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Isles of Scilly habitat and biotope mapping survey

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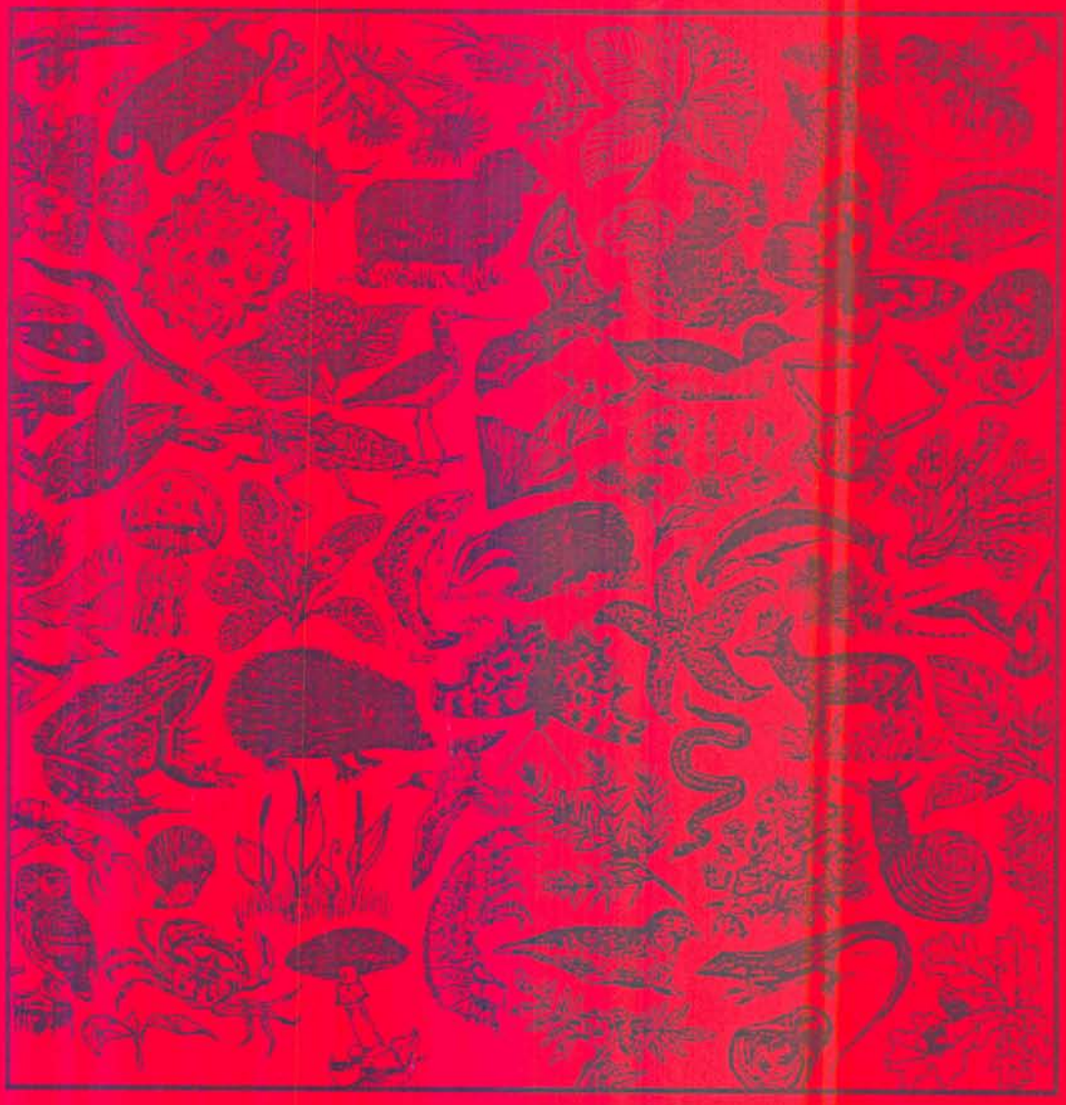

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Isles of Scilly Subtidal Habitat and Biotope Mapping Survey

A report on a mapping study of subtidal biotopes, in particular sediment biotopes, occurring within the Isles of Scilly archipelago

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EXECUTIVE SUMMARY

A survey of the Isles of Scilly, Cornwall, South-West England, was conducted between the 21st of September and the 22nd of October 1997. The aim of this survey was to map the extent of subtidal sediment habitats, differentiating between different biological components to the most detail possible, using a combination of Biomar lifeform and MNCR biotopes where possible. These habitats would be mapped from Mean Low Water down to around the 50m depth contour, but with most effort concentrated on the shallower (<30m) sedimentary areas. Spatial variation in elements of the physical and biological benthic environment were mapped using RoxAnn acoustic methodology (a computer-based system for analysing the return signals from an echo sounder) and aerial photographs. The data obtained from these two survey methods were ground truthed, to identify the nature of the biotope, by grab-sampling of sediments and remotely-operated video surveys. Biotope and sediment distribution data collected have been incorporated within a personal-computer based Geographical Information System (Mapinfo) and presented as a series of maps within this report. The distribution of sediment and biotopes is discussed and the presence of rare or uncommon species highlighted.

The archipelago is very exposed, the islands being the exposed summit of a granite batholith which rises from a sand plain at 50-70m depth, some 50km west of Lands End. The seabed consists largely of sand, gravel, cobbles and boulders with much exposed bedrock. Muddy substrates are not found. Extensive intertidal flats and bars cover much of the inner region of the archipelago. The outer slopes of the batholith are characteristically steep and dominated by boulder and bedrock substrates. Sedimentary areas occupy subtidal sounds within the Island complex.

The survey revealed the area to be highly complex, in terms of the distribution of sediment types and the associated biological communities. Overall species diversity appears to be high, but most species were recorded at low abundance levels. This may be a function of the harsh environmental conditions that prevail, combined with the low levels of productivity, the area being remote from coastal nutrient sources.

The similarity between infaunal samples was found to be very low; cluster analysis and multi-dimensional scaling did not show any obvious grouping of infaunal samples. Little correlation was also found between sand type and infaunal assemblage, consequently sand areas were mapped solely on the basis of habitat characteristics. However it was possible to correlate biological and physical habitat data for mixed substrate (gravel, cobble, boulder and rock outcrop), sand veneer over rock and bedrock areas. These areas have therefore been mapped in terms of both physical and biological features, and sea bed types present within each mapped category have been listed.

The implications of this survey for future, similar studies are discussed. Recommendations for further work around the archipelago, based on the findings of this survey, have also been made. Key points arising from this study are given below

1. It is clear that, in areas of this complexity, mapping of infauna by means of a limited grab sampling programme, and subsequent extrapolation over large areas, is unlikely to be successful. However, detailed sediment type mapping is required before any targeted infaunal sampling programme can be devised.

2. The conservation value of sediment features is difficult to assess, given the lack of identifiable communities that can be linked to the sediment types mapped. The

exception to this is *Zostera* beds. *Zostera* beds, particularly those on St Martin's Flats, were found to support the greatest number of infaunal species of any of the sediment categories. They also showed the greatest, within-category, similarity in infaunal composition. The *Zostera* beds within the Scillies complex have previously been identified as being of extremely high conservation value. The results of this survey support these earlier findings.

3. The spatial complexity of sediment distribution, coupled with the overall species diversity and the apparent diversity in species assemblages between broadly similar habitat types, is considered very uncommon, and of significant conservation importance.

4. Deeper, fine and medium sand areas, in general, were found to support a greater diversity of infauna than shallow sediment areas. Deep, exposed medium sand areas south of St Agnes and St Mary's appeared particularly rich.

5. Much of the sublittoral previously considered sediment proved to consist of thin sediment veneers over bedrock, or mixtures of sand, gravel, cobbles, boulders and bedrock. As these types of substrates cannot be properly sampled by grab, or surveyed in detail by remote video, the conservation value of such areas remains to be identified.

6. Sublittoral bedrock around the Scillies was already known to support epifaunal communities of high conservation importance; however, some of the deeper circalittoral bedrock areas (40-65m) surveyed during this survey appeared very rich, supporting high densities of infrequently recorded erect sponge species. They are therefore considered to be of high conservation importance and worthy of further investigation.

The following recommendations for future work have been made.

1 It is recommended that a targeted grab sampling programme is conducted in order to define the main infaunal communities present within the larger areas of sediment and the dominant sediment types identified during this survey.

2 A sampling programme using diver-operated suction sampler is recommended for the mixed substrate areas.

3 The deeper rock areas are clearly highly diverse. Deep bedrock (>40m bcd) is relatively uncommon around southern Britain; a remote video or remote video/diver survey is considered likely to identify new areas of interest around the archipelago.

1. INTRODUCTION

The Isles of Scilly lie some 50km west of Lands End in the Western Approaches. They are the most southerly islands within British waters. The Scillies archipelago has been designated a Marine Park and Sensitive Marine Area, and is a candidate Special Area of Conservation (cSAC). The habitats for which the island complex has been put forward as a candidate SAC are its lower shore sand flats and sublittoral sediment habitats. Littoral and sublittoral sediment habitats are considered internationally important, supporting extremely rich and varied communities. No major population centres occur within the archipelago, nor is it influenced significantly by industrial activity, thus the waters are relatively pollution-free. The very large number of rocky outcrops within and around the archipelago prevents mobile, benthic fishing from operating in the area. Consequently, the sediment areas around the Scillies are uncommonly free from anthropogenic disturbance.

Long term monitoring of the sublittoral rock communities has been conducted since the mid-eighties; however, less attention has been given to the sublittoral sediment areas. The studies that have been conducted on the sublittoral sediment communities have found then to be very complex, and have identified them as being of high nature conservation importance (Rostron, 1988).

A survey of the Isles of Scilly, Cornwall, South-West England (Map 1), was conducted between the 21st of September and the 22nd of October 1997. The aim of this survey was to map the extent of subtidal sediment habitats, differentiating between different biological components to the most detail possible, using a combination of Biomar lifeform and MNCR biotopes where possible. These habitats would be mapped from Mean Low Water down to around the 50m depth contour, but with most effort concentrated on the shallower (<30m) sedimentary areas. Biotopes, in the marine context, have been defined (Connor *et al*, 1996) as the 'environmental (physical) habitat (i.e. the substratum and the particular conditions of wave exposure, salinity, tidal streams and other factors which contribute to the overall nature of the location) together with its associated community of species'. Data were collected by remote survey techniques and used to map habitats and biotopes. Where possible, the features surveyed have been identified in terms of the biotope categories described within the current version of the Marine Nature Conservation Review's (MNCR) Marine biotopes classification for Britain and Ireland: Sublittoral biotopes (Connor *et al*, 1997). The information was presented within the Mapinfo computer based Geographical Information System (GIS).

2. THE PHYSICAL BACKGROUND

2.1 General

A review of marine physical processes in Scilly has been undertaken recently, relating available information on wave and tidal energy to sediment transport and shoreline stability (Isles of Scilly Shoreline Management Plan, 1996). Key aspects of this study, pertinent to biotope distributions, are summarised here.

2.2 Geology and geomorphology

Scilly is a geologically defined archipelago, the weathered remnants of a granite boss (or 'batholith'). The boss rises sharply from a flat seabed plain at about 70m below sea level, to a highest point of 63m on St Mary's. The single rock-type has resulted in a uniform morphology. The detailed form of the archipelago (Map 1) is controlled by crystalline variation within the

granite, fault patterns and variation in exposure to wave energy.

During the past 2 million years of the Pleistocene and Recent periods, major climatic fluctuations have resulted in a series of marine transgressions affecting the islands; at times sea-levels have been 100m below present level. During these long periods of advancing and receding sea levels, the presently sub-tidal slopes of the Scilly batholith would have been subject to intense erosion and sediment redistribution as a result of shoreline wave action. These processes produced peripheral slopes dominated by massive granite exposure and boulder deposits, passing into sand and gravel deposits of the seabed plain surrounding the archipelago. Although sedimentary deposits are widespread within the archipelago, shallow seismic profiling has shown that in many areas these sediment layers are very thin (<1m); however localised deeper basins of deposition occur.

The three major active sources of intertidal and subtidal sediments in Scilly are:

- Breakdown of the granite under present-day wave action and weathering processes.

- Reworking and redistribution of deposits formed during the Pleistocene and Flandrian periods, notably ram (periglacial sediments), alluvium, marine and wind-blown sands.

- Shell material, generated by the population of shell-forming organisms that inhabit the Scilly intertidal and subtidal zones.

Extensive intertidal flats, bars and shallow subtidal areas cover much of the inner region of the archipelago (Map 1); most of the subtidal between Tresco, St Mary's and St Martin's is no more than 5m below Chart Datum (bcd). Broad, fairly shallow sounds radiate outwards from the central areas, for example St Mary's Road, a sound between Tresco and St Mary's and extending to the south west, varies between 5m bcd (at the north eastern end) to 15 - 25m bcd (off Annet to the south west). The outer slopes of the batholith are characteristically steep and dominated by boulder and bedrock substrates. To the north, east and south of the archipelago, the 50m contour mostly lies within 500m of the shore, and frequently within 100m.

2.3 Tides and tidal streams

Scilly is subject to a semi-diurnal tidal regime. The mean spring tide range is 5.0m and mean neap tide range is 2.3m. The critical levels relative to local Chart Datum are as follows:

Highest Astronomical Tide (HAT)	6.4m	
Mean High Water Springs (MHWS)	5.7m	
Mean High Water Neaps (MHWN)	4.3m	
Mean Sea Level (MSL)	2.91m	ORDNANCE DATUM (OD)
Mean Low Water Neaps (MLWN)	2.0m	
Mean Low Water Springs (MLWS)	0.7m	
Lowest Astronomical Tide (LAT)	0.0m	CHART DATUM (CD)

Tidal stage has been recorded for many years at St Mary's quay. The unit was destroyed by wave damage in 1989, but has been subsequently replaced. Considerable water surface gradients are believed to exist due to frictional effects of tidal flow through the archipelago; level differences possibly attain values approaching 1m on mid spring tides.

The semi-diurnal tidal rise and fall generates a complex flow of water through the Islands. The tide in the open sea is a progressive wave, with slack water 4 hours before and 2 hours after HW.

The currents flow in a rotary fashion through the cycle. The following table summarises the pattern of flow through the Islands on a typical tidal cycle.

FIRST FLOOD (HW-4 to HW-2). Flow is from the S through SW. Water is funnelled into St Mary's Sound and leaves via all other exits. At the end of the period flow is starting to enter between Tresco and St Martins.

LATE FLOOD (HW-2 to HW+2). Flow is from SW, W, NW then N. Water enters St Mary's Sound and between Bryher and Tresco and Tresco and St Martins, exits between St Mary's and St Agnes and St Mary's and St Martins. After HW there is little flow into St Mary's Sound, and flow reverses in the Bar Point area carrying water southwards.

EARLY EBB (HW+2 to HW +4). Flow is from N to NE. Water enters between Bryher and Tresco, Tresco and St Martins and St Martins and St Mary's. Exits via St Mary's Sound.

LATE EBB (HW+4 to HW-4). Flow is from NE, E then SE. Water enters between St Mary's and St Martins, and exits by all other routes.

Tidal currents rarely exceed 1 knot (0.5 ms^{-1}) within the Island complex, but flows of 2 knots (1 ms^{-1}) or greater occur around the outer margins of the archipelago, with strong tidal races off major headlands. Only a limited number of current meter measurements have been made.

2.4 Wave climate

Wave data are available for Scilly from a series of recorded data sets and from 'Metwave' model output. The Islands are very exposed to wave energy, storm wave heights attaining 14m height and 9s being the commonest zero-crossing period, with the longest waves exceeding 13s. The directional data show the largest waves to approach from between SW and NW, but that large waves can also approach from the east.

Through processes of refraction the island system is a focus for wave energy. With short wavelength there is less efficient refraction on shoaling, and much of this wave energy is lost as waves break against or reflect from the outward facing coasts, leaving the inner waters of the archipelago relatively calm. The longest wavelengths however are more able to deform to the tortuous nature of the major inlets, and more efficiently penetrate the inner waters, particularly at high tide.

2.5 Sediment mobility

Sand transport by tides or under combined tide/wave action is evident from the nature of the deposits in several parts of the archipelago. In the Crow Bar area, in the channels between Tresco, Tean and St Martins and in the channel between Bryher and Tresco and Samson and Tresco (Hulman area), tidally-generated megaripples and sand ribbons have been identified in side-scan sonar records and aerial photos.

Available current meter data indicate that in these areas peak velocities 0.5m above the bed attain a maximum of 0.5m s^{-1}. Such velocities are sufficient to transport sands and fine gravels in saltatory (i.e. lifting in short hops) or rolling movement, consistent with the observation that bedload transport of sands is regularly taking place in these zones.

Current meter data show the presence of asymmetry in the distribution of ebb and flood tidal stream velocities at many sites. The apparent direction of residual transport of sand resulting from these asymmetries has been tentatively identified.

The simplest pattern of residual sand transport consistent with the available data indicates a movement of sand from the north of the archipelago to the south. On the Bryher-Tresco-St Martin's Flats areas there appears to be a consistent southward movement of sand. In the latter area this splits in the vicinity of Crow Bar to pass east and west of St Mary's. Current meter data confirms a southward movement of sand between St Mary's and St Agnes. There appears to be a balance between east and west going transport at the southern end of Crow Bar, which may explain the accumulation of sand in this area as a function of longer-term residence. If tidal currents are not competent to transport sand in the St Mary's Road and Crow Sound areas (there are no data available) these zones may be sink sites for sand.

The passage of a wave produces an orbital motion in the water column beneath the wave. In shoal water this motion impinges upon the seabed, where it is compressed to a simple to-and-fro movement, with a stronger onshore flow which produces a net landward movement of sediment moving as bedload. Within the archipelago wave action will tend to move medium sands and coarser material, moving as near-bed load, towards the high-water marks. Due to the interrelation of the viscosity of water and sediment particles, sand finer than about 200µm tends to be dispersed into suspension once the threshold of movement is exceeded. For this reason sand of this size will tend to disperse into quieter, deeper waters. Extensive deposits of this size of sand are commonly found in water depths of 10m or more seawards of sand beaches on exposed coasts, where they have accumulated after escaping from the littoral zone. Only localised deposits of this nature have previously been identified in the sub-littoral zone in Scilly, attesting to the high-energy characteristics of the environment. Material of this size generated by attrition/abrasion processes, or through the destruction of finer deposits such as ram (peri-glacial deposits), may therefore be largely lost from the local sedimentary system into deeper water.

Most of the more exposed substrates on Scilly are composed of 'residual' deposits of cobbles and boulders, or are rock, and hence are essentially stable, subject to some readjustment during the severest wave action. Sediment areas will almost all be mobile at some time - the frequent observation of wave-induced ripples on sand made during the relatively calm autumn period of this survey attests to the effectiveness of this energy. In the absence of records of wave climate made within the archipelago, where most sedimentary areas are found, it is impossible to make predictions of the frequency with which seabed disturbance by wave action takes place.

3. PREVIOUS BIOLOGICAL SURVEYS

A number of studies of particular taxonomic groups have been published, notably Harris (1972) on polychaetes; King (1972) pycnogonids; Robins (1969) cnidarians and ctenophores; Rowe (1971) echinoderms; Thurston (1970) natant decapods and Warwick and Coles (1977) on free-living nematodes. There have also been a number of recent studies on intertidal species and communities (e.g. Nichols and Harris, 1982; Holme, 1983).

Much attention has been focussed on the epifauna of the rocky sublittoral around Scillies, though most of this has been related to site-specific monitoring rather than distribution mapping (e.g. Hiscock 1984 d, 1984e, 1985; Fowler 1990, 1992). A wide-ranging study by the Oil Pollution Research Unit (OPRU) in 1983 surveyed throughout the sublittoral of the archipelago. Bishop (1985 and 1986) conducted a series of studies on *Echinus* population density and size structure, in relation to the local urchin fishery.

Two previous surveys of sublittoral sediment infaunal communities have been conducted in

recent years (Rostron, 1983, as part of the OPRU study, and Rostron, 1988). These were conducted using a diver-operated suction sampler. This method collected far larger samples than the Day grab used in this study, it also facilitated sampling in areas where a grab could not penetrate or form an effective seal, such as on cobble and boulder substrates. However, significantly fewer sites can be covered per day, using a suction sampler and so the number of samples is therefore limited in these studies. Nine sites were sampled during the 1983 study, two samples were collected at eight of the sites (17 samples in total); 15 sites were sampled during the 1988 study, one sample from each. These sites were spread across most of the shallower subtidal within the archipelago, (excepting north and west of Bryher, Tresco and St Martin's, and south of St Mary's and St Agnes) down to a depth of 30m bcd.

Monitoring of the density of *Zostera* plants, within beds at Old Grimsby, Tresco and English Island, was conducted by the Nature Conservancy Council (NCC) between 1984 and 1991 (Fowler and Pilley, 1992). Latterly this monitoring programme also assessed the presence of wasting disease (a parasitic slime mould, *Labyrinthula* sp., which attacks *Zostera*). This programme monitoring *Zostera* density and condition was then continued by the Coral Cay Conservation Sub-Aqua Club (CCC-SAC), from 1992 to 1996 (Irving and Mackenzie, 1996). In addition, the CCC-SAC programme also investigated the spread of the non-native algae *Sargassum muticum* within *Zostera* beds.

4. FIELD METHODS

4.1 Approach

Field techniques fell into two main categories: i) acoustic mapping techniques whereby the distribution of acoustically different features was mapped, and ii) ground truthing, where a number of locations (survey stations) representing the range of acoustic features recorded during the mapping phase were re-visited and biological and sedimentary characteristics were identified. The data from the ground truthing were then used to identify the sedimentary and biological features correlating to particular acoustic signals. Recent aerial photographs were also used to provide spatially continuous data on the nature of the seabed down to depths of about 10m bcd.

For this survey it was decided to conduct the acoustic mapping and ground-truthing during two separate phases. This allowed time for the acoustic data to be fully worked up before identifying and surveying ground-truthing stations, thus ensuring that ground-truthing data were collected for the full range of acoustically discrete areas mapped.

Acoustic mapping data were collected using a RoxAnn Groundmaster system operating at 200kHz. Trials were also run in the St Mary's Sound area using a side scan sonar. The latter system was a Dowty Widescan instrument using a 3502 thermal recorder. The instrument was operated at 325 kHz short pulse at 100m range to provide high resolution seabed images.

Two complementary ground truthing techniques were used, grab sampling and drop-down video. Stations were initially surveyed by drop-down video (except for two stations where depth and currents prevented the video reaching the bottom). Features discerned from the on-board monitor were recorded on log sheets; the video image was also recorded on tape for subsequent analysis. If the video image indicated significant sediment on the seabed, a 0.1 m^2 Day grab was deployed and a sample collected.

The archipelago was divided into nine physiographic areas for purposes of survey management. As previous experience with the RoxAnn system had indicated that the relationship between acoustic 'signatures' and substrate type may vary from region to region on the basis of local energy levels, an attempt was made to select these areas on the basis of similar environmental conditions. The nine areas are identified in Map 2.

4.2 Vessels and position fixing

RoxAnn and side-scan mapping was conducted from the English Nature vessel *Melza*, a 7m GRP survey launch with an open wheelhouse and forward accommodation. The grab sampling and video survey was conducted from the vessel *Josephine*. This was a 12m long GRP vessel with large deck space, enclosed wheelhouse and winch/davit facility for grab operation.

Differential GPS (DGPS) was used for position fixing during both acoustic mapping and ground truthing surveys. This system used was a Del Norte local DGPS, giving 1s data logging and ±1m accuracy. During the RoxAnn survey the output string from the Groundmaster system (depth, E1, E2) was fed in to the logging computer system, and recorded at the 1s DGPS update rate.

Plate 1. Day Grab in operation.

The datum used for the survey was the updated Ordnance Survey of Great Britain OSGB (SN)80. It should be noted that the error between this and the earlier OSGB1936 datum is of the order of 0.1km in the Isles of Scilly.

A DGPS position reference point was set up for Quality Control (QC) purposes. This was located on the outer south-west corner of St Mary's pier, at 90265E 10977N. This site was visited daily to check position accuracy; all positions recorded were within ± 2m of the given position, which was deemed acceptable due to vessel manoeuvring restrictions in other than

calm weather.

Overboard cable length was recorded at all times during the side-scan sonar survey, and fish lay-back (i.e. distance behind survey vessel) computed accordingly.

4.3 RoxAnn acoustic survey

Mapping was undertaken using a RoxAnn *Groundmaster* 200khz echo-sounder signal processing system. Details of the theory underlying this equipment are provided within Appendix 5. The transducer was overside-mounted at 0.5m below water level. Trials were carried out using the system to ensure low ambient noise and reproducible results. Previous experience had indicated problems with the standard system in areas of strong tides or turbulence, due to the digitising system locking on to other than seabed echoes. Consequently Marine Micro Systems were asked to supply a more sensitive blanking switch than is normally fitted, thus enabling the manual elimination of spurious midwater echoes. RoxAnn values (E1, E2, depth, position and time) were logged on a PC system at 1s intervals (position update frequency) and results displayed using SEARANO software. The survey was undertaken at 4-6 knots. Survey lines were spaced at 200m intervals and normally aligned N-S, although considerable deviation was necessary to avoid shallow areas. The survey track is shown in Map 2.

Depth data recorded were accurate to $\pm$ 0.1m. These data have not been processed to correct for tide-level variation and therefore represent Mean Sea Level (~Ordnance Datum) with an accuracy of $\pm$2.5m. Tide levels were being simultaneously recorded by the Proudman Oceanographic Laboratory instrument on St Mary's Quay, and tide level reduction to accuracies of $\pm$0.5m (expected level variation within the archipelago) can be undertaken in the future if required.

4.4 Initial RoxAnn data work up and ground truthing station identification

In the week period following the acoustic survey, the data were processed for quality control purposes and also for an initial appraisal of the distribution of substrate types for ground-truth station selection. All records with depth values of <0.5m or >50m were rejected, thus excluding most false echoes and all deepwater sites (the 200kHz Groundmaster system is not recommended for water depths >60m). SGPlus statistical software was used to examine relationships within the data, determine cluster locations within the E1/E2 plots and define the range of values encountered. Contour maps of E1 and E2 values and the vessel track were produced using Surfer software. Ground truth sampling stations at on-track locations were subsequently defined. Within each area, ten station positions (on average) were selected to provide a reasonable coverage of the range of RoxAnn values encountered, and the range of depths present. Additional video transects were plotted to run across areas identified from the aerial photographs as supporting flora (dark, shallow areas). These transects were distributed across the entire survey area, selected on the basis of differences in patterning and wave shelter/exposure, to aid differentiation between areas of *Zostera* and algal cover. The transects were also positioned to run along, or cross several, RoxAnn tracks and so further aid discrimination.

4.5 Side scan sonar

A Dowty Widescan instrument using a 3502 thermal recorder was deployed for the survey. The instrument was operated at 325 kHz short pulse at 100m range to provide high resolution seabed images. The auto-range correction facility was used to log true seabed distances from the towfish. The survey was run at 3-4 knots at 200m line spacing. Vessel position was logged

at 10s intervals, and the paper record automatically annotated at 30s intervals.

The side-scan survey was initiated in the North Channel, but the small size of the survey vessel and the prevailing wave conditions combined to create unacceptably lively vessel motion. This resulted in an un-interpretable record. Consequently the survey was confined to the calmer waters within St Mary's Road. The survey lines were aligned SW-NE to minimise depth variation during runs, and the survey was confined to those areas largely devoid of rock outcrops, which may have damaged the towed fish.

4.6 Aerial photographs

Colour aerial photographs were made available by English Nature. The aerial survey, conducted as part of a *Zostera* mapping programme by BKS Surveys Ltd. (BKS Surveys Ltd., undated), had been conducted during an equinoctial low spring tide on 15th September 1996. The prints were produced at approximately 1:10,000 scale. These allowed identification of boundaries between light and dark features (e.g. algal cover and clean sand) down to about 10m bcd.

4.7 Grab and video ground truthing

Grab and video stations were selected primarily to ground truth the RoxAnn data. At each station one grab sample was taken (where the substrate was suitable) and the drop-down video deployed. Eighty eight stations were sampled (Map 3), together with some video transects (details given in Appendix 3, Tables 2 and 3).

A 0.1m^2 Day Grab was used for grab sampling (see Plate 1). Grab handling and vessel manoeuvring were sufficiently accurate for samples always to be collected within a 10m radius of the station position (logged by DGPS). On hard ground, up to five sampling attempts were made to ensure the best possible representation of the coarse, difficult to sample substrate. Each sample was inspected, and the sediment characteristics and conspicuous macrobiota recorded. A sub-sample was then removed for subsequent particle size analysis. The remaining material was then sieved through a 0.5mm sieve and the retained sample placed in labelled buckets in 10% formalin solution for subsequent infaunal analysis.

Particle-size analysis was carried out on 53 of the samples collected. All samples were oven-dried at 105° C, then dry sieved from 2mm to 63µm (-2phi to 4 phi) at 0.5 phi sieve intervals. The weight percentages of gravel (>2mm), sand (2mm-63µm) and mud (<63µm) were subsequently calculated for all samples. A graph was produced showing the particle-size distribution of the sand fraction, from which sand particle population modes were identified. Data are presented in Appendix 3, Figure 1, Tables 1 and 2.

The drop down video system used consisted of a Sony Hi8 camcorder within a dome-ported aluminium housing. This was enclosed within a custom built aluminium cradle fitted with arm-mounted 100W lights. This was linked to the surface operators by a 75m umbilical. Images were recorded on Hi8 tape within the camcorder, while simultaneously viewed on a colour monitor. The video was deployed by hand (Plate 2), and allowed to drift just off the seabed or, alternatively, dropped onto the seabed for closer inspection. The date was burnt into the tape at the beginning of each day and time burnt in continuously during the survey.

5. DATA ANALYSIS, RESULTS AND INTERPRETATION

5.1 Acoustic survey and aerial photograph mapping

5.1.1 RoxAnn calibration

Considerable effort was made to ensure the accurate calibration of the RoxAnn signal. On the data collection side, emphasis was placed on accurate position fixing, so as to minimise variability in areas of rapidly changing substrate and hence relate each acoustic signal to the correct substrate type (see Appendix 2). The overall accuracy of the DGPS enabled positioning to within ±1m. Grab samples were collected within 10m of the sampled RoxAnn location; video was recorded whilst drifting. In variable wind conditions, approaches were made from different directions until video footage was gained whilst the video was drifting through the 10m radius circle around the RoxAnn position (Plate 3). The recorded timecode at which the video entered and left the circle was noted, and only the footage recorded between these points used for subsequent map interpretation.

To accommodate the potential positioning error that remained, the RoxAnn track extending approximately 10m (~ ± 5s) either side of the nominal sampling position was examined to detect possible discrepancies between ground truthing and RoxAnn signal due to rapidly

Plate 2. Remote video being deployed.

changing substrate. The mean value of the E1, E2 and depth values were calculated from this sample of data representing each side, as well as the average deviation from the mean value, and are presented in Volume II, Table 2 and plotted as envelopes containing the scatter of points in the E1/E2 calibration diagrams (Appendix 2, Figure 2). This exercise helped the calibration procedure considerably, giving confidence to those calibration points with low mean deviations, and allowing samples with very large deviations to be recognised as containing two or more distinct substrate types.

A problem with the RoxAnn classification system is that it does not directly measure particle-size or visual appearance, the normal criteria for assessing substrate type. This commonly leads to the problem that a RoxAnn acoustic 'signature' may not uniquely describe a certain type of seabed, thus often necessitating the application of a different calibration within different areas mapped. When all the ground truth data for this survey were initially plotted on a single E1/E2 calibration diagram, it was clearly evident that such 'overlap' occurred. Consequently the interpretation methodology adopted has been to calibrate each of the nine survey areas individually, but at the same time adjusting the calibrations as far as possible so as to maintain a broadly consistent set of boundary E1/E2 values between substrate types in the region.

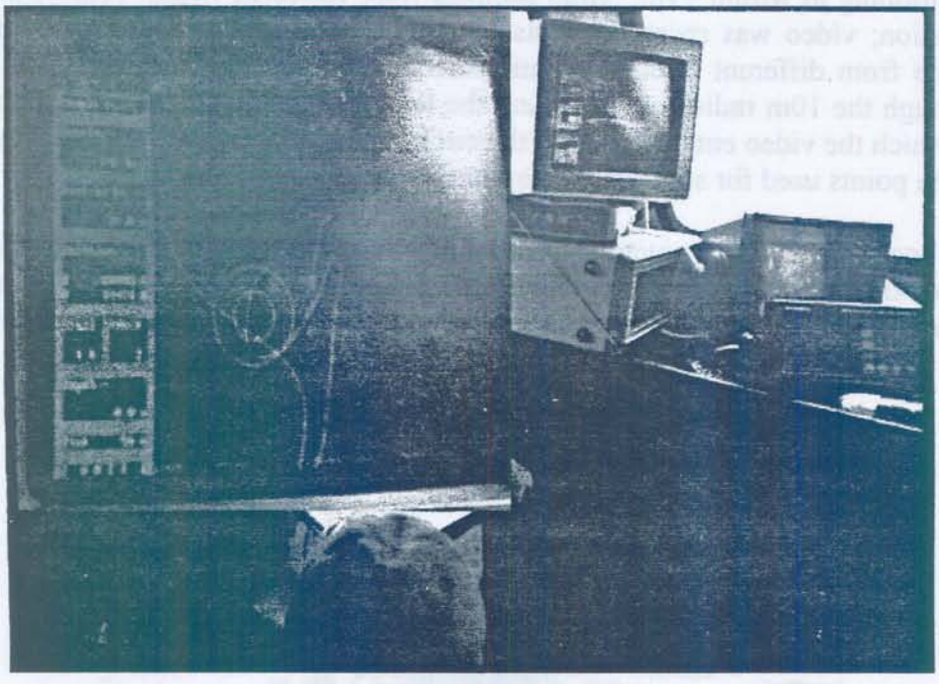


Plate 3. On-board monitor showing vessel track and 10 and 20m radius circles around RoxAnn position (inset showing monitor screen).

For each of the nine areas the E1/E2 scatter plot was contoured according to frequency of data point occurrence (Appendix 1 Figure 3). This focused attention onto the plot areas where a good calibration was important. An immediate observation apparent from these plots is that variability in most cases is dominated by the E1 (roughness) value, and there is only limited variation in the E2 (hardness) index. This can be explained for the Isles of Scilly environment by:

1) The overall high energy level of the environment producing a complete absence of soft muds or muddy sands.

2) The fact that most hard substrates are very stable and frequently coated with a dense algal or faunal turf, thus masking their acoustic hardness.

This factor has restricted to some extent the ability of the RoxAnn system to very efficiently discriminate between ground types in this survey.

A further problem encountered in the calibration exercise has been the lack of ground truthing

stations per plot. This has come about because of:

1) The necessity to divide the region into smaller areas due to different acoustic property/substrate type relationships.

2) The inability to clearly differentiate between sedimentary substrates and hard substrates with a very thin sedimentary veneer at the time of the initial processing of the RoxAnn data. Thus only about 50% of the ground-truthing sites visited were true sediment sites.

The combined effect of all these factors is that only a relatively limited number of RoxAnn-defined substrate types have been clearly identifiable, each covering quite a broad range of conditions. At this stage it also remains unclear how and why there is a variability in the acoustic properties of sands between the various areas.

5.1.2 Side scan sonar data and comparison with RoxAnn system

The side-scan sonar records were processed manually with features plotted on a trackplot at a scale of 1:1000. Features were mapped by eye within successive boxes defined by the track width at 1 minute time intervals. The accuracy of boundaries mapped using this method would normally be expected to be of the order of $\pm$ 10m.

The range of seabed acoustic reflector types identified are illustrated in Appendix 1 Figure 4. The information from the hand-mapped plots was digitised as Mapinfo polygons (Map 4).

The seabed classification of St Mary's Roads using side-scan sonar was undertaken completely independently of the RoxAnn-based classification. Both maps are presented and provide a comparison of the discrimination potential of the two techniques.

An important aspect of the comparison of the two acoustic systems was that the RoxAnn was logistically the easier and more economical system to deploy. This resulted from:

1) The weight (transport costs) of the side scan unit
2) The ability to use RoxAnn in poorer wave conditions when only a vessel of limited size is available, thus reducing down-time.
3) The lack of overboard impediment with the RoxAnn system; the towed fish of the side scan would have been very risky to deploy in areas of rapidly changing depth due to local, steep rock outcrops, characteristic of Scilly.

Data processing is more time consuming with side-scan, and is often very subjective, requiring a highly skilled/experienced interpreter which is an expense in itself. RoxAnn processing is rapid and automated. The ground-truthing experience/skill level required is probably about the same for both systems. 'Experimentation' in the ground-truthing process is possible with RoxAnn due to the digital data format; with side-scan the potential for manipulating the data is very limited.

Side scan provides a much better spatial coverage of the seabed per unit effort, even though the survey is conducted at a slower speed. The mapping accuracy that can be achieved with side scan is lower than with RoxAnn however, due to the vagaries in determining the relationship between the DGPS antenna and the fish (this can be overcome in more expensive systems). RoxAnn data are very accurately located along survey tracks, but feature
Mapping between tracks is only by interpolation.

Both systems have their advantages and disadvantages in terms of habitat recognition. In general RoxAnn is the more useful system in featureless mud/sand/gravel areas because of automatic gain systems in side-scan units such substrates are capable of being represented by very similar records. When a habitat is classified by morphological features however, such as a mobile sand area (mega-rippled) or Eel grass beds with eroding margins, the side-scan system provides more information. In this particular survey there was no clear difference in the performance of the two systems in terms of habitat mapping.

Although substrate categories mapped using each systems were often not directly compatible, the seabed classification maps of the St Mary's Roads area produced by each correlated very well.

5.1.3 Aerial photograph interpretation

A base map of the Islands was prepared at a scale of 1:15,000, showing the national grid and high and low water marks. Colour photocopies were made of the aerial photos, reduced to this scale. These were best-located on the base-map, using a light table, on the basis of the alignment of high and low water marks. One kilometre squares were cut from the photocopies on this basis, and patched to form a mosaic of the Islands. In this way the distortion within the aerial photographs was eliminated to a level of accuracy suitable for the project. The mosaics were subsequently digitised into a CAD system, identifying light-coloured reflectors (sand or gravel substrates free of algae or *Zostera*) and ground patterns thought to be indicative of *Zostera* beds. These polygons were used in conjunction with the RoxAnn data to help define shallow biotope boundaries.

5.2 Biological data analysis

Videotape records from the drop-down video were copied on to VHS tape and reviewed. Habitat type and species that could be identified from the video were noted. For bedrock, boulder and cobble areas, biological categories developed were based on solely on the video data, modified using environmental factors (such as light penetration, degree of sediment scour, wave exposure) known to limit distribution of the various species/taxonomic groups recorded. For sediment areas video data was compared with sedimentological and infaunal data from grab samples. This was necessary to build a complete picture of each site. Much of the survey area was extremely heterogeneous; grab samples were often taken from within sediment/cobble/rock matrices and so presented a limited picture of the species and habitat present. These data are presented in Appendix 3, Table 3.

Day grab samples from the 57 stations sampled were analysed for infauna. Samples were sorted, identified to species level where possible, and counted. Complete species lists for all sampled stations are given in Appendix 3, Table 4. To facilitate identification of samples containing similar species' assemblages, Bray-Curtis similarity was calculated and Multi-dimensional Scaling (MDS) performed on the derived matrix, using *Primer* statistical analysis software. Epilithic species recorded on cobbles or pebbles within the samples were removed from the datasets before analysis, as they were not part of the sediment community and their inclusion would only serve to skew results. Bray-Curtis similarity is depicted in dendrogram form in Appendix 1, Figure 1, whilst the MDS plot is shown in Appendix 1, Figure 2. From Figure 1, it can be seen that the similarity between clusters is extremely low, nearly all sample separation occurring in a band between 20-35% similarity. Neither are distinctive groupings apparent in the MDS plot; additionally the plot indicates low confidence in the relative positioning of sample points. (The stress value for MDS is an indication of the goodness of fit of the data when compressed into a two-dimensional plot. At 0.32, the stress level for the

samples plot indicates a poor fit, the confidence levels for the spatial relationship the samples was low.)

Despite the low confidence in the clustering and relative position of sample points, the dendrogram and MDS plots were analysed in conjunction with physical habitat classification developed to see if correlations between proximate infaunal sample stations and sediment type could be found. However, no such correlations were apparent.

The raw infaunal data were also visually inspected to see if similarities in infaunal composition could be detected between stations of similar sediment type, depth range and/or geographic area. Various permutations were tried: habitat types were sub-divided into smaller categories on the basis of depth zone (e.g. 0-5m, 6-15m, 16-25m, 26-45m and 46m+), exposure to wave action, spatial proximity and physiographic area. Infaunal lists for the sampled stations were then re-ordered to look for correlations. Again however, no significant correlations in infaunal composition could be detected for any of categories created in this manner. The one partial exception to this was infauna from stations within *Zostera* beds. These stations had markedly more species common to two of the four stations sampled, but this still amounted to a fraction of the total species recorded.

Possible reasons for the lack of similarities between infaunal samples are:

1. Most species appeared to exist at low densities, possibly due to the relatively harsh, exposed environment and lack of nutrients within the sediment.
2. The survey area is physically very complex at both meso and macro scales.
3. The survey area appears to support a very wide range of infaunal assemblages.

Given the above, a single grab sample at each station may well have been insufficient to provide a truly representative species list for that station. Also, 57 stations may have been too few to provide multiple samples of each species assemblage, and so allow assemblage categories (and species-habitat relationships) to be recognised.

Whilst these problems can be identified now, the level of habitat complexity was not anticipated. Additionally, the distribution of the various sediment habitats were only mapped following the ground truthing survey, and so it would not have been possible to devise a highly targeted grab sampling programme in advance.

The absence of strongly defined infaunal assemblage groupings, and the lack of correlation between infaunal sample clusters and sediment classification groups, has meant that infaunal assemblages could not be used in the definition of mapped sediment biotopes.

5.3 Mapping - approach and units

The RoxAnn data was mapped initially by colour-coding the RoxAnn tracks according to the classifications identified in Appendix 1, Figure 3, then hand-drawing polygons to areas of similar predicted substrate type. This process was undertaken in Mapinfo against a displayed background of depth information (Admiralty chart) and the information abstracted from the aerial photographs. At the boundaries between some of the nine areas it was necessary to slightly modify the polygons to merge the differences in the E1/E2 classifications adopted for each area.

This physical habitat map (Figure 4) was then modified by incorporating mappable hydrographic and aerial photography data, producing a sea bed type classification system. The descriptions by which the features are defined are derived from the biological and sedimentological ground truthing data. Consequently, the level at which the mapped units are defined, and the amount of detail in each description, is a function of the strengths and weaknesses of the acoustic mapping and ground truthing techniques used.

The features resolved by acoustic mapping are generally not those used to define MNCR classification biotopes. Acoustic mapping using RoxAnn will only enable areas of similar seabed roughness and hardness combinations to be mapped. Experience has shown that very different seabed types may produce virtually indistinguishable RoxAnn roughness/hardness values: for example, areas of gravel waves and cobble plains; level bedrock 'softened' by faunal turf and areas of compacted sand. The accuracy with which the acoustic properties can be interpreted is consequently highly dependent on the amount of ground truthing undertaken and the positional accuracy of ground truthing. Secondly, many biotopes are differentiated or defined by features to which RoxAnn is completely insensitive. This applies to the vast majority of biological features; clearly different algal or faunal turf species cannot be distinguished by acoustic mapping, nor whether the turf consists predominantly of algal or faunal species, nor in many instances whether the substrate supports a turf at all. Neither, obviously, is the composition of infaunal communities directly related to seabed acoustic properties. Consequently, biotopes can only be linked to areas of similar acoustic properties through the data derived from ground truthing. As an acoustically defined area is likely to contain a number of biotopes, the more ground truthing stations that are located within it, the better the range of biotopes it may incorporate will be defined. The biotopes grouped within a single, acoustically defined, mapped unit will frequently not correlate to defined biotope complexes; often they are listed within quite different branches of the MNCR biotope hierarchical system (e.g. Infralittoral Gravel and Sand, and Exposed Infralittoral Rock). Consequently to attempt to place (and name) the mapped areas within biotope complex categories would be highly misleading in many cases.

Incorporation of data from other sources (e.g. aerial photography, knowledge of community distribution in relation to depth, wave exposure etc.) will greatly improve the definition of seabed types, but identification to biotope or biotope complex level still remains the exception.

For the above reasons, the sea bed types mapped generally do not directly correspond to the biotopes or biotope complexes defined within the MNCR current Marine biotope classification for Britain and Ireland. Within rock, boulder and cobble areas, it has been possible to recognise a number of MNCR defined biotopes at ground truthing stations. These have been included within the mapped category description as present within parts, but not necessarily all, of that category. As described above it has not been possible to link infauna assemblage data to sediment type categories. Consequently it has not been possible to map sediment faunal assemblages. Application of MNCR sediment biotope definitions, on the available data, would be limited to splitting between infralittoral gravels and sands (IGS) and circalittoral gravels and sands (CGS). This does not add to the sedimentological descriptions, so has not been included. The exception to the above is the *Zostera* biotope; as dense beds could be discriminated by aerial photography and RoxAnn, this is a feature that has been mapped.

5.3.1 Sea bed features differentiated and mapped

Interpretation of RoxAnn and aerial photographs, in conjunction with the sediment analysis data, enabled the following 7 major physical features to be discerned and mapped.

Fine-medium/fine, suspension sand.
Medium, bedload sand.
Coarse sand.
Sandy gravels; thin sand veneers over hard substrates; large sand or gravel patches between rock/cobble/boulder zones.
Localised rock outcrop, cobbles and boulder fields.
Massive rock areas.
Zostera

Analysis of remote video data, and application of bathymetry, water clarity, and wave and tidal stream exposure considerations, and the more specific substrate type data that could be tagged to each of the 9 areas (Figure 3), allowed these features to be further defined and differentiated into 15 habitat or habitat/species assemblage (biotope) categories, listed in Table 1. These 15 categories are the ones addressed in the final maps produced.

5.3.2 Major sea bed features identified / habitat/species categories mapped

Detailed descriptions of each category are given below. The distribution of these categories is depicted in Maps 5 to 12. The sandy gravels with sand veneers; cobble, boulder and bedrock outcrop and bedrock and boulder categories contain a number of identifiable Marine Biotope Classification biotopes. Those that were identified from video and/or grab data at the ground truthing stations are listed in Table 1. The list also includes biotopes that could not be positively be identified due to limitations of video and, at some sites, poor water conditions but are considered highly likely to be present. Drop down video provided little biological data for the sand areas other than those supporting *Zostera*.

1. FINE-MEDIUM/FINE, SUSPENSION SAND.

When sands finer than about 200um are subject to motion, they tend to move directly into suspension rather than behaving as bed load, and are thus subject to wide dispersion potential. Sand deposits of this nature normally represent fallout zones, subject to the settling out of fine sands from adjacent high energy areas. By definition these fallout zones are normally stable areas of low ambient energy, but they may be subject to intermittent wave-induced disturbance during high energy storm waves. Substrates of this type were located in:

Area 1. An extensive zone off the north-eastern shore of St Mary's, in Crow Sound (10-30m bcd). This zone may represent a lee area sheltered by St Mary's from the prevailing direction of storm wave approach and also a fallout zone from the area of higher tidal activity to the north-west in the Crow Bar area.

Area 2. The deeper-water margin areas (25-50m bcd) to the north and north-east of St Martins. Again an area in the lee of the archipelago relative to the prevailing wave approach. These sands contain substantial quantities of coarse biogenic material.

Area 3. Localised intertidal patches in sheltered bays e.g. Green Bay on Bryher, off East Porth on Samson and in St Mary's harbour. Localised patches of fine sands also occur in St Mary's Roads (5-10m bcd), possibly associated (trapping effects) with *Zostera* beds.

Medium-fine sands may also be associated with higher energy, sand recirculation zones. Sometimes, because of a sand recirculation system created by a local pattern of tidal flows, fine sand moving in suspension is unable to escape into quieter areas. As a result

an accumulation of sand occurs, typically forming a bank or a shoal complex. In contrast to fallout areas, the sand is frequently in motion, and the bed is normally contorted into mega-ripple sequences. The extensive, shallow, medium-fine sand zone in the Crow Bar - south St Martins Flats area is likely to be such a zone, subject to tidal and wave-induced transport and displaying mega-ripple and sandwave areas. These sands are well sorted, consistent with the high level of sediment mobility.

The three depth/wave exposure zones mapped correspond roughly with the three examples given above.

Shallow (<20m), sheltered fine sand.
These occur in areas very sheltered from wave exposure, mostly between Tresco, Bryher and St Martin's, in sheltered bays or adjacent to *Zostera* beds. This includes intertidal and very shallow subtidal (<10m bcd) areas.

Medium depth (10-20m) moderately exposed fine sand.
These areas again correspond to the shallower fine sand areas off the north-eastern shore of St Mary's. They are sheltered by St Mary's from the prevailing west and south-westerly waves.

Deep (>30m) wave exposed, fine sand.
These correspond to the deep-water margin areas described above. They are not sheltered by the main islands, but are low energy, fallout areas for fine sediment due to their depth. Most are situated to the north of St Martin's and the east of St Mary's.

The number of species recorded in samples from fine sand stations ranged from 12 to 36, with very few species common to multiple stations. The mean number of species was 20.4. The highest number of species (36) was recorded at the deepest station (stn. 2.9, 49m below sea level), but there was no clear relationship between depth and species numbers.

2. MEDIUM, BEDLOAD SAND.

This sediment type (particle population mode in the range 200-600um) forms the commonest sedimentary substrate widely found within the survey area. In areas of strong tidal flow it forms shoals of mega-rippled sand, for example in the vicinity of Crow Bar, in the channels between Tresco, Tean and St Martins, in the channels between Bryher and Tresco and Samson and Tresco (Hulman area) and in the channel between Gugh and St Mary's (St Mary's Sound). Many of these medium sand substrates bore wave-induced ripple marks at the time of the survey, and hence are subject to frequent wave disturbance.

This grouping has been split into four sub-groups on the basis of depth, wave exposure and gravel content.

Shallow, sheltered medium sand with variable or low gravel content.
This occupied much of the channels between the main islands, frequently bounding more sheltered, or deeper, areas of fine sediment. Mostly this type was found in water of 5m or less.
Species numbers in samples from stations within the category ranged from 8 to 39.

(four stations, mean number of species 22). No species common to all or most stations within this category were found.

Shallow, moderately exposed, well-sorted medium sand.
This was found mainly in St Mary's Road. Transitional between the shallow sheltered sands and the more exposed medium sands, this tended to occupy the 5-15m bcd zone. The sands in this group were generally well sorted through exposure to strong wave action.

Species numbers in samples from stations within the category were relatively low, ranging from 12 to 19 (four stations). No species common to all or most stations within this category were found.

Exposed medium sand.
Medium sand in wave-exposed regions around the outside of the main islands occurred either in relatively deep water (>20m bcd) or very shallow and intertidally within exposed bays, where it has been trapped by wave action. This category consists mainly of the former, although it does also include some shallow and intertidal sands. Exposed medium sand forms a major band of sediment along the southern edge of the archipelago, in the deeper water below the bedrock and cobbles.

Seven stations within this category were analysed for infauna. Species numbers ranged from 15 to 48. The most diverse stations (30 and 48 spp.) were also the deepest (52 and 65 m sea level, respectively). Very few species were common to multiple stations.

Deep, exposed, moderately sorted medium sand with variable gravel content.
This differs from the exposed medium sand category in the presence of significant rock and shell gravel content within the sediment. This category is also found in relatively deep water, but is mostly confined to the south-eastern side of the archipelago.

Only two stations within this category were grab sampled and analysed for infauna. Species numbers were 30 and 43, with very few species common to both stations.

3. COARSE, SANDS.

These sands occurred widely in the highly exposed Area 7 in depths of 30-40m CD, and in localised areas at similar depths in Areas 1 and 9. Examination under the microscope showed these sands to be composed exclusively of shell fragments and other biogenic debris. In Area 7 these sands were mega-rippled, thus being mobile under storm wave conditions.

These sands have been mapped as:
Wave exposed coarse shell sand (mostly >20m).

Only two stations within this category were grab sampled and analysed for infauna. Species numbers were 39 and 49, station depths were 39m and 49m (sea level) respectively. Only four species were common to both stations, *Glycera lapidum*; *Polygordius* sp.; *Echinocyamus pusillus* and *Branchiostoma lanceolatum*.

4. SANDY GRAVELS; THIN SAND VENEERS OVER HARD SUBSTRATES; LARGE SAND OR GRAVEL PATCHES BETWEEN ROCK/BOULDER/COBBLE ZONES.

The distribution of this sediment type is very varied within the archipelago. In Areas 5 and 6 the substrate type is hardly represented. In Areas 1, 2 and 9 it occurs but infrequently. Areas 7 and 8 it is well represented but in Areas 3 and 4 it forms a common substrate type. It is essentially a peripheral zone separating rockier areas from areas of extensive sand accumulation. The gravels are commonly lithogenic. Where the sand veneer is thin, epiflora or fauna (e.g. foliose algae, *Nemertesia* sp.) could be seen protruding through the sand. This grouping has been split into two categories, on the basis of the likely mean boundary (20m bcd) between algae and fauna dominated epibiota, based on knowledge of the area and video data.

Shallow (<20m) sandy gravel, cobbles, small boulders or sand veneers over bedrock.

At infralittoral depths, this habitat supports scour and sand burial tolerant algae. The amount of algae observed varied markedly, depending on the water depth, depth of sediment and stability of the underlying rock, from occasional red or green algal plants to kelp park. Species recorded include *Chorda* sp., *Desmarestia* sp., *Halidryis siliquosa*, *Laminaria saccharina*, *Saccorhiza polyschides*, *Sargassum muticum*, foliose red and green algae indet.

Deep (>20m) sandy gravels, cobbles, small boulders or sand veneers over bedrock.

Circalittaoral areas are typically colonised by *Polymastia boletiformis*, *Nemertesia* spp., *Pentapora foliacea* and Alcyonidium *diaphanum*. *Ciocalypta penicillus* appeared common on low rock areas with significant sand cover. Higher relief areas and rock outcrops are dominated by *Alcyonium digitatum* colonies and occasional *Cliona celata*.

5. LOCALISED ROCK OUTCROP, COBBLES AND BOULDER FIELDS.

This 'lag' material, the winnowed remnants of rock outcrops and periglacial weathering deposits, dominates subtidal Scilly with the exception of Areas 3 and 4. The substrate is mostly covered faunal or algal turf, kelp park or kelp forest, depending on depth, stability and wave exposure. Very localised patches of sands and/or gravels may also occur within this grouping.

This substrate has been mapped as:

Cobble, boulder and bedrock outcrops.

This is a very wide category, including both infralittoral and circalittoral biotopes. Species recorded on infralittoral (<20m) areas included *L. hyperborea*; *L. saccharina*; *Saccorhiza polyschides*; *Dictyopteris membranacea*; foliose algae indet.; *Echinus esculentus*. Species at circalittoral sites included *Cliona celata*, *Polymastia boletiformis; Ciocalypta penicillus;* encrusting sponges indet.; *Caryophyllia* sp.; *Alcyonium digitatum; Pentapora foliacea*; encrusting bryozoans indet.

6. MASSIVE ROCK.

Most survey lines avoided major reef areas, however certain RoxAnn mapped areas showed exceptionally high roughness values (Appendix 3 Figure 3). Ground-truthing showed these to be steep rock slopes, usually topped by dense kelp forest. With the

side-scan sonar it was clearly possible to identify massive rock exposure from the rock structure.

Although a minor part of this study, bedrock was the most straightforward feature to map in terms of biotopes. For mapping purposes, this has been split into three depth zone categories.

Infralittoral (or littoral) bedrock or boulders with kelp/Chorda/fucoids - grazed/scoured bedrock.

This category clearly incorporates a wide range of biotopes. The very large number of small rocky outcrops between and around the main islands made separation of littoral and shallow sublittoral rock an impractical task. Consequently, areas defined as this category may contain littoral rock biotopes in addition to infralittoral ones. Most of the upper infralittoral bedrock and boulder areas supported kelp forest or kelp park. This included stands of *L. digitata* (sublittoral fringe); *L. hyperborea*, mixed *L. hyperborea/L. saccharina/Saccorhiza polyschides*; mixed *L. hyperborea/L. ochroleuca*, and mixed stands of kelp and *Chorda filum*. Lower infralittoral habitats included algal/faunal turfs with moderately dense *Dictyopteris membranacea*, kelp sporelings and occasional *Alcyonium digitatum*, to bare/very low turf boulders in heavily urchin grazed or sand scoured areas. Given the exceptional clarity (for British waters) normally found around the Scillies, infralittoral rock has been mapped down to the 20m contour. This generally concurred with ground truthing observations.

Circalittoral bedrock with faunal turf.

Exposed bedrock and massive boulder slopes deeper than 20m bcd are widely distributed around the periphery of the archipelago. This category was found to support faunal turf of varying composition and density, depending largely on wave exposure, urchin grazing and scour. Typically this consists of a hydroid/bryozoan turf with conspicuous massive sponges (*Cliona celata*, *Pachmatisma johnstonia* and *Polymastia boletiformis*), *Alcyonium digitatum* is frequent or common on rock promontories. Deeper areas (30+m) frequently support an assemblage rich in Axinellid sponges (in particular *Axinella dissimilis*; *Raspailia* and *Stelligera spp.*), with occasional *Pentapora foliacea* colonies also conspicuous. Relatively bare rock, supporting only a very low turf and occasional small *A. digitatum* colonies, is also fairly common at all levels within the circalittoral zone. Such areas are considered to be heavily (urchin) grazed, scoured or a combination of both. *Echinus esculentus* was common and ubiquitous on circalittoral rock.

Deep (45m+) circalittoral bedrock with faunal turf including dense Axinellids.

Bedrock around 45m bcd or deeper generally fell into two categories. In some areas it is very bare, either extremely scoured or heavily grazed (or both); in other it supports a rich hydroid/bryozoan/sponge turf. This turf was similar in many aspects to the assemblage found on circalittoral bedrock below 30m, both supported high densities of *Axinella dissimilis* and *Raspailia* and *Stelligera spp.* There appeared a qualitative difference however, the deeper sites supporting significantly higher densities of Axinellids. *Homaxinella subdola* and flask-shaped Axinellids (probably *Axinella infundibuliformis*) also formed a significantly greater percentage of the sponges observed.

7. ZOSTERA.

Zostera beds occurred in Areas 1 and 4. With the RoxAnn system it was possible to clearly differentiate between dense *Zostera* and sand, but impossible to differentiate between *Zostera* and alga covered rocky areas or gravelly areas. A 'potential *Zostera*' classification box was therefore defined from the RoxAnn data (Appendix 1 Figure 3), and this was further refined with depth and wave exposure restrictions and ground-truthing observations to produce the best possible map of *Zostera* cover. The side-scan sonar clearly demarcated dense *Zostera* stands with marked (eroding?) margins, but was insensitive to thin *Zostera* cover.

Areas considered to support dense beds have been mapped as:
Zostera

Four stations within this category were grab sampled and analysed for infauna. Species numbers ranged from 10 to 57; the mean number of species (28.5) was the highest of all sediment categories. The station with 57 species recorded, amongst the highest for all samples, was located within the *Zostera* bed on St Martin's Flats. Although *Zostera* beds occurred on a wide range of sediment types, from fine sand to sand with gravel and stones, the infauna within this category shared more common species than other sediment categories. No species were recorded at all four stations however 20 species occurred at two or more *Zostera* stations.

Major sea bed types	Habitat or habitat/species assemblage categories	MNCR biotopes recorded (or considered likely to be present)
Fine-medium/fine, suspension sand.	Shallow (<20m), sheltered fine sand; diverse and variable fauna	
	Medium depth (10-20m) moderately exposed fine sand	
	Deep (>30m) wave exposed, fine sand	
Medium, bedload sand	Shallow, sheltered medium sand with variable or low gravel content	
	Shallow, moderately exposed, well-sorted medium sand	
	Exposed medium sand	
	Deep, exposed, moderately sorted medium sand with variable gravel content	
Coarse sand	Wave exposed coarse shell sand (mostly >20m)	
Sandy gravels; thin sand veneers over hard substrates; large sand or gravel patches between rock/cobble/boulder zones	Shallow (<20m) sandy gravel, cobbles, small boulders or sand veneers over bedrock	IGS.FaG; IGS.FaS.Mob; MIR.PolAhn; MIR.SedK; LGS; SLR.Fx.
	Deep (>20m) sandy gravels, cobbles, small boulders or sand veneers over bedrock	IGS.FaG; IGS.FaS.Mob; MIR.PolAhn; MIR.SedK; LGS; SLR.Fx.
Localised rock outcrop, cobbles and boulder fields	Cobble, boulder and bedrock outcrops	EIR.LhypR..Pk; MIR.EphR; MIR.Lhyp.Pk; MIR.Lhyp.Ft; MIR.SedK; ECR.Alc; ECR.AlcMaS; ECR.Efa; ECR.PomByC; MCR.ErSPolSH; MCR.GzFa; MCR.ByH
Massive rock areas	Infralittoral (or littoral) bedrock or boulders with kelp/*Chorda*/fucoids - grazed/scoured bedrock	EIR.Lhyp.Pk; EIR.LhypFt; EIR.LhypFa; EIR.LsacSac; EIR.KfaR; EIR.KforDic; EIR.For; MIR.Lhyp.Pk; MIR.Ldig; MIR.LhypGz.Pk; MIR.Sac; MIR.EphR; IR.AlcByH; MCR.GzFa
	Circalittoral bedrock with faunal turf	ECR.Alc; MCR.ByH; MCR.GzFa
	Deep (45m+) circalittoral bedrock with faunal turf including dense Axinellids	MCR.ByH; MCR.ErSPbolSH; MCR.PhaAxi?
Zostera	*Zostera*	IMS.Zmar

Table 1. Major sea bed features identified, habitat/species categories mapped and biotopes recorded or considered likely to be present.

6. GENERAL DISCUSSION

6.1 Overview

The distribution of substrate types within the Isles of Scilly archipelago has proved to be extremely complex. This is, in part at least, due to the equally complex bathymetry and resultant patterns of erosion and deposition that occur. The harsh, dynamic nature of most of the area coupled with low nutrient levels may also act to keep densities low and species diversity high.

It is now clear that, in areas of this complexity, mapping of infauna by means of a limited grab sampling programme, and subsequent extrapolation over large areas, is unlikely to be successful. However, detailed sediment type mapping is required before any targeted infaunal sampling programme can be devised. This obviously would have considerable cost implications for similar projects, which would need to be weighed against the validity of map boundaries derived from simpler programmes.

6.2 Comparison with previous survey data

The sediment types mapped concur well with the sediment types described for the sampling sites in Rostron 1983 and 1988, although the greater detail in distribution mapping produced by the current study has shown the overall pattern of distribution to be far more complex than was previously realised. As the sampling methods were quite different, the 1983 and 1988 studies collecting much larger samples than this study, direct comparisons of species densities are inappropriate. The two earlier studies also collected significantly more epifaunal species and (by excavating a larger volume) would be more likely to sample larger and lower density infauna (e.g. burrowing urchins and larger bivalves). Consequently a degree of caution must be exercised when directly comparing species lists.

Rostron (1983 and 1988) found the diversity of infaunal species to be high (197 taxa recorded from the 1988 study samples) but the similarity between infaunal samples was found to be very low, with a wide variation in the number of taxa at each site. This also agrees well with the findings of the current study, where over 300 taxa were recorded but again similarities between stations were very low. Rostron (1988) noted that communities within fine sediments appeared more uniform. That was not found during this study (see figures 2 and 3, stations 3.3, 1.6, 1.8, 2.3 and 2.9). However, the number of samples from fine sediments was too limited in both studies (two samples in 1988 and five in this study) to draw firm conclusions regarding homogeneity of fine sediment assemblages.

Hiscock (1983) notes the presence of highly grazed sites on the north side the archipelago, and the abundance of *Echinus*. Similar sites were recorded during this survey and *Echinus* clearly has a major modifying effect on infralittoral and circalittoral boulder and bedrock communities.

6.3 Conservation value of mapped features

The conservation value of sediment features is difficult to assess, given the lack of identifiable communities that can be linked to the sediment types mapped. The exception to this is *Zostera* beds. *Zostera* beds, particularly those on St Martin's Flats, were found to support the greatest number of infaunal species of any of the sediment categories. They also showed the greatest, within-category, similarity in infaunal composition. *Zostera* beds within the archipelago may, therefore, be treated as a coherent biological assemblage with more confidence than other categories defined principally on physical attributes. The *Zostera* beds within the Scillies

complex have previously been identified as being of extremely high conservation value. The results of this survey support these earlier findings, and help assess their importance relative to other sediment habitats within the archipelago.

The spatial complexity of sediment distribution, coupled with the overall species diversity and the apparent diversity in species assemblages between broadly similar habitat types, is considered very uncommon, and must contribute to the conservation value of the area. It is felt that more detailed sampling, of the different sediment types now defined, is required before a full conservation assessment of the shallow sediment areas can be made.

Deeper, fine and medium sand areas, in general, were found to support a greater diversity of infauna than shallow sediment areas. Deep, exposed medium sand areas south of St Agnes and St Mary's appeared particularly rich. Consequently they are provisionally assessed as being amongst the sediment areas of highest conservation importance within the Scillies complex.

Much of the sublittoral previously considered sediment proved to consist of thin sediment veneers over bedrock, or mixtures of sand, gravel, cobbles, boulders and bedrock. As these types of substrates cannot be properly sampled by grab, or surveyed in detail by remote video, the conservation value of such areas remains to be identified.

Sublittoral bedrock around the Scillies was already known to support epifaunal communities of high conservation importance; however, some of the deeper circalittoral bedrock areas (40-65m) surveyed during this survey appeared very rich, supporting high densities of infrequently recorded erect sponge species. They are therefore considered to be of high conservation importance and worthy of further investigation.

6.4 Monitoring recommendations

The study has identified the fact that spatial variations in biological community structure are great. As yet, little data exists on temporal variation within these communities.

This study has collected quantitative infaunal samples, sediment data and video records for 57 stations widely distributed around the archipelago, the locations have been recorded with a high degree of precision. A further 31 stations and 7 transects, on areas of mixed or hard substrate, have been recorded using video only. It is suggested that this baseline data may be used as the basis for a comprehensive monitoring programme investigating temporal changes (natural or anthropogenic) in substrate type or infauna. However, as it has not been possible to identify characteristic species for most of the sediment types identified, it is felt that a more targeted infaunal sampling programme, based on the sediment areas identified by this survey, needs to be undertaken before a monitoring strategy is implemented. This would allow characteristic species to be identified (where they exist) for the major sediment areas and sediment types mapped. Monitoring stations could then be selected to cover all or most species assemblages identified.

On suitable substrates, it is suggested that grab replicates are increased to three per station, in order to better record low density species and detect anomalies due to small scale spatial heterogeneity. Areas of mixed substrate would better sampled by either changing from a Day grab to a larger Van Veen grab (complimented by drop down video) or by diver recording and sampling using a suction sampler. Areas of hard substrate (including sediment veneers over rock) would be best monitored by divers, drop down video or ROV. For such areas, sequential video records are useful as part of a monitoring strategy for detecting qualitative changes.

With all these techniques, positional accuracy is considered to be extremely important (especially in areas of heterogeneous substrate) in order to be able to differentiate between temporal change and spatial variation.

6.5 Rare and uncommon species

The JNCC have produced a report listing criteria for assessing rarity within marine benthic species (Sanderson, 1996). Unfortunately, the distribution data required is not available for most infaunal species, consequently it has not been possible to use these criteria for the infrequently recorded species found during this survey.

The spionid worm *Prionospio banyulensis* is considered uncommon and is not believed to have been recorded around the Scillies previously. It was found to be widely distributed during this study (recorded at 16 stations) particularly in area 1. The Ophelidd polychaete *Polyopthalmus pictus* is similarly considered uncommon and a new record for the Scillies. It was recorded in areas 1, 3 and 4. The sponge *Axinella infundibuloformis* is a relatively rare species in UK waters, confined to deeper circalittoral areas around western shores. Hiscock (1983) recorded it as present at 'rare' or 'uncommon' abundances around Scillies. High densities of cup Axinellids that are most probably this sponge, were recorded in deep water off the north of the archipelago.

A number of rare and uncommon species were recorded during the 1983 and 1988 surveys, including polychaetes *Ehlersia garciai*, *Spio mecznikowianus*, amphipod *Melita gladiosa*, isopod *Natalana gallica* and bivalve *Tellina squalida*. Of these, only *Melita gladiosa* was found during this study, in areas 1, 3 and 4.

6.6 Recommendations for future work

1. While this study has mapped the distribution of sediment types within the archipelago, it has not been possible to tag infaunal communities to sediment type. It is recommended that a targeted grab sampling programme is conducted in order to define the main infaunal communities present within the larger areas of sediment and the dominant sediment types identified during this survey. This will also determine the degree of variability within infaunal communities occupying spatially contiguous areas of similar sediment type, and so aid monitoring design and interpretation.
2. A sampling programme using diver-operated suction sampler is recommended for the mixed substrate areas.
3. The deeper rock areas are clearly highly diverse. Deep bedrock (>40m bcd) is relatively uncommon around southern Britain; a remote video or remote video/diver survey is considered likely to identify new areas of interest around the archipelago.

ACKNOWLEDGEMENTS

Our thanks go to Cyril Nicholas and Keith Pope, skippers of the MV *Melza* and MV *Josephine*, for their skill and enthusiasm which greatly assisted the smooth running of both acoustic mapping and ground truthing surveys. Our thanks also to the survey team members: Julian Hull, Sue Gilbert and Rob Forster, for their hard work and enthusiasm through fairly unpleasant weather conditions during the surveys. Andrew Gibson of the Isles of Scilly Environment Trust gave much assistance with moving equipment and around the Island, for which we are very grateful.

On the data analysis and reporting side, we would like to thank Dale Rostron for the many long hours she put in on the identification of our infaunal samples. We would also like to thank English Nature Project Officers Paul Gilliland and Roger Covey for their advice throughout the project, and to thank them also, and Geoff Wigham of Plymouth University, for reviewing the draft report and providing many helpful comments.

REFERENCES

Bishop, G.M., 1985. Study of *Echinus esculentus* L. populations in the Isles of Scilly, October 1984. Report to the Nature Conservancy Council.

Bishop, G.M. 1986. Study of *Echinus esculentus* L. populations in the Isles of Scilly, September, 1985 Institute of Offshore Engineering report to the Nature Conservancy Council.

Bishop, G.M. 1986. Study of *Echinus esculentus* L. populations in the Isles of Scilly, September, 1986 Marine Conservation Society report to the Nature Conservancy Council.

BKS Surveys Ltd. (undated). Mapping *Zostera* beds in Special Areas of Conservation by aerial photography.

Connor, D.W., Brazier, D.P., Hill, T.O., Holt, R.H.F., Northern, K.O. and Sanderson, W.G., 1996. Marine Nature Conservation Review: marine biotopes. A working classification for the British Isles. Version 96.7. Peterborough, Joint Nature Conservation Committee.

Connor, D.W., Brazier, D.P., Hill, T.O., Holt, R.H.F., and Sanderson, W.G., 1997. Marine Nature Conservation Review: marine biotope classification for the British Isles. Volume 2. Sublittoral biotopes. Version 97.06. JNCC report, No. 230. Peterborough, Joint Nature Conservation Committee.

Fowler, S.L. and Pilley, G.M., 1992. Report on the Lundy and Isles of Scilly marine monitoring programmes 1984 to 1991.

Harris, T. 1972. The marine flora and fauna of the Isles of Scilly: Polychaeta. *J Nat. Hist. 6*, 93-117.

Hiscock, K. 1984. Sublittoral survey of the Isles of Scilly: July 2nd to 16th, 1983. A report to the Nature Conservancy Council from the Field Studies Council, Oil Pollution Research Unit.

Irving, R.A. and Mackenzie,G. 1996. Report of the Coral Cay Conservation Sub-Aqua Club 1996 Expedition to the Isles of Scilly, 27 July - 3 August 1996.

King, P.E., 1972. The marine flora and fauna of the Isles of Scilly: Pycnogonida. *J Nat. Hist. 6*, 621-624.

Nichols, D. and Harris, T., 1982. A survey of the low-tide flats of the Isles of Scilly. Exeter University report to the Nature Conservancy Council.

Nunny, R.S., 1995. Isles of Scilly shoreline management plan: a review of physical processes. Report by Sea Sediments to DHV (UK) Ltd.

Robins, M.W., 1969. The marine flora and fauna of the Isles of Scilly: Cnidaria and Ctenophora. *J Nat. Hist. 3*, 329-343.

Rowe, F.W.E., 1971. The marine flora and fauna of the Isles of Scilly: Echinodermata. *J Nat. Hist. 5*, 233-238.

APPENDIX 1.

FIGURES AND MAPS

Figure 1. Bray-Curtis similarity dendrogram for infaunal samples.

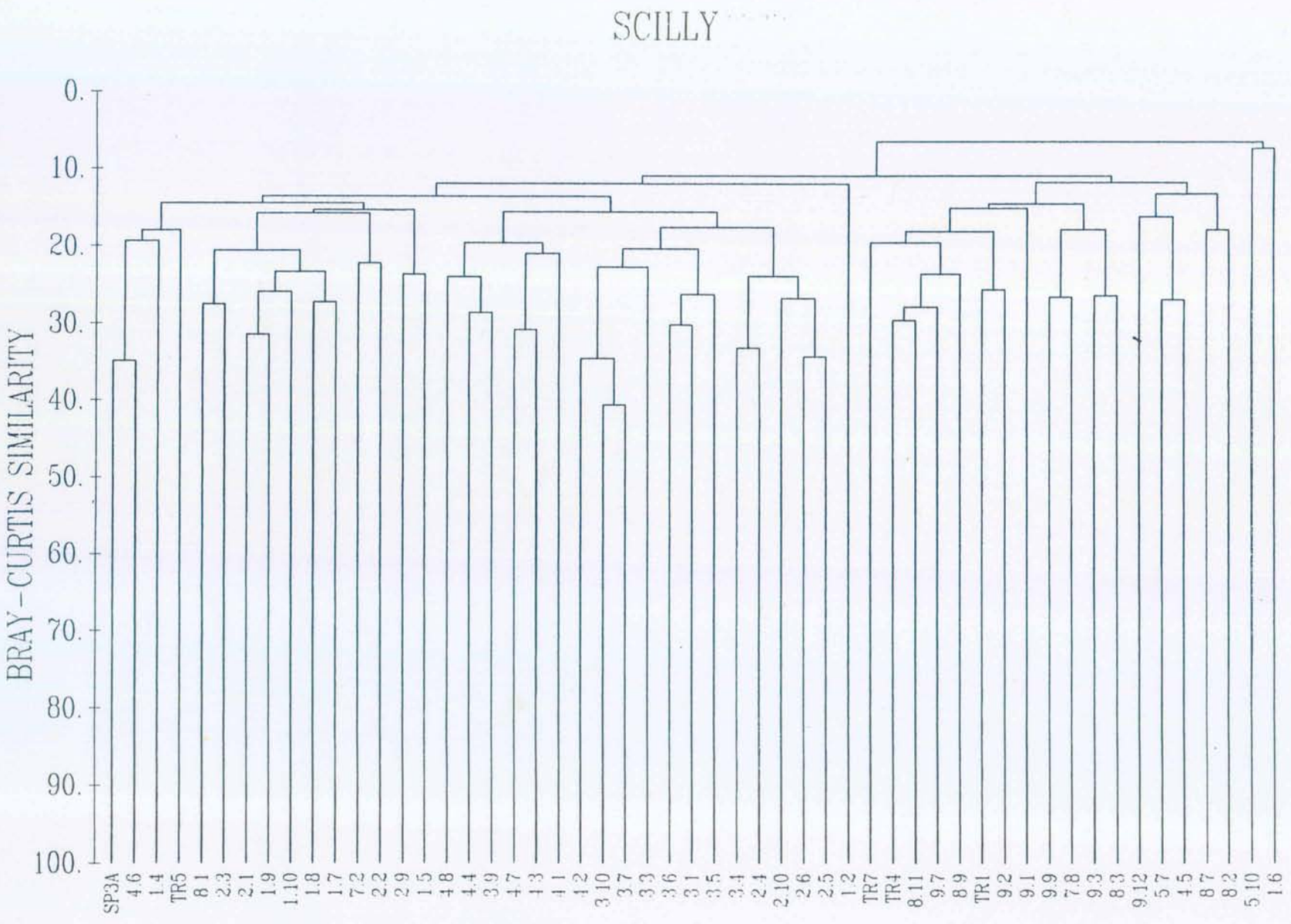


Figure 2. MDS Plot for infaunal samples.

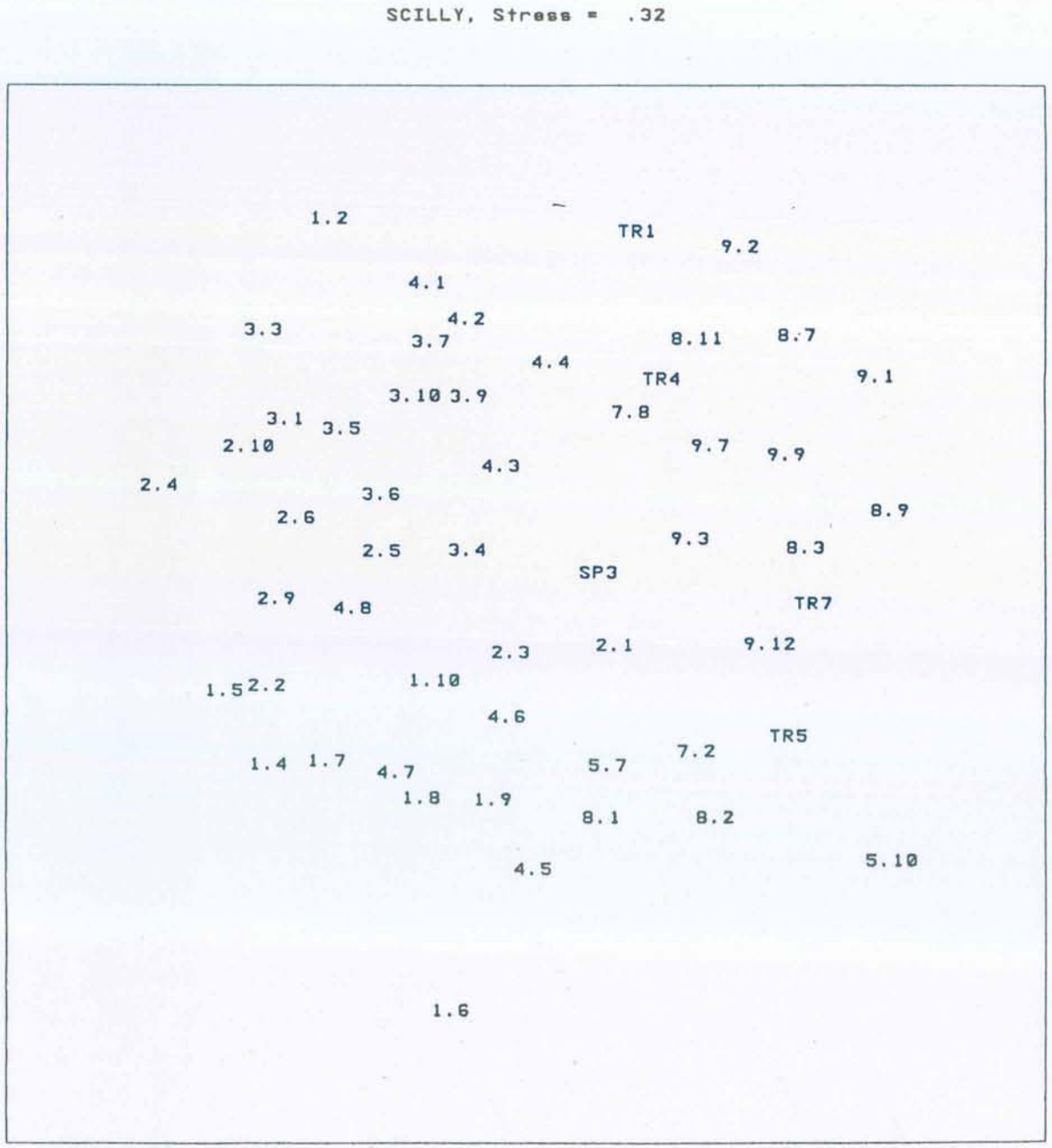
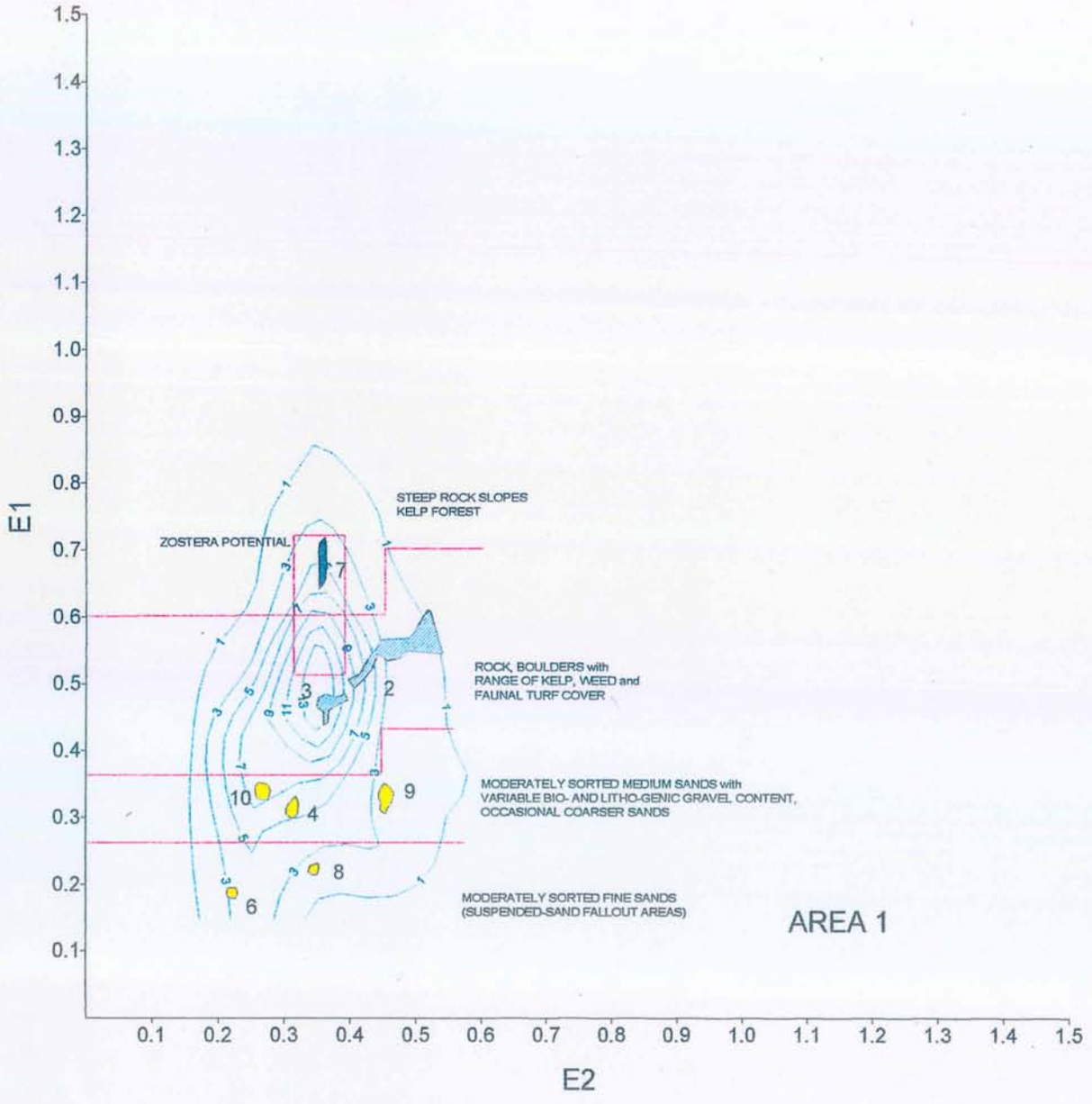


Figure 3. RoxAnn values/habitat type plots.

Areas 1-9.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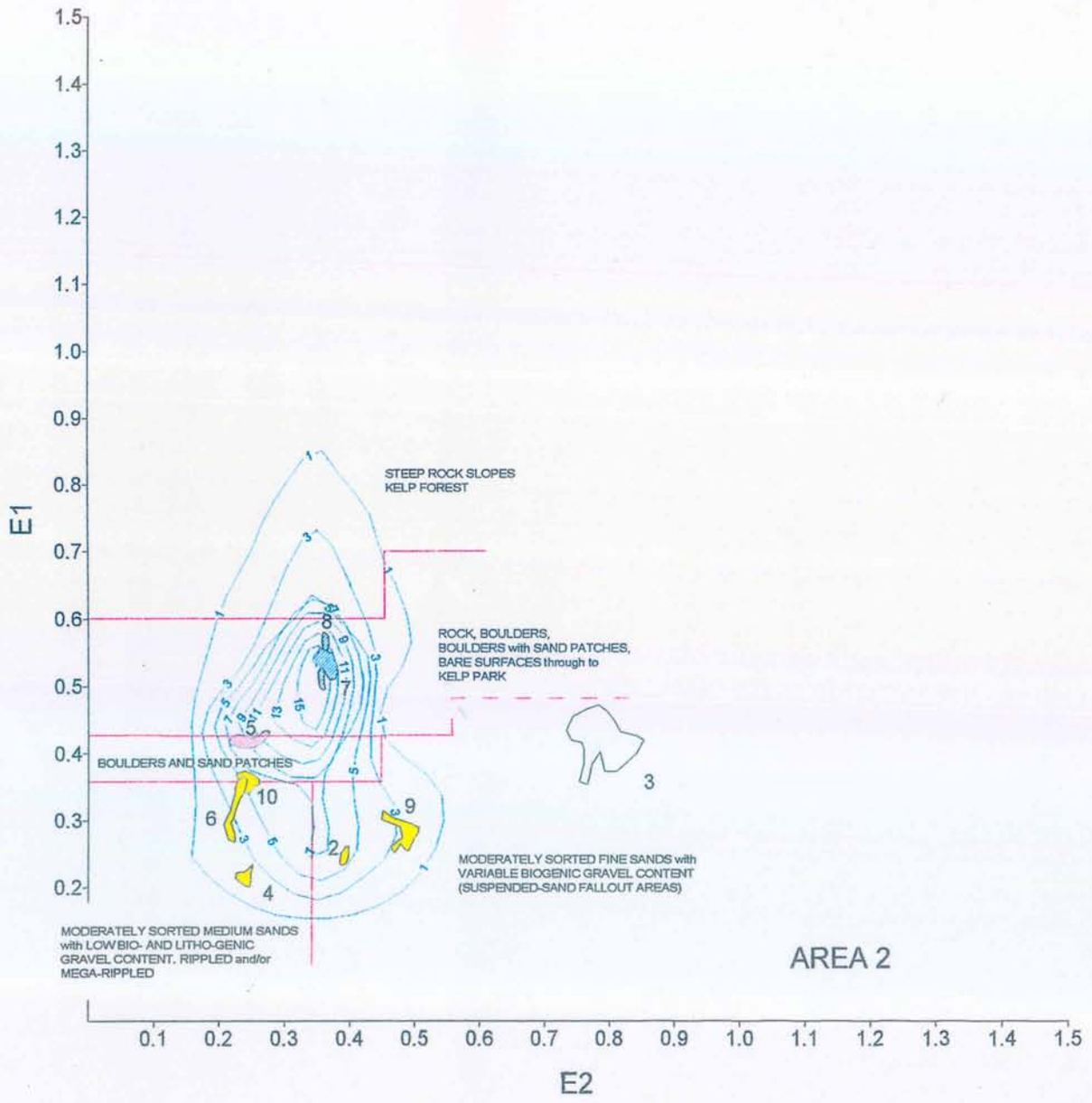
STEEP ROCK SLOPES
KELP FOREST
ZOSTERA POTENTIAL
ROCK, BOULDERS with
RANGE OF KELP, WEED and
FAUNAL TURF COVER
MODERATELY SORTED MEDIUM SANDS with
VARIABLE BIO- AND LITHO-GENIC GRAVEL CONTENT,
OCCASIONAL COARSER SANDS
MODERATELY SORTED FINE SANDS
(SUSPENDED-SAND FALLOUT AREAS)
AREA 1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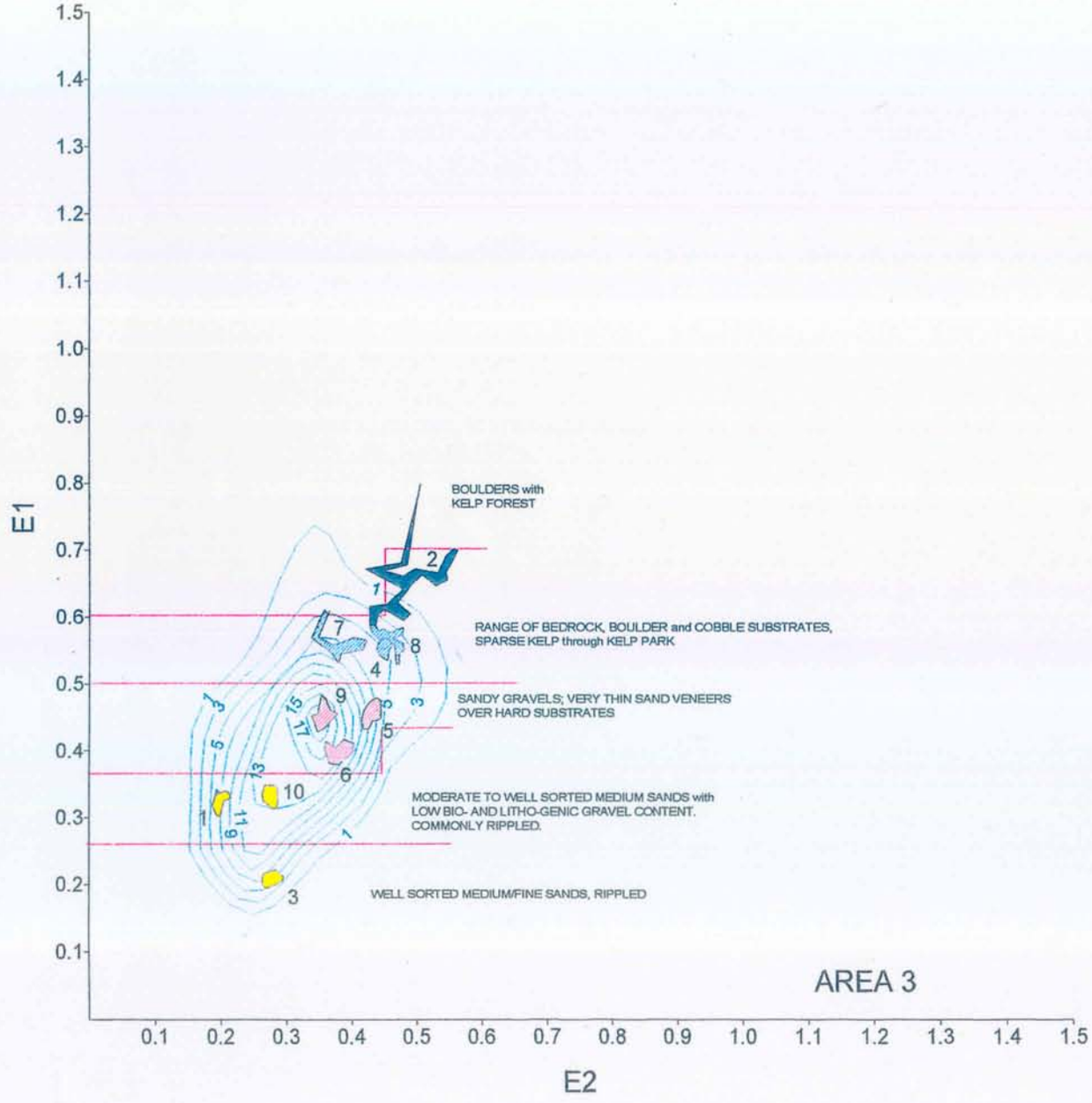
STEEP ROCK SLOPES
KELP FOREST
ROCK, BOULDERS,
BOULDERS with SAND PATCHES,
BARE SURFACES through to
KELP PARK
BOULDERS AND SAND PATCHES
MODERATELY SORTED FINE SANDS with
VARIABLE BIOGENIC GRAVEL CONTENT
(SUSPENDED-SAND FALLOUT AREAS)
MODERATELY SORTED MEDIUM SANDS
with LOW BIO- AND LITHO-GENIC
GRAVEL CONTENT. RIPPLED and/or
MEGA-RIPPLED
AREA 2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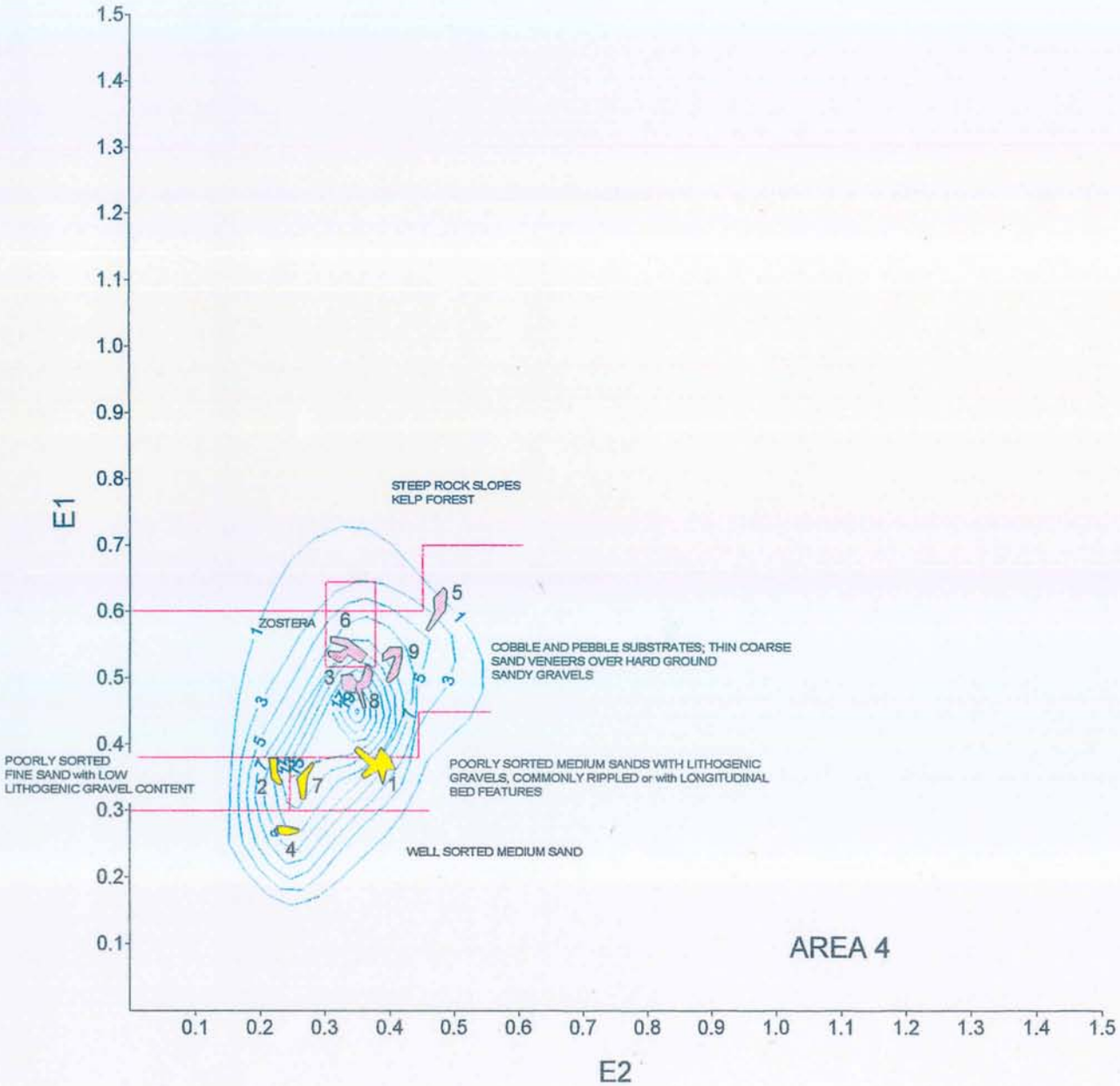
BOULDERS with KELP FOREST
RANGE OF BEDROCK, BOULDER and COBBLE SUBSTRATES, SPARSE KELP through KELP PARK
SANDY GRAVELS; VERY THIN SAND VENEERS OVER HARD SUBSTRATES
MODERATE TO WELL SORTED MEDIUM SANDS with LOW BIO- AND LITHO-GENIC GRAVEL CONTENT. COMMONLY RIPPLED.
WELL SORTED MEDIUM/FINE SANDS, RIPPLED
AREA 3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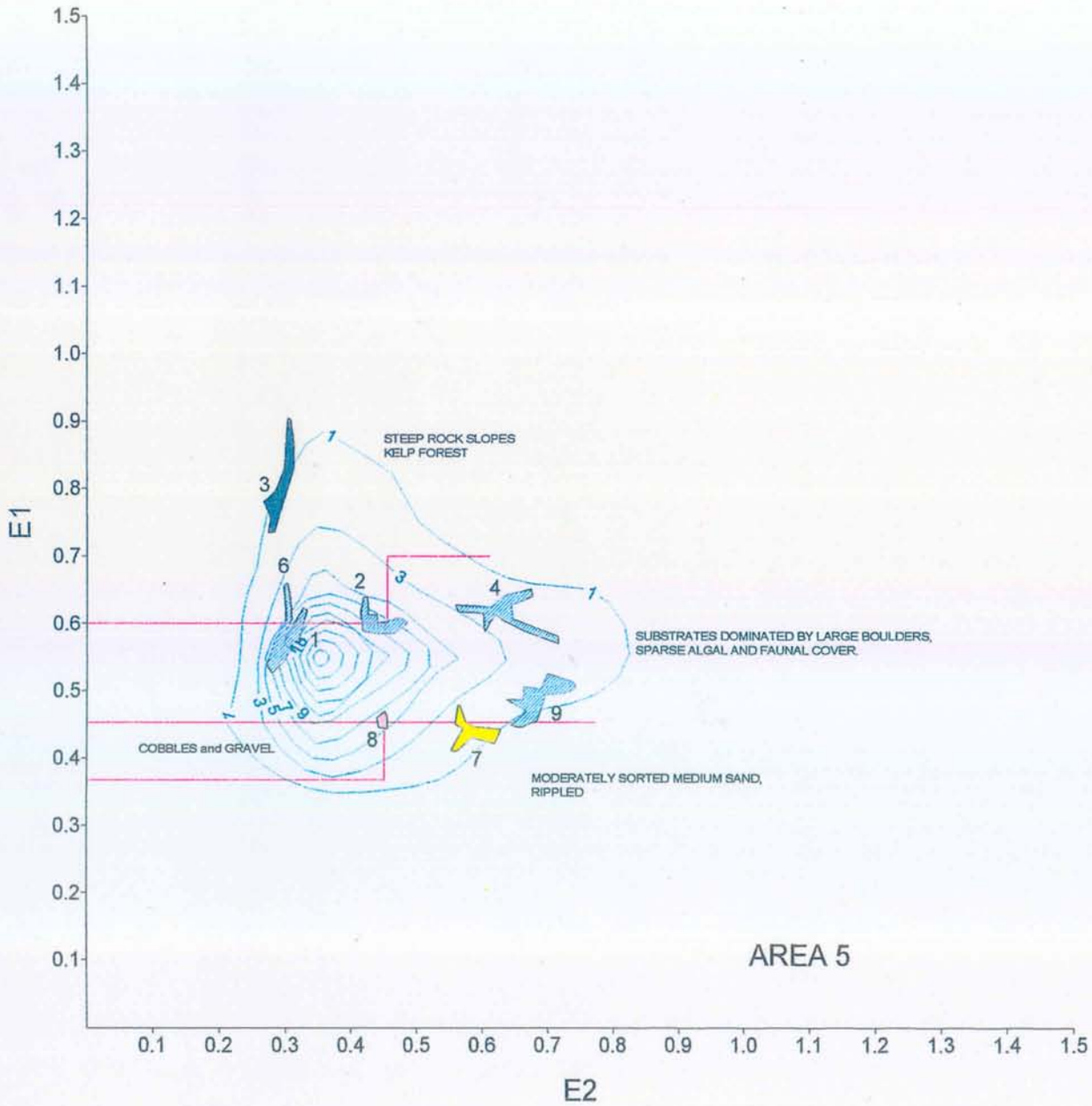
STEEP ROCK SLOPES
KELP FOREST
ZOSTERA
COBBLE AND PEBBLE SUBSTRATES; THIN COARSE
SAND VENEERS OVER HARD GROUND
SANDY GRAVELS
POORLY SORTED
FINE SAND with LOW
LITHOGENIC GRAVEL CONTENT
POORLY SORTED MEDIUM SANDS WITH LITHOGENIC
GRAVELS, COMMONLY RIPPLED or with LONGITUDINAL
BED FEATURES
WELL SORTED MEDIUM SAND
AREA 4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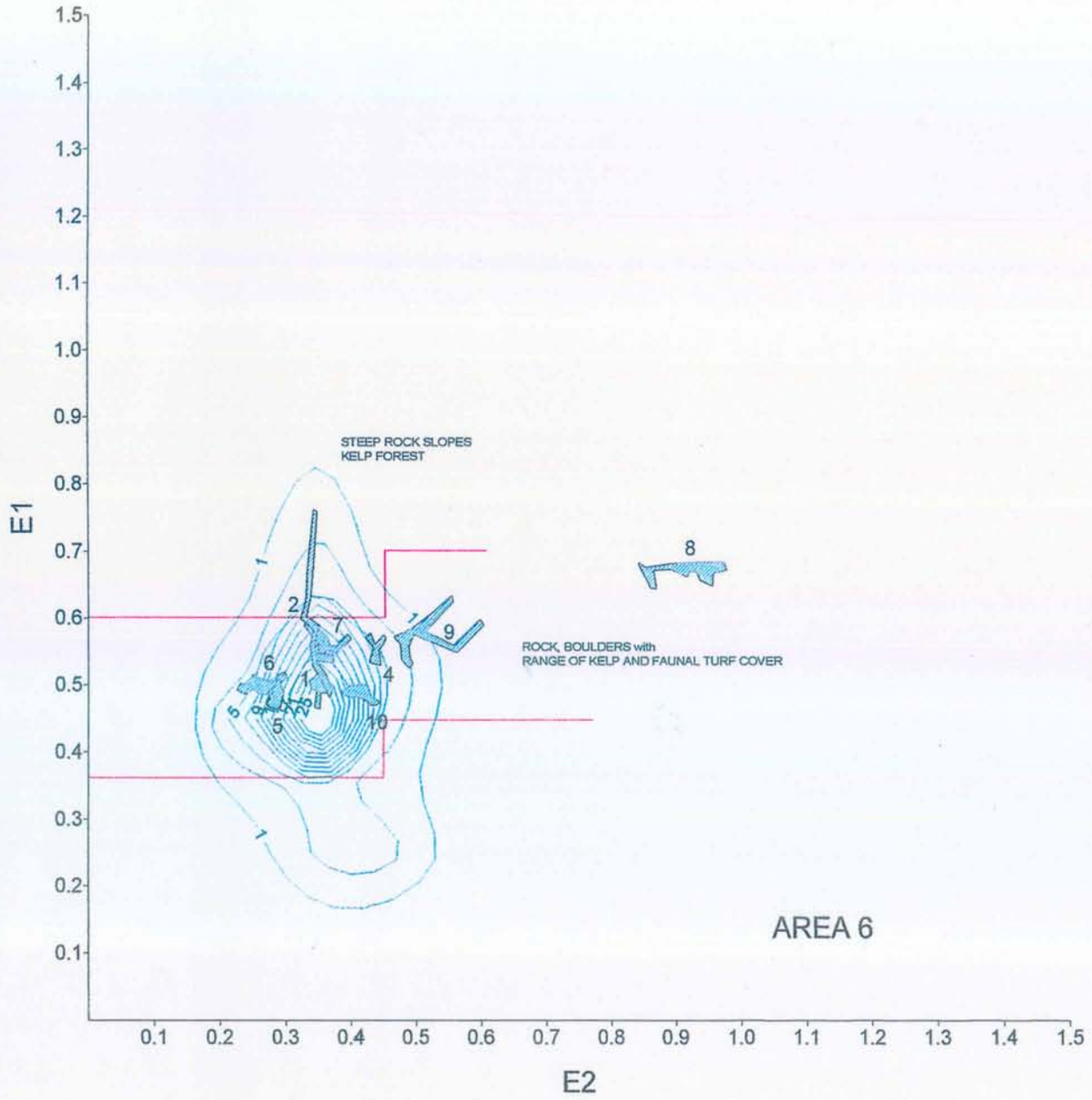
STEEP ROCK SLOPES
KELP FOREST
SUBSTRATES DOMINATED BY LARGE BOULDERS,
SPARSE ALGAL AND FAUNAL COVER.
COBBLES and GRAVEL
MODERATELY SORTED MEDIUM SAND,
RIPPLED
AREA 5


STEEP ROCK SLOPES
KELP FOREST
ROCK, BOULDERS with
RANGE OF KELP AND FAUNAL TURF COVER
AREA 6
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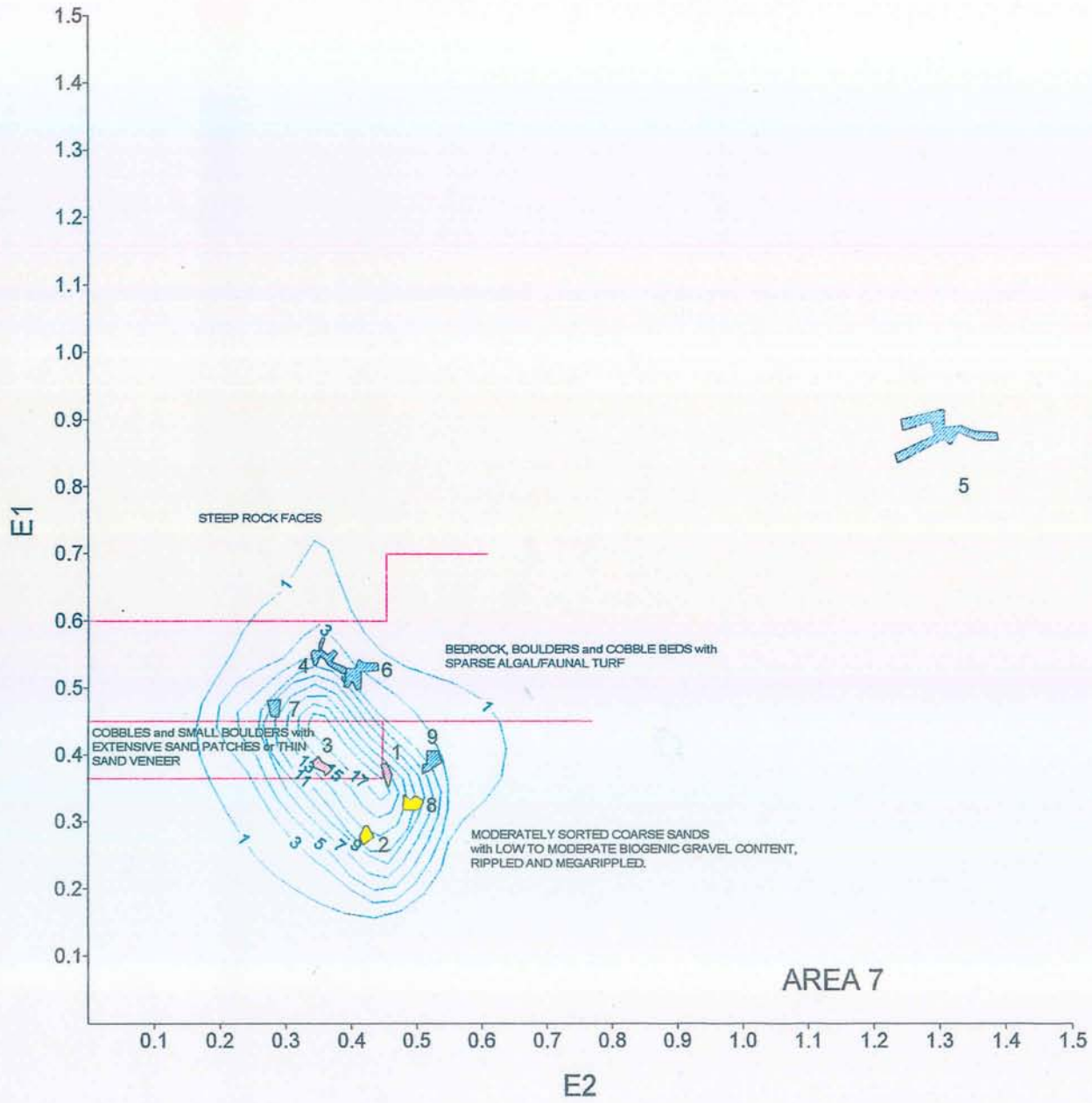
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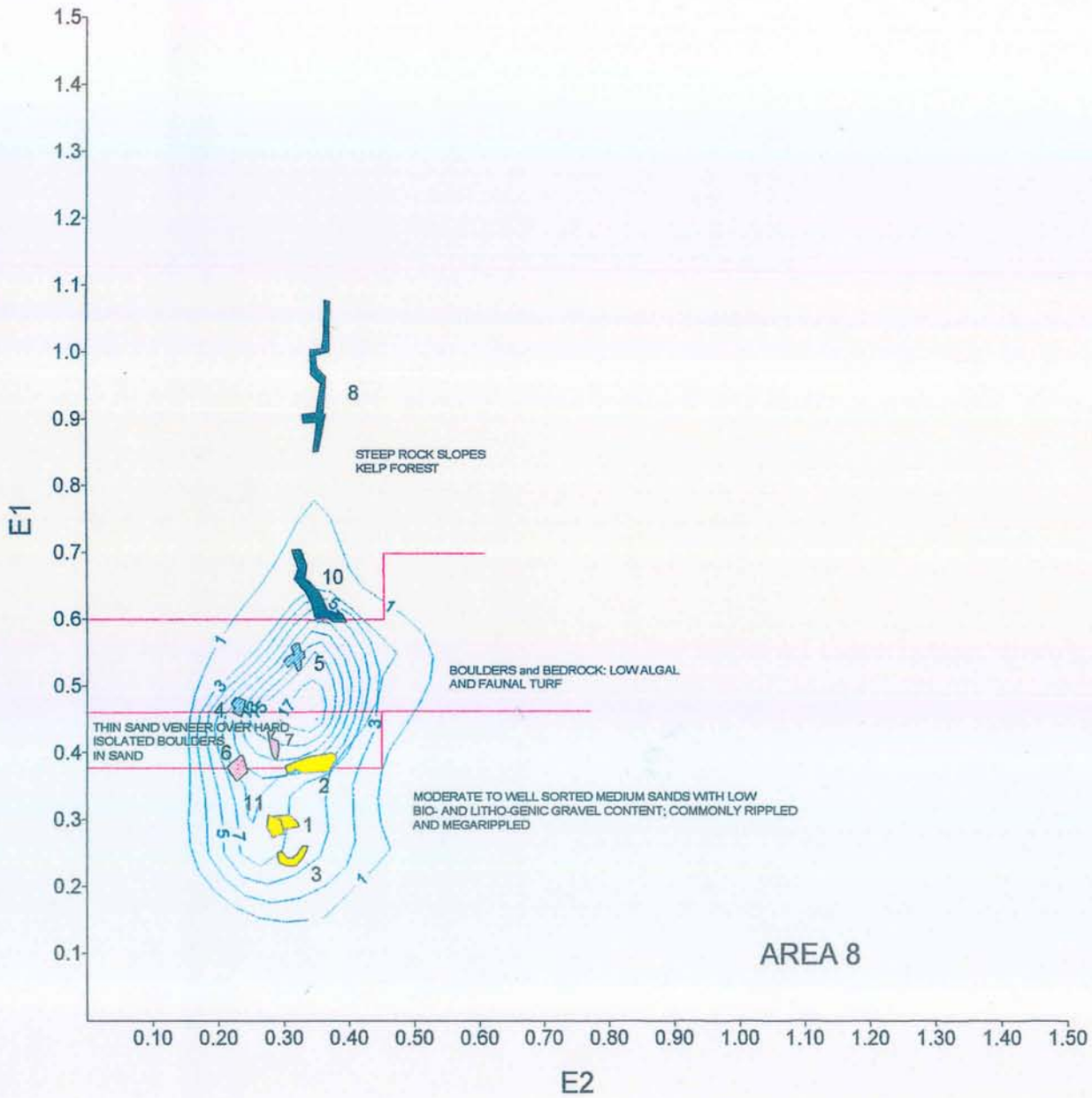
STEEP ROCK FACES
BEDROCK, BOULDERS and COBBLE BEDS with SPARSE ALGAL/FAUNAL TURF
COBBLES and SMALL BOULDERS with EXTENSIVE SAND PATCHES or THIN SAND VENEER
MODERATELY SORTED COARSE SANDS with LOW TO MODERATE BIOGENIC GRAVEL CONTENT, RIPPLED AND MEGARIPPLED.
5
AREA 7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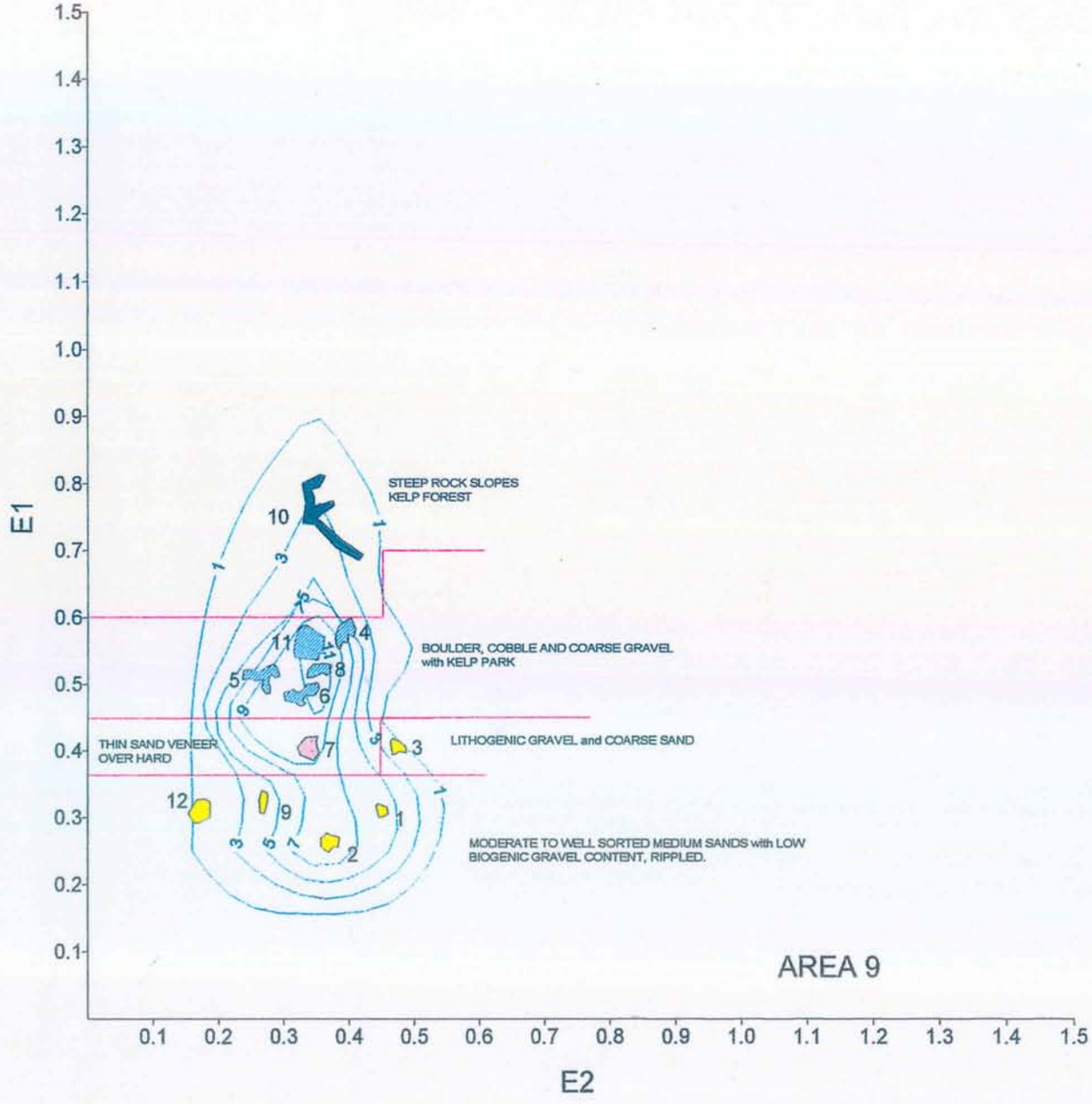
STEEP ROCK SLOPES
KELP FOREST
BOULDERS and BEDROCK: LOW ALGAL
AND FAUNAL TURF
THIN SAND VENEER OVER HARD
ISOLATED BOULDERS
IN SAND
MODERATE TO WELL SORTED MEDIUM SANDS WITH LOW
BIO- AND LITHO-GENIC GRAVEL CONTENT; COMMONLY RIPPLED
AND MEGARIPPLED
AREA 8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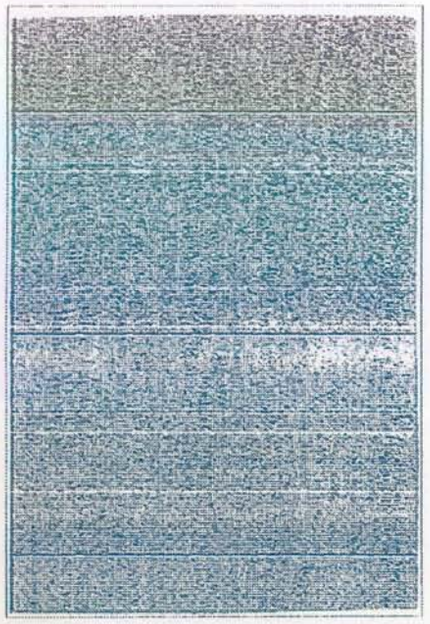
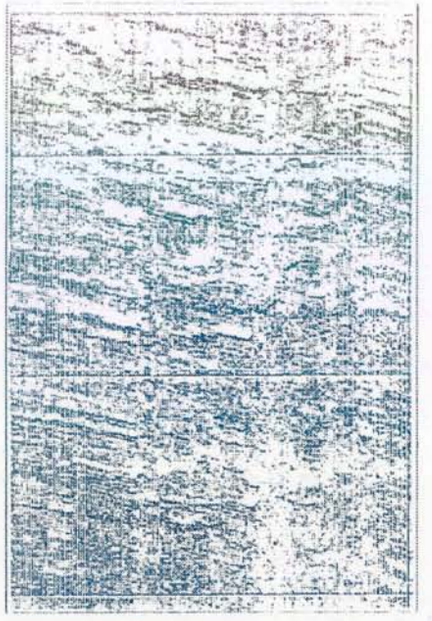
STEEP ROCK SLOPES
KELP FOREST
BOULDER, COBBLE AND COARSE GRAVEL
with KELP PARK
LITHOGENIC GRAVEL and COARSE SAND
THIN SAND VENEER
OVER HARD
MODERATE TO WELL SORTED MEDIUM SANDS with LOW
BIOGENIC GRAVEL CONTENT, RIPPLED.
AREA 9

Figure 4. Side scan sonar seabed acoustic reflector types identified.

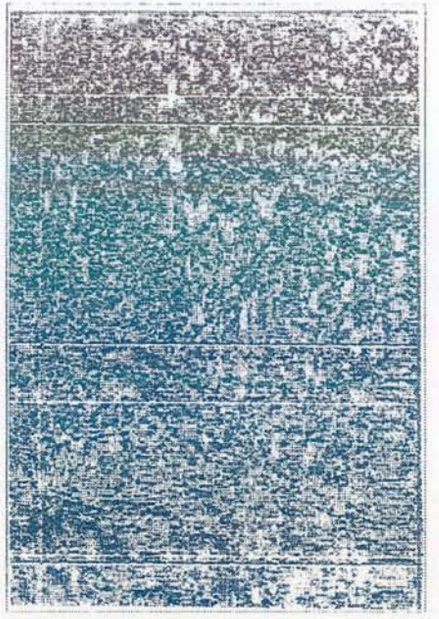


FEATURELESS SAND

SANDY MIXED SEDIMENTS

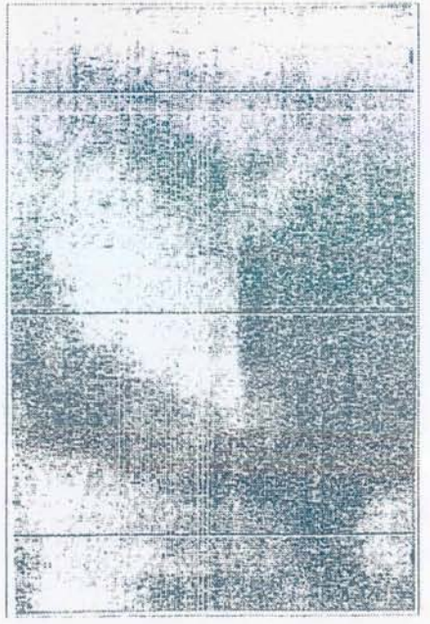


ROCKY MIXED SEDIMENTS

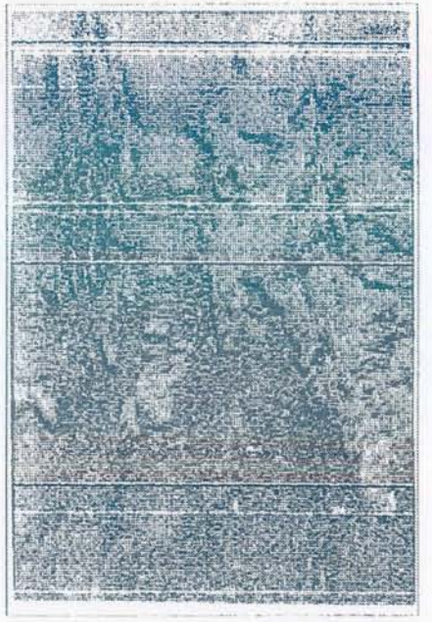


BOULDER FIELD

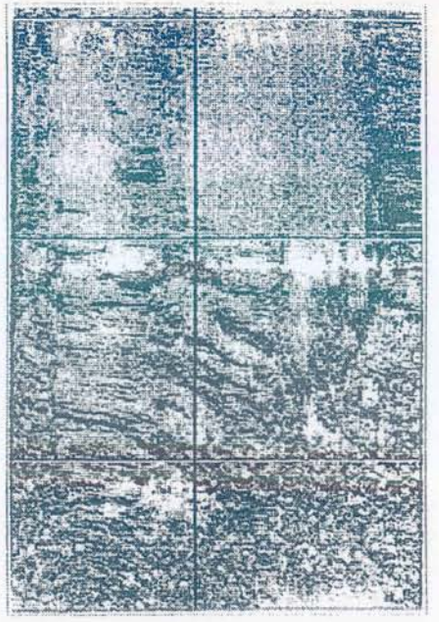
MEGARIPPLED SANDS



GRAVEL WINDOW IN SAND

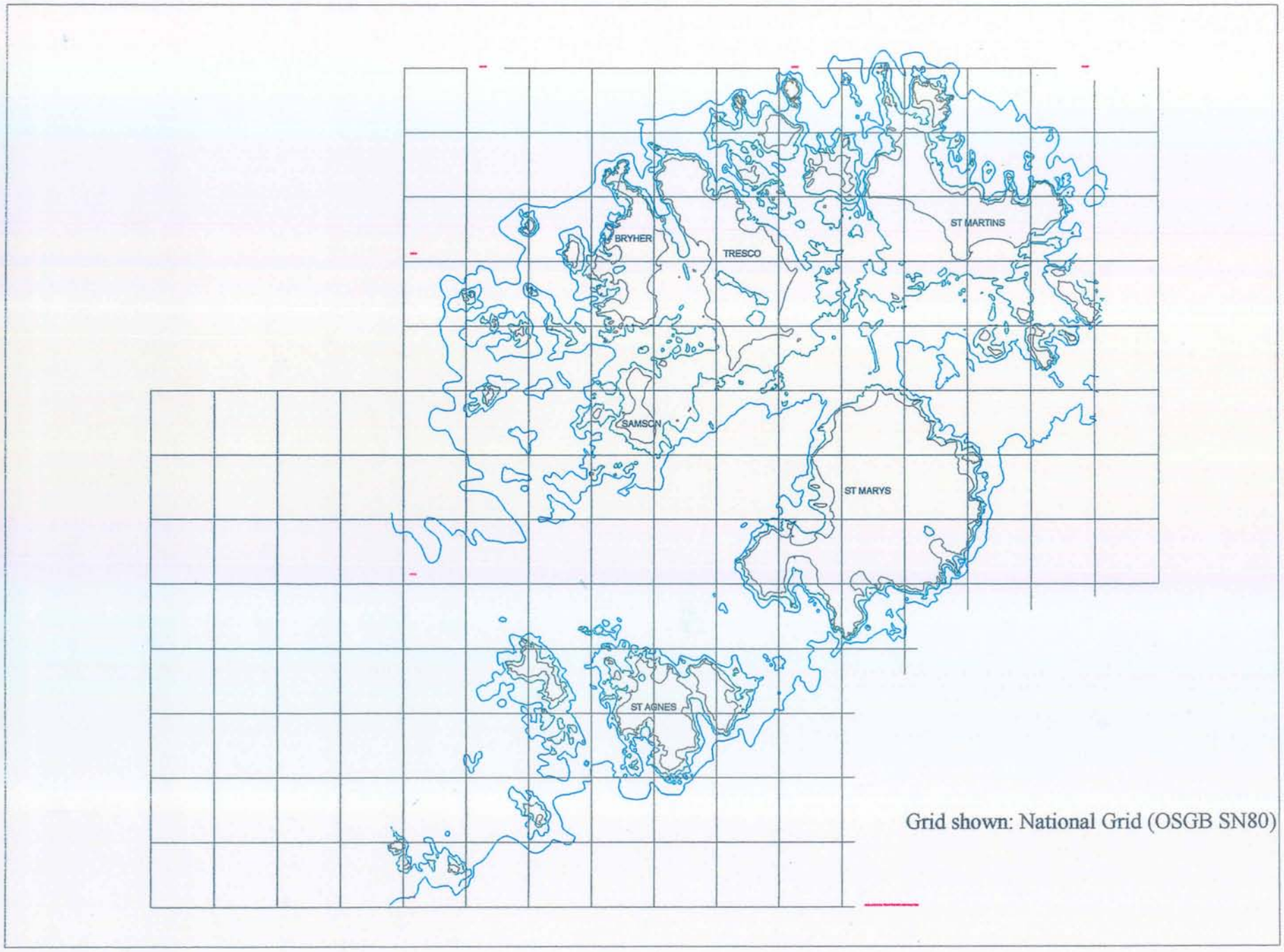


DENSE ZOSTERA WITH WELL-DEFINED EDGES

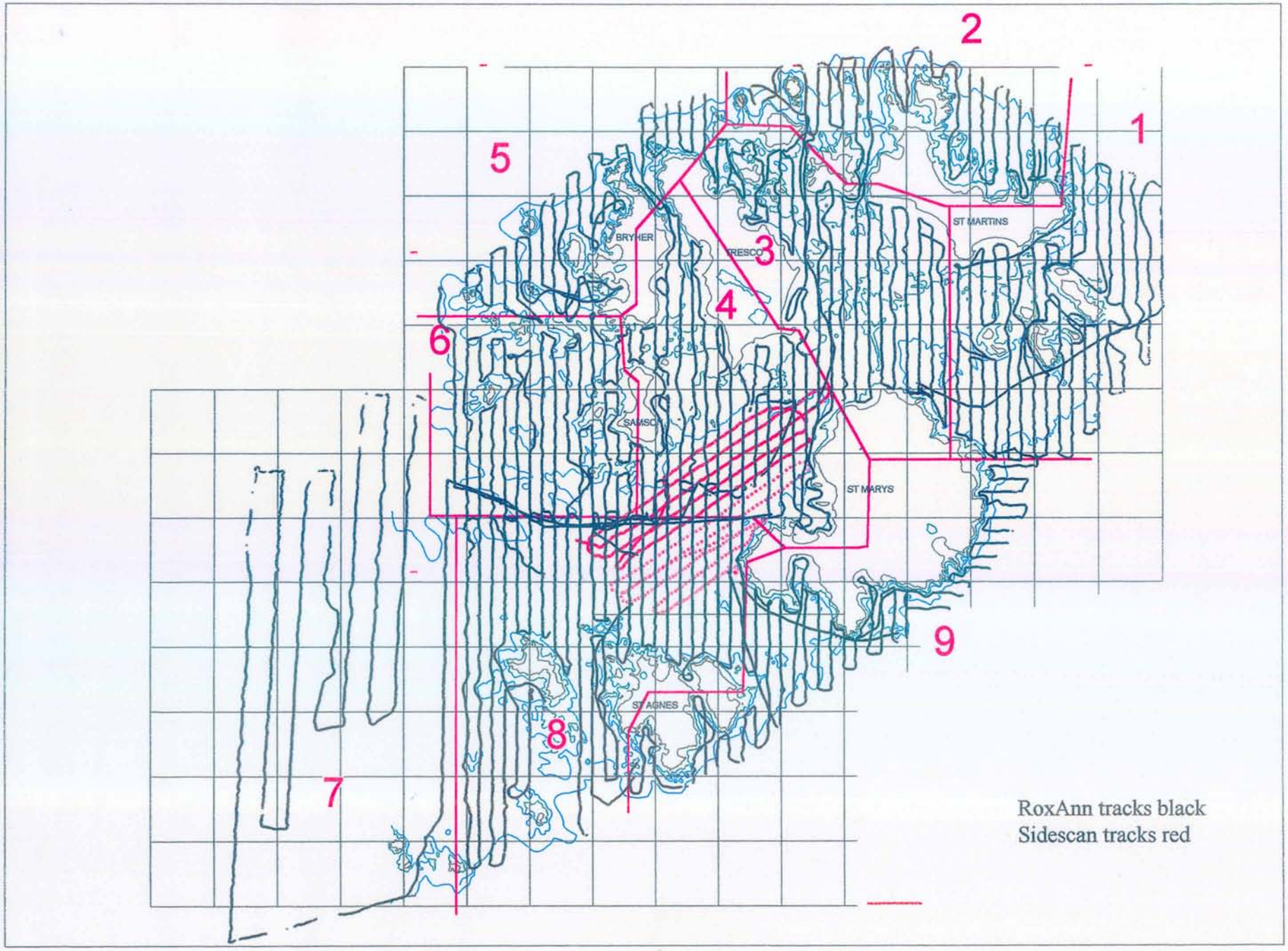


BEDROCK (GRANITE)

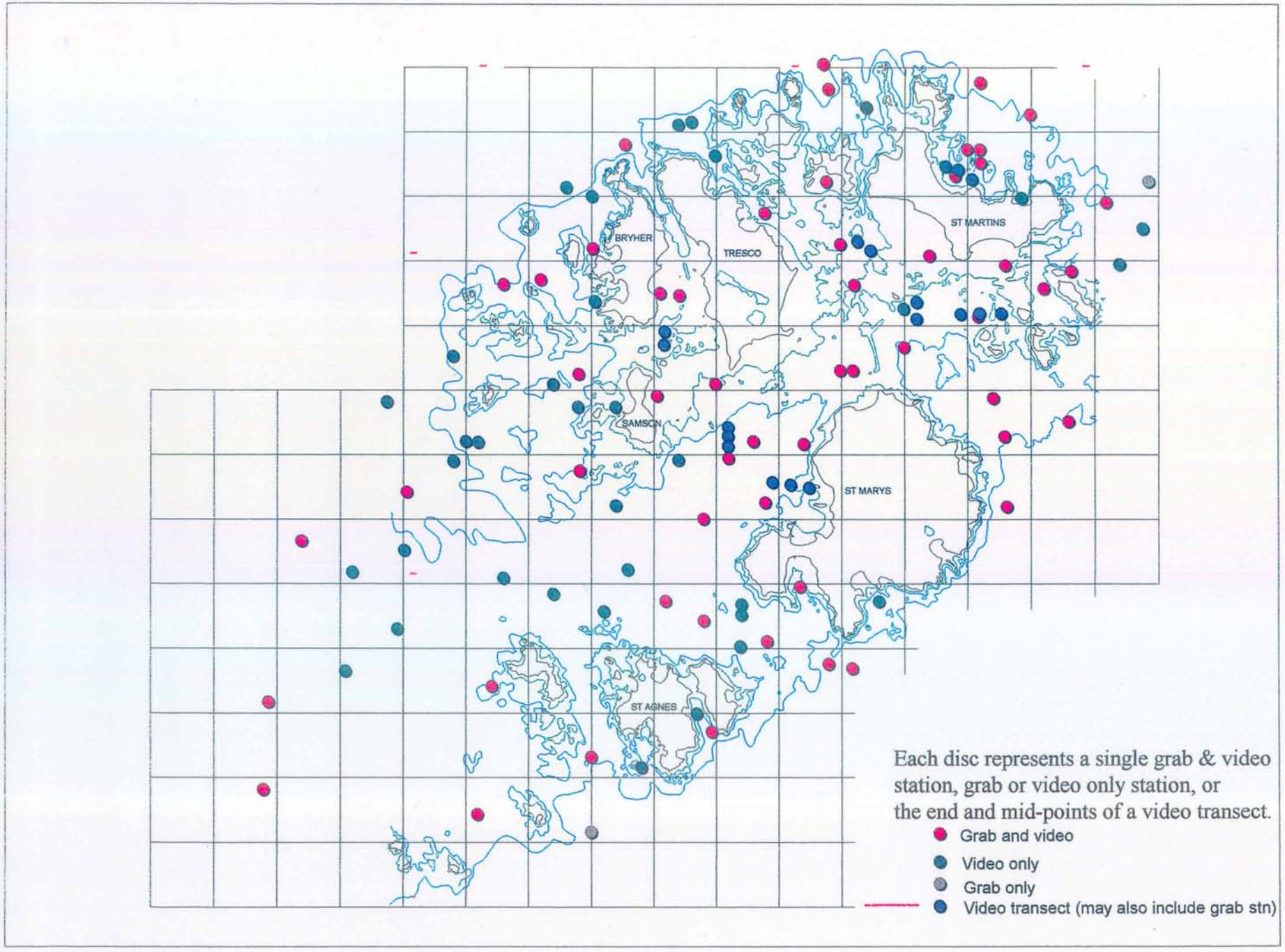
Map 1. Isles of Scilly archipelago, showing HWM, LWM, 5m and 30 depth contours



Map 2. Nine survey areas, RoxAnn and sidescan acoustic survey tracks.



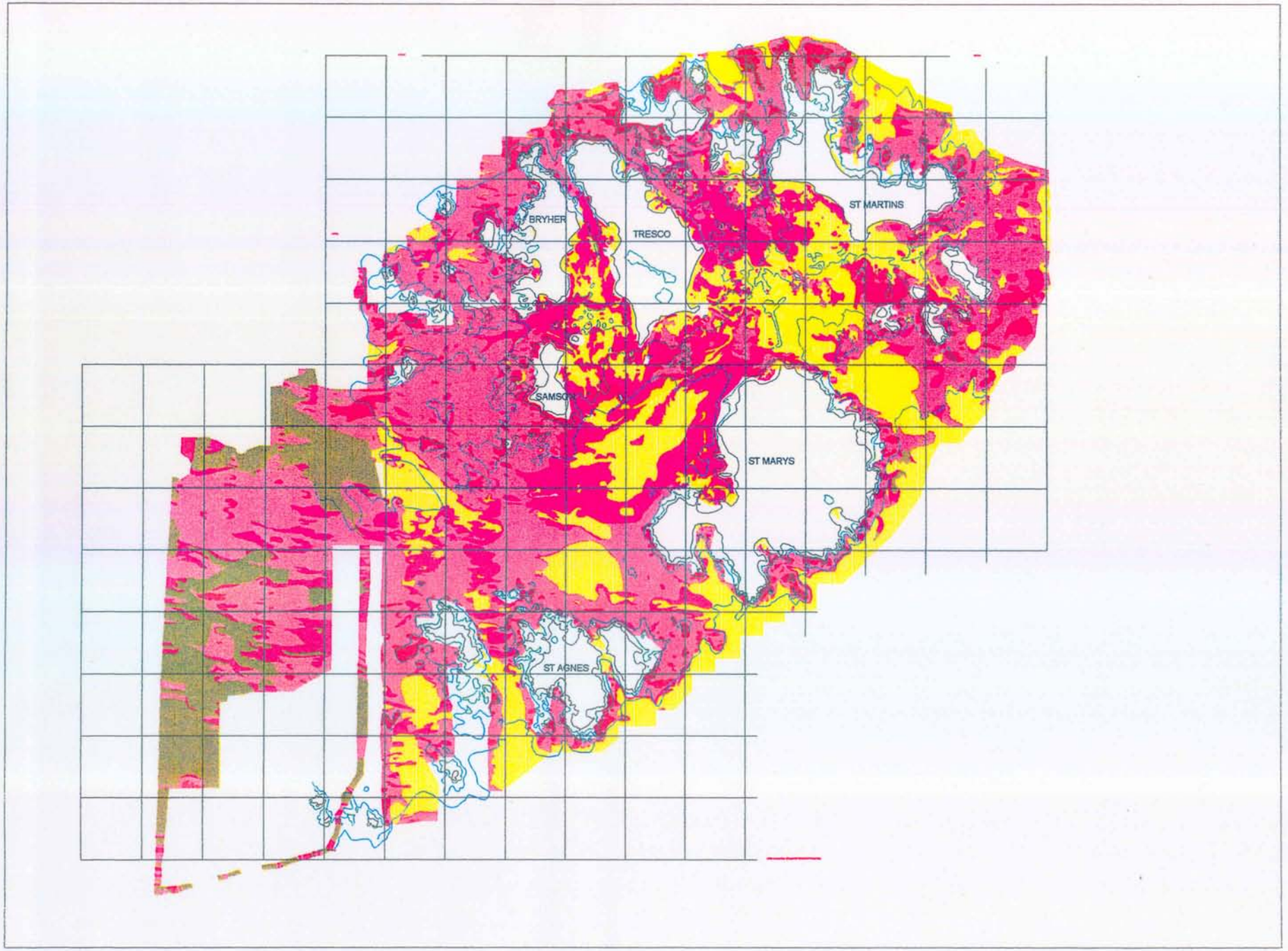
Map 3. Grab and drop-down video ground truthing station locations.



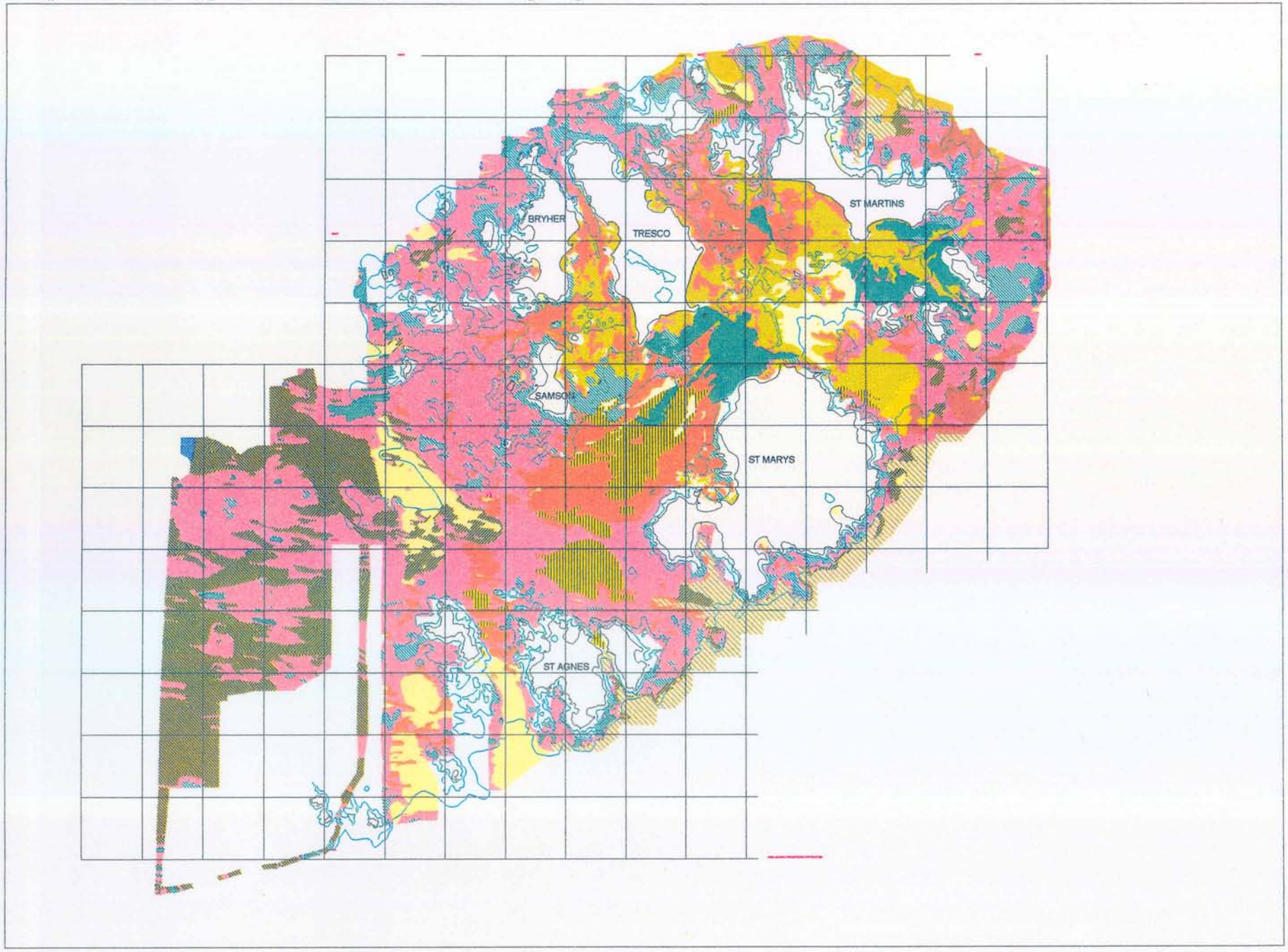
Sea bed types map colour coding key

- Circalittoral bedrock w. faunal turf
- Cobbles, boulders & bedrock outcrops
- Deep (30m+) wave exposed, fine sand
- Deep (45m+) circalitt. bedrock, faunal turf including dense Axinellids
- Deep (>20m) sandy gravels, cobbles, small boulders or sand veneer over bedrock
- Deep, exposed, moderately sorted medium sand with variable gravel content
- Exposed medium sand
- Infralitt. (or littoral) bedrock or boulders w. kelp/Himanthalia/fucoids-grazed
- Medium depth (10-20m) moderately exposed fine sand
- Shallow (<20m) sandy gravel, cobbles, sm. boulders or sand veneers over bedrock
- Shallow (<20m), sheltered fine sand.
- Shallow, moderately exposed, well-sorted medium sand
- Shallow, sheltered, medium sand w. variable or low gravel content
- Wave-exposed coarse shell sand, (mostly >20m)
- Zostera

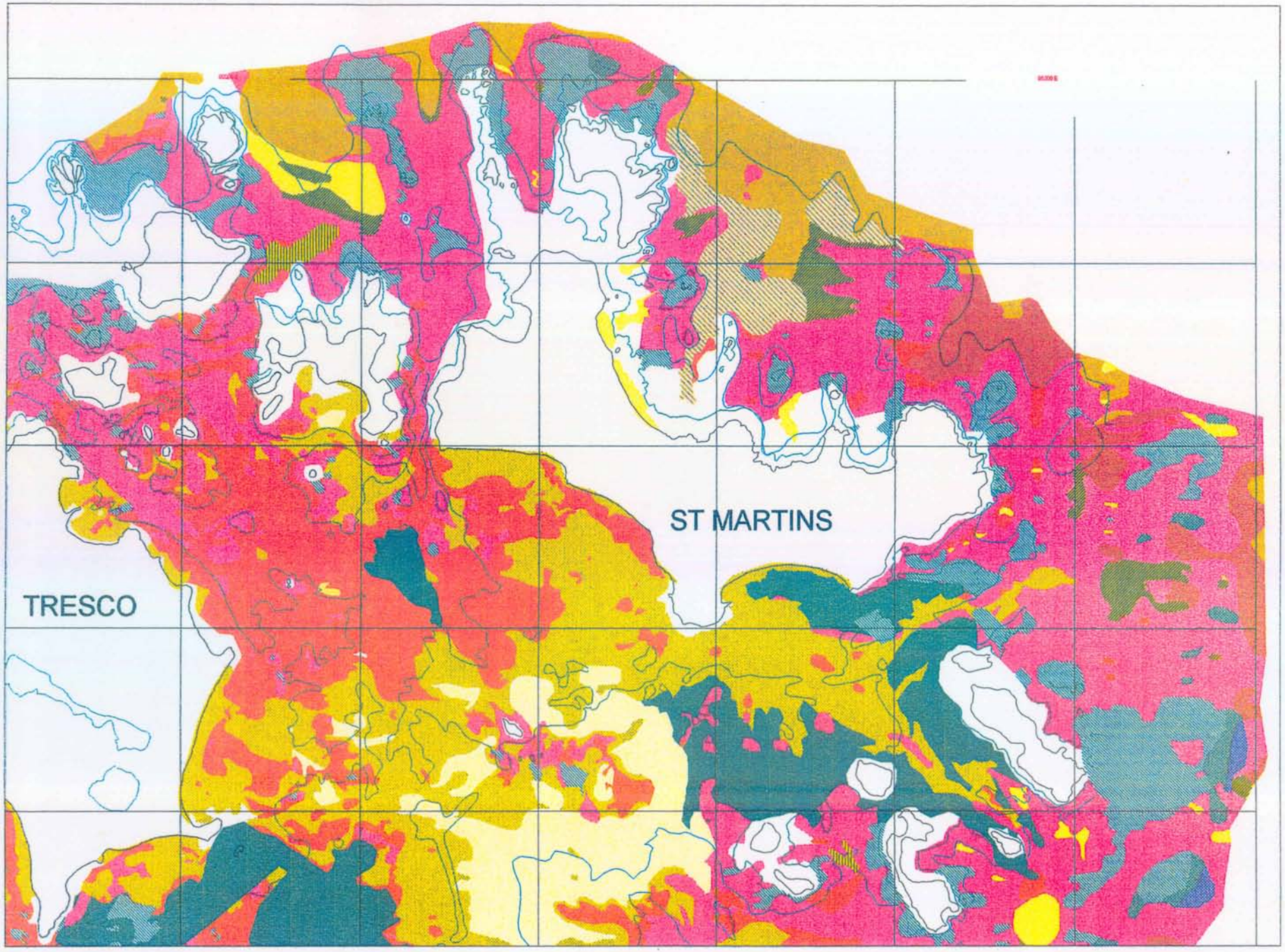
Map 4. Initial physical 'habitat' map derived from RoxAnn data



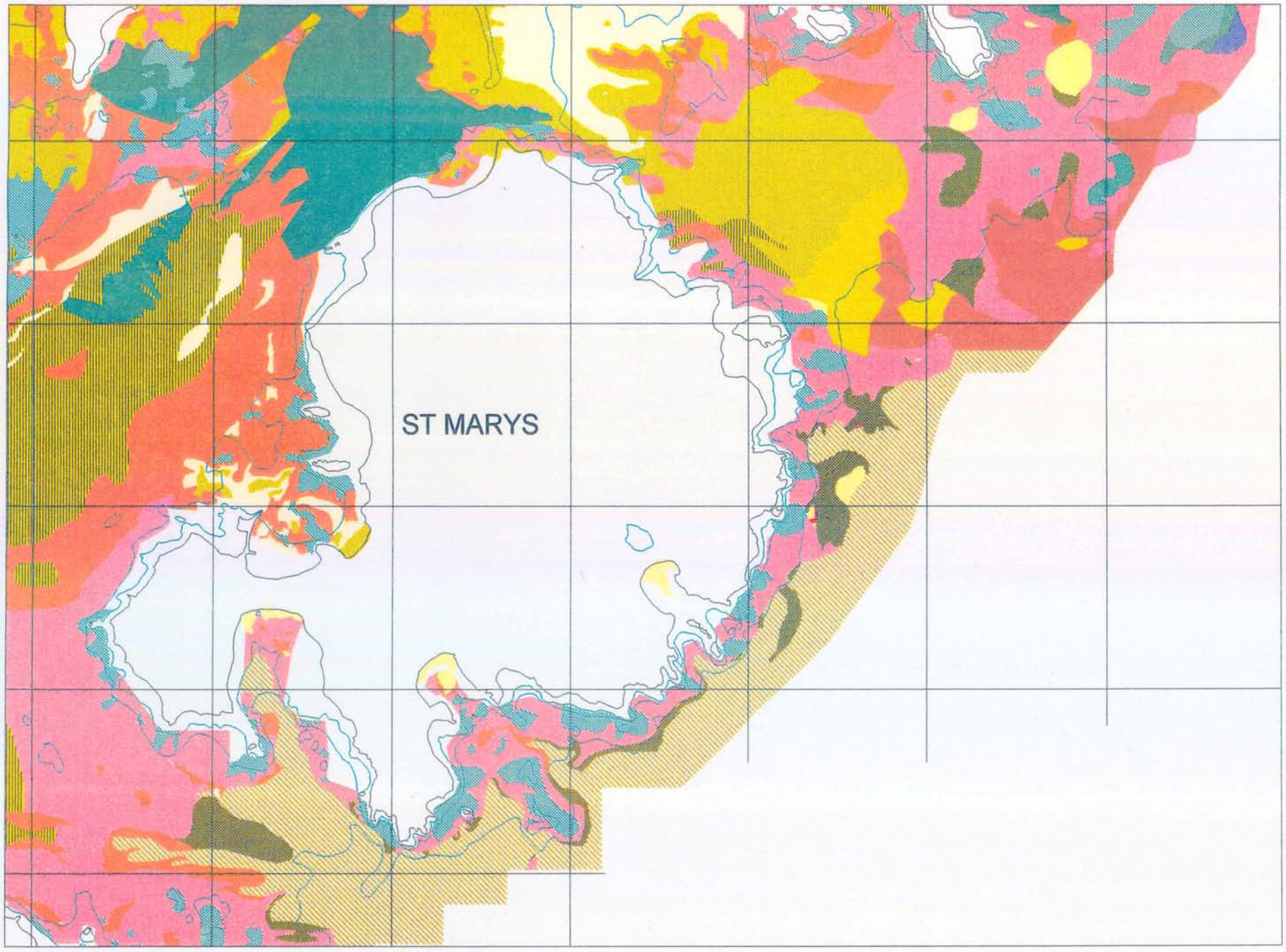
Map 5. Sea bed types distribution, Scillies archipelago.



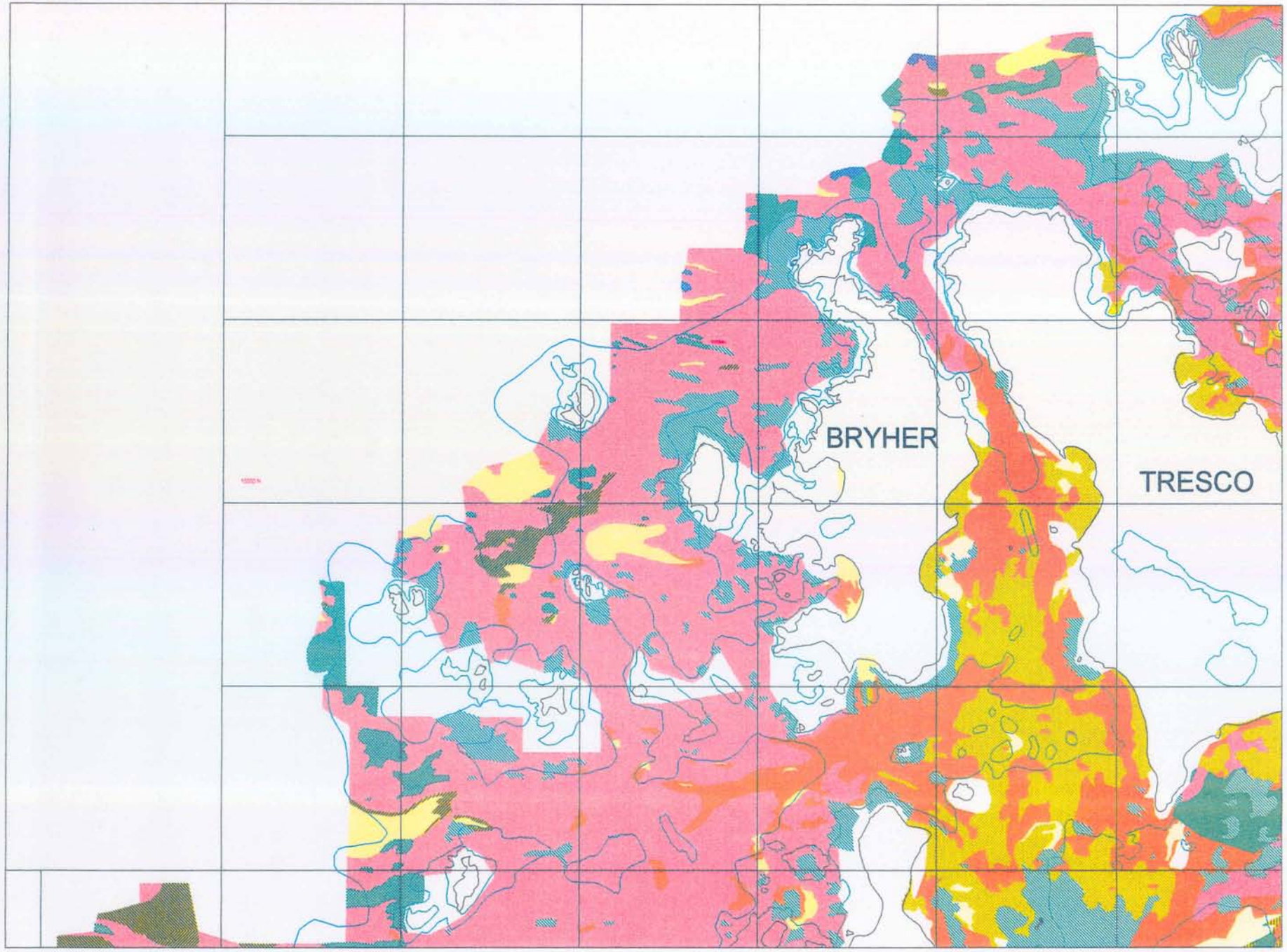
Map 6. Sea bed types distribution, North East Scillies.



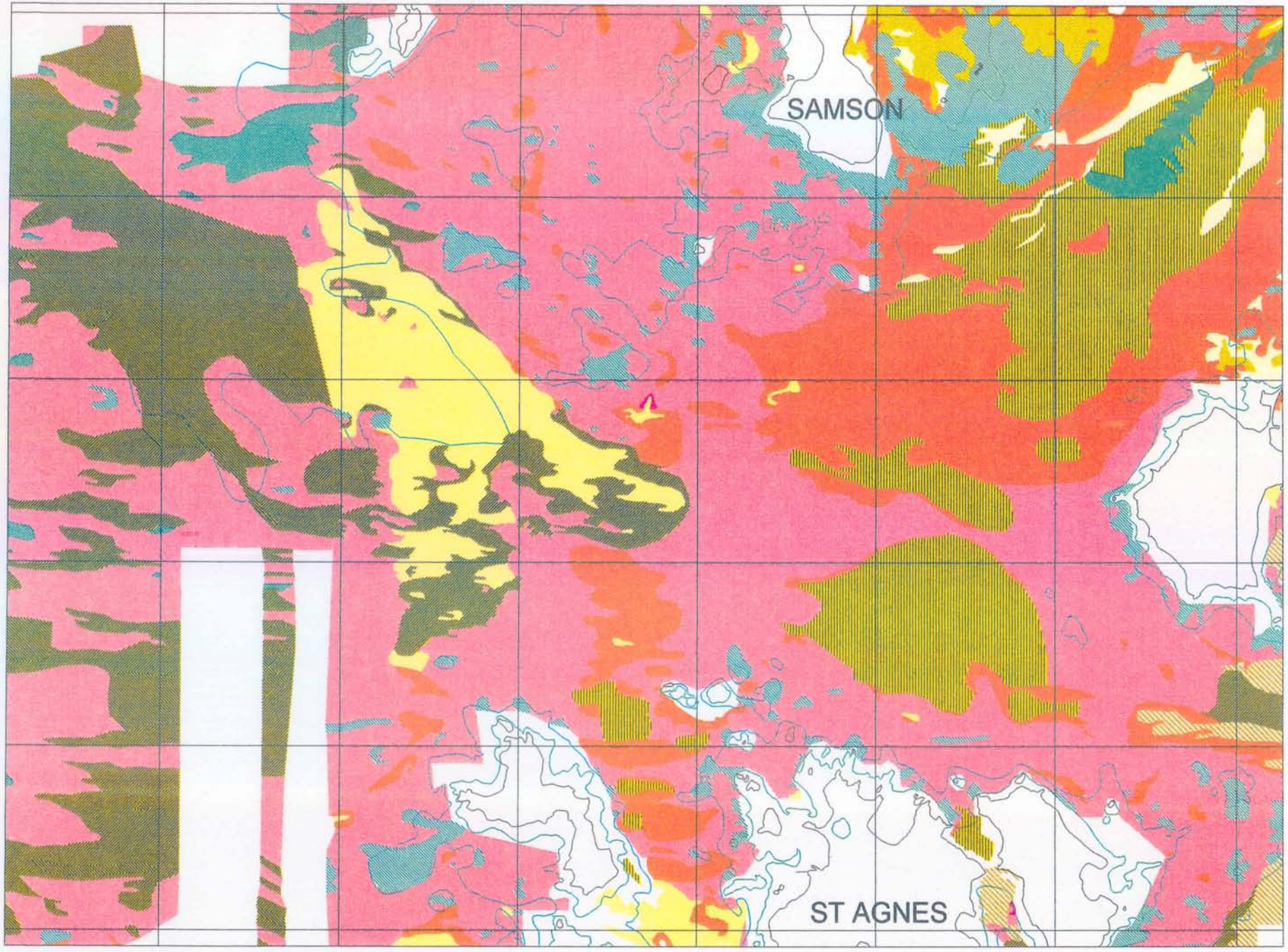
Map 7. Sea bed types distribution, East Scillies.



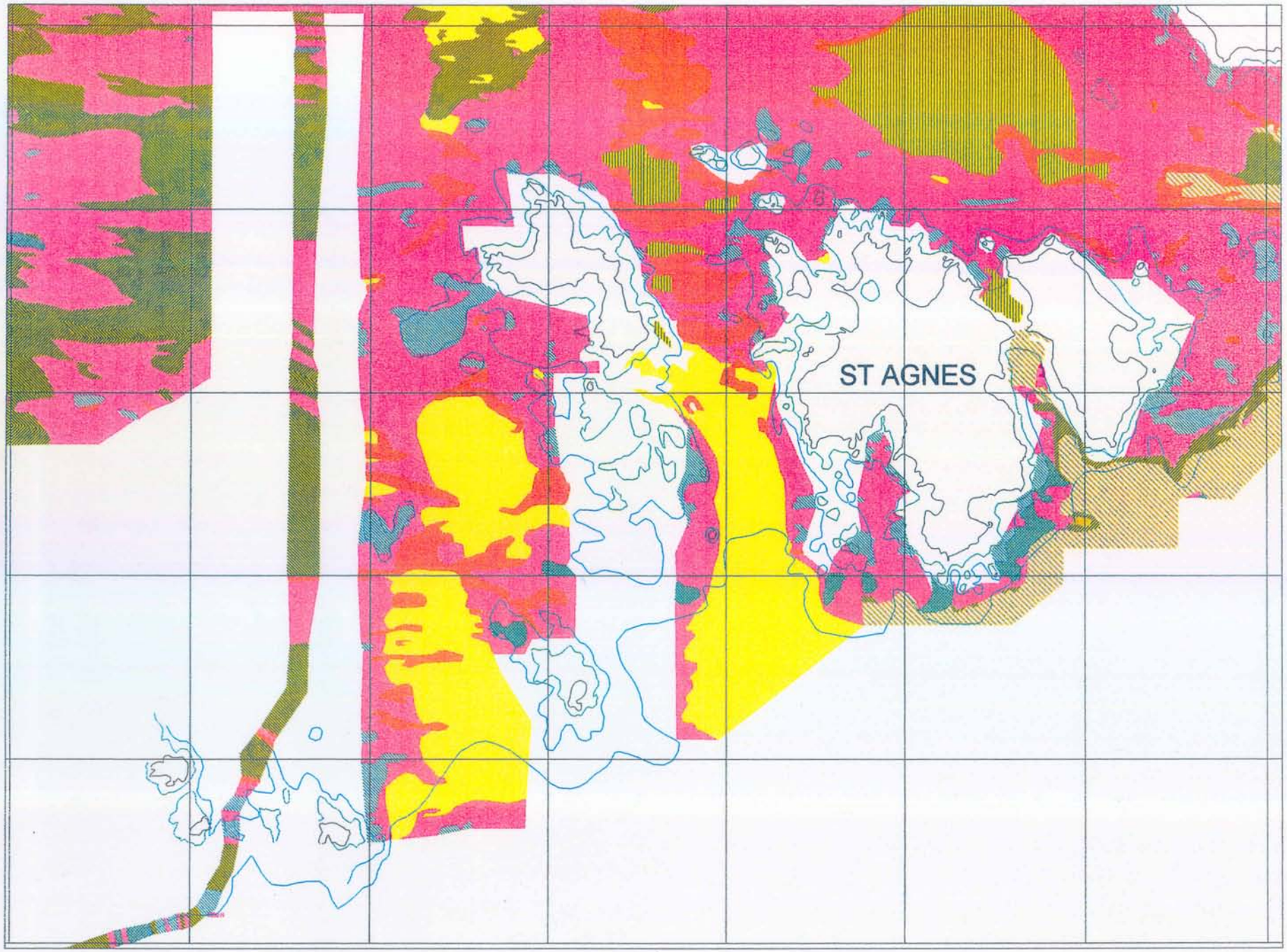
Map 8. Sea bed types distribution, North Scillies.



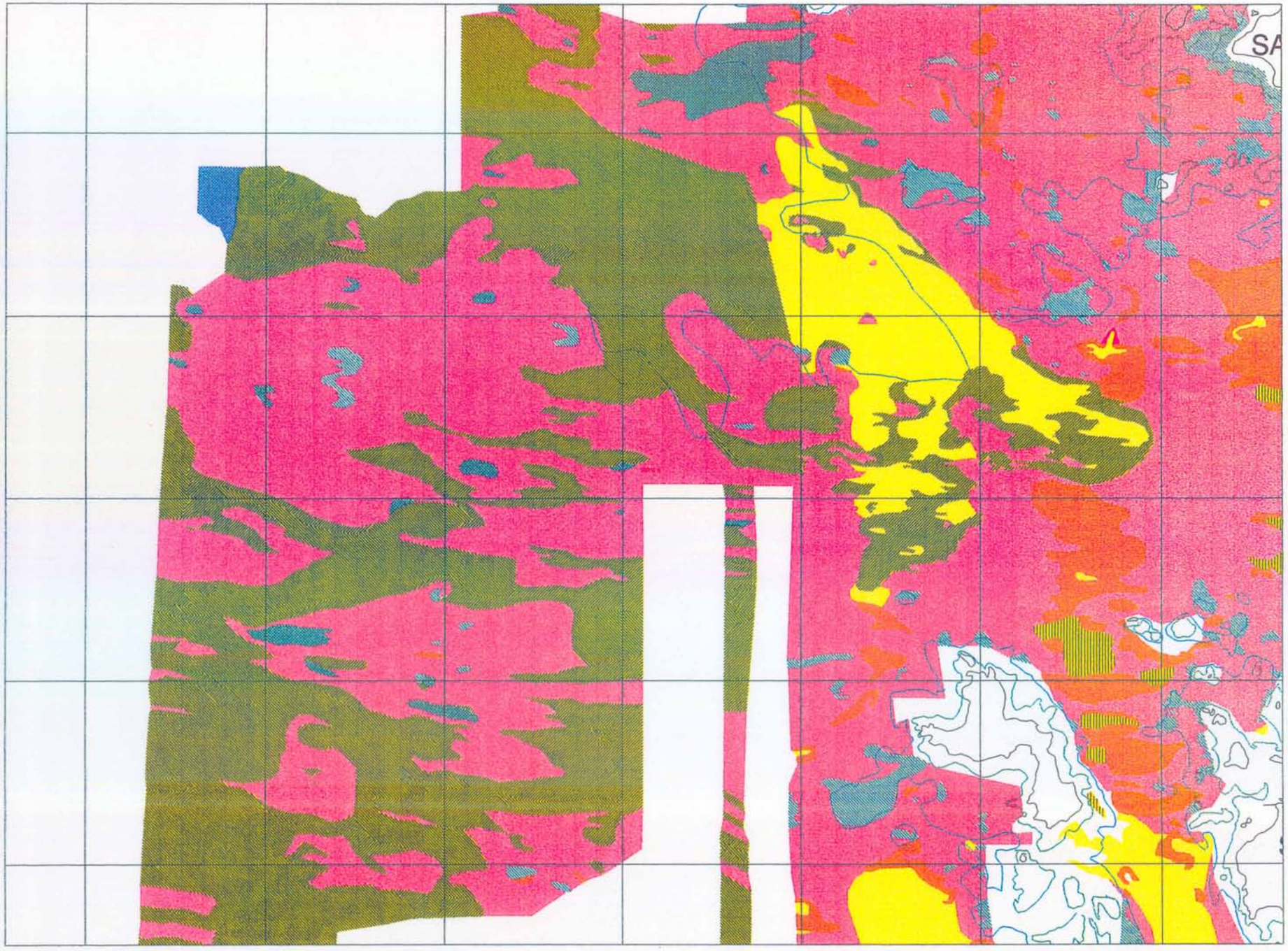
Map 9. Sea bed types distribution, St Mary's Road.



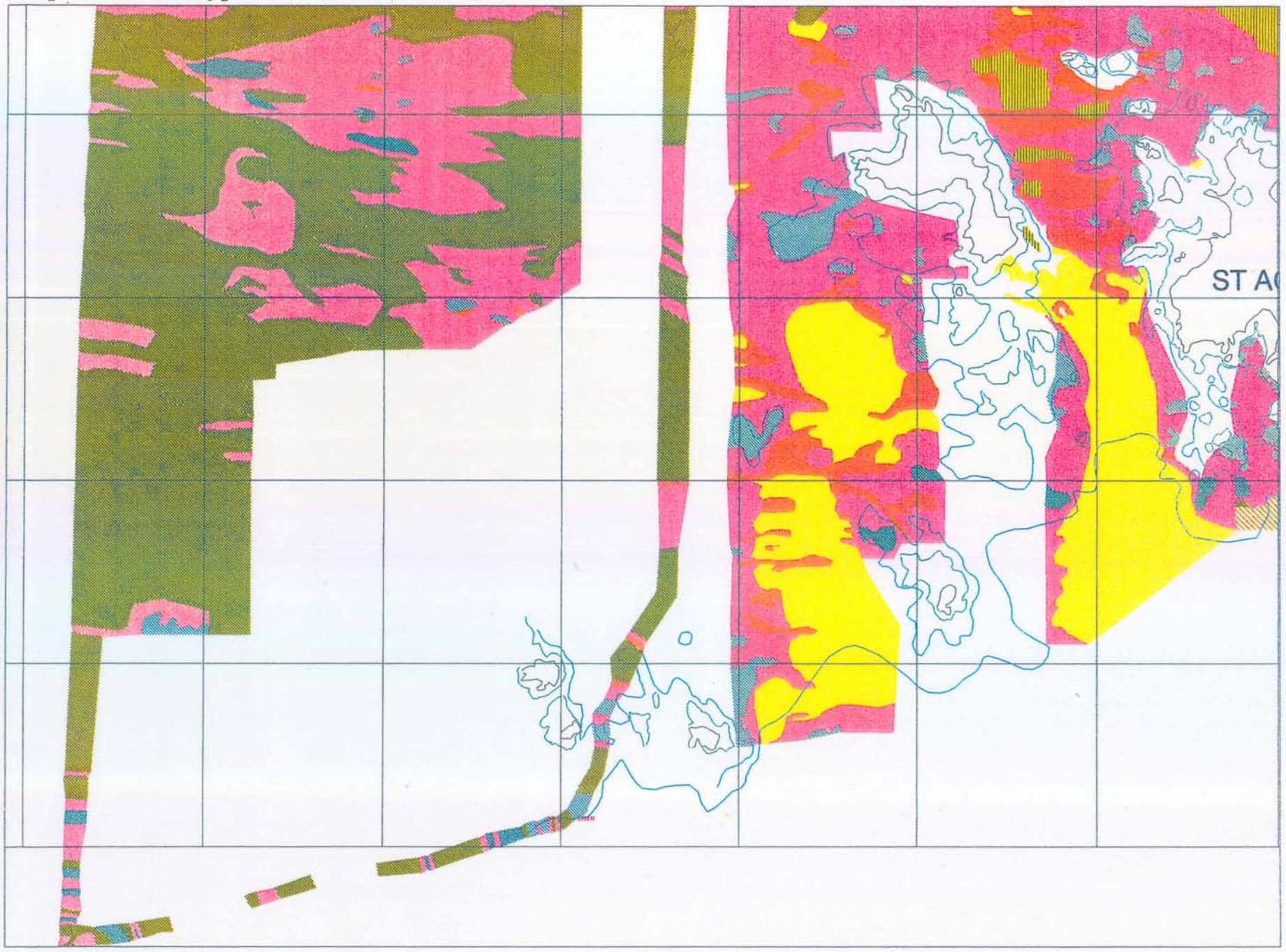
Map 10. Sea bed type distributions, St Agnes.



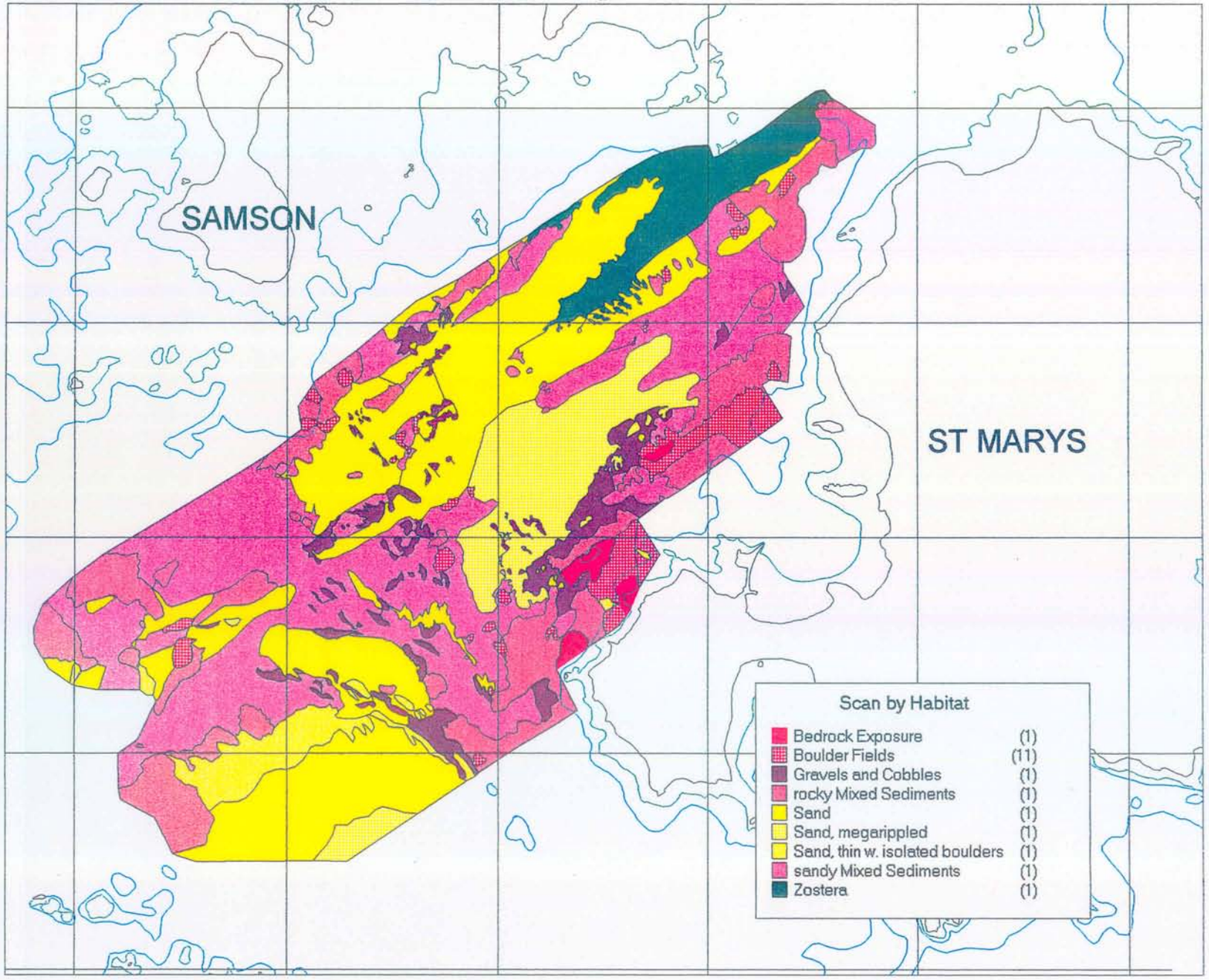
Map 11. Sea bed types distribution, North Channel.



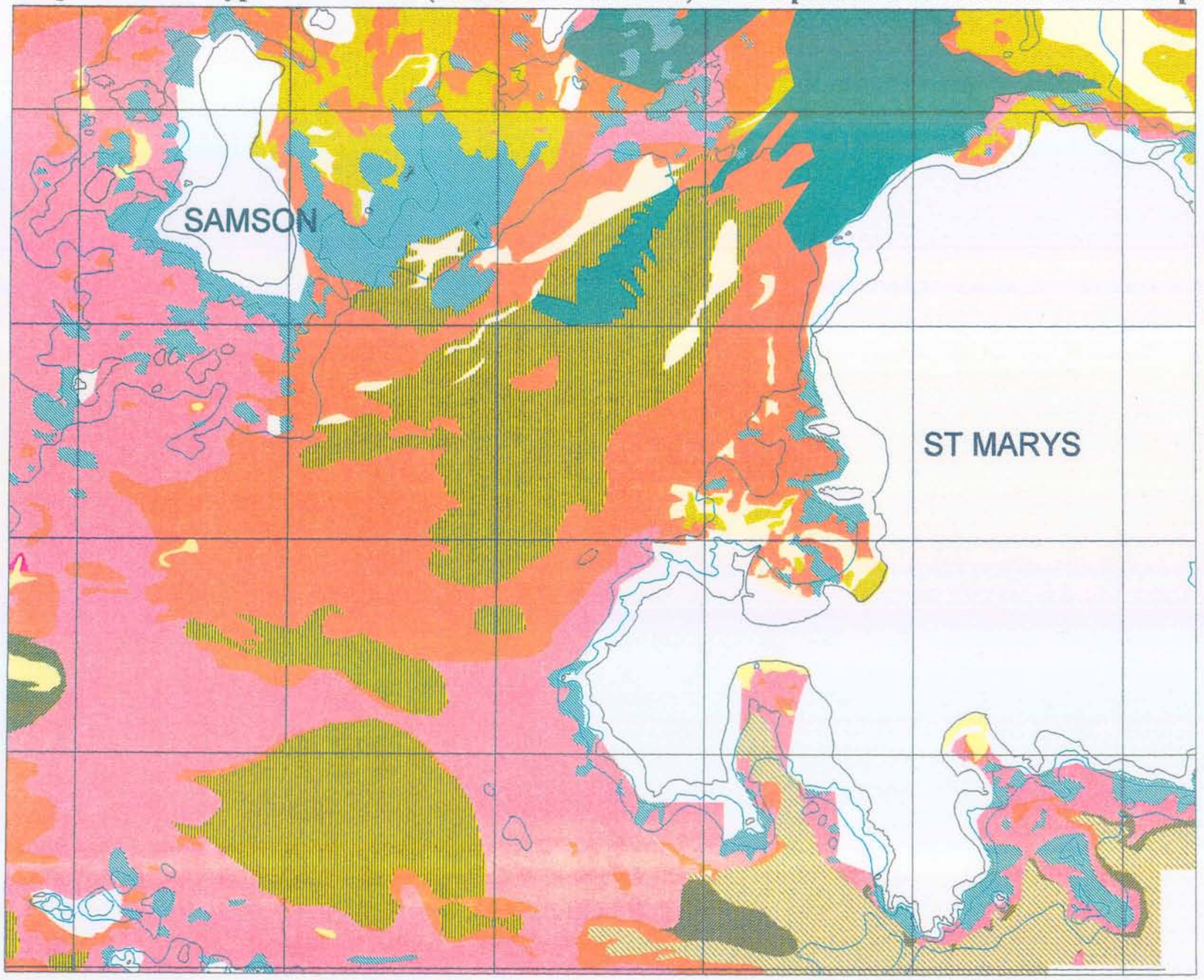
Map 12. Sea bed types distribution, Broad Sound.



Map 13. Side scan survey habitat identification map.



Map 14. Sea bed types distribution (derived from RoxAnn) for comparison with side scan habitat map.



APPENDIX 2.

ACOUSTIC MAPPING METHODS AND THEORY USING THE ROXANN SYSTEM

The RoxAnn System is very portable, comprising only a signal amplifier, which connects to the back of any echo sounder, and a signal processing box. The latter outputs a stream of data to a computer, which is also receiving position data from the DGPS. The RoxAnn software on the computer logs and plots these two coincidentally recorded sets of data, producing in real time mapped transects of seabed conditions.

- The RoxAnn data stream contains three pieces of information, updated at a rate pre-set by the user, normally of the order of a few seconds. These depth E1 and E2; the latter relate to seabed roughness and hardness respectively. These two parameters are derived as follows.

- E1. If the seabed were to be made of a sheet of glass, the 'first return' of an echo signal (SLIDE1) would be a brief spike, as only the ray of sound hitting the seabed at 90 would be returned. As seabeds are granular and irregular however their multifaceted nature allows signal returns (as 'backscatter') from rays striking the seabed with a significant angle of incidence. Thus the first return consists of the initial spike and a tail of backscattered energy, illustrated in SLLIDE 2. The volume of energy contained in this 'tail' is a measure of the backscattering potential, i.e. The 'roughness', of the seabed, and it is this that RoxAnn measurers and labels as E1.

- E2. The strength of the signal first returned to the transducer is largely a function of the sound-absorptive properties of the seabed, with hard materials such as rock reflecting much and absorbing little and thus giving a strong signal, and the converse happening with soft mud. Unfortunately, high ambient noise conditions, such as may be associated with bed sea conditions, readily mask this relationship. The empirical observation has been made however that the properties of the second echo return, that which has been re-reflected from the sea surface (SLIDE 1), are equally strongly related to the hardness of the seabed, but for some reason far less susceptible to interference. Thus RoxAnn measures the total volume of the second echo return (SLIDE 2), as a measure of 'hardness' and labels this E2.

- The computer software plots E1 against E2 using the 'RoxAnn Square' (SLIDE 3), assigns a colour code to the combination which is then plotted on the chart as surveying takes place. The format of the RoxAnn Square can be automatically applied when surveying first takes place, but can also be modified during post-processing. A range of more complex post-processing techniques can also be applied.

GROUND-TRUTHING ROXANN DATA

The successful utilisation of RoxAnn data for seabed mapping purposes requires two critical areas to be addressed.

1. A need for a high level of positioning accuracy and observation of detail when calibrating the acoustic data to the ground-truth observation.
2. The recognition that RoxAnn does not uniquely categorise sediments in terms of their particle-size characteristics, and mitigation of this situation.

Positioning effects.

The inter-relation of acoustic and ground-truth data relies heavily upon accurate position fixing. Compound errors may build during sampling as follows (SLIDE 4, this example shows accuracy levels associated with a public broadcast DGPS signal):

Acoustic data position DGPS error	Grab/video position DGPS error	Grab/video vessel location error	Potential compound error
8m	8m	10m	26m

thus when a position is located on the acoustic trackplot, and ground truth data is collected from that location, the actual truthing position may be up to 20-30m away from the originally identified point. To take account of this potential variability, the RoxAnn values along the vessels course for 30m (~10s) either side of the selected location need to be examined. This procedure gives insight into both the effects of positioning errors, and the heterogeneity of the local sediment body.

Variability in these data can be quantified by determining the mean and standard deviation of the ten data points centred on the theoretical sample location, and by producing a histogram showing the frequency distribution (SLIDE 5). These three pieces of information provide a more informed basis from which to embark upon the calibration process than the raw E1 and E2 values from the theoretical sampling location.

The calibration process involves producing a scatter plot of the mean E1 (y-axis) and E2 (x-axis) values, coded according to their particle-size content (%mud, %sand, %gravel, modal grain size of sand population) and/or visual description in the case of rock, boulder or coarse 'lag' deposits. These plot can be contoured or block categorised accordingly, using suitable modelling software such as SURFER. Each point on this calibration scatter plot can now be examined individually. Where the standard deviations of the E1/E2 values are small, and where the histogram frequency distribution shows a 'normal' situation (e.g. SLIDE 5, station 25), confidence can be placed in the individual point, and particle-size content isolines and/or block categories consistent with these data points can be confirmed. Where however, standard deviations are large, the mean values of E1/E2 can mislead the calibration process. Two situations become apparent when examining the histograms for calibration points with large standard deviations:

1. A wide scatter of RoxAnn values (e.g. SLIDE 5, station 10) suggesting a highly variable seabed on a small scale. Data points of this nature are not suitable for calibration purposes, and are probably best abandoned.

2. The presence of two (or more) seabed reflector types within the sampled area, thus the presence of two (or more) modal values for E1/E2 (e.g. SLIDE 5, station 11). In this instance it is realistic to adopt the E1/E2 modal value that fits best the calibration pattern established using 'good' data points (low standard deviations).

Through an iterative, and not particularly time-consuming process, the original calibration scatter plots and fitted seabed-type distributions can be reworked, removing or modifying 'rogue' points and generally allowing a simpler pattern to emerge. Finally, the E1/E2 scatter plot can be boxed into seabed types based on a combination of particle-size and visual appearance.

Uniqueness of Acoustic Signal

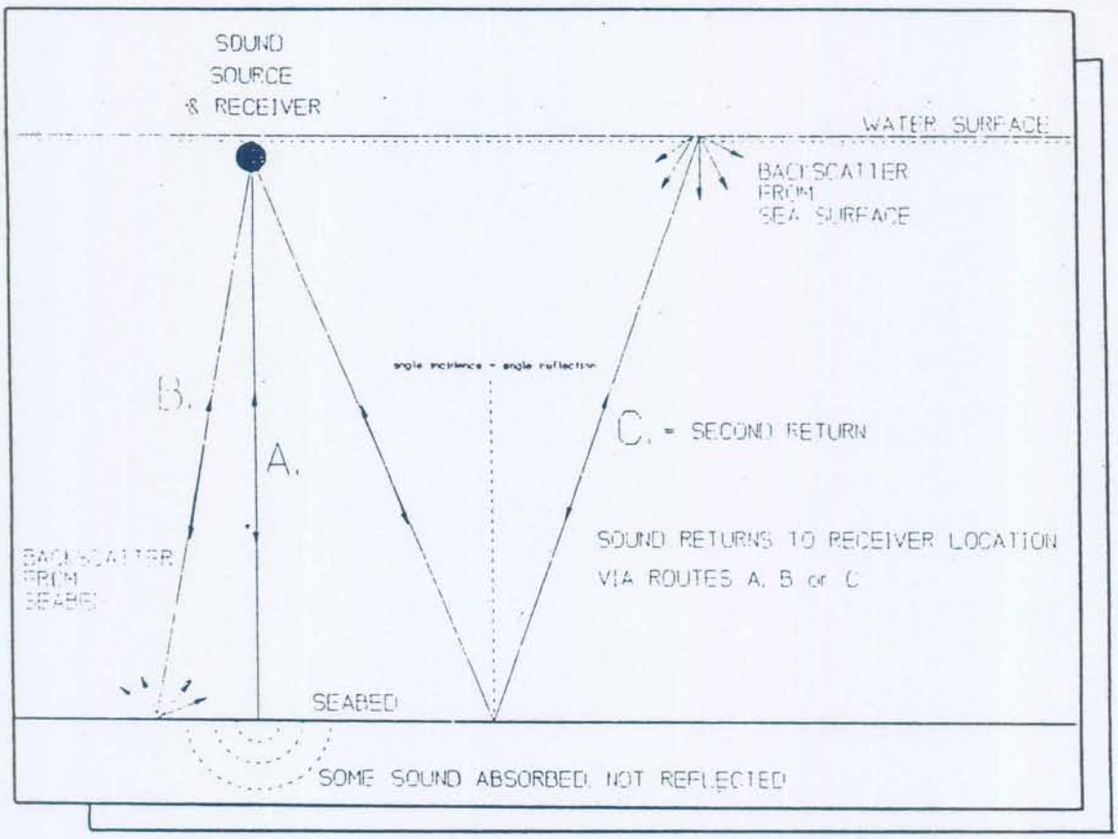
A problem basic to all Spatially Continuous Mapping is that we traditionally rely upon particle-size and visual appearance (morphology) in our seabed classification, whereas remote sensing methods map other parameters. In the case of RoxAnn we are mapping aspects of the acoustic reflectivity of the seabed, viz. the local variability in reflection (E1, equating to physical roughness) and sound-absorptive properties (E2, equating to physical hardness). Although grain size and bed morphology play a role in determining roughness and hardness of the seabed, other factors such as sediment compactness (history of disturbance) play an equal role. Thus it frequently happens that sediments with a similar RoxAnn signature have very different appearance and particle-size content.

There are three steps that can be practically applied to mitigate this problem.

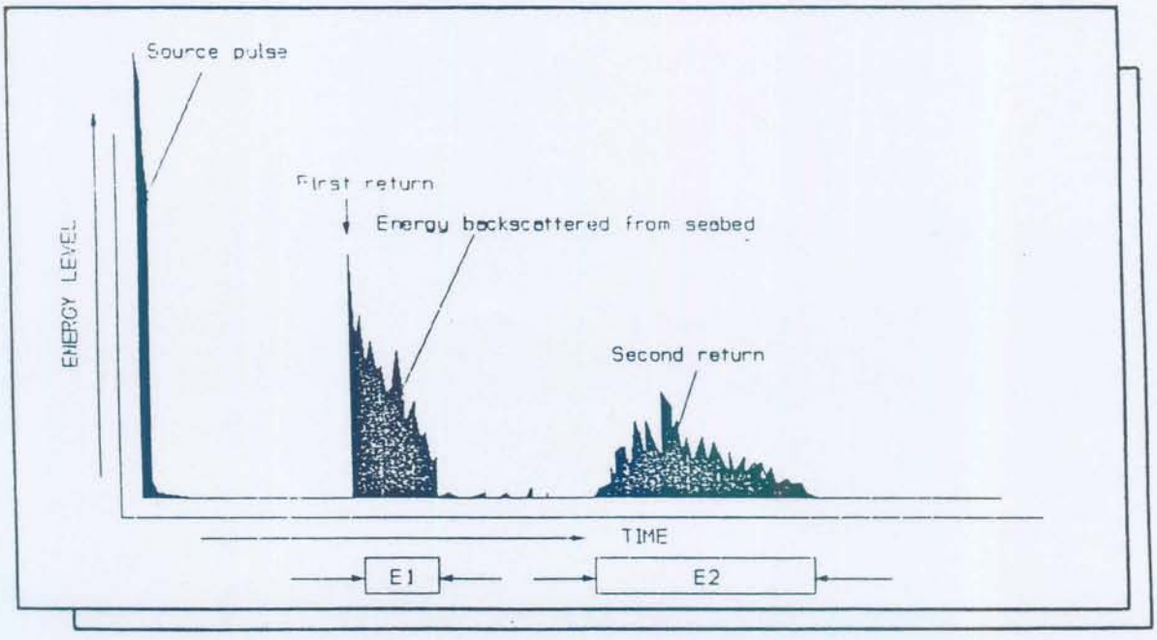
1. Always collect a large number of ground truth samples, with several samples from each acoustic type.

2. Initially produce calibration diagrams for areas of similar water energies e.g. upper estuary, lower estuary, and sea coast. If they prove to be compatible they may be amalgamated at a later stage, but it is commonly found that parts of the calibrations will vary between such areas.

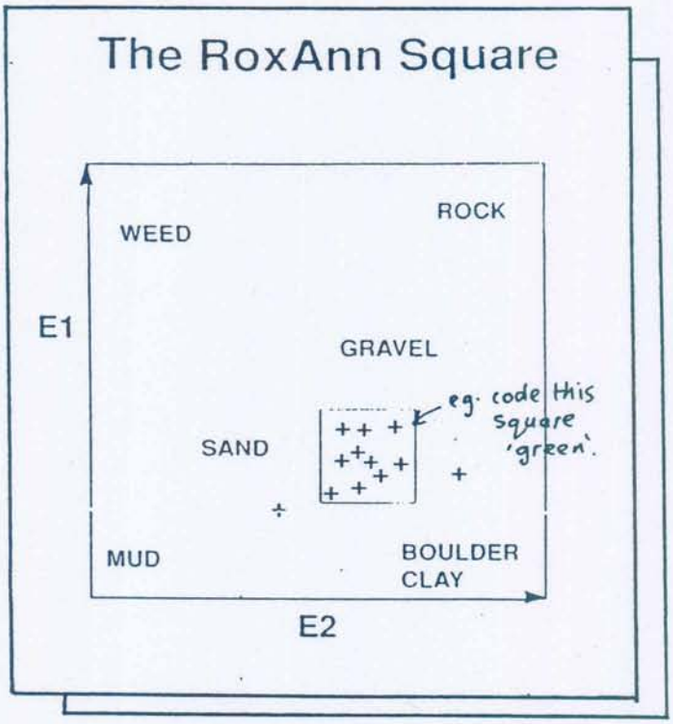
3. Be prepared to revisit sites to further ground truth areas of acoustic signal where ambiguity of classification may exist.



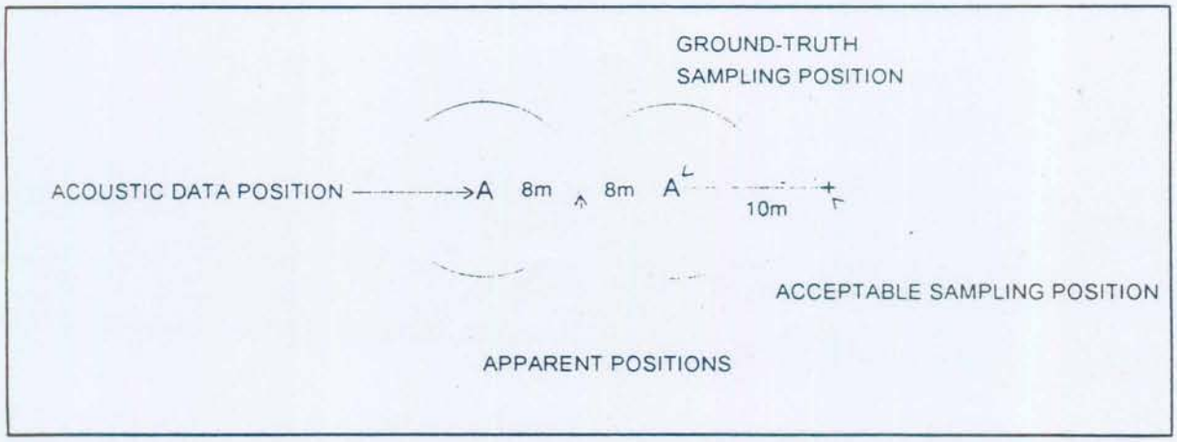
SLIDE 1. SOUND RAY PATHS



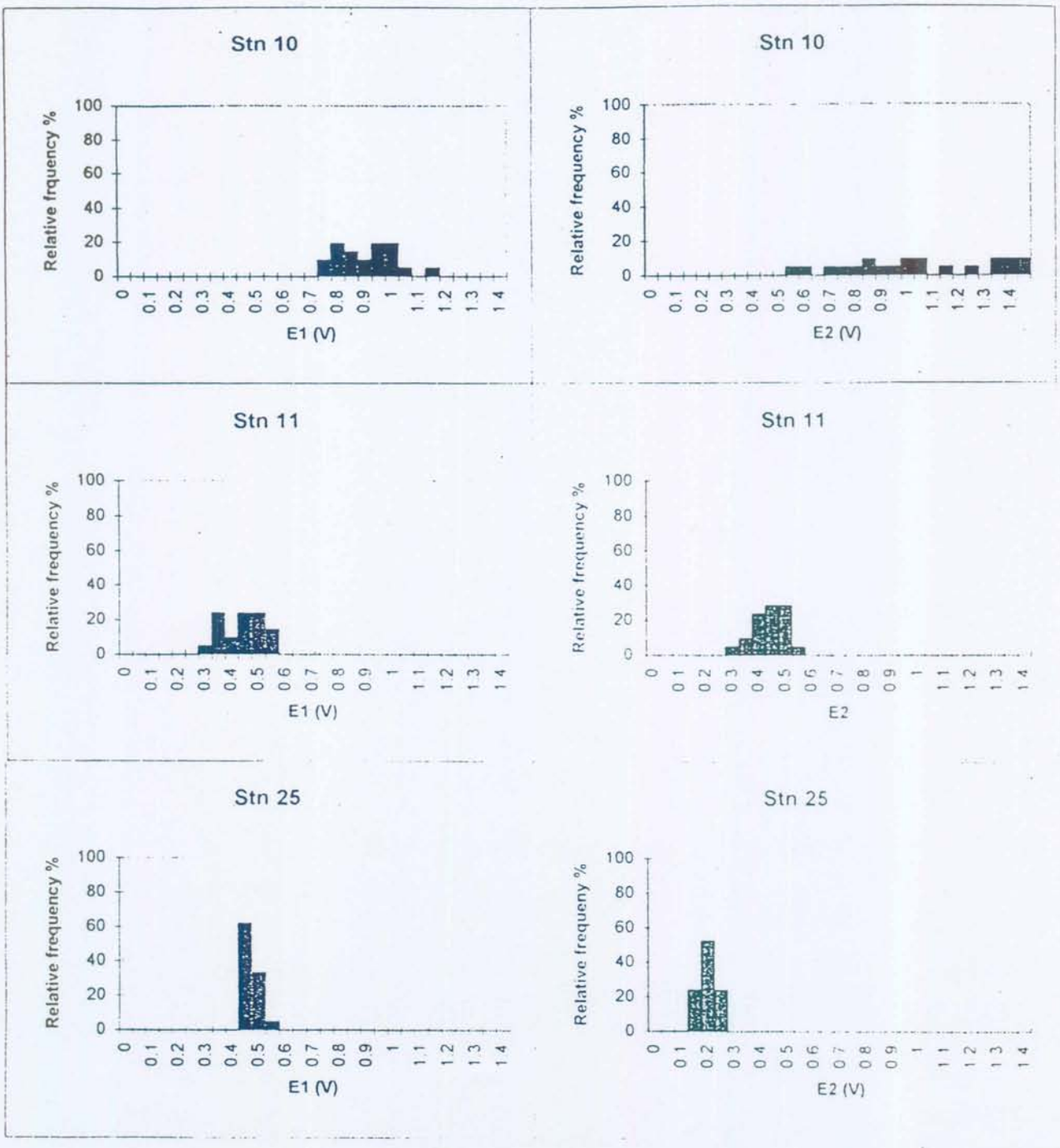
SLIDE 2. PLOT OF SOUND ENERGY VERSUS TIME FROM A TYPICAL ECHO-SOUNDER PULSE.



SLIDE 3. COMBINING E1 AND E2 VALUES



SLIDE 4. THE COMPOUNDING OF POSITIONING ERRORS



SLIDE 5. TYPICAL FREQUENCY HISTOGRAMS OF E1 AND E2 VALUES ALONG A 40m ACOUSTIC TRACKPLOT

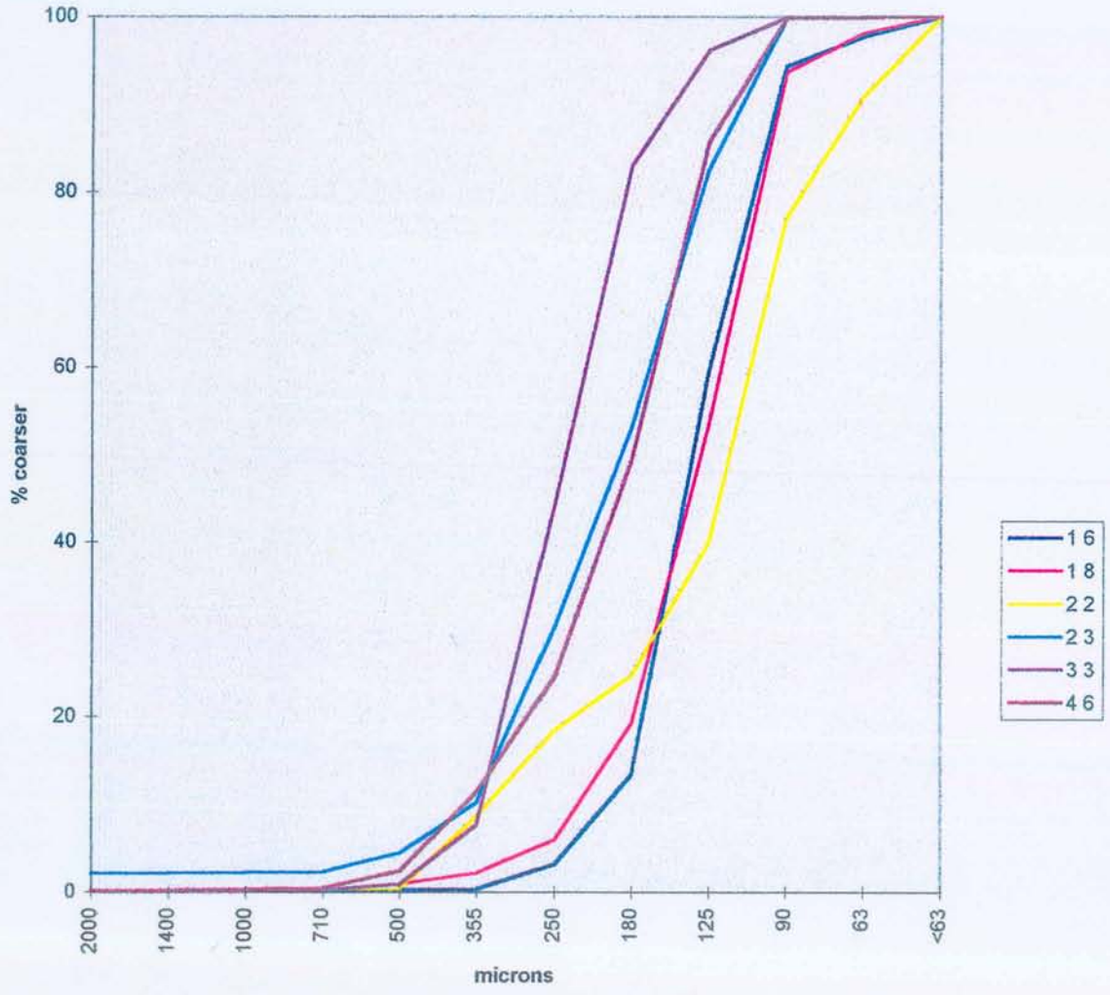
APPENDIX 3.

GRAB AND VIDEO GROUND TRUTHING STATIONS DATA.

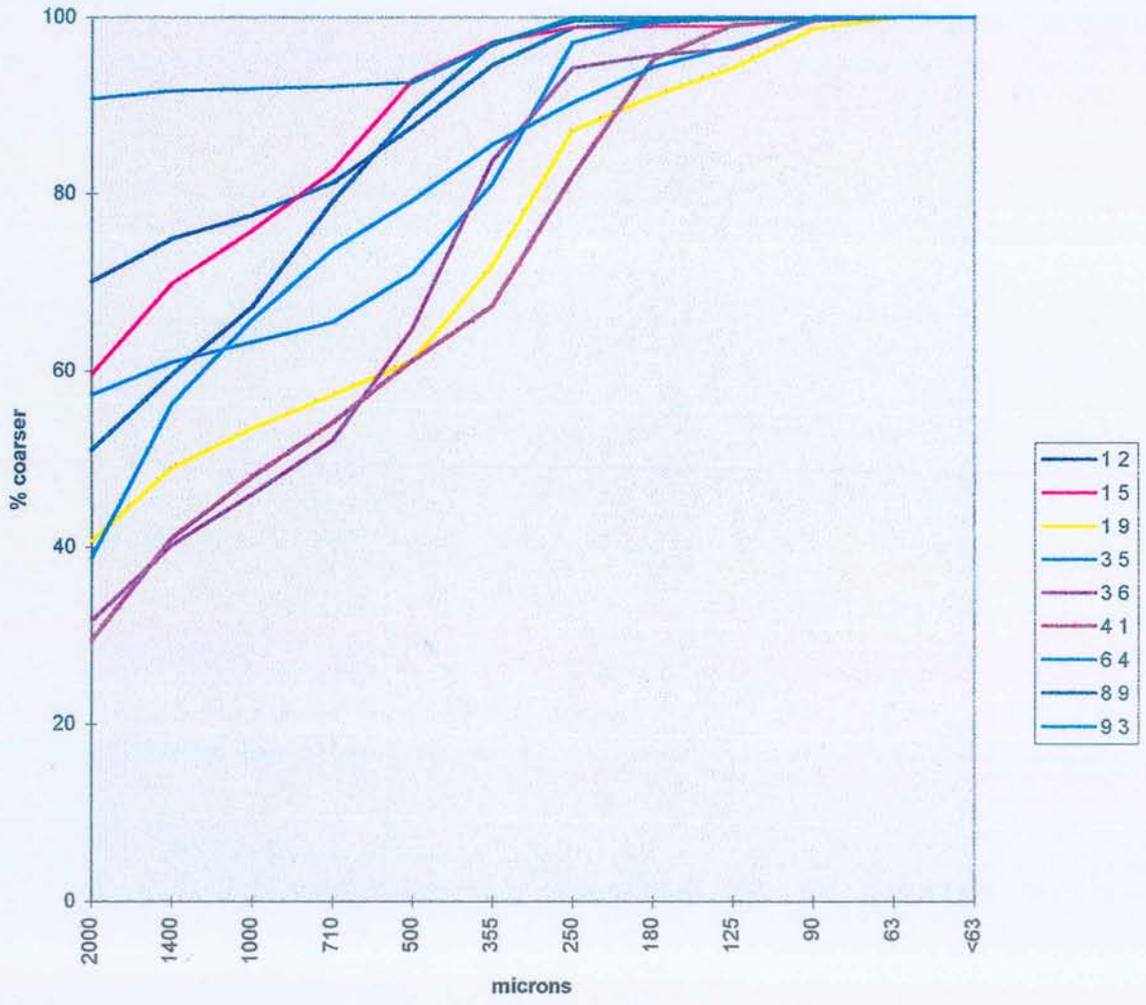
FIGURE 5 Sediment samples: Particle size distribution graphs of sand fraction

1a Fine/medium-fine sands
1b Coarse sands and gravels
1c Gravels withmedium sand
1d Poorly-sorted medium sands with gravel
1e Moderately-sorted medium sands with gravel
1f Medium sands

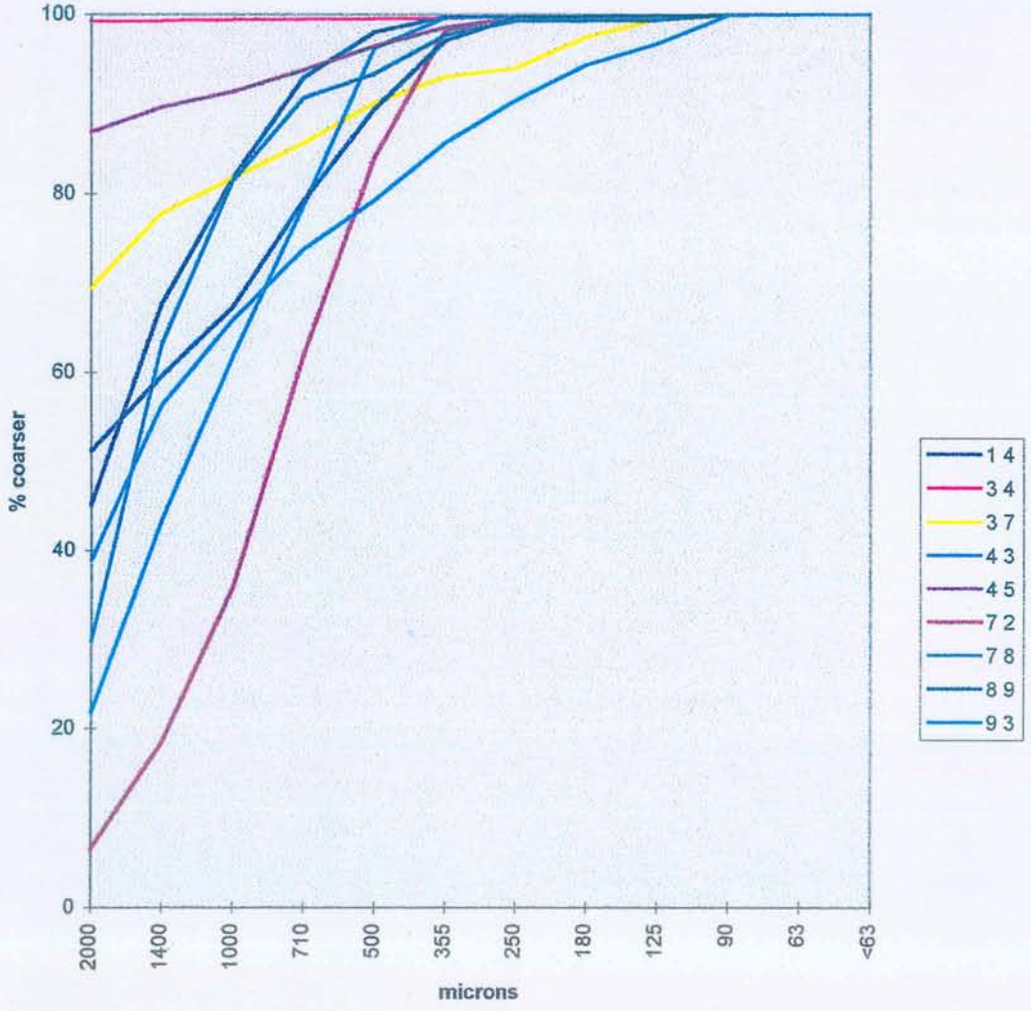
FINE/MEDIUM-FINE SANDS



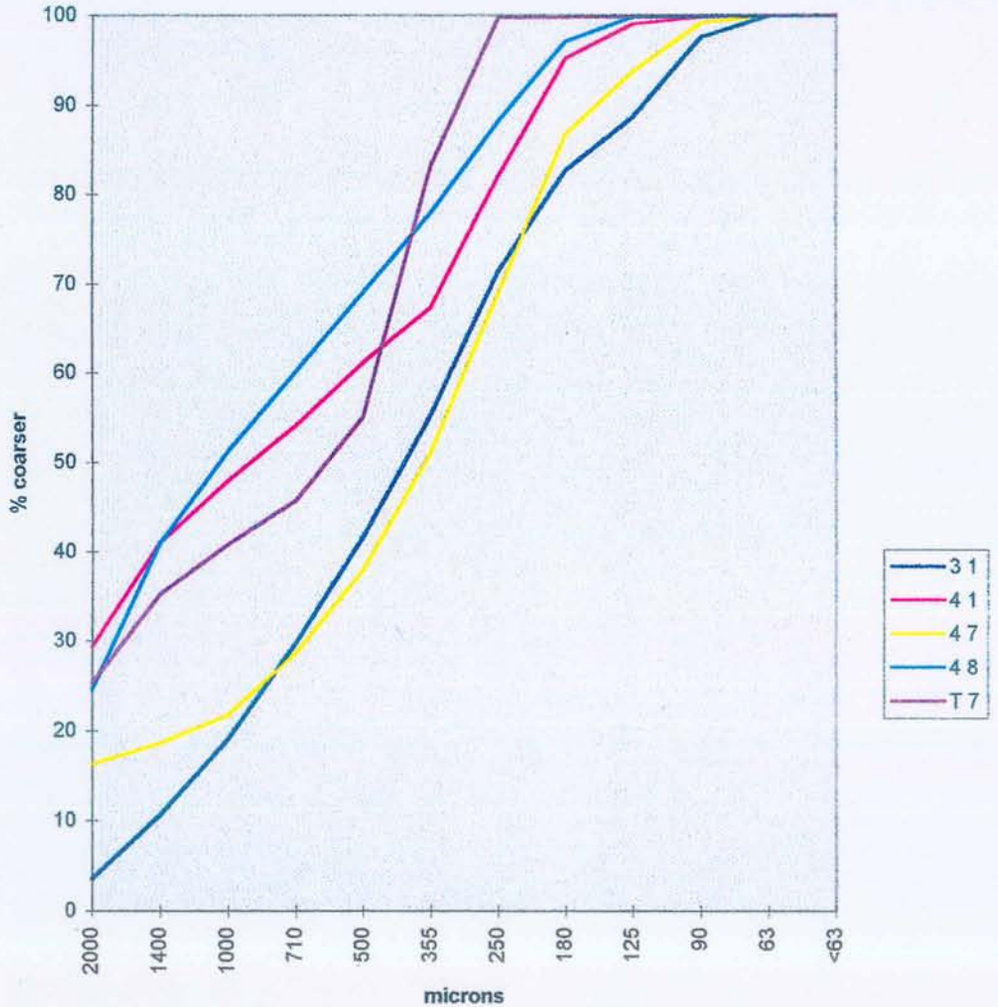
GRAVELS with MEDIUM SAND

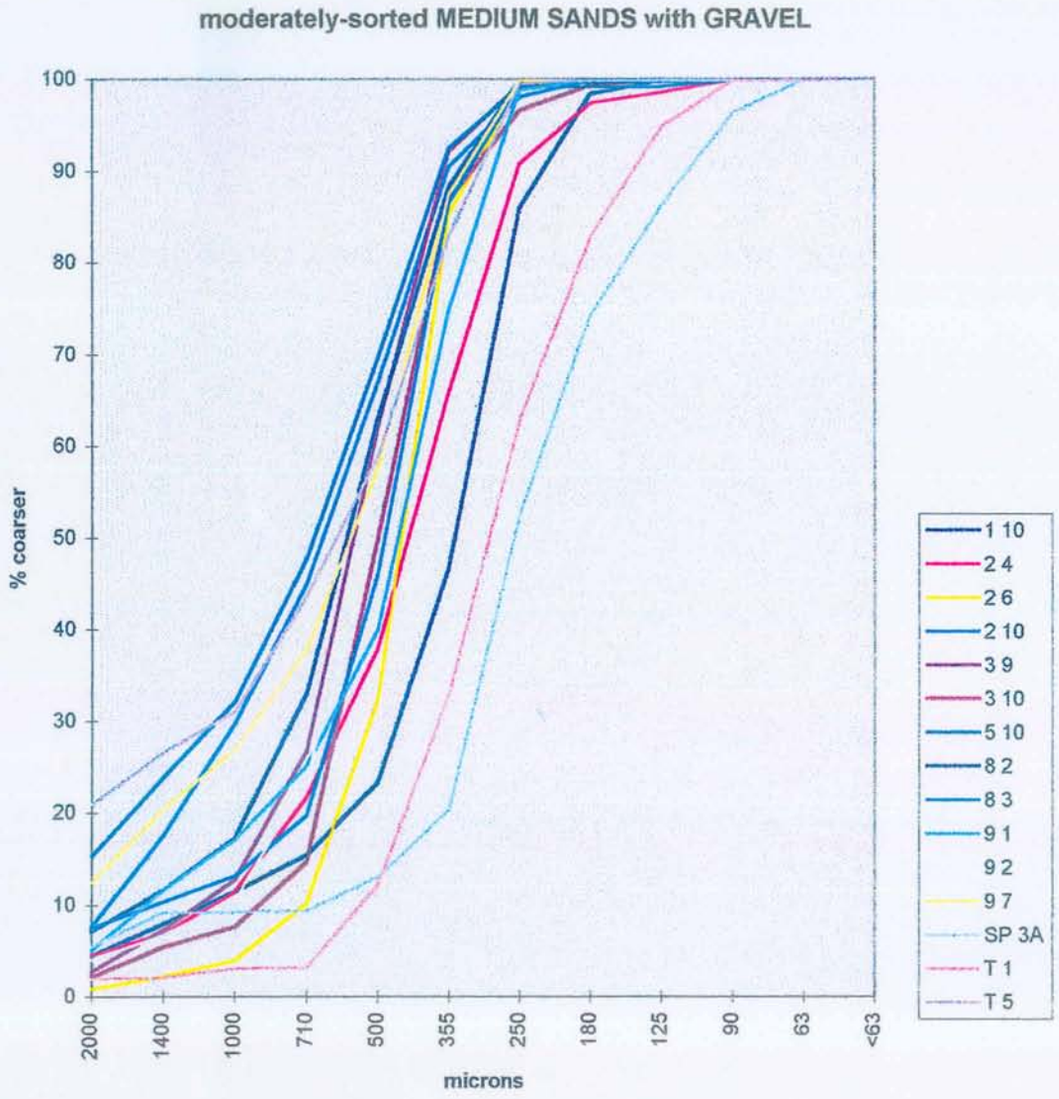


COARSE SANDS and GRAVELS



poorly-sorted MEDIUM SANDS with GRAVEL




moderately-sorted MEDIUM SANDS with GRAVEL
% coarser
100
90
80
70
60
50
40
30
20
10
0
2000
1400
1000
710
500
355
250
180
125
90
63
<63
microns
1 10
2 4
2 6
2 10
3 9
3 10
5 10
8 2
8 3
9 1
9 2
9 7
SP 3A
T 1
T 5

MEDIUM SANDS

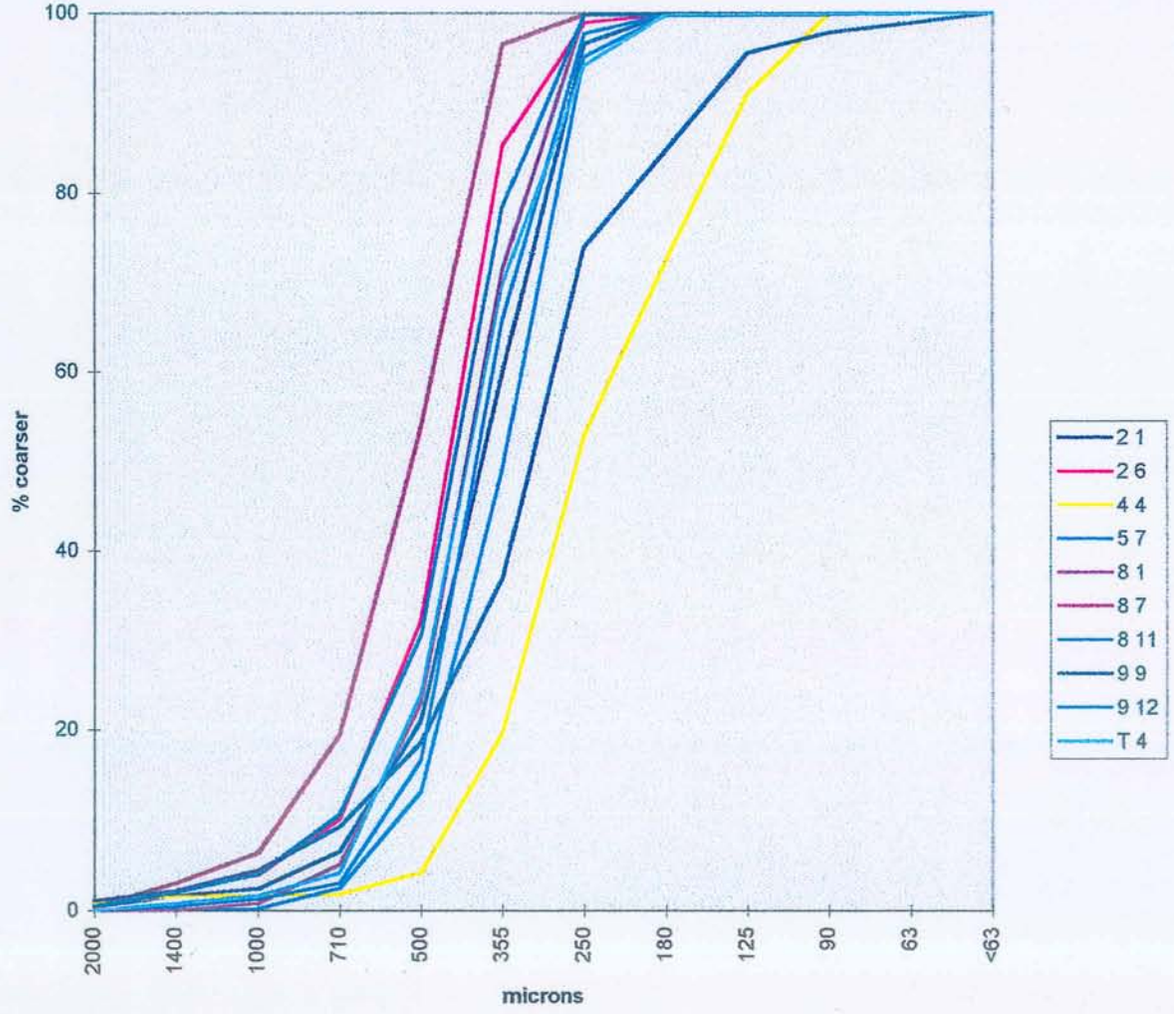


Table 2. Particle size analysis

SITE	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3
SAMPLE NO	2	4	5	6	7	8	9	10	1	2	3	4	6	9	10	1	3	4	5	6	7
PERCENTAGES																					
2000	70	45	60	0	19	0	41	4	0	0	2	5	1	17	8	4	0	99	57	32	69
1400	5	23	10	0	3	0	8	3	1	0	0	2	1	11	10	7	0	0	4	9	8
1000	3	14	6	0	2	0	4	3	1	0	0	5	2	6	12	8	0	0	2	6	4
710	4	11	7	0	2	0	4	4	4	0	0	10	6	7	15	11	0	0	2	6	4
500	6	5	10	0	3	1	4	8	14	0	2	16	22	7	22	12	1	0	5	13	4
355	7	2	4	0	6	1	11	23	39	8	6	28	53	7	23	14	7	0	10	19	3
250	4	0	2	3	14	4	15	39	37	10	20	25	14	9	8	16	37	0	16	10	1
180	1	0	0	10	15	13	4	12	3	6	23	7	1	8	2	11	39	0	2	1	3
125	1	0	0	46	15	34	3	1	0	15	29	1	0	9	0	6	13	0	0	1	2
90	0	0	1	35	17	40	4	0	0	37	17	1	0	13	0	9	4	0	0	3	0
63	0	0	0	3	2	4	1	0	0	14	0	0	0	3	0	2	0	0	0	0	0
<63	0	0	0	2	0	2	0	0	0	9	0	0	0	2	0	0	0	0	0	0	0
CUMULATIVE % COARSER																					
2000	70	45	60	0	19	0	41	4	0	0	2	5	1	17	8	4	0	99	57	32	69
1400	75	68	70	0	22	0	49	8	2	0	2	7	2	28	18	11	0	99	61	40	78
1000	78	82	76	0	25	0	53	11	2	0	2	11	4	35	30	19	0	99	63	46	82
710	81	93	83	0	27	0	57	15	7	0	2	22	10	42	45	30	0	99	66	52	86
500	88	98	93	0	31	1	61	23	21	0	5	38	32	49	67	42	1	99	71	65	90
355	95	100	97	0	37	2	72	47	60	9	10	66	85	56	90	55	8	100	81	84	93
250	99	100	99	3	51	6	87	86	97	18	30	91	99	65	98	71	44	100	97	94	94
180	99	100	99	13	66	19	91	98	100	25	53	97	100	72	100	83	83	100	99	96	97
125	100	100	99	60	81	54	94	100	100	40	83	99	100	82	100	89	96	100	100	96	99
90	100	100	100	94	97	94	99	100	100	77	100	100	100	95	100	98	100	100	100	100	100
63	100	100	100	98	100	98	100	100	100	91	100	100	100	98	100	100	100	100	100	100	100
<63	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table 2. Particle size analysis

SITE	3	3	4	4	4	4	4	4	4	4	5	5	6	7	7	8	8	8	8	8	8
SAMPLE NO	9	10	1	2	3	4	5	6	7	8	7	10	4	2	8	1	2	3	7	9	11
PERCENTAGES																					
2000	3	2	29	14	22	1	87	0	16	25	0	15	91	7	30	0	7	8	0	51	1
1400	5	3	12	6	22	1	3	0	2	16	0	9	1	12	33	0	5	3	3	9	2
1000	5	2	7	4	18	0	2	0	3	10	0	8	0	17	18	1	6	3	3	8	2
710	14	7	6	5	17	0	2	0	7	9	2	16	0	26	9	4	16	7	13	12	7
500	35	35	7	6	18	2	3	2	9	9	11	22	0	22	3	18	30	26	34	10	20
355	30	37	6	6	3	15	2	9	13	9	36	23	4	14	4	46	25	40	43	8	46
250	7	10	13	8	0	33	1	13	18	10	46	7	3	2	2	28	12	13	3	3	21
180	0	3	15	13	0	19	0	25	18	9	5	0	0	0	0	0	0	0	0	0	0
125	0	1	4	16	0	19	0	36	7	3	0	0	0	0	0	0	0	0	0	0	0
90	0	0	1	18	0	9	0	14	5	0	0	1	0	0	1	0	0	0	0	0	0
63	0	0	0	4	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
<63	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CUMULATIVE																					
% COARSER																					
2000	3	2	29	14	22	1	87	0	16	25	0	15	91	7	30	0	7	8	0	51	1
1400	7	5	41	19	43	2	90	0	19	41	0	24	92	18	63	0	12	10	3	60	2
1000	13	8	48	24	62	2	91	0	22	51	0	32	92	36	81	1	17	13	6	67	4
710	27	15	54	29	79	2	94	0	29	60	3	48	92	62	91	5	33	20	19	79	11
500	62	50	61	34	96	4	96	2	38	69	13	70	93	84	93	23	63	46	54	89	31
355	92	87	67	40	100	20	98	11	51	78	49	92	97	98	98	71	88	86	96	97	78
250	99	97	80	48	100	53	100	24	69	88	95	99	100	100	99	100	100	100	100	100	100
180	100	99	95	61	100	72	100	50	87	97	100	99	100	100	99	100	100	100	100	100	100
125	100	100	99	77	100	91	100	86	94	100	100	99	100	100	99	100	100	100	100	100	100
90	100	100	100	94	100	100	100	100	99	100	100	100	100	100	100	100	100	100	100	100	100
63	100	100	100	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
<63	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table 2. Particle size analysis

SITE	9	9	9	9	9	9	SP	T	T	T	T						
SAMPLE NO	1	2	3	7	9	12	3A	1	4	5	7						
PERCENTAGES																	
2000	5	4	39	12	1	0	5	2	0	21	25						
1400	7	3	17	8	1	0	4	0	1	6	10						
1000	5	4	10	6	2	1	0	1	1	4	6						
710	8	13	8	11	5	2	0	0	2	13	5						
500	15	30	6	20	9	14	4	9	20	15	9						
355	35	34	6	30	18	49	7	21	46	24	28						
250	24	12	5	12	37	32	32	30	24	17	17						
180	1	0	4	0	11	2	22	20	6	0	0						
125	0	0	2	0	11	0	12	12	0	0	0						
90	0	0	3	0	2	0	10	5	0	0	0						
63	0	0	0	0	1	0	4	0	0	0	0						
<63	0	0	0	0	1	0	0	0	0	0	0						
CUMULATIVE																	
% COARSER																	
2000	5	4	39	12	1	0	5	2	0	21	25						
1400	12	7	56	20	2	0	9	2	1	27	35						
1000	17	10	66	27	4	1	9	3	2	31	41						
710	25	24	74	38	9	3	9	3	4	44	46						
500	40	53	79	58	19	17	13	12	24	59	55						
355	75	87	86	87	37	66	20	33	70	83	83						
250	99	100	90	100	74	98	52	63	94	99	100						
180	100	100	94	100	85	100	74	83	100	100	100						
125	100	100	97	100	96	100	86	95	100	100	100						
90	100	100	100	100	98	100	96	100	100	100	100						
63	100	100	100	100	99	100	100	100	100	100	100						
<63	100	100	100	100	100	100	100	100	100	100	100						

Table 3. Grab and video stations: RoxAnn values and sediment data.

SITE		N	E	E2	E1	E3	DEPTH	E2md	E1md	DEPTHmd	sed	% gravel	mode um
1	1	15487	95761	0.9	0.46	1.46	51	0.036	0.022	1.494	m		
1	2	14825	94647	0.46	0.54	1.44	3	0.035	0.02	0.559	m	70	355
1	3	14929	95398	0.37	0.47	0.90	20	0.009	0.007	0.56	r		
1	4	15890	95187	0.31	0.31	0.65	31	0.003	0.006	0.314	s	45	nil
1	5	16213	95850	1.1	0.69	1.72	66	0.047	0.059	2.224	s	60	500
1	6	12866	93414	0.22	0.19	0.18	19	0.002	0.001	0.304	s	0	125
1	7	14134	93180	0.36	0.68	1.02	5	0.002	0.019	0.089	s	19	125
1	8	12275	93596	0.34	0.22	0.30	32	0.003	0.001	0.479	s	0	90
1	9	12506	94598	0.45	0.33	0.85	44	0.003	0.011	0.258	s	41	250
1	10	14917	93608	0.27	0.34	0.48	3	0.003	0.003	0.071	s	4	250
2	1	18041	90712	0.84	0.57	1.66	54	0.041	0.051	2.352	m	0	355
2	2	17652	90790	0.39	0.25	0.48	40	0.002	0.004	0.357	s	0	90
2	3	17747	93205	0.78	0.42	1.41	47	0.024	0.027	1.26	s	2	125
2	4	16707	93204	0.24	0.22	0.70	23	0.005	0.005	0.268	s	5	355
2	5	16500	93213	0.23	0.42	0.81	17	0.01	0.003	0.144	m		
2	6	16301	92813	0.23	0.32	1.20	7	0.006	0.026	0.18	s	1	355
2	7	17367	91395	0.36	0.53	1.02	10	0.008	0.013	0.552	r		
2	8	15957	93859	0.36	0.53	1.08	7	0.002	0.022	0.274	m		
2	9	17260	93993	0.48	0.28	1.16	47	0.014	0.015	2.625	s	17	90
2	10	16716	93001	0.24	0.36	1.02	17	0.015	0.006	1.631	s	8	500
3	1	16215	90761	0.2	0.31	0.78	2	0.004	0.008	0.04	s	4	250
3	2	14246	91995	0.49	0.64	1.63	4	0.042	0.044	1.167	m		
3	3	13660	92002	0.28	0.2	0.70	10	0.007	0.003	0.198	s	0	180
3	4	13295	90989	0.45	0.54	0.78	6	0.004	0.008	0.157	s	99	0
3	5	13295	91192	0.43	0.44	0.88	6	0.007	0.008	0.142	s	57	250
3	6	14613	91208	0.38	0.39	0.93	5	0.01	0.007	0.076	s	32	355
3	7	15727	89784	0.39	0.55	1.16	6	0.018	0.011	0.306	m	69	nil
3	8	16620	88986	0.46	0.55	1.10	13	0.013	0.012	0.17	r		
3	9	15248	90986	0.36	0.44	0.85	4	0.005	0.009	0.096	s	3	500
3	10	15070	92406	0.28	0.31	0.74	3	0.003	0.008	0.058	s	2	355
4	1	14459	88418	0.38	0.33	1.10	3	0.014	0.011	0.05	s	29	180
4	2	14492	88110	0.22	0.33	0.74	2	0.004	0.007	0.066	s	14	90
4	3	13089	88993	0.34	0.46	0.65	5	0.005	0.004	0.131	s	22	nil
4	4	11939	89201	0.24	0.24	0.65	13	0.008	0.001	0.109	s	1	250
4	5	12156	90406	0.48	0.57	1.00	10	0.007	0.013	0.083	m	87	nil
4	6	12197	89604	0.34	0.5	1.06	8	0.015	0.008	0.149	s	0	125
4	7	12902	88061	0.27	0.31	0.78	2	0.004	0.008	0.058	s	16	250
4	8	11248	89793	0.36	0.46	0.93	11	0.005	0.012	0.05	s	25	250
4	9	11912	88399	0.41	0.48	0.98	13	0.005	0.014	0.101	m		
5	1	17096	88393	0.32	0.56	1.00	24	0.006	0.014	0.372	r		
5	2	17096	88393	0.44	0.57	1.15	9	0.018	0.01	0.233	r		
5	3	17142	88602	0.29	0.77	1.40	15	0.012	0.038	1.372	r		
5	4	15990	87012	0.64	0.58	1.44	34	0.035	0.02	0.818	r		
5	5	15184	87033	0.47	0.56	1.43	9	0.036	0.018	0.243			
5	6	14364	87064	0.3	0.54	1.30	6	0.008	0.032	0.329	r		
5	7	14698	86200	0.57	0.43	1.51	31	0.035	0.03	0.375	s	0	250
5	8	14623	85607	0.45	0.42	0.60	40	0.003	0.005	0.094	s		
5	9	16126	86604	0.69	0.45	1.33	49	0.025	0.018	0.623	r		
5	10	16789	87548	1.64	1.19	1.89	55	0.079	0.077	3.352	s	15	500

Table 3. Grab and video stations: RoxAnn values and sediment data.

SITE		N	E	E2	E1	E3	DEPTH	E2md	E1md	DEPTHmd	sed	% gravel	mode um
6	1	13080	86399	0.35	0.46	0.78	9	0.004	0.008	0.431	m		
6	2	12732	86795	0.35	0.55	1.53	6	0.01	0.057	0.517	r		
6	3	11739	86826	0.42	0.52	1.00	12	0.01	0.01	0.182			
6	4	13243	86809	0.44	0.52	0.93	10	0.006	0.011	0.058	m	91	355
6	5	12189	85202	0.28	0.45	0.65	28	0.003	0.006	0.26	r		
6	6	12200	85004	0.27	0.47	1.10	24	0.018	0.007	0.468	r		
6	7	13520	84796	0.36	0.53	1.11	33	0.015	0.011	0.57	r		
6	8	11894	84804	0.91	0.64	1.36	41	0.036	0.01	0.202	r		
6	9	12729	87398	0.51	0.54	1.43	4	0.032	0.022	1.026	r		
6	10	11204	87401	0.41	0.45	0.93	19	0.012	0.005	0.291	r		
7	1	8159	81872	0.45	0.34	0.70	45	0.003	0.007	0.347	m		
7	2	6803	81791	0.42	0.24	0.40	39	0.002	0.003	0.261	s	7	710
7	3	9286	83912	0.36	0.34	0.65	32	0.005	0.004	0.21	m		
7	4	10655	82391	0.36	0.51	1.06	21	0.014	0.009	0.498	r		
7	5	10170	83196	1.3	0.84	1.41	30	0.036	0.016	0.63	r		
7	6	8637	83084	0.41	0.48	1.02	33	0.011	0.01	0.369	r		
7	7	10513	84023	0.28	0.43	0.65	27	0.004	0.005	0.453	r		
7	8	11418	84065	0.49	0.29	0.78	50	0.008	0.004	0.851	s	30	nil
7	9	12808	83746	0.52	0.35	0.81	54	0.005	0.008	0.851	r		
8	1	9718	88198	0.28	0.26	0.60	13	0.003	0.005	0.098	s	0	355
8	2	9414	88809	0.34	0.35	1.06	16	0.018	0.005	0.05	s	7	500
8	3	7303	87007	0.32	0.21	0.85	30	0.01	0.004	0.464	s	8	355
8	4	9829	86400	0.23	0.43	0.65	19	0.003	0.006	0.213	r		
8	5	10077	85604	0.23	0.34	0.60	26	0.004	0.004	0.598	r		
8	6	10208	87592	0.32	0.51	0.85	20	0.006	0.008	0.117	s		
8	7	6419	85190	0.28	0.37	0.81	22	0.003	0.01	0.55	m	0	355
8	8	8402	85422	0.35	0.93	1.42	9	0.008	0.045	0.696			
8	9	6143	87006	1.09	0.73	1.90	63	0.074	0.084	1.155	s	51	710
8	10	9558	87212	0.34	0.6	1.28	13	0.014	0.024	0.838	r		
8	11	10995	88807	0.29	0.25	0.93	18	0.01	0.007	0.096	s	1	355
9	1	8679	91182	0.45	0.27	0.54	53	0.004	0.003	0.506	s	5	355
9	2	8747	90804	0.37	0.23	0.60	37	0.004	0.004	0.266	s	4	355
9	3	11188	93627	0.47	0.37	0.54	52	0.004	0.003	0.142	s	39	nil
9	4	9666	89410	0.39	0.54	0.85	15	0.006	0.008	0.19	m		
9	5	9505	89411	0.27	0.48	0.95	15	0.011	0.007	0.555	m		
9	6	9015	89393	0.33	0.45	0.95	14	0.012	0.006	0.264	r		
9	7	9097	89819	0.34	0.37	0.81	23	0.006	0.007	0.134	s	12	500
9	8	7981	88695	0.36	0.49	0.78	8	0.009	0.003	0.536	r		
9	9	7700	88938	0.27	0.29	0.54	27	0.001	0.006	0.385	s	1	355
9	10	7143	87813	0.36	0.72	1.37	12	0.019	0.028	1.026	r		
9	11	9716	91601	0.34	0.53	0.98	14	0.009	0.01	0.737	r		
9	12	9947	90348	0.17	0.27	0.65	9	0.003	0.006	0.326	s	0	500
0	0	6000	81600	0	0		75	0.1	0.1	5			
										r=rock/boulder/cobble			
										s=sediment			
										m=mixed sediment/hard ground			

Table 4. Grab and video stations: video descriptions and biotope codes.

AREA	STATION	VIDEO, GRAB	DATE SURVEY	TIME SURVEY	EASTING	NORTHING	DEPTH (m, sea level)	SUBSTRATE TYPE (VIDEO)	SEDIMENT (SAMPLE) TYPE	VIDEO DESCRIPTION	BIOTOPE CODE
1	1	V only	22/10/97	16:12	95761	15487	52	Cobbles, bedrock,		Plain of rough cobbles; low bedrock outcrops w. dense hydroid/bryozoan turf (mainly Crisia sp.?) Nemertesia Antennina, Axinella dissimilis, Homaxinella subdola	MCR.ByH
1	2	V+G	22/10/97	12:02	94647	14825	3.5	Stones, gravel, boulders	Poorly sorted sand & gravel	Stones and gravel; occasional small boulders. Sparse red and green algae, sparse L. digitata, L. saccharina, Chorda.	MIR.EphR
1	3	V only	22/10/97	16:29 & 16: 41	95398	14929	20.3	Bedrock ridges		Bedrock ridges with fairly sparse foliose algae, Kelp (R), Alcyonium digitatum (R-O), Echinus (O). Bedrock ridges w. foliose red algae, sand patches.	EIR. ?/ EIR.KFoR.Dic?
1	4	V+G	22/10/97	15:53	95187	15890	30.4	Silty shell gravel	Coarse sand & gravel	Level plain of silty, coarse shell gravel.	CGS.
1	5	G only	22/10/97	15:40	95850	16213	65.6		Medium coarse sand & gravel		CGS.
1	6	V+G	19/10/97	17:55	93414	12866	19.7	Sand	Fine & v fine sand	Rippled sand with drift algae and Zostera.	IGS / CGS
1	7	V+G	22/10/97	11:08	93180	14134	4.9	Sand, stones	Fine sand w gravel	Sand with stones. Dense Zostera, Fucoids	IMS.Zmar
1	8	V+G	19/10/97	17:40	93596	12275	31.9	Sand	Fine & v fine sand	Rippled sand with drift algae and Zostera.	CGS
1	9	V+G	19/10/97	18:05	94598	12506	43.9	Sand, shell, small stones	Poorly sorted sand & gravel	Compact, level sand with shells/ small stones; drift Zostera.	CGS
1	10	V+G	22/10/97	11:47	93608	14917	3.4	Sand	Medium & fine sand	Wave rippled sand	LGS. / IGS.

Table 4. Grab and video stations: video descriptions and biotope codes.

AREA	STATION	VIDEO, GRAB	DATE SURVEY	TIME SURVEY	EASTING	NORTHING	DEPTH (m, sea level)	SUBSTRATE TYPE (VIDEO)	SEDIMENT (SAMPLE) TYPE	VIDEO DESCRIPTION	BIOTOPE CODE
1	11	V+G	22/10/97	16:55	94210	14560	2.1	Sand, cobbles, stones		V. silty, steep bedrock. Abundant Axinellid sponges (Raspailiia/Stelligera spp., Axinella dissimilis, A. infundibuliformis) Alcyonium digitatum, A. glomeratum., Pentapora. Edge of area-coarse sand.	IMS.Zmar
2	1	V+G	22/10/97	114:14 & 4:24	90712	18041	53	Silty bedrock / coarse sand	Mixed sediment	Plain of featureless fine (silty?) sand.	MCR.PhaAxi / CGS
2	2	V+G	20/10/97	15:16	90790	17652	40.5	Sand	s	Rippled sand, shells.	CGS.
2	3	V+G	22/10/97	14:48	93205	17747	43.1	Sand	s	Sand with megaripples	CGS.
2	4	V+G	22/10/97	12:42	93204	16707	22.9	Sand	s	Boulders and bedrock, sand plain nearby. Kelp park (L. hyperborea), some Halidrys, sparse foliose red algae; few Echinus.	CGS.
2	5	V+G	22/10/97	12:58	93213	16500	17.2	Boulders, bedrock, sand	Mixed sediment	Rippled sand; drift algae.	MIR.LHyp.Pk
2	6	V+G	22/10/97	13:09	92813	16301	6.5	Sand	s	Sand with large boulders, Laminaria hyperborea park. Sparse foliose algae on boulders, Echinus (C).	IGS.
2	7	V only	20/10/97	15:38	91395	17367	10	Sand, boulders		Boulders and sand patches. Kelp park (L. hyperborea, l. ochroleuca?).	MIR.LHyp.Pk
2	8	V only	22/10/97	12:28	93859	15957	6.5	Sand, boulders		Level, silty, gravelly sand with shell fragmenst.	MIR.LHyp.Pk
2	9	V+G	22/10/97	15:09	93993	17260	49	Sand, gravel	s	Plain of sand with megaripples. Numerous stones in troughs. Sparse foliose algae.	CGS.

Table 4. Grab and video stations: video descriptions and biotope codes.

AREA	STATION	VIDEO, GRAB	DATE SURVEY	TIME SURVEY	EASTING	NORTHING	DEPTH (m, sea level)	SUBSTRATE TYPE (VIDEO)	SEDIMENT (SAMPLE) TYPE	VIDEO DESCRIPTION	BIOTOPE CODE
2	10	V+G	22/10/97	13:45	93001	16716	18.2	Sand	s	Level sand with shell frags	CGS. / MIR.Eph
3	1	V+G	22/10/97	08:50	90761	16215	1.7	Sand	s	Sand w boulders; kelp (L. digitata, L. saccharina) Chorda.	LGS.S
3	2	V only	22/10/97	10:41	91995	14246		Sand, boulders		Rippled sand; drift algae.	MIR.Kr / ELR.Him
3	3	V+G	22/10/97	10:53	92002	13660	9.3	Sand	s	Sand, stones, cobbles. Sparse kelp, foliose algae, Zostera.	IGS.
3	4	V+G	22/10/97	17:29	90989	13295	6	Sand, stones, cobbles	s	Sand and stones w. much foliose algae protruding through the sand.	MIR.SedK?/ IMS.Zmar
3	5	V+G	22/10/97	17:21	91192	13295	5.9	Sand, stones	s	Rippled sand with shell gravel. Large amounts of attached red algae (mostly Gracilaria verrucosa) protruding through sand. Lanice conchilega (O)	MIR.SedK?
3	6	V+G	22/10/97	09:20	91208	14613	4.4	Sand, gravel	s	Sheltered plain of sand, gravel and cobbles; few boulders. L. saccharina (O-C), Halidrys (P), Ulva/Enteromorpha (O-F)	
3	7	V+G	20/10/97	14:37	89784	15727	6.6	Sand, gravel, cobbles	Mixed sediment	Moderately exposed plain of bedrock and boulders with kelp park (mainly L. hyperborea); Halidrys. Some sand patches.	MIR.LsacChor / MIR.EphR / MIR.HalXK
3	8	V only	20/10/97	14:22	88986	16620	13.3	Bedrock, boulders		Level plain of sand, gravel, small stones. Sparse attached red and green algae. Occasional Laminaria saccharina, Chorda. Carcinus maenus (P)	MIR.Lhyp.Pk
3	9	V+G	22/10.97	09:06	90986	15248	3.8	Sand, gravel, small stones	s	Wave rippled clean sand; shell frags, drift algae	IMX. ? / IMX.LsacX

Table 4. Grab and video stations: video descriptions and biotope codes.

AREA	STATION	VIDEO, GRAB	DATE SURVEY	TIME SURVEY	EASTING	NORTHING	DEPTH (m, sea level)	SUBSTRATE TYPE (VIDEO)	SEDIMENT (SAMPLE) TYPE	VIDEO DESCRIPTION	BIOTOPE CODE
3	10	V+G	22/10/97	09:57	92406	15070	2.8	Sand	s	Level sand with small stones/shells. Small amount of attched filamentous algae.	LGS / IGS
4	1	V+G	20/10/97	09:55	88417.5	14459	2.8	Sand, small stones/ shells	s	Level sand with some attached algae on small stones/shells; occasional low, rounded boulders with fucoids.	LGS
4	2	V+G	20/10/97	09:38	88109.9	14492	2.1	Sand, small stones/ shells	s	Coarse , level sand, (stones/berock subsurface) some attached red and green algae, Sargassum muticum (P), Chorda (P).	LGS / SLR.FX
4	3	V+G	20/10/97	08:33	88992.9	13089	5.5	Sand (over rock)	s	Plain of slightly rippled sand, drift Zostera and algae.	LGS / SLR.FX
4	4	V+G	20/10/97	16:38	89201.4	11939	13.1	Sand	s	Tideswept gravel and sand. Small stones and few cobbles. Sparse red and green foliose algae and Zostera, sparse Laminaria saccharina and Laminaria sp., Halidrys; drift algae and Zostera.	IGS.
4	5	V+G	20/10/97	16:11	90406.3	12156	10	Gravel, sand, small stones, cobbles	Mixed sediment	Dense Zostera marina bed on clean sand.	IGS
4	6	V+G	20/10/97	16:25	89603.6	12197	7.9	Sand	s	Level, clean shell sand; shells with attached green algae, occasional large, rounded boulders with fucoids.	IMS.Zmar
4	7	V+G	20/10/97	09:03	88060.5	12902	2.3	Sand, boulders	s		LGS / SLR.FX
4	8	V+G	18/10/97	13:40	89793.3	11248	11.2		s	Cobbles and pebbles on sand (veneer over rock?). Coralline crusts and foliose red and green algae.	IGS.FaS
4	9	V only	20/10/97	17:07	88399	11912	12.8	Sand, cobbles, small stones (over rock?)		Exposed/moderately exposed site. Large, silt-covered boulders. Small Alcyonium digitatum (F-C), Caryophyllia (F+), Echinus (F-C).	MIR.EphR

Biotope codes.

AREA	STATION	VIDEO, GRAB	DATE SURVEY	TIME SURVEY	EASTING	NORTHING	DEPTH (m, sea level)	SUBSTRATE TYPE (VIDEO)	SEDIMENT (SAMPLE) TYPE	VIDEO DESCRIPTION	BIOTOPE CODE
5	1	V only	20/10/97	13:57	88393	17096	23.1	Large boulders		Large boulders, cobbles. Laminaria hyperborea park / forest.	MCR.GzFa
5	2	V only	20/10/97	13:37	88393	17096	9.1	Large boulders		Exposed/moderately exposed, lower infralittoral, grazed bedrock/large boulders with sparse foliose algae (Dictyopteris?, kelp sporelings) and coralline crusts. Echinus (F-C), rising v steeply. Sheer faces with silty hydroids/bryozoan turf (inc dense Tubularia, Cliona) and small Alcyonium digitatum (C). Rising to L. hyperborea forest.	MIR.Lhyp.Pk / MIR.Lhyp.Ft
5	3	V only	20/10/97	14:07	88602	17142	15.4	Bedrock, boulders		Plain of large boulders, small boulders and cobbles. Sand/silt covered, v. sparse epifauna (few Caryophyllia), Echinus (O). V. scoured/heavily grazed?	MIR.LhypGz.Pk? + IR.AlcByH + MIR.Lhyp.Ft
5	4	V only	20/10/97	12:48	87012	15990	33	Boulders, cobbles			MCR.ByH / MCR.GzFa ?
5	5	Not sampled			87033	15184				Moderately exposed. Large boulders, small boulders, cobbles. Mixed kelp forest (Mainly L. hyperborea, Saccorhiza polyschides)	
5	6	V only	20/10/97	11:16	87064	14364	6.5	Boulders, cobbles		Rippled, sand	EIR.LsacSac / MIR.
5	7	V+G	20/10/97	11:30	86200	14698	30.8	Sand	s	Plain of small boulders, cobbles, pebbles and gravel.	CGS
5	8	V+G	20/10/97	12:08	85607	14623	40	Small boulders, cobbles, pebbles, gravel.	s	Plain of large, silt-covered boulders. Sparse small Alcyonium digitatum, few Caryophyllia. Ascidia mentula (P), Echinus (P).	CMX.? / ECR.PomByC
5	9	V only	20/10/97	12:55	86604	16126	50.4	Large boulders		Rippled sand	MCR.ByH / MCR.GzFa ?

Table 4. Grab and video stations: video descriptions and biotope codes.

AREA	STATION	VIDEO, GRAB	DATE SURVEY	TIME SURVEY	EASTING	NORTHING	DEPTH (m, sea level)	SUBSTRATE TYPE (VIDEO)	SEDIMENT (SAMPLE) TYPE	VIDEO DESCRIPTION	BIOTOPE CODE
5	10	V+G	20/10/97	13:14	87548	16789	58.5	Sand	s	Exposed site. Sand with cobbles and small boulders. Kelp park, mainly Saccorhiza polyschides, some Desmarestia sp., red algae.	CGS
6	1	V only	20/10/97	10:56	86399	13080	9.2	Sand, cobbles, small boulders.		bedrock ridges. Laminaria hyperborea forest	MIR.Sac / MIR.EphR
6	2	V only	20/10/97	10:46	86795	12732	6.8	Bedrock ridges			EIR.Lhyp
6	3	Not sampled			86826	11739				Boulders, cobbles, pebbles, sand. Kelp park, mostly Laminaria hyperborea.	
6	4	V+G	20/10/97	10:30	86809	13243	10.4	Boulders, cobbles, pebbles, sand.	Mixed sediment	Boulder plane. Very low faunal turf (grazed? - scoured?), Alcyonium digitatum (R-O), Echinus (O-F).	EIR.LhypR.Pk / MIR.SEdK
6	5	V only	19/10/97	14:54	85202	12189	28.4	Boulders		Boulder plane; rising bedrock. Very low faunal turf (grazed?), Alcyonium digitatum (F-C), Echinus (O-F), Cliona (P).	ECR. Efa?
6	6	V only	19/10/97	14:46	85004	12200	24.8	Boulders		Large boulders, bedrock platforms and sloping faces. Very low faunal turf (heavily grazed?) Alcyonium digitatum (F-C), Echinus (O-F).	ECR.Alc / MCR.GaFa?
6	7	V only	19/10/97	14:31	84796	13520	31.8	Boulders, bedrock.		Boulder plane. Low faunal turf; Alcyonium digitatum (F-C), sponge/bryozoan crusts.	ECR.Alc / MCR.GzFa?
6	8	V only	19/10/97	15:08	84804	11894	41.3	Boulders.		Exposed boulders, bedrock outcrops, sand. Dense stands of Chorda; kelp on rock outcrops.	ECR.Alc
6	9	V only	20/10/97	10:20	87398	12729	5.4	Boulders, bedrock, sand.		Boulders, cobbles and bedrock. Laminaria hyperborea park; dense red algal understorey.	ELR.Him / MIR.Ldig

Table 4. Grab and video stations: video descriptions and biotope codes.

AREA	STATION	VIDEO, GRAB	DATE SURVEY	TIME SURVEY	EASTING	NORTHING	DEPTH (m, sea level)	SUBSTRATE TYPE (VIDEO)	SEDIMENT (SAMPLE) TYPE	VIDEO DESCRIPTION	BIOTOPE CODE
6	10	V only	20/10/97	17:26	87401	11204	19.1	Boulders, cobbles, bedrock.		Numerous small boulders, cobbles (& bedrock?) protruding through layer of sand. Sparse, small , Alcyonium digitatum (C) and Polymastia boletiformis colonies (F) on cobbles.	EIR.LhypR.Pk / MIR.Lhyp.Pk
7	1	V+G	19/10/97	11:57	81872	8159	44.9	Small boulders, cobbles, sand, cobbles,(rock below?)	Mixed sediment	Slightly rippled & megarippled clean shell sand.	CGS / CMX or ECR.Alc / MCR.ErSPbolSH (poor)
7	2	V+G	19/10/97	11:40	81791	6803	39	Sand	s	Low bedrock outcrops and sand patches; bedrock with thin veneer of sand. Low faunal turf, Pentapora foliacea (O) Polymastia boletiformis (O), Alcyonium digitatum (O); Ciocalypta penicillus (P).	CGS
7	3	V only	19/10/97	12:44	83912	9286	31.4	Low bedrock, sand		Bedrock; ridges, wide gullies, steep faces and wide plateaus. Follose red algae and kelp sporelings; Echinus. Grazed.	MCR.ByH / MCR.Xfa
7	4	V only	19/10/97	13:18	82391	10655	21.7	Bedrock ridges		Boulder and cobble plain. Low faunal turf and encrusting spp.; Alcyonium digitatum (O-F), Pentapora (O), Echinus (O-F).	EIR.FoR
7	5	V only	19/10/97	13:00	83196	10170	30.2	Boulder and cobble plain.		Low bedrock outcrops, boulders and cobbles with patchy sand pockets. Alcyonium digitatum (C), esp on raised bedrock; occasional Pentapora foliacea, low faunal turf covering, Echinus, Holothuria.	ECR.Alc / MCR.ByH
7	6	V only	19/10/97	12:28	83084	8637	33.3	Low bedrock outcrops, boulders, cobbles, patchy sand.		Low bedrock, boulders and cobbles. Low faunal turf; Alcyonium digitatum (F-C), A. glomeratum? (P), Cliona celata (O), Echinus (O).	ECR.Alc / MCR.ByH
7	7	V only	19/10/97	14:13	84023	10513	26.2	Low bedrock, boulders and cobbles.		Very coarse, megarippled, shell sand.	ECR.AlcMaS
7	8	V+G	19/10/97	13:55	84065	11418	48.7	V. coarse sand	s	Low bedrock and boulders, sand patches. Low faunal turf; Alcyonium digitatum (C), Polymastia boletiformis (O), Cliona celata (P).	CGS
7	9	V only	19/10/97	13:39	83746	12808	54.7	Low bedrock and boulders, sand patches.		Rippled sand	ECR.Alc / MCR.ErSPbolSH

Table 4. Grab and video stations: video descriptions and biotope codes.

AREA	STATION	VIDEO, GRAB	DATE SURVEY	TIME SURVEY	EASTING	NORTHING	DEPTH (m, sea level)	SUBSTRATE TYPE (VIDEO)	SEDIMENT (SAMPLE) TYPE	VIDEO DESCRIPTION	BIOTOPE CODE
8	1	V+G	22/10/97	18:25	88198	9718	12.9	Sand	s	Rippled sand	IGS.
8	2	V+G	22/10/97	18:34	88809	9414	15.8	Sand	s	Sand	IGS.
8	3	V+G	19/10/97	09:52	87007	7303	29.7	Sand	s	Exposed low-relief, bedrock, boulders and cobbles. Foliose red lagae, kelp sporelings, Dictyopteris membranacea, coralline crusts. Echinus (O-F).	CGS
8	4	V only	19/10/97	15:51	86400	9829	18.8	low-relief, bedrock, boulders and cobbles.	Rock	Exposed boulders and bedrock. Low faunal turf and coralline crusts; Alcyonium digitatum (O-F) on faces of raised bedrock; Echinus ((O-F), Holothuria (P), Pachymatisma johnstonia (P). Dictyopteris membranacea (F-C) on upper surfaces.	EIR.For
8	5	V only	19/10/97	15:35	85604	10077	26	boulders and bedrock.		Sand plain, cobbles below. Considerable foliose red algae protruding through sand.	ECR.Alc
8	6	V only	22/10/97	18:15	87592	10208	20	Sand plain, cobbles below.		Large, rounded boulders/ bedrock outcrops within plain of clean, med-coarse shell sand. Tubularia indivisa and foliose red algae on upper surfaces. Alcyonium digitatum on vertical faces of large rock outcrops.	MIR.SedK / MIR.PolAhn
8	7	V+G	19/10/97	10:51	85190	6419	22.7	Large, boulders/ bedrock outcrops within plain of sand.	Mixed sediment		IGS / CGS
8	8	Not sampled			85422	8402				Coarse shell sand, few encrusted stones and shells.	
8	9	G only	19/10/97	10:20	87006	6143	85.8	Sand, stones, shells.	s	Kelp forest (mainly L. hyperborea) on bedrock	CGS

Table 4. Grab and video stations: video descriptions and biotope codes.

AREA	STATION	VIDEO, GRAB	DATE SURVEY	TIME SURVEY	EASTING	NORTHING	DEPTH (m, sea level)	SUBSTRATE TYPE (VIDEO)	SEDIMENT (SAMPLE) TYPE	VIDEO DESCRIPTION	BIOTOPE CODE
8	10	V only	22/10/97	18:05	87212	9558	13.4	Bedrock		Level sand with fine tracks (crab / gasropod) across surface. Drift algae.	EIR.LHypFa
8	11	V+G	20/10/97	17.:52	88807	10995	17.6	Sand	s	Rippled, medium sand	IGS. / CGS.
9	1	V+G	19/10/97	16:37	91182	8679	53.4	Sand	s	Rippled, medium sand	CGS
9	2	V+G	19/10/97	16:18	90804	8747	36.9	Sand	s	Level plain of shell gravel. Much drift Zostera marina.	CGS
9	3	V+G	19/10/97	17:11	93627	11188	52.4	Shell gravel	s	Exposed, tideswept, coarse gravel plain with sparse boulders. Patchy Laminaria hyperborea cover, sparse foliose algae. Fauna: Echinus (P), Cereus pedunculatus (P).	CGS
9	4	V only	18/10/97	14:00	89410	9666	15.2	Coarse gravel plain with sparse boulders.		Tideswept plain of cobbles and small boulders supporting Laminaria hyperborea kelp park. Some L. ochroleuca. Coralline crusts, v sparse foliose understorey.	MIR.XKScrR - IGS.(FaG?)
9	5	V only	18/10/97	14:22	89411	9505	15.5	cobbles and small boulders		Tideswept plain of cobbles and small boulders with Laminaria hyperborea kelp park. Sparse foliose understorey. (Poor vis at time of svy so video not detailed)	MIR.LhypGzPk
9	6	V only	18/10/97	14:34	89393	9015	14.5	cobbles and small boulders		Clean (med?) sand over rock (boulders and cobbles?, not visible). V sparse red algae and occasional kelp plant protruding. Some Nemertesia antennina visible.	MIR.LhypGzPk
9	7	V+G	18/10/97	14:50	89819	9097	22.5	Sand over rock.	s	Tideswept large boulders supporting mixed kelp park. Sparse understorey; scoured (& grazed ?)	IGS.FaS Mob / MIR.XKScrR (poor)
9	8	V only	18/10/97	15:16	88695	7981	8.1	large boulders		Level, wave-rippled sand	MIR.GzK.Pk / MIR.XkScrR
9	9	V+G	18/10/1997; 19/10/97	15:24 (vid) 09:30 (grab)	88938	7700	26.8	Sand	s	Exposed, steeply rising (stepped) bedrock supporting Laminaria hyperborea kelp forest. (grazed understorey?)	IGS / CGS

Table 4. Grab and video stations: video descriptions and biotope codes.

AREA	STATION	VIDEO, GRAB	DATE SURVEY	TIME SURVEY	EASTING	NORTHING	DEPTH (m, sea level)	SUBSTRATE TYPE (VIDEO)	SEDIMENT (SAMPLE) TYPE	VIDEO DESCRIPTION	BIOTOPE CODE
9	10	V only	19/10/97	09:39	87813	7143	11.8	steeply rising (stepped) bedrock		Exposed boulders and steep bedrock. Kelp park (L. hyperborea/ochroleuca?), Halidrys siliquosa, Dictyopetris?, coralline crusts.	EIR.LhyperR.Ft
9	11	V only	19/10/97	16:54	91601	9716	14.1	Bedrock		Rippled sand, drift algae.	EIR.Kfar / MIR.Lhyp
9	12	V+G	22/10/97	17:50	90348	9947	22.5	Sand	s	Dense Zostera	IGS. / CGS.
Transe	1 North	V+G	22/10/97	09:33:00 - 09:42:00	91280	15290	5			Narrow band of dense Zostera; patch of bare sand; bands of dense Zostera / bare sand; sparses Zostera & more algae; patchy Zostera, Chorda; patches of dense Zostera / bare sand.	IGS. / IMS.Zmar
Transe	1 South	V+G	22/10/97	09:33:00 - 09:42:00	91470	15150	5			West to East. Sand with cobbles and occasional boulders. Dense algae on boulders. Occasional L. saccharina and L. hyperborea. West end: more boulders, kelp forest. (L. hyperborea).	IGS. / IMS.Zmar
Transe	2 West	V only	22/10/97	18:47	89910	11570	12			Dense Zostera	MIR.SedK > MIR.Lhyp.Ft
Transe	2 Mid	V only	22/10/97	18:47	90200	11530	12			Wave rippled clean sand; sand w stones and algae; large rock outcrop w. Himanthalia and kelp; clean sand, sand w. cobbles and small boulders, kelp and himanthalia; dense kelp and Chorda; sand w. patchy Zostera; sand w. boulders, kelp and Himanthalia.	
Transe	2 East	V only	22/10/97	18:47	90490	11480	12			Plain of wave rippled sand, then sand w. some gravel with attached algae, increasing gravel, small stones, attached algae and some Zostera; then to dense Zostera bed	
Transe	3 West	V only	22/10/97	11:23:- 11:27	92900	14170	6			East end: Gravel, stones, cobbles and boulders w. kelp park; > gradually more sand to extensive sand plain around midway. Then more stones, cobbles, boulders and kelp park (L. hyperborea, L. ochroleuca?) at West end.	IMS.Zmar
Transe	3 Mid	V only	22/10/97	11:23:- 11:27	93540	14180	6			Level sand, small stones, occasional small boulders. Attached red (inc. Gracilaria ?) and green algae, some Laminaria saccharina on boulders.	IMS.Zmar
Transe	3 East	V only	22/10/97	11:23:- 11:27	93200	14180	6				IMS.Zmar

Table 4. Grab and video stations: video descriptions and biotope codes.

AREA	STATION	VIDEO, GRAB	DATE SURVEY	TIME SURVEY	EASTING	NORTHING	DEPTH (m, sea level)	SUBSTRATE TYPE (VIDEO)	SEDIMENT (SAMPLE) TYPE	VIDEO DESCRIPTION	BIOTOPE CODE
Transe	4 North	V+G	22/10/97	10:08 -10:24	92200	14350	5				IGS. > ELR.Him/ MIR.KR > IMS.Zmar > ELR.Him/ MIR.KR
Transe	4 South	V+G	22/10/97	10:08 -10:24	92200	14090	5				IGS. > ELR.Him/ MIR.KR > IMS.Zmar > ELR.Him/ MIR.KR
Transe	5 North	V+G	20/10/97	16:47	89200	12420	10				IGS.
Transe	5 Mid	V+G	20/10/97	16:47	89200	12280	10				IGS.
Transe	5 South	V+G	20/10/97	16:47	89200	12120	10				IMS.Zmar
Transe	6 Northwest	V only	22/10/97	13:31 - 13:37	92660	16450	10				MIR.Lhyp.Pk
Transe	6 Mid	V only	22/10/97	13:31 - 13:37	92860	16400	10				IGS.
Transe	6 Southeast	V only	22/10/97	13:31 - 13:37	93080	16250	10				MIR.Lhyp.Pk
Transe	7 North	V+G	20/10/97	09:23	88180	13900	6				LGS / SLR.FX
Transe	7 South	V+G	20/10/97	09:23	88170	13700	6				LGS / SLR.FX

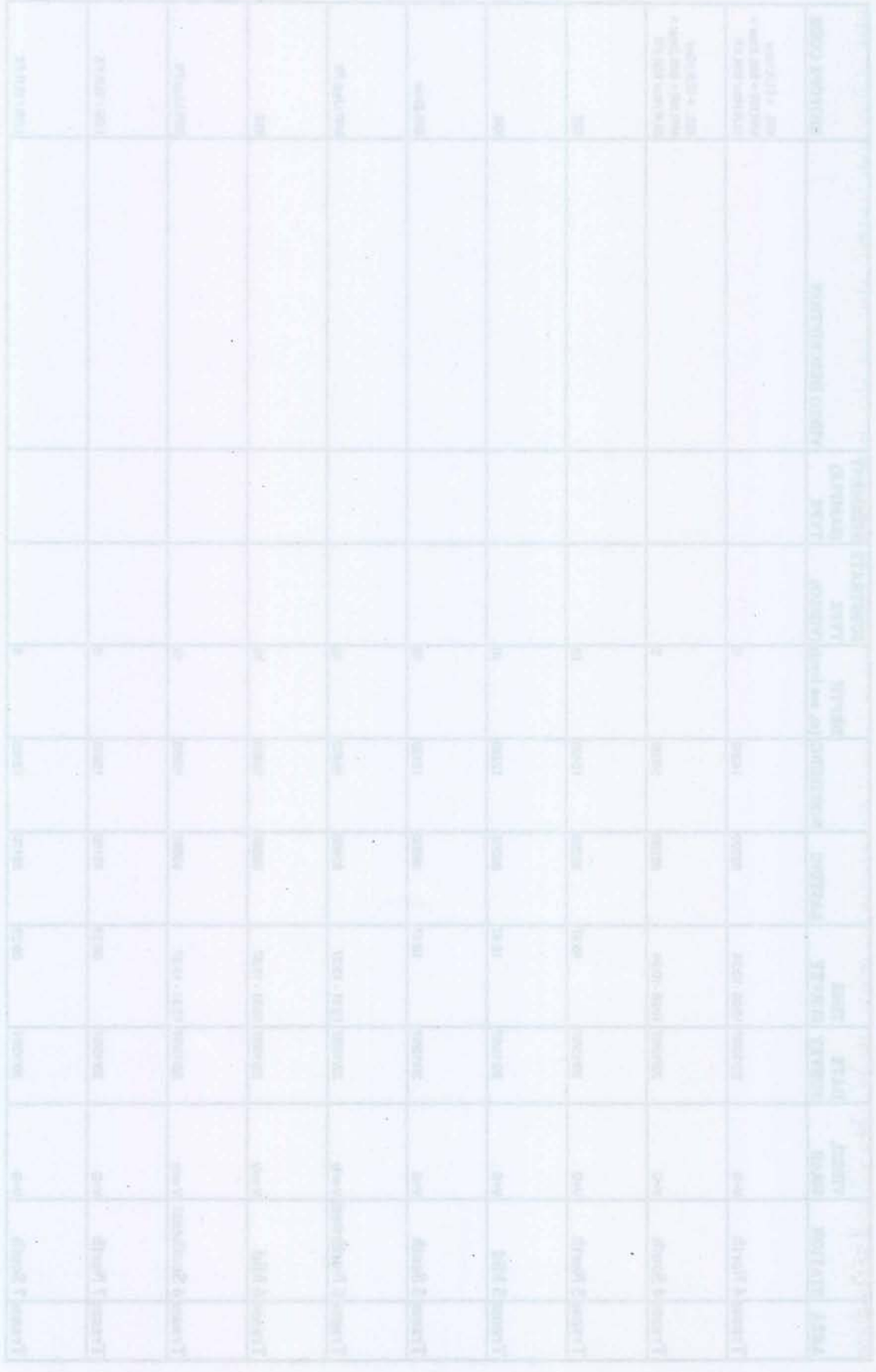


Table 5. Grab sample infauna data.

		1.2	1.4	1.5	1.6	1.7	1.8	1.9	1.10
PROTOZOA									
Astrorhiza limicola									
PORIFERA									
Scypha ciliata	C0035	1							
COELENTERATA									
Haliclystis auriculata	D0017					2			
Lucernariopsis campanulata	D0029								
Anthozoa indet	D1006	2		1	1	7			
Adamsia carciniopados	D1291								
NEMATODA									
Nematoda	E0001		15	4		13			1
PLATYHELMINTHES									
Platyhelminthe	F0001		1						
NEMERTEA									
Nemertea	G0001	1	1	2	2	3		7	2
Oerstedia dorsalis?	G0148								
SIPUNCULIDA									
Golfingia sp	N0007			1					
Phascolion strombus	N0028								
Aspidosihon muelleri	N0034								
POLYCHAETA									
Pisione remota	P0020								
Antinoella finmarchia	P0069			2					
Harmothoe indet (no scales etc)	P0097			3					
Harmothoe ljungmani	P0108	3	7						
Harmothoe lunulata	P0120								
Pholoe inornata	P0169								
Sthenelais boa	P0187				1				
Sthenelais limicola	P0189								
Phyllodocid indet	P0199								
Eteone foliosa	P0204								
Hesionura elongata	P0213								
Pseudomystides sp	P0228		2						
Pseudomystides limbata	P0230								
Phyllodoce mucosa	P0257	5				3			
Eulalia mustela	P0279								
Eumida sanguinea	P0285							9	
Eumida ockelmanni	P0286								
Glycera dayi/celtica	P0474								
Glycera gigantea	P0475								
Glycera lapidum	P0476	6	15	7				3	
Glycera tridactyla	P0481							1	
Goniada norvegica	P0493			2				1	
Goniadella sp	P0499		2						
Ephesiella sp	P0507								
Sphaerodoropsis ?minuta	P0521		1						
Sphaerodorum flavum	P0526					1			
Kefersteinia cirrata	P0552	4	4			2			
Nereimyra punctata	P0563			4					
Ophiodromus flexuosus	P0568								
Micropthalmus sp	P0594								
Syllis indet	P0636	1							
Ehlersia cornuta	P0648		1	1					
Trypanosyllis coeliaca	P0661								
Typosyllis vittata	P0674								
Eusyllis blomstrandi	P0686		1					3	
Odontosyllis gibba	P0700	2				1			
Streptosyllis ?websteri	P0720								2
Exogone hebes	P0744				1				
Exogone naidina	P0745								
Sphaerosyllis bulbosa	P0749		1						
Sphaerosyllis 'magnidentata'	P0750								
Sphaerosyllis thomasi	P0751			1					
Autolytus inermis	P0766								
Perinereis cultrifera	P0842								
Platynereis dumerilii	P0849	12				27			
Aglaophamus malmgremi	S0862								
Nephtys assimilis	P0869								
Nephtys cirrosa	P0870								
Nephtys kersivalensis	P0872					1	10	1	3
Nephtys ?longosetosa	P0875				10				
Onuphis conchylega	P0947		2						
Marphysa bellii	P0984								

Table 5. Grab sample infauna data.

		1.2	1.4	1.5	1.6	1.7	1.8	1.9	1.10
Lumbrineris (black aciculae)	P1007								
Lumbrineris gracilis	P1008		2	1	1		1	7	
Protodorvillei kefersteini	P1104	8	1	1					
Schistomeringos neglecta	P1114								
Scoloplos armiger	P1152								
Aricidea minuta	P1158								
Paradoneis lyra	P1185							1	
Apistobranchus tullbergi	P1210							1	
Aonides oxycephala	P1227	15		1		5		1	
Aonides paucibranchiata	P1228	1	4						
Laonice bahusiensis	P1250		1	3					
Malacoceros fuliginosus/tetra	P1257	3							
Malacoceros vulgaris	P1258								
Polydora sp	P1274	1							
Prionospio banyulensis	P1301		13	6	2	1	1	2	
Spio indet	P1302			1					
Pygospio elegans	P1317								
Scololepis gilchristi	P1321								
Spio filicornis	P1336								
Spio martinensis	P1337								
Spiophanes bombyx	P1343				2		2		
Magelona alleni	P1362						2		
Magelona filiformis	P1363				8		7	2	
Magelona mirabilis	P1364								
Magelona minuta	P1365								
Caulleriella alata	P1394	4							
Caulleriella bioculata	P1395		1						
Tharyx killariensis	P1397								
Chaetozone setosa (eyes)	P1403								
Cirratulus sp	P1407								
Aphelochaeta ?vivipera	P1427				16				
Cossura sp	P1464								
Macrochaeta sp	P1501		3						
Capitella	P1530	11							
Mediomastus fragilis	P1558		1	1				6	
Notomastus latericeus	P1563		3	1		3			
Arenicola marina	P1576								
Clymenura sp	P1623		1						
Leiochone sp	P1627								
Euclymene sp	P1628					2		1	
Ophelia limacina	P1692								
Ophelia ?neglecta	P1693								
Travesia forbesii	P1706								1
Polyopthalmus pictus	P1716					7			
Scalibregma celtica	P1742								
Scalibregma inflatum	P1743								
Polygordius sp	P1798	1	18	1					
Protodrilus sp	P1808								
Myriochele heeri	P1827				7	2			
Galathowenia oculata	P1828				11	10	2	1	
Owenia fusiformis	P1836		1	1		2		3	
Terebellidae indet	P1840								
Pectinaria auricoma	P1843								
Lagis koreni	P1854								
Sabellaria spinulosa	P1876								
Ampharete lindstroemi	P1910		1						
Terebellides stroemi	P1990								
Tricobranchus ?rosea	P1996			1					
Nicolea venustula	P2060			1					
Pista cristata	P2076	1	5						
Polycirrus norvegicus	P2125			1					
Branchiomma bombyx	P2162			2					
Chone duneri	P2169								
Chone fauveli	P2170		1						
Chone filicaudata	P2171								
Jasmineira caudata	P2204		1						
Pseudopotamilla reniformis	P2255			2					
Serpulid indet	P2285								
Hydroides norvegica	P2288		5	51				15	
Pomatoceros lamarcki	P2303			26					
Tubificoides benedii	P2487	15				6			
String oligochaete	P2488	2		1					
Oligochaeta	P2489								

Infauna data 2

Table 5. Grab sample infauna data.

		1.2	1.4	1.5	1.6	1.7	1.8	1.9	1.10
HIRUDINEA									
Hirudinea indet									
CRUSTACEA-PYCNOGONIDA									
Nymphon gracile	Q0006								
Achelia echinata	Q0017								
Endeis charybdaea	Q0038			1					
Endeis spinosa	Q0039								
CRUSTACEA									
Verruca stroemi	R0064		2	1					
Ostracod sp	R3518					3		1	
Nebalia bipes	S0006								
CRUSTACEA-AMPHIPODA									
Apherusa bispinosa	S0171					12			
Apherusa ?jurinei	S0175								
Monoculodes sp	S0219								
Perioculodes longimanus	S0228				8	3	1		
Pontocrates arenarius	S0234								
Synchelidium maculatum	S0240								
Amphilocus neapolitanus	S0281					1			
Leucothoe incisa	S0313								
Metopa sp	S0333								
Stenothoe ?monoculoides	S0371					3			
Urothoe brevicornis	S0428								
Urothoe elegans	S0429					1		5	
Urothoe marina	S0430								
Urothoe poseidonis	S0431								7
Harpinia antennaria	S0438				7	3	3		
Achidostoma obesum	S0467								
Metaphoxus fultoni	S0477		2						
Hippomedon denticulatus	S0494								
Lysianassa plumosa	S0511			2					
Orchomene humilis	S0538	4							
Socarnes erythropthalmus	S0556	3							
Panoplea minuta	S0628	1		1		2			
Atylus falcatus	S0681								
Atylus swammerdami	S0683					2			
Atylus vedlomensis	S0684								
Dexamine spinosa	S0690	5				15			
Guernea coalita	S0696								
Ampilesca tenuicornis	S0720					3		8	
Ampilesca typica	S0722								
Bathyporeia guilliamsoniana	S0743								
Bathyporeia pelagica	S0745								1
Bathyporeia pilosa	S0746								
Cheirocratus sundvalli	S0825			1		1			
Elasmopus rapax	S0830								
Gammarella fucicola	S0845	87				44			
Maera grossimana	S0850								
Maera othonis	S0853			3				1	
Melita gladiosa	S0863	12				4			
Melita hergensis	S0864	13							
Melita obtusata	S0865	2				25			
Ampithoe ramondi	S0879								
Ampithoe rubricata	S0880					27			
Pleonexes ?neglecta	S0884								
Sunamphithoe pelagica	S0891								
Gammaropsis maculata	S0898								
Microprotopus maculatus	S0918	1							
Photis longicaudata	S0923					3			
Protomedia fasciata	S0931	8							
Ischryoceridae indet	S0935								
Erichthonius ?punctatus	S0944					6			
Ischyrocerus anguipes	S0950					1			
Jassa sp	S0954								
Megaluropus agilis	S0970								
Aoriidae indet	S0972	1							
Aora typica	S0974								
Leptocheirus hirsutimanus	S0988								
Microdeutopus stationis	S1000					16			
Corophium ?crassicorne	S1023								
Corophium sextonae									
Podocerus variegatus	S1063	4							
CRUSTACEA-CAPRELLIDAE									

Table 5. Grab sample infauna data.

		1.2	1.4	1.5	1.6	1.7	1.8	1.9	1.10
Caprella acanthifera	S1072	2				2			
Phtisica marina	S1096			3		1			
CRUSTACEA-ISOPODA									
Eurydice pulchra	S1422		1						
Cymodoce truncata	S1437	8							
Janira maculosa	S1484	3							
Idotea baltica	S1560					2			
CRUSTACEA-TANAIDACEA									
Tanaiopsis graciloides	S1931								
Apseudes latreilli	S1977	23				2			
CRUSTACEA-CUMACEA									
Bodotria scorpoides	S2003								
Iphinoe trispinosa	S2015								
CRUSTACEA-DECAPODA									
Hippolyte varians	S2271	1							
Thoralus cranchii	S2293					4			
Pontophilus fasciatus	S2343					2			
Paguriidae indet	S2444	1		2				2	
Anapagurus hyndmani	S2447								
Pagurus carnea	S2466								
Pagurus prideaux	S2470								
Galathea intermedia	S2486	1							
Galathea squamifera	S2489								
Pisidia longicornis	S2502	2		2					
Ebalia tuberosa	S2543			1					
Ebalia tumefacta	S2544								
Macropodia deflexa	S2583								
Macropodia linaresi	S2584			1					
Eurynome aspersa	S2592			1					
Eurynome spinosa	S2593			1					
Atelecyclus rotundatus	S2626								
Pirimela denticulata	S2639	1				1			
Liocarcinus sp	S2666								
Liocarcinus arcuatus	S2667					1			
Liocarcinus marmoreus	S2671			1	1				
Carcinus maenas	S2690								
Xantho pilipes	S2746			1					
MOLLUSCA-POLYPLACOPHORA									
Leptochiton ascellus	W0055								
Lepidochiton cinereus	W0074	3				2			
Callochiton achatinus	W0082								
MOLLUSCA-PROSOBRANCHIA									
Tectura testudinalis	W0125								
Tectura virginea	W0126	1							
Helcion pellucidum	W0139	1							
Margarites helicinus?(broken)	W0161	1							
Gibbula cineraria	W0193					1			
Tricolia pullus	W0231	2							
Lacuna parva	W0240	1							
Rissoa parva	W0285								
Onoba semicostata	W0340								
Turritella communis	W0442				2		3		
Melanella alba	W0664								
Vitreolina sp (like devians)	W0684			1					
Lunatia alderi	W0774				1				
Lunatia montagui	W0775			1					
Hinia incrassata	W0887	1		1					
Hinia reticulata	W0889	2				1			
Mangelia attenuata	W0918								
MOLLUSCA-OPISTHOBRANCIA									
Opisthobranch indet	W0953								
Aplysia punctata	W1102								
Lomanotus marmoratus	W1252								
Doto pinnatifida	W1288								
MOLLUSCA-BIVALVIA									
Nucula nitidosa	W1618				1				
Modiolus sp	W1675			2					
Glycimeris glycimeris	W1717		3	1					
Limaria loscombi	W1741		1						
Myrtea spinifera	W1838								
Lucinoma borealis	W1842				1	1			
Tellimya ferruginosa	W1911								
Goodallia triangularis	W1953								

Table 5. Grab sample infauna data.

		1.2	1.4	1.5	1.6	1.7	1.8	1.9	1.10
Parvicardium ovale	W1977					1			
Parvicardium scabrum	W1978								
Cerastoderma edule	W1991								
Ensis sp(shell end)	W2022								
Phaxas pellucidus	W2032				2			1	
Tellina donacina	W2061								
Moerella pygmaea	W2063								
Gari costulata	W2089								
Gari tellinella	W2090		2						
Abra alba	W2102				1				
Abra nitida	W2104				1				
Circomphalus casina	W2151			1					
Gouldia minima	W2155			6					
Dosinia lupinus	W2164				1			2	
Chamelea gallina	W2189					1		1	
Clausinella fasciata	W2193								
Timoclea ovata	W2201	1	3	3		3			
Corbula gibba	W2239				1				
Hiatella arctica	W2251								
Thracia villosiuscula	W2353								
PHORONIDAE									
Phoronis muelleri	ZA0005					1	1		
ECHINODERMATA									
Asterias rubens (juv)	ZB0190								
Ophiothrix fragilis	ZB0235								
Ophiactis balli	ZB0268			1					
Amphiura chiajei	ZB0286				3				
Amphiura filiformis	ZB0288							1	
Amphipholis squamata	ZB0300	12		1		16	2		1
Ophiura albida	ZB0313			1		3			
Echinocyamus pusillus	ZB0388		21	7			1	1	
Spatangus purpureus	ZB0401								
Echinocardium flavescens	ZB0408								
Echinocardium (juvs)									
Leptosynapta ?inhaerens	ZB0526								
CHORDATA									
Branchiostomma lanceolatum	ZC0001		5						

Table 5. Grab sample infauna data.

	2.1	2.2	2.3	2.4	2.5	2.6	2.9	2.10
PROTOZOA								
Astrorhiza limicola								
PORIFERA								
Scypha ciliata								
COELENTERATA								
Haliclystis auriculata								
Lucernariopsis campanulata								
Anthozoa indet	1							
Adamsia carciniopados			1					
NEMATODA								
Nematoda					9	1		
PLATYHELMINTHES								
Platyhelminthe			1					
NEMERTEA								
Nemertea			2		2	1	1	2
Oerstedia dorsalis?								
SIPUNCULIDA								
Golfingia sp								
Phascolion strombus								
Aspidosihon muelleri								
POLYCHAETA								
Pisione remota					11			
Antinoella finmarchia								
Harmothoe indet (no scales etc)								
Harmothoe ljungmani					1			3
Harmothoe lunulata					1		1	1
Pholoe inornata							1	
Sthenelais boa	5							
Sthenelais limicola			2					
Phyllodocid indet								
Eteone foliosa								
Hesionura elongata								
Pseudomystides sp								
Pseudomystides limbata								2
Phyllodoce mucosa				1				
Eulalia mustela								
Eumida sanguinea								
Eumida ockelmanni								
Glycera dayi/celtica	7	1					1	1
Glycera gigantea							4	
Glycera lapidum					34		1	15
Glycera tridactyla				1			3	
Goniada norvegica							4	
Goniadella sp								
Ephesiella sp								
Sphaerodoropsis ?minuta								
Sphaerodorum flavum								
Kefersteinia cirrata					5			1
Nereimyra punctata								
Ophiodromus flexuosus		1						
Micropthalmus sp								
Syllis indet								
Ehlersia cornuta								
Trypanosyllis coeliaca								
Typosyllis vittata								
Eusyllis blomstrandi								
Odontosyllis gibba								
Streptosyllis ?websteri								
Exogone hebes								
Exogone naidina								
Sphaerosyllis bulbosa								
Sphaerosyllis 'magnidentata'								
Sphaerosyllis thomasi								
Autolytus inermis								
Perinereis cultrifera								
Platynereis dumerilii								
Aglaophamus malmgremi								
Nephtys assimilis								
Nephtys cirrosa								
Nephtys kersivalensis		19	8				1	
Nephtys ?longosetosa								
Onuphis conchylega								
Marphysa bellii								

Table 5. Grab sample infauna data.

	2.1	2.2	2.3	2.4	2.5	2.6	2.9	2.10
Lumbrineris (black aciculae)								
Lumbrineris gracilis							20	
Protodorvillei kefersteini				5	22			8
Schistomeringos neglecta								
Scoloplos armiger								
Aricidea minuta								
Paradoneis lyra								
Apistobranchus tullbergi							5	
Aonides oxycephala								
Aonides paucibranchiata					3	2		
Laonice bahusiensis								
Malacoceros fuliginosus/tetra				10				
Malacoceros vulgaris								
Polydora sp							1	
Prionospio banyulensis			1		18			2
Spio indet								
Pygospio elegans								
Scololepis gilchristi	1							
Spio filicornis								
Spio martinensis								
Spiophanes bombyx			1					
Magelona alleni		1					1	
Magelona filiformis			1					
Magelona mirabilis							1	
Magelona minuta								
Caulleriella alata			2					
Caulleriella bioculata					4	1		1
Tharyx killariensis								
Chaetozone setosa (eyes)								
Cirratulus sp								
Aphelochaeta ?vivipera			3				1	
Cossura sp								
Macrochaeta sp								
Capitella				122				
Mediomastus fragilis	5				25	1	22	12
Notomastus latericeus								1
Arenicola marina								
Clymenura sp								
Leiochone sp								
Euclymene sp			1				1	
Ophelia limacina								
Ophelia ?neglecta								
Travesia forbesii								
Polyopthalmus pictus								
Scalibregma celtica							2	
Scalibregma inflatum							3	
Polygordius sp								
Protodrilus sp								
Myriochele heeri			2					
Galathowenia oculata								
Owenia fusiformis	14						1	
Terebellidae indet								
Pectinaria auricoma							1	
Lagis koreni		1						
Sabellaria spinulosa								
Ampharete lindstroemi							1	
Terebellides stroemi								
Tricobranchus ?rosea								
Nicolea venustula								
Pista cristata					2			5
Polycirrus norvegicus								
Branchiomma bombyx								
Chone duneri								
Chone fauveli								
Chone filicaudata								
Jasmineira caudata								
Pseudopotamilla reniformis								
Serpulid indet								
Hydroides norvegica							7	
Pomatoceros lamarcki								
Tubificoides benedii				1				
String oligochaete								
Oligochaeta					1			1

Table 5. Grab sample infauna data.

	2.1	2.2	2.3	2.4	2.5	2.6	2.9	2.10
HIRUDINEA								
Hirudinea indet								
CRUSTACEA-PYCNOGONIDA								
Nymphon gracile								
Achelia echinata								
Endeis charybdaea								
Endeis spinosa								
CRUSTACEA								
Verruca stroemi								
Ostracod sp			1		1			
Nebalia bipes								
CRUSTACEA-AMPHIPODA								
Apherusa bispinosa								
Apherusa ?jurinei								
Monoculodes sp					1			
Perioculodes longimanus		1	1					
Pontocrates arenarius								
Synchelidium maculatum								
Amphilocus neapolitanus								
Leucothoe incisa								
Metopa sp								
Stenothoe ?monoculoides								
Urothoe brevicornis						2		
Urothoe elegans								
Urothoe marina	1			1	1			
Urothoe poseidonis								
Harpinia antennaria		1						
Achidostoma obesum								
Metaphoxus fultoni								
Hippomedon denticulatus								
Lysianassa plumosa								
Orchomene humilis								
Socarnes erythropthalmus								
Panoplea minuta								
Atylus falcatus								
Atylus swammerdami								
Atylus vedlomensis								
Dexamine spinosa								
Guernea coalita								
Ampilesca tenuicornis					1		9	
Ampilesca typica								
Bathyporeia guilliamsoniana								
Bathyporeia pelagica						2		
Bathyporeia pilosa								
Cheirocratus sundvalli							1	
Elasmopus rapax								
Gammarella fucicola								
Maera grossimana								
Maera othonis							1	
Melita gladiosa								
Melita hergensis								
Melita obtusata								
Ampithoe ramondi								
Ampithoe rubricata								
Pleonexes ?neglecta								
Sunamphithoe pelagica								
Gammaropsis maculata								
Microprotopus maculatus								
Photis longicaudata								
Protomedia fasciata								
Ischryoceridae indet								
Erichthonius ?punctatus								
Ischyrocerus anguipes								
Jassa sp								
Megaluropus agilis								
Aoriidae indet								
Aora typica								
Leptocheirus hirsutimanus								
Microdeutopus stationis								
Corophium ?crassicorne								
Corophium sextonae								
Podocerus variegatus								
CRUSTACEA-CAPRELLIDAE								

Table 5. Grab sample infauna data.

	2.1	2.2	2.3	2.4	2.5	2.6	2.9	2.10
Caprella acanthifera								
Phtisica marina								
CRUSTACEA-ISOPODA								
Eurydice pulchra								
Cymodoce truncata								
Janira maculosa								
Idotea baltica								
CRUSTACEA-TANAIDACEA								
Tanaiopsis graciloides								
Apseudes latreilli				4	4			
CRUSTACEA-CUMACEA								
Bodotria scorpoides								
Iphinoe trispinosa								
CRUSTACEA-DECAPODA								
Hippolyte varians								
Thoralus cranchii								
Pontophilus fasciatus			1					
Paguriidae indet								
Anapagurus hyndmani								
Pagurus carnea								
Pagurus prideaux			1					
Galathea intermedia								
Galathea squamifera								
Pisidia longicornis								
Ebalia tuberosa								
Ebalia tumefacta								1
Macropodia deflexa								
Macropodia linaresi								
Eurynome aspersa								
Eurynome spinosa								
Atelecyclus rotundatus								
Pirimela denticulata								
Liocarcinus sp								
Liocarcinus arcuatus								
Liocarcinus marmoreus					1			1
Carcinus maenas								
Xantho pilipes								
MOLLUSCA-POLYPLACOPHORA								
Leptochiton ascellus								
Lepidochiton cinereus								
Callochiton achatinus								
MOLLUSCA-PROSOBRANCHIA								
Tectura testudinalis								
Tectura virginea								
Helcion pellucidum								
Margarites helicinus?(broken)								
Gibbula cineraria								
Tricolia pullus								
Lacuna parva								
Rissoa parva								
Onoba semicostata								
Turritella communis								
Melanella alba								
Vitreolina sp (like devians)								
Lunatia alderi								
Lunatia montagui								
Hinia incrassata								
Hinia reticulata								
Mangelia attenuata								
MOLLUSCA-OPISTHOBRANCIA								
Opisthobranch indet								
Aplysia punctata								
Lomanotus marmoratus								
Doto pinnatifida								
MOLLUSCA-BIVALVIA								
Nucula nitidosa							2	
Modiolus sp								
Glycimeris glycimeris								
Limaria loscombi								
Myrtea spinifera							2	
Lucinoma borealis							1	
Tellimya ferruginosa	1							
Goodallia triangularis								

Table 5. Grab sample infauna data.

	2.1	2.2	2.3	2.4	2.5	2.6	2.9	2.10
Parvicardium ovale							8	
Parvicardium scabrum								
Cerastoderma edule								
Ensis sp(shell end)								
Phaxas pellucidus		1	2				1	
Tellina donacina	1						1	1
Moerella pygmaea								
Gari costulata								
Gari tellinella								
Abra alba		4	2					
Abra nitida		3						
Circomphalus casina								
Gouldia minima								
Dosinia lupinus								
Chamelea gallina			4					
Clausinella fasciata								
Timoclea ovata								
Corbula gibba		1		2			3	
Hiatella arctica								
Thracia villosiuscula								
PHORONIDAE								
Phoronis muelleri								
ECHINODERMATA								
Asterias rubens (juv)							1	
Ophiothrix fragilis								
Ophiactis balli								
Amphiura chiajei								
Amphiura filiformis		5					3	
Amphipholis squamata								
Ophiura albida								
Echinocyamus pusillus			1		3			1
Spatangus purpureus								
Echinocardium flavescens	1					1	1	
Echinocardium (juvs)								
Leptosynapta ?inhaerens								
CHORDATA								
Branchiostomma lanceolatum					5	12		3

Table 5. Grab sample infauna data.

	3.1	3.3	3.4	3.5	3.6	3.7	3.9	3.10
PROTOZOA								
Astrorhiza limicola								
PORIFERA								
Scypha ciliata								
COELENTERATA								
Haliclystis auriculata								
Lucernariopsis campanulata								
Anthozoa indet	8			2				
Adamsia carciniopados								
NEMATODA								
Nematoda	1		24	2	3	13	46	16
PLATYHELMINTHES								
Platyhelminthe							1	
NEMERTEA								
Nemertea			1	1	2		8	2
Oerstedia dorsalis?					1			
SIPUNCULIDA								
Golfingia sp								
Phascolion strombus								
Aspidosihon muelleri								
POLYCHAETA								
Pisione remota							1	16
Antinoella finmarchia								
Harmothoe indet (no scales etc)								
Harmothoe ljungmani							1	
Harmothoe lunulata								
Pholoe inornata						1		
Sthenelais boa								
Sthenelais limicola								
Phyllodocid indet								
Eteone foliosa							1	
Hesionura elongata								
Pseudomystides sp								
Pseudomystides limbata								6
Phyllodoce mucosa				2				
Eulalia mustela								
Eumida sanguinea			1				10	
Eumida ockelmanni								
Glycera dayi/celtica		1						
Glycera gigantea								
Glycera lapidum			2	3	5	4	20	2
Glycera tridactyla								
Goniada norvegica								
Goniadella sp								
Ephesiella sp								
Sphaerodoropsis ?minuta								
Sphaerodorum flavum								
Kefersteinia cirrata			3	3		6	5	
Nereimyra punctata								
Ophiodromus flexuosus								
Micropthalmus sp								
Syllis indet					1			
Ehlersia cornuta								3
Trypanosyllis coeliaca								
Typosyllis vittata								
Eusyllis blomstrandi								
Odontosyllis gibba			1			1		
Streptosyllis ?websteri		2		1	59		4	9
Exogone hebes						1		
Exogone naidina	1				7			11
Sphaerosyllis bulbosa								
Sphaerosyllis 'magnidentata'	1			2	17	1	44	4
Sphaerosyllis thomasi					1	3	5	49
Autolytus inermis								
Perinereis cultrifera	1			4			7	
Platynereis dumerilii			2	5	3	18	22	
Aglaophamus malmgremi								
Nephtys assimilis								
Nephtys cirrosa		3						
Nephtys kersivalensis								1
Nephtys ?longosetosa								
Onuphis conchylega								
Marphysa bellii								

Table 5. Grab sample infauna data.

	3.1	3.3	3.4	3.5	3.6	3.7	3.9	3.10
Lumbrineris (black aciculae)								
Lumbrineris gracilis							2	
Protodorvillei kefersteini				2	1			
Schistomeringos neglecta								
Scoloplos armiger								16
Aricidea minuta								
Paradoneis lyra								
Apistobranchus tullbergi								
Aonides oxycephala			5	8	16	49	182	
Aonides paucibranchiata						2		
Laonice bahusiensis								
Malacoceros fuliginosus/tetra			1				1	
Malacoceros vulgaris								
Polydora sp								
Prionospio banyulensis								
Spio indet								
Pygospio elegans	4							
Scololepis gilchristi								
Spio filicornis	17			1				
Spio martinensis		2			49			12
Spiophanes bombyx								
Magelona alleni								
Magelona filiformis		6						
Magelona mirabilis		1						
Magelona minuta								
Caulleriella alata				2	312	3	1	4
Caulleriella bioculata			13	20	29		3	1
Tharyx killariensis								
Chaetozone setosa (eyes)								
Cirratulus sp								
Aphelochaeta ?vivipera								
Cossura sp								
Macrochaeta sp								
Capitella			15	24	55		13	5
Mediomastus fragilis	1		1			19	1	
Notomastus latericeus	4			1	1	4	3	
Arenicola marina								
Clymenura sp								
Leiochone sp								
Euclymene sp								
Ophelia limacina								
Ophelia ?neglecta								179
Travesia forbesii								
Polyopthalmus pictus			2	2				
Scalibregma celtica								
Scalibregma inflatum								
Polygordius sp								
Protodrilus sp								22
Myriochele heeri								
Galathowenia oculata								
Owenia fusiformis								
Terebellidae indet								
Pectinaria auricoma								
Lagis koreni								
Sabellaria spinulosa								
Ampharete lindstroemi								
Terebellides stroemi								
Tricobranchus ?rosea								
Nicolea venustula								
Pista cristata								
Polycirrus norvegicus		4		1		2		
Branchiomma bombyx								
Chone duneri								
Chone fauveli								
Chone filicaudata								
Jasmineira caudata								
Pseudopotamilla reniformis								
Serpulid indet								
Hydroides norvegica								
Pomatoceros lamarcki			1	1				
Tubificoides benedii			2	1		46	126	
String oligochaete						1	1	7
Oligochaeta			1		2		14	

Table 5. Grab sample infauna data.

	3.1	3.3	3.4	3.5	3.6	3.7	3.9	3.10
HIRUDINEA								
Hirudinea indet								
CRUSTACEA-PYCNOGONIDA								
Nymphon gracile								
Achelia echinata								
Endeis charybdaea								
Endeis spinosa								
CRUSTACEA								
Verruca stroemi								
Ostracod sp								
Nebalia bipes		1						
CRUSTACEA-AMPHIPODA								
Apherusa bispinosa								
Apherusa ?jurinei				2				
Monoculodes sp				1				
Perioculodes longimanus		3			3		3	2
Pontocrates arenarius								
Synchelidium maculatum								
Amphilocus neapolitanus								
Leucothoe incisa								
Metopa sp								
Stenothoe ?monoculoides							2	
Urothoe brevicornis	1							
Urothoe elegans	9							
Urothoe marina				2				
Urothoe poseidonis		1						
Harpinia antennaria								
Achidostoma obesum								
Metaphoxus fultoni								
Hippomedon denticulatus								
Lysianassa plumosa								
Orchomene humilis							26	
Socarnes erythropthalmus								
Panoplea minuta			2	2		1		
Atylus falcatus								
Atylus swammerdami				1				
Atylus vedlomensis								
Dexamine spinosa								
Guernea coalita								
Ampilesca tenuicornis								
Ampilesca typica								
Bathyporeia guilliamsoniana								
Bathyporeia pelagica								
Bathyporeia pilosa								
Cheirocratus sundvalli			8			19	13	
Elasmopus rapax								
Gammarella fucicola			8			36	3	
Maera grossimana						3		
Maera othonis			1					
Melita gladiosa			3			8		
Melita hergensis			41					
Melita obtusata								
Ampithoe ramondi								
Ampithoe rubricata				1		6		
Pleonexes ?neglecta								
Sunamphithoe pelagica				2				
Gammaropsis maculata								
Microprotopus maculatus	9							
Photis longicaudata								
Protomedia fasciata								
Ischryoceridae indet								
Erichthonius ?punctatus								
Ischyrocerus anguipes			3	1	1			
Jassa sp								
Megaluropus agilis		1		1				
Aoriidae indet						5		
Aora typica								
Leptocheirus hirsutimanus								
Microdeutopus stationis								
Corophium ?crassicorne	20		1					
Corophium sextonae								
Podocerus variegatus								
CRUSTACEA-CAPRELLIDAE								

Table 5. Grab sample infauna data.

	3.1	3.3	3.4	3.5	3.6	3.7	3.9	3.10
Caprella acanthifera			1					
Phtisica marina								
CRUSTACEA-ISOPODA								
Eurydice pulchra								
Cymodoce truncata		1						
Janira maculosa						10		
Idotea baltica				1				
CRUSTACEA-TANAIDACEA								
Tanaiopsis graciloides								
Apseudes latreilli	314		26	47	592		837	
CRUSTACEA-CUMACEA								
Bodotria scorpoides								
Iphinoe trispinosa	2							
CRUSTACEA-DECAPODA								
Hippolyte varians				1				
Thoralus cranchii								
Pontophilus fasciatus								
Paguriidae indet			1			1		
Anapagurus hyndmani								
Pagurus carnea					1			
Pagurus prideaux								
Galathea intermedia						1		
Galathea squamifera								
Pisidia longicornis						2		
Ebalia tuberosa								
Ebalia tumefacta								
Macropodia deflexa								
Macropodia linaresi								
Eurynome aspersa								
Eurynome spinosa								
Atelecyclus rotundatus								
Pirimela denticulata				1				
Liocarcinus sp					1			
Liocarcinus arcuatus								
Liocarcinus marmoreus								
Carcinus maenas								
Xantho pilipes								
MOLLUSCA-POLYPLACOPHORA								
Leptochiton ascellus								
Lepidochiton cinereus				1				
Callochiton achatinus				1				
MOLLUSCA-PROSOBRANCHIA								
Tectura testudinalis				2				
Tectura virginea								
Helcion pellucidum								
Margarites helicinus?(broken)								
Gibbula cineraria								
Tricolia pullus								
Lacuna parva								
Rissoa parva				6				
Onoba semicostata								
Turritella communis								
Melanella alba				1				
Vitreolina sp (like devians)								
Lunatia alderi			1				1	
Lunatia montagui								
Hinia incrassata								
Hinia reticulata	1						1	
Mangelia attenuata								
MOLLUSCA-OPISTHOBRANCIA								
Opisthobranch indet								
Aplysia punctata								
Lomanotus marmoratus								
Doto pinnatifida								
MOLLUSCA-BIVALVIA								
Nucula nitidosa								
Modiolus sp								
Glycimeris glycimeris								
Limaria loscombi								
Myrtea spinifera								
Lucinoma borealis								
Tellimya ferruginosa								
Goodallia triangularis								

Table 5. Grab sample infauna data.

	3.1	3.3	3.4	3.5	3.6	3.7	3.9	3.10
Parvicardium ovale								
Parvicardium scabrum	1							
Cerastoderma edule								
Ensis sp(shell end)								
Phaxas pellucidus								
Tellina donacina								1
Moerella pygmaea				1	5		1	
Gari costulata							1	
Gari tellinella				2	2		2	
Abra alba								
Abra nitida								
Circomphalus casina								
Gouldia minima							1	
Dosinia lupinus							1	
Chamelea gallina								
Clausinella fasciata								
Timoclea ovata	1	1						
Corbula gibba								
Hiatella arctica								
Thracia villosiuscula								
PHORONIDAE								
Phoronis muelleri						10	1	
ECHINODERMATA								
Asterias rubens (juv)								
Ophiothrix fragilis								
Ophiactis balli								
Amphiura chiajei								
Amphiura filiformis								
Amphipholis squamata						4	3	
Ophiura albida								
Echinocyamus pusillus			1	1				7
Spatangus purpureus								
Echinocardium flavescens								
Echinocardium (juvs)								
Leptosynapta ?inhaerens							1	
CHORDATA								
Branchiostomma lanceolatum					12		1	1

Table 5. Grab sample infauna data.

	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	5.7	5.10
PROTOZOA										
Astrorhiza limicola										
PORIFERA										
Scypha ciliata										
COELENTERATA										
Haliclystis auriculata										
Lucernariopsis campanulata										
Anthozoa indet			9		1					
Adamsia carciniopados										
NEMATODA										
Nematoda		3	2			1	1			3
PLATYHELMINTHES										
Platyhelminthe						1				
NEMERTEA										
Nemertea	1			1	3					2
Oerstedia dorsalis?										
SIPUNCULIDA										
Golfingia sp			1							
Phascolion strombus										
Aspidosihon muelleri										
POLYCHAETA										
Pisione remota			2			1		2		4
Antinoella finmarchia										
Harmothoe indet (no scales etc)										
Harmothoe ljungmani			2		3					
Harmothoe lunulata										4
Pholoe inornata										
Sthenelais boa										
Sthenelais limicola										
Phyllodocid indet										
Eteone foliosa										
Hesionura elongata										
Pseudomystides sp			3							
Pseudomystides limbata										
Phyllodoce mucosa		1								
Eulalia mustela										
Eumida sanguinea					1					
Eumida ockelmanni					3					
Glycera dayi/celtica										4
Glycera gigantea										
Glycera lapidum			8	2	14			1	4	4
Glycera tridactyla										
Goniada norvegica					1					1
Goniadella sp										
Ephesiella sp					1					
Sphaerodoropsis ?minuta										
Sphaerodorum flavum										
Kefersteinia cirrata										
Nereimyra punctata					3					
Ophiodromus flexuosus										
Micropthalmus sp							1			
Syllis indet					1					
Ehlersia cornuta			37		1					2
Trypanosyllis coeliaca										
Typosyllis vittata										
Eusyllis blomstrandi										
Odontosyllis gibba										
Streptosyllis ?websteri	2			2					1	
Exogone hebes	1	6			1	1	3			
Exogone naidina										
Sphaerosyllis bulbosa			27							
Sphaerosyllis 'magnidentata'	5						1			
Sphaerosyllis thomasi										
Autolytus inermis					1					
Perinereis cultrifera			1							
Platynereis dumerilii		1	6		2	1				
Aglaophamus malmgremi										
Nephtys assimilis				1		1				
Nephtys cirrosa								1		
Nephtys kersivalensis						3				
Nephtys ?longosetosa										
Onuphis conchylega										
Marphysa bellii			6							

Table 5. Grab sample infauna data.

	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	5.7	5.10
Lumbrineris (black aciculae)										
Lumbrineris gracilis				1						8
Protodorvillei kefersteini					11					27
Schistomeringos neglecta			1							
Scoloplos armiger		4			1		4			
Aricidea minuta				13						
Paradoneis lyra										
Apistobranchus tullbergi										
Aonides oxycephala	2	2	59		42				1	
Aonides paucibranchiata	4		3		15		1		2	7
Laonice bahusiensis										
Malacoceros fuliginosus/tetra		1			3		1			
Malacoceros vulgaris										
Polydora sp		1								
Prionospio banyulensis			1		1					7
Spio indet										
Pygospio elegans		3								
Scololepis gilchristi										
Spio filicornis	3	12		1						
Spio martinensis							2			
Spiophanes bombyx										
Magelona alleni				1						2
Magelona filiformis				2						
Magelona mirabilis										
Magelona minuta										
Caulleriella alata		1		17	96					13
Caulleriella bioculata	1		4		79					
Tharyx killariensis										
Chaetozone setosa (eyes)					1					
Cirratulus sp			1							
Aphelochaeta ?vivipera				1	3					
Cossura sp										
Macrochaeta sp										
Capitella	17	11			5		18			
Mediomastus fragilis	1	6	2		30					306
Notomastus latericeus	1	21			1					
Arenicola marina		1								
Clymenura sp										
Leiochone sp										
Euclymene sp										
Ophelia limacina									1	
Ophelia ?neglecta										
Travesia forbesii										
Polyopthalmus pictus					3					
Scalibregma celtica										
Scalibregma inflatum										
Polygordius sp			4					1	1	
Protodrilus sp										
Myriochele heeri										
Galathowenia oculata										
Owenia fusiformis				1						1
Terebellidae indet										3
Pectinaria auricoma										
Lagis koreni										
Sabellaria spinulosa										
Ampharete lindstroemi										
Terebellides stroemi										
Tricobranchus ?rosea										
Nicolea venustula										
Pista cristata					1			1		7
Polycirrus norvegicus										
Branchiomma bombyx										
Chone duneri										
Chone fauveli										6
Chone filicaudata										
Jasmineira caudata										
Pseudopotamilla reniformis										
Serpulid indet										
Hydroides norvegica										
Pomatoceros lamarcki					10					
Tubificoides benedii		1	11		5		1			1
String oligochaete	3		5		18					
Oligochaeta	2								2	

Table 5. Grab sample infauna data.

	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	5.7	5.10
HIRUDINEA										
Hirudinea indet			1		1					
CRUSTACEA-PYCNOGONIDA										
Nymphon gracile					1					
Achelia echinata										
Endeis charybdaea										
Endeis spinosa										
CRUSTACEA										
Verruca stroemi										
Ostracod sp		1			1					1
Nebalia bipes					1					
CRUSTACEA-AMPHIPODA										
Apherusa bispinosa										
Apherusa ?jurinei										
Monoculodes sp					1					
Perioculodes longimanus						3				
Pontocrates arenarius								2		1
Synchelidium maculatum				2						
Amphilocus neapolitanus										
Leucothoe incisa			2							
Metopa sp										
Stenothoe ?monoculoides			1		1					
Urothoe brevicornis										
Urothoe elegans		1								
Urothoe marina								1		
Urothoe poseidonis								1		
Harpinia antennaria										
Achidostoma obesum					1					
Metaphoxus fultoni										
Hippomedon denticulatus				1						
Lysianassa plumosa										1
Orchomene humilis			38		1					
Socarnes erythropthalmus			1		3					
Panoplea minuta										
Atylus falcatus										
Atylus swammerdami										
Atylus vedlomensis										
Dexamine spinosa			2							
Guernea coalita			1							
Ampilesca tenuicornis										
Ampilesca typica										3
Bathyporeia guilliamsoniana										
Bathyporeia pelagica								5		
Bathyporeia pilosa				4						
Cheirocratus sundvalli		1	18		45					
Elasmopus rapax										
Gammarella fucicola					6					
Maera grossimana										
Maera othonis					8					
Melita gladiosa					8					
Melita hergensis										
Melita obtusata										
Ampithoe ramondi										
Ampithoe rubricata			1		1					
Pleonexes ?neglecta			1							
Sunamphithoe pelagica										
Gammaropsis maculata										
Microprotopus maculatus	2			1						
Photis longicaudata										
Protomedia fasciata										
Ischryoceridae indet										
Erichthonius ?punctatus										
Ischyrocerus anguipes										
Jassa sp										
Megaluropus agilis										
Aoriidae indet										
Aora typica										
Leptocheirus hirsutimanus			1							
Microdeutopus stationis						2				
Corophium ?crassicorne										
Corophium sextonae										
Podocerus variegatus										
CRUSTACEA-CAPRELLIDAE										

Table 5. Grab sample infauna data.

	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	5.7	5.10
Caprella acanthifera										
Phtisica marina										
CRUSTACEA-ISOPODA										
Eurydice pulchra									1	
Cymodoce truncata										
Janira maculosa					1					
Idotea baltica										
CRUSTACEA-TANAIDACEA										
Tanaiopsis graciloides										
Apseudes latreilli	133	385	7		52					
CRUSTACEA-CUMACEA										
Bodotria scorpoides										
Iphinoe trispinosa		6		5		1				
CRUSTACEA-DECAPODA										
Hippolyte varians										
Thoralus cranchii										
Pontophilus fasciatus										
Paguriidae indet										
Anapagurus hyndmani					4					1
Pagurus carnea										
Pagurus prideaux										
Galathea intermedia										
Galathea squamifera										
Pisidia longicornis										
Ebalia tuberosa										
Ebalia tumefacta					1					
Macropodia deflexa										
Macropodia linaresi										
Eurynome aspersa										
Eurynome spinosa										
Atelecyclus rotundatus										
Pirimela denticulata					2					
Liocarcinus sp										
Liocarcinus arcuatus										
Liocarcinus marmoreus										
Carcinus maenas		3					1			
Xantho pilipes										
MOLLUSCA-POLYPLACOPHORA										
Leptochiton ascellus										
Lepidochiton cinereus	2		1		33					
Callochiton achatinus										
MOLLUSCA-PROSOBRANCHIA										
Tectura testudinalis										
Tectura virginea										
Helcion pellucidum										
Margarites helicinus?(broken)										
Gibbula cineraria										
Tricolia pullus										
Lacuna parva										
Rissoa parva										
Onoba semicostata										
Turritella communis										
Melanella alba										
Vitreolina sp (like devians)										
Lunatia alderi										
Lunatia montagui										
Hinia incrassata										
Hinia reticulata		1			1					
Mangelia attenuata										
MOLLUSCA-OPISTHOBRANCIA										
Opisthobranch indet										
Aplysia punctata					2					
Lomanotus marmoratus										
Doto pinnatifida										
MOLLUSCA-BIVALVIA										
Nucula nitidosa										
Modiolus sp										
Glycimeris glycimeris										
Limaria loscombi										
Myrtea spinifera										
Lucinoma borealis										
Tellimya ferruginosa										
Goodallia triangularis										

Table 5. Grab sample infauna data.

	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	5.7	5.10
Parvicardium ovale										
Parvicardium scabrum					1					
Cerastoderma edule		1					1			
Ensis sp(shell end)			1							
Phaxas pellucidus				2						
Tellina donacina			1							4
Moerella pygmaea	1									
Gari costulata										
Gari tellinella			1							
Abra alba										
Abra nitida										
Circomphalus casina										
Gouldia minima										
Dosinia lupinus										
Chamelea gallina				1						
Clausinella fasciata										
Timoclea ovata	2				1					
Corbula gibba										
Hiatella arctica										
Thracia villosiuscula			1							
PHORONIDAE										
Phoronis muelleri										
ECHINODERMATA										
Asterias rubens (juv)										
Ophiothrix fragilis										
Ophiactis balli										
Amphiura chiajei										
Amphiura filiformis										
Amphipholis squamata					5					
Ophiura albida										
Echinocyamus pusillus			1		1			14	7	
Spatangus purpureus										
Echinocardium flavescens									1	1
Echinocardium (juvs)									3	
Leptosynapta ?inhaerens										
CHORDATA										
Branchiostomma lanceolatum			6							

Table 5. Grab sample infauna data.

	7.2	7.8	8.1	8.2	8.3	8.7	8.9	8.11
PROTOZOA								
Astrorhiza limicola								
PORIFERA								
Scypha ciliata								
COELENTERATA								
Haliclystis auriculata								
Lucernariopsis campanulata								
Anthozoa indet								
Adamsia carciniopados							1	
NEMATODA								
Nematoda		2		2		1	3	
PLATYHELMINTHES								
Platyhelminthe								
NEMERTEA								
Nemertea			4	5				1
Oerstedia dorsalis?						1		
SIPUNCULIDA								
Golfingia sp								
Phascolion strombus		1						
Aspidosihon muelleri					1		1	
POLYCHAETA								
Pisione remota	2		1	63		3		
Antinoella finmarchia								
Harmothoe indet (no scales etc)							1	
Harmothoe ljungmani		4						
Harmothoe lunulata								
Pholoe inornata					1			
Sthenelais boa								
Sthenelais limicola								
Phyllodocid indet		1						
Eteone foliosa								
Hesionura elongata								
Pseudomystides sp		1						
Pseudomystides limbata								
Phyllodoce mucosa								
Eulalia mustela							3	
Eumida sanguinea		1						
Eumida ockelmanni								2
Glycera dayi/celtica								
Glycera gigantea								
Glycera lapidum	1	14		15		10	12	6
Glycera tridactyla								
Goniada norvegica		2					2	
Goniadella sp								
Ephesiella sp								
Sphaerodoropsis ?minuta								
Sphaerodorum flavum								
Kefersteinia cirrata		7					8	
Nereimyra punctata								
Ophiodromus flexuosus								
Micropthalmus sp								
Syllis indet	1						4	
Ehlersia cornuta							4	
Trypanosyllis coeliaca		1						
Typosyllis vittata		1		1				
Eusyllis blomstrandi					4			
Odontosyllis gibba								
Streptosyllis ?websteri					4			
Exogone hebes								
Exogone naidina								
Sphaerosyllis bulbosa		1						
Sphaerosyllis 'magnidentata'								
Sphaerosyllis thomasi								
Autolytus inermis								
Perinereis cultrifera								
Platynereis dumerilii							1	
Aglaophamus malmgremi						1		
Nephtys assimilis								
Nephtys cirrosa			3					
Nephtys kersivalensis								
Nephtys ?longosetosa								
Onuphis conchylega								
Marphysa bellii								

Table 5. Grab sample infauna data.

	7.2	7.8	8.1	8.2	8.3	8.7	8.9	8.11
Lumbrineris (black aciculae)								
Lumbrineris gracilis								
Protodorvillei kefersteini	1						1	
Schistomeringos neglecta								
Scoloplos armiger								
Aricidea minuta								
Paradoneis lyra				2		1	1	1
Apistobranchus tullbergi								
Aonides oxycephala								
Aonides paucibranchiata		7					4	3
Laonice bahusiensis		6				2	5	
Malacoceros fuliginosus/tetra								
Malacoceros vulgaris								
Polydora sp								
Prionospio banyulensis		12					4	
Spio indet								
Pygospio elegans								
Scololepis gilchristi						1		
Spio filicornis						1		1
Spio martinensis		1						
Spiophanes bombyx							1	1
Magelona alleni								
Magelona filiformis								
Magelona mirabilis								
Magelona minuta								
Caulleriella alata		5					4	
Caulleriella bioculata		2						
Tharyx killariensis								
Chaetozone setosa (eyes)								
Cirratulus sp								
Aphelochaeta ?vivipera								
Cossura sp								
Macrochaeta sp		1					1	
Capitella								
Mediomastus fragilis		5					13	1
Notomastus latericeus							2	
Arenicola marina								
Clymenura sp								
Leiochone sp							1	
Euclymene sp								
Ophelia limacina								
Ophelia ?neglecta								
Travesia forbesii								
Polyopthalmus pictus								
Scalibregma celtica								
Scalibregma inflatum								
Polygordius sp	6	7	3	35		1	1	2
Protodrilus sp			4					
Myriochele heeri								
Galathowenia oculata								
Owenia fusiformis		1						
Terebellidae indet								
Pectinaria auricoma								
Lagis koreni								
Sabellaria spinulosa							1	
Ampharete lindstroemi		1						
Terebellides stroemi							1	
Tricobranchus ?rosea								
Nicolea venustula								
Pista cristata		3					1	
Polycirrus norvegicus		11					9	
Branchiomma bombyx								
Chone duneri							1	
Chone fauveli								
Chone filicaudata							1	
Jasmineira caudata								
Pseudopotamilla reniformis								
Serpulid indet							2	
Hydroides norvegica					9		52	
Pomatoceros lamarcki					9		24	
Tubificoides benedii								
String oligochaete								
Oligochaeta								

Table 5. Grab sample infauna data.

	7.2	7.8	8.1	8.2	8.3	8.7	8.9	8.11
HIRUDINEA								
Hirudinea indet								
CRUSTACEA-PYCNOGONIDA								
Nymphon gracile								
Achelia echinata					1			
Endeis charybdaea								
Endeis spinosa								
CRUSTACEA								
Verruca stroemi								
Ostracod sp								
Nebalia bipes								
CRUSTACEA-AMPHIPODA								
Apherusa bispinosa								
Apherusa ?jurinei								
Monoculodes sp							4	
Perioculodes longimanus								
Pontocrates arenarius		1						
Synchelidium maculatum		1						
Amphilocus neapolitanus				1				
Leucothoe incisa								
Metopa sp					1			
Stenothoe ?monoculoides								
Urothoe brevicornis			1					2
Urothoe elegans								
Urothoe marina				1	1		4	
Urothoe poseidonis								
Harpinia antennaria								
Achidostoma obesum								
Metaphoxus fultoni		1						
Hippomedon denticulatus								
Lysianassa plumosa							1	
Orchomene humilis								
Socarnes erythropthalmus								
Panoplea minuta								
Atylus falcatus			1					
Atylus swammerdami								
Atylus vedlomensis		1					3	
Dexamine spinosa			1					
Guernea coalita								
Ampilesca tenuicornis								
Ampilesca typica								
Bathyporeia guilliamsoniana			2					5
Bathyporeia pelagica								
Bathyporeia pilosa								
Cheirocratus sundvalli								
Elasmopus rapax								
Gammarella fucicola					1			
Maera grossimana								
Maera othonis							3	
Melita gladiosa								
Melita hergensis								
Melita obtusata								
Ampithoe ramondi		1						
Ampithoe rubricata								
Pleonexes ?neglecta								
Sunamphithoe pelagica								
Gammaropsis maculata							1	
Microprotopus maculatus								
Photis longicaudata								
Protomedia fasciata								
Ischryoceridae indet								
Erichthonius ?punctatus								
Ischyrocerus anguipes								
Jassa sp								1
Megaluropus agilis								
Aoriidae indet								
Aora typica								
Leptocheirus hirsutimanus								
Microdeutopus stationis					1			
Corophium ?crassicorne								
Corophium sextonae								
Podocerus variegatus								
CRUSTACEA-CAPRELLIDAE								

Table 5. Grab sample infauna data.

	7.2	7.8	8.1	8.2	8.3	8.7	8.9	8.11
Caprella acanthifera								
Phtisica marina					1			
CRUSTACEA-ISOPODA								
Eurydice pulchra								
Cymodoce truncata								
Janira maculosa								
Idotea baltica								
CRUSTACEA-TANAIDACEA								
Tanaiopsis graciloides								
Apseudes latreilli			2	1				1
CRUSTACEA-CUMACEA								
Bodotria scorpoides								
Iphinoe trispinosa								
CRUSTACEA-DECAPODA								
Hippolyte varians								
Thoralus cranchii								
Pontophilus fasciatus								
Paguriidae indet							1	
Anapagurus hyndmani					1			
Pagurus carnea								
Pagurus prideaux							1	
Galathea intermedia							2	
Galathea squamifera								
Pisidia longicornis							1	
Ebalia tuberosa		1					2	
Ebalia tumefacta		1						
Macropodia deflexa								
Macropodia linaresi								
Eurynome aspersa								
Eurynome spinosa								
Atelecyclus rotundatus						1	1	
Pirimela denticulata								
Liocarcinus sp								
Liocarcinus arcuatus								
Liocarcinus marmoreus						1		
Carcinus maenas								
Xantho pilipes								
MOLLUSCA-POLYPLACOPHORA								
Leptochiton ascellus							3	
Lepidochiton cinereus								
Callochiton achatinus								
MOLLUSCA-PROSOBRANCHIA								
Tectura testudinalis								
Tectura virginea								
Helcion pellucidum								
Margarites helicinus?(broken)								
Gibbula cineraria								
Tricolia pullus								
Lacuna parva								
Rissoa parva								
Onoba semicostata								
Turritella communis								
Melanella alba								
Vitreolina sp (like devians)								
Lunatia alderi								
Lunatia montagui								
Hinia incrassata								
Hinia reticulata								
Mangelia attenuata								
MOLLUSCA-OPISTHOBRANCIA								
Opisthobranch indet		1	1					
Aplysia punctata								
Lomanotus marmoratus					2			
Doto pinnatifida					2			
MOLLUSCA-BIVALVIA								
Nucula nitidosa								
Modiolus sp								
Glycimeris glycimeris		2						
Limaria loscombi								
Myrtea spinifera								
Lucinoma borealis								
Tellimya ferruginosa								
Goodallia triangularis			1					

Table 5. Grab sample infauna data.

	7.2	7.8	8.1	8.2	8.3	8.7	8.9	8.11
Parvicardium ovale								
Parvicardium scabrum								
Cerastoderma edule								
Ensis sp(shell end)								
Phaxas pellucidus								
Tellina donacina		1						2
Moerella pygmaea					1			
Gari costulata								
Gari tellinella							1	
Abra alba								
Abra nitida								
Circomphalus casina								
Gouldia minima		1						
Dosinia lupinus								
Chamelea gallina				1				
Clausinella fasciata		1						
Timoclea ovata		2					6	
Corbula gibba								
Hiatella arctica								
Thracia villosiuscula								
PHORONIDAE								
Phoronis muelleri								
ECHINODERMATA								
Asterias rubens (juv)		1						
Ophiothrix fragilis								
Ophiactis balli								
Amphiura chiajei								
Amphiura filiformis								
Amphipholis squamata								
Ophiura albida								
Echinocyamus pusillus	2	18				35	38	2
Spatangus purpureus		1				2		
Echinocardium flavescens						2		1
Echinocardium (juvs)								
Leptosynapta ?inhaerens								
CHORDATA								
Branchiostomma lanceolatum	2	1				1		

Table 5. Grab sample infauna data.

	9.1	9.2	9.3	9.7	9.9	9.12	TR1	TR4	TR5	TR7	SP3A
PROTOZOA											
Astrorhiza limicola			1								
PORIFERA											
Scypha ciliata											
COELENTERATA											
Haliclystis auriculata											
Lucernariopsis campanulata											1
Anthozoa indet		1					1				4
Adamsia carciniopados											
NEMATODA											
Nematoda	1		1		1				3	13	18
PLATYHELMINTHES											
Platyhelminthe											
NEMERTEA											
Nemertea		1	1		1	1		3	3	2	3
Oerstedia dorsalis?											
SIPUNCULIDA											
Golfingia sp											
Phascolion strombus									1		
Aspidosihon muelleri											
POLYCHAETA											
Pisione remota	8	7							2		
Antinoella finmarchia											
Harmothoe indet (no scales etc)											1
Harmothoe ljungmani									4		
Harmothoe lunulata											
Pholoe inornata											2
Sthenelais boa											
Sthenelais limicola											
Phyllodocid indet											
Eteone foliosa											
Hesionura elongata	2	4									
Pseudomystides sp	2										
Pseudomystides limbata									1	1	
Phyllodoce mucosa							3				1
Eulalia mustela											
Eumida sanguinea		1								1	
Eumida ockelmanni											
Glycera dayi/celtica											
Glycera gigantea										1	
Glycera lapidum	7	4	4	1		2			35	3	2
Glycera tridactyla					2						
Goniada norvegica			1								
Goniadella sp											
Ephesiella sp											
Sphaerodoropsis ?minuta											
Sphaerodorum flavum											3
Kefersteinia cirrata			3						34		3
Nereimyra punctata											
Ophiodromus flexuosus											
Micropthalmus sp											
Syllis indet											1
Ehlersia cornuta									2		
Trypanosyllis coeliaca									2		
Typosyllis vittata											
Eusyllis blomstrandi				20							
Odontosyllis gibba											3
Streptosyllis ?websteri						2	1	2		27	
Exogone hebes		1			2					1	
Exogone naidina										6	
Sphaerosyllis bulbosa									1		
Sphaerosyllis 'magnidentata'										16	
Sphaerosyllis thomasi										5	
Autolytus inermis											
Perinereis cultrifera											
Platynereis dumerilii			1				4				129
Aglaophamus malmgremi	2	2		1							
Nephtys assimilis											
Nephtys cirrosa						6		1		1	
Nephtys kersivalensis					5						
Nephtys ?longosetosa											
Onuphis conchylega			1								
Marphysa bellii											

Table 5. Grab sample infauna data.

	9.1	9.2	9.3	9.7	9.9	9.12	TR1	TR4	TR5	TR7	SP3A
Lumbrineris (black aciculae)		1									
Lumbrineris gracilis			4								9
Protodorvillei kefersteini									13		
Schistomeringos neglecta											
Scoloplos armiger						1		19		1	
Aricidea minuta											
Paradoneis lyra	1										
Apistobranchus tullbergi											
Aonides oxycephala							2		1	4	104
Aonides paucibranchiata	1	1							30	3	
Laonice bahusiensis	1		1								
Malacoceros fuliginosus/tetra							3				
Malacoceros vulgaris											5
Polydora sp				1							1
Prionospio banyulensis		2							11	1	
Spio indet											4
Pygospio elegans											
Scololepis gilchristi											
Spio filicornis						13				6	
Spio martinensis							17			1	
Spiophanes bombyx					1						
Magelona alleni					5						
Magelona filiformis					1						
Magelona mirabilis											
Magelona minuta											
Caulleriella alata			1			58	2		20	13	
Caulleriella bioculata	1			1	1		1		18	24	
Tharyx killariensis					3						
Chaetozone setosa (eyes)											
Cirratulus sp											
Aphelochaeta ?vivipera											
Cossura sp	1										
Macrochaeta sp											
Capitella							5			37	2
Mediomastus fragilis			27		6				33	1	2
Notomastus latericeus									3	3	7
Arenicola marina											
Clymenura sp											
Leiochone sp		1									
Euclymene sp											8
Ophelia limacina											
Ophelia ?neglecta								1			
Travesia forbesii											
Polyopthalmus pictus											
Scalibregma celtica					1						
Scalibregma inflatum											
Polygordius sp	7	8		3					13		
Protodrilus sp										1	
Myriochele heeri											
Galathowenia oculata					1						
Owenia fusiformis					2						
Terebellidae indet											
Pectinaria auricoma					1						
Lagis koreni											
Sabellaria spinulosa											
Ampharete lindstroemi											
Terebellides stroemi											
Tricobranchus ?rosea											
Nicolea venustula			1								
Pista cristata			1						12		
Polycirrus norvegicus	1								6		1
Branchiomma bombyx											
Chone duneri											
Chone fauveli											
Chone filicaudata											
Jasmineira caudata											
Pseudopotamilla reniformis											
Serpulid indet											
Hydroides norvegica			33								
Pomatoceros lamarcki			28								
Tubificoides benedii											30
String oligochaete							1		12	3	1
Oligochaeta					16	1	2			3	7

Table 5. Grab sample infauna data.

	9.1	9.2	9.3	9.7	9.9	9.12	TR1	TR4	TR5	TR7	SP3A
HIRUDINEA											
Hirudinea indet											
CRUSTACEA-PYCNOGONIDA											
Nymphon gracile											
Achelia echinata											
Endeis charybdaea											
Endeis spinosa											1
CRUSTACEA											
Verruca stroemi											
Ostracod sp										1	53
Nebalia bipes											2
CRUSTACEA-AMPHIPODA											
Apherusa bispinosa											26
Apherusa ?jurinei											
Monoculodes sp											
Perioculodes longimanus						1					
Pontocrates arenarius	1										
Synchelidium maculatum											
Amphilocus neapolitanus											1
Leucothoe incisa											
Metopa sp											
Stenothoe ?monoculoides											2
Urothoe brevicornis						1		8			
Urothoe elegans			1								
Urothoe marina							3		28	5	
Urothoe poseidonis											
Harpinia antennaria			1								6
Achidostoma obesum											
Metaphoxus fultoni			1								
Hippomedon denticulatus											
Lysianassa plumosa											
Orchomene humilis									7		
Socarnes erythropthalmus									2		
Panoplea minuta				2							4
Atylus falcatus											
Atylus swammerdami											1
Atylus vedlomensis											
Dexamine spinosa							1				17
Guernea coalita											
Ampilesca tenuicornis					8						27
Ampilesca typica											
Bathyporeia guilliamsoniana											
Bathyporeia pelagica									1		
Bathyporeia pilosa											
Cheirocratus sundvalli									8		
Elasmopus rapax											1
Gammarella fucicola											106
Maera grossimana											8
Maera othonis											
Melita gladiosa							1				18
Melita hergensis											8
Melita obtusata											8
Ampithoe ramondi											9
Ampithoe rubricata											85
Pleonexes ?neglecta											
Sunamphithoe pelagica											5
Gammaropsis maculata				1							7
Microprotopus maculatus									1		
Photis longicaudata											9
Protomedia fasciata											
Ischryoceridae indet											
Erichthonius ?punctatus											37
Ischyrocerus anguipes											
Jassa sp				1							
Megaluropus agilis											
Aoriidae indet					2						4
Aora typica											5
Leptocheirus hirsutimanus									1		
Microdeutopus stationis											61
Corophium ?crassicorne					1						1
Corophium sextonae					2						16
Podocerus variegatus											
CRUSTACEA-CAPRELLIDAE											

Table 5. Grab sample infauna data.

	9.1	9.2	9.3	9.7	9.9	9.12	TR1	TR4	TR5	TR7	SP3A
Caprella acanthifera					1						
Phtisica marina											1
CRUSTACEA-ISOPODA											
Eurydice pulchra											
Cymodoce truncata											2
Janira maculosa											1
Idotea baltica											2
CRUSTACEA-TANAIDACEA											
Tanaiopsis graciloides			1								
Apseudes latreilli							4		5	51	89
CRUSTACEA-CUMACEA											
Bodotria scorpoides											1
Iphinoe trispinosa										3	
CRUSTACEA-DECAPODA											
Hippolyte varians					1						
Thoralus cranchii											
Pontophilus fasciatus										1	6
Paguriidae indet									6		
Anapagurus hyndmani									2		5
Pagurus carnea											
Pagurus prideaux											
Galathea intermedia											
Galathea squamifera											2
Pisidia longicornis											1
Ebalia tuberosa			3								
Ebalia tumefacta			1								
Macropodia deflexa											1
Macropodia linaresi											
Eurynome aspersa											
Eurynome spinosa											
Atelecyclus rotundatus											
Pirimela denticulata											
Liocarcinus sp											
Liocarcinus arcuatus											1
Liocarcinus marmoreus											
Carcinus maenas							1				
Xantho pilipes											
MOLLUSCA-POLYPLACOPHORA											
Leptochiton ascellus			1								
Lepidochiton cinereus									1		2
Callochiton achatinus											
MOLLUSCA-PROSOBRANCHIA											
Tectura testudinalis											1
Tectura virginea											
Helcion pellucidum											
Margarites helicinus?(broken)											
Gibbula cineraria											
Tricolia pullus											1
Lacuna parva											
Rissoa parva											
Onoba semicostata											2
Turritella communis			1								
Melanella alba									1		
Vitreolina sp (like devians)											
Lunatia alderi											
Lunatia montagui											
Hinia incrassata											4
Hinia reticulata							1				3
Mangelia attenuata			1						1		
MOLLUSCA-OPISTHOBRANCIA											
Opisthobranch indet										1	
Aplysia punctata					1						
Lomanotus marmoratus											
Doto pinnatifida											
MOLLUSCA-BIVALVIA											
Nucula nitidosa											2
Modiolus sp											
Glycimeris glycimeris	1										
Limaria loscombi											
Myrtea spinifera											
Lucinoma borealis											4
Tellimya ferruginosa											
Goodallia triangularis											

Table 5. Grab sample infauna data.

	9.1	9.2	9.3	9.7	9.9	9.12	TR1	TR4	TR5	TR7	SP3A
Parvicardium ovale											
Parvicardium scabrum											
Cerastoderma edule											
Ensis sp(shell end)										1	
Phaxas pellucidus											
Tellina donacina						1				10	1
Moerella pygmaea									1	3	
Gari costulata									1		
Gari tellinella									1		
Abra alba					3						1
Abra nitida					3						
Circomphalus casina			1		1					1	
Gouldia minima											
Dosinia lupinus											
Chamelea gallina											
Clausinella fasciata			5						1		
Timoclea ovata			7							1	
Corbula gibba											
Hiatella arctica			1								
Thracia villosiuscula											
PHORONIDAE											
Phoronis muelleri											
ECHINODERMATA											
Asterias rubens (juv)					1						
Ophiothrix fragilis											1
Ophiactis balli											
Amphiura chiajei											
Amphiura filiformis											32
Amphipholis squamata											
Ophiura albida											
Echinocyamus pusillus	3	13	12		1				4	2	
Spatangus purpureus											
Echinocardium flavescens											
Echinocardium (juvs)											
Leptosynapta ?inhaerens											
CHORDATA											
Branchiostomma lanceolatum	5	5							8	9	

Table 6. Grab samples: epifauna from pebble and cobble samples.

		5.8	7.1	9.4
Porifera indet	C0001	P	P	P
Alcyonium digitatum	D1024		P	
Caryophyllia smithii	D1370	P	P	
Nematoda	E0001			1
Platyhelminthe	F0001			1
Oerstedia dorsalis?	G0148			3
Harmothoe indet	P0097	1	3	5
Pholoe synopthalmica	P0171			1
Eumida sanguinea	P0285			14
Syllidia armata	P0583		1	
Syllis indet	P0636			1
Small syllid sp	P0637	1	1	
Amblyosyllis formosa	P0680	1		
Eusyllis blomstrandi	P0686			26
Odontosyllis ctenostoma	P0698			3
Odontosyllis gibba	P0700	4	1	4
Autolytus sp 1	P0764			12
Autolytus sp 2	P0765			9
Nereis pelagica	P0835			4
Euphrosine foliosa	P0919	1		
Sabellaria spinulosa	P1876	P	10	
Lanice conchilega	P2031	1		
Oriopsis hynensis	P2234			1
Hydroides norvegica	P2288	6	147	
Pomatoceros lamarcki	P2303	340	106	295
Achelia hispida	Q0018	3	3	4
Callipallene brevirostris	Q0045	1		
Verruca stroemi	R0064		P	
Apherusa bispinosa	S0171			1
Apherusa jurinei	S0175			1
Peltocoxa brevirostris	S0306	1		
Stenothoe marina	S0370			5
Panoplea minuta	S0628	1		10
Dexamine thea	S0691			3
Maera othonis	S0853	3		
Jassa falcata	S0955			16
Aora gracilis	S0973			2
Corophium sextonae	S1026	2		123
Caprella acanthifera	S1072			1
Phytisca marina	S1096		1	1
Anthura gracilis	S1335	2	1	11
Synisoma lancifer	S1573			1
Arcturella damnoniensis	S1584		1	
Thoralus cranchii	S2293			1
Paguridae	S2444	1		
Galathea intermedia	S2486	4		
Galathea squamifera	S2489	1		

		E4	J7	K4
Fontana rivoli	C0037	P	P	P
Adyorium delphium	D1234		P	
Carpophila emmi	D1273	P	P	
Nemacola	E0001			7
Pachydermia	F0021			1
Dentalia donalis?	G0142			2
Hemiptera indet.	F0087	7	2	2
Fredos arrogantissa	P0171			1
Lunaria temporaria	P0288			14
Sylvilla arnotia	P0283		1	
Dyera indet.	P0292			1
Dyad splot sp	P0297	7	7	
Ambrosyla formosa	P0180	1		
Dasylla bernalensis	P0285			35
Odontosylla chevronata	P0283			2
Odontosylla ogilvia	P0170	4	1	4
Autolyrus sp 1	P0284			12
Autolyrus sp 2	P0178			2
Nemo peregrin	P0282			4
Lucrotidia tolosa	P0287	1		
Sabellaria spinulosa	P1678	8	10	
Lanice conchilega	P2001	1		
Owenia fusiformis	P2234			1
Hyalinoecia tubicola	P2288	6	127	
Pomatoceros lamarcki	P2003	340	106	280
Amphitrite rubra	D3478	3	3	4
Cirratulus cirratus	D0045	1		
Ventilabrum trevorcarteri	P0284		2	
Aphelochaeta	P0178			1
Aphelochaeta jasoni	P0179			1
Pilargis berkeleyae	D0276	1		
Sternaspis fossor	D0279			4
Chone infundibuliformis	D0280	1		10
Demonax pius	D0281			1
Mesochaetopterus sagittarius	D0283	3		
Jasmineira elegans	D0284			10
Axiothella rubrocincta	D0285			2
Owenia fusiformis	D1678	2		123
Clymenura columbiana	D1072			1
Praxillella affinis	D1088	1		1
Amphicteis gunneri	D1536	2	1	11
Ophelina acuminata	D1073			1
Ampharete goesi	D1084		1	
Terebellides stroemii	D2263			1
Polycirrus	D2464	1		
Galathea intermedia	F2409	1		
Galathea squamifera	D0435	1		

Table 6. Grab samples: epifauna from pebble and cobble samples.

		5.8	7.1	9.4
Pisidia longicornis	S2502	17	1	26
Leptochiton ascellus	W0055		1	
Callochiton achatinus	W0082			1
Acanthochitonia crinitus	W0088			2
Tectura testudianlis	W0125			9
Helcion pellucidum	W0139			2
Tricolia pullus	W0231	1		
Lacuna pallidula	W0239			1
Rissoa parva	W0285			3
Odostomia sp	W0537			2
Opisthobranchia indet	W0953		3	2
Aplysia punctata	W1102			2
Anomiidae	W1813	P	P	P
Parvicardium ovale	W1977	1		
Clausinella fasciata	W2193	1		
Hiatella arctica	W2251			2
Crisidia cornuta	Y0010			P
Crisia eburnea	Y0028			P
Tubulipora ?lilacea	Y0049	P		P
Disporella hispida	Y0121	P		P
Alcyonidium diaphanum	Y0137	P	P	
Celleporella hyalina	Y0571			P
Celleporina hassalli	Y0612			P
Aetea anguina	Y0643			P
Membranipora membranacea	Y0664			P
Electra pilosa	Y0678			P
Cellaria fistulosa	Y0812	P		
Cellaria sinuosa	Y0814		P	
Scrupocellaria scrupea	Y0840	P	P	
Bugula plumosa	Y0875	P	P	
Bugula turbinata	Y0879	P		
Antedon bifida	ZB0011		1	2
Ophiothrix fragilis	ZB0235			2
Ophiactis balli	ZB0268			1
Psammechinus miliaris? (j)	ZB0355			2
Echinocyamus pusillus	ZB0388	1		
Aplidium sp	ZD0057			P
Didemnidae indet	ZD0068	P	P	
Ascidiella scabra	ZD0143	1		P
Polycarpa rustica	ZD0188			P
Botyllus schlosseri	ZD0209		P	P
Molgula citrina	ZD0254		P	
