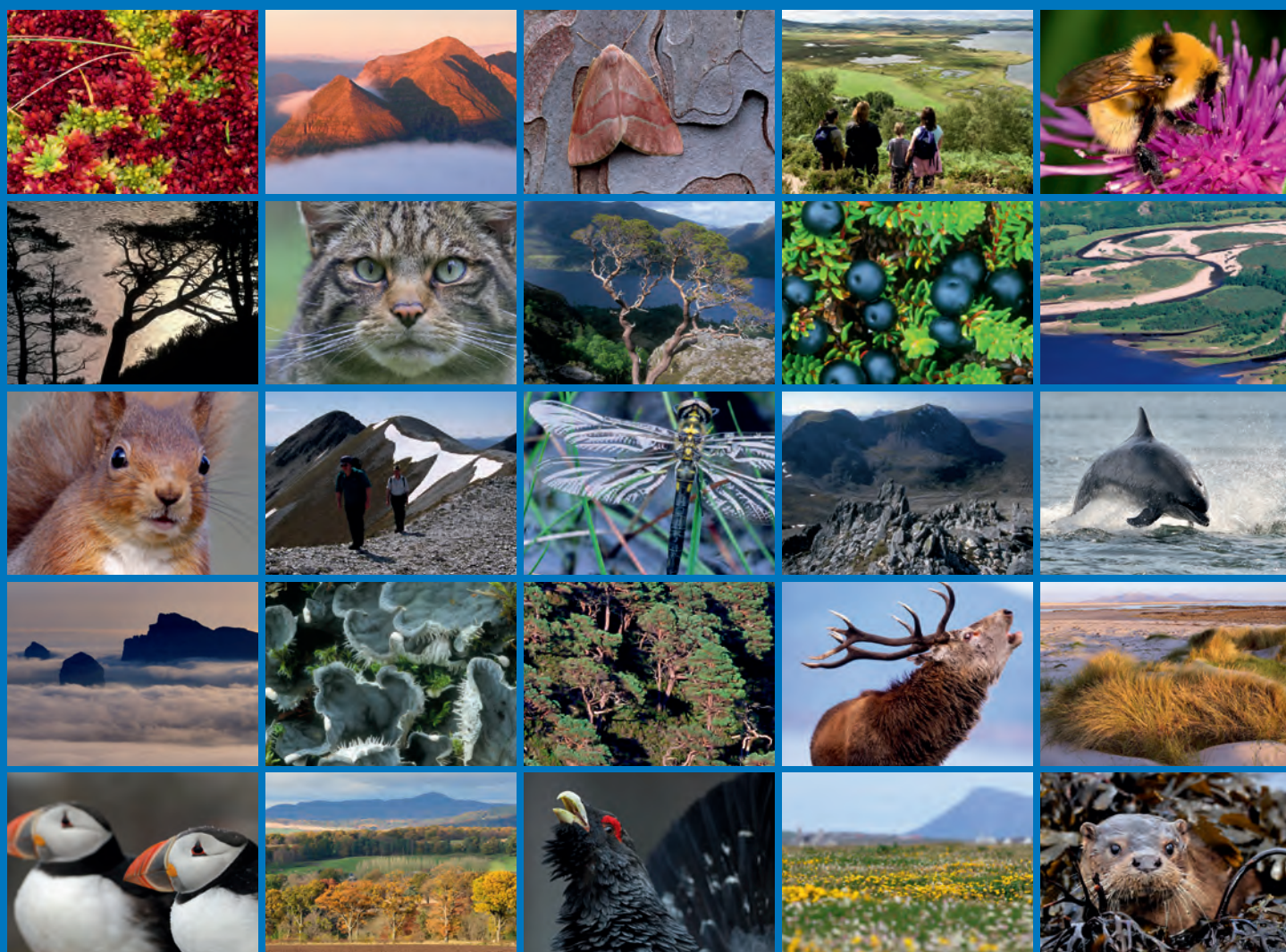


Infaunal and PSA analyses of benthic samples collected from Loch Alsh, in March 2014





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COMMISSIONED REPORT

Commissioned Report No. 790

**Infaunal and PSA analyses of benthic
samples collected from Loch Alsh, in March
2014**

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COMMISSIONED REPORT

Summary

Infaunal and PSA analyses of benthic samples collected from Loch Alsh, in March 2014

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Project no: 15134

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Keywords

Marine survey; MPA; Lochs Duich, Long and Alsh; protected features; PMF; seabed habitats; infauna.

Background

Scottish Natural Heritage and the Joint Nature Conservation Committee have generated a focused list of habitats and species of importance in Scottish waters - the Priority Marine Features (PMFs), which are regarded as priorities for conservation action in territorial waters. A subset of these biological features, together with a list of large-scale features of functional importance to Scotland's seas (collectively termed MPA search features) have driven the identification of a network of Nature Conservation Marine Protected Areas (MPAs). To ensure that the network meets the legislative obligations for MPAs, other representative features of Scotland's seas more generally have also been included for formal designation. The combination of MPA search features and representative features protected within an MPA are collectively referred to as protected features.

The aim of the present investigation was to improve knowledge of the occurrence and distribution of species and habitats of recognised conservation importance in the Lochs Duich, Long and Alsh MPA, including the protected features burrowed mud and flame shell beds. This was achieved through the analysis of grab samples collected at 12 stations within Loch Alsh, during research cruises conducted by Scottish Natural Heritage on the Scottish Environment Protection Agency vessel *RV Sir John Murray*. This report documents the faunal and particle size analysis (PSA) of these samples, and provides a brief interpretation to characterise the benthic communities and biotopes.

Main findings

- PSA of the seabed samples highlighted the presence of variable sediment types ranging from sandy-muds through to slightly gravelly muddy-sand and gravels.
- Species diversity was variable but generally high (20 to 82 species per 0.1 m²) with highest numbers of taxa associated with flame shell beds; 221 species were recorded in total during the survey. The majority of stations exhibited high Shannon's diversity values (H' values > 4.5 at 10 of the 12 grab samples collected).

- The most widespread taxa included polychaetes (*Polycirrus* sp., *Notomastus* sp. and *Mediomastus fragilis*) along with flatworms (Nemerteans) followed by the tower shell *Turritella communis*, other polychaetes including *Pholoe baltica*, *Diplocirrus glaucus* and juvenile *Laonice* sp.. In terms of abundance *Pholoe inornata* and juvenile horse mussel *Modiolus* sp. (juv.) were the most abundant taxa but were recorded at relatively few stations followed by *Polycirrus* sp., Nematoda spp., *Amphiura chiajei*, *Owenia fusiformis* and *Amphiura filiformis* which collectively accounted for just over 30% of the total abundance.
- The ocean quahog *Arctica islandica* (a PMF species) was recorded at four stations.
- A number of biotopes were recorded, including **SS.SMu.CFiMu** ('Circalittoral fine mud') at one station at the centre of the loch. Full analysis of video evidence collected during the survey may identify examples of burrowing megafauna and the presence of the burrowed mud protected feature.
- Specimens of maerl were collected at one station within Loch Alsh, albeit at abundances too low to qualify as a record of maerl bed biotopes (**SS.SMp.Mrl**).
- Other biotopes recorded include **SS.SMx.CMx** ('Circalittoral mixed sediments'), **SS.SCS.ICS** ('Infralittoral coarse sediments'), **SS.SMu.CSaMu.AfilMysAnit** ('*Amphiura filiformis*, *Mysella bidentata* and *Abra nitida* in circalittoral sandy mud') and **SS.SSa.OSa.OfusAfil** ('*Owenia fusiformis* and *Amphiura filiformis* in offshore circalittoral sand or muddy sand').
- **SS.SMx.IMx.Lim** ('*Limaria hians* beds in tide-swept sublittoral muddy mixed sediment') was recorded at three stations beyond the mouth of the loch. In conjunction with preliminary results from a video survey carried out in 2014, these records increase the estimated extent of the flame shell bed protected feature of the Loch Duich, Long and Alsh MPA.

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1. INTRODUCTION

Provisions to designate new Marine Protected Areas (MPAs) within Scottish waters were introduced through the Marine (Scotland) Act 2010 and the UK Marine and Coastal Access Act 2009. Scottish Natural Heritage (SNH) has generated a focused list of habitats and species regarded as priorities for conservation action in territorial waters - the Priority Marine Features (PMFs) (Scottish Government, 2013). A subset of these biological features, together with a number of large-scale features of functional importance to Scotland's seas (collectively termed MPA search features) informed the identification and subsequent designation of 30 Nature Conservation MPAs (MPAs) in July 2014. To ensure that the MPA network meets legislative obligations and wider international commitments, other features representative of Scotland's seas more generally have also been designated as protected features of these new sites.

In March 2014, SNH undertook benthic survey work within Loch Alsh on board the Scottish Environment Protection Agency vessel *RV Sir John Murray* to determine the wider distribution, and validate the continued presence, extent, and status of protected features within the Lochs Duich, Long and Alsh MPA.

Precision Marine Limited was contracted by SNH to undertake the infaunal analysis of the 12 grab samples collected during the 2014 survey. Analysis included infaunal identification, particle size analysis (PSA), assigning of a biotope to each sample, and identification of protected features. The data derived from the survey and subsequent processing will then be used to create a Marine Recorder data product. This report presents the results from this analysis and a brief interpretation of the data.

2. METHODS

2.1 Infaunal Sample Collection

On the 25th and 26th March 2014 SNH undertook a benthic survey on-board the Scottish Environment Protection Agency vessel *RV Sir John Murray*, covering areas within and immediately outside Loch Alsh on the west coast of Scotland in water depths ranging from 6 m to 78 m (Figure 1). A total of 12 infaunal samples were collected during the survey although PSA samples were only collected at 10 of these. At each station a single grab was collected using a 0.1 m² Day grab. This approach enabled a level of community analysis while also enabling coverage of the widest possible geographical area during the survey. Improving our knowledge on the distribution and extent of benthic habitats in the area is currently of primary importance. Once the grab was recovered on board a small sub-sample was removed for separate particle size analysis (PSA) and stored in plastic bags before being frozen. Each infaunal sample was then passed through a 1 mm mesh sieve and the infaunal sieve residue retained and fixed with buffered formalin. The samples were then collected by Precision Marine Survey Ltd for processing. A summary of the sampling details for the survey is provided in Table 1.

Table 1. Sampling details from the 2014 Loch Alsh survey.

Station	Area	Date	Time	Latitude	Longitude	Depth (m CD)
G01 [#]	Loch Alsh	25/03/2014	13:43:43	57.277531	-5.753959	6
G03 [#]	Loch Alsh	25/03/2014	13:50:57	57.275959	-5.749511	10
G16	Loch Alsh	25/03/2014	16:56:58	57.280307	-5.649258	49
G18	Loch Alsh	25/03/2014	14:59:20	57.274292	-5.644506	76
G35	Loch Alsh	26/03/2014	11:27:35	57.265915	-5.607079	61
G37	Loch Alsh	26/03/2014	13:20:08	57.264885	-5.597495	78
G38	Loch Alsh	26/03/2014	11:59:23	57.274986	-5.604160	40
G41	Loch Alsh	26/03/2014	13:46:49	57.265415	-5.588143	21
G47	Loch Alsh	26/03/2014	14:12:52	57.271885	-5.581346	8
G50	Loch Alsh	26/03/2014	15:11:05	57.268887	-5.551902	22
G66	Loch Alsh	25/03/2014	16:21:39	57.265598	-5.645406	67
GEX7	Loch Alsh	26/03/2014	08:44:48	57.281666	-5.762284	10

No PSA sample taken

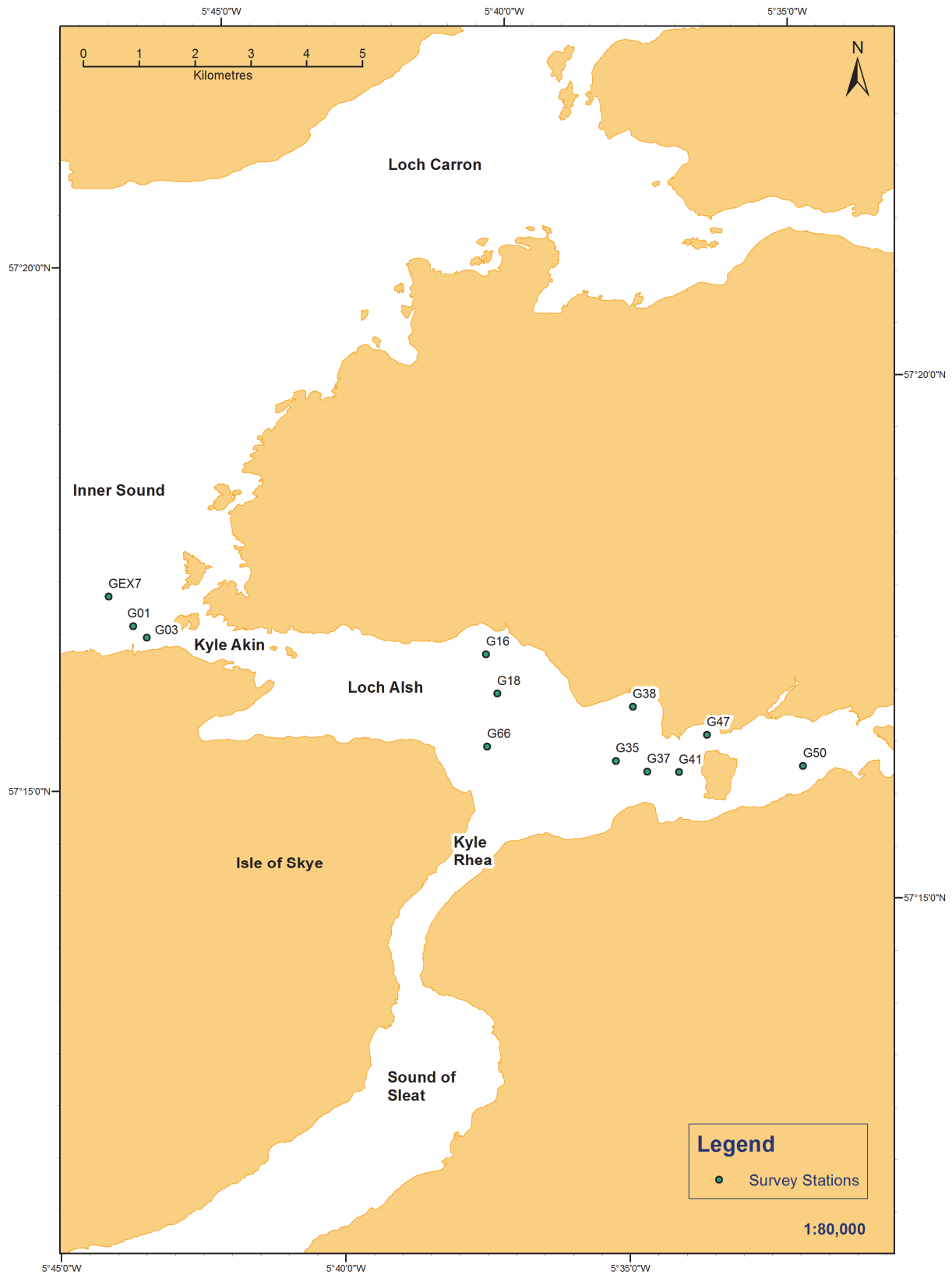


Figure 1. Map of 2014 infaunal sample stations in Loch Alsh. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2014. All rights reserved.

2.2 Laboratory Processing

All laboratory methodologies were based on best practice (Marine Monitoring Handbook procedural guideline 3-9; Rees *et al.*, 1990; Rees, 1999; Cooper and Rees, 2002; Worsfold and Hall, 2010; Ware and 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 the sample sorting, conducting 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 was then split by phyla and placed in glass vials with 70% IMS and stored ready for identification. Each petri dish was then checked for a final time by another member of staff.

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

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

The particle size analysis was carried out by a combination of dry sieving and laser particle size analysis (for the fraction <1 mm) using a Malvern Mastersizer 3000. Prior to analysis, photographs were taken of all samples and the samples were assessed to determine the amount of coarse material (>1 mm) to assess whether the samples required both secondary sieving and analysis of fines using laser granulometry. As the samples collected during the current survey comprised a wide range of sediments the samples were split with one sub-

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

2.3 Analysis of Biological Data

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

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

Multivariate analysis of the abundance data was carried out in order to describe the main patterns and assemblages within the area following standard methodologies (Clarke and Warwick, 2001). Classification (cluster analysis) of the data was undertaken using the Bray-Curtis similarity coefficient and grouped average (UPGMA) clustering technique followed by a non-metric MDS (multi-dimensional scaling) ordination both using the PRIMER package (Clarke and Gorley, 2006). Cluster analysis is used to display graphically the similarity between stations based upon their species composition whereby the similarity between stations is calculated (in this case using the Bray-Curtis similarity coefficient) to produce a similarity matrix showing the percent similarity of stations (0% indicating no species in common and 100% indicating an identical community). These values are then used to plot a dendrogram or tree diagram in which stations are linked at their respective similarity to other stations and consequently it is possible to define groups of stations with similar species composition at a predefined level of similarity.

Non-metric MDS graphically displays the (rank) similarity between stations as a two dimensional plot in which the distances between stations indicates the level of similarity between them. The stress value associated with an MDS plot indicates how faithful the plot is in representing the similarity between stations, with low values (below 0.2) generally indicating a good fit. The station groupings derived from cluster analysis have subsequently been superimposed onto the MDS plots and been input into GIS. The dominant species and mean environmental and biological parameters for each group were also calculated. Station groupings were derived using the similarity profile test (SIMPROF) within the PRIMER package. Characteristic taxa within each group were assessed using calculations of mean

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

3. RESULTS

3.1 Sedimentary Parameters

The results of particle size analysis are provided in Annex 1 with a summary of key parameters given in Table 2 which highlights a wide range of sediments including slightly gravelly muddy-sands, slightly gravelly sandy-muds, muddy sandy-gravels and gravels. Quantities of gravel at the survey stations were highly variable and ranged from 0.5% at stations G16 to 81.30% at station G47. Stations G16, G18, G35, G37, G38, G41 and G66 had gravel contents below 10%. Mud content was also variable with one station (G47) having very little mud (0.8%) whilst stations G18, G35, G37, G38, G41, G50, G66 and GEX7 with muddy-sands or gravelly muddy-sands exhibited mud contents ranging from 13.05% to 37.06%. Station G16 had the highest mud content at 51.46%. This variability was reflected in sediment sorting with all stations exhibiting poorly or very poorly sorted sediments. Two of the stations sampled in *Limaria* beds (stations G01 and G03) had no PSA samples so are not listed in Table 2.

The spatial distribution of sediment types is illustrated in Figures 2 and 3 which highlight sediment composition (% sand, gravel and mud) and sediment type (textural group) respectively. In general stations in the outer or inner loch tended to have somewhat higher gravel content whilst those in middle reaches tended to be fairly uniform muddy-sands or sandy-muds with low quantities of gravel.

Table 2. Summary of sedimentary parameters.

Station	Sediment Type	Median phi	Mean phi	Sorting (phi)		Gravel	Sand	Mud
G16	Slightly Gravelly Sandy-Mud	4.09	4.43	2.07	Very Poorly Sorted	0.50	48.03	51.46
G18	Slightly Gravelly Muddy-Sand	2.61	3.24	2.27	Very Poorly Sorted	0.57	71.16	28.27
G35	Slightly Gravelly Muddy-Sand	2.59	3.19	2.36	Very Poorly Sorted	1.16	72.05	26.79
G37	Slightly Gravelly Muddy-Sand	3.23	3.75	2.28	Very Poorly Sorted	1.49	61.45	37.06
G38	Slightly Gravelly Muddy-Sand	2.62	3.19	2.57	Very Poorly Sorted	2.63	67.30	30.08
G41	Slightly Gravelly Muddy-Sand	2.55	3.28	2.12	Very Poorly Sorted	1.27	73.34	25.40
G47	Gravel	-1.86	-1.97	1.15	Poorly Sorted	81.30	17.89	0.80
G50	Gravelly Muddy-Sand	2.25	2.53	3.50	Very Poorly Sorted	14.54	53.28	32.17
G66	Gravelly Muddy-Sand	1.99	2.51	2.80	Very Poorly Sorted	8.68	66.45	24.87
GEX7	Muddy Sandy-Gravel	-0.69	-0.12	2.53	Very Poorly Sorted	37.50	49.45	13.05

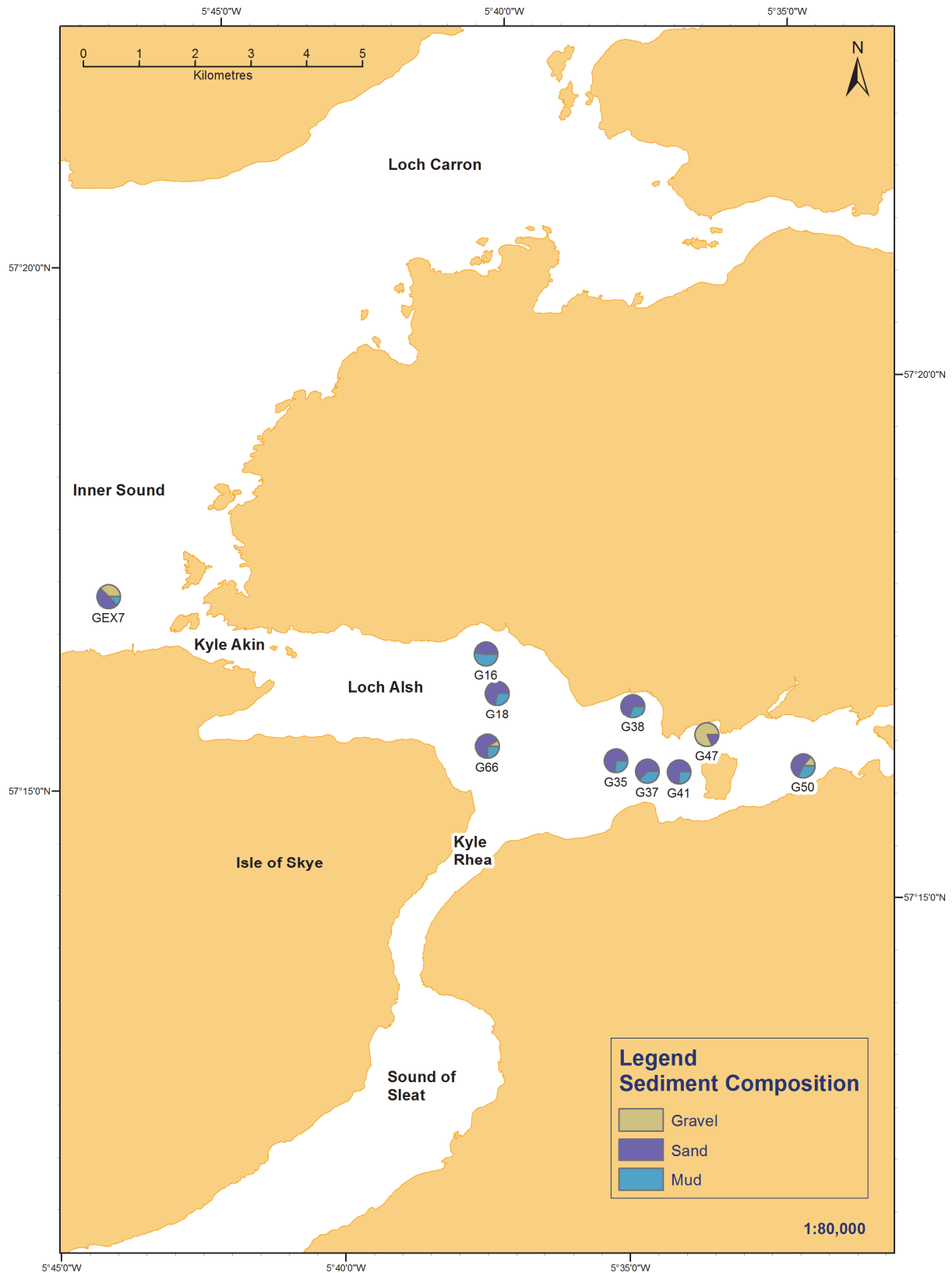


Figure 2. Sediment composition of infaunal samples collected in Loch Alsh. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2014. All rights reserved.

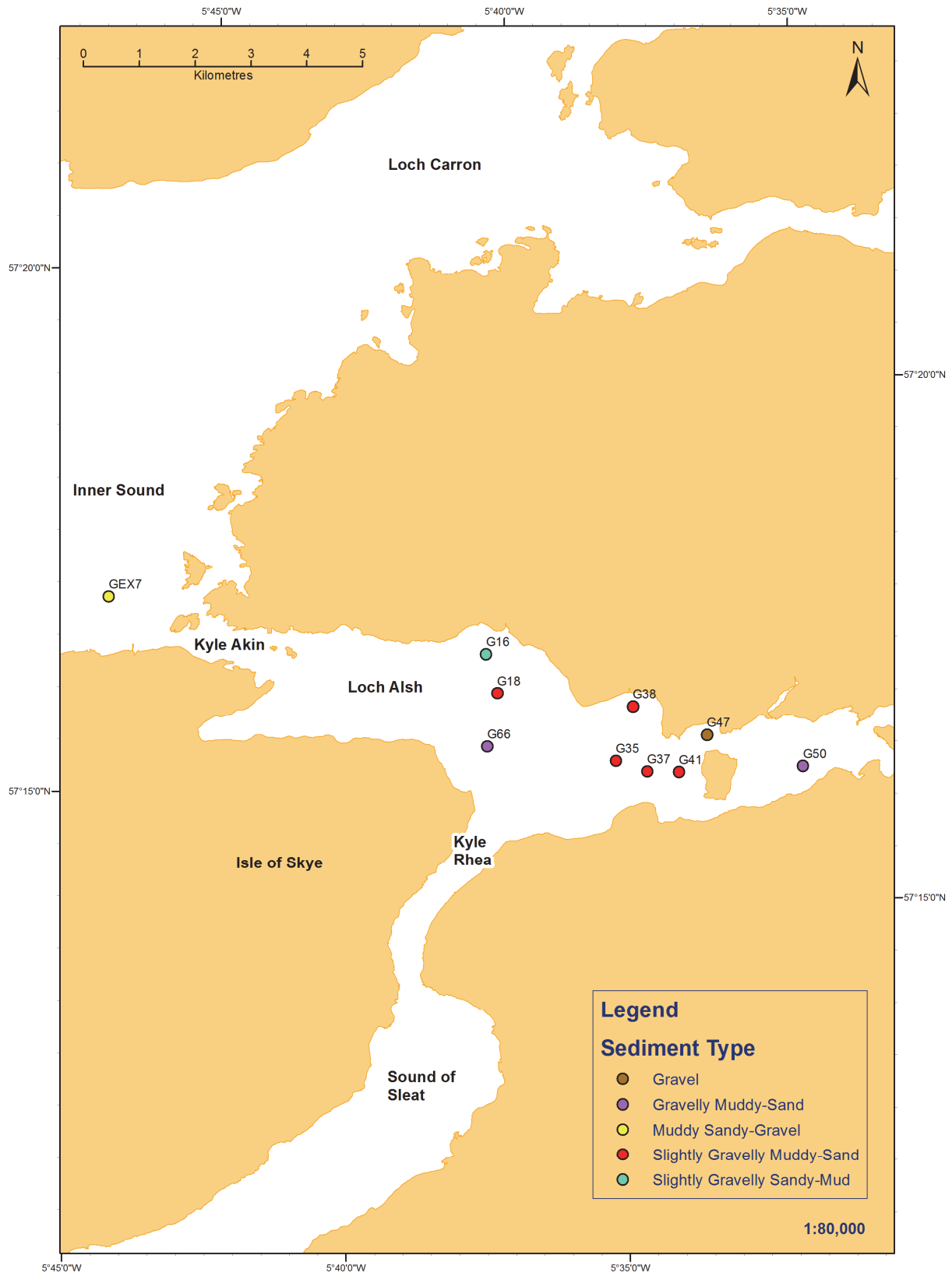


Figure 3. Sediment type (textural group) of infaunal samples collected in Loch Alsh. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2014. All rights reserved.

3.2 Primary and Derived Biological Parameters

The stations sampled in Loch Alsh exhibited diverse communities in terms of species richness, Shannon's diversity and Pielou's evenness whilst the densities of infaunal organisms were more variable (Table 3). The numbers of species recorded per sample station ranged from 20 taxa per 0.1 m² at G16 to 82 taxa per 0.1 m² at station GEX7. Seven of the 12 stations had 50 or more taxa per 0.1 m². The highest number of taxa tended to occur in sites in the outer loch in the vicinity of the flame shell beds (G01, G03 and in particular GEX7), with more variation within the loch (Figure 4). Total infaunal abundance ranged from <100 individuals at G16 and G50 up to 705 individuals per 0.1 m² at station GEX7. The majority of stations had between 100 to 300 individuals per 0.1 m² with highest values recorded in the outer stations in the vicinity of the flame shell beds (Figure 5). Diversity indices indicated high levels of diversity and evenness. All stations with the exception of station G16 had values of Shannon's diversity above 4 with stations G38 and G66 having values above 5 and all stations exhibited high evenness values above 0.75. There was no clear spatial pattern in terms of diversity with high values occurring in outer loch areas (flame shell beds) but also at certain stations deeper within the loch (Figure 6).

Table 3. Primary and derived biological parameters.

Station	Number of Species	Total Abundance (A)	Margalef's d	Pielou's Evenness J	Shannon's Diversity H'
G01	62	598	8.76	0.81	4.75
G03	58	624	8.23	0.78	4.47
G16	20	60	4.15	0.90	3.76
G18	54	279	9.41	0.81	4.66
G35	38	142	7.47	0.77	4.04
G37	50	316	8.34	0.84	4.70
G38	48	158	9.09	0.90	5.02
G41	51	126	9.92	0.84	4.69
G47	49	174	8.33	0.83	4.52
G50	38	84	8.12	0.91	4.74
G66	62	203	11.10	0.87	5.14
GEX7	82	705	11.74	0.79	4.96

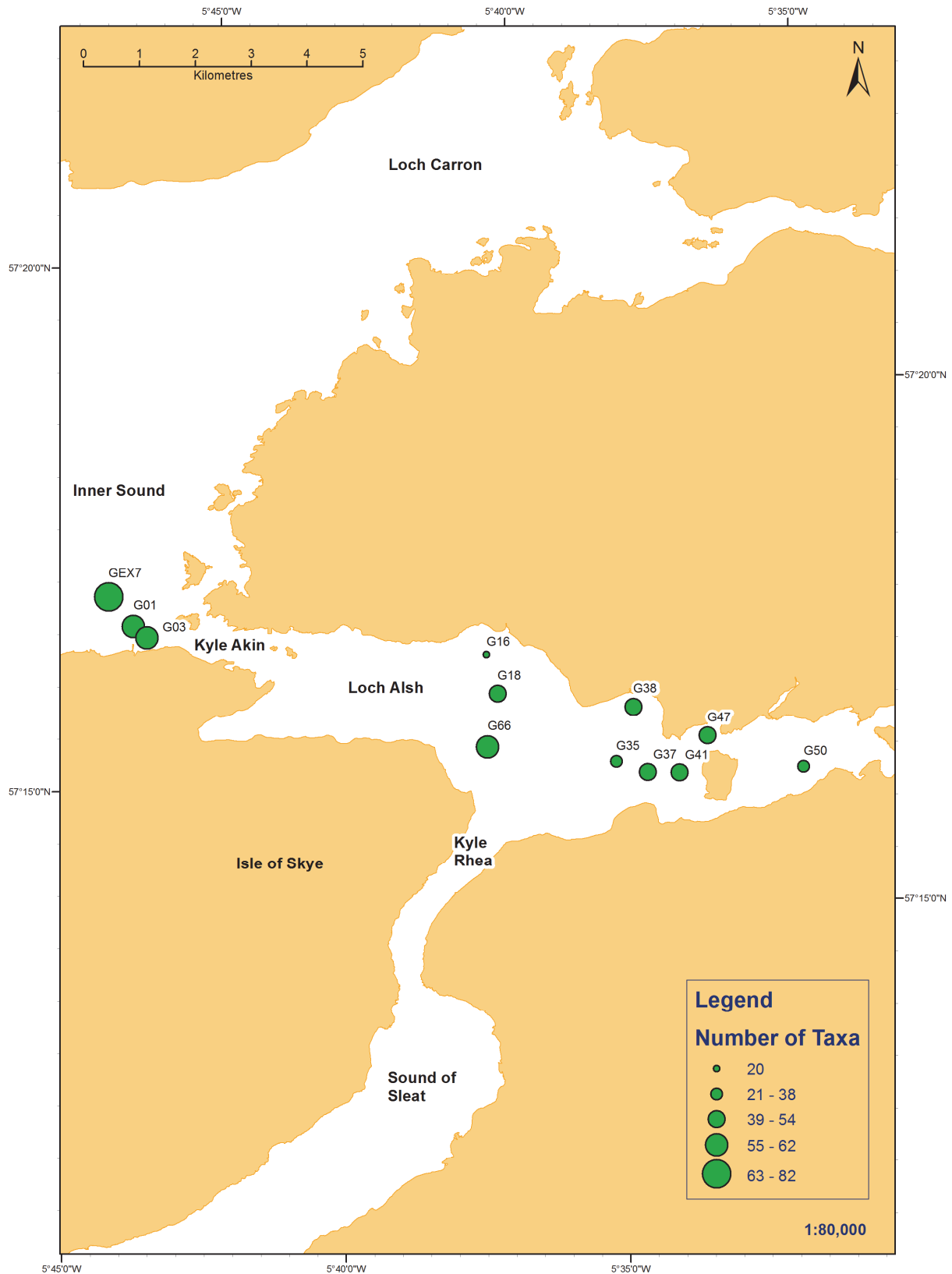


Figure 4. Total numbers of taxa (including qualitative species) collected at the survey stations. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2014. All rights reserved.

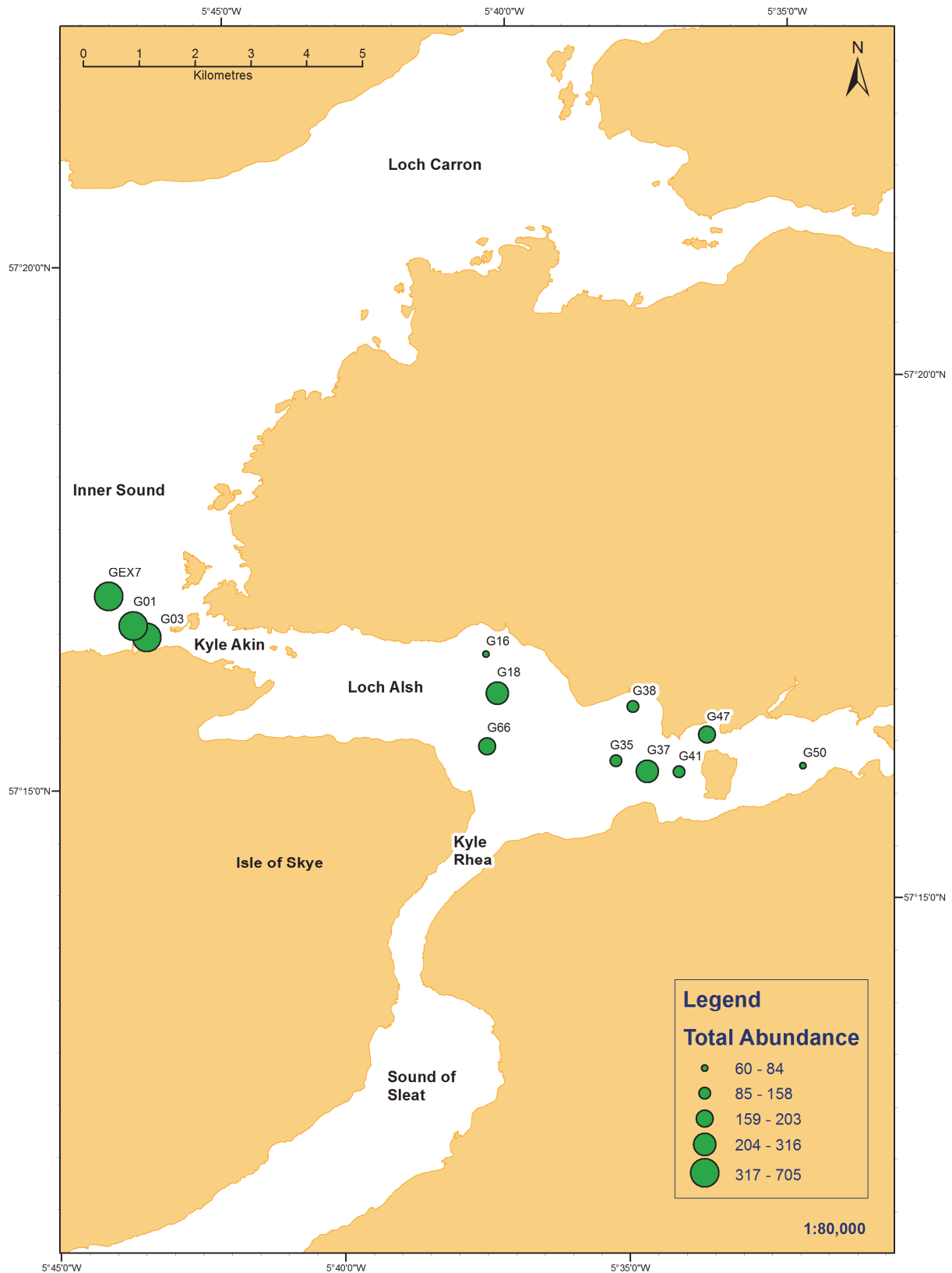


Figure 5. Total abundance (numbers of individuals) within infauna samples collected at the survey stations. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2014. All rights reserved.

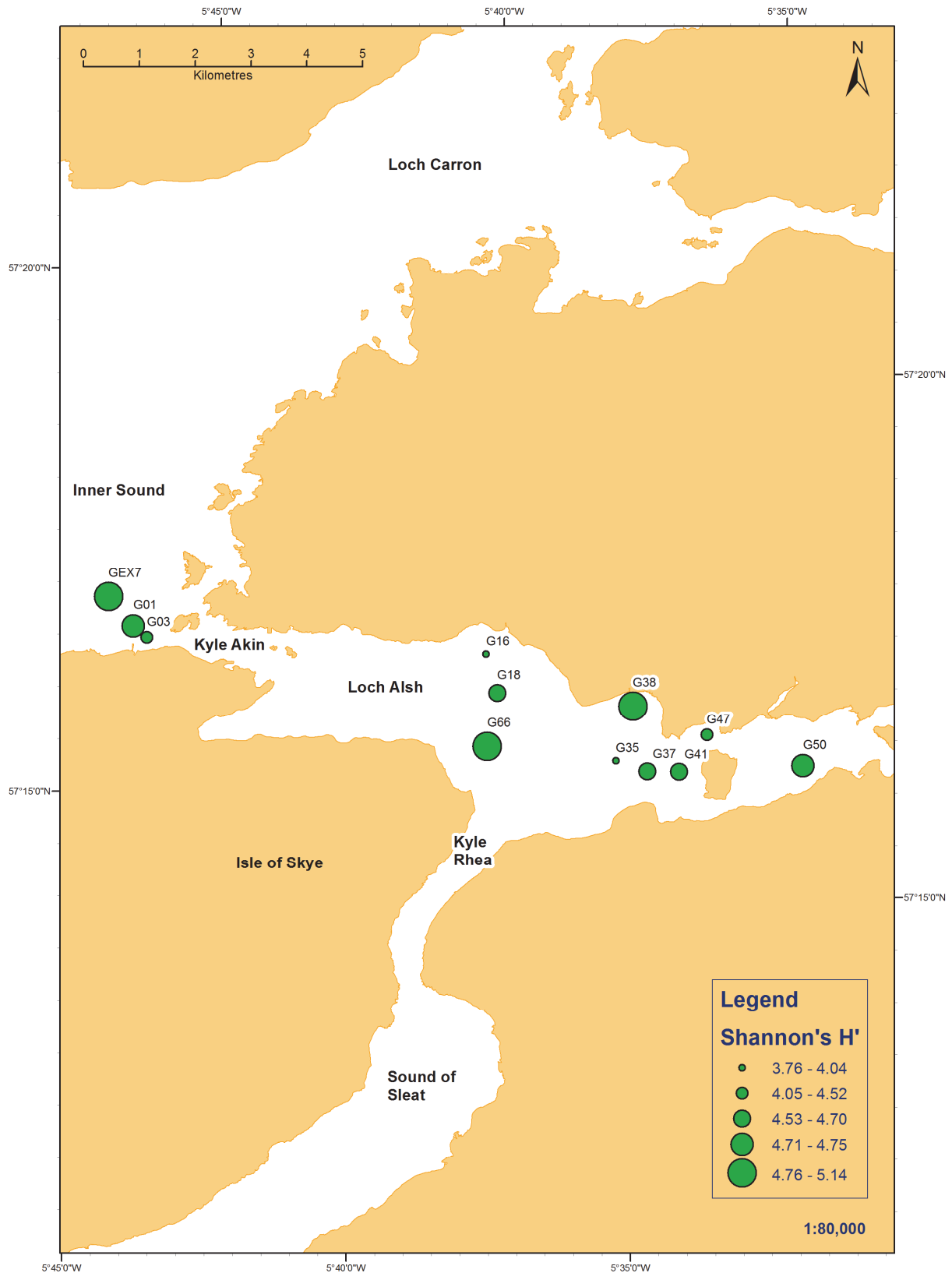


Figure 6. Shannon's diversity (H') of the infauna sample collected at the survey stations. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2014. All rights reserved.

3.3 Species Composition

In total 221 taxa were recorded from the 12 samples collected. A list of the most dominant taxa ranked by abundance is provided in Table 4 which shows those taxa which accounted for 75% of the total abundance (39 taxa). This shows that few taxa were widespread throughout the area and no single taxa was collected at every station. The most widespread taxa included *Polycirrus* sp., *Notomastus* sp., and Nemertea sp. (11 stations) followed by *Mediomastus fragilis* (9 stations) and *Turritella communis*, *Pholoe baltica*, *Diplocirrus glaucus* and juvenile *Laonice* sp. (8 stations) (*Laonice* sp. (juv.) had a total abundance of 12 and is therefore not shown in Table 4). *Pholoe inornata* and *Modiolus* sp. (juv.) were the most abundant taxa (but only occurred at 3 and 4 stations respectively), followed by *Polycirrus* sp., Nematoda spp., *Amphiura chiajei*, *Owenia fusiformis* and *Amphiura filiformis* which collectively accounted for just over 30% of the total abundance. The remaining taxa were recorded in relatively modest numbers with other important taxa (in terms of relative contribution to total abundance) including *Golfingia vulgaris vulgaris*, *Flabelligera affinis*, *Arcopagia crassa*, *Turritella communis*, *Pholoe baltica*, *Jasmineira elegans*, *Notomastus* sp., *Leptochiton asellus* and *Thraciidae* sp. (juv.) which in combination with the taxa listed above contributed to 50% of the total abundance. A wide range of other taxa were also recorded including polychaetes, bivalves, echinoderms and crustacea including some species of conservation importance such as the flame shell *Limaria hians* (stations G01, G03 and GEX7) and the ocean quahog *Arctica islandica* (stations G18, G37, G41 and G66).

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

Taxa	Total Abundance	Mean Abundance	% of Total Abundance	No. of Stations	% of Samples
<i>Pholoe inornata</i>	258	21.50	7.44	3	25
<i>Modiolus</i> sp. (juv.)	206	17.17	13.38	4	33
<i>Polycirrus</i> sp.	146	12.17	17.58	11	92
Nematoda spp.	143	11.92	21.71	5	42
<i>Amphiura chiajei</i>	130	10.83	25.45	7	58
<i>Owenia fusiformis</i>	112	9.33	28.68	7	58
<i>Amphiura filiformis</i>	108	9.00	31.80	7	58
<i>Golfingia vulgaris vulgaris</i>	80	6.67	34.10	5	42
<i>Flabelligera affinis</i>	76	6.33	36.29	3	25
<i>Arcopagia crassa</i>	76	6.33	38.48	3	25
<i>Turritella communis</i>	74	6.17	40.62	8	67
<i>Pholoe baltica</i>	70	5.83	42.63	8	67
<i>Jasmineira elegans</i>	68	5.67	44.59	3	25
<i>Notomastus</i> sp.	67	5.58	46.53	11	92
<i>Leptochiton asellus</i>	65	5.42	48.40	4	33
Thraciidae sp. (juv.)	64	5.33	50.25	4	33
<i>Diplocirrus glaucus</i>	63	5.25	52.06	8	67
<i>Nereimyra punctata</i>	59	4.92	53.76	5	42
<i>Galathowenia oculata</i>	57	4.75	55.41	5	42
<i>Limaria hians</i>	57	4.75	57.05	3	25
Spionidae sp. (juv.)	54	4.50	58.60	4	33
<i>Labidoplax buskii</i>	51	4.25	60.07	5	42
<i>Amphipholis squamata</i>	46	3.83	61.40	3	25
<i>Psamathe fusca</i>	44	3.67	62.67	3	25
<i>Nucula nucleus</i>	37	3.08	63.74	5	42
<i>Onoba semicostata</i>	37	3.08	64.80	2	17
<i>Mediomastus fragilis</i>	36	3.00	65.84	9	75
<i>Kurtiella bidentata</i>	35	2.92	66.85	6	50

Taxa	Total Abundance	Mean Abundance	% of Total Abundance	No. of Stations	% of Samples
Nemertea spp.	34	2.83	67.83	11	92
<i>Glycera lapidum</i> agg.	30	2.50	68.69	4	33
<i>Nucula nitidosa</i>	29	2.42	69.53	6	50
<i>Euclymene oerstedii</i>	28	2.33	70.34	5	42
<i>Spiophanes kroyeri</i>	27	2.25	71.12	7	58
Polynoidae sp.	27	2.25	71.89	4	33
<i>Lumbrineris cingulata</i>	26	2.17	72.64	5	42
<i>Uromunna petiti</i>	26	2.17	73.39	3	25
<i>Praxillella affinis</i>	25	2.08	74.11	6	50
<i>Eumida bahusiensis</i>	24	2.00	74.81	5	42
Amphiuridae sp. (juv.)	24	2.00	75.50	4	33

A limited number of colonial or sessile (qualitative) taxa were also present in the samples attached to larger shell or stones although these tended to be present in low quantities and have a relatively restricted distribution. Such taxa included barnacles (*Verruca stroemi* and *Balanus crenatus*), red algae (Rhodophyta spp., Corallinaceae spp., *Delesseria sanguinea* and *Plocamium cartilagineum*), occasional sponges and bryozoans such as *Alcyonidium diaphanum* and *Cellaria* sp. Fragments of live maerl (predominantly *Phymatolithon calcareum*) were also recorded at one station (G47).

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

Qualitative Taxa	No. of Samples	% of Samples
<i>Verruca stroemia</i>	4	33
<i>Balanus crenatus</i>	4	33
Rhodophyta spp.	4	33
Corallinaceae spp.	4	33
Porifera sp.	2	17
<i>Alcyonidium diaphanum</i>	2	17
<i>Cellaria</i> sp.	1	8
<i>Delesseria sanguinea</i>	1	8
<i>Plocamium cartilagineum</i>	1	8
Maerl	1	8

3.4 Multivariate Analysis

The results of multivariate analysis on the benthic samples are provided in Figure 7 whilst the spatial distribution of the groups derived from cluster analysis are provided in Figure 8. Similarities between individual samples ranges from 10% to 70% highlighting a varied benthic assemblage. Low levels of similarity between some samples may in part reflect the variability of species distribution as many taxa were recorded in very low numbers and had a restricted distribution (i.e. were recorded in few samples). The SIMPROF routine was used to define sample groups with similar species composition. The dendrogram shown in Figure 7 indicates the groups of samples identified by SIMPROF, with groups containing >1 sample highlighted in red. The main divisions between samples split groups a, b and c from the remaining samples at 10% similarity respectively whilst groups d and e were separated from groups f to g at around 30% similarity. Groups f and g were more closely related and separated at just over 40% similarity.

The characteristic taxa which accounted for 90% of the similarity in sample groups are provided in Table 6, which also includes the list of samples and a summary of the sediment types and water depth. For groups with just a single station (groups a, b, d and e) just the most abundant taxa are shown. Group a comprises the most gravelly station (G47) in shallow water and was characterised by fragments of live maerl along with taxa such as *Leptochiton asellus*, Nematoda spp., *Modiolus* sp. (juv.), Amphiuroidae sp. (juv.), *Golfingia vulgaris vulgaris* and *Clausinella fasciata*.

Groups b (station GEX7) and c (stations G01 and G03) were relatively similar and included stations in the outer loch in the vicinity of the flame shell beds. Station GEX7 (group b) was characterised by shallow muddy sandy gravel with *Modiolus* sp. (juv.), *Arcopagia crassa*, *Polycirrus* sp., Nematoda spp., *Notomastus* sp., *Pholoe inornata* and Spionidae sp. (juv.) along with moderate numbers of flame shells (*Limaria hians*). Stations G01 and G03 (group c) were taken from flame shell nest material (no PSA sample) and included a similar range of taxa but with higher densities of *Limaria hians* along with taxa such as *Pholoe inornata*, *Modiolus* sp. (juv.), *Polycirrus* sp., *Nereimyra punctata*, *Jasmineira elegans* and *Flabelligera affinis*.

Groups d and e comprised just a single station in each group with group d (G16) characterised by moderately deep slightly gravelly sandy-mud with *Turritella communis*, *Amphiura chiajei*, *Abyssoninoe hibernica*, *Nephtys incisa*, *Myrtea spinifera* and *Thyasira flexuosa* whilst group e (G50) was characterised by shallower gravelly muddy-sand with *Lumbrineris cingulata*, *Mediomastus fragilis*, *Chaetozone gibber*, *Owenia fusiformis*, *Aricidea (Acmira) simonae*, *Leptosynapta decaria*, *Pholoe baltica* and *Glycera alba*.

Group f included four stations (G35, G66, G18 and G37) in deep, slightly gravelly muddy-sand characterised by high numbers of brittlestars such as *Amphiura filiformis* and *Amphiura chiajei*, and Oweniidae polychaetes (*Owenia fusiformis* and *Galathowenia oculata*) along with other taxa such as *Pholoe baltica*, *Diplocirrus glaucus*, Nemertea spp., *Spiophanes kroyeri* and *Labidoplax buskii*. Group g included two stations (G38 and G41) in shallower circalittoral slightly gravelly muddy-sand with a faunal assemblage characterised by relatively low numbers of taxa such as *Turritella communis*, *Diplocirrus glaucus*, *Lumbrineris cingulata*, *Euclymene oerstedii*, *Abra nitida*, Amphiuroidae brittlestars (*Amphiura chiajei* and *Amphiura filiformis*), *Dipolydora coeca*, *Spiophanes kroyeri*, *Mediomastus fragilis* and *Notomastus* sp.

The results of the BEST routine highlight the correlation between the environmental parameters and species data (Table 7). All environmental parameters had correlations above 0.25 with mean and median grain size, gravel, mud and sand content exhibiting the highest correlations (>0.6) whilst moderately low correlations were recorded for kurtosis (0.272). The best combination of parameters (mean and median grain size, mud content,

depth and sorting) produced a very high correlation of 0.912 indicating that the environmental variables recorded during the survey are highly correlated to patterns in species composition.

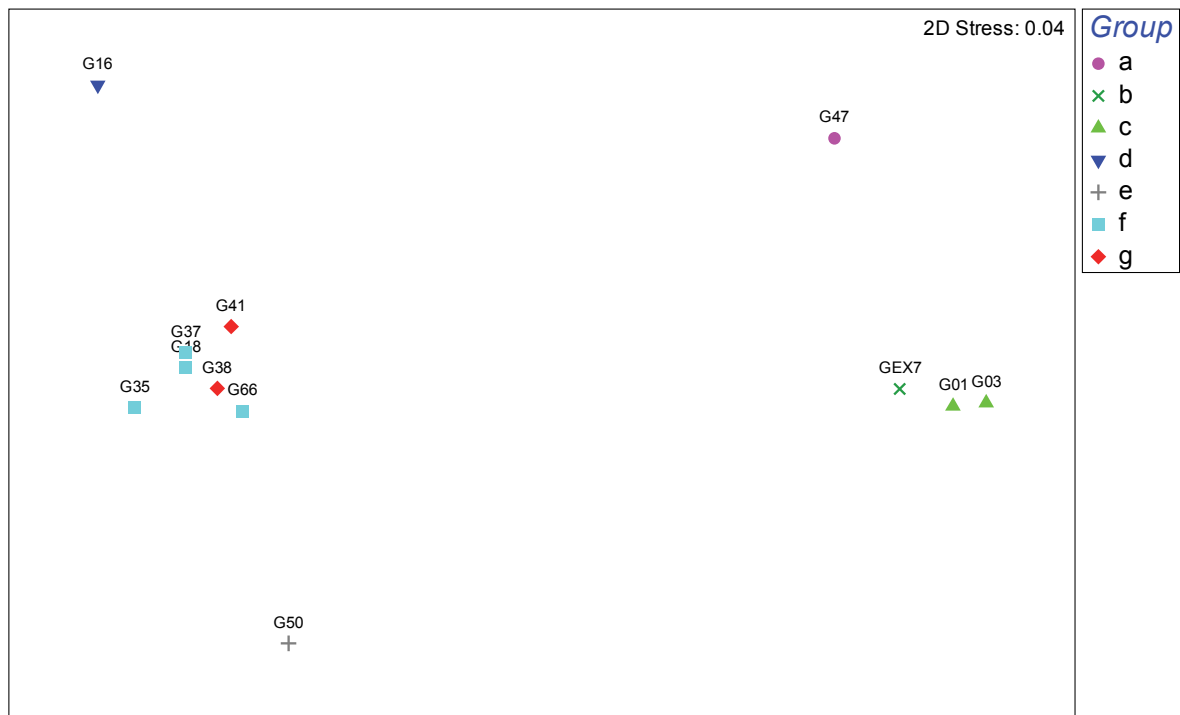
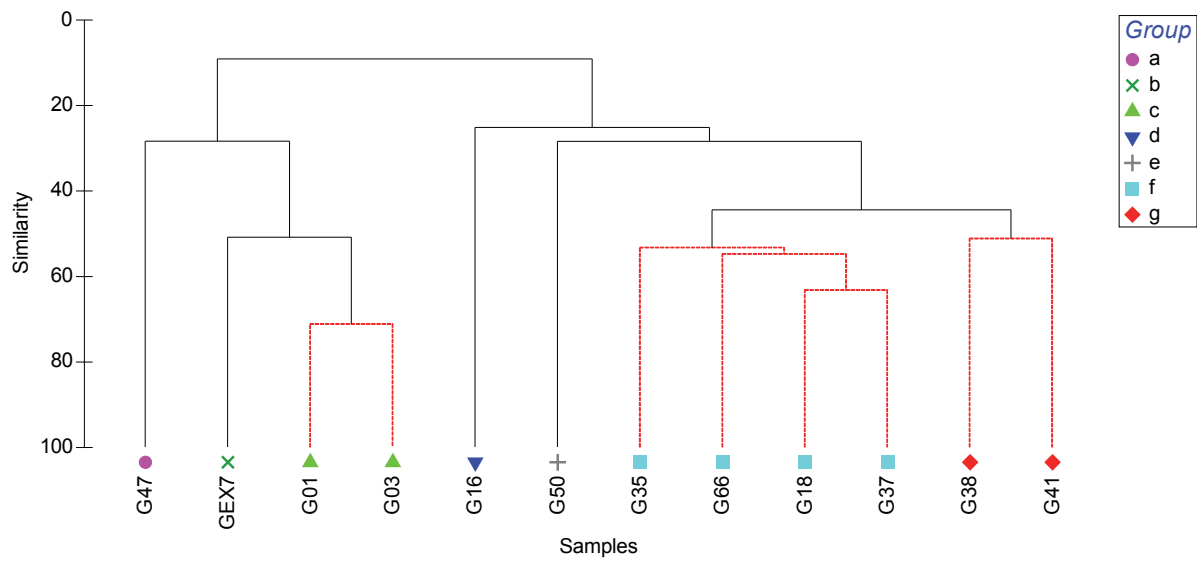


Figure 7. Results of cluster analysis and MDS (samples connected by red lines in the dendrogram denote SIMPROF groupings).

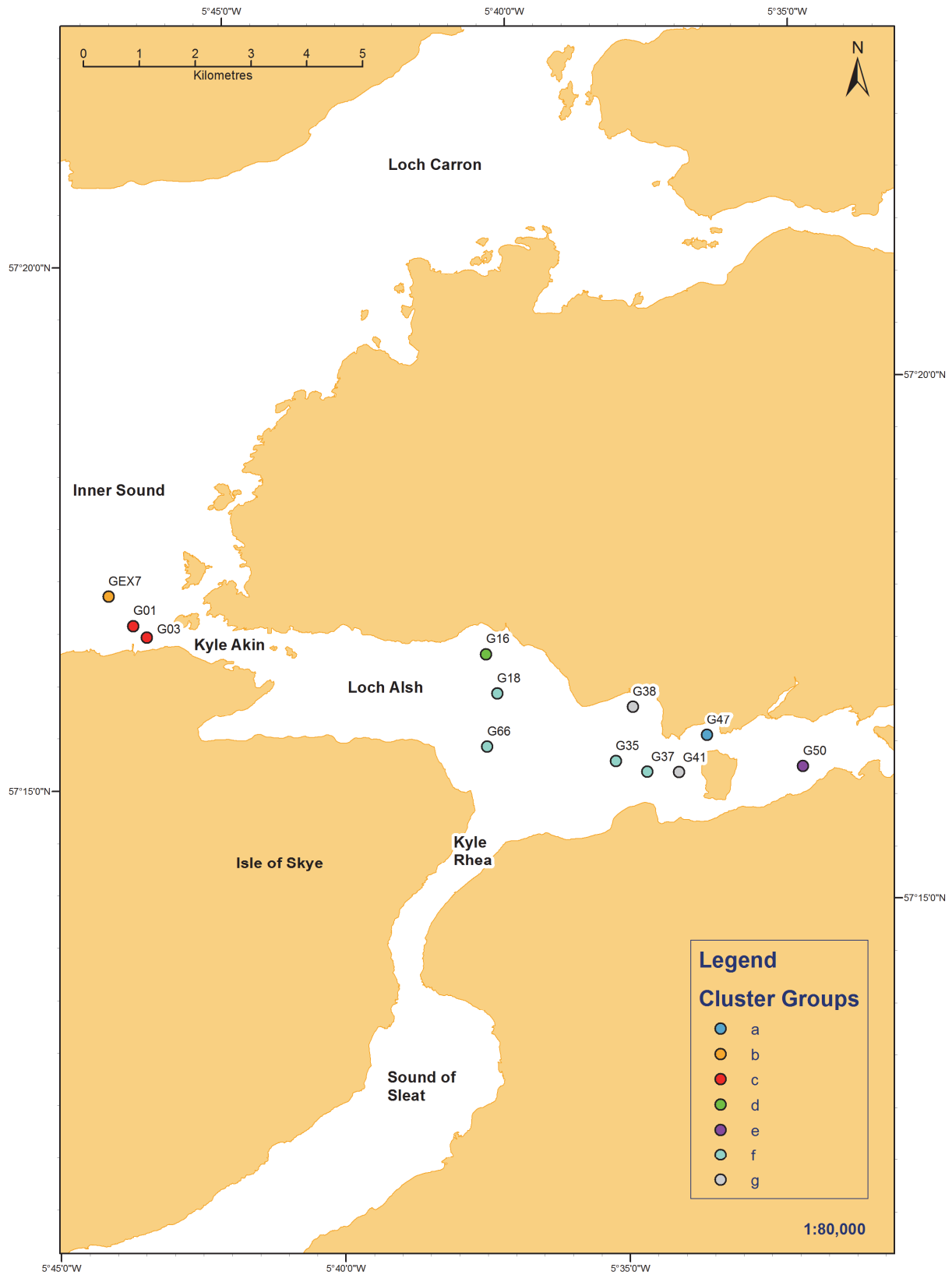


Figure 8. Groups derived from cluster analysis. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right 2014. All rights reserved.

Table 6. Characteristic taxa within the SIMPROF groups derived from cluster analysis.

Station	Sediment Type	Group A			Depth (m CD)
		% Gravel	% Sand	% Mud	
G47	Gravel	81.30	17.89	0.80	8
	Taxa	Abundance	Cum. %		
	<i>Leptochiton asellus</i>	38	22		
	Nematoda spp.	15	30		
	<i>Modiolus</i> sp. (juv.)	10	36		
	Amphiuridae sp. (juv.)	10	42		
	<i>Golfingia vulgaris vulgaris</i>	9	47		
	<i>Clausinella fasciata</i>	9	52		
	<i>Crenella decussata</i>	8	57		
	<i>Gibbula tumida</i>	7	61		
	<i>Timoclea ovata</i>	7	65		
	<i>Polycirrus</i> sp.	5	68		
	<i>Paradialychone filicaudata</i>	4	70		
	<i>Goodallia triangularis</i>	4	72		
	<i>Arcopagia crassa</i>	4	75		
	<i>Glycera lapidum</i> agg.	3	76		
	<i>Psamathe fusca</i>	3	78		

Station	Sediment Type	Group B			Depth (m CD)
		% Gravel	% Sand	% Mud	
GEX7	Muddy Sandy Gravel	37.50	49.45	13.05	10
	Taxa	Abundance	Cum. %		
	<i>Modiolus</i> sp. (juv.)	81	11		
	<i>Arcopagia crassa</i>	62	20		
	<i>Polycirrus</i> sp.	52	28		
	Nematoda spp.	47	34		
	<i>Notomastus</i> sp.	43	40		
	<i>Pholoe inornata</i>	42	46		
	Spionidae sp. (juv.)	42	52		
	<i>Golfingia vulgaris vulgaris</i>	33	57		
	Thraciidae sp. (juv.)	29	61		
	<i>Leptochiton asellus</i>	21	64		
	<i>Glycera lapidum</i> agg.	20	67		
	<i>Amphipholis squamata</i>	17	69		
	<i>Limatula subauriculata</i>	14	71		
	<i>Leptochiton cancellatus</i>	12	73		
	<i>Kurtiella bidentata</i>	12	75		
	<i>Hesiospina aurantiaca</i>	11	76		
	<i>Timoclea ovata</i>	11	78		
	<i>Nucula nucleus</i>	10	79		
	<i>Limaria hians</i>	10	81		

Group C (Average similarity: 71.19%)					
Station	Sediment Type	% Gravel	% Sand	% Mud	Depth (m CD)
G01	No PSA				6
G03	No PSA				10
	Taxa	Av. Abund	% of Sites	Contrib%	Cum.%
	<i>Pholoe inornata</i>	108	100	9.69	9.69
	<i>Modiolus</i> sp. (juv.)	57.5	100	5.7	15.38
	<i>Polycirrus</i> sp.	35	100	5.54	20.92
	<i>Nereimyra punctata</i>	28	100	4.94	25.86
	<i>Jasmineira elegans</i>	29.5	100	4.94	30.79
	<i>Flabelligera affinis</i>	35	100	4.75	35.54
	<i>Limaria hians</i>	23.5	100	4.35	39.89
	Nematoda spp.	40	100	4.25	44.14
	<i>Psamathe fusca</i>	20.5	100	4.25	48.39
	Thraciidae sp. (juv.)	16.5	100	3.29	51.68
	<i>Uromunna petiti</i>	12.5	100	3.15	54.83
	<i>Golfingia vulgaris vulgaris</i>	18.5	100	3	57.83
	Polynoidae sp.	12	100	2.69	60.52
	<i>Eumida bahusiensis</i>	8.5	100	2.51	63.03
	<i>Hiatella arctica</i>	9	100	2.51	65.54
	<i>Amphipholis squamata</i>	14.5	100	2.33	67.87
	<i>Aonides oxycephala</i>	6.5	100	2.12	69.99
	Gammaropsis sp.	8	100	2.12	72.12
	<i>Kurtiella bidentata</i>	8.5	100	2.12	74.24
	<i>Lepidonotus squamatus</i>	4.5	100	1.9	76.14
	<i>Nereis pelagica</i>	4	100	1.9	78.04
	Spionidae sp. (juv.)	4.5	100	1.9	79.94
	<i>Onoba semicostata</i>	18.5	100	1.9	81.84
	<i>Glycera lapidum</i> agg.	3.5	100	1.65	83.48
	<i>Syllis columbretensis</i>	3.5	100	1.65	85.13
	<i>Notomastus</i> sp.	2.5	100	1.34	86.47
	<i>Orchomene humilis</i>	3	100	1.34	87.82
	<i>Janira maculosa</i>	2.5	100	1.34	89.16
	<i>Leptochiton asellus</i>	3	100	1.34	90.5

Group D					
Station	Sediment Type	% Gravel	% Sand	% Mud	Depth (m CD)
G16	Slightly Gravelly Sandy Mud	0.50	48.03	51.46	49
	Taxa	Abundance	Cum. %		
	<i>Turritella communis</i>	9	15		
	<i>Amphiura chiajei</i>	9	30		
	<i>Abyssoninoe hibernica</i>	7	42		
	<i>Nephtys incisa</i>	5	50		
	<i>Myrtea spinifera</i>	5	58		
	<i>Thyasira flexuosa</i>	5	67		
	<i>Polycirrus</i> sp.	3	72		
	<i>Nucula nitidosa</i>	3	77		
	<i>Oxydromus flexuosus</i>	2	80		
	<i>Praxillella affinis</i>	2	83		
	<i>Rhodine</i> sp.	2	87		
	<i>Chaetoderma nitidulum</i>	2	90		

Group E					
Station	Sediment Type	% Gravel	% Sand	% Mud	Depth (m CD)
G50	Gravelly Muddy Sand	14.54	53.28	32.17	22
	Taxa	Abundance	Cum. %		
	<i>Lumbrineris cingulata</i>	12	14		
	<i>Mediomastus fragilis</i>	10	26		
	<i>Chaetozone gibber</i>	5	32		
	<i>Owenia fusiformis</i>	5	38		
	<i>Aricidea (Acmira) simonae</i>	3	42		
	<i>Leptosynapta decaria</i>	3	45		
	<i>Pholoe baltica</i>	2	48		
	<i>Glycera alba</i>	2	50		
	<i>Goniada maculata</i>	2	52		
	<i>Prionospio</i> sp.	2	55		
	<i>Spiophanes kroyeri</i>	2	57		
	<i>Chaetozone setosa</i>	2	60		
	<i>Monticellina dorsobranchialis</i>	2	62		
	<i>Polycirrus</i> sp.	2	64		
	<i>Euchone rubrocincta</i>	2	67		
	<i>Ampelisca spinipes</i>	2	69		
	<i>Othomaera othonis</i>	2	71		
	<i>Leptochiton cancellatus</i>	2	74		
	<i>Turritella communis</i>	2	76		
	<i>Phaxas pellucidus</i>	2	79		
	<i>Phoronis</i> sp.	2	81		

Group F (Average similarity: 55.47%)					
Station	Sediment Type	% Gravel	% Sand	% Mud	Depth (m CD)
G18	Slightly Gravelly Muddy Sand	0.57	71.16	28.27	76
G35	Slightly Gravelly Muddy Sand	1.16	72.05	26.79	61
G37	Slightly Gravelly Muddy Sand	1.49	61.45	37.06	78
G66	Gravelly Muddy Sand	8.68	66.45	24.87	67
	Taxa	Av. Abund	% of Sites	Contrib%	Cum.%
	<i>Amphiura filiformis</i>	25.25	100	8.81	8.81
	<i>Amphiura chiajei</i>	26.75	100	8.2	17.02
	<i>Owenia fusiformis</i>	25.75	100	7.65	24.67
	<i>Galathowenia oculata</i>	13.25	100	6.39	31.06
	<i>Pholoe baltica</i>	14.25	100	5.11	36.17
	<i>Diplocirrus glaucus</i>	10.75	100	4.56	40.73
	Nemertea spp.	5	100	3.49	44.22
	<i>Spiophanes kroyeri</i>	4.5	100	3.49	47.7
	<i>Labidoplax buskii</i>	12.5	100	3.38	51.09
	<i>Notomastus</i> sp.	3	100	3.01	54.09
	<i>Nucula nitidosa</i>	4.75	100	2.96	57.05
	<i>Prionospio fallax</i>	2.25	100	2.83	59.88
	<i>Turritella communis</i>	2.75	100	2.3	62.18
	<i>Ampharete lindstroemi</i>	1.75	100	2.13	64.31
	<i>Laonice</i> sp. (juv.)	1.5	100	2.12	66.43
	<i>Praxillella affinis</i>	4	75	2.09	68.53
	<i>Thysanocardia procera</i>	1.5	100	2	70.53
	<i>Monticellina dorsobranchialis</i>	1.5	100	2	72.53
	<i>Leptosynapta inhaerens</i>	1	100	2	74.54

Group G (Average similarity: 51.2%)					
Station	Sediment Type	% Gravel	% Sand	% Mud	Depth (m CD)
G38	Slightly Gravelly Muddy Sand	2.63	67.30	30.08	40
G41	Slightly Gravelly Muddy Sand	1.27	73.34	25.40	21
Taxa		Av. Abund	% of Sites	Contrib%	Cum.%
<i>Turritella communis</i>		26	100	11.54	11.54
<i>Diplocirrus glaucus</i>		9	100	7	18.54
<i>Lumbrineris cingulata</i>		5	100	5.29	23.83
<i>Euclymene oerstedii</i>		8	100	5.29	29.13
<i>Abra nitida</i>		3.5	100	4.58	33.71
<i>Amphiura chiajei</i>		7	100	4.58	38.29
<i>Dipolydora coeca</i>		2	100	3.74	42.04
<i>Spiophanes kroyeri</i>		3.5	100	3.74	45.78
<i>Mediomastus fragilis</i>		3	100	3.74	49.52
<i>Notomastus</i> sp.		2.5	100	3.74	53.27
<i>Praxillella affinis</i>		3.5	100	3.74	57.01
<i>Owenia fusiformis</i>		2	100	3.74	60.75
<i>Amphictene auricoma</i>		2	100	3.74	64.5
<i>Amphiura filiformis</i>		3	100	3.74	68.24
Nemertea spp.		1.5	100	2.65	70.89
<i>Thysanocardia procera</i>		1.5	100	2.65	73.53
<i>Aphrodita aculeata</i>		1.5	100	2.65	76.18
<i>Pholoe baltica</i>		3	100	2.65	78.83
<i>Laonice</i> sp. (juv.)		1	100	2.65	81.47
<i>Laonice bahusiensis</i>		1	100	2.65	84.12
<i>Monticellina dorsobranchialis</i>		1	100	2.65	86.77
<i>Melinna palmata</i>		1	100	2.65	89.41
<i>Polycirrus</i> sp.		2.5	100	2.65	92.06

Table 7. Results of the BEST routine.

Parameter	Correlation (r)	Best Combination (r=0.912)
Mean Phi Grain Size	0.855	✓
Median Phi Grain Size	0.826	✓
Gravel	0.751	
Mud	0.746	✓
Sand	0.609	
Skewness	0.43	
Sorting	0.381	✓
Depth	0.38	✓
Kurtosis	0.272	

3.5 Biotope Composition

Biotores were assigned to each station on the basis of species composition, sedimentary parameters, water depth and the results of multivariate analysis. A number of the stations supported infaunal communities which could not be assigned to a single biotope with complete certainty. A summary of biotope codes for the stations is provided in Table 8 and a breakdown of biotores for stations in each of the groups derived by cluster analysis with sediment descriptions and dominant taxa is provided in Table 9. Uncertain biotores have been listed with a qualifier (marked with ?) and the spatial distribution of biotores is provided in Figure 9. Figure 10 shows the location of sites with protected features and Priority Marine Features (PMFs) within the survey area based on infaunal data.

Station G47 (group a) includes a range of polychaetes and molluscs along with small quantities of maerl fragments in shallow gravel, and has been assigned **SS.SCS.ICS** (Infralittoral coarse sediment). Groups b and c (stations GEX7, G01 and G03) include a diverse assemblage with the flame shell *Limaria hians* and have been assigned the biotope **SS.SMx.IMx.Lim** (*Limaria hians* beds in tide-swept sublittoral muddy mixed sediment) and are therefore a protected feature within the Lochs Duich, Long and Alsh MPA. Group d is composed of the muddiest station (G16) with circalittoral sandy-mud characterised by *Turritella communis*, *Amphiura chiajei*, *Abyssoninoe hibernica*, *Nephtys incisa* and *Myrtea spinifera*. These species are often recorded in circalittoral fine mud communities; therefore G16 (group d) has been assigned **SS.SMu.CFiMu** (Circalittoral fine mud). Group e is also composed of only one station (G26), which is found in shallow circalittoral mixed sediment (gravelly muddy-sand) and whilst the presence of species such as *Lumbrineris cingulata* and *Mediomastus fragilis* could suggest the presence of **SS.SCS.CCS.MedLumVen** (*Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel) the sample is relatively muddy and lacks the usual complement of robust bivalves so has been classified as **SS.SMx.CMx** (Circalittoral mixed sediment).

Groups f and g include a closely related number of stations with slightly gravelly muddy-sand in either deep water (group f) or intermediate depths (circalittoral) with a somewhat variable infaunal community. Group f is dominated by high numbers of Amphiuridae brittlestars along with Oweniidae polychaetes such as *Owenia fusiformis* and as such are considered a slightly muddier deep sea loch variant of **SS.SSa.OSa.OfusAfil** (*Owenia fusiformis* and *Amphiura filiformis* in offshore circalittoral sand or muddy sand). The occasional presence of taxa such as *Kurtiella (Mysella) bidentata* and/or *Abra nitida* also indicates elements of biotores such as **SS.SMu.CSaMu.AfilMysAnit** (*Amphiura filiformis*, *Mysella bidentata* and *Abra nitida* in circalittoral sandy mud) although such biotores are usually in shallower muddier habitats. Group g (stations G38 and G41) shows some similarity to group f but in shallower water with a reduced Oweniidae component and lower numbers of *Amphiura* spp. but with higher numbers of *Abra nitida* along with *Kurtiella (Mysella) bidentata* and is dominated by taxa such as *Turritella communis*, *Diplocirrus glaucus*, *Lumbrineris cingulata* and *Euclymene oerstedii*. As such these stations are potentially the biotope **SS.SMu.CSaMu.AfilMysAnit** (*Amphiura filiformis*, *Mysella bidentata* and *Abra nitida* in circalittoral sandy mud) albeit with a somewhat reduced *Amphiura* component and a higher than average sand content. The communities in groups f and g do not correlate exactly to existing offshore or circalittoral biotores but are perhaps intermediate forms of **SS.SSa.OSa.OfusAfil** and **SS.SMu.CSaMu.AfilMysAnit**. A number of stations in these groups also include the PMF species *Arctica islandica* (Ocean quahog).

Table 8. Biotopes at each station.

Sample	Biotope	Location	Protected Feature	PMF#
G01	SS.SMx.IMx.Lim	Loch Alsh	Flame shell beds	
G03	SS.SMx.IMx.Lim	Loch Alsh	Flame shell beds	
G16	SS.SMu.CFiMu	Loch Alsh		
G18	SS.SSa.OSa.OfusAfil ?	Loch Alsh		Ocean quahog
G35	SS.SSa.OSa.OfusAfil ?	Loch Alsh		
G37	SS.SSa.OSa.OfusAfil ?	Loch Alsh		Ocean quahog
G38	SS.SMu.CSaMu.AfilMysAnit ?	Loch Alsh		
G41	SS.SMu.CSaMu.AfilMysAnit ?	Loch Alsh		Ocean quahog
G47	SS.SCS.ICS	Loch Alsh		
G50	SS.SMx.CMx ?	Loch Alsh		
G66	SS.SSa.OSa.OfusAfil ?	Loch Alsh		Ocean quahog
GEX7	SS.SMx.IMx.Lim	Loch Alsh	Flame shell beds	

Priority Marine Feature

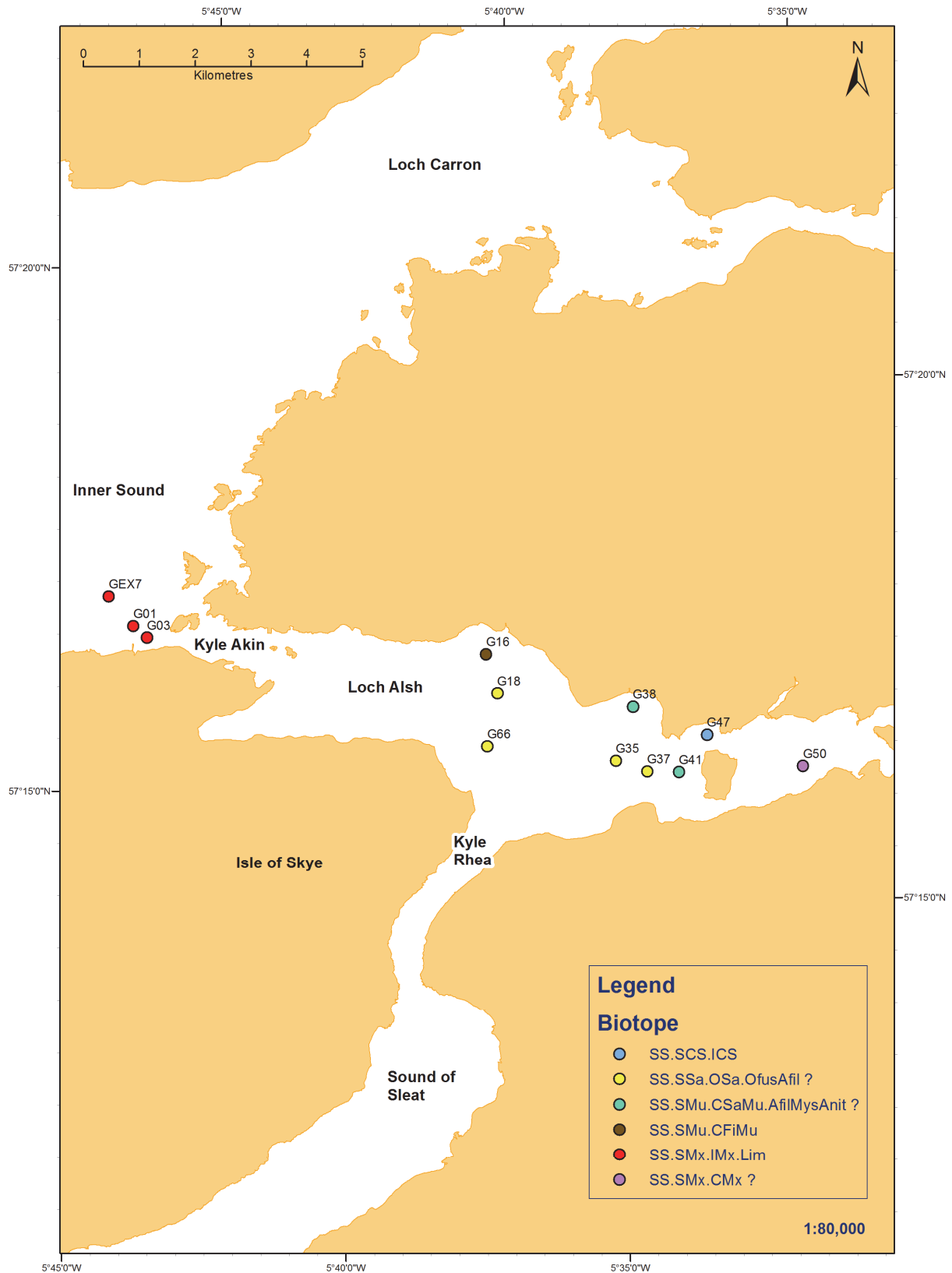


Figure 9. Biotopes at the survey stations. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right [2014]. All rights reserved. Ordnance Survey Licence number 100017908.

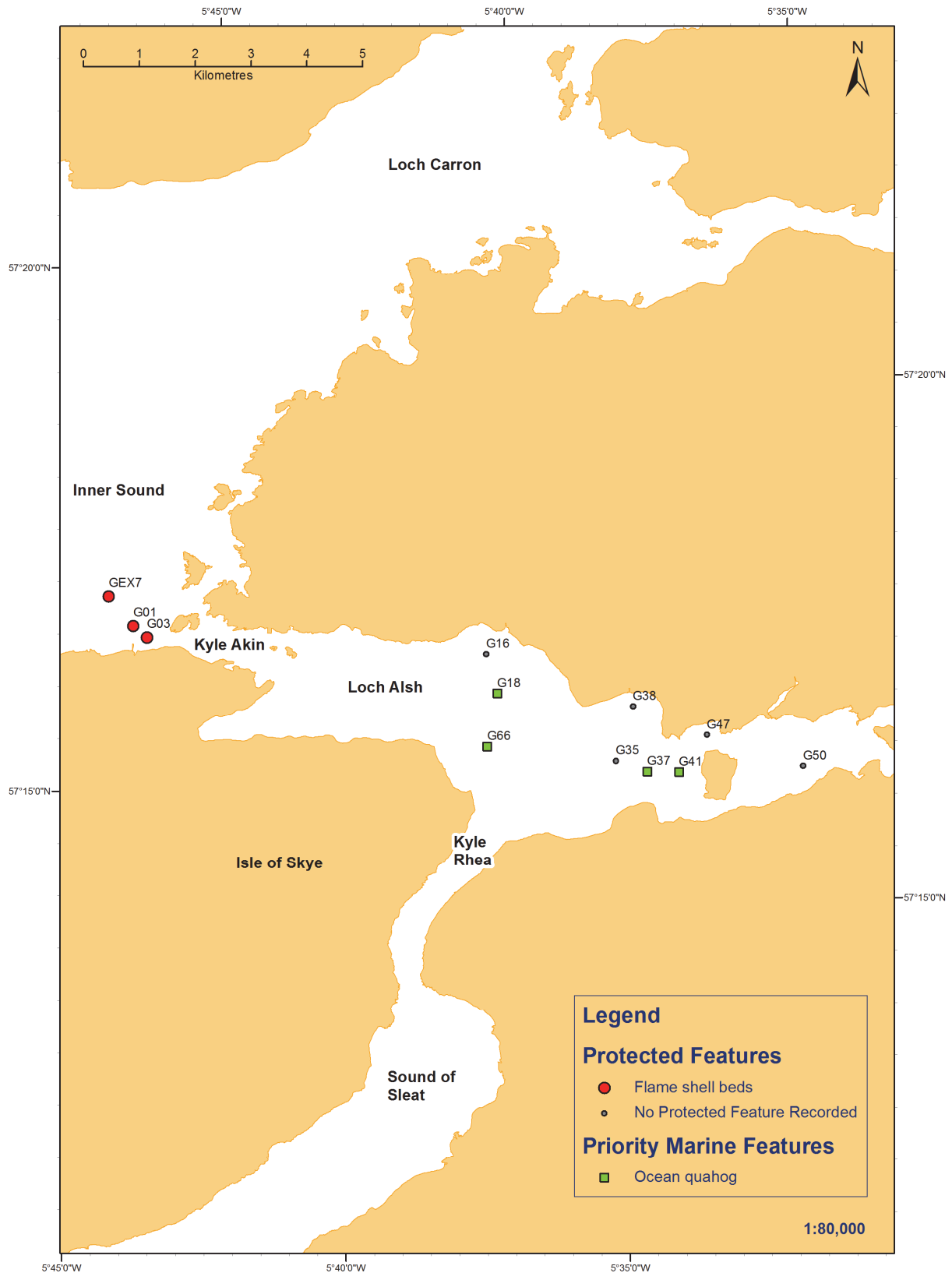


Figure 10. Protected Features and Priority Marine Features at the survey stations. Reproduced by permission of Ordnance Survey on behalf of HMSO. © Crown copyright and database right [2014]. All rights reserved. Ordnance Survey Licence number 100017908.

Table 9. Biotopes, sediment descriptions and ten most abundant taxa at each station within cluster groups.

Group	Station	Biotope	Sediment Type	Depth (m CD)	Dominant Taxa
a	G47	SS.SCS.ICS	Gravel	8	<i>Leptochiton asellus</i> , Nematoda spp., <i>Modiolus</i> sp. (juv.), Amphiuroidae sp. (juv.), <i>Golfingia vulgaris vulgaris</i> , <i>Clausinella fasciata</i> , <i>Crenella decussata</i> , <i>Gibbula tumida</i> , <i>Timoclea ovata</i> , <i>Polycirrus</i> sp.
b	GEX7	SS.SMx.IMx.Lim	Muddy Sandy Gravel	10	<i>Modiolus</i> sp. (juv.), <i>Arcopagia crassa</i> , <i>Polycirrus</i> sp., Nematoda spp., <i>Notomastus</i> sp., <i>Pholoe inornata</i> , Spionidae sp. (juv.), <i>Golfingia vulgaris vulgaris</i> , Thraciidae sp. (juv.), <i>Leptochiton asellus</i>
c	G01	SS.SMx.IMx.Lim	No PSA	6	<i>Pholoe inornata</i> , <i>Modiolus</i> sp. (juv.), <i>Polycirrus</i> sp., <i>Onoba semicostata</i> , <i>Jasmineira elegans</i> , <i>Golfingia vulgaris vulgaris</i> , <i>Nereimyra punctata</i> , <i>Limaria hians</i> , <i>Flabelligera affinis</i> , <i>Psamathe fusca</i>
	G03	SS.SMx.IMx.Lim	No PSA	10	<i>Pholoe inornata</i> , <i>Modiolus</i> sp. (juv.), Nematoda spp., <i>Flabelligera affinis</i> , <i>Polycirrus</i> sp., <i>Nereimyra punctata</i> , <i>Jasmineira elegans</i> , <i>Amphipholis squamata</i> , <i>Limaria hians</i> , <i>Psamathe fusca</i>
d	G16	SS.SMu.CFiMu	Slightly Gravelly Sandy Mud	49	<i>Turritella communis</i> , <i>Amphiura chiajei</i> , <i>Abyssoninoe hibernica</i> , <i>Nephtys incisa</i> , <i>Myrtea spinifera</i> , <i>Thyasira flexuosa</i> , <i>Polycirrus</i> sp., <i>Nucula nitidosa</i> , <i>Oxydromus flexuosus</i> , <i>Praxillella affinis</i>
e	G50	SS.SMx.CMx ?	Gravelly Muddy Sand	22	<i>Lumbrineris cingulata</i> , <i>Mediomastus fragilis</i> , <i>Chaetozone gibber</i> , <i>Owenia fusiformis</i> , <i>Aricidea (Acmira) simonae</i> , <i>Leptosynapta decaria</i> , <i>Pholoe baltica</i> , <i>Glycera alba</i> , <i>Goniada maculata</i> , <i>Prionospio</i> sp.

Group	Station	Biotope	Sediment Type	Depth (m CD)	Dominant Taxa
f	G18	SS.SSa.OSa.OfusAfil ?	Slightly Gravelly Muddy Sand	76	<i>Amphiura chiajei</i> , <i>Labidoplax buskii</i> , <i>Owenia fusiformis</i> , <i>Amphiura filiformis</i> , <i>Pholoe baltica</i> , <i>Euclymene</i> sp., <i>Galathowenia oculata</i> , <i>Diplocirrus glaucus</i> , <i>Octobranchus floriceps</i> , <i>Praxillella affinis</i>
	G35	SS.SSa.OSa.OfusAfil ?	Slightly Gravelly Muddy Sand	61	<i>Owenia fusiformis</i> , <i>Amphiura filiformis</i> , <i>Amphiura chiajei</i> , <i>Galathowenia oculata</i> , <i>Praxillella affinis</i> , <i>Antalis entalis</i> , <i>Pholoe baltica</i> , <i>Glycera fallax</i> , <i>Ancistrosyllis groenlandica</i> , <i>Mediomastus fragilis</i>
	G37	SS.SSa.OSa.OfusAfil ?	Slightly Gravelly Muddy Sand	78	<i>Amphiura chiajei</i> , <i>Amphiura filiformis</i> , <i>Owenia fusiformis</i> , <i>Pholoe baltica</i> , <i>Labidoplax buskii</i> , <i>Diplocirrus glaucus</i> , <i>Galathowenia oculata</i> , <i>Abra alba</i> , <i>Nucula nitidosa</i> , <i>Nucula nucleus</i>
	G66	SS.SSa.OSa.OfusAfil ?	Gravelly Muddy Sand	67	<i>Amphiura filiformis</i> , <i>Galathowenia oculata</i> , <i>Amphiura chiajei</i> , <i>Diplocirrus glaucus</i> , <i>Mediomastus fragilis</i> , <i>Nemertea</i> spp., <i>Pholoe baltica</i> , <i>Spiophanes kroyeri</i> , <i>Owenia fusiformis</i> , <i>Turritella communis</i>
g	G38	SS.SMu.CSaMu.AfilMysAnit ?	Slightly Gravelly Muddy Sand	40	<i>Turritella communis</i> , <i>Euclymene oerstedii</i> , <i>Diplocirrus glaucus</i> , <i>Amphiura chiajei</i> , <i>Lumbrineris cingulata</i> , <i>Pholoe baltica</i> , <i>Praxillella affinis</i> , <i>Ampelisca typica</i> , <i>Dosinia</i> sp. (juv.), <i>Mediomastus fragilis</i>
	G41	SS.SMu.CSaMu.AfilMysAnit ?	Slightly Gravelly Muddy Sand	21	<i>Turritella communis</i> , <i>Diplocirrus glaucus</i> , <i>Nucula nitidosa</i> , <i>Abludomelita obtusata</i> , <i>Spiophanes kroyeri</i> , <i>Lumbrineris cingulata</i> , <i>Euclymene oerstedii</i> , <i>Notomastus</i> sp., <i>Chaetoderma nitidulum</i> , <i>Abra nitida</i>

4. DISCUSSION

The sampling stations surveyed in Loch Alsh in March 2014 (part of the Lochs Duich, Long and Alsh MPA) covered a range of seabed habitats. There was one example of **SS.SMu.CFiMu** (Circalittoral fine mud) identified at station G16. The dominant taxa may indicate the presence of the burrowing megafaunal biotopes **SS.SMu.CFiMu.SpnMeg** (Seapens and burrowing megafauna in circalittoral fine mud) or **SS.SMu.CFiMu.MegMax** (Burrowing megafauna and *Maxmuelleria lankesteri* in circalittoral mud), both of which are components of the burrowed mud protected feature of the MPA. Identifying these biotopes from infaunal grab data alone is often problematic. Characteristic species such as seapens, *Nephrops norvegicus*, *Maxmuelleria lankesteri* and *Callianassa subterranea* may not be present in sufficient densities to be sampled within single or even multiple grab samples. Full analysis of video evidence collected during this survey should allow further refinement of this biotope assessment and the possible identification of the burrowed mud feature.

Three examples of **SS.SMx.IMx.Lim** (*Limaria hians* beds in tide-swept sublittoral muddy mixed sediment) were recorded beyond the mouth of the loch. These exhibited particularly high levels of species richness. There are numerous records of the **.Lim** biotope within a large flame shell bed at the mouth of Loch Alsh (running under the Skye Bridge), however, the three records from this report are outwith the previous predicted area of extent (Moore *et al.*, 2013). In conjunction with preliminary results from video evidence collected from the same survey (SNH, 2014a) these records increase the estimated extent of the flame shell bed protected feature within the Lochs Duich, Long and Alsh MPA (SNH, 2014b).

A number of other biotopes were present including examples of **.CMx** (Circalittoral mixed sediments) and **.ICS** (Infralittoral coarse sediments). The station classified as **.ICS** (G47) also contained fragments of live maerl although the density of material within the infaunal sample was not considered sufficient for the station to qualify as a record of a maerl bed biotope (a PMF).

Other biotopes included somewhat poorly defined records of **SS.SMu.CSaMu.AfilMysAnit** (*Amphiura filiformis*, *Mysella bidentata* and *Abra nitida* in circalittoral sandy mud) and **SS.SSa.OSa.OfusAfil** (*Owenia fusiformis* and *Amphiura filiformis* in offshore circalittoral sand or muddy sand). These habitats in the middle part of the loch appeared to be intermediates of other biotopes and included deeper circalittoral communities which are currently rather poorly defined by the current UK biotope classification. In a recent similar survey around the Small Isles, Inner Hebrides (Howson *et al.*, 2012), infaunal and PSA grab sampling recorded **.AfilMysAnit** and **.OfusAfil** biotopes, with associated video analysis confirming that these infaunal habitat were overlain by a muddy veneer of the related biotopes **.SpnMeg.Fun** and **.MegMax** (Howson *et al.*, 2012). The stations assigned to **.AfilMysAnit** and **.OfusAfil** biotopes in this survey of Loch Alsh fall within the current predicted extent of burrowed mud (based on acoustic data; see Envision Mapping Ltd., 2014). It is therefore possible that at these locations a similar biotope assemblage could be found, with burrowed mud overlaying these mixed sediment communities. A full assessment of epibiota from associated video evidence collected during the survey (SNH, 2014a) may assist in biotope derivation in areas where a habitat mosaic is present or where infaunal data are inconclusive with regards to finer resolution biotope assignments. The 2014 video data may also inform an assessment of the maerl habitat within the loch.

5. REFERENCES

- Clarke, K.R., & Warwick R.M. 2001. *Change in marine communities: an approach to statistical analysis and interpretation, 2nd edition*. PRIMER-E, Plymouth.
- Clarke, K.R. & Gorley, R.N. 2006. *PRIMER v6: User Manual/Tutorial*. PRIMER-E, Plymouth.
- Connor, D.W., Allen, J.H., Golding, N., Howell, K.L., Lieberknecht, L.M., Northen, K.O. & Reker, J.B. 2004. *The National Marine Habitat Classification for Britain and Ireland. Version 04.05*. Joint Nature Conservation Committee, Peterborough. ISBN: 1 861 07561 8 (internet version). Available from <<http://jncc.defra.gov.uk/page-1584>>
- Cooper, K. & Rees, H.L. 2002. Review of Standard Operating Procedures (SOPs). *Sci. Ser., Aquat. Environ. Prot: Analyt. Meth.*, CEFAS Lowestoft, (13) 57pp. Available from <<http://www.cefas.defra.gov.uk/publications/aquatic/aepam13.pdf>>
- Envision Mapping Ltd. 2014. Predictive Mapping of MPA protected features within selected possible Nature Conservation MPAs in Scottish territorial waters using available datasets. *Scottish Natural Heritage Commissioned Report No. 600*. Available from <http://www.snh.org.uk/pdfs/publications/commissioned_reports/600.pdf>
- Howson, C. M., Clark, L., Mercer, T. S. & James, B. 2012. Marine biological survey to establish the distribution and status of fan mussels *Atrina fragilis* and other Marine Protected Area (MPA) search features within the Sound of Canna, Inner Hebrides. *Scottish Natural Heritage Commissioned Report No. 438*. Available from <http://www.snh.org.uk/pdfs/publications/commissioned_reports/438.pdf>
- Marine Scotland. 2011. Marine Protected Areas in the Seas around Scotland. Guidelines on the selection of MPAs and development of the MPA network. Available from <<http://www.scotland.gov.uk/marinescotland/mpaguidelines>>
- Moore, C.G., Harries, D.B., Cook, R.L., Hirst, N.E., Saunders, G.R., Kent, F.E.A., Trigg, C. & Lyndon, A.R. 2013. The distribution and condition of selected MPA search features within Lochs Alsh, Duich, Creran and Fyne. *Scottish Natural Heritage Commissioned Report No. 566*. <http://www.snh.org.uk/pdfs/publications/commissioned_reports/566.pdf>
- Rees, H.L. 1999. Review of Standard Operating Procedures for Sampling and Analysis of Benthic Macrofauna. In: *Report of the ICES Benthos Ecology Working Group*. ICES CM 1999/E:1 41-43.
- Rees, H.L., Moore, D.C., Pearson, T.H., Elliott, M., Service, M., Pomfret, J. & Johnson, D. 1990. Procedure for the monitoring of marine benthic communities at UK sewage sludge disposal sites. *Scottish Fisheries Information Pamphlet Number 18*. Department of Agriculture and Fisheries for Scotland, Aberdeen. 78 pp. Available from <<http://www.scotland.gov.uk/Uploads/Documents/No%2018.pdf>>
- Scottish Government. 2013. *Planning Scotland's Seas. Consultation on Priority Marine Features*. Available from <<http://www.scotland.gov.uk/Resource/0042/00428389.pdf>>
- SNH. 2014a. Lochs Duich, Long and Alsh. *Ground-truthing and proposed protected feature validation survey March 25 and 26, 2014*. Unpublished survey summary.

SNH. 2014b. SNH's advice on selected responses to the 2013 Marine Scotland consultation on Nature Conservation Marine Protected Areas (MPAs). *Scottish Natural Heritage Commissioned Report No. 747*. Available from http://www.snh.org.uk/pdfs/publications/commissioned_reports/747.pdf

Ware, S.J. & Kenny, A.J. 2011. *Guidelines for the Conduct of Benthic Studies at Marine Aggregate Extraction Sites (2nd Edition)*. Marine Aggregate Levy Sustainability Fund, 80 pp. Available from <http://www.cefas.defra.gov.uk/media/477907/mepf-benthicguidelines.pdf>

[WoRMS Editorial Board](http://www.marinespecies.org). 2014. World Register of Marine Species. Available from <http://www.marinespecies.org> at VLIZ .

Worsfold, T & Hall, D. 2010. *Guidelines for processing marine macrobenthic invertebrate samples: A Processing Requirements Protocol*. NMBAQC. Available from <http://www.nmbaqcs.org/media/9732/nmbaqc%20-%20inv%20-%20prp%20-%20v1.0%20june2010.pdf>

ANNEX 1: SEDIMENT PARTICLE SIZE ANALYSES DATA

SAMPLE	PARAMETER	G16	G18	G35	G37	G38
SAMPLE TYPE:		Bimodal, Very Poorly Sorted	Bimodal, Very Poorly Sorted	Bimodal, Very Poorly Sorted	Bimodal, Very Poorly Sorted	Trimodal, Very Poorly Sorted
TEXTURAL GROUP:		Slightly Gravelly Sandy Mud	Slightly Gravelly Muddy Sand	Slightly Gravelly Muddy Sand	Slightly Gravelly Muddy Sand	Slightly Gravelly Muddy Sand
SEDIMENT NAME:		Slightly Fine Gravelly Very Fine Sandy Very Coarse Silt	Slightly Fine Gravelly Medium Silty Fine Sand	Slightly Very Fine Gravelly Medium Silty Fine Sand	Slightly Very Fine Gravelly Medium Silty Fine Sand	Slightly Very Fine Gravelly Medium Silty Medium Sand
FOLK AND WARD METHOD (µm)	MEDIAN GRAIN SIZE D ₅₀ (µm)	58.8	163.7	166.2	106.4	163.1
	MEAN GRAIN SIZE (µm)	46.31	105.90	109.6	74.5	109.8
	SORTING	4.190	4.810	5.146	4.858	5.958
	SKEWNESS	-0.210	-0.393	-0.348	-0.280	-0.277
	KURTOSIS	0.826	0.992	1.091	0.901	0.958
FOLK AND WARD METHOD (phi)	MEDIAN GRAIN SIZE D ₅₀ (phi):	4.089	2.611	2.589	3.232	2.616
	MEAN GRAIN SIZE (phi):	4.433	3.239	3.189	3.747	3.186
	SORTING	2.067	2.266	2.364	2.281	2.575
	SKEWNESS	0.210	0.393	0.348	0.280	0.277
	KURTOSIS	0.826	0.992	1.091	0.901	0.958
FOLK AND WARD METHOD (Description)	MEAN:	Very Coarse Silt	Very Fine Sand	Very Fine Sand	Very Fine Sand	Very Fine Sand
	SORTING:	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted
	SKEWNESS:	Fine Skewed	Very Fine Skewed	Very Fine Skewed	Fine Skewed	Fine Skewed
	KURTOSIS:	Platykurtic	Mesokurtic	Mesokurtic	Mesokurtic	Mesokurtic
BULK GRAIN SIZE	% GRAVEL:	0.50	0.57	1.16	1.49	2.63
	% SAND:	48.03	71.16	72.05	61.45	67.30
	% MUD:	51.46	28.27	26.79	37.06	30.08
	% 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:	0.01	0.00	0.00	0.00	0.01
	% FINE GRAVEL:	0.29	0.34	0.32	0.41	0.64
	% V FINE GRAVEL:	0.20	0.23	0.85	1.08	1.98
	% V COARSE SAND:	0.47	0.91	3.01	2.28	6.36
	% COARSE SAND:	0.94	11.11	11.40	4.48	10.04
	% MEDIUM SAND:	8.25	22.56	20.22	14.11	19.23
	% FINE SAND:	17.17	23.42	23.70	22.74	18.71
	% V FINE SAND:	21.20	13.15	13.72	17.85	12.95
	% V COARSE SILT:	14.64	6.09	5.14	8.79	6.25
	% COARSE SILT:	11.47	6.58	5.93	8.70	6.59
	% MEDIUM SILT:	11.51	7.05	6.94	9.11	7.66
	% FINE SILT:	10.20	6.25	6.37	7.76	6.89
% V FINE SILT:	3.61	2.27	2.37	2.67	2.61	
% CLAY:	0.04	0.03	0.03	0.03	0.08	

SAMPLE	PARAMETER	G41	G47	G50	G66	GEX7
SAMPLE TYPE:		Bimodal, Very Poorly Sorted	Bimodal, Poorly Sorted	Polymodal, Very Poorly Sorted	Polymodal, Very Poorly Sorted	Unimodal, Very Poorly Sorted
TEXTURAL GROUP:		Slightly Gravelly Muddy Sand	Gravel	Gravelly Muddy Sand	Gravelly Muddy Sand	Muddy Sandy Gravel
SEDIMENT NAME:		Slightly Medium Gravelly Fine Silty Fine Sand	Very Fine Gravel	Coarse Gravelly Coarse Silty Medium Sand	Very Fine Gravelly Medium Silty Medium Sand	Medium Silty Sandy Very Fine Gravel
FOLK AND WARD METHOD (µm)	MEDIAN GRAIN SIZE D ₅₀ (µm)	171.26	3634.9	210.95	251.6	1617.5
	MEAN GRAIN SIZE (µm)	102.62	3919.7	173.0	175.1	1089.8
	SORTING	4.334	2.213	11.28	6.962	5.786
	SKEWNESS	-0.491	0.190	-0.014	-0.216	-0.446
	KURTOSIS	1.232	1.021	1.066	1.150	3.008
FOLK AND WARD METHOD (phi)	MEDIAN GRAIN SIZE D ₅₀ (phi):	2.546	-1.862	2.245	1.991	-0.694
	MEAN GRAIN SIZE (phi):	3.285	-1.971	2.531	2.513	-0.124
	SORTING	2.116	1.146	3.495	2.800	2.533
	SKEWNESS	0.491	-0.190	0.014	0.216	0.446
	KURTOSIS	1.232	1.021	1.066	1.150	3.008
FOLK AND WARD METHOD (Description)	MEAN:	Very Fine Sand	Very Fine Gravel	Fine Sand	Fine Sand	Very Coarse Sand
	SORTING:	Very Poorly Sorted	Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted
	SKEWNESS:	Very Fine Skewed	Coarse Skewed	Symmetrical	Fine Skewed	Very Fine Skewed
	KURTOSIS:	Leptokurtic	Mesokurtic	Mesokurtic	Leptokurtic	Extremely Leptokurtic
BULK GRAIN SIZE	% GRAVEL:	1.27	81.30	14.54	8.68	37.50
	% SAND:	73.34	17.89	53.28	66.45	49.45
	% MUD:	25.40	0.80	32.17	24.87	13.05
	% V COARSE GRAVEL:	0.00	0.00	0.00	0.00	0.00
	% COARSE GRAVEL:	0.00	9.36	8.88	0.00	1.14
	% MEDIUM GRAVEL:	0.63	9.41	0.00	2.14	5.57
	% FINE GRAVEL:	0.11	26.08	3.13	2.89	7.62
	% V FINE GRAVEL:	0.53	36.46	2.53	3.66	23.17
	% V COARSE SAND:	1.97	17.31	7.73	7.08	41.54
	% COARSE SAND:	3.41	0.13	8.79	15.68	3.00
	% MEDIUM SAND:	25.05	0.14	15.48	18.71	1.69
	% FINE SAND:	30.46	0.14	12.76	14.70	1.32
	% V FINE SAND:	12.44	0.17	8.52	10.27	1.90
	% V COARSE SILT:	5.38	0.19	7.39	5.93	2.47
	% COARSE SILT:	5.03	0.22	7.99	5.73	3.37
	% MEDIUM SILT:	6.20	0.20	7.87	6.10	3.51
	% FINE SILT:	6.26	0.15	6.56	5.21	2.78
% V FINE SILT:	2.47	0.05	2.33	1.87	0.91	
% CLAY:	0.07	0.00	0.03	0.03	0.01	

ANNEX 2: SPECIES DATA

Taxa (abundance per 0.1m ²)	G01	G03	G16	G18	G35	G37	G38	G41	G47	G50	G66	GEX7
Porifera sp.	0	0	0	0	0	0	0	0	P	0	P	0
Actiniaria sp.	0	0	0	0	0	0	0	1	0	0	0	0
Obelia sp.	0	0	0	0	0	0	0	0	0	0	0	0
Turbellaria	0	2	0	0	0	0	0	0	0	0	0	3
Nemertea spp.	3	0	1	6	2	4	2	1	2	1	8	4
Nematoda spp.	20	60	0	1	0	0	0	0	15	0	0	47
Golfingia (Golfingia) vulgaris vulgaris	27	10	0	0	0	0	0	1	9	0	0	33
Thysanocardia procera	0	0	0	1	1	3	2	1	1	0	1	0
Phascolion (Phascolion) strombus strombus	0	0	0	0	0	0	1	0	0	0	0	0
Aphrodita aculeata	0	0	0	1	0	2	1	2	0	0	0	0
Polynoidae sp.	8	16	0	0	0	0	0	0	0	1	0	2
Gattyana cirrhosa	0	0	0	0	0	2	0	0	0	0	0	0
Harmothoe impar	1	1	0	0	0	0	0	0	0	0	0	0
Lepidonotus squamatus	4	5	0	0	0	0	0	0	0	0	0	3
Harmothoe globifera	1	0	0	0	0	0	0	0	0	0	0	0
Malmgrenia sp.	0	0	0	1	0	0	0	0	0	0	0	0
Malmgrenia andreapolis	0	0	1	0	1	0	0	0	0	0	1	0
Malmgreniella mcintoshii	1	0	0	0	0	0	0	0	2	0	0	0
Pholoe inornata	112	104	0	0	0	0	0	0	0	0	0	42
Pholoe baltica	5	0	0	20	4	26	5	1	0	2	7	0
Eteone longa agg.	2	0	0	0	0	0	0	0	0	1	0	0
Phyllodoce rosea	0	0	0	0	0	3	0	0	0	0	0	0
Eulalia mustela	0	0	0	0	0	0	0	0	0	0	0	1
Eumida bahusensis	10	7	0	0	0	0	0	0	2	0	1	4
Eumida sanguinea	0	0	0	0	0	0	0	0	0	0	0	8
Pterocirrus macroceros	1	2	0	0	0	0	0	0	0	0	0	0
Sige fusigera	0	0	0	0	0	0	0	0	0	0	1	0
Glycera alba	0	0	0	2	1	0	3	0	0	2	1	0
Glycera fallax	0	0	0	1	3	4	3	0	0	0	0	0
Glycera lapidum agg.	3	4	0	0	0	0	0	0	3	0	0	20
Glycera unicornis	0	0	0	0	1	0	0	0	0	0	4	0
Goniada maculata	0	0	0	1	1	0	1	0	0	2	2	0
Sphaerodorum gracilis	1	0	0	2	0	3	0	0	1	1	1	1
Nereimyra punctata	27	29	0	0	0	0	1	0	1	1	0	0
Oxydromus flexuosus	0	0	2	1	0	1	0	0	0	0	1	0
Psamathe fusca	21	20	0	0	0	0	0	0	3	0	0	0
Hesiospina aurantiaca	0	0	0	0	0	0	0	0	0	0	0	11
Syllidia armata	3	0	0	0	0	0	0	0	0	0	0	2
Ancistrosyllis groenlandica	0	0	P	0	3	3	0	0	0	0	0	0
Syllis cornuta	0	0	0	2	1	0	0	0	0	0	0	2
Syllis armillaris	2	0	0	1	0	0	0	0	0	0	0	1
Eusyllis blomstrandii	0	0	0	0	0	0	0	1	0	0	0	0
Odontosyllis fulgurans	0	0	0	1	0	0	0	0	0	0	0	0
Syllis columbretensis	3	4	0	0	0	0	0	0	0	0	0	0
Eunereis longissima	0	0	0	0	0	0	0	0	0	1	0	0
Nereis pelagica	4	4	0	0	0	0	0	0	0	0	0	0
Platynereis dumerilii	2	0	0	0	0	0	0	0	0	0	0	1
Nephtys sp. (juv.)	0	0	0	0	0	0	0	0	0	0	1	0
Nephtys hombergii	0	0	0	0	1	3	0	1	0	0	1	0
Nephtys incisa	0	0	5	0	0	0	0	0	0	0	0	0

Taxa (abundance per 0.1m ²)	G01	G03	G16	G18	G35	G37	G38	G41	G47	G50	G66	GEX7
Pareurythoe borealis	0	0	0	0	0	0	0	0	1	0	0	1
Lysidice unicornis	3	1	0	0	0	0	0	0	0	0	0	2
Lumbrineris cingulata	0	0	0	0	0	0	6	4	0	12	2	2
Abyssoninoe hibernica	0	0	7	0	0	2	0	0	0	0	0	0
Notocirrus scoticus	0	0	0	0	0	0	0	1	0	0	4	0
Protodorvillea kefersteini	0	0	0	0	0	0	0	0	0	0	0	1
Aricidea (Acmira) simonae	0	0	0	1	0	0	3	0	0	3	3	0
Paradoneis lyra	0	0	0	1	2	0	2	0	0	1	1	1
Spionidae sp. (juv.)	4	5	0	0	0	0	0	0	0	0	3	42
Aonides oxycephala	8	5	0	0	0	0	0	0	1	0	0	0
Aonides paucibranchiata	0	0	0	0	0	0	0	0	0	0	0	3
Laonice sp. (juv.)	0	0	0	2	1	2	1	1	2	0	1	2
Laonice bahusiensis	0	0	0	5	0	4	1	1	2	0	1	3
Dipolydora coeca	0	0	0	0	0	0	2	2	0	0	0	0
Prionospio sp.	0	0	0	0	0	0	0	1	0	2	0	0
Prionospio fallax	0	0	0	3	2	2	0	1	0	0	2	0
Scolecopsis bonnierii	0	0	0	0	0	0	0	0	0	0	1	0
Spio filicornis	0	0	0	0	0	0	0	0	0	1	0	0
Spio martinensis	0	0	0	0	0	0	0	0	0	0	0	2
Spiophanes kroyeri	0	0	0	4	2	6	2	5	0	2	6	0
Magelona alleni	0	0	0	0	0	0	0	0	0	0	1	0
Aphelochaeta marioni	0	0	0	0	0	0	0	0	0	0	1	0
Chaetozone gibber	0	0	0	0	0	0	0	0	0	5	4	0
Chaetozone setosa	0	0	0	0	0	0	0	1	0	2	1	0
Monticellina dorsobranchialis	0	0	0	1	1	1	1	1	0	2	3	0
Diplocirrus glaucus	0	0	1	14	2	17	11	7	0	1	10	0
Diplocirrus stopbowitzi	1	0	0	0	0	0	0	0	0	0	0	0
Flabelligera affinis	25	45	0	0	0	0	0	0	0	0	0	6
Mediomastus fragilis	1	1	0	2	3	0	4	2	0	10	9	4
Notomastus sp.	2	3	1	2	2	4	2	3	1	0	4	43
Praxillura longissima	0	0	0	0	2	0	0	0	0	0	0	0
Clymenura sp.	0	0	0	2	0	0	0	0	0	0	0	0
Microclymene tricirrata	0	0	0	0	0	0	3	0	0	0	0	0
Euclymene sp.	0	0	0	16	3	2	1	0	0	0	0	0
Euclymene lombricoides	0	0	0	0	0	2	0	0	0	0	0	0
Euclymene oerstedii	0	0	0	5	0	5	12	4	0	0	2	0
Praxillella affinis	0	0	2	7	6	0	5	2	0	0	3	0
Rhodine sp.	0	0	2	0	0	0	0	0	0	0	0	0
Rhodine loveni	0	0	0	0	0	0	1	0	0	0	0	0
Polyopthalmus pictus	0	0	0	0	0	0	0	0	1	0	0	2
Sclerocheilus minutus	0	0	0	0	0	0	0	0	0	0	0	1
Polyphysia crassa	0	0	0	0	0	0	0	0	0	0	0	1
Scalibregma celticum	1	1	0	0	0	0	0	0	0	0	0	1
Polygordius appendiculatus	0	0	0	0	0	0	0	0	1	0	0	0
Galathowenia oculata	0	0	0	15	7	16	4	0	0	0	15	0
Owenia fusiformis	0	0	0	26	44	27	2	2	0	5	6	0
Amphictene auricoma	0	0	0	1	1	0	2	2	0	0	4	0
Pectinaria (Pectinaria) belgica	0	0	0	0	0	1	0	0	0	0	0	0
Melinna palmata	0	0	0	0	1	0	1	1	0	0	0	0
Ampharete lindstroemi	0	0	0	2	1	1	0	0	0	0	3	0
Amphicteis gunneri	0	0	0	1	0	0	0	0	0	0	1	0

Taxa (abundance per 0.1m ²)	G01	G03	G16	G18	G35	G37	G38	G41	G47	G50	G66	GEX7
Anobothrus gracilis	0	0	0	3	0	0	0	1	0	0	0	0
Sosane sulcata	0	0	0	0	0	0	0	1	0	1	1	0
Octobranchus floriceps	0	0	0	11	0	0	0	0	0	0	0	0
Terebellides stroemii	0	1	0	0	2	6	4	0	0	0	3	2
Trichobranchus roseus	3	1	0	0	0	0	0	2	0	0	0	1
Amphitrite cirrata	0	0	0	3	0	2	0	1	0	0	0	0
Eupolymnia nesidensis	0	1	0	0	0	0	0	0	1	0	1	0
Pista cristata	0	0	0	0	0	0	0	0	1	0	1	0
Polycirrus sp.	34	36	3	3	0	3	4	1	5	2	3	52
Paradialychone filicaudata	0	0	0	0	0	0	0	0	4	0	0	1
Euchone rubrocincta	0	0	0	1	1	0	0	0	0	2	0	0
Jasmineira caudata	0	0	0	1	0	0	0	0	0	1	0	2
Jasmineira elegans	32	27	0	0	0	0	0	0	0	0	0	9
Hydroides norvegicus	0	0	0	0	0	0	0	0	1	0	0	0
Spirobranchus triqueter	0	2	0	0	0	0	0	0	2	1	0	1
Grania sp.	0	0	0	0	0	0	0	0	0	0	0	3
Verruca stroemia	P	P	0	0	0	0	0	P	0	0	P	0
Balanus crenatus	P	P	0	0	0	0	0	P	0	0	0	P
Ostracoda	0	0	0	0	0	0	0	0	0	0	0	2
Mysidae sp.	2	0	0	0	0	0	0	0	0	0	0	4
Metaphoxus fultoni	1	0	0	0	0	0	0	0	1	0	0	8
Orchomene humilis	4	2	0	0	0	0	0	0	0	0	0	0
Orchomenella nana	0	1	0	0	0	0	0	0	0	0	0	0
Ampelisca diadema	0	0	0	1	0	0	0	0	0	0	0	0
Ampelisca spinipes	0	0	0	0	0	0	0	0	0	2	0	0
Ampelisca typica	0	0	0	0	0	1	5	1	0	0	1	0
Abludomelita obtusata	0	0	0	0	0	0	1	6	0	0	1	0
Animoceradocus semiserratus	0	0	0	0	0	0	0	0	1	0	0	0
Othomaera othonis	11	0	0	0	0	0	0	1	0	2	0	1
Gammaropsis sp.	5	11	0	0	0	0	0	0	0	0	0	0
Gammaropsis maculata	0	4	0	0	0	0	0	0	0	0	0	0
Leptocheirus hirsutimanus	0	0	0	0	0	0	0	0	1	0	0	0
Conilera cylindracea	0	0	0	0	0	0	0	0	1	0	0	0
Janira maculosa	3	2	0	0	0	0	0	0	0	0	0	2
Uromunna petiti	11	14	0	0	0	0	0	0	0	0	0	1
Tanaopsis graciloides	0	0	0	0	0	0	3	0	0	0	0	0
Iphinoe serrata	0	0	0	0	0	0	0	1	0	0	0	0
Eualus cranchii	1	1	0	0	0	0	0	0	0	0	0	3
Pagurus bernhardus	0	0	0	0	0	0	0	0	0	0	1	0
Galathea intermedia	0	3	0	0	0	0	0	0	0	0	0	3
Pisidia longicornis	3	1	0	0	0	0	0	0	0	0	0	0
Hyas coarctatus	0	1	0	0	0	0	0	0	0	0	0	0
Cancer pagurus (juv.)	2	0	0	0	0	0	0	0	0	0	0	0
Chaetoderma nitidulum	0	0	2	0	0	0	0	3	0	0	1	0
Leptochiton asellus	4	2	0	0	0	0	0	0	38	0	0	21
Leptochiton cancellatus	0	0	0	0	0	0	0	0	2	2	0	12
Tonicella marmorea	0	0	0	0	0	0	0	0	0	0	0	1
Gibbula tumida	0	0	0	0	0	0	0	0	7	0	0	1
Turritella communis	0	0	9	1	1	4	19	33	0	2	5	0
Alvania beanii	0	0	0	0	0	0	0	0	0	0	0	1
Onoba semicostata	33	4	0	0	0	0	0	0	0	0	0	0

Taxa (abundance per 0.1m ²)	G01	G03	G16	G18	G35	G37	G38	G41	G47	G50	G66	GEX7
<i>Crepidula fornicata</i> (juv.)	0	2	0	0	0	0	0	0	0	0	0	0
<i>Buccinum undatum</i> (juv.)	0	0	0	0	0	0	0	0	0	0	0	1
<i>Nassarius incrassatus</i>	2	0	0	0	0	0	0	0	0	0	0	0
<i>Odostomia plicata</i>	5	0	0	0	0	0	0	0	0	0	0	0
<i>Cylichna cylindracea</i>	0	0	0	3	0	1	0	0	0	0	0	0
<i>Philine aperta</i>	0	0	0	0	0	0	0	0	0	0	1	0
<i>Antalis entalis</i>	0	0	0	1	5	0	0	0	0	0	1	0
<i>Nucula nitidosa</i>	0	0	3	5	1	9	0	7	0	0	4	0
<i>Nucula nucleus</i>	17	0	0	2	0	7	0	1	0	0	0	10
<i>Glycymeris glycymeris</i>	0	0	0	0	0	0	0	0	1	0	0	0
<i>Mytilus edulis</i> (juv.)	1	1	0	0	0	0	0	0	0	0	0	1
<i>Modiolus</i> sp. (juv.)	36	79	0	0	0	0	0	0	10	0	0	81
<i>Crenella decussata</i>	0	0	0	0	0	0	0	0	8	0	0	0
<i>Musculus subpictus</i>	0	1	0	0	0	0	0	0	0	0	0	0
<i>Limaria hians</i>	26	21	0	0	0	0	0	0	0	0	0	10
<i>Limatula subauriculata</i>	0	0	0	0	0	0	0	0	2	0	0	14
<i>Aequipecten opercularis</i>	0	0	0	0	0	0	0	0	0	0	0	1
<i>Anomia ehippium</i>	0	3	0	0	0	0	0	0	0	0	0	0
<i>Myrtea spinifera</i>	0	0	5	0	0	5	1	0	0	0	0	0
<i>Thyasira flexuosa</i>	0	0	5	0	0	7	0	2	0	1	0	0
<i>Tellinella ferruginosa</i>	0	0	0	0	0	0	0	0	0	0	0	1
<i>Kurtiella bidentata</i>	12	5	0	0	0	2	2	0	0	0	2	12
<i>Astarte sulcata</i>	0	0	0	0	0	0	0	0	1	0	0	0
<i>Goodallia triangularis</i>	0	0	0	0	0	0	0	0	4	0	0	0
<i>Parvicardium scabrum</i>	0	1	0	0	0	0	0	0	0	0	0	0
<i>Phaxas pellucidus</i>	0	0	0	0	0	0	3	0	0	2	0	0
<i>Arcopagia crassa</i>	0	10	0	0	0	0	0	0	4	0	0	62
<i>Gari tellinella</i>	0	0	0	0	0	0	0	0	0	0	0	1
<i>Abra alba</i>	0	0	1	0	0	13	1	0	0	0	0	0
<i>Abra nitida</i>	0	0	0	1	0	5	4	3	0	0	0	0
<i>Arctica islandica</i>	0	0	0	1	0	5	0	1	0	0	1	0
<i>Venus casina</i>	0	0	0	0	0	1	0	0	0	0	0	1
<i>Clausinella fasciata</i>	1	1	0	0	0	0	0	0	9	0	0	4
<i>Timoclea ovata</i>	0	0	0	0	0	0	0	0	7	1	0	11
<i>Dosinia</i> sp. (juv.)	0	0	0	0	0	1	5	0	2	0	1	2
<i>Dosinia exoleta</i>	0	0	0	1	0	0	2	0	0	0	0	0
<i>Mysia undata</i>	0	0	0	0	0	0	1	1	0	0	0	0
<i>Mya</i> sp. (juv.)	0	0	0	0	0	0	0	1	1	0	0	0
<i>Corbula gibba</i>	0	0	0	0	0	1	1	0	0	0	0	0
<i>Hiatella arctica</i>	7	11	0	0	0	0	0	0	0	0	0	2
<i>Thraciidae</i> sp. (juv.)	21	12	0	0	0	0	0	2	0	0	0	29
<i>Thracia convexa</i>	0	0	0	0	0	1	0	0	0	0	0	1
<i>Thracia phaseolina</i>	9	0	0	0	0	0	0	0	0	0	0	4
<i>Cellaria</i> sp.	0	0	0	0	0	0	0	0	P	0	0	0
<i>Alcyonidium diaphanum</i>	0	0	0	0	0	P	0	0	0	P	0	0
<i>Phoronis</i> sp.	0	0	0	1	0	0	0	0	0	2	3	0
<i>Ophiothrix fragilis</i>	0	0	0	0	0	0	0	0	0	1	0	0
<i>Ophiocomina nigra</i>	0	2	0	0	0	0	0	0	0	0	0	5
<i>Amphiuridae</i> sp. (juv.)	0	9	0	0	0	0	2	0	10	0	3	0
<i>Amphiura chiajei</i>	0	0	9	35	14	43	11	3	0	0	15	0
<i>Amphiura filiformis</i>	0	0	1	24	15	33	4	2	0	0	29	0

Taxa (abundance per 0.1m ²)	G01	G03	G16	G18	G35	G37	G38	G41	G47	G50	G66	GEX7
<i>Amphiura</i> (<i>Ophiopeltis</i>) <i>securigera</i>	0	0	0	0	0	0	0	0	0	0	0	1
<i>Amphipholis squamata</i>	6	23	0	0	0	0	0	0	0	0	0	17
Ophiuridae sp. (juv.)	0	0	0	0	0	0	0	0	0	1	0	0
<i>Echinocardium cordatum</i>	0	0	0	0	0	1	0	0	0	0	0	0
<i>Pseudothyone raphanus</i>	0	0	0	1	1	0	0	0	0	0	0	0
<i>Thyone fusus</i>	0	0	0	0	0	0	0	0	1	0	0	0
<i>Leptopentacta elongata</i>	0	0	0	0	0	0	0	1	0	0	0	0
<i>Leptosynapta</i> sp.	0	0	P	0	0	0	P	0	0	0	0	0
<i>Leptosynapta decaria</i>	0	0	0	0	1	0	0	0	0	3	0	0
<i>Leptosynapta inhaerens</i>	0	0	0	1	1	1	0	0	0	0	1	0
<i>Leptosynapta minuta</i>	0	0	0	0	0	0	0	0	1	0	0	0
<i>Labidoplax buskii</i>	0	0	0	28	1	18	0	0	0	0	3	1
<i>Asciella aspersa</i>	0	0	0	0	0	0	0	1	0	0	0	0
Rhodophyta spp.	P	P	0	0	0	0	0	0	P	0	0	P
Corallinaceae spp.	P	P	0	0	0	0	0	0	P	0	0	P
<i>Delesseria sanguinea</i>	P	0	0	0	0	0	0	0	0	0	0	0
<i>Plocamium cartilagineum</i>	0	0	0	0	0	0	0	0	0	0	0	P
Maerl	0	0	0	0	0	0	0	0	P	0	0	0

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