MAPPING OF SEDIMENTARY MARINE BIOTOPES AROUND LUNDY, UK

by

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ABSTRACT

This paper presents the results of the first spatially continuous survey of subtidal sedimentary habitats and benthos around Lundy. The survey was undertaken in August 2007. A novel approach was used to provide a more cost-effective, objective and reliable method for biotope mapping. Spatial continuity of mapping was achieved by using GIS-modelled output of key physical parameters. Relationships between these physically defined polygons and benthic data from 49 grab samples were used to define the biotopes and their boundaries. Ten subtidal sedimentary biotopes were identified. A total of 478 invertebrate taxa and 9 seaweeds were recorded in the survey.

Keywords: *Lundy, biotope mapping, benthos, sediment, marine, Bristol Channel, GIS.*

INTRODUCTION

Biotopes are geographic units that contain broadly similar habitat characteristics and biota. Boundaries between adjacent biotopes can be very clear (as in the case of zonation of different fucoid seaweeds on a steep rocky shore) or very indistinct, as is commonly the case in marine sedimentary habitats. There is an increasing demand for biotope mapping from regulatory bodies who see it as a more practical tool for management than relying on biological data not specifically related to habitat. For example, natural fluctuations in recruitment success between years can affect the relative abundance of species at a location. Seasonal variations in the biota at a location can also result in different species being dominant in different seasons. These fluctuations in dominant species can make it extremely difficult to assess whether changes are natural or affected by human activities such as fishing or dredging. Biotope mapping can assist regulatory bodies to assess whether there have been changes in the potential of the site to support the biological community expected for a particular habitat type.

The aim of this study was to map subtidal sedimentary biotopes around Lundy based on the established biotope classification as described by the Joint Nature Conservation Committee (Connor *et al.*, 2004). Due to the restricted budget, the challenge was to produce a highly cost-effective method of sampling, sample processing and biotope matching.

Mapping of subtidal sedimentary biotopes is derived from analysis of the benthic biota (species living in or on the sediment), requiring sampling of the benthos at selected sites using grabs or corers, combined with information on habitat such as depth, sediment type and water energy (wave and tidal action). Unfortunately the high cost of analysing benthic samples means that relatively few samples can be processed, which means that the location of boundaries between different biotopes is often uncertain. In recent years biotope mapping using a combination of remotely sensed data (such as sidescan and high resolution multibeam depth) and ground-truthing using grab samples has become relatively common (e.g. Foster-Smith *et al.*, 2004; Mackie *et al.*, 2006; McGonigle *et al.*, 2009; Shumchenia & King, 2010). Combining the biological data from discrete points with physical data (either modelled or acquired by remote sensing) has not proved an easy task and is made more difficult when the desired end-point is a map showing biotopes that have previously been described and agreed at a national level. We report here on a novel approach to bringing biological and physical datasets together for subtidal biotope mapping that allows likely boundaries between biotopes to be mapped more accurately and objectively.

The marine fauna of Lundy has previously been described mainly from intertidal and dive surveys and the results have been summarised in a series of papers on various taxonomic groups (e.g. Hiscock, 1975; George, 1975; Brown and Hunnam, 1977; Hayward, 1977; King, 1977; Tyler, 1979; Atkinson and Schembri, 1981; Moore, 1981; Hiscock *et al.*, 1984). The full set of papers is available at *http://www.lundy.org.uk/island/marinebiol.html*. In addition, there was a survey in July 1975, mainly on the east coast of Lundy, which included sediment cores taken by divers (Hoare and Wilson, 1977).

METHODS

Primary Data Sources. Following a review of existing data in late August 2007, 52 sampling sites were identified and a field survey was undertaken during the period 31 August to 2 September 2007 from the survey vessel 'Datchet' operating from Bideford.

Guidance at sea was achieved using the vessel's GPS system. Positioning of each grab sample (landing on the seabed) was also taken using a Garmin 12XL GPS in stand-alone mode giving a nominal accuracy of ±5m. Positions were logged using the WGS84 and are available in both latitude and longitude or OSGB 1936 UTM projection (converted using standard settings).

Single grab samples were taken at each of 52 sites (Figure 1) using a Mini Hamon grab ($0.04m^2$). Dips were repeated if necessary to try and collect a single representative sample of the sediment. Sites were positioned to give a good geographical coverage in relation to an initial assessment of the likely habitat distribution.

The Hamon grab was chosen to give the best chance of acquiring reasonable samples of the coarse (gravel/cobble) substrata thought to be common around Lundy. In the event, nine of the 52 sites could not be sampled for sediment (interpreted as sediment absence), and three could not be sampled for biota. Epiflora and epifauna were obtained at six of the sites that yielded no sediment.

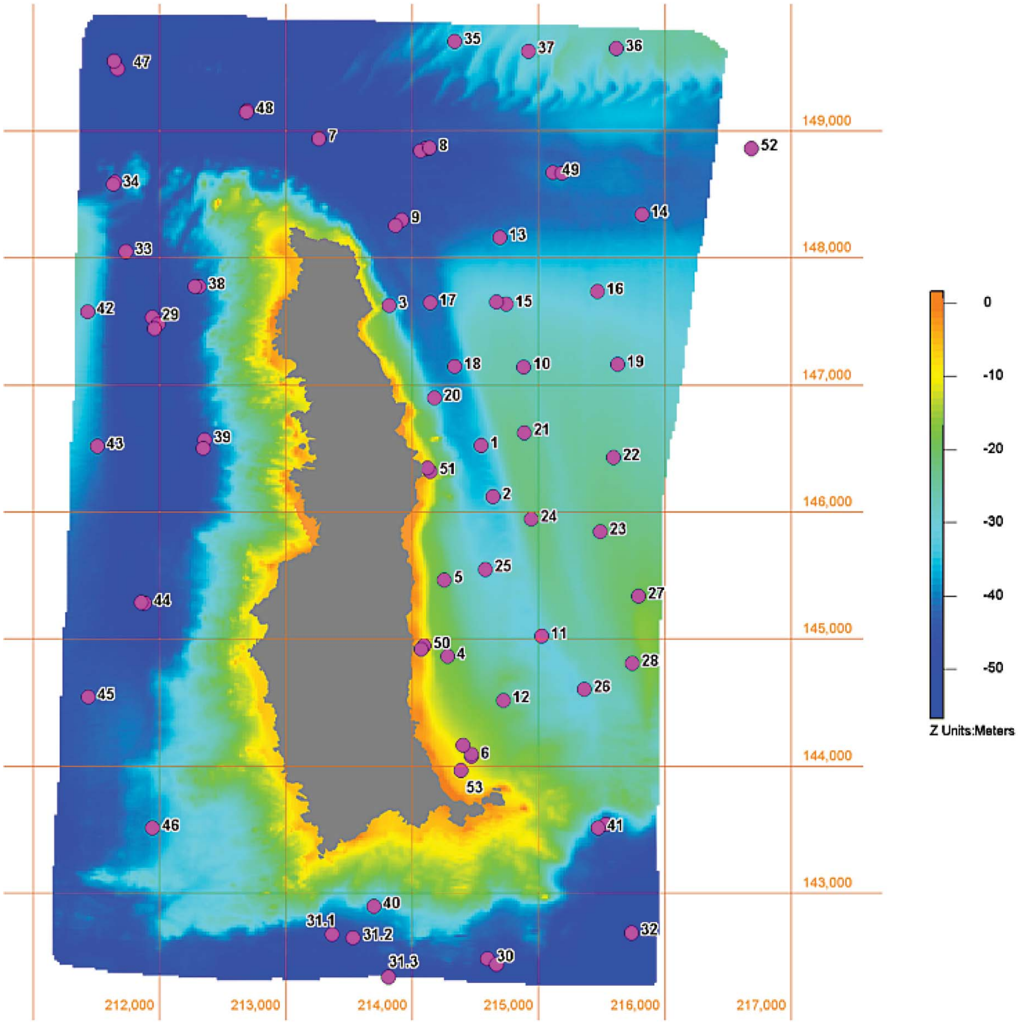

Figure 1: Sampling sites off Lundy, 2007. Seabed bathymety is shown (depth below Chart Datum)

Field processing of sediment samples. In order to retain particle-size accuracy (for gravel samples), but at the same time minimise the number of grab samples collected, a methodology was adopted whereby the coarser sediment fractions of the total sample collected were sieved for particle-size at sea, then examined for fauna. This required careful control of sieve cleaning, to ensure that biota was not lost during the sieving for particle-size. Each grab sample was examined and processed as follows:

- The full sample from the grab was emptied into a bin. A small (~250 ml) sample of the sand and fine gravel fraction (rejecting material >10mm approximately) was collected for laboratory particle-size analysis.
- The remaining sample was washed over a 4mm sieve into the receptor of a sieving table. The latter drained to the deck via a 0.5mm sieve. Thus the sample was split into two fractions (>4 mm, 4-0.5 mm) and the finer elements allowed to run to waste.

- The drained wet-weight of the 4-0.5mm fraction was recorded using a spring balance. This fraction was then examined for fauna.
- The >4 mm fraction was hand-sieved over a 0.5phi nest of sieves (-6 to -2phi, 90 to 4mm) and the weights retained on each recorded using a spring balance. These sediments were then returned to a single container and examined for fauna.

Laboratory analysis of sediments. Particle-size analysis (PSA), organic carbon (of sediments with >~5% mud) and photograph (gravel fraction, microscope images of sand) information was generated. The PSA of the fine sediment sample collected (<10mm) was analysed using standard laboratory methods. These data were combined with the field-sieved >4mm data based on the 4-10mm overlap, a method approved by The Centre for Environment, Fisheries and Aquaculture Science (CEFAS) for gravel PSA.

Field processing of biological material. After obtaining the grab sample a decision on how to process it was made, depending on the nature of the sediment. In most cases the sediment was gently agitated with seawater from a hose whilst the sample was still in a large plastic tray. The sediment was then transferred to the sieve table and the gentle washing continued until all the sediment had been thoroughly but carefully washed. During this process, just the seawater (and associated fauna) was carefully sieved over a 0.5mm mesh. Material retained on the sieve was transferred to a labelled screw-top container fixed, then preserved using 10% formalin, (buffered with borax to prevent dissolution of shell material). This 'first flush' technique has proved highly successful in previous surveys by Aquatonics Ltd as a method of obtaining small, delicate species in very good condition. The remainder of the sample was then sieved more conventionally, but using a relatively coarse mesh (1.8mm) to reduce the amount of material that had to be examined in the laboratory. Any live specimens seen on the sieve were removed, identified as far as possible and combined with the preserved material from the 0.5mm mesh. This continued until no more specimens were found. A varying proportion (5-100%, depending on volume and sediment type) of the >1.8mm fraction was then put in a labelled lidded bucket and 10% buffered formalin was added. The purpose of adding the sediment fraction was to check for any species that may be small (and therefore not visible) but dense and therefore not present in the 'first flush'. Later laboratory analysis confirmed that very few specimens were in the sediment fraction.

For samples that were mainly cobbles and coarse gravel, the material from the grab was placed onto the sieve table and hosed with water to remove surface-dwelling species, as these are often smaller and more delicate. This material was collected on a sieve with a mesh size of 0.5mm. This 'first flush' material was fixed and preserved in 10% buffered formalin in a labelled screw-top container. The remainder of the sample was then sieved through a 1.8mm mesh. Any specimens that could be seen on the 1.8mm mesh screen were removed and added to the 'first-flush' material. Representative pebbles and cobbles with attached macrofauna and species-rich stones were selected and put into a labelled lidded bucket and 10% buffered formalin was added. If sand and gravel was present a proportion (20-100%) was added to the lidded bucket.

The biota present in each sample were identified as far as practicable by eye in the field and this information was recorded on the survey log. Accurate counts were not attempted for numerous species, as they could be counted later in the laboratory. Some specimens that could be readily identified in the field were counted and returned alive, but most required laboratory checking to get an accurate identification. Any specimens returned alive were noted on the field log.

The field sampling techniques were suited to the main purpose of the survey, which was to provide a biotope map of sedimentary habitats around Lundy. Although it is likely to have recorded the majority of species present in a grab sample it will inevitably have missed some.

Laboratory examination of biota. Formalin was removed by washing each sample on a 0.5mm sieve with tap water. The 'first-flush' and hand-picked material was examined first, as this contained the majority of the specimens. With the exception of the largest cobbles, which were examined in a white tray by eye for specimens, all other material was examined under a binocular microscope, using magnifications of 7-45. Most specimens were identified by Aquatonics Ltd, using a range of taxonomic keys. Specimens which were difficult to identify in the short time available per sample were put aside and sent to Dr Peter Garwood of Identichaet for identification. Dr Garwood also provided QA advice for specimens for the voucher collection which has been produced for the Lundy study.

A modified version of the SACFOR scale was used to record the abundance of seaweeds and colonial invertebrates in the samples. The relative abundance of each taxon was assessed by eye, on a six point scale. Prior to exporting the spreadsheet to Primer®, all the taxa that were recorded on the modified SACFOR scale were assigned a score of 1 to 100, depending on their frequency in the sample.

S	Superabundant	100
A	Abundant	50
C	Common	20
F	Frequent	10
O	Occasional	5
R	Rare	1

Data were entered onto the Aquatonics Ltd Microsoft Access® database. Taxonomic nomenclature generally follows that in Howson and Picton (1997), but some taxa (e.g. some species of the polychaete genus *Syllis*) have not been described in the taxonomic literature and in these cases the most appropriate name has been used. Where available the Marine Conservation Society (MCS) code is shown (Howson and Picton, 1997), along with any common names. Data were exported to a Microsoft Excel® spreadsheet for statistical analysis.

Secondary data. A range of sources of secondary data were used to identify habitat conditions (e.g. bed sediments and tides), which included the following:

- Tides, sediments and biotopes in the outer Bristol Channel (Mackie *et al.*, 2006).
- Diver and video observations of seabed type at the Lundy European Marine Site. (Mercer *et al.*, 2004)

- Multibeam bathymetric survey of the Lundy Marine Protected Area in 2005 (data provided by HydroSurveys).
- Admiralty chart tide data.

All data were entered into a MapInfo® GIS system. Grids were generated and analysed using Vertical Mapper software running within MapInfo. The data were interpreted and a map produced to (a) guide the field survey and (b) inform the final mapping process.

BIOLOGICAL DATA PROCESSING

Data manipulation. With such a large data set (49 sampled stations and almost 490 taxa) a statistical package was needed to determine the similarities between the fauna assemblages recorded. The analytical package used was Primer®, the most commonly used statistical package for assessing benthic data. The biological data were analysed using two techniques, Cluster analysis and Multi-Dimensional Scaling (MDS), which show how similar sites are to each other (Clarke, 1993).

In Primer® the data were transformed to reduce the importance of the species that were numerous. The transformation chosen was $\log_{10}$ (N+1) where N is the number of individuals in a particular taxon. A similarity matrix was calculated in Primer® using the Bray-Curtis method. This similarity matrix was then used for Cluster Analysis and MDS.

Cluster analysis and MDS. Cluster analysis links sites that are most similar to each other in a dendrogram. The dendrogram was examined to determine clusters that could be related to JNCC biotopes. These clusters were plotted and were used as an aid in assigning biotopes.

MDS produces a two dimensional plot in which the sites most similar to each other occur closest together. The MDS plot is generally easier to interpret than the dendrogram from the cluster analysis, but there is still a subjective element in deciding which sites should be considered as a coherent group.

BIOTOPE DEFINITION

Assessing similarities between the biota at the sample stations was achieved by first examining the dendrogram to determine suitable clusters. These were then plotted onto the MDS figure to determine if the two methods produced similar groupings. However, cluster analysis and MDS do not give any additional weight to species that are important for biotope matching. There also has to be a subjective final sorting of the station groupings to take account of key characterising species and substratum type. All the sites from a cluster were grouped together on the Excel spreadsheet. Species that were characteristic of the cluster and other species that commonly occurred were listed.

With the habitat data derived from the primary and secondary data sources, a MapInfo GIS was created with eight layers of information (as polygons, described in results section below). From these layers, a series of eight grid files were created using Vertical Mapper (region to grid facility). The grid node spacing was 20m. With all grids open in Vertical Mapper, two types of analysis were performed to generate biotopes.

Step 1: The eight grids were interrogated and a dataset generated showing their value for every 20m spaced node across the survey area. These data were explored by sorting and generating subsets where different habitat conditions prevailed. The largest of these subsets were plotted to enable an understanding of how benthic conditions were varying within the study area. These were combined iteratively with the output of the faunal clusters to try and define the major associations between biotic assemblages and habitat type (see summary diagram in Appendix 1). This information was used to match to existing Joint Nature Conservation Committee (JNCC) biotopes where possible (Connor *et al.*, 2004). In some cases there was no good match, and the nearest JNCC biotope is shown. A few sites were not similar to any others in the survey and showed no match with any JNCC biotope. These are considered to be outliers that may require additional sampling before they can be matched.

Step 2: Once proto-biotopes had been identified, the range of habitat conditions found at each individual grab station were grouped and an envelope of conditions defined. These data were fed into the GIS as Grid Queries to generate maps of zones where the specified habitat conditions prevailed. The output of this exercise was a series of point samples where the biotope faunal assemblage was identified, and an associated polygon with comparable habitat conditions to those found at the point samples, where similar biotope conditions would therefore be expected. At most sites this process worked extremely well; at some sites the limiting conditions were not specific enough and no biotope habitat zone could be practically generated. This process was also only possible where several sites possessed the same cluster type; single-station biotopes have no spatial extent data associated with them. Also, there are zones in the survey area where sampling failed to provide information on bed conditions, primarily due to the hard nature of the substratum, and definition of biotope zones was not practical.

RESULTS

Flora and fauna. A total of 478 invertebrate taxa and 9 seaweed taxa were recorded (summarised in Table 1). The records will be added to the Marine Recorder database by Natural England. As expected, the greatest number of taxa was in the phylum Annelida (mainly polychaete worms), followed by Crustacea and Mollusca. Further taxa are likely to be present in the samples, especially amongst hydroids, encrusting bryozoans, sponges and nudibranchs. The full list of taxa recorded is shown in Appendix 2. The full data set of specimens found at each site is available from Aquatonics Ltd.

Some taxa were relatively ubiquitous, for example *Glycera lapidum* occurred at 63% of sites. Taxa that occurred at 10 or more sites are listed in Table 2.

Results from the cluster analysis and Multi-dimensional Scaling statistical analyses are shown in Figures 2 and 3 respectively.

Table 1: Summary of taxa recorded in the 2007 survey around Lundy

PHYLUM	NUMBER OF TAXA
Annelids (polychaete and oligochaete worms)	195
Crustaceans (e.g. shrimps, crabs and barnacles)	128
Molluscs (bivalves, snails and sea slugs)	68
Bryozoans (sea mats)	28
Echinoderms (brittlestars, sea urchins and starfish)	16
Hydroids and anemones	16
Nemertea (ribbon worms)	6
Chordates (tunicates or sea squirts)	5
Sipunculids	5
Chelicerates (sea spiders)	4
Sponges	2
Chaetognaths (arrow worms)	2
Others (1 each of flatworm, phoronid & *Branchiostoma*)	3
Total faunal taxa	478
Algae (seaweeds)	9

Rare and scarce species. The criteria to identify Rare and Scarce benthic species have been defined by Sanderson (1998):

- 'Nationally Rare' marine benthic species are those that occur in 8 or fewer of the 1546 10km x 10km squares within the 3-mile territorial limit of Great Britain and the Isle of Man.
- 'Nationally Scarce' marine benthic species are those that occur in 9-55 of the 1546 10km x 10km squares.

Unfortunately many marine species are small and easily overlooked in surveys and their true distribution is often only poorly known. The 'Rare and Scarce' concept is mainly useful for the more easily identifiable or larger species. Although this survey produced some unusual records, such as the capitellid polychaete *Peresiella clymenoides*, many would not be considered Rare or Scarce due to unreliability of the underlying marine datasets for small, difficult to identify species. For example *Peresiella clymenoides* has only recently been recorded from Irish waters (Dinneen, 1982) and may have been mis-identified in many surveys of UK benthos.

The Nationally Scarce 'thumbnail' crab *Thia scutellata* was recorded at Station 27 (Biotope 7A). This crab is a specialist burrower in loosely packed medium sands (Rees, 2001). It has also been recorded in similar sediments nearby by Mackie *et al.* (2006), but was not included in the list of decapods recorded around Lundy (Atkinson and Schembri, 1981).

The Nationally Scarce anemone *Mesacmaea mitchellii* was recorded at Station 19 (Biotope 5D), towards the northern end of the east coast sampling stations. It burrows in sand or gravel and has been recorded from depths of 15-100 m at locations near Plymouth, north Devon, south-west and mid Wales, the Isle of Man and West Ireland. It has previously been recorded by divers from muddy gravel and sand off the southern part of the east coast of Lundy (Hiscock, 1975).

Table 2: Taxa recorded at 10 or more stations in the 2007 survey

MCS Code	Latin name	Number of stations	% of stations
P 260	*Glycera lapidum*	31	63.3
P 579	*Lumbrineris gracilis*	29	59.2
ZB 212	*Echinocyamus pusillus*	27	55.1
G 1	Nemertea indeterminate	26	53.1
P 50	*Harmothoe* spp. (juv.)	25	51.0
S 539	*Gammaropsis cornuta*	24	49.0
Q 44	*Anoplodactylus petiolatus*	23	46.9
P 919	*Mediomastus fragilis*	22	44.9
S 440	*Ampelisca tenuicornis*	21	42.9
ZB 161	*Amphipholis squamata*	19	38.8
W 1702	*Modiolus modiolus*	19	38.8
P 699	*Paradoneis lyra*	19	38.8
S 248	*Urothoe elegans*	19	38.8
P 766	*Prionospio banyulensis*	18	36.7
W 2059	*Abra alba*	17	34.7
ZB 154	*Amphiura filiformis*	17	34.7
W 1805	Anomiidae (saddle oysters)	17	34.7
P 1026	*Scalibregma celticum*	17	34.7
P 712	*Apistobranchus tullbergi*	16	32.7
S 1197	*Bodotria scorpioides*	16	32.7
P 380	*Eusyllis blomstrandi*	16	32.7
P 421	*Exogone hebes*	16	32.7
P 846	*Tharyx killariensis*	16	32.7
R 41	*Verruca stroemia*	16	32.7
S 503	*Cheirocratus* spp.	15	30.6
P 1117	*Sabellaria spinulosa*	15	30.6
P 789	*Spio decorata*	15	30.6
W 2104	*Timoclea ovata*	15	30.6
Q 15	*Achelia echinata*	14	28.6
Q 33	*Callipallene brevirostris*	14	28.6
P 829	*Caulleriella alata*	14	28.6
Y 14	*Crisia aculeata*	14	28.6
P 804	*Magelona alleni*	14	28.6
ZB 166	*Ophiura* spp.(juv.)	14	28.6
S 262	*Parametaphoxus pectinatus*	14	28.6
P 94	*Pholoe synophthalmica*	14	28.6
P 718	*Poecilochaetus serpens*	14	28.6
S 138	*Synchelidium maculatum*	14	28.6
S 186	*Cressa dubia*	13	26.5
S 1208	*Eudorella truncatula*	13	26.5
P 1093	*Galathowenia oculata*	13	26.5
S 254	*Harpinia antennaria*	13	26.5
P 1098	*Owenia fusiformis*	13	26.5
W 2006	*Phaxas pellucidus*	13	26.5
P 971	*Praxillela affinis*	13	26.5
P 321	*Syllidia armata*	13	26.5
S 438	*Ampelisca spinipes*	12	24.5
S 159	*Amphilochus neopolitanus*	12	24.5
D 649	*Epizoanthus couchii*	12	24.5
P 494	*Nephtys* spp. (juv.)	12	24.5
P 921	*Notomastus latericeus*	12	24.5
S 1482	*Pisidia longicornis*	12	24.5
W 491	*Polinices pulchellus*	12	24.5
P 358	*Syllis* sp. E	12	24.5
S 498	*Abludomelita obtusata*	11	22.4
S 579	*Aora gracilis*	11	22.4
NONE	*Branchiostoma lanceolatum*	11	22.4
P 502	*Nephtys kersivalensis*	11	22.4
L 11	*Sagitta* spp.	11	22.4
P 430	*Sphaerosyllis taylori*	11	22.4
P 796	*Spiophanes kroyeri*	11	22.4
S 1142	*Tanaopsis graciloides*	11	22.4
S 423	*Ampelisca* spp. (juv.)	10	20.4
P 1139	*Ampharete lindstroemi*	10	20.4
Y 17	*Crisia eburnea*	10	20.4
P 422	*Exogone naidina*	10	20.4
S 651	*Pariambus typicus*	10	20.4
P 925	*Peresiella clymenoides*	10	20.4
P 762	*Polydora socialis*	10	20.4
P 794	*Spiophanes bombyx*	10	20.4

Seventy taxa were found at 10 or more sites. For each taxon the Marine Conservation Society Code (MCS) is shown.

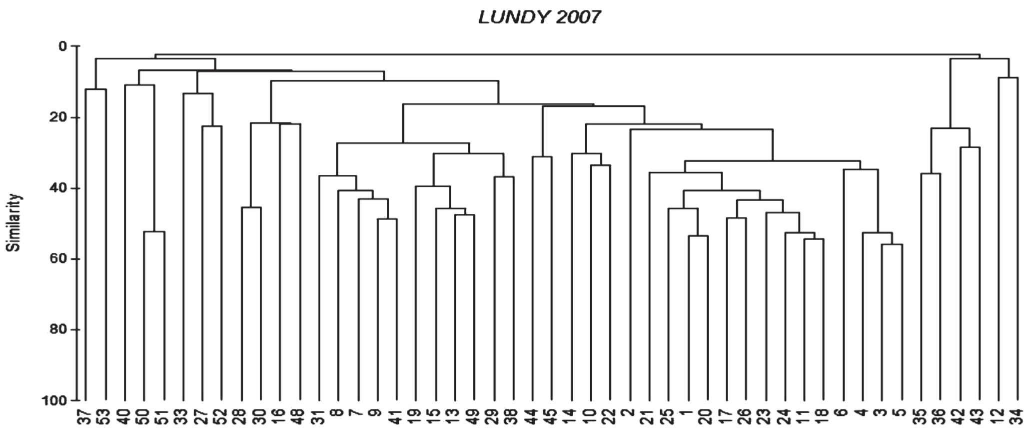

Figure 2: Dendrogram from Primer cluster analysis of community similarity between sample sites. The x axis shows the site number. The y-axis is the Bray Curtis % similarity coefficient

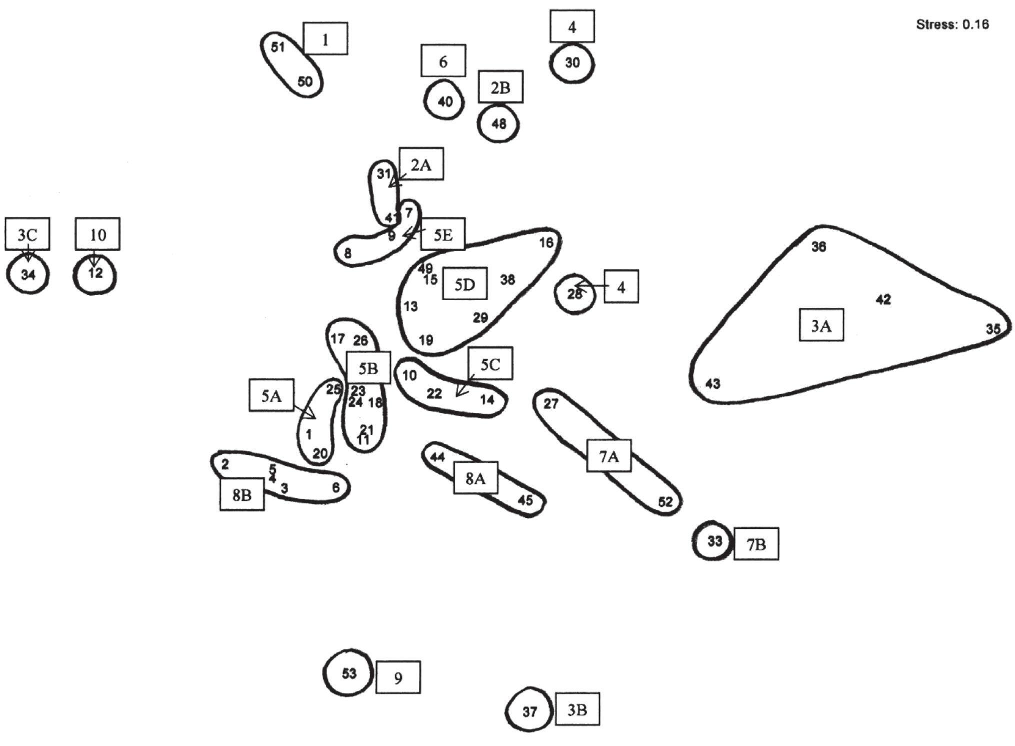

Figure 3: Multi-dimensional Scaling (MDS) plot. Polygons were drawn around sites that were considered to be in the same biotope. Labels in boxes are the biotope numbers used in Table 5

Bio-Physical Parameters

Bed sediments. The particle-size and visual characteristics of the bed sediment provide:
1) A description of the physical substrata that the benthic fauna inhabit.
2) A guide to the sedimentary conditions (water column energy, sediment sources and transport, carbon input and accumulation), key factors controlling the type of fauna found. These data also provide information on the connectivity in time and space between sampled sites, linking zones where processes have created similar deposit characteristics.

The organic carbon of the mud fraction of the sediments was very constant (1.35 to 1.68%, eight analyses conducted), so mud content can be used as a good indicator of carbon content.

A series of indices were derived that would reflect key characteristics of the sediment in determining the faunal assemblages. These are listed in Figure 4 and Table 3, and explained here.

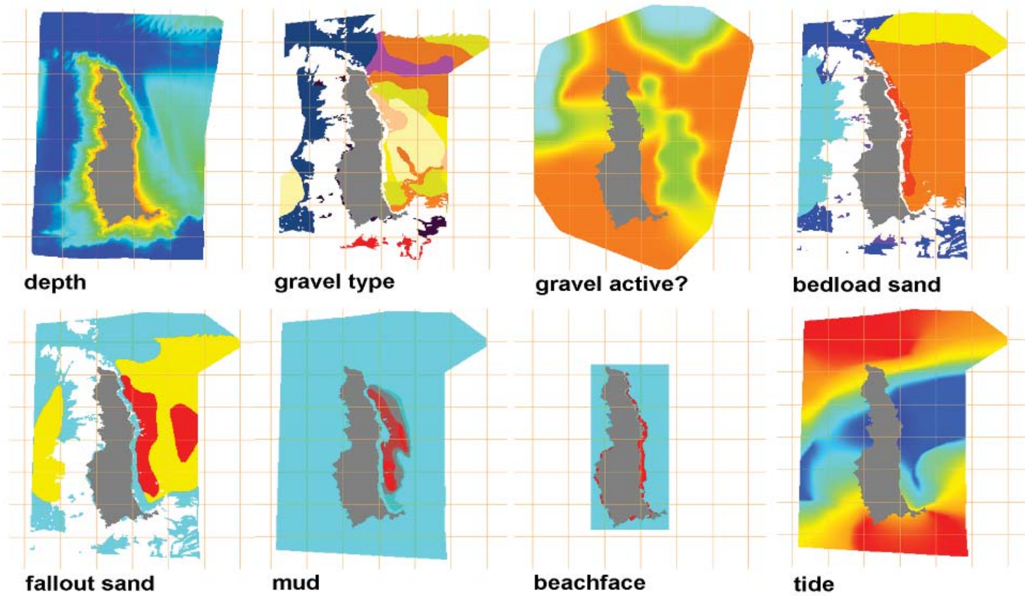

Figure 4: Habitat grids used for biotope definition. See Table 4 for colour codes

<u>GRAVEL and COBBLES</u>

1. The % content of material >2 mm, categories grouped as zero, 1-10%, 10-20% and then local higher ranges (e.g. 50-90%). At about 35% gravel, all finer sediment is essentially matrix material.
2. Whether the gravel was shell or of lithologic origin. Three categories were defined, all shell, shell with traces of stone, or mixed stone and shell. These distinctions have important implications for the stability of the sediments.
3. Whether the gravel was bright or dull - that is it had been exposed at the sediment water interface or buried within the sediment (see Plate 1). Three indices were measured, bright, dull or an indeterminate mix, for purposes of the biotope map. The information indicates whether the benthic interface was gravel or not.

Plate 1: Photographs of buried gravel (dull, left) and active gravel (bright, right)

Table 3: Categories of physical habitat parameters used in the GIS analysis. A GIS layer was created for each of the seven 'variables' listed in the table. The range of values assignable to each variable is shown, together with the GIS search instruction that could be applied to that layer during grid analyses (e.g. equal to, less than). This Table is a key for Figure 6

DEPTH	= < >		Any value (m)
GRAVEL TYPE	and/or	G1	1-10% all shell
	and/or	G2	1-10%, shell with traces of lithogenoc material
	and/or	G3	1-10%, mixed shell and lithogenic material
	and/or	G4	10-20% all shell
	and/or	G5	10-20% shell with traces of lithogenic material
	and/or	G6	10-20% mixed shell and lithogenic material
	and/or	G7	30-40% shell in sandy gravels amongst rock on W and S coast
	and/or	G8	20-30% mixed shell and lithogenic material, north of Lundy
	and/or	G9	30-70% mixed shell and lithogenic gravel, scour zone patchy deposits
	and/or	G10	50-90% principally lithogenic material, scour zone south & west of Lundy
GRAVEL ACTIVE?	= < >	0	No gravel present
		1	Dull (buried) gravel
		2	Intermediate/indeterminate
		3	Bright (active) gravel
BEDLOAD SAND	=<>	0	No or little sand
		1	West Coast, principally lithogenic mode 2.0-1.9 phi, well sorted
		2	Ridges to the north east of Lundy, principally lithogenic mode 1.5phi, very well sorted
		3	East coast, principally lithogenic, mode 2.0 phi, moderately to well sorted
		4	East coast, sand zone below beach foot, principally lithogenic, mode 0.2 - 1.5 phi moderately sorted
		5	West and South coasts, coarse shell sands within/bordering rock platforms
FINE FALLOUT SAND	=<>	0	Fine/very fine sand population absent
		1	Fine/very fine sand population forms minor component of sand fraction
		2	Fine/very fine sand population dominates sand fraction
MUD	=<>	0	0-5% siltclay
		5	5-10% siltclay
		10	10-15% siltclay
		15	15-20% siltclay
		20	>20% siltclay
BEACHFACE	Null or Any Value		Polygon of extents of subtidal beachface
TIDE	=<>	50	
		75	
		100	
		125	
		150	

SAND

With the high tidal energy levels at Lundy, the sediments generally contained well defined lognormal sand grain populations. Examples are shown in Figure 5.

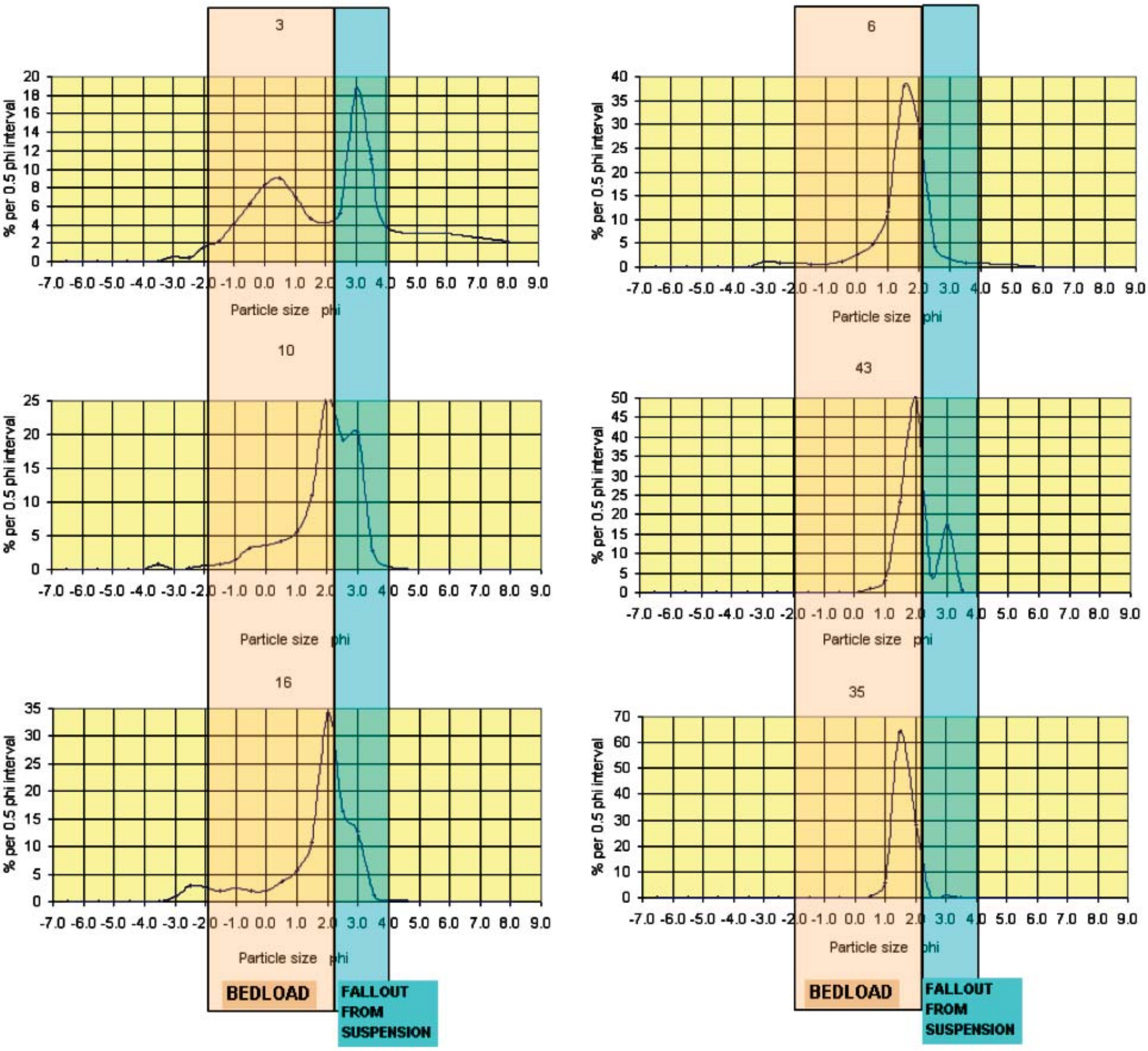

Figure 5: Examples of sand particle-size populations. For sample sites see Figure 1

4. Bedload sand population (sand mode in the range 200 to 2000μm). The presence of this population shows the occurrence of periods of bedload sand transport under tide or wave action. In general the frequency of occurrence of these episodes is indicated by the level of sorting, and the energy of the water movement by the modal size (coarser equals higher velocity). Five zones of consistent bedload type were identified for biotope mapping, with modes mostly in the range 1.5 to 2.0phi (355 to 250μm). In zones 1-4 the sands were of consistent nature, predominantly of lithogenic origin. In zone five the sands were composed of shell and bryozoan debris.

5. Suspended sand population (sand mode in the range 63 to 200μm). A particle population with a mode at 3phi (125μm) was ubiquitous through much of the survey area. The presence of this population shows a fallout of fine sand from suspension. Seven levels of the relative contribution of this population to the sand fraction at each station were identified, from absent through to very dominant. This fine sand is being generated within the Lundy surf zone, from where it escapes to accumulate in deeper quieter waters, carried by the residual currents mostly to the east, much accumulating in the lee of Lundy (Figure 6). An index was prepared from this data (suspended sand population absent, subsidiary or dominant) for use in the habitat mapping.

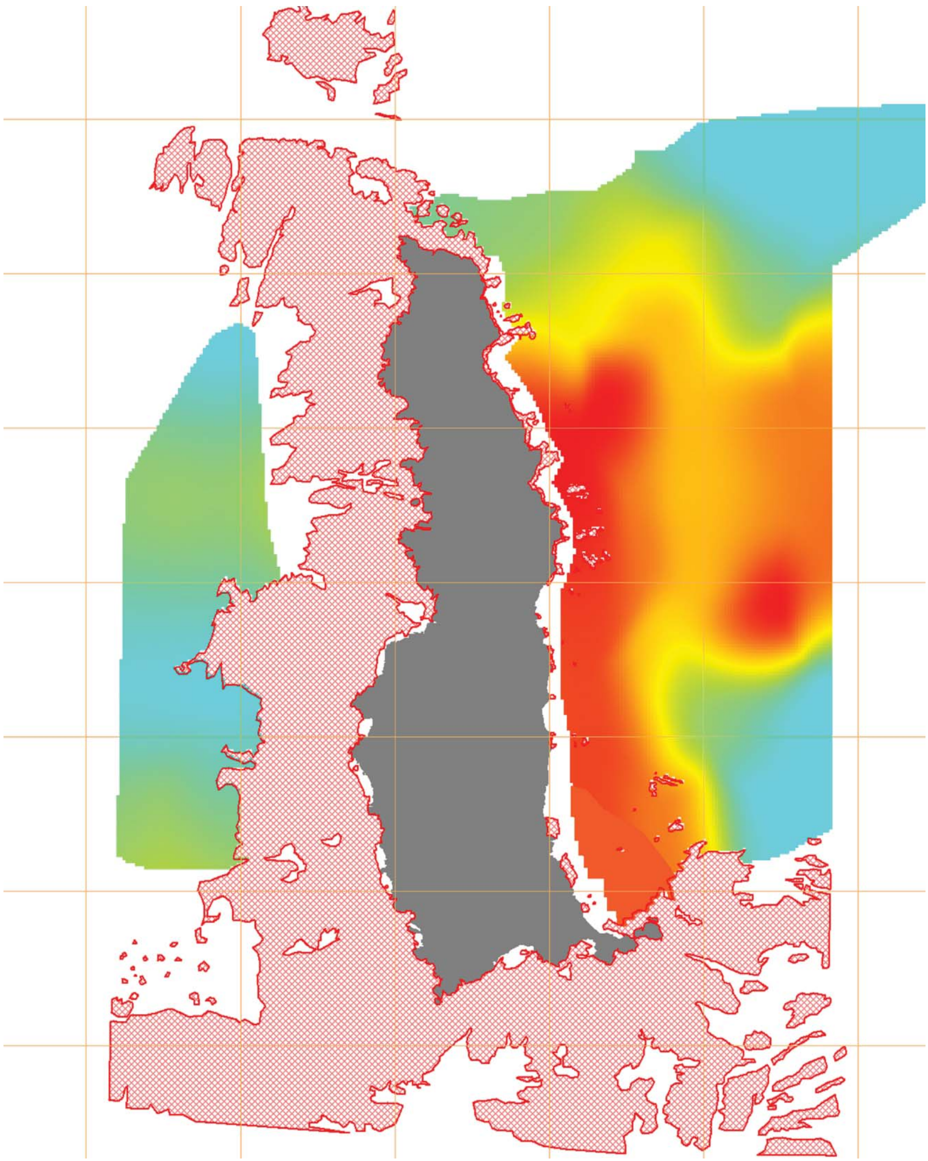

Figure 6: Fine/very fine sand accumulation around Lundy (blue is low level, red is high level, pink is rock outcrop). From GIS contouring of point sample data

SILTCLAY

6. Mud is only present in a restricted zone in the lee (east inshore) side of Lundy, where it can reach ~28% of the sediment. Five mud-content zones were created, defined by the minimum siltclay (material <63 μm) content in the zone.

Water parameters, bathymetry and tide. Salinity and temperature were taken to be uniform across the survey area. Bathymetric data were available from the 2005 Hydrosurveys work. Depths are plotted in Figures 1 and 4. When mapping zones of bed sediment conditions as regions and grids in the GIS, information plotted from earlier surveys was used as a guide, together with (in the zone immediately east of Lundy), a map of bed backscatter values (see data sources). The high-resolution (1m bin) multibeam bathymetric data was used to plot the distribution of rock (based on recognition of strata). It was also possible to plot the extent of the subtidal beachface along the eastern shore of Lundy from this data, as the extensive coarse (boulder/cobble/gravel) beach has a distinct break of slope at its foot. Smaller beachface deposits elsewhere were 'guesstimated' from OS map data.

Peak tidal current values were derived from the BIOMOR4 study, originally predicted from a modelling study of the whole Bristol Channel. The isolines in this source of information stopped several kilometres short of the Lundy coast, but based on tide race information (Chart) an approximate map showing the peak depth-averaged flow velocities has been generated (Figure 4). Peak depth-averaged velocities range from 40-150 cm s^{-1}.

Biotopes Recorded

The biotope map for grab sampling sites from the 2007 survey is shown in Figure 7 and the characteristics of each biotope are summarised in Table 4.

In the following biotope descriptions characterising taxa are listed in descending numerical combined counts for all sites in the biotope (or for colonial species the equivalent numerical value 1=Rare, 5=Occasional, 10=Frequent, 20=Common, 50=Abundant, 100=Superabundant). Where there is a tie in numerical value they are then listed alphabetically. More complete listings are provided in Appendix 2.

The JNCC biotope names used are shorthand versions of the full biotope name and start with the substratum type, which is either IR (for infralittoral rock) or SS (for subtidal sediments)

Biotope 1: Tide-swept mixed substrata. Stations 50 and 51. Cobbles and boulders in photic zone, east coast of Lundy.

Close match with JNCC biotope IR.MIR.KR.LhypTX *Laminaria hyperborea* on tide-swept, infralittoral mixed substrata. However, as there are a large number of JNCC biotopes that include *Laminaria hyperborea* it is possible that surveys by divers may record a slightly different biotope. 34-41 taxa recorded, total of 52 taxa at two stations.

Characterising taxa - algae: *Laminaria hyperborea, Membranipora membranacea, Phycodrys rubens, Membranoptera alata*. Also recorded: *Palmaria palmata, Cryptopleura ramosa, Rhodymenia pseudopalmata* and *Lomentaria articulata*.

Table 4: Summary of biotopes recorded

BIOTOPE	STATIONS IN BIOTOPE	TAXA PER GRAB (AND TOTAL IN BIOTOPE)	CHARACTERISING TAXA INCLUDE	NEAREST JNCC BIOTOPE
1	50 & 51	34-41 (52)	*Laminaria hyperborea, Membranipora membranacea, Phycodrys rubens, Membranoptera alata. Helcion pellucidum, Odontosyllis ctenostoma, Jassa falcata, Eusyllis blomstrandi, Crisia eburnea, Obelia geniculata, Aora gracilis, Electra pilosa* and *Alcyonidium gelatinosum*	IR.MIR.KR.LhypTX *Laminaria hyperborea* on tide-swept, infralittoral mixed substrata
2A	31 & 41	60-100 (126)	Barnacles (mainly *Verruca stroemia*, also *B. crenatus*), Anomiidae (saddle oysters), *Pisidia longicornis, Amphipholis squamata, Eusyllis blomstrandi, Epizoanthus couchii, Pomatoceros triqueter & P. lamarckii, Pseudoprotella phasma, Modiolus modiolus, Amphilochus manudens,* Nudibranchs	Species rich version of SS.SCS.CCS.PomB *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles
2B	48	23	Anomiidae, *Puellina venusta, Eusyllis blomstrandi, Abietinaria abietina, Electra pilosa, Escharella variolosa, Sertularia cupressina, Sertularia* spp. *Tridentata distans* and *Pomatoceros lamarckii*	Some similarities with SS.SCS.CCS.PomB *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles
3A	35, 36, 42 & 43	2-12 (18)	*Nephtys cirrosa,* often with *Glycera oxycephala, Magelona johnstoni* and *Scolelepis bonnieri*	SS.SSA.IFiSa.IMoSa Infralittoral mobile clean sand with sparse fauna
3B	37	3	*Magelona alleni*, *Magelona* sp. and *Echinocyamus pusillus*	SS.SSA.IFiSa.IMoSa Infralittoral mobile clean sand with sparse fauna
3C	34	4	*Caecum glabrum, Erichthonius* spp. *Lagis koreni, Mediomastus fragilis, Nephtys* spp. (juv) and the brittlestar *Ophiactis balli*	SS.SSA.IFiSa.IMoSa Infralittoral mobile clean sand with sparse fauna
4	28 & 30	7-26 (28)	*Modiolus modiolus, Sertularia cupressina, Dynamena pumila, Electra pilosa* and *Verruca stroemia*. Single specimens of hermit crabs (*Paguridae*) and Amphioxus (*Branchiostoma lanceolatum*) were recorded at Station 28	Similar to SS.SSA.IFiSa.ScupHyd *Sertularia cupressina* and *Hydrallmania falcata* on tide- swept sublittoral sand with cobbles or pebbles. Note that *Hydrallmania falcata* not recorded
5A	1, 20 & 2	46-66 (108)	*Ampelisca tenuicornis, Apistobranchus tullbergi, Parametaphoxus pectinatus, Eudorella truncatula,* Nemertea indeterminate, *Mediomastus fragilis, Lumbrineris gracilis, Praxillela affinis, Exogone hebes, Harmothoe* spp (juv)., *Paradoneis lyra, Nephtys kersivalensis, Tanaopsis graciloides, Spio decorata, Bodotria scorpioides* and *Spiophanes bombyx*	Station 25 had some similarities with SS.SCS.CCS.MedLumVen *Mediomastus fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel, due to the presence of the venerid bivalve *Timoclea ovata*. Stations 1 & 20 shared many taxa with St 25, but also had similarities with Biotope 8B
5B	11, 17, 18, 21, 23, 24,	47-100 (217)	Characterising taxa: *Ampelisca tenuicornis, Apistobranchus tullbergi, Urothoe elegans, Poecilochaetus serpens, Lumbrineris gracilis, Gammaropsis cornuta, Glycera lapidum, Harpinia antennaria. Timoclea ovata* and *Mediomastus fragilis*	Most stations were a good match with SS.SCS.CCS.MedLumVen *Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel
5C	10, 14 & 22	32-63 (101)	*Abludomelita obtusata, Gammaropsis cornuta, Urothoe elegans, Glycera lapidum, Echinocyamus pusillus, Nemertea indeterminate, Lumbrineris gracilis, Anoplodactylus petiolatus* and *Paradoneis lyra*.	Stations 10 and 22 were a reasonably good match with SS.SCS.CCS.MedLumVen *Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel. The venerid bivalves were *Timoclea ovata* (St 10) and *Circomphalus casina* and *Dosinia lupinus* | (both at St 22)
5D	13, 15, 16, 19, 29, 38	23-78 (192)	*Gammaropsis cornuta, Glycera lapidum* and *Echinocyamus pusillus.* Usually present: *Sabellaria spinulosa, Modiolus modiolus, Verruca stroemia,* Anomiidae, *Crisia aculeata, Achelia echinata, Prionospio banyulensis, Ampelisca spinipes, Syllis* sp. E and *Timoclea ovata*	Some stations were a reasonably good match with SS.SCS.CCS.MedLumVen *Mediomastus fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel. The densities of *Sabellaria spinulosa* were moderately high at 5 of the 6 stations, and it may be that this grouping represents a biotope complex of SS.SCS.CCS.MedLumVen and S.SBR.PoR.SspiMx *Sabellaria spinulosa* on stable circalittoral mixed sediment.

Table 4: Summary of biotopes recorded (cont.)

BIOTOPE	STATIONS IN BIOTOPE	TAXA PER GRAB (AND TOTAL IN BIOTOPE)	CHARACTERISING TAXA INCLUDE	NEAREST JNCC BIOTOPE
5E	7, 8 & 9	91-123 (208)	Anomiidae (saddle oysters), *Sabellaria spinulosa, Modiolus modiolus, Verruca stroemia, Pisidia longicornis, Harmothoe* spp., *Achelia echinata, Eusyllis blomstrandi, Crisia aculeata, Cressa dubia, Glycera lapidum, Phtisica marina, Amphipholis squamata,* Nudibranchia indeterminate, *Aora gracilis, Echinocyamus pusillus, Modiolarca tumida, Syllidia armata, Lumbrineris gracilis, Erichthonius punctatus, Sphenia binghami, Epizoanthus couchii, Hiatella arctica, Ampelisca tenuicornis, Ampharete lindstroemi, Callipallene brevirostris, Maera othonis, Gammaropsis cornuta, Parvicardium ovale, Crisia eburnea, Adyte pellucida, Pholoe synophthalmica* and *Ampelisca spinipes*	SS.SBR.PoR.SspiMx *Sabellaria spinulosa* on stable circalittoral mixed sediment
6	40	25	Large number of the gammarid amphipod *Socarnes erythrophthalmus* and high diversity of foliose bryozoans (*Crisia aculeata, Crisia eburnea, Crisia denticulata* and *Crisidia cornuta*)	Unmatched to any JNCC biotope. The substrate was fine shell gravel, with the venerid *Clausinella fasciata* present. The substrate and presence of venerid bivalves suggests some similarities with SS.SCS.CCS.MedLumVen *Mediomastus fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel, but *M. fragilis and Lumbrineris* spp. were absent
7A	27 & 52	13-30 (38)	*Glycera lapidum*, *Polygordius lacteus, Hesionura elongata, Pisione remota* and *Grania* spp.	Similar to SS.SCS.ICS.HeloMsim *Hesionura elongata* and *Microphthalmus similis* with other interstitial polychaetes in infralittoral mobile coarse sand. In these examples the polychaete *Microphthalmus similis* was not recorded
7B	33	4	Single specimens each of *Glycera lapidum*, *Hesionura elongata*, *Amphilochus neopolitanus* and *Ophiura* sp.	Similar to SS.SCS.ICS.HeloMsim *Hesionura elongata* and *Microphthalmus similis* with other interstitial polychaetes in infralittoral mobile coarse sand. In these examples the polychaete *Microphthalmus similis* was not recorded
8A	44 & 45	36-37 (53)	*Abra alba, Echinocyamus pusillus, Glycera lapidum, Spisula elliptica, Phaxas pellucidus, Sthenelais limicola, Sagitta* spp., *Callianassa subterranea, Lagis koreni* and *Polinices pulchellus*	No close match with any JNCC biotope. Intermediate between SS.SMU.CSaMu.LkorPpel *Lagis koreni* and *Phaxas pellucidus* in circalittoral sandy mud and SS.SSA.CMuSa.AalbNuc *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment
8B	2, 3, 4, 5, 6	30-52 (117)	*Tubificoides amplivasatus, Parametaphoxus pectinatus, Tharyx killariensis, Spio decorata,* Nemertea indeterminate, *Ampelisca tenuicornis, Ampelisca* spp. (juv) and *Lumbrineris gracilis*. Usually present *Harpinia antennaria, Eudorella truncatula, Abra alba, Pariambus typicus, Amphiura filiformis, Perioculodes longimanus, Phaxas pellucidus, Anoplodactylus petiolatus, Nephtys hombergii* & *Mediomastus fragilis*	No close match with any JNCC biotope. Intermediate between SS.SMU.CSaMu.LkorPpel *Lagis koreni* and *Phaxas pellucidus* in circalittoral sandy mud and SS.SSA.CMuSa.AalbNuc *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment
9	53	11	*Ampelisca brevicornis, Magelona alleni, Marphysa bellii, Aricidea minuta, Lumbrineris gracilis, Nephtys hombergii, Pariambus typicus, Phaxas pellucidus, Polydora socialis, Terebellides stroemi* and *Tharyx killariensis*	No close match with any JNCC biotope. Intermediate between SS.SMU.CSaMu.LkorPpel *Lagis koreni* and *Phaxas pellucidus* in circalittoral sandy mud and SS.SSA.IMuSa.SsubNhom *Spisula subtruncata* and *Nephtys hombergii* in shallow muddy sand. Note that neither *Lagis koreni* nor *Spisula subtruncata* were recorded
10	12	14	*Hydroides norvegica, Epizoanthus couchii, Golfingia vulgaris vulgaris, Notomastus latericeus, Ampelisca spinipes, Amphiura filiformis, Euclymene lumbricoides, Mediomastus fragilis, Nematonereis unicornis, Notomastus sp., Photis longicaudata, Terebellides stroemi, Trichobranchus roseus* and *Upogebia deltaura.*	Species-poor variation of SS.SMX.OMx Offshore circalittoral mixed sediment?

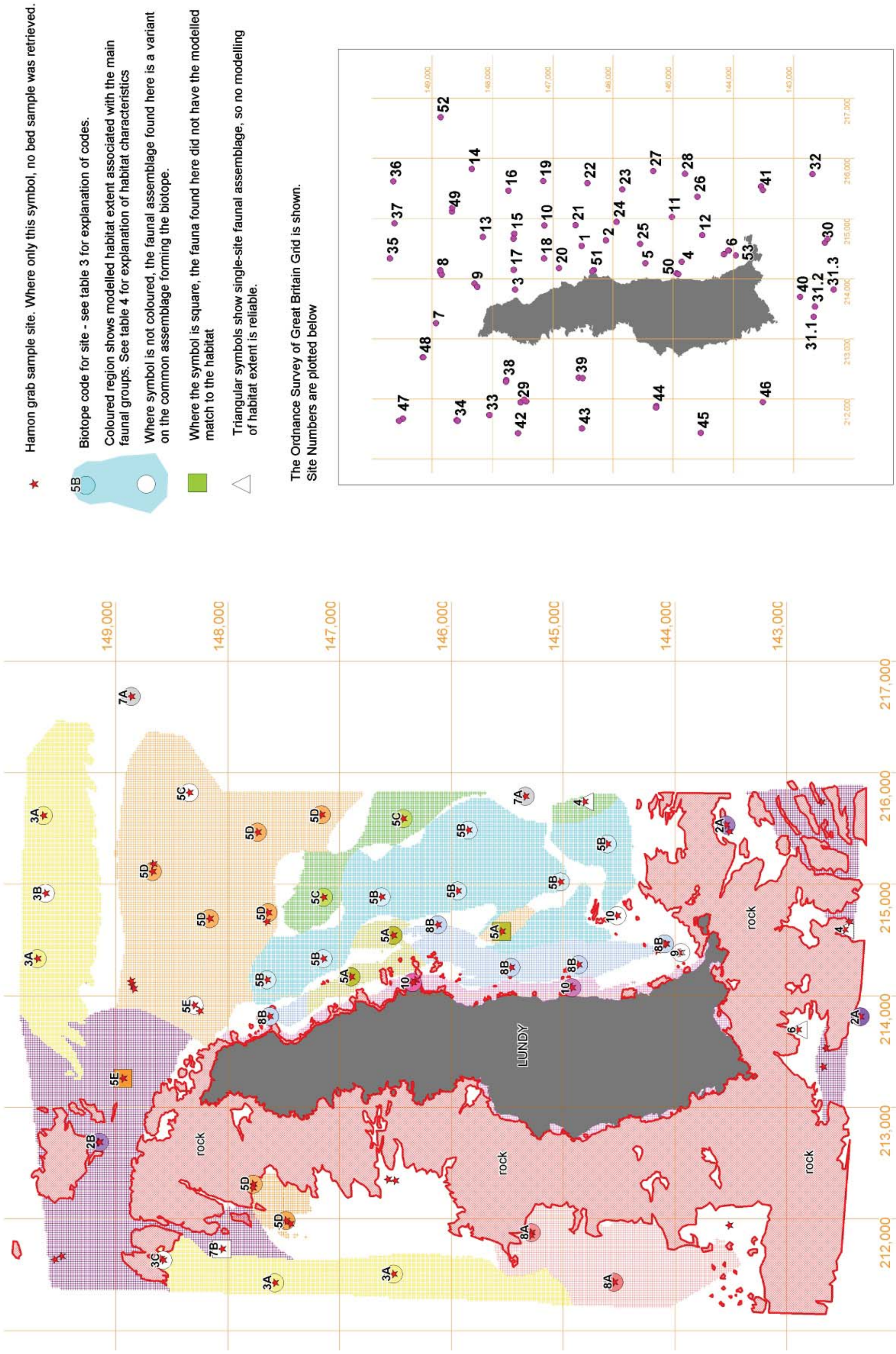

Figure 7: Map of sedimentary biotopes around Lundy

Characterising taxa - invertebrates: *Helcion pellucidum, Odontosyllis ctenostoma, Jassa falcata, Eusyllis blomstrandi, Crisia eburnea, Obelia geniculata, Aora gracilis, Electra pilosa, Dexamine spinosa, Pseudoprotella phasma, Apherusa bispinosa, Ischyrocerus anguipes*?, *Autolytus* spp., *Phtisica marina, Caprella acanthifera, Oriopsis armandi, Modiolus modiolus, Ophiothrix fragilis* and *Alcyonidium gelatinosum*.

Biotope 2 complex: Cobbles and pebbles. Similar to SS.SCS.CCS.PomB *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles.

Biotope 2A. Stations 31 & 41. Cobbles. Scoured cobble pavements at St 31; stable cobbles with some gravel/sand matrix at St 41.

Similar to SS.SCS.CCS.PomB *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles. This is a species-rich variation, suggesting that the cobbles are not regularly disturbed.

60-100 taxa per grab, total of 126 taxa recorded in three sites.

Similar to Assemblage V of Mackie *et al.* (2006), which they did not assign to a JNCC biotope and considered to be a biotope complex. However, they also stated that the presence of *Pomatoceros* spp., barnacles and bryozoans could be viewed as indicative of SS.SCS.CCS.PomB. Their nearest station in this Assemblage was OBC 28. This was their second closest station to Lundy, approximately due north.

Characterising taxa: Barnacles (mainly *Verruca stroemia*, also *B. crenatus* at Station 31), Anomiidae (saddle oysters), *Pisidia longicornis, Harmothoe* spp., *Amphipholis squamata, Eusyllis blomstrandi, Epizoanthus couchii, Pomatoceros triqueter, P. lamarckii*, *Pseudoprotella phasma, Modiolus modiolus, Amphilochus manudens, Cressa dubia,* Nudibranchia indeterminate, *Balanus crenatus, Ceradocus semiserratus, Janira maculosa, Cheirocratus* spp., *Stenothoe marina, Glycera lapidum, Callipallene brevirostris, Hinia incrassata, Pholoe synophthalmica, Sphaerosyllis bulbosa, Lepidonotus squamatus* and *Munna minuta.*

Biotope 2B. Station 48. Scoured cobble pavement.

Some similarities with SS.SCS.CCS.PomB *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles; however at Station 48 no barnacles were recorded.

23 taxa per grab.

Similar to Assemblage V of Mackie *et al.* (2006), which they did not assign to a JNCC biotope and considered to be a biotope complex (see above). Their nearest station in this Assemblage was OBC 28. This was their second closest station to Lundy, approximately due north of the island and close to Station 48.

The commonest (or, in the case of colonial bryozoans, the most widespread) taxa were Anomiidae, *Puellina venusta, Eusyllis blomstrandi, Abietinaria abietina, Electra pilosa, Escharella variolosa, Sertularia cupressina, Sertularia* spp. *Tridentata distans* and *Pomatoceros lamarckii*.

Biotope 3 complex: Mobile medium sand. SS.SSA.IFiSa.IMoSa

Biotope 3A. Stations 35, 36, 42 & 43. Well sorted medium sands with active bed transport. SS.SSA.IFiSa.IMoSa Infralittoral mobile clean sand with sparse fauna.

2-12 taxa per grab. Total of 18 taxa recorded at the four stations.

Characterising taxa: *Nephtys cirrosa.*

Other taxa recorded at 50% of stations: *Glycera oxycephala, Magelona johnstoni* and *Scolelepis bonnieri.*

Biotope 3B. Station 37. Well sorted medium sands with active bed transport. SS.SSA.IFiSa.IMoSa Infralittoral mobile clean sand with sparse fauna.

3 taxa per grab (*Magelona alleni*, *Magelona* sp. and *Echinocyamus pusillus*).

Due to the very sparse invertebrate fauna in this biotope it is possible that Station 37 was very similar to those in Biotope 3A, and that further grab samples at this location would have included specimens of, for example, *Nephtys cirrosa*.

Biotope 3C. Station 34. Well sorted medium sands with active bed transport.

SS.SSA.IFiSa.IMoSa Infralittoral mobile clean sand with sparse fauna.

The only taxa recorded were single specimens of *Caecum glabrum, Erichthonius* sp. *Lagis koreni, Mediomastus fragilis, Nephtys* sp. (juv) and the brittlestar *Ophiactis balli*.

Biotope 4: Tide-swept sand with cobbles or pebbles. Stations 28 & 30. Two different sediment types. Station 28 was 1-10% gravel (shell with some lithogenic) and medium sand bedload transport. Station 30 was sandy gravel with a 30-40% shell content.

Similar to SS.SSA.IFiSa.ScupHyd *Sertularia cupressina* and *Hydrallmania falcata* on tide-swept sublittoral sand with cobbles or pebbles. Note that *Hydrallmania falcate* was not recorded.

7-26 taxa per grab. Total of 28 taxa recorded at the three stations.

Similar to Assemblage IVc of Mackie *et al.* (2006).

Characterising taxa: *Modiolus modiolus, Sertularia cupressina, Dynamena pumila, Electra pilosa* and *Verruca stroemia*.

Single specimens of hermit crabs (Paguridae) and Amphioxus (*Branchiostoma lanceolatum*) were recorded at Station 28.

Biotope 5 complex: Coarse sand or gravel/mixed sediment. 5A-5D had similarities with SS.SCS.CCS.MedLumVen *Mediomastus fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel. Biotope 5D had relatively high densities of *Sabellaria spinulosa* and may be intermediate between S.SCS.CCS.MedLumVen and SS.SBR.PoR.SspiMx *Sabellaria spinulosa* on stable circalittoral mixed sediment. Biotope 5E had even higher densities of *Sabellaria spinulosa* and was a reasonable match with SS.SBR.PoR.SspiMx. One of the most interesting features of Biotopes 5A and 5B were the high densities of the polychaete *Apistobranchus tullbergi*, which was not recorded at any of the locations sampled by Mackie *et al.* (2006). This species is strongly associated with the higher mud fraction sediments that lie along the east coast of Lundy. It is possible that the presence of this species in high densities represents an entity that could be proposed to the JNCC as a new biotope.

Sabellaria spinulosa was recorded at 15 stations. The highest densities occurred at St 8 (218 individuals, equivalent to 5450 m^{-2}), in Biotope 5E. The two other stations in Biotope 5E (St 7 and St 9) also had moderately high densities of *S. spinulosa,* equivalent to 525 and 875 m^{-2} respectively. St 26 (Biotope 5B) had a density of 1975 m^{-2}. Using a proposed scoring system for evaluating *Sabellaria spinulosa* 'reefiness' (Hendrick & Foster-Smith, 2006) most of the locations where *Sabellaria spinulosa* was present in reasonable numbers would be considered to belong to the 'low reefiness' category, but St 26 and St 8 were of 'medium reefiness'. The latter two stations were not in the 'high reefiness' category as the tubes did not extend more than 15 cm above the surface and there is no evidence that they were found 'persistently over time' at the same location.

Biotope 5A. Stations 1, 20 and 25. Three samples with various mixed sediments (St 1 mud with some medium sand and shell gravel; St 20 sand with some mud and some fine shell gravel; St 25 gravel with medium /coarse sand and some mud).

Station 25 had some similarities with SS.SCS.CCS.MedLumVen *Mediomastus fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel, due to the presence of the venerid bivalve *Timoclea ovata*.

Stations 1 & 20 shared many taxa with St 25, but also had similarities with Biotope 8B.

46-66 taxa per grab (mean 54 taxa). Total of 108 taxa at three stations.

Broad similarities with Assemblage IVa of Mackie *et al.* (2006).

Characterising taxa: *Ampelisca tenuicornis, Apistobranchus tullbergi, Parametaphoxus pectinatus, Eudorella truncatula,* Nemertea indeterminate*, Mediomastus fragilis, Lumbrineris gracilis, Praxillela affinis, Exogone hebes, Harmothoe* spp.*, Paradoneis lyra, Nephtys kersivalensis, Tanaopsis graciloides, Spio decorata, Bodotria scorpioides* and *Spiophanes bombyx*. Taxa present at 67% of stations: *Tubificoides amplivasatus, Anoplodactylus petiolatus, Spiophanes kroyeri, Peresiella clymenoides, Gammaropsis cornuta, Abra alba, Tharyx killariensis, Galathowenia oculata, Scalibregma celticum, Euclymene* sp A, *Notomastus latericeus, Sthenelais boa, Ampharete lindstroemi, Amphiura filiformis, Glycera alba, Glycera lapidum, Phyllodoce rosea, Diastylis* sp (juv), *Ebalia cranchii, Glycinde nordmanni, Nephtys* spp. (juv), *Phaxas pellucidus* and *Podarkeopsis capensis*.

Biotope 5B. Stations 11, 17, 18, 21, 23, 24 & 26.

Most sites had 1-10% gravel (shell or mixed), 20-25% mud and bedload transport of medium sand. Most stations were a good match with SS.SCS.CCS.MedLumVen *Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel. As would be expected for this biotope the main venerid bivalve was *Timoclea ovata*. The high densities of the polychaete *Apistobranchus tullbergi* are probably unusual for this biotope, particularly considering that this species was not recorded at any locations in the nearby survey by Mackie *et al.* (2006).

47-100 taxa per grab (mean 78.4). Total of 217 taxa at seven stations.

Similar to Assemblage IVa of Mackie *et al.* (2006).

Characterising taxa: *Ampelisca tenuicornis, Apistobranchus tullbergi, Urothoe elegans, Poecilochaetus serpens, Lumbrineris gracilis, Gammaropsis cornuta, Glycera lapidum* and *Harpinia antennaria*.

Taxa present at 71% of stations included: *Abra alba, Tubificoides diazi*?, *Praxillela affinis, Harmothoe* spp.*, Tharyx killariensis, Anoplodactylus petiolatus,* Nemertea indeterminate*, Amphiura filiformis, Exogone hebes, Nephtys kersivalensis, Phoronis* spp.*, Parametaphoxus pectinatus, Galathowenia oculata, Mediomastus fragilis, Echinocyamus pusillus, Pholoe synophthalmica, Photis longicaudata, Scalibregma inflatum, Eudorella truncatula, Paradoneis lyra, Amphipholis squamata, Caulleriella alata, Owenia fusiformis, Spiophanes kroyeri, Tanaopsis graciloides, Magelona alleni, Scalibregma celticum, Euclymene oerstedii, Prionospio banyulensis, Timoclea ovata, Bodotria scorpioides* and *Polinices pulchellus*.

Biotope 5C. Stations 10, 14 and 22. Stations 10 and 22 had 1-10% mixed gravel, with bedload transport of medium sand and some fine sand fallout. Station 14 was broadly similar but had a higher proportion of gravel.

Sites 10 and 22 were a reasonably good match with SS.SCS.CCS.MedLumVen *Mediomastus fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel. The venerid bivalves were *Timoclea ovata* (Station 10) and *Circomphalus casina* and *Dosinia lupinus* (both at Station 22). Only Station 10 had *Mediomastus fragilis* present (a single specimen).

32-63 taxa (mean 46.0). Total of 101 taxa at three stations.

Broad similarities with Assemblage IVa of Mackie *et al.* (2006).

Characterising taxa: *Abludomelita obtusata, Gammaropsis cornuta, Urothoe elegans Glycera lapidum, Echinocyamus pusillus,* Nemertea indeterminate*, Lumbrineris gracilis, Anoplodactylus petiolatus* and *Paradoneis lyra*.

Taxa present at 67% of stations: *Tubificoides diazi*?*, Apistobranchus tullbergi, Amphilochus neopolitanus, Exogone hebes, Notomastus* sp. E*, Phyllochaetopterus (socialis?), Galathowenia oculata, Owenia fusiformis, Amphipholis squamata, Amphiura filiformis, Syllides japonica, Synchelidium maculatum, Aglaophamus rubella, Aponuphis bilineata, Caulleriella alata, Guernea coalita, Marphysa bellii, Sphaerosyllis bulbosa, Syllis* sp. D*, and* venerid bivalves (*Timoclea ovata, Circomphalus casina & Dosinia lupinus*).

Biotope 5D. Stations 13, 15, 16, 19, 29, 38 and 49. Most stations had 10-20% of mixed gravel, with bedload transport of medium sand and a zone of some fine sand fallout. Station 29 was similar but with 30-70% of mixed gravel.

Some stations were a reasonably good match with SS.SCS.CCS.MedLumVen *Mediomastus fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel. As would be expected for this biotope the main venerid bivalve was *Timoclea ovata*. The number of *Mediomastus fragilis* was lower than expected and this species was only recorded at Stations 13 and 29. The densities of *Sabellaria spinulosa* were moderately high at 5 of the 6 stations, and it may be that this grouping represents a biotope complex of SS.SCS.CCS.MedLumVen and S.SBR.PoR.SspiMx *Sabellaria spinulosa* on stable circalittoral mixed sediment.

23-78 taxa per grab (mean = 58). Total of 192 taxa at seven stations.

Similar to Assemblage IVe of Mackie *et al.* (2006).

Characterising taxa: *Gammaropsis cornuta, Glycera lapidum* and *Echinocyamus pusillus.*
Taxa present at 71% of stations: *Sabellaria spinulosa, Modiolus modiolus, Verruca stroemia,* Anomiidae*, Crisia aculeata, Amphilochus neopolitanus, Cheirocratus* spp.*, Cressa dubia, Harmothoe* spp. *Achelia echinata, Leptocheirus hirsutimanus, Polydora socialis, Anoplodactylus petiolatus, Prionospio banyulensis, Ampelisca spinipes, Syllis* sp. E and *Timoclea ovata.*

Other notable taxa: the Nationally Scarce burrowing anemone *Mesacmaea mitchellii* was recorded at Station 19.

Biotope 5E. Stations 7, 8, 9. Stations 8 & 9 had 20-30% mixed gravel, with bedload transport of medium sand and a zone of some fine sand fallout. Station 7 was different, possibly a patch of mobile gravel on scoured bed. SS.SBR.PoR.SspiMx *Sabellaria spinulosa* on stable circalittoral mixed sediment.

91-123 taxa per grab, total of 208 taxa recorded in three sites.

Very similar to Assemblage IVe of Mackie *et al.* (2006).

Characterising taxa: Anomiidae (saddle oysters), *Sabellaria spinulosa, Modiolus modiolus, Verruca stroemia, Pisidia longicornis, Harmothoe* spp., *Achelia echinata, Eusyllis blomstrandi, Crisia aculeata, Cressa dubia, Glycera lapidum, Phtisica marina, Amphipholis squamata,* Nudibranchia indeterminate, *Aora gracilis, Echinocyamus pusillus, Modiolarca tumida, Syllidia armata, Lumbrineris gracilis.*

Taxa present at 67% of stations: *Erichthonius punctatus*, Anomiidae, *Sphenia binghami, Epizoanthus couchii, Cheirocratus* spp., *Hiatella arctica, Ampelisca tenuicornis, Ampharete lindstroemi, Callipallene brevirostris, Maera othonis, Gammaropsis cornuta, Parvicardium ovale, Crisia eburnea, Adyte pellucida, Pholoe synophthalmica* and *Ampelisca spinipes.*

Biotope 6. Fine shell gravel. Station 40. Sandy gravel, with 30-40% shell and coarse shell sand. Unmatched to any JNCC biotope. The substratum was fine shell gravel, with the venerid *Clausinella fasciata* present. Further sampling is needed to accurately assess this biotope. The substratum and presence of venerid bivalves suggests some similarities with SS.SCS.CCS.MedLumVen *Mediomastus fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel, though neither *Mediomastus fragilis* nor *Lumbrineris* spp. were present in the sample.

25 taxa recorded at a single station.

The main characteristics of the fauna at Station 40 were the large number of the gammarid amphipod *Socarnes erythrophthalmus*, and the high diversity of turf-forming bryozoans (*Crisia aculeata, Crisia eburnea, Crisia denticulata* and *Crisidia cornuta*).

Biotope 7 complex. Mobile coarse sand. Similar to SS.SCS.ICS.HeloMsim *Hesionura elongata* and *Microphthalmus similis* with other interstitial polychaetes in infralittoral mobile coarse sand. In these examples the polychaete *Microphthalmus similis* was not recorded.

<u>Biotope 7A</u>. Stations 27 & 52. Both stations had some fine sand fallout. Station 27 had 20% shell gravel, with bedload transport of medium sand and some coarse sand. Station 52 had 1-10% mixed gravel, with bedload transport of medium-coarse sand. Similar to SS.SCS.ICS.HeloMsim *Hesionura elongata* and *Microphthalmus similis* with other interstitial polychaetes in infralittoral mobile coarse sand. In these examples the polychaete *Microphthalmus similis* was not recorded.

13-30 taxa per grab. Total of 38 taxa at two sites.

Similar to Assemblage IIIc of Mackie *et al.* (2006), which also lacked *Microphthalmus similis.*

Characterising taxa: *Glycera lapidum*, *Polygordius lacteus, Hesionura elongata, Pisione remota* and *Grania* spp.

Other notable taxa: Station 27 had the only record of the Nationally Scarce crab *Thia scutellata*. As this species is only found at sites with loosely packed medium sands that allow easy burrowing, it is likely that its distribution is closely linked to that of this biotope. Mackie *et al.* (2006) found most *Thia scutellata* in the equivalent assemblage (IIIa-d).

<u>Biotope 7B</u>. Station 33. Within a scoured zone of lag deposits, patchy sediment with 30-70% mixed gravel and some matrix sand. Similar to SS.SCS.ICS.HeloMsim *Hesionura elongata* and *Microphthalmus similis* with other interstitial polychaetes in infralittoral

mobile coarse sand. In these examples the polychaete *Microphthalmus similis* was not recorded. Similar to Assemblage IIIc of Mackie *et al.* (2006), which also lacked *Microphthalmus similis.*

4 taxa per grab (single specimens each of *Glycera lapidum*, *Hesionura elongata*, *Amphilochus neopolitanus* and *Ophiura* sp.).

Biotope 8 complex. Mud and sand. No close match with any JNCC biotope, but intermediate between SS.SMU.CSaMu.LkorPpel *Lagis koreni* and *Phaxas pellucidus* in circalittoral sandy mud and SS.SSA.CMuSa.AalbNuc *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment.

Biotope 8A. Stations 44 & 45. Both stations had bedload transport of medium sand and traces of fine sand fallout. Station 44 had 30-70% mixed gravel; Station 45 had 1-10% shell gravel. No close match with any JNCC biotope, but intermediate between SS.SMU.CSaMu.LkorPpel *Lagis koreni* and *Phaxas pellucidus* in circalittoral sandy mud and SS.SSA.CMuSa.AalbNuc *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment. Only single specimens of *Lagis koreni* were recorded at each station. *Nucula nitidosa* was not recorded. The JNCC biotope classification (Connor *et al.*, 2004) considers that these two biotopes and SS.SSA.IMuSa.SsubNhom *Spisula subtruncata* and *Nephtys hombergii* in shallow muddy sand may be found at the same locations in different years, due to differences in recruitment success of the dominant taxa.

36-37 taxa. Total of 53 taxa at two stations.

Similar to Assemblages IIb and IIc of Mackie *et al.* (2006).

Characterising taxa: *Abra alba, Echinocyamus pusillus, Glycera lapidum, Spisula elliptica, Phaxas pellucidus, Sthenelais limicola, Sagitta* spp.*, Callianassa subterranea, Lagis koreni* and *Polinices pulchellus*.

Biotope 8B. Stations 2, 3, 4, 5 & 6. All sites had 1-10% gravel (shell or mixed) with bedload transport of medium and coarse sand, all dominated by fine sand fallout. No close match with any JNCC biotope, but intermediate between SS.SMU.CSaMu.LkorPpel *Lagis koreni* and *Phaxas pellucidus* in circalittoral sandy mud and SS.SSA.CMuSa.AalbNuc *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment. Note that *Lagis koreni* was only recorded at Station 5 and *Nucula nitidosa* was not recorded. The JNCC biotope classification (Connor *et al.*, 2004) considers that these two biotopes and SS.SSA.IMuSa.SsubNhom *Spisula subtruncata* and *Nephtys hombergii* in shallow muddy sand may be found at the same locations in different years, due to differences in recruitment success of the dominant taxa.

30-52 taxa per grab (mean 45.2). Total of 117 taxa at five stations.

Similar to Assemblages IIb and IIc of Mackie *et al.* (2006).

Characterising taxa: *Tubificoides amplivasatus, Parametaphoxus pectinatus, Tharyx killariensis, Spio decorata,* Nemertea indeterminate, *Ampelisca tenuicornis, Ampelisca* spp. (juv) & *Lumbrineris gracilis*.

Present at 80% of stations: *Harpinia antennaria, Eudorella truncatula, Abra alba, Pariambus typicus, Amphiura filiformis, Perioculodes longimanus, Phaxas pellucidus, Anoplodactylus petiolatus, Nephtys hombergii* & *Mediomastus fragilis*.

Biotope 9. Muddy sand. Station 53 (Mooring site). Gravelly sand with a small amount of silt and clay. This location was used to test the grab, and was not part of the main sampling program. However, the sample was preserved and analysed. Station 53 was well-separated from the other sampling stations on the cluster analysis and MDS. The MDS plot shows some affinities with Biotope 8B, which is geographically very close, immediately west of Station 53.

No close match with any JNCC biotope, but intermediate between SS.SMU.CSaMu.LkorPpel *Lagis koreni* and *Phaxas pellucidus* in circalittoral sandy mud and SS.SSA.IMuSa.SsubNhom *Spisula subtruncata* and *Nephtys hombergii* in shallow muddy sand. Note that neither *Lagis koreni* nor *Spisula subtruncata* were recorded.

11 taxa. In order of densities recorded (then alphabetically) these were *Ampelisca brevicornis, Magelona alleni, Marphysa bellii, Aricidea minuta, Lumbrineris gracilis, Nephtys hombergii, Pariambus typicus, Phaxas pellucidus, Polydora socialis, Terebellides stroemi* and *Tharyx killariensis*.

Station 53 was one of only two stations that had the amphipod *Ampelisca brevicornis* present, the other was Station 6, the closest station to the SW. Station 53 was also similar to Station 6 in the relatively high numbers (2 & 4 respectively) of the polychaete *Marphysa bellii*, which was only recorded at a few stations to the east of Lundy.

Biotope 10. Mixed sediment. Station 12. Sediment was 10-20% mixed gravel with some bedload medium sand, dominated by fallout sand. Unmatched with any JNCC biotope, but may perhaps be a species-poor variation of SS.SMX.OMx Offshore circalittoral mixed sediment. The substratum at Station 12 was sand, shell gravel and some mud. Normally this combination would support a relatively diverse fauna, but at Station 12 only 14 taxa were recorded. These included the burrowing shrimp *Upogebia deltaura*. This species and *U. stellata* were mainly recorded in the nearby Biotope 5A, but there were few other species in common.

14 taxa: *Hydroides norvegica, Epizoanthus couchii, Golfingia vulgaris vulgaris, Notomastus latericeus, Ampelisca spinipes, Amphiura filiformis, Euclymene lumbricoides, Mediomastus fragilis, Nematonereis unicornis, Notomastus* sp., *Photis longicaudata, Terebellides stroemi, Trichobranchus roseus* and *Upogebia deltaura*.

DISCUSSION

Comparison with previous surveys

The previous survey of the benthic macrofauna in sediments around Lundy in July 1975 used divers to take cores and identify or collect epifauna at eleven locations in shallow waters, mainly on the east coast (Hoare and Wilson, 1977). They recorded 81 invertebrate taxa, compared to 478 from 49 stations in our 2007 survey. There are likely to be several reasons for the large difference in the number of taxa, for example sampling method, sorting method, total amount of sediment sorted and the greater diversity of locations and substrata in our survey. Detailed comparison between the two surveys is not practical due to differences in methodology, but we have examined whether the most widespread species were similar and where the highest number of taxa occurred.

Of the 21 taxa that Hoare and Wilson (1977) found at 3 of more stations, 17 were recorded in the 2007 survey. However, many of the most common taxa in our survey (see Table 2) were not recorded by Hoare and Wilson (1977). For example, the small echinoderm *Echinocyamus pusillus* was recorded in 55% of samples in 2007 but was not recorded in 1975. In some cases the differences may be due to identifications of difficult groups. We did not record the capitellid polychaete *Capitella capitata*, but in July 1975 it was recorded at 4 stations. We recorded the capitellid *Mediomastus filiformis* at 45% of our stations, but this species was not recorded in 1975, so it is possible that it was mis-identified as *Capitella capitata*. In general, the 1975 survey did not record many of the smaller polychaetes and gammarid amphipods.

Hoare and Wilson (1977) found the greatest diversity at two stations on the central part of the east coast (Quarry Bay, 31 taxa and Halfway Bay 37 taxa). We recorded a broadly similar number of taxa at Stations 2, 4 & 5 (30-52 taxa per station). However, the highest numbers of taxa in our surveys were from two locations off the north coast. Station 8 had 105 taxa and St 9 123 taxa. With St 7 (91 taxa) these formed a very species-rich group, with a total of 208 taxa recorded at just three stations. These three sites formed Biotope 5E, which was a good match with the JNCC biotope SS.SBR.PoR.SspiMx *Sabellaria spinulosa* on stable circalittoral mixed sediment. The other stations with high numbers of taxa were all off the east coast of Lundy and mainly belonged to Biotopes 5B and 5D.

The marine fauna lists for Lundy provide information on 753 invertebrate taxa (see *http://www.lundy.org.uk/island/marinebiol.html* for details). The 2007 survey recorded 478 taxa, many of them apparently not previously recorded around Lundy. It is beyond the scope of this paper to provide a detailed update to each of these faunal lists for the various taxonomic groups. For some groups, grab sampling is a good method of obtaining specimens that are in a suitable condition for identification. For example, we identified 62 amphipod crustaceans in the 2007 survey, which compares well with the 59 amphipods listed by Moore (1981). For other groups, such as coelenterates and opisthobranchs, identification of fixed specimens is often very difficult and in these cases the 2007 survey adds little new information.

Biotope mapping

The biotope concept (understanding biological communities in relation to their habitat) is relied upon in marine environment management and impact-assessment legislative frameworks. The application of biotope identification processes is problematic in sub-tidal sedimentary areas where biological information is available only at restricted numbers of sampling points and transects (from diving, video and grabbing) and where highly mobile/variable phytoplankton provide the primary input to the ecosystems (cf rocky intertidal and terrestrial environments where static vegetation plays a key role in biotope definition). The high financial cost of sampling and identifying the benthos to species level (with statistical confidence) exacerbates the problem by limiting the number of point samples that can be taken. It is often not easy to identify biotopes, or assess the geographical significance of any biotopes that are identified (total area, juxtaposition) or be assured that all biotopes present have been sampled. Thus the marine biotope maps we are generating today often fall short of providing the useful information for which the biotope concept was originally developed.

Acoustic seabed mapping projects around the world are now economically creating spatially continuous maps of sedimentary and geological features of the seabed. If specific benthic communities were associated with different sediment types, then the distribution of those sediments could be used as a proxy to provide spatially continuous maps of benthic biotopes, and provide a more reliable (temporally stable) basis for mapping (Roff *et al.*, 2003). However, although species are adapted to live in different sediments, sediment type is not the only determinant of habitat suitability. Other factors such as depth and clarity of water, salinity and temperature regimes, and wave and current velocity (bed stability and dispersion) are also influential in defining the composition of benthic communities. These data are also relatively easy to measure or model to give spatial continuity of habitat information. However, even when taking all such bio-physical habitat characteristics into account, the species composition of benthic sediment communities will often vary as a function of purely biological factors (often cyclic or variable over periods of years to decades), which mean that through time any fixed benthic habitat may be 'home' for more than one community of species. Another important area of uncertainty is the extent to which fishing practices (particularly bottom trawling) modify biotopes. Such impacts may have implications for the mapped area east of Lundy, which includes an experimental no-take zone.

The novel aspects of this study have been 1) experimenting with field methods to increase cost-efficiency of data gathering, 2) reliance on detailed sediment properties as indicators of key benthic habitat conditions and 3) using GIS methods to bring together biological and physical data sets (matching communities to habitat). The key steps exemplifying the approaches used in this study can be summarised as follows:

1) It is important to initially make an effective study of readily available data to both guide survey design and input to the final database. In terms of physical habitat, recent (post this survey) government investment in freely available datasets has made this approach very effective in UK waters, providing spatially continuous data (often modelled but calibrated to field information) for parameters such as bathymetry, wave energy and tidal currents (Nunny, 2010).

2) Undertake necessary field and laboratory work to both identify infauna and characterise seabed conditions. Field surveys can effectively be run together, and can use innovative techniques to less precisely but much more cost effectively acquire data.

3) Independently analyse the habitat and biological data, the former on a spatially continuous and the latter on a clustered-point basis.

4) Examine the interaction between the two data sets using a GIS grid model, iteratively adjusting the fit to allow key parameters and relationships to emerge.

5) Once base relationships have emerged the spatially-consistent attributes of the infaunal assemblages can be readily described and applied to clearly defined seabed areas, using GIS interrogation and mapping methods.

6) Although the biotope descriptions that emerge often do not precisely conform to the growing national database, this is a healthy sign and producing locally valid biotope descriptions is internationally recognised best practice (ICES, 2008).

7) Final biotope descriptions can be 'tweaked' to best-fit the JNCC classification wherever possible, or if not the possible existence of a new biotope should be flagged.

8) Clear identification of how well observed biotopes 'fit' established categories (such as is presented in this paper) is important, as it will encourage ongoing revision and clarification of common biotope definitions.

ACKNOWLEDGEMENTS

We would like to thank Natural England for funding this study and providing permission for this work to be published. We would also like to thank two anonymous referees who provided very helpful comments.

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APPENDIX 1: GIS grid search parameters best corresponding to faunal assemblages. An 'x' in a column indicates the parameter was not used in defining that biotope

GRID DEFINITION PARAMETERS

Sample Station		Biotope code	General Habitat	Depth m	Gravel type	Active gravel?	Bedload sand	Fallout sand	Mud	Beachface	Tide	
50	1	1	0,0m0	X	X	X	X	X	X	Any	X	
51		1	0,0m0									
31	2	2A		<-45	G9 or G7	X	X	X	X	X	>100	
41		2A	G10,0,0m0									
47		2B										
48		2B	G9,0,0m0									
7		***5E***	G9,3,0m0									
35	3	3A	,1,0m0	<-20	Null	X	>0.5	X	X	X	X	
36		3A	,1,0m0	>-45			<2.5					
42		3A	.1,1m0									
43		3A	,2,0m0									
37		3B	,2,0m0									
34		3C	,2,0m0									
28	4	4	G2,3,1m0									
30		4	G7,0,0m0									
1	5	5A	G4,3,2m5 to m15	<-20	G2 or G3	>2.5	>2.5	>0.5	0	X	X	
20		5A	G4,4,2m15	>-27			<3.5					
25		5A	G6,3,1m0									
11	5	5B	G1,3,1mo to m15	<-20	G3 or G1	<2.5	>2.3	>0.5	<10	X	X	
17		5B	G3,3,1m0 to some m15	>-45			<3.5					
18		5B	G1,3,2m0 to m20									
21		5B	G1,3,1mo to m15									
23		5B	G1,3,2m0 to m20									
24		5B	G1,3,1mo to m15									
26		5B	G3,3,1m0 to some m15									
10	5	5C	G3,3,1m0 to some m15	<-15	G4	<2	>2.5	>1.5	<15	X	X	
22		5C	G2,3,2m0	>-37			<4.5		>9.5			
8	5	5E	G6,3,0m0	<-25	G6 or G8	X	>2.5	<1.5	X	X	X	East coast
9		5E	G8,3,1m0	>-50			<3.5					
13		5D	G8,3,1m0									
15		5D	G6,3,1m0									
16		5D	G6,3,1m0									
19		5D	G6,3,1m0									
49		5D	G6,3,1m0									
14		***5C***	G8,3,1m0									
38	5	5D	G10,1,0m0	<40	G9 or G10	>2.5	>0.5	<1.5	X	X	>60	West coast
29		5D	G9,1,1m0	>50			<1.5					
2	5	8B	G1,3,2m0 to m20	<-10	G1 or G2	>2	>2.5	>0.5	>4.5	X	X	
4		8B	G2,4,2m15 t0 m20	>-36	or G3 or							
5		8B	G2,4,2m15 t0 m20		G4							
3		8B	G3,4,1m0 to m15									
6		8B	G3,3,1m0 to some m15									
40	6	6	G7,5,m0									
27	7	7A	G4,3,1m0 to some 15	terms. Part of major biotope surrounding Lundy?								
52		7A	G3,2,1m0									
33		7B	G9,0,0m0									
44	8	8A	G9,1,1m0	<40	G1 or G9	>2.5	<1.5	<1.5	0	X	<60	
45		8A	G1,1,1m0	>50								
53	9	9	G5,3,0m0									
12	10	10	G5,3,2m0 to m10									

APPENDIX 2: Full list of taxa recorded

Phylum	MCS Code	Family	Taxon
Porifera	C 133	Sycettidae	*Scypha ciliata*
Porifera	C 480	Clionidae	*Cliona celata*
Anthozoa	D 407	Sertulariidae	Sertulariidae
Anthozoa	D 409	Sertulariidae	*Abietinaria abietina*
Anthozoa	D 422	Sertulariidae	*Dynamena pumila*
Anthozoa	D 424	Sertulariidae	*Hydrallmania falcata*
Anthozoa	D 430	Sertulariidae	*Sertularella polyzonias*
Anthozoa	D 433	Sertularidae	*Sertularia* spp.
Anthozoa	D 435	Sertulariidae	*Sertularia cupressina*
Anthozoa	D 445	Sertulariidae	*Tridentata distans*
Anthozoa	D 455	Plumulariidae	*Kirchenpaueria pinnata*
Anthozoa	D 466	Plumulariidae	*Nemertesia ramosa*
Anthozoa	D 520	Campanulariidae	*Obelia geniculata*
Anthozoa	D 597	Alcyoniidae	*Alcyonium digitatum*
Anthozoa	D 649	Epizoanthidae	*Epizoanthus couchii*
Anthozoa	D 673	Actiniidae	Actiniidae (indet.)
Anthozoa	D 743	Hormathiidae	*Adamsia carciniopados*
Anthozoa	D 753	Haloclavidae	*Mesacmaea mitchelii*
Turbellaria	F 2		Turbellaria (indet.)
Nemertea	G 1		Nemertea (indet.)
Nemertea	G 34	Tubulanidae	*Tubulanus polymorphus*
Nemertea	G 41	Cerebratulidae	*Cerebratulus fuscus*
Nemertea	G 60	Lineidae	*Micrura* sp. (possibly *M.auriantica*)
Nemertea	G 62	Lineidae	*Micrura fasciolata*
Nemertea	G 63	Lineidae	*Micrura lactea?*
Chaetognatha	L 11		*Sagitta* spp.
Chaetognatha	L 29		*Spadella cephaloptera*
Sipuncula	N 1		Sipuncula (indet.)
Sipuncula	N 17	Golfingiidae	*Golfingia vulgaris vulgaris*
Sipuncula	N 25	Golfingiidae	*Nephasoma minutum*
Sipuncula	N 28	Golfingiidae	*Thysanocardia procera*
Sipuncula	N 34	Phascolionidae	*Phascolion strombus strombus*
Annelida	P 15	Pisionidae	*Pisione remota*
Annelida	P 19	Aphroditidae	*Aphrodita aculeata*
Annelida	P 32	Polynoidae	*Adyte pellucida*
Annelida	P 49	Polynoidae	*Gattyana cirrosa*
Annelida	P 50	Polynoidae	*Harmothoe pagenstecheri*
Annelida	P 50	Polynoidae	*Harmothoe* spp.
Annelida	P 55	Polynoidae	*Malmgrenia castanea*
Annelida	P 59	Polynoidae	*Harmothoe fragilis*
Annelida	P 65	Polynoidae	*Harmothoe impar*
Annelida	P 68	Polynoidae	*Malmgrenia marphysae*
Annelida	P 70	Polynoidae	*Malmgrenia mcintoshi*
Annelida	P 82	Polynoidae	*Lepidonotus squamatus*
Annelida	P 92	Pholoidae	*Pholoe inornata*
Annelida	P 93	Pholoidae	*Pholoe pallida*
Annelida	P 94	Pholoidae	*Pholoe synophthalmica*
Annelida	P 106	Sigalionidae	*Sthenelais* spp. (juv.)
Annelida	P 107	Sigalionidae	*Sthenelais boa*
Annelida	P 109	Sigalionidae	*Sthenelais limicola*
Annelida	P 122	Phyllodocidae	*Hesionura elongata*
Annelida	P 127	Phyllodocidae	*Mysta picta*
Annelida	P 130	Phyllodocidae	*Mystides caeca*
Annelida	P 136	Phyllodocidae	*Pseudomystides limbata*
Annelida	P 141	Phyllodocidae	*Anaitides groenlandica*
Annelida	P 142	Phyllodocidae	*Anaitides lineata*
Annelida	P 146	Phyllodocidae	*Phyllodoce rosea*
Annelida	P 151	Phyllodocidae	*Eulalia aurea*
Annelida	P 155	Phyllodocidae	*Eulalia mustela*
Annelida	P 156	Phyllodocidae	*Eulalia ornata*
Annelida	P 159	Phyllodocidae	*Eulalia tripunctata*
Annelida	P 163	Phyllodocidae	*Eumida* spp.
Annelida	P 164	Phyllodocidae	*Eumida bahusiensis*
Annelida	P 165	Phyllodocidae	*Eumida ockelmanni*
Annelida	P 167	Phyllodocidae	*Eumida sanguinea*
Annelida	P 171	Phyllodocidae	*Nereiphylla rubiginosa*
Annelida	P 188	Phyllodocidae	*Pterocirrus macroceros*
Annelida	P 255	Glyceridae	*Glycera* spp.
Annelida	P 256	Glyceridae	*Glycera alba*
Annelida	P 257	Glyceridae	*Glycera celtica*
Annelida	P 260	Glyceridae	*Glycera lapidum*
Annelida	P 262	Glyceridae	*Glycera oxycephala*
Annelida	P 268	Goniadidae	*Glycinde nordmanni*
Annelida	P 271	Goniadidae	*Goniada maculata*
Annelida	P 291	Sphaerodoridae	*Sphaerodorum gracilis*
Annelida	P 319	Hesionidae	*Podarkeopsis capensis*
Annelida	P 321	Hesionidae	*Syllidia armata*
Annelida	P 350	Syllidae	*Ehlersia ferruginea*
Annelida	P 355	Syllidae	*Eurysyllis tuberculata*
Annelida	P 358	Syllidae	*Syllis variegata (Syllis* sp. C)
Annelida	P 358	Syllidae	*Syllis* sp. E
Annelida	P 358	Syllidae	*Syllis* sp. H
Annelida	P 358	Syllidae	*Syllis* sp. D
Annelida	P 358	Sylllidae	*Syllis* spp. (indet.)
Annelida	P 362	Syllidae	*Trypanosyllis coeliaca*
Annelida	P 375	Syllidae	*Amblyosyllis formosa*
Annelida	P 379	Syllidae	*Eusyllis assimilis*
Annelida	P 380	Syllidae	*Eusyllis blomstrandi*
Annelida	P 382	Sylllidae	*Eusyllis lamelligera*
Annelida	P 384	Iphimediidae	*Iphimedia spatula*
Annelida	P 386	Syllidae	*Odontosyllis ctenostoma*
Annelida	P 388	Syllidae	*Odontosyllis gibba*
Annelida	P 400	Syllidae	*Pionosyllis pulligera*
Annelida	P 405	Syllidae	*Streptosyllis websteri*
Annelida	P 406	Syllidae	*Syllides japonica*
Annelida	P 407	Syllidae	*Syllides benedicti*
Annelida	P 421	Syllidae	*Exogone hebes*
Annelida	P 422	Syllidae	*Exogone naidina*
Annelida	P 423	Syllidae	*Exogone verugera*
Annelida	P 424	Syllidae	*Sphaerosyllis* 'blobby'
Annelida	P 425	Syllidae	*Sphaerosyllis bulbosa*
Annelida	P 426	Syllidae	*Sphaerosyllis erinaceus*
Annelida	P 430	Syllidae	*Sphaerosyllis taylori*
Annelida	P 431	Syllidae	*Sphaerosyllis tetralix*
Annelida	P 434	Syllidae	*Autolytus sp.indeterminate*
Annelida	P 437	Syllidae	*Autolytus brachycephalus*
Annelida	P 440	Syllidae	*Autolytus langerhansi*
Annelida	P 444	Syllidae	*Autolytus prolifera*
Annelida	P 451	Syllidae	*Proceraea* spp.
Annelida	P 455	Sylllidae	*Procerastea* spp. (indet.)
Annelida	P 482	Nereididae	*Platynereis* spp.
Annelida	P 483	Nereididae	*Platynereis coccinea*
Annelida	P 484	Nereidae	*Platynereis dumerilii*
Annelida	P 487	Nereididae	*Websterinereis glauca*
Annelida	P 493	Nephtyidae	*Aglaophamus rubella*
Annelida	P 494	Nephtyidae	*Nephtys* spp. (juv.)
Annelida	P 498	Nephtyidae	*Nephtys cirrosa*
Annelida	P 499	Nephtyidae	*Nephtys hombergii*
Annelida	P 502	Nephtyidae	*Nephtys kersivalensis*
Annelida	P 526	Amphinomidae	*Euphrosine borealis*?
Annelida	P 539	Onuphidae	*Aponuphis bilineata*
Annelida	P 544	Onuphidae	*Nothria britannica*
Annelida	P 553	Eunicidae	Eunicidae (indet.)
Annelida	P 564	Eunicidae	*Marphysa bellii*
Annelida	P 566	Eunicidae	*Marphysa sanguinea*
Annelida	P 568	Eunicidae	*Nematonereis unicornis*
Annelida	P 571	Lumbrineridae	*Lumbrineriopsis paradoxa*
Annelida	P 579	Lumbrineridae	*Lumbrineris gracilis*
Annelida	P 591	Oenonidae	*Drilonereis filum*
Annelida	P 613	Dorvilleidae	*Ophryotrocha* spp.

APPENDIX 2: Full list of taxa recorded (cont.)

Phylum	MCS Code	Family	Taxon
Annelida	P 638	Dorvilleidae	*Protodorvillea kefersteini*
Annelida	P 643	Dorvilleidae	*Schistomeringos rudolphi*
Annelida	P 665	Orbiniidae	*Orbinia sertulata*
Annelida	P 672	Orbiniidae	*Scoloplos armiger*
Annelida	P 676	Paraonidae	*Aricidea* spp.
Annelida	P 677	Paraonidae	*Aricidea minuta*
Annelida	P 685	Paraonidae	*Aricidea cerrutii*
Annelida	P 699	Paraonidae	*Paradoneis lyra*
Annelida	P 712	Apisthobranchidae	*Apistobranchus tullbergi*
Annelida	P 718	Poecilochaetidae	*Poecilochaetus serpens*
Annelida	P 722	Spionidae	*Aonides oxycephala*
Annelida	P 723	Spionidae	*Aonides paucibranchiata*
Annelida	P 733	Spionidae	*Laonice bahusiensis*
Annelida	P 744	Spionidae	*Microspio mecznikowianus*
Annelida	P 747	Spionidae	*Minuspio cirrifera*
Annelida	P 748	Spionidae	*Polydora* spp.
Annelida	P 750	Spionidae	*Polydora caeca*
Annelida	P 754	Spionidae	*Polydora flava*
Annelida	P 762	Spionidae	*Polydora socialis*
Annelida	P 766	Spionidae	*Prionospio banyulensis*
Annelida	P 773	Spionidae	*Pseudopolydora paucibranchiata*
Annelida	P 774	Spionidae	*Pseudopolydora pulchra*
Annelida	P 778	Spionidae	*Scolelepis* spp.
Annelida	P 779	Spionidae	*Scolelepis bonnieri*
Annelida	P 787	Spionidae	*Spio* sp. 1
Annelida	P 788	Spionidae	*Spio armata*
Annelida	P 789	Spionidae	*Spio decorata*
Annelida	P 791	Spionidae	*Spio martinensis*
Annelida	P 794	Spionidae	*Spiophanes bombyx*
Annelida	P 796	Spionidae	*Spiophanes kroyeri*
Annelida	P 802	Magelonidae	*Magelona johnstoni*
Annelida	P 803	Magelonidae	*Magelona* spp.
Annelida	P 804	Magelonidae	*Magelona alleni*
Annelida	P 806	Magelonidae	*Magelona minuta*
Annelida	P 811	Chaetopteridae	*Chaetopterus* spp.
Annelida	P 817	Chaetopteridae	*Phyllochaetopterus* (*P. socialis*?)
Annelida	P 818	Spionidae	*Scolelepis korsuni*
Annelida	P 823	Cirratulidae	*Aphelochaeta* sp. A
Annelida	P 828	Cirratulidae	*Caulleriella* spp.
Annelida	P 829	Cirratulidae	*Caulleriella alata*
Annelida	P 833	Cirratulidae	*Chaetozone gibber*
Annelida	P 846	Cirratulidae	*Tharyx killariensis*
Annelida	P 878	Flabelligeridae	*Diplocirrus glaucus*
Annelida	P 907	Capitellidae	*Capitella capitata*
Annelida	P 913	Capitellidae	*Dasybranchus* spp.
Annelida	P 919	Capitellidae	*Mediomastus fragilis*
Annelida	P 920	Capitellidae	*Notomastus* spp.
Annelida	P 921	Capitellidae	*Notomastus latericeus*
Annelida	P 923	Capitellidae	*Notomastus* sp. E
Annelida	P 925	Capitellidae	*Peresiella clymenoides*
Annelida	P 927	Capitellidae	*Pseudonotomastus southerni*
Annelida	P 955	Maldanidae	*Clymenura tricirrata*
Annelida	P 955	Maldanidae	*Clymenura* spp.
Annelida	P 963	Maldanidae	*Euclymene lumbricoides*
Annelida	P 964	Maldanidae	*Euclymene oerstedii*
Annelida	P 965	Maldanidae	*Euclymene* spp.
Annelida	P 965	Maldanidae	*Euclymene* sp. A
Annelida	P 967	Maldanidae	*Heteroclymene robusta*
Annelida	P 970	Maldanidae	*Praxillela* spp.
Annelida	P 971	Maldanidae	*Praxillela affinis*
Annelida	P 985	Maldanidae	*Petaloproctus* spp.
Annelida	P 1012	Opheliidae	*Ophelina* spp.
Annelida	P 1021	Scalibregmatidae	*Asclerocheilus* spp.
Annelida	P 1026	Ophelidae	*Scalibregma celticum*
Annelida	P 1027	Scalibregmatidae	*Scalibregma inflatum*

Phylum	MCS Code	Family	Taxon
Annelida	P 1063	Polygordiidae	*Polygordius appendiculatus*
Annelida	P 1065	Polygordiidae	*Polygordius lacteus*
Annelida	P 1093	Oweniidae	*Galothowenia oculata*
Annelida	P 1098	Oweniidae	*Owenia fusiformis*
Annelida	P 1100	Pectinariidae	Pectinariidae (juv.)
Annelida	P 1107	Pectinariidae	*Lagis koreni*
Annelida	P 1117	Sabellaridae	*Sabellaria spinulosa*
Annelida	P 1133	Ampharetidae	*Ampharete* spp. (juv.)
Annelida	P 1139	Ampharetidae	*Ampharete lindstroemi*
Annelida	P 1175	Trichobranchidae	*Terebellides stroemi*
Annelida	P 1178	Trichobranchidae	*Trichobranchus roseus*
Annelida	P 1179	Terebellidae	Terebellidae (juv.)
Annelida	P 1187	Terebellidae	*Axionice maculata*
Annelida	P 1215	Terebellidae	*Phisidia aurea*
Annelida	P 1217	Terebellidae	*Pista cristata*
Annelida	P 1234	Terebellidae	*Lysilla nivea*
Annelida	P 1242	Terebellidae	*Polycirrus medusa*
Annelida	P 1243	Terebellidae	*Polycirrus norvegicus*
Annelida	P 1254	Terebellidae	*Thelepus cincinnatus*
Annelida	P 1263	Sabellidae	*Branchiomma bombyx*
Annelida	P 1269	Sabellidae	*Chone filicaudata*
Annelida	P 1290	Sabellidae	*Jasmineira elegans*
Annelida	P 1304	Sabellidae	*Oriopsis armandi*
Annelida	P 1316	Sabellidae	*Pseudopotamilla reniformis*
Annelida	P 1334	Serpulidae	*Hydroides norvegica*
Annelida	P 1340	Serpulidae	*Pomatoceros lamarckii*
Annelida	P 1341	Serpulidae	*Pomatoceros triqueter*
Annelida	P 1343	Serpulidae	*Serpula vermicularis*
Annelida	P 1489	Tubificidae	*Tubificoides amplivasatus*
Annelida	P 1491	Tubificidae	*Tubificoides brownae*
Annelida	P 1494	Tubificidae	*Tubificoides diazi*?
Annelida	P 1501	Enchytraeidae	Enchytraeidae
Annelida	P 1524	Enchytraeidae	*Grania* spp.
Chelicerata	Q 15	Ammotheidae	*Achelia echinata*
Chelicerata	Q 33	Callipallenidae	*Callipallene brevirostris*
Chelicerata	Q 44	Phoxichilidiidae	*Anoplodactylus petiolatus*
Chelicerata	Q 51	Pycnogonidae	*Pycnogonum littorale*
Crustacea	R 41	Verrucidae	*Verruca stroemia*
Crustacea	R 68	Archaeobalanidae	*Elminius modestus*
Crustacea	R 77	Balanidae	*Balanus crenatus*
Crustacea	S 25		Mysidacea (indet.)
Crustacea	S 92	Mysidae	*Heteromysis formosa*
Crustacea	S 102	Eusiridae	*Apherusa bispinosa*
Crustacea	S 131	Oedicerotidae	*Perioculodes longimanus*
Crustacea	S 137	Oedicerotidae	*Synchelidium haplocheles*
Crustacea	S 138	Oedicerotidae	*Synchelidium maculatum*
Crustacea	S 158	Amphilochidae	*Amphilochus manudens*
Crustacea	S 159	Amphilochidae	*Amphilochus neopolitanus*
Crustacea	S 164	Amphilochidae	*Gitana sarsi*
Crustacea	S 173	Amphilochidae	*Peltocoxa brevirostris*
Crustacea	S 177	Leucothoidae	*Leucothoe incisa*
Crustacea	S 178	Leucothoidae	*Leucothoe lilljeborgi*
Crustacea	S 186	Cressidae	*Cressa dubia*
Crustacea	S 191	Ischyroceridae	*Microjassa cumbrensis*
Crustacea	S 204	Stenothoidae	*Parametopa kervillei*
Crustacea	S 213	Stenothoidae	*Stenothoe marina*
Crustacea	S 214	Stenothoidae	*Stenothoe monoculoides*
Crustacea	S 216	Stenothoidae	*Stenothoe* cf *tergestina*
Crustacea	S 217	Stenothoidae	*Stenothoe valida*?
Crustacea	S 248	Urothoidae	*Urothoe elegans*
Crustacea	S 253	Phoxocephalidae	*Harpinia* spp. (juv.)
Crustacea	S 254	Phoxocephalidae	*Harpinia antennaria*
Crustacea	S 255	Phoxocephalidae	*Harpinia crenulata*
Crustacea	S 257	Phoxocephalidae	*Harpinia pectinata*
Crustacea	S 258	Phoxocephalidae	*Harpinia serrata*

APPENDIX 2: Full list of taxa recorded (cont.)

Phylum	MCS Code	Family	Taxon
Crustacea	S 262	Phoxocephalidae	*Parametaphoxus pectinatus*
Crustacea	S 330	Lysianassidae	*Socarnes erythrophthalmus*
Crustacea	S 360	Argissidae	*Argissa hamatipes*
Crustacea	S 378	Iphimediidae	*Iphimedia* spp. (indet.)
Crustacea	S 380	Iphimediidae	*Iphimedia minuta*
Crustacea	S 381	Iphimediidae	*Iphimedia nexa*
Crustacea	S 399	Liljeborgiidae	*Listriella mollis*
Crustacea	S 412	Dexaminidae	*Atylus swammerdamei*
Crustacea	S 413	Dexaminidae	*Atylus vedlomensis*
Crustacea	S 415	Dexaminidae	*Dexamine spinosa*
Crustacea	S 418	Dexaminidae	*Guernea coalita*
Crustacea	S 423	Ampeliscidae	*Ampelisca* spp. (juv.)
Crustacea	S 427	Ampeliscidae	*Ampelisca brevicornis*
Crustacea	S 438	Ampeliscidae	*Ampelisca spinipes*
Crustacea	S 440	Ampeliscidae	*Ampelisca tenuicornis*
Crustacea	S 442	Ampeliscidae	*Ampelisca typica*
Crustacea	S 452	Pontoporeiidae	*Bathyporeia elegans*
Crustacea	S 489	Melphidippidae	*Megaluropus agilis*
Crustacea	S 493	Melphidippidae	*Melphidippella macra*
Crustacea	S 497	Melitidae	*Abludomelita gladiosa*
Crustacea	S 498	Melitidae	*Abludomelita obtusata*
Crustacea	S 502	Melitidae	*Ceradocus semiserratus*
Crustacea	S 503	Melitidae	*Cheirocratus* spp. (indet.)
Crustacea	S 504	Melitidae	*Cheirocratus assimilis*
Crustacea	S 505	Melitidae	*Cheirocratus intermedius*
Crustacea	S 506	Melitidae	*Cheirocratus sundevallii*
Crustacea	S 519	Melitidae	*Maera othonis*
Crustacea	S 521	Melitidae	*Maerella tenuimana*
Crustacea	S 537	Isaeidae	Isaeidae (indet.)
Crustacea	S 539	Isaeidae	*Gammaropsis cornuta*
Crustacea	S 541	Isaeidae	*Gammaropsis maculata*
Crustacea	S 543	Isaeidae	*Gammaropsis palmata*
Crustacea	S 552	Isaeidae	*Photis longicaudata*
Crustacea	S 558	Ischyroceridae	Ischyroceridae (indet.)
Crustacea	S 561	Ischyroceridae	*Erichthonius* spp. (indet.)
Crustacea	S 564	Ischyroceridae	*Erichthonius punctatus*
Crustacea	S 567	Ischyroceridae	*Ischyrocerus anguipes*?
Crustacea	S 568	Ischyroceridae	*Jassa* spp. (indet.)
Crustacea	S 569	Ischyroceridae	*Jassa falcata*
Crustacea	S 579	Aoridae	*Aora gracilis*
Crustacea	S 588	Aoridae	*Leptocheirus hirsutimanus*
Crustacea	S 605	Corophiidae	*Corophium* spp. (indet.)
Crustacea	S 615	Corophiidae	*Corophium sextonae*
Crustacea	S 621	Corophiidae	*Unciola crenatipalma*
Crustacea	S 640	Caprellidae	*Caprella* spp.?
Crustacea	S 641	Caprellidae	*Caprella acanthifera*
Crustacea	S 651	Caprellidae	*Pariambus typicus*
Crustacea	S 657	Phtisicidae	*Phtisica marina*
Crustacea	S 659	Phtisicidae	*Pseudoprotella phasma*
Crustacea	S 792	Gnathiidae	Gnathiidae (praniza)
Crustacea	S 796	Gnathiidae	*Gnathia oxyuraea*
Crustacea	S 803	Anthuridae	*Anthura gracilis*
Crustacea	S 850	Cirolanidae	*Eurydice* spp.
Crustacea	S 892	Janiridae	*Janira maculosa*
Crustacea	S 907	Munnidae	*Munna minuta*
Crustacea	S 950	Arcturidae	*Arcturella damnoniensis*
Crustacea	S 1140	Anarthruridae	*Pseudoparatanais batei*
Crustacea	S 1142	Leptognathiidae	*Tanaopsis graciloides*
Crustacea	S 1154	Typhlotanaidae	*Typhlotanais microcheles*
Crustacea	S 1177	Apseudidae	*Apseudes talpa*
Crustacea	S 1184	Bodotriidae	Bodotriidae
Crustacea	S 1187	Bodotriidae	*Cumopsis fagei*
Crustacea	S 1196	Bodotriidae	*Bodotria pulchella*
Crustacea	S 1197	Bodotriidae	*Bodotria scorpiodes*
Crustacea	S 1208	Leuconiidae	*Eudorella truncatula*

Phylum	MCS Code	Family	Taxon
Crustacea	S 1224	Nannastacidae	*Cumella pygmaea*
Crustacea	S 1236	Pseudocumatidae	*Pseudocuma longicornis*
Crustacea	S 1237	Pseudocumatidae	*Pseudocuma similis*
Crustacea	S 1247	Diastylidae	*Diastylis* spp. (juv.)
Crustacea	S 1251	Diastylidae	*Diastylis laevis*
Crustacea	S 1345	Hippolytidae	*Eualus pusiolus*
Crustacea	S 1350	Hippolytidae	*Hippolyte varians*
Crustacea	S 1362	Processidae	*Processa* spp. (indet.)
Crustacea	S 1374	Pandalidae	*Pandalina brevirostris*
Crustacea	S 1386	Crangonidae	*Crangon bispinosus neglecta*
Crustacea	S 1415	Callianassidae	*Callianassa subterranea*
Crustacea	S 1419	Upogebiidae	*Upogebia deltaura*
Crustacea	S 1421	Upogebiidae	*Upogebia stellata*
Crustacea	S 1445	Paguridae	Paguridae (juv., indet.)
Crustacea	S 1448	Paguridae	*Anapagurus hyndmanni*
Crustacea	S 1462	Paguridae	*Pagurus prideaux*
Crustacea	S 1470	Galatheidae	*Galathea* spp.
Crustacea	S 1472	Galatheidae	*Galathea intermedia*
Crustacea	S 1478	Galatheidae	*Munida rugosa*
Crustacea	S 1482	Porcellanidae	*Pisidia longicornis*
Crustacea	S 1485		*Brachyura megalopa*
Crustacea	S 1505	Leucosiidae	*Ebalia cranchii*
Crustacea	S 1508	Leucosiidae	*Ebalia tuberosa*
Crustacea	S 1518	Majidae	*Hyas araneus*
Crustacea	S 1524	Majidae	*Dorhynchus thomsoni*?
Crustacea	S 1526	Majidae	*Inachus dorsettensis*
Crustacea	S 1529	Majidae	*Macropodia sp indeterminate*
Crustacea	S 1531	Majidae	*Macropodia linaresi*
Crustacea	S 1535	Majidae	*Eurynome* spp.
Crustacea	S 1555	Atelecyclidae	*Atelecylus rotundatus*
Crustacea	S 1559	Thiidae	*Thia scutellata*
Crustacea	S 1577	Portunidae	*Liocarcinus* spp.
Crustacea	S 1584	Portunidae	*Liocarcinus pusillus*
Crustacea	S 1606	Goneplacidae	*Goneplax rhomboides*
Crustacea	S 1615	Xanthidae	*Pilumnus hirtellus*
Mollusca	W 53	Leptochitonidae	*Leptochiton asellus*
Mollusca	W 161	Trochidae	*Gibbula tumida*
Mollusca	W 234	Patellidae	*Helcion pellucidum*
Mollusca	W 273	Cerithiopsidae	*Cerithiopsis barleei*
Mollusca	W 289	Littorinidae	*Lacuna pallidula*
Mollusca	W 344	Rissoidae	*Alvania punctura*
Mollusca	W 376	Rissoidae	*Pusillina inconspicua*?
Mollusca	W 410	Iravadiidae	*Hyala vitrea*
Mollusca	W 418	Caecidae	*Caecum glabrum*
Mollusca	W 491	Naticidae	*Polinices pulchellus*
Mollusca	W 603	Eulimidae	*Eulima bilineata*
Mollusca	W 669	Eulimidae	*Vitreolina philippi*
Mollusca	W 708	Buccinidae	*Buccinum undatum*
Mollusca	W 747	Buccinidae	*Hinia incrassata*
Mollusca	W 965	Pyramidellidae	*Partulida pellucida*
Mollusca	W 1002	Philinidae/Diaphanidae	*Philine* sp./*Diaphana minuta* (juv.)
Mollusca	W 1028	Cylichnidae	*Cylichna cylindracea*
Mollusca	W 1069	Haminoeidae	*Haminoea navicula*
Mollusca	W 1243		Nudibranch A (orange spots on white)
Mollusca	W 1243		Nudibranch B (red bands on rhinophores)
Mollusca	W 1243		Nudibranchia (indet.)
Mollusca	W 1289	Dotidae	*Doto tuberculata*
Mollusca	W 1302	Goniodorididae	*Goniodoris nodosa*
Mollusca	W 1325	Onchidorididae	*Onchidoris muricata*
Mollusca	W 1334	Onchidorididae	*Adalaria* spp.
Mollusca	W 1349	Polyceridae	*Polycera faeroensis*?
Mollusca	W 1560		Bivalvia (indet.) - with brown markings

APPENDIX 2: Full list of taxa recorded (cont.)

Phylum	MCS Code	Family	Taxon
Mollusca	W 1566	Nuculidae	*Nucula* spp.
Mollusca	W 1577	Nuculanidae	*Nuculoma tenuis*
Mollusca	W 1688	Glycymerididae	*Glycymeris glycymeris*
Mollusca	W 1691	Mytilidae	Mytilidae
Mollusca	W 1700	Mytilidae	*Modiolus adriaticus*
Mollusca	W 1702	Mytilidae	*Modiolus modiolus*
Mollusca	W 1718	Mytilidae	*Modiolarca tumida*
Mollusca	W 1768	Pectinidae	Pectinidae
Mollusca	W 1773	Pectinidae	*Aequipecten opercularis*
Mollusca	W 1805	Anomiidae	Anomiidae
Mollusca	W 1837	Thyasiridae	*Thyasira flexuosa*
Mollusca	W 1882	Galeommatidae	*Semierycina nitida*
Mollusca	W 1906	Montacutidae	*Mysella bidentata*
Mollusca	W 1943	Cardiidae	*Acanthocardia echinata*
Mollusca	W 1951	Cardiidae	*Parvicardium ovale*
Mollusca	W 1952	Cardiidae	*Parvicardium scabrum*
Mollusca	W 1959	Cardiidae	*Laevicardium crassum*
Mollusca	W 1975	Mactridae	*Spisula elliptica*
Mollusca	W 1977	Mactridae	*Spisula solida*
Mollusca	W 1978	Mactridae	*Spisula subtruncata*
Mollusca	W 1996	Pharidae	*Ensis* spp. (damaged, indet.)
Mollusca	W 2006	Pharidae	*Phaxas pellucidus*
Mollusca	W 2015	Tellinidae	*Arcopagia crassa*
Mollusca	W 2021	Tellinidae	*Moerella donacina*
Mollusca	W 2023	Tellinidae	*Moerella pygmaea*
Mollusca	W 2049	Psammobiidae	*Gari tellinella*
Mollusca	W 2051	Psammobiidae	*Gari fervensis*
Mollusca	W 2059	Semelidae	*Abra alba*
Mollusca	W 2061	Semelidae	*Abra nitida*
Mollusca	W 2062	Semelidae	*Abra prismatica*
Mollusca	W 2091	Veneridae	*Circomphalus casina*
Mollusca	W 2095	Veneridae	*Gouldia minima*
Mollusca	W 2098	Veneridae	*Chamelea gallina*
Mollusca	W 2100	Veneridae	*Clausinella fasciata*
Mollusca	W 2104	Veneridae	*Timoclea ovata*
Mollusca	W 2113	Veneridae	*Tapes rhomboides*
Mollusca	W 2128	Veneridae	*Dosinia lupinus*
Mollusca	W 2152	Myidae	*Sphenia binghami*
Mollusca	W 2157	Corbulidae	*Corbula gibba*
Mollusca	W 2166	Hiatellidae	*Hiatella arctica*
Mollusca	W 2233	Thraciidae	*Thracia villosiuscula*
Bryozoa	Y 8	Crisiidae	*Crisidia cornuta*
Bryozoa	Y 14	Crisiidae	*Crisia aculeata*
Bryozoa	Y 16	Crisiidae	*Crisia denticulata*
Bryozoa	Y 17	Crisiidae	*Crisia eburnea*
Bryozoa	Y 41	Diastoporidae	*Plagioecia patina*?
Bryozoa	Y 42	Diastoporidae	*Plagioecia samiensis*
Bryozoa	Y 54	Annectocymidae	*Entalophoroecia deflexa*
Bryozoa	Y 66	Lichenoporidae	*Disporella hispida*?
Bryozoa	Y 76	Alcyonidiidae	*Alcyonidium diaphanum*
Bryozoa	Y 77	Alcyonidiidae	*Alcyonidium gelatinosum*
Bryozoa	Y 137	Vesiculariidae	*Bowerbankia* spp.
Bryozoa	Y 138	Vesiculariidae	*Bowerbankia citrina*
Bryozoa	Y 141	Vesiculariidae	*Bowerbankia imbricata*
Bryozoa	Y 154	Aeteidae	*Aetea anguina*
Bryozoa	Y 155	Aeteidae	*Aetea sica*
Bryozoa	Y 170	Membraniporidae	*Membranipora membranacea*
Bryozoa	Y 172	Membraniporidae	*Conopeum reticulum*
Bryozoa	Y 178	Electridae	*Electra pilosa*
Bryozoa	Y 206	Calloporidae	*Callopora rylandi*
Bryozoa	Y 300	Cellariidae	*Cellaria fistulosa*
Bryozoa	Y 302	Cellariidae	*Cellaria sinuosa*
Bryozoa	Y 325	Cribilinidae	*Puellina venusta*
Bryozoa	Y 337	Hippothoidae	*Celleporella hyalina*
Bryozoa	Y 369	Escharellidae	*Escharella variolosa*

Phylum	MCS Code	Family	Taxon
Bryozoa	Y 401	Adeonidae	*Reptadonella violacea*
Bryozoa	Y 418	Hippoporinidae	*Pentapora foliacea*
Bryozoa	Y 425	Schizoporellidae	*Schizoporella dunkeri*
Bryozoa	Y 502	Celleporidae	*Lagenipora lepralioides*?
Phoronida	ZA 3	Phoronidae	*Phoronis* spp.
Echinodermata	ZB 75	Pterasteridae	*Crossaster papposus*
Echinodermata	ZB 100	Asteriidae	*Asterias rubens*
Echinodermata	ZB 124	Ophiotrichidae	*Ophiothrix fragilis*
Echinodermata	ZB 143	Ophiactidae	*Ophiactis balli*
Echinodermata	ZB 154	Amphiuridae	*Amphiura filiformis*
Echinodermata	ZB 161	Amphiuridae	*Amphipholis squamata*
Echinodermata	ZB 166	Ophiuridae	*Ophiura* spp.
Echinodermata	ZB 167	Ophiuridae	*Ophiura affinis*
Echinodermata	ZB 168	Ophiuridae	*Ophiura albida*
Echinodermata	ZB 170	Ophiuridae	*Ophiura ophiura*
Echinodermata	ZB 193	Parechinidae	*Psammechinus miliaris*
Echinodermata	ZB 212	Fibulariidae	*Echinocyamus pusillus*
Echinodermata	ZB 222	Loveniidae	*Echinocardium* spp. (juv.)
Echinodermata	ZB 224	Loveniidae	*Echinocardium flavescens*
Echinodermata	ZB 272	Cucumariidae	*Paracucumaria hyndmani*?
Echinodermata	ZB 280	Cucumariidae	*Leptopentacta elongata*
Echinodermata	ZD 85	Ascidiidae	*Ascidiella scabra*
Tunicata	ZD 110	Styelidae	*Polycarpa* spp.
Tunicata	ZD 120	Styelidae	*Dendrodoa grossularia*
Tunicata	ZD 145	Molgulidae	Molgulidae
Tunicata	ZD 152	Molgulidae	*Molgula occulta*
Chordata	None	Branchiostomatidae	*Branchiostoma lanceolatum*
Rhodophycota	ZM 1		Encrusting red algae
Rhodophycota	ZM 170	Palmariaceae	*Palmaria palmata*
Rhodophycota	ZM 455	Lomentariaceae	*Lomentaria articulata*
Rhodophycota	ZM 468	Rhodymeniaceae	*Rhodymenia pseudopalmata*
Rhodophycota	ZM 592	Delesseriaceae	*Cryptopleura ramosa*
Rhodophycota	ZM 611	Delesseriaceae	*Membranoptera alata*
Rhodophycota	ZM 616	Delesseriaceae	*Phycodrys rubens*
Chromophycota	ZR 351	Laminaraceae	*Laminaria hyperborea*