COMMISSIONED REPORT

Commissioned Report No.258

Biotope mapping of the Sound of Barra, Scotland

(ROAME No. R06PA04)

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COMMISSIONED REPORT

Summary

Biotope mapping of the Sound of Barra, Scotland

Commissioned Report No. (ROAME No. 258 RO6PA04)
Contractor: Heriot-Watt University, University of Edinburgh and Agri-Food and Biosciences Institute, Belfast
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Background

The Sound of Barra is a topographically complex marine area situated between South Uist and Barra in the Outer Hebrides. Marine biological studies that have been conducted in the past include environmental impact assessments of ferry terminal developments on Barra (Cordah 2000b) and Eriskay (Cordah 2000a) and of the Eriskay causeway (Cordah 1999). In 2001 a subtidal biotope mapping survey was conducted which encompassed the waters around Gighay, Hellisay and Fuiay in the southern part of the Sound and also the Sound of Eriskay and approaches in the northern part of the Sound (Bates *et al* 2004a). The primary purpose of this study is to extend the coverage of subtidal biotope mapping to encompass the central and western parts of the Sound and to conduct intertidal biotope mapping over the whole of the Sound including those areas surveyed subtidally in 2001.

An increased knowledge of the marine biotope distribution in the Sound of Barra is desirable in order to both assess the potential impacts of any proposed future developments in the area and to increase knowledge of habitats of conservation importance in Scottish waters. This study utilised satellite imagery, underwater acoustic sensing techniques and biological ground surveys to develop a biotope distribution map of the area and relate this distribution to prevailing environmental conditions.

Habitats are subject to anthropogenic modification in localised areas near existing developments such as the jetties and moorings at North Bay and the ferry terminals on Barra and Eriskay. The causeway built between Eriskay and South Uist in 2000 has potential to create modification over a much broader area. A secondary aim of this study is to assess any ongoing changes affecting the marine biota near the Eriskay causeway. Impacts attributable to fishing activity are likely to be minimal. Benthic fishing does occur in the eastern part of the Sound but is unlikely to be productive elsewhere in the Sound. Creeling and scallop diving are conducted to a limited extent.

Main findings

Extensive (~360ha) *Zostera* beds are present but the density of the *Zostera* is often low. They generally occur on sandy substrates in moderately exposed or sheltered environments. Maerl beds are present in exposed environments. Maerl is present over a wide (~902ha) area but the abundance of live maerl is often low.

The marine benthic communities are strongly influenced both by exposure to wave action and by tidal currents. Substrate type can be described as a mosaic of rocky reefs and sediment patches of varying size extending over the whole of the site.

The western part of the Sound is highly exposed. Sediments are sandy and tend to be impoverished due to their high mobility. Stable infralittoral rocky substrates are dominated by kelp communities that are often modified by sand scour and tidal currents.

The channels in the mid part of the Sound are tide swept. Sediments are generally sandy but contain a more diverse fauna due to a combination of the tidal currents and reduced exposure. Maerl is also present. Stable rock substrates are dominated by kelp communities with a diverse associated fauna characteristic of accelerated tidal currents. These communities are also modified by sand scour in many locations.

The depth increases to the east. Areas SW of the Stack Islands are characterised by stable fine sand with small amounts of silt and a diverse infaunal community. Towards the eastern margin the sediment is gravelly with large pronounced ripples and small amounts of maerl. Shallower rock substrates support kelp forests some of which show characteristics of accelerated tidal currents. Deeper rock surfaces support a turf of foliose red algae mixed with scour tolerant epifauna.

The southern part of the Sound is more sheltered and sediments are composed of fine sand with small amounts of silt. Sediment communities are variable in composition but are often dominated by algal mats. Kelp communities are those characteristic of more sheltered environments.

The survey of areas in the vicinity of the Eriskay causeway provided no convincing evidence of substantial changes in the composition of the biota between 2001 and 2006. Clear changes had occurred in *Zostera* distribution resulting in a net loss of *Zostera* coverage.

A combined spectral and acoustic classification for the Sound of Barra was produced which drew on further rules based on known tolerances of biotopes to exposure and water depth, overcoming the problems of a purely spectral based approach. Biotopes were also combined to appropriate hierarchical levels where they were poorly distributed in the Sound or where their reflectances were spectrally similar. As a result, a total of 12 intertidal and subtidal biotopes and biotope groupings were discriminated with an overall accuracy of 71**%** with all but 1 class individually discriminated to 50% accuracy or better.

The project has shown that a combined acoustic and optical approach exploits synergies in the two techniques allowing discrimination of biotopes in shallow zones using optical data where light penetration is good, combined with the accurate mapping of biotopes using acoustic data in deeper waters where light penetration is low and where the optical datasets are of more limited utility.

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1 INTRODUCTION

This report details the results of the second biotope mapping survey of the Sound of Barra, Outer Hebrides, with the overall aim of producing a comprehensive biotope map of the Sound. The survey is based on a range of integrated methods, incorporating satellite imaging and acoustic survey, combined with extensive groundtruthing. The work was undertaken by the Universities of Heriot-Watt (HWU) and Edinburgh (EDU) and with acoustic data supplied under subcontract by Agri-Food and Biosciences Institute (AFBI).

The overall aims of the project were:

- In conjunction with extensive groundtruthing, to produce comprehensive biotope maps of the Sound of Barra based on an integration of the methods involved.
- To assess biological changes occurring in the Sound of Eriskay in the vicinity of the causeway.

1.1 Sound of Barra – Site background

The Sound of Barra comprises a mixture of islands, extensive rocky reefs, sand banks and shallow channels in a broad stretch between the southern end of South Uist and the north eastern shore of the island of Barra in the Outer Hebrides. The complex topography, diversity of habitat types and fast tidal streams have created an area of high biodiversity interest.

The limits of the intertidal survey area are shown in figure 1.1.1 and the limits of the subtidal biotope mapping survey and the Eriskay causeway change assessment survey are shown in figure 1.1.2. The difference in coverage between intertidal and subtidal mapping surveys is because some areas of the Sound were previously mapped subtidally by a survey conducted in 2001 (Bates *et al* 2004a).

Figure 1.1.1 Extent of the Sound of Barra intertidal biotope survey.

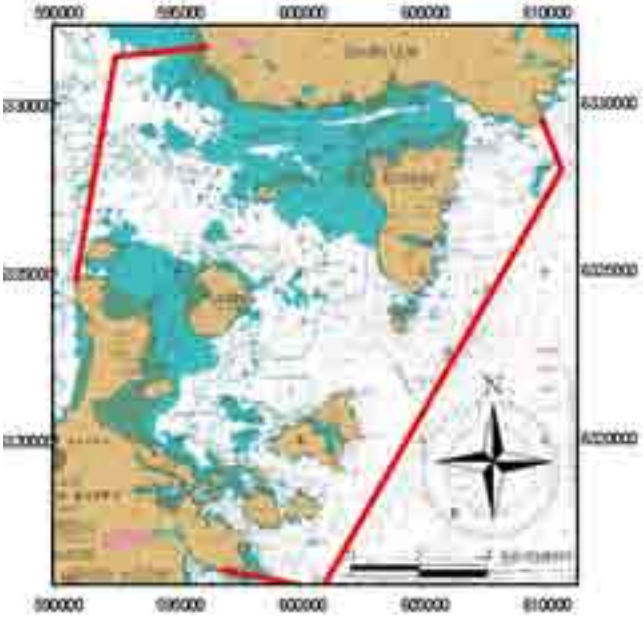
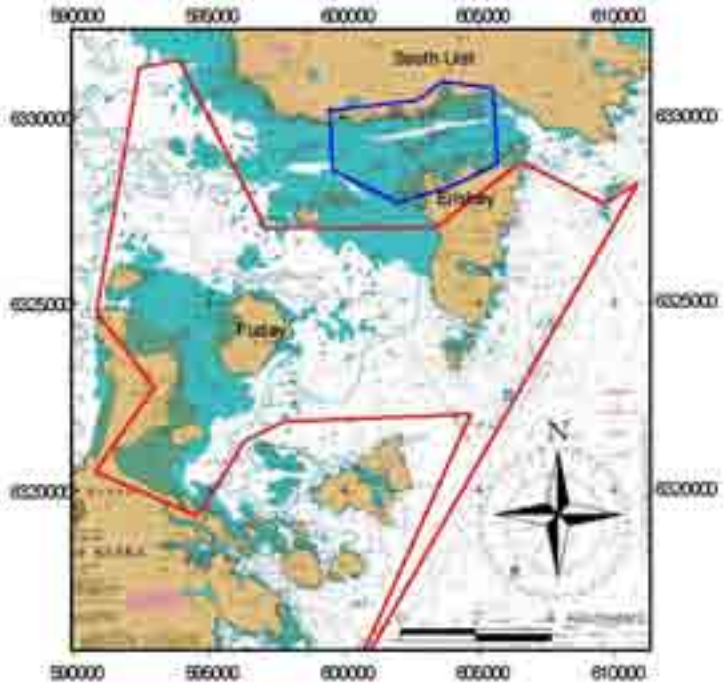


Figure 1.1.2 Extent of the Sound of Barra subtidal biotope survey (red line) and Eriskay causeway survey area (blue line).



1.2 Geological background

The Outer Hebrides are composed almost entirely of Pre-Cambrian basement rocks (known collectively as Lewisian), some of the oldest and most durable rocks found around the world (1.7–2.8 billion years). These rocks mostly comprise a series of monotonous grey gneisses, which are cut by a variety of Permo-Carboniferous and Tertiary basic igneous dykes and sills. Granitic veining is also common. The landscape was modified by a period of intense glacial erosion during the Quaternary in which nearly the whole of the Outer Hebrides was heavily glaciated. This weathered the region to its distinctive subdued hummocky landscape. Dunes and extensive flats of blown sand (machair) characterise the backing of sandy beaches. This complex formation process has led to a Sound with a highly complex morphology, being laced with islands and rocky outcrops separated by areas of sand and sand and mud in both intertidal and subtidal regions. The complexity of the morphology leads to a complex biology through providing a variety of different habitat niches.

1.3 Pre-existing data

Pre-existing biological data are available for specific localities within the Sound as a result of environmental impact assessments of a ferry terminal development on Barra (Cordah 2000b), of a corresponding ferry terminal development on Eriskay (Cordah 2000a) and of the Eriskay causeway (Cordah 1999). In 2001 a subtidal biotope mapping survey was conducted which encompassed the waters around Gighay, Hellisay and Fuiay in the southern part of the Sound and also the Sound of Eriskay and approaches in the northern part of the Sound (Bates *et al* 2004a). Data from comparable environments are available from the 2005 survey of the Sound of Harris (Malthus *et al* 2006). These studies are discussed in more detail in section 5 of this report.

Like the Sound of Harris, the Sound of Barra is a topographically complex area encompassing a range of exposure levels and various tidal current regimes. It was anticipated that this complexity would be reflected in the distribution of biotopes and that the composition of biotopes would be broadly similar to those recorded on the 2001 Sound of Barra survey and the 2005 Sound of Harris survey.

2 METHODS

2.1 Scientific staff

A number of research scientists from HWU, EDU and AFBI, were involved with the field surveys and subsequent data analysis. These individuals are listed in Table 2.1.1

Table 2.1.1 Scientific Staff involved in the 2006 Sound of Barra mapping survey

Scientist	*Field Responsibility*	*Processing responsibility*	*Institution*
Carol Daniels	Biological surveying	Project management	SNH
Dr Tim J Malthus	EDU Team leader, optical ground truthing	Optical image analysis, reporting	EDU
Dr Evanthia Karpouzli	Optical ground truthing	Optical image analysis	EDU
Antonino Maltese	-	3D fly throughs	EDU
Dr Dan Harries	HWU Team leader, biological surveying and project management	Post survey biological data processing and reporting, overall project management	HWU
Dr Colin Moore	Biological surveying, Skipper *RV Serpula*	Providing advice on data processing & interpretation	HWU
Dr Alastair Lyndon	Biological surveying		HWU
Dr James D Mair	Biological surveying		HWU
Dan Edwards	Biological surveying	Granulometric sample processing	HWU
Colin Trigg	Biological surveying		HWU
Stuart Brown	Biological surveying		HWU
Sue Hamilton		Infaunal sample processing	HWU
C. Harper	Acoustic survey		AFBI
T. Stevenson	Acoustic survey		AFBI
Dr Matt Service		Acoustic data processing	AFBI
Anikka Mitchell		Acoustic data processing	AFBI
Fiona Ware	Specimen preservation	Curation of voucher collection held at National Museums of Scotland	NMS

2.2 Biological ground survey

2.2.1 Biotope mapping survey station selection

The distribution of the ground survey stations was dictated by the requirement to relate biotopes to both the acoustic classification and the satellite image. It was also necessary to ensure that the distribution of the stations gave good geographical coverage of the Sound and were representative of the range of prevailing environmental conditions.

The subtidal stations were selected by subdividing the survey area into 12 sectors. The relative extent of each sector was dictated by anticipated habitat and environmental complexity based on an examination of the Admiralty chart and the satellite image. Within each sector a roughly equivalent number of potential stations were selected to give broad and representative coverage of features discernible on the satellite image and chart. Intertidal stations were selected in a similar manner with the addition of extra sectors to cover the intertidal survey areas that lie outside of the subtidal survey area limits.

2.2.2 Biotope mapping field procedures

The survey was conducted by 2 teams.

One team (Team A) operated from the main survey vessel (*RV Serpula*) and concentrated on deeper areas of the Sound surveying groundtruth stations by dropdown video. A representative selection of sedimentary habitats were sampled by Van Veen grab ($0.1m^2$) to aid biotope identification.

The second team (Team B) operated from an Avon inflatable concentrating on shallow or inaccessible areas. Stations were surveyed by diver. At each station divers spent 10 minutes recording details of substrate, environmental conditions and biological communities. The divers also recorded video footage to give an overview of the nature of the site. A representative selection of sedimentary habitats were sampled by 5 deployments of a $0.045m^2$ mini Van Veen grab to aid biotope identification.

During periods of low tide each team visited a number of intertidal groundtruth stations. At each site surveyors recorded details of substrate, environmental conditions and biological communities dividing the shore profile into biological zones as appropriate. Zones of sufficient extent to be discernable on the satellite image were identified for use in the supervised classification of the image. In addition to field records, representative video footage and digital stills images were taken at each shore location. At selected sediment shores infaunal samples were collected, each sample consisting of 8 cores of 10 cm internal diameter taken to a depth of 15 cm. In addition, a dig-over was made of a $1m^2$ area and the presence of any fauna noted.

Records were acquired from a total of 204 subtidal stations. Of these, 137 were surveyed by drop-down video and 67 by diver. A total of 46 shore locations were visited and records acquired from 258 shore zones. Sediment infauna samples were collected from 56 locations (40 subtidal and 16 intertidal) and all were selected for full identification and enumeration.

2.2.3 Eriskay causeway survey

Five sites previously surveyed in 2001 were revisited and resurveyed by divers recording details of substrate, environmental conditions and biological communities. The divers also

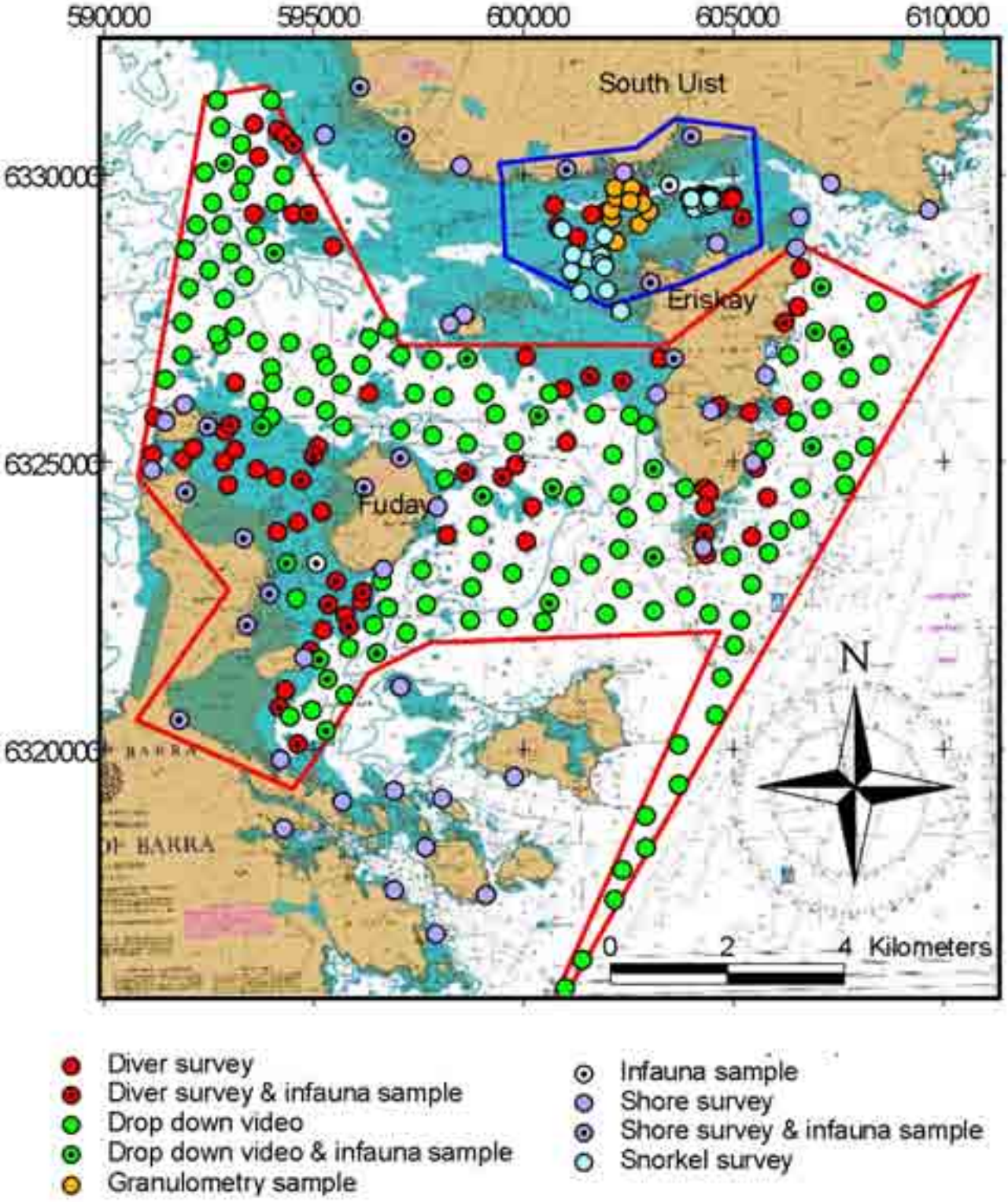
recorded video footage to give an overview of the nature of the site. These sites included two maerl sites and one *Zostera* site. Two sites previously sampled for infauna in 2001 were re-sampled including one of the diver survey sites.

Change in *Zostera* distribution was assessed by visiting a series of pre-determined point locations. These sites were selected by comparison of the 2001 and 2006 satellite images to identify points where changes in *Zostera* had occurred as well as points where *Zostera* abundance had been maintained. These locations were surveyed by diver or snorkel as appropriate. Additional *Zostera* groundtruth data were collected by drifting over the *Zostera* beds in an inflatable boat while viewing the seabed with a mask and snorkel and recording the position of boundaries between dense *Zostera* and areas of open sand.

Granulometric samples for assessing potential future changes were collected by a 0.045m^2 mini Van Veen grab at ten locations in the vicinity of the causeway.

The locations and survey methods for the groundtruth stations are shown in Figure 2.2.1.

Figure 2.2.1 Locations and survey methods for biological groundtruth stations within the Sound of Barra



All subtidal and intertidal infaunal samples were sieved on a 1 mm mesh and preserved in 5% buffered saline formaldehyde. Sediment subsamples were retained for granulometric analysis.

Station positions were established using satellite differential GPS units. Positions were recorded in decimal degrees WGS 84 datum and subsequently converted to UTM (by the OS "Grid InQuest" conversion software) for plotting.

Corrections to chart datum were made based on tidal rise predictions for North Bay provided by the UK Hydrographic Office 'Total Tide' software.

2.2.4 Coding system for survey stations

A coding system was established in order to avoid duplications in the labelling of data records and sample containers. Station codes were prefixed by SB06 denoting the Sound of Barra survey 2006. Intertidal sites are labelled with 'I' and subtidal sites with 'S'. The survey teams are identified with 'A' (Serpula team) or 'B' (inflatable team). Each team numbered their intertidal and subtidal sites consecutively. Hence, SB06 IA5 was the 5th intertidal location visited by team A. For convenience the SB06 prefix is omitted from the text of this report.

2.2.5 Post survey processing

All video records were reviewed and additional notes on substrate and biota were incorporated with field notes.

Sediment infauna were extracted from the samples, identified and enumerated at species level. A reference collection was retained for incorporation into the biological collections of the National Museums of Scotland.

Corresponding sediment samples were processed to establish particle size distribution. After drying, washing and disaggregation, sediments were processed by dry-sieving and recording the dry weight of particle size fractions at half phi intervals. Appropriate biologically relevant parameters were then calculated (*e.g.* median grain size, silt/clay content, gravel content).

2.2.6 Biotope allocation

The biotope classification scheme is that of Connor *et al* (2004).

2.2.6.1 Rock substrates

A provisional categorisation was made based on the field records and the information provided by the video review. The consistency of this categorisation was subsequently confirmed by conducting exhaustive cross checks for each biotope using the video footage and images.

2.2.6.2 Sediment substrates

Biotopes were initially allocated for the sampled sites on the basis of the infaunal data, particle size analysis, field records and video review records. Multi dimensional scaling (MDS) was used to verify the biotope categorisation of samples. Biotopes were allocated to remaining sites based on rigorous cross checks of video footage and field records.

Biotope distribution was examined by plotting them onto a background chart and satellite image using ArcView GIS software. The distribution was examined to confirm that the biotopes allocated to the stations were consistent with the prevailing environmental conditions at the stations.

2.3 Satellite imaging

2.3.1 Satellite imagery

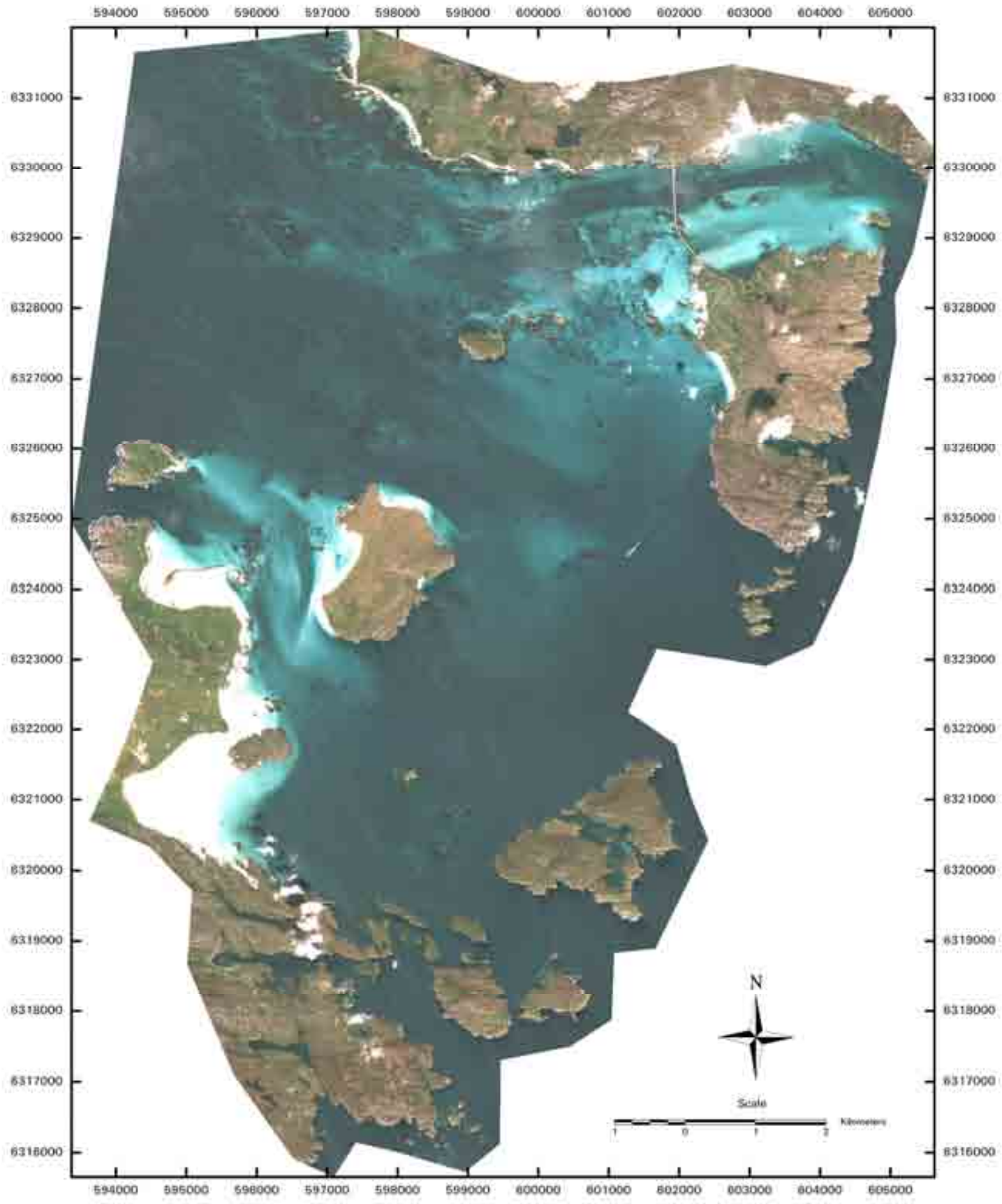
Orders were placed for a QuickBird satellite sensor multispectral image acquisition over the Sound of Barra from June 2006. The characteristics and spectral response functions of the QuickBird sensor can be found in Bates et al. (2004b). Conditions on the acquisition in terms of timing were also placed by the need for acquisition during periods of low tide to ensure intertidal regions were exposed and to minimise the effects of water column attenuation. This requirement restricted the image acquisition 'windows' to two periods per month of approximately 7 days each.

A relatively cloud free multispectral image was acquired on 9th of July 2006, the characteristics of which are given in Table 2.3.1. The image acquired was close to cloud free, with two small bands of cloud and associated shadow overlying the island of Eriskay and areas of water to the north and east and a small band of cloud and shadow lining the coast of the island of Barra (Figure 2.3.1). Visual inspection of the data revealed few radiometric problems or other flaws such as missing scan lines, etc. The tidal height at the time of acquisition was 1.3 m above Chart Datum. This dataset was used in all subsequent satellite image processing and for mapping the biotopes in the Sound of Barra and for change detection in the Sound of Eriskay.

Table 2.3.1 Sound of Barra QuickBird image data acquisition characteristics.

Acquisition Date:	9th July 2006
Acquisition Time:	12:09 GMT
Platform altitude:	450 kilometers
Orbit:	98 degrees, sun-synchronous
Geometric Processing Level:	Standard
Interpolation Method:	Nearest neighbour
Bits per Pixel:	11 (2048 brightness levels)
Satellite Azimuth:	278.3˚
Satellite Elevation:	76.9˚
Sun Angle Azimuth:	169.7˚
Sun Angle Elevation:	55.2˚
Multispectral data spatial resolution:	2.5 m
Multispectral bands: Blue Green Red Near Infrared	 450 - 520 nm 520 - 600 nm 630 - 690 nm 760 - 900 nm

*Figure 2.3.1 The raw QuickBird image acquired over the Sound of Barra***.**



2.3.2 Field methods

All field-based measurements associated with the acquisition of data to support the processing of the satellite imagery were collected during a targeted field campaign in the Sound of Barra from the 6th to 13th August 2006.

2.3.2.1 Establishment of ground control points

The QuickBird imagery was supplied by DigitalGlobe Inc. in geocorrected form to a 1:50,000 scale accuracy. To check the accuracy of the imagery, 51 prominent and permanently located sites which were discernable on the imagery were measured for their precise location using a WAAS-enabled 12 channel Magellan Marine GPS unit. GPS station positions were recorded for at least 10 minutes, which, with EGNOS availability, gave a positional accuracy of approximately 2 m, within one pixel of the true position of the multispectral imagery. Positions were recorded in UTM WGS84 coordinates.

The same GPS unit was used to accurately locate all other land and water-based measuring sites.

2.3.2.2 Measurements of land field target for atmospheric correction

Atmospheric correction of the imagery was undertaken using the empirical line method which provides an accurate method for atmospherically correcting high spatial resolution satellite imagery (Karpouzli and Malthus, 2002). Five large and relatively homogeneous land targets of varying brightness were measured for their spectral reflectance properties using a GER 1500 spectroradiometer hired for this research from the NERC Field Spectroscopy Facility (Table 2.3.2). The targets used ranged from dark tarmac, a grass field, and a sand dune. The methods employed are outlined in detail in Bates et al. (2004a). These sites were augmented by a further four sites measured during the biotope survey undertaken in 2001 (Bates et al. 2004a).

Table 2.3.2 Locations of the five new land targets measured for atmospheric correction of the Sound of Barra QuickBird imagery, together with the 2001 sites used in the analysis.

Station	*Surface type*	*Easting*	*Northing*
2006 sites			
SB06CA01	Concrete	596972	6319482
SB06CA02	Black asphalt	594998	6322215
SB06CA03	Grass	594969	6322244
SB06CA04	Sand	594343	6321613
SB06CA05	Grey Asphalt	595619	6318597
2001 sites			
	Grass	602759	6327477
	Sand	602762	6326864
	Black Tar	602614	6326463
	Grass lawn	601957	6330434

2.3.2.3 Measurements of within-water spectral and broad band attenuation

To characterise the spectral nature of light attenuation in the region, 8 high spectral resolution attenuation measurements were made at 4 sites in the Sound of Barra (Table 2.3.3). The measurements were made using a GER 1500 spectroradiometer and fibre optic probe fitted with a cosine-corrected sensor (Bates et al. 2004a). Measurements were made at 0.5 m intervals down to ~4 m below the water surface. A reference photometer on the boat was used to check for any variations in overhead irradiance during the measurements.

Table 2.3.3 Location of spectral attenuation measurement sites in the Sound of Barra.

Station	*Easting*	*Northing*	*Date*
SB06CSp01	600780	6323078	11.08.06
SB06CSp02	601137	6328992	11.08.06
SB06CSp03	600830	6329526	11.08.06
SB06CSp04	602352	6329633	11.08.06

Measurements of gross spatial variations in downwelling Photosynthetically Active Radiation (PAR) attenuation were also made at 4 selected stations in the Sound using a suitable broad band underwater sensor (Table 2.3.4).

All attenuation measurements were made between 10:00 and 15:00 hours local time each day, to minimise solar angle effects.

Table 2.3.4 Location and calculated broad band attenuation coefficients for a number of sites in the Sound of Barra. Figures in brackets represent a repeated measurement at the same site.

Station	*Easting*	*Northing*	*Attenuation coefficient (PAR, m^{-1})*	*Date measured*
SB06CP01	600775	6323067	0.50	11.08.06
SB06CP02	601147	6328981	0.51 (0.58)	11.08.06
SB06CP03	600830	6329524	0.44	11.08.06
SB06CP04	602365	6329646	0.41 (0.40)	11.08.06

2.3.3 Satellite image processing

2.3.3.1 Geocorrection

Qualitative comparison of field-measured GPS data points with that of the original image supplied by DigitalGlobe indicated that the original data supplied were accurate to within ~20 m of 'true' location. The shift was largely in a Westerly direction. A geometric correction was performed on the data, and in total 32 of the 50 GCP's were used which reduced the positional error to less than the dimension of a single pixel (Total RMSE = 2.3 m). A simple linear shift was performed with nearest neighbour resampling. Further details of the geocorrection procedure can be found in Bates et al. (2004a).

2.3.3.2 Atmospheric correction

Using the homogeneous target data measured with the field spectroradiometer in both 2006 and 2001 (Section 2.3.2.2), relationships were developed between the calculated ground-based QuickBird reflectance values and related values extracted from the corresponding pixel locations in the multispectral QuickBird image dataset. The relationships for all four bands were all highly linear (R^2 values ≥ 0.97, Table 2.3.5). These empirically derived relationships were used to atmospherically correct the QuickBird data to percent reflectance (Karpouzli and Malthus, 2002).

Table 2.3.5 Relationships between ground target reflectance (x) and image (y) pixel values used for atmospheric correction of the satellite data.

QuickBird Band	*Equation*	R^2
Blue	y = 0.1102x - 19.338	0.976
Green	y = 0.0659x - 13.513	0.970
Red	y = 0.0829x - 8.700	0.976
Near infrared	y = 0.0817x - 9.587	0.974

2.3.3.3 Masking

To remove land areas, the corrected QuickBird image dataset was masked to a manually adjusted Scottish coastline vector dataset previously supplied by SNH. Areas of cloud and cloud shadow were also removed from the imagery by manually digitising around the affected areas.

2.3.3.4 Water column correction

To account for the effects of water depth and scattering and absorption in the water column the image was further processed to better recognise bottom habitats. The method applied was that of Lyzenga (1978, 1981) whose method involves the initial linearisation of reflectances in all available bands for the attenuating effects of water depth, using:

$X_i = \ln (L_i - Ls_i)$

where L_i is the measured radiance in band i, and Ls_i is the measured radiance over deep water. This is followed by the calculation of relative bottom reflectance (Yi) determined by:

$Y_i = k_j X_i - K_i X_j / (k_i^2 + k_j^2)^{0.5}$, where k_i is the attenuation coefficient in band i.

2.3.3.5 Biotope classification

Our previous experience in the classification of marine biotopes using optical and acoustic remotely sensed data indicates that raw automated approaches such as supervised maximum likelihood classification give poor results where considerable spectral mixing between classes leads to inaccurate results on account of similarities between subtidal and intertidal components (Malthus et al. 2006). To improve on these purely spectral- or intensity-based approaches a combined spectral/acoustic and expert systems-based approach to classification was used. This classification used the spectral information from the training areas defined above and combined it with defined rules based on expert knowledge of the zonation patterns of biotopes and the depth ranges and exposures within which they occur.

Separate classifications were produced for the intertidal and subtidal components which were later combined into a single classification map for the entire study area. The ground truthing survey data conducted by HWU were used to provide the basis for training the classification process. All ground truthing station data were first assigned a biotope class and a separate ID code. Training areas were then delineated and assigned on each image component for each biotope except for those biotopes for which there were found to be ~3 or fewer stations identified (those that were not included are mentioned in the results section below). Approximately two thirds of the groundtruthing sites were used for training with one third (168 sites) held over for accuracy assessment.

Biotopes that were spectrally or acoustically indistinguishable from other similar biotopes were combined in common biotope class definitions on the basis of their hierarchical biotope groupings (Connor et al. 2004). The separate intertidal and subtidal classifications were then combined to form a separate biotope classification map. Further details on the classification process are provided in the results section.

2.4 Acoustic survey

2.4.1 Survey methodology and calibration

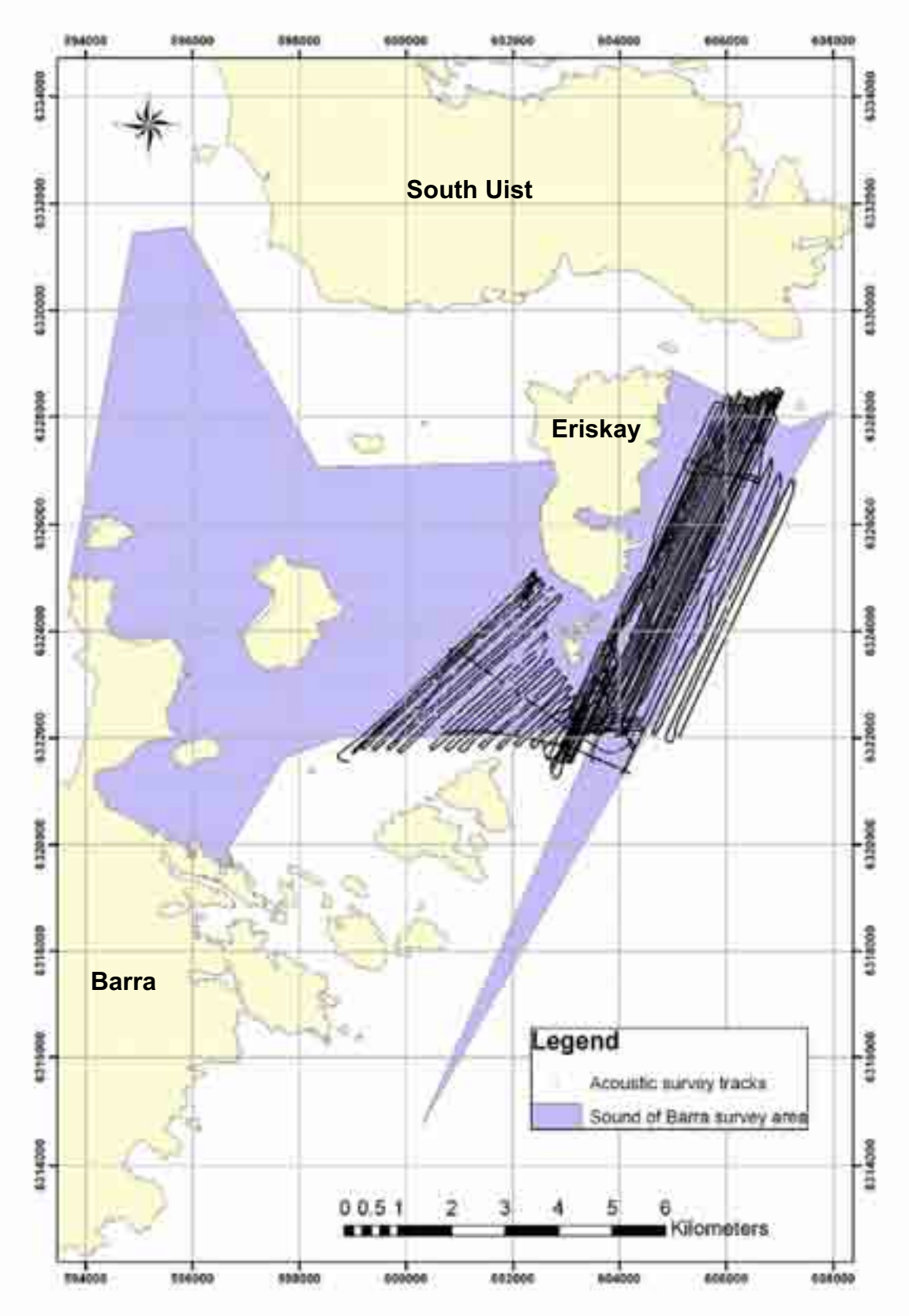
In order to achieve 100% coverage of the deeper subtidal area within the Sound of Barra study site, a swathe sonar system is required. Such acoustic systems can achieve high resolution bathymetric data across a wide swathe either side of the survey vessel, which maximises coverage while minimising survey time. In addition to the bathymetric data collection, such systems also collect data from the return echoes known as backscatter (the strength and wave decay pattern), which can provide additional and valuable information relating to the nature of the seabed substrates.

A number of swathe sonar systems are available, but upon consideration of the survey site and the depth range, an interferometric sonar system was selected for this project (GeoAcoustics^{TM} GeoSwath Plus bathymetric sonar). Such a system is vessel-mounted, and records high-resolution bathymetric data and also backscatter data of sidescan sonar-like quality. The system has accurate motion sensing so that all images will be high quality and corrected for motion and tide. Bathymetric data can be collected using the system to IHO Order 1 standard where required.

A QTC-View Series V (Quester Tangent Corporation Inc.) Acoustic Ground Discrimination System (AGDS) was run concurrently to the GeoSwath Plus system aboard the survey vessel, and the information was used to assist the interpretation of the swath/side scan sonar data.

Deployment strategy:
The survey area was selected from within the overall survey site to cover subtidal regions deeper than the satellite imagery extinction depths. Track spacing varied between 40m and 160m according to depth to ensure 100% coverage as far as possible, and each track line was plotted by the hydrographic surveyor Chris Harper on the ships navigation software, and allowance was made to avoid navigational hazards. Figure 2.4.1 below shows the overall survey area and the vessel tracks of the acoustic survey.

Figure 2.4.1 Survey area and acoustic survey tracks



2.4.2 Technical specification

2.4.2.1 Swath bathymetry/side scan sonar

GeoAcoustics GeoSwath Plus meets IHO SP44 Special Order specifications. It is an interferometric system operating at 250kHz, which uses the phase content of the signal to measure the angle of the wave front of the returning echo. The depth of the seabed-reflecting surface is calculated from this angle and elapsed time. The system also measures signal amplitude and side scan images are derived from this information. The system offers a good resolution from which accurate and detailed bathymetric models can be produced. The GeoSwath Plus transducer was pole-mounted from the side of the RV *Aora*.

2.4.2.2 QTC-View Series V AGDS

The QTC-View Series V AGDS was used simultaneously with the GeoSwath system. The QTC-View system is permanently installed aboard the RV *Aora* and operates via a hull-mounted Simrad EK60 38kHz split beam echosounder (200W power; ping rate 1 Hz). The system is regularly calibrated according to the manufacturer's instructions (QTC Inc.) and optimised for use aboard the RV *Aora.* Acoustic ground discrimination systems (AGDS) are based on single beam echosounders and use the return echoes to not only calculate depth but also use the strength and decay of the echo to indicate seabed texture and hardness. For instance a strong return echo indicates a hard seabed substrate; a long echo decay indicates a rough seabed. These properties can be used to discriminate broad categories of sea floor habitats (Foster-Smith *et al*., 2000, 2001; Foster-Smith and Sotheran, 2003). The acoustic data, together with GPS data, are logged onto a computer. Data is visible in real time as it is collected, and quality checks are regularly made throughout the survey to ensure data is reliable.

Once a survey is complete, the data is processed using QTC-Impact (section 3.3.1).

2.4.2.3 Performance of the acoustic systems

The GeoSwath Plus system was operated by Chris Harper at 250 kHz and at various power settings and swath widths between 50 and 200m depending on water depth and line spacing. The AGDS operated at 38 kHz. The survey was undertaken between 19th and 22nd of July 2006, with mobilisation and demobilisation occurring on the days immediately prior to and following the survey respectively.

Basic processing (during which data is corrected for GPS offsets, tide and variations in speed of sound, gridded and mosaiced) cannot be undertaken with the GeoSwath system (on previously collected data) at the same time as data is being acquired. The raw data was backed up every evening and processed after returning to base. Data was inspected at the end of each day for quality assurance.

The AGDS was operated by Tom Stevenson, who undertook processing at the end of the survey while still aboard the RV *Aora.* During the survey data was saved using QTC-View proprietary software at a rate of one record every 5 seconds.

2.4.3 GeoSwath Calibration

The GeoSwath system was fully tested and calibrated by Chris Harper en route to the survey site from Millport. The manufacturer's calibration methods were followed, which are detailed by Malthus *et al.* (2006). In addition, a calibration area was chosen at the survey site that was surveyed on the first and last days of the survey.

2.4.4 Tide Data

Tidal gauge data was collected from the nearest stations courtesy of the British Oceanographic Data Centre for the duration of the acoustic survey. This data was compared to tidal models provided by UKHO for the region. The calibrated models were used to apply tidal corrections to the bathymetric data collected by the GeoSwath system. Tidal corrections were not made to the AGDS data, as this information was not required as it overlaps the more accurate GeoSwath bathymetric data.

2.4.5 Sound Velocity Profiler Data

A Seabird SBE 19plus CTD recorder was used to generate sound velocity profiles at six locations within the survey area. These data were used to adjust the sound velocity settings within the GeoSwath system during data collection, and also used to help clean data during processing (the sound velocity profiles are provided in Appendix 8).

2.4.6 GPS Calibration

A Simrad GN30D differential GPS receiver was used for heading sensing and dGPS data. The GPS was calibrated/verified by collecting 10 minutes duration of data points (between 300-500 points) at a fixed location in Castlebay. The calibration data set provided a consistent and accurate position with the variation being ±0.35m.

2.4.7 Vessel Calibration

Physical measurements of the vessel and the location of the GPS antenna and acoustic transducers were recorded; these data were then used when processing the swath data to compensate for any offsets and geometrical errors. All measurements were entered into the vessel survey section of the GeoSwath Plus data acquisition software.

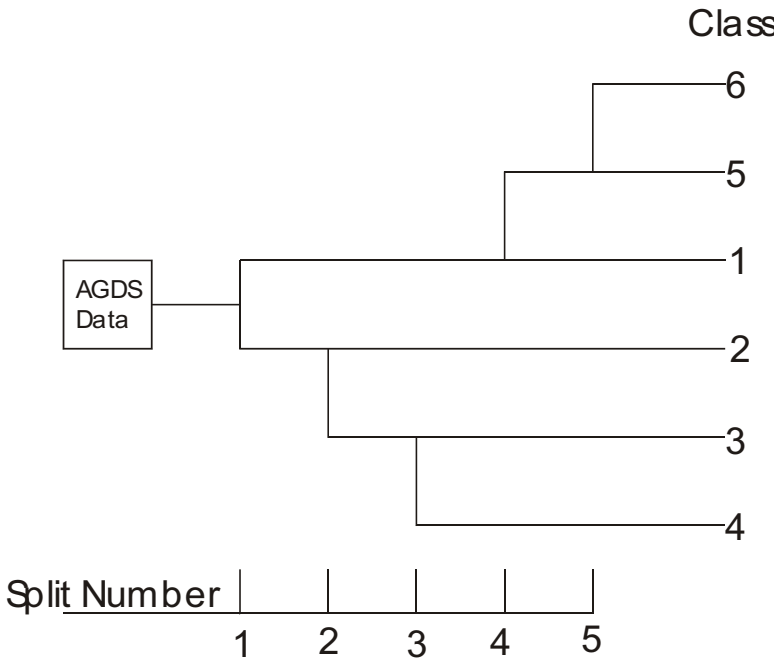
2.4.8 Data Processing

2.4.8.1 QTC-View AGDS

Tom Stevenson completed all data processing after the survey was complete. The raw AGDS data collected throughout the survey using the QTC-View Series V was combined into a single file and processed using QTC-Impact (an unsupervised classification). Potentially erroneous data, such as depth spikes or missing values, was examined and removed, with 1368 erroneous records deleted leaving 21,168 datapoints for further analysis. This level of erroneous data records is common in AGDS, especially where weather conditions are not ideal due to waves entraining bubbles beneath the transducer. A Principle Components Analysis (PCA) undertaken by the QTC-Impact software. The first three principle components were used in the classification (and the values for pc1, pc2 & pc3 are available in the QTC data). Six acoustic classes were identified from the data; the order in which the

clusters were ‘split’ is indicated below (Figure 2.4.2). The resulting catalogue was used to classify each QTC data point into one of the six classes.

Figure 2.4.2 The order in which the QTC-View acoustic classes 1-6 were split apart.



2.4.8.2 GeoSwath Processing

The GeoSwath Plus data were processed using proprietary GeoAcoustics software. Bathymetric data processing involves replaying the raw data and applying any correction required from the calibration procedure: this removes effects of vessel movement, tide, speed of sound through the water column and the geometric offsets of equipment set up on the data. In addition to applying the corrections above this procedure allows for the data to be filtered to remove noise and increase the accuracy of the processed data. These filters are detailed in Malthus *et al.* (2006). Chris Harper undertook all bathymetric data processing successfully to produce clean XYZ (eastings, northings, depths (relative to Lowest Astronomical Tide)) datasets.

The sidescan sonar (backscatter) data is also processed through the software, which allows the overlapping track data to be cleaned and mosaiced with user input to decide on which track to favour where areas overlap. Finally, GeoTexture software, developed by GeoAcoustics for use with GeoSwath data, uses backscatter textures to classify the entire survey area into a number of classes which may relate to seabed ground-types.

3 RESULTS

3.1 Infaunal analysis

All station data and biotope identities of the groundtruth stations are presented in Appendix Tables 7.1.1 to 7.1.3. Images (where available) of the biotopes and a summary list of records are given in Appendix Tables 7.2.1 to 7.2.4. A note on the biotope coding system is provided in appendix 7.

Samples from 56 selected stations were fully processed and the data are given in Appendix Tables 7.3.1 to 7.3.3 in the form of species by site matrices. Diversity indices were calculated and are given in Tables 3.1.1 and 3.1.3. Corresponding granulometric data are given in Tables 3.1.2 and 3.1.4.

3.1.1 Sublittoral samples

Six samples were designated to the biotope **SS.SSa.IFiSa.IMoSa**. These were characterised by a very impoverished infaunal community with no clear affinities to other biotopes. The samples were from a range (5-11m) of depths at exposed high energy sites with rippled clean medium to fine sands.

Seven samples were designated to the biotope **SS.SSa.IFiSa.NcirBat**. These were characterised by a high proportion of *Bathyporeia* and the presence of *Nephtys cirrosa*. However, often they also contain low abundances of *Morella* and venerid bivalves (**SS.SCS.ICS.MoeVen**) and the more impoverished examples of this biotope grade into **SS.SSa.IFiSa.IMoSa**. The sample sites are indistinguishable from **SS.SSa.IFiSa.IMoSa** in terms of appearance and sediment type. They occurred on sandbanks over a slightly shallower depth range (2 – 8m).

Seven samples were designated to the biotope **SS.SCS.ICS.MoeVen**. These were characterised by a high proportion of *Morella* and venerid bivalves. The infaunal composition overlaps with **SS.SSa.IFiSa.NcirBat** often including *Nephtys* and high proportions of *Bathyporeia.* Sediment appearance was variable, often indistinguishable from **SS.SSa.IFiSa.IMoSa** and **SS.SSa.IFiSa.NcirBat** but with less developed rippling at some sites. Sediment type is also largely indistinguishable from **SS.SSa.IFiSa.IMoSa** and **SS.SSa.IFiSa.NcirBat** but with a slightly increased gravel content at some of the sites.

One sample was designated to the biotope **SS.SCS.ICS.HeloMsim**. This included a high proportion of turbellarians and the presence of *Microphthalmus*. The fauna is otherwise similar to an impoverished version of **SS.SSa.IFiSa.NcirBat**. The substrate was indistinguishable from **SS.SSa.IFiSa.IMoSa** and **SS.SSa.IFiSa.NcirBat** in terms of appearance and sediment type. It originated from a tideswept shallow (~4m) sandbank similar to the **SS.SSa.IFiSa.NcirBat** sites.

Five samples were designated to the biotope **SS.SSa.IMuSa.FfabMag**. These were characterised by an infauna more abundant and species rich than the biotopes described above. The samples were somewhat variable in species composition but there are marked similarities within the group and the characterising species of **SS.SSa.IMuSa.FfabMag** are well represented in some of the samples. The sediment was fine sand generally with slight hummocks but no ripples. The sediment contained slightly more silt / clay (~2%) and occurred in slightly deeper (9-20m) than was the case for the preceding biotopes.

Five samples were designated to the biotope **SS.SSa.IFiSa.TbAmPo**. These were similar to **SS.SSa.IMuSa.FfabMag** in terms of species richness and abundance but have an infauna characterised by tube-dwelling amphipods such as *Corophium crassicorne*. The sediment appeared similar but was slightly coarser and siltier (~4%) than the **SS.SSa.IMuSa.FfabMag** samples. Sample locations were shallower (4-11m) and occurred at relatively sheltered sites.

Three samples were designated to the biotope **SS.SMp.KSwSS.LsacGraFS**. These were designated on the basis of a well developed cover of algae on the sediment surface. The infauna was variable showing affinities to **SS.SSa.IFiSa.TbAmPo** and to **SS.SMu.ISaMu.MelMagThy**. Sediment type was similar to **SS.SSa.IFiSa.TbAmPo** and occurred in similarly sheltered environments at similar depths (4-10m).

Two samples were designated to the biotope **SS.SMu.ISaMu.MelMagThy**. The overall species richness and abundance were similar to both **SS.SSa.IMuSa.FfabMag** and **SS.SSa.IFiSa.TbAmPo** but the infauna included a high proportion of the species characteristic of the biotope including *Thyasira flexuosa*. Sediment type was of fine sand with a higher proportion of silt / clay (8-13%) than seen in **SS.SSa.IMuSa.FfabMag** and **SS.SSa.IFiSa.TbAmPo**. Both samples came from neighbouring areas of a sheltered part of the survey area.

Two samples were designated to the biotope **SS.SSa.CFiSa.EpusOborApri**. Faunal abundances were low relative to **SS.SSa.IMuSa.FfabMag** and **SS.SSa.IFiSa.TbAmPo** but species richness remained high. The infauna included a high proportion of the species characteristic of the biotope including *Echinocyamus pusillus* and *Abra nitida*. The sediment was a slightly rippled fine sand with a silt / clay content similar to that of **SS.SSa.IFiSa.TbAmPo**. Both samples originated from relatively deep (25-26m) water in an exposed area in the northeastern part of the survey site.

One sample was designated to the biotope **SS.SCS.CCS.MedLumVen**. In terms of overall abundance the infauna was similar to **SS.SSa.CFiSa.EpusOborApri** but with slightly more species present. The composition of the infauna does not provide a clear match to any biotope but it does include species characteristic of **SS.SCS.CCS.MedLumVen** and the environment was appropriate to the biotope. The sediment is slightly coarser and has a relatively low silt / clay content in comparison to **SS.SSa.IMuSa.FfabMag**, **SS.SSa.IFiSa.TbAmPo**, **SS.SMu.ISaMu.MelMagThy** and **SS.SSa.CFiSa.EpusOborApri**.

One sample was designated to the biotope **SS.SMp.SSgr.Zmar**. The biotope was assigned on the basis of the dense cover of *Zostera* at the site. The infauna is abundant and species rich with no clear affinities with other biotopes in the area in terms of composition.

One sample was designated to the biotope **SS.SMp.Mrl.Pcal**. The biotope was assigned on the basis of the dense cover of maerl at the site. The infauna is abundant and species rich with a composition distinct from that of all other samples. The sediment type is also distinct from the other areas having a much coarser grain size and a low proportion of silt / clay. The sample came from a deep (23m) area in the eastern part of the site.

One sample was designated to the biotope **SS.SMu.IFiMu.Beg**. The infauna was very impoverished containing only a single species. The sediment type of soft sandy mud was distinct from other samples. The biotope was assigned on the basis of high *Beggiotoa* cover and signs of organic enrichment at the site.

3.1.2 Intertidal samples

Intertidal infauna samples showed significant variation in abundance and species composition. They fall into 3 major biotope complexes, **LS.LSa.MoSa**, **LS.LSa.FiSa** and **LS.LSa.MuSa**.

Six samples were designated to the biotope complex **LS.LSa.MoSa**. These were from medium to fine well drained sand shores which lacked surface ripples and had a relatively steep gradient. Sand grain size is slightly coarser than other samples. The infauna differs from that of the other samples in terms of species composition and also in having relatively low diversity levels.

Two of these were designated to the biotope **LS.LSa.MoSa.BarSa**. These contained an impoverished fauna and originated from the lower shore of steep exposed beaches. The remaining four samples were from dry upper shore sand at less exposed locations. Two were designated to the biotope **LS.LSa.MoSa.Ol.FS**. These were characterised by high abundances of Enchytraeid oligochaetes. One sample was designated to the biotope **LS.LSa.MoSa.AmSco.Eur** on the basis of the very high abundance of *Eurydice pulchra*. The remaining sample was not allocated to a specific biotope within **LS.LSa.MoSa**. The fauna contained a high proportion of species (e.g. *Malacoceros* & *Capitella*) indicative of organic enrichment. It does not match well with any intertidal biotope but include species characteristic of the muddy subtidal biotope **SS.SMu.ISaMu.Cap**.

Six samples were designated to the biotope complex **LS.LSa.FiSa**. Five of these are within the biotope **LS.LSa.FiSa.Po** and all originate from lower shore rippled wet sand. Four of the five are designated to sub biotope level based on the abundances of the characterising species. Two samples were designated to **LS.LSa.FiSa.Po.Ncir** and one each to **LS.LSa.FiSa.Po.Pful** and **LS.LSa.FiSa.Po.Aten** respectively. The remaining **LS.LSa.FiSa.Po** sample was dominated by species indicative of organic enrichment (e.g. *Malacoceros, Hediste* & *Capitella*). It does not match well with any intertidal biotope but include species characteristic of the muddy subtidal biotope **SS.SMu.ISaMu.Cap**.

The sixth sample designated to the biotope complex **LS.LSa.FiSa** was not allocated to a specific biotope. The infaunal species composition is a clear outlier amongst the intertidal samples. The fauna was considerably more abundant and species rich than other samples and it includes species more typical of subtidal sites (*e.g.* **SS.SSa.IFiSa.TbAmPo**). It is considered that strong onshore winds may have temporarily modified the species composition by displacing subtidal fauna onto the shore.

The remaining four samples were designated to the biotope complex **LS.LSa.MuSa** and have a considerable degree of infaunal overlap with the **LS.LSa.FiSa** samples. The samples were from fine, rippled wet lower shore sand of slightly finer grain than **LS.LSa.FiSa**. The samples originated from sheltered locations where *Cerastoderma* are present. Three of these samples were designated to the biotope **LS.LSa.MuSa.MacAre**. Both *Cerastoderma* and *Arenicola* occurred in significant quantities at two of these sites. The third site lacked *Cerastoderma* but had large numbers of *Arenicola* casts on fine hummocked sand. It occurred in a localised area of sheltered sediment and contained species indicative of organic enrichment (e.g. *Capitella*). The fourth sample was designated to the biotope **LS.LSa.MuSa.CerPo**. This site was a similar area of localised shelter with fine sand and *Cerastoderma* but no *Arenicola*.

Table 3.1.1 Diversity, species richness, abundance & biotope identity of subtidal infauna samples

Sample	*Shannon's Index (log_e)*	*Number of Species*	*Abundance*	*Biotope*
SA75	1.10	11	76	**SS.SCS.ICS.MoeVen**
SA121	2.28	18	71	**SS.SCS.ICS.MoeVen**
SA71	2.93	24	47	**SS.SCS.ICS.MoeVen**
SB28	2.39	14	33	**SS.SCS.ICS.MoeVen**
SB56	1.44	10	46	**SS.SCS.ICS.MoeVen**
SB38	3.04	29	69	**SS.SCS.ICS.MoeVen**
SB37	1.23	16	161	**SS.SCS.ICS.MoeVen**
SB66	1.77	8	28	**SS.SCS.ICS.HeloMsim**
SB24	3.28	40	95	**SS.SCS.CCS.MedLumVen**
SA92	1.54	6	11	**SS.SSa.IFiSa.IMoSa**
SA22	1.83	7	9	**SS.SSa.IFiSa.IMoSa**
SA87	1.79	7	18	**SS.SSa.IFiSa.IMoSa**
SA10	2.67	15	17	**SS.SSa.IFiSa.IMoSa**
SB57	1.60	5	5	**SS.SSa.IFiSa.IMoSa**
SB61	1.25	4	8	**SS.SSa.IFiSa.IMoSa**
SA107	1.55	9	21	**SS.SSa.IFiSa.NcirBat**
SB60	1.58	8	29	**SS.SSa.IFiSa.NcirBat**
SB11	2.44	15	32	**SS.SSa.IFiSa.NcirBat**
SB34	2.35	16	41	**SS.SSa.IFiSa.NcirBat**
SB47	1.93	11	43	**SS.SSa.IFiSa.NcirBat**
SB29	2.39	20	86	**SS.SSa.IFiSa.NcirBat**
SB6	1.42	15	132	**SS.SSa.IFiSa.NcirBat**
SA55	3.02	48	195	**SS.SSa.IFiSa.TbAmPo**
SB18	2.36	38	222	**SS.SSa.IFiSa.TbAmPo**
SB1	2.73	62	686	**SS.SSa.IFiSa.TbAmPo**
SA114	2.97	33	88	**SS.SSa.IMuSa.FfabMag**
SA68	3.22	39	105	**SS.SSa.IMuSa.FfabMag**
SA81	2.52	39	192	**SS.SSa.IMuSa.FfabMag**
SA132	2.97	45	165	**SS.SSa.IMuSa.FfabMag**
SB16	2.97	38	207	**SS.SSa.IMuSa.FfabMag**
SA54	2.66	28	104	**SS.SSa.CFiSa.EpusOborApri**
SA52	3.04	32	70	**SS.SSa.CFiSa.EpusOborApri**
SA5	3.03	38	153	**SS.SMu.ISaMu.MelMagThy**
SA57	2.57	40	254	**SS.SMu.ISaMu.MelMagThy**
SB21	0.00	1	10	**SS.SMu.IFiMu.Beg**
SA42	2.92	55	257	**SS.SMp.Mrl.Pcal**
SA1	3.12	54	374	**SS.SMp.KSwSS.LsacGraFS**
SB2	2.68	18	45	**SS.SMp.KSwSS.LsacGraFS**
SB32	2.82	28	86	**SS.SMp.KSwSS.LsacGraFS**
SB30	2.91	51	488	**SS.SMp.SSgr.Zmar**

Table 3.1.2 Sediment data corresponding to subtidal infauna samples

	Median grain size (μ)	*% silt/clay*	*% gravel*	*Biotope*
SA75	353.55	1.37	0.02	**SS.SCS.ICS.MoeVen**
SA121	353.55	1.18	8.81	**SS.SCS.ICS.MoeVen**
SA71	574.35	1.91	0.65	**SS.SCS.ICS.MoeVen**
SB28	217.64	1.45	0.44	**SS.SCS.ICS.MoeVen**
SB56	329.88	1.22	0.02	**SS.SCS.ICS.MoeVen**
SB38	287.18	1.25	2.04	**SS.SCS.ICS.MoeVen**
SB37	307.79	0.92	0.10	**SS.SCS.ICS.MoeVen**
SB66	466.52	0.95	0.98	**SS.SCS.ICS.HeloMsim**
SB24	659.75	1.52	1.00	**SS.SCS.CCS.MedLumVen**
SA92	189.47	1.20	0.04	**SS.SSa.IFiSa.IMoSa**
SA22	435.28	1.53	0.07	**SS.SSa.IFiSa.IMoSa**
SA87	267.94	1.21	0.00	**SS.SSa.IFiSa.IMoSa**
SA10	435.28	1.40	0.00	**SS.SSa.IFiSa.IMoSa**
SB57	378.93	1.26	0.13	**SS.SSa.IFiSa.IMoSa**
SB61	287.18	1.03	0.51	**SS.SSa.IFiSa.IMoSa**
SA107	250.00	1.12	0.02	**SS.SSa.IFiSa.NcirBat**
SB60	267.94	1.33	0.00	**SS.SSa.IFiSa.NcirBat**
SB11	466.52	1.34	0.32	**SS.SSa.IFiSa.NcirBat**
SB34	329.88	0.11	0.00	**SS.SSa.IFiSa.NcirBat**
SB47	329.88	1.06	0.00	**SS.SSa.IFiSa.NcirBat**
SB29	203.06	1.82	0.07	**SS.SSa.IFiSa.NcirBat**
SB6	378.93	1.39	0.35	**SS.SSa.IFiSa.NcirBat**
SA55	153.89	5.39	0.02	**SS.SSa.IFiSa.TbAmPo**
SB18	435.28	3.56	0.78	**SS.SSa.IFiSa.TbAmPo**
SB1	707.11	4.01	0.10	**SS.SSa.IFiSa.TbAmPo**
SA114	203.06	1.86	3.85	**SS.SSa.IMuSa.FfabMag**
SA68	153.89	2.39	1.80	**SS.SSa.IMuSa.FfabMag**
SA81	164.94	4.36	0.15	**SS.SSa.IMuSa.FfabMag**
SA132	143.59	3.10	0.91	**SS.SSa.IMuSa.FfabMag**
SB16	217.64	2.98	0.43	**SS.SSa.IMuSa.FfabMag**
SA54	153.89	4.07	0.29	**SS.SSa.CFiSa.EpusOborApri**
SA52	176.78	3.52	0.61	**SS.SSa.CFiSa.EpusOborApri**
SA5	133.97	8.41	0.09	**SS.SMu.ISaMu.MelMagThy**
SA57	133.97	12.63	0.00	**SS.SMu.ISaMu.MelMagThy**
SB21	<63.00	53.84	0.82	**SS.SMu.IFiMu.Beg**
SA42	2639.01	1.62	22.18	**SS.SMp.Mrl.Pcal**
SA1	82.47	36.59	0.03	**SS.SMp.KSwSS.LsacGraFS**
SB2	203.06	1.39	1.52	**SS.SMp.KSwSS.LsacGraFS**
SB32	189.47	3.27	0.05	**SS.SMp.KSwSS.LsacGraFS**
SB30	353.55	1.37	0.02	**SS.SMp.SSgr.Zmar**

Table 3.1.3 Diversity, species richness, abundance & biotope identity of intertidal infauna samples

Sample	*Shannon's Index (log_e)*	*Number of Species*	*Abundance*	*Biotope*
IA 1	0.37	4	86	**LS.LSa.MoSa**
IA 19	0.00	1	48	**LS.LSa.MoSa.BarSa**
IA 22	1.15	4	7	**LS.LSa.MoSa.BarSa**
IB 9(A)	0.47	7	127	**LS.LSa.MoSa.Ol.FS**
IA 9(A)	1.21	11	120	**LS.LSa.MoSa.Ol.FS**
IA 4	0.29	5	327	**LS.LSa.MoSa.AmSco.Eur**
IB 21	2.13	32	432	**LS.LSa.FiSa**
IA 16	1.28	9	208	**LS.LSa.FiSa.Po**
IB 10	1.20	8	40	**LS.LSa.FiSa.Po.Pful**
IA 20	1.74	7	37	**LS.LSa.FiSa.Po.Aten**
IB 19	1.73	8	19	**LS.LSa.FiSa.Po.Ncir**
IB 9(B)	1.66	7	11	**LS.LSa.FiSa.Po.Ncir**
IB 2	0.42	6	162	**LS.LSa.MuSa.MacAre**
IA 10	1.19	4	10	**LS.LSa.MuSa.MacAre**
IA 9(B)	2.05	9	13	**LS.LSa.MuSa.MacAre**
IB 23	1.88	7	9	**LS.LSa.MuSa.CerPo**

Table 3.1.4 Sediment data corresponding to intertidal infauna samples

	Median grain size (μ)	*% silt/clay*	*% gravel*	*Biotope*
IA 1	203.06	1.32	1.09	**LS.LSa.MoSa**
IA 19	233.26	1.10	0.00	**LS.LSa.MoSa.BarSa**
IA 22	466.52	1.01	0.21	**LS.LSa.MoSa.BarSa**
IB 9(A)	574.35	1.50	5.16	**LS.LSa.MoSa.Ol.FS**
IA 9(A)	no sample			**LS.LSa.MoSa.Ol.FS**
IA 4	435.28	1.22	0.00	**LS.LSa.MoSa.AmSco.Eur**
IB 21	435.28	1.30	9.50	**LS.LSa.FiSa**
IA 16	287.18	1.40	1.11	**LS.LSa.FiSa.Po**
IB 10	217.64	1.25	0.17	**LS.LSa.FiSa.Po.Pful**
IA 20	189.47	1.15	0.00	**LS.LSa.FiSa.Po.Aten**
IB 19	203.06	1.52	0.00	**LS.LSa.FiSa.Po.Ncir**
IB 9(B)	203.06	1.80	0.00	**LS.LSa.FiSa.Po.Ncir**
IB 2	153.89	1.21	0.00	**LS.LSa.MuSa.MacAre**
IA 10	250.00	0.90	0.24	**LS.LSa.MuSa.MacAre**
IA 9(B)	no sample			**LS.LSa.MuSa.MacAre**
IB 23	153.89	1.33	0.00	**LS.LSa.MuSa.CerPo**

3.2 Satellite mapping

3.2.1 In situ broad band and spectral light attenuation measurements

Details of the PAR light attenuation and downwelling spectral measurements are given in Appendix 9. Whilst low, calculated PAR light attenuation coefficients in the Sound of Barra (Table 2.3.4) were higher than those recorded in the Sound of Harris measured in 2005 (0.4 to 0.58 m^{-1} and 0.23 to 0.34 m^{-1}, respectively). This may have been the result of re-suspended bottom sediments as a result of windy weather encountered during the field survey. However, the relatively low values indicate that the waters in the Sound are relatively clear and that attenuation is not significantly spatially variable (Figs. 7.8.1 and 7.8.2).

Of the measured downwelling spectral data, measured at 4 sites, little variation in the spectral quality of penetrating light was observed to the depth to which the measurements were made (4 m). Attenuation was low over most of the visible range with higher attenuation of blue light observed which could be the result of increased scattering and absorption by dissolved humic inputs from runoff from surround land. No visible signs of phytoplankton absorption were observed, suggesting that phytoplankton concentrations in the Sound remain low.

3.2.2 Initial processed QuickBird image

The fully corrected satellite image (including geocorrection, atmospheric correction, land masking, cloud and cloud shadow masking) is shown in Figure 3.2.1. The extent of the image has also been trimmed to the boundary extent of the study area as defined by SNH.

The image shows good penetration to bottom sediments particularly in the blue and green spectral bands. There is some noise introduced as a result of surface reflectance effects due to wave action, particularly in the west and southern regions of the Sound. The presence of small elements of cloud and cloud shadow masking some areas means that there are small areas where classification of habitat type using the image data was not possible.

3.2.3 Water column correction

The light attenuation measurements suggest that a single attenuation value could reasonably be assumed for depth correction of the remotely sensed data. The water column corrected image is presented in Figure 3.2.2. The correction produced a ‘flat’ image to suggest that water depth has been well catered for and with bottom features evident across the whole study area. In the northern section bottom features are relatively clear being only slightly affected by the presence of thin cloud in a few places. Towards the south of the study area, however, the depth correction appears to have been affected by interference from surface reflectance due to wave action. These effects appear to have been accentuated by the depth correction algorithm and bottom features at depth are less evident than in the original image.

In those regions where bottom reflectance has become more evident as a result of the depth correction process, particularly in regions of up to ~10 m in depth, differences in apparent bottom reflectance show up well; exposed intertidal and algal covered areas show up bright green in this colour combination, with darker submersed seagrass and rock surfaces showing up darker against the more brightly coloured sand and mud sediments. In deeper waters where surface reflectance effects are small, the apparent reflectance is darker. Although these deeper waters may indicate that the depth correction technique may be approaching its depth limits, the extent of these dark reflectances would suggest that the

bottom surface here is influenced by darker organic or inorganic surface features through this zone. This concurs with the findings of the biological survey.

Figure 3.2.1 The corrected and masked QuickBird satellite image, prior to water column correction.

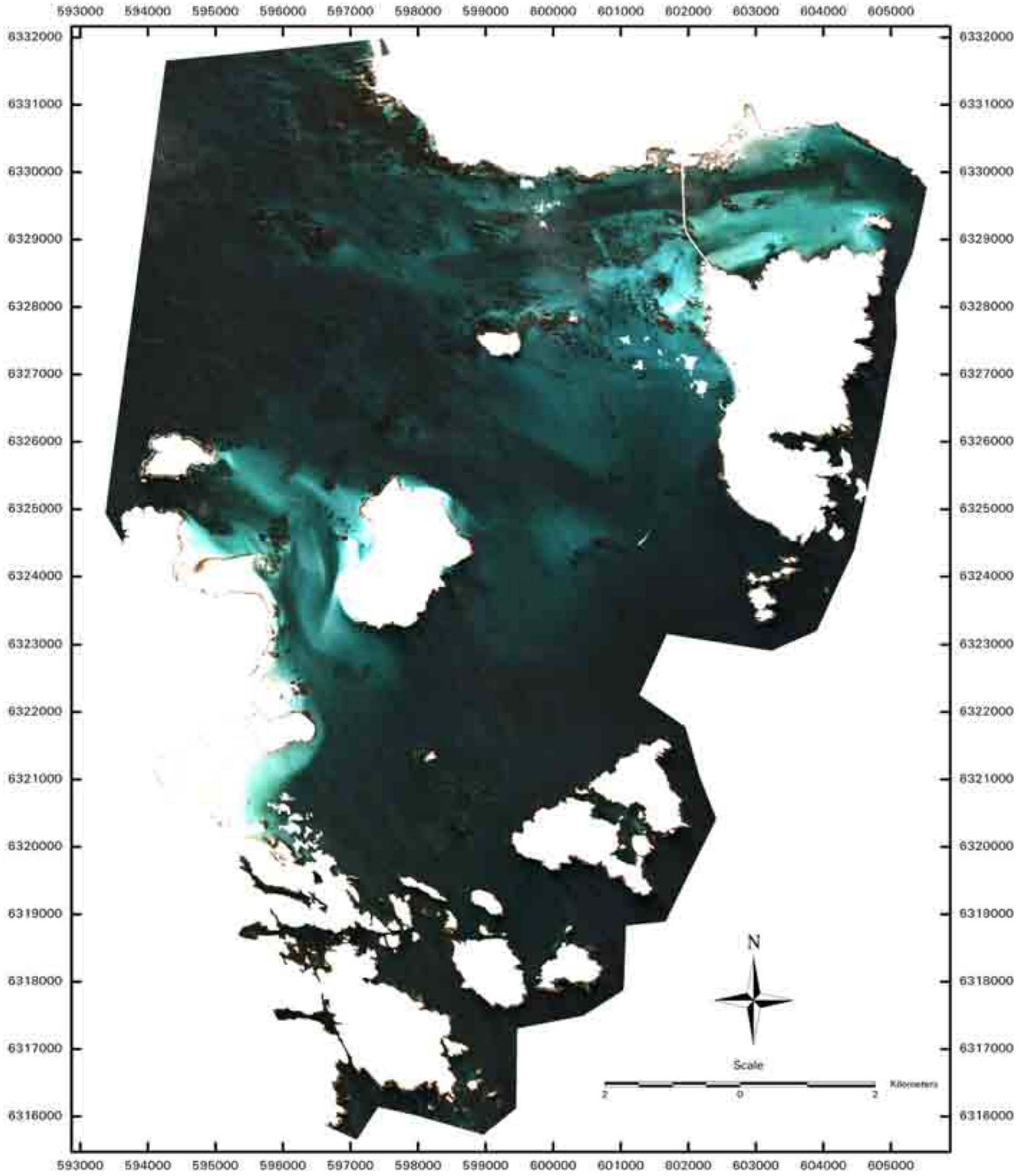
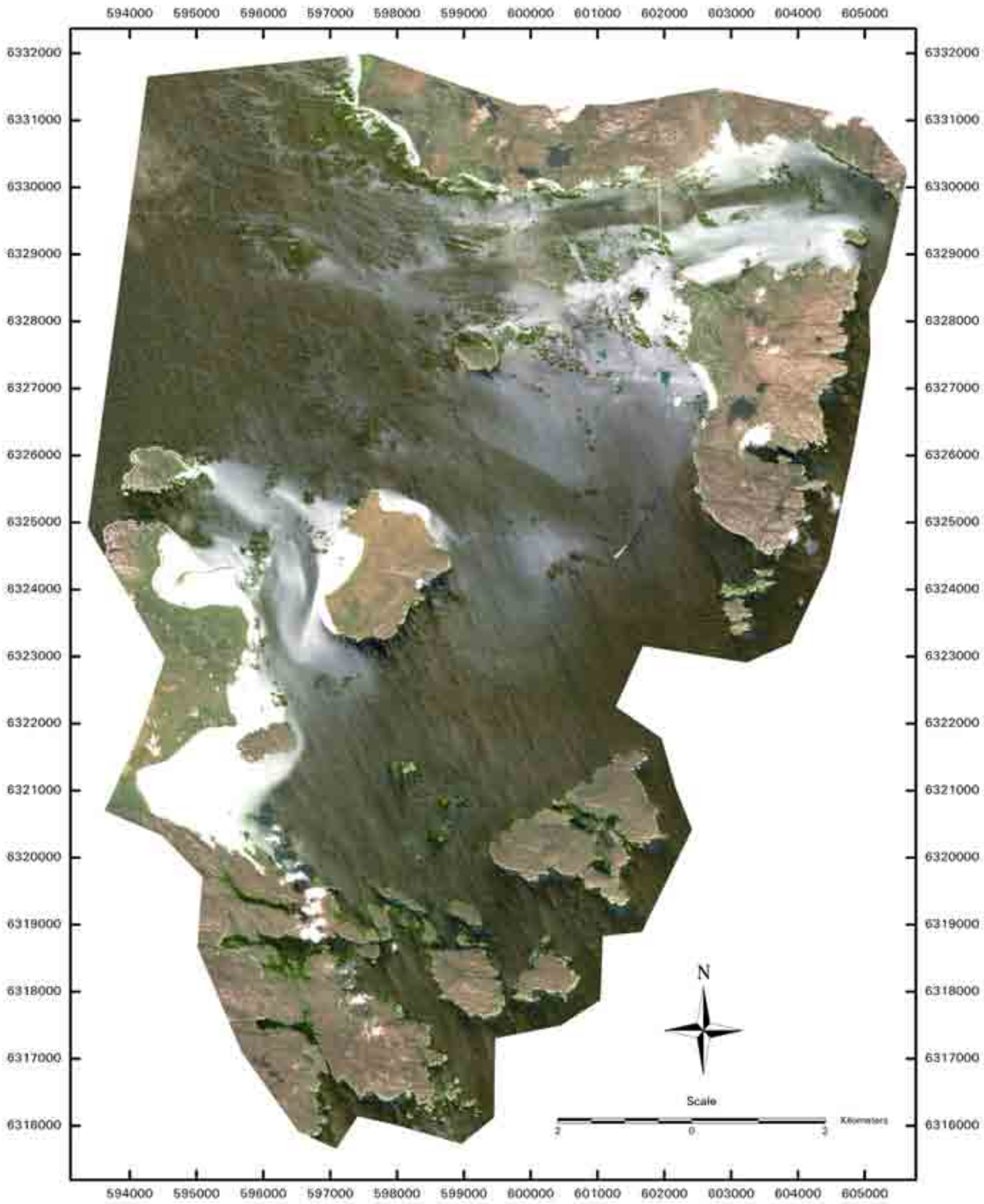


Figure 3.2.2 Image of apparent bottom reflectance after correction for water depth, superimposed upon the original image to give land features as context.



3.3 Acoustic Survey

3.3.1 AGDS

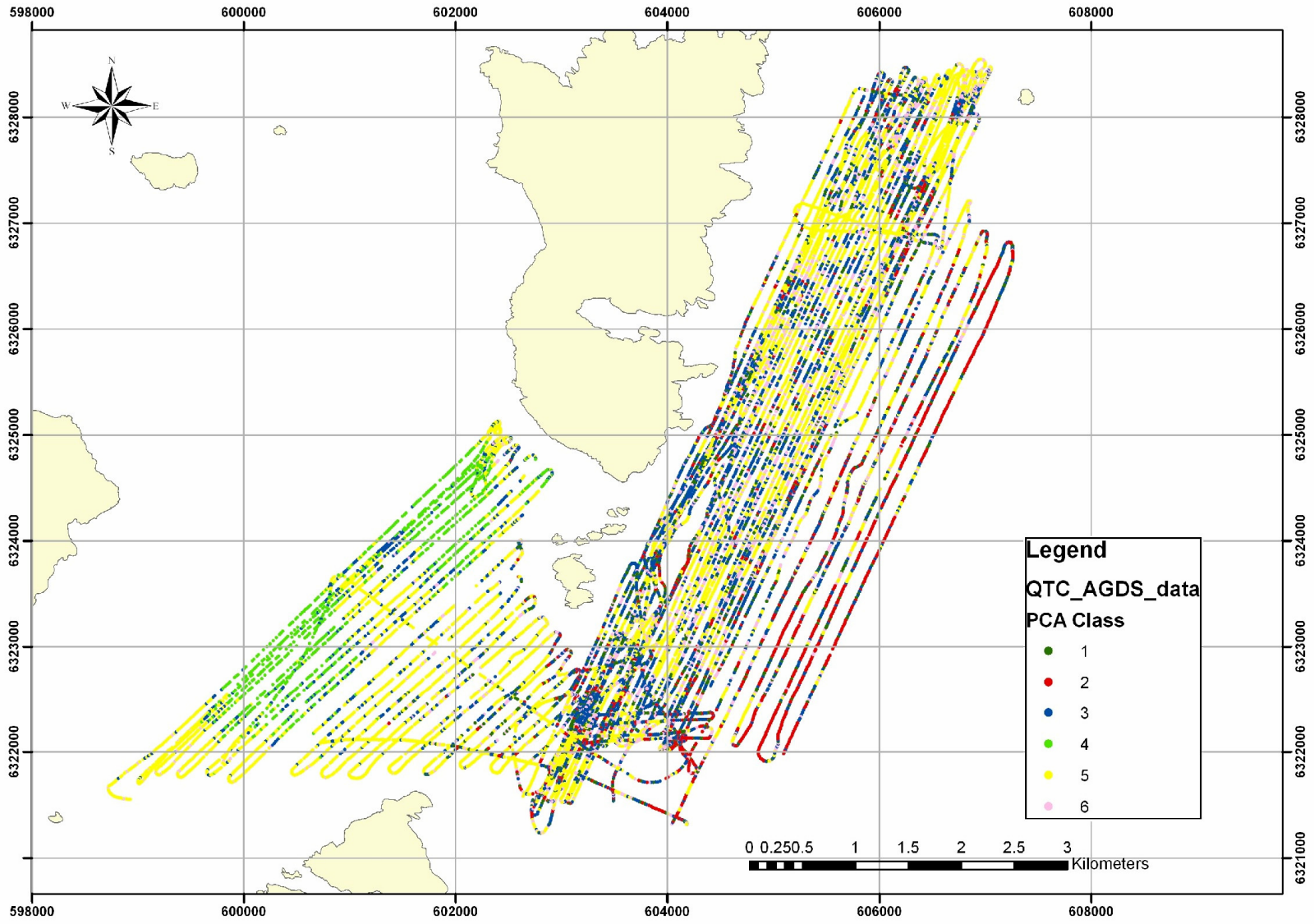
The QTC-View AGDS processed data is presented in Figure 3.3.1 below. The data is presented as PCA classes, as derived from the QTC-Impact processing. The data has not been interpolated, as it is believed that the high-resolution complete coverage GeoSwath data should be used primarily to distinguish major habitats spatially across the survey area, and the AGDS data used only to complement this. AGDS is particularly good at distinguishing differences in softer or mixed sediments, and identifying sediment veneers over rock due to its use of lower frequency sound (38kHz), which penetrates further into the substrate. However, due to the use of a standard echosounder, AGDS receives data from a large acoustic footprint below the sounder which averages any acoustic differences that may be present within that footprint, and is thus of lower resolution than the swathe system. It should therefore be considered as a broadscale technique only that can add further ground-type discriminatory power to swathe acoustic data but should not be used at the primary dataset where swathe data has also been gathered.

It is possible to see a number of distinct spatial patterns from the QTC-View data, which when compared to the GeoSwath datasets seem to correspond with the following ground-types (as inferred prior to ground-truthing):

PCA Group 1: boulders and cobbles
PCA Group 2: sloping or rough bedrock and boulders
PCA Group 3: bedrock
PCA Group 4: homogeneous fine sand plains, or shallow sand
PCA Group 5: homogeneous medium-coarse sand plains
PCA Group 6: coarse sediments (gravel, cobbles)

PCA group 5 (sand) dominates the western, shallower area in the actual Sound, with two large areas to the west of PCA group 4, which may be finer sands. This region is generally quite homogeneous; although moderately small rock outcrops (up to 200m across) are present which are shown largely as PCA group 3. To the east of the survey area, in deeper water, the picture is somewhat more complicated. The area is characterised by complex bedrock outcrops, ranging in size from under 50m across to over 500m across, and separated by only small patches of level ground. These rock outcrops appear to be shown as mainly PCA groups 2 and 3, although PCA groups 1 and 6 often mark their edges. The sedimentary areas in-between the outcrops are characterised by PCA group 5, with some records of PCA group 6 found within these areas.

Figure 3.3.1 QTC-View AGDS data presented as PCA classes (see section 3.3.1 PCA groups for interpretation of key)



3.3.2 Swath bathymetry

The cleaned XYZ datasets from the GeoSwath survey were converted to ESRI grids using ArcGIS Spatial Analyst, retaining the same resolution as the original XYZ files (2m). The bathymetry grid showed high-resolution full coverage of the survey site, with only a few small data gaps (<50m across in width). Some artefacts in the data are visible, some of which were due to problems with the motion reference unit on the first survey day, while others are due to tidal effects. The artefacts are visible as straight 'creases' in the imagery. Figure 3.3.2 below shows the hillshaded bathymetry for the survey area.

As described above, the survey site is very complex, with relatively level, homogeneous and presumably sedimentary areas to the west in the Sound, where the seabed shallows to -5m, to highly complex reef features encompassing small outcrops in the shallow Sound area to deep reefs in the east rising from a depth of –95m to shoal at very shallow depths (-9 to -11m CD). Such reefs could be justifiably called pinnacles, and have extremely steeply sloping sides which are likely to harbour a unique array of epibiota. However, these deep reef features lie outside the defined survey area so biological groundtruth data were not collected.

The depth in the survey area slopes gently from the shallows of the Sound (-5m) to the eastern 'plateau' at between -28 and -19m depth, which extends up to 2km across (east - west). Superimposed on this 'plateau', extensive and numerous reefs shoal to –8m, surrounded by level homogeneous regions (presumably sediment). The seabed then rapidly slopes into deep waters (-95m) over a short distance (less than 400m, east - west).

The bathymetric data grid was post-processed using ArcGIS Spatial Analyst to derive slope angles and aspect. Additionally Benthic Terrain Modeller (NOAA) extension for ArcGIS was used to calculate rugosity (surface complexity) from the bathymetric data. These datasets were saved as ESRI grids and ERDAS Imagine grid files at 2m spatial resolution. Figures 3.3.3 to 3.3.5 below illustrate slope, aspect and rugosity throughout the survey area respectively. Finally, aspect, slope and bathymetry data grids were used to create a multi-spectral (3-band) image, which highlights the complex topography of the region (see Figure 3.3.6 below).

Figure 3.3.2 GeoSwath bathymetric data grid (2m resolution).

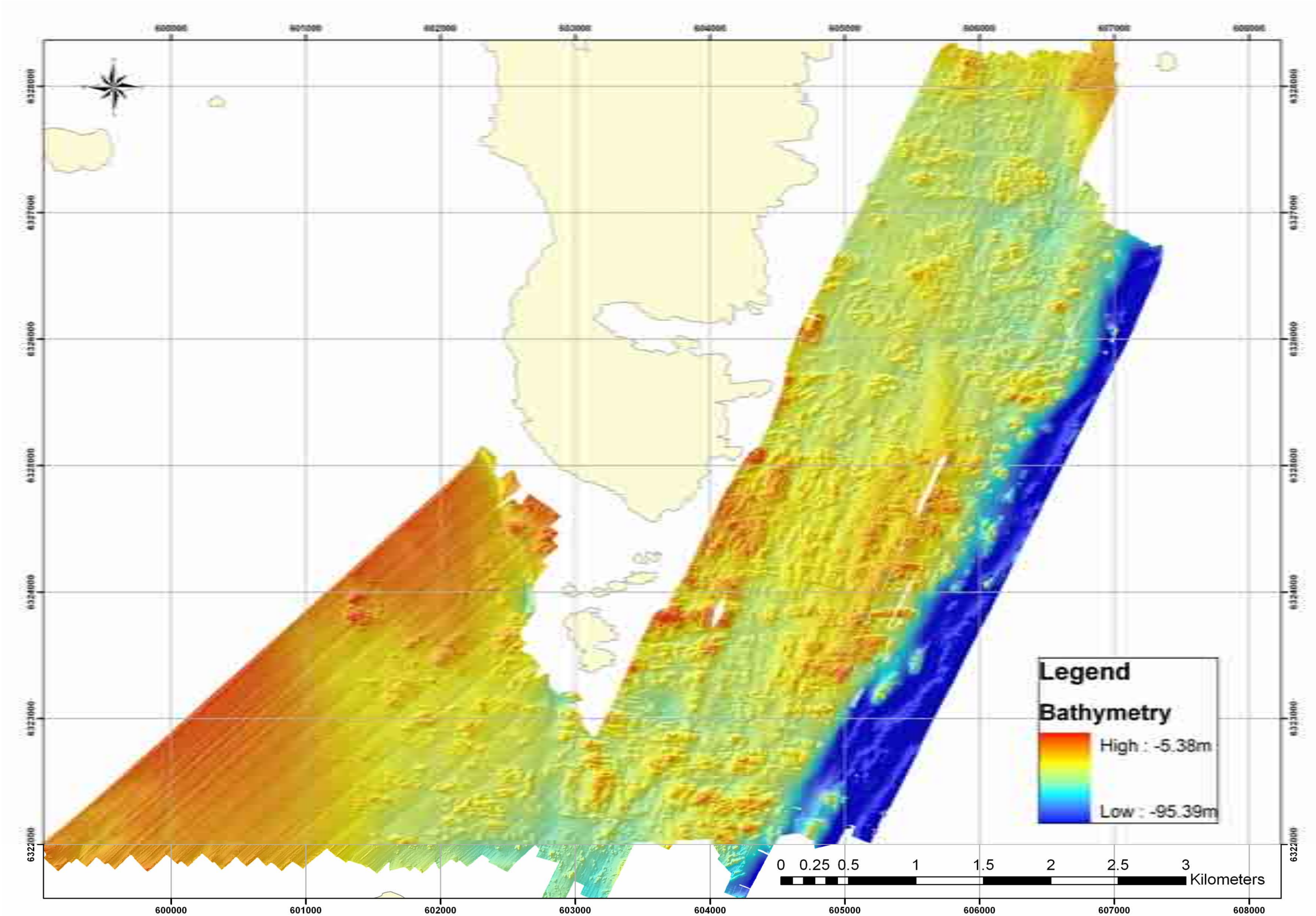


Figure 3.3.3 Slope angles (in degrees) of seabed calculated from GeoSwath bathymetric grid (2m resolution)

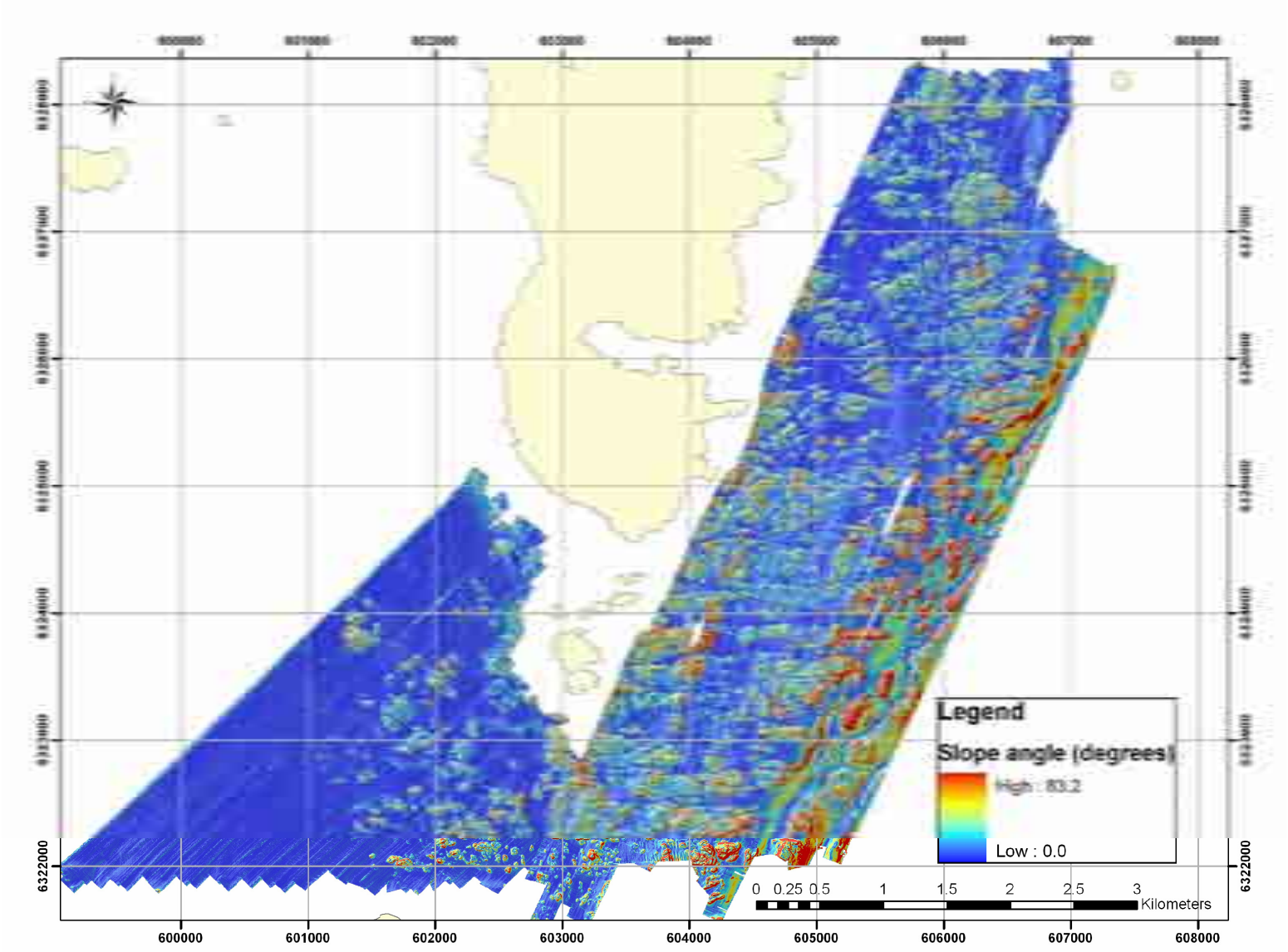


Figure 3.3.4 Aspect (0-360^{o}) of seabed calculated from GeoSwath bathymetric grid (2m resolution)

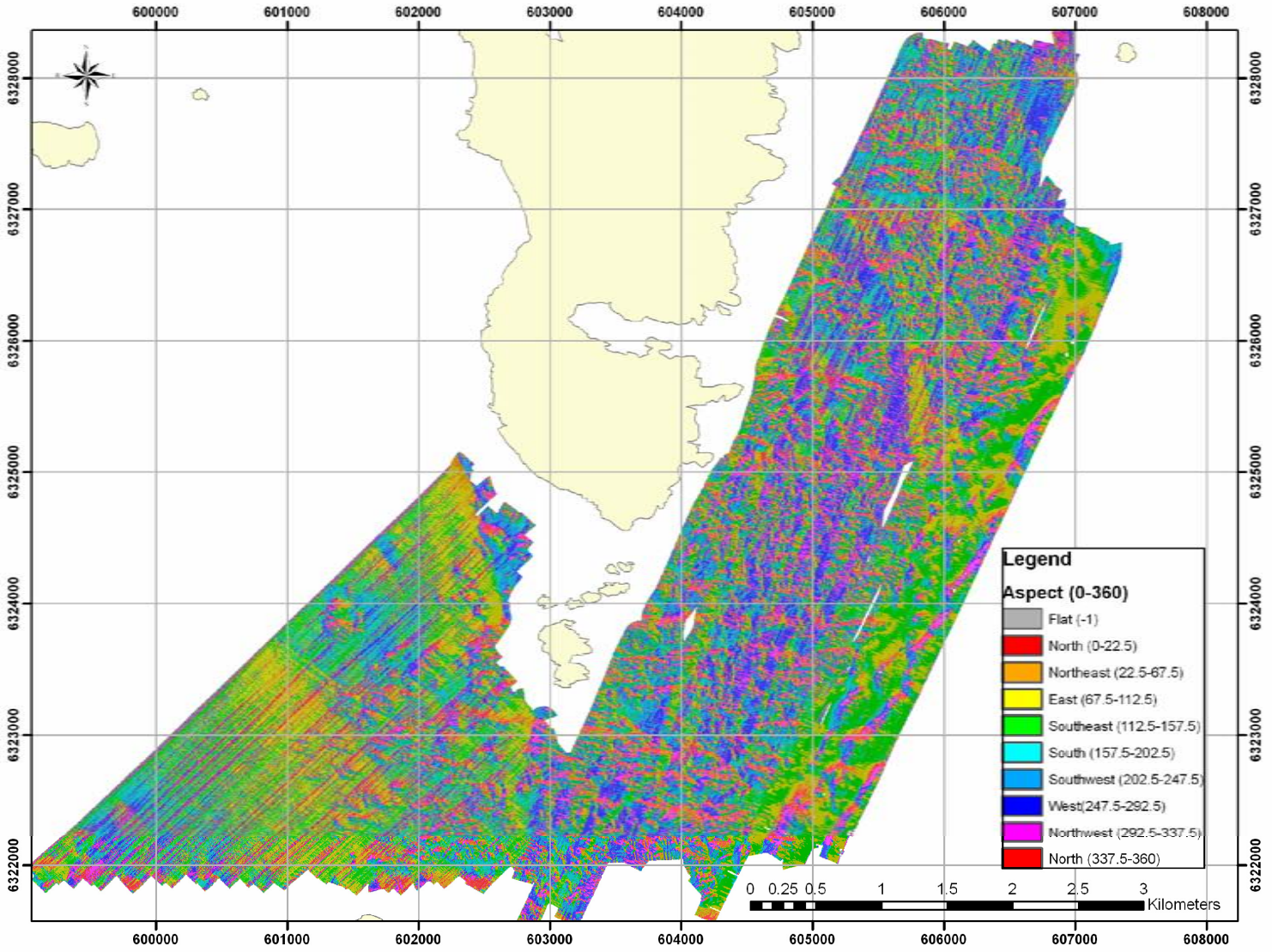


Figure 3.3.5 Rugosity (surface complexity) of seabed calculated from GeoSwath bathymetric grid (2m resolution)

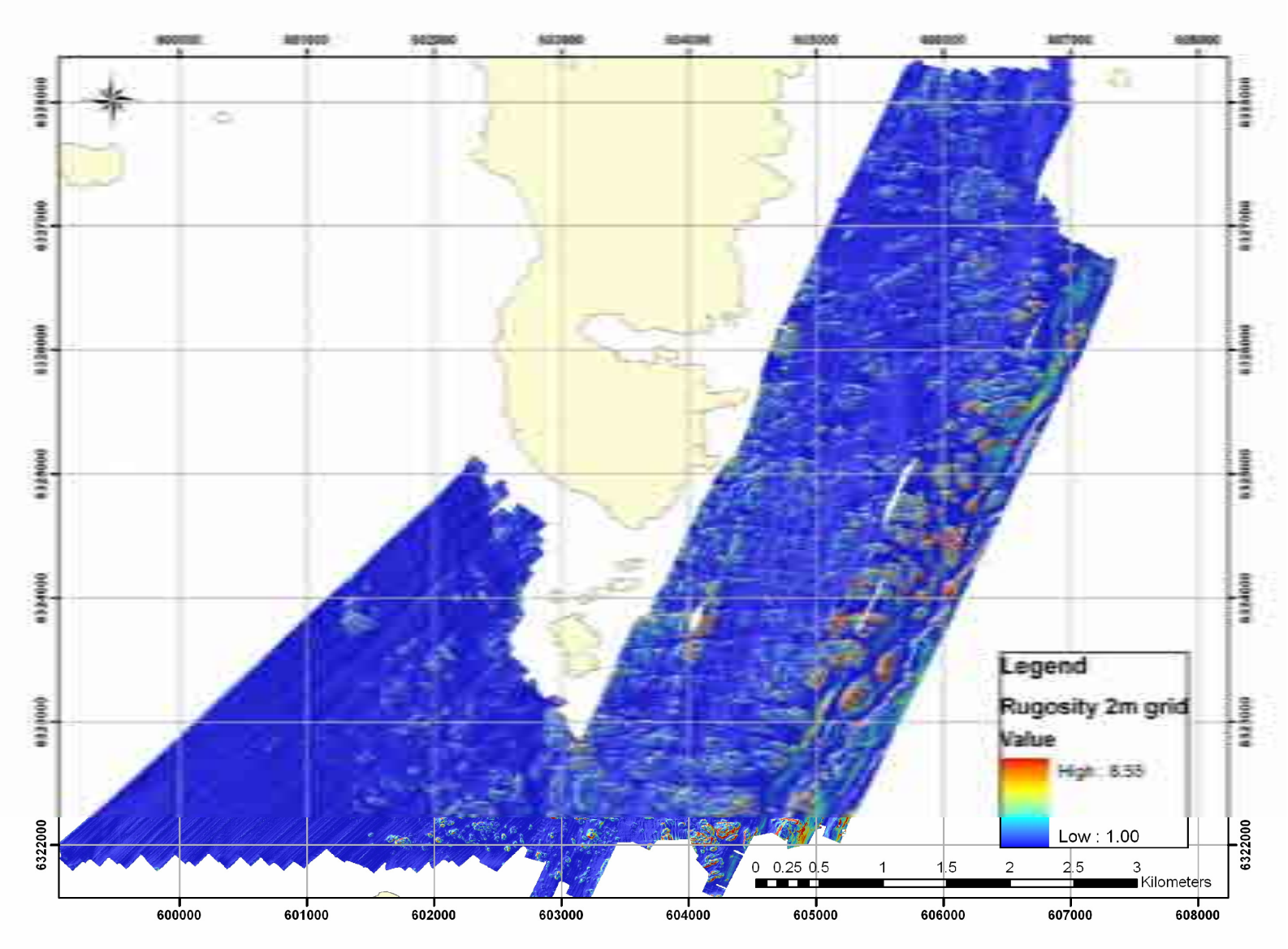
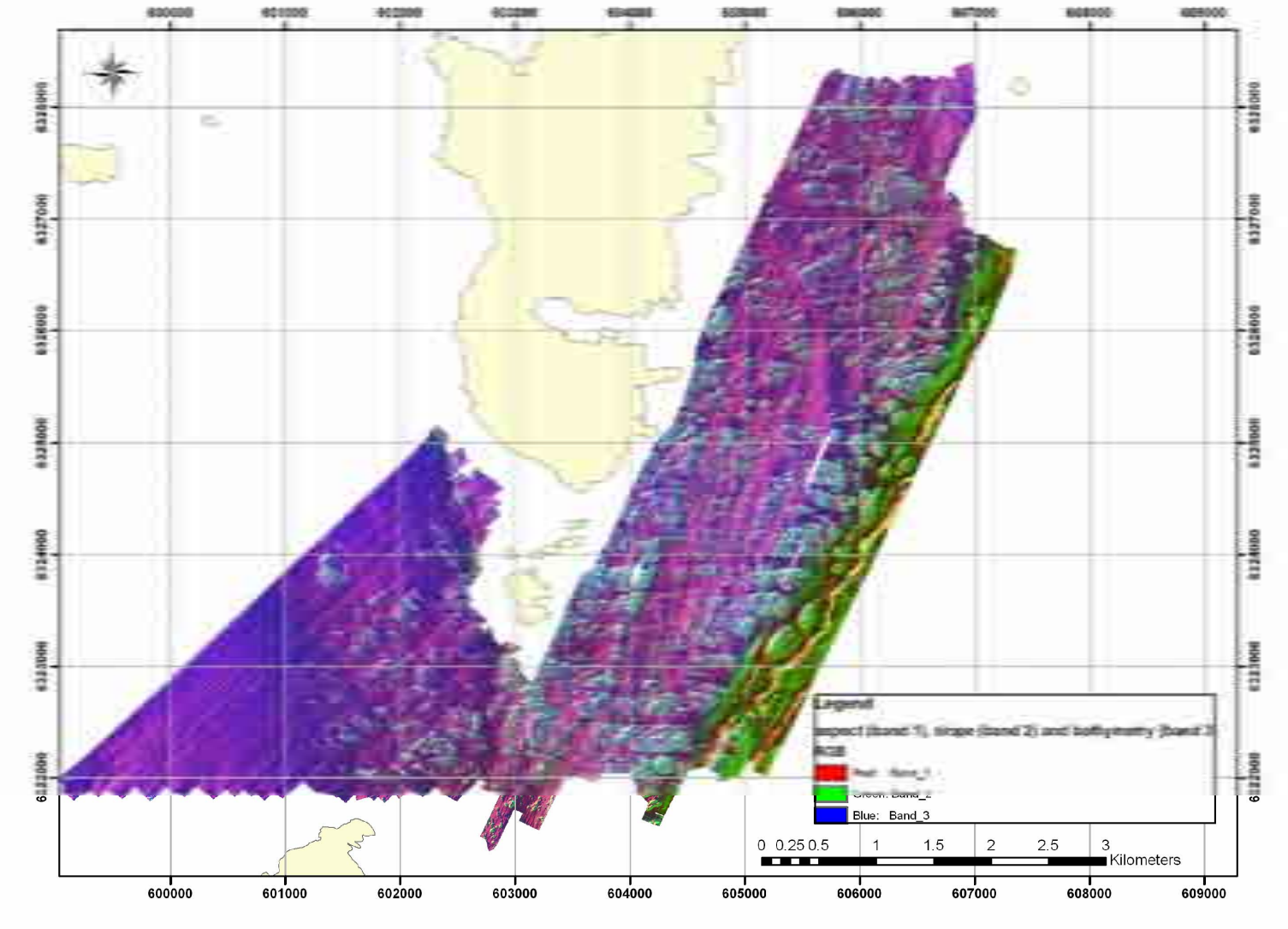


Figure 3.3.6 Multi-spectral image (3-band) of seafloor topography (aspect, slope and bathymetry) created from GeoSwath bathymetric grid (2m resolution). Aspect is represented by band 1 (red), slope is represented by band 2 (green) and bathymetry is represented by band 3 (blue).



3.3.3 GeoSwath backscatter

The GeoSwath Plus backscatter data was filtered, cleaned and mosaiced using a 5m bin to produce complete coverage of the survey area. Careful consideration was given to overlapping data between tracks such that the dataset showing the clearest imagery was used over the other dataset; this was selected section by section along each trackline. Both GeoTiff images and XYA (eastings, northings (in UTM Zone 29N; WGS 1984 datum), amplitude) datasets were produced for the backscatter data. The backscatter data mosaic is presented in Figure 3.3.7, which was symbolised using a minimum-maximum stretch. The mosaic shows clearly the bedrock outcrops, and also the different sediment grades from the finer sediments in the sound itself to the coarser sediments separating the bedrock outcrops in the eastern section. The influence of tidal currents on the seabed facies (probably through scour) within the Sound are also quite clear in the backscatter image, showing a predominant north-west to south-east flow.

The backscatter data was subjected to a form of textural image analysis specifically developed for use in conjunction with GeoSwath data. GeoTexture (by GeoAcoustics) identifies a number of statistically distinct textures (through a type of cluster analysis) and uses these textural signatures to classify the entire survey area to produce a classified GeoTiff image. Initially a 'broad' classification is undertaken which will often reduce the likelihood of data artefacts being emphasised in the classified image through smoothing out the input of less dominant textures, and then a 'fine' classification is undertaken which may allow more classes of textures to be defined and classified. The results of both classifications are presented in Figures 3.3.8 and 3.3.9 below. Where possible the sonar data used to form the signatures is included in the legend. However, until ground-truthing data is incorporated it is impossible to ascertain with any certainty which texture classes represent what sediment type (i.e. 'finer 4' class may not be finer than 'fine' class).

The classified images appear to have detected the major seabed 'ground-types' and discerned from the bathymetric datasets and the AGDS data, and in particular the fine classification agrees very well with the AGDS data and classifies most of the bedrock outcrops that can be inferred from the backscatter mosaic and bathymetry datasets. It is also very encouraging to see that despite the rapid depth changes towards the eastern-most boundary of the survey area the classification has continued to perform reliably to indicate a large amount of bedrock outcropping in this region.

Unfortunately, due to an erroneous data acquisition setting change part of the way through the eastern section of the survey this has resulted in a strip of mis-classified data. However it is easy to disregard this and where necessary utilise the actual backscatter mosaic and bathymetry datasets to map features within this area.

The GeoTexture classified images related well to ground-truthing data and formed a template for the drawing of final habitat polygons.

Figure 3.3.7 GeoSwath sonar backscatter data mosaic (at 5m grid resolution); note that the lighter band running through the middle of the eastern section is due to a settings change during data acquisition. 8-bit greyscale image scaled between 0-255.

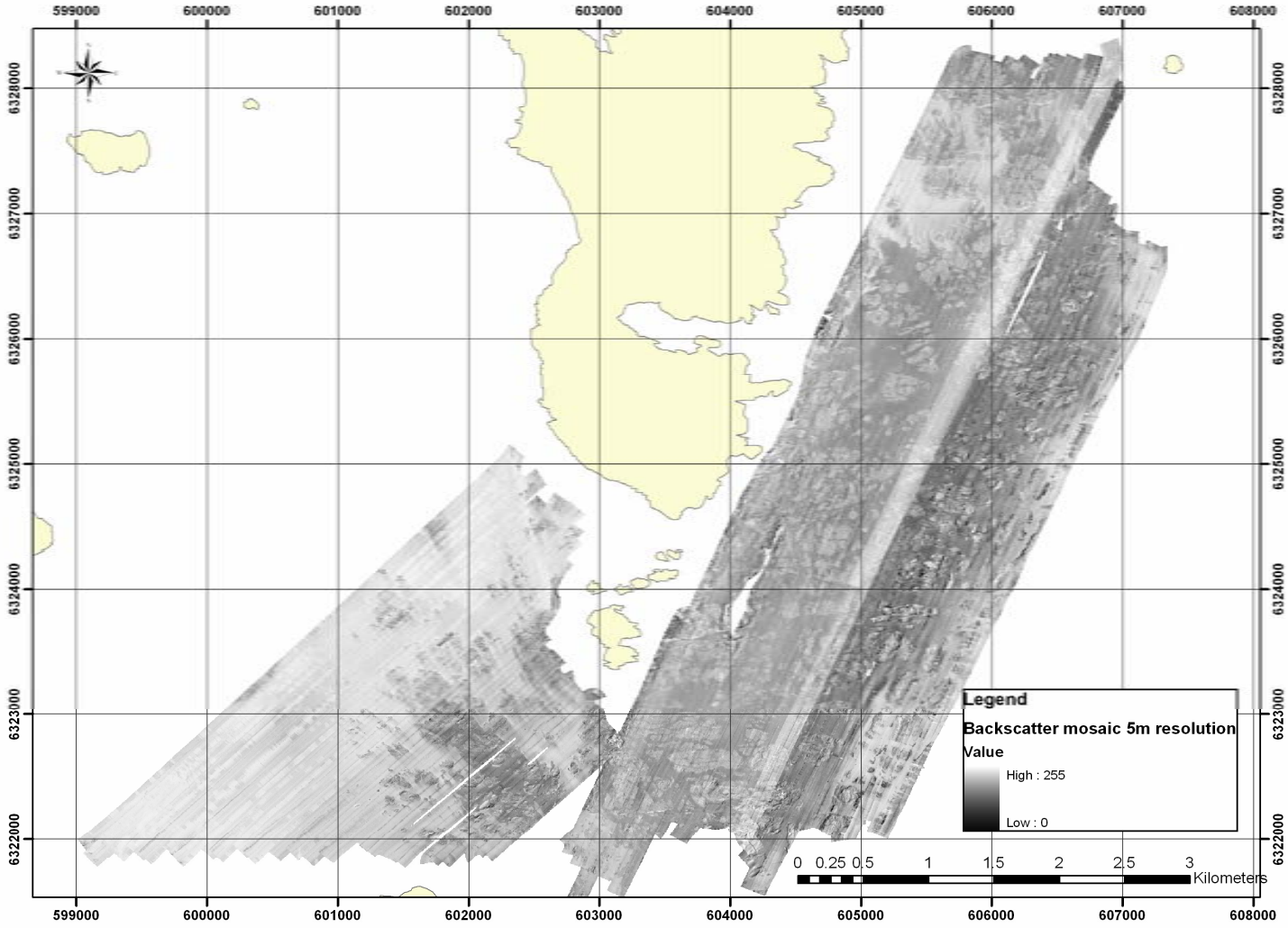


Figure 3.3.8 GeoSwath sonar backscatter data smoothed classification (at 5m grid resolution), using automated GeoTexture software; note that the lighter band running through the middle of the eastern section is due to a settings change during data acquisition. Texture classifications provided to left of map, with examples of sonar data used to create the texture signatures.

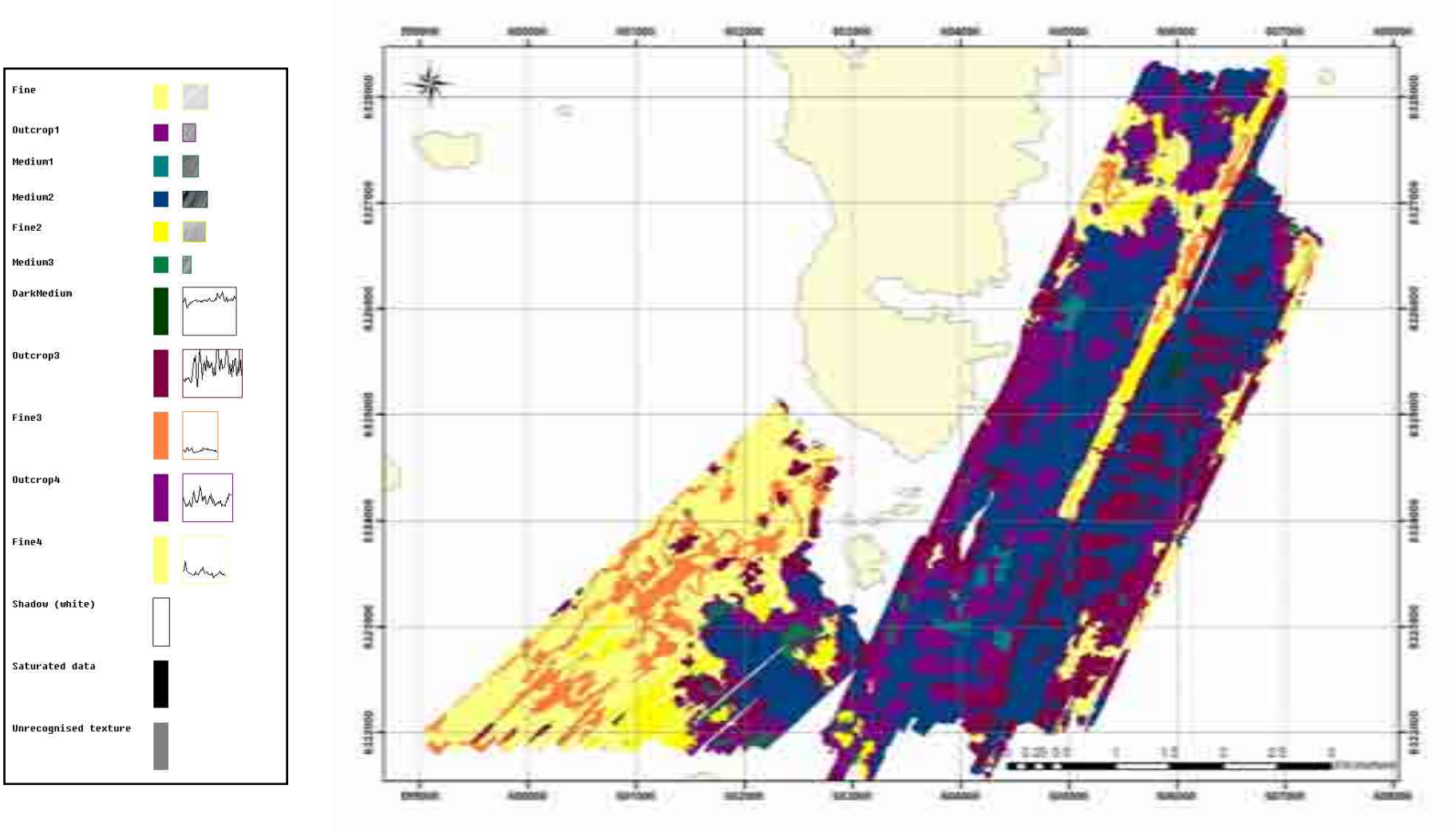
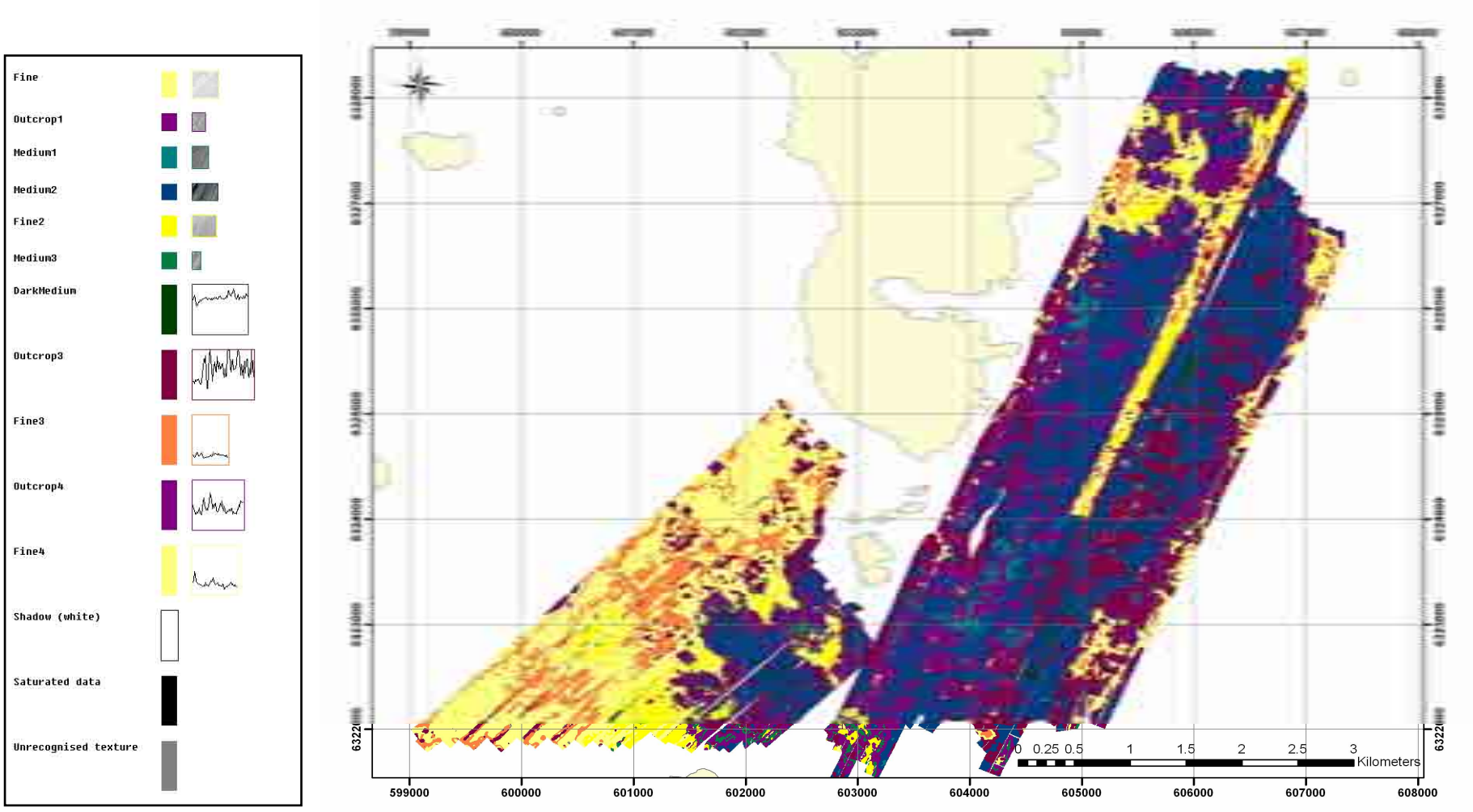


Figure 3.3.9 GeoSwath sonar backscatter data fine classification (at 5m grid resolution), using automated GeoTexture software; note that the lighter band running through the middle of the eastern section is due to a settings change during data acquisition. Texture classifications provided to left of map with examples of sonar data used to create the texture signatures.

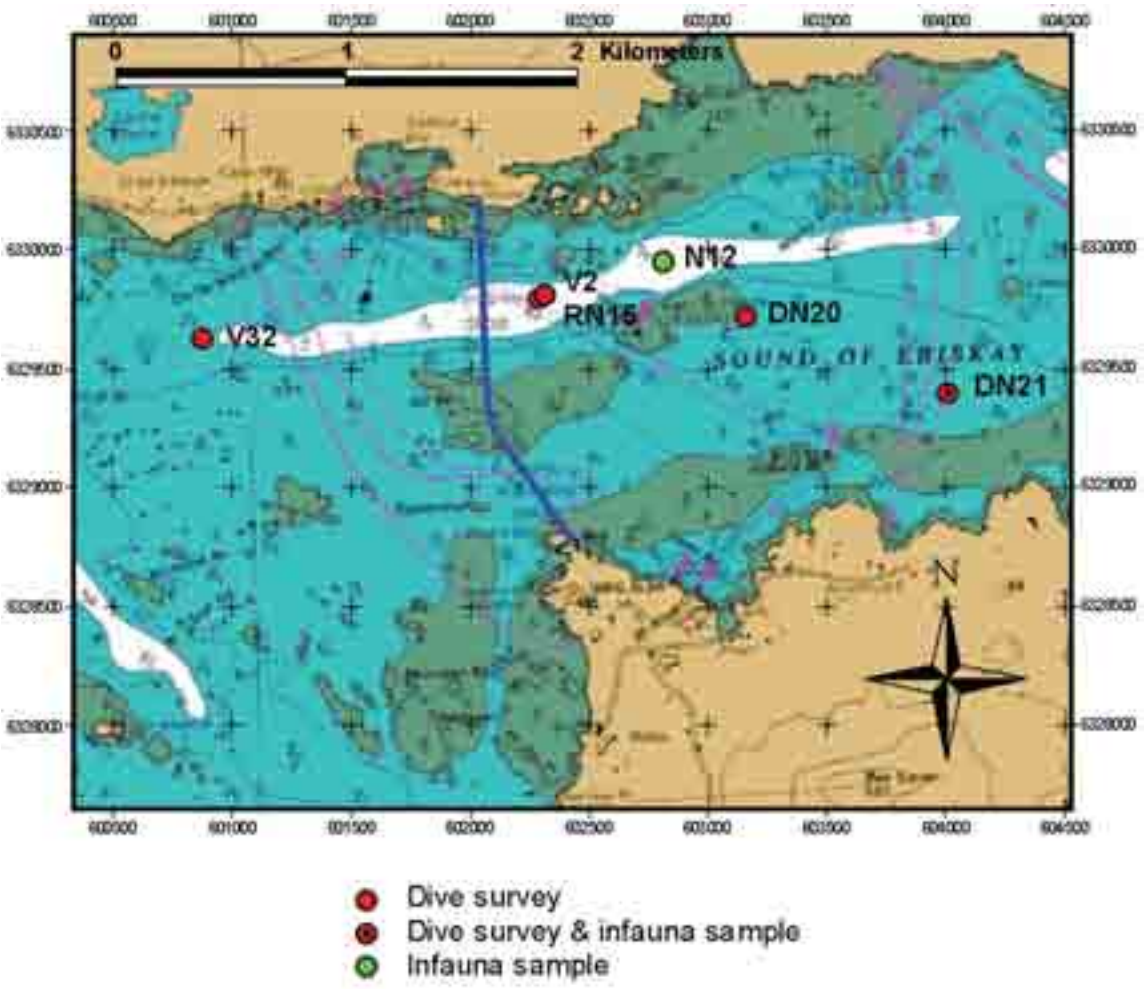


3.4 Eriskay causeway survey

3.4.1 Stations repeated from 2001 (Bates et al 2004a)

The data from the repeat diver surveys are summarised in appendix table 7.4.1 together with the corresponding data from 2001. Infaunal sample abundance data (for stations N12 and DN21) are given in appendix table 7.5.1 and associated granulometric parameters and diversity indices are given in appendix table 7.5.2. The locations of the dive survey stations and sample stations are shown in figure 3.4.1. In all cases the coordinates indicate that the repeat surveys were conducted within 10m of the original survey station.

Figure 3.4.1 Locations and survey methods for 2001 repeat stations



The 2006 repeat surveys do not provide evidence of a substantial change in the biota at any of the stations.

Biotopes recorded in 2001 were designated from the 1997 version of the biotope classification system (Connor et al. 1997). Where these biotopes are referred to they are identified with '(97)' to distinguish them from the 2004 biotope classification system used elsewhere in this report.

The most westerly of the stations (V32) was surveyed by drop down video in 2001 and resurveyed by diver in 2006. The biotope of the station was designated as **IGS.Phy.R (97)** in 2001 which is a direct equivalent of the biotope designated on the basis of the 2006 survey (**SS.SMp.Mrl.Pcal.R**). The station is a maerl bed with profuse cover of foliose and filamentous red algae.

Station RN15 was surveyed by ROV in 2001. Station V2 lies ~40m northeast of RN15 and was surveyed by drop down video in 2001. In 2006 both stations were resurveyed by diver. The diver began the survey at RN15 and then swam an estimated 40m northeast and signalled the surface cover boat to record the coordinates and confirm that V2 had been located with sufficient accuracy. Two biotopes were recorded in this area in 2001. **IMS.EcorEns (97)** is a shallow sand biotope mainly defined by epibiota. This biotope was patchy and was not encountered by the diver in 2006. The second biotope was **IGS.Phy.R (97)**, a direct equivalent of the biotope recorded in 2006 (**SS.SMp.Mrl.Pcal.R**). Both the 2001 and 2006 surveys recorded sparse living maerl with a dense cover of red algae.

Station N12 was sampled by standard Van Veen grab in both 2001 and 2006. Just over 50% of the species present in the 2006 sample had also been present in the 2001 sample. A comparison of the ten most abundant species in each sample showed that only one was common to the top ten of both samples indicating a shift in community composition. The infauna of the 2001 sample shows no clear affinity to any biotope and it was originally designated as **IMS.EcorEns (97)**. The infauna of the 2006 sample includes significant proportions of the amphipods *Ampelisca* spp. and *Corophium crassicorne* which are indicative of the biotope **SS.SSa.IFiSa.TbAmPo**. An examination of the granulometric data shows that the 2006 sediment was finer with an increased proportion of silt / clay and reduced proportion of gravel.

Station DN20 was surveyed by diver in both 2001 and 2006. The dense *Zostera* bed present at the station in 2001 (**IMS.Zmar (97)**) was unchanged in 2006 (**SS.SMp.SSgr.Zmar**). The records of associated biota are very similar in both years with sediment covered by dense *Trailliella* and *Zostera* fronds supporting abundant *Obelia geniculata* and didemnid ascidians.

Station DN21 was surveyed by diver and sampled for infauna in both 2001 and 2006. The designated biotope in 2001 was **IMS.EcorEns (97)** and the designated biotope in 2006 was **SS.SCS.ICS.MoeVen**. The **EcorEns** biotope is recognised to be an epibiotic overlay which is likely to overlap a range of other biotopes. In both years the station was on sand with a sparse epibiota including *Arenicola* and collapsing burrow holes indicating the presence of *Ensis*. The infaunal samples show that 50% of the species present in the 2006 sample had also been present in the 2001 sample. A comparison of the ten most abundant species in each sample showed that four were common to the top ten of both samples. The infaunal community composition appears to be broadly similar in each sample and approximates to the biotope **SS.SCS.ICS.MoeVen**. An examination of the granulometric data shows that the 2006 sediment was slightly finer with an increased proportion of silt / clay and reduced proportion of gravel.

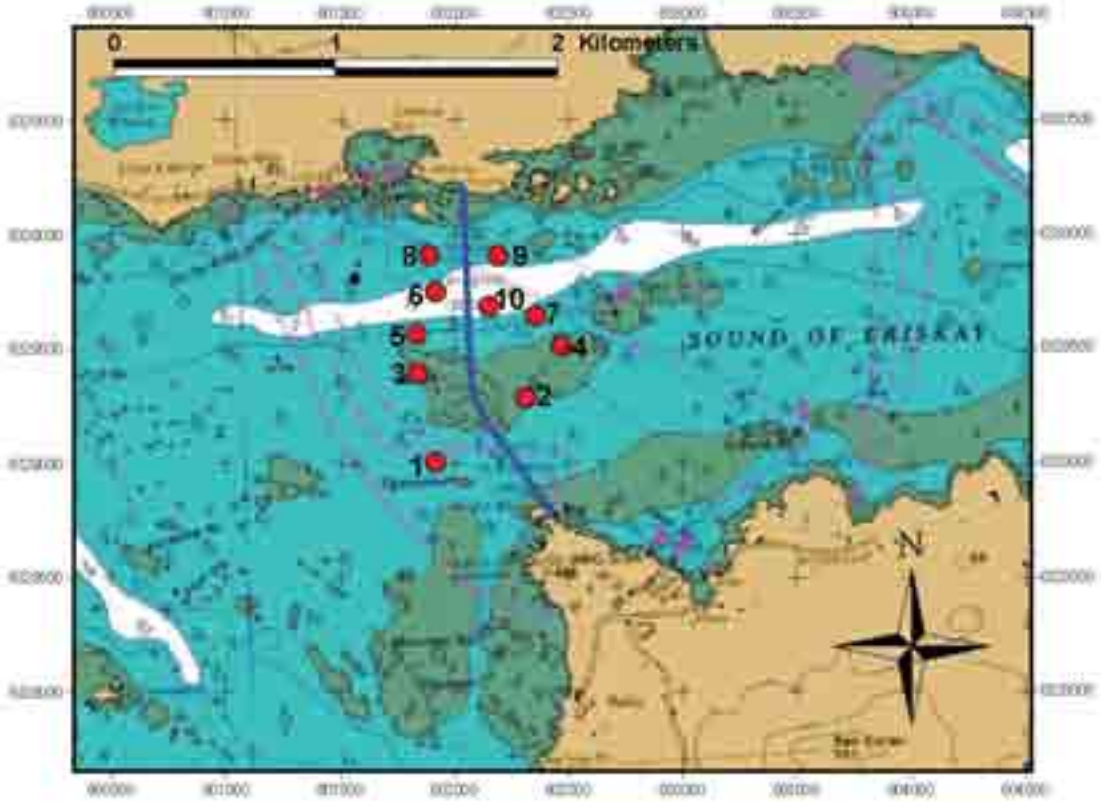
3.4.2 Granulometric samples

A summary of the biologically relevant parameters from the granulometric data is given in table 3.4.1 and the location of the sample stations is shown in figure 3.4.2.

Table 3.4.1 Eriskay causeway granulometric sample summary.

Station	Median grain size	% silt/clay	% gravel	UTM E	UTM N
1	307.79	1.48	0.29	601791	6328863
2	233.26	2.06	1.53	602198	6329148
3	435.28	1.40	1.56	601711	6329251
4	353.55	1.58	2.44	602360	6329382
5	535.89	2.92	0.90	601702	6329433
6	435.28	5.85	10.11	601793	6329621
7	353.55	7.09	15.04	602243	6329515
8	307.79	2.86	1.49	601759	6329787
9	217.64	6.28	0.00	602072	6329785
10	406.13	8.37	24.50	602033	6329560

Figure 3.4.2 Locations of granulometry sample stations



All the samples from areas west of the causeway (samples 1, 3, 5, 6 & 8) were medium sand and all contained low proportions of silt /clay (<3%) and gravel (<2%) with the exception of one sample (sample 6) from the central channel which contained higher proportions of silt / clay (~6%) and gravel (~10%).

Two of the samples (samples 2 & 9) from areas east of the causeway were of fine sand and the remainder (samples 4, 7 & 10) were medium sand. Samples 7, 9 and 10 were from the vicinity of the channel and had relatively high proportions of silt / clay (6-8%) and samples 7 and 10 had high proportions of gravel (15-24%). Samples 2 and 4 had low proportions both of silt / clay and gravel (<3%).

Overall the sediments on the east side of the causeway appear to be somewhat finer and siltier than those on the west side. However, when these differences were tested by analysis of variance they were found not to be statistically significant.

3.4.3 Zostera change assessment – Biological groundtruth stations

The positions of the groundtruth drift transects and the groundtruth point locations east of the causeway are shown in figure 3.4.3. The *Zostera* beds take the form of alternating bands of dense *Zostera* and areas of open sand. Appendix table 7.6.1 gives the coordinates of points where the transects intersect boundaries between these areas of dense *Zostera* and the open sand patches. The records for the groundtruth point locations east of the causeway are shown in appendix table 7.6.2.

The records for groundtruth point locations west of the causeway are shown in appendix table 7.6.3 and the positions are shown in figure 3.4.4. These positions were determined by a comparison of the 2001 and 2006 satellite images to predict where *Zostera* extent appeared to have increased (gain), decreased (loss) or remained unchanged. The prediction of locations where *Zostera* appeared to have colonised or to no longer be present were 100% correct. The predictions of locations where *Zostera* presence was unchanged were only correct for one station with the other stations having rocky substrates and kelp forests.

Figure 3.4.3 Locations of Zostera transects and groundtruth stations east of the causeway

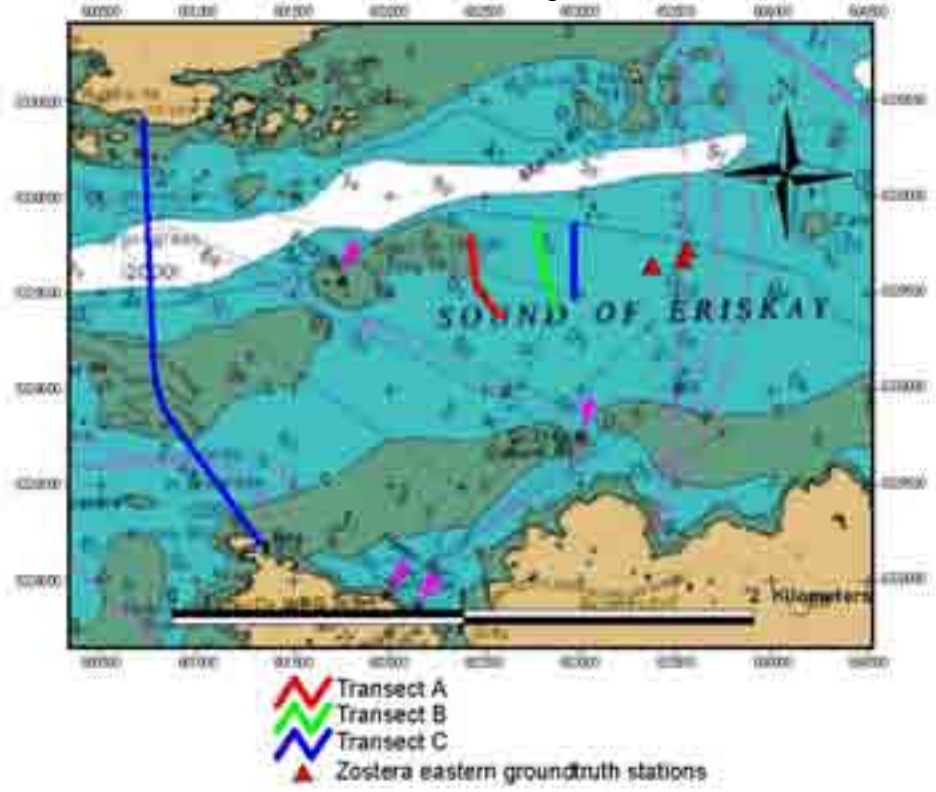
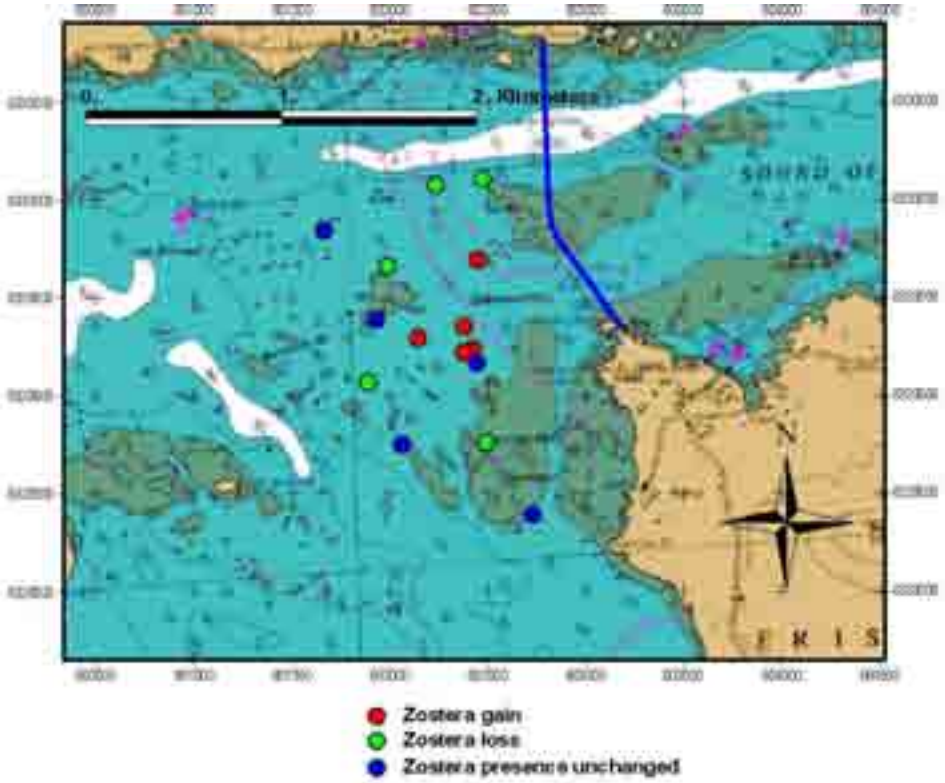


Figure 3.4.4 Locations of Zostera groundtruth stations west of the causeway



3.4.4 Zostera change assessment – Satellite imagery

3.4.4.1 Qualitative comparisons

Change detection techniques were applied to determine change between the 2006 Quickbird image dataset (2.4 m) and the 2001 IKONOS image (4 m) dataset obtained as part of the earlier study in the region (Bates et al. 2001). Both datasets were pre-processed using similar methods: they were geometrically corrected using ground based GPS measurements and atmospherically corrected based to ground surface reflectance. This allows an objective assessment of change irrespective of differences in atmospheric conditions between the two image dates.

The masked images from both time periods were subsetted to the region around the causeway in the Sound of Eriskay. The precise registration of both images was checked to ensure that changes detected were the result of real changes in the field and not the result of poor image co-registration. The histograms of both datasets were also compared to confirm that further radiometric normalisation (to ensure comparability) was not required.

Prior to the application of automated change detection techniques a qualitative analysis of changes apparent in the two raw image datasets was performed. This analysis reveals a degree of change detectable within mainly the *Zostera* beds in the Sound of Eriskay. Example comparative images of areas of the main beds of seagrass are shown in Figures 3.4.5 to 3.4.8.

Figure 3.4.5 Qualitative comparison of main Zostera bed on the eastern side of the Eriskay causeway showing evidence of thinning of the bed in the five year period. Left image, 2001; right image, 2006. For an explanation please refer to the text.

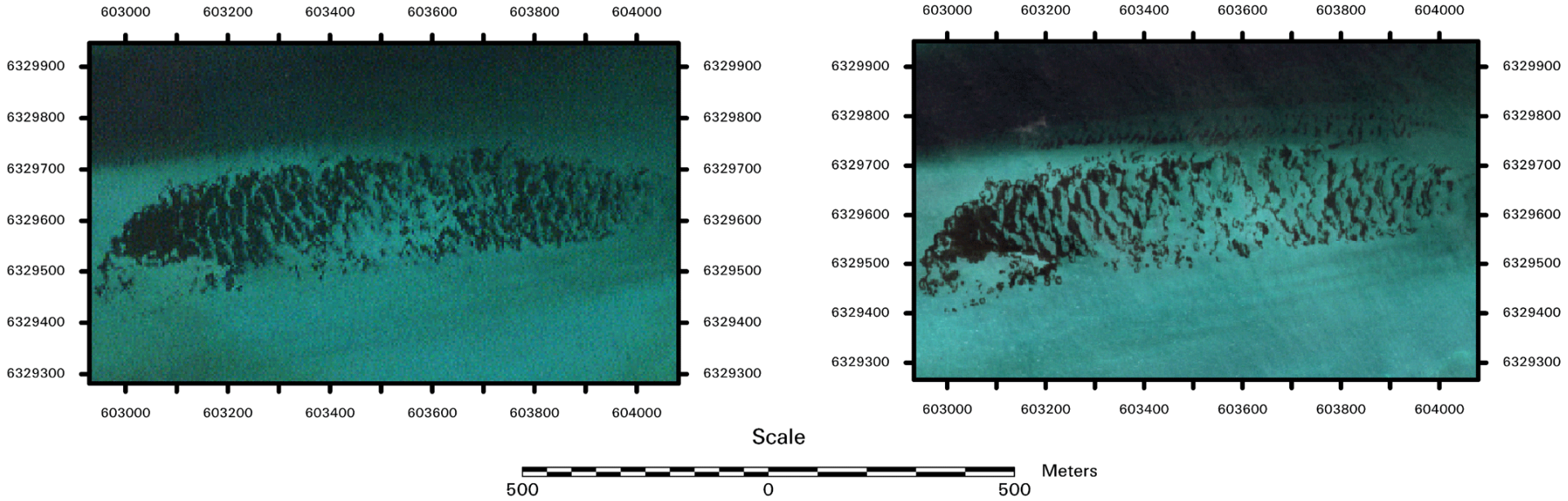


Figure 3.4.6 Qualitative comparison of area of predominantly Zostera bed on the western side of Eriskay island and causeway showing evidence of changes in extent of the bed in the five year period. Left image, 2001; right image, 2006. For an explanation please refer to the text.

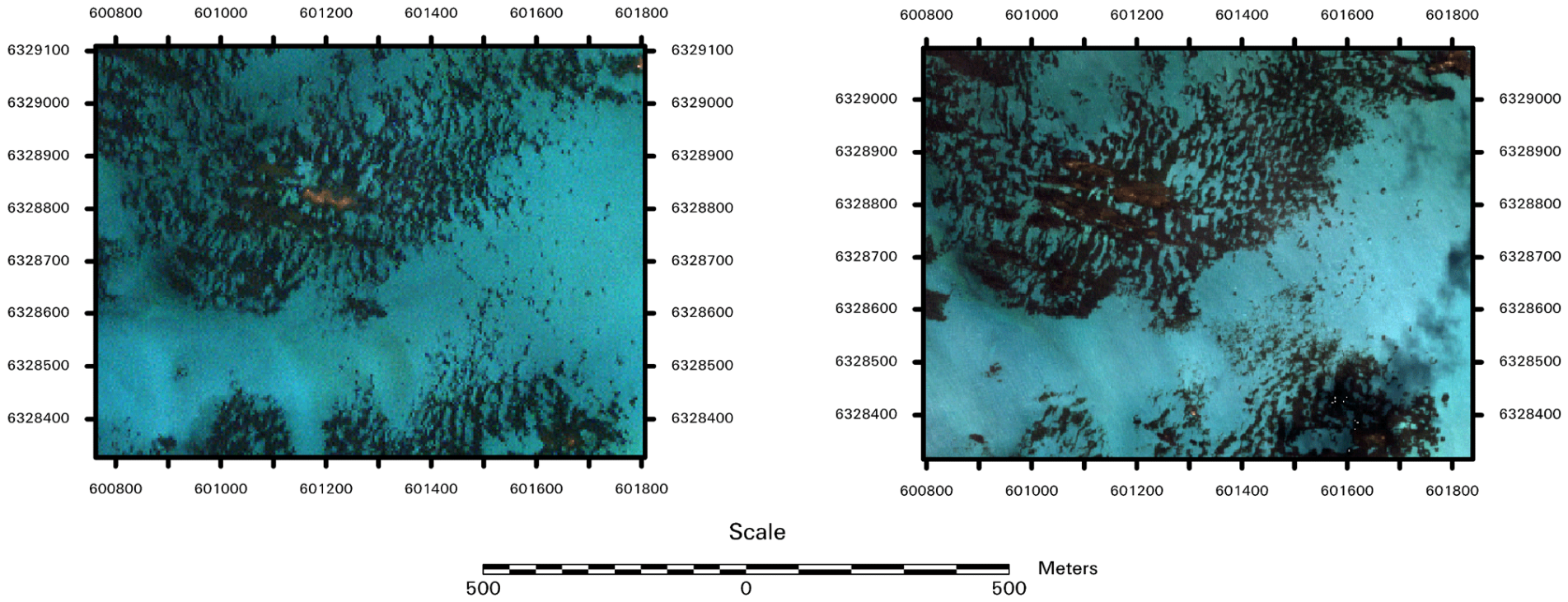


Figure 3.4.7 Qualitative comparison of area of predominantly Zostera bed on the western side of the Eriskay causeway showing evidence of changes in the extent of beds in the five year period. Left image, 2001; right image, 2006. For an explanation please refer to the text.

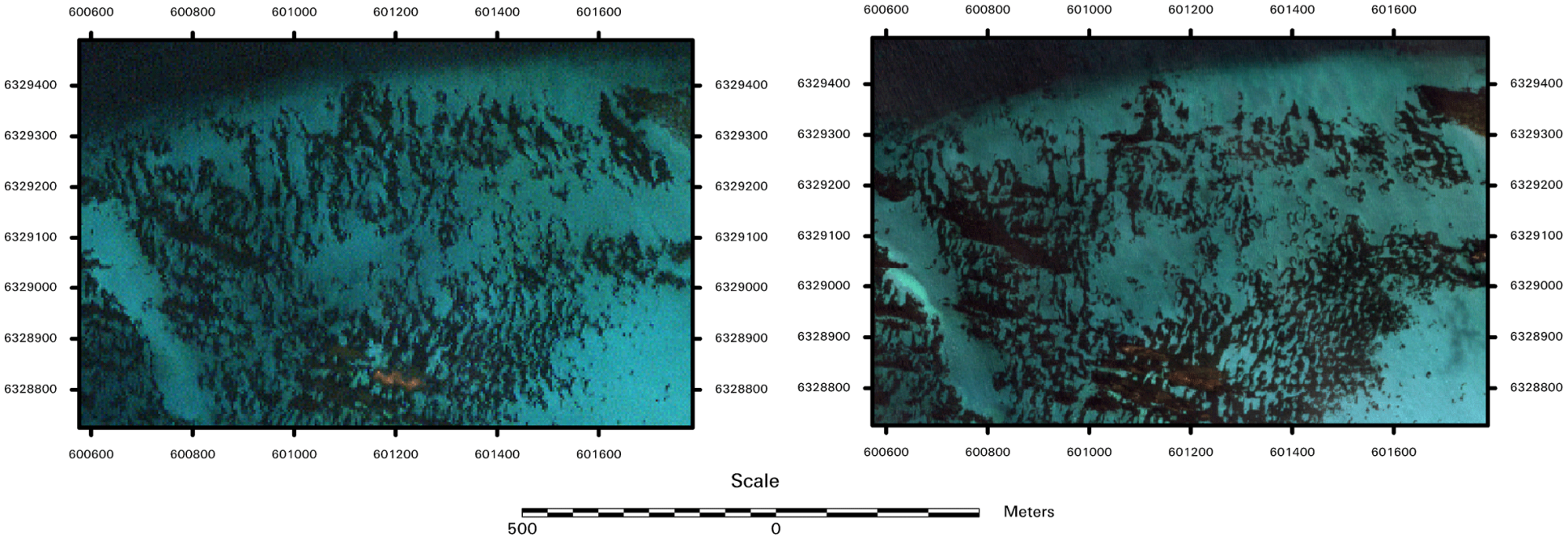
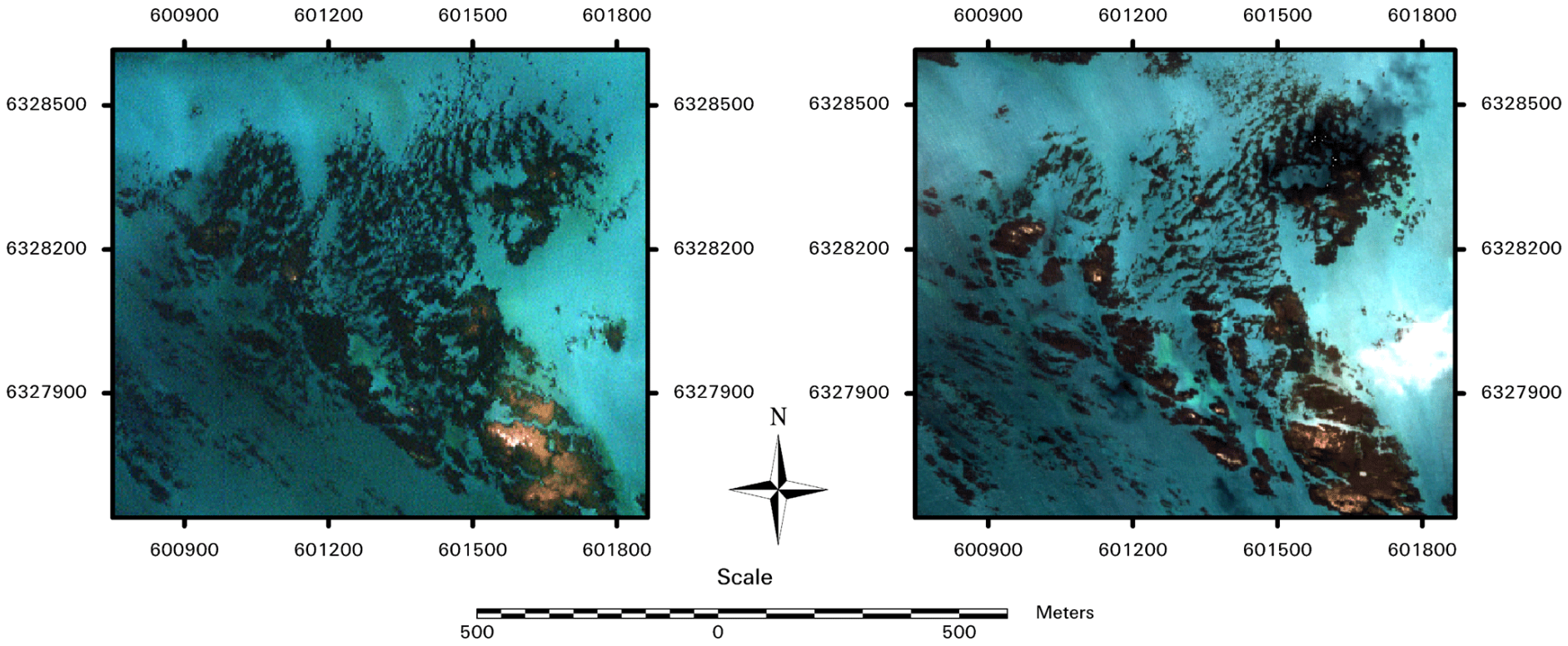


Figure 3.4.8 Qualitative comparison of area of predominantly Zostera and kelp to the west of the island of Eriskay showing evidence of changes in the extent of beds in the five year period. Left image, 2001; right image, 2006. For an explanation please refer to the text.



Comparison of cover in the main seagrass bed to the east of the Eriskay causeway reveals an apparent thinning of seagrass extent in this bed. But possibly increased growth on the slope leading into the main channel (Figure 3.4.5). To the west of the causeway, there is evidence of an apparent increase in cover over the five year period in some places; Figure 3.4.6 shows predominantly an apparent increase in density but some evidence of reductions in cover, particularly to the south and west of this image subset. To the north of the bed shown in Figure 3.4.6, Figure 3.4.7 suggests that there has been a thinning of seagrass density along the edge of the Eriskay channel and potentially a thinning of cover within the seagrass bed itself. The most dramatic qualitative changes observed occur in a region of seagrass and kelp coverage to the west of the island of Eriskay (Figure 3.4.8) where a significant reduction in extent is evident over the 5 year period with beds showing considerable thinning.

In summary, a qualitative comparison of the two images would suggest that subtle changes in seagrass extent are evident over the 5 year time period, despite differences in the resolutions of the two images. However, no clear single direction of change (in terms of overall loss or accumulation) is evident, with some regions showing a reduction in cover, but increases in cover being observed in others.

3.4.4.2 Automated change detection techniques - Image subtraction

Image subtraction is a simple but powerful technique in change detection as it may allow, through the evaluation of the resulting image histogram, for both the degree and magnitude of change to be assessed. For example, changes in a negative direction (i.e. disappearance of *Zostera*) can be separated from those in a positive direction (i.e. accumulation of *Zostera*).

Image subtraction was performed on the basis of subtraction of the green bands (band 2) of the 2001 IKONOS and 2006 QuickBird images. The resulting difference image is shown in Figure 3.4.9. Areas of positive change are highlighted in dark (black) shades and areas of negative change are highlighted in light (white) shades. Grey shades represent areas of little change during the time period between the two images. Areas of apparent change in the vicinity of the shorelines probably have more to do with subtle differences in tidal height between the two images than with real differences in habitat type. Regions of change are most evident in the vicinity of the seagrass beds on both sides of the causeway. The changes highlighted generally reinforce the qualitative changes observed in Figures 3.4.5 to 3.4.8 above. The change detected in the main *Zostera* bed to the east of the causeway would indicate that, overall, there has been a loss of seagrass cover with only a small amount of accumulation at its western end. In the beds to the west of the causeway, negative change is apparent on the northern edge of the bed, near to the deeper channel which bisects the Sound. Cover within the main seagrass bed itself would also appear to have been reduced in a number of places. There is, however, an apparent increase in cover evident along the southern edge of the main seagrass bed (in black). The major reductions in cover observed in the seagrass and kelp bed to the west of the island of Eriskay (highlighted in Figure 3.4.8 above) are clearly highlighted with this change detection method with areas of major reduction in cover showing up in whiter shades.

3.4.4.3 Automated change detection techniques - Principal components analysis

Principal Components Analysis (PCA) is a multivariate statistical method which can be used as a powerful change detection tool. Bands 1, 2 and 3 (covering visible blue, green and red waveband regions) from both datasets (2001 and 2006) were combined in a single image file upon which PCA was performed.

A display of the raw, combined dataset is already very useful in displaying potential changes which may be detected in the dataset. For example, Figure 3.4.10 shows one such colour combination of the two images combined where reductions in mainly *Zostera* beds are highlighted in blue and areas of an increase in density showing up as pale yellow/green.

When PCA is performed on the multitemporal image data a series of principal components images are produced, some of which will display change which is evident over the time period. For the Barra 2001 to 2006 comparison, the first four principal components calculated in the analysis are displayed in Figure 3.4.11. The first principal component largely contains a summary of the brightness evident in both images so it resembles an intensity image of the region. The second principal component highlights intertidal rocky areas in white, clouds in black. It also shows some evidence of changes detected in cover within the seagrass beds either side of the Eriskay causeway. The third component appears to have described an axis related to channel depth and shows a good approximation of a depth corrected image and bottom brightness. The fourth component, however, shows an image most related to multitemporal change evident in the images, where areas of negative change (loss of cover) are represented in dark shades and positive changes are shown in lighter shades.

Figure 3.4.9 Difference image for the Sound of Eriskay region resulting from the subtraction of the 2001 IKONOS image from the 2006 QuickBird image. Positive changes (increases in cover) are shown in darker shades, negative changes (decreases in cover) are shown in lighter shades.

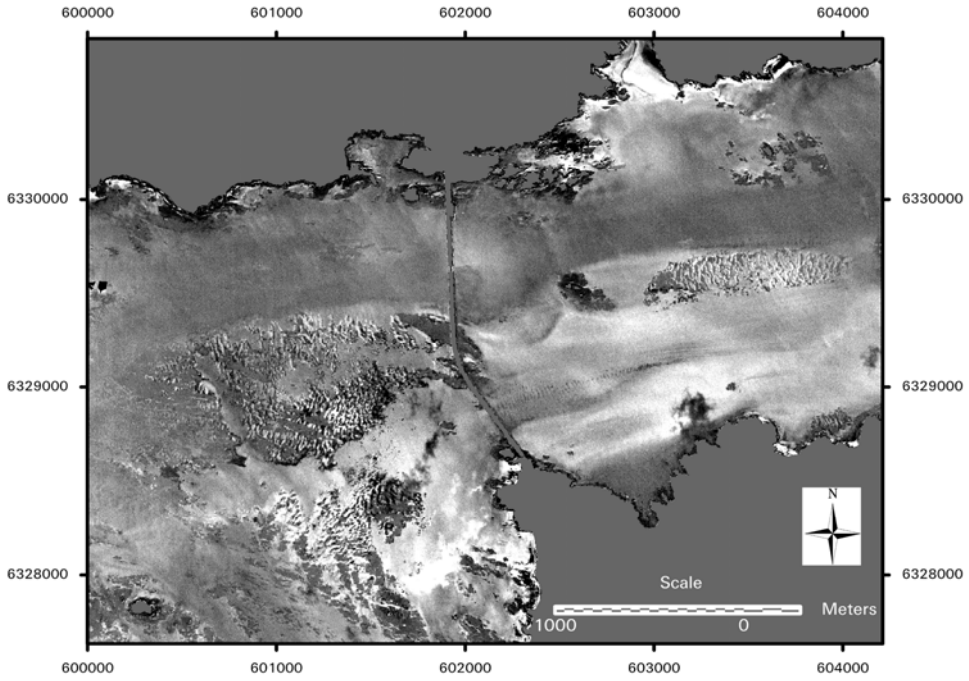


Figure 3.4.10 Raw display of the combined image dataset used in the Principal Components analysis. The bands displayed are bands 2 (green wavelength region) and 1 (blue wavelength region) from the 2001 dataset and band 5 (green wavelength region) from the 2006 dataset in RGB, respectively.

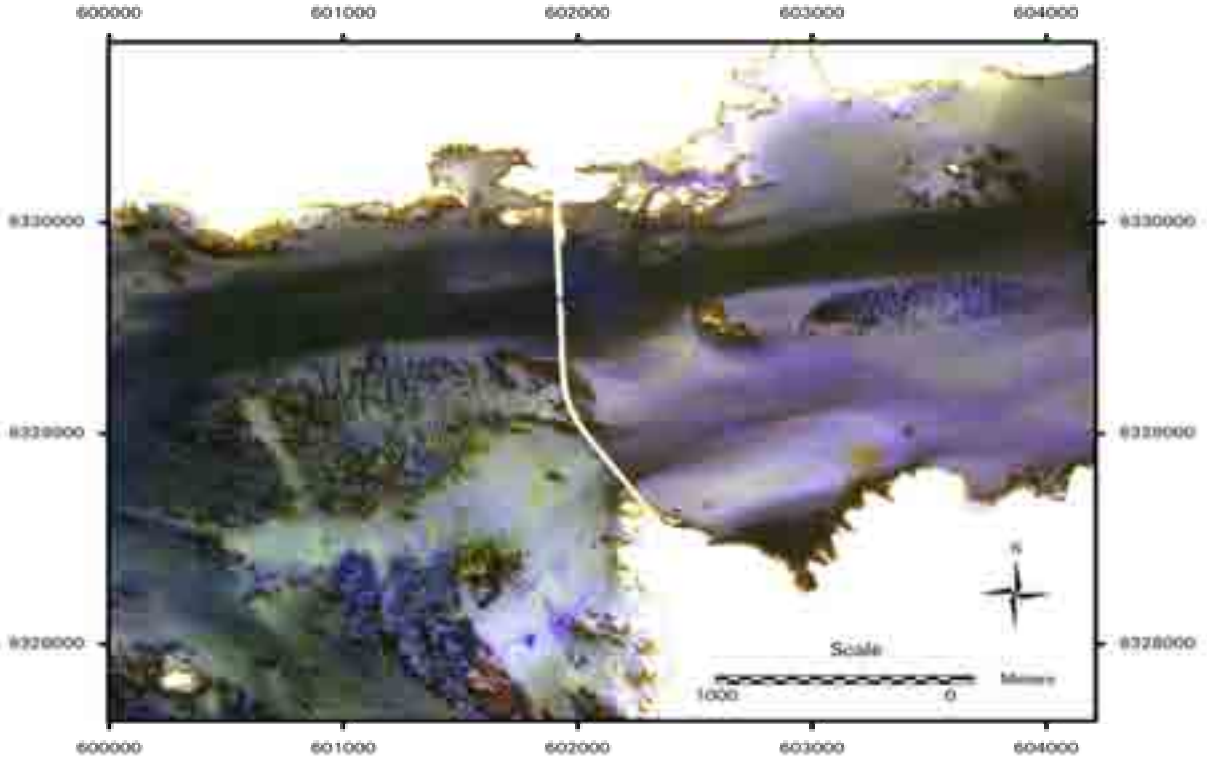
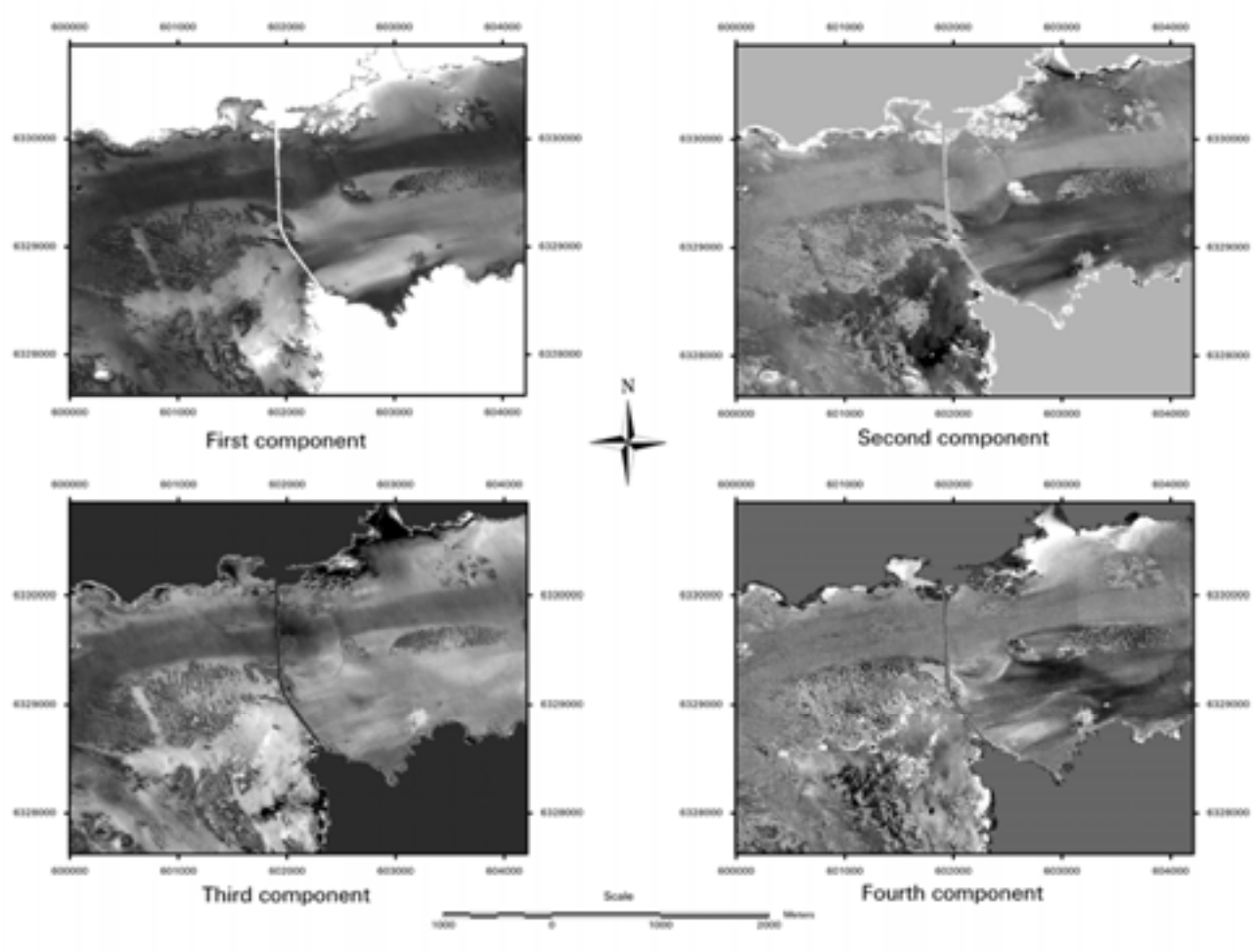
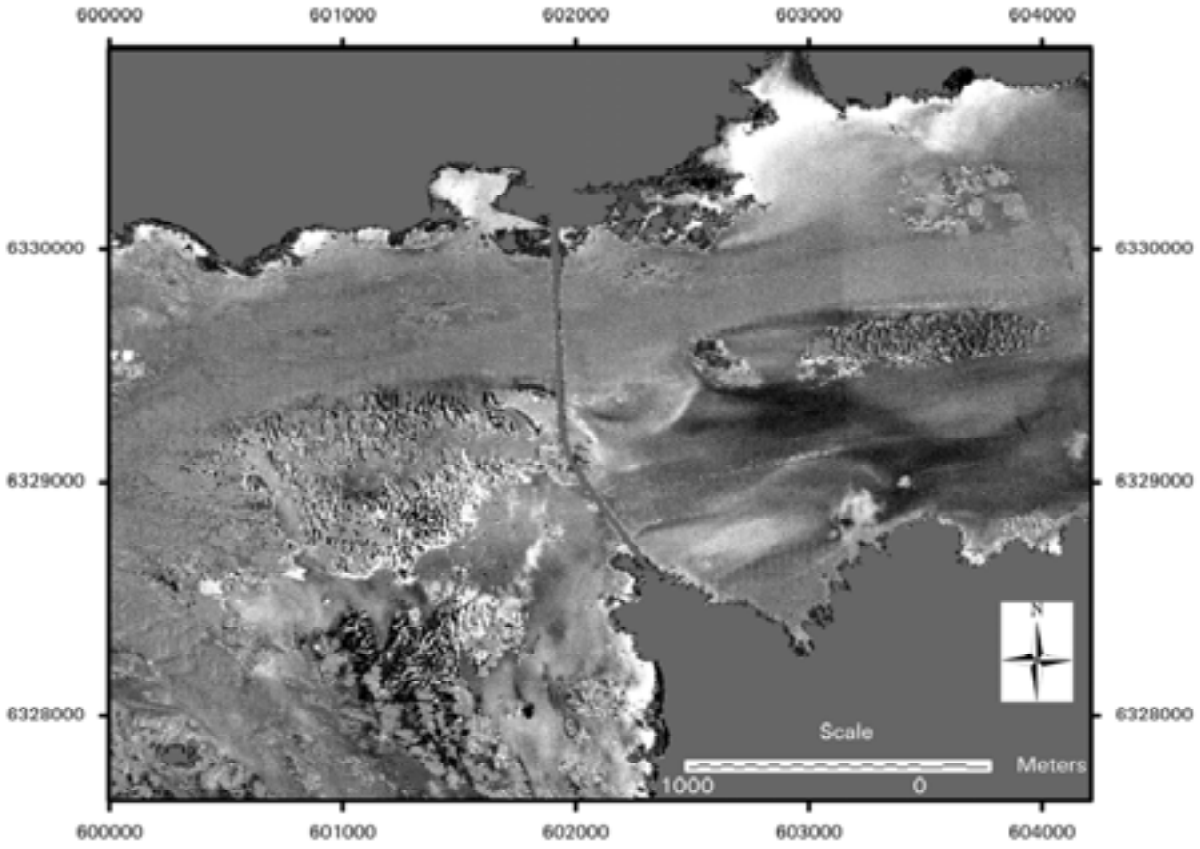


Figure 3.4.11 The first four components generated following a Principal Components Analysis applied to the 2001 IKONOS and 2006 QuickBird image of the Sound of Eriskay.



The fourth Principal Component is shown in enlarged view in Figure 3.4.12. Note that the greyscale range used to display changes here are the reverse of changes shown in Figure 3.4.9. Consequently in Figure 3.4.11 white represents positive change and darker shades represent negative change. It can be seen that this image reinforces the changes observed in Figures 3.4.9 (difference image) and 3.4.10 (combined image).

Figure 3.4.12 The fourth component generated following a Principal Components Analysis applied to the 2001 IKONOS and 2006 QuickBird image of the Sound of Eriskay. This image highlights change in the seagrass beds either side of the Eriskay causeway. Areas where seagrass has reduced are shown in black; areas of seagrass expansion are shown in white. Areas showing no change are highlighted in grey tones.



4 DATA INTEGRATION

4.1 Geography, features and abiotic factors

The Sound of Barra lies with the northern shore of Barra on its southern boundary and the southern shore of South Uist in the north. The area is topographically complex.

The main axis of the Sound is ~3km broad and runs approximately northwest to southeast between Barra and South Uist. Most of this area is >5m in depth but shallower rock reefs and sandbanks occur in a few locations. To the southwest of this axis is the north coast of Barra and associated islands such as Fiaray, Fuday and Gighay. To the northeast of the Sound is the south coast of South Uist with associated islands such as Eriskay and Lingay.

The north western tip of Barra forms a peninsular that supports the village of Eoligarry and terminates at Scurrival Point. The northern and eastern shores of the peninsular have extensive sandy shores such as Traigh Scurrival and Traigh Mhor. To the north of the peninsular there is a shallow (<5m) area of subtidal sand with sandbanks and rocky reefs bounded to the west by the island of Fiaray and to the east by the island of Fuday. This complex shallow area extends southeast through the tideswept Sound of Fuday to open out into the deeper more sheltered and predominantly sandy area of An Oitir Mhor.

To the east and south of An Oitir Mhor is a complex of emergent rocks and islands including Fuiay, Flodday, Hellisay and Gighay. The waters of An Oitir Mhor and some of this island group tend to be more sheltered and include areas of deeper (>10m) water.

The area to the north of the main axis of the Sound is dominated by the island of Eriskay. Eriskay is separated from the south shore of South Uist by the Sound of Eriskay which is mostly shallow (<5m) with sandbanks and rocky reefs. To the northwest of Eriskay is an extensive shallow (<5m) area peppered with emergent rocks and shallow rocky reefs. This area extends to the island of Lingay and the rocks of Hasgeir Fiaray in the west.

The bathymetry of the area trends from shallower areas in the west to deeper areas in the east. The 10m depth contour runs roughly southwest to northeast, from Inner An Oitir Mhor to the southwest shore of Eriskay. West of this line the majority of the seabed is <10m in depth with the exception of a few relatively small basins of slightly deeper water. To the east of the 10m contour there is a gradual increase in depth and the majority of the eastern part of the survey area lies in depths of 20-30m.

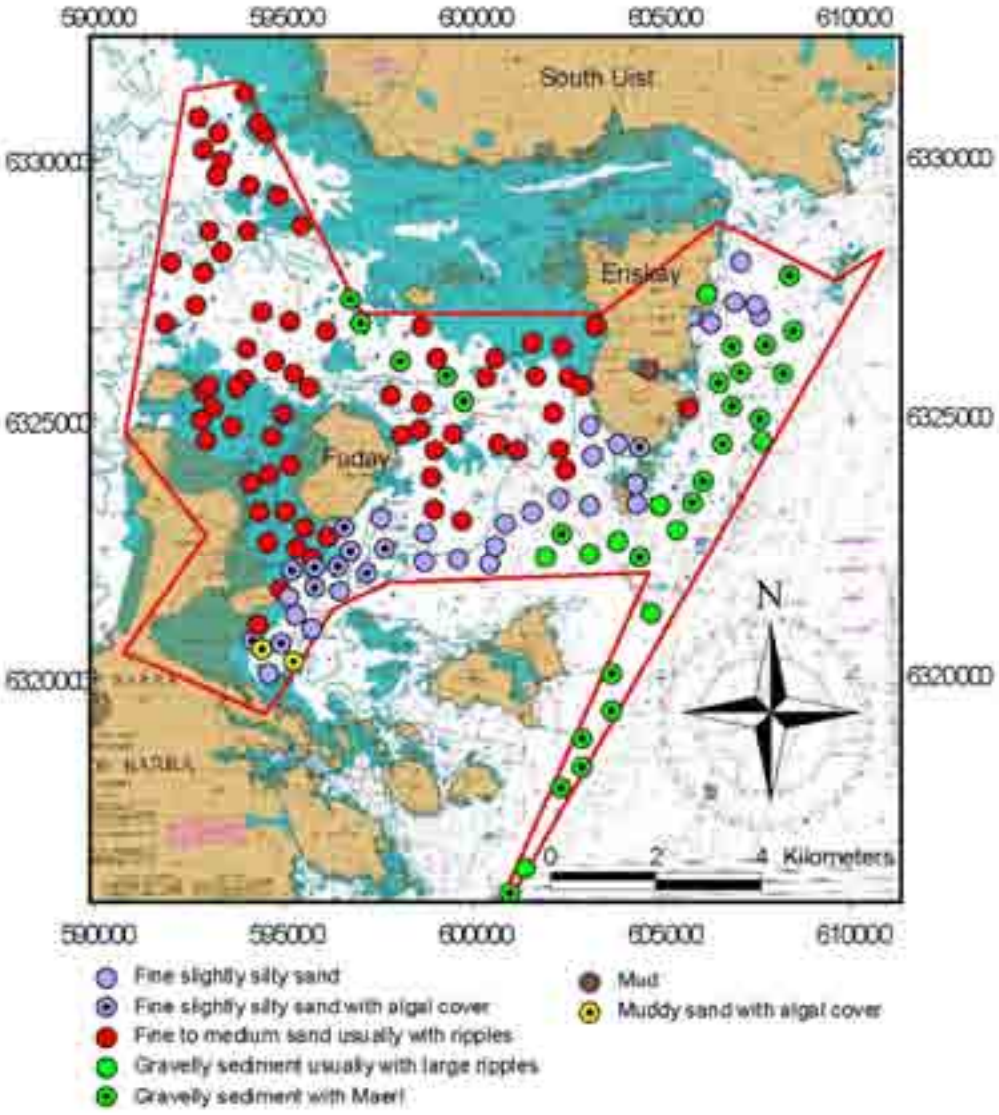
Three habitat types listed in Annex I of the EC Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (Habitats Directive) are of specific interest in the Sound of Barra. These are: ‘Mudflats and sandflats not covered by seawater at low tide’; ‘Sandbanks which are slightly covered by sea water at all times’; and ‘Reefs’, including extensions into the intertidal region. These habitats are broadly defined in the Interpretation Manual of European Union Habitats, in which there is some scope for interpretation.

‘Reefs’ occur in both the intertidal and subtidal parts of the sound and are taken to include any areas of rocky substrate sufficiently continuous to support communities of rock epibiota. This includes areas of stable boulders, bedrock outcrops and aggregations of cobbles. None of the sites investigated in the survey included biogenic reefs which would also qualify under the definition of ‘reefs’ in the Habitats Directive.

‘Mudflats and sandflats not covered by seawater at low tide’ are taken to include any intertidal sedimentary habitat. In the Sound of Barra all such sites were sandy and no mudflats were encountered.

'Sandbanks which are slightly covered by sea water at all times' encompasses the vast majority of the subtidal sediment habitats within the Sound of Barra. The category 'sand' is taken to include all sediments with a median grain size of between 63µm and 4mm and a silt / clay content of less than 20% by weight (Connor *et al.* 2004). Apart from a couple of isolated sheltered sites all sediments encountered in the Sound fall within this definition. The definition of the habitat explains that 'slightly covered by sea water at all times' "means that above a sandbank the water depth is seldom more than 20 m below chart datum. Sandbanks can, however, extend beneath 20 m below chart datum" and so encompasses the deeper maerl beds in the eastern part of the Sound.

Figure 4.1.1 Location of the main subtidal sandbank habitats encountered by the groundtruth survey.



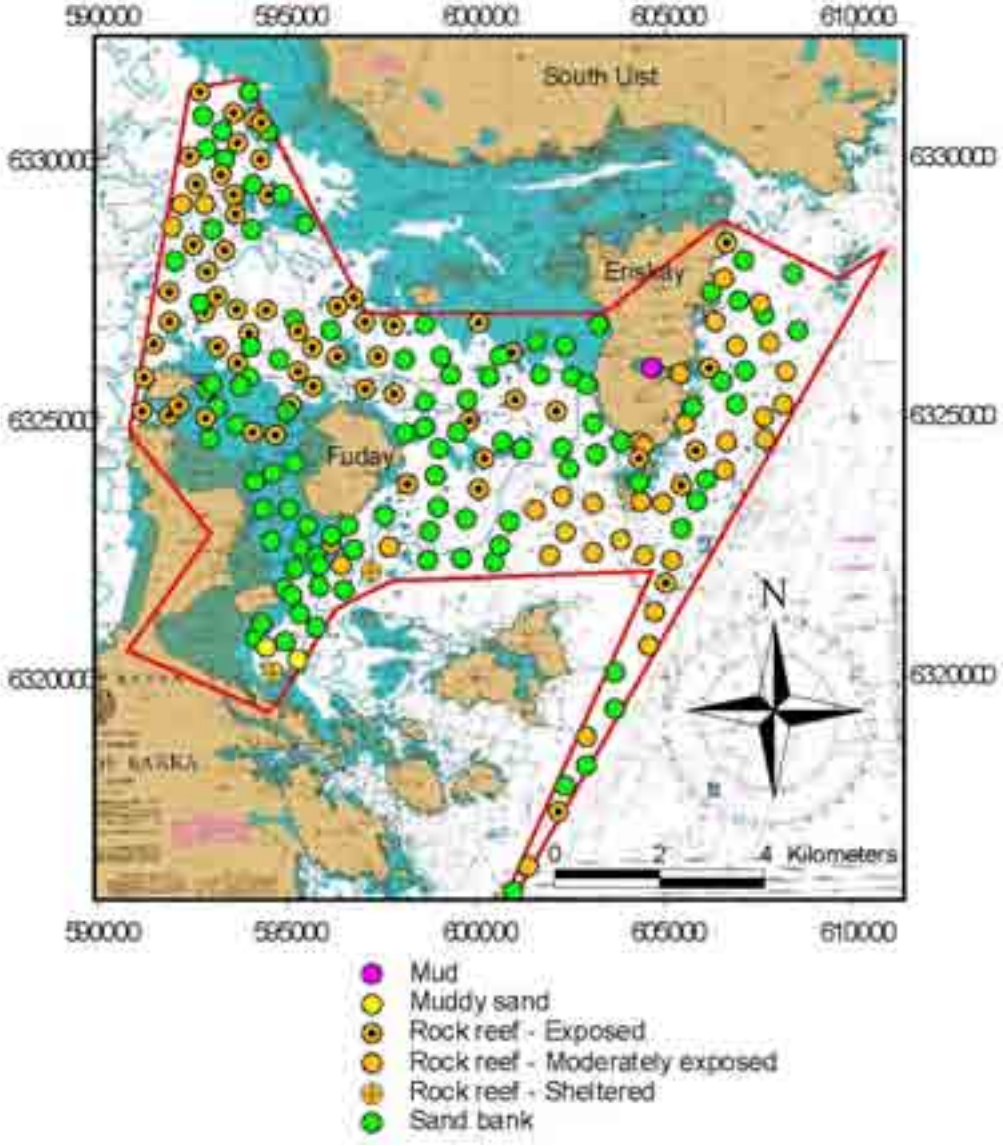
Sediments on the west of the site are dominated by clean mobile rippled medium to fine sands. These predominate in the Sound of Fuday, areas north of the Eoligarry peninsula and in the shallow tideswept central part of the Sound between Fuday and Eriskay.

Finer siltier sands predominate in Inner and Outer An Oitir Mhor and extend into areas below the 10m contour in the central Sound continuing north to the south of Eriskay. These sands also occur in an area to the east of the northern part of Eriskay.

Gravelly coarse sediment predominates over much of the relatively deep (>20m) eastern part of the area and frequently includes living maerl. These sediments predominate over much of the area east of Eriskay and extend southwards to areas east of Bruernish, Fuiay, Hellisay and Gighay. Maerl gravels also occur in the central part of the sound between Fuday and Lingay.

Although areas of sand occur throughout the site, outcrops of rock reefs of varying sizes are also present at many locations and in some areas may account for a significant proportion of the area of seabed.

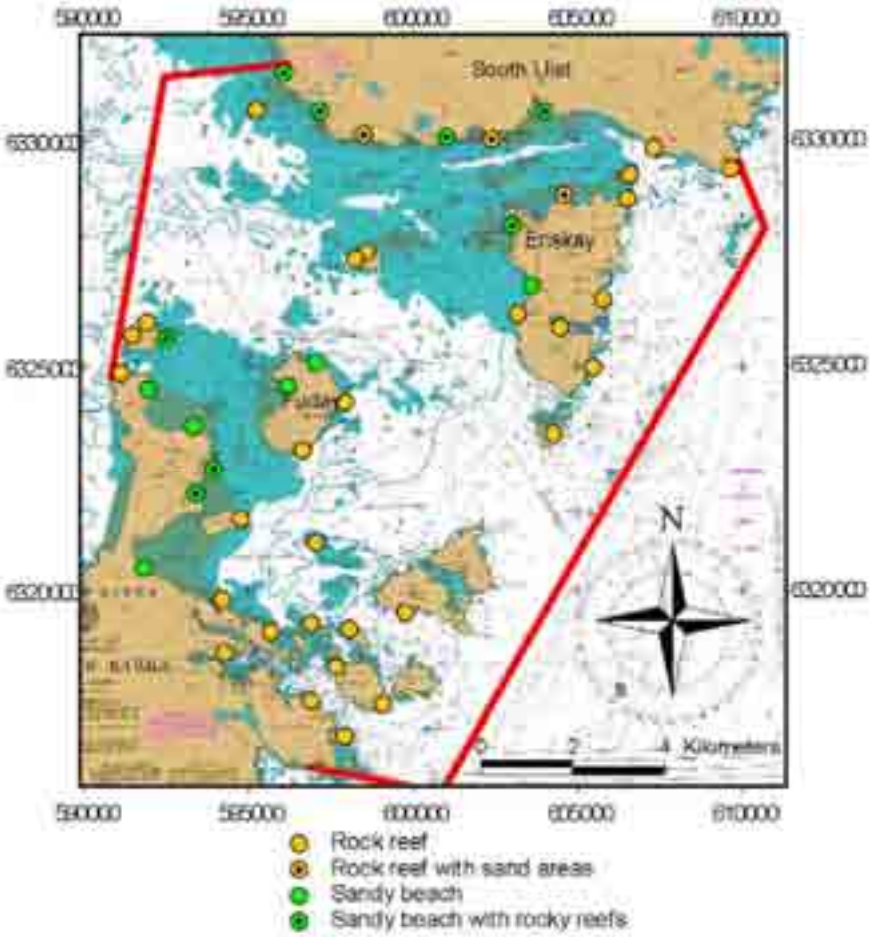
Figure 4.1.2 Location and exposure levels of subtidal reef habitats encountered by the groundtruth survey.



A high proportion of stations north of the Eoligarry peninsula and Fuday included rock reef habitats and rock appears to be the most extensive substrate type in this area. Sandbank habitats predominate in the Sound of Fuday, An Oitir Mhor and many parts of the central Sound between Fuday and Eriskay. Rock reefs were also recorded at many of the stations in the eastern part of the Sound. The individual rock reefs encountered in this area tended to be small and the proportion of seabed composed of rock reef is likely to be less than in the exposed western areas of the Sound.

Exposure levels are generally high throughout the subtidal survey area. The open areas to the west are the most highly exposed although open areas to the east and to a lesser extent areas in the central part of the Sound also include a high proportion of exposed sites. At many locations rapid tidal currents contribute to the high energy levels of the environment. The topographical complexity of the Sound provides areas of localised shelter at many locations but the only significant sheltered area lies within Inner An Oitir Mhor.

Figure 4.1.3 Location of the main intertidal habitat features recorded by the groundtruth survey.

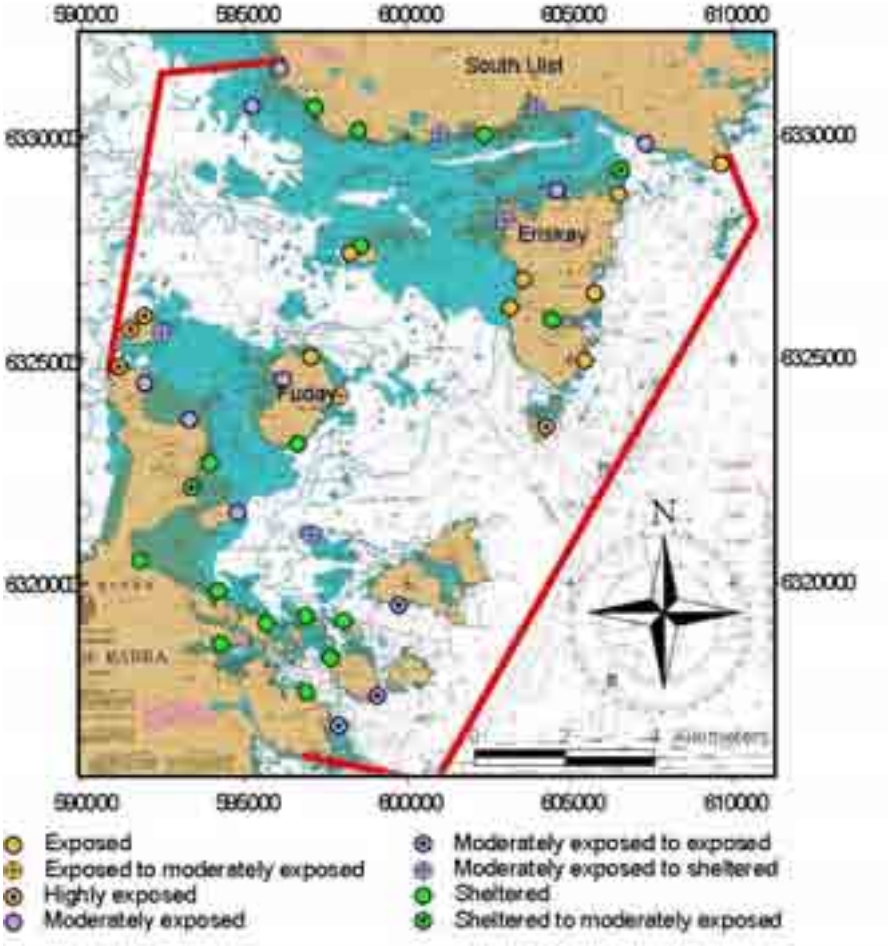


The shores of the south eastern part of the Sound are predominantly rocky reefs. Sandflats account for significant areas of the eastern shores of the Eoligarry peninsula. Sandy beaches exist on some of the islands but the majority of shorelines are of rocky reefs. Shorelines around the shallow area north west of Eriskay include many sandy beaches interspersed with rock reefs.

Figure 4.1.4 shows the relative exposure levels of the intertidal groundtruth survey stations as indicated by the composition of predominant biotopes on the shore.

Many shores in the south and south eastern part of the Sound are predominantly sheltered. Areas of shelter and moderate exposure occur along the eastern shores of the Eoligarry peninsula. Many of the west or east facing shores of the islands are exposed or highly exposed. Many of the shores on South Uist and in the Sound of Eriskay are often protected by offshore rocky reefs and there are many localised areas of shelter and regions of moderate exposure.

Figure 4.1.4 The relative exposure levels of the intertidal groundtruth survey stations as indicated by the predominant biotopes.



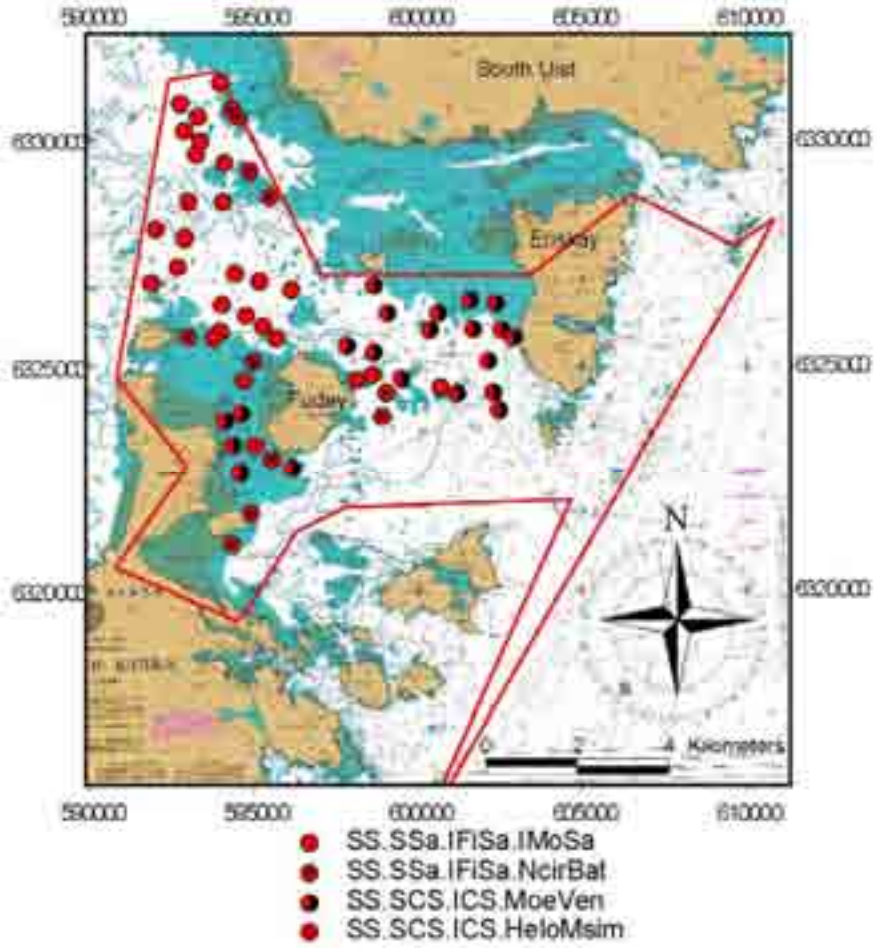
4.2 Distribution patterns of biotopes

4.2.1 Sublittoral sediments

The distribution of sandbank biotopes largely follows the distribution of sediment composition as shown in figure 4.1.1.

Clean rippled mobile medium to fine sands predominate the sediments of much of the western and central parts of the Sound (figure 4.2.1). Due to its instability the sand often contains an impoverished infaunal community (**SS.SSa.IFiSa.IMoSa**) particularly at exposed sites. Other sites which were otherwise identical had better developed infaunal communities characteristic of biotopes such as **SS.SSa.IFiSa.NcirBat** and **SS.SCS.ICS.HeloMsim**. The biotope **SS.SCS.ICS.MoeVen** is characterised by an infauna of bivalve molluscs. This biotope was recorded at sites with a more stable sandy substrate often at tideswept locations in the Sound of Fuday and the central part of the Sound.

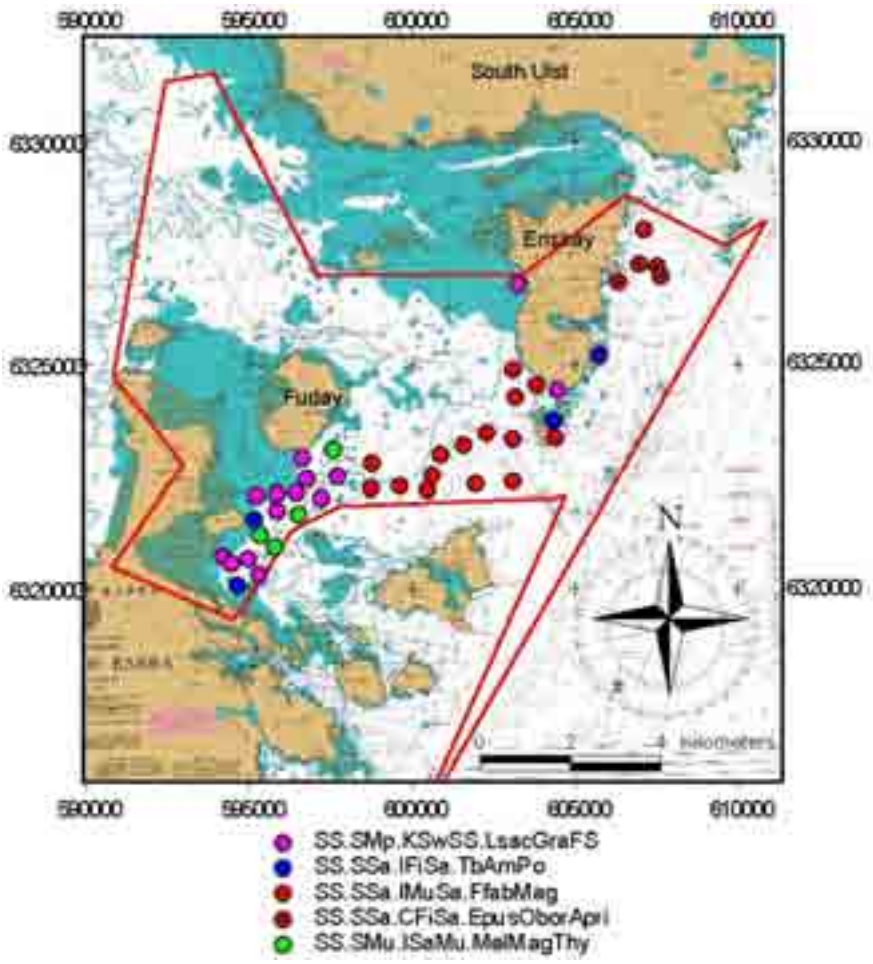
Figure 4.2.1 Distribution of mobile sand sites



The slightly silty fine sandbank habitats shown in figure 4.1.1 fall into five main biotopes (figure 4.2.2). The infaunal communities are generally much more abundant and species rich than in the mobile sands of the western part of the Sound. Local differences in exposure

levels, depth and granulometry modify the community composition of the infauna in different parts of the area. The sheltered area of Inner An Oitir Mhor is dominated by sediments blanketed by *Laminaria saccharina* and a range of other algae. Sediment infauna contains species characteristic of the biotope **SS.SSa.IFiSa.TbAmPo** or of **SS.SMu.ISaMu.MelMagThy** in slightly deeper siltier areas. More exposed areas such as Outer An Oitir Mhor and areas south of Eriskay are dominated by fine hummocked sands with a variable infaunal composition which approximates to the biotope **SS.SSa.IMuSa.FfabMag**. Similar fine sands are found in a deep area east of the northern part of Eriskay where the infaunal community composition corresponded to the biotope **SS.SSa.CFiSa.EpusOborApri**.

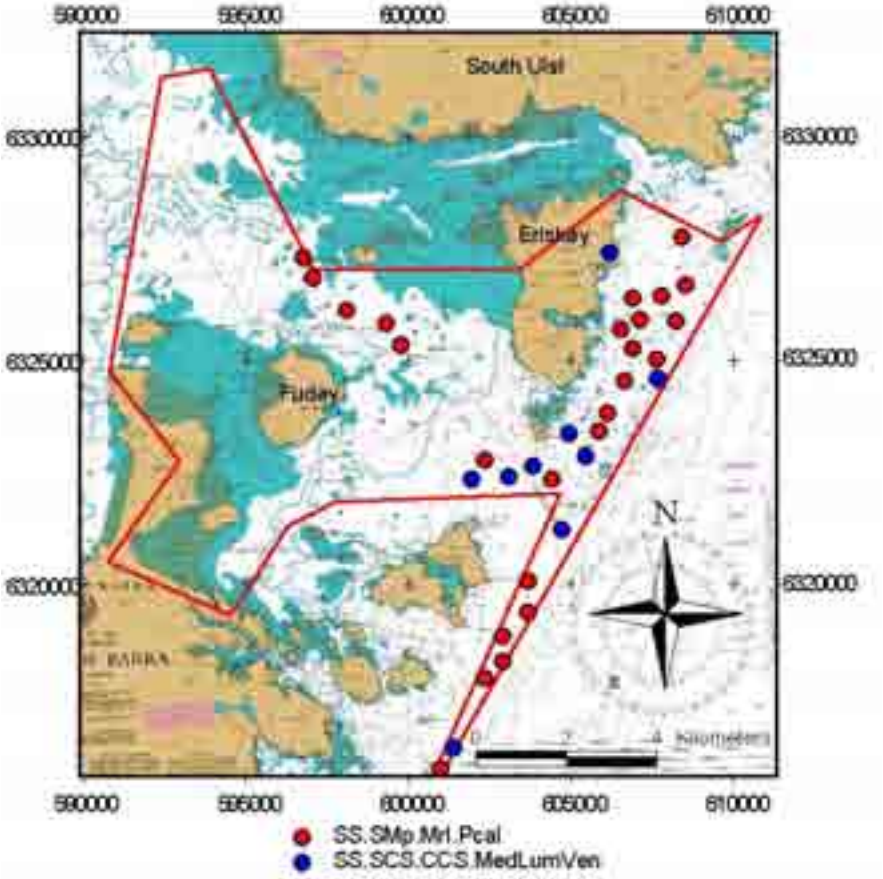
Figure 4.2.2 Distribution of fine sand sites



The gravelly coarse sands shown in figure 4.1.1 are subdivided into two biotopes although the distinction between the two is debatable. The sediment in these areas is predominantly gravelly coarse sand with large pronounced ripples and a high proportion of shell fragments and dead maerl on the surface. Where no live maerl was found this sediment was designated to the biotope **SS.SCS.CCS.MedLumVen**. Where live maerl was found it was designated to the biotope **SS.SMp.Mrl.Pcal**. The abundance of live maerl was low (often <10% cover) at many stations and it is unlikely that the distinction between the two biotopes has real biological significance. These substrates are well developed in the eastern parts of the sound and merge with the fine sand areas both south and north east of Eriskay. Maerl is

also found amongst the mobile sands further west in the Sound in the tideswept channel between Fuday and Lingay.

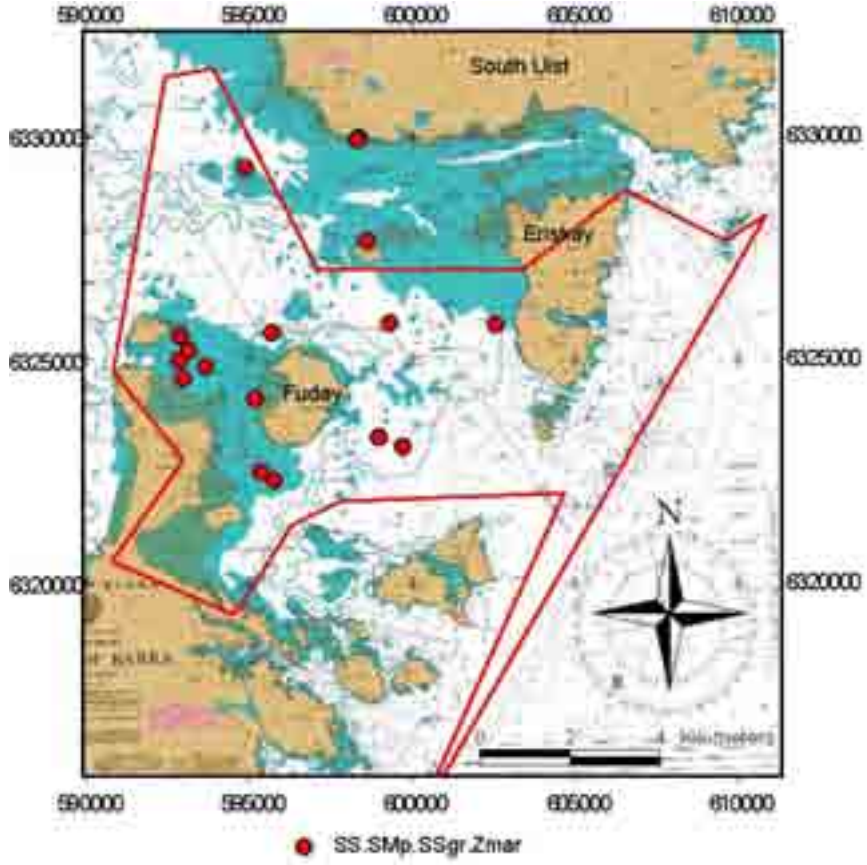
Figure 4.2.3 Distribution of gravelly coarse sand sites



Subtidal sandbanks supported dense beds of the seagrass *Zostera marina* at various locations within the Sound (figure 4.2.4). These cover extensive areas of the shallow sands south east of Fiaray and similar well developed smaller beds occur in the Sound of Fuday. There is a large but more diffuse bed of *Zostera* to the south east of Fuday and it also occurs in smaller isolated patches at various locations within the Sound.

The beds typically consist of a series of bands of dense *Zostera* several metres wide with adjacent areas of bare sand separating the *Zostera* bands. The composition of the infauna from these areas of bare sand is modified by the presence of the *Zostera* and the sediment itself is slightly more heterogeneous than in corresponding areas devoid of *Zostera*. This is presumably due to shelter provided by the dense stands of *Zostera* which may have a sward height of well over a metre. In some places the stabilising influence of the *Zostera* rhizomes can be seen where the *Zostera* forms banks with the sediment surface several cm higher than that of adjacent areas of loose sand. The fauna tends to be more diverse than would be expected in the absence of *Zostera* and often includes epiphytic species.

Figure 4.2.4 Distribution of Zostera sites

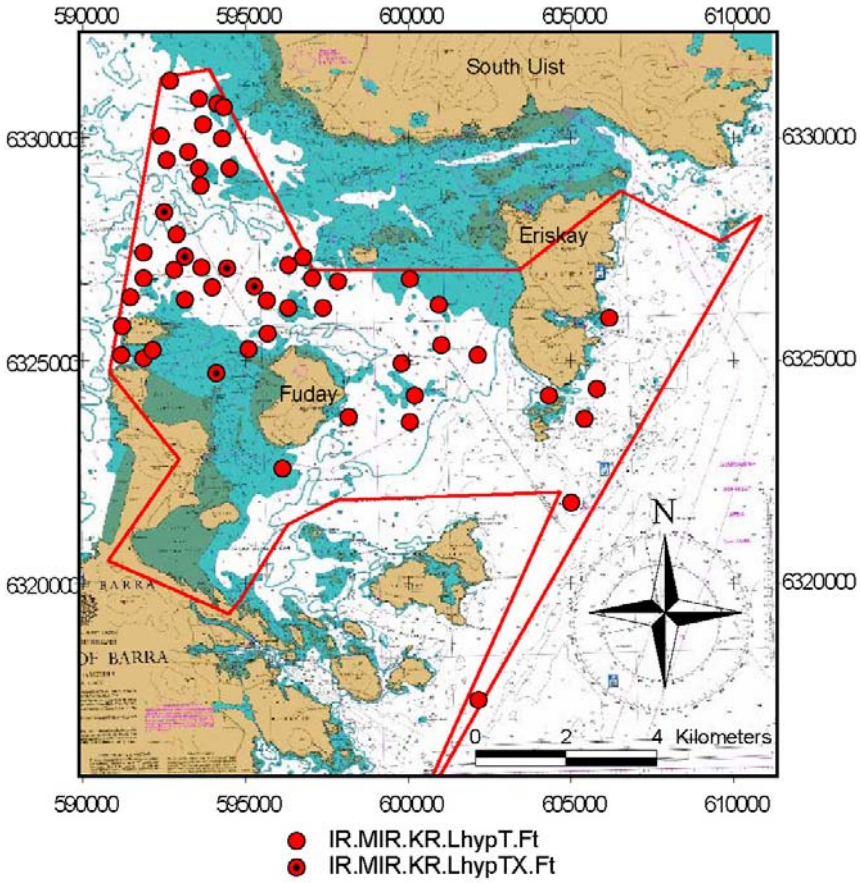


4.2.2 Sublittoral rock

The majority of sublittoral rock reefs within the Sound lie in the infralittoral. They are tideswept and /or sediment scoured in many locations particularly in the western part of the Sound.

The exposed and tide swept areas that cover much of the Sound tend to be dominated by *Laminaria hyperborea* forests (**IR.MIR.KR.LhypT.Ft**). These are particularly prevalent in the western part of the Sound and are characterised by a dense epibiota on the stipes including filter-feeding taxa such as sponges, bryozoans and ascidians (figure 4.2.5). Rock surfaces lack a dense red algal turf and show evidence of sand scour at some locations. There are significant populations of *Echinus esculentus* at some locations but the rock biota does not appear to be under major grazing pressure. The biotope **IR.MIR.KR.LhypTX.Ft** is used where rock substrates are patchy but this is biologically indistinguishable from **IR.MIR.KR.LhypT.Ft**.

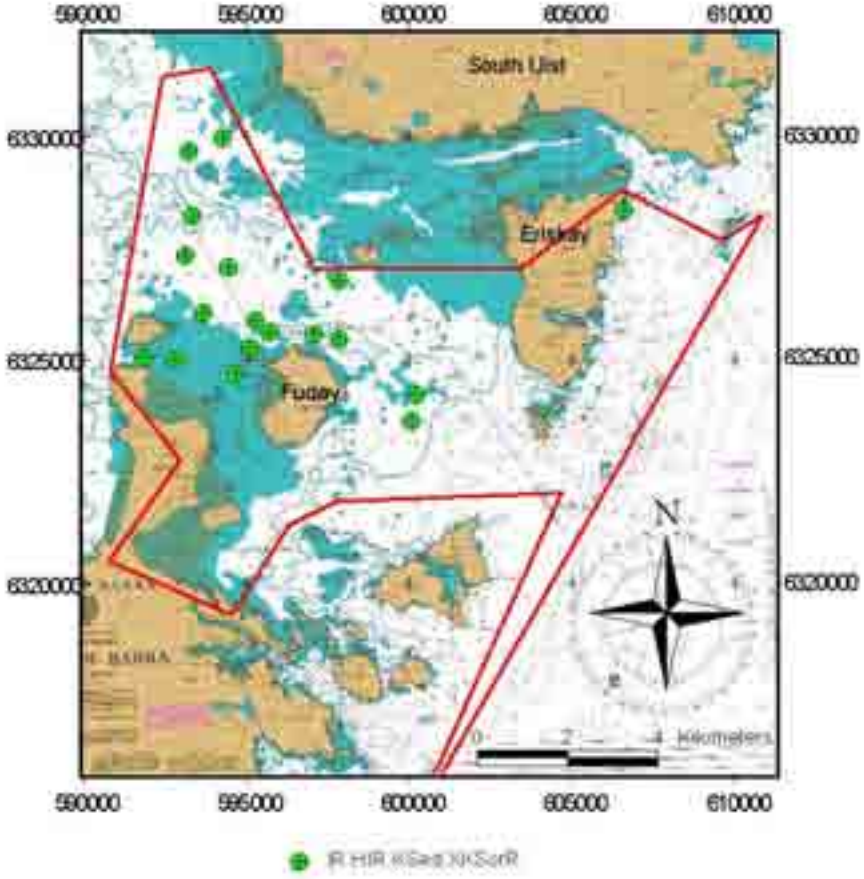
Figure 4.2.5 Distribution of exposed tideswept Laminaria hyperborea sites



Where the effects of sand scour are particularly pronounced gaps are created in the perennial *Laminaria hyperborea* canopy and colonised by faster growing species of kelp such as *Saccorhiza polyschides* and *Laminaria saccharina* (**IR.HIR.KSed.XKScrR**). These seasonally disturbed high energy habitats are particularly prevalent in the western parts of

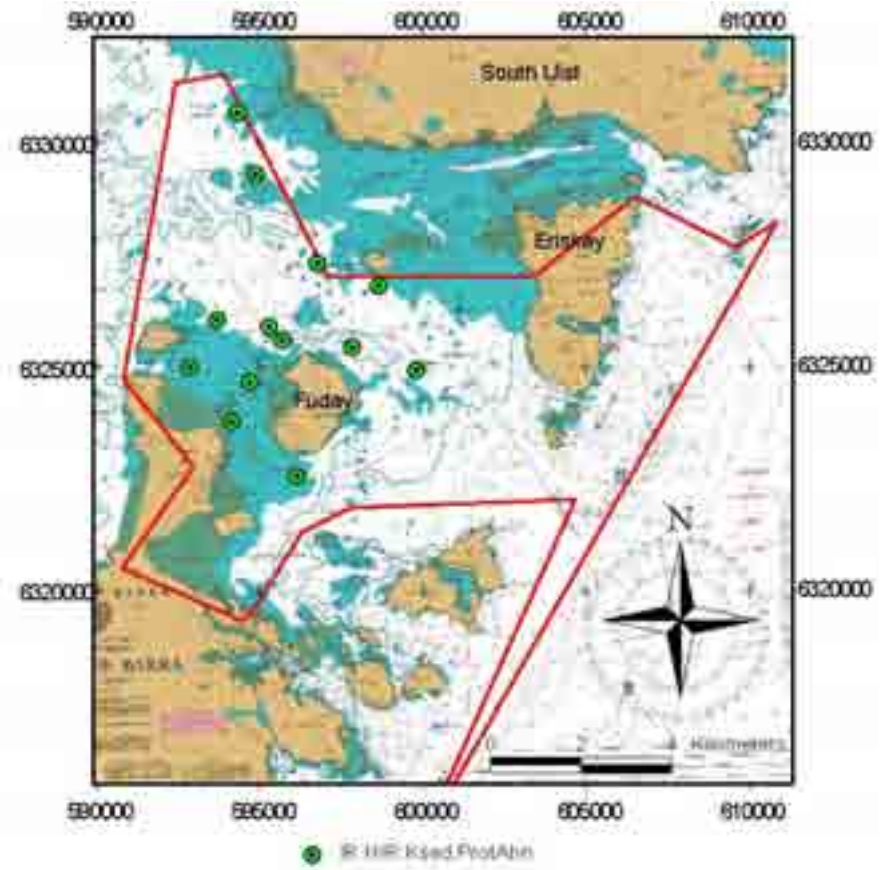
the Sound and often co-occur with areas of more established tideswept *Laminaria hyperborea* (**IR.MIR.KR.LhypT.Ft**) and patches of mobile sand (**SS.SSa.IFiSa.IMoSa**).

Figure 4.2.6 Distribution of exposed tideswept mixed kelp sites



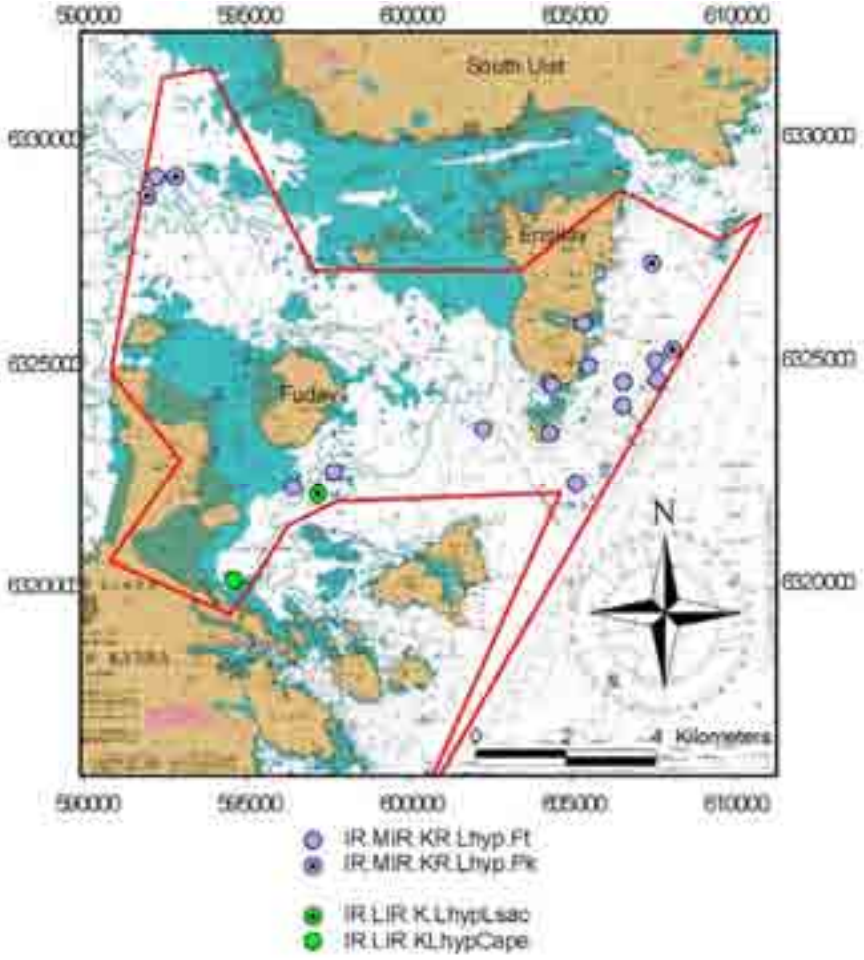
The biotope **IR.HIR.KSed.ProtAhn** (figure 4.2.7) is a more extreme variant of **IR.HIR.KSed.XKScrR**. The substrate is unstable cobbles or other rock surfaces subject to periodic burial or scour by adjacent areas of mobile sand. Conditions are too unstable for kelp forests to develop and surfaces are colonised by ephemeral or scour tolerant algae such as *Furcellaria*. Like **IR.HIR.KSed.XKScrR** this biotope is most prevalent in the exposed western part of the Sound and often occurs at the margins of rock reefs where the influence of adjacent areas of mobile sand is greatest. The biotope lacks a continuous rock substrate and is not considered to be a constituent biotope of the rock reef feature. It is not thought to cover extensive areas of the Sound and appears to occur in localised patches on the margins of exposed rock reefs.

Figure 4.2.7 Distribution of disturbed macroalgal sites



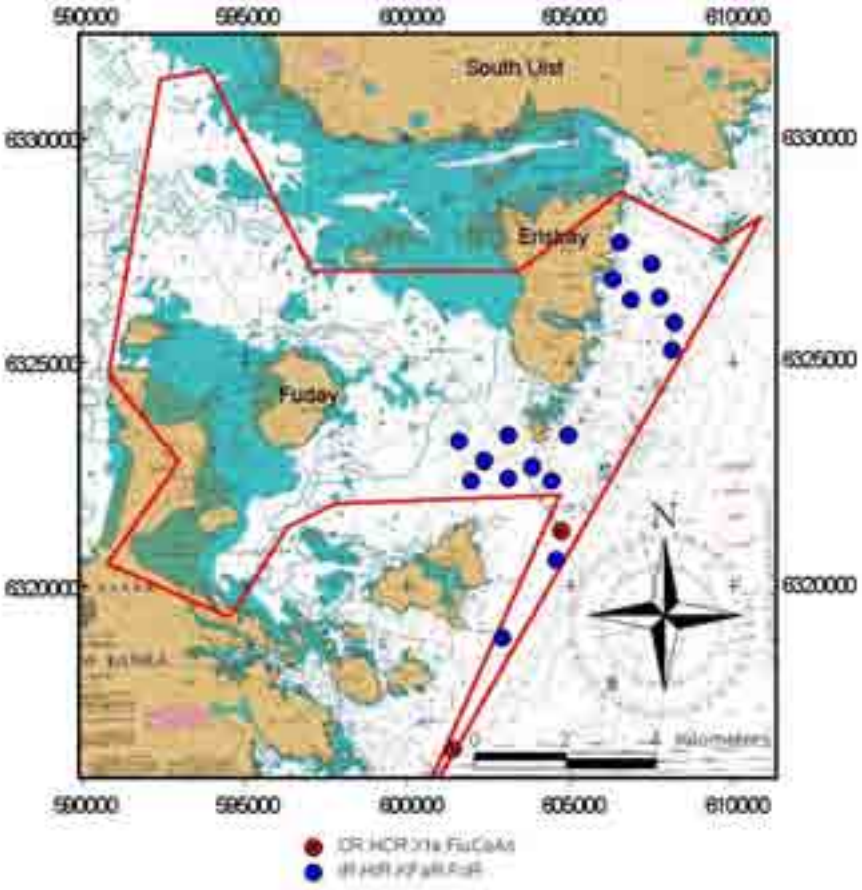
Lower energy *Laminaria hyperborea* forests (**IR.MIR.KR.Lhyp.Ft** & **IR.MIR.KR.Lhyp.Pk**) exist in other parts of the Sound (figure 4.2.8). These typically lack the dense stipe epibiota of **IR.MIR.KR.LhypT.Ft** but are similar in many other respects. Their distribution is partially depth related. On the deeper rock reefs in the eastern part of the site and in deeper basins of the western part of the site the energy levels are reduced and this is reflected in the biota of the kelp forests. These biotopes also occur at shallower stations in areas of localised shelter and within Inner An Oitir Mhor. The high level of shelter in parts of Inner An Oitir Mhor allows for the development of the characteristic sheltered kelp biotopes **IR.LIR.K.LhypLsac** and **IR.LIR.K.LhypCape**.

Figure 4.2.8 Distribution of relatively sheltered kelp sites



The rock reefs of the eastern part of the site are deeper than in most other parts of the Sound and are subject to scour by the surrounding coarse gravelly sediments (figure 4.2.9). The majority of these deeper reefs are dominated by a dense turf of red algae (**IR.HIR.KFaR.FoR**). The development of kelp forests is likely to be limited by a combination of the depth and scour effects. The fauna includes various scour tolerant taxa including *Flustra* and *Alcyonidium digitatum*. At the deeper locations the red algal turf is sparse or absent although the faunal component is similar and corresponds to the biotope **CR.HCR.Xfa.FluCoAs**.

Figure 4.2.9 Distribution of deeper rock reef sites

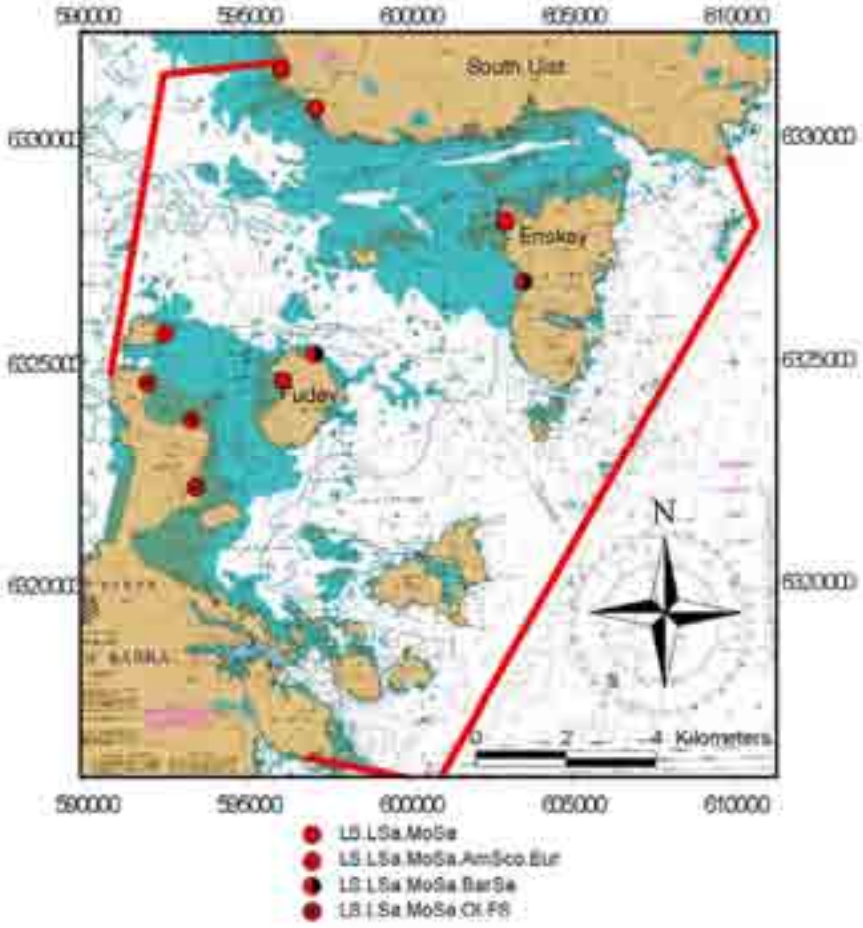


4.2.3 Littoral sediments

All sandy beaches examined on the survey included a strandline with numerous *Talitrus* amphipods (**LS.LSa.St.Tal**) and the distribution of this ubiquitous biotope is not shown separately to that of other intertidal sand biotopes.

The distribution of stations corresponding to the **LS.LSa.MoSa** habitat complex is shown in figure 4.2.10. Two beaches (north Fuday & west Eriskay) are distinctive in showing elevated exposure levels relative to other shores in the Sound. They were characterised by an impoverished infauna (**LS.LSa.MoSa.BarSa**) and a relatively steep shore profile with no lower shore of finer sand. The remaining stations are characterised by a relatively narrow band of dry steep unrippled **LS.LSa.MoSa** sand in the upper shore above a plain of rippled wet sand in the lower shore. The infaunal composition of this dry upper shore sand was variable but included a high proportion of oligochaetes (**LS.LSa.MoSa.Ol.FS**) on the beaches of the Eoligarry peninsula and a high proportion of *Eurydice* on a beach on the east side of Fiaray.

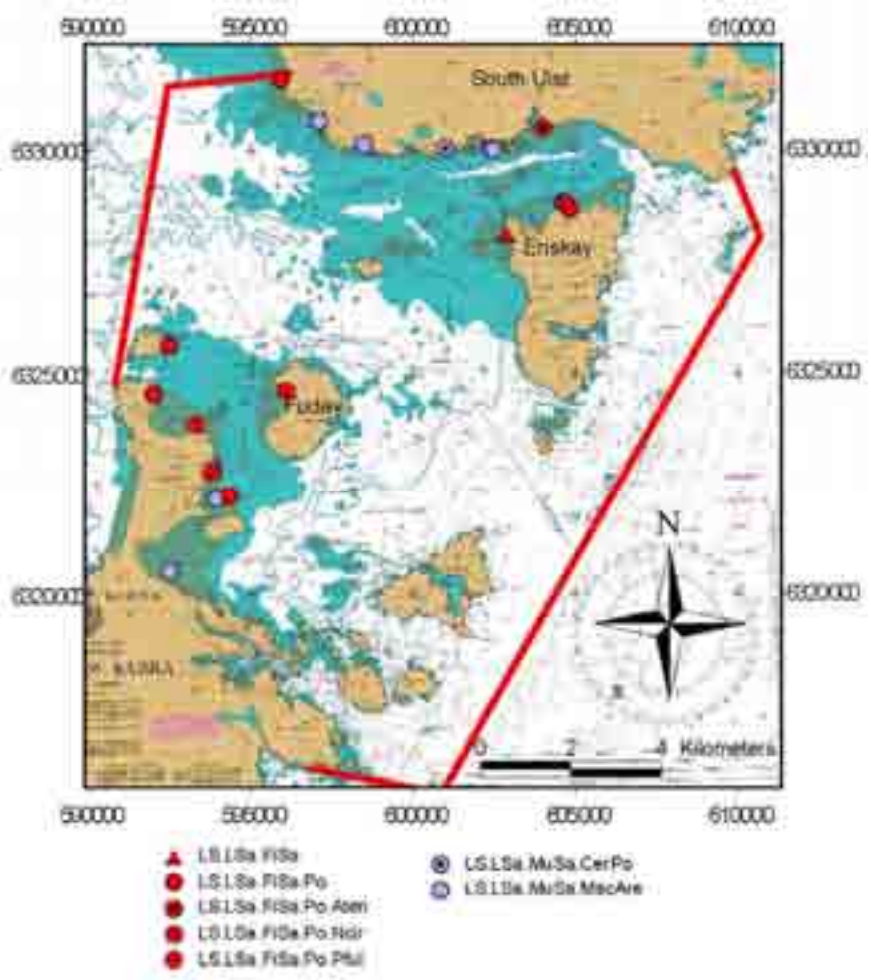
Figure 4.2.10 Distribution of littoral mobile sand sites



On most of the sandy shores the majority of the intertidal area was composed of relatively flat rippled fine sand with standing water (**LS.LSa.FiSa** & **LS.LSa.MuSa**). The distribution of these sites is shown in figure 4.2.11. The composition of the infauna was variable consisting largely of amphipods and polychaetes. Most of the stations approximate to the biotope **LS.LSa.FiSa.Po** and some are matched to sub-biotopes based on the relative proportions of the characterising taxa. In locations with more sheltered conditions the beach sands tended to be finer and *Cerastoderma* and *Arenicola* were prominent (**LS.LSa.MuSa.MacAre** & **LS.LSa.MuSa.CerPo**). These included locations such as Traigh Mhor and also areas of the South Uist shore where offshore reefs provide a degree of shelter. One location on the northwest of Eriskay was aberrant in having a highly diverse infauna including subtidal taxa. This is assumed to be due to strandings caused by strong onshore winds and no biotope was allocated within the **LS.LSa.FiSa** habitat complex.

The intertidal infaunal communities and corresponding biotopes are likely to be transient and changeable on these beaches and different littoral fine sand biotopes may occur within different parts of the same beach. The effect of organic enrichment was noted on various shores with elevated populations of taxa characteristic of such conditions. This is likely to be due to the large quantities of drift algae stranded by winter storms and decomposing within the upper shore sand.

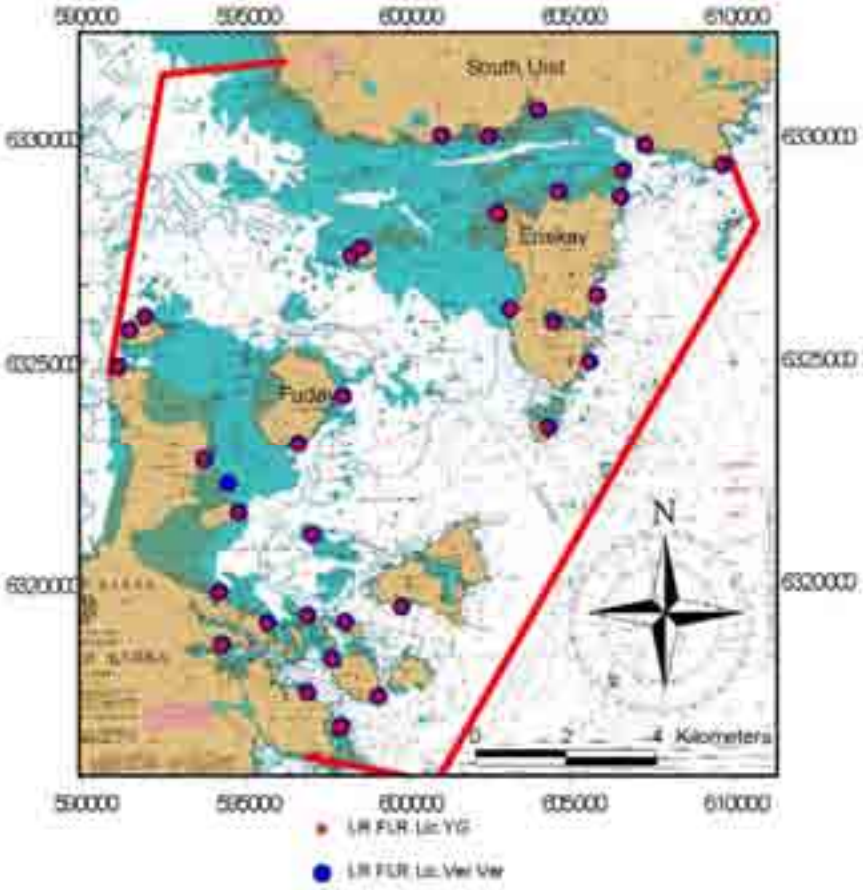
Figure 4.2.11 Distribution of littoral lower shore sand sites



4.2.4 Littoral rock

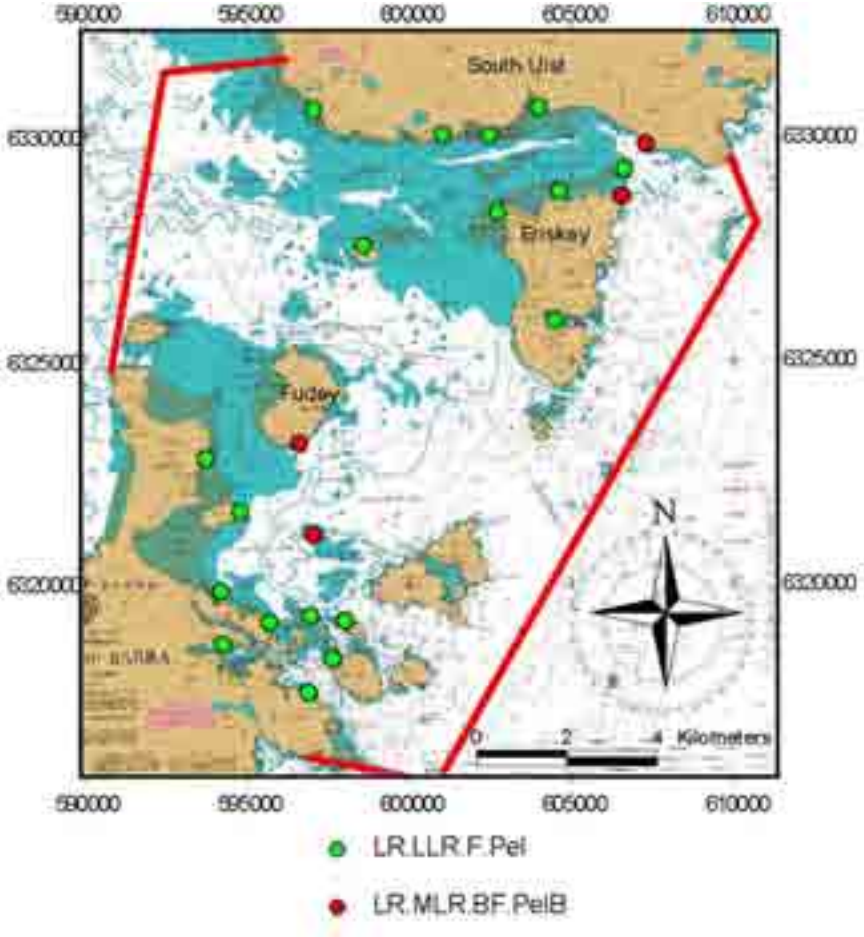
The supralittoral lichen biotopes **LR.FLR.Lic.YG** and **LR.FLR.Lic.Ver.Ver** are ubiquitous in the Sound and are found wherever there is suitable rocky substrate in the upper shore (figure 4.2.12). At sheltered sites the lichen bands are often narrow but at more exposed locations they tend to be broader and extend further above the littoral zone.

Figure 4.2.12 Distribution of lichen biotopes



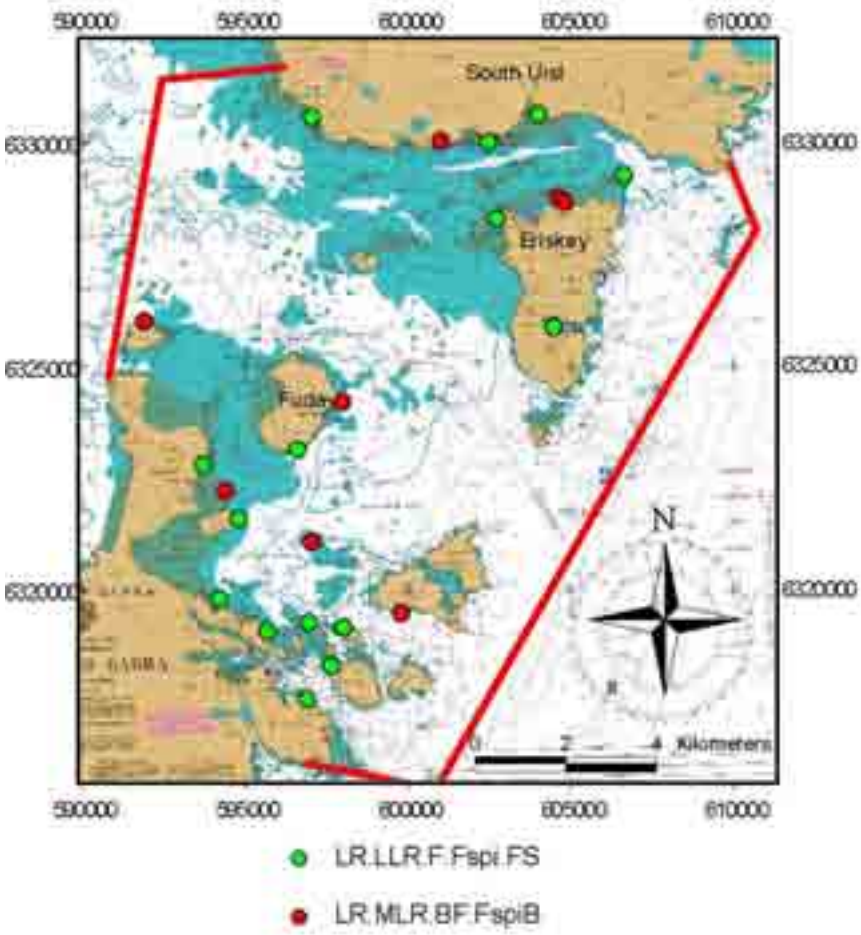
The upper shore fucoid algae *Pelvetia* occurs on sheltered and slightly exposed shores forming a narrow band at the top of shores dominated by other fucoids such as *Ascophyllum* or *Fucus vesiculosus* (figure 4.2.13). A well defined *Pelvetia* zone is absent from the more exposed locations but occurs on sheltered (**LR.LLR.F.Pel**) and some moderately exposed locations where it typically occurs in combination with barnacles (**LR.MLR.BF.PelB**).

Figure 4.2.13 Distribution of Pelvetia biotopes



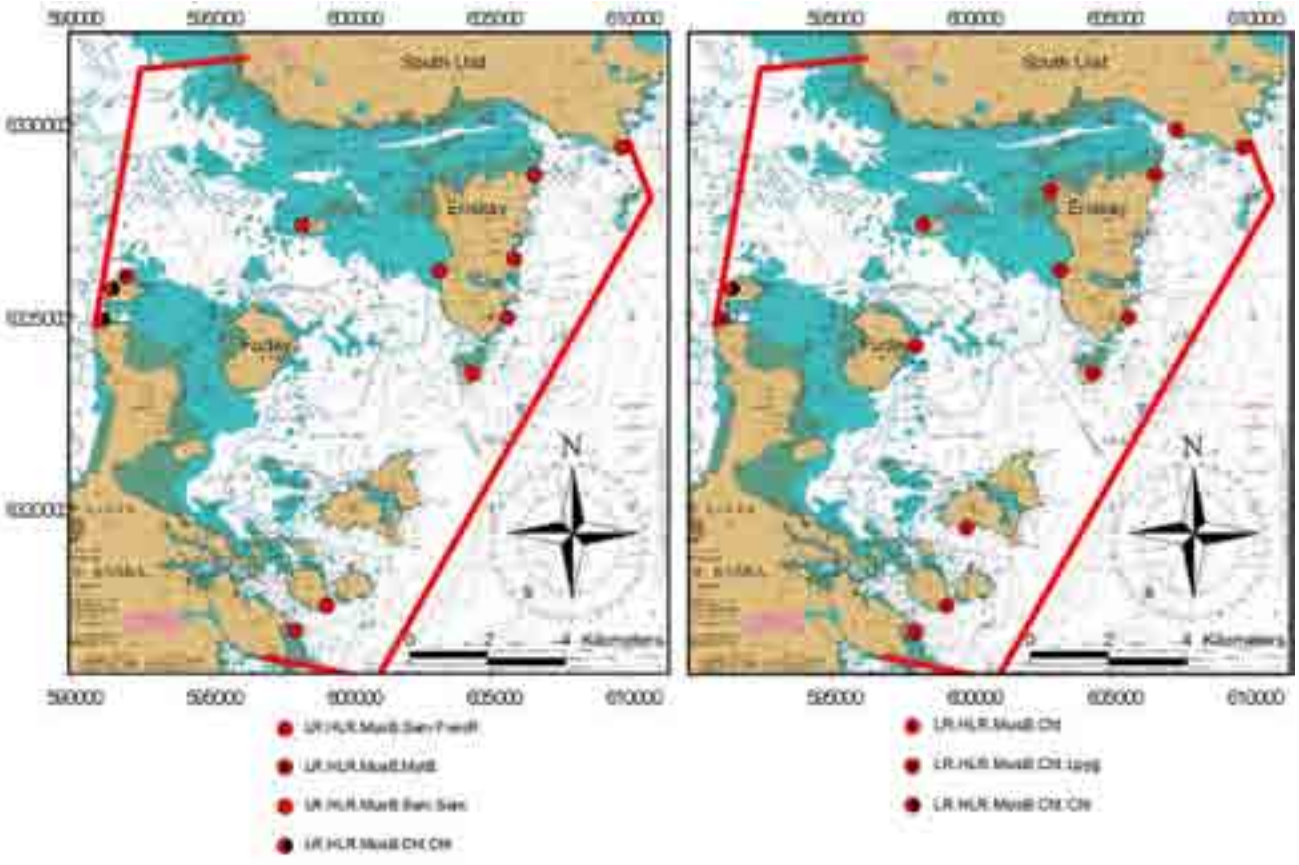
Like *Pelvetia*, the upper shore fucoid algae *Fucus spiralis* occurs on sheltered and slightly exposed shores and typically forms a narrow band below the *Pelvetia* zone (figure 4.2.14). A well defined *Fucus spiralis* zone is absent from the more exposed locations but occurs on sheltered (**LR.LLR.F.Fspi.FS**) and some moderately exposed locations where it typically occurs in combination with barnacles (**LR.MLR.BF.FspiB**).

Figure 4.2.14 Distribution of Fucus spiralis biotopes



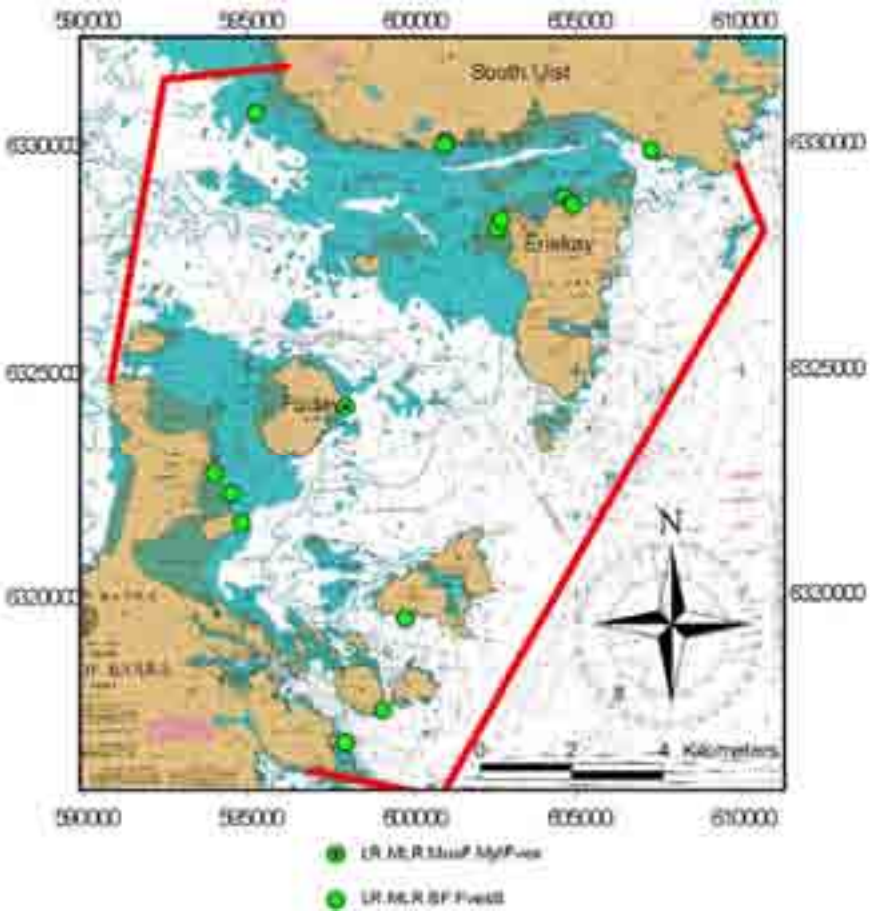
In the more exposed areas of the Sound the shores are almost entirely dominated by barnacles (figure 4.2.15). Patches of mussels and sparse tufts of *Fucus vesiculosus* may be present (**LR.HLR.MusB.Sem.FvesR** & **LR.HLR.MusB.MytB**). At most locations the barnacle cover is dominated by *Semibalanus* (**LR.HLR.MusB.Sem.Sem**) but at the most highly exposed sites the shores are dominated by *Chthamalus* (**LR.HLR.MusB.ChtCht**) and these stations also support a zone of *Corallina* turf on the lower shore (**LR.HLR.FR.Coff**). *Chthamalus* is a characteristic taxon of exposed rocky shore sites. It often occurs as a separate band above the *Semibalanus* that dominate most of the shore (**LR.HLR.MusB.Cht**). *Lichina pygmaea* may also occur in this *Chthamalus* zone (**LR.HLR.MusB.Cht.Lpyg**).

Figure 4.2.15 Distribution of barnacle dominated shores



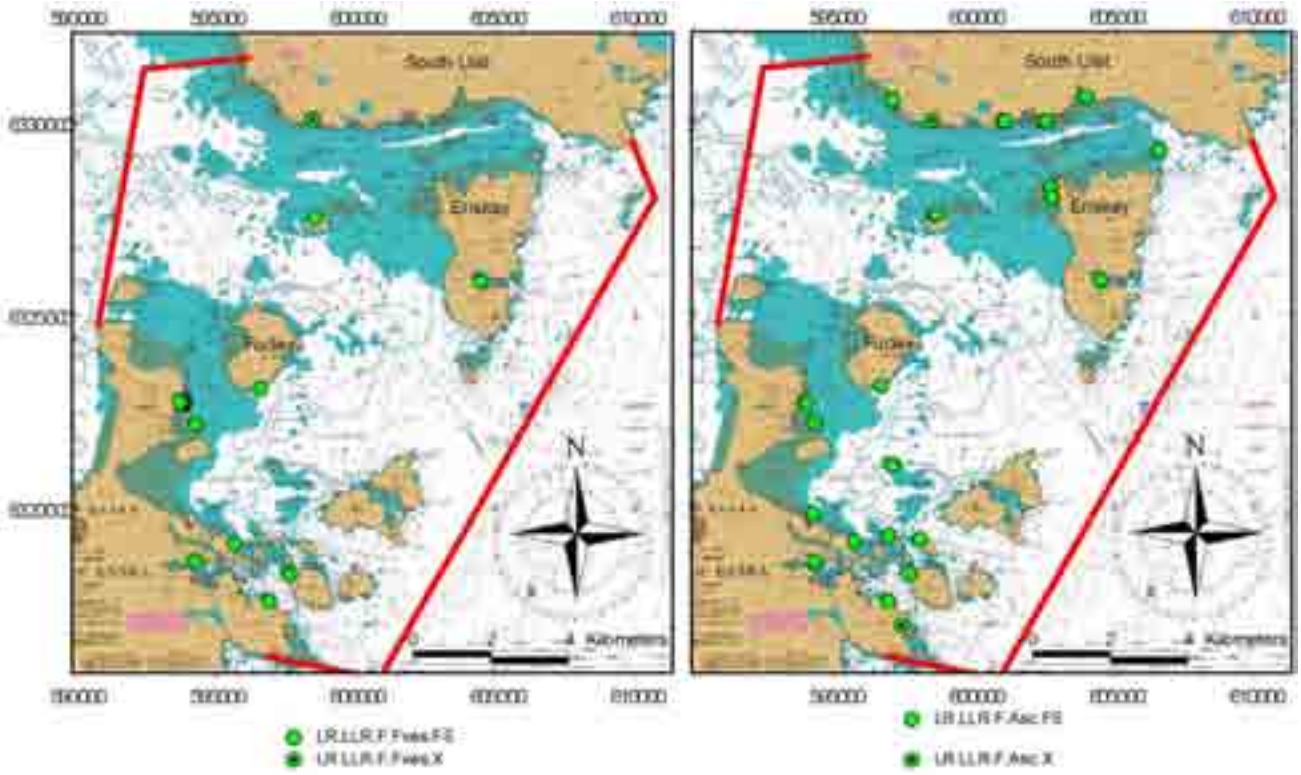
At slightly less exposed sites stands of *Fucus vesiculosus* can develop and form a mosaic of seaweed clumps and barnacle patches (**LR.MLR.BF.FvesB**) with mussels present at the more exposed variants (**LR.MLR.MusF.MytFves**) (figure 4.2.16).

Figure 4.2.16 Distribution of shores dominated by barnacle / fucoid mosaics



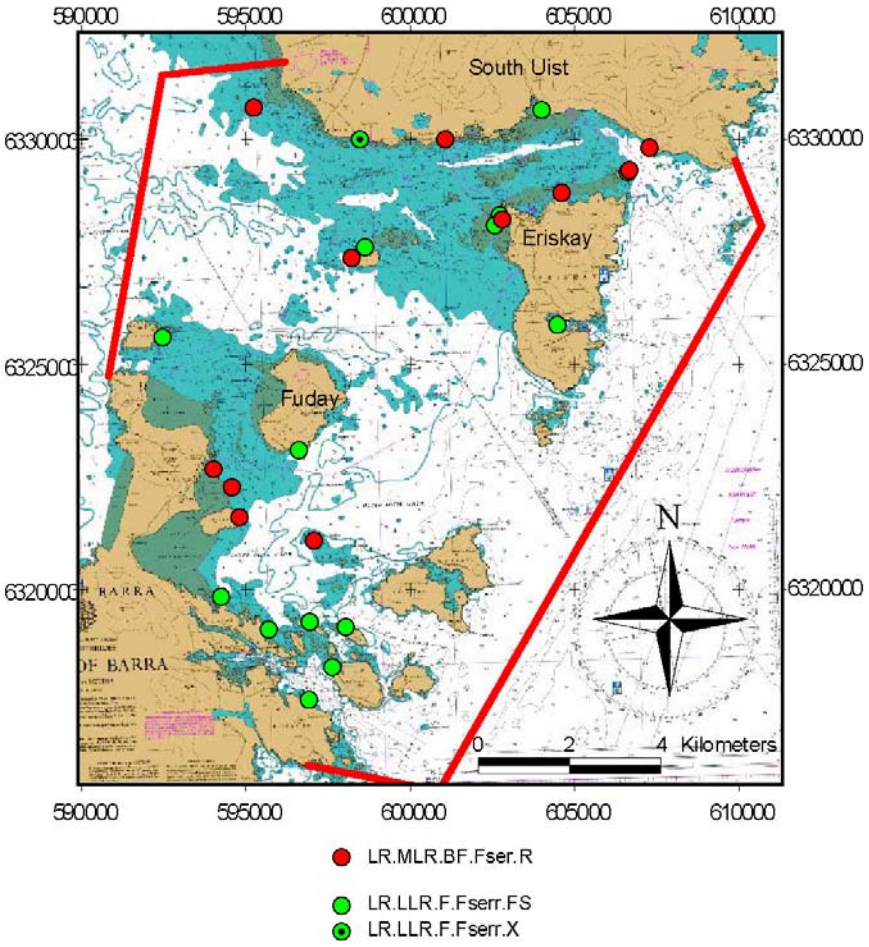
With increasing shelter the abundance of *Fucus vesiculosus* tends to increase and dominate the shore (**LR.LLR.F.Fves.FS** & **LR.LLR.F.Fves.X**) (figure 4.2.17). This did occur on certain rock reef outcrops on sandy shores but these biotopes generally occurred as a relatively narrow zone above a much more extensive zone of *Ascophyllum* (**LR.LLR.F.Asc.FS** & **LR.LLR.F.Asc.X**). These biotopes predominate in the more sheltered parts of the Sound but also occur in isolated pockets of shelter at more exposed locations.

Figure 4.2.17 Distribution of shores dominated by fucoids



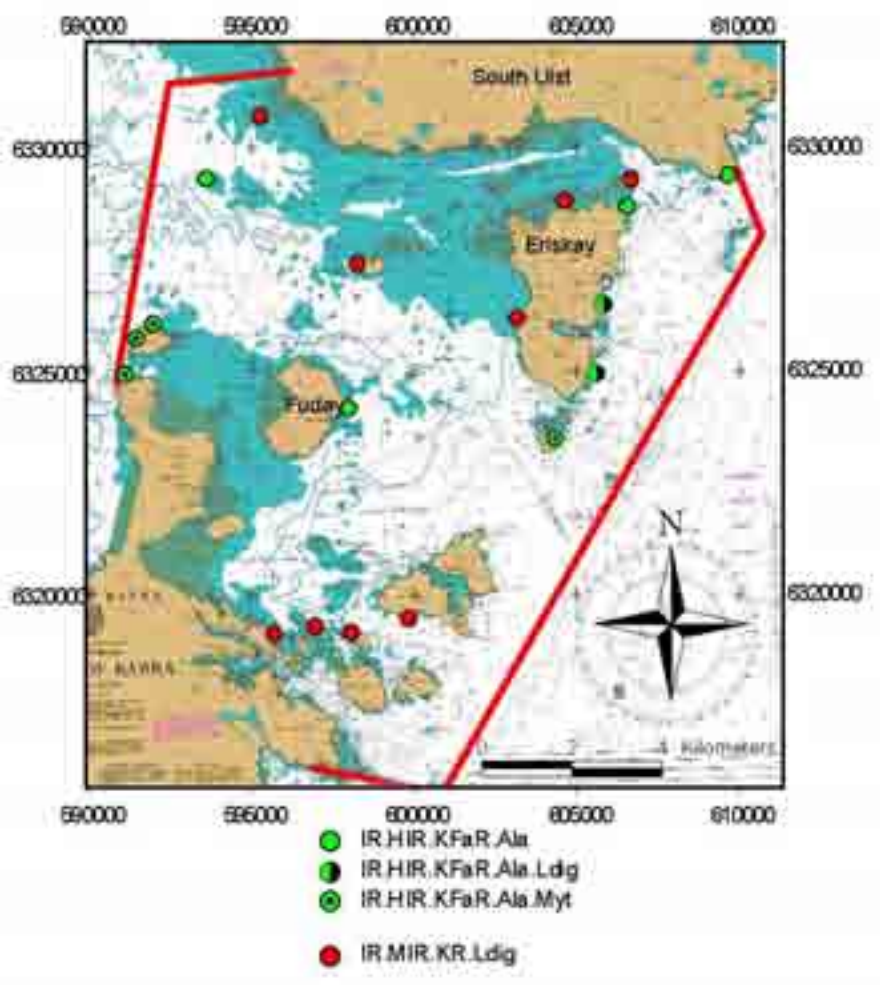
The lower shores of most sheltered (**LR.LLR.F.Fserr.FS** & **LR.LLR.F.Fserr.X**) and moderately exposed (**LR.MLR.BF.Fser.R**) areas support a narrow band of *Fucus serratus* on the waterline just above the sublittoral fringe (figure 4.2.18).

Figure 4.2.18 Distribution of Fucus serratus biotopes



The sublittoral fringe is typically occupied by kelps with dominance shifting from *Alaria esculenta* (**IR.HIR.K.FaR.Ala**) in conditions of high exposure to *Laminaria digitata* (**IR.MIR.KR.Ldig**) in conditions of moderate exposure (figure 4.2.19). At highly exposed sites patches of mussels and *Corallina* turf may occur amongst the *Alaria* (**IR.HIR.K.FaR.Ala.Myt**) and at slightly less exposed sites *Laminaria digitata* may occur amongst the *Alaria* (**IR.HIR.K.FaR.Ala.Ldig**).

Figure 4.2.19 Distribution of Alaria & Laminaria digitata biotopes



4.3 Integrated biotope classification and accuracy assessment

To classify the biotopes found in the Sound of Barra using the acoustic and optical remote sensing data obtained in this study, a combined spectral and expert systems-based approach to classification was attempted (as outlined in Section 2.3.3.5). This classification used the spectral information from a refined training area dataset and combined it with defined rules based on expert knowledge of the occurrence of different biotopes in areas differing in *exposure* and *bathymetry*, as outlined in detail for each biotope in Section 4.2. Exposure is a key variable within the definition of the biotope classification system (Connor et al. 2004) and zonation according to depth is readily observed in the field.

At this stage similar biotopes in both intertidal and subtidal areas were also combined but done so following as close as possible their hierarchical grouping as defined by Connor et al. (2004). The reasons for doing so were due to:

- The lack of spectral discrimination to separate biologically similar species. For example, for fucoid species where the presence of similar photosynthetic pigments gives similar spectral reflectance properties. In addition to this, those biotopes which were only distinguishable following the laboratory-based infaunal analysis were also combined, i.e. for biotopes where visual differences could not be observed using drop-down video or diver's video and where infaunal differences would not likely influence their spectral reflectance properties.
- The low occurrence of some biotopes – where biotopes were only found at a few sites in the ground survey they were combined with other similar biotopes, or left out of the classification.

The resulting detailed grouped biotope listings used for the classification are presented in Tables 4.3.1 and 4.3.2.

To set the rules for exposure, regimes of high, middle and low exposure were defined on the satellite image dataset on the basis of exposure to the prevailing wind and currents. This information was distilled from the spatial knowledge of the area of the biological survey teams. Depth ranges for each biotope were defined using the information recorded during the groundtruthing survey. These formed the depth rules for each biotope where crude depth information was derived from the digitised HO bathymetric chart. For depths over 10 m the classification was heavily weighted to the acoustic data, by integrating the accurate classification results obtained from the sonar survey (Section 3.3).

Table 4.3.1 Detailed listing of the grouped subtidal biotopes used for the integrated classification.

Biotope ID	*Biotope Name*	*Broad Class Description*
1	**IR.HIR.KFaR.FoR**	Rocky substrate dominated by a red algal turf
3	**IR.MIR.KR.LhypT.Ft** **IR.MIR.KR.LhypTX.Ft** **IR.MIR.KR.Lhyp.Ft** **IR.HIR.KSed.XKScrR**	Kelp on Infralittoral rock
7	**SS.SMp.KSwSS.LsacGraFS**	Sediment with extensive cover by algae
8	**SS.SMp.Mrl.Pcal** **SS.SMp.Mrl.Pcal.R** **SS.SCS.CCS.MedLumVen**	Infralittoral coarse/medium sand with surface gravel of maerl, Circalittoral gravels & sand
9	**SS.SMp.SSgr.Zmar**	Seagrass Beds
11	**SS.SSa.IfiSa.ImoSa** **SS.SSa.IFiSa.NcirBat** **SS.SCS.ICS.MoeVen**	Mobile sand
13	**SS.SSa.ImuSa.Ffab.Mag** **SS.SSa.IfiSa.TbAmPo** **SS.SSa.CFiSa.EpusOborApri** **SS.SMu.ISaMu.MelMagThy**	Circalittoral and Infralittoral muddy sand

Table 4.3.2 Detailed listing of the grouped intertidal biotopes used for the integrated classification

Biotope ID	*Biotope Name*	*Broad Class Description*
20	**LR.FLR.Lic.Ver.Ver**	Black lichens
21	**LR.FLR.Lic.YG**	White lichens
23	**LR.LLR.F.Asc.FS** **LR.LLR.F.Asc.X**	Dense *Ascophyllum*
24	**LR.LLR.F.Fves.FS** **LR.LLR.Fserr.FS** **LR.LLR.F.Fserr.X** **LR.MLR.BF.Fser** **LR.MLR.BF.FvesB**	Dense fucoids Barnacle and fucoid mosaics
31	**LS.LSa.MoSa** **LS.LSa.FiSa.Po** **LS.LSa.MuSa.MacAre** **LS.LSa.MoSa.Ol.FS**	Mobile fine beach sand

For the subtidal classification, there were classes that were not represented, nor used in training because they were found in very few sites and considered not representative for the broadscale approach. These included:

- Deeper rock dominated by a faunal turf: **CR.HCR.Xfa.FluCoAs**
- The relatively sheltered kelp classes**: IR.MIR.KR.Lhyp.Pk**, **IR.MIR.KR.Lhyp.GzFt**, **IR.LIR.K.LhypLsac**, **IR.LIR.KLhypCape**
- Mobile sand: **SS.SCS.ICS.HeloMsim**

Although prevalent, mixed pebbles & cobbles on mobile sand with scour tolerant or ephemeral algae (**IR.HIR.KSed.ProtAhn**) were not included in the classification because they were found to be too localised forming long thin bands beyond the resolution of the sensors used.

For the intertidal classification, a number of classes were also omitted for similar reasons, including:

- The fucoid biotopes: **LR.LLR.F.Fves.X**, **LR.MLR.MusF.MytFves** (too few sites)
- Littoral mobile sand biotopes: **LS.LSa.MoSa.AmSco.Eur**, **LS.LSa.FiSa**, **LS.LSa.FiSa.Po.Aten**, **LS.LSa.MuSa.CerPo** (too few sites)

Barnacle dominated shores (**LR.HLR.MusB.Sem.Sem**, **LR.HLR.MusB.Cht.Lpyg**, **LR.HLR.MusB.Cht**) were not represented in the classification because they were considered too narrow to map effectively given the resolution of the image. Similarly, *Pelvetia* biotopes (**LR.MLR.BF.PelB**, **LR.LLR.F.Pel**) and *Fucus spiralis* biotopes (**LR.MLR.BF.FspiB**, **LR.LLR.F.Fspi.FS**) were also omitted.

4.3.1 Intertidal classification of areas not surveyed in 2001

The intertidal shores of the areas which were omitted during the survey conducted in 2001 were surveyed in this (2006) survey. This included predominantly the intertidal areas in the Sound of Eriskay and the southern region of the Sound of Barra. Maps of the classification of biotopes for the intertidal areas surveyed are given in Figures 4.3.1 and 4.3.2 separated by regions north and south.

For this classification, two thirds of the groundtruthing intertidal sites were used for training with one third held over for accuracy assessment. Assessment of the accuracy of classification of the two intertidal regions was assessed separately. Average users classification accuracy for the intertidal areas were 67.5% and 83.5% for the north and south regions, respectively. The mobile find beach sand class (Class 31) was the most accurately classified at 100%, followed by dense *Ascophyllum* (Class 23, 90%) and dense fucoids (Class 24, 80%).

Figure 4.3.1 Map of the intertidal areas of the northern part of the Sound of Barra (adjacent subtidal areas were mapped in 2001).

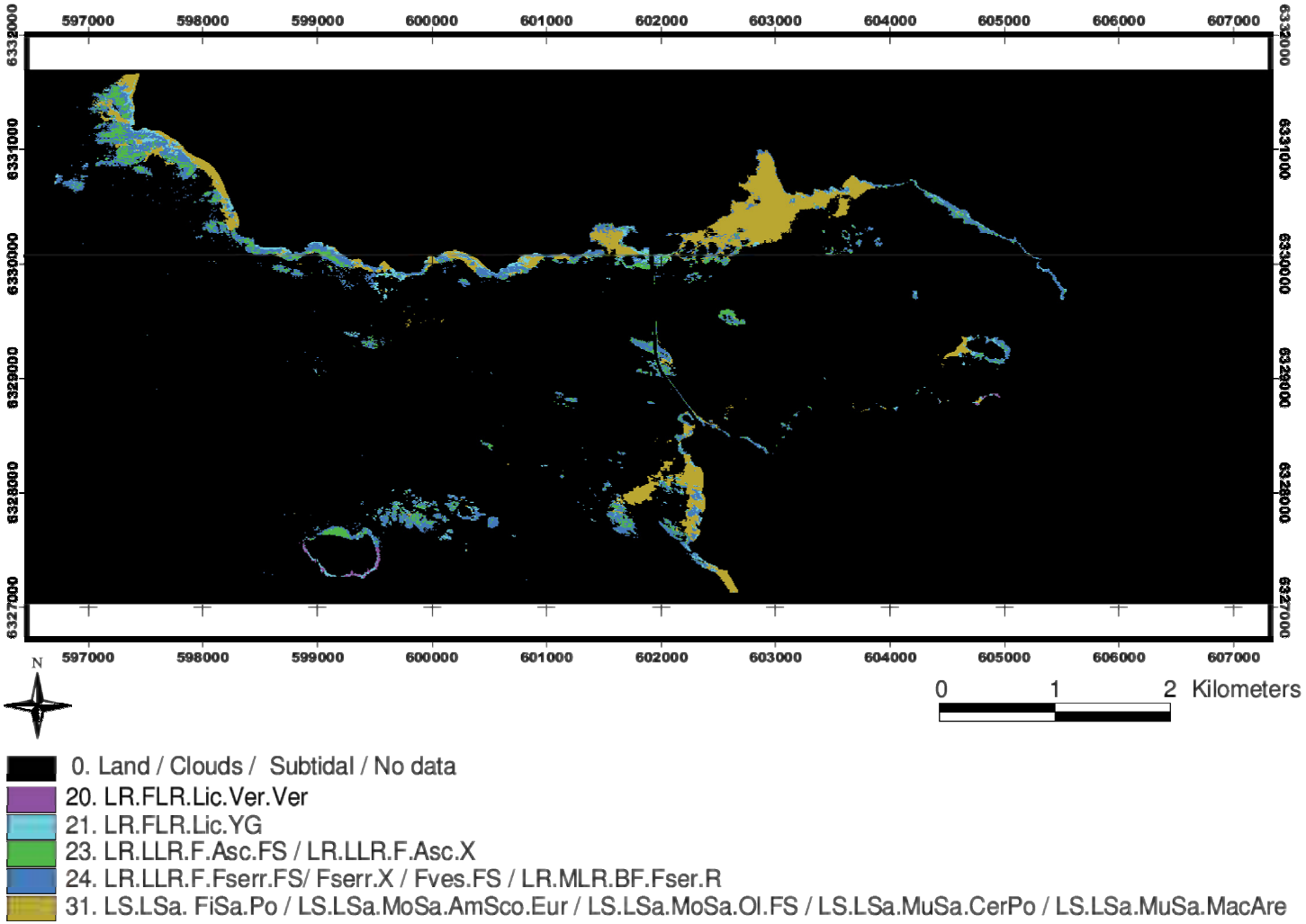
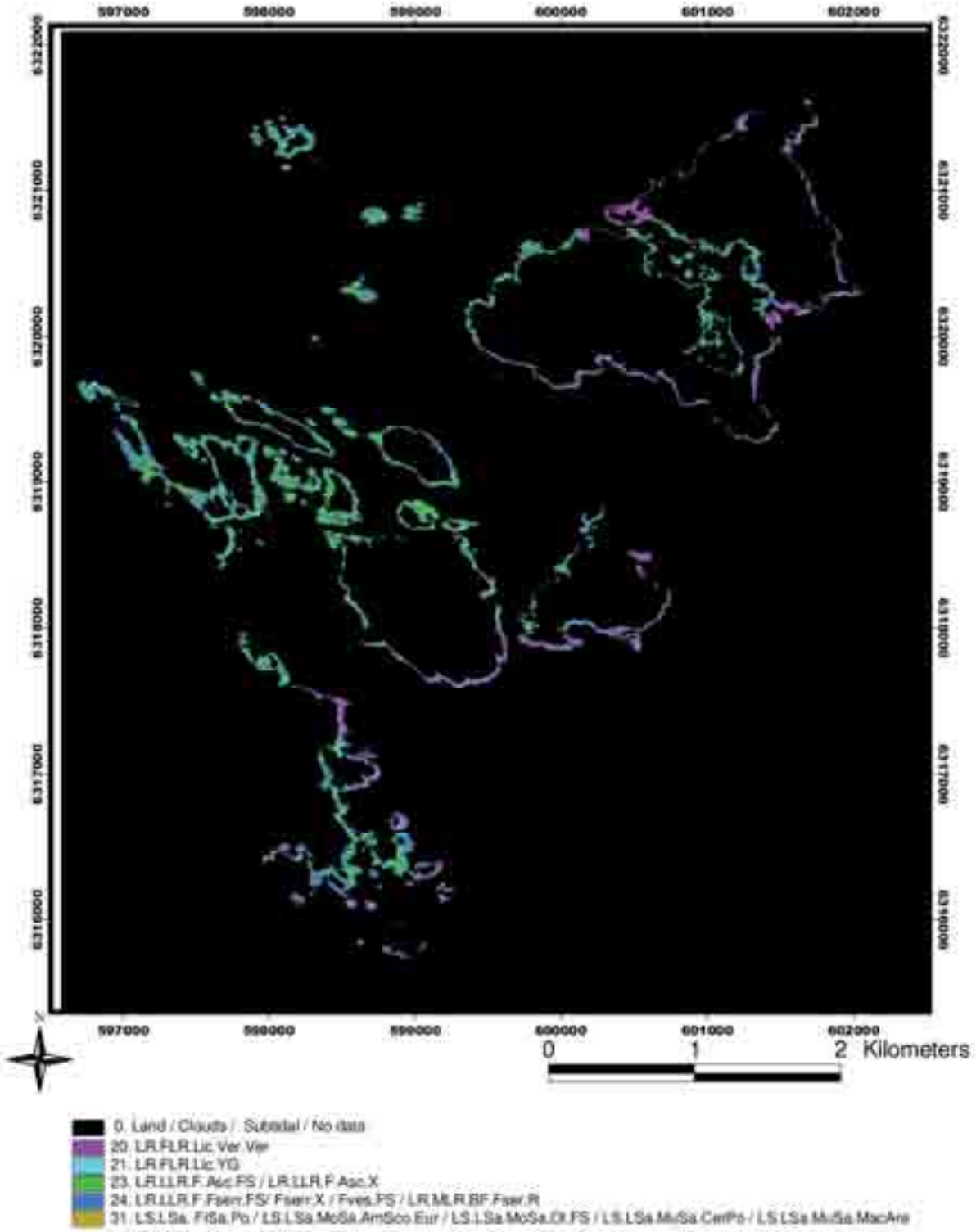


Figure 4.3.2 Map of the intertidal areas of the southern part of the Sound of Barra (adjacent subtidal areas were mapped in 2001).



4.3.2 Integrated biotope classification

The resulting, integrated, biotope classification of the intertidal and subtidal areas surveyed in 2006 is presented in Figure 4.3.3. For this classification, two thirds of the groundtruthing sites were used for training with one third held over for accuracy assessment. The assessment of the accuracy of classification was therefore based on a total of 166 groundtruthing sites. The resulting confusion matrix is presented in Table 4.3.3. The overall average users classification accuracy is calculated as 71%. When assessed separately, the classification accuracy for the biotopes classified on the basis of the optical satellite data (i.e. for areas shallower than ~10 m) was 82%; for the biotopes classified on the basis of the acoustic data (deeper waters) the classification accuracy was 44%.

Classes which were very well discriminated (at 100%) included: class 9 (seagrass beds), 20 (black lichens), 23 (dense *Ascophyllum*), and 31 (mobile beach sand). However, only two sites were used for class 9 (*Zostera*) beds but previous experience confirms that this class is always well discriminated. Black lichens classified very well because this group formed a distinctive and wide enough band to be resolved by the satellite data and, although in the visible spectrum its reflectance is very similar to dense *Ascophyllum* and fucoids, it was discriminated from them on the basis of the infrared band where this species reflects much lower.

The sedimentary classes 7 (sediment with algal cover), 11 (mobile sand) and 13 (circalittoral and infralittoral muddy sand) were also adequately discriminated because of their distinctive spectral and acoustic signatures which can be easily distinguished even in deep water.

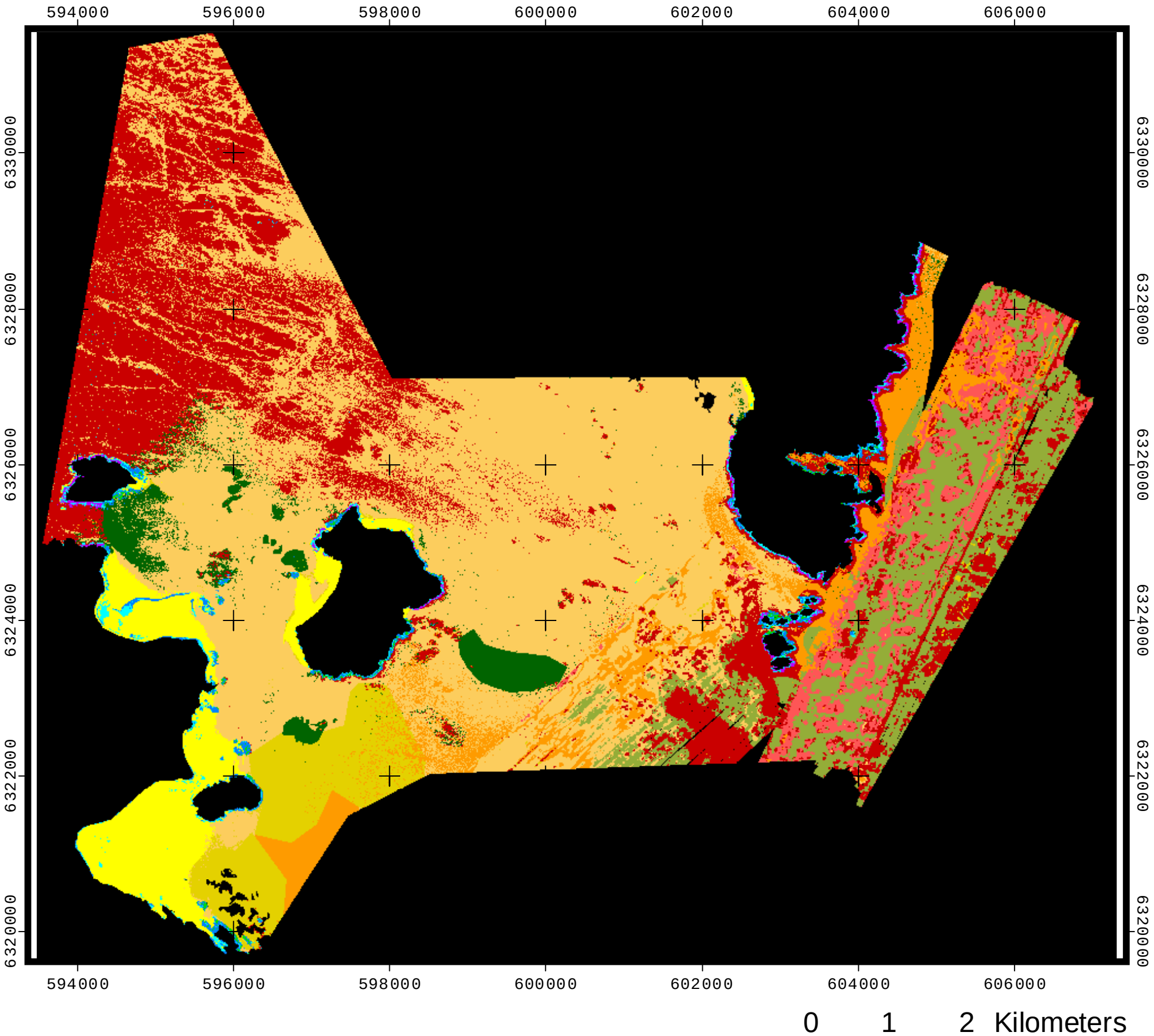
Class 8 (gravelly substrate with maerl: **SS.SMp.Mrl.Pcal** and **SS.SCS.CCS.MedLumVen**) were poorest classified because their acoustic signals were confused with rocky substrate with red algal turf (class 1).

Class 3 (kelp on Infralittoral rock) was classified moderately at 55%, being mainly confused with rocky substrate dominated by red algae (Class 1). This confusion occurred mostly in the deeper areas where spectral signals for an accurate discrimination are poorer.

Table 4.3.3 Confusion matrix resulting from the accuracy assessment performed on the detailed biotope classification presented in Figure 4.3.1. Biotope class numbers correspond to those ID numbers presented in Table 4.3.1.

	Reference class												
Image Class	**1**	**3**	**7**	**8**	**9**	**11**	**13**	**20**	**21**	**23**	**24**	**31**	**User's Accuracy (%)**
1	2	0	0	1	0	0	0	0	0	0	0	0	**67**
3	4	11	0	3	0	1	1	0	0	0	0	0	**55**
7	0	0	5	0	0	0	2	0	0	0	1	0	**71**
8	3	0	0	1	0	0	1	0	0	0	0	0	**12.5**
9	0	0	0	0	2	0	0	0	0	0	0	0	**100**
11	0	4	0	2	2	26	5	0	0	0	0	0	**67**
13	0	1	0	0	0	0	2	0	0	0	0	0	**67**
20	0	0	0	0	0	0	0	4	0	0	0	0	**100**
21	0	0	0	0	0	0	0	1	3	0	1	1	**50**
23	0	0	0	0	0	0	0	0	0	3	0	0	**100**
24	0	0	0	0	0	0	0	1	1	1	5	0	**62.5**
31	0	0	0	0	0	0	0	0	0	0	0	2	**100**

Figure 4.3.3 Integrated detailed biotope classification for the Sound of Barra



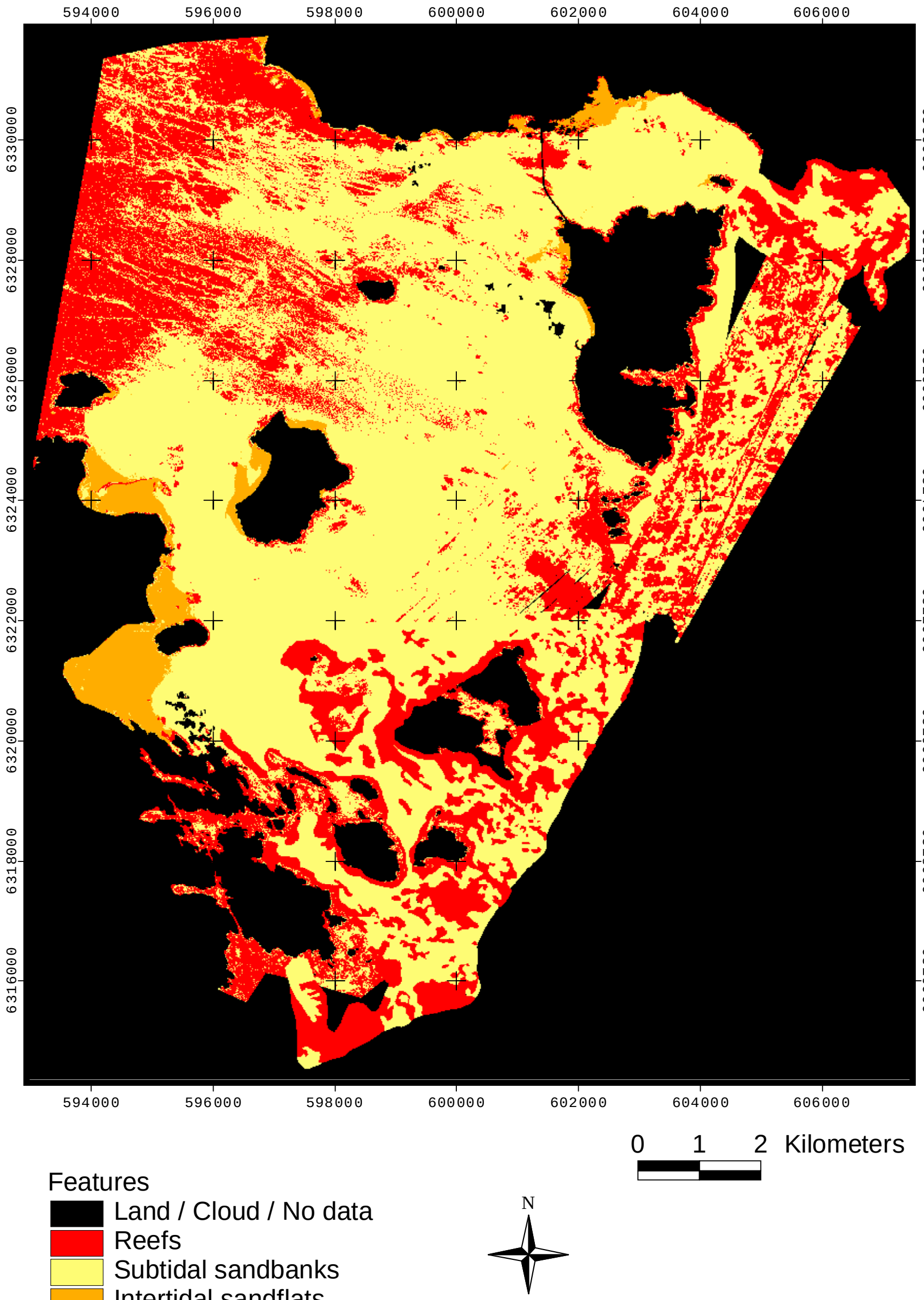
4.3.3 Integrated Natura features map

A second broader classification was undertaken incorporating data from both the surveys of 2001 and 2006 to provide a complete Natura features classification of the entire Sound of Barra region (Figure 4.3.4). Classes were amalgamated to three Natura feature classes on the basis of *in-situ* records made during the 2006 biological groundtruth survey and biotope records from the 2001 groundtruth survey:

- Class 1 – Reefs
- Class 2 – Subtidal sandbanks
- Class 3 – Intertidal sandflats

The accuracy of this broad classification map is expected to be a least as good as that for the more detailed biotope classification and even approaching 100%. We estimate that subtidal reefs account for approximately 40% of the survey area and the remaining 60% is composed of sandbanks. Areal extent of substrates that do not fit into these categories is negligible. Approximately 9% of the sandbank feature lies in depths of over 20m BCD.

Figure 4.3.4 Integrated features map of the Sound of Barra, combining data from the surveys of 2001 and 2006.



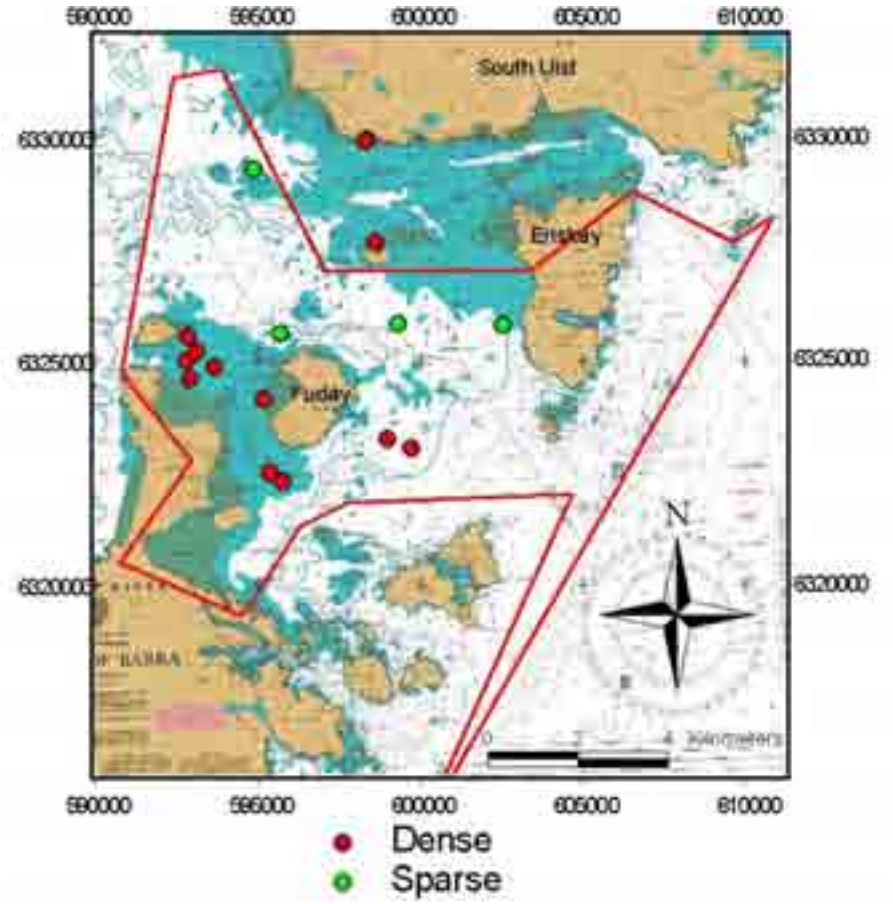
5 DISCUSSION

5.1 The biota of the Sound of Barra

The Sound of Barra contains a range of biological communities which are of interest. Rock reef communities occur at a range of depths and many are modified by the effects of sand scour. Sandbank communities include extensive areas of sparse maerl and extensive well developed *Zostera* beds. The environmental conditions in the Sound are generally those of moderate to high exposure although sheltered areas exist in Inner An Oitir Mhor and within the island group in the south east. The substrate is extremely patchy particularly in areas on the western and eastern margins of the Sound. Over much of the Sound the seabed is composed of a complex mosaic of sandbanks and rock reefs with patch size and the relative proportion of rock and sediment varying throughout the Sound. The heterogeneous substrate and high exposure levels can result in multiple biotopes occurring within relatively small areas.

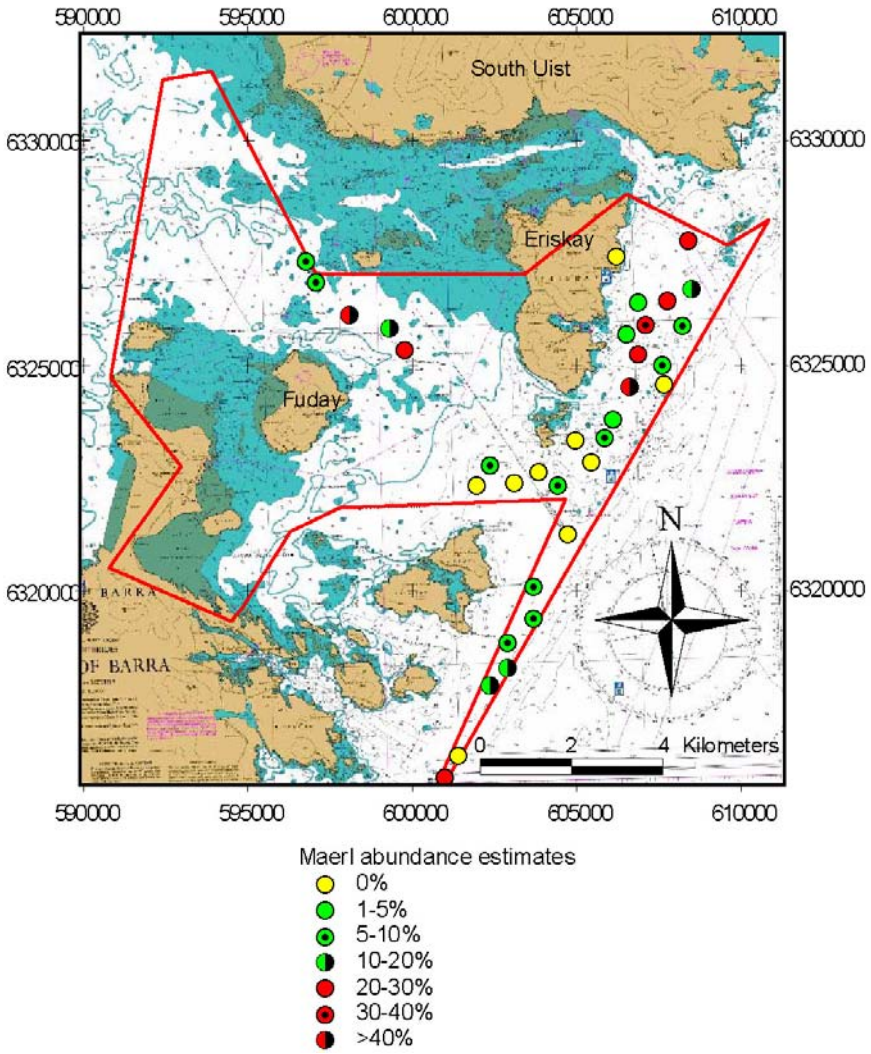
The beds of *Zostera* and maerl are perhaps the main points of interest on the subtidal sandbanks of the Sound of Barra. *Zostera* occurs principally in moderately exposed areas in the west of the site usually at depths of less than 5m (figure 5.1.1). Particularly extensive and well developed beds exist to the southeast of Fiaray and areas west of the Eriskay causeway (Bates *et al* 2004a). Smaller well defined beds occur in the Sound of Fuday and east of the Eriskay causeway (Bates *et al* 2004a). An extensive but diffuse *Zostera* bed is present southeast of Fuday and sparse scattered *Zostera* patches are present elsewhere in the Sound. The overall extent of the *Zostera* is estimated at 360ha. The beds typically take the form of a series of bands of dense *Zostera* alternating with bands of open sand with each band being several metres wide. Within a band the *Zostera* fronds are densely packed and the sward height can be ~1.5m in well-developed beds. The *Zostera* rhizomes act to stabilise the mobile sand and at some locations the sediment surface of the *Zostera* bands is several cm higher than the adjacent areas of loose sand. Epifaunal taxa associated with the *Zostera* include *Anemonia*, *Haliclystis*, *Diplosoma* and a range of gastropods including *Gibbula cinerea*, *Tricolia pullus*, *Lacuna vincta* and rissoids. The abundance and species richness of the associated infauna was amongst the highest recorded in the infauna samples.

Figure 5.1.1 Zostera beds & relative density



Maerl beds in the Sound are composed of *Phymatolithon calcareum* and dominate the sediments in eastern parts of the Sound. They occur in areas east of Eriskay and extend as far south as areas east of Bruernish. They also occur in the central part of the Sound between Fuday and Lingay. The maerl beds occur on coarse shelly gravel sediments (**SS.SCS.CCS.MedLumVen**) which often has large (several cm high) ripples. There is a high proportion of dead maerl and the distribution of live maerl is very patchy, often confined to ripple troughs. Figure 5.1.2 shows estimates of live maerl abundance at the survey stations. The estimates are derived from viewing drop-down video footage and indicate maximum live maerl abundance in localised areas not the average abundance of maerl over the entire video run. This illustrates the patchiness of the maerl distribution and indicates a trend of reduced abundance in the area between Gighay and Eriskay. Most of these deeper eastern maerl beds are too deep and dynamic for the development of significant associated communities of foliose algae. The shallower beds between Fuday and Lingay support varying amounts of attached associated algae and tend towards the composition of the sub-biotope **SS.SMp.Mrl.Pcal.R**. As was the case for *Zostera* the maerl infauna was of a distinct community composition and included a large number of species.

Figure 5.1.2 Maerl beds & relative density

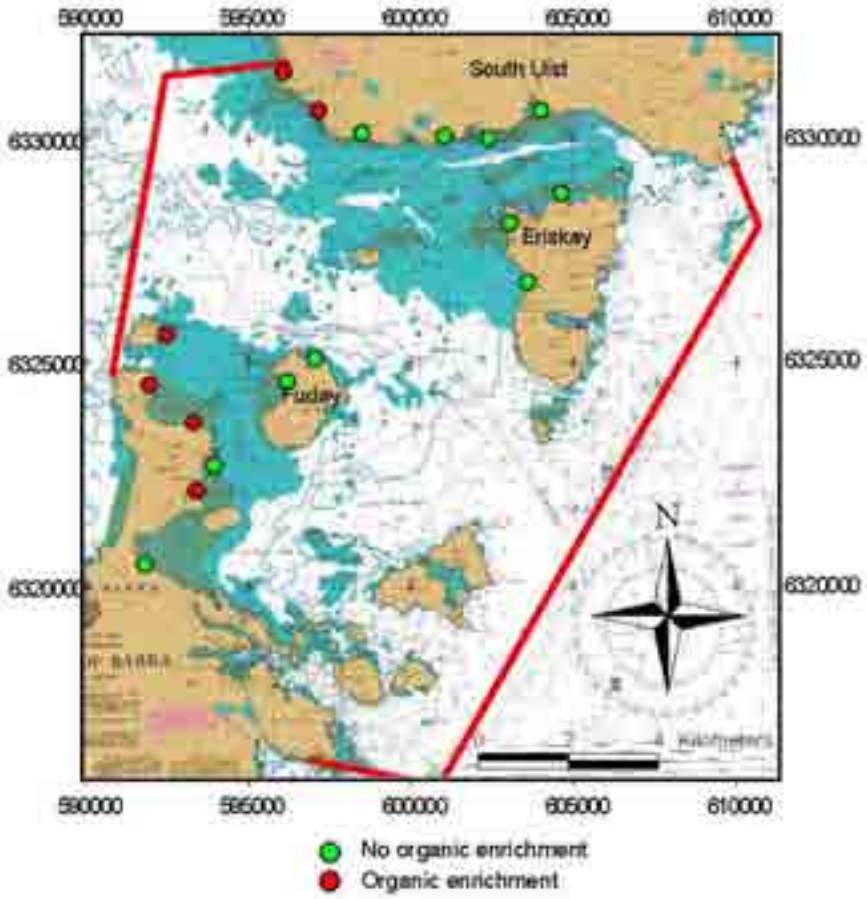


The remaining subtidal sandbank communities of the Sound of Barra fall into three main groups. The mobile sands of the west and central parts of the Sound tend to support a relatively sparse infauna with low numbers of species. This is most pronounced in the most mobile wave exposed sands in the west (**SS.SSa.IFiSa.IMoSa**) and diversity increases in less exposed tideswept areas (**SS.SCS.ICS.MoeVen**) in the central parts of the Sound. The other two groups are the somewhat deeper slightly silty fine sands that occur both to the southeast and the east of Eriskay and the shallower siltier sediments that occur in the sheltered area of Inner An Oitir Mhor. The infaunal communities of these sediments are considerably more abundant, species rich and varied than those of the mobile sands. In Inner An Oitir Mhor the variability is increased by the patchy but dense cover of algal mats which include a significant proportion of *Laminaria saccharina* and *Gracilaria*. This algal cover modifies environmental conditions, increases habitat complexity and generally acts to increase the heterogeneity of the benthic communities.

The intertidal sandflats of the Sound are most extensive on the east side of the Eoligarry peninsula and the western shore of Fuday. In these locations they form wide expanses of

flat rippled intertidal sand. Significant beaches occur elsewhere in the Sound (e.g. south coast of South Uist) but tend to be less extensive and are associated with a higher proportion of outcropping rock reefs. The biota of these sandflats is variable in composition featuring varying proportions of amphipods and polychaetes with increased populations of *Arenicola* and *Cerastoderma* at the more sheltered sites. At some sites (e.g. north Fuday and west Eriskay) exposure levels are higher resulting in narrower steeper beaches of unstable sand with an impoverished infauna. At a number of sites the beach infauna included a high proportion of taxa indicative of organic enrichment (e.g. *Capitella*, *Malacoceros*, oligochaetes). This tended to occur more on beaches in the western part of the Sound (figure 5.1.3). It is probable that the source of organic material is drift weed and kelp which can be deposited in large quantities on hebridean beaches by winter storms.

Figure 5.1.3 Organic enrichment of beaches



Subtidal rock reefs occur as isolated outcrops throughout the Sound but are most extensive in the exposed western areas and, to a lesser extent, also in the eastern part of the Sound. The biota of the rock reefs, particularly in the western parts of the Sound, are dominated by tideswept forests of the kelp *Laminaria hyperborea* (**IR.MIR.KR.LhypT.Ft**). These forests are characterised by a profuse kelp stipe epibiota including filter feeding species such as the sponge *Halichondria panicea*, the bryozoan *Alcyonidium hirsutum* and ascidians like *Didemnum candida* and *Ascidiella scabra*. These communities occur in high energy environments and wave surge as well as tidal currents may provide the necessary conditions. At the margins of rock reefs or other situations where sand scour is intensified the *Laminaria hyperborea* may be subject to periodic removal or fail to establish. At these

locations a mixed kelp community may develop including *Saccorhiza polyschides* and *Laminaria saccharina* (**IR.HIR.KSed.XKScrR**). *Laminaria hyperborea* forests also occur in lower energy environments such as can occur with increased depth. In these cases the stipe epibiota in general is less profuse and lacks significant abundance of filter feeding invertebrates (**IR.MIR.KR.Lhyp.Ft**).

The eastern part of the Sound is considerably deeper than in the west and consequently many rock reefs are beyond the depth where the light penetration can support kelp forests. Many of the reefs in this area are dominated by a turf of red algae (**IR.HIR.KFaR.FoR**) and also include a range of invertebrates characteristic of high energy conditions and scour (*e.g. Flustra foliacea*, *Alcyonidium digitatum*, *Cliona celata*). With increasing depth the cover of red algae on the reefs decreases and there is an increased dominance of invertebrates similar to those of the shallower reefs (**CR.HCR.Xfa.FluCoAs**).

The intertidal rock reefs of the site support communities characteristic of a wide spectrum of exposure conditions. In the most exposed sites there are shores dominated by barnacles of the genus *Cthamalus* with patches of small mussels, a turf of *Corallina officianalis* in the lower shore and a sublittoral fringe dominated by *Alaria esculenta*. With decreasing exposure levels the shores are dominated by the barnacle *Semibalanus balanoides* and tufts of *Fucus vesiculosus* become increasingly frequent. Moderately exposed shores are characterised by a patchy mosaic of *Semibalanus* and *Fucus vesiculosus* and in the most sheltered conditions the shores are dominated by a dense blanket of *Ascophyllum nodosum*.

5.2 Comparison with neighbouring areas

5.2.1 Sound of Barra biotope mapping survey 2001 (Bates et al. 2004a).

In 2001 a subtidal biotope mapping survey was conducted in two areas of the Sound of Barra. The areas concerned were a southern sector encompassing the waters around Fuiay, Flodday, Hellisay and Gighay and a northern sector encompassing the Sound of Eriskay and approaches. Biotopes recorded in 2001 were designated from the 1997 version of the biotope classification system (Connor *et al.* 1997). Where these biotopes are referred to they are identified with '(97)' to distinguish them from the 2004 biotope classification system used elsewhere in this report.

The general pattern of biotopes recorded in 2006 is in agreement with the biotopes recorded from adjacent areas by the 2001 survey.

In the western parts of the 2001 northern sector there was a mosaic of rock reefs and sand channels. The reefs supported *Laminaria hyperborea* forests and highly scoured areas of mixed kelps. The sandbanks were designated to the biotope **IGS.SeII (97)** (updated to **SS.SCS.ICS.MoeVen** and related biotopes). This corresponds well with the 2006 survey where the exposed western areas supported *Laminaria hyperborea* and mixed kelps and the impoverished sand communities of the outer parts of the Sound grade into the more diverse **SS.SCS.ICS.MoeVen** communities of tideswept channels further into the Sound.

The eastern parts of the 2001 northern sector were characterised by rock reef outcrops surrounded by coarse rippled sediments with maerl. The rock was found to support scoured mixed kelps (**MIR.XKScrR (97)** (updated to **IR.HIR.KSed.XKScrR**)) in the shallower areas and scour tolerant faunal turfs in deeper areas (**MCR.Flu.HByS (97)** (updated to the **CR.HCR.Xfa** biotope complex)). Sediments were designated as **IGS.Phy.Hec (97)** (updated as a sub-biotope of **SS.SMp.Mrl.Pcal**) in the presence of maerl and **CGS.Ven.Neo (97)** (updated to **SS.SCS.CCS.Nmix** – an epibiotic overlay of **SS.SCS.CCS.MedLumVen**) in the absence of maerl. This corresponds well with the 2006 survey which recorded

IR.HIR.KSed.XKScrR on the northeast tip of Eriskay, **IR.HIR.KFaR.FoR** / **CR.HCR.Xfa.FluCoAs** on deeper reefs and **SS.SMp.Mrl.Pcal** / **SS.SCS.CCS.MedLumVen** on sediment areas.

The eastern part of the 2001 southern sector was of a similar composition to the eastern part of the northern sector. Forests of *Laminaria hyperborea* or mixed kelp occurred on shallower rock, scour tolerant faunal turfs occurred on deeper rock and the coarse sediments contained maerl. The adjacent areas surveyed in 2006 correspond with this pattern although not including any rock reefs shallow enough to support kelp.

The only notable difference in the eastern part of the Sound is that most of the deeper reefs were dominated by a red algal turf in 2006 rather than the faunal turfs which predominated in 2001. This is likely to be due to natural inter-annual variability. Both surveys were conducted at the same time of year so the difference is not a seasonal effect. It is possible that in 2001 the effects of scour were slightly greater or the growing conditions were slightly less favourable for red algae.

The northern parts of the 2001 southern sector lies within the predominantly sedimentary area of Outer An Oitir Mhor. These sediments were designated as **CMS.AfilEcor (97)** in 2001 and adjacent areas sampled in 2006 were designated as **SS.SSa.IMuSa.FfabMag**. **CMS.AfilEcor (97)** has been updated to **SS.SMu.CSaMu.AfilMysAnit** which is known to grade into **SS.SSa.IMuSa.FfabMag** as depth and silt / clay content decrease (Connor *et al.* 2004). This fits the pattern as the areas sampled in 2006 contained less silt / clay (~2-4%) than the more southern areas sampled in 2001 (9-10% silt / clay).

The 2001 survey found the sediments of Inner An Oitir Mhor to be muddier than the outer stations and to contain an infaunal community that was broadly similar in composition. The sediments of these areas were covered by extensive algal mats and were designated as the biotope **IMX.LsacX (97)** (a broadly defined biotope that has been split and includes **SS.SMp.KSwSS.LsacGraFS**). This corresponds to records made in 2006 where the deeper parts of Inner An Oitir Mhor were found to have a relatively high silt / clay content and algal mats (**SS.SMp.KSwSS.LsacGraFS**) were a common feature of the area. The infaunal communities recorded in 2006 approximated to the biotope **SS.SMu.ISaMu.MelMagThy**. The 2001 samples were of roughly similar composition containing high proportions of characterising taxa such as *Thyasira*.

5.2.2 Environmental impact assessment survey for Eriskay ferry terminal 1999 (Cordah 2000a)

In September 1999 CORDAH conducted a survey to assess the potential environmental damage of constructing a ferry terminal (now in place) on the west coast of Eriskay to serve a ferry route to Barra. The findings of the 2006 survey are in general agreement with the biotopes identified by the 1999 survey.

The intertidal surveys in 1999 reported a rocky shore colonised by communities associated with exposed conditions. This included *Cthamalus* on the upper shore with *Semibalanus* dominating the majority of the shore. They also reported a slightly more sheltered area (now occupied by the ferry terminal) of barnacle / fucoid mosaic (**LR.MLR.BF.FvesB**).

The 1999 subtidal sample infauna were reported as showing affinities to **IGS.SelI (97)** (updated to **SS.SCS.ICS.MoeVen** and related biotopes) and **IGS.NcirBat (97)** (updated to **SS.SSa.IFiSa.NcirBat**) with the fauna frequently including varying proportions of the characterising species of both biotopes. The 2006 survey would predict that this area would predominantly be composed of **SS.SCS.ICS.MoeVen** but, as previously discussed, the

SS.SCS.ICS.MoeVen and **SS.SSa.IFiSa.NcirBat** fauna are overlapping and the biotopes are likely to grade from one to the other. The most southerly of the 1999 samples was organically enriched by accumulations of drift weed. The fauna was considered to show affinities with **SS.SSa.IMuSa.FfabMag** and indeed this station is close to the northern boundary of the **SS.SSa.IMuSa.FfabMag** area identified by the 2006 survey.

5.2.3 Environmental impact assessment survey for Barra ferry terminal 2000 (Cordah 2000b)

In May 2000 CORDAH conducted a survey to assess the potential environmental damage of constructing a ferry terminal (now in place) on the northeast coast of Barra to serve a ferry route to Eriskay. The survey included shore and near shore dive surveys at Aird Mhor on the Barra coast and a grab sampling survey of Inner An Oitir Mhor. The findings of the 2006 survey are in general agreement with the biotopes identified by the 2000 survey.

The shores surveyed in 2000 were sheltered and primarily dominated by *Ascophyllum nodosum*. Some of the transects included restricted areas of biotopes characteristic of less sheltered conditions (e.g. **LR.MLR.BF.FvesB** & **LR.MLR.BF.Fser.R**). These tended to be relatively narrow bands on steep rock in the lower shore. The survey also recorded small patches of intertidal muddy sand (i.e. **LS.LSa.MuSa.MacAre**) on some transects. This sediment biotope and the barnacle / fucoid mosaic biotopes were of very limited extent and the generalisation that this part of the Sound is predominantly rocky and dominated by *Ascophyllum* holds true.

The near shore diving survey in 2000 covered areas directly adjacent to the 2006 subtidal mapping survey and recorded a series of algae dominated sheltered biotopes. Substrates were often mixed and community composition was variable including dense cape form *Laminaria hyperborea* (**IR.LIR.K.LhypCape**) sometimes mixed or dominated by *Laminaria saccharina* (**IR.LIR.K.LhypLsac** & **IR.LIR.K.Lsac**) as well as sediments with algal mats (**SS.SMp.KSwSS**). Forests of mixed kelp including *Saccorhiza polyschides* were also encountered. These should not be confused with the **IR.HIR.KSed.XKScrR** biotope records of the 2006 survey which refer to exposed locations distinct from the sheltered area covered by the 2000 survey. The mixed kelp communities recorded in 2000 were on mixed substrates and were probably subject to physical disturbance during winter storms. In view of the sheltered environment they might be a more appropriate fit to the **IR.LIR.K.LhypLsac** biotope which does include the presence of *Saccorhiza* in some cases.

The grab sample stations of the 2000 survey were at locations with a high silt / clay content (25-98%). The infaunal communities were designated to the **IGS.SeII (97)** (updated to **SS.SCS.ICS.MoeVen** and related biotopes) and **SS.SSa.IMuSa.FfabMag** biotopes. The **IGS.SeII (97)** biotope is not a good match to the environment in view of the high proportion of silt / clay. An examination of the numerically dominant taxa of the samples indicates a high degree of similarity with neighbouring sediments sampled in 2006. They correspond to the 2006 biotope categories of **SS.SSa.IFiSa.TbAmPo** (high proportion of *Corophium crassicorne*), **SS.SMu.ISaMu.MelMagThy** (high proportion of *Thyasira* & *Melinna*) and **SS.SSa.IMuSa.FfabMag** (high proportion of *Fabulina* & *Magelona*).

5.2.4 Environmental impact assessment survey for Eriskay causeway 1999 (Cordah 1999)

In January 1999 CORDAH conducted a survey to assess the potential environmental damage of constructing the causeway (now in place) in the Sound of Eriskay. The study included mapping shore biotopes within 1 kilometre of the proposed causeway on the shores of South Uist and Eriskay. The time available for the survey was limited and work was hampered by adverse weather.

The results of this work are in accordance with the 2006 study. The shores are predominantly rocky and generally dominated by fucoids typical of moderately sheltered conditions. Sediment areas were typically characterised by the presence of *Cerastoderma*.

5.2.5 Sound of Harris biotope mapping survey 2005 (Malthus et al. 2006).

In 2005 a biotope mapping survey was conducted in the Sound of Harris some 80km further north in the Outer Hebrides island chain. The Sound of Barra and the Sound of Harris are very similar but major differences exist on the eastern and southern margins of the sites.

The western parts of the Sound of Barra and the Sound of Harris are similar. In both sites there is a mosaic of rock with tideswept and scoured kelp which is interspersed with areas of mobile sand with an impoverished infauna. There is a considerably higher proportion of rock reefs and the sand infauna is consistently less impoverished over a wider area in the Sound of Barra than is the case in the equivalent area of the Sound of Harris. This may indicate slightly higher exposure levels or higher sediment mobility in the Sound of Harris.

The central areas of the sites are also comparable, with tideswept kelp on the rock reefs and a relatively diverse infaunal community including venerid bivalves in the sand. The topography of the Sound of Harris is more complex and there are more islands and tideswept channels in the central part of the sound which results in a greater range and diversity of habitats and communities than in the Sound of Barra.

This trend of greater habitat complexity in the Sound of Harris is much more apparent in the southern parts of the sites. In the Sound of Harris there is a complex network of semi-enclosed basins which create very sheltered conditions and often feature tideswept sheltered channels linking the basins and supporting diverse communities. This creates environments which are not present in the Sound of Barra and hence a much greater range of habitats and communities.

The eastern areas of the sites show substantial differences. The depths are greater in the Sound of Harris and the sediments are dominated by muddy sands and fine sands with a diverse infauna and rock reefs dominated by axinellid sponges and *Swiftia*. The corresponding area of the Sound of Barra is shallower and has higher exposure levels. The rock reefs are dominated by a turf of foliose red algae and scour tolerant fauna. The sediments are coarse with pronounced ripples and sparse maerl. The eastern areas of these two sites represent entirely different environments and each site supports different but diverse biological communities.

The extent of maerl and maerl gravel is considerably greater in the Sound of Barra (>902ha) than in the Sound of Harris. The relatively deep eastern part of the Sound of Barra accounts for the majority of the area of maerl beds although the abundance of live maerl is often low. Well developed maerl beds are present in the Sound of Harris but they appear to be relatively localised. The main Harris maerl beds are in fairly shallow water and support an abundant community of foliose algae. These beds are directly comparable to the beds that occur between Lingay and Fuday in the Sound of Barra. A relatively small area of sheltered tideswept maerl was recorded in the Sound of Harris which does not have a direct equivalent in the Sound of Barra. This maerl was on a muddy substrate with an abundant cover of *Phyllophora* and a rich faunal community.

The extent of *Zostera* beds is less in the Sound of Harris (280ha) than in the Sound of Barra (360ha). However, the Sound of Barra includes extensive areas of relatively sparse *Zostera* such as the area south east of Fuday. The *Zostera* beds in the Sound of Harris tend to be

more uniformly well developed and constitute overall a greater abundance of *Zostera* than is seen in the Sound of Barra.

In summary, the extent of maerl and of exposed kelp dominated reefs is greater in the sound of Barra than in the Sound of Harris whereas the abundance of *Zostera* and overall diversity of rock reef communities is greater in the Sound of Harris than in the Sound of Barra.

5.3 Satellite survey

QuickBird satellite sensor imagery of extremely high quality was obtained for this project under the fairly strict conditions of low tidal state and cloud free conditions. This highlights the potential for fairly routine acquisition of such data over targeted areas of Scotland's coastline. The geocorrection undertaken by the data providers was found not to be accurate enough and the data required further geocorrection using GPS measured ground stations. This refined the spatial accuracy of the image to within one pixel of locations measured in the field.

Empirical line atmospheric correction was employed in this and was shown to give an acceptable result for correcting the dataset to ground-leaving reflectance. Although this correction could be eliminated from the processing chain, it is recommended to retain it, particularly to allow a standardised comparison of different satellite datasets acquired over the same region of interest.

5.4 Integrated biotope classification

A combined spectral and expert systems-based approach to biotope classification was used on the satellite and acoustic data sets. This approach drew on differences in spectral reflectance and combined it with rules based on known tolerances to exposure, water depth and acoustic signature. Similar biotopes were also combined following as close as possible their hierarchical grouping on the logical basis that they were poorly distributed in the Sound or that their reflectances were spectrally similar. When this approach was adopted the overall classification achieved for the subtidal biotopes was increased by 21% from 61% to 82% on the basis of the optical data. Furthermore, a much larger number of classes were discriminated reliably, ranging from individual biotopes to small hierarchical groupings of similar biotopes. In total 12 different subtidal and intertidal biotope classes were discriminated using either their optical or acoustic signature with an overall accuracy of 71% which is regarded as very high for this type of mapping work. Only one class (gravelly substrate with maerl) failed to be classified to 50% accuracy or better. As a result of the rule based approach spatial reliability maps for the classifications could not be produced but detailed confusion matrices were instead reported.

Maps of the classification of biotopes for the intertidal areas which were not surveyed in 2001 were also presented separately for the northern and southern regions surveyed. Accuracies for the two maps were 67.5% and 83.5% for the north and south regions, respectively. Spatial resolution can be a factor restricting accuracy of classification of these areas as some narrow intertidal regions were difficult to both train (i.e. to define training polygons) and classify as were the similarities of certain classes (e.g. between fucoid classes).

Irrespective of subtidal or intertidal, the classification produced is a hard classification which attempts to classify to a single, presumed dominating biotope class. As such, for training purposes a single biotope ID was attributed to each field site and similarly for the accuracy assessment only the dominant class was used with which to assess the classification. However, this process ignores the coexistence of biotope classes at the spatial scale that cannot be resolved by the resolution of the satellite imagery (< 2.4 m) or in the case where

classes are vertically overlapping. Example classes include the mosaic of kelp on rock and muddy sand (two different biotopes attributed to this, one sand and one rocky), the coexistence of *Fucus* and *Ascophyllum,* and barnacle species and fucoids frequently encountered on the intertidal shore. Additionally, on many occasions the biotope is not always attributed to the dominant substrate or dominant epifauna but to key biota found within it but which may have little influence on the spectral signature of the site. This limits classifications based on spectral signatures alone, and highlights the limitations of using biotopes as the mapping unit of broadscale mapping projects.

Penetration of light is severely limited by the water column and therefore the usefulness of optical datasets is limited to shallow areas. Measurements of the optical properties of the water column of the study area revealed the high transparency of the water column in that region which allowed moderate discrimination of the seabed habitats up to approximately 17 m. The deeper regions of the study area were accurately classified using the acoustic dataset, and the integration of the two methods proved highly successful.

5.5 3-D Fly throughs

A range of 3D fly throughs have been produced as outputs for this project. These were produced using a three-dimensional visualization tool that allows the display of a digital elevation model overlaid with layers of raster imagery. The raster data (the atmospherically corrected Quick Bird image displayed as a true colour composition and the detailed integrated biotope and features classifications) were laid over an elevation layer. One fly through was produced using each layer in turn.

The software provides a Flight Path Editor tool in order to establish the flight path parameters of the virtual aircraft, and the following parameters must be defined: X (northing), Y (easting), ASL (elevation above sea level), AGL (elevation above ground level), Look Azimuth (positive looking right), Look Pitch (null at the horizontal and negative looking down), FOV (field of view), Roll (positive clockwise) and Speed. The ASL was defined as 1500 m and the FOV as 55 degrees to ensure coverage of the whole study area. The Look Pitch has been defined to range between -50 and -70 degrees with the aim of highlighting the relief. Finally, a flight path was defined to cover the most interesting areas of the Sound of Barra. To facilitate the location of the viewed target in the study area a geographically linked view has been created showing the flight path, aircraft and target position, and the field of view.

5.6 Eriskay causeway survey

5.6.1 Stations repeated from 2001 and granulometric data

The current data do not provide convincing evidence of substantial changes in the biota of the Sound of Eriskay between 2001 and 2006. There is a significant proviso in that the baseline data (2001) was gathered for the purpose of biotope mapping and not for detecting future community changes at a high level of resolution. Also, the 2006 survey was compromised by adverse weather and less time was available for the causeway survey than originally planned. High resolution change detection would require time series data from a replicated sampling program covering multiple sample stations and would be well beyond the scope of the current survey.

This study shows that no gross (biotope level) changes have occurred at the surveyed sites between 2001 and 2006. However, it is likely that changes beyond the resolution of this survey are ongoing and over time will become detectable and lead to significant modification of the distribution of biota in the Sound of Eriskay. The two infaunal and granulometric samples from east of the causeway did show some differences between 2001 and 2006. At one site there were indications of a change in infaunal community composition to a community typical of silty sediments and sheltered conditions. At both sites the sediments were finer and siltier in 2006 than was the case in 2001. Such changes would be in accordance with a reduction of exposure levels in the eastern Sound following causeway construction. However the granulometric samples collected from either side of the causeway do not provide supporting evidence.

The construction of the Eriskay causeway will certainly have modified the hydrodynamic regime of the area and will eventually result in a redistribution of sediments and their associated biota. It is difficult to confidently predict the exact nature and timescale of such changes. One possible approach might be to examine older existing causeways (e.g. Vatersay) in an attempt to evaluate any gross changes which have occurred since their construction. If reliable pre-causeway information (e.g. photographs) is available it may help to predict how the Sound of Eriskay may look once the redistributed sediment reaches a state of dynamic equilibrium.

5.6.2 Zostera change assessment

Overall, a number of different approaches to analysing change in seagrass extent between the 2001 and 2006 images in the Sound of Eriskay have shown similar results – that the overall change observed is largely one of a decline in seagrass coverage over the five year period. Thinning in bed coverage was observed in the main bed to the east of the causeway, in the southernmost beds on the western side of the causeway and on the northern edge of the seagrass beds lining the channel which bisects the Sound. This was the most obvious change observed. However, in other areas, an increase in coverage was observed, notably in the westernmost edge of the main bed to the east of the causeway (highlighted in white in Figure 3.4.12), and in shallow water areas to the west of the causeway along an area of bare sand which intersects the two principal beds on the western side.

It should be noted that a number of factors could have contributed to erroneous detection of change between the two images. These include: differences in the spatial resolution between the two images (the 2001 image is a 4m resolution image, the 2006 image is at 2.6 m resolution); the influence of natural seasonal variation in seagrass growth (27th September for the 2001 IKONOS image, 9th of July for the 2006 QuickBird image); errors from possible differences in tidal state (not thought to be significant in this case), and; possible errors due to different currents causing seagrass to orientate leaves in a different direction (but given

that seagrass fronds are maximally 70cm to a metre in length, this is not thought to have a significant influence at the scales of resolution of the two images). In conclusion then, it is felt that, despite the potential for errors in the changes detected, the changes calculated in most places in the Sound of Eriskay are too large for the above factors to fully explain the differences observed.

The observed changes in seagrass distribution over the five year period between the images may be a response in the species to the changes in hydrological pattern induced by the construction of the causeway. However, it must be pointed out that changes observed between just two images do not make a trend; from just two images, it is difficult to establish whether the changes observed are the result of changes induced by the construction of the Eriskay causeway, or simply the result of natural fluctuations in seagrass density over time. Thus, continued monitoring of seagrass density and distribution in the region is required in order to conclusively establish that the overall declines in seagrass density observed are a direct result of the causeway itself.

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7 APPENDICES

7.1 Appendix 1 – Biological groundtruth data

Table 7.1.1 Details of ground truth survey stations surveyed by diving or snorkelling

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	Date	UTM E	UTM N
SB1	**IR.LIR.KLhypCape SS.SSa.IFiSa.TbAmPo**	Area of coarse shelly sand adjacent to low relief bedrock. Small amounts (~1%) of large shell fragments on the sand including *Ensis*.	Sand : sparse *Lanice* & scattered algal clumps. Rock : dense silty cape form *L. hyperborea* with significant amounts of epibiota on fronds.	1.6	25/07/06	596347	6320269
SB2	**SS.SMp.KSwSS.LsacGraFS**	Fine sand, slightly hummocked. Small amounts (~1%) of large shell fragments on the sand including *Ensis*.	High proportion of ephemeral algae on sediment. Significant numbers of *Lanice* & *Arenicola*.	1.7	25/07/06	596029	6320896
SB3	**SS.SSa.IFiSa.NcirBat**	Fine sand. Rippled with wavelength ~10cm.	Significant numbers of *Lanice* & *Arenicola*.	0.3 ACD	25/07/06	596151	6321202
SB4	**IR.MIR.KR.LhypT.Ft**	Bedrock with a fine dusting of sand. Boulders in gullies.	Dense *L. hyperborea* forest with heavily fouled stipes. Rock surfaces with common anemones and variable cover of foliose reds.	5.0	26/07/06	595602	6330885
SB5	**IR.MIR.KR.LhypT.Ft**	Bedrock	*L. hyperborea* forest with heavily fouled stipes. Rock surfaces with common anemones and variable cover of foliose reds.	3.1	26/07/06	596011	6330762

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	Date	UTM E	UTM N
SB6	**SS.SSa.IFiSa.NcirBat**	Clean, well sorted rippled sand	No visible fauna.	5.2	26/07/06	596270	6330522
SB7	**SS.SSa.IFiSa.NcirBat** **IR.MIR.KR.LhypT.Ft** **IR.HIR.KSed.ProtAhn**	Small (2m X 2m) patch of boulders on plain of clean, well sorted rippled medium sand.	Rock : *L. hyperborea* forest with heavily fouled stipes. Sand: No visible fauna	3.9	26/07/06	596150	6330691
SB8	**IR.MIR.KR.LhypT.Ft**	Bedrock / boulders. Small sand (medium) patches are present but small proportion (~10%) of the area.	Rock : *L. hyperborea* forest with heavily fouled stipes. Sand: anemones (F)	8.2	26/07/06	595687	6330319
SB9	**IR.MIR.KR.LhypT.Ft** **IR.HIR.KFaR.Ala**	Bedrock	*L. hyperborea* forest with heavily fouled stipes. *Alaria* present. Rock surfaces with anemones, sponges & colonial ascidians.	1.0	26/07/06	595612	6329341
SB10	**IR.MIR.KR.LhypT.Ft**	Bedrock with a fine dusting of sand	*L. hyperborea* forest with heavily fouled stipes. Rock surfaces with anemones, *Echinus* and sparse foliose reds.	2.4	26/07/06	596281	6329327
SB11	**SS.SSa.IFiSa.NcirBat** **SS.SMp.SSgr.Zmar** **IR.HIR.KSed.ProtAhn**	Rippled sand, clean & well sorted. Occasional (~5%) cobbles & pebbles.	Sand with sparse epifauna. Stoney areas with *Laminaria saccharina*, *Desmarestia* & ephemeral algae. Patches of *Zostera* present.	4.4	27/07/06	596531	6329338
SB12	**SS.SSa.IFiSa.NcirBat**	Rippled sand, clean & well sorted. Sparse scattered cobbles & pebbles.	*Arenicola* on sand and sparse mixed kelp on cobbles.	3.3	27/07/06	596970	6328795

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	Date	UTM E	UTM N
SB13	**IR.MIR.KR.LhypT.Ft**	Bedrock	*L. hyperborea* forest with heavily fouled stipes. Rock surfaces with anemones and foliose reds.	6.7	27/07/06	593919	6325867
SB14	**IR.MIR.KR.LhypT.Ft**	Bedrock with patches of pebbles & cobbles in shallow gullies	*L. hyperborea* forest with heavily fouled stipes. Rock surfaces with anemones and foliose reds.	5.8	27/07/06	593884	6325225
SB15	**IR.MIR.KR.LhypT.Ft**	Bedrock / boulders.	*L. hyperborea* forest with heavily fouled stipes. Rock surfaces with anemones and foliose reds.	4.6	27/07/06	595298	6326434
SB16	**SS.SSa.IMuSa.FfabMag** **IR.MIR.KR.Lhyp.Ft**	Medium sand with slight hummocks. Poorly sorted, sparse pebbles & shell fragments (<<1%) including *Ensis*. Digging pits present. Slightly silty bedrock reefs ~8m away from shot.	Sand with occasional *Arenicola*, *Cerianthus* & *Bispira*. Rock with fairly bare surfaces, abundant *L. hyperborea* and common *Echinus*.	16.7	28/07/06	603346	6323498
SB17	**IR.MIR.KR.LhypT.Ft** **CR.MCR.EcCr.AdigVt**	Bedrock. Slope of ~30 deg with gullies.	*L. hyperborea* forest with heavily fouled stipes. Rock surfaces with *Echinus*, foliose reds and high abundance of *Alcyonium* in some gullies.	9.2	28/07/06	604103	6323818
SB18	**SS.SSa.IFiSa.TbAmPo**	Sand with slight hummocks & microbial film. Shell fragments present including *Ensis*. Digging pits present.	Frequent *Cerianthus* and various mobile epifauna.	10.3	28/07/06	603315	6323878

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	Date	UTM E	UTM N
SB19	**IR.MIR.KR.Lhyp.GzFt**	Gentle bedrock slope. Slopes down to the SE for 4-5m horizontally meeting plain of medium sand with shell fragments & drift algae @ ~17m BSL	Rock : *L. hyperborea* forest with relatively unfouled stipes. Rock surfaces with *Echinus* & foliose reds. Appeared to be a well grazed area. Sand : no obvious epifauna	14.7	28/07/06	604184	6324997
SB20	**IR.MIR.KR.LhypT.Ft**	Bedrock.	Dense *L. hyperborea* forest with heavily fouled stipes. Rock surfaces with *Echinus*, Anemones and *Alcyonium*.	3.3	28/07/06	604379	6324473
SB21	**SS.SMu.IFiMu.Beg**	Soft mud.	*Nephrops* burrows, microalgal film and large (>5m2) localised patches of *Beggiotoa*. Very impoverished infauna.	11.1	01/08/06	603557	6326045
SB22	**IR.MIR.KR.Lhyp.Ft**	Bedrock slope with small gullies	*L. hyperborea* forest with sparse fouling of stipes. Rock surfaces with *Echinus*, sparse foliose reds, sponges & anemones.	1.6	01/08/06	604066	6325931
SB23	**IR.MIR.KR.LhypT.Ft**	Bedrock slope with small gullies	*L. hyperborea* forest with heavily fouled stipes in some areas. Rock surfaces with *Echinus*, foliose algae (mostly *Dictyota*), sponges & anemones.	6.0	01/08/06	604640	6326059
SB24	**SS.SCS.CCS.MedLumVen**	Coarse rippled sand. Amplitude up to 10cm. Poorly sorted with lots of drift foliose reds and shell fragments.	Sparse mobile epifauna.	14.6	01/08/06	604664	6327492

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	Date	UTM E	UTM N
SB25	**IR.HIR.KFaR.FoR**	Margin of bedrock reef. Reef had a fairly level surface and was coated with a light dusting of sand. At margin reef drops ~2m to meet an extensive sandy area.	Dense cover of foliose reds dominated by *Dilsea*. Small *Laminaria* sporelings. *Flustra* and *Echinus* common.	19.7	01/08/06	604887	6327756
SB26	**CR.MCR.EcCr.FaAlCr.Car IR.HIR.KSed.XKScrR**	Bedrock & boulders (slightly silty) forming the margins of a ~8m wide gully with a floor of poorly sorted coarse sand.	>5m inshore of shot (~17m BSL) - rock with *Saccorhiza*. Rock around shot with *Echinus* & *Caryophyllia*. Sand plain with no visible fauna.	18.7	01/08/06	604963	6328406
SB27	**IR.MIR.KR.LhypT.Ft IR.HIR.KSed.ProtAhn**	Bedrock reef. Slightly silty / dusted with sand.	*L. hyperborea* forest with heavily fouled stipes. Rock surfaces rather bare with *Echinus*, sparse foliose algae, anemones and barnacles.	2.0	02/08/06	597428	6322703
SB28	**SS.SCS.ICS.MoeVen**	Fine sand. Very slight rippling / hummocks. Sparse shell fragments including *Ensis* & *Echinocardium*. Sparse drift algae (single frond of *L. saccharina*).	Microbial film on surface. Burrowing infauna and mobile epifauna noted.	3.4	02/08/06	597479	6322862
SB29	**SS.SSa.IFiSa.NcirBat**	Medium rippled sand. Very sparse (<1%) shell fragments including *Ensis*, *Echinocardium* & *Spisula*.	Mobile epifauna noted but visible infauna sparse (*Lutraria* & *Lanice*).	1.9	02/08/06	597019	6323058

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	Date	UTM E	UTM N
SB30	**SS.SMp.SSgr.Zmar**	Boundary between an area of medium sand and an area of sand with scattered boulders.	Sand with a mosaic of dense *Zostera* and open sand patches. Boulders dominated by *Saccorhiza.*	3.5	02/08/06	596894	6322654
SB31	**SS.SMp.SSgr.Zmar**	Medium sand, poorly sorted.	Mosaic of dense *Zostera* and open sand patches	3.5	02/08/06	597179	6322469
SB32	**SS.SMp.KSwSS.LsacGraFS**	Fine soft sand. Lots of *Ensis* shell fragments.	Frequent tufts of algae attached to shell fragments & *Arenicola* common. Algal cover 10-20%. Microbial film 30-40%.	5.1	02/08/06	597232	6322285
SB33	**SS.SMp.KSwSS.LsacGraFS**	Fine soft sand. Sparse (<1%) shell fragments including *Ensis.*	Occasional tufts of algae attached to shell fragments & *Arenicola* common. Algal cover 10-20%.	4.6	02/08/06	596790	6322223
SB34	**SS.SSa.IFiSa.NcirBat**	Fine slightly rippled sand. Clean and well sorted. Sparse (<1%) shell fragments including Ensis.	Dominated by *Lanice* & *Arenicola*	0.5	02/08/06	596553	6321844
SB35	**IR.MIR.KR.LhypT.Ft**	Bedrock with light dusting of sand.	*L. hyperborea* forest with moderate fouling of stipes. Rock surfaces relatively bare with *Echinus* & foliose reds.	2.9	03/08/06	600267	6326895
SB36	**IR.MIR.KR.LhypT.Ft**	Bedrock	*L. hyperborea* forest with heavily fouled stipes. Rock surfaces with *Echinus*, foliose reds & *Sagartia.*	2.1	03/08/06	600883	6326353
SB37	**SS.SCS.ICS.MoeVen**	Medium rippled clean well sorted sand. Sparse (<1%) drift algae and shell fragments including *Ensis* & *Spisula*)	Burrowing infauna and mobile epifauna noted.	4.7	03/08/06	601333	6326543

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	Date	UTM E	UTM N
SB38	**SS.SCS.ICS.MoeVen**	Medium rippled clean sand. Shell fragments (1-5%) including dead *Ensis*. Sparse drift algae.	Sparse *Zostera* with *Chorda* & *Anemonia*.	4.6	03/08/06	601908	6326466
SB39	**SS.SMp.KSwSS**	Medium flat clean well sorted sand. Near 100% cover of loose / drift algae.	Extensive cover by mat of detached algae (*Trailliella*?) and drift *Zostera* & macroalgae.	2.3	03/08/06	602534	6326871
SB40	**IR.MIR.KR.LhypT.Ft**	Bedrock. Gullies (~2m) with cobbles & sand on floor.	*L. hyperborea* forest with heavily fouled stipes. Rock surfaces with *Echinus*, foliose reds & *Sagartia*.	3.0	03/08/06	600955	6325440
SB41	**IR.MIR.KR.Lhyp.Ft**	Bedrock. Uneven slope.	*L. hyperborea* forest with lightly fouled stipes. Rock surfaces fairly bare with *Echinus*, foliose reds & *Urticina*.	0.9	03/08/06	603308	6324643
SB42	**SS.SMp.KSwSS.LsacGraFS IR.MIR.KR.Lhyp.Ft**	Poorly sorted coarse shelly sand with slight hummocks. Shell fragments 5-10% including dead *Ensis*.	Algal cover 10-20% including *Laminaria saccharina*. *Chaetopterus* & *Gibbula magus*.	6.4	03/08/06	603381	6324561
SB43	**IR.MIR.KR.LhypT.Ft**	Bedrock with gullies.	*L. hyperborea* forest with heavily fouled stipes. Rock surfaces fairly bare with numerous *Sagartia*.	2.0	03/08/06	603315	6324320
SB44	**SS.SMp.SSgr.Zmar**	Medium sand	Dense well developed (~1.5m fronds) *Zostera* alternating with bands of relatively open sand.	1.0	04/08/06	595107	6325615

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	Date	UTM E	UTM N
SB45	**IR.MIR.KR.LhypT.Ft** **IR.HIR.KSed.XKScrR**	Bedrock with shallow cobble filled gullies.	*L. hyperborea* forest with heavily fouled stipes. Rock surfaces with *Echinus*, foliose reds & anemones. Cobbles with mixed kelps.	4.6	04/08/06	594395	6325139
SB46	**IR.MIR.KR.LhypT.Ft**	Bedrock interspersed with small patches (~5m X ~2m) of clean unrippled medium sand with 5-10% pebbles & cobbles.	*L. hyperborea* forest with heavily fouled stipes. Rock surfaces with *Echinus*, foliose reds & anemones. Sand patches with ephemeral algae on pebbles & cobbles.	5.2	04/08/06	594587	6325332
SB47	**SS.SSa.IFiSa.NcirBat**	Medium sand. Pronounced ripples, clean & well sorted. Drift algae 1-5%.	Sparse *Arenicola* & mobile epifauna.	0.1 ACD	04/08/06	595214	6325736
SB48	**SS.SMp.SSgr.Zmar**	Medium sand. Pebbles & shell fragments.	Dense *Zostera* on slightly raised (~8cm) banks of sand consolidated by rhizoids. Interspersed with areas of less dense *Zostera*.	3.1	04/08/06	595278	6325309
SB49	**SS.SMp.SSgr.Zmar** **IR.HIR.KSed.XKScrR** **IR.HIR.KSed.ProtAhn**	Mosaic of mixed substrates. Medium sand, shell fragments, pebbles, cobbles & boulders.	*Zostera* patches on sand. *Halidrys* on pebbles/cobbles. Mixed kelps on boulders. *Furcellaria*/*Polyides* in large clumps.	4.7	04/08/06	595085	6325095
SB50	**SS.SMp.SSgr.Zmar**	Fine sand. Well compacted.	Dense *Zostera*.	2.0	04/08/06	595165	6324705
SB51	**SS.SMp.SSgr.Zmar**	Fine sand. Well compacted. Rippled in open areas.	Alternating patches of dense *Zostera* and relatively open sand with sparse *Zostera* and *Arenicola.*	4.2	04/08/06	595670	6324947

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	Date	UTM E	UTM N
SB52	**IR.MIR.KR.LhypT.Ft**	Boulders / bedrock.	*L. hyperborea* forest with heavily fouled stipes. Rock surfaces with *Echinus*, foliose reds & *Sagartia*.	1.1	06/08/06	598901	6323857
SB53	**IR.MIR.KR.LhypT.Ft** **IR.HIR.KSed.XKScrR**	Bedrock. Well scoured by coarse sand. Lots of drift algae.	Mixed *L.hyperborea* and *Saccorhiza*. *L. hyperborea* with heavily fouled stipes.	4.4	06/08/06	600241	6323736
SB54	**IR.MIR.KR.LhypT.Ft** **IR.HIR.KSed.XKScrR**	Boulders / bedrock. Patches of coarse sand with cobbles. Well scoured.	Mixed *L.hyperborea* and *Saccorhiza*. *L. hyperborea* with heavily fouled stipes.	3.5	06/08/06	600365	6324329
SB55	**IR.MIR.KR.LhypT.Ft** **IR.HIR.KSed.ProtAhn**	Bedrock. Narrow (~1.5m wide) gully with sand ~2m? NE of shot. Narrow (~0.5m wide) gully with pebbles ~2m? S of shot.	*L. hyperborea* forest with heavily fouled stipes. Rock surfaces with foliose reds & anemones. Gullies with *Furcellaria*/*Polyides* & *Ulva*.	3.9	06/08/06	600072	6325040
SB56	**SS.SCS.ICS.MoeVen**	Medium rippled sand. Shell fragments.	Very sparse biota.	4.4	06/08/06	599853	6324827
SB57	**SS.SSa.IFiSa.IMoSa**	Medium rippled sand. Clean & well sorted. Shell fragments very sparse (<<1%).	Very sparse biota. Drift algae <<1%.	6.7	06/08/06	599230	6324914
SB58	**IR.MIR.KR.LhypT.Ft**	Bedrock with small shallow gullies with cobbles.	*L. hyperborea* forest with heavily fouled stipes. Rock surfaces with *Echinus*, foliose reds & anemones.	2.1	06/08/06	597570	6326268
SB59	**IR.HIR.KSed.XKScrR** **IR.MIR.KR.LhypT.Ft**	Boulders, cobbles and sand patches. Sand patches with dense drift kelp.	Mixed *L.hyperborea*, *L.saccharina* and *Saccorhiza*. *L. hyperborea* with heavily fouled stipes.	1.2	07/08/06	596688	6325370
SB60	**SS.SSa.IFiSa.NcirBat**	Medium clean well sorted rippled sand. Drift algae 1-5%.	No visible fauna	0.2 ACD	07/08/06	596607	6325210

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	Date	UTM E	UTM N
SB61	**IR.HIR.KSed.XKScrR** **SS.SSa.IFiSa.IMoSa** **IR.HIR.KSed.ProtAhn**	Medium clean rippled sand over 60-70% of area. Rock (bedrock/v lrg boulders) patches (size 2-3m X 4-5m) 30-40% of area. Rock surfaces often covered by thin layer of sand.	Sand : No visible fauna Rock : 50% area dominated by mixed kelp (*L.Hyperborea* & *Saccorhiza*); 50% area dominated by *Furcellaria*/*Polyides* with numerous anemones	2.2	07/08/06	596396	6324784
SB62	**SS.SMp.SSgr.Zmar**	Medium sand. Slightly (~0.3m) raised banks with *Zostera* and rippled clean sand in channels separating the banks.	Dense *Zostera* on slightly raised (~0.3m) banks of sand consolidated by rhizoids. Separated by open channels of bare sand.	3.1	07/08/06	596743	6324246
SB63	**SS.SCS.ICS.MoeVen** **IR.HIR.KSed.ProtAhn**	Clean rippled sand. Coarse in places with surface gravel.	Sparse (<1%) algae on shell fragments. Very sparse (<<<1%) *Zostera*.	3.1	07/08/06	596000	6323901
SB64	**IR.MIR.KR.LhypTX.Ft**	Mixed ground of gravel, pebbles & boulders.	*Laminaria hyperborea* forest. Stipes fouled with red algae, *Electra* & *Halichondria*. Rock surfaces with sparse foliose reds & well developed coralline crusts. Pebbles with *Pomatoceros* & Barnacles.	0.5 ACD	07/08/06	595970	6324832
SB65	**SS.SCS.ICS.MoeVen**	Fine, strongly rippled sand. Clean & well sorted.	No visible fauna. Sparse (<1%) drift algae.	0.5	07/08/06	596350	6324048

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	Date	UTM E	UTM N
SB66	**SS.SCS.ICS.HeloMsim**	Shallow sandbank		0.2	07/08/06	596676	6323369
SB67	**IR.HIR.KFaR.FoR**	Bedrock.	Dominated by a turf of red algae and erect bryozoans.	20.3	10/08/06	605149	6326463

Table 7.1.2 Details of ground truth survey stations surveyed by drop down video

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	date	Start UTM	End UTM
SA1	**SS.SMp.KSwSS.LsacGraFS**	Slightly hummocked muddy sand	Plentiful algal cover, 10-20% (locally 50-70%) - mainly *Laminaria saccharina*. Many small (amphipod) tubes in sediment. Also noted, microbial film, *Asperococcus*, *Carcinus*.	8.8 - 9.4	25/07/06	596828E 6320505N	596831E 6320542N
SA2	**SS.SMp.KSwSS.LsacGraFS**	Hummocked muddy sand	Plentiful algal cover, 30-40% (mainly *Laminaria saccharina*, also, *Ulva*, *Asperococcus*). *Chorda* (C). Many *Arenicola*. *Pomatoshistus*.	6.6 - 5.9	25/07/06	596223E 6320730N	596198E 6320772N
SA3	**SS.SMp.KSwSS.LsacGraFS**	Hummocked sand	Plentiful algal cover, 40-50% (mainly *Laminaria saccharina*, also, *Ulva*, *Asperococcus*, *Chorda*). Many small (amphipod) tubes in sediment. Also noted, *Arenicola* (O-F), *Macropodia*, *Arctica*, *Necora* & spirobids on kelp fronds.	7.9 - 6.2	25/07/06	596601E 6320848N	596598E 6320908N

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	date	Start UTM	End UTM
SA4	**SS.SMu.ISaMu.MelMagThy**	Hummocked sand	Algal cover more sparse than SA1 to SA3, ~10% (locally 20-30%) (mainly *Laminaria saccharina*, also, *Dictyota*). Small (amphipod) tubes in sediment. Also noted, *Arenicola*, microbial film, *Carcinus*.	9.3 - 8.0	25/07/06	597184E 6321113N	597181E 6321157N
SA5	**SS.SMu.ISaMu.MelMagThy**	Slightly hummocked fine sand	Sparse algal cover (<10%). Microbial film (~80%). Also noted, *Arenicola*, *Chorda* (O), *Liocarcinus depurator*.	7.9 - 8.3	25/07/06	596860E 6321369N	596835E 6321392N
SA6	**IR.MIR.KR.LhypT.Ft**	Bedrock with a dusting of sand.	*Laminaria hyperborea* (A) forest. Stipes fouled by foliose red algae. Understory of sparse foliose reds. Also noted, *Echinus*, *Odontothalia*, *Desmarestia lingulata*, *Membranipora* on kelp fronds.	7.7 - 5.2	26/07/06	594972E 6331269N	594939E 6331311N
SA7	**SS.SSa.IFiSa.IMoSa**	Fine to medium sand. Clean & well sorted. Long well defined ripples.	No visible epibiota.	5.9 - 5.1	26/07/06	595889E 6331264N	595910E 6331274N
SA8	**SS.SSa.IFiSa.IMoSa**	Fine to medium sand. Clean & well sorted. Rippled.	No visible epibiota.	7.8 - 8.0	26/07/06	595018E 6330834N	594992E 6330833N
SA9	**SS.SSa.IFiSa.IMoSa**	Fine to medium sand. Clean & well sorted. Rippled.	No visible epibiota.	7.7 - 8.1	26/07/06	595391E 6330546N	595380E 6330553N

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	date	Start UTM	End UTM
SA10	**SS.SSa.IFiSa.IMoSa**	Fine to medium sand. Clean & well sorted. Rippled.	No visible epibiota.	8.2 - 8.2	26/07/06	595095E 6330223N	595112E 6330203N
SA11	**IR.MIR.KR.LhypT.Ft**	Bedrock with patches of boulders & cobbles. Rock with a dusting of sand.	*Laminaria hyperborea* (A) forest. Stipes with heavy fouling by foliose red algae. Understory of sparse foliose reds. Also noted, *Echinus* on stipes, *Odontothalia*.	7.1 - 5.3	26/07/06	594757E 6330052N	594812E 6330016N
SA12	**SS.SSa.IFiSa.IMoSa**	Fine to medium sand. Clean & well sorted. Long well defined ripples.	No visible epibiota.	7.1 - 7.1	26/07/06	595440E 6330001N	595450E 6330003N
SA13	**IR.MIR.KR.LhypT.Ft** **IR.HIR.KSed.XKScrR**	Boulders & cobbles with sand as infill and in small patches.	*Laminaria hyperborea* (A) forest. Stipes with fouling by foliose red algae. Understory of sparse (~10%) foliose reds. Also noted, *Echinus*, extensive coralline crusts. *Laminaria saccharina* locally common at the boundaries of the sand patches.	5.3 - 5.1	26/07/06	596101E 6330000N	596166E 6329953N
SA14	**SS.SSa.IFiSa.IMoSa**	Fine to medium sand. Clean & well sorted. Rippled.	No visible epibiota.	7.3 - 7.0	26/07/06	595988E 6329522N	596025E 6329499N

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	date	Start UTM	End UTM
SA15	**SS.SSa.IFiSa.IMoSa** **IR.MIR.KR.LhypT.Ft** **IR.HIR.KSed.XKScrR**	Initially, clean rippled sand with occasional patches of boulders & cobbles. Drifting into an area of dominated by rocky substrate.	No visible epibiota on sand. Rock patches with *Saccorhiza, Laminaria saccharina* & *Furcellaria*. Area of continuous rock with dense *Laminaria hyperborea* (A), stipes heavily fouled by foliose red algae, sponges & didemnids, *Echinus* present.	7.6 - 9.2	26/07/06	595383E 6329708N	595460E 6329634N
SA16	**IR.MIR.KR.LhypT.Ft**	Bedrock	*Laminaria hyperborea* (A) forest. Stipes with fouling by foliose red algae & didemnids. *Odontothalia* on rock.	4.4 - 4.7	26/07/06	594902E 6329514N	594958E 6329474N
SA17	**IR.MIR.KR.Lhyp.Ft**	Rock	*Laminaria hyperborea* (A) forest. Stipes with relatively light fouling by foliose red algae. *Echinus* on stipes. Rock surfaces relatively bare, sponge crusts & foliose reds noted.	7.4 - 8.1	26/07/06	594631E 6329155N	594670E 6329132N
SA18	**IR.MIR.KR.Lhyp.Pk**	Cobbles & boulders. Rock surfaces appear fairly bare (scoured?).	Patchy *Laminaria hyperborea* forest. Cobbles with *Pomatoceros* & coralline crusts. Also noted, *Echinus, Delessaria, Saccorhiza, Laminaria saccharina*.	9.1 - 9.7	26/07/06	595053E 6329159N	595104E 6329106N

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	date	Start UTM	End UTM
SA19	**IR.MIR.KR.Lhyp.Pk**	Pebbles & cobbles	*Laminaria hyperborea* park on mixed ground. Stipes only lightly fouled. Many *Echinus*. Also noted, *Laminaria saccharina* & *Asterias*.	12.2 - 10.9	26/07/06	594453E 6328726N	594495E 6328710N
SA20	**SS.SSa.IFiSa.IMoSa**	Rippled sand. Clean & well sorted. Ripples irregular.	No visible epibiota.	10.2 - 10.1	26/07/06	595214E 6328669N	595246E 6328659N
SA21	**IR.MIR.KR.LhypT.Ft**	Bedrock with a few very small patches of sand. Rock surfaces with a dusting of sand.	*Laminaria hyperborea* (A) forest. Stipes with fouling by *Ascidiella scabra*. Also noted, *Echinus* & *Desmarestia*. Rock surfaces generally bare.	7.8 - 5.1	26/07/06	595628E 6328972N	595666E 6328939N
SA22	**SS.SSa.IFiSa.IMoSa**	Fine to medium sand. Clean & well sorted. Rippled.	No visible epibiota.	8.1 - 7.6	26/07/06	595948E 6328669N	595979E 6328649N
SA23	**IR.HIR.KSed.XKScrR**	Area dominated by patches of boulders & cobbles alternating with patches of well sorted fine to medium sand.	Kelp & other algae on rock patches including *Laminaria hyperborea*, *Laminaria saccharina* & *Halidrys*. Also noted *Echinus*.	12.0 - 6.7	27/07/06	595454E 6328274N	595394E 6328320N
SA24	**IR.MIR.KR.LhypTX.Ft**	Mixed ground of rock with small sand patches	*Laminaria hyperborea* forest / park on mixed ground. Also noted, *Echinus*.	11.0 - 10.1	27/07/06	594850E 6328377N	594789E 6328412N
SA25	**SS.SSa.IFiSa.IMoSa**	Fine to medium sand. Well sorted. Slight rippling.	No visible epibiota.	9.8 - 9.8	27/07/06	594491E 6328057N	594473E 6328086N

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	date	Start UTM	End UTM
SA26	**IR.MIR.KR.LhypT.Ft SS.SSa.IFiSa.IMoSa**	Area of boulders seen briefly at start of run. Most of run was over clean, well sorted, rippled sand.	Boulder area with *Laminaria hyperborea* forest with heavily fouled stipes. No visible epibiota on sand.	7.2 - 9.7	27/07/06	595109E 6327889N	595083E 6327924N
SA27	**IR.MIR.KR.LhypT.Ft**	Rock	*Laminaria hyperborea* (A) forest. Stipes with moderate to dense fouling including sponges. Also noted, *Echinus* & *Asterias*. Rock surfaces with a sparse understory of foliose reds.	5.2 - 5.3	27/07/06	594103E 6326505N	594194E 6326569N
SA28	**IR.MIR.KR.LhypT.Ft SS.SSa.IFiSa.IMoSa**	Bedrock and patches of cobbles with a dusting of sand. At end of run there was open sand, clean & well sorted.	*Laminaria hyperborea* (A) forest. Stipes with moderate to dense fouling including *Halichondria* & foliose reds. Also noted, *Desmarestia lingulata*. No visible epibiota on sand.	5.2 - 8.5	27/07/06	594396E 6326937N	594505E 6326997N
SA29	**IR.MIR.KR.LhypT.Ft**	Bedrock	*Laminaria hyperborea* (A) forest. Stipes with moderate to dense fouling including *Halichondria*. *Obelia geniculata* on fronds. *Echinus* 10, locally 3. Also noted, *Delessaria*, *Asterias*.	5.8 - 5.0	27/07/06	595058E 6327103N	595165E 6327116N
SA30	**SS.SSa.IFiSa.IMoSa**	Rippled sand. Clean & well sorted. Fine to medium.	No visible epibiota.	7.8 - 7.4	27/07/06	594969E 6327260N	595004E 6327268N

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	date	Start UTM	End UTM
SA31	**IR.MIR.KR.LhypTX.Ft** **IR.HIR.KSed.XKScrR**	Mixed ground of boulder patches and pebbly sand patches	Predominantly *Laminaria hyperborea* forest. Stipes with moderate fouling. Also noted, *Echinus*. Localised areas with *Desmarestia*, *Laminaria saccharina* and *Saccorhiza*.	7.4 - 7.4	27/07/06	595288E 6327407N	595334E 6327413N
SA32	**IR.MIR.KR.LhypT.Ft**	Bedrock with patches of boulders & cobbles.	*Laminaria hyperborea* (A) forest. Stipes with dense fouling. Also noted, *Desmarestia*.	5.5 - 5.0	27/07/06	594401E 6327470N	594480E 6327509N
SA33	**IR.MIR.KR.LhypT.Ft**	Bedrock with patches of boulders & cobbles.	*Laminaria hyperborea* (A) forest. Stipes with dense fouling. Many *Echinus*.	5.0 - 5.8	27/07/06	595671E 6327171N	595701E 6327158N
SA34	**IR.MIR.KR.LhypTX.Ft** **IR.HIR.KSed.XKScrR** **SS.SSa.IFiSa.IMoSa**	Mixed ground of boulders & cobbles with areas of clean rippled sand with some pebbles.	Patches of *Laminaria hyperborea* forest with *Echinus*. *Laminaria saccharina* on pebbles. Saccorhiza present. No visible epibiota on sand.	6.8 - 8.9	27/07/06	596217E 6327124N	596291E 6327100N
SA35	**IR.HIR.KFaR.FoR** **SS.SCS.CCS.MedLumVen**	Initially over a low bedrock outcrop. Then waves of poorly sorted coarse sand with gravel and many pebbles & shell fragments (most of run).	Rock with *Alcyonidium*, *Flustra* & red algae. Nothing noted on sediment.	21.4 - 23.3	28/07/06	603752E 6323475N	603771E 6323407N
SA36	**SS.SMp.Mrl.Pcal**	Coarse shell gravel with many shell fragments.	Live maerl <10% (no attached algae). Also noted, *Liocarcinus depurator*.	23.1 - 22.7	28/07/06	604399E 6323534N	604421E 6323471N

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	date	Start UTM	End UTM
SA37	**SS.SMp.Mrl.Pcal**	Coarse shell gravel with many shell fragments. Pronounced megaripples.	Small amounts of live maerl in troughs <5%. Also noted, Paguridae indet.	21.1 - 17.9	28/07/06	604570E 6323934N	604601E 6323866N
SA38	**IR.MIR.KR.Lhyp.Ft**	Initially, predominantly rock with increasing cover of sand patches as run progresses. Towards end of run the substrate returns to rock.	Rock with *L. hyperborea* forest. Stipes appear bare. *Obelia geniculata* on fronds. Foliose reds on rock surfaces. Also noted, *Urticina* & *Delessaria*.	16.3 - 17.3	28/07/06	604922E 6324100N	604951E 6324004N
SA39	**SS.SMp.Mrl.Pcal IR.MIR.KR.Lhyp.Ft**	Initially, waves of maerl gravel. Moving onto bedrock which dominates most of the run.	Maerl gravel with dense (~50%) live maerl. Rock with dense *L. hyperborea* forest & red algal turf. Also noted, *Dilsea*, encrusting sponges, *Alcyonidium*, *Flustra*??	18.6 - 19.8	28/07/06	604955E 6324654N	604967E 6324571N
SA40	**IR.MIR.KR.Lhyp.Ft SS.SCS.CCS.MedLumVen**	Slightly silty bedrock. Coarse, poorly sorted sand with megaripples at end of run.	Initially, *L. hyperborea* forest. Stipes appear bare. Sparse foliose reds on rock surfaces. Also noted, *Echinus*. Nothing noted on sediment.	11.4 - 17.2	28/07/06	605694E 6324693N	605717E 6324618N
SA41	**SS.SSa.IFiSa**	Fine to medium sand with slight rippling. Sparse (1-5%) shell fragments.	Drift algae (1-5%).	16.7 - 16.7	28/07/06	604310E 6325308N	604309E 6325312N
SA42	**SS.SMp.Mrl.Pcal**	Coarse shell gravel with megaripples.	Rich live maerl ~20-30% (no attached algae).	22.6 - 22.1	28/07/06	605125E 6325347N	605123E 6325355N
SA43	**SS.SMp.Mrl.Pcal IR.MIR.KR.Lhyp.Ft**	Coarse shell gravel with megaripples. Moving onto bedrock at end of run.	Live maerl in troughs <10%. Also noted, *Liocarcinus depurator*. *L hyperborea* forest on rock at end	16.6 - 15.8	28/07/06	605661E 6325112N	605662E 6325084N

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	date	Start UTM	End UTM
SA44	**IR.HIR.KFaR.FoR** **IR.MIR.KR.Lhyp.Pk**	Rock	Dense red algal turf then kelp park with rich red algal turf then back to red algal turf. Also noted, *Botryllus*, *Macropodia*, *Necora*, Hydroids?	19.7 - 21.9	28/07/06	606047E 6325354N	606019E 6325383N
SA45	**SS.SMp.Mrl.Pcal**	Coarse shell gravel with megaripples & many shell fragments.	Sparse live maerl <5%. Also noted, *Lanice*, *Pomatoceros* on shell fragments.	23.4 - 22.6	01/08/06	604877E 6325796N	604904E 6325724N
SA46	**SS.SMp.Mrl.Pcal**	Coarse shell gravel with megaripples.	Much live maerl (20-40%), especially in troughs	21.9 - 21.9	01/08/06	605290E 6325984N	605306E 6325916N
SA47	**SS.SMp.Mrl.Pcal** **IR.HIR.KFaR.FoR**	Waves of maerl gravel then area of rock, them back to maerl gravel and again back to rock	Red algae on rock. Dense live maerl.	24.7 - 23.1	01/08/06	606093E 6325962N	606134E 6325854N
SA48	**SS.SMp.Mrl.Pcal**	Coarse shell gravel with large pronounced megaripples.	Live maerl ~20%	25.6 - 23.1	01/08/06	606300E 6326771N	606327E 6326701N
SA49	**SS.SMp.Mrl.Pcal** **IR.HIR.KFaR.FoR**	Initially rock then moving onto an area of gravelly sand with megaripples and many shell fragments. Subsequently moving over more rock before returning to megarippled sand at end of run.	Rock with dense red algal turf. Also many *Alcyonidium*, some hydroids and *Laminaria* sporelings. Sand with 20-30% live maerl.	20.9 - 21.4	01/08/06	605768E 6326537N	605805E 6326445N

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	date	Start UTM	End UTM
SA50	**SS.SMp.Mrl.Pcal IR.HIR.KFaR.FoR**	Initially coarse shell sand with megaripples & shell fragments. Moving over outcrop of bedrock / boulders before returning to megarippled sand area. Run finishes over a second area of bedrock / boulders with small patches of sand.	Sediment with sparse (<5%) live maerl. Rock with red algal turf. Also noted, *Nemertesia ramosa*, *Cliona*, *Necora*, *Mathasterias*, *Alcyonidium*, *Flustra*.	21.5 - 23.2	01/08/06	605145E 6326469N	605188E 6326336N
SA51	**SS.SSa.CFiSa.EpusOborApri IR.HIR.KFaR.FoR**	Initially fine/medium slightly silty sand with hummocks and slight rippling. Moving onto boulder area then returning to similar sediment with poorly defined megaripples with shell fragments in troughs. Run ends over an area of bedrock.	Sand with *Arenicola* mounds and sparse (~1%) drift algae. Rock areas with red algal turf, *Alcyonidium*, *Nemertesia ramosa*, *Cliona*, *Echinus*, *Asterias*.	20.9 - 21.1	01/08/06	604748E 6326923N	604811E 6326774N
SA52	**SS.SSa.CFiSa.EpusOborApri**	Fine/medium slightly muddy sand with hummocks and slight rippling. Poorly sorted with many (5-10%) shell fragments.	Very sparse maerl (<1%) and drift algae (1%). Also noted, *Chaetopterus*, *Liocarcinus depurator*, *Turritella*??	23.9 - 23.7	01/08/06	605668E 6327065N	605700E 6326934N

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	date	Start UTM	End UTM
SA53	**SS.SSa.CFiSa.EpusOborApri IR.HIR.KFaR.FoR IR.MIR.KR.Lhyp.Pk**	Initially slightly silty fine sand with ripples. Moving onto rock for remainder of run.	Nothing noted on sand. Rock initially with dense red algal turf, *Cliona*, *Flustra*, *Nemertesia ramosa* and *Laminaria* sporelings. Later moving into an area of *Laminaria hyperborea* park. Stipes relatively bare, profuse *Obelia geniculata* on fronds. Moving back to rock dominated by red algae at end of run.	16.4 - 20.0	01/08/06	605587E 6327280N	605609E 6327152N
SA54	**SS.SSa.CFiSa.EpusOborApri**	Fine/medium silty sand with slight rippling.	Sparse drift algae (<1%). Also noted, *Turritella*.	23.3 - 23.2	01/08/06	605180E 6327333N	605191E 6327203N
SA55	**SS.SSa.IFiSa.TbAmPo**	Silty fine sand. Sparse (<<1%) surface gravel & shell fragments including occasional dead *Ensis* shells.	*Arenicola*. *Chorda* (O), algae <10% including drift kelp (1-5%). Microbial film on surface. *Echinocardium* in grab.	6.7 - 8.0	02/08/06	596714E 6321720N	596733E 6321633N
SA56	**SS.SMp.KSwSS.LsacGraFS**	Fine sand. Sparse (<1%) shell fragments including occasional dead *Ensis* shells.	Microbial film (20-40%). Patchy surface algae (20-40%) mainly *Laminaria saccharina* but also including *Chorda*, *Dictyota* & *Desmarestia*. Also noted, *Carcinus*, *Asterias*.	6.5 - 6.9	02/08/06	597226E 6321921N	597237E 6321838N
SA57	**SS.SMu.ISaMu.MelMagThy**	Silty fine sand with hummocks.	Microbial film (20-40%). Surface algae (<10%) including *Laminaria saccharina*. Also noted, *Liocarcinus depurator*. *Echinocardium* in grab	12.1 - 13.0	02/08/06	597719E 6321834N	597731E 6321781N

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	date	Start UTM	End UTM
SA58	**IR.MIR.KR.Lhyp.Ft SS.SMp.KSwSS.LsacGraFS**	Initially rock. Towards the end of the run moving onto fine sand with sparse (<1%) shell fragments including occasional dead *Ensis* shells.	Rock with *Laminaria hyperborea* forest. Stipes with limited fouling, fronds with a lot of ectocarpaceae & crisid bryozoans. Rock surfaces relatively bare with *Echinus* (C). Also noted, *Chorda*, *Desmarestia*. Sand with 20-40% algal cover including *Laminaria saccharina*, *Dictyota* & *Chorda*.	3.6 - 6.0	02/08/06	597655E 6322295N	597676E 6322227N
SA59	**IR.LIR.K.LhypLsac SS.SMp.KSwSS.LsacGraFS**	Initially boulders. Moving onto fine hummocked sand.	Rock with *Laminaria hyperborea* (with fouled fronds), *Laminaria saccharina* & *Ulva*. Sand with *Arenicola* and ~80% algal cover including *Laminaria saccharina*, *Asperococcus* & *Dictyota*.	5.4 - 7.0	02/08/06	598224E 6322178N	598260E 6322088N
SA60	**SS.SMp.KSwSS.LsacGraFS**	Fine hummocked sand.	Algal cover 20-30% (locally higher) including *Laminaria saccharina* & *Chorda*. Microbial film 20-30%.	8.5 - 8.6	02/08/06	597904E 6322590N	597915E 6322531N

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	date	Start UTM	End UTM
SA61	**IR.MIR.KR.Lhyp.Ft SS.SMp.KSwSS.LsacGraFS**	Initially rock with dusting of sand. Moving onto hummocked sand with algal cover. Subsequently moving to rock. Then briefly returning to sand before ending the run on rock.	Rock with *Laminaria hyperborea*. Stipes fouled by foliose reds and *Echinus* present. Sand with *Arenicola* and 40-60% algal cover including *Laminaria saccharina, Dictyota, Ulva*.	7.3 - 7.5	02/08/06	598568E 6322643N	598564E 6322571N
SA62	**SS.SMp.KSwSS.LsacGraFS**	Fine hummocked sand.	Algal cover 20-30% including *Laminaria saccharina, Chorda, Ulva, Helminthocladia, Dictyota*.	7.8 - 7.2	02/08/06	597785E 6323059N	597783E 6323003N
SA63	**SS.SMu.ISaMu.MelMagThy**	Fine hummocked sand.	Algal cover ~1% (but locally 10-20%). *Arenicola*. Microbial film.	12.3 - 11.6	02/08/06	598466E 6323238N	598488E 6323168N
SA64	**SS.SSa.IMuSa.FfabMag**	Fine sand with slight hummocks (no obvious rippling) & shell fragments.	Algal cover ~5%.	6.5 - 6.7	02/08/06	599313E 6322934N	599312E 6322876N
SA65	**SS.SSa.IMuSa.FfabMag**	Silty sand with slight hummocks.	Algal cover ~5% including *Laminaria saccharina* (drift?). Also noted, *Liocarcinus depurator*.	11.6 - 12.8	02/08/06	599293E 6322378N	599283E 6322302N
SA66	**SS.SSa.IMuSa.FfabMag**	Fine sand with no obvious rippling or hummocks.	Algal cover 1-5%. *Arenicola*.	10.6 - 11.2	02/08/06	599937E 6322446N	599940E 6322359N
SA67	**SS.SSa.IMuSa.FfabMag**	Fine sand with slight hummocks (no obvious rippling).	Algal cover ~5-10% including *Laminaria saccharina*. Also noted, *Liocarcinus depurator*.	12.2 - 12.4	02/08/06	600548E 6322368N	600558E 6322283N
SA68	**SS.SSa.IMuSa.FfabMag**	Fine sand with slight hummocks (no obvious rippling).	Algal cover ~1% including *Laminaria saccharina*.	11.4 - 11.5	02/08/06	600653E 6322677N	600666E 6322621N

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	date	Start UTM	End UTM
SA69	**SS.SMp.SSgr.Zmar**	Fine sand with shell fragments.	Initially dense *Zostera* then open sand with microbial film (50-60%) and sparse (<1%) algae. Returning to dense *Zostera* at end of run.	6.3 - 6.7	02/08/06	600018E 6323179N	600014E 6323134N
SA70	**IR.HIR.KSed.XKScrR IR.MIR.KR.LhypT.Ft**	Bedrock / boulders with small sand patches.	Initially *Laminaria hyperborea* with many *Saccorhiza* and also *Laminaria saccharina* & *Desmarestia*. Moving onto *Laminaria hyperborea* forest with profuse stipe epibiota towards end of run.	3.9 - 5.7	03/08/06	598649E 6326843N	598701E 6326789N
SA71	**SS.SCS.ICS.MoeVen IR.HIR.KSed.ProtAhn**	Fine to medium clean sand with slight rippling.	Algae generally sparse <1% and includes *Laminaria saccharina*. Large patch of *Furcellaria / Polyides*.	7.2 - 6.1	03/08/06	599246E 6326859N	599292E 6326810N
SA72	**SS.SCS.ICS.MoeVen**	Poorly sorted slightly rippled sand with shell debris.	Algae ~5% including *Chorda*. Drift *Zostera*.	5.9 - 5.5	03/08/06	599531E 6326256N	599586E 6326199N
SA73	**SS.SMp.Mrl.Pcal SS.SMp.SSgr.Zmar**	Sand and coarse shell gravel with shell fragments.	Localised patches of dense *Zostera*. Live maerl up to 20% in localised patches. Also noted, *Carcinus*.	6.8 - 6.2	03/08/06	599710E 6325905N	599797E 6325848N
SA74	**SS.SMp.Mrl.Pcal**	Coarse shell sand with hummocks.	Live maerl up to 20-30% in localised patches. Algal cover 10-20%.	7.8 - 8.7	03/08/06	600038E 6325451N	600134E 6325372N
SA75	**SS.SCS.ICS.MoeVen**	Clean rippled sand.	Sparse (~1%) algae.	4.9 - 4.8	03/08/06	600467E 6325877N	600517E 6325834N

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	date	Start UTM	End UTM
SA76	**SS.SCS.ICS.MoeVen**	Fine to medium sand. Clean & well sorted. Pronounced rippling. Sparse (<1%) shell debris.	Sparse (~1%) algae. Small patch of *Furcellaria* / *Polyides*.	5.1 - 5.4	03/08/06	600651E 6326253N	600684E 6326217N
SA77	**SS.SCS.ICS.MoeVen**	Fine to medium sand. Clean & well sorted. Pronounced rippling. Very sparse (<<1%) shell debris.	Very sparse (<<1%) algae.	6.7 - 6.7	03/08/06	601415E 6325921N	601439E 6325890N
SA78	**SS.SCS.ICS.MoeVen SS.SMp.SSgr.Zmar**	Rippled sand with sparse (~1%) shell debris.	*Zostera* present, sparse overall but with the occasional dense patch. Sparse (~1%) algae. Also noted, *Chorda*.	4.2 - 4.5	03/08/06	602029E 6325886N	602087E 6325846N
SA79	**SS.SCS.ICS.MoeVen**	Rippled medium clean sand with slight hummocks. Shell fragments 1-5%.	Algae 5-10% cover mostly composed of drift *Zostera* & attached ephemerals.	11.9 - 10.9	03/08/06	602306E 6325724N	602353E 6325675N
SA80	**SS.SCS.ICS.MoeVen IR.MIR.KR.LhypT.Ft**	Initially clean rippled fine to medium sand. Subsequently over rock for remainder of run.	Nothing noted on sand. Rock with *Laminaria hyperborea* forest. Stipe fouling variable but locally heavy with foliose red algae & *Ascidiella scabra*. Fronds fouled by *Obelia geniculata*. Rock surfaces with sparse foliose reds (*Cryptopleura*) and extensive coralline crusts. Also noted, *Actinothoe* & *Echinus*.	6.1 - 5.8	03/08/06	601737E 6325225N	601791E 6325182N

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	date	Start UTM	End UTM
SA81	**SS.SSa.IMuSa.FfabMag**	Fine sand with slight hummocks and occasional pebbles.	Algal cover sparse (~1%). *Chaetopterus*. *Pomatoceros* on pebbles. Drift *Zostera*.	15.8 - 15.1	03/08/06	602428E 6324994N	602465E 6324946N
SA82	**SS.SSa.IMuSa.FfabMag**	Fine sand with poorly defined hummocks.	Algal cover 5-10% including *Laminaria saccharina* & *Ulva*. Also noted, *Arenicola* & *Liocarcinus depurator*.	10.8 - 10.7	03/08/06	602958E 6324636N	602969E 6324628N
SA83	**SS.SSa.IMuSa.FfabMag**	Fine sand with slight hummocks.	Algae 1-5% cover. *Liocarcinus depurator*.	16.2 - 15.6	03/08/06	602486E 6324407N	602536E 6324376N
SA84	**SS.SCS.ICS.MoeVen**	Clean sand with ripples & hummocks.	Algal cover sparse (~1%). *Arenicola*. Microbial film.	11.0 - 11.1	03/08/06	601980E 6324144N	601999E 6324126N
SA85	**SS.SCS.ICS.MoeVen**	Sand with ripples & hummocks. Sparse (<1%) shell fragments including dead *Ensis*.	Algal cover sparse (<1%). Microbial film (~10%). Burrowing bivalves (*Ensis*?) present. Also noted, *Carcinus*, *Liocarcinus depurator*.	8.6 - 8.9	03/08/06	601842E 6324530N	601869E 6324531N
SA86	**SS.SCS.ICS.MoeVen**	Rippled sand.	Algal cover sparse (~1%) including drift *Laminaria saccharina*. Microbial film (~5%).	6.9 - 7.4	03/08/06	601075E 6324521N	601093E 6324521N
SA87	**SS.SSa.IFiSa.IMoSa**	Sand with pronounced ripples.	Algal cover very sparse drift (<<1%). Microbial film (~5%).	3.5 - 3.8	03/08/06	600696E 6324652N	600704E 6324667N

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	date	Start UTM	End UTM
SA88	**IR.MIR.KR.LhypT.Ft**	Rock.	*Laminaria hyperborea* forest. Stipes with moderate fouling of foliose reds, *Alcyonidium* & *Halichondria*. Rock with ~30% cover of foliose reds. Also noted, *Saccorhiza, Echinus, Odontothalia* & coralline crusts.	5.9 - 6.4	04/08/06	595901E 6326725N	595950E 6326720N
SA89	**SS.SSa.IFiSa.IMoSa**	Rippled clean sand.	Sparse (<1%) drift algae including *Laminaria saccharina*. Sparse (<1%) attached ephemerals including *Helminthocladia*. Small patch of *Furcellaria*/Polyides.	7.8 - 8.2	04/08/06	595938E 6326458N	595996E 6326447N
SA90	**IR.HIR.KSed.ProtAhn IR.HIR.KSed.XKScrR**	Sand with numerous pebbles (40%).	Algal cover ~20%. Includes *Gracilaria, Saccorhiza, Laminaria saccharina, Dictyota, Desmarestia lingulata, Desmarestia aculeata, Furcellaria*/*Polyides*.	6.9 - 7.0	04/08/06	595686E 6326141N	595770E 6326152N
SA91	**SS.SSa.IFiSa.IMoSa**	Rippled well sorted clean sand. Sparse (~1%) shell debris.	Algal cover sparse (~1%). Also noted, *Zostera*, *Furcellaria*/*Polyides*.	5.3 - 5.0	04/08/06	595910E 6325873N	595960E 6325876N
SA92	**SS.SSa.IFiSa.IMoSa**	Well sorted clean sand with pronounced ripples.	Sparse (~1%) drift weed.	2.1 - 2.5	04/08/06	595738E 6325708N	595826E 6325699N
SA93	**SS.SSa.IFiSa.IMoSa**	Rippled clean sand with occasional pebbles. Very sparse (<<1%) shell debris.	Tufts of *Furcellaria*/*Polyides*. Ephemeral algae attached to pebbles <1%.	8.1 - 6.8	04/08/06	596455E 6326201N	596518E 6326182N

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	date	Start UTM	End UTM
SA94	**SS.SSa.IFiSa.IMoSa**	Rippled sand with shell debris & pebbles in troughs (~1%).	Algal cover sparse (<1%). Very sparse (<<1%) attached ephemerals. Also noted, *Carcinus*.	8.1 - 7.4	04/08/06	596762E 6326947N	596808E 6326932N
SA95	**IR.MIR.KR.LhypTX.Ft**	Mixed ground of boulders & cobbles on sand. Predominantly rocky.	*Laminaria hyperborea* forest. Stipes with heavy fouling of foliose reds, *Alcyonidium* & *Botryllus*. Rock with sparse foliose reds & coralline crusts.	3.1 - 5.0	04/08/06	596840E 6326743N	596889E 6326722N
SA96	**SS.SSa.IFiSa.IMoSa** **IR.HIR.KSed.ProtAhn** **IR.HIR.KSed.XKScrR**	Rock with patches of rippled sand.	Rock with kelps including *Saccorhiza* & *Desmarestia*. Sand with patches of *Furcellaria*/*Polyides* on pebbles.	8.5 - 9.7	04/08/06	596830E 6325982N	596867E 6325923N
SA97	**SS.SSa.IFiSa.IMoSa** **IR.MIR.KR.LhypT.Ft** **IR.HIR.KSed.ProtAhn** **IR.HIR.KSed.XKScrR** **SS.SMp.SSgr.Zmar**	Initially fine/medium clean rippled sand with occasional pebbles. Subsequently moving onto area of rock.	Sand with 1-5% algae including *Chorda* & ephemerals on pebbles. Sparse *Zostera* but dense patches locally. *Furcellaria*/*Polyides* on margin of rock area. Rock with *Laminaria hyperborea* forest. Stipes heavily fouled with foliose reds & *Alcyonidium*. Patches of mixed kelp including *Halidrys*, *Saccorhiza* & *Desmarestia*.	8.3 - 6.1	04/08/06	597129E 6325692N	597186E 6325723N

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	date	Start UTM	End UTM
SA98	**IR.MIR.KR.LhypT.Ft**	Predominantly rock but patches of coarse poorly sorted sand present.	Rock with *Laminaria hyperborea* forest. Stipes heavily fouled with foliose reds & Electra. Rock surfaces with ~50% foliose reds. Also noted, *Echinus*, *Laminaria saccharina* & *Saccorhiza*.	6.6 - 6.5	04/08/06	597090E 6326415N	597110E 6326428N
SA99	**SS.SSa.IFiSa.IMoSa**	Clean rippled sand with occasional pebbles.	Ephemeral algae on pebbles (~5%) including *Furcellaria*/*Polyides* & *Desmarestia*.	4.5 - 7.1	04/08/06	597444E 6326766N	597459E 6326765N
SA100	**IR.MIR.KR.LhypT.Ft**	Predominantly rock.	*Laminaria hyperborea* forest. Stipes fouled with foliose reds including *Delessaria*. *Obelia geniculata* on fronds. Rock surfaces with sparse foliose reds and extensive coralline crusts. Also noted, *Echinus*, *Actinothoe*, *Necora* & *Dictyota*.	6.2 - 7.3	04/08/06	597568E 6327213N	597563E 6327211N
SA101	**IR.HIR.KSed.ProtAhn SS.SMp.Mrl.Pcal IR.MIR.KR.LhypT.Ft**	Gravelly sand with numerous (~40%) pebbles. Rock at end of run.	Sand with 5-10% ephemeral algae including *Gracilaria*. Maerl sparse but locally ~10%. Rock with *Laminaria hyperborea* forest. Also noted, *Echinus*.	5.9 - 5.0	04/08/06	597887E 6327363N	597872E 6327374N

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	date	Start UTM	End UTM
SA102	**IR.MIR.KR.LhypT.Ft SS.SMp.Mrl.Pcal**	Rock with sand patches.	*Laminaria hyperborea* forest. Stipes fouled with foliose reds, Electra, *Alcyonidium* & *Halichondria*. *Membranipora* on fronds. Maerl sparse, locally ~10%. Also noted, *Laminaria saccharina, Desmarestia lingulata* & *Desmarestia aculeata*.	4.1 - 5.5	04/08/06	598115E 6326914N	598101E 6326932N
SA103	**IR.MIR.KR.LhypT.Ft**	Predominantly rock with patches of open sand with pebbles.	*Laminaria hyperborea* forest. Stipes fouled with foliose reds, *Electra, Alcyonidium* & *Halichondria*. *Membranipora* & *Obelia geniculata* on fronds. Rock surfaces with sparse foliose reds (inc *Cryptopleura*) and extensive coralline crusts. *Furcellaria*/*Polyides* at rock margins. Also noted, *Echinus, Actinothoe* & *Desmarestia aculeata*.	7.4 - 4.6	04/08/06	598343E 6326255N	598333E 6326279N
SA104	**IR.HIR.KSed.XKHal**	Clean sand with pebbles, cobbles & occasional boulders.	Overall algal cover ~50% dominated by *Halidrys*. Also present, *Laminaria hyperborea, Dictyota, Furcellaria*/Polyides, *Ulva, Desmarestia, Scinia turgida*. Also noted, *Carcinus*.	10.0 - 9.3	04/08/06	598113E 6325646N	598116E 6325687N

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	date	Start UTM	End UTM
SA105	**SS.SMp.SSgr.Zmar**	Fine hummocked sand. Sparse (~1%) shell fragments including dead Ensis.	Initially dense *Zostera* then open sand with microbial film and sparse (F) *Zostera*. Returning to dense *Zostera* at end of run.	4.9 - 4.9	06/08/06	599473E 6323407N	599512E 6323377N
SA106	**SS.SSa.IFiSa.NcirBat**	Clean well sorted rippled sand. Shell debris very sparse.	*Zostera* sparse (F) but widespread. Ephemeral algae very sparse (<<1%).	5.1 - 5.0	06/08/06	599437E 6324015N	599481E 6323968N
SA107	**SS.SSa.IFiSa.NcirBat**	Clean well sorted rippled sand.	No visible epibiota.	5.8 - 6.3	06/08/06	599510E 6324509N	599571E 6324469N
SA108	**SS.SCS.ICS.MoeVen**	Rippled sand.	Small tufts of ephemeral algae (<1%) including *Ulva*.	10.0 - 9.6	06/08/06	599233E 6325398N	599314E 6325369N
SA109	**IR.HIR.KSed.ProtAhn** **IR.HIR.KSed.XKScrR** **SS.SCS.ICS.MoeVen**	Clean rippled sand with scattered cobbles and pebbles. Some boulder patches.	Most of area with ephemerals attached to pebbles 20-30%. Patches of *Furcellaria*/*Polyides*. Boulder area with *Saccorhiza* and *Laminaria saccharina*.	9.6 - 10.5	06/08/06	598669E 6325545N	598789E 6325464N
SA110	**SS.SMp.Mrl.Pcal.R**	Coarse gravelly sand with megaripples.	Dense maerl, locally 50-60%. Some attached ephemeral algae including *Dictyota* & *Ulva*.	6.1 - 6.1	06/08/06	598842E 6326204N	no wptE no wptN
SA111	**SS.SSa.IMuSa.FfabMag**	Fine sand with poorly defined hummocks / ripples.	Ephemeral algae (1-5%).	11.6 - 12.4	06/08/06	600845E 6323140N	600908E 6323104N
SA112	**SS.SSa.IMuSa.FfabMag** **IR.HIR.KFaR.FoR**	Initially slightly silty hummocked fine sand. Moving onto rock before returning to fine sand at end of run.	Sand with *Chaetopterus*, *Liocarcinus depurator* and *Turritella*? Rock with dense foliose red algae, *Laminaria* sporelings (C) & *Macropodia*.	17.7 - 16.5	06/08/06	601349E 6323336N	601421E 6323300N

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	date	Start UTM	End UTM
SA113	**IR.MIR.KR.Lhyp.Ft** **SS.SSa.IMuSa.FfabMag**	Initially rock but soon moving onto slightly hummocked fine sand with shell debris (1-5%) including dead *Ensis*.	Rock with *Laminaria hyperborea* forest. Stipes relatively bare. Sand with 5-10% cover of drift algae. Also noted, *Pagurus bernhardus.*	13.7 - 15.3	06/08/06	601841E 6323598N	601900E 6323574N
SA114	**IR.HIR.KFaR.FoR** **SS.SSa.IMuSa.FfabMag**	Initially rock. Moving onto fine poorly sorted shelly sand with shell debris (1-5%).	Rock with foliose red algae & *Alcyonidium*. Sand with sparse (~1%) algal cover.	17.5 - 17.4	06/08/06	602430E 6323464N	602473E 6323425N
SA115	**SS.SMp.Mrl.Pcal** **IR.HIR.KFaR.FoR**	Initially coarse shell sand & gravel with megaripples & many shell fragments in troughs. Subsequently moving onto an area of bedrock.	Sand with sparse (~10%) live maerl in troughs. Also noted, *Desmarestia* & *Lanice*. Rock with dense red algal turf (including *Callophyllis* & *Plocamium*), *Alcyonidium* & *Flustra.*	19.4 - 19.0	06/08/06	601903E 6322921N	601978E 6322883N
SA116	**SS.SCS.CCS.MedLumVen** **IR.HIR.KFaR.FoR** **SS.SSa.IMuSa.FfabMag**	Initially coarse sandy gravel with shell fragments. Subsequently moving onto an area of bedrock. Then moving over an area of fine sand with hummocks before returning to a rocky substrate at the end of the run.	Rock with dense red algal turf, *Alcyonidium*, *Flustra*, *Nemertesia antennina*, *Laminaria* sporelings, *Halidrys* & *Necora*. Fine sand with *Cerianthus*.	20.0 - 18.4	06/08/06	602444E 6322551N	602501E 6322529N
SA117	**SS.SCS.CCS.MedLumVen** **IR.HIR.KFaR.FoR**	Initially rock with dusting of sand. Moving onto fine sand with many pebbles (20%) & shell debris (5-10%).	Rock with red algal turf, *Alcyonidium*, *Flustra*, *Nemertesia antennina*, *Nemertesia ramosa*.	22.7 - 22.4	06/08/06	602958E 6322772N	603064E 6322743N

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	date	Start UTM	End UTM
SA118	**SS.SMp.Mrl.Pcal IR.HIR.KFaR.FoR**	Initially coarse shell sand with megaripples. Subsequently moving onto an area of bedrock before returning to shell gravel at end of run.	Sand with ~10% live maerl. Rock with dense red algal turf, *Flustra* & erect bryozoans?	21.1 - 19.6	06/08/06	603395E 6322484N	603471E 6322467N
SA119	**SS.SCS.CCS.MedLumVen IR.HIR.KFaR.FoR SS.SSa.IMuSa.FfabMag**	Initially rock. Moving onto coarse sand and shell gravel. Returning to rock. Moving onto finer hummocked sand with surface shell gravel. Returning to rock at end of run.	Rock with dense red algal turf, *Flustra, Nemertesia antennina, Laminaria* sporelings. Also noted, *Liocarcinus depurator*.	17.9 - 18.2	06/08/06	601614E 6322505N	601674E 6322484N
SA120	**SS.SSa.IFiSa.IMoSa**	Clean well sorted sand with irregular ripples & hummocks.	no visible life	3.3 - 2.9	06/08/06	598877E 6324789N	598905E 6324767N
SA121	**SS.SCS.ICS.MoeVen**	Sand without pronounced rippling or hummocks. Shell debris ~5% including Ensis.	Drift *Zostera* & ephemeral algae ~10%. *Chorda* occasional.	5.2 - 4.9	07/08/06	596161E 6323370N	596176E 6323402N
SA122	**SS.SCS.ICS.MoeVen**	Rippled clean sand with sparse (1-5%) shell debris.	Very sparse (<<1%) drift algae.	1.5 - 1.5	07/08/06	596323E 6322746N	596314E 6322772N
SA123	**SS.SMp.Mrl.Pcal**	Initially rock but immediately moving onto megarippled maerl gravel.	High proportion of live maerl, no ephemeral algae.	26.7 - 26.5	10/08/06	600910E 6316085N	600902E 6315943N

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	date	Start UTM	End UTM
SA124	**CR.HCR.Xfa.FluCoAs SS.SCS.CCS.MedLumVen**	Initially rock. Moving onto coarse gravelly shell sand with megaripples.	Rock with bryozoan turf, *Galathea*, *Alcyonidium*, *Flustra*, Foliose reds very sparse or absent. Sand without obvious live maerl in significant quantities.	33.0 - 25.5	10/08/06	601222E 6316571N	601217E 6316409N
SA125	**IR.MIR.KR.LhypT.Ft**	Bedrock.	*Laminaria hyperborea* forest. Stipes lightly fouled with foliose reds & *Alcyonium*. Also noted, *Echinus*.	14.3 - 14.6	10/08/06	601769E 6317613N	601743E 6317504N
SA126	**SS.SMp.Mrl.Pcal**	Coarse megarippled maerl gravel.	Live maerl in troughs 10-20%. No ephemeral algae.	27.9 - 28.4	10/08/06	602299E 6318487N	602284E 6318379N
SA127	**SS.SMp.Mrl.Pcal**	Coarse megarippled maerl gravel.	Live maerl in troughs ~10%. No ephemeral algae.	27.8 - 30.3	10/08/06	602843E 6319575N	602848E 6319451N
SA128	**IR.HIR.KFaR.FoR**	Initially coarse megarippled maerl gravel but immediately moving onto rock.	Rock with red algal turf, initially ~10% but rising to 50-60%. Also, *Alcyonidium*, *Flustra*, *Nemertesia antennina*.	24.5 - 24.7	10/08/06	603498E 6320774N	603502E 6320651N
SA129	**IR.MIR.KR.Lhyp.Ft**	Rock.	*Laminaria hyperborea* forest. Stipes appear relatively free of fouling. Rock surfaces appear bare, *Alcyonidium* present. Also noted, *Echinus*.	14.6 - 19.4	10/08/06	603919E 6322380N	603915E 6322267N
SA130	**SS.SCS.CCS.MedLumVen**	Coarse gravel with shell fragments & poorly defined megaripples.	No significant amounts of live maerl seen.	24.2 - 23.2	10/08/06	604107E 6323001N	604107E 6322882N
SA131	**SS.SMp.Mrl.Pcal**	Coarse megarippled maerl gravel.	Live maerl 10-20% (locally 30-40%).	21.5 - 19.4	10/08/06	606217E 6327814N	606219E 6327758N

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	date	Start UTM	End UTM
SA132	**SS.SSa.IMuSa.FfabMag**	Fine sand with hummocks. Sparse (~1%) shell debris.	Sparse (~1%) algal cover of drift algae & ephemerals. Also noted, *Liocarcinus depurator* & *Turritella*.	22.3 - 20.4	10/08/06	605300E 6328080N	605328E 6328016N
SA133	**IR.MIR.KR.LhypT.Ft**	Mainly rock with some small sand patches.	*Laminaria hyperborea* forest. Stipes heavily fouled with foliose reds & *Alcyonium*. Also noted, *Echinus* & red algal understory.	12.0 - 10.5	12/08/06	603809E 6321951N	603820E 6321912N
SA134	**SS.SCS.CCS.MedLumVen CR.HCR.Xfa.FluCoAs**	Initially coarse gravel. Moving briefly onto rock. Returning to gravel at end of run. No pronounced megaripples.	No live maerl seen. Rock with *Flustra, Nemertesia antennina, Nemertesia ramosa*.	27.1 - 28.9	12/08/06	603605E 6321400N	603606E 6321303N
SA135	**SS.SMp.Mrl.Pcal**	Coarse megarippled maerl gravel.	Live maerl in troughs ~10%.	22.3 - 23.1	12/08/06	602847E 6320271N	602855E 6320197N
SA136	**IR.HIR.KFaR.FoR SS.SMp.Mrl.Pcal**	Initially rock but immediately moving onto megarippled maerl gravel.	Rock with sparse foliose reds, *Alcyonidium* & *Flustra*. Live maerl 5-10%. No significant algal cover. *Pomatoceros* on shell fragments.	20.1 - 23.6	12/08/06	602299E 6319029N	602281E 6318949N
SA137	**SS.SMp.Mrl.Pcal**	Coarse megarippled maerl gravel.	Live maerl 10% (locally 20%).	21.0 - 22.3	12/08/06	601911E 6318101N	601889E 6318015N

Table 7.1.3 Details of intertidal ground truth survey station

Shore code	Biotopes	Notes on substrate	Notes on biota	Date	UTM E	UTM N
IB1	**LS.LSa.St.Tal** **LR.FLR.Eph.Ent** **LS.LSa.MuSa.MacAre** **LR.LLR.F.Fves.X** **LR.LLR.F.Asc.X** **LR.LLR.F.Fserr.X** **IR.LIR.KVS.Cod** **SS.SMp.SSgr.Zmar**	Sandy upper shore with cobbles & boulders in lower parts. Below this is an extensive area of boulders with small patches of sand.	Shore overwhelmingly dominated by *Ascophyllum* on the extensive boulder area. Terrestrial vegetation and a *Talitrus* dominated strandline on the sandy supralittoral. Lower down on the sand is an area with *Enteromorpha* on cobbles. Sand near the boundary with the boulders is dominated by *Arenicola* with *F. vesiculosus* on the scattered rock. Beyond this is the extensive area of *Ascophyllum* with a band of *F. serratus* on the lower margin.	26/07/06	599135	6330153
IB2	**LS.LSa.St.Tal** **LS.LSa.MoSa** **LS.LSa.MuSa.MacAre** **LR.FLR.Eph.Ent** **LR.LLR.F.Pel** **LR.LLR.F.Fspi.FS** **LR.LLR.F.Asc.FS**	Sand beach with scattered pebbles on upper shore. Area of Machair is adjacent.	*Talitrus* on strandline, relatively steep dry sand on upper shore. Lower shore sand with many *Arenicola* casts.	26/07/06	598197	6330669
IB3	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.HLR.MusB.Cht.Cht** **LR.FLR.Rkp.G** **LR.FLR.Rkp.FK** **LR.HLR.FR.Coff** **IR.HIR.KFaR.Ala.Myt**	Sloping bedrock shore with rock terraces	Wide area of supralittoral lichens. Mid shore dominated by *Cthamalus* with patches of *Mytilus*. Lower shore with abundant *Corallina* and sublittoral fringe dominated by *Alaria*.	27/07/06	594107	6325771

Shore code	Biotopes	Notes on substrate	Notes on biota	Date	UTM E	UTM N
IB4	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.HLR.MusB.Cht.Lpyg** **LR.HLR.MusB.Cht.Cht** **IR.HIR.KFaR.Ala.Myt** **LR.HLR.FR.Coff**	Sloping bedrock shore	Wide area of supralittoral lichens. Mid shore dominated by barnacles with patches of *Mytilus*. Lower shore with abundant *Corallina* and sublittoral fringe dominated by *Alaria*.	27/07/06	593849	6324967
IB5	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.HLR.MusB.Cht** **LR.HLR.MusB.Sem.Sem** **IR.HIR.KFaR.Ala.Myt**	Steep (~45 deg) bedrock shore	Upper slope with supralittoral lichens. Mid shore dominated by barnacles with patches of *Mytilus*. Lower shore dominated by *Alaria*.	28/07/06	603290	6323634
IB6	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.HLR.MusB.Cht** **LR.HLR.MusB.Sem.FvesR** **IR.HIR.KFaR.Ala.Ldig**	Sloping bedrock shore	Wide area of supralittoral lichens. Mid shore dominated by barnacles with patches of *Mytilus*. Lower shore with mixed *Alaria* & *L. digitata*.	28/07/06	604134	6325085
IB7	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.LLR.F.Pel** **LR.LLR.F.Fspi.FS** **LR.LLR.F.Asc.FS** **LR.LLR.F.Fserr.FS** **IR.MIR.KR.Ldig**	Sloping bedrock shore	Supralittoral lichens on upper slope above bands of *Pelvetia* & *F. spiralis*. *Ascophyllum* dominating mid shore and *F. serratus* on lower shore.	29/07/06	598009	6319460
IB8	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.LLR.F.Pel** **LR.LLR.F.Fspi.FS** **LR.LLR.F.Asc.FS** **LR.LLR.F.Fserr.FS**	Gentle bedrock slope (~10-20 deg) with boulders in the lower shore.	Supralittoral lichens on upper slope above bands of *Pelvetia* & *F. spiralis*. *Ascophyllum* dominating mid shore and *F. serratus* on lower shore.	29/07/06	596064	6320001

Shore code	Biotopes	Notes on substrate	Notes on biota	Date	UTM E	UTM N
IB9	**LS.LSa.St.Tal** **LS.LSa.MoSa.Ol.FS** **LS.LSa.FiSa.Po.Ncir**	Extensive sandy beach backed by dunes. Relatively steep dry sand in upper shore. Most of shore a wide expanse of wet rippled sand.	*Talitrus* on strandline. No visible biota in upper shore. Lower shore sand with *Arenicola*.	31/07/06	595416	6323779
IB10	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.LLR.F.Pel** **LR.LLR.F.Fspi.FS** **LR.LLR.F.Fves.FS** **LR.LLR.F.Asc.FS** **LR.MLR.BF.FvesB** **LR.MLR.BF.Fser** **LS.LSa.St.Tal** **LS.LSa.FiSa.Po.Pful**	Extensive sandy beach with low bedrock reefs. Reefs with small (~2m X 2m) sand patches (<10% overall area of reef).	Upper shore rock with supralittoral lichens and bands of *Pelvetia* and *F. spiralis*. Rock outcrops lower on shore dominated by mixed fucoids. Sand with no visible biota.	31/07/06	595867	6322827
IB11	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.MLR.BF.PelB** **LR.HLR.MusB.Cht** **LR.FLR.Rkp.Cor** **LR.HLR.MusB.Sem.FvesR** **IR.HIR.KFaR.Ala**	Bedrock slope	Upper shore with supralittoral lichens and a *Pelvetia* band. Then a narrow *Cthamalus* zone above a mosaic of *Semibalanus*, *Mytilus* & *F. vesiculosus*. *Alaria* in sublittoral fringe.	01/08/06	604862	6328752

Shore code	Biotopes	Notes on substrate	Notes on biota	Date	UTM E	UTM N
IB12	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.LLR.F.Pel** **LR.LLR.F.Fspi.FS** **LR.LLR.F.Asc.FS** **LR.LLR.F.Fserr.FS** **LR.MLR.BF.FspiB** **LR.MLR.BF.Fser.R** **IR.MIR.KR.Ldig**	Sloping bedrock shore dropping to a narrow (~4m wide) channel that separates a rock knoll from the main shore.	Upper part of main shore with supralittoral lichens and bands of *Pelvetia* & *F. spiralis*. Lower parts of slope with *Ascophyllum* above a zone of *F. serratus* which also dominates the channel and lower parts of the rock knoll. The higher parts of the rock knoll are dominated by *F. spiralis*.	01/08/06	604931	6329286
IB13	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.LLR.F.Pel** **LR.LLR.F.Fspi.FS** **LR.MLR.BF.FvesB** **LR.MLR.BF.Fser.R**	Sloping bedrock	Upper part shore with supralittoral lichens and bands of *Pelvetia* & *F. spiralis*. Lower parts of slope with *F. vesiculosus* above a zone of *F. serratus*.	02/08/06	596468	6321755
IB14	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.MLR.BF.PelB** **LR.MLR.BF.FspiB** **LR.MLR.BF.Fser.R** **LR.LLR.F.Asc.FS**	Broken bedrock & boulders.	Upper part shore with supralittoral lichens and bands of *Pelvetia* & *F. spiralis*. Lower parts of shore with *F. serratus* mixed with *F. vesiculosus* and adjacent patches of dense *Ascophyllum*.	02/08/06	598117	6321255
IB15	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.LLR.F.Pel** **LR.LLR.F.Fspi.FS** **LR.LLR.F.Fves.FS** **LR.LLR.F.Fserr.FS** **LR.LLR.F.Asc.X** **LR.LLR.F.Asc.FS**	Irregular bedrock slope on rocky headland. Wide embayment to the east.	Upper part shore with supralittoral lichens and bands of *Pelvetia* & *F. spiralis*. Lower parts of shore with *F. vesiculosus* zone above an *F. serratus* zone. Embayment dominated by extensive areas of *Ascophyllum*.	03/08/06	598000	6317780

Shore code	Biotopes	Notes on substrate	Notes on biota	Date	UTM E	UTM N
IB16	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.HLR.MusB.Cht** **LR.MLR.BF.FvesB** **LR.HLR.MusB.Sem.FvesR** **LR.LLR.F.Asc.X**	Bedrock slope	Upper shore with supralittoral lichens. Narrow band of *Cthamalus* above a mosaic of *F. vesiculosus* and *Semibalanus*. *Ascophyllum* in neighbouring embayment.	05/08/06	598702	6317011
IB17	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.HLR.MusB.Cht** **LR.MLR.BF.FvesB** **LR.HLR.MusB.Sem.FvesR**	Bedrock slope	Supralittoral lichens above a barnacle / fucoid mosaic.	06/08/06	599555	6317694
IB18	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.LLR.F.Pel** **LR.LLR.F.Fves.FS** **LR.LLR.F.Asc.X** **LR.LLR.F.Asc.FS** **LR.LLR.F.Fserr.FS** **SS.SMp.SSgr.Zmar**	Wide undulating rocky shore of bedrock & boulders	Shore mainly dominated by *Ascophyllum*. Relatively narrow bands of other Fucoids & supralittoral lichens in upper shore. *F. serratus* band on lower shore.	07/08/06	599192	6327610
IB19	**LS.LSa.St.Tal** **LS.LSa.MoSa** **LS.LSa.FiSa.Po.Ncir**	Sandy beach with dunes above shore.	Patchy terrestrial vegetation at head of shore immediately above a strandline with *Talitrus*. Relatively steep upper shore sand with no obvious biota. Rippled sand with sparse *Arenicola* in lower shore.	07/08/06	597496	6324672
IB20	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.HLR.MusB.Cht** **LR.MLR.BF.FspiB** **LR.MLR.BF.FvesB** **IR.MIR.KR.Ldig**	Undulating bedrock slope	Upper shore with supralittoral lichens. Narrow band of *Cthamalus* above a mosaic of *F. vesiculosus* and *Semibalanus*.	08/08/06	600043	6319696

Shore code	Biotopes	Notes on substrate	Notes on biota	Date	UTM E	UTM N
IB21	**LS.LSa.St.Tal** **LS.LSa.MoSa** **LS.LSa.FiSa** **LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.LLR.F.Pel** **LR.LLR.F.Fspi.FS** **LR.MLR.BF.FvesB** **LR.LLR.F.Asc.FS** **LR.LLR.F.Fserr.FS** **LR.MLR.BF.Fser.R** **LR.HLR.MusB.Cht**	Sandy beach with low bedrock outcrops. Rocky shore on northern margin.	Beach with little obvious biota. Rock with variable cover of fucoids and fucoid barnacle mosaics depending on shore height and localised exposure levels.	09/08/06	602380	6328165
IB22	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.LLR.F.Pel** **LR.MLR.BF.FspiB** **LR.MLR.BF.FvesB** **LR.MLR.BF.Fser.R** **IR.MIR.KR.Ldig** **LS.LSa.FiSa.Po**	Upper shore is a bedrock slope and this meets a sand plain in the lower intertidal. Small rock reef outcrops from sand.	Supralittoral lichens and bands of *Pelvetia* & *F. spiralis* on upper parts of rock shore. Barnacle / fucoid mosaic on mid shore. Diverse *F. serratus* zone on lower rocks. *L. digitata* on nearby rock reef. Sand with no obvious biota in lower shore.	09/08/06	603530	6328826
IB23	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.LLR.F.Pel** **LR.MLR.BF.FspiB** **LR.MLR.BF.FvesB** **LR.LLR.F.Asc.FS** **LS.LSa.MuSa.CerPo**	Upper shore is a bedrock slope with a lower shore beach of fine rippled sand.	Supralittoral lichens and bands of *Pelvetia* & *F. spiralis* on upper parts of rock shore. Barnacle / fucoid mosaic on mid shore. *Ascophyllum* zone on lower rocks. Sand with sparse *Lanice* & *Cerastoderma.*	09/08/06	600936	6330096

Shore code	Biotopes	Notes on substrate	Notes on biota	Date	UTM E	UTM N
IB24	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.LLR.F.Pel** **LR.LLR.F.Fspi.FS** **LR.LLR.F.Asc.FS** **LR.LLR.F.Asc.X** **LS.LSa.MuSa.MacAre**	Sheltered shore of bedrock outcrops surrounded by hummocked fine sand.	Supralittoral lichens and bands of *Pelvetia* & *F. spiralis* on upper parts of rock shore. Most rock surfaces overwhelmingly dominated by *Ascophyllum*. Sediments with *Arenicola* & *Cerastoderma*.	09/08/06	601939	6330058
IA1	**LS.LSa.St.Tal** **LS.LSa.MoSa** **LR.FLR.Eph.EntPor** **LS.LSa.FiSa.Po**	Beach of clean fine sand. With rock outcrops & boulders in the mid & lower shore.	Strandline algae quite wide and scattered. No visible biota on sand. Mixed ephemeral green algae & fucoids on rocks in the mid & lower shore.	26/07/06	597417	6331525
IA2	**LR.MLR.BF.FvesB** **LR.MLR.BF.Fser.R** **LR.FLR.Rkp.Cor** **IR.MIR.KR.Ldig**	Bedrock/boulders	Barnacles / fucoid mosaic with *Laminaria digitata* in sublittoral fringe.	26/07/06	596816	6330705
IA3	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.FLR.Rkp.G** **LR.MLR.BF.FspiB** **LR.FLR.Rkp.Cor.Cor** **LR.HLR.MusB.MytB** **LR.HLR.FR.Coff** **IR.HIR.KFaR.Ala.Myt**	Moderately steep rocky shore (bedrock) with tidal gullies.	Shore dominated by barnacles with patches of mussels. Lower shore with turf of *Corallina* and *Alaria* in sublittoral fringe.	27/07/06	594419	6326088
IA4	**LS.LSa.St.Tal** **LS.LSa.MoSa.AmSco.Eur** **LS.LSa.FiSa.Po** **LR.LLR.F.Fserr.FS**	Sand dunes above sandy beach sloping down to pitted sand embankment with decaying algae enclosed on seaward side by rock outcrops.	Dry supralittoral sand above a strandline with *Talitrus*. Upper shore sand with Eurydice. Lower shore sand covered by mat of decaying algae. Lower shore rock outcrops with dense cover of *Fucus serratus* and scattered *Ascophyllum*.	27/07/06	594800	6325703

Shore code	Biotopes	Notes on substrate	Notes on biota	Date	UTM E	UTM N
IA5	**LR.FLR.Lic.YG LR.FLR.Lic.Ver.Ver LR.HLR.MusB.Sem.FvesR IR.HIR.KFaR.Ala.Ldig**	Steep bedrock shore sloping directly into deep (~4m @1440) water.	Shore dominated by barnacles with patches of mussels. *Alaria* in sublittoral fringe.	28/07/06	604349	6326588
IA6	**LR.FLR.Lic.YG LR.FLR.Lic.Ver.Ver LR.LLR.F.Pel LR.LLR.F.Fspi.FS LR.LLR.F.Fves.FS LR.LLR.F.Asc.FS LR.LLR.F.Fserr.FS**	Sloping bedrock in sheltered embayment. Mainly bedrock, some pebbles & sand in small horizontal gullies.	Fucoid dominated shore with extensive *Ascophyllum*.	28/07/06	603420	6325958
IA7	**LR.FLR.Lic.YG LR.FLR.Lic.Ver.Ver LR.LLR.F.Pel LR.LLR.F.Fspi.FS LR.LLR.F.Asc.FS LR.LLR.F.Fserr.FS IR.MIR.KR.Ldig**	Moderately sloping bedrock shore.	Fucoid dominated shore with extensive *Ascophyllum*.	29/07/06	598814	6319342
IA8	**LR.FLR.Lic.YG LR.FLR.Lic.Ver.Ver LR.LLR.F.Pel LR.LLR.F.Fspi.FS LR.LLR.F.Fves.FS LR.LLR.F.Asc.FS LR.LLR.F.Fserr.FS IR.MIR.KR.Ldig**	Steep bedrock shore, transverse gullies.	Fucoid dominated shore with extensive *Ascophyllum*.	29/07/06	597113	6319285

Shore code	Biotopes	Notes on substrate	Notes on biota	Date	UTM E	UTM N
IA9	**LS.LSa.St.Tal** **LS.LSa.MoSa.Ol.FS** **LR.FLR.Eph.Ent** **LS.LSa.MuSa.MacAre** **LR.FLR.Lic.Ver.Ver** **LR.LLR.F.Fves.FS** **LR.LLR.F.Asc.FS** **LS.LSa.FiSa.Po** **LR.MLR.BF.FspiB** **LR.MLR.BF.FvesB** **LR.MLR.BF.Fser.R**	Flat sandy beach. Rock outcrop on lower shore, scattered rock outcrops at top of beach.	*Talitrus* on strandline above slope of well drained sand with no visible biota. Upper shore rock with ephemeral algae. Lower shore of extensive areas of wet rippled sand with *Arenicola*, *Cerastoderma* and *Lanice*. Lower shore rock with dense fucoids on sheltered shoreward areas and barnacle / fucoid mosaic on more exposed seaward areas.	31/07/06	595488	6322300
IA10	**LS.LSa.St.Tal** **LS.LSa.MuSa.MacAre**	Sand dunes, low berm of shell fragments on sand, extensive flat sand.	Strandline with *Talitrus* on upper shore. Extensive areas of flat sand with *Arenicola* and *Cerastoderma*.	31/07/06	594326	6320699
IA11	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.MLR.BF.PelB** **LR.HLR.MusB.Cht** **LR.MLR.BF.FvesB** **LR.MLR.BF.Fser.R**	Steep uneven bedrock, wide lichen zone backed by heather & grass turf on steep slope	Shore dominated by barnacle / fucoid mosaic	01/08/06	605449	6329866
IA12	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.HLR.MusB.Cht** **LR.HLR.MusB.Sem.FvesR** **IR.HIR.KFaR.Ala**	Near vertical cliff, steep rock.	Barnacle dominated shore with scattered fucoids and *Alaria* in sublittoral fringe.	01/08/06	607132	6329423

Shore code	Biotopes	Notes on substrate	Notes on biota	Date	UTM E	UTM N
IA13	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.HLR.MusB.Cht** **LR.MLR.BF.FspiB** **LR.MLR.BF.FvesB** **LR.MLR.MusF.MytFves** **IR.HIR.KFaR.Ala**	Bedrock & boulders on a moderate slope.	Shore dominated by barnacle / fucoid mosaic with patches of mussels and *Alaria* in sublittoral fringe.	02/08/06	598746	6324333
IA14	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.MLR.BF.PelB** **LR.LLR.F.Fspi.FS** **LR.LLR.F.Fves.FS** **LR.LLR.F.Asc.FS** **LR.LLR.F.Fserr.FS**	Sloping bedrock ridge, lower boulder shore backed by cliff to west.	Fucoid dominated shore with mixed fucoids and small patches of barnacles.	02/08/06	597808	6323271
IA15	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.LLR.F.Pel** **LR.LLR.F.Fspi.FS** **LR.LLR.F.Fves.FS** **LR.LLR.F.Asc.FS** **LR.LLR.F.Fserr.FS**	Moderately sloping bedrock backed by steep cliff	Fucoid dominated shore with extensive *Ascophyllum*.	03/08/06	598537	6318500
IA16	**LS.LSa.St.Tal** **LS.LSa.MoSa.Ol.FS** **LS.LSa.FiSa.Po** **LR.FLR.Eph.Ent**	Low cliff line with saltmarsh vegetation below on clean medium sand. Sloping sand at top of beach onto flat rippled waterlogged sand.	Strandline with *Talitrus*. Upper shore sand with no visible biota. Lower shore with *Arenicola*.	05/08/06	594436	6324590

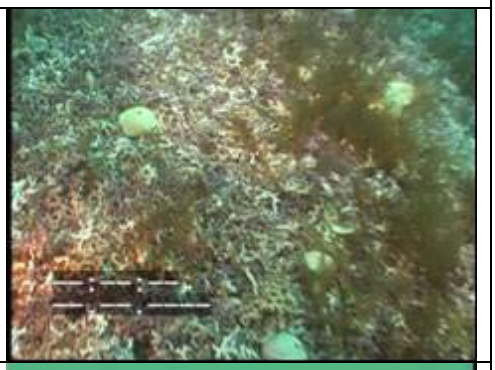
Shore code	Biotopes	Notes on substrate	Notes on biota	Date	UTM E	UTM N
IA17	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.LLR.F.Pel** **LR.LLR.F.Fves.FS** **LR.LLR.F.Asc.FS**	Bedrock & boulders.	Fucoid dominated shore with extensive *Ascophyllum*.	05/08/06	596116	6318827
IA18	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.HLR.MusB.Cht** **LR.HLR.MusB.Sem.FvesR** **LR.MLR.BF.Fser.R** **IR.MIR.KR.Ldig**	Creviced bedrock slope with occasional large boulders at the bottom.	Barnacle dominated shore with scattered fucoids and *Laminaria digitata* in sublittoral fringe.	07/08/06	598957	6327458
IA19	**LS.LSa.St.Tal** **LS.LSa.MoSa.BarSa**	Long, wide beach of fine sand. Marram grass at top of shore. Sand with berm (2 levels).	Relatively steep sand with no visible biota.	07/08/06	598105	6325180
IA20	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.LLR.F.Pel** **LR.LLR.F.Fspi.FS** **LR.LLR.F.Asc.FS** **LS.LSa.FiSa.Po.Aten** **LR.LLR.F.Fserr.FS**	Long flat sandy shore with upper part of angular fissured bedrock and boulders	Upper shore rocks are fucoid dominated. Extensive beach of waterlogged rippled sand with *Arenicola*, *Lanice* and *Angulus tenuis*.	09/08/06	603072	6330662
IA21	**LR.FLR.Lic.YG** **LR.FLR.Lic.Ver.Ver** **LR.HLR.MusB.Cht** **LR.HLR.MusB.Sem.FvesR** **IR.MIR.KR.Ldig**	Exposed bedrock shore. Smooth weathered undulating rock with fissures/crevices.	Barnacle dominated shore with scattered fucoids and *Laminaria digitata* in sublittoral fringe.	09/08/06	602482	6326268
IA22	**LS.LSa.St.Tal** **LS.LSa.MoSa.BarSa**	Exposed flat sandy shore backed by Marram dunes	Relatively steep sand with sparse *Eurydice*	09/08/06	602773	6326877

7.2 Appendix 2 – List of biotopes with images

Table 7.2.1 Subtidal sediment biotopes

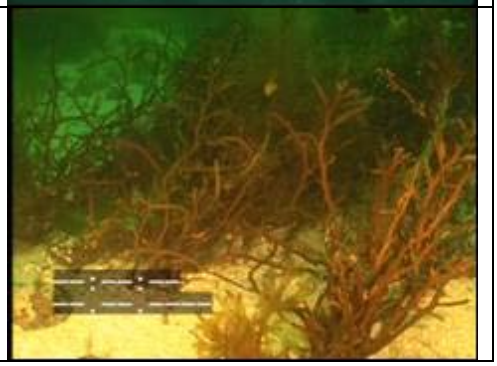
Biotope & feature	Stations	No. of stations	Image
SS.SCS.ICS.MoeVen Sandbank	SA71, SA72, SA75, SA76, SA77, SA78, SA79, SA80, SA84, SA85, SA86, SA108, SA109, SA121, SA122, **SB28**, SB37, SB38, SB56, SB63, SB65	21	
SS.SCS.ICS.HeloMsim Sandbank	SB66	1	No image available
SS.SCS.CCS.MedLumVen Sandbank	SA35, SA40, SA116, SA117, SA119, SA124, SA130, **SA134**, SB24	9	
SS.SSa.IFiSa Sandbank	**SA41**	1	
SS.SSa.IFiSa.IMoSa Sandbank	SA7, SA8, SA9, SA10, SA12, SA14, SA15, SA20, SA22, SA25, SA26, SA28, SA30, SA34, SA87, SA89, SA91, **SA92**, SA93, SA94, SA96, SA97, SA99, SA120, SB57, SB61	26	

Biotope & feature	Stations	No. of stations	Image
SS.SSa.IFiSa.NcirBat Sandbank	SA106, SA107, SB3, **SB6**, SB7, SB11, SB12, SB29, SB34, SB47, SB60	11	
SS.SSa.IFiSa.TbAmPo Sandbank	SA55, SB1, **SB18**	3	
SS.SSa.IMuSa.FfabMag Sandbank	SA64, SA65, SA66, SA67, SA68, **SA81**, SA82, SA83, SA111, SA112, SA113, SA114, SA116, SA119, SA132, SB16	16	
SS.SSa.CFiSa.EpusOborApri Sandbank	SA51, SA52, SA53, **SA54**	4	
SS.SMu.ISaMu.MelMagThy Sandbank	SA4, SA5, **SA57**, SA63	4	

Biotope & feature	Stations	No. of stations	Image
SS.SMu.IFiMu.Beg none	**SB21**	1	
SS.SMp.Mrl.Pcal Sandbank	SA36, SA37, SA39, **SA42**, SA43, SA45, SA46, SA47, SA48, SA49, SA50, SA73, SA74, SA101, SA102, SA115, SA118, SA123, SA126, SA127, SA131, SA135, SA136, SA137	24	
SS.SMp.Mrl.Pcal.R Sandbank	**SA110**	1	
SS.SMp.KSwSS Sandbank	**SB39**	1	

Biotope & feature	Stations	No. of stations	Image
SS.SMp.KSwSS.LsacGraFS Sandbank	SA1, SA2, SA3, SA56, SA58, SA59, SA60, SA61, SA62, **SB2**, SB32, SB33, SB42	13	
SS.SMp.SSgr.Zmar Sandbank	IB1, IB1, IB18, SA69, SA73, SA78, SA97, SA105, SB11, **SB30**, SB31, SB44, SB48, SB49, SB50, SB51, SB62	17	

Table 7.2.2 Subtidal rock biotopes

Biotopes	Stations	No. of stations	Image
IR.HIR.KFaR.Ala Reef	IA12, IA13, IB11, **SB9**	4	
IR.HIR.KFaR.Ala.Myt Reef	IA3, IB3, **IB4**, IB5	4	
IR.HIR.KFaR.Ala.Ldig Reef	IA5, IB6	2	No image available
IR.HIR.KSed.XKScrR Reef	SA13, SA15, SA23, SA31, SA34, SA70, SA90, SA96, SA97, SA109, **SB26**, SB45, SB49, SB53, SB54, SB59, SB61	17	
IR.HIR.KSed.XKHal Reef	**SA104**	1	

Biotopes	Stations	No. of stations	Image
IR.HIR.KSed.ProtAhn Reef	SA71, SA90, SA96, SA97, SA101, SA109, **SB7**, SB11, SB27, SB49, SB55, SB61, SB63	13	
IR.HIR.KFaR.FoR Reef	SA35, SA44, SA47, SA49, SA50, SA51, SA53, SA112, SA114, SA115, SA116, SA117, SA118, SA119, SA128, SA136, **SB25**, SB67	18	
IR.MIR.KR.Ldig Reef	IA2, IA7, IA8, IA18, IA21, IB7, IB12, IB20, IB22	9	No image available
IR.MIR.KR.LhypT.Ft Reef	SA6, SA11, SA13, SA15, SA16, SA21, SA26, SA27, SA28, SA29, SA32, SA33, SA70, SA80, SA88, SA97, SA98, SA100, SA101, SA102, SA103, SA125, SA133, **SB4**, SB5, SB7, SB8, SB9, SB10, SB13, SB14, SB15, SB17, SB20, SB23, SB27, SB35, SB36, SB40, SB43, SB45, SB46, SB52, SB53, SB54, SB55, SB58, SB59	48	 

Biotopes	Stations	No. of stations	Image
IR.MIR.KR.LhypTX.Ft Reef	SA24, SA31, SA34, **SA95**, SB64	5	
IR.MIR.KR.Lhyp.Ft Reef	SA17, SA38, SA39, SA40, SA43, SA58, SA61, SA113, SA129, SB16, SB22, **SB41**, SB42	13	
IR.MIR.KR.Lhyp.Pk Reef	**SA18**, SA19, SA44, SA53	4	
IR.MIR.KR.Lhyp.GzFt Reef	**SB19**	1	

Biotopes	Stations	No. of stations	Image
IR.LIR.K.LhypLsac Reef	**SA59**	1	
IR.LIR.KLhypCape Reef	**SB1**	1	
IR.LIR.KVS.Cod Reef	IB1	1	No image available
CR.HCR.Xfa.FluCoAs Reef	SA124, **SA134**	2	
CR.MCR.EcCr.FaAlCr.Car Reef	**SB26**	1	

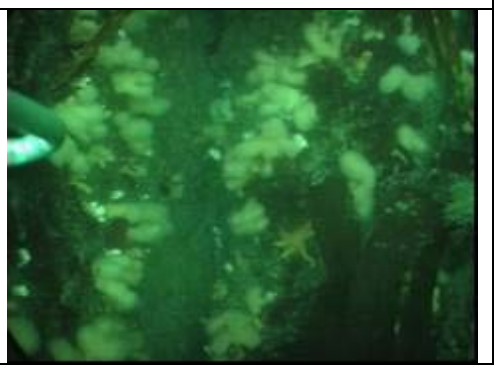
Biotopes	Stations	No. of stations	Image
CR.MCR.EcCr.AdigVt Reef	**SB17**	1	

Table 7.2.3 Intertidal sediment biotopes

Biotopes	Stations	No. of stations	Image
LS.LSa.St.Tal Sandflat / mudflat	IA1, IA4, IA9, IA10, IA16, IA19, IA22, IB1, IB2, IB9, IB10, IB19, **IB21**	13	
LS.LSa.MoSa Sandflat / mudflat	IA1, IB2, IB19, **IB21**	4	
LS.LSa.MoSa.BarSa Sandflat / mudflat	IA19, **IA22**	2	

Biotopes	Stations	No. of stations	Image
LS.LSa.MoSa.Ol.FS Sandflat / mudflat	IA9, IA16, **IB9**	3	
LS.LSa.MoSa.AmSco.Eur Sandflat / mudflat	IA4	1	No image available
LS.LSa.FiSa Sandflat / mudflat	**IB21**	1	
LS.LSa.FiSa.Po Sandflat / mudflat	IA1, IA4, **IA9**, IA16, IB22	5	
LS.LSa.FiSa.Po.Pful Sandflat / mudflat	**IB10**	1	

Biotopes	Stations	No. of stations	Image
LS.LSa.FiSa.Po.Aten Sandflat / mudflat	**IA20**	1	
LS.LSa.FiSa.Po.Ncir Sandflat / mudflat	**IB9,** IB19	2	
LS.LSa.MuSa.MacAre Sandflat / mudflat	**IA9**, IA10, IB1, IB2, IB24	5	
LS.LSa.MuSa.CerPo Sandflat / mudflat	**IB23**	1	

Table 7.2.4 Intertidal rock biotopes

Biotopes	Stations	No. of stations	Image
LR.HLR.MusB.MytB Reef	**IA3**	1	
LR.HLR.MusB.Cht Reef	IA11, IA12, IA13, IA18, IA21, **IB5**, IB6, IB11, IB16, IB17, IB20, IB21	12	
LR.HLR.MusB.Cht.Cht Reef	IB3, **IB4**	2	
LR.HLR.MusB.Cht.Lpyg Reef	**IB4**	1	

Biotopes	Stations	No. of stations	Image
LR.HLR.MusB.Sem.Sem Reef	**IB5**	1	
LR.HLR.MusB.Sem.FvesR Reef	IA5, IA12, IA18, **IA21**, IB6, IB11, IB16, IB17	8	
LR.HLR.FR.Coff Reef	IA3, **IB3**, IB4	3	
LR.MLR.MusF.MytFves Reef	**IA13**	1	

Biotopes	Stations	No. of stations	Image
LR.MLR.BF.PelB Reef	**IA11**, IA14, IB11, IB14	4	
LR.MLR.BF.FspiB Reef	IA3, IA9, IA13, IB12, **IB14**, IB20, IB22, IB23	8	
LR.MLR.BF.FvesB Reef	IA2, IA9, IA11, IA13, IB10, IB13, IB16, IB17, **IB20**, IB21, IB22, IB23	12	
LR.MLR.BF.Fser Reef	**IB10**	1	

Biotopes	Stations	No. of stations	Image
LR.MLR.BF.Fser.R Reef	IA2, IA9, IA11, IA18, **IB12**, IB13, IB14, IB21, IB22, IB23	10	
LR.LLR.F.Pel Reef	IA6, IA7, IA8, IA15, IA17, IA20, IB2, **IB7**, IB8, IB10, IB12, IB13, IB15, IB18, IB21, IB22, IB23, IB24	18	
LR.LLR.F.Fspi.FS Reef	**IA6**, IA7, IA8, IA14, IA15, IA20, IB2, IB7, IB8, IB10, IB12, IB13, IB15, IB21, IB24	15	

Biotopes	Stations	No. of stations	Image
LR.LLR.F.Fves.FS Reef	IA6, IA8, **IA9**, IA14, IA15, IA17, IB10, IB15, IB18	9	
LR.LLR.F.Fves.X Reef	**IB1**	1	
LR.LLR.F.Asc.FS Reef	IA6, IA7, IA8, IA9, IA14, IA15, IA17, IA20, IB2, **IB7**, IB8, IB10, IB12, IB14, IB15, IB18, IB21, IB23, IB24	19	
LR.LLR.F.Asc.X Reef	IB1, IB15, IB16, **IB18**, IB24	5	

Biotopes	Stations	No. of stations	Image
LR.LLR.F.Fserr.FS Reef	IA4, IA6, IA7, IA8, IA14, IA15, IA20, IB7, IB8, **IB12**, IB15, IB18, IB21	13	
LR.LLR.F.Fserr.X Reef	**IB1**	1	
LR.FLR.Lic.YG Reef	IA3, IA5, IA6, IA7, IA8, IA11, IA12, IA13, IA14, IA15, IA17, IA18, IA20, **IA21**, IB3, IB4, IB5, IB6, IB7, IB8, IB10, IB11, IB12, IB13, IB14, IB15, IB16, IB17, IB18, IB20, IB21, IB22, IB23, IB24	34	

Biotopes	Stations	No. of stations	Image
LR.FLR.Lic.Ver.Ver Reef	**IA3**, IA5, IA6, IA7, IA8, IA9, IA11, IA12, IA13, IA14, IA15, IA17, IA18, IA20, IA21, IB3, IB4, IB5, IB6, IB7, IB8, IB10, IB11, IB12, IB13, IB14, IB15, IB16, IB17, IB18, IB20, IB21, IB22, IB23, IB24	35	
LR.FLR.Rkp.G Reef	IA3, **IB3**	2	
LR.FLR.Rkp.Cor Reef	**IA2**, IB11	2	
LR.FLR.Rkp.Cor.Cor Reef	**IA3**	1	
LR.FLR.Rkp.FK Reef	IB3	1	No image available

Biotopes	Stations	No. of stations	Image
LR.FLR.Eph.Ent none	**IA9**, IA16, IB1, IB2	4	
LR.FLR.Eph.EntPor Reef	**IA1**	1	

7.3 Appendix 3 – Infaunal sample data

Table 7.3.1 Species abundance for subtidal infauna samples (collected by 5X 0.045m^2 mini Van Veen grab)

Part I: SB1 – SB16

Taxon	Authority	SB1	SB2	SB6	SB11	SB16
Edwardsia claparedii	(Panceri 1869)					1
PLATYHELMINTHES sp	-					
NEMERTEA spp	-	7			1	5
NEMATODA spp > 1cm	-	3				
Golfingia margaritacea	(M Sars 1851)	3				
Golfingia vulgaris	(de Blainville 1827)	1				
Pisione remota	(Southern 1914)					
Harmothoe extenuata	(Grube 1840)	2				
Harmothoe imbricata	(Linnaeus 1767)		5			
Pholoe inornata/synopthalmica	Johnston 1839	1				
Sigalion mathildae	Audouin & Milne-Edwards in Cuvier 1830					
Sthenelais limicola	(Ehlers 1864)					
Pseudomystides limbata	(Saint-Joseph 1888)	3				
Anaitides rosea	(McIntosh 1877)					
Eumida bahusiensis	Bergstrom 1914		1			
Eumida sanguinea	(Oersted 1843)	1				
Nereiphylla ?rubiginosa	(Saint-Joseph 1888)					1
Glycera alba	(Muller 1776)					
Glycera fallax	Quatrefages 1850					
Glycera lapidum	Quatrefages 1866	49				
Kefersteinia cirrata	(Keferstein 1862)	2				
Microphthalmus similis	Bobretzky 1870					
Typosyllis variegata	(Grube 1860)					
Typosyllis sp E		1				
Typosyllis sp G		1				
Odontosyllis ctenostoma	Claparede 1868	1				
Opisthodonta sp	-			1	1	
Pionosyllis serrata	Southern 1914					
Streptosyllis bidentata	Southern 1914			3		
Streptosyllis websteri	Southern 1914					
Exogone hebes	(Webster & Benedict 1884)			1		
Sphaerosyllis taylori	Perkins 1980	1				1
Autolytus spp	Grube 1850					
Platynereis dumerilii	(Audouin & Milne-Edwards 1833)	1	2			
Aglaophamus rubella	(Michaelsen 1897)					
Nephtys spp juv/indet	Cuvier 1817					
Nephtys cirrosa	Ehlers 1868		5	1	2	11
Nephtys hombergii	Savigny 1818					
Nephtys assimilis	Oersted 1843					
Aponuphis bilineata	(Baird 1870)					
Lumbrineris gracilis	(Ehlers 1868)					
Protodorvillea kefersteini	(McIntosh 1869)					
Scoloplos armiger	(O F Muller 1776)		2			
Aricidea minuta	Southward 1956					1
Paraonis fulgens	(Levinsen 1884)					
Aonides oxycephala	(M Sars 1862)	2				
Aonides paucibranchiata	Southern 1914	4				
Malacoceros vulgaris	(Johnston 1927)	2				
Prionospio banyulensis	Laubier 1966	2				

Taxon	Authority	SB1	SB2	SB6	SB11	SB16
Pseudopolydora pulchra	(Carazzi 1895)	6	3			
Pygospio elegans	Claparede 1863					
Scolelepis (S) bonnieri	(Mesnil 1896)					3
Spio decorata	Bobretzky 1870					1
Spio filicornis	(O F Muller 1766)	10				
Spiophanes bombyx	(Claparede 1870)					3
Magelona filiformis	Wilson 1959					1
Caulleriella alata	(Southern 1914)	1				
Chaetozone christiei	Chambers 2000		2			
Cirriformia tentaculata	(Montagu 1808)	2			2	1
Capitella capitata	(Fabricius 1780)			8	1	
Mediomastus fragilis	Rasmussen 1973	9				1
Notomastus latericeus	M Sars 1851	10				
Clymenura sp indet	Verrill 1900					
Clymenura johnstoni	(McIntosh 1915)	1				
Clymenura leiopygos	(Grube 1860)		1			
Praxillella affinis	(M Sars 1872)	4				
Travisia forbesii	Johnston 1840			22	1	
Polygordius lacteus	Schneider 1868	3				
Owenia fusiformis	Chiaje 1842					
Ampharete lindstroemi	(Malmgren 1867)					
Lanice conchilega	(Pallas 1776)		5			
Nicolea zostericola (juvs)	(Oersted 1844)					
Pista cristata	(O F Muller 1776)	13				
Polycirrus medusa	Grube 1850	12				
Polycirrus norvegicus	Wollebaek 1912					3
Chone duneri	Malmgren 1867	7				
Chone filicaudata	Southern 1914	15				
Hydroides norvegica	Gunnerus 1768					
Pomatoceros triqueter	(Linnaeus 1758)					
Tubificoides benedii	(Udekem 1855)					
Grania spp	Southern 1913	4				
OSTRACODA spp	-	2				
Nebalia herbstii	(Leach 1814)	2				3
Sarsinebalia typhlops	(G O Sars 1870)	3				
MYSIDACEA sp indet						
Paramysis arenosa	(G O Sars 1877)			2		
GAMMARIDEA spp juv/indet		3	1			
Monoculodes carinatus	(Bate 1856)					
Perioculodes longimanus	(Bate & Westwood 1868)					4
Pontocrates altamarinus	(Bate & Westwood 1862)			2		
Pontocrates arenarius	(Bate 1858)			2	1	
Synchelidium haplocheles	(Grube 1864)				1	
Synchelidium maculatum	Stebbing 1906					1
Leucothoe incisa	Robertson 1892	9				
Urothoe elegans	(Bate 1856)	1				
Urothoe marina	(Bate 1857)	139				
Harpinia pectinata	G O Sars 1891					
Metaphoxus fultoni	(Scott 1890)	7				
Acidostoma obesum	(Bate & Westwood 1861)					1
Hippomedon denticulatus	(Bate 1857)					4
Lysianassa ceratina	(A O Walker 1895)					
Orchomene nanus	(Kroyer 1846)					

Taxon	Authority	SB1	SB2	SB6	SB11	SB16
Tmetonyx similis	(G O Sars 1891)					5
Tryphosites longipes	(Bate & Westwood 1861)					1
Iphimedia minuta	G O Sars 1882					
Atylus falcatus	Metzger 1871					
Atylus guttatus	(Costa 1851)				2	
Atylus swammerdami	(H Milne-Edwards 1830)					
Atylus vedlomensis	(Bate & Westwood 1862)					
Dexamine spinosa	(Montagu 1813)		2			
Dexamine thea	Boeck 1861	1				
Guernea coalita	(Norman 1868)	2				
Ampelisca sp juv/indet						
Ampelisca brevicornis	(da Costa 1853)		6			37
Ampelisca tenuicornis	Lilljeborg 1855					
Ampelisca typica	(Bate 1856)	6				15
Bathyporeia guilliamsoniana	(Bate 1856)		1	81	6	22
Bathyporeia pelagica	(Bate 1856)					3
Megaluropus agilis	Hoek 1889			1		
Cheirocratus sundevalli	(Rathke 1843)	2				
Abludomelita obtusata	(Montague 1813)					
Ampithoe rubricata	(Montagu 1808)					
ISAEIDAE spp		1				
Gammaropsis cornutus	(Norman 1869)	5				
Microprotopus maculatus	Norman 1867					
Ericthonius punctatus	(Bate 1857)					
Ischyrocerus anguipes	Kroyer 1838					
Jassa falcata	(Montagu 1808)				4	
AORIDAE spp ♀	-					
Aora gracilis	(Bate 1857)					
Leptocheirus hirsutimanus	(Bate 1862)	30				
Leptocheirus pectinatus	(Norman 1869)	25				
Microdeutopus anomalus	(Rathke 1843) versiculatus??					
Microdeutopus versicularis	(Bate 1856)	24				
Corophium sp indet	Latreille 1806					
Corophium bonnellii	(H Milne-Edwards 1830)					
Corophium crassicorne	Bruzelius 1859	208		1		
Siphonoecetes kroyeranus	Bate 1856	6				1
Caprella acanthifera	(Leach 1814)					
Pariambus typicus	(Krøyer 1845)					
Phtisica marina	Slabber 1769	2	2			
Pseudoprotella phasma	(Montagu 1804)					
Euridice pulchra	Leach 1815	1				
Munna kroyeri	Goodsir 1842					
Idotea sp juv	Fabricius 1798					
Iphinoe trispinosa	(Goodsir 1843)					3
Diastylis rugosa	G O Sars 1865					1
Hippolyte varians	Leach 1814	1				
Liocarcinus marmoreus	(Leach 1814)					
Liocarcinus puber	(Linnaeus 1767)					
Lepidochitona cinerea	(Linnaeus 1767)	1				
Polinices pulchellus	Risso 1826	1				
OPISTHOBRANCHIA sp juv/indet	-					
NUDIBRANCHIA spp indet						
Lucinoma borealis	(Linnaeus 1767)					

Taxon	Authority	SB1	SB2	SB6	SB11	SB16
Thyasira flexuosa/gouldi	(Montagu 1803)					
Mysella bidentata	(Montagu 1803)					
Spisula elliptica	(Brown 1827)					
SOLENACEA sp indet	Schumacher 1817					1
Ensis arcuatus	(Jeffreys 1865)					8
Ensis ensis	(Linnaeus 1758)	1				
Phaxas pellucidus	(Pennant 1777)		1			
Angulus tenuis	(da Costa 1778)					
Fabulina fabula	(Gmelin 1791)		4			3
Moerella donacina	(Linnaeus 1758)					
Moerella pygmaea	(Loven 1846)	3		5	1	6
Gari fervensis	(Gmelin 1791)					
Gari tellinella	(Lamarck 1818)	2				
Abra alba	(W Wood 1802)					
Abra prismatica	(Montagu 1808)					
Gouldia minima	(Montagu 1803)					
Dosinia spp juv	Scopoli 1777					
Dosinia lupinus	(Linnaeus 1758)		1			7
Dosinia exoleta	(Linnaeus 1758)				2	
Tapes rhomboides	(Pennant 1777)					
Chamelea gallina	(Linnaeus 1758)		1			5
Timoclea ovata	(Pennant 1777)			1	6	3
Turtonia minuta	(Fabricius 1780)	1				
Thracia phaseolina	(Lamarck 1818)					7
Thracia villosiuscula	(Macgillivray 1827)				1	1
Cochlodesma praetenue	(Pulteney 1799)			1		30
Amphipholis squamata	(Chiaje 1829)	13				
Echinocyamus pusillus	(O F Muller 1776)	1				2
Leptosynapta bergensis	(Ostergren 1905)					
ENTEROPNEUSTA spp	-					
Hyperoplus lanceolatus	(Le Sauvage 1824)					

Table 7.3.1 contd. Part II: SB18 – SB34

Taxon	SB18	SB21	SB24	SB28	SB29	SB30	SB32	SB34
Edwardsia claparedii				1				
PLATYHELMINTHES sp								
NEMERTEA spp	1					5		
NEMATODA spp > 1cm	1					1		
Golfingia margaritacea								
Golfingia vulgaris								
Pisione remota			1					
Harmothoe extenuata								
Harmothoe imbricata						9		
Pholoe inornata/synopthalmica								
Sigalion mathildae							1	
Sthenelais limicola			1					
Pseudomystides limbata								
Anaitides rosea							1	
Eumida bahusiensis								
Eumida sanguinea								
Nereiphylla ?rubiginosa								
Glycera alba			1					
Glycera fallax			4					
Glycera lapidum	4							
Kefersteinia cirrata								
Microphthalmus similis								
Typosyllis variegata						1		
Typosyllis sp E								
Typosyllis sp G								
Odontosyllis ctenostoma								
Opisthodonta sp								
Pionosyllis serrata						1		
Streptosyllis bidentata	1							
Streptosyllis websteri								
Exogone hebes						1		
Sphaerosyllis taylori	1							
Autolytus spp						1		
Platynereis dumerilii						18		
Aglaophamus rubella								
Nephtys spp juv/indet			1				1	
Nephtys cirrosa	7			5	2			13
Nephtys hombergii		10			2	1	3	
Nephtys assimilis			1					
Aponuphis bilineata			1					
Lumbrineris gracilis				1	1		1	
Protodorvillea kefersteini	1		2					
Scoloplos armiger				1	5	1	3	
Aricidea minuta							1	
Paraonis fulgens							1	
Aonides oxycephala			1					
Aonides paucibranchiata	5							
Malacoceros vulgaris								
Prionospio banyulensis								
Pseudopolydora pulchra							1	2
Pygospio elegans							5	
Scolelepis (S) bonnieri								

Taxon	SB18	SB21	SB24	SB28	SB29	SB30	SB32	SB34
Spio decorata								
Spio filicornis	9		5		1	6	3	
Spiophanes bombyx					1			
Magelona filiformis							3	
Caulleriella alata	2		13				2	1
Chaetozone christiei	9				5	1	16	
Cirriformia tentaculata	2		6					
Capitella capitata	1							
Mediomastus fragilis	1		9					
Notomastus latericeus			1					
Clymenura sp indet					1			1
Clymenura johnstoni								
Clymenura leiopygos								
Praxillella affinis								
Travisia forbesii								
Polygordius lacteus								
Owenia fusiformis	1							
Ampharete lindstroemi			1					
Lanice conchilega								2
Nicolea zostericola (juvs)						38		
Pista cristata			5					
Polycirrus medusa	3							
Polycirrus norvegicus								
Chone duneri								
Chone filicaudata								
Hydroides norvegica						3		
Pomatoceros triqueter						1		
Tubificoides benedii			1					
Grania spp						1		
OSTRACODA spp	1							
Nebalia herbstii	4		1					
Sarsinebalia typhlops			1					
MYSIDACEA sp indet								
Paramysis arenosa								
GAMMARIDEA spp juv/indet			1					
Monoculodes carinatus	6		1					
Perioculodes longimanus	1		3			2	1	
Pontocrates altamarinus								
Pontocrates arenarius	5		2					
Synchelidium haplocheles	1		1					
Synchelidium maculatum								
Leucothoe incisa								
Urothoe elegans			1			1		
Urothoe marina	2							
Harpinia pectinata						3		
Metaphoxus fultoni								
Acidostoma obesum								
Hippomedon denticulatus	1			1				
Lysianassa ceratina								
Orchomene nanus						1		
Tmetonyx similis			8					
Tryphosites longipes								1
Iphimedia minuta						2		

Taxon	SB18	SB21	SB24	SB28	SB29	SB30	SB32	SB34
Atylus falcatus	6							
Atylus guttatus								
Atylus swammerdami								
Atylus vedlomensis			1					
Dexamine spinosa						15		
Dexamine thea						3		
Guernea coalita								
Ampelisca sp juv/indet	2							
Ampelisca brevicornis			1		25		15	
Ampelisca tenuicornis	1						2	1
Ampelisca typica			3	1	5	2	9	2
Bathyporeia guilliamsoniana	109			3	13		1	4
Bathyporeia pelagica					1			
Megaluropus agilis								
Cheirocratus sundevalli						2		
Abludomelita obtusata						27		
Ampithoe rubricata						37		
ISAEIDAE spp								
Gammaropsis cornutus								
Microprotopus maculatus						1		
Ericthonius punctatus						67		
Ischyrocerus anguipes						3		
Jassa falcata						2		
AORIDAE spp ♀			1			25		
Aora gracilis						5		
Leptocheirus hirsutimanus								
Leptocheirus pectinatus								
Microdeutopus anomalus						2		
Microdeutopus versicularis						49		
Corophium sp indet						1		
Corophium bonnellii						78		
Corophium crassicorne					2	34		1
Siphonoecetes kroyeranus				3	1			
Caprella acanthifera						4		
Pariambus typicus						2		
Phtisica marina	1				10	6		
Pseudoprotella phasma								
Euridice pulchra								
Munna kroyeri						1		
Idotea sp juv								
Iphinoe trispinosa	7		2	1	2			1
Diastylis rugosa							1	
Hippolyte varians						16		
Liocarcinus marmoreus								
Liocarcinus puber						1		
Lepidochitona cinerea								
Polinices pulchellus								
OPISTHOBRANCHIA sp juv/indet								
NUDIBRANCHIA spp indet								
Lucinoma borealis						1	1	
Thyasira flexuosa/gouldi						1	1	
Mysella bidentata							4	
Spisula elliptica								

Taxon	SB18	SB21	SB24	SB28	SB29	SB30	SB32	SB34
SOLENACEA sp indet								
Ensis arcuatus							2	3
Ensis ensis	1		1	1	1			
Phaxas pellucidus	1		3					
Angulus tenuis				2				1
Fabulina fabula					6		3	
Moerella donacina			1					
Moerella pygmaea	8		2	5				
Gari fervensis	2							
Gari tellinella								
Abra alba							1	
Abra prismatica								
Gouldia minima						1		
Dosinia spp juv								
Dosinia lupinus	4		2	2	1			5
Dosinia exoleta			1					
Tapes rhomboides						1		
Chamelea gallina			1	6	1		2	1
Timoclea ovata							1	
Turtonia minuta								
Thracia phaseolina	1							
Thracia villosiuscula			1			1		
Cochlodesma praetenue	7		2					2
Amphipholis squamata								
Echinocyamus pusillus	2					1		
Leptosynapta bergensis						1		
ENTEROPNEUSTA spp								
Hyperoplus lanceolatus								

Table 7.3.1 contd. Part III: SB37 – SB66

Taxon	SB37	SB38	SB47	SB56	SB57	SB60	SB61	SB66
Edwardsia claparedii								
PLATYHELMINTHES sp								11
NEMERTEA spp								
NEMATODA spp > 1cm								
Golfingia margaritacea								
Golfingia vulgaris								
Pisione remota								
Harmothoe extenuata								
Harmothoe imbricata								
Pholoe inornata/synopthalmica								
Sigalion mathildae								
Sthenelais limicola								
Pseudomystides limbata								
Anaitides rosea								
Eumida bahusiensis								
Eumida sanguinea								
Nereiphylla ?rubiginosa								
Glycera alba						1		
Glycera fallax								
Glycera lapidum								
Kefersteinia cirrata								
Microphthalmus similis								4
Typosyllis variegata								
Typosyllis sp E								
Typosyllis sp G								
Odontosyllis ctenostoma								
Opisthodonta sp								
Pionosyllis serrata								
Streptosyllis bidentata								
Streptosyllis websteri		1						
Exogone hebes	1							
Sphaerosyllis taylori								
Autolytus spp								
Platynereis dumerilii								
Aglaophamus rubella				1	1			
Nephtys spp juv/indet		1						
Nephtys cirrosa	1	6	3	6		5		4
Nephtys hombergii								
Nephtys assimilis								
Aponuphis bilineata								
Lumbrineris gracilis		1			1		3	
Protodorvillea kefersteini								
Scoloplos armiger								
Aricidea minuta								
Paraonis fulgens		1				1		
Aonides oxycephala								
Aonides paucibranchiata								
Malacoceros vulgaris								
Prionospio banyulensis								
Pseudopolydora pulchra								
Pygospio elegans								
Scolelepis (S) bonnieri			1					

Taxon	SB37	SB38	SB47	SB56	SB57	SB60	SB61	SB66
Spio decorata		1						
Spio filicornis	1							
Spiophanes bombyx								
Magelona filiformis								
Caulleriella alata								
Chaetozone christiei		6						
Cirriformia tentaculata								
Capitella capitata								
Mediomastus fragilis		3						
Notomastus latericeus						1		
Clymenura sp indet								
Clymenura johnstoni								
Clymenura leiopygos								
Praxillella affinis								
Travisia forbesii	2		1	2				1
Polygordius lacteus								
Owenia fusiformis								
Ampharete lindstroemi								
Lanice conchilega								
Nicolea zostericola (juvs)								
Pista cristata								
Polycirrus medusa								
Polycirrus norvegicus								
Chone duneri								
Chone filicaudata								
Hydroides norvegica								
Pomatoceros triqueter								
Tubificoides benedii								
Grania spp								
OSTRACODA spp								
Nebalia herbstii								
Sarsinebalia typhlops	1	2						
MYSIDACEA sp indet				1				
Paramysis arenosa								
GAMMARIDEA spp juv/indet								
Monoculodes carinatus								
Perioculodes longimanus	2	4		2	1			
Pontocrates altamarinus	1		3	2		3		
Pontocrates arenarius			6	2				3
Synchelidium haplocheles								
Synchelidium maculatum		1						
Leucothoe incisa								
Urothoe elegans								
Urothoe marina								
Harpinia pectinata								
Metaphoxus fultoni								
Acidostoma obesum								
Hippomedon denticulatus	1							
Lysianassa ceratina							1	
Orchomene nanus								
Tmetonyx similis								
Tryphosites longipes								
Iphimedia minuta								

Taxon	SB37	SB38	SB47	SB56	SB57	SB60	SB61	SB66
Atylus falcatus		1						
Atylus guttatus								
Atylus swammerdami		1						
Atylus vedlomensis								
Dexamine spinosa								
Dexamine thea								
Guernea coalita								
Ampelisca sp juv/indet								
Ampelisca brevicornis								
Ampelisca tenuicornis								
Ampelisca typica		1						
Bathyporeia guilliamsoniana	45	11	10			3		
Bathyporeia pelagica	2		14			14	3	2
Megaluropus agilis								
Cheirocratus sundevalli								
Abludomelita obtusata								
Ampithoe rubricata								
ISAEIDAE spp								
Gammaropsis cornutus								
Microprotopus maculatus								
Ericthonius punctatus		2						
Ischyrocerus anguipes								
Jassa falcata								
AORIDAE spp ♀		1						
Aora gracilis								
Leptocheirus hirsutimanus								
Leptocheirus pectinatus								
Microdeutopus anomalus								
Microdeutopus versicularis								
Corophium sp indet								
Corophium bonnellii								
Corophium crassicorne								
Siphonoecetes kroyeranus								
Caprella acanthifera								
Pariambus typicus								
Phtisica marina								
Pseudoprotella phasma		1						
Euridice pulchra								
Munna kroyeri								
Idotea sp juv				1				
Iphinoe trispinosa	1	3		1				
Diastylis rugosa								
Hippolyte varians								
Liocarcinus marmoreus			1					
Liocarcinus puber								
Lepidochitona cinerea								
Polinices pulchellus		1						
OPISTHOBRANCHIA sp juv/indet	1							
NUDIBRANCHIA spp indet		1						
Lucinoma borealis		3						
Thyasira flexuosa/gouldi								
Mysella bidentata								
Spisula elliptica		2						

Taxon	SB37	SB38	SB47	SB56	SB57	SB60	SB61	SB66
SOLENACEA sp indet		1						
Ensis arcuatus		5	1					
Ensis ensis								
Phaxas pellucidus								
Angulus tenuis								
Fabulina fabula								
Moerella donacina								
Moerella pygmaea	96	3	2	28				2
Gari fervensis								
Gari tellinella								
Abra alba								
Abra prismatica	1							
Gouldia minima								
Dosinia spp juv						1		
Dosinia lupinus	4	1			1			1
Dosinia exoleta								
Tapes rhomboides								
Chamelea gallina		3						
Timoclea ovata		1	1					
Turtonia minuta							1	
Thracia phaseolina								
Thracia villosiuscula								
Cochlodesma praetenue	1							
Amphipholis squamata								
Echinocyamus pusillus								
Leptosynapta bergensis								
ENTEROPNEUSTA spp					1			
Hyperoplus lanceolatus			1					

Table 7.3.2 Species abundance for subtidal infauna samples (collected by 0.1m^2 Van Veen grab)

Part I: SA1 – SA22

Taxon	Authority	SA1	SA5	SA10	SA22
Edwardsia claparedii	(Panceri 1869)	1	1		
NEMERTEA spp	-	1	1		
Tubulanus polymorphus	Reiner 1804				
Cerebratulus spp	Renier 1804	2	1		
NEMATODA spp > 1cm	-			1	
Phascolion strombus	(Montagu 1804)				
Pisione remota	(Southern 1914)			1	
Harmothoe spp juv/indet	Kinberg 1855				
Harmothoe imbricata	(Linnaeus 1767)	5	2		
Harmothoe ljungmani	(Malmgren 1867)				
Harmothoe andreapolis	(McIntosh 1874)				
Harmothoe glabra	(Malmgren 1865)				
Harmothoe lunulata/arenicolae	(Chiaje 1841)		1		
Pholoe baltica	Örsted 1843	1			
Sigalion mathildae	Audouin & Milne-Edwards in Cuvier 1830		2		
Sthenelais spp juv	Kinberg 1855				
Sthenelais limicola	(Ehlers 1864)				
PHYLLODOCIDAE sp indet					
Hypereteone foliosa	(Quatrefages 1866)				
Pseudomystides limbata	(Saint-Joseph 1888)				
Eumida sanguinea	(Oersted 1843)				
Lacydonia miranda	Marion & Bobretzky 1875				
Glycera fallax	Quatrefages 1850				1
Glycera lapidum	Quatrefages 1866			1	
Glycera tridactyla	Schmarda 1861				
Glycinde nordmanni	(Malmgren 1866)				
Goniadella gracilis	(Verrill 1873)				
Podarkeopsis capensis	(Day 1963)	1	2		
Gyptis rosea	(Malm 1874)				
Amphiduros fuscescens	(Marenzeller 1875)	1			
Hesiospina similis	(Hessle 1925)				
Kefersteinia cirrata	(Keferstein 1862)				
Trypanosyllis coeliaca	Claparede 1868				
Typosyllis variegata	(Grube 1860)		1		
Typosyllis cf *vittata*	(Grube 1840)				
Typosyllis sp E					
Typosyllis sp G					
Eusyllis blomstrandi	Malmgren 1867				
Odontosyllis gibba	Claparede 1863	2			
Opisthodonta sp	-				1
Sphaerosyllis bulbosa	Southern 1914				
Sphaerosyllis ?hystrix	Claparede 1863				
Platynereis dumerilii	(Audouin & Milne-Edwards 1833)	4	3		
Nephtys spp juv/indet	Cuvier 1817				
Nephtys cirrosa	Ehlers 1868			1	
Nephtys hombergii	Savigny 1818	4	2		
Nephtys kersivalensis	McIntosh 1908	2			
Aponuphis bilineata	(Baird 1870)				
Nothria britannica	(McIntosh 1903)				

Taxon	Authority	SA1	SA5	SA10	SA22
Lumbrineris gracilis	(Ehlers 1868)	12	13		
Protodorvillea kefersteini	(McIntosh 1869)				
Aricidea catherinae	Laubier 1967	4	3		
Poecilochaetus serpens	Allen 1904				
Aonides paucibranchiata	Southern 1914				
Laonice bahusiensis	Soderstrom 1920				
Malacoceros vulgaris	(Johnston 1927)				
Polydora flava	Claparede 1870	1			
Polydora quadrilobata	Jacobi 1883	4			
Prionospio fallax	Soderstrom 1920				
Prionospio banyulensis	Laubier 1966				
Pseudopolydora cf paucibranchiata	(Okuda 1937)	1			
Scolelepis (S) bonnieri	(Mesnil 1896)				
Spio decorata	Bobretzky 1870				
Spio filicornis	(O F Muller 1766)			1	
Spiophanes bombyx	(Claparede 1870)				
Spiophanes kroyeri	Grube 1860	1			
Magelona alleni	Wilson 1958		1		
Magelona filiformis	Wilson 1959		7		1
Magelona minuta	Eliason 1962				
Magelona johnstoni	Fiege, Licher & Mackie 2002				
Caulleriella alata	(Southern 1914)				
Chaetozone christiei	Chambers 2000				
Cirriformia tentaculata	(Montagu 1808)				
Tharyx killariensis	(Southern 1914)				
Diplocirrus glaucus	(Malmgren 1867)	2			
Mediomastus fragilis	Rasmussen 1973				
Notomastus latericeus	M Sars 1851	14	3		
Lumbriclymene sp	M Sars 1872				
Clymenura johnstoni	(McIntosh 1915)	1			
Clymenura leiopygos	(Grube 1860)		1		
Euclymene droebachiensis	(M Sars 1872)				
Euclymene lumbricoides	(Quatrefages 1865)				
Euclymene oerstedii	(Claparede 1863)	10	3		
Ophelia celtica	Amoureux & Dauvin 1981				
Travisia forbesii	Johnston 1840			2	
Polygordius lacteus	Schneider 1868				
Owenia fusiformis	Chiaje 1842	4			
Amphictene auricoma	(O F Muller 1776)				
Melinna palmata	Grube 1869	54			
Ampharete lindstroemi	(Malmgren 1867)		2		
Terebellides stroemi	M Sars 1835	10			
Lanice conchilega	(Pallas 1776)				
Eupolymnia nesidensis	(Chiaje 1828)	1			
Pista cristata	(O F Muller 1776)	2			
Polycirrus medusa	Grube 1850				
Polycirrus norvegicus	Wollebaek 1912		1		
Polycirrus plumosus	Wollebaek 1912				
Branchiomma bombyx	(Dalyell 1853)	1			
Chone duneri	Malmgren 1867				
Chone filicaudata	Southern 1914				
Euchone rubrocincta	(M Sars 1861)				
Jasmineira sp indet	Langerhans 1881	1			

Taxon	Authority	SA1	SA5	SA10	SA22
Laonome kroyeri	Malmgren 1866	1			
Pomatoceros lamarcki	(Quatrefages 1866)				
Pomatoceros triqueter	(Linnaeus 1758)				
Grania spp	Southern 1913				
Anoplodactylus petiolatus	(Kroyer 1844)				
COPEPODA spp	-				3
OSTRACODA spp	-				
Nebalia herbstii	(Leach 1814)				1
Sarsinebalia typhlops	(G O Sars 1870)				
GAMMARIDEA spp juv/indet					
Apherusa bispinosa	(Bate 1856)		1		
Perioculodes longimanus	(Bate & Westwood 1868)		2		
Pontocrates arenarius	(Bate 1858)				
Synchelidium maculatum	Stebbing 1906				
Leucothoe lilljeborgi	Boeck 1861				
Stenothoe marina	(Bate 1856)				
Urothoe elegans	(Bate 1856)				
Harpinia antennaria	Meinert 1890	3	1		
Harpinia crenulata	(Boeck 1871)	8			
Metaphoxus fultoni	(Scott 1890)				
Acidostoma obesum	(Bate & Westwood 1861)				
Hippomedon denticulatus	(Bate 1857)				
Lysianassa plumosa	Boeck 1871	1			
Orchomene nanus	(Kroyer 1846)				
Socarnes erythrophthalmus	Robertson 1892				
Tmetonyx cicada	(Fabricius 1780)				
Tmetonyx similis	(G O Sars 1891)				
Tryphosella sarsi	Bonnier 1893				
Tryphosites longipes	(Bate & Westwood 1861)				
Dexamine spinosa	(Montagu 1813)	2	2		
Dexamine thea	Boeck 1861				
Ampelisca brevicornis	(da Costa 1853)				
Ampelisca tenuicornis	Lilljeborg 1855	14			
Ampelisca typica	(Bate 1856)				
Bathyporeia spp juv/indet	Lindstom 1855			1	
Bathyporeia guilliamsoniana	(Bate 1856)				1
Bathyporeia pelagica	(Bate 1856)			1	
Gammarus ?salinus	Spooner 1947		15		
MELITIDAE sp indet	-				
Ceradocus semiserratus	(Bate 1862)				
Cheirocratus spp ♀	Norman 1867	1			
Cheirocratus sundevalli	(Rathke 1843)				
Maera othonis	(H Milne-Edwards 1830)				
Abludomelita obtusata	(Montague 1813)				
Ericthonius punctatus	(Bate 1857)	34			
AORIDAE spp ♀	-				
Leptocheirus pectinatus	(Norman 1869)	2			
Microdeutopus anomalus	(Rathke 1843) versiculatus??				
Microdeutopus versicularis	(Bate 1856)	8			
Corophium bonnellii	(H Milne-Edwards 1830)	21			
Corophium crassicorne	Bruzelius 1859		1		
Siphonoecetes kroyeranus	Bate 1856			1	
Caprella acanthifera	(Leach 1814)				

Taxon	Authority	SA1	SA5	SA10	SA22
Pariambus typicus	(Krøyer 1845)				
Phtisica marina	Slabber 1769	12			
Pseudoprotella phasma	(Montagu 1804)				
Gnathia sp. praniza	Leach 1814				
Gnathia oxyuraea	(Lilljeborg)				
Euridice pulchra	Leach 1815				
Eurydice spinigera	Hansen 1890			1	1
Janira maculosa	Leach 1813				
Idotea baltica	(Pallas 1772)		2		
Idotea emarginata	(Fabricius 1793)		3		
Idotea neglecta	G O Sars 1897		15		
Vaunthompsonia cristata	Bate 1858	1			
Bodotria scorpioides	(Montagu 1804)			1	
Eudorella truncatula	(Bate 1856)	2			
Diastylis laevis	Norman 1869				
Diastylis rugosa	G O Sars 1865		2		
Hippolyte varians	Leach 1814	1			
Thoralus cranchii	(Leach 1817)	1			
Anapagurus hyndmanni	(Bell 1845)				
Liocarcinus depurator	(Linnaeus 1758)				
Turitella communis	Risso 1826				
Polinices pulchellus	Risso 1826				
Cylichna cylindracea	(Pennant 1777)				
Retusa obtusa	(Montagu 1803)				
PELECYPODA spp indet	-				
Modiolus modiolus juv	(Linnaeus 1758)				
Glycymeris glycymeris	(Linnaeus 1758)				
Lucinoma borealis	(Linnaeus 1767)	4	4		
Thyasira flexuosa/gouldi	(Montagu 1803)	65	31		
Mysella bidentata	(Montagu 1803)	6	6		
Parvicardium scabrum	(Philippi 1844)				
Spisula elliptica	(Brown 1827)				
SOLENACEA sp indet	Schumacher 1817				
Ensis arcuatus	(Jeffreys 1865)				
Ensis ensis	(Linnaeus 1758)				
Phaxas pellucidus	(Pennant 1777)				
Angulus tenuis	(da Costa 1778)				
Arcopagia crassa	(Pennant 1777)				
Fabulina fabula	(Gmelin 1791)		8		
Moerella donacina	(Linnaeus 1758)	1			
Moerella pygmaea	(Loven 1846)			2	
Gari fervensis	(Gmelin 1791)				
Gari tellinella	(Lamarck 1818)				
Abra alba	(W Wood 1802)	6			
Abra nitida	(O F Muller 1776)	4			
Abra prismatica	(Montagu 1808)				
Gouldia minima	(Montagu 1803)				
Dosinia spp juv	Scopoli 1777				
Dosinia lupinus	(Linnaeus 1758)		1		
Dosinia exoleta	(Linnaeus 1758)				
Tapes rhomboides	(Pennant 1777)				
Chamelea gallina	(Linnaeus 1758)		2		
Timoclea ovata	(Pennant 1777)			1	

Taxon	Authority	SA1	SA5	SA10	SA22
Mysia undata	(Pennant 1777)	1			
Hiatella arctica	(Linnaeus 1767)				
Thracia phaseolina	(Lamarck 1818)		4	1	
Thracia villosiuscula	(Macgillivray 1827)				
Cochlodesma praetenue	(Pulteney 1799)				
Phoronis sp	Wright 1856				
Astropecten irregularis	(Pennant 1777)				
Amphiura brachiata	(Montagu 1804)				
Amphiura chiajei	Forbes 1843	3			
Amphiura filiformis	(O F Muller 1776)	1			
Amphipholis squamata	(Chiaje 1829)				
Echinocyamus pusillus	(O F Muller 1776)				
Echinocardium cordatum	(Pennant 1777)				
Leptopentacta elongata	(Duben & Koren 1845)		1		
Leptosynapta bergensis	(Ostergren 1905)		2		
Labidoplax media	(Ostergren 1905)	24			
ENTEROPNEUSTA spp	-				
COLLEMBOLA sp				1	

Table 7.3.2 contd. Part II: SA42 – SA75

Taxon	SA42	SA52	SA54	SA55	SA57	SA68	SA71	SA75
Edwardsia claparedii		2	8		3	1	1	
NEMERTEA spp						1	1	1
Tubulanus polymorphus						1		
Cerebratulus spp								
NEMATODA spp > 1cm	13	1						1
Phascolion strombus		1						
Pisione remota	4						4	
Harmothoe spp juv/indet				1	2			
Harmothoe imbricata				2				
Harmothoe ljungmani	1							
Harmothoe andreapolis				1				
Harmothoe glabra		1						
Harmothoe lunulata/arenicolae								
Pholoe baltica								
Sigalion mathildae				2				
Sthenelais spp juv			1					
Sthenelais limicola					2			
PHYLLODOCIDAE sp indet							1	
Hypereteone foliosa							1	
Pseudomystides limbata	1							
Eumida sanguinea	1							
Lacydonia miranda	1							
Glycera fallax								
Glycera lapidum	5						7	
Glycera tridactyla								
Glycinde nordmanni		1						
Goniadella gracilis	3						1	
Podarkeopsis capensis								
Gyptis rosea	2							
Amphiduros fuscescens								
Hesiospina similis	3							
Kefersteinia cirrata	3							
Trypanosyllis coeliaca	7							
Typosyllis variegata								
Typosyllis cf *vittata*	2							
Typosyllis sp E	6							
Typosyllis sp G							3	
Eusyllis blomstrandi		1						
Odontosyllis gibba	2							
Opisthodonta sp								
Sphaerosyllis bulbosa	3							
Sphaerosyllis ?hystrix	1							
Platynereis dumerilii				7				
Nephtys spp juv/indet						1		
Nephtys cirrosa		2	2			1	2	
Nephtys hombergii				1	4			
Nephtys kersivalensis								
Aponuphis bilineata		1						
Nothria britannica								
Lumbrineris gracilis		1			10			
Protodorvillea kefersteini							2	
Aricidea catherinae								

Taxon	SA42	SA52	SA54	SA55	SA57	SA68	SA71	SA75
Poecilochaetus serpens								
Aonides paucibranchiata	1						4	
Laonice bahusiensis	1							
Malacoceros vulgaris				1				
Polydora flava					2			
Polydora quadrilobata					1			
Prionospio fallax						2		
Prionospio banyulensis	1							
Pseudopolydora cf paucibranchiata								
Scolelepis (S) bonnieri			1					
Spio decorata				1				
Spio filicornis		1				1	1	
Spiophanes bombyx						1		
Spiophanes kroyeri						1		
Magelona alleni					1	2		
Magelona filiformis				1		6		
Magelona minuta					1	2		
Magelona johnstoni						3		
Caulleriella alata				1		1		
Chaetozone christiei						3		
Cirriformia tentaculata								6
Tharyx killariensis								
Diplocirrus glaucus					7			
Mediomastus fragilis								
Notomastus latericeus	1	2		3	4			
Lumbriclymene sp	1							
Clymenura johnstoni								
Clymenura leiopygos				2				
Euclymene droebachiensis								
Euclymene lumbricoides				2				
Euclymene oerstedii					1	2		
Ophelia celtica							5	
Travisia forbesii							1	
Polygordius lacteus	93						2	
Owenia fusiformis					2	2		
Amphictene auricoma		1						
Melinna palmata					32			
Ampharete lindstroemi					3			
Terebellides stroemi				1	2			
Lanice conchilega								
Eupolymnia nesidensis								
Pista cristata	1	2	3					
Polycirrus medusa							1	
Polycirrus norvegicus	1						1	
Polycirrus plumosus					1			
Branchiomma bombyx								
Chone duneri	1				2			
Chone filicaudata	5							
Euchone rubrocincta				1				
Jasmineira sp indet								
Laonome kroyeri								
Pomatoceros lamarcki								
Pomatoceros triqueter	1							

Taxon	SA42	SA52	SA54	SA55	SA57	SA68	SA71	SA75
Grania spp	3							
Anoplodactylus petiolatus						1		
COPEPODA spp	13							
OSTRACODA spp	1							
Nebalia herbstii				1				
Sarsinebalia typhlops			3					
GAMMARIDEA spp juv/indet	1							
Apherusa bispinosa								
Perioculodes longimanus			1		1			
Pontocrates arenarius							1	
Synchelidium maculatum								
Leucothoe lilljeborgi				1				
Stenothoe marina			1					
Urothoe elegans		1	1	6	1	1		
Harpinia antennaria				9	3			
Harpinia crenulata								
Metaphoxus fultoni	1							
Acidostoma obesum								
Hippomedon denticulatus			2					
Lysianassa plumosa	1							
Orchomene nanus								
Socarnes erythrophthalmus	14							
Tmetonyx cicada								
Tmetonyx similis			3					
Tryphosella sarsi	1				1			
Tryphosites longipes		1						
Dexamine spinosa				2				
Dexamine thea				1				
Ampelisca brevicornis		3	1		2	2		
Ampelisca tenuicornis					30			
Ampelisca typica		2	1	5		1		
Bathyporeia spp juv/indet								
Bathyporeia guilliamsoniana	1	2				7		4
Bathyporeia pelagica			11			9		
Gammarus ?salinus								
MELITIDAE sp indet					1			
Ceradocus semiserratus	4							
Cheirocratus spp ♀								
Cheirocratus sundevalli				1				
Maera othonis					4			
Abludomelita obtusata				1				
Ericthonius punctatus				3				
AORIDAE spp ♀		2		5				
Leptocheirus pectinatus								
Microdeutopus anomalus				4				
Microdeutopus versicularis				3				
Corophium bonnellii								
Corophium crassicorne				49			1	
Siphonoecetes kroyeranus								
Caprella acanthifera				2		1		
Pariambus typicus						1		
Phtisica marina				26		1		
Pseudoprotella phasma						3		

Taxon	SA42	SA52	SA54	SA55	SA57	SA68	SA71	SA75
Gnathia sp. praniza								
Gnathia oxyuraea								
Euridice pulchra	2							
Eurydice spinigera								
Janira maculosa	1							
Idotea baltica								
Idotea emarginata								
Idotea neglecta	1							
Vaunthompsonia cristata								
Bodotria scorpioides			2					
Eudorella truncatula					1			
Diastylis laevis					1			
Diastylis rugosa								
Hippolyte varians				3				
Thoralus cranchii				1				
Anapagurus hyndmanni	3							
Liocarcinus depurator			1					
Turitella communis		5	26			2		
Polinices pulchellus	1							1
Cylichna cylindracea								
Retusa obtusa				1				
PELECYPODA spp indet	1	1	1					
Modiolus modiolus juv	1							
Glycymeris glycymeris	5							
Lucinoma borealis		1			2			
Thyasira flexuosa/gouldi				5	88	2		
Mysella bidentata				18	14	4		
Parvicardium scabrum	1							
Spisula elliptica								
SOLENACEA sp indet						1		
Ensis arcuatus							1	
Ensis ensis								
Phaxas pellucidus		1	1	1				
Angulus tenuis								
Arcopagia crassa	1							
Fabulina fabula				5	2	6		
Moerella donacina								
Moerella pygmaea		5					2	56
Gari fervensis			2					
Gari tellinella	9							
Abra alba				3				
Abra nitida					8			
Abra prismatica		8	5	1	1			
Gouldia minima	2				1			
Dosinia spp juv								
Dosinia lupinus			1	1		3	2	1
Dosinia exoleta	7							3
Tapes rhomboides	2	1						
Chamelea gallina				1	1	1		1
Timoclea ovata	10	2	1					
Mysia undata					2			
Hiatella arctica		1						
Thracia phaseolina			4	3	3	5		

Taxon	SA42	SA52	SA54	SA55	SA57	SA68	SA71	SA75
Thracia villosiuscula	2	1					1	
Cochlodesma praetenue		1	2	1		19		
Phoronis sp						1		
Astropecten irregularis								
Amphiura brachiata								
Amphiura chiajei			1					
Amphiura filiformis			1		6			
Amphipholis squamata				2				
Echinocyamus pusillus	3	14	17	1		1		1
Echinocardium cordatum				1				
Leptopentacta elongata								
Leptosynapta bergensis				1	1		1	
Labidoplax media								
ENTEROPNEUSTA spp		1				2		1
COLLEMBOLA sp								

Table 7.3.2 contd. Part III: SA81 – SA132

Taxon	SA81	SA87	SA92	SA107	SA114	SA121	SA132
Edwardsia claparedii	1				2		9
NEMERTEA spp	2				1		1
Tubulanus polymorphus							1
Cerebratulus spp					1		
NEMATODA spp > 1cm							
Phascolion strombus							
Pisione remota							
Harmothoe spp juv/indet							
Harmothoe imbricata							
Harmothoe ljungmani							
Harmothoe andreapolis							
Harmothoe glabra					1		1
Harmothoe lunulata/arenicolae							
Pholoe baltica							1
Sigalion mathildae							1
Sthenelais spp juv							
Sthenelais limicola							
PHYLLODOCIDAE sp indet							
Hypereteone foliosa							
Pseudomystides limbata							
Eumida sanguinea							
Lacydonia miranda							
Glycera fallax					1		1
Glycera lapidum					1		
Glycera tridactyla	1						1
Glycinde nordmanni							
Goniadella gracilis							
Podarkeopsis capensis							
Gyptis rosea							
Amphiduros fuscescens							
Hesiospina similis					1		
Kefersteinia cirrata							
Trypanosyllis coeliaca							
Typosyllis variegata							
Typosyllis cf *vittata*							
Typosyllis sp E							
Typosyllis sp G							
Eusyllis blomstrandi							
Odontosyllis gibba							
Opisthodonta sp							
Sphaerosyllis bulbosa							
Sphaerosyllis ?hystrix							
Platynereis dumerilii							
Nephtys spp juv/indet							
Nephtys cirrosa				1	3	2	1
Nephtys hombergii							
Nephtys kersivalensis							
Aponuphis bilineata							
Nothria britannica							1
Lumbrineris gracilis				1		10	
Protodorvillea kefersteini							
Aricidea catherinae	3						

Taxon	SA81	SA87	SA92	SA107	SA114	SA121	SA132
Poecilochaetus serpens					1		
Aonides paucibranchiata							
Laonice bahusiensis							
Malacoceros vulgaris							
Polydora flava							
Polydora quadrilobata							
Prionospio fallax	5						
Prionospio banyulensis					1		
Pseudopolydora cf paucibranchiata							
Scolelepis (S) bonnieri							
Spio decorata					2		
Spio filicornis	3						
Spiophanes bombyx					1	1	
Spiophanes kroyeri							
Magelona alleni	8						23
Magelona filiformis	82				5		6
Magelona minuta	1						
Magelona johnstoni	7		1				3
Caulleriella alata					1		
Chaetozone christiei	3						5
Cirriformia tentaculata					1	4	
Tharyx killariensis	1						
Diplocirrus glaucus	1						1
Mediomastus fragilis					1		
Notomastus latericeus			2			8	
Lumbriclymene sp							
Clymenura johnstoni						1	
Clymenura leiopygos							
Euclymene droebachiensis	1						
Euclymene lumbricoides							
Euclymene oerstedii							
Ophelia celtica							
Travisia forbesii							
Polygordius lacteus							
Owenia fusiformis	7						1
Amphictene auricoma							
Melinna palmata							
Ampharete lindstroemi							1
Terebellides stroemi							
Lanice conchilega						1	
Eupolymnia nesidensis							
Pista cristata					2		2
Polycirrus medusa						1	
Polycirrus norvegicus							1
Polycirrus plumosus							
Branchiomma bombyx							
Chone duneri							
Chone filicaudata							
Euchone rubrocincta							
Jasmineira sp indet							
Laonome kroyeri							
Pomatoceros lamarcki	1				1	1	
Pomatoceros triqueter							

Taxon	SA81	SA87	SA92	SA107	SA114	SA121	SA132
Grania spp							
Anoplodactylus petiolatus							
COPEPODA spp					1		
OSTRACODA spp	1	1					2
Nebalia herbstii							
Sarsinebalia typhlops							
GAMMARIDEA spp juv/indet							
Apherusa bispinosa							
Perioculodes longimanus	1	2					
Pontocrates arenarius				1			
Synchelidium maculatum	1						1
Leucothoe lilljeborgi							
Stenothoe marina							
Urothoe elegans	1				1		11
Harpinia antennaria	5						3
Harpinia crenulata	1						
Metaphoxus fultoni							
Acidostoma obesum							1
Hippomedon denticulatus							1
Lysianassa plumosa							
Orchomene nanus	1						
Socarnes erythrophthalmus							
Tmetonyx cicada	1						
Tmetonyx similis					1		
Tryphosella sarsi							
Tryphosites longipes							
Dexamine spinosa							
Dexamine thea							
Ampelisca brevicornis	17				8		
Ampelisca tenuicornis	1						3
Ampelisca typica	3				4		1
Bathyporeia spp juv/indet			1				
Bathyporeia guilliamsoniana		3	1	12	14	10	
Bathyporeia pelagica	2		5	2	6		8
Gammarus ?salinus							
MELITIDAE sp indet							
Ceradocus semiserratus							
Cheirocratus spp ♀						1	
Cheirocratus sundevalli							
Maera othonis	1					21	
Abludomelita obtusata							
Ericthonius punctatus							
AORIDAE spp ♀							
Leptocheirus pectinatus							
Microdeutopus anomalus							
Microdeutopus versicularis							
Corophium bonnellii							
Corophium crassicorne						1	
Siphonoecetes kroyeranus							
Caprella acanthifera							
Pariambus typicus	1						
Phtisica marina							
Pseudoprotella phasma							

Taxon	SA81	SA87	SA92	SA107	SA114	SA121	SA132
Gnathia sp. praniza					1		
Gnathia oxyuraea					1		
Euridice pulchra							
Eurydice spinigera							
Janira maculosa							
Idotea baltica							
Idotea emarginata							
Idotea neglecta							
Vaunthompsonia cristata							
Bodotria scorpioides			1				1
Eudorella truncatula							
Diastylis laevis							
Diastylis rugosa							
Hippolyte varians							
Thoralus cranchii							
Anapagurus hyndmanni							
Liocarcinus depurator							
Turitella communis	10						43
Polinices pulchellus							
Cylichna cylindracea							1
Retusa obtusa							
PELECYPODA spp indet							
Modiolus modiolus juv							
Glycymeris glycymeris							
Lucinoma borealis							
Thyasira flexuosa/gouldi	2						
Mysella bidentata		1			1		2
Parvicardium scabrum							
Spisula elliptica						1	
SOLENACEA sp indet							
Ensis arcuatus							
Ensis ensis	1				2	2	
Phaxas pellucidus							3
Angulus tenuis		4		1			
Arcopagia crassa							
Fabulina fabula	5						2
Moerella donacina							
Moerella pygmaea		5		1	3	4	
Gari fervensis							
Gari tellinella							
Abra alba							
Abra nitida							
Abra prismatica							1
Gouldia minima							
Dosinia spp juv				1			
Dosinia lupinus	2					1	3
Dosinia exoleta						1	
Tapes rhomboides							
Chamelea gallina	2	2					3
Timoclea ovata							1
Mysia undata	2						1
Hiatella arctica							
Thracia phaseolina					2		2

Taxon	SA81	SA87	SA92	SA107	SA114	SA121	SA132
Thracia villosiuscula							
Cochlodesma praetenue	1				15		2
Phoronis sp							
Astropecten irregularis							1
Amphiura brachiata							1
Amphiura chiajei							
Amphiura filiformis							5
Amphipholis squamata							
Echinocyamus pusillus					1		
Echinocardium cordatum				1			
Leptopentacta elongata							
Leptosynapta bergensis							
Labidoplax media							
ENTEROPNEUSTA spp	3						1
COLLEMBOLA sp							

Table 7.3.3 Species abundance for intertidal infauna samples (collected by 8X 10cm diameter cores to a depth of ~15cm)

Part I: IB2 – IB9

Taxon	Authority	IB 2	IB 9(A)	IB 9(B)
Edwardsia claparedii	(Panceri 1869)			
NEMERTEA spp	-		1	
Cerebratulus spp	Renier 1804			
NEMATODA spp > 1cm	-			
Pseudomystides limbata	(Saint-Joseph 1888)	1		
Typosyllis sp E				
Typosyllis sp G				
Streptosyllis websteri	Southern 1914			
Exogone hebes	(Webster & Benedict 1884)			
Exogone verugera	(Claparede 1868)			
NEREIDIDAE spp juv	-			
Hediste diversicolor	(O F Muller 1776)			
Nephtys cirrosa	Ehlers 1868			1
Nephtys hombergii	Savigny 1818			
Scoloplos armiger	(O F Muller 1776)			1
Paraonis fulgens	(Levinsen 1884)			
Malacoceros fuliginosus	(Claparede 1868)			
Pseudopolydora pulchra	(Carazzi 1895)			
Pygospio elegans	Claparede 1863	2		
Scolelepis (S) bonnieri	(Mesnil 1896)			
Scolelepis (S) squamata	(Abildgaard 1806)			
Spio armata	Thulin 1957			
Spio martinensis	Mesnil 1896	11		
Capitella capitata	(Fabricius 1780)	146	1	
Notomastus latericeus	M Sars 1851			
Arenicola marina	(Linnaeus 1758)	1		
Clymenura leiopygos	(Grube 1860)			
Euclymene oerstedii	(Claparede 1863)			
Ophelia rathkei	McIntosh 1908		1	
Travisia forbesii	Johnston 1840			
Protodrilus sp	Hatschek 1882			
TUBIFICIDAE spp	-	1		
ENCHYTRAEIDAE spp	-		114	
Grania spp	Southern 1913			
COPEPODA spp	-			
GAMMARIDEA spp juv/indet				
Gammarellus angulosus	(Rathke 1843)			
Perioculodes longimanus	(Bate & Westwood 1868)			
Pontocrates arenarius	(Bate 1858)			
Talitrus saltator	(Montagu 1808)			
Urothoe marina	(Bate 1857)			
Bathyporeia spp juv/indet	Lindstom 1855			
Bathyporeia guilliamsoniana	(Bate 1856)		1	1
Bathyporeia pelagica	(Bate 1856)			5
GAMMARIDAE spp				
Leptocheirus hirsutimanus	(Bate 1862)			
Corophium crassicorne	Bruzelius 1859			
Euridice pulchra	Leach 1815		7	
Tanaissus lilljeborgi	Stebbing 1891			

Taxon	Authority	IB 2	IB 9(A)	IB 9(B)
Iphinoe trispinosa	(Goodsir 1843)			
Lamprops fasciata	G O Sars 1863			
Crangon crangon	(Linnaeus 1758)		2	1
Rissoa interrupta	(J Adams 1800)			
Retusa obtusa	(Montagu 1803)			
Mysella bidentata	(Montagu 1803)			1
Parvicardium scabrum	(Philippi 1844)			
Cerastoderma edule	(Linnaeus 1758)			
Angulus tenuis	(da Costa 1778)			
Moerella pygmaea	(Loven 1846)			
Dosinia spp juv	Scopoli 1777			
Dosinia lupinus	(Linnaeus 1758)			
Timoclea ovata	(Pennant 1777)			1
Ophiothrix fragilis	(Abildgaard 1789)			
Leptosynapta bergensis	(Ostergren 1905)			
COLLEMBOLA sp				

Table 7.3.3 contd. Part II: IB10 – IA4

Taxon	IB 10	IB 19	IB 21	IB 23	IA 1	IA 4
Edwardsia claparedii			5			
NEMERTEA spp	1		1			
Cerebratulus spp			1			
NEMATODA spp > 1cm						
Pseudomystides limbata						
Typosyllis sp E			4			
Typosyllis sp G			1			
Streptosyllis websteri			2			
Exogone hebes			8			
Exogone verugera			34			
NEREIDIDAE spp juv						
Hediste diversicolor						
Nephtys cirrosa		2	1	1		
Nephtys hombergii						
Scoloplos armiger	1		2	2		
Paraonis fulgens	27					
Malacoceros fuliginosus					78	
Pseudopolydora pulchra			7			
Pygospio elegans	2	5	5			
Scolelepis (S) bonnieri						
Scolelepis (S) squamata						
Spio armata	4			1		
Spio martinensis						
Capitella capitata	3			2	6	2
Notomastus latericeus				1		
Arenicola marina					1	
Clymenura leiopygos			8			
Euclymene oerstedii						
Ophelia rathkei						
Travisia forbesii		1	3			
Protodrilus sp						
TUBIFICIDAE spp						
ENCHYTRAEIDAE spp						6
Grania spp			1			
COPEPODA spp			9			
GAMMARIDEA spp juv/indet			10			
Gammarellus angulosus		1				
Perioculodes longimanus			1			
Pontocrates arenarius		1	11			
Talitrus saltator						3
Urothoe marina			18			
Bathyporeia spp juv/indet						
Bathyporeia guilliamsoniana			24			
Bathyporeia pelagica		7				
GAMMARIDAE spp						8
Leptocheirus hirsutimanus			3			
Corophium crassicorne			190			
Euridice pulchra		1				308
Tanaissus lilljeborgi			70			
Iphinoe trispinosa			1	1		
Lamprops fasciata			1			
Crangon crangon			6	1		

Taxon	IB 10	IB 19	IB 21	IB 23	IA 1	IA 4
Rissoa interrupta						
Retusa obtusa			1			
Mysella bidentata						
Parvicardium scabrum	1					
Cerastoderma edule						
Angulus tenuis		1				
Moerella pygmaea			1			
Dosinia spp juv			1			
Dosinia lupinus			1			
Timoclea ovata						
Ophiothrix fragilis					1	
Leptosynapta bergensis			1			
COLLEMBOLA sp	1					

Table 7.3.3 contd. Part III: IA9 – IA22

Taxon	IA 9(A)	IA 9(B)	IA 10	IA 16	IA 19	IA 20	IA 22
Edwardsia claparedii							
NEMERTEA spp		1					
Cerebratulus spp							
NEMATODA spp > 1cm	1						
Pseudomystides limbata							
Typosyllis sp E							
Typosyllis sp G							
Streptosyllis websteri							
Exogone hebes							
Exogone verugera							
NEREIDIDAE spp juv	12						
Hediste diversicolor	1			45			
Nephtys cirrosa							
Nephtys hombergii		1					
Scoloplos armiger		3				7	
Paraonis fulgens		3	1	1			
Malacoceros fuliginosus	1			112			
Pseudopolydora pulchra							
Pygospio elegans		1	4	17		11	
Scolelepis (S) bonnieri							1
Scolelepis (S) squamata	1						
Spio armata							
Spio martinensis							
Capitella capitata				28			
Notomastus latericeus						2	
Arenicola marina			1			1	
Clymenura leiopygos							
Euclymene oerstedii						8	
Ophelia rathkei	1						
Travisia forbesii						4	
Protodrilus sp	2						
TUBIFICIDAE spp							
ENCHYTRAEIDAE spp	72			2			1
Grania spp							
COPEPODA spp							
GAMMARIDEA spp juv/indet							
Gammarellus angulosus							
Perioculodes longimanus							
Pontocrates arenarius				1			1
Talitrus saltator	1						
Urothoe marina							
Bathyporeia spp juv/indet		1		1			
Bathyporeia guilliamsoniana							
Bathyporeia pelagica				1	48		
GAMMARIDAE spp	27						
Leptocheirus hirsutimanus							
Corophium crassicorne							
Euridice pulchra							4
Tanaissus lilljeborgi							
Iphinoe trispinosa							
Lamprops fasciata							
Crangon crangon		1					

Taxon	IA 9(A)	IA 9(B)	IA 10	IA 16	IA 19	IA 20	IA 22
Rissoa interrupta		1					
Retusa obtusa							
Mysella bidentata							
Parvicardium scabrum							
Cerastoderma edule	1	1	4				
Angulus tenuis						4	
Moerella pygmaea							
Dosinia spp juv							
Dosinia lupinus							
Timoclea ovata							
Ophiothrix fragilis							
Leptosynapta bergensis							
COLLEMBOLA sp							

7.4 Appendix 4 – Sound of Eriskay repeat survey data

Table 7.4.1 Details of Eriskay causeway 2001 repeat survey stations surveyed by diving or snorkelling

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	Date	UTM E	UTM N
DN20 (2001)	**IMS.Zmar**	Medium sand	100% cover *Zostera*, hydroids & didemnids on blades, margins of *Zostera* with more *Chorda* & high % cover of red filamentous algae	0.5	15/08/01	603064	6329599
DN20 (2006)	**SS.SMp.SSgr.Zmar**	Medium sand	Dense *Zostera*. Sward height ~1m. *Obelia geniculata* dense on fronds. Sediment with a dense mat of *Trailliella*. Other epibionts on *Zostera* include *Lacuna vincta* and *Diplosoma listerianum*.	0	11/08/06	603068	6329595
DN21 (2001)	**IMS.EcorEns**	Medium sand with dead *Ensis* shells	Sparse epibota including *Lanice* and *Arenicola*.	0.5 - 0.7	15/08/01	603941	6329262
DN21 (2006)	**SS.SCS.ICS.MoeVen**	Clean rippled sand (E-W alignment of ripples). Shell fragments <1%.	Sparse algae & epifauna. Evidence of burrowing bivalves (*Ensis*?). Occasional *Arenicola*.	0	11/08/06	603950	6329266
RN15 (2001)	**IMS.EcorEns** **IGS.Phy.R**	Coarse sand - also areas of finer better sorted sand with dead *Ensis* & ripples	Sparse maerl overall but some large areas where maerl is dense. Abundant foliose red algae.	8.0	15/08/01	602173	6329669
V2 (2001)	**IMS.EcorEns**	Medium - coarse poorly sorted sand with some shell gravel, flattish, some rippling	Filamentous algae. Sparse dead maerl.	8.0	12/08/01	602201	6329692

Station	Biotopes	Notes on substrate	Notes on biota	Depth (BCD)	Date	UTM E	UTM N
V2/RN15 (2006)	**SS.SMp.Mrl.Pcal.R**	Medium to coarse poorly sorted sand with dead maerl gravel. Drift algae (*L. saccharina*, *Chorda* & *Dictyota*) 1-5%. Shell fragments (inc *Ensis*) 5-10%.	Dense mat of filamentous algae (*Trailliella*) overlying sparse maerl.	8.3	11/08/06	602171	6329665
V32 (2001)	**IGS.Phy.R**	Maerl gravel	Maerl bed with binding turf filamentous algae (?*Trailliella*), *Ulva* sp., *Clavelina* ascidians, sparse *Zostera marina*, *Chorda filum* and *Dictoyota*	3.8	13/08/01	600715	6329500
V32 (2006)	**SS.SMp.Mrl.Pcal.R**	Fine sand with maerl. Drift algae (*L. saccharina*, *Saccorhiza* & *Zostera*) 5-10%.	Dense mat of filamentous algae (*Trailliella*) overlying patchy maerl.	4.1	11/08/06	600721	6329498

7.5 Appendix 5 – Sound of Eriskay repeat infaunal sample data

Table 7.5.1 Species abundance for subtidal infauna samples from the Sound of Eriskay

	N12 (2001)	**DN21 (2001)**	**N12 (2006)**	**DN21 (2006)**
NEMERTEA spp.	3	9	1	0
NEMATODA spp.	1	2	0	0
Harmothoe imbricata	2	0	0	0
Pholoe inornata	2	0	0	0
Eteone longa	2	0	0	0
Pseudomystides limbata	1	0	0	0
Anaitides mucosa	2	0	0	0
Kefersteinia cirrata	2	0	0	0
Syllidia armata	1	0	0	0
Streptosyllis websteri	22	3	0	0
Exogone hebes	3	36	0	0
Exogone naidina	3	0	0	0
Exogone verugera	0	0	1	0
Nephtys cirrosa	19	7	0	7
Nephtys hombergii	0	0	2	0
Ophryotrocha hartmanni	23	0	0	0
Scoloplos armiger	53	1	2	1
Aricidea minuta	87	18	2	0
Malacoceros spp. juv./indet.	2	0	0	0
Polydora quadrilobata	0	0	2	0
Prionospio fallax	0	0	3	0
Prionospio banyulensis	3	1	0	0
Spio decorata	1	1	0	0
Spio filicornis	1	0	0	0
Spiophanes bombyx	0	0	0	1
Magelona filiformis	2	0	2	0
Magelona minuta	0	0	1	0
CIRRATULIDAE spp. indet.	3	0	0	0
Chaetozone setosa	11	0	0	0
Chaetozone christiei	0	0	5	0
Capitella capitata	35	0	3	0
Mediomastus fragilis	2	0	0	0
Arenicola marina juv.	10	0	1	0
Clymenura leiopygos	0	0	1	0
Travisia forbesii	0	0	0	10
Ophelina modesta	1	0	0	0
Amphictene auricoma	1	0	0	0
AMPHARETIDAE spp. juv.	1	0	0	0
Terebellides stroemi	0	0	1	0
Lanice conchilega	0	1	0	0
Chone filicaudata	2	0	0	0
TUBIFICIDAE type A	3	0	0	0
Grania spp.	0	10	0	1
OSTRACOD sp. f	3	0	0	0
Perioculodes longimanus	96	41	1	13
Pontocrates arenarius	4	22	0	0
Synchelidium haplocheles	0	2	0	0

	N12 (2001)	DN21 (2001)	N12 (2006)	DN21 (2006)
Leucothoe lilljeborgi	2	0	0	0
Hippomedon denticulatus	0	1	0	3
Atylus falcatus	0	1	0	0
Ampelisca tenuicornis	0	0	26	0
Ampelisca typica	12	0	16	0
Bathyporeia	0	2	0	0
Bathyporeia guilliamsoniana	4	0	1	8
Megaluropus agilis	0	21	0	0
Cheirocratus intermedius	0	0	1	0
Microprotopus maculatus	63	1	0	0
ISCHYROCERIDAE	1	0	0	0
AORIDAE spp ♀	0	0	1	0
Aora gracilis	1	0	0	0
Leptocheirus pectinatus	0	1	0	0
Microdeutopus anomalus	0	1	0	0
Corophium bonnellii	2	0	0	0
Corophium crassicorne	12	0	6	0
Siphonoecetes kroyeranus	0	12	0	3
Pariambus typicus	14	0	0	0
Phtisica marina	21	0	0	2
ISOPODA	0	1	0	0
Iphinoe trispinosa	45	11	1	10
Pseudocuma longicornis	27	16	0	0
Liocarcinus depurator	0	0	1	0
GASTROPODA spp. indet.	2	0	0	0
Cylichna cylindracea	0	0	1	0
Retusa obtusa	14	0	0	0
PELECYPODA sp. juv.	1	0	0	0
PELECYPODA spp. indet.	5	0	0	0
Crenella decussata	0	3	0	0
Lucinoma borealis	1	0	5	0
Thyasira flexuosa/gouldi	0	0	8	0
Mysella bidentata	5	0	6	0
Spisula elliptica	1	0	0	0
Angulus tenuis	0	2	0	0
Fabulina fabula	2	0	5	1
Moerella pygmaea	1	12	0	11
Abra spp. indet.	3	0	0	0
Abra alba	11	0	2	0
Dosinia spp. juv.	0	0	0	1
Dosinia exoleta	0	3	0	0
Dosinia lupinus	0	0	2	1
Chamelea gallina	1	0	0	4
Clausinella fasciata	0	10	0	0
Mya truncata juv.	2	0	1	0
Thracia spp. juv.	0	1	0	0
Thracia phaseolina	1	0	0	0
Cochlodesma praetenue	0	2	0	0
Leptosynapta inhaerens	1	1	0	0

Table 7.5.2 Granulometric parameters and diversity indices associated with subtidal infauna samples from the Sound of Eriskay

Sample	***Median grain size (mm)***	***% silt/clay***	***% gravel***	***Shannon's Index (log_e)***	***Number of Species***	***Abundance***
N12 (2001)	298.50	2.6	0.1	3.13	61	662
DN21 (2001)	434.70	0.6	0.9	2.84	33	256
N12 (2006)	217.64	3.9	0.0	2.84	31	111
DN21 (2006)	307.79	1.2	0.2	2.40	16	77

7.6 Appendix 6 – Sound of Eriskay *Zostera* change assessment

Table 7.6.1 Zostera drift transects (11/08/06)

Transect	**Boundary between dense *Zostera* and sand areas**	**UTM E**	**UTM N**
Transect A	North - Open sand. South - Dense *Zostera*	603049.9	6329629
Transect A	North - Dense *Zostera.* South - Open sand	603069.1	6329506
Transect A	North - Open sand. South - Dense *Zostera*	603106.6	6329462
Transect A	North - Dense *Zostera.* South - Open sand	603111.8	6329457
Transect A	North - Open sand. South - Dense *Zostera*	603125.1	6329451
Transect A	North - Dense *Zostera.* South - Open sand	603130.2	6329450
Transect B	North - Open sand. South - Dense *Zostera*	603282.8	6329687
Transect B	North - Dense *Zostera.* South - Open sand	603285.2	6329672
Transect B	North - Open sand. South - Dense *Zostera*	603287.5	6329663
Transect B	North - Dense *Zostera.* South - Open sand	603287.6	6329660
Transect B	North - Open sand. South - Dense *Zostera*	603294.6	6329621
Transect B	North - Dense *Zostera.* South - Open sand	603295.1	6329602
Transect B	North - Open sand. South - Dense *Zostera*	603295.1	6329598
Transect B	North - Dense *Zostera.* South - Open sand	603296.2	6329595
Transect B	North - Open sand. South - Dense *Zostera*	603297.5	6329586
Transect B	North - Dense *Zostera.* South - Open sand	603308.4	6329552
Transect B	North - Open sand. South - Dense *Zostera*	603323.9	6329501
Transect B	North - Dense *Zostera.* South - Open sand	603324.9	6329499
Transect C	North - Open sand. South - Dense *Zostera*	603404.4	6329672
Transect C	North - Dense *Zostera.* South - Open sand	603404.6	6329664
Transect C	North - Open sand. South - Dense *Zostera*	603403.9	6329651
Transect C	North - Dense *Zostera.* South - Open sand	603404.6	6329623
Transect C	North - Open sand. South - Dense *Zostera*	603404.7	6329620
Transect C	North - Dense *Zostera.* South - Open sand	603405.5	6329588
Transect C	North - Open sand. South - Dense *Zostera*	603401.7	6329538
Transect C	North - Dense *Zostera.* South - Open sand	603401.8	6329534

Table 7.6.2 Zostera point stations east of causeway surveyed by diver (10/08/06)

Station	Notes on substrate	Notes on *Zostera* distribution	Depth (BCD)	UTM E	UTM N
East 1	Sand	Amongst patchy *Zostera*. Dense *Zostera* (S) (sward height 0.5-0.75m) to areas west of shot. *Zostera* band extends ~3m due west then open area with very sparse *Zostera*. Dense *Zostera* extends >5m to southwest of shot. East of shot is open sand for ~2m then a elongate patch (~7m X ~3m) of *Zostera* orientated north-northwest to south-southeast.	0.9	603783	6329646
East 2	Medium rippled sand	Shot on open sand. Sand continues for beyond 5m due west & due south. Boundaries with dense *Zostera* ~5m north and at ~6m east.	0.1	603667	6329587
East 3	Sand	Shot on open sand. Boundaries with dense *Zostera* at ~6m west, ~3m north, ~5m east, ~7-8m south.	0.7	603773	6329609

Table 7.6.3 Zostera point stations west of causeway (11/08/06)

Station	**Prediction**	**Notes on substrate**	**Notes on *Zostera* distribution**	**UTM E**	**UTM N**	**Method**
ZG1	*Zostera* gain	Sand	Dense *Zostera* (S) (over 70-80% of area). With sand patches (~2X3m size, covering 20-30% of area).	601559.9	6328516	Snorkel survey
ZG2	*Zostera* gain	Sand	Dense *Zostera* (S) (over ~50% of area). With sand patches (~3X4m size).	601278.7	6328570	Snorkel survey
ZG3	*Zostera* gain	Sand	Dense *Zostera* (S) (over 70-80% of area). With sand patches (~2X3m size, covering 20-30% of area).	601521.8	6328625	Snorkel survey
ZG4	*Zostera* gain	Sand	Dense *Zostera* (S). Sward height ~1m.	601518	6328493	Snorkel survey
ZG5	*Zostera* gain	Sand	Dense *Zostera* (S) (over ~50-60% of area). With sand patches (~3X4m size).	601586.2	6328968	Snorkel survey
ZL1	*Zostera* loss	Rippled clean sand	Shot on open sand. Sand continues for over 5m in all directions apart from a small *Zostera* patch ~3m SE.	601026.6	6328340	Snorkel survey
ZL2	*Zostera* loss	Rippled clean sand	Open sand, no *Zostera* seen.	601630.4	6328032	Snorkel survey
ZL3	*Zostera* loss	Medium sand	Open sand, very sparse small *Zostera* (O). Drift *Zostera* 1-5%. Patch (~6m X 3m) of drift kelp & *Zostera* within ~5m of shot. *Zostera* boundary within 10m of shot.	601122.3	6328934	Diver survey

Station	**Prediction**	**Notes on substrate**	**Notes on *Zostera* distribution**	**UTM E**	**UTM N**	**Method**
ZL4	*Zostera* loss	Rippled medium sand	Open sand, *Zostera* absent, drift *Zostera* ~1%	601611.4	6329382	Diver survey
ZL5	*Zostera* loss	Rippled medium sand	Open sand, drift *Zostera* 1-5%, shell fragments ~1%.	601371.7	6329350	Diver survey
ZN1	*Zostera* presence unchanged	Boulders	*L. hyperborea* (A) forest. Boundary with dense *Zostera* ~5m NE.	600797.4	6329119	Diver survey
ZN2	*Zostera* presence unchanged	Bedrock. Above water at time of survey.	*L. digitata* (A), *Himanthalia* (C)	601062.2	6328662	Snorkel survey
ZN3	*Zostera* presence unchanged	Sand	Dense *Zostera* (S). Sward height ~1m.	601580.9	6328442	Snorkel survey
ZN4	*Zostera* presence unchanged	Bedrock.	*L. hyperborea* (A) forest.	601196.1	6328021	Snorkel survey
ZN5	*Zostera* presence unchanged	Bedrock.	Dense *L. digitata* (A)	601863.7	6327666	Snorkel survey

7.7 Appendix 7 – Note on biotope codes

A full explanation of the biotope coding system and descriptions of biotopes are given in Connor *et al.* 2004 which is available online via the JNCC website.

Biotope codes are hierarchical. The initial part of the code denotes the broad habitat type, the second part denotes the habitat complex and the third part denotes the biotope complex. Subsequent parts of the code denote biotope and sub-biotope respectively.

Biotope codes. Interpretation of broad habitat types, habitat complexes and biotope complexes recorded on this survey.

Broad habitat type & habitat complex	Biotope complex
SS.SCS Sublittoral sediment. Sublittoral coarse sand.	**ICS** – Infralittoral coarse sediment. **CCS** – Circalittoral coarse sediment.
SS.SSa Sublittoral sediment. Sublittoral sand.	**IFiSa** - Infralittoral fine sand. **IMuSa** - Infralittoral muddy sand. **CFiSa** – Circalittoral fine sand.
SS.SMu Sublittoral sediment. Sublittoral mud.	**ISaMu** – Infralittoral sandy mud. **IFiMu** – Infralittoral fine mud.
SS.SMp Sublittoral sediment. Sublittoral macrophyte-dominated sediment.	**Mrl** – Maerl beds. **KSwSS** – Kelp and seaweed communities on sublittoral sediment. **SSgr** – Sublittoral seagrass beds.
IR.HIR Infralittoral rock. High energy infralittoral rock.	**KFaR** – Kelp with cushion fauna and/or foliose red seaweed. **KSed** – Sediment affected or disturbed kelp and seaweed communities.
IR.MIR Infralittoral rock. Moderate energy infralittoral rock.	**KR** – Kelp and red seaweeds.
IR.LIR Infralittoral rock. Low energy infralittoral rock.	**K** – Kelp in silted conditions. **KVS** – Kelp in variable or reduced salinity.
CR.HCR Circalittoral rock. High energy circalittoral rock.	**Xfa** – Mixed faunal turf communities.
CR.MCR Circalittoral rock. Moderate energy circalittoral rock.	**EcCr** – Echinoderms and crustose communities.
LS.LSa Littoral sediment. Littoral sand.	**St** – Strandline. **MoSa** – Barren or amphipod dominated mobile sand shores. **FiSa** – Polychaete / amphipod dominated fine sand shores. **MuSa** - Polychaete / bivalve dominated muddy sand shores.
LR.HLR Littoral rock. High energy littoral rock.	**MusB** – Mussel and/or barnacle communities. **FR** – Robust fucoid and/or red seaweed communities.
LR.MLR Littoral rock. Moderate energy littoral rock.	**MusF** – Mussels and fucoids on moderately exposed shores. **BF** - Barnacles and fucoids on moderately exposed shores.
LR.LLR Littoral rock. Low energy littoral rock.	**F** – Fucoids on sheltered marine shores.
LR.FLR Littoral rock. Features of littoral rock.	**Lic** – Lichens or small green algal communities. **Rkp** – Rockpools. **Eph** – Ephemeral green or red seaweed communities.

7.8 Appendix 8 - Sound velocity profiles for GeoSwath acoustic survey

Sound velocity profiles for GeoSwath acoustic survey: 19th July to 22nd July 2006.

Figure A8.1. CTD Cast 1: 19th July 2006 1057h BST; 57°01.103'N 07°17.779W

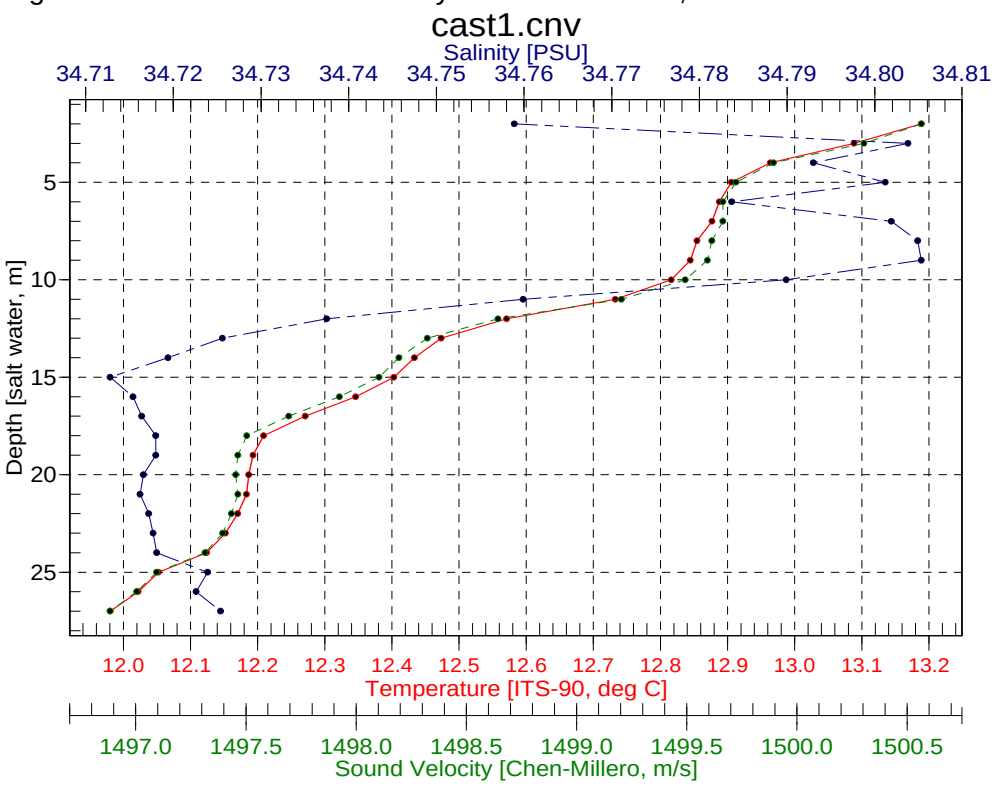


Figure A8.2. CTD Cast 2: 20th July 2006 0650h BST; 57°01.754'N 07°17.59W

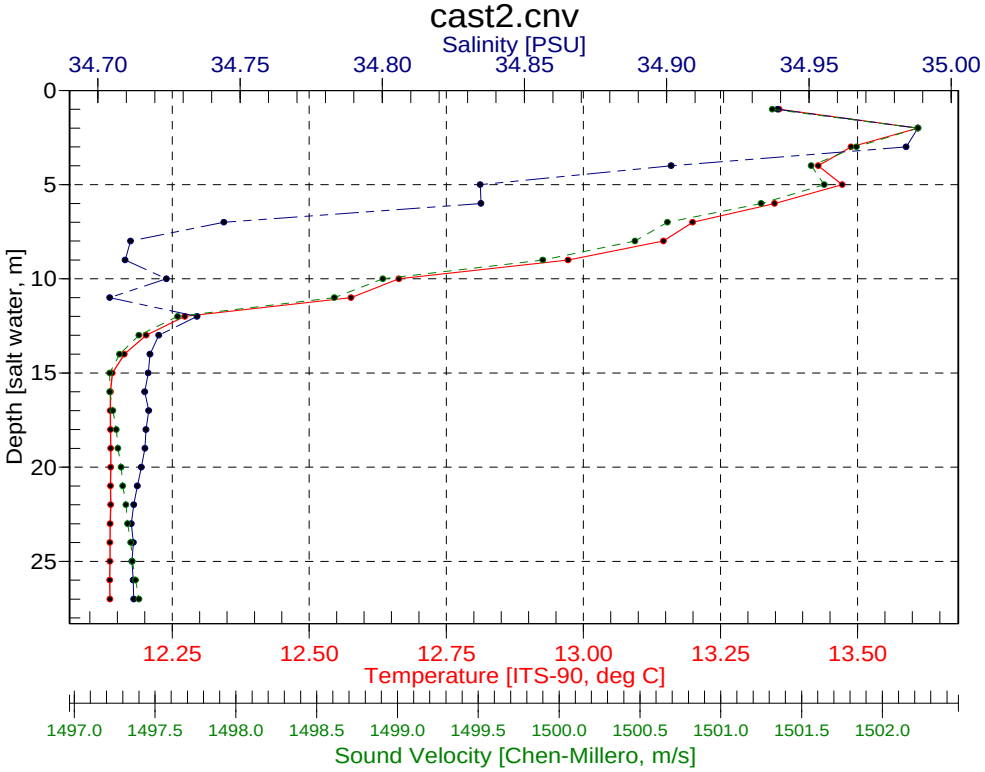


Figure A8.3. CTD Cast 3: 20th July 2006 1824h BST; 57°01.631'N 07°17.397W

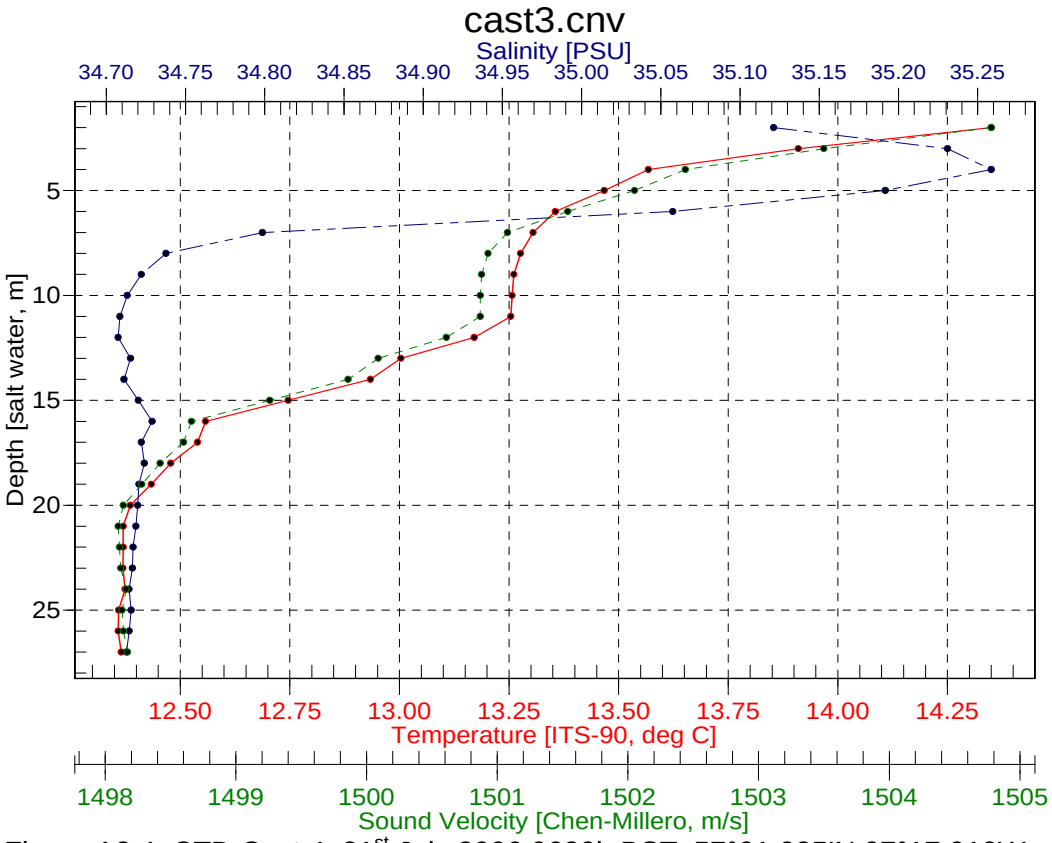


Figure A8.4. CTD Cast 4: 21st July 2006 0620h BST; 57°01.035'N 07°17.919W

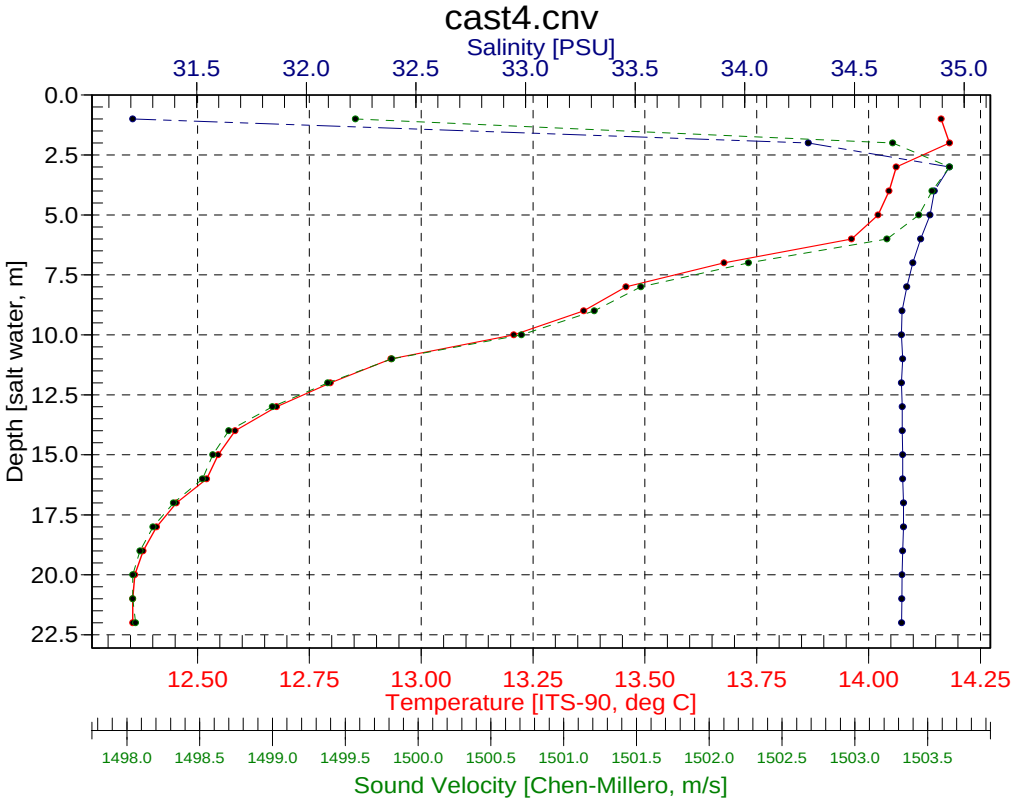


Figure A8.5. CTD Cast 5: 21st July 1356h BST; 57°01.468'N 07°18.651W

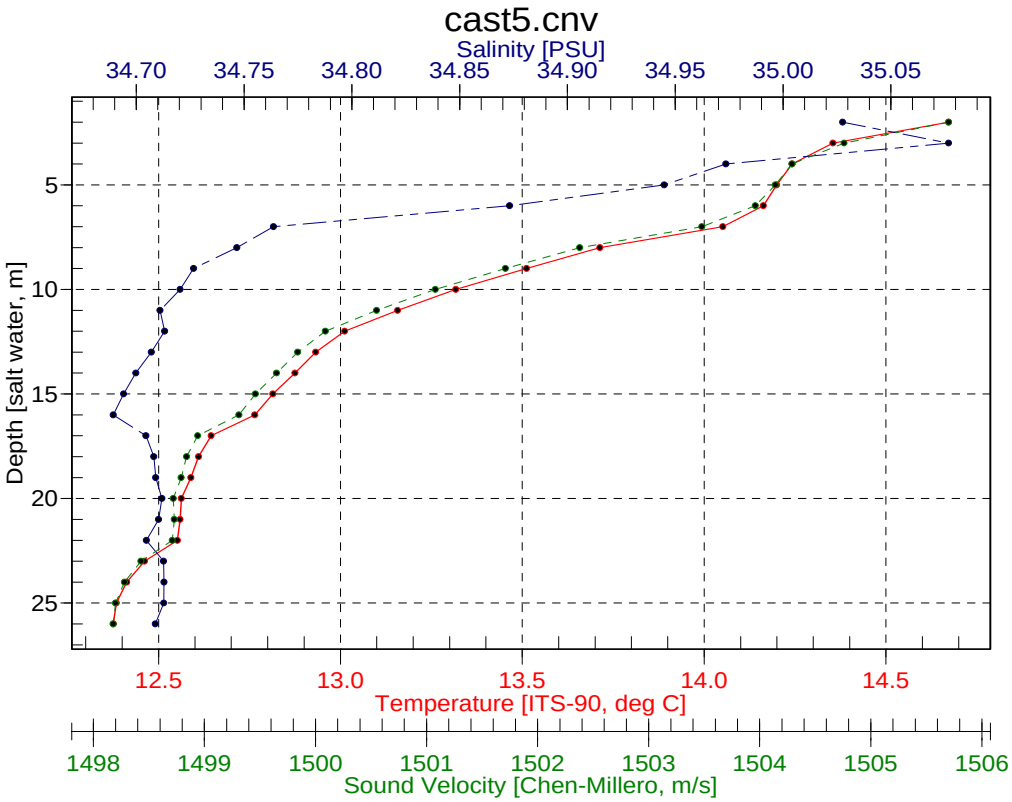
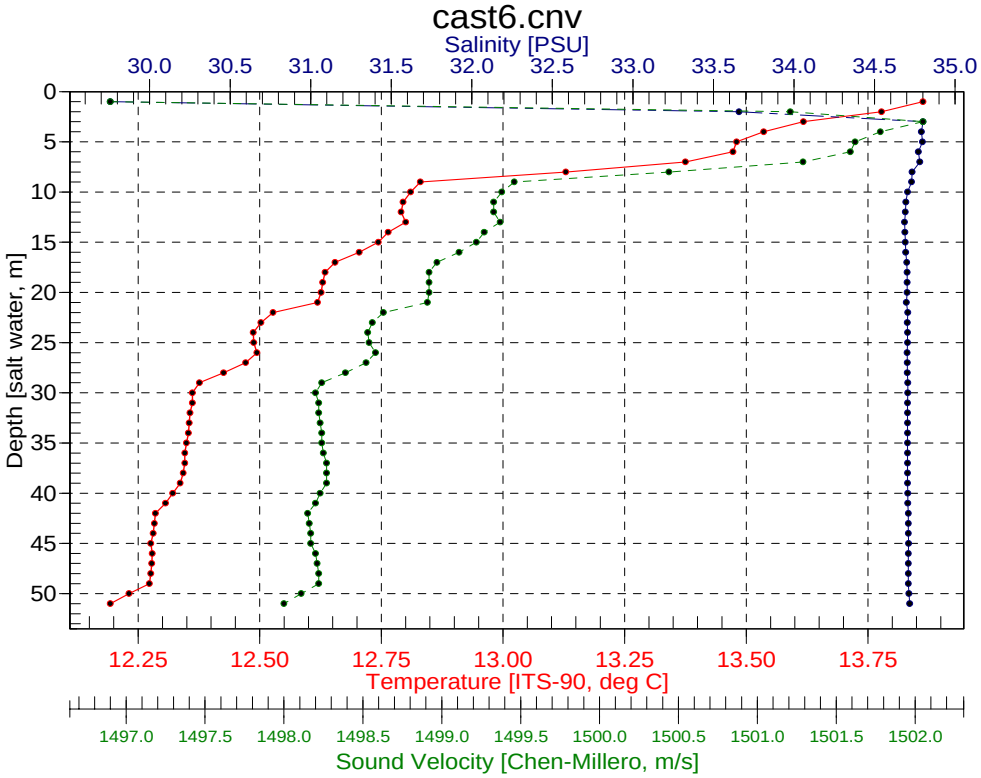


Figure A8.6. CTD Cast 6: 22nd July 0709h BST; 57°01.443'N 07°17.253W



7.9 Appendix 9 – Details of broad band and spectral in situ measurements

Broad band attenuation measurements

Calculated PAR light attenuation coefficients in the Sound of Barra were low and varied only over a small range from 0.4 to 0.58 m^{-1} (Table 2.3.4). Whilst low, these figures were higher than those recorded in the Sound of Harris recorded in 2005 (0.23 to 0.34 m^{-1}) which may have been the result of re-suspended bottom sediments as a result of windy weather during the field survey. Nevertheless, the relatively low values indicate that the waters in the Sound are relatively clear and that attenuation is not significantly spatially variable.

In situ spectral attenuation measurements

Representative examples of downwelling spectral measurements, made at two sites using the spectroradiometer fitted with the fibre optic probe, are presented in Figures 7.8.1 and 7.8.2. Both sets of spectra show little variation in the spectral quality of penetrating light, at least to the 4 m depth limit to which the measurements were made. Calculated spectral attenuation is largely similar across the Sound of Barra (Figure 7.8.3). Attenuation is lowest over the visible; increases at approximately 600, 650 and 700 nm are due to increases in absorption of light by water itself. Higher attenuation of blue light, compared to other visible light wavelengths, was observed at stations in the surrounds of the Eriskay causeway and could be the result of increased scattering and possible absorption by dissolved aquatic humus (the latter potentially arising from runoff from land). The spectra show no visible signs of absorption due to pigments in phytoplankton, suggesting that phytoplankton concentrations in the Sound, at least at the time of measurement, were low.

The results suggest that a single attenuation value could reasonably be assumed for depth correction of the remotely sensed data.

Figure 7.9.1 Measured spectral variation in downwelling light at 0.5 m intervals at Station 1.

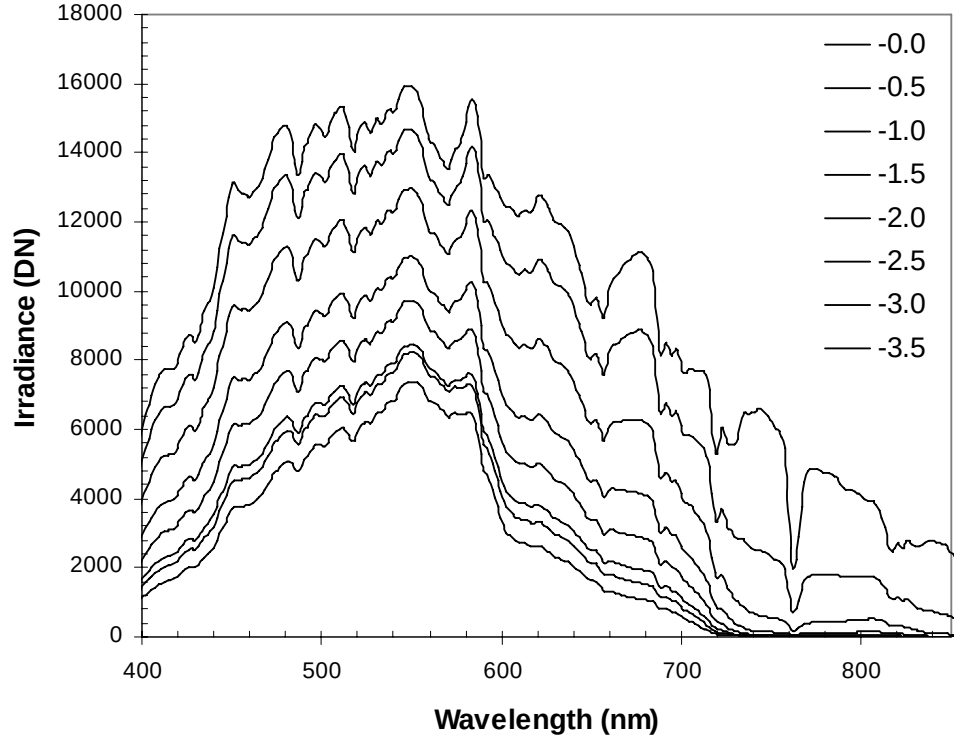


Figure 7.9.2 Measured spectral variation in downwelling light at 0.5 m intervals at Station 4..

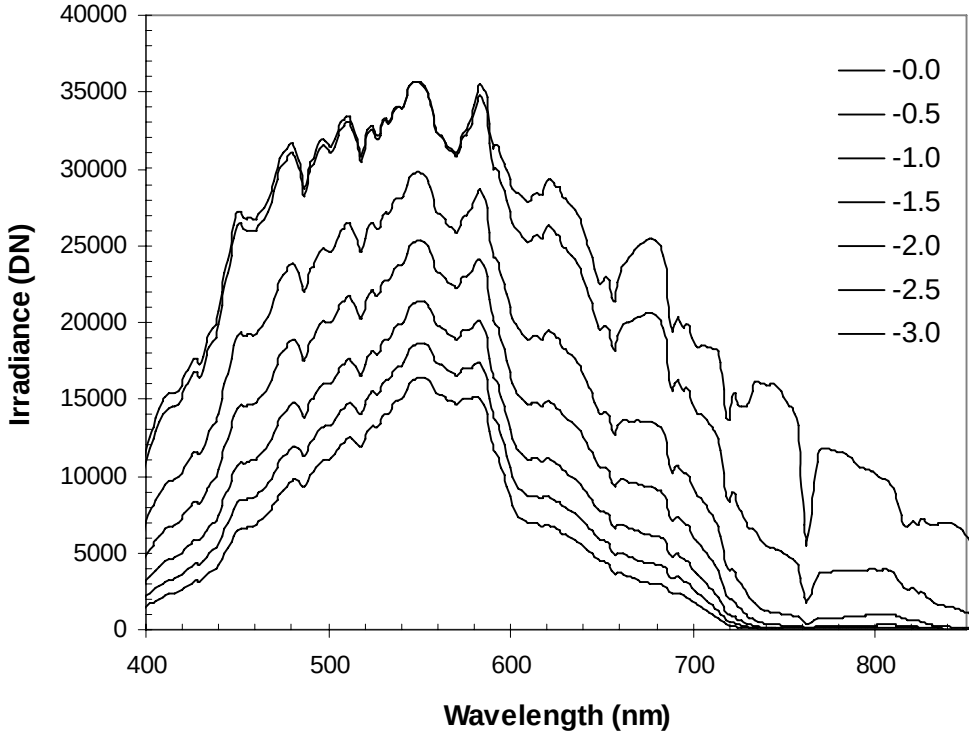
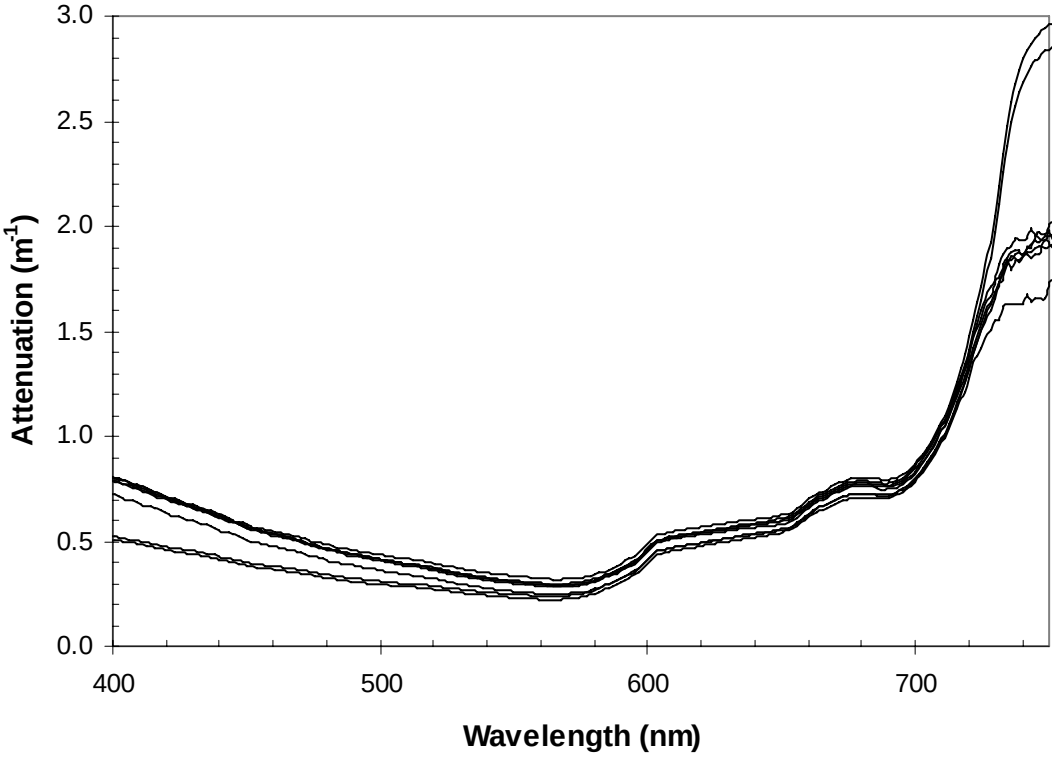


Figure 7.9.3 Calculated spectral attenuation coefficients for all measurements in the Sound of Barra.



7.10 Appendix 10 - Digital data products

A. Subdirectory: Groundtruthing

Description of contents
The digital survey data (including data files, GIS products, digital images & video footage) are held by SNH Coastal & Marine Ecosystems Unit; for access contact the nominated officer of this project (see title page). All the subdirectories and individual data files are described below including details of the contents of the individual files.

Sub directory: Groundtruthing\Biological Data

S of Barra infauna sample data.xls
Excel spreadsheet showing the species abundance data from the 56 infaunal sediment samples in the form of a species by site matrix. This is the source of appendix table 7.3. Derived univariate parameters are shown in report tables 3.1.1. and 3.1.3.

S of Barra sediment sample data.xls
Excel spreadsheet showing the full granulometric data corresponding to the infaunal samples. Tables show sediment fraction weights at half Phi intervals as raw data, weight percentage and cumulative weight percentage. Cumulative weight percentages are also expressed graphically. Sediment parameters shown in the tables are quartile phis, median grain size (expressed in phi and microns), quartile deviation and weight percentages of silt/clay (>63µm), sand (63-4000µm) and gravel (>4000µm). These data are presented in summary form in report table 3.1.2. and 3.1.4.

Station data drop down video surveys.xls
Excel spreadsheet showing the station data for sites surveyed by drop-down video. Includes station code, biotopes present, notes on substrate, notes on biota, depth BCD, date, time, geographic coordinates (start & end of run), initials of surveyor/leader of survey team (refer to table 2.1.1 for full names). Selected data fields from this table are presented in appendix table 7.1.2.

Station data subtidal diver surveys.xls
Excel spreadsheet showing the station data for sites surveyed by diving or snorkelling. Includes station code, biotopes present, notes on substrate, notes on biota, depth BCD, date, time, geographic coordinates, initials of surveyor (refer to table 2.1.1 for full names). Selected data fields from this table are presented in appendix table 7.1.1.

Station data intertidal surveys.xls
Excel spreadsheet showing the station data for intertidal sites. Includes station code, biotopes present, notes on substrate, notes on biota, date, time, geographic coordinates, initials of surveyor/leader of survey team (refer to table 2.1.1 for full names). Selected data fields from this table are presented in appendix table 7.1.3.

Station data intertidal zones.xls
Excel spreadsheet showing further details of the shores that are summarised in the above (Station data intertidal surveys.xls) file. Each shore location is separated into a series of zones and data are given for each zone at each shore location. Includes station code, zone number, biotopes present, notes on substrate, notes on biota, geographic coordinates and position of coordinates in relation to zone

Sub directory: Groundtruthing\Eriskay Causeway

Eriskay Causeway infauna sample data.xls
Excel spreadsheet showing the species abundance data from the 2 repeat infaunal sediment samples in the form of a species by site matrix. Corresponding data from 2001 is also shown. This is the source of appendix table 7.5.1. Derived univariate parameters are shown in appendix table 7.5.2.

Eriskay Causeway sediment sample data.xls
Excel spreadsheet showing the full granulometric data corresponding to the 2 repeat infaunal samples and the 10 granulometric samples. Tables show sediment fraction weights at half Phi intervals as raw data, weight percentage and cumulative weight percentage. Cumulative weight percentages are also expressed graphically. Sediment parameters shown in the tables are quartile phis, median grain size (expressed in phi and microns), quartile deviation and weight percentages of silt/clay (>63µm), sand (63-4000µm) and gravel (>4000µm). The data corresponding to the 2 repeat infaunal samples are presented in summary form in appendix table 7.5.2. The data corresponding to the 10 granulometric samples are presented in summary form in report table 3.4.1.

Eriskay Causeway *Zostera* change assessment.xls
Excel spreadsheet showing the data from stations surveyed to assess change in *Zostera* distribution near the Eriskay causeway. The file contains 3 worksheets. "West of Causeway" includes the information presented in appendix table 7.6.3. "East of Causeway (points)" includes the information presented in appendix table 7.6.2. "East of Causeway (transects)" includes the information presented in appendix table 7.6.1.

Eriskay Causeway Repeat stations.xls
Excel spreadsheet showing the data from stations previously surveyed in 2001 and subsequently resurveyed in 2006 by diving or snorkelling. This includes the information presented in appendix table 7.4.1.

Sub directory: Groundtruthing\Field log

Event Log.xls
Spreadsheet of events of the field survey. Provided to enable the user to establish the sequence of sites surveyed and identify the individual team members associated with the surveying of specific sites.

Sub directory: Groundtruthing\GIS Tables
Sub directory: Groundtruthing\GIS Tables\All stations

All biotopes.xls
Excel spreadsheet showing all biotopes recorded with corresponding station codes & geographic coordinates. This is provided to allow users to plot the distribution of individual biotopes or groups of biotopes according to their needs.

Station methods.txt
Table showing survey methods used at all sites. Shows station code, geographic coordinates and survey method. First column is coded with "1" to denote groundtruth stations or "2" to denote Eriskay Causeway stations. This allows the two components of the survey to be readily separated. This table was used to produce report figure 2.2.1.

Sub directory: Groundtruthing\GIS Tables\Littoral biotopes

Text files containing tables for plotting the distribution of selected groups of biotopes. Tables contain biotope identity, station code and geographic coordinates.

File title	Biotopes	Corresponding report figure
Alaria.txt	IR.HIR.KFaR.Ala IR.HIR.KFaR.Ala.Ldig IR.HIR.KFaR.Ala.Myt	4.2.19
AscFS.txt	LR.LLR.F.Asc.FS	4.2.17
AscX.txt	LR.LLR.F.Asc.X	4.2.17
Cht.txt	LR.HLR.MusB.Cht	4.2.15
ChtCht.txt	LR.HLR.MusB.Cht.Cht	4.2.15
ChtLpyg.txt	LR.HLR.MusB.Cht.Lpyg	4.2.15
FiSa.txt	LS.LSa.FiSa LS.LSa.FiSa.Po LS.LSa.FiSa.Po.Ncir LS.LSa.FiSa.Po.Aten LS.LSa.FiSa.Po.Pful	4.2.11
Fser.txt	LR.LLR.F.Fserr.FS LR.LLR.F.Fserr.X	4.2.18
FserR.txt	LR.MLR.BF.Fser.R	4.2.18
FspiB.txt	LR.MLR.BF.FspiB	4.2.14
FspiFS.txt	LR.LLR.F.Fspi.FS	4.2.14
Fves.txt	LR.LLR.F.Fves.FS LR.LLR.F.Fves.X	4.2.17
FvesB.txt	LR.MLR.BF.FvesB	4.2.16
FvesR.txt	LR.HLR.MusB.Sem.FvesR	4.2.15
Ldig.txt	IR.MIR.KR.Ldig	4.2.19
MoSa.txt	LS.LSa.MoSa LS.LSa.MoSa.BarSa LS.LSa.MoSa.AmSco.Eur LS.LSa.MoSa.Ol.FS	4.2.10
MuSa.txt	LS.LSa.MuSa.CerPo LS.LSa.MuSa.MacAre	4.2.11
MytB.txt	LR.HLR.MusB.MytB	4.2.15
MytFves.txt	LR.MLR.MusF.MytFves	4.2.16
Pel.txt	LR.LLR.F.Pel	4.2.13
PelB.txt	LR.MLR.BF.PelB	4.2.13
SemSem.txt	LR.HLR.MusB.Sem.Sem	4.2.15
Verrucaria.txt	LR.FLR.Lic.Ver.Ver	4.2.12
YG.txt	LR.FLR.Lic.YG	4.2.12

Sub directory: Groundtruthing\GIS Tables\Sublittoral biotopes

Text files containing tables for plotting the distribution of selected groups of biotopes. Tables contain biotope identity, station code and geographic coordinates.

File title	Biotopes	Corresponding report figure
deep rock.txt	IR.HIR.KFaR.FoR CR.HCR.Xfa.FluCoAs	4.2.9
EpusOborApri.txt	SS.SSa.CFiSa.EpusOborApri	4.2.2
FfabMag.txt	SS.SSa.IMuSa.FfabMag	4.2.2
HeloMsim.txt	SS.SCS.ICS.HeloMsim	4.2.1
IFiSa.txt	SS.SSa.IFiSa SS.SSa.IFiSa.TbAmPo	4.2.2
IMoSa.txt	SS.SSa.IFiSa.IMoSa	4.2.1
KSwSS.txt	SS.SMp.KSwSS SS.SMp.KSwSS.LsacGraFS	4.2.2
LhypFt.txt	IR.MIR.KR.Lhyp.Ft IR.MIR.KR.Lhyp.GzFt	4.2.8
LhypPk.txt	IR.MIR.KR.Lhyp.Pk	4.2.8
LhypT.txt	IR.MIR.KR.LhypT.Ft	4.2.5
LhypTX.txt	IR.MIR.KR.LhypTX.Ft	4.2.5
Low E kelp.txt	IR.LIR.K.LhypLsac IR.LIR.KLhypCape	4.2.8
MedLumVen.txt	SS.SCS.CCS.MedLumVen	4.2.3
MelMagThy.txt	SS.SMu.ISaMu.MelMagThy	4.2.2
Mixed kelp.txt	IR.HIR.KSed.XKHal IR.HIR.KSed.XKScrR	4.2.6
MoeVen.txt	SS.SCS.ICS.MoeVen	4.2.1
NcirBat.txt	SS.SSa.IFiSa.NcirBat	4.2.1
Pcal.txt	SS.SMp.Mrl.Pcal SS.SMp.Mrl.Pcal.R	4.2.3
ProtAhn.txt	IR.HIR.KSed.ProtAhn	4.2.7
Zmar.txt	SS.SMp.SSgr.Zmar	4.2.4

Sub directory: Groundtruthing\GIS Tables\Features

Text files containing tables for plotting the distribution of habitat features.

Station features & exposure subtidal.txt

Table for plotting subtidal habitat features. Table includes station codes and geographic coordinates. Column titled “Sediment type” indicates the type of sediment present at a site. If no sediments were present the column shows a blank. This was used to produce report figure 4.1.1. Column titled “Rock exposure levels” indicates if a rock reef feature is present at a site and gives the exposure level. If no rock reef feature is present the column shows the sediment type present. This was used to produce report figure 4.1.2.

Station features & exposure intertidal.txt

Table for plotting intertidal habitat features. Table includes station codes and geographic coordinates. Column titled “Substrate” indicates the habitat features present at a site. This was used to produce report figure 4.1.3. Column titled “Exposure level” indicates the exposure level of a site based on the combination of biotopes present. This was used to produce report figure 4.1.4.

Sub directory: Groundtruthing\GIS Tables\Eriskay Causeway

Text files containing tables for plotting the distribution of sites surveyed in the vicinity of the Eriskay causeway. Tables include station code and geographic coordinates.

File title	Purpose of table	Corresponding report figure
Eriskay repeat stations.txt	Location of stations revisited, previously surveyed in 2001	3.4.1
Eriskay PSA.txt	Location of granulometric sample stations	3.4.2
Eriskay east pts.txt	Location of point locations for *Zostera* change assessment east of the causeway	3.4.3
Eriskay transects.txt	Location of drift transects for *Zostera* change assessment east of the causeway	3.4.3
Eriskay west pts.txt	Location of point locations for *Zostera* change assessment west of the causeway	3.4.4

Sub directory: Groundtruthing\GIS Tables\Discussion

Text files containing tables for plotting the distribution of sites to illustrate points made in the report discussion section. Tables include station code and geographic coordinates.

File title	Purpose of table	Corresponding report figure
Zmar density.txt	Shows distribution of dense and sparse *Zostera*	5.1.1
Pcal abund.txt	Shows distribution of maerl sites with approximate abundance of live maerl	5.1.2
organically enrich.txt	Shows distribution of beaches with communities characteristic of organic enrichment	5.1.3

Sub directory: Groundtruthing\Images & video

Images
A total of 716 digital stills images were taken at intertidal sites over the course of the survey. The images are held by SNH maritime group, for access contact the nominated officer of this project (see title page). Images are available from the majority of shores visited during the survey but at two sites (IB17 & IA8) it was not possible to obtain images due to a combination of equipment failure and adverse weather conditions. For ease of access, the images are stored within subdirectories named with the appropriate shore code.

Image log.xls
Excel spreadsheet listing the individual images. Includes corresponding site codes, zone identity and biotopes present. For further information on specific site codes please refer to 'Station data intertidal surveys.xls'. For information on specific zones within an intertidal site please refer to Station data intertidal zones.xls (both files are described above and contained within the 'Biological Data' subdirectory).

Video footage
Representative video footage was obtained from both subtidal and intertidal sites over the course of the survey. There are 249 sections of video footage recorded on a series of 17 Mini DV tapes. Each section of footage begins with a short section showing the corresponding site code on a slate. The footage is held by SNH maritime group, for access contact the nominated officer of this project (see title page). Footage is available from the majority of sites visited during the survey but at a number of sites it was not possible to obtain footage due to a combination of equipment failure and adverse weather conditions. Footage is not available for the following sites, IB17, IA7, IA8 and IA17.

Video log.xls
Excel spreadsheet listing the individual sections of video footage. Includes site codes, tape label and time code for start of footage section. For further information on specific site codes please refer to 'Station data intertidal surveys.xls' in the case of intertidal sites (IA or IB), 'Station data drop down video surveys.xls' in the case of drop-down video sites (SA) and 'Station data subtidal diver surveys.xls' in the case of sites surveyed by diver (SB) (these files are described above and contained within the 'Biological Data' subdirectory).

B. Subdirectory: Satellite data

The satellite data are presented as compressed .zip files to save file space. Files are in Erdas Imagine format except for the original QuickBird image data which were supplied in geotiff format. Filenames and an explanation of directories and contents are as follows:

Sub directory: Satellite data \01_Raw satellite image

File:	Raw QB 2006 Barra image.zip
Enclosed Filenames:	06JUL09120910-M2AS-005558302020_01_P001-BROWSE.JPG 06jul09120910-m2as-005558302020_01_p001.aux 06JUL09120910-M2AS-005558302020_01_P001.IMD 06JUL09120910-M2AS-005558302020_01_P001.RPB 06JUL09120910-M2AS-005558302020_01_P001.TIF 06JUL09120910-M2AS-005558302020_01_P001.TIL 06JUL09120910-M2AS-005558302020_01_P001.XML 06JUL09120910-M2AS-005558302020_01_P001_README.TXT
Explanation of contents:	Raw QuickBird Multispectral image in original supplied format (geotif), with associated metadata and quicklooks files

Sub directory: Satellite data \01_Raw satellite image\ Imagine format

File:	Raw_image_Imagine format.zip
Enclosed Filenames:	06JUL09120910-M2AS-005558302020_01_P001.img 06JUL09120910-M2AS-005558302020_01_P001.rrd
Explanation of contents:	Raw QuickBird Multispectral image in Imagine (.img) format, with associated statistics file

Sub directory: Satellite data \02_Image with Atmospheric, Geometric Correction

File:	Image with Atmospheric, Geometric Correction.zip
Enclosed Filenames:	barra_2006_atm_geo.img barra_2006_atm_geo.rrd
Explanation of contents:	Geomtrically and atmospherically corrected multispectral image with associated statistics file

Sub directory: Satellite data \03_Image with Atmos,geocorrection, masked

File:	03_Image with Atmos,geocorrection, masked.zip
Enclosed Filenames:	barra_2006_atm_geo_masked.img barra_2006_atm_geo_masked.rrd
Explanation of contents:	Fully processed dataset, including: • Geometric correction • Atmospheric correction • Land mask • Cloud and cloud shadow mask

Sub directory: Satellite data \04_Depth invariant image

File:	04_Depth invariant image.zip
Enclosed Filenames:	barra_2006_depth_invariant.img

barra_2006_depth_invariant.rrd

Explanation of contents: Depth corrected image

Sub directory: Satellite data \05_Classification Grids

Each dataset is saved as a grid which opens in ARCView 3.2. Each grid consists of two folders, one called 'info' with the second folder representing the actual name of the grid. To open them, add Theme in a View and from 'data source types' choose 'grid data source'. Add the grid from the individual folder as described above. When opened load the respective label for each theme with a unique value under 'legend type' and choose 'field as value'.

Sub directory: Satellite data \05_Classification Grids\ grid_intergr_06

Contents: Grid file of the detailed biotope classification representing the integration of both optical and acoustic datasets, as displayed in the report - containing two folders and two files

Sub directory: Satellite data \05_Classification Grids\ grid_features_06

Contents: Grid file of the broader features map, as displayed in the report, and containing two folders and two files

Sub directory: Satellite data \05_Classification Grids\ grid_north_inter_06

Contents: Grid file of classified intertidal biotopes in the northern section of the Sound of Barra, as displayed in the report and containing two folders and two files

Sub directory: Satellite data \05_Classification Grids\ grid_south_inter_06

Contents: Grid file of classified intertidal biotopes in the southern section of the Sound of Barra, as displayed in the report and containing two folders and two files

C. Subdirectory: Acoustic_data

Sound of Barra 2.mxd GIS Project Read Me document

Project saved in ArcInfo version 9.1, also exported as a .pmf file which can be read in ArcReader (free software from ESRI)

The following data layers are presented in the GIS project and included on the CD:

1. QTC AGDS data.shp (under the main folder): presents AGDS data by PCA group number, in WGS 84 datum

2. Acoustic survey tracks.lyr - links to the above shapefile but just shows location of tracks

3. coast25.shp (under main folder): coastline shapefile provided by SNH, in British National Grid

4. Sound of Barra survey area.lyr (under main folder) - links to survey3.shp showing survey area, in British National Grid

5. Barra5mfine.img (under main folder) - ERDAS Imagine grid file generated from GeoTexture fine classification, in WGS 84 UTM Zone 29N at 5m resolution (for Evanthia & Tim's use)

6. 6_class_asp_slope_bathy.img (under main folder) - ERDAS Imagine grid file, in WGS 84 UTM, generated by unsupervised classification (cluster analysis) of bathymetric data at 2m resolution

7. aspect (band 1), slope (band 2) and bathymetry (band 3).lyr (under main folder)- links to asp_slope_bathy1.img - ERDAS Imagine grid file, in WGS 84 UTM, of three-band image created from bathymetric data at 2m resolution

8. Aspect (0-360).lyr (under main folder)- links to aspect_2mres.img - ERDAS Imagine grid file, in WGS 84 UTM, of aspect created from bathymetric data at 2m resolution

9. Slope angle (degrees).lyr (under main folder)- links to slope_angle_2mres.img - ERDAS Imagine grid file, in WGS 84 UTM, of slope angle created from bathymetric data at 2m resolution

10. Barra_5mBin_FineClfctn.tif (under Backscatter\Barra\Images\) - tif image in WGS 84 UTM Zone 29N of GeoTexture fine classification, 5m resolution

11. Barra_5mBin_SmoothedClsfctn.tif (under Backscatter\Barra\Images\) - tif image in WGS 84 UTM Zone 29N of GeoTexture smoothed classification, 5m resolution

12. Backscatter mosaic 5m resolution.lyr (under Backscatter\Barra\Images\) - links to Barra_5mBin_Mosaic.tif image in WGS 84 UTM Zone 29N of GeoSwath Plus backscatter data, 5m resolution

13. Rugosity 2m grid.lyr (under Bathymetry\) - links to rugosity2m ESRI grid in WGS 84 UTM Zone 29N of rugosity data derived from GeoSwath bathymetry data, at 2m resolution

14. Bathymetry.lyr (under Bathymetry\) - links to BarraBathy2m.img- ERDAS Imagine grid in WGS 84 UTM Zone 29N generated from 2m horizontal resolution XYZ bathymetry data from GeoSwath Plus survey

15. barrahillshade315.img (under Bathymetry\) - ERDAS Imagine grid in WGS 84 UTM Zone 29N generated from GeoSwath Plus bathymetric data, with sun angle at 315 degrees (2m resolution)

GIS data layers in Sound of Barra 1 project:

1. QTC AGDS data: QTC-View single-beam data classified using Principle Components Analysis (PCA) via the software QTC-Impact, to derive the first three significant components- q1, q2 and q3. This data is then auto-classified (unsupervised classification) through the QTC-Impact software into a number of classes. Six classes appeared to be optimal. This data is provided in the spreadsheet 'barraseabed'. This data is presented via the QTC_AGDS_data layer in the GIS project.

2. 6_class_asp_slope_bathy: This ERDAS Imagine file is an unsupervised classification of the Geoswath post-processed bathymetric data: Aspect, Slope and Bathymetry, completed using Image Analysis extension of ArcGIS (by Leica Geosystems). Six classes were chosen. The data is messy due to artefacts in the bathymetric data but does show key patterns and highlights the influence of differing aspects of reefs. 2m resolution grid file.

3. Asp_slope_bathy1: This ERDAS Imagine file is a stack of three datasets (one per colour band): Aspect, Slope and Bathymetry, as derived from the Geoswath data. This file was created prior to the unsupervised classification (see above) but shows interesting patterns that were not as discernable by eye from inspecting the individual datasets. 2m resolution grid file.

4. Aspect_2m res: This ERDAS Imagine file shows aspect divided into directions (e.g. southwest), which is derived from the Geoswath bathymetric data using Spatial Analyst extension of ArcGIS. 2m resolution grid file.

5. Slope_angle_2m res: This ERDAS Imagine file shows slope angle (in degrees: 0-90 maximum range), derived from the Geoswath bathymetric data using Spatial Analyst extension of ArcGIS. 2m resolution grid file.

6. Barra_mean2m_backscatter: This ESRI Grid file (source file name: Barra_mean2m) presents the Geoswath backscatter/sidescan data at 2m resolution. This indicates the texture of the seabed. Artefacts are common but may possibly be removed with subsequent processing by Geoswath experts and could then be subjected to classification analysis.

7. Barrahillshade315: This ERDAS Imagine file shows a hillshaded image based on the Geoswath bathymetric data, with the light coming from an azimuth of 315 degrees and altitude of 45 degrees. 2m resolution grid file.

8. BarraBathy2m: This ERDAS Imagine file presents the 2m resolution bathymetric data from the Geoswath system. This may be used to create a DEM or TIN.

9. Coast25: shapefile of the Scottish coastline

10. Sound_barra and survey3: Shapefiles for survey planning provided by SNH.

PLEASE NOTE that all grids derived from the Geoswath data (items 2-8) are in the projected coordinates of UTM Zone 29N, with the datum as WGS 1984.

Items 7 and 8 are located within the 'Bathymetry' subfolder; Item 6 within the 'Backscatter' subfolder. All other items are in the main 'Barra SNH Project- AFBI survey results' folder.

D. Subdirectory: Report

Subdirectory: Report\Report Figures

Figures labelled to match figures in the report text.

Subdirectory: Report\Text

Sound of Barra mapping 2006.doc
Word file containing the completed and final report text.