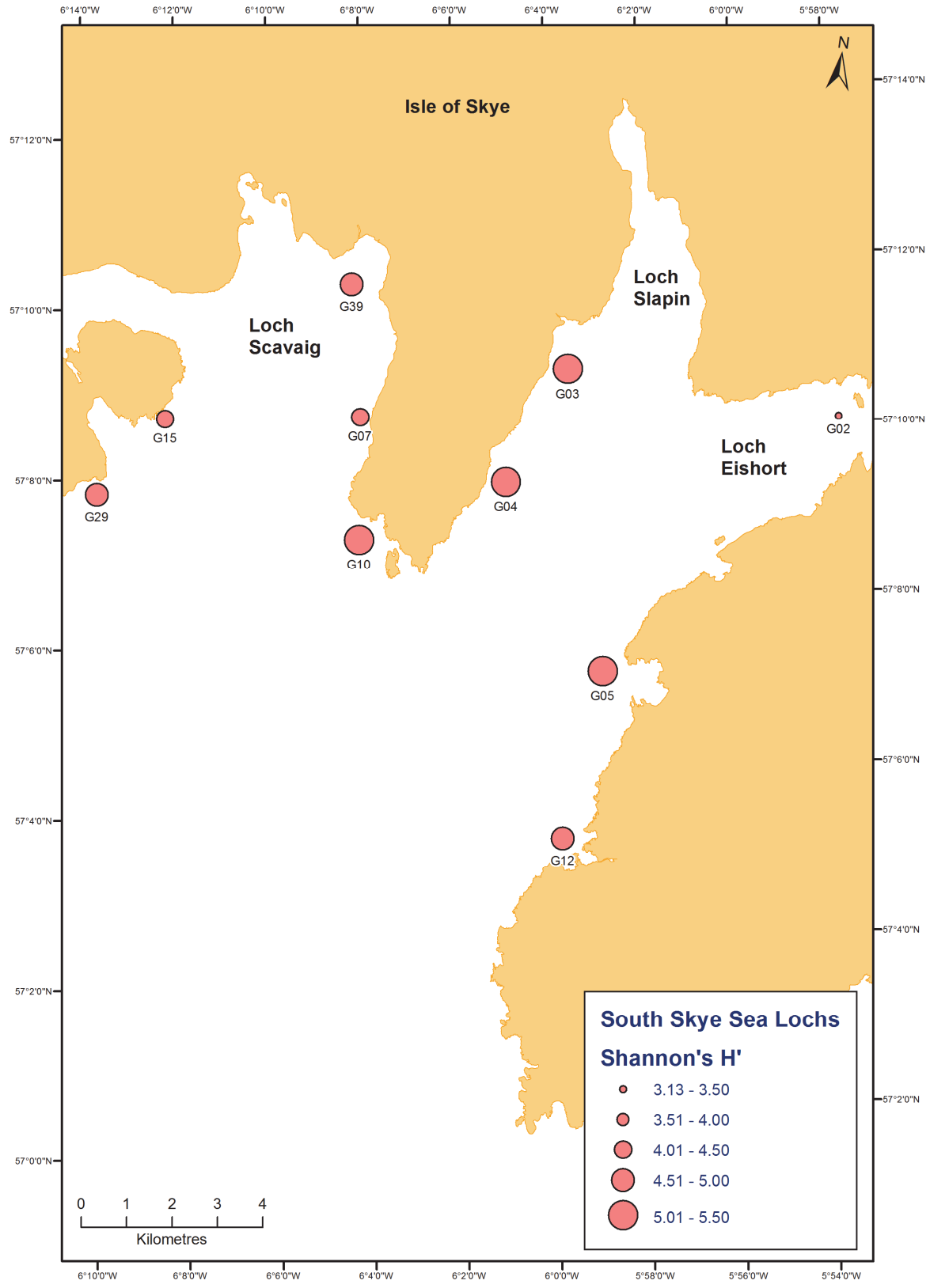

Figure 16. Shannon's diversity (H') of the infauna sample collected at the south Skye sea loch survey stations. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2018. All rights reserved. Ordnance Survey Licence number 100017908.

5.3 Species composition

A wide variety of taxa were recorded from the grab samples in the south Skye sea lochs with 276 taxa recorded in total (Annex 7). Numerically dominant taxa which account for 50% of the total abundance of animals recorded in the samples are provided in Table 16. The most dominant taxa included a variety of molluscs, echinoderms, polychaetes and crustacea. Taxa such as nematode worms (*Balanus balanus* and *Kurtiella bidentate*) were most abundant, accounting for around 21% of the total abundance, but had a somewhat variable distribution and were recorded in 40 to 60% of the stations. Other key taxa in terms of abundance included *Alvania beanii, Lysidice unicornis, Hilbigneris gracilis, Acrocnida brachiata, Leptochiton cancellatus, Psamathe fusca, Aponuphis bilineata, Glycera lapidum* agg., *Echinocyamus pusillus, Pisione remota, Leptochiton asellus,, Lysianassa plumosa, Vaunthompsonia cristata* and *Modiolula phaseolina* which collectively accounted for 50% of the total abundance. Many of these taxa were recorded in less than 50% of stations with *Echinocyamus pusillus* the most widespread taxa being recorded in 90% of the survey stations. Significant quantities of live maerl (predominantly *Phymatolithon* spp. and possibly *Lithothamnion* spp.) were also recorded in many samples including G03, G04, G07, G12, G15 and G39. The maximum length of live maerl fragments (>5 mm) from this survey (and maerl samples from Mousa) are recorded in Annex 5. Five specimens of the flame shell (*Limaria hians*) were also recorded at site G03 and subsequently measured (Annex 8).

Table 16. Dominant taxa (by abundance) recorded at the south Skye sea loch survey stations.

Taxa (South Skye Sealochs)	Total Abundance (all 10 samples)	Mean Abundance per 0.1 m^2	Cumulative % of Total Abundance	No. of Samples	% of Samples
Nematoda	295	29.50	11.19	6	60
Balanus balanus	134	13.40	16.27	4	40
Kurtiella bidentata	122	12.20	20.89	5	50
Alvania beanii	96	9.60	24.54	3	30
Lysidice unicornis	93	9.30	28.06	7	70
Hilbigneris gracilis	80	8.00	31.10	6	60
Acrocnida brachiata	80	8.00	34.13	3	30
Leptochiton cancellatus	63	6.30	36.52	6	60
Psamathe fusca	51	5.10	38.45	5	50
Aponuphis bilineata	48	4.80	40.27	8	80
Glycera lapidum agg.	46	4.60	42.02	7	70
Echinocyamus pusillus	40	4.00	43.53	9	90
Pisione remota	40	4.00	45.05	3	30
Leptochiton asellus	37	3.70	46.45	7	70
Lysianassa plumosa	34	3.40	47.74	7	70
Vaunthompsonia cristata	34	3.40	49.03	6	60
Modiolula phaseolina	34	3.40	50.32	6	60

5.4 Multivariate analysis (South Skye Sea Lochs)

The results of cluster analysis and nMDS on the South Skye sea loch samples are provided in Figure 17. Similarities between samples range from around 15% to just below 50%. The SIMPROF routine identified 6 groups of samples as highlighted in Figure 17, although this included three groups containing a single sample. The results of SIMPER analysis on the cluster groups were derived from SIMPROF (which highlights characteristic taxa) and are provided in Annex 9, whilst a summary of the groups with top 10 most abundant taxa for each sample and biotope type is provided in Table 17.

Group a included a single station (G02) in Loch Eishort characterised by (slightly gravelly) muddy sand and taxa including *Kurtiella bidentata*, *Acrocnida brachiata*, *Turritella communis*, *Cylichna cylindracea*, *Thyasira flexuosa* and *Nephtys hombergii*. Group b includes two stations in gravelly sand or sandy gravel in Loch Scavaig and further south off the Sleat peninsula. This group is characterised by Nematoda, *Pisione remota*, *Psamathe fusca*, *Leptochiton cancellatus*, *Glycera lapidum* agg., *Gari tellinella*, *Aonides paucibranchiata* and *Atylus vedlomensis.*A variety of other polychaete, bivalve or amphipod taxa were also found in this group as well as moderate quantities of live maerl. A few specimens of the lancelet *Branchiostoma lanceolatum* were also recorded at these stations.

Station G29 (group c) is characterised by gravelly sand with taxa such as *Urothoe* sp. (juv.), *Mediomastus fragilis*, *Pisidia longicornis*, *Aponuphis bilineata*, *Notomastus* sp. and *Glycera lapidum* (agg.) and also includes bivalves such as *Moerella donacina.* On the other hand, station G03 (group d) was characterised by gravelly muddy sand with taxa including *Alvania beanii*, *Modiolula phaseolina*, *Leptochiton cancellatus*, *Urothoe elegans*, *Vaunthompsonia cristata*, *Lysianassa plumosa*, *Rissoa parva* and *Leptochiton asellus.* Live maerl and the occasional flame shell (*Limara hians*) were also associated with group d. Station G39 (group e) in Loch Scavaig was also characterised by gravelly muddy sand with taxa such as *Lysidice unicornis*, *Aponuphis bilineata*, *Lumbrineris latreilli* (agg.), *Kurtiella bidentata*, *Leptochiton cancellatus*, *Echinocyamus pusillus*, *Pholoe inornata*, *Notomastus* sp. and *Vaunthompsonia cristata* and included significant quantities of live maerl.

Group f included four stations (G04, G05, G10 and G15) characterised by gravelly muddy sand or muddy sandy gravel. Taxa associated with this group included *Hilbigneris gracilis*, *Lysidice unicornis*, *Edwardsia claparedii*, *Aponuphis bilineata*, *Aricidea (Aricidea) minuta*, *Ampelisca tenuicornis*, *Terebellides stroemii*, Nemertea, *Glycinde nordmanni* and *Echinocyamus pusillus.* Stations G04 and G15 also had significant quantities of live maerl.

The results of the BEST routine (Table 17) indicated that mean phi grain size had the highest correlation to patterns in species similarity data (0.51) followed by mud content (0.432), median phi grain size (0.425), sediment sorting (0.334) and gravel content (0.199). Skewness, sand content, kurtosis and water depth had low individual correlations. The best combination of parameters was mean phi grain size, mud content, sediment sorting and water depth, with a combined correlation of 0.596.

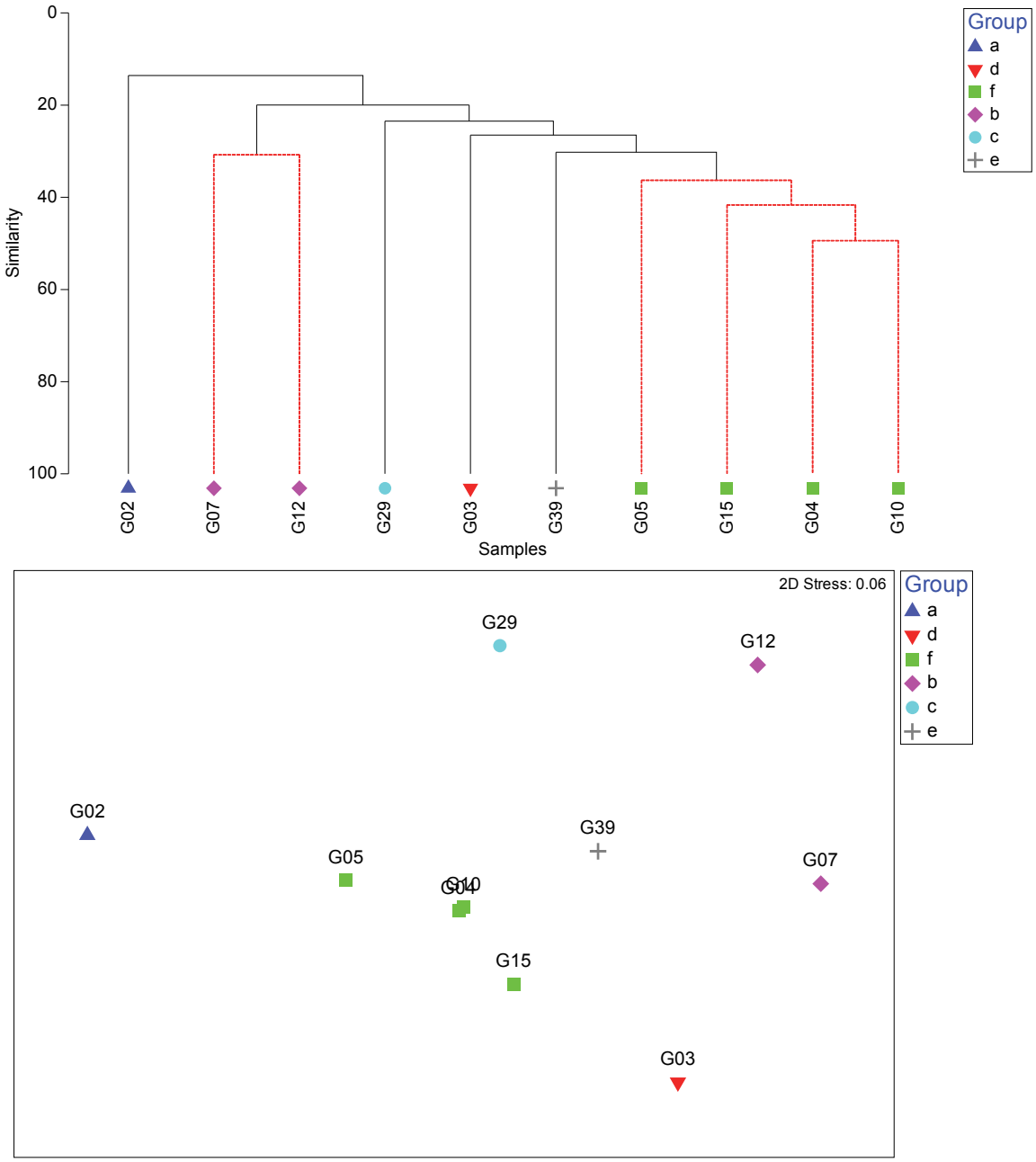

Figure 17. Results of cluster analysis and nMDS for the south Skye sea loch survey stations.

Table 17. Results of the BEST routine. Parameters with ticks highlight those parameters which in combination produced the highest correlation with species similarity data.

Parameter	Correlation (r)	Best Combination (r=0.596)
Mean Phi	0.51	☐
Mud	0.432	☐
Median Phi	0.425	
Sorting	0.334	☐
Gravel	0.199	
Skewness	0.091	
Sand	0.025	
Kurtosis	0.005	
Depth (m CD)	-0.024	☐

Biotope composition (South Skye Sea Lochs)

The south Skye groups defined from the cluster analysis have been tabulated with biotope and dominant taxa in Table 18 and Figure 18. Group a (station G02) has been classified as **SS.SMx.CMx.MysThyMx (*Mysella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment)** due to the dominance by *Kurtiella (*previously *Mysella) bidentata* along with *Thyasira flexuosa*. The coarser sediment stations G07 and G12 in group b includes dead maerl gravel and low to moderate quantities of live maerl fragments, but it is uncertain whether densities of maerl are sufficient to classify the habitats as a maerl bed. The infaunal community at G07 and G12 includes taxa such as *Polygordius* sp. and *Pisione remota* along with low numbers of the lancelet *Branchiostoma lanceolatum,* which indicates these may be rather transitional or maerl influenced examples of **SS.SCS.CCS.Blan (*Branchiostoma lanceolatum* in circalittoral coarse sand with shell gravel)**. Station G12 found in deeper water had lower densities of live maerl than the other maerl stations (15 fragments) and has subsequently been assigned **SS.SCS.CCS.Blan.** The higher densities of live maerl recorded at the shallower station G07 means that this station has been tentatively classified as **SS.SMp.Mrl (Maerl beds),** although this sample could equally be a shallow maerl influenced example of **SS.SCS.CCS.Blan.** The shallow gravelly sand station in group C (G29) includes low numbers of the bivalve *Moerella donacina* and other robust bivalves, along with taxa such as *Mediomastus fragilis* and *Lumbrineris latreilli* agg. and has therefore been assigned the biotope **SS.SCS.ICS.MoeVen (Moerella spp. with venerid bivalves in infralittoral gravelly sand)**.

Groups d to f include a rather variable and quite diverse faunal assemblage and often included significant quantities of live maerl so have largely been assigned the biotope *SS.SMp.Mrl (Maerl beds).* ***However, stations G05 and G10 were located in slightly deeper water which had a similar community characterised by taxa such as* Hilbigneris gracilis *(previously* Lumbrineris gracilis*) but lacked live maerl (although dead maerl gravel was present in the sediment). Therefore, G05 and G010 have tentatively been assigned as maerl influenced examples of the biotope*** *SS.SCS.CCS.MedLumVen (*Mediomastus fragilis*,* Lumbrineris *spp. and venerid bivalves in circalittoral coarse sand or gravel)***.**

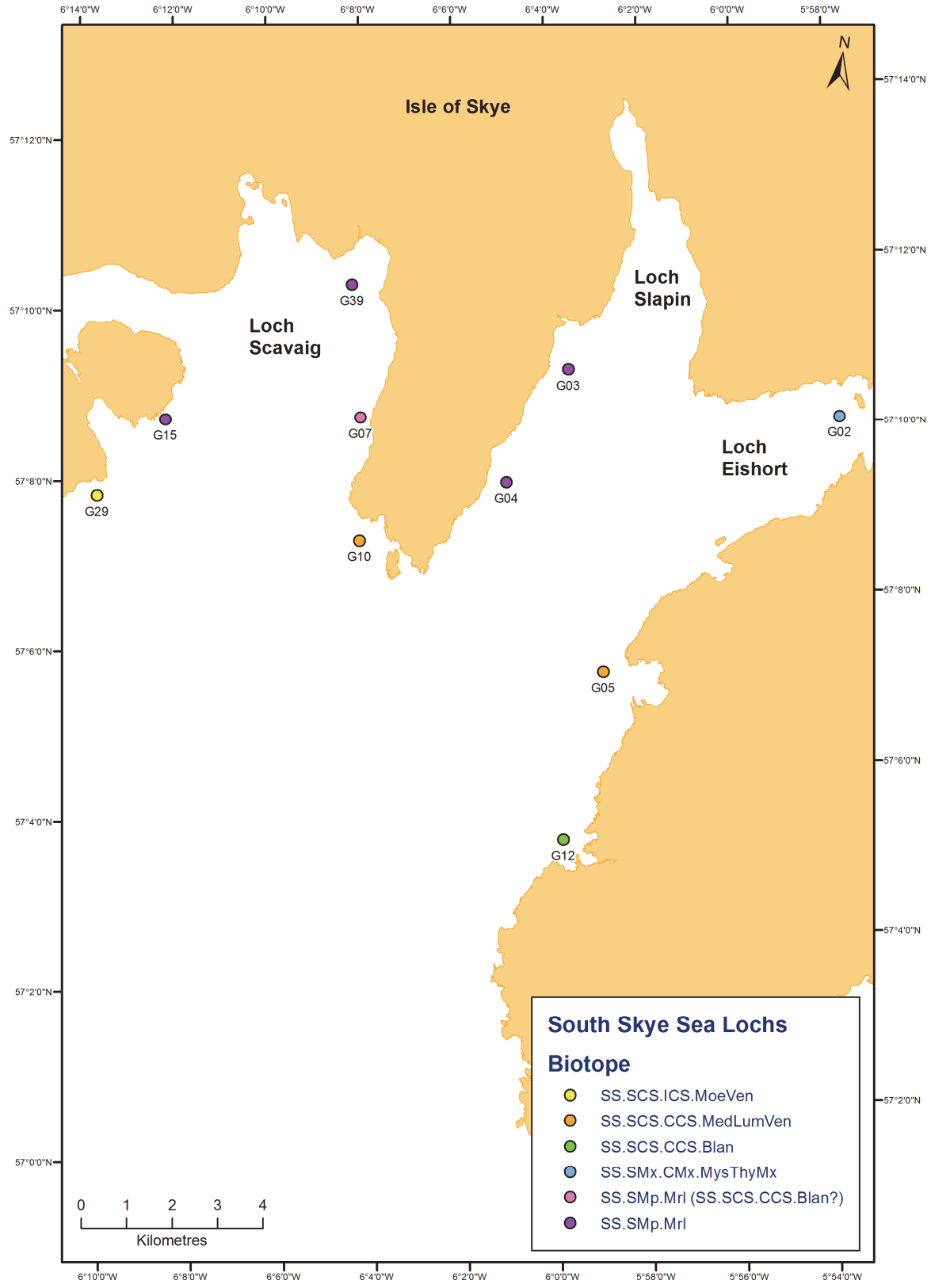

Figure 18. Biotopes at the south Skye sea loch survey stations. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2018. All rights reserved. Ordnance Survey Licence number 100017908.

Table 18. Biotopes, and dominant taxa within cluster groups for the South Skye sea loch survey stations.

Group	Station	Biotope		Sediment Type	Depth (m CD)	Dominant Taxa
a	G02	SS.SMx.CMx.MysThyMx		Slightly Gravelly Muddy Sand	16.6	*Kurtiella bidentata, Acrocnida brachiata, Turritella communis, Cylichna cylindracea, Thyasira flexuosa, Nephtys hombergii, Aricidea (Aricidea) minuta, Ampelisca tenuicornis, Leptosynapta inhaerens, Melinna palmata*
b	G07	SS.SMp.Mrl (SS.SCS.CCS.Blan?)	?	Gravelly Sand	9.8	Nematoda, *Psamathe fusca, Pisione remota, Harmothoe* sp. (juv./dam.), *Aonides paucibranchiata, Socarnes erythrophthalmus, Glycera lapidum* agg., *Malmgrenia* sp. (juv./dam.), *Sphaerosyllis bulbosa, Syllis cornuta* (Also live Maerl)
b	G12	SS.SCS.CCS.Blan	?	Sandy Gravel	18.0	Nematoda, *Gari tellinella, Polygordius* sp., *Pisione remota, Goodallia triangularis, Clausinella fasciata, Psamathe fusca, Kurtiella bidentata, Amphipholis squamata, Leptochiton cancellatus* (& occasional live Maerl)
c	G29	SS.SCS.ICS.MoeVen		Gravelly Sand	13.9	*Urothoe* sp. (juv.), *Mediomastus fragilis, Pisidia longicornis, Aponuphis bilineata, Notomastus* sp., *Glycera lapidum* agg., *Ampelisca typica, Aonides paucibranchiata, Lanice conchilega, Phtisica marina* (& *Moerella donacina*)
d	G03	SS.SMp.Mrl		Gravelly Muddy Sand	8.0	*Alvania beanii, Modiolula phaseolina, Leptochiton cancellatus, Urothoe elegans, Vaunthompsonia cristata, Lysianassa plumosa, Rissoa parva, Leptochiton asellus, Harmothoe (impar?), Onoba semicostata* (Also live Maerl & occasional *Limaria hians*)
e	G39	SS.SMp.Mrl		Gravelly Muddy Sand	12.5	*Lysidice unicornis, Aponuphis bilineata, Lumbrineris latreilli* agg., *Kurtiella bidentata, Leptochiton cancellatus, Echinocyamus pusillus, Pholoe inornata, Notomastus* sp., *Vaunthompsonia cristata, Aonides oxycephala* (Also live Maerl)

f	G04	SS.SMp.Mrl		Gravelly Muddy Sand	16.7	*Lysidice unicornis, Hilbigneris gracilis, Echinocyamus pusillus,* Nemertea*, Leptochiton asellus, Aponuphis bilineata, Aricidea (Aricidea) minuta, Edwardsia claparedii, Harmothoe (impar?), Terebellides stroemii* (Also live Maerl)
f	G05	SS.SCS.CCS.MedLumVen	?	Gravelly Muddy Sand	24.7	*Hilbigneris gracilis, Chaetozone* sp.*, Ampelisca tenuicornis, Lysidice unicornis, Aponuphis bilineata, Glycera lapidum* agg.*, Aricidea (Aricidea) minuta, Edwardsia claparedii, Lepidepecreum longicornis, Acrocnida brachiata*
f	G10	SS.SCS.CCS.MedLumVen	?	Gravelly Muddy Sand	23.1	*Hilbigneris gracilis, Lysidice unicornis, Aponuphis bilineata, Ampelisca typica, Edwardsia claparedii, Atylus vedlomensis, Glycera lapidum* agg.*, Pholoe baltica, Amphiura filiformis, Harmothoe* sp. (juv./dam.)
f	G15	SS.SMp.Mrl		Muddy Sandy Gravel	16.1	*Balanus balanus, Lysidice unicornis, Hilbigneris gracilis, Edwardsia claparedii, Leptochiton cancellatus, Owenia fusiformis, Alvania beanii, Echinocyamus pusillus, Leptochiton asellus, Terebellides stroemii* (Also live Maerl)

6. DISCUSSION

The current project involved analysis of marine benthic samples from three separate areas in Scottish waters. This included intertidal samples from Southannan Sands SSSI, subtidal grab samples from sea lochs to the south of Skye and diver cores from maerl beds off Mousa.

The samples collected from Southannan Sands SSSI revealed a varied infaunal community, often exhibiting moderately high diversities. Previous studies in this area undertaken in 2005 (ERT, 2006) also highlighted moderately high diversity and infaunal abundance, although in general the samples collected during the current survey tended to have consistently higher numbers of species. With the exception of a few sites from the 2005 survey (which had very high numbers of oligochaetes or sabellid polychaetes), the current survey also tended to have higher densities of invertebrates per sample. In the 2005 survey, 68 taxa were recorded in 22 samples (each containing 8 pooled core samples), whilst 110 taxa were recorded in only 14 samples in the current survey.

A range of infaunal taxa were recorded within the Southannan Sands SSSI with taxa such as *Macomangulus tenuis* and *Pygospio elegans* with *Scoloplos (Scoloplos) armiger*, *Crassicorophium crassicorne*, *Tubificoides benedii* and small individuals of *Parvicardium* sp. (*P. pinnulatum*?) making up 80% of the total abundance. In comparison with the 2005 survey, the range of taxa from both surveys were broadly similar, although ERT (2006) found much higher numbers of oligochaetes (particularly enchytraeids at some sites). On the other hand, the current survey had greater variety of bivalve taxa and greater densities of taxa such as *Macomangulus tenuis* and *Parvicardium* spp. and also quite high numbers of other amphipod taxa (e.g. *Crassicorophium crassicorne*) as well as higher numbers of taxa more commonly associated with subtidal habitats. A variety of biotopes were recorded in the area including **LS.LSa.MoSa.BarSa** (Barren littoral coarse sand), **LS.LSa.FiSa.Po.Aten** (Polychaetes and *Angulus tenuis* in littoral fine sand), **LS.LSa.MuSa.CerPo** (*Cerastoderma edule* and polychaetes in littoral muddy sand), **LS.LMp.LSgr.Znol** (*Zostera noltii* beds in littoral muddy sand) and an uncertain variant of **LS.LMx.Mx.CirCer** (Cirratulids and *Cerastoderma edule* in littoral mixed sediment).

The 2005 surveys of this area also recorded a number of similar biotopes to those reported here, including **LS.LSa.FiSa.Po** and **LS.LMp.Sgr.Znol** on midshore habitats at Fairlie Sands and Hunterston Sands. However, the 2005 surveys recorded biotopes such as **LS.LSa.MuSa.MacAre** (*Macoma balthica* and *Arenicola marina* in littoral muddy sand) and **LS.LSa.MuSa.Lan** (*Lanice conchilega* in littoral sand) on the low shore, whereas in the current survey, low shore sample locations were generally recorded as **LS.LSa.FiSa.Po.Aten.** Some low shore areas in the current survey (e.g. Hunterston Sands) had moderate numbers of *Arenicola* from the quadrat surveys but the infauna more closely resembled **LS.LSa.FiSa.Po.Aten** and numbers of *Limicola (Macoma) balthica* were generally very low. Highest recordings of *Arenicola* were from the *Zostera* bed at Hunterston Sands (HS5). *Lanice* was also recorded sporadically during the current survey but only one low shore site at Southannan Sands (SS1) had high densities of *Lanice* recorded in the quadrat survey. The infaunal community (from core data) at this site matched those classified as **LS.LSa.FiSa.Po.Aten** although from an epifaunal perspective this area could also be classified as **LS.LSa.MuSa.Lan**.

The 2005 survey also included different upper shore biotopes in some areas such as **LS.LMu.MEst.HedMac** (*Hediste diversicolor* and *Macoma balthica* in littoral sandy mud) and **LS.LSa.St.Tal** (Talitrids on the upper shore and strand-line) (ERT, 2006). Some of the observed differences between 2005 and the current survey are likely to be due to variations in sampling coverage or interpretation of the biotope classification, although there does appear to be some differences in sediments and invertebrate taxa in some areas.

Some of the biotopes recorded in 2016 were rather uncertain matches or exhibited transitional or intermediate forms and this reflects (in part) the quite high proportion of taxa recorded during survey which are usually more prevalent in sublittoral habitats (e.g. *Parvicardium* sp.). It is uncertain whether the presence of such species is a long-term feature of these intertidal habitats or reflects seasonal variation in recruitment. Nevertheless, the presence of sublittoral taxa in conjunction with more commonly recorded intertidal species is reflected in the relatively high diversities recorded.

Correlations between community structure and environmental parameters based on the BEST routine were relatively weak and whilst not definitively quantified in the analysis, shore position (and by association exposure) seem to drive the community composition to an extent. Aside from subtle variations in mud content (which may itself reflect shore position and tidal regime/exposure), the correlations between sediment parameters and species assemblage were generally low. Seagrass beds are known to increase stability of sediments and also provide a habitat which encourages a wide range of intertidal taxa to inhabit such areas (D'Avack *et al.,* 2015). Biotopes within or adjacent to seagrass beds (and those in mixed sediments e.g. **LS.LMx.Mx.CirCer**) tended to be more diverse than others on the shore. It is likely that the presence of features such as seagrass beds within the Southannan Sands SSSI has an influence on the overall diversity of the infaunal communities here.

Diver core sampling off Mousa indicated the presence of very poorly sorted sandy gravel with a small amount of mud (<3%) and the majority of the gravel collected in the samples was maerl gravel. The infaunal community at this site was moderately diverse, however, numbers of taxa tended to be lower per core than other maerl beds sampled recently (e.g. Wyre Sound; Allen, 2017). Aside from high densities of live maerl (*Phymatolithon* spp. and possibly *Lithothamnion* spp.), infaunal taxa included the bivalve *Modiolula phaseolina* and the tunicate *Clavelina lepadiformis,* which were present in moderate numbers. Nematode worms were also present at this site and accounted just under half of the total abundance and were present in all samples. A wide range of other taxa were recorded (79 taxa in total) including juvenile Amphiuridae sp., *Trypanosyllis (Trypanosyllis) coeliaca* the amphipods *Protomedeia fasciata* and *Othomaera othonis* along with other taxa such as Ophiuroidea sp., *Gari tellinella*, Nemertean worms, *Abra nitida* and *Limatula subauriculata*.

Grab sampling in south Skye was undertaken throughout lochs Eishort, Slapin, Scavaig and Soay Sound. Sediment types at the survey stations were predominantly rather heterogeneous gravelly muddy sands but also include more mixed muddy sandy gravel and gravelly sand or sandy gravel whilst (slightly gravelly) muddy sand was also recorded at station G02 in Loch Eishort. Biological parameters tended to be rather variable but generally exhibited moderate to high levels of species richness and diversity with numbers of species ranging from 37 taxa per 0.1 m^2 to 107 taxa per 0.1 m^2. Low to moderate numbers of individuals were collected and diversity values (e.g. Shannon's H') were generally high (>4) with a number of stations exhibiting values of H' in excess of 5.

The grab samples from the south Skye sea loch survey exhibited a rather varied infauna with most taxa recorded in relatively low numbers and often restricted to a few samples. The most abundant taxa were nematode worms, *Balanus balanus* and *Kurtiella bidentata* although these were only recorded in 40 to 60% of the stations. The flame shell, *Limaria hians,* was recorded at a single station in the south Skye sea loch survey (station G03), whilst a number of stations included specimens of maerl and abundances of live maerl at some stations in the south Skye sea lochs were sufficiently high to qualify as records of maerl bed biotopes (**SS.SMp.Mrl**). Other biotopes included **SS.SMx.CMx.MysThyMx** (*Mysella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment), **SS.SCS.CCS.Blan** (*Branchiostoma lanceolatum* in circalittoral coarse sand with shell gravel) and **SS.SCS.ICS.MoeVen** (*Moerella* spp. with venerid bivalves in infralittoral gravelly sand) which is a Priority Marine Feature.

The maerl beds and associated maerl influenced coarse/mixed sediment habitats in the south Skye sea lochs tended to have a very diverse infauna assemblage, characterised by a variety of molluscs, echinoderms and polychaetes, including a range of amphipod and isopod crustacean. A number of polychaete and amphipod species recorded here have a high specificity to maerl beds (BIOMAERL team, 1999). The relatively high levels of diversity recorded here (up to 107 taxa per 0.1 m^2 grab sample) are in keeping with those recorded for other maerl habitats, which often exhibit increased diversity in relation to adjacent areas (Lancaster *et al*., 2014; Birkett *et al*., 1998).

A number of the survey stations in south Skye had somewhat intermediate biotopes, particularly those in maerl influenced habitats. Some of these stations had relatively low densities of live maerl so could not be assigned a maerl bed biotope, although the results of video survey may clarify the wider distribution of maerl beds in these areas. The infaunal communities in these habitats were often quite similar to other stations which had high densities of live maerl (and classified as maerl beds). These intermediate communities lacked significant quantities of live maerl and appear to be maerl influenced variants of coarse sediment biotopes such as **SS.SCS.CCS.Blan** or **SS.SCS.CCS.MedLumVen.** Similar habitats have been recorded elsewhere in recent surveys in Scottish waters (e.g. off Arran (Allen 2014; 2017)) and these coarse mixed sediment communities is an area of the biotope classification which is currently less well defined. Maerl influenced coarse sediment biotopes have recently been evaluated as part of an ongoing project coordinated by JNCC to revise sublittoral soft sediment biotopes. As such, examples of these coarse sediment or maerl influenced habitats are likely to be under-reported and would benefit from additional data to improve the knowledge-base of such communities within Scottish Waters.

Maerl beds have previously been documented in south Skye area during drop down video surveys (Moore, 2015). The communities recorded in south Skye during the present study build on the Moore 2015 data but also extend the findings to loch Scavaig where maerl beds were also found in 2016 (in 3 out of 5 stations). Overall the findings of the current study improve the resolution of data and increase our understanding regarding the extent and distribution of intertidal and seabed communities within the three survey areas in Scotland. Furthermore, information on the infaunal species present in key seabed habitats such as maerl beds in Mousa and south Skye are reported as well as seagrass beds in the Southannan Sands SSSI.

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ANNEX 1: SAMPLING DETAILS FROM THE 2016 SURVEYS

Southannon Sands SSSI Transects and Zones

Location	Event (zone)	Date	Latitude	Longitude	Zone Position
Hunterston Sands Transect	HS_1	25/07/2016	55.73247	-4.89830	Lower zone position
Hunterston Sands Transect	HS_1	25/07/2016	55.73232	-4.89778	Upper zone position
Hunterston Sands Transect	HS_2	25/07/2016	55.73232	-4.89778	Lower zone position
Hunterston Sands Transect	HS_2	25/07/2016	55.73188	-4.89672	Upper zone position
Hunterston Sands Transect	HS_3	25/07/2016	55.73188	-4.89672	Lower zone position
Hunterston Sands Transect	HS_3	25/07/2016	55.72957	-4.88928	Upper zone position
Hunterston Sands Transect	HS_4	25/07/2016	55.72957	-4.88928	Lower zone position
Hunterston Sands Transect	HS_4	25/07/2016	55.72853	-4.88613	Upper zone position
Hunterston Sands Transect	HS_5	25/07/2016	55.72853	-4.88613	Lower zone position
Hunterston Sands Transect	HS_5	25/07/2016	55.72845	-4.88598	Upper zone position
Hunterston Sands Transect	HS_6	25/07/2016	55.72845	-4.88598	Lower zone position
Hunterston Sands Transect	HS_6	25/07/2016	55.72842	-4.88588	Upper zone position
Hunterston Sands Transect	HS_7	25/07/2016	55.72842	-4.88588	Lower zone position
Hunterston Sands Transect	HS_7	25/07/2016	55.72833	-4.88572	Upper zone position
Southannan Sands Transect	SS_1	26/07/2016	55.74645	-4.88305	Lower zone position
Southannan Sands Transect	SS_1	26/07/2016	55.74602	-4.88037	Upper zone position
Southannan Sands Transect	SS_2	26/07/2016	55.74602	-4.88037	Lower zone position
Southannan Sands Transect	SS_2	26/07/2016	55.74558	-4.87695	Upper zone position
Southannan Sands Transect	SS_3	26/07/2016	55.74558	-4.87695	Lower zone position
Southannan Sands Transect	SS_3	26/07/2016	55.74538	-4.87533	Upper zone position
Southannan Sands Transect	SS_4	26/07/2016	55.74538	-4.8753	Lower zone position
Southannan Sands Transect	SS_4	26/07/2016	55.74508	-4.87283	Upper zone position
Southannan Sands Transect	SS_5	26/07/2016	55.74508	-4.87283	Lower zone position
Southannan Sands Transect	SS_5	26/07/2016	55.74483	-4.87008	Upper zone position
Southannan Sands Transect	SS_6	26/07/2016	55.74483	-4.87008	Lower zone position
Southannan Sands Transect	SS_6	26/07/2016	55.74485	-4.87003	Upper zone position
Fairlie Sands Transect	FS_7	27/07/2016	55.75122	-4.86608	Lower zone position
Fairlie Sands Transect	FS_7	27/07/2016	55.75102	-4.86390	Upper zone position
Fairlie Sands Transect	FS_6	27/07/2016	55.75102	-4.86390	Lower zone position
Fairlie Sands Transect	FS_6	27/07/2016	55.75063	-4.86040	Upper zone position
Fairlie Sands Transect	FS_5	27/07/2016	55.75063	-4.86040	Lower zone position
Fairlie Sands Transect	FS_5	27/07/2016	55.75052	-4.85883	Upper zone position
Fairlie Sands Transect	FS_4	27/07/2016	55.75052	-4.85883	Lower zone position
Fairlie Sands Transect	FS_4	27/07/2016	55.75045	-4.85772	Upper zone position
Fairlie Sands Transect	FS_3	27/07/2016	55.75045	-4.85772	Lower zone position
Fairlie Sands Transect	FS_3	27/07/2016	55.75045	-4.85767	Upper zone position
Fairlie Sands Transect	FS_2	27/07/2016	55.75045	-4.85767	Lower zone position
Fairlie Sands Transect	FS_2	27/07/2016	55.75047	-4.85757	Upper zone position
Fairlie Sands Transect	FS_1	27/07/2016	55.75047	-4.85757	Lower zone position
Fairlie Sands Transect	FS_1	27/07/2016	55.75047	-4.85753	Upper zone position

Southannon Sands SSSI Sample Locations

Location	Sample	Latitude	Longitude	Samples	PSA
Hunterston Sands Transect	HS_1	55.73248	-4.89830	Quadrats	No Sample
Hunterston Sands Transect	HS_2	55.73215	-4.89752	Quadrats, Cores & Dig Over	1
Hunterston Sands Transect	HS_3	55.73137	-4.89555	Quadrats, Cores & Dig Over	1
Hunterston Sands Transect	HS_4	55.72938	-4.88867	Quadrats, Cores & Dig Over	1
Hunterston Sands Transect	HS_5	55.72845	-4.88612	Quadrats, Cores & Dig Over	1
Hunterston Sands Transect	HS_6	55.72845	-4.88593	Quadrats, Cores & Dig Over	1
Hunterston Sands Transect	HS_7	NIL	NIL	No Sample	No Sample
Southannan Sands Transect	SS_1	55.74613	-4.88162	Quadrats, Cores & Dig Over	1
Southannan Sands Transect	SS_2	55.74565	-4.87820	Quadrats, Cores & Dig Over	1
Southannan Sands Transect	SS_3	55.74548	-4.87607	Quadrats, Cores & Dig Over	1
Southannan Sands Transect	SS_4	55.74517	-4.87365	Quadrats, Cores & Dig Over	1
Southannan Sands Transect	SS_5	55.74498	-4.87088	Quadrats, Cores & Dig Over	1
Southannan Sands Transect	SS_6	NIL	NIL	No Sample	No Sample
Fairlie Sands Transect	FS_7	55.75107	-4.86453	Quadrats, Cores & Dig Over	1
Fairlie Sands Transect	FS_6	55.75072	-4.86100	Quadrats, Cores & Dig Over	1
Fairlie Sands Transect	FS_5	55.75050	-4.85973	Quadrats, Cores & Dig Over	1
Fairlie Sands Transect	FS_4	55.75050	-4.85842	Quadrats, Cores & Dig Over	1
Fairlie Sands Transect	FS_3	55.75045	-4.85768	Quadrats	1
Fairlie Sands Transect	FS_2	55.75047	-4.85757	No Sample	No Sample
Fairlie Sands Transect	FS_1	55.75047	-4.85753	No Sample	No Sample

Mousa maerl core station

Location	Event	Sample	Date	Latitude	Longitude	Depth Start (m)	Depth End (m)
Mousa	Maerl cores	1	01/08/2016	60.0085	-1.20621	25.7	26

South of Skye Sea Loch Stations

Station	Sample	Area	Date	Time	Latitude	Longitude	Depth (m CD)
G29	SSS_16_G29b	South Skye Sea Lochs	24/08/2016	12:58	57.131517	-6.204100	13.9
G15	SSS_16_G15b	South Skye Sea Lochs	24/08/2016	13:10	57.148167	-6.183267	16.1
G39	SSS_16_G39b	South Skye Sea Lochs	24/08/2016	13:29	57.179400	-6.122600	12.5
G07	SSS_16_G07a	South Skye Sea Lochs	24/08/2016	13:44	57.153700	-6.113200	9.8
G10	SSS_16_G10a	South Skye Sea Lochs	24/08/2016	13:57	57.129667	-6.107667	23.1
G04	SSS_16_G04c	South Skye Sea Lochs	24/08/2016	14:21	57.144867	-6.057467	16.7
G03	SSS_16_G03	South Skye Sea Lochs	24/08/2016	14:33	57.168617	-6.040683	8.0
G02	SSS_16_G02a	South Skye Sea Lochs	24/08/2016	14:56	57.166538	-5.940783	16.6
G05	SSS_16_G05	South Skye Sea Lochs	24/08/2016	15:49	57.110333	-6.013567	24.7
G12	SSS_16_G12	South Skye Sea Lochs	24/08/2016	16:06	57.076483	-6.019833	18.0

ANNEX 2: SEDIMENT PARTICLE SIZE ANALYSES DATA

SAMPLE	PARAMETER	HS_2	HS_3	HS_4	HS_5	HS_6
SAMPLE TYPE:		Trimodal, Very Poorly Sorted	Unimodal, Moderately Well Sorted	Unimodal, Moderately Well Sorted	Unimodal, Moderately Sorted	Unimodal, Moderately Sorted
TEXTURAL GROUP:		Gravelly Sand	Slightly Gravelly Sand	Slightly Gravelly Sand	Slightly Gravelly Sand	Slightly Gravelly Sand
SEDIMENT NAME:		Fine Gravelly Medium Sand	Slightly Fine Gravelly Medium Sand	Slightly Fine Gravelly Fine Sand	Slightly Very Fine Gravelly Fine Sand	Slightly Coarse Gravelly Medium Sand
	MEDIAN GRAIN SIZE D_{50} (µm)	371.5	254.7	230.1	199.8	280.9
FOLK AND	MEAN GRAIN SIZE (µm)	669.57	254.16	225.7	198.7	260.7
WARD METHOD	SORTING	4.209	1.558	1.624	1.797	1.977
(µm)	SKEWNESS	0.559	-0.005	-0.082	-0.047	-0.267
	KURTOSIS	1.036	0.969	1.001	1.047	1.323
	MEDIAN GRAIN SIZE D_{50} (phi):	1.429	1.973	2.120	2.323	1.832
FOLK AND	MEAN GRAIN SIZE (phi):	0.579	1.976	2.147	2.332	1.940
WARD METHOD	SORTING	2.073	0.639	0.700	0.845	0.984
(phi)	SKEWNESS	-0.559	0.005	0.082	0.047	0.267
	KURTOSIS	1.036	0.969	1.001	1.047	1.323
	MEAN:	Coarse Sand	Medium Sand	Fine Sand	Fine Sand	Medium Sand
FOLK AND WARD METHOD	SORTING:	Very Poorly Sorted	Moderately Well Sorted	Moderately Well Sorted	Moderately Sorted	Moderately Sorted
(Description)	SKEWNESS:	Very Coarse Skewed	Symmetrical	Symmetrical	Symmetrical	Fine Skewed
	KURTOSIS:	Mesokurtic	Mesokurtic	Mesokurtic	Mesokurtic	Leptokurtic
BULK GRAIN SIZE	% GRAVEL:	22.53	0.14	0.07	0.32	1.29
	% SAND:	75.47	98.22	96.89	95.62	92.65
	% MUD:	2.00	1.64	3.05	4.07	6.06
	% V COARSE GRAVEL:	0.00	0.00	0.00	0.00	0.00
	% COARSE GRAVEL:	1.12	0.00	0.00	0.02	0.86
	% MEDIUM GRAVEL:	7.15	0.00	0.00	0.00	0.07
	% FINE GRAVEL:	8.08	0.12	0.03	0.04	0.28
	% V FINE GRAVEL:	6.17	0.02	0.03	0.25	0.08
	% V COARSE SAND:	4.37	0.14	0.04	1.21	0.34
	% COARSE SAND:	9.08	5.15	2.89	3.51	9.32
	% MEDIUM SAND:	36.77	46.16	40.27	29.33	47.73
	% FINE SAND:	23.49	43.59	46.18	45.80	27.74
	% V FINE SAND:	1.76	3.19	7.51	15.77	7.52
	% V COARSE SILT:	0.57	0.09	0.75	0.65	3.21
	% COARSE SILT:	0.61	0.74	1.23	1.90	1.40
	% MEDIUM SILT:	0.39	0.50	0.60	0.86	1.03
	% FINE SILT:	0.40	0.30	0.46	0.60	0.41
	% V FINE SILT:	0.02	0.00	0.00	0.05	0.00
	% CLAY:	0.00	0.00	0.00	0.00	0.00

SAMPLE	PARAMETER	SS_1	SS_2	SS_3	SS_4	SS_5
SAMPLE TYPE:		Unimodal, Moderately Well Sorted	Unimodal, Moderately Sorted	Unimodal, Moderately Well Sorted	Unimodal, Poorly Sorted	Unimodal, Moderately Sorted
TEXTURAL GROUP:		Slightly Gravelly Sand	Gravelly Sand	Slightly Gravelly Sand	Gravelly Muddy Sand	Slightly Gravelly Sand
SEDIMENT NAME:		Slightly Coarse Gravelly Medium Sand	Medium Gravelly Medium Sand	Slightly Very Fine Gravelly Medium Sand	Fine Gravelly Coarse Silty Medium Sand	Slightly Medium Gravelly Medium Sand
	MEDIAN GRAIN SIZE D_{50} (µm)	277.93	310.6	254.11	311.4	274.5
FOLK AND	MEAN GRAIN SIZE (µm)	277.15	311.6	249.5	312.5	274.0
WARD METHOD	SORTING	1.451	1.989	1.49	3.669	1.632
(µm)	SKEWNESS	-0.060	0.276	-0.071	0.029	-0.055
	KURTOSIS	1.043	2.312	0.996	2.823	1.241
	MEDIAN GRAIN SIZE D_{50} (phi):	1.847	1.687	1.977	1.683	1.865
FOLK AND	MEAN GRAIN SIZE (phi):	1.851	1.682	2.003	1.678	1.868
WARD METHOD	SORTING	0.537	0.992	0.571	1.875	0.707
(phi)	SKEWNESS	0.060	-0.276	0.071	-0.029	0.055
	KURTOSIS	1.043	2.312	0.996	2.823	1.241
	MEAN:	Medium Sand	Medium Sand	Fine Sand	Medium Sand	Medium Sand
FOLK AND WARD METHOD	SORTING:	Moderately Well Sorted	Moderately Sorted	Moderately Well Sorted	Poorly Sorted	Moderately Sorted
(Description)	SKEWNESS:	Symmetrical	Coarse Skewed	Symmetrical	Symmetrical	Symmetrical
	KURTOSIS:	Mesokurtic	Very Leptokurtic	Mesokurtic	Very Leptokurtic	Leptokurtic
BULK GRAIN SIZE	% GRAVEL:	0.89	6.01	0.36	11.12	3.43
	% SAND:	96.75	91.69	96.89	79.86	92.13
	% MUD:	2.36	2.29	2.75	9.02	4.45
	% V COARSE GRAVEL:	0.00	0.00	0.00	0.00	0.00
	% COARSE GRAVEL:	0.32	0.00	0.00	1.13	1.24
	% MEDIUM GRAVEL:	0.23	3.36	0.05	3.65	1.44
	% FINE GRAVEL:	0.17	1.39	0.15	3.78	0.52
	% V FINE GRAVEL:	0.17	1.26	0.16	2.56	0.22
	% V COARSE SAND:	0.20	0.76	0.18	1.78	0.14
	% COARSE SAND:	2.04	5.23	1.09	10.12	3.33
	% MEDIUM SAND:	58.62	59.89	49.94	40.94	51.77
	% FINE SAND:	35.67	25.71	43.76	24.02	35.60
	% V FINE SAND:	0.22	0.10	1.92	3.00	1.28
	% V COARSE SILT:	0.19	0.22	0.52	1.92	1.64
	% COARSE SILT:	1.11	0.80	1.07	2.39	1.46
	% MEDIUM SILT:	0.73	0.64	0.70	2.23	0.81
	% FINE SILT:	0.33	0.60	0.45	1.95	0.52
	% V FINE SILT:	0.00	0.03	0.00	0.54	0.01
	% CLAY:	0.00	0.00	0.00	0.00	0.00

SAMPLE	PARAMETER	FS_3	FS_4	FS_5	FS_6	FS_7
SAMPLE TYPE:		Trimodal, Very Poorly Sorted	Unimodal, Poorly Sorted	Bimodal, Poorly Sorted	Trimodal, Very Poorly Sorted	Unimodal, Moderately Well Sorted
TEXTURAL GROUP:		Gravelly Muddy Sand	Gravelly Muddy Sand	Gravelly Sand	Muddy Sandy Gravel	Slightly Gravelly Sand
SEDIMENT NAME:		Coarse Gravelly Very Coarse Silty Very Fine Sand	Fine Gravelly Coarse Silty Medium Sand	Coarse Gravelly Medium Sand	Very Coarse Silty Sandy Very Fine Gravel	Slightly Very Fine Gravelly Fine Sand
	MEDIAN GRAIN SIZE D_{50} (µm)	152.358	244.4	302.7	848.8	227.5
FOLK AND	MEAN GRAIN SIZE (µm)	450.7	230.829	300.609	902.433	222.835
WARD METHOD	SORTING	12.4	3.220	2.739	5.689	1.608
(µm)	SKEWNESS	0.439	-0.027	0.147	-0.060	-0.082
	KURTOSIS	0.800	1.954	2.660	0.969	0.982
	MEDIAN GRAIN SIZE D_{50} (phi):	2.7	2.033	1.724	0.237	2.136
FOLK AND	MEAN GRAIN SIZE (phi):	1.1	2.115	1.734	0.148	2.166
WARD METHOD	SORTING	3.6	1.687	1.453	2.508	0.685
(phi)	SKEWNESS	-0.439	0.027	-0.147	0.060	0.082
	KURTOSIS	0.800	1.954	2.660	0.969	0.982
	MEAN:	Medium Sand	Fine Sand	Medium Sand	Coarse Sand	Fine Sand
FOLK AND WARD METHOD	SORTING:	Very Poorly Sorted	Poorly Sorted	Poorly Sorted	Very Poorly Sorted	Moderately Well Sorted
(Description)	SKEWNESS:	Very Coarse Skewed	Symmetrical	Coarse Skewed	Symmetrical	Symmetrical
	KURTOSIS:	Platykurtic	Very Leptokurtic	Very Leptokurtic	Mesokurtic	Mesokurtic
BULK GRAIN SIZE	% GRAVEL:	26.92	7.03	8.56	39.46	0.03
	% SAND:	52.75	83.42	86.16	52.48	97.38
	% MUD:	20.33	9.55	5.28	8.06	2.59
	% V COARSE GRAVEL:	0.00	0.00	0.00	0.00	0.00
	% COARSE GRAVEL:	10.98	0.00	4.04	0.00	0.00
	% MEDIUM GRAVEL:	9.85	1.07	0.57	6.74	0.00
	% FINE GRAVEL:	3.48	3.45	2.67	13.50	0.01
	% V FINE GRAVEL:	2.61	2.52	1.28	19.22	0.02
	% V COARSE SAND:	1.76	1.51	0.65	10.22	0.05
	% COARSE SAND:	2.79	7.44	7.63	5.24	2.01
	% MEDIUM SAND:	7.69	32.89	47.80	21.08	40.19
	% FINE SAND:	16.80	30.16	27.21	12.92	47.07
	% V FINE SAND:	23.72	11.42	2.88	3.01	8.06
	% V COARSE SILT:	8.71	2.92	2.22	2.18	0.32
	% COARSE SILT:	4.23	3.16	1.34	2.12	1.11
	% MEDIUM SILT:	3.94	2.09	1.03	1.74	0.70
	% FINE SILT:	2.61	1.22	0.67	1.48	0.46
	% V FINE SILT:	0.83	0.16	0.02	0.54	0.00
	% CLAY:	0.00	0.00	0.00	0.00	0.00

SAMPLE	PARAMETER	Mousa Mearl Bed	SSS_G02	SSS_G03	SSS_G04	SSS_G05
SAMPLE TYPE:		Bimodal, Very Poorly Sorted	Bimodal, Very Poorly Sorted	Trimodal, Very Poorly Sorted	Unimodal, Very Poorly Sorted	Polymodal, Very Poorly Sorted
TEXTURAL GROUP:		Sandy Gravel	Slightly Gravelly Muddy Sand	Gravelly Muddy Sand	Gravelly Muddy Sand	Gravelly Muddy Sand
SEDIMENT NAME:		Sandy Very Fine Gravel	Slightly Fine Gravelly Medium Silty Very Fine Sand	Very Fine Gravelly Coarse Silty Very Coarse Sand	Very Fine Gravelly Coarse Silty Very Coarse Sand	Very Fine Gravelly Coarse Silty Very Coarse Sand
	MEDIAN GRAIN SIZE D_{50} (µm)	1291.5	71.3	202.9	1189.6	619.9
FOLK AND	MEAN GRAIN SIZE (µm)	1515.390	50.299	194.641	809.391	426.820
WARD METHOD	SORTING	4.305	4.220	10.430	4.433	6.495
(µm)	SKEWNESS	0.234	-0.300	-0.039	-0.514	-0.347
	KURTOSIS	1.378	0.809	0.719	1.606	0.980
	MEDIAN GRAIN SIZE D_{50} (phi):	-0.369	3.810	2.301	-0.250	0.690
FOLK AND	MEAN GRAIN SIZE (phi):	-0.600	4.313	2.361	0.305	1.228
WARD METHOD	SORTING	2.106	2.077	3.383	2.148	2.699
(phi)	SKEWNESS	-0.234	0.300	0.039	0.514	0.347
	KURTOSIS	1.378	0.809	0.719	1.606	0.980
	MEAN:	Very Coarse Sand	Very Coarse Silt	Fine Sand	Coarse Sand	Medium Sand
FOLK AND WARD METHOD	SORTING:	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted
(Description)	SKEWNESS:	Coarse Skewed	Fine Skewed	Symmetrical	Very Fine Skewed	Very Fine Skewed
	KURTOSIS:	Leptokurtic	Platykurtic	Platykurtic	Very Leptokurtic	Mesokurtic
BULK GRAIN SIZE	% GRAVEL:	33.82	0.09	21.02	23.19	20.04
	% SAND:	63.93	53.57	46.27	65.64	63.11
	% MUD:	2.26	46.34	32.71	11.17	16.85
	% V COARSE GRAVEL:	7.21	0.00	0.00	0.00	0.00
	% COARSE GRAVEL:	5.13	0.00	0.00	0.00	0.00
	% MEDIUM GRAVEL:	2.40	0.00	2.05	0.00	1.84
	% FINE GRAVEL:	4.54	0.05	5.50	4.28	2.87
	% V FINE GRAVEL:	14.53	0.04	13.48	18.91	15.32
	% V COARSE SAND:	25.54	0.09	11.90	34.77	20.78
	% COARSE SAND:	20.67	2.70	4.71	15.98	13.21
	% MEDIUM SAND:	13.52	7.07	9.15	8.28	10.75
	% FINE SAND:	3.55	21.26	10.91	3.66	11.16
	% V FINE SAND:	0.65	22.45	9.60	2.95	7.21
	% V COARSE SILT:	0.72	10.42	7.76	2.82	3.90
	% COARSE SILT:	0.67	10.83	8.06	3.05	4.41
	% MEDIUM SILT:	0.53	11.70	7.78	2.71	4.07
	% FINE SILT:	0.33	9.76	6.51	2.01	3.33
	% V FINE SILT:	0.01	3.54	2.50	0.58	1.13
	% CLAY:	0.00	0.10	0.10	0.00	0.01

SAMPLE	PARAMETER	SSS_G07	SSS_G10	SSS_G12	SSS_G15	SSS_G29
SAMPLE TYPE:		Unimodal, Poorly Sorted	Bimodal, Very Poorly Sorted	Unimodal, Moderately Well Sorted	Trimodal, Very Poorly Sorted	Bimodal, Poorly Sorted
TEXTURAL GROUP:		Gravelly Sand	Gravelly Muddy Sand	Sandy Gravel	Muddy Sandy Gravel	Gravelly Sand
SEDIMENT NAME:		Very Fine Gravelly Very Coarse Sand	Very Fine Gravelly Medium Silty Very Coarse Sand	Sandy Very Fine Gravel	Medium Silty Sandy Very Fine Gravel	Very Fine Gravelly Coarse Sand
	MEDIAN GRAIN SIZE D_{50} (µm)	1275.9	480.94	1784.47	823.99	776.84
FOLK AND	MEAN GRAIN SIZE (µm)	1199.997	253.914	1854.977	328.636	757.666
WARD METHOD	SORTING	2.851	7.635	1.419	10.691	3.572
(µm)	SKEWNESS	-0.339	-0.434	0.197	-0.509	-0.212
	KURTOSIS	2.526	0.820	1.206	0.679	1.420
	MEDIAN GRAIN SIZE D_{50} (phi):	-0.352	1.056	-0.835	0.279	0.364
FOLK AND	MEAN GRAIN SIZE (phi):	-0.263	1.978	-0.891	1.605	0.400
WARD METHOD	SORTING	1.511	2.933	0.505	3.418	1.837
(phi)	SKEWNESS	0.339	0.434	-0.197	0.509	0.212
	KURTOSIS	2.526	0.820	1.206	0.679	1.420
	MEAN:	Very Coarse Sand	Medium Sand	Very Coarse Sand	Medium Sand	Coarse Sand
FOLK AND WARD METHOD	SORTING:	Poorly Sorted	Very Poorly Sorted	Moderately Well Sorted	Very Poorly Sorted	Poorly Sorted
(Description)	SKEWNESS:	Very Fine Skewed	Very Fine Skewed	Coarse Skewed	Very Fine Skewed	Fine Skewed
	KURTOSIS:	Very Leptokurtic	Platykurtic	Leptokurtic	Platykurtic	Leptokurtic
BULK GRAIN SIZE	% GRAVEL:	20.47	10.46	34.37	31.73	17.73
	% SAND:	72.86	64.58	65.00	38.63	74.79
	% MUD:	6.67	24.97	0.63	29.64	7.48
	% V COARSE GRAVEL:	0.00	0.00	0.00	0.00	0.00
	% COARSE GRAVEL:	0.00	0.00	0.00	0.00	0.00
	% MEDIUM GRAVEL:	0.00	0.00	0.00	0.00	1.73
	% FINE GRAVEL:	4.08	1.58	4.25	6.67	1.56
	% V FINE GRAVEL:	16.39	8.87	30.13	25.06	14.45
	% V COARSE SAND:	50.36	25.34	64.30	17.43	23.60
	% COARSE SAND:	16.29	13.59	0.26	3.52	25.54
	% MEDIUM SAND:	3.12	10.77	0.19	4.65	18.15
	% FINE SAND:	1.44	9.70	0.12	6.38	5.29
	% V FINE SAND:	1.66	5.17	0.12	6.64	2.22
	% V COARSE SILT:	1.93	4.89	0.14	6.18	1.82
	% COARSE SILT:	1.98	6.45	0.16	6.74	2.00
	% MEDIUM SILT:	1.52	6.48	0.15	7.00	1.81
	% FINE SILT:	1.03	5.30	0.13	6.46	1.45
	% V FINE SILT:	0.21	1.82	0.05	3.00	0.39
	% CLAY:	0.00	0.02	0.00	0.25	0.00

SAMPLE	PARAMETER	SSS_G39
SAMPLE TYPE:		Polymodal, Very Poorly Sorted
TEXTURAL GROUP:		Gravelly Muddy Sand
SEDIMENT NAME:		Very Fine Gravelly Medium Silty Very Coarse Sand
	MEDIAN GRAIN SIZE D_{50} (µm)	293.6
FOLK AND	MEAN GRAIN SIZE (µm)	190.79
WARD METHOD	SORTING	8.427
(µm)	SKEWNESS	-0.277
	KURTOSIS	0.766
	MEDIAN GRAIN SIZE D_{50} (phi):	1.768
FOLK AND	MEAN GRAIN SIZE (phi):	2.390
WARD METHOD	SORTING	3.075
(phi)	SKEWNESS	0.277
	KURTOSIS	0.766
	MEAN:	Fine Sand
FOLK AND WARD METHOD	SORTING:	Very Poorly Sorted
(Description)	SKEWNESS:	Fine Skewed
	KURTOSIS:	Platykurtic
BULK GRAIN SIZE	% GRAVEL:	10.49
	% SAND:	60.05
	% MUD:	29.46
	% V COARSE GRAVEL:	0.00
	% COARSE GRAVEL:	0.02
	% MEDIUM GRAVEL:	0.00
	% FINE GRAVEL:	1.63
	% V FINE GRAVEL:	8.84
	% V COARSE SAND:	17.29
	% COARSE SAND:	13.30
	% MEDIUM SAND:	11.33
	% FINE SAND:	10.11
	% V FINE SAND:	8.02
	% V COARSE SILT:	5.93
	% COARSE SILT:	7.04
	% MEDIUM SILT:	7.26
	% FINE SILT:	6.42
	% V FINE SILT:	2.69
	% CLAY:	0.13

ANNEX 3: SPECIES DATA – SOUTHANNAN SANDS SSSI

Taxa	FS4	FS5	FS6	FS7	HS2	HS3	HS4	HS5	HS6	SS1	SS2	SS3	SS4	SS5
Enchytraeidae spp.		2	40		1								61	
Baltidrilus costatus			7											
Tubificoides benedii	267	316	17				1	5					7	
Tubificoides pseudogaster agg.	115	38			1		21	4					22	
Glycera lapidum agg.										1		1		
Oxydromus flexuosus			2											
Nephtys caeca										1				
Nephtys cirrosa				2									1	
Nephtys hombergii						2					1			1
Nephtys sp. (juv.)				1										
Eunereis longissima												2		
Eteone longa/flava agg.	2	4		2	63	18		2		1	1	19	56	20
Eulalia viridis													3	6
Mysta picta												1		2
Phyllodoce mucosa			1	5	2	4					1	7	5	6
Malmgrenia marphysae										1				
Exogone naidina												4		
Exogone verugera		4	38		4					6	1	18	88	44
Parexogone hebes		2	48	1	5	2	1			3		21	124	30
Streptosyllis websteri			1		4							3		2
Pseudofabricia aberrans	100	36	33										91	2
Spirobranchus triqueter					1									
Dipolydora coeca			7	39			21					18	21	
Dipolydora quadrilobata				29								25	79	79
Malacoceros fuliginosus			1											
Polydora ciliata													7	20
Prionospio fallax														2
Pygospio elegans	219	146	134	66	27	30	37	30	1	15	14	107	271	182
Spio armata agg.			3			2								8
Spio filicornis				3								4	2	
Spionidae (Polydorini sp.)													1	
Lanice conchilega														1
Arenicola marina				1										
Arenicola marina (juv.)												22		1
Capitella capitata agg.	17	5	5	6	1		1					1	43	17
Capitella sp.														1
Notomastus sp.			2	15								39		12
Euclymene oerstedii			13				3					6	74	28
Ophelia rathkei		42	46	2	1		2				2		16	6
Scoloplos (Scoloplos) armiger	160	94	82	6	9	34	97	48					254	84
Aricidea (Aricidea) minuta		31	22											
Scalibregma inflatum											1		1	
Travisia forbesii				59						17	17	10	1	32
Copepoda													1	
Chironomidae sp. larvae		3	2			1						1	1	
Diptera sp. larvae	40													1
Ampelisca brevicornis				1								1		
Bathyporeia guilliamsoniana				2		1				78		29		
Bathyporeia nana												1		
Bathyporeia pelagica										3	2		4	
Bathyporeia pilosa		1										3		
Bathyporeia sarsi						2				14	15	2	1	
Bathyporeia sp. (dam.)										2				
Crassicorophium crassicorne				4		3				5	86	573		5
Dexamine thea										2				
Gammarus salinus					1									
Gammaridae sp. (juv./dam.)				1						4				
Haustorius arenarius												12		
Melita palmata			2											
Urothoe brevicornis					3	8						78		
Urothoe elegans						23					20			
Urothoe sp. (juv./dam.)										1				1
Gammaridea sp. (dam.)	4													3
Lamprops fasciatus										1				
Crangon crangon						1								
Eurydice pulchra					1									
Idotea chelipes	2													
Mysida sp. (juv.)													4	
Actinopterygii sp. larvae	1													
Actiniaria sp.	1		4					1					1	

Taxa	FS4	FS5	FS6	FS7	HS2	HS3	HS4	HS5	HS6	SS1	SS2	SS3	SS4	SS5
Hydrozoa sp. (dam.)										p				
Ophiura albida										1				
Ensis sp. (juv.)				1						2			2	
Phaxas pellucidus			2											
Pharidae sp. (juv./dam.)						1								
Cerastoderma edule	4	9	23			2	4					1	4	4
Parvicardium sp. (pinnulatum?)			32	58	12	82	42	4			139	40	82	73
Parvicardium sp. (juv.)			2											
Cardiidae sp. (juv./dam.)		11												1
Limecola balthica	2													
Macomangulus tenuis		1	84	610	30	98	27			234	338	455	61	165
Mya arenaria			2				1							2
Mya sp. (juv./dam.)						1								
Mytilus edulis	1										1	4		5
Mytiloidea sp. (juv.)										66			2	5
Chamelea striatula														1
Clausinella fasciata				1						2		3		
Dosinia lupinus (juv.)												2		
Venerupis corrugata	1		14											3
Veneridae sp. (juv.)				2	1						1	1	2	
Spisula (subtruncata) juv.							1							
Kurtiella bidentata			3	3	1	3	1					3	1	21
Thracia villosiuscula				8		1					1	5		2
Retusa obtusa	4	5	1			11	3						4	6
Retusa truncatula				2						10		2	1	2
Peringia ulvae	18	12	43				1	16			1		1	1
Littorina littorea			4											
Littorina obtusata								4						
Littorina saxatilis	17		1					5						
Euspira nitida										1				
Skeneopsis planorbis													3	5
Buccinidae sp. (juv.)							1							
Lepidochitona cinerea			5											1
Nematoda	188	19	3		2			8					17	
Nemertea	32	30	69	7	2	5	7	4		14	10	12	20	17
Phoronis sp.			6				p			p	1	23	70	118
Golfingia sp.													3	
Phaeophyceae			p		p							p	p	
Chlorophyceae sp.			p											
Rhodophyta spp.										p				
Zostera sp. (noltii?)	p							p						

ANNEX 4: CHARACTERISTIC TAXA & ENVIRONMENTAL DATA FROM SIMPROF GROUPS - SOUTHANNAN SANDS CORE SAMPLES

		Group A			
Station	**Sediment Type**	**% Gravel**	**% Sand**	**% Mud**	**Shore Position**
HS_6	Slightly Gravelly Sand	1.29	92.65	6.06	Upper
	Taxa	**Abundance**	**Cum. %**		
	Pygospio elegans	1	100		

	Group B (Average similarity: 40.86%)				
Station	**Sediment Type**	**% Gravel**	**% Sand**	**% Mud**	**Shore Position**
HS_3	Slightly Gravelly Sand	0.14	98.22	1.64	Mid/Low
SS_1	Slightly Gravelly Sand	0.89	96.75	2.36	Mid-low
SS_2	Gravelly Sand	6.01	91.69	2.29	Mid-low
SS_3	Slightly Gravelly Sand	0.36	96.89	2.75	Mid-low
FS_7	Slightly Gravelly Sand	0.03	97.38	2.59	Low
	Dominant Taxa	**Av. Abund**	**% of Sites**	**Contrib%**	**Cum.%**
	Macomangulus tenuis	347.00	100	34.35	34.35
	Pygospio elegans	46.40	100	10.92	45.27
	Parvicardium sp. *(pinnulatum?)*	63.80	80	10.5	55.77
	Nemertea	9.60	100	6.5	62.27
	Crassicorophium crassicorne	134.20	100	6.16	68.44
	Travisia forbesii	20.60	80	5.13	73.57
	Eteone longa/flava agg.	8.20	100	3.29	76.86
	Bathyporeia sarsi	6.60	80	2.84	79.7
	Bathyporeia guilliamsoniana	22.00	80	2.41	82.11
	Phyllodoce mucosa	3.40	80	2.09	84.21
	Parexogone hebes	5.40	80	1.75	85.95
	Thracia villosiuscula	3.00	80	1.63	87.58
	Urothoe elegans	8.60	40	1.43	89.01
	Kurtiella bidentata	1.80	60	1.11	90.12

Group C (Average similarity: 37.37%)					
Station	**Sediment Type**	**% Gravel**	**% Sand**	**% Mud**	**Shore Position**
HS_2	Gravelly Sand	22.53	75.47	2.00	Low
HS_4	Slightly Gravelly Sand	0.07	96.89	3.05	Upper Mid
HS_5	Slightly Gravelly Sand	0.32	95.62	4.07	Upper
	Dominant Taxa	**Av. Abund**	**% of Sites**	**Contrib%**	**Cum.%**
	Pygospio elegans	31.33	100	27.25	27.25
	Scoloplos (Scoloplos) armiger	51.33	100	22.24	49.49
	Parvicardium sp. *(pinnulatum?)*	19.33	100	12.53	62.01
	Nemertea	4.33	100	8.3	70.31
	Macomangulus tenuis	19.00	67	7.9	78.21
	Tubificoides pseudogaster agg.	8.67	100	6.88	85.09
	Eteone longa/flava agg.	21.67	67	2.69	87.77
	Nematoda	3.33	67	2.69	90.46
	Tubificoides benedii	2.00	67	1.73	92.19
	Peringia ulvae	5.67	67	1.73	93.92
	Parexogone hebes	2.00	67	1.52	95.44
	Capitella capitata agg.	0.67	67	1.52	96.96
	Ophelia rathkei	1.00	67	1.52	98.48
	Kurtiella bidentata	0.67	67	1.52	100

Group D (Average similarity: 47.41%)					
Station	**Sediment Type**	**% Gravel**	**% Sand**	**% Mud**	**Shore Position**
FS_4	Gravelly Muddy Sand	7.03	83.42	9.55	Upper
FS_5	Gravelly Sand	8.56	86.16	5.28	Mid
	Dominant Taxa	**Av. Abund**	**% of Sites**	**Contrib%**	**Cum.%**
	Tubificoides benedii	291.50	100	22.94	22.94
	Pygospio elegans	182.50	100	16.96	39.9
	Scoloplos (Scoloplos) armiger	127.00	100	13.61	53.51
	Tubificoides pseudogaster agg.	76.50	100	8.65	62.17
	Pseudofabricia aberrans	68.00	100	8.42	70.59
	Nemertea	31.00	100	7.69	78.28
	Nematoda	103.50	100	6.12	84.4
	Peringia ulvae	15.00	100	4.86	89.26
	Capitella capitata agg.	11.00	100	3.14	92.4
	Cerastoderma edule	6.50	100	2.81	95.21
	Retusa obtusa	4.50	100	2.81	98.01
	Eteone longa/flava agg.	3.00	100	1.99	100

Group E (Average similarity: 57.49%)					
Station	**Sediment Type**	**% Gravel**	**% Sand**	**% Mud**	**Shore Position**
SS_4	Gravelly Muddy Sand	11.12	79.86	9.02	Mid
SS_5	Slightly Gravelly Sand	3.43	92.13	4.45	Upper
FS_6	Muddy Sandy Gravel	39.46	52.48	8.06	Mid
	Dominant Taxa	**Av. Abund**	**% of Sites**	**Contrib%**	**Cum.%**
	Pygospio elegans	195.67	100	13.26	13.26
	Scoloplos (Scoloplos) armiger	140.00	100	9.9	23.17
	Macomangulus tenuis	103.33	100	9.04	32.21
	Parvicardium sp. *(pinnulatum?)*	62.33	100	7.14	39.35
	Exogone verugera	56.67	100	6.88	46.23
	Parexogone hebes	67.33	100	6.49	52.72
	Phoronis sp.	64.67	100	4.67	57.39
	Nemertea	35.33	100	4.62	62.01
	Euclymene oerstedii	38.33	100	4.5	66.51
	Ophelia rathkei	22.67	100	3.23	69.73
	Pseudofabricia aberrans	42.00	100	3.1	72.83
	Capitella capitata agg.	21.67	100	3.08	75.9
	Dipolydora quadrilobata	52.67	67	3.01	78.92
	Enchytraeidae spp.	33.67	67	2.27	81.19
	Cerastoderma edule	10.33	100	2.18	83.37
	Eteone longa/flava agg.	25.33	67	1.52	84.88
	Phyllodoce mucosa	4.00	100	1.51	86.39
	Retusa obtusa	3.67	100	1.43	87.82
	Kurtiella bidentata	8.33	100	1.38	89.19
	Peringia ulvae	15.00	100	1.09	90.28

ANNEX 5: SPECIES DATA - MOUSA

Taxa	Maerl core 1	Maerl core 2	Maerl core 3	Maerl core 4
Grania sp.	2			1
Pareurythoe borealis	1	1	1	
Schistomeringos neglecta				1
Glycera lapidum	3	3	1	
Goniada maculata			1	
Psamathe fusca	1			
Pholoe inornata			1	
Eulalia viridis			1	
Nereiphylla rubiginosa			3	
Harmothoe sp. (dam)			1	
Polynoinae sp.	2	2		2
Sphaerodorum gracilis			2	
Sphaerosyllis bulbosa		1		
Trypanosyllis (Trypanosyllis) coeliaca	6	6	4	3
Spirobranchus triqueter				1
Aonides oxycephala		1		
Aonides paucibranchiata	1	2		3
Spio sp. (juv./dam.)			1	
Lanice conchilega			1	
Polycirrus sp.				1
Terebellidae sp.		p		
Trichobranchus roseus				2
Notomastus sp.	1	3		1
Polygordius sp.				p
Protomedeia fasciata		16		
Socarnes filicornis		1		
Othomaera othonis			13	
Megamphopus cornutus		1		
Galathea intermedia	1		2	2
Brachyura larvae			1	
Jaera (Jaera) nordmanni			2	
Electra pilosa			p	
Scruparia ambigua				p
Scruparia sp.			p	
Crisidia cornuta			p	
Lichenoporidae sp.			p	
Clavelina lepadiformis	p	p	81	p
Henricia sp. (juv.)				1
Strongylocentrotus droebachiensis			1	
Strongylocentrotus	2	2		1
Echinocyamus pusillus	1	1	2	2
Oestergrenia digitata	1	1		1
Amphiuridae sp.	11			
Amphiuridae sp. (juv.)		1		20
Ophiopholis aculeata		3		
Ophiocomina nigra	1			6
Ophiuroidea sp. (juv./dam.)			12	
Hiatella arctica				1
Glycymeris glycymeris	1	1		
Gari tellinella	1	7		2
Abra nitida			9	
Limatula subauriculata	1	3		4
Crenella decussata	3			
Modiolula phaseolina	14	16	49	9
Anomia ephippium			2	
Heteranomia squamula			1	
Clausinella fasciata	1	4		1
Dosinia exoleta			1	
Gouldia minima	1			
Mysia undata			2	
Polititapes rhomboides			4	
Venerupis corrugata	2	1		
Veneridae sp. (juv.)			3	
Spisula elliptica			1	
Thracia villosiuscula			1	
Vitreolina philippi				1
Lacuna parva	1	1		
Littorina saxatilis			1	
Alvania beanii		1	1	
Aeolidiidae sp.			1	

Taxa	Maerl core 1	Maerl core 2	Maerl core 3	Maerl core 4
Tectura virginea			1	
Stenosemus albus			2	
Leptochiton asellus	1	1	5	
Nematoda	23	16	8	14
Nemertea	3	1	3	2
Platyhelminthes				2
Sycon ciliatum			1	p
Phaeophyceae sp.			p	
Maerl indet spp.	p	p	p	p

ANNEX 6: MAERL LENGTH DATA

Maximum length of maerl specimens (mm)									
Mousa	Mousa	Mousa	Mousa	Skye	Skye	Skye	Skye	Skye	Skye
Maerl core 1	Maerl core 2	Maerl core 3	Maerl core 4	G03	G04c	G07a	G12	G15b	G39b
19	26	33	22	50	11	20	9	46	34
20	27	27	26	46	16	22	27	25	31
24	31	24	27	31	20	13	17	31	26
29	24	28	18	39	32	38	18	21	50
21	23	25	29	45	30	50	15	35	38
25	22	29	24	42	37	19	16	28	27
26	28	27	21	40	29	45	11	25	24
17	21	22	23	48	25	24	15	28	32
21	31	24	29	31	12	37	13	27	38
26	30	34	30	31	16	18	11	25	20
26	32	22	19	34	13	19	10	28	17
31	42	12	20	41	19	21	6	44	26
29	39	21	16	42	20	14	8	29	22
23	32	17	21	52	21	16	12	30	21
26	20	17	28	50	13	18	7	20	29
19	24	21	17	32	10	9		22	21
24	30	22	20	43	8	15		21	19
25	18	20	23	39	14	24		20	23
23	37	21	30	39	16	17		20	30
25	19	20	20	56	12	14		24	60
27	22	28	18	44	7	7		20	24
20	18	25	24	44	19	9		21	17
27	28	25	19	41	16	13		21	25
18	29	22	22	38	10	6		17	18
22	20	22	12	43	12	5		25	23
31	19	21	16	33	15			18	17
21	23	17	24	43	16			20	28
21	21	17	16	39	12			15	19
18	27	17	18	38	14			35	18
20	12	23	29	36	17			24	23
16	23	16	30	38	20			22	13
21	19	15	17	43	15			15	16
29	16	15	14	42	13			18	17
21	18	17	18	40	10			17	19
22	15	15	27	38	9			21	24
20	19	16	23	31	6			27	15
21	27	16	19	52	7			19	14
25	22	17	28	32	11			21	19
20	24	18	20	30	12			30	21
21	21	17	24	35	9			18	29
21	24	14	23	45	19			16	17
24	32	14	27	29	11			16	32
25	23	13	26	30	10			21	15
19	17	14	28	31	8			17	16
24	22	15	29	34	9			19	24
17	31	14	22	27	8			22	14
22	23	14	32	27	9			15	22
21	27	15	28	27	11			15	20
25	19	15	24	44	14			18	17
19	24	11		50	12			13	14

ANNEX 7: SOUTH SKYE SEA LOCHS SPECIES DATA

Taxa	G02a	G03	G04c	G05	G07a	G10a	G12	G15b	G29b	G39b
Enchytraeidae					6					
Protodorvillea kefersteini					2					
Schistomeringos neglecta		1	1							
Lysidice unicornis		13	25	4	2	12		17		20
Hilbigneris gracilis		9	19	7		28	1	16		
Lumbrineris aniara				1						
Lumbrineris latreilli agg.		1	1			3			2	13
Lumbrineridae sp. (dam.)			3							
Aponuphis bilineata			5	4	1	11	2	4	7	14
Glycera alba								1		
Glycera lapidum agg.			2	4	20	6	4		6	4
Glycera oxycephala								1		
Glycinde nordmanni	2		3	1		2		3	1	1
Goniada maculata			2							
Gyptis propinqua		1								
Hesiospina aurantiaca		2								
Nereimyra punctata		8		2						
Psamathe fusca		3			38	2	6			2
Nephtys hombergii	6									
Nephtys kersivalensis										1
Nephtys sp. (juv./dam.)								1		
Nereis pelagica		1								
Nereis zonata							1			
Nereididae sp. (juv.)					2					
Pholoe baltica	1	5	2	1		5		1	2	
Pholoe inornata		3		1	2	1		1		8
Phyllodocidae sp.			1							
Eteone longa/flava agg.				1	1					
Eteone sp. (dam.)				1						
Eulalia expusilla						2				2
Eulalia viridis		2				1				
Eulalia sp. (dam.)		1								
Eumida sanguinea								3		
Nereiphylla rubiginosa		3			1		1			
Nereiphylla sp.							1			
Harmothoe impar					2			3		
Harmothoe (impar?)		15	4							
Harmothoe sp. (juv./dam.)				1	24	4				
Malmgrenia marphysae	1		3							
Malmgrenia mcintoshi		2				2				
Malmgrenia sp. (juv./dam.)					15	4		2		
Polynoinae sp.							3			
Alentia gelatinosa		1								
Pisione remota					31		8		1	
Ephesiella abyssorum					2					
Sphaerodorum gracilis								1		
Eurysyllis tuberculata		1			2					
Sphaerosyllis bulbosa					12					
Syllis cornuta					12					
Trypanosyllis (Trypanosyllis) coeliaca		2	1		5					
Galathowenia oculata				1						
Owenia fusiformis	p	1	2			2		7		1
Jasmineira candela							1			
Jasmineira caudata			1							
Jasmineira elegans					1					4
Sabellidae sp.			2	1	1				2	
Hydroides elegans							1			
Hydroides norvegica		2			2	1	1	3		
Spirobranchus triqueter		1					1			
Magelona alleni	2	1	1			2		1		
Aonides oxycephala		1								5
Aonides paucibranchiata					24		3		3	
Dipolydora caulleryi					1					
Dipolydora coeca						1		1		
Laonice bahusiensis						1				
Laonice sp. (dam.)			2		4			1		
Malacoceros tetracerus									1	
Prionospio cirrifera	2									
Prionospio multibranchiata									1	
Prionospio sp. (dam.)				1						

Taxa	G02a	G03	G04c	G05	G07a	G10a	G12	G15b	G29b	G39b
Spio sp. (dam.)				1						
Macrochaeta clavicornis					10	1				
Macrochaeta sp.							2			
Ampharete lindstroemi	1			1				3		
Amphicteis gunneri						1				
Melinna palmata	3									
Ampharetidae sp. (juv.)						1				
Chaetozone gibber						1				
Chaetozone setosa		1								
Chaetozone zetlandica		2	2			1			2	2
Chaetozone sp.			1	6						
Diplocirrus glaucus			2		1					
Flabelligera affinis		2								
Amphictene auricoma			1			1				2
Petta pusilla		2	1	1				1		
Lanice conchilega									3	1
Pista mediterranea		3								2
Polycirrus sp.		2	1				1	3	1	3
Terebellidae sp. (juv.)		5								
Terebellides stroemii		3	4	2		2		5		
Trichobranchus glacialis		6		2				3		
Mediomastus fragilis	1	6	2		1		1		13	
Notomastus sp.	2	1	1		1	2		1	7	6
Chaetopterus variopedatus						1				
Euclymene oerstedii	1			2						
Euclymene sp.		1								
Nicomache lumbricalis (dam.)	p									
Praxillella affinis			1			4				
Maldanidae sp. (dam.)									p	
Polyophthalmus pictus		1								
Aricidea (Aricidea) minuta	4		5	4		4		3		
Polygordius lacteus					7					
Polygordius sp.							9			
Scalibregma inflatum			1							1
Balanus balanus		3			1		3	127		
Musculus discors		2								
Verruca stroemia		1								
Copepoda		1	1		2	1			2	
Ampelisca brevicornis	1								1	
Ampelisca diadema				1				3		
Ampelisca spinipes									1	
Ampelisca tenuicornis	4		2	5		4	3	2	1	
Ampelisca typica			3			8			6	
Ampelisca sp. (dam.)			1			2				
Amphilochidae sp. (juv.)					4					
Nototropis guttatus					1					
Atylus vedlomensis			1		4	7	2	1		1
Apherusa bispinosa					11					
Parvipalpus capillaceus								2		
Phtisica marina					3			1	3	2
Caprellidae sp. (dam.)						3				
Crassicorophium crassicorne		1								
Leptocheirus hirsutimanus					2	1	2			
Leptocheirus pectinatus					5					
Leucothoe incisa					3		2		1	
Lepidepecreum longicornis			1	3	1					
Lysianassa plumosa		17	2	1	6	1		2		5
Socarnes erythrophthalmus					24			1		
Animoceradocus semiserratus					2		1			
Othomaera othonis							1			
Melita hergensis					4					
Monoculodes carinatus			3			1				
Monoculodes sp. (dam.)		1	1	1					2	
Gammaropsis sp. (dam.)					3					
Megamphopus cornutus					1					
Photis longicaudata			2			3		2		1
Parametaphoxus fultoni					6					
Urothoe elegans		22								
Urothoe marina					1				3	
Urothoe sp. (juv.)									16	
Amphipoda sp. (juv./dam.)			1		3			1	2	
Bodotria arenosa						1				

Taxa	G02a	G03	G04c	G05	G07a	G10a	G12	G15b	G29b	G39b
Iphinoe serrata	1									
Vaunthompsonia cristata		18	1		4	1		4		6
Diastylis rugosa				1						
Diastylis tumida						1				
Cumacea sp. (dam.)										3
Atelecyclus rotundatus								1		
Galathea intermedia		1			1		3	2	2	
Galathea sp. (juv.)		1			6					1
Galatheidae sp. (juv.)						1				
Hippolytidae sp. (dam.)		1								
Achaeus cranchii		1								
Eurynome spinosa		7								
Homarus gammarus (juv.)				1						
Paguridae sp. (juv./dam.)		6	2		1			1		
Liocarcinus pusillus								4		
Liocarcinus (pusillus) juv.					2					
Pisidia longicornis		3		1	2			4	9	
Processa nouveli nouveli subsp. Holthusi	1									
Caridea sp. (juv./dam.)		3			1					
Pleocyemata sp. (dam.)						2				
Eurydice pulchra					1		1			1
Gnathia oxyuraea								1		
Gnathiidae sp. (larvae)							1			
Janira maculosa					1					
Dynamene bidentata		3								
Nebalia bipes						1				
Leptognathia sp.								2		
Ostracoda		1			1					
Callipallene sp. (dam.)		1								
Cradoscrupocellaria reptans		p								
Electra pilosa		p								
Crisia eburnea		p								
Tubuliporidae sp.		p								
Pomatoschistus sp. (juv.)					2					
Ascidiacea sp.								1		
Branchiostoma lanceolatum					1		2			
Edwardsia claparedii	3		5	4		8		11		
Edwardsiidae sp.									1	2
Athenaria sp.						3		1		
Cerianthus lloydii	1		1			2		2		
Asterias rubens		1								
Strongylocentrotus sp. (juv.)		10	1		1					2
Echinocyamus pusillus		2	14	1	2	1	3	6	1	10
Leptosynapta decaria									1	
Leptosynapta inhaerens	4									
Leptosynapta sp. (dam.)									1	
Neopentadactyla mixta					1					
Thyone fusus					1					
Acrocnida brachiata	72			3						5
Amphipholis squamata		11				2	5	1		
Amphiura filiformis						5		5		
Amphiuridae sp. (juv.)										1
Ophiocomina nigra							2			
Ophiothrix fragilis			1					2		
Ophiocten affinis									3	
Ophiura albida		3	2	2				2		
Ophiuroidea sp. (juv.)			2		8	1		5		
Hiatella arctica		3								
Parvicardium sp. (dam.)					1					
Gari tellinella					4		11			
Abra alba	2									
Abra nitida	2									
Fabulina fabula										2
Moerella donacina			1						2	
Goodallia triangularis							8			
Limaria hians		5								
Limatula gwyni					1					
Lucinoma borealis	1									
Myrtea spinifera	1									
Thyasira flexuosa	8	1								
Modiolula phaseolina		24			1		3	4	1	1
Musculus subpictus							3			2

Taxa	G02a	G03	G04c	G05	G07a	G10a	G12	G15b	G29b	G39b
Ennucula tenuis										1
Anomia ephippium		7								
Chamelea striatula		3			6		1			
Clausinella fasciata			1	1	2		7			1
Dosinia sp. (juv.)			2							
Mysia undata								1		
Tapes sp. (juv.)			2							
Timoclea ovata	1		1	2		1		2	1	
Venerupis corrugata (juv.)		2			4					
Venus casina						1				
Veneridae sp. (juv./dam.)								2		
Hemilepton nitidum										1
Devonia perrieri	2									
Kurtiella bidentata	96	2					6	5		13
Thracia villosiuscula		1			1				1	2
Bivalvia sp. (dam.)			1	1						
Caudofoveata sp.	1		1							
Bittium reticulatum		3								
Turritella communis	22	1						2		
Cylichna cylindracea	10									
Diaphana minuta		1								
Eatonina fulgida		6								
Lacuna parva	1									
Alvania beanii		87						7		2
Alvania sp. (juv.)		2								
Crisilla semistriata		2								
Onoba semicostata		14								
Rissoa parva		17								
Mangelia sp. (dam.)		1								
Nassarius incrassatus		3	1	1						
Nassarius reticulatus		1								
Raphitoma linearis		1								
Onchidoridae sp.			1							
Tectura virginea		6								
Patella pellucida		1								
Pyrgiscus rufescens		4								
Gibbula cineraria		1	1							
Gibbula tumida							1			
Trochidae sp.								1		
Gastropoda sp. (dam.)					1					
Trochoidea sp.							1			
Acanthochitona crinita										1
Callochiton septemvalvis		2								
Leptochiton asellus		16	6		4		1	6	1	3
Leptochiton cancellatus		23			12	1	5	10		12
Nematoda		1	1	1	269	2	21			
Lineus longissimus		2								
Nemertea	2	6	7	3	3	4		1	1	3
Phoronis sp.		3	3			1		1		1
Platyhelminthes sp.		1		1				3		
Sycon ciliatum					1			3		
Cliona celata							p			
Porifera sp.		p						p		
Golfingia (Golfingia) elongata	1									
Golfingia (Golfingia) vulgaris	1							4		
Golfingia sp.		1	1			1				
Phascolion (Phascolion) strombus						1				
Phaeophyceae		p	p		p			p		
Rhodophyta spp.		P								
Phycodrys rubens		p								
Phyllophora crispa		p								
Maerl indet spp.		p	p		p		p	p		p

ANNEX 8: LIMARIA SIZE DATA (SOUTH SKYE SEA LOCHS)

Sample	Length (mm)	Width (mm)	Breadth (mm)
Skye G03	13	9	20
Skye G03	10	7	18
Skye G03	5	3	8
Skye G03	4	2	6
Skye G03	4	2	6

ANNEX 9: CHARACTERISTIC TAXA & ENVIRONMENTAL DATA FROM SIMPROF GROUPS – SOUTH SKYE SEA LOCH GRAB SAMPLES

Group A					
Station	**Sediment Type**	**% Gravel**	**% Sand**	**% Mud**	**Depth (m CD)**
G02	Slightly Gravelly Muddy Sand	0.09	53.57	46.34	16.6
	Taxa	**Abundance**	**Cum. %**		
	Kurtiella bidentata	96	36		
	Acrocnida brachiata	72	64		
	Turritella communis	22	72		
	Cylichna cylindracea	10	76		
	Thyasira flexuosa	8	79		
	Nephtys hombergii	6	81		
	Aricidea (Aricidea) minuta	4	83		
	Ampelisca tenuicornis	4	84		
	Leptosynapta inhaerens	4	86		
	Melinna palmata	3	87		
	Edwardsia claparedii	3	88		

Group B (Average similarity: 30.77%)					
Station	**Sediment Type**	**% Gravel**	**% Sand**	**% Mud**	**Depth (m CD)**
G07	Gravelly Sand	20.47	72.86	6.67	9.8
G12	Sandy Gravel	34.37	65.00	0.63	18
	Dominant Taxa	**Av. Abund**	**% of Sites**	**Contrib%**	**Cum.%**
	Nematoda	145.00	100	12.42	12.42
	Pisione remota	19.50	100	7.67	20.08
	Psamathe fusca	22.00	100	6.64	26.72
	Leptochiton cancellatus	8.50	100	6.06	32.78
	Glycera lapidum agg.	12.00	100	5.42	38.2
	Gari tellinella	7.50	100	5.42	43.62
	Aonides paucibranchiata	13.50	100	4.69	48.32
	Atylus vedlomensis	3.00	100	3.83	52.15
	Leptocheirus hirsutimanus	2.00	100	3.83	55.98
	Leucothoe incisa	2.50	100	3.83	59.81
	Echinocyamus pusillus	2.50	100	3.83	63.65
	Clausinella fasciata	4.50	100	3.83	67.48
	Aponuphis bilineata	1.50	100	2.71	70.19
	Nereiphylla rubiginosa	1.00	100	2.71	72.9
	Hydroides norvegica	1.50	100	2.71	75.61
	Mediomastus fragilis	1.00	100	2.71	78.32
	Balanus balanus	2.00	100	2.71	81.03
	Animoceradocus semiserratus	1.50	100	2.71	83.74
	Galathea intermedia	2.00	100	2.71	86.45
	Eurydice pulchra	1.00	100	2.71	89.16
	Branchiostoma lanceolatum	1.50	100	2.71	91.87
	Modiolula phaseolina	2.00	100	2.71	94.58
	Chamelea striatula	3.50	100	2.71	97.29
	Leptochiton asellus	2.50	100	2.71	100

Station	Sediment Type	Group C % Gravel	% Sand	% Mud	Depth (m CD)
G29	Gravelly Sand	17.73	74.79	7.48	13.9
	Taxa	**Abundance**	**Cum. %**		
	Urothoe sp. (juv.)	16	14		
	Mediomastus fragilis	13	25		
	Pisidia longicornis	9	33		
	Aponuphis bilineata	7	39		
	Notomastus sp.	7	45		
	Glycera lapidum agg.	6	50		
	Ampelisca typica	6	56		
	Aonides paucibranchiata	3	58		
	Lanice conchilega	3	61		
	Phtisica marina	3	63		
	Urothoe marina	3	66		
	Ophiocten affinis	3	69		
	Lumbrineris latreilli agg.	2	70		
	Pholoe baltica	2	72		
	Sabellidae sp.	2	74		
	Chaetozone zetlandica	2	76		
	Copepoda	2	77		
	Monoculodes sp. (dam.)	2	79		
	Amphipoda sp. (juv./dam.)	2	81		
	Galathea intermedia	2	83		
	Moerella donacina	2	84		

Station	Sediment Type	Group D % Gravel	% Sand	% Mud	Depth (m CD)
G03	Gravelly Muddy Sand	21.02	46.27	32.71	8
	Taxa	**Abundance**	**Cum. %**		
	Alvania beanii	87	18		
	Modiolula phaseolina	24	23		
	Leptochiton cancellatus	23	27		
	Urothoe elegans	22	32		
	Vaunthompsonia cristata	18	36		
	Lysianassa plumosa	17	39		
	Rissoa parva	17	42		
	Leptochiton asellus	16	46		
	Harmothoe (impar?)	15	49		
	Onoba semicostata	14	52		
	Lysidice unicornis	13	54		
	Amphipholis squamata	11	57		
	Strongylocentrotus sp. (juv.)	10	59		
	Hilbigneris gracilis	9	60		
	Nereimyra punctata	8	62		
	Eurynome spinosa	7	63		
	Anomia ephippium	7	65		
	Trichobranchus glacialis	6	66		
	Mediomastus fragilis	6	67		
	Paguridae sp. (juv./dam.)	6	69		
	Eatonina fulgida	6	70		
	Tectura virginea	6	71		
	Nemertea	6	72		
	Pholoe baltica	5	73		
	Terebellidae sp. (juv.)	5	74		
	Limaria hians	5	75		

Group E					
Station	**Sediment Type**	**% Gravel**	**% Sand**	**% Mud**	**Depth (m CD)**
G39	Gravelly Muddy Sand	10.49	60.05	29.46	12.5
	Taxa	**Abundance**	**Cum. %**		
	Lysidice unicornis	20	11		
	Aponuphis bilineata	14	19		
	Lumbrineris latreilli agg.	13	27		
	Kurtiella bidentata	13	34		
	Leptochiton cancellatus	12	41		
	Echinocyamus pusillus	10	46		
	Pholoe inornata	8	51		
	Notomastus sp.	6	54		
	Vaunthompsonia cristata	6	58		
	Aonides oxycephala	5	60		
	Lysianassa plumosa	5	63		
	Acrocnida brachiata	5	66		
	Glycera lapidum agg.	4	68		
	Jasmineira elegans	4	71		
	Polycirrus sp.	3	72		
	Cumacea sp. (dam.)	3	74		
	Leptochiton asellus	3	76		
	Nemertea	3	77		

Group F (Average similarity: 40.29%)					
Station	**Sediment Type**	**% Gravel**	**% Sand**	**% Mud**	**Depth (m CD)**
G04	Gravelly Muddy Sand	23.19	65.64	11.17	16.7
G05	Gravelly Muddy Sand	20.04	63.11	16.85	24.7
G10	Gravelly Muddy Sand	10.46	64.58	24.97	23.1
G15	Muddy Sandy Gravel	31.73	38.63	29.64	16.1
	Dominant Taxa	**Av. Abund**	**% of Sites**	**Contrib%**	**Cum.%**
	Hilbigneris gracilis	17.50	100	9.13	9.13
	Lysidice unicornis	14.50	100	7.57	16.7
	Edwardsia claparedii	7.00	100	6.07	22.77
	Aponuphis bilineata	6.00	100	5.65	28.42
	Aricidea (Aricidea) minuta	4.00	100	5.22	33.64
	Ampelisca tenuicornis	3.25	100	4.25	37.89
	Terebellides stroemii	3.25	100	4.15	42.04
	Nemertea	3.75	100	4.01	46.05
	Glycinde nordmanni	2.25	100	3.4	49.45
	Echinocyamus pusillus	5.50	100	3.33	52.78
	Timoclea ovata	1.50	100	2.97	55.75
	Pholoe baltica	2.25	100	2.96	58.71
	Lysianassa plumosa	1.50	100	2.93	61.64

www.nature.scot

ISBN: 978-1-78391-525-5

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