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Biodiversity of macroinvertebrate and fish assemblages of the northwestern Ross Sea shelf

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EXECUTIVE SUMMARY

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In March 2004, RV *Tangaroa* completed a ‘BioRoss Survey’ to assess the biodiversity of selected marine assemblages in the northwestern Ross Sea. Five transects were sampled on the Ross Sea shelf, each of which was divided into three depth strata (50–250 m, 250–500 m, 500–750 m), running perpendicular to the Victoria Land coast between Cape Adare in the north and Cape Hallett in the south. This stratified random sampling programme allowed geographic and depth-related comparisons of the benthic assemblages and the testing of a number of diversity hypotheses.

The influence of environmental parameters acting on different spatial scales on the benthic assemblages was assessed by determining primary productivity (on a large-scale), disturbance (specifically iceberg-scouring; quantified on different spatial scales) and habitat heterogeneity (on a small-scale).

More than 820 putative macroinvertebrate species and 43 fish species were identified from the sampling area. Several species are new to science and the distribution range for others can be extended because of samples collected in this survey.

Although clear geographic gradients could not be established for either the environmental parameters nor for the macroinvertebrate and fish assemblages, depth-related differences in the biodiversity and composition of assemblages were well defined. While depth-related variables were the main environmental drivers for the fish assemblages of the Ross Sea shelf, the results suggest that a combination of large-scale oceanographic (i.e., surface chlorophyll *a*, seasonal ice cover) and local habitat variables influence the patterns of macroinvertebrate assemblage composition in the northwestern Ross Sea.. Thus the study served to highlight that multiple environmental drivers working on varying spatial scales influence the biodiversity and composition of the deeper benthic assemblages of the Ross Sea shelf.

Future data analysis and the further processing of samples recovered during the study voyage will continue to improve biological knowledge of the region and provide useful information for conservation and environmental management purposes.

1. INTRODUCTION

1.1 Overview

The Antarctic continental landmass is surrounded by a deep shelf and deep oceanic water. It has been isolated from adjacent shelf environments for approximately 40 million years by these cold deep waters and by the circumantarctic current systems, which are of importance for the biology and evolution of the Antarctic benthos (Gallardo 1987). The benthic macrofauna (invertebrates and fish) of the Antarctic shelf are considered by many researchers to have a circumpolar distribution, extending along the continent's entire 35 000 km coastline. This interpretation was supported by early taxonomic studies of a few faunal groups, but as study of other taxa progressed some suggestion of geographic sub-divisions emerged (see reviews Knox 1994, Dayton et al. 1994). Examination of the continent–wide distributional patterns of macrofaunal assemblages has not been possible, owing to the paucity of complete taxonomic sampling (see review Arntz et al. 1994). However, large regions of the Antarctic shelf have received intensive sampling and relatively complete identification of the fauna present (e.g., off the Antarctic Peninsula – Mühlenhardt-Siegel 1988). Most notable among these large-scale surveys are those conducted along the 2250 km shelf of the Weddell and Lazarev Seas, where macroinvertebrate assemblages have been identified and described (Galéron et al. 1992, Gerdes et al. 1992, Gutt & Starmans 1998). Such studies have allowed for consideration of how certain "environmental drivers" may influence macroinvertebrate assemblages of the shelf (Gutt 2000). Gutt (2000) systematically examined evidence for a number of those factors, thought to be important structuring agents in Antarctica, in determining the composition/biodiversity and spatial distribution of benthic assemblages of Weddell/Lazarev Sea region. Gutt (2000) concluded, like many other researchers before him, that it is difficult to disentangle the relative importance of a number of obviously important environmental variables, and that further quantitative investigations are essential.

The relationship between the spatial distribution of benthic macrofauna assemblages and environmental parameters has been the subject of numerous studies. It seems likely from recent evidence that the characteristics of organic matter flux derived from primary production, influenced by oceanographic variables, will explain a great deal about the large-scale distribution of seabed assemblages (e.g., Levin & Gage 1998). In Antarctica, the flow of organic matter from the pelagic domain to the seabed represents an important energy source for benthic organisms (Grebmeier & Barry 1991). Factors such as the persistence of ice cover, and the strength and direction of water currents, will influence the quality and quantity of organic matter flux and thereby the distribution of different macrofauna assemblages (Cattaneo-Vietti et al. 1999). In addition to the influence of large-scale variables on assemblage composition, variables operating on intermediate and small spatial scales are also likely to control the composition of the macrofauna assemblages. Physical disturbance of the seabed has been shown to variably influence the composition of benthic macrofauna assemblages over time (Hall 1994). On Antarctic continental shelves, the physical disturbance caused by anchor ice or iceberg scour appears to exert considerable influence on assemblage composition over widespread areas (Dayton et al. 1970). On smaller spatial scales, the provision of habitat heterogeneity by the biogenic elements of an assemblage has been shown to influence marine faunal diversity and assemblage composition in a number of benthic environments (e.g., by sponges, Barthel 1992, Barthel & Gutt 1992, Bell & Barnes 2001). Indeed, the importance of the sponge component of Antarctic benthic assemblages was suggested over thirty years ago (Bullivant 1967a), and the relationship between habitat forming species and diversity was clearly demonstrated by Gutt & Starmans (1998).

Benthic macrofauna assemblages of continental shelves can be modified by human activities, even in Antarctica (e.g., hydrocarbon/PCB/metal pollution at McMurdo Station, see Lenihan & Oliver 1995), and threats exist for the future as a consequence of increased tourist boat traffic and the opening of the region to bottom fishing (Arntz et al. 1994, Dayton et al. 1994), increased temperatures from global warming and acidification from CO_2 uptake (Clarke & Harris 2003). Understandably, calls have been made to set aside marine protected areas of sufficient size to fulfill conservation objectives (Gallardo 1987). Appropriate selection of these areas will require methodological improvements to both descriptive and experimental research, and that this research be extended around the Antarctic continent (Gallardo 1987). Within New Zealand's Ross Dependency, areas which face current and potential threats (e.g., toothfish fishery and tourism,Waterhouse 2001) and about which relatively little is known about the benthic macrofauna, that may require the establishment of protected areas, include the northwestern Ross Sea (Fenwick & Bradford-Grieve 2002).

1.2 The study area, survey and hypotheses

1.2.1 Ross Sea shelf

The Ross Sea (Figure 1) is atypical for Antarctica in having a wide continental shelf, while off other parts of the continent the shelf is narrow or virtually absent. Due to the weight of the ice, Antarctic shelves are suppressed and thus the shelf break in the Ross Sea occurs at comparatively great depth (about 800 m) (Gallardo 1987). The continental shelf of the Ross Sea is covered by sea ice for most of the year, with growth typically starting in late February and decay beginning in late October near the ice shelf front. The interannual variation in the length of the ice season appears to be related to climatic forcing. The large-scale ocean circulation on the continental shelf of the Ross Sea consists of Antarctic Surface Water, Low Salinity Shelf Water and Modified Circumpolar Deep Water inflows from the north and east. These water masses are seasonally cooled and warmed, salinised by sea ice formation and freshened by melt water. On the open shelf, surface circulation generally moves ice and water to the west and north, and is bounded by a strong, narrow coastal current along the Ross Sea Ice Shelf and a westward flow near the continental shelf break (see Jacobs & Giulivi 1999). Katabatic winds and the physical characteristics of the region serve to maintain the large Ross Sea polynya (an area of low ice concentration or open water surrounded by complete ice cover) adjacent to the ice shelf front, and the small persistent Terra Nova Bay polynya near 75° S on the Victoria Land coast (see Jacobs 1985). The irregular topography of the shelf's seabed is thought to be due to shaping by glacial action (Kennett 1968). Due to the presence of sub-angular glacial erractics of varying sizes the seabed sediments are generally poorly sorted throughout the whole area . Gravelly to sandy sediments are found in the shallower waters (including offshore banks), whilst muddy sediments occur in a nearshore belt of deep water and in front of the Ross Sea Ice Shelf. The varying amounts of organic constituents of the sediments are associated with planktonic detritus, terrigenous sources, sponge spicules, foraminifera and diatoms (Kennett 1968, Anderson et al.1984).

The majority of studies of benthic macroinvertebrates in the Ross Sea have been undertaken in shallow water (less than 30 m), where samples can be obtained using SCUBA (e.g., Oliver & Slattery 1985). Sampling of macroinvertebrates in deeper water on the shelf has been less extensive. Apart from some early sporadic sampling by expeditions of discovery and exploration, the first extensive and systematic surveys of macroinvertebrates of the shelf were carried out by the New Zealand Oceanographic Institute (NZOI) between 1959 and 1961 (Bullivant 1967b). Some of the results of these surveys were used to describe macroinvertebrate assemblages of the Ross Sea (Bullivant 1967a). A number of other surveys have subsequently been carried out in the Ross Sea (e.g., Italian oceanographic voyages 1987–1995, see Faranda et al. 2000) that have included examination of the benthos. However, there exists a poor appreciation of the large-scale composition and distribution of macroinvertebrate communities in the region, and no shelf-wide appreciation of the benthic communities in the Ross Sea similar to that obtained for the shelf on the opposite side of Antarctica (i.e., Weddell/Lazarev Sea, Gutt & Starmans 1998). Consequently, Bullivant's (1967a) macroinvertebrate assemblages are effectively the current benthic community model, and because there has been no concurrent examination of the environmental variables now thought likely to be responsible for the pattern observed, it is not possible to understand clearly the reasons for the apparently heterogeneous distribution of communities observed.

The Ross Sea fish fauna is also not well known. The benthic and benthopelagic fishes from nearshore to deep water have only been sporadically sampled, and new species of fish have been described from material collected as recently as 1996 and 1997 (Chernova & Eastman 2001, Eakin & Eastman 1998, and Eastman & Eakin 1999). There have been few surveys designed to systematically sample fish from the area in contrast, for instance, to the Weddell Sea where Germany has maintained a regular collecting programme for 15 years (Eastman & Hubold 1999). Despite the limited sampling, the Ross Sea fish fauna appears to be as diverse as that of the Weddell Sea (with at least 80 species in 12 families compared to 83 species in 14 families; Eastman & Hubold 1999). Many of these species have large depth ranges, possibly because the continental shelf extends out to approximately 800 m in the Ross Sea, in contrast to other areas where the shelf break is at about 200 m (Angel 1997). No investigations have taken place to consider the reasons for the apparently diverse Ross Sea fish fauna and the spatial distribution of assemblages.

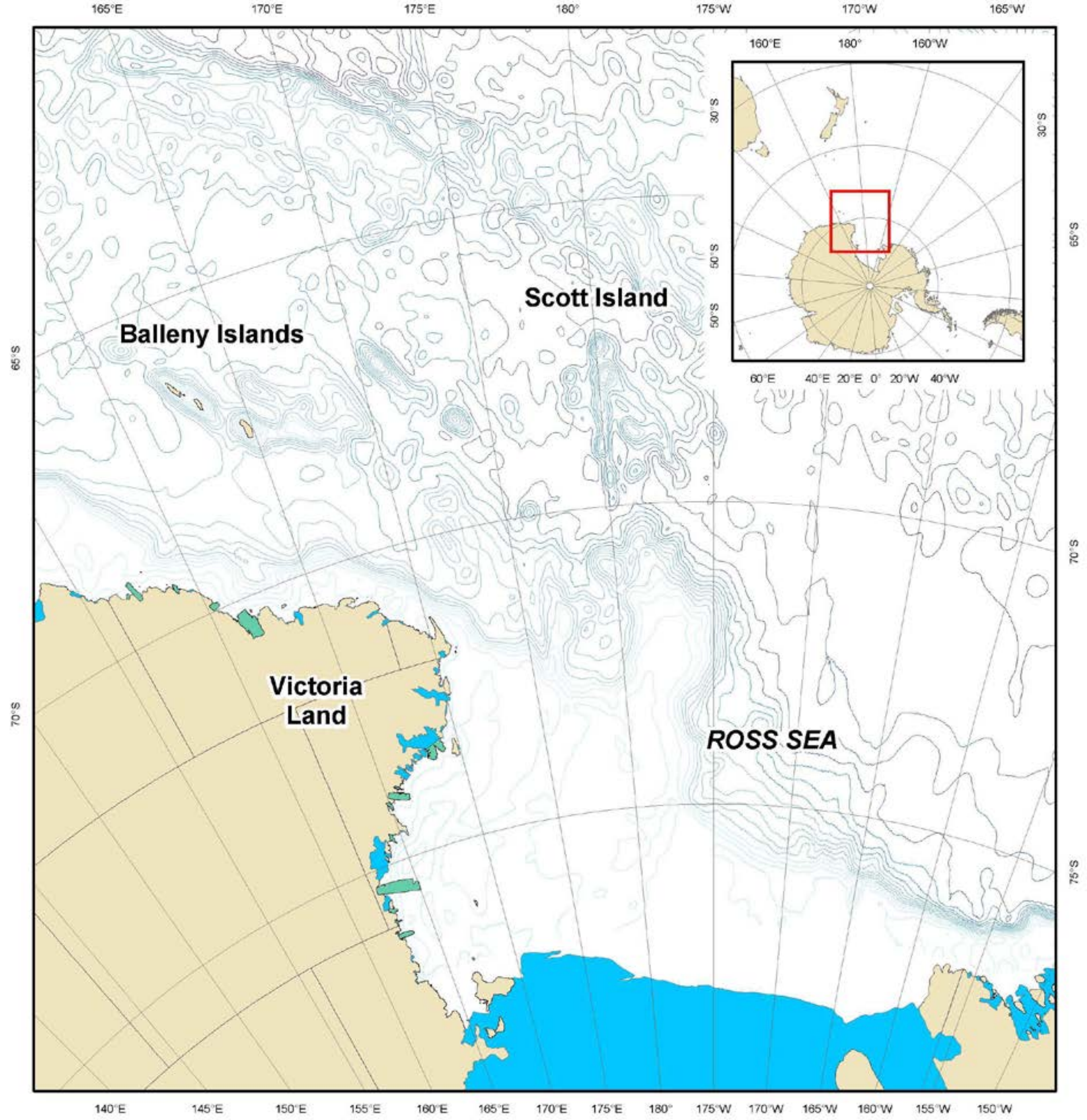

Figure 1: Map showing the Ross Sea and Balleny Islands and their position relative to the Antarctic continent and New Zealand. Blue areas indicate sea ice shelves (the largest of which is the Ross Sea Ice Shelf), green areas land ice tongues.

1.2.2 The BioRoss Survey

With the publication of the reviews by Bradford-Grieve & Fenwick (2001 it was apparent that relatively little was known about the benthic macroinvertebrate and fish biodiversity of the Ross Sea. Whilst a number of reasons have been suggested for the distribution of macroinvertebrate (Bullivant 1967a) and fish (Eastman & Hubold 1999) assemblages of the Ross Sea shelf, and the Balleny Islands (Dawson 1970), no formal testing of any hypothesis thought to account for the region's benthic biodiversity has occurred. The New Zealand Biodiversity Strategy (Anon. 2000) suggests that this deficit of knowledge and understanding should be addressed. After preliminary assessments (Stewart & Roberts 2001; Page et al. 2002), the New Zealand Ministry of Fisheries (MFish), proposed that a quantitative survey of the biodiversity of selected marine communities of the Ross Sea region and Balleny Islands be undertaken in 2004 under the auspices of the Mfish Biodiversity Programmae (MFish is one of the government agencies responsible for implementing the Biodiversity Strategy). The 'BioRoss Survey' was undertaken in March 2004 using RV *Tangaroa*.

1.2.3 Study hypotheses

Answering the question as to why assemblages and biodiversity are distributed heterogeneously has long been an objective for ecologists. Understanding this is a prerequisite to identifying gaps in knowledge, and making reccommendations about areas or communities that could be the subject of future research (Currie et al. 1999). A number of general hypotheses have been proposed to explain the types of patterns observed, a number of which appear to be particularly applicable to the macroinvertebrate and fish assemblages of Antarctica, including the Ross Sea. The following hypotheses were chosen for testing during the BioRoss study.

1.2.3.1 The energy-diversity hypothesis

A relationship between a measure of diversity and a measure of the productivity of a system has often been observed in terrestrial habitats, and this has been formulated into what is known as the 'energy-diversity hypothesis' (see Rosenzweig 1995). However, the nature of the relationship is inconsistent across habitats and taxa, and further empirical data (particularly for aquatic species) are required before the mechanisms that explain the relationship can be understood (Mittelbach et al. 2001). The waters of the Ross Sea display spatial and temporal variations in primary productivity (Arrigo et al. 1998) that could be predicted to have an influence on macrofauna community composition and diversity on the seabed. However, it is likely that the extent and duration of ice cover, and bottom currents will influence the arrival and distribution of the organic phytodetritus derived from surface primary production (Barry & Dayton 1988, Smith & Dunbar 1998, Cattaneo-Vietti et al. 1999), and thereby moderate the expected pelagic-benthic coupling relationship. Thus, any examination of the energy-diversity hypothesis in the Ross Sea would need to take into account the interaction of these variables (e.g., Gutt et al. 1998, Gutt 2000).

1.2.3.2 The disturbance-diversity hypothesis

The relationship between a measure of diversity and a measure of disturbance of a system has been observed in terrestrial and aquatic habitats, and formulated into what is known as the 'diversity–disturbance hypothesis' or sometimes more specifically as the 'intermediate disturbance hypothesis' (see Rosenzweig 1995). However, the nature of the relationship is not consistent for disturbance phenomena or across habitats nor taxa, and further empirical data are required in order to better resolve and understand the relationship (Dial & Roughgarden 1998). Many sorts of natural environmental and anthropogenic phenomena are responsible for disturbances of the seabed in

Antarctica (Lenihan & Oliver 1995). For the macrofauna assemblages of Antarctic continental shelves, the most influential natural disturbance is scour from drifting icebergs (Gutt 2001). Ice scour has generally been thought to influence the seabed and macrofauna of shallow coastal areas of the Ross Sea (Dayton et al. 1970), but significant ice scour has recently been observed (via acoustic image data) between water depths of 200–400 m on the northwest region of the continental shelf (Mitchell 2001). Ice scour at similar depths (300 m) in the Weddell Sea was shown to be associated with relatively impoverished macrofauna assemblages (Gutt et al. 1996). There is also evidence that mobile non-benthic species such as fish, especially of genus *Trematomus*, are associated with certain recovery stages following iceberg disturbance (Brenner et al. 2001).

1.2.3.3 The habitat heterogeneity-diversity hypothesis

The relationship between a measure of habitat heterogeneity and a measure of diversity has been observed in both terrestrial and aquatic habitats, and incorporated into a number of ecological hypotheses (see Rosenzweig 1995). In Antarctic shelf environments, where macrofauna communities dominated by relatively large habitat-forming epifauna are particularly common, significant positive relationships between the number of macrofauna species and the abundance of two "types" of sponges have been shown (Gutt & Starmanns 1998). Other organisms such as bryozoans and gorgonians are thought, like sponges, to play an important role in providing a suitable habitat for a considerable number of macrofauna, explaining in part the local community composition and high species diversity observed in Antarctic waters (Gutt & Schickan 1998, Gutt 2000). In the Ross Sea, evidence for the importance of the habitat provided by, in particular, sponges (and their spicules) for community development has been forthcoming (Dayton et al. 1994, Cattaneo-Vietti et al. 1999 since Bullivant (1967a) inferred the relevance of such structural fauna from bottom photographs of the region's shelf.

1.2.3.4 Examining multiple hypotheses

Examinations of the relationships between primary production (energy), iceberg scour (disturbance), structural species (habitat heterogeneity) and macrofauna diversity and assemblage composition have particular pertinence today. Changes in the climate regime in the Ross Sea could possibly alter the dynamics of phytoplankton distribution and abundance, increase the frequency of iceberg calving and initiate changes in the distribution and abundance of benthic macrofauna (see Anisimov & Fitzharris 2001), including populations of the habitat-forming sponges (Dayton 1989). Since it is probable that such environmental factors will co-vary with the spatial pattern of macrofauna diversity and assemblage composition, it is necessary (and efficient) to simultaneously test multiple hypotheses, and ensure that examinations are made at the appropriate spatial-scales (Currie et al. 1999). To date, no concurrent examination of the above hypotheses as they relate to the macrofauna communities of the Ross Sea shelf has been reported, even in the post-hoc fashion that Gutt (2000) adopted for the Weddell/Lazarev Sea. However, the simultaneous investigation of a number of physico-chemical variables and their relationship to the biological communities of the Ross Sea is the goal of the Latitudinal Gradient Programme (LGP) (Petersen & Howard-Williams 2001). The marine component of the LGP project has a focus from Cape Adare in the north to McMurdo Sound in the south. The study reported upon here provided an ideal opportunity to contribute to the LGP by describing and quantifying the diversity of the benthic macroinvertebrate and fish assemblages of the northwest Ross Sea shelf, and examining the effect of environmental variables influencing the observed assemblage composition.

In this study we had proposed that the nature of the relationship between the spatial distribution of macroinvertebrate and fish assemblages and environmental variables could be elucidated and quantified using univariate and multivariate statistical techniques However, if patterns are to provide insight and predictive power, it is important to ensure that the scale of the sampling and the scale of the processes that are hypothesized to explain patterns in assemblage composition are closely matched (Gaston 2000).

1.3 OBJECTIVES

The overall objective of the project was to carry out a quantitative study of the biodiversity of selected marine communities in the Ross Sea region. The specific objective was: to describe and quantify the diversity of the benthic macroinvertebrates and fish assemblages of the northwestern Ross Sea shelf, and to determine the importance of certain environmental variables influencing assemblage composition.

2. METHODS

2.1 Study area

The study area comprised the shelf area of the northwestern Ross Sea between Cape Adare at approximately 70° S and Cape Hallett at approximately 72° S (Figure 2).

2.2 Sampling Design

A stratified random design was selected to address directly two of the three biodiversity hypotheses to be examined (‘diversity–energy’ and ‘disturbance–diversity’) at the appropriate spatial scales. Five transects running across the shelf (perpendicular to the depth contours and generally aligned SW-NE) were sampled in the Ross Sea between the Hallett Peninsula and north-west of Cape Adare (Figure 2). Transect start points (N to S, approximate latitudes, approximate length) were: Transect 1 (Cape Adare, 70° 20’, 25 km), Transect 2 (71° 35’, 45 km), Transect 3 (Cape McCormick, 71° 50’, 40 km), Transect 4 (72° 05’, 80 km), Transect 5 (Cape Hallett, 72° 20’, 120 km). Each transect was divided into three depth strata (50–250 m, 250–500 m, 500–750 m). The along-shelf (transect strata) distribution of sampling effort was to encompass a supposed latitudinal difference in surface primary productivity along the Victoria Land coast (Peterson & Howard-Williams 2001). The across-shelf depth strata designations would encompass a difference in the quantity of iceberg scour, based upon the spatial appreciation of the shelf determined from multibeam mapping undertaken by a previous survey of the area (Mitchell 2001). Mitchell (2001) revealed that iceberg scour was particularly evident between depths of 200-400 m in the northwest region of the shelf.

To sample different components of the faunal assemblages present (infauna, epifauna, mega-epifauna), a combination of gear types was employed. Although random replicate sampling within each of the three depth strata was planned (four sampling stations were assigned per stratum using random numbers to determine the direction the tow should progress and to select a tow start depth), it was not always possible to obtain all replicates due to ice and/or weather conditions. Each transect was mapped using the ship’s swath multibeam technology first (in the offshore direction) to establish bathymetry and backscatter. Biological samples were taken on the return path along the transect. Additional opportunistic samples were taken at Adare (Robertson Bay one beam trawl and three sleds) and close to the Possession Islands (grapnel line). Such additional samples were excluded from all quantitative analyses.

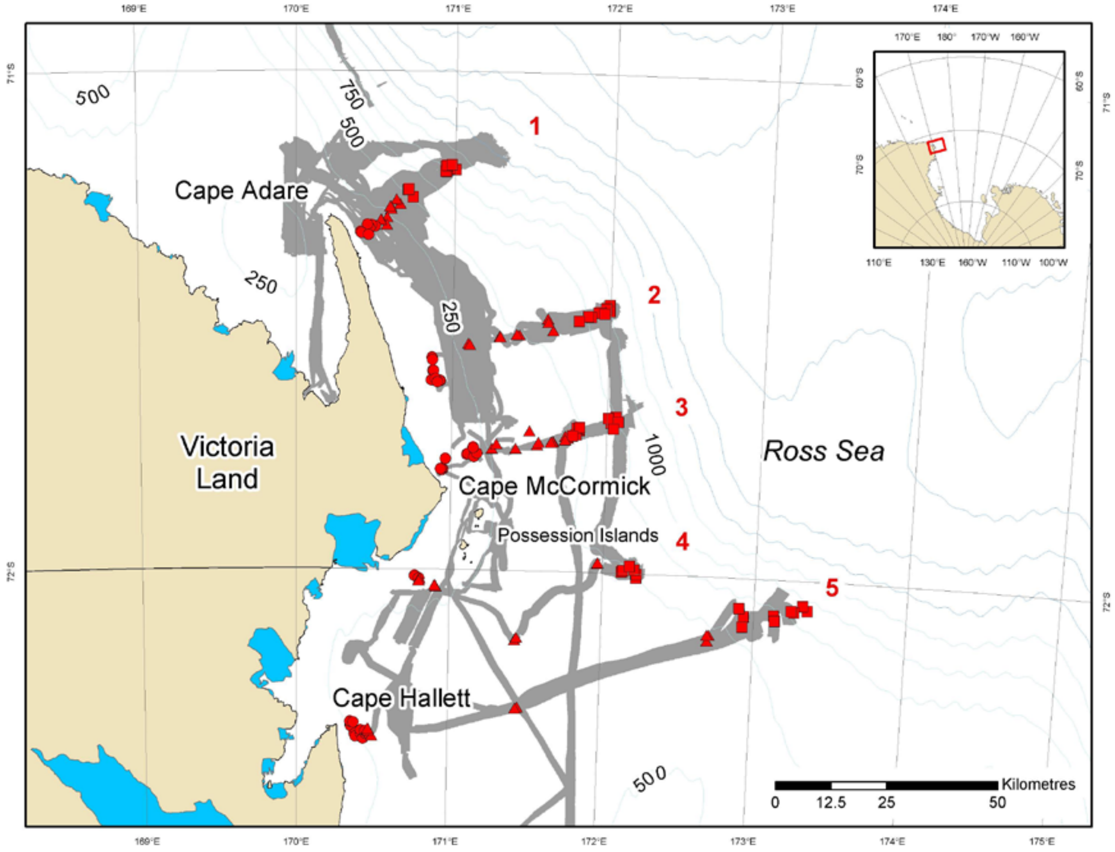

Figure 2: Map of the northwestern Ross Sea showing the BioRoss study area in which stations were sampled along five (numbered) transects. Blue areas indicate sea ice shelves. Multibeam swathed area marked in light grey. Sampling stations and their depth stratification are indicated by different symbols: circle= 50-250 m, triangle= 250-500 m, square= 500-750 m.

2.3 Sample Collection

2.3.1 Direct biological sampling

At each station macroinvertebrates and fish were sampled using a bottom trawl, an epibenthic sled with a video camera and a van Veen grab with a video camera mounted on its frame in order to sample three major components of the benthos: the mega-epifaunal component with a wider distribution (trawl), the epifauna (sled) and the infauna (grab) (see Appendix 1 for photographs of gear used). Additionally, a beam trawl was used on three occasions in the Ross Sea area. Following the successful retrieval of the sampling gear, the sample volume was recorded and digital images of macrofauna sampled were taken to provide a visual record to aid later identification of specimens (all fish specimens but not all macroinvertebrates were photographed). Whenever time constraints prohibited processing of the total sample, sub-sampling was undertaken (see Appendix 2 for station and sample details).

2.3.1.1 Bottom trawl

In order to sample the mega-epifaunal invertebrate and the demersal and pelago-benthic fish fauna, an orange roughy wing trawl (mouth opening 40 by 40 m, 40 mm stretched mesh diameter in cod end) was employed. The trawl tow length was approximately one nautical mile, depending upon sampling rate and composition. A cone net (mesh diameter 2 mm) was attached to the trawl to sample the planktonic component of the fauna. Samples recovered by the cone net are not included in any analyses (but were included in the data incorporated into the Ocean Biogeographic Information System (OBIS) node (http://www.iobis.org/) via the Southwestern Pacific Regional OBIS Node http://www.nzobis.niwa.co.nz.

2.3.1.2 Epibenthic sled

An epibenthic sled (mouth opening 1.4 by 0.5 m, 2 m long, 25 mm stretched mesh diameter) was employed to sample the epifaunal and uppermost infaunal components of the benthic communities. The epibenthic sled was towed parallel to the depth contour at a standard target speed of 1.5–2.0 knots (actual speed, 1–2.7 knots) and 15 minute duration (actual tow length, 0.12–0.70 nautical miles).

2.3.1.3 van Veen grab

A van Veen grab (surface area 0.2 m^2, volume 90 l) was deployed to sample the infaunal macroinvertebrate component of the benthos. After retrieving the grab, sub-samples (approximately 30 ml) for investigating sediment characteristics (see below) were taken through ports on the top of the grab, using either a cut-off 60 ml syringe or a small scoop, before the sample volume was established (by emptying contents into a pre-calibrated bin). The contents of the grab were then removed from the bin and gently washed through a sieve with a 1 mm screen size.

2.3.1.4 Beam trawl

A beam trawl (4 m opening, stretched mesh diameter 30 mm) was deployed when conditions allowed (relatively flat and soft substratum seabed) in order to sample benthic invertebrates and fishes. Although the beam trawl is a useful method for obtaining qualitative data, it was not used as a standard sampling tool because of the limited range of bottom types that it could be deployed on. Thus, data derived from beam trawl deployments were excluded from quantitative analyses but were included in the OBIS node.

2.3.2 Video sampling

Video cameras were mounted onto the frames of the sled and the grab (see Rowden et al. 2002 and Blackwood & Parolski 2001 for details of camera set-up) in order to provide additional information about abundance/cover/morphology of structural species (such as sponges and corals). The combination of grab and camera allowed for quantitative assessments of the faunal assemblages present on and in the seabed, and measurement of some key environmental variables (i.e., sediment characteristics) at the same small spatial scale. Two parallel lasers were used to project points (20 cm apart) that were used for scaling video images. Video records from the epibenthic sled were used to confirm the identity of some species caught by the sled and to assist in the appreciation of the spatial distribution and structure of particular fauna or habitat.

2.3.3 Environmental sampling

In order to address the influence of environmental variables operating at small to intermediate spatial scales on the composition of benthic macrofauna assemblages, four separate sediment sub-samples (approximately 200 g) were taken from the undisturbed surface of each grab sample. The sub-samples were analysed for sediment grain size distribution and sediment sponge spicule content (per gram of sediment); sediment particulate organic carbon content (% POC) and particulate nitrogen content (%

PN); sediment surface phytodetritus (chlorophyll *a*) content (ng/mg). Samples were also taken for the analysis of meiofauna.

2.4 Sample Processing

2.4.1 Biological

2.4.1.1 Faunal identification

Macrofauna recovered by the direct sampling methods were identified onboard to the lowest possible taxonomic level (in the time available), counted and their weight estimated (to plus or minus 0.01 kg). Length measurements of fish were also taken (to plus or minus 1 mm). Guidance and assistance from taxonomists was sought for confirmation or adjustment of on-board identifications of the benthic macroinvertebrate taxa sampled (see Appendix 3 for the list of all taxonomists or parataxonomists who contributed their skill and time to this project).

2.4.1.2 Sample treatment

Biological samples were fixed, preserved and stored, in a manner appropriate for future sample identification and management, following best practices used by NIWA and National Museum of New Zealand Te Papa Tongarewa collections. The majority of biological samples were preserved in 80% ethanol. Where required (e.g., for medusae), samples were fixed in 5% buffered formalin. All sponge samples and some bulk samples of other taxa were frozen at -20°C (e.g., ascidians, holothurians). Sub-samples of unsorted material from trawl, sled and grab sampling were also frozen for potential later analysis (due to time constraints). The sieved unsorted grab samples were fixed in 5% buffered formalin prior to sorting in the laboratory at NIWA. After sorting, samples were transferred to 80% ethanol for storage. Sediment sub-samples taken for environmental determinations were transferred to labelled plastic bags and frozen at -20°C for later analysis at NIWA. Meiofauna subsamples were transferred to labelled containers and fixed with 10% buffered formalin. However, these samples have not been analysed because this was not part of the project, and thus are not reported further here. Samples are currently stored in the NIWA Invertebrate Collection facilities and the National Museum of New Zealand Te Papa Tongarewa (fishes). Collection databases have recorded the location and MFish ownership of specimens recovered by the sampling.

2.4.1.3 Image analysis

Sub-samples of the video images from grab deployments were used to identify the visible macrofauna (typically of size larger than 0.5 cm, Gutt & Starmans 1998) to the lowest possible taxonomic level, and to determine their abundance. Sub-portions (50 by 50 cm), which were non-overlapping, of good quality (in-focus and sufficient illumination) and included the presence of both the scaling laser marks, were selected in Ulead Video Studio 5 software before being imported into ImageJ (a Java image processing software) for image analysis. Sedentary macrofauna (structural species) taxa were manually outlined with the freehand drawing tool, and the area covered was calculated by the software as a proportion (expressed as a percentage) of the sub-portion image. Motile macrofauna taxa were counted and their size (to plus or minus 0.01 cm) determined using the measuring tool in ImageJ. Sediment characteristics were also determined from the same sub-portion images. That is, the percentage cover (of area not covered by macrofauna) of boulders (larger than 25 cm), cobbles (6.5–25 cm), pebbles (0.4–6.4 cm), gravel (up to 0.4 cm; ‘black’ and ‘pale’ components determined separately), sand (sediment with a ‘coarse’ appearance; ‘pale’ and ‘dark’ components determined separately), and mud (sediment with a 'fine and silty' appearance) was also determined and recorded. The percentage cover of biogenic elements of the substrate (‘broken barnacle shell’, ‘dead scleractinian coral’, ‘mixed broken shell/dead coral fragments’, and ‘mud burrows’ – which were also counted) were similarily determined. As many 50 cm by 50 cm (non-overlapping) images as possible were analysed from each deployment of the grab-camera. Mostly, only one image suitable for analysis was obtained from the video records of grabs deployed at sampling stations. However, there were 17 cases where two, 7 where three, 1 where four, and 2 where six images were obtained and analysed.

An index of biological habitat complexity (BHC) was developed for each image using the following formula:

$$\frac{N \times CN_{ST}}{NP} + CS_B$$

where *N*= the mean number of 'patches' of structural taxa per image, CN_{ST} = the total area (%) covered by *N* per image, *NP*= the total number of different patches per image and CS_B = the mean area (%) covered by biogenic substrate per image.

Images obtained by a video camera mounted on epibenthic sleds were used only in a qualitative manner (e.g., to appreciate the general extent of some fauna, or to assist in the identification of preserved material).

2.4.2 Environmental

2.4.2.1 Grain size analysis

Aliquots of sediment from the sub-samples were initially wet weighed and dry weights were obtained after oven drying at 60 ºC for approximately 12 hrs. The dried samples were soaked in a washing solution made of NaH_2CO_3 and $NaHCO_3$ to disperse the particles and then washed over a 63μm sieve using a fine spray of washing solution. The sediment fine fraction (less than 63 μm) was allowed to settle and excess washing solution was siphoned off. This fraction was then run through the Micromeritics Sedigraph 5100 when sufficient material for this process was available. The coarse fraction (larger than 63 μm) was oven dried and sieved into seven size fractions from 63–125 μm to more than 4 mm, with each size fraction being weighed separately. Mean and median grain size and sorting coefficients were calculated using the indices of Folk & Ward (Folk & Ward 1957).

2.4.2.2 Sediment sponge spicule content

Sponge spicule estimates were obtained by counting the number of spicules in a 1 g sediment aliquot under a dissecting microscope using a 16-fold magnification.

2.4.2.3 Sediment particulate organic carbon and particulate nitrogen

Sub-samples for particulate organic Carbon (POC) and particulate Nitrogen (PN) analyses were treated with sulphuric acid to remove inorganic carbon before combustion in a pure oxygen environment at 900°C. Catalysts were used to ensure complete combustion of C and N to CO_2 and N_2. Any carbon monoxide was oxidised further to CO_2 by passing the gases through a column of copper. The gases were separated using a chromatographic column and measured as a function of thermal conductivity (Manual of Analytical Methods Vol 1. The National Laboratory for Environmental Testing, Burlington, Ontario, Canada. Method 01-1090). Almost all PN values were less than 0.02% and thus were excluded from further analysis.

2.4.2.4 Sediment surface chlorophyll *a* content

The method of Humphreys & Jeffrey (1997) was followed to extract chlorophyll *a* from sediment sub-samples. Samples were extracted with the addition of 40 ml of cold acetone into a 100 ml container which was then sonicated for 20 pulses. After being left for 4 hrs at 4 °C to extract, samples were agitated, allowed to settle and 10 ml of the sample was removed and centrifuged for 10 min. In order to detect the total absorption in a visible spectrum, the extract was scanned (340–750 nm) in a spectrometer before being transferred to a fluorometer where sample readings were taken before and after acidification (excitation 431, emission 670, band width 5nm).

Calibrations were performed at a 5 nm bandwith from a freshly made stock sample. The chlorophyll *a* (ng/g) and phaeopigment *a* (ng/g) contents of the sediment samples were then calculated using the following equations:

$$\text{chlorophyll } a \text{ (ng/g)} = K \times Fm \times v(Fo - Fa)/[W(Fm - 1)]$$

$$\text{phaeophytin } a \text{ (ng/g)} = K \times Fm \times v(Fm \times Fo)/[W(Fm - 1)]$$

where
K = fluorescence sensitivity coefficient in extraction solvent (ng Chl *a*/ml)/instrument flow unit
Fm = maximum ratio Fo/Fa in the absence of phaeopigments and Chl *b*
Fo = fluorescence before acidification
Fa = fluorescence after acidification.
v = volume of acetone used for extraction (ml)
W = total weight of sample extracted (mg).

Environmental variables that might influence the compositional patterns of macrofauna assemblages at intermediate to large spatial scales in the study area were also examined. These included chlorophyll *a* content of the surface water and ice cover from satellite image data, iceberg scour from acoustic bottom topography data of the northwest Ross Sea shelf, and bottom water currents from mathematical models of the Ross Sea.

2.4.2.5 Seabed current velocity

Velocities (cm/sec) for the sampling stations were extracted from the Navy Coastal Ocean Model (NCOM) real time model runs for the period 1 January 2004 to 31 March 2004. Data were provided on 35 depth levels between the surface and 5500 m. NCOM has a nominal global resolution of 1/8º, however, in the Cape Adare region the resolution is 1/8º by 3/14º. In many places stations were close to each other at spacing less than the model resolution. Because there would be no noticeable difference in velocities from the model at stations close to each other, one set of model velocities was used for each cluster of stations. Stations were placed into clusters so that the minimum distance between stations in any two different clusters was 1.2 nautical mile. The position of each cluster was taken to be the mean of all the cluster members. As the main focus of the study was seabed velocity, the deepest velocity at each horizontal grid point inside the study area was found. The seabed velocities were then linearly interpolated to the cluster position. This gave a velocity time series for each cluster.

2.4.2.6 Surface chlorophyll *a* content

Sea Viewing Wide Field-of-view Sensor (SeaWiFS: Hooker et al. 1992) surface chlorophyll concentration data (mg/m^3) were obtained from the ocean colour ftp archive at http://oceancolor.gsfc.nasa.gov/ftp.html in Standard Mapped Image format (SMI: Campbell et al. 1995) with a spatial resolution of approximately 9 km. The chlorophyll data were generated from whole-of-mission atmospherically corrected satellite radiances using the OC4v4 algorithm (O'Reilly et al. 1998, 2000), and composited into climatological means for each month (Jan-Dec) using an arithmetic average. The means for the spring (Sep-Nov) and summer (Dec-Feb) period were calculated from the monthly values. Because the OC4v4 algorithm was developed for open ocean systems, it uses ocean colour to generate chlorophyll data. Thus when used for coastal areas, the algorithm cannot distinguish between surface water coloration due to primary production or to terrigenous sediment run-off.

2.4.2.7 Ice cover

Sea-ice distributions (% cover of 25 by 25 km pixel) were obtained from the National Snow and Ice Data Centre (NSIDC), University of Colorado, Boulder, CO, USA (http://nsidc.org). Special Sensor Microwave/Imager (SSM/I) and Scanning Multichannel Microwave Radiometer (SMMR) brightness temperatures were used as input to the bootstrap algorithm (Comiso et al. 1997) to derive climatological monthly sea ice concentrations. These data represent mean ice concentration (percentage of grid cell covered by ice) for each month averaged over the entire time period of the data set (November 1978 to December 2003) at a spatial resolution of about 25 km. The annual and seasonal means were calculated for spring (Sep-Nov), summer (Dec-Feb), autumn (Mar-May) and winter (Jun-Aug) from monthly values. However, only mean values for spring, summer and annual ice cover were included for analysis due to their perceived stronger influence on the biological communities. Due to the relatively large size of the pixels used for ice cover data, land contamination can introduce some error. That is, the pixels closest to the coast are likely to overlap sea and land ice and thus might slightly distort the sea ice cover values. The algorithm used distinguishes the different light refractions of water and ice and thus a melt water pool on the ice would be interpreted as open water.

2.4.2.8 Iceberg disturbance

The acquired multibeam bathymetry data was post-processed using the Benthic Terrain Modeler v1.0 (BTM) software, which operates as an add-in to ArcGIS. The technique relies on the Bathymetric Position Index (BPI) (Iampietro et al. 2005), which is a measure of seafloor height at a location relative to the locations surrounding it (based on the Terrestrial Position Index developed by Weiss 2001). The BTM was used to quantify how much of the 5 transects in the study area had been exposed to iceberg scouring.. The BPIwas applied to a 25 m Digital Elevation Model (DEM) and ‘tuned’ to detect troughs or depressions on the seafloor. The data set was then methodically scanned by eye to detect falsely identified scoured areas which were deleted. The result was a spatial data set indicating for each transect how much of the area was multibeamed (ice cover occasionally prevented multibeam operations) and the proportion of the multibeamed area that was scoured by icebergs. The dataset was used to create a set of statistics for each station. In the Weddell Sea, centres of ice scour disturbance are on average 750–2000 m apart (Potthoff et al. 2006). Thus, for the present study a radius of 1 km was created around each station and the number of iceberg scours within each radius were recorded as well as the percentage area scoured by icebergs (of the total area multibeamed). An index of iceberg scour intensity at a scale of less than one kilometre was obtained by dividing the number of scours by the % area scoured for each radius (Figure 3). In order to include an assessment of disturbance by iceberg scour potentially operating on macroinvertebrate and fish assemblage composition at larger spatial scales, the distance from each station to the nearest scour (independent of the radius) was also measured.

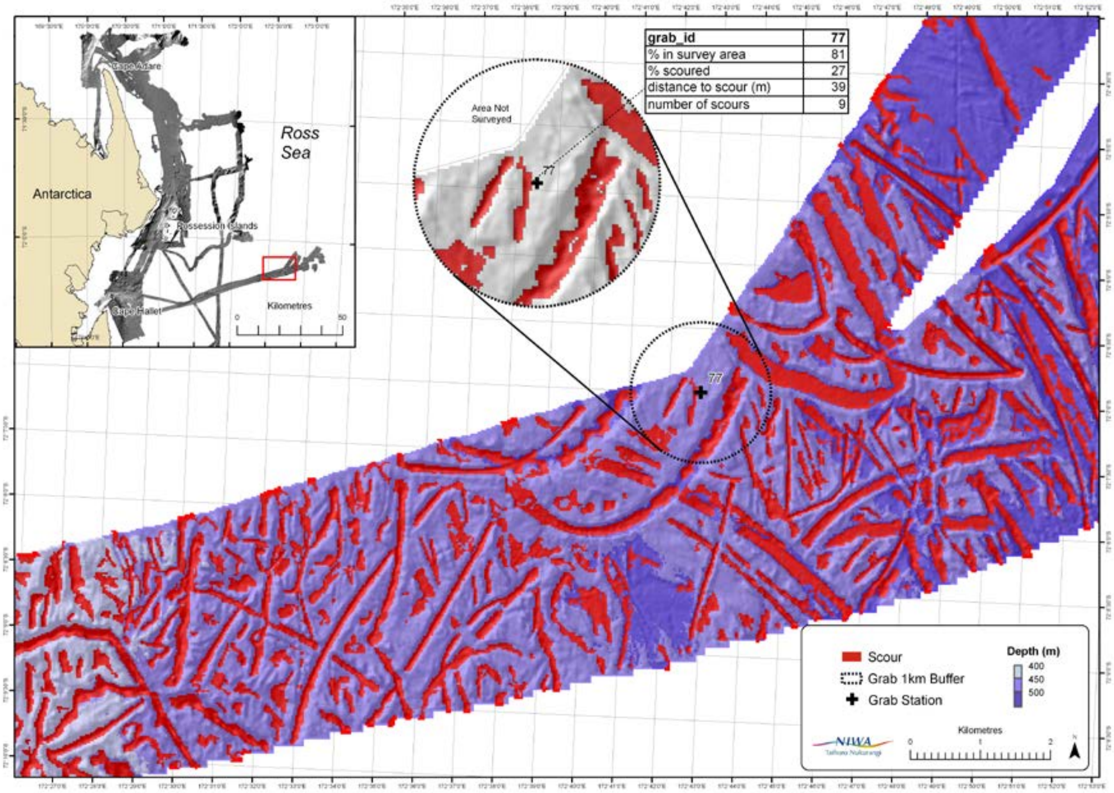

Figure 3: Multibeam swath of seafloor (e.g. transect 5, station 77) with the Benthic Positioning Index (Iampietro et al. 2005) applied for quantification of iceberg scouring. For each station the following were recorded: area multibeamed (%), area scoured (%), number of scours per 1 km radius and, independently from the radius, the distance to the next nearest scour (m).

2.5 Data Analysis

All biological and environmental data generated directly by the survey were added to the BioRoss database, and data from bottom trawl samples were also added to the Ministry for Primary Industries Trawl database maintained by NIWA. All macroinvertebrate and fish data were also incorporated into the South Western Pacific Regional OBIS portal (http://www.nzbois.niwa.co.nz) and summarised in the main Ocean Biogeographic Information System (OBIS) node (http://www.iobis.org/).

The survey was not designed to sample taxa such as algae, foraminiferans and nematodes. That is, the sampling/processing methodology employed precluded knowledge of the live/dead status of foraminiferans and also precluded the quantitative sampling of nematodes (which are also often considered to be part of the meiofauna). Thus these taxa are excluded from analyses. Furthermore, the survey was not designed for the sampling of planktonic taxa such as medusae and copepoda. Consequently these taxa are also excluded from analyses. Nemerteans have a tendency to fragment, which makes estimating of abundance problematic. Thus this macroinvertebrate taxon has not been included in any quantitative analysis in this report.

2.5.1 Univariate analysis

2.5.1.1 Choice of biodiversity metric

A prerequisite for the description of biodiversity is the need to define it in ecologically meaningful ways that are practical to measure. The most widely used measures of biodiversity are those based on the number of species present, sometimes adjusted for the number of individuals sampled, or indices that describe the evenness of the distribution of the numbers of individuals among species, or that combine both richness and evenness properties (see review by Magurran 2004). Changes in such measures are not explicitly linked to changes in functional diversity, and so their ecological significance is difficult to establish. Traditional diversity measures have disadvantages in assessing biodiversity change on wide spatial scales because they are often sample method-, size- or habitat-specific. In response to these limitations alternative measures have been devised to overcome these problems. Such a measure is average taxonomic distinctness (AvTD), which is based on the degree of relatedness of species, and is independent of sample size (Warwick & Clarke 1995). Clarke & Warwick (1998) have also devised a randomisation test to detect a difference in the average taxonomic distinctness, for any observed set of species, from the 'expected' value derived from a 'master species list' for the relevant group of organisms (Clarke & Warwick 1999). Taxonomic distinctness also appears to be explicitly related to trophic diversity (i.e., one aspect of 'functional' diversity) (Warwick & Clarke 1998). This diversity measure is beginning to find application in broad scale geographical comparisons of biodiversity (Piepenburg et al. 1997, Price et al. 1999) and in environmental impact assessment (Hall & Greenstreet 1998, Rogers et al. 1999) in the marine environment. Most recently, Clarke & Warwick (2001b) have presented another measure, variation in taxonomic distinctness (VarTD), which reflects the unevenness of the taxonomic tree. This measure is particularly relevant for comparing biodiversity at larger spatial scales where, in addition to anthropogenic environmental degradation, habitat heterogeneity is likely to influence patterns of diversity. Therefore, the present assessment of biodiversity patterns in the Ross Sea study area adopted the use of these two biodiversity indices.

In consideration of the sampling methods employed, the presence-absence forms of the biodiversity indices were used based on data obtained from the three main gear types from stations associated with the *a priori* sampling design and number of species greater than one. The taxonomic categories used in the analysis were: species, genus, family, order, class and phylum (phylum was only used for macroinvertebrate biodiversity). The weightings of the path lengths between hierarchical taxonomic levels were standardised so that two species connected at the highest (taxonomically coarsest) possible level would have a weighting of 100. Steps between each level were set as being equal. It has been found that for some taxa an inherent correlation (either positive or negative) can exist between AvTD and VarTD (Warwick & Clarke 2001). If a correlation between the two indices is inherent, then the indices cannot be interpreted separately because one is a surrogate of the other. The macroinvertebrate and the fish data were examined for the existence of a linear correlation. No such correlations were found, and therefore the values for both indices are reported.

See Appendix 4 for additional information on the use of taxonomic distinctness metrics.

2.5.1.2 Predictions and tests

Studies have shown that species richness and taxonomic distinctness are not generally related in their response to environmental variables (e.g., Heino et al. 2005) and thus it is not possible to simply replace predictions based on diversity hypotheses for species richness with those for taxonomic distinctness. Hence, it is necessary to make specific predictions for taxonomic distinctness based upon a qualitative understanding of how the taxonomic composition of an assemblage may be expected to react to various forcing factors (Bates et al. 2005). Below, the hypotheses being tested in the present study are examined with respect to how measures of taxonomic distinctness may respond.

It has been argued that a continuous low or high supply of energy-limiting parameters (e.g., light, nutrients, primary productivity) results in steady-state assemblages, where some species able to compete for the energy resource develop in high abundances, while weaker competitors are scarce or completely excluded (Sommer 1985, Capblancq 1995). On the other hand, a discontinuous or moderate supply of an energy resource would encourage the coexistence of species and thus would support high species richness (Mittelbach et al. 2001), with species being distributed relatively evenly among a large range of taxonomic groups. The results of a study examining the influence of nutrient supply on phytoplankton assemblages in lakes have demonstrated that high and low nutrient inputs were associated with assemblages dominated by relatively few closely related taxa (low measures of AvTD and high VarTD) whilst moderate nutrient inputs stimulated the growth of different taxonomic groups (high AvTD) and increased the evenness of assemblages (low VarTD) (Spatharis et al. 2007). In the present study the potential supply of energy to benthic macrofauna was primarily assessed using a proxy measure of surface water primary productivity (which peaks or is highest primarily in spring and summer months). It would be reasonable to expect that where productivity is low (or extremely high – if such a situation should exist in the northwestern Ross Sea) assemblages will be dominated by a few species within a limited number of taxonomic groups, and hence AvTD would be low and VarTD high. However where productivity is relatively high (i.e. at moderate/intermediate levels), assemblages would be expected to have relatively high values of AvTD and low values of VarTD. It is possible that because the proxy measures of productivity are better suited for examining relationships with macroinvertebrate assemblages than fish assemblages, such a prediction may not necessarily be expected to apply to the latter taxonomic group.

Benthic communities that have been subjected to anthropogenic or natural disturbance are generally composed of relatively few, often closely related, species. That is, disturbed assemblages will have low measures of AvTD, and because some taxa will be over-represented and others under-represented, high measures of VarTD. In contrast, less disturbed communities tend to be composed of a range of different species belonging to many different taxonomic groups, and will have the converse measures of AvTD and VarTD (Warwick & Clarke 1995). While there have been studies that support this argument (e.g., Warwick & Clarke 1998 – pollution stress on nematode communities, Brown et al. 2002 – physical stress on coral communities, Gristina et al. 2006 – fishing pressure on fish communities, Marchant 2007 – anthopogenic disturbance on stream insect communities), there have also been studies that provide evidence that measures of TD and disturbance do not always follow the predicted relationship (Hall & Greenstreet 1998 – fishing pressure on demersal fish communities, Somerfield et al. 1997 – oil field related disturbance on macroinvertebrate communities, Machias et al. 2005 – impact of fish farms on fish communities). The reason for this discrepancy may relate to the nature of the stress-generating factor and the disturbance history of the assemblages studied, and therefore the use of TD measures as a diagnostic indicator of disturbance should be treated with caution (Wlodarska-Kowalczuk et al. 2005). Another reason for the lack of a consistent pattern almost certainly relates to the non-linear relationship between disturbance and diversity (the so-called intermediate disturbance hypothesis). That is, intermediate levels of disturbance can result in benthic communities of high diversity, and high AvTD and low VarTD measures (Cusson et al. 2007). Thus, interpretation of the results of an analysis that involves measures of TD might need to include a qualitative assessment of the relative level of disturbance the study assemblages are/have been subjected to (unless a large disturbance range is actually measured), as well as a prediction of the response of such assemblages to the disturbance in question. In the case of the BioRoss study, the scale of iceberg scouring received by the shallow depth stratum was found to be very low (see Results). As far as can be determined from the few estimates that exist for the spatial frequency of iceberg scouring in deep-water in Antarctica, the level of iceberg disturbance for the middle and deep depth strata was of a relatively high level. However, because of the nature by which the disturbance operates on each of the two study assemblage types, the relative level of 'high' for these strata is different for each assemblage type. Iceberg disturbance directly (e.g., physical disturbance) as well as indirectly (e.g., changes in local current patterns and therefore also in sedimentation patterns, Conlan et al. 1998, Barnes & Conlan 2007; and even levels of primary production, Arrigo & van Dijken 2004) affects the macroinvertebrate assemblages, whilst the fish assemblages sampled will only be indirectly affected by the disturbance (e.g., via altering benthic food resource availability). Thus, the level of disturbance in the deeper two strata for macroinvertebrate assemblages is likely to be high, whilst for the fish assemblages iceberg scouring in these strata probably represents a lower level, perhaps even an intermediate level, of disturbance. Thus, it is reasonable to predict for the macroinvertebrate assemblages that measures of AvTD for the shallow stratum will be higher than those for the deeper strata, with measures of VarTD being the converse. Whilst for the fish assemblages measures of AvTD for deeper strata will be higher than those for the shallow stratum, and measures of VarTD the converse.

Heterogeneous environmental conditions allow for a range of species that are adapted to distinct conditions to coexist. These taxa with contrasting ecological requirements are often distantly related. That is, high habitat heterogeneity leads to high biodiversity, both in terms of species richness and taxonomic distinctness (high AvTD) (Warwick & Clarke 1998). Conversely, when habitat heterogeneity is low, the number of species supported is also low and these species are likely to be more closely related (low AvTD). Because some higher taxa are associated with specific habitats (e.g., most species of the phyla Porifera (sponges) live attached to hard substrate), if such habitats are absent then the assemblage may contain gaps in the taxonomic spectrum, leading to high VarTD (Clarke & Warwick 2001b). With an increase in habitat heterogeneity, the increase in species richness could be represented by congeneric species which are either able to avoid direct competition or are adapted to slightly different niches – which would result in a decrease in VarTD. However because such taxonomic structure patterns do not always follow, taxonomic distinctness may not be a particularly useful metric for habitat heterogeneity-diversity studies, something which Warwick & Clarke (1998) noted when they examined the influence of habitat heterogeneity on the average taxonomic distinctness of free-living nematode communities. These authors concluded that measures of species richness are more strongly affected by relative levels of habitat heterogeneity than measures of taxonomic distinctness. Thus for the BioRoss, no attempt was made to relate values of AvTD and VarTD for macroinvertebrate assemblages to values of the habitat heterogeneity variables measured (measures of habitat heterogeneity relevant to fish assemblages were not obtained).

In order to test and examine the energy and disturbance hypotheses thought likely to explain the patterns of macrofauna biodiversity composition on the northwest shelf of the Ross Sea, the following analyses were undertaken. Differences in AvTD and VarTD among the *a priori* defined sampling groups (i.e. transects and depth strata) were identified using univariate methods. Means of AvTD and VarTD for each sampling group were computed (using the Taxdisc sub-routine of the DIVERSE routine in the statistical software package PRIMER v 6.15; Clarke & Gorley 2001, Clarke & Warwick 2001a) and tested using one-way ANOVA models (STATISTICA 7.1, StatSoft, Inc.). The Shapiro Wilk W test and Cochran's test were used to assess data assumptions of normal distribution and homoscedasticity, respectively. In most cases such assumptions were violated and thus the one-way ANOVA was conducted using ranked data. For multiple post-hoc comparisons Tukey's Honestly Significant difference (HSD) test for unequal n was used.

2.5.2 Multivariate analysis

2.5.2.1 Choice of statistical methods

Multivariate statistical techniques that utilise similarity measures have long been employed in benthic ecology (e.g., Stephenson et al. 1970) to describe assemblages, and have been successfully used to nominate Antarctic assemblages (e.g., Gerdes et al. 1992). Numerous similarity measures and associated multivariate techniques have been applied and the rationale for the choice of particular methods used is rarely given. The rationale for adopting the suite of multivariate statistical procedures contained within the PRIMER software package (Clarke & Gorley 2001) used in the present study relate to convincing arguments made in the book that supports the package (Clarke & Warwick

2001a). Peer-reviewed arguments have also been made by these and other authors in the primary literature concerning the comparative usefulness of the PRIMER procedures (e.g. Warwick & Clarke 1991, Clarke 1993). A recent textbook on ecological statistics supports the contentions by Clarke & Warwick (2001a) regarding the applicability of non-metric multidimensional scaling (NMDS) ordination (the technique promoted by PRIMER) to the type of study undertaken (Gotelli & Ellison 2004, see Chapter 12).

For all multivariate analyses of invertebrate and fish assemblage compositional patterns, only data derived from the three main gear types from stations associated with the *a priori* sampling design and with more than one macroinvertebrate or fish species were included in the analysis. For initial visual comparisons of data from different gear types and for analyses of the macroinvertebrate assemblage compositions, data were presence-absence transformed. Fish abundance data were standardised and square-root transformed to down-weight the influence of dominant taxa and increase the weight of rare taxa. Similarity matrices were constructed for these data using the Bray-Curtis Index (Bray & Curtis 1957). Non-metric multidimensional-scaling ordination (NMDS) plots were produced to visualise the (dis)similarity of macroinvertebrate assemblages. The different gear types were used in order to sample different components of the macroinvertebrate assemblages (mega-epifauna, epifauna and infauna) and thus it can be expected that an analysis of assemblage composition may reveal gear type to be a significant factor which could override differences caused by latitude and/or depth. Thus it was seen as prudent to test for gear differences (one-way ANOSIM) and to subsequently analyse the different faunal components separately.

2.5.2.2 Predictions and tests

According to the hypotheses examined by the study, and the findings of previous studies in the region (see Introduction), the composition of the benthic assemblages is predicted to be different among areas presumed to represent different productivity (transects) and disturbances (depth stata) regimes, and sites with different levels of habitat heterogeneity (variously quantified). The influence of other potential drivers of assemblage composition (some of which are likely to interact with the main variables e.g. ice cover) were also predicted to exhibit some influence on the compositional patterns observed.

In order to test and examine the energy, disturbance and structural heterogeneity hypotheses thought likely to explain the patterns of macrofauna assemblage composition on the northwest shelf of the Ross Sea, the following analyses were undertaken. A two-way crossed ANOSIM (Analysis of Similarities) (Warwick et al. 1990) was performed to test for significant differences in assemblage composition among the *a priori* sampling groups of transect and depth strata. The null hypotheses tested were ($H_0$1) no difference of assemblage composition among transects, allowing for differences among depth strata, and ($H_0$2) no difference of assemblage composition among depth strata, allowing for differences among transects.

A two-way crossed SIMPER analysis (similarity percent analysis, Clarke 1993) was employed to calculate the assemblage similarities and dissimilarities within and among the *a priori* sample groupings, and to identify those species contributing most to the average similarity for each grouping (typifying species) and dissimilarities among such groups (discriminatory species; only for groups being significantly different). Relatively high ratios (greater than 1.3) of the average (dis)similarity to standard deviation of the (dis)similarity were used to identify typifying and discriminatory species.

To assess the possible effect of perturbation or stress on the macroinvertebrate and fish assemblages, the PRIMER routine MVDISP was employed to calculate the relative dispersion of replicate samples within the depth strata sampling group (Warwick & Clarke 1993). The assumptions underlying the use of MVDISPe are that perturbation leads to increased variability in assemblage composition (i.e., reflected in greater variability between samples from the same sample group), and that disturbance of the seabed by icebergs represents such a perturbation.

Relationships between the patterns of macroinvertebrate and fish assemblage composition and measured environmental variables were examined using the statistical correlation technique BVSTEP (e.g., Clarke & Ainsworth 1993). All pairwise combinations of environmental variables were visually examined (using draftsman plots) to assess the possible need for transformation and for co-correlation prior to conducting the BVSTEP analysis. For pairs of variables with a correlation factor greater than or equal to 0.9, one variable was excluded from the analysis. Variables excluded from analyses and variables requiring log-transformations are listed in the respective results sections. All variables were normalised prior to the BVSTEP analysis.

3. RESULTS

3.1 Environment

Data for surface chlorophyll *a* content averaged for spring and summer seasons, minimum and maximum current speed, current direction (compass), mean seasonal and annual sea ice cover and maximal depth are detailed for each station in Appendix 5 Data for the sediment characteristics obtained from grab samples and the Biological Habitat Complexity Index (BHC), which were derived from image analysis data, are detailed in Appendix 6

Surface chlorophyll *a* data (averaged for the austral summer Dec-Feb) were used as a proxy for primary productivity. In contrast to the initial assumption concerning a latitudinal productivity gradient (Peterson & Howard-Williams 2001), there was neither an increasing gradient in surface water chl *a* nor in sediment chl *a* with increasing latitude. Mean surface chl *a* values ranged between 0.29 and 0.58 mg m^{-3}; although the highest values were found for transect 5, the southernmost transect near Cape Hallett, the lowest values were found in transect 3, near Cape McCormick (Figure 4a). The sediment chl *a* values followed a similar pattern with highest values in transect 5 (0.80 $\mu g\ g^{-1}$) and the lowest values occurring in transects 3 and 4 (0.20 $\mu g\ g^{-1}$) (Figure 4b). As predicted from analysis of multibeam data from a previous survey of the area (Mitchell 2001), iceberg scouring was most prevalent in the mid depth stratum (250–500 m) with about 6% of the surveyed area covered by scour depressions (Figure 4c). However, it had not been predicted that the extent of scouring would be similar in the deep stratum (500–750 m), where about 5% iceberg scour by area was detected. In the shallow depth stratum (50–250 m) less than 1% of the bottom showed evidence of scour marks detectable by the analysis of multibeam data.

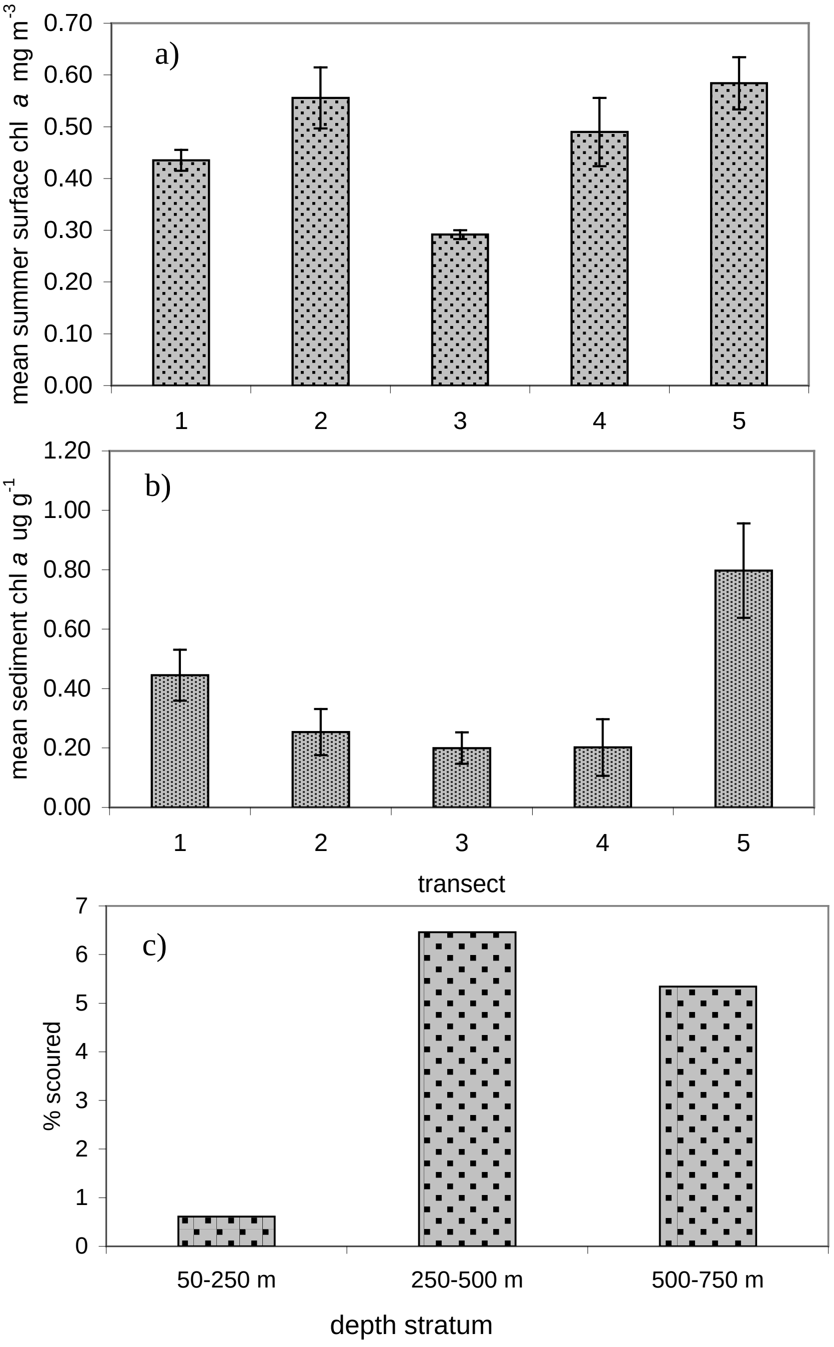

Figure 4: a) Mean surface water chl a concentration (mg m^{-3}) for austral summer (December–February 2004-2005; SeaWiFS), and b) mean sediment chl a content (µg g^{-1}) for five transects in the northwestern Ross Sea shelf. c) Area (%) scoured by icebergs as detected by Bathymetric Position Index from multibeam data for three depth strata in the northwestern Ross Sea shelf. Error bars indicate plus or minus 1 SE.

No expectations for any particular patterns were made for the remaining environmental variables measured. Some of these patterns are briefly described below and mean values of all measured environmental variables (except those in presented in Figure 4) are detailed in Table 1. The mean maximum current speed decreased with latitude from 20.2 cm s^{-1} in transect 1 to 7.8 m s^{-1} in transect 5. No difference was detected between the shallow and mid strata (approximately 17.6 cm s^{-1}) whereas in the deep stratum the mean maximum current speed was noticeably lower (10.1 cm s^{-1}).

Differences in mean annual ice cover amongst transects (59.3–62.4%) as well as amongst depth strata (59.0–62.6%) were minimal. The mean summer ice cover was slightly more varied, ranging between transects from 27.7% cover at transect 1 to 21.9% at transect 2, and was highest in the shallow stratum (32.4%) and lowest in the deep stratum (16.5%). In all transects and strata the sediment consisted mainly of poorly sorted very fine gravel and very coarse sand. Only in the deep stratum was the particle size slightly smaller and the sediment consisted of poorly sorted coarse to very coarse sand.

Table 1: Mean values for environmental variables for five transects and three depth strata in the northwestern Ross Sea. Values for standard errors have been omitted for clarity in the table.

	Transect					Depth stratum		
Environmental Variable (mean)	1	2	3	4	5	50–250 m	250–500 m	500–750 m
Max. current speed (m s^{-1})	20.17	16.81	20.62	12.46	7.76	17.56	17.77	10.07
Mean current direction (º)	338.37	346.95	342.40	273.99	196.35	229.45	300.67	344.86
Annual ice cover (%)	61.65	59.30	59.46	61.80	62.40	62.64	61.53	59.00
Summer ice cover (%)	27.66	21.87	24.04	25.56	26.57	32.44	27.34	16.53
Particle size (phi)	-0.02	-0.11	0.17	-1.00	-0.15	-0.78	-0.15	0.58
Sorting coefficient	1.61	1.36	1.83	1.21	2.06	1.39	1.71	1.95
POC content (%)	0.12	0.03	0.13	0.04	0.27	0.19	0.11	0.10
% fine	1.15	0.87	7.60	0.17	11.89	1.28	5.14	8.96
% pebbles	26.50	23.29	25.41	45.00	33.84	20.35	26.92	40.84

3.2 Macroinvertebrate assemblages

On the northwestern Ross Sea shelf area a total of 53 grab, 55 sled and 29 trawl deployments rendered 821 putative macroinvertebrate species, 404 of which were colonial and thus no abundance data are available for them. Colonial phyla were the most speciose phyla with 191 bryozoan species (24% of all species) and 114 sponge species (14%). The solitary taxa contributed 11 675 individuals belonging to 417 species, of which the phylum Mollusca was the most speciose phylum with 113 species, contributing 14% of all species. Annelida (polychaetes and hirudinea; 92 species) and Arthropoda (89 species) each contributed 11% of species. For a list of macroinvertebrate species derived from stations used in quantitative analysis see Appendix 7 The complete species inventory (including qualitative samples and samples outside the a priori sampling design) has been incorporated into the South Western Pacific Regional OBIS Node (http://nzbois.niwa.co.nz) and summarised in the main Ocean Biogeographic Information System (OBIS) node (http://www.iobis.org/).

Table 2 lists mean numbers of species (separately for solitary and colonial taxa) and mean numbers of individuals for colonial taxa for the sample groupings transect and depth stratum. Macroinvertebrate species richness was highest in the southernmost transect (5) with 475 species. In transect 4 the lowest number of species was identified (S=296), but the highest mean abundance for solitary taxa was also recorded in this transect (*N*=160). The mid-depth stratum(250–500 m) showed highest overall species richness with 563 putative species whereas the lowest number of species was recorded for the deep stratum with 389 species. The highest mean abundance of solitary taxa was found in the shallow stratum (*N*=115) and the lowest in the deep stratum (*N*=51). For number of species (solitary and colonial species separately) and number of individuals (solitary species only) per station see Appendix 8 However, these values cannot be used for any statistically meaningful comparison because of the differences in the number of samples (and gears used to obtain these samples) among strata. Thus, as noted earlier, measures of taxonomic distinctness were employed to allow for robust diversity analysis.

Table 2: Number of samples (grab, sled and trawl), mean number of individuals *N* (solitary taxa) and mean number of species *S* (colonial and solitary taxa) for macroinvertebrate assemblages in sample groupings "transect" and "depth stratum" on the northwestern Ross Sea shelf.

Sample grouping	Group	Number of samples	Mean *S* colonial taxa	Mean *S* solitary taxa	Mean *S* total	Mean *N* solitary taxa
Transect	1	27	170	249	419	101
	2	28	159	174	333	70
	3	34	210	223	433	73
	4	16	130	166	296	160
	5	32	257	218	475	61
Depth stratum	50–250 m	40	275	280	555	115
	250–500 m	50	273	290	563	94
	500–750 m	47	180	209	389	51

3.2.1 Univariate analysis

No significant differences were detected by the ANOVA test when comparing the mean AvTD and VarTD values among the sampling groups transect and depth stratum (Table 3).

Table 3: ANOVA results for comparisons of biodiversity indices Average taxonomic distinctness (AvTD) and Variation in taxonomic distinctness (VarTD) of macroinvertebrate assemblages on the northwestern Ross Sea shelf. Where ANOVA data assumptions were violated, ranked data were used.

Group	Factor	Data	MS	F	dF	*p*-value
Transect	AvTD	ranked	409.6	0.2543	4	0.9066
	VarTD	ranked	652.6	0.4070	4	0.8034
Depth stratum	AvTD	ranked	524.5	0.3296	2	0.7198
	VarTD	ranked	489.2	0.3073	2	0.7359

The pattern for TD measures for macroinvertebrate assemblages among transects (Figure 5, top) did not conform to the initial prediction that AvTD would be high (and VarTD would be low) when proxy measures of potential energy input (surface water and surface sediment chlorophyll *a*) were low (compare with Figure 4) and conversely.

Although not statistically significant, the pattern for AvTD measures for macroinvertebrate assemblages among depth stata (Figure 5, bottom) did to some extent conform to the hypothesis prediction. That is, AvTD for the shallow, least iceberg scour disturbed stratum was higher than for the two deeper, most iceberg scour disturbed strata. The pattern for VarTD did not conform to the initial converse prediction.

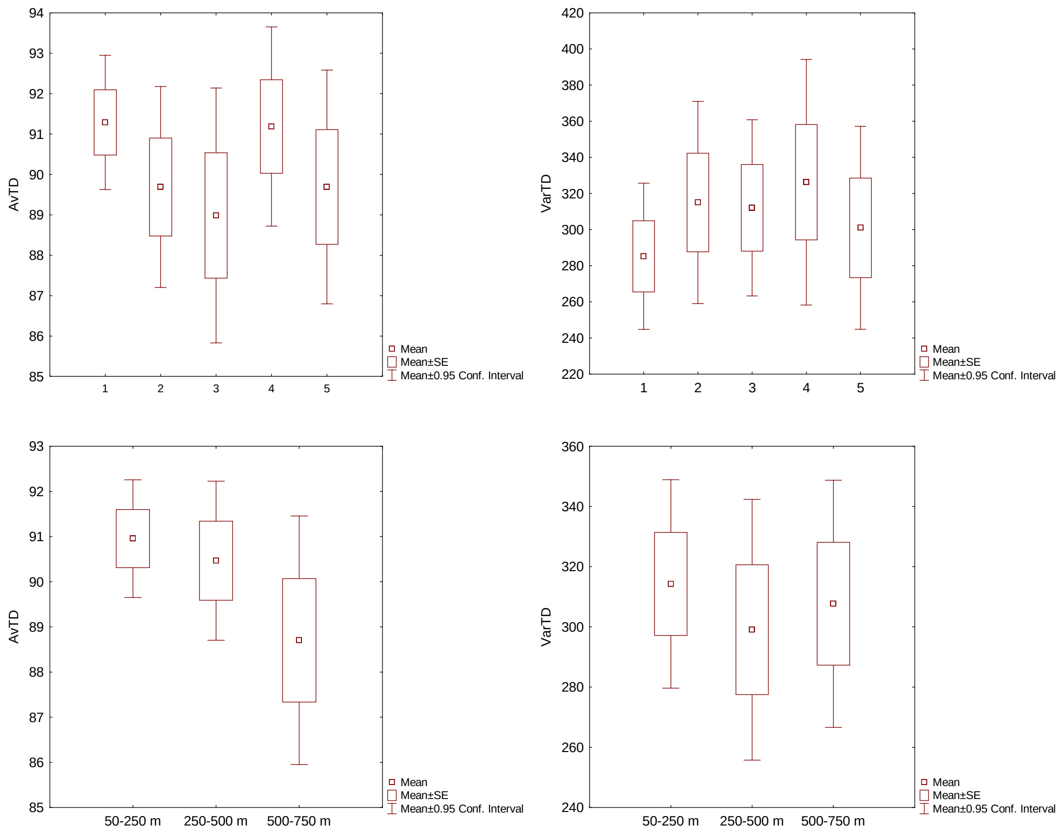

Figure 5: Mean values for Average taxonomic distinctness (AvTD) and Variation in taxonomic distinctness (VarTD) of macroinvertebrate assemblages on the northwestern Ross Sea shelf for sampling groups transect (top) and depth stratum (bottom). Standard error (SE) and mean 95% confidence intervals are also given.

3.2.2. Multivariate analysis

To derive a representative picture of the different benthic components of the macroinvertebrate assemblages of the northwestern Ross Sea shelf, different gear types were used to target the infauna (grab), the epifauna (sled) and the widely dispersed mega-epifauna (trawl). Ideally, data from all three gear types would be combined and analysed together to represent the whole macroinvertebrate assemblage. However, if gears do sample completely distinct assemblage types then in the event of an unequal distribution of sampling effort among sampling strata by gear (as eventuated in the present study) there is a risk that any observed pattern maybe confounded by gear type. Thus, as a first step in the data analysis an MDS ordination of the macroinvertebrate abundance data was performed in order to evaluate the likelihood of confounding. This plot showed that although sled samples were somewhat interspersed among samples from the trawl, in the main there was clustering of samples according to their gear type (Figure 6). An *a postori* one-way ANOSIM test confirmed that the assemblages sampled by the different gears are significantly different from one another (Global R=0.525 with $p \leq 0.001$). Thus, although somewhat cumbersome, all further analyses are conducted for each gear/assemblage type separately.

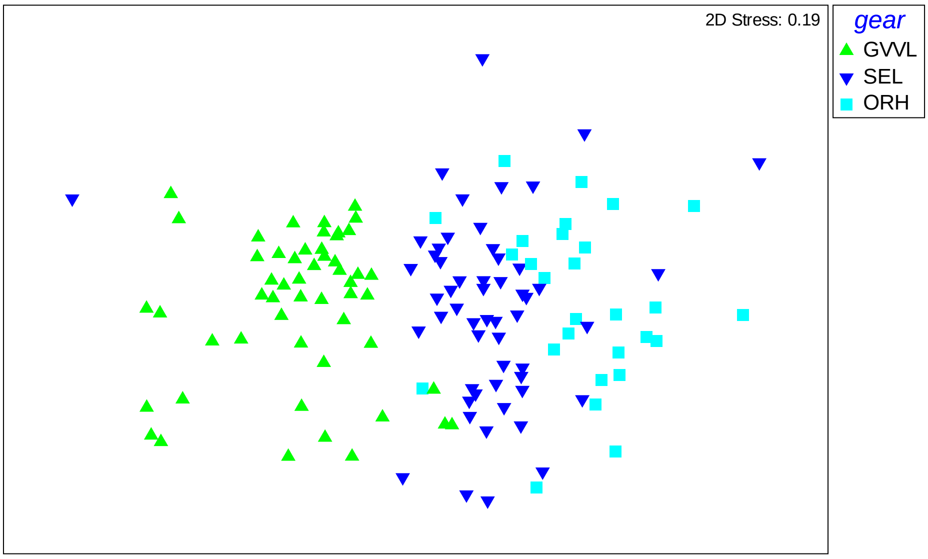

Figure 6: MDS ordination of Bray-Curtis similarities for macroinvertebrate abundance data for infauna (grab; GVVL), epifauna (sled; SEL) and mega-epifauna (trawl, ORH). Data presence-absence transformed. Outlier station 68 (ORH) omitted.

A visual inspection of the MDS plots for each assemblage type indicates that some clustering of samples by transect is apparent, although such clustering is most obvious for the mega-epifauna (Figure 7). The formal ANOSIM tests revealed that the three macroinvertebrate assemblage types all showed significant differences among transects (Table 3). For both the in- and the epifauna, differences in assemblage composition among the sample grouping transect were relatively weak (Global R=0.25 and $p\leq0.001$ for both). Only for the mega-epifauna were the differences in composition more pronounced (Global R=0.49, $p\leq0.001$) among transects. Post-hoc pairwise comparisons revealed that for all assemblage types transect 5 was significantly different from transects 2 and 3 in its assemblage composition. Other pairwise differences in composition were observed between transects but these were not common among assemblage types (Table 4).

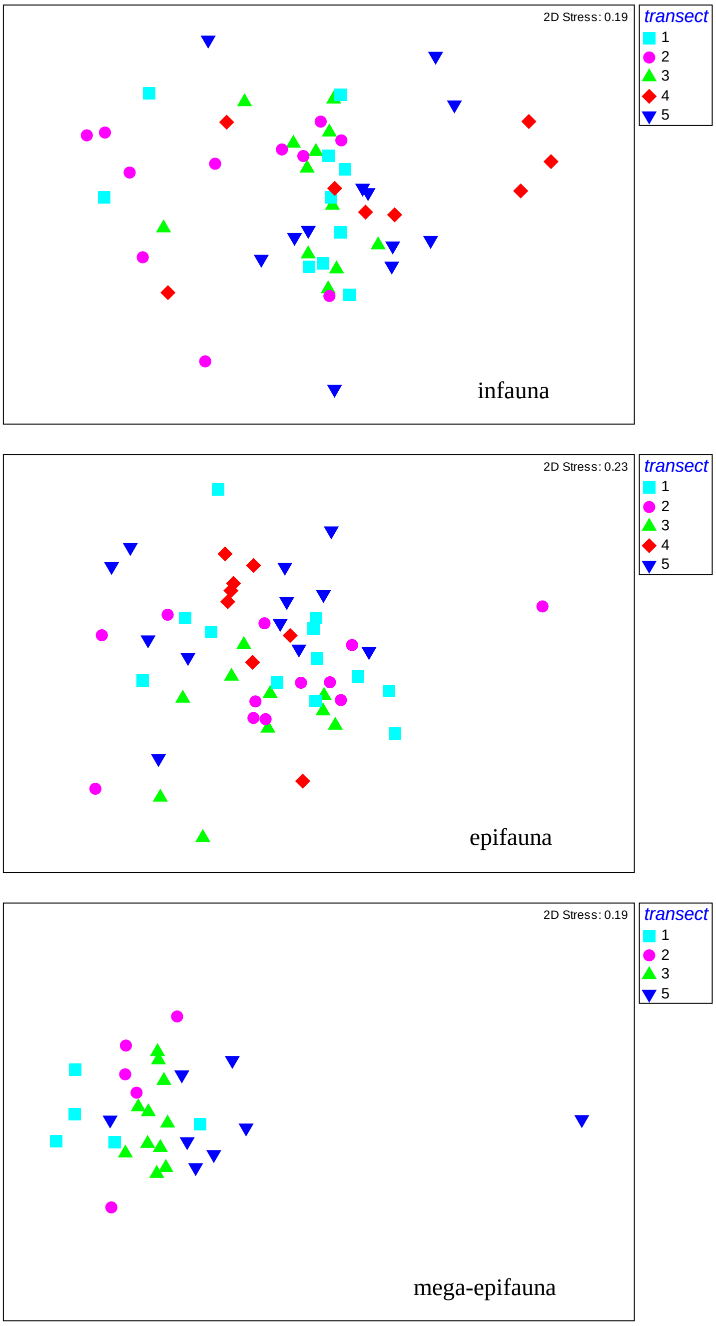

Figure 7: MDS ordination of Bray-Curtis similarities for infauna (top), epifauna (middle), and mega-epifauna (bottom) abundance data (presence-absence transformed) for the northwestern Ross Sea shelf. Stress = 0.19, 0.23, 0.19, respectively. Note that for the epifauna plot, outlier Stn 6 (transect 3) is not shown, and for the mega-epifauna there are no data for transect 4.

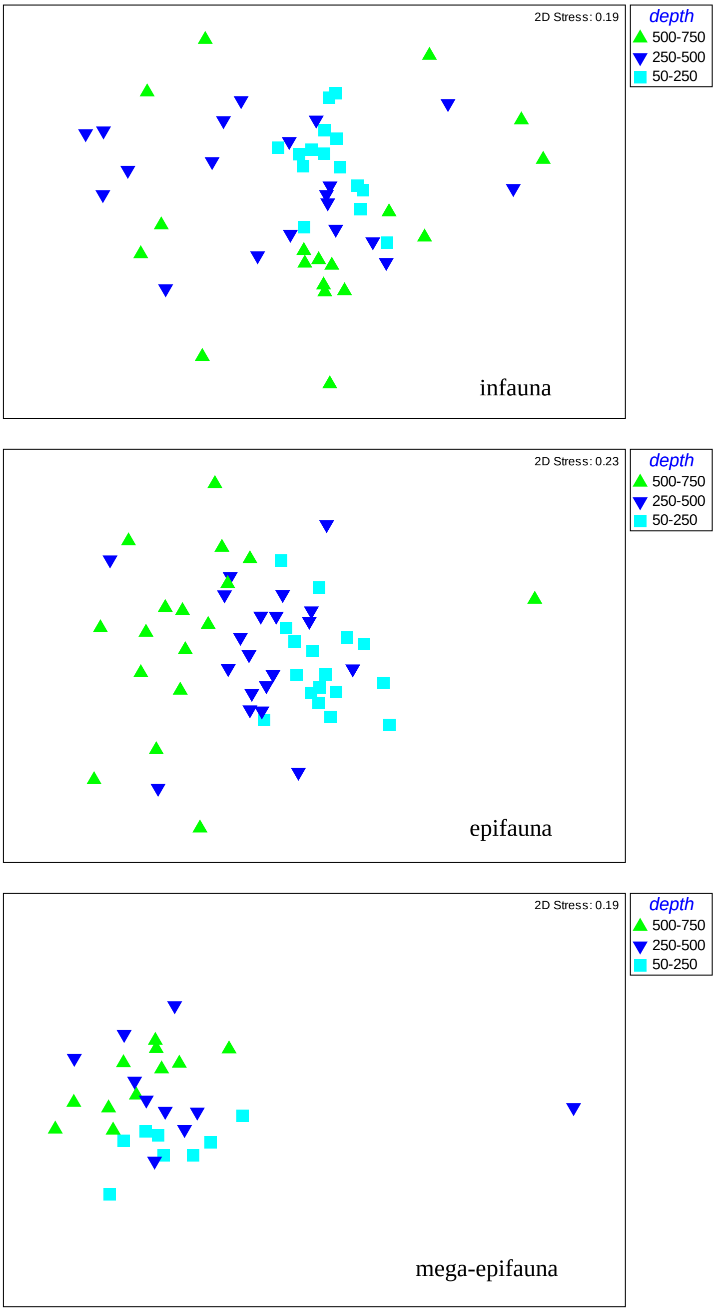

Figure 8: MDS ordination of Bray-Curtis similarities for infauna (top), epifauna (middle), and mega-epifauna (bottom) abundance data (presence-absence transformed) for the northwestern Ross Sea shelf. Stress = 0.19, 0.23, 0.19, respectively. Note that for the epifauna plot the outlier Stn 6 (depth strata 500-750 m) is not shown.

Table 4: Two-way-crossed ANOSIM results for global and pairwise tests for significant differences among transects and depth strata for three macroinvertebrate assemblage types from the northwestern Ross Sea shelf. Bold *p*-values indicate significance at a level of $p \leq 0.05$. Abundance data presence-absence transformed.

Assemblage type	Sampling grouping	Groups compared	*R* -value	Significance level *p*
Infauna	Transect	All transects	0.248	**0.001**
		1, 2	0.096	0.201
		1, 4	0.003	0.498
		3, 1	0.132	0.099
		3, 2	0.301	**0.030**
		3, 4	0.460	**0.005**
		3, 5	0.382	**0.006**
		4, 2	0.412	0.190
		5, 1	0.143	0.099
		5, 2	0.526	**0.002**
		5, 4	-0.147	0.826
	Depth stratum	All depth strata	0.257	**0.001**
		250–500, 50–250	0.140	0.097
		500–750, 50–250	0.514	**0.001**
		500–750, 250–500	0.139	0.073
Epifauna	Transect	All transects	0.246	**0.001**
		1, 2	0.193	0.050
		1, 4	0.326	**0.030**
		3, 1	0.199	**0.024**
		3, 2	0.063	0.247
		3, 4	0.313	**0.023**
		3, 5	0.408	**0.002**
		4, 2	0.350	**0.021**
		5, 1	0.420	**0.001**
		5, 2	0.203	**0.018**
		5, 4	0.242	**0.032**
	Depth stratum	All depth strata	0.406	**0.001**
		250–500, 50–250	0.366	**0.001**
		500–750, 50–250	0.563	**0.001**
		500–750, 250–500	0.359	**0.001**
Mega-epifauna	Transect	All transects	0.492	**0.001**
		1, 2	0.429	0.050
		3, 1	0.667	**0.017**
		3, 2	0.644	**0.004**
		3, 5	0.465	**0.004**
		5, 1	0.186	0.300
		5, 2	0.483	**0.044**
	Depth stratum	All depth strata	0.457	**0.001**
		250–500, 50–250	0.259	0.077
		500–750, 50–250	0.767	**0.003**
		500–750, 250–500	0.345	**0.024**

With regard to depth-related differences in assemblage composition, a visual inspection of the MDS plots for each assemblage type indicates that some clustering of samples by depth is apparent, although clustering patterns for the different depth strata differ among the assemblage types (Figure 8). ANOSIM tests revealed that there were significant depth-related differences in assemblage composition (Table 4). Differences for the infaunal assemblages amongst depth strata were nearly as weak as amongst transects (Global $R= 0.26$, $p \leq 0.001$). For the epifauna depth-related differences in assemblage composition were stronger (Global $R=0.41$, $p \leq 0.001$) than differences among transects.

For the mega-epifauna depth-related compositional differences were slightly less pronounced (Global *R*= 0.46, *p*≤0.001) than differences among transects. Pairwise analysis revealed that for all three assemblage types, differences between the shallow and the deep strata were significant (Table 4). Such differences were similar for the in- and the epifauna (*R*=0.51 and 0.56, respectively with *p*≤0.001 for both), but were more pronounced for the mega-epifauna (*R*=0.77 with *p*≤0.001). The epi- and mega-epifaunal assemblages also showed significant differences in composition between the 250–500 m and the 500–750 m strata (epifauna: *R*=0.36 with *p*≤0.001; mega-epifauna: *R*=0.35 with *p*=0.024).

The group-average similarities (percentages) in assemblage composition were relatively low for all assemblage types for transects and also for depth strata (Table 5). Infaunal assemblage similarity was lowest in transect 4 (13.9%) and highest in transect 3 (33.3%). The epifaunal assemblage composition was least similar in transect 5 and most similar in transect 4 (32.7%). For the mega-epifauna transect 5 proved to be the least and transect 3 the most similar in terms of assemblage composition (note that no quantitative mega-epifaunal data were available for transect 4 - due to ice and/or weather conditions). Assemblage similarities were slightly higher for depth strata than for transects, with all assemblage types showing highest compositional similarities in the shallow stratum (infauna = 37.4%, epifauna = 28.9% and mega-epifauna = 25.2%). For the in- and the meaga-epifauna the assemblages of the mid-depth stratum were the least similar compositionally (18.4% and 14.7%, respectively), and for the epifauna least assemblage similarity occurred in the deep stratum (18.0%).

Table 5: Group-average similarity (%) for macroinvertebrate assemblages of the northwestern Ross Sea shelf for the sample groupings transect and depth stratum analysed separately for each assemblage type (data presence-absence-transformed). No quantitative mega-epifaunal data was available for transect 4.

Sample grouping	Group	Similarity (%)		
		Infauna	Epifauna	Mega-epifauna
Transect	1	21.90	25.69	18.43
	2	23.43	23.00	15.18
	3	33.25	19.97	28.42
	4	13.88	32.66	-
	5	19.84	19.61	11.90
Depth stratum	50–250 m	37.43	28.88	25.21
	250–500 m	18.40	23.26	14.70
	500–750 m	19.75	18.00	23.70

Species contributing most to the average assemblage similarity of each transect are listed in Appendix 11. Individual species generally contributed little to the similiarity measure for the infaunal assemblages. The exception is transect 2 where only three polychaete species made up 54.5% of the cumulative similarity. In transects 1–4 the infauna was dominated by polychaetes, in particular by the polychaete *Glycera kerguelensis*, and bryozoans. Only in transect 3 did two species occur frequently enough to qualify as typifying species: the bryozoan *Lacerna hosteensis* (Av. Sim./SD=1.7) and the polychaete *G. kerguelensis* (Av. Sim./SD=1.3). The latter species contributed only little to the average similarity of transect 5 however.

The epifaunal assemblages were dominated by a range of different phyla. Individual species' contribution to the assemblage similarity of each transect were low, with the cumulative similarities for five species making up between 19.5 % (transect 1) and 35.5% (transect 5). For transects 2, 3 and 5 no species qualified as typifying, i.e., no species occurred consistently enough for a ratio of average similarity/SD of more than 1.3. Transect 1 was characterised by the holothurian *Psolus dubiosus* (Av.Sim./SD=1.3). For transect 4 the five species contributing most were also typifying species: the polychaete *Polynoe laevis* (Av.Sim./SD=7.1), the ophiuroids *Ophiacantha pentactis* and *O. vivipara*

(Av.Sim./SD=7.1 and 1.3, respectively), the stylasterid coral *Errina fissurata* (Av.Sim./SD=1.3) and the gorgonian *Thouarella* sp. 2 (Av.Sim./SD=4.1).

Cumulative similarities for each transects contributed by the five mega-epifaunal species contributing most ranged between 32.6% (transect 3) and 58.1% (transect 1). The demisponge *Tedania (Hemitedania) oxeata* was the only typifying mega-epifaunal species and it characterised transect 1 (Av. Sim./SD=1.5).

For the species contributing most to the average similarity of assemblages for each depth stratum see Appendix 12. Individual species' contributions to the similarity of depth strata assemblages were in general small for all three assemblage types. However, the 250–500 m stratum was strongly dominated by the polychaete *G. kerguelensis* the frequency of occurrence of which contributed 30% to the cumulative similarity. Nonetheless, the low Av.Sim./SD value (0.65) indicated that *G. kerguelensis* was not a typifying species for this stratum. The shallow transect (50–250 m) was characterised by five infaunal species, the bryozoans *L. hosteensis*, *Micropora brevissima* (Av.Sim./SD=3.8 for both) and *Kymella polaris*, the polychaete *G. kerguelensis* (Av.Sim./SD=1.4 for both) and the pycnogonid *Achelia spicata* (Av.Sim./SD=1.5). The shallow stratum was also characterised by one epifaunal species, the polychaete *Perkinsiana littoralis* (Av.Sim./SD=1.6). None of the species occurring in the mid-depth and the deep strata occurred consistently enough to be a characterising species.

Pairwise average dissimilarities for the sampling groups transect and depth stratum are given in Table 6 with dissimilarities between transects ranging between 77.6% (infauna: transects 3 and 2) and 93.1% (mega-epifauna: transects 5 and 2). Note that only significantly different pairwise comparisons are listed (2-way crossed ANOSIM; see Table 4).

Species contributing most to the average dissimilarites for pairwise comparisons of assemblages from transects are listed in Appendix 13. The contributions of individual species to dissimilarities between pairwise comparisons are small for all assemblage types. The cumulative dissimilarities of the five species contributing most is between 5.5% (infauna: transects 3 and 5) and 10.7% (mega-epifauna: transects 3 and 1). No species stood out as a particularly good discriminating species for the infaunal assemblages. Only the bryozoan *Tracheloptyx antarctica* discriminated between assemblages from transects 3 and 4 (higher abundances in transect 3; Av. Sim./SD=1.5). For the epifaunal assemblages several species occurred consistently enough to be good discriminatory species between transects. The ophiuroid *O. pentactis* occurred so consistently in the assemblage of transect 4 that it discriminated transect 4 from assemblages from all other transects (Av. Sim./SD for transect 1=1.91, transect 2=1.74, transect 3=1.6 and transect 5=1.4). Another good discriminator was the stylasterid *E. fissurata* (transects 3 and 1 with Av. Sim./SD=1.3; transects 4 and 2 with Av. Sim./SD=1.4). The consistent occurrence of the polynoid polychaete *Polynoe laevis* in transect 4 made this species a good discriminator between assemblages from transects 3 and 5. Only 3 mega-epifaunal species qualified as discriminating species: the gorgonian *Thouarella* sp. 1 between assemblages of transects 3 and 1 (Av. Sim./SD=2.2; *Thouarella* did not occur in transect 1), the echinoid *Ctenocidaris gigantea* and the holothurian *Abyssocucumis* sp. B discriminated between the assemblages of transects 3 and 2 with more frequent occurrences in transect 3 than in 2 (Av. Sim./SD=1.3 and 1.4, respectively).

Table 6: Average Dissimilarity (%) for group-wise comparisons of macroinvertebrate assemblages from the northwestern Ross Sea for the sampling groups transect and depth stratum analysed for each of three assemblage types. Data presence-absence transformed. Only significantly different pairwise comparisons are listed (2-way crossed ANOSIM).

Assemblage Type	Sampling Group	Average Dissimilarity %
	Transect	
Infauna	3, 2	77.55
	3, 4	84.89
	3, 5	80.65
	5, 2	87.37
Epifauna	1, 4	79.92
	3, 1	81.68
	3, 4	85.64
	3, 5	87.52
	4, 2	83.46
	5, 1	84.51
	5, 2	82.28
	5, 4	83.32
Mega-epifauna	3, 1	87.05
	3, 2	84.03
	3, 5	85.00
	5, 2	93.12
	Depth stratum	
Infauna	500–750, 50–250	84.56
Epifauna	500–750, 250–500	87.57
	500–750, 50–250	90.13
	250–500, 50–250	80.58
Mega-epifauna	500–750, 250–500	87.57
	500–750, 50–250	90.13

Dissimilarites between pairwise comparisons of depth strata were similar and slightly higher than the dissimilarities between transects. Lowest dissimilarity occurred for the epifaunal assemblages between the shallow and the mid-depth strata (80.6%) and highest dissimilarities occurred, for both the epifaunal and the mega-epifaunal assemblages, between the shallow and the deep strata (90.1% for both). Individual contributions to dissimilarities between depth strata were small for all assemblage types (below 2%). For the five species contributing most to the dissimilarities in assemblages among depth strata see Appendix 14. The bryozoans *Kymella polaris* and *L. hosteensis* and the pycnogonid *Achelia spicata* occurred more frequently in the shallow than in the deep stratum (*K. polaris* did not occur at all in the deep stratum) and thus were good discriminators for the infaunal assemblages between the shallow and the deep strata (Av. Sim./SD= 1.6, 1.3 and 1.4, respectively). The sabellid polychaete *Perkinsiana littoralis* occurred frequently in the shallow but not at all in the 500–750 m stratum and thus proved to be a good discriminator for the epifauna as well as for the mega-epifauna assemblage type between the shallow and the deep stratum (Av. Sim./SD=2.1 for both). This species also discriminated between the epifaunal assemblages of the shallow and the mid-stratum (Av. Sim./SD=1.5).

The measure of relative dispersion was used in order to assess the possible effect of disturbance as caused by, for instance, iceberg scouring on the macroinvertebrate assemblages of the northwestern Ross Sea shelf (Table 7). The pattern of dispersion, or apparent disturbance, with regard to depth strata was consistent among the three assemblage types. All assemblage types showed highest variability in assemblage composition in the deep (in- and mega-epifauna=1.2, epifauna=1.3) and least variability in the shallow stratum (infauna=0.5, epifauna=0.7, mega-epifauna=0.9).

Table 7: Relative dispersion values for macroinvertebrate assemblages of three depth strata from the northwestern Ross Sea. Values calculated from presence-absence-transformed abundance data for each assemblage type separately.

Sample grouping	Group	Relative Dispersion		
		Infauna	Epifauna	Mega-epifauna
Depth stratum	50–250	0.476	0.657	0.882
	250–500	1.146	0.967	0.890
	500–750	1.178	1.346	1.212

In order to assess the relationships between the the patterns of macroinvertebrate assemblage composition and measured environmental variables the statistical correlation technique BVSTEP was used. Note that sediment variables could only be used for the correlation of infaunal assemblage patterns with environmental variables. Variables included in the analysis are listed in Table 8. Variables excluded from analysis due to a correlation value of at least 0.9 were mean bottom current speed (correlated with maximum current speed) and median grain size (correlated with mean grain size). Mean current direction and mean autumn and winter ice cover were ultimately considered not to be relevant for the analysis and thus excluded from the BVSTEP analysis.

For the infauna the best Spearman rank correlation (ρ=0.42, p=0.01) occurred for a combination of three environmental variables: the mean ice cover spring and summer, and the sponge spicule content. For the epifauna a combination of water depth and the mean ice cover in summer best explained the observed assemblage patterns (ρ=0.38, p=0.01), whereas for the mega-epifauna a combination of maximum current speed (≡ mean current speed), mean surface chl *a* in summer, the mean ice cover in spring and the mean ice annual ice cover proved to be the combination with the best explanatory power (ρ=0.39, p=0.01) (Table 9).

Table 8: List of environmental variables included in BVSTEP analysis.

Environmental variables included in BVSTEP
Water depth (m)
Max bottom current speed (cm^3/s)
Mean surface chl *a* content spring (mg/m^3)
Mean surface chl *a* content summer (mg/m^3)
Mean annual ice cover (%)
Mean spring ice cover (%)
Mean summer ice cover (%)
Number of scours/% area scoured
Distance to nearest ice scour (km)
Biological habitat complexity (BHC) *
Sorting coefficient*
Mean grain size (phi) *
Sediment chl *a* content (ng/g) *
% particulate organic carbon (POC) *
% fines *
% pebbles *
Sponge spicule content *

* Variables only available for grab samples, i.e., only for correlation between infaunal assemblages and environmental variables.

Table 9: Environmental variables (best combination and best single variable) explaining macroinvertebrate assemblage composition patterns for infaunal, epifaunal and mega-epifaunal assemblages in the northwestern Ross Sea.

Assemblage type	Best combination	Spearman rank correlation ρ	Best single variable	Spearman rank correlation ρ
Infauna	Mean ice cover summer Mean ice cover spring Sponge spicule content	0.416*	Mean ice cover spring	0.323
Epifauna	water depth Mean ice cover summer	0.381*	Water depth	0.359
Mega-epifauna	Maximum current speed Surface chl *a* summer Mean ice cover spring Mean annual ice cover	0.389*	Mean annual ice cover	0.330

* Significance level *p*=0.01.

3.3 Fish assemblages

A total of 1830 individual fish belonging to 43 species in 9 families were identified from all locations sampled in the northwestern Ross Sea shelf area (see Appendix 15 for species list). The ice cod family (Nototheniidae) was the most speciose family with 15 species listed.

The largest number of species (20) was recorded in transect 3 and fewest species in transect 4 from which only one sample (a sled) was included in the analysis (Table 10). The depth strata were similar in mean number of species ranging from 19 species in the mid-depth stratum to 22 species in the deep stratum. The mean number of individuals varied markedly as well amongst transects as amongst depth strata. However, these values cannot be used for any statistically meaningful comparison because of the differences in the number of samples (and gear used to obtain these samples) between strata. Thus, as noted earlier, measures of taxonomic distinctness were employed to allow for a robust diversity analysis.

Table 10: Number of samples, mean number of species *S* and mean number of individuals *N* for fish assemblages in sample groupings transect and depth stratum in the northwestern Ross Sea.

Sample grouping	Group	Number of samples	Mean *S*	Mean *N*
Transect	1	9	13	101
	2	8	16	21
	3	12	26	44
	4	1	2	2
	5	9	20	26
Depth stratum	50–250 m	17	21	18
	250–500 m	10	19	46
	500–750 m	12	22	97

3.3.1 Univariate analysis

When comparing the mean AvTD and VarTD values among the sampling groups transect and depth stratum using ANOVA, only the AvTD values for the three depth strata were significantly different from each other (one-way ANOVA using ranked data $F = 8.241$, MS = 1106.6, dF=2, $p = 0.001$). Post-hoc comparisons revealed a significant difference between the shallow and the deep stratum ($p = 0.002$, Tukey HSD) (Table 11).

Table 11: ANOVA results for comparisons of biodiversity indices Average taxonomic distinctness (AvTD) and Variation in taxonomic distinctness (VarTD) of fish assemblages on the northwestern Ross Sea shelf. Where ANOVA data assumptions were violated, ranked data were used. Significant results in red (significance level set at $p \leq 0.05$).

Group	Factor	Data	MS	F	dF	*p*-value
Transect	AvTD	Ranked	151.49	0.7997	4	0.5339
	VarTD	Ranked	229.78	1.9987	4	0.1169
Depth stratum	AvTD	Ranked	1106.06	8.241	2	0.0011
	VarTD	Ranked	45.60	0.3466	2	0.7094

The pattern for TD measures for fish assemblages among transects (Figure 9, top) did not conform to the initial prediction that AvTD would be high and VarTD low when proxy measures of potential energy input (surface water and surface sediment chlorophyll *a*) were low (compare with Figure 4) and conversely.

The pattern for AvTD measures for fish assemblages among depth stata (Figure 9, bottom) did to some extent conform to the initial hypothesis prediction. That is, AvTD for the shallow, least iceberg scour disturbed stratum was lower than for the two deeper, most iceberg scour disturbed strata. However, difference was only statistically significant between the shallow and deep stata. The pattern for VarTD did not conform to the initial converse prediction.

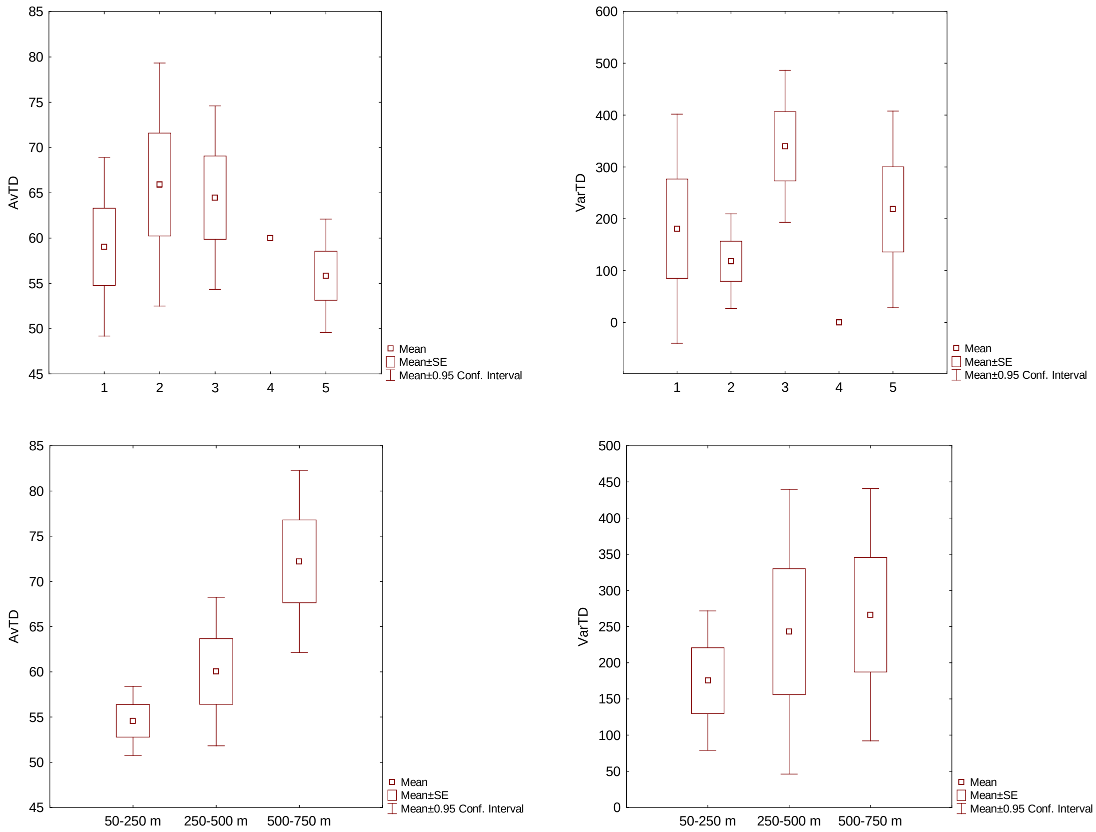

Figure 9: Mean values for Average taxonomic distinctness (AvTD) and Variation in taxonomic distinctness (VarTD) of fish assemblages on the northwestern Ross Sea shelf for sampling groups transect (top) and depth stratum (bottom). Standard error (SE) and mean 95% confidence interval are also given.

3.3.2 Multivariate analysis

With reference to the previously noted caution regards the use of combined data, an initial visual comparison of the MDS ordination for fish assemblage data derived from sled and trawl deployments (data presence-absence transformed) was performed. This plot shows that sled and trawl samples cluster separately (Figure 10). Trawl samples appeared to be relatively homogenous in their assemblage composition and thus were clustered more distinctly, whilst sled samples showed a higher degree of variability. Such an observation was confirmed by an *a postori* ANOSIM test (Global R=0.392 with p<0.001). Because the majority of fish were recorded from trawl samples (1786 fish from 28 trawl deployments compared to 45 fish from 11 sled deployments), it was decided that further analyses be conducted using only trawl data. Before further multivariate analyses could proceed using fish abundance data, the possible influence of sample size was investigated via a regression analysis between towed trawl distance and number of fish species caught in a trawl. The slightly positive linear correlation proved to be non-significant (y=5.267x+1.848, r^2=0.113, dF=28) and so data were deemed suitable for quantitative analysis. Note that for transect 4 there are no quantitative fish data derived from trawl samples.

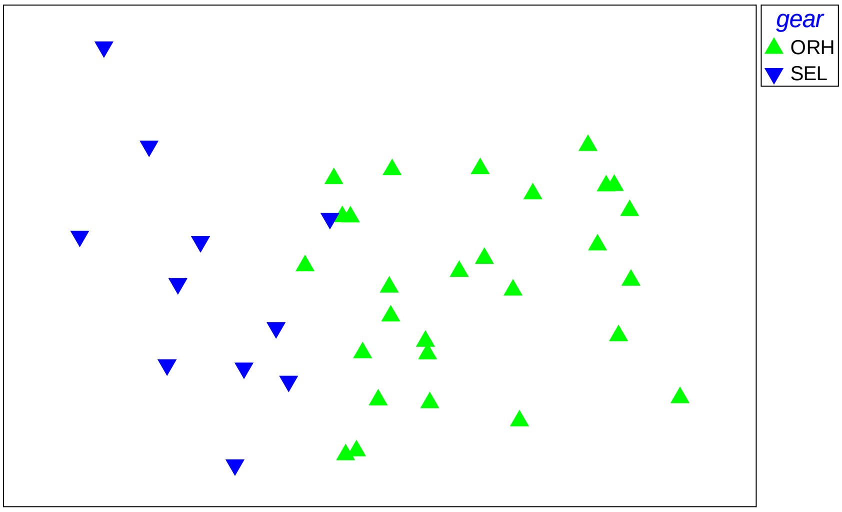

Figure 10: MDS ordination of Bray-Curtis similarities for fish assemblage data derived from trawl (ORH) and sled (SEL) deployments on the northwestern Ross Sea shelf. Data presence-absence transformed. Stress value = 0.15.

The MDS ordination plot of the fish abundance data shows no clear pattern of clustering of samples for transects (Figure 11, top). That is, samples of all transect groups were widely dispersed, especially samples of transects 2 and 3. Clustering of samples according to depth stratum was more apparent (Figure 11, bottom). Samples from the shallow and the deep strata formed two distinct groups with stations from the shallow stratum being located in the top right hand part and stations from the deep stratum being placed in the left hand part of the ordination. Samples from the mid-depth strata were generally placed between the sample clusters of the other two strata. The stress level of the ordination is relatively high (0.16), thus care should be taken when visually interpreting these results.

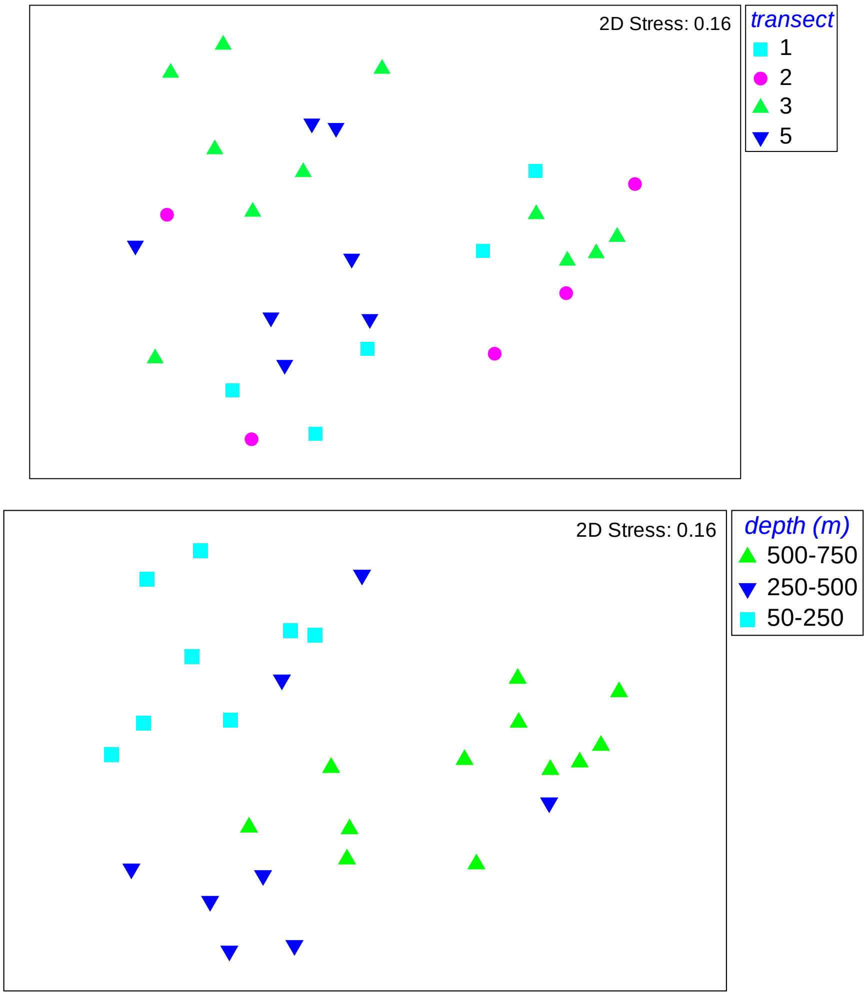

Figure 11: MDS ordination plots of Bray-Curtis similarity for standardised and square-root transformed fish abundance data derived from trawl deployments on the northwestern Ross Sea shelf. Sample grouping transect (top) and depth stratum (bottom). Stress value = 0.16.

A two-way crossed ANOSIM analysis revealed that differences in fish assemblage composition among transect and among depth strata were significant, with differences being less pronounced among transects (Global *R*=0.483; *p*=0.001) than among depth strata (Global *R*=0.738; *p*=0.001) (Table 12). Pairwise comparisons between transects showed assemblage compositions to be significantly different between most transects with the exception of transect 2, which was not different from transects 1 and 3. Transects 1 and 5 were also not significantly different in their fish assemblage composition. The most pronounced difference in assemblage composition occurred between transects 2 and 5 (*R*=0.754; *p*=0.017) and 3 and 5 (*R*=0.706; *p*=0.002). Differences in the fish assemblage composition between depth strata were greatest between the shallow and the deep stratum, (*R*=1.0; *p*=0.001) and least between the shallow and mid-depth stratum (*R*=0.435, *p*=0.04).

Table 12: Two-way-crossed ANOSIM results for global and pairwise tests for significant differences among transects and depth strata for fish assemblages derived from trawl deployments on the northwestern Ross Sea shelf. Bold *p*-values indicate significance at a level of $p \leq 0.05$. Abundance data standardised and square-root transformed.

Sample grouping	Groups compared	*R* -value	Significance level *p*
Transect	All four transects	0.483 (Global *R*)	**0.001**
	1, 2	0.385	0.10
	3, 1	0.361	**0.043**
	3, 2	0.24	0.129
	3, 5	0.706	**0.002**
	5, 1	0.52	0.067
	5, 2	0.754	**0.017**
Depth stratum	All three strata	0.738 (Global *R*)	**0.001**
	250–500, 50–250	0.435	**0.024**
	500–750, 50–250	1.00	**0.001**
	500–750, 250–500	0.552	**0.04**

Group-average similarity levels for fish assemblages for transects were relatively low and ranged from 31.85% for transect 2 to 57.08% for transect 5 (Table 13). Compositional similarities were slightly higher for depth strata, ranging from 29.13% for assemblages from the mid-depth to 55.49% for assemblages from the deep stratum.

Table 13: Group-average similarity (%) for fish assemblages from the northwestern Ross Sea shelf for the sample groupings transect and depth stratum. Abundance data obtained from trawl deployments. Data standardised and square-root transformed.

Sample grouping	Group	Similarity (%)
Transect	1	56.41
	2	31.85
	3	50.68
	5	57.08
Depth stratum	50–250 m	53.12
	250–500 m	29.13
	500–750 m	55.49

Only relatively few fish species contributed to the cumulative similarities of the assemblages from the four transects analysed; however, most of these species did not prove to be good typifying species due to their low ratios of average similarity/SD (Table 14). The Antarctic silverside *Pleurogramma antarcticum* was a typifying species for the assemblage of transect 5; however, the highest abundance of *P. antarcticum* was recorded in transect 1. The slender scalyhead *Trematomus lepidorhirus* was a typifying species both for transect 5 and transect 1. The rattail *Macrourus whitsoni* contributed most to fish assemblage similarity in transect 2 (approximately 80%) and in transect 3 (approximately 35%), but did not occur consistently enough to be a typifying species.

Table 14: Breakdown of average similarity, within sample grouping, transect into contributions from each species of fish assemblages on the northwestern Ross Sea shelf. Species are ordered in decreasing contribution (cut-off applied at 70%), Av. Abund=average abundance per transect, Av. Sim=average similarity (%), SD=standard deviation of average similarity, Contrib %=contribution to similarity, Cum %=cumulative similarity. Abundance data: standardised and square-root transformed.

Transect	Species	Av. Abund.	Av. Sim.	Av. Sim./ SD	Contrib. %	Cum. %
1	*Trematomus lepidorhinus*	3.95	25.33	1.45	44.90	44.90
	Pleuragramma antarcticum	5.56	19.71	0.63	34.95	79.85
2	*Macrourus whitsoni*	5.26	25.39	0.71	79.71	79.71
3	*Macrourus whitsoni*	3.18	17.67	0.77	34.86	34.86
	Artedidraco orianae	3.32	11.79	0.90	23.26	58.12
	Trematomus lepidorhinus	2.09	4.67	0.68	9.21	67.33
	Chinodraco hamatus	1.52	4.57	0.48	9.01	76.35
5	*Pleuragramma antarcticum*	4.47	11.18	1.87	22.70	22.70
	Trematomus lepidorhinus	2.98	7.21	1.19	14.64	37.34
	Trematomus pennellii	2.30	7.05	0.74	14.32	51.66
	Chinodraco hamatus	1.72	5.67	0.91	11.52	63.18
	Artedidraco shackletoni	1.68	5.22	0.88	10.60	73.78

The sharp-spined nototheniid *Trematomus pennelli* and the icefish *Chinodraco hamatus* best typified the shallow stratum assemblage, and were the only species which qualified as typifying species for assemblages of any of the strata (Table 15). The high density of the Antarctic silverside *P. antarcticum* in the mid-depth stratum explained the high contribution this species made to the cumulative similarity (45%) of this stratum. For the deep stratum, only the two species, *M. whitsoni* and the slender scalyhead *T. lepidorhinus*, were responsible for approximately 73% of the cumulative similarity, but occurred too infrequently to be good typifying species.

Table 15: Breakdown of average similarity within sampling group depth stratum into contributions from each species of the fish assemblage on the northwestern Ross Sea shelf. Species are ordered in decreasing contribution (cut-off applied at 70%). Av. Abund=average abundance per depth statum, Av. Sim=average similarity (%), SD=standard deviation of average similarity, Contrib %=contribution to similarity, Cum %=cumulative similarity. Abundance data standardised and square-root transformed.

Depth Stratum	Species	Av. Abund.	Av. Sim.	Sim/ SD	Contrib %	Cum %
50–250 m	*Artedidraco orianae*	3.98	17.63	1.48	33.20	33.20
	Trematomus pennellii	4.51	12.32	1.13	23.19	56.38
	Chinodraco hamatus	2.60	4.79	1.25	9.02	65.41
	Pleuragramma antarcticum	1.26	3.48	0.65	6.55	71.96
250–500 m	*Pleuragramma antarcticum*	5.22	13.15	0.45	45.12	45.12
	Trematomus lepidorhinus	2.01	4.84	0.45	16.63	61.75
	Artedidraco orianae	1.59	4.84	0.45	16.63	78.38
500–750 m	*Macrourus whitsoni*	5.57	27.32	1.18	49.23	49.23
	Trematomus lepidorhinus	3.24	13.71	1.12	24.71	73.94

Table 16: Breakdown of average dissimilarity between sample grouping transect into contributions from each species of the fish assemblage on the northwestern Ross Sea shelf. Only the five species contributing most are listed. Av. Abund=average abundance per transect, Av. Diss.=average dissimilarity (%), SD=standard deviation of average dissimilarity, Contrib. %=contribution to dissimilarity, Cum. %=cumulative dissimilarity. Only groups being significantly different (as per ANOSIM test) in assemblage composition are listed. Abundance data standardised and square-root transformed.

Groups compared	Av. Diss %	Species	*Group 1* Av. Abund.	*Group 2* Av. Abund.	Av. Diss.	Av. Diss./ SD	Contrib. %	Cum. %
3, 1	64.16	*Pleuragramma antarcticum*	0.98	5.56	13.40	1.24	20.89	20.89
		Trematomus lepidorhinus	2.09	3.95	11.17	1.67	17.41	38.30
		Macrourus whitsoni	3.18	2.86	8.25	0.81	12.85	51.15
		Bathyraja eatonii	0.90	0.07	4.57	0.87	7.12	58.27
		Chinodraco hamatus	1.89	0.00	3.73	0.43	5.81	64.08
3, 5	76.95	*Macrourus whitsoni*	3.18	0.00	9.92	0.86	12.90	12.90
		Pleuragramma antarcticum	0.98	4.47	9.48	1.13	12.31	25.21
		Artedidraco orianae	3.32	0.97	6.65	1.24	8.64	33.85
		Chinodraco hamatus	1.89	1.72	5.76	1.71	7.48	41.33
		Trematomus lepidorhinus	2.09	2.98	5.35	1.41	6.95	48.28
5, 2	78.72	*Macrourus whitsoni*	0.00	5.26	15.23	1.21	19.34	19.34
		Chinodraco hamatus	1.72	1.65	9.15	1.93	11.62	30.96
		Pleuragramma antarcticum	4.47	3.02	8.37	0.85	10.63	41.60
		Trematomus lepidorhinus	2.98	0.63	7.27	1.74	9.24	50.84
		Lepidontothen kempi	1.71	0.00	5.70	0.69	7.24	58.08

Dissimilarities in fish assemblage composition between transects were relatively high, but did exhibit somewhat of a range (Table 16). Transects 5 and 2 were most dissimilar (78.72%) and transects 3 and 1 were least dissimilar (64.16%) in their fish assemblage composition. The small nototheniid *Trematomus lepidorhinus* and the Antarctic silverside *Pleuragramma antarcticus* were good discriminators between fish assemblages from transects 3 and 1. The relatively high and frequent occurrence of the icefish *Chinodraco hamatus* in transect 5 made this species a good discriminator between the fish assemblages of transects 5 and 3, but also between 5 and 2. *Trematomus lepidorhinus* was also a good discriminator between assemblages from transects 5 and 2 and transects 3 and 5 with higher mean abundance in transect 5.

Table 17: Breakdown of average dissimilarity between sampling group depth stratum into contributions from each species of the fish assemblage on the northwestern Ross Sea shelf. Only the five species contributing most to the overall dissimilarity are listed. Av. Abund=average abundance per depth stratum, Av. Diss.=average dissimilarity (%), SD=standard deviation of average dissimilarity, Contrib. %=contribution to dissimilarity, Cum. %=cumulative dissimilarity. Only groups being significantly different (as per ANOSIM test) in assemblage composition are listed. Abundance data standardised and square-root transformed.

Groups compared	Av. Diss. %	Species	*Group 1* Av. Abund.	*Group 2* Av. Abund.	Av. Diss.	Av. Diss./SD	Contrib. %	Cum. %
250–500, 50–250	69.73	*Trematomus pennellii*	0.00	4.51	9.98	1.79	14.39	14.39
		Chinodraco hamatus	1.52	2.60	8.36	1.15	12.05	26.45
		Pleuragramma antarcticum	5.22	1.76	7.66	1.31	11.05	37.49
		Trematomus lepidorhinus	2.01	1.47	6.84	1.38	9.85	47.35
		Artedidraco orianae	1.59	3.98	6.11	1.00	8.81	56.15
500–750, 50–250	88.24	*Macrourus whitsoni*	5.57	0.00	14.39	1.34	16.31	16.31
		Artedidraco orianae	0.22	3.98	10.54	1.66	11.95	28.26
		Trematomus pennellii	0.00	4.51	10.51	1.84	11.91	40.17
		Chinodraco hamatus	0.68	2.60	6.76	1.19	7.66	47.83
		Trematomus lepidorhinus	3.24	1.47	4.83	1.26	5.47	53.30
500–750, 250–500	78.59	*Macrourus whitsoni*	5.57	1.08	17.77	1.54	22.61	22.61
		Pleuragramma antarcticum	2.42	5.22	11.11	0.96	14.14	36.75
		Trematomus lepidorhinus	3.24	2.01	9.66	1.21	12.29	49.03
		Artedidraco orianae	0.22	1.59	5.46	0.83	6.95	55.98
		Chinodraco hamatus	0.68	1.52	5.00	0.58	6.36	62.34

For the three depth strata the highest dissimilarity in assemblage composition was found between the deep and the shallow stratum (88.24%) with the nototheniid *Trematomus pennellii*, which only occurred in the shallow but not in the deep stratum, being a particularly good discriminating species for assemblages from these the two strata (Table 17). *Trematomus pennellii* was also a discriminating species between assemblages of the shallow and the mid-depth stratum due its presence in the former and its absence in the latter. *Pleuragramma antarcticum* was particularly abundant in the mid-depth stratum, making it also a good discriminating species between the fish assemblages of this stratum and that of the shallow stratum. The rattail *Macrourus whitsoni* was a good discriminator between the assemblages of the mid- and the deep strata and contributed most to the cumulative dissimilarity between assemblages of the two strata (22.61%).

Relative dispersion values for fish assemblages of the depth strata sample grouping were high (Table 18). Of the three depth strata, the mid-depth stratum assemblages had the highest dispersion value (1.26) and the shallow stratum assemblages the lowest levels of dispersion (0.59). These results are also visualised in the MDS ordinations of Figure 11.

Table 18: Results of the MVDISP analysis indicating the relative dispersion values for sample grouping depth of the fish assemblages of the northwestern Ross Sea shelf. Values were calculated from standardized and square-root transformed abundance data.

Sample grouping	Group	Relative Dispersion
Depth stratum	50–250	0.858
	250–500	1.261
	500–750	0.949

The BVSTEP procedure was conducted in order to examine correlations between biological and environmental data, thus elucidating the extent to which the patterns of fish assemblage composition could be related to the following environmental variables: water depth, maximum current speed, the surface water chlorophyll *a* content averaged for spring and summer, the mean annual ice cover and the mean ice cover for spring and summer. The environmental variable minimum current speed was excluded from the analysis due to a co-correlation (coefficient of more than 0.9) with maximum current speed. With a Spearman rank correlation of ρ=0.50 (p=0.01), the single variable water depth best explained the patterns in fish assemblage composition observed. The mean summer ice cover was the next best single environmental variable to explain the fish assemblage patterns (ρ=0.39). However, the combination of depth and mean annual ice cover had a correlation of ρ=0.50, thus explaining the biotic patterns no better than the variable depth alone.

4. DISCUSSION

4.1 The sampling effort and the taxonomic impediment

During the BioRoss study extensive sampling was undertaken of the deepwater (50–750 m) benthic macroinvertebrate and fish assemblages on the northwestern Ross Sea shelf off the Victoria Land coast between Cape Adare and Cape Hallett. Furthermore, the study also sampled the benthic macroinvertebrate and fish assemblages of four seamounts, two of which are part of the Balleny Islands, further north in the Southern Ocean. Since the return of the sampling voyage from Antarctica in March 2004, over 8000 specimen lots have been processed, and the identification of 1190 taxa to putative species level took a great deal of effort by a large number of people and three years to complete. In part the delay between sampling and the delivery of data that could be analysed is the result of the so-called “taxonomic impediment” (Giangrande 2003), which is a concern in the New Zealand context (Nelson & Gordon 1997). However, analysis of those data resulting from the BioRoss study has now allowed for a description and quantification of the diversity of the target assemblages, and a determination of the importance of certain environmental variables that influence benthic assemblage composition in part of New Zealand’s Ross Dependency.

4.2 A wider context for discussing the results

Since the BioRoss study was conceived and conducted a number of papers have been published which report on various components of the Ross Sea fauna (e.g., macrozoobenthos: Rehm et al. 2006, isopods: Choudhury & Brandt 2007), including those that have already incorporated a significant amount of data from the study itself (echinoderms: De Domenico et al. 2006, molluscs: Schiaparelli et al. 2006, peracarid crustaceans: Rehm et al. 2007, polychaetes: Kröger & Rowden 2008). These publications for the Ross Sea include those which have attempted to elucidate the environmental drivers of benthic faunal composition in the shallow (Cummings et al. 2006) and deep (Barry et al. 2003, Povero et al. 2006) waters of the shelf. There are also now available recent Ross Sea/Antarctic publications which deal with specific environmental drivers (i.e., iceberg disturbance: Gerdes et al.

2003, Brown et al. 2004, Teixidó et al. 2004) or review and synthesize information on the general themes examined by the BioRoss study (Thrush et al. 2006, Barnes & Conlan 2007, Gutt 2007, Teixidó et al. 2007). Thus, the present results for the northwestern Ross Sea can now be discussed with respect to a significantly wider understanding and context than was originally envisaged at the time of the study (as outlined in the Introduction).

4.3 The environment of the northwestern Ross Sea shelf

The environmental differences between transects/depth strata did not conform to the initial expectations on which the sampling strategy was based. That is, differences among transect groups with respect to actual measures of chl *a* (both in the surface waters and the sediment) did not exhibit the linearity expected; and for depth strata, iceberg scour intensity was almost as great in the deepest stratum as the initially predicted middle depth stratum. It is perhaps not surprising that gradients in the proxy measures of primary productivity were not observed, considering the relatively short distance over which the transects were distributed. Mean surface water and sediment chl *a* values are highest for transect 5, the southernmost transect off Cape Hallett, and the lowest for transect 3, off Cape McCormick. However, the pattern among transects is not entirely concordant for the two measures, with relatively high values for surface chl *a* for transects 2 and 4 matched by relatively low values for these transects for sediment chl *a*. A mismatch between the two variables can be expected where the deposition of surface-derived matter to the seafloor is laterally advected by currents (Smith et al. 2006). Overall, the values for surface water and sediment chlorophyll are comparable to those recorded previously for the Ross Sea (surface water chl *a*: less than 1 mg m^{-3} in northwestern Ross Sea in summer, Arrigo & van Dijken 2004; sediment chl *a*: 0.3μg g^{-1}, at 440 m near Cape Adare, Fabiano & Danovaro 1998).

As expected from previously obtained multibeam data (Mitchell 2001), iceberg scouring was least in the shallow depth stratum (less than 1% of the bottom showed evidence of scour marks) and most prevalent in the middle depth stratum, with about 6% of the surveyed area covered by scour depressions. However the extent of scouring in the deep stratum (about 5% iceberg scour by area) was similar to that of the middle stratum, and was observed to occur at depths of up to 550 m. Gutt (2000) estimates that approximately 5% of the Antarctic shelf is affected by iceberg scouring, with certain areas experiencing much higher values. Iceberg scouring has been observed in the Weddell Sea to reach depths of 500 m, where such disturbance is predicted to be responsible over geological time for re-working seabed sediments over 54% of the shelf (Barnes & Lien 1988). No particular patterns were expected for the remaining environmental variables measured during the study. Some varied little over the area (e.g., sediment type) whilst others displayed a particular pattern (e.g., current speed). The influence of measured variables on the observed assemblage composition was considered by the various analyses, and specific attention is paid later to discussing the results with respect to the three diversity hypotheses detailed in the Introduction.

4.4. Macroinvertebrate assemblages

4.4.1 Univariate analysis

4.4.1.1 Energy-diversity hypothesis

The measures of AvTD and VarTD for the macroinvertebrate assemblages of the transect strata were not significantly different from one another. Thus the results do not directly support the hypothesis that primary productivity influences the diversity (as measured using TD indices) of the macroinvertebrate assemblages along the northwestern Ross Sea shelf. However as predicted, where productivity is lowest (as measured by surface water and sediment chl *a*), i.e., at transect 3, the mean measure of AvTD is the lowest observed among the transect assemblages. Also as predicted, where productivity levels are higher at transect 1, this assemblage has a relatively high mean measure of AvTD. However, at transect 5 where productivity was also high, AvTD was not similarly high. The possible reasons for a lack of a consistent relationship between the proxy measures of productivity and measures of biodiversity for macroinvertebrate assemblages along the shelf are discussed below (in the multivariate analysis section). The pattern for assemblage VarTD among transects was opposite to that initially predicted.

4.4.1.2 Disturbance-diversity hypothesis

The measures of AvTD and VarTD for the macroinvertebrate assemblages of the depth strata were not significantly different from one another. Thus the results do not directly support the hypothesis that iceberg scouring disturbance influences the diversity (as measured using TD indices) of the macroinvertebrate assemblages across the northwestern Ross Sea shelf. However, there are some noticeable differences in taxonomic structure between the assemblages that do appear to at least in part support the initial predictions. That is, as predicted the mean value for AvTD was highest for the least disturbed (as measured by % iceberg scouring) shallow stratum. However, whilst the more disturbed mid and deep depth strata had lower mean values of AvTD than the shallow stratum, these similarly iceberg scoured strata had dissimilar mean values (being lowest for the deepest stratum). The apparent trend in decreasing AvTD with increasing depth is probably related in part to factors other than iceberg disturbance (see later discussion in multivariate analysis section). The initial predictions for the relationship between assemblage diversity, as measured by VarTD, and disturbance are not supported by the results. VarTD was highest for the shallow stratum assemblage and lowest for the most disturbed depth stratum.

4.4.2 Multivariate analysis

4.4.2.1 Energy-diversity hypothesis

Multivariate analyses revealed that the three macroinvertebrate assemblage types, i.e., infauna, epifauna and mega-epifauna, all showed significant differences in composition among transects, although these differences were only reasonably pronounced for the mega-epifaunal component. The greater among-transect differences observed for the mega-epifaunal componentcould be because such mobile and more sparsely distributed organisms may be controlled more closely by environmental variables that operate on large spatial scales (such as productivity) rather than those that vary on smaller scales (such as those that describe habitat heterogeneity) (Barry et al. 2003). However, pairwise comparisons revealed that for all assemblage types transect 5 was significantly different from transects 3 and 2 in its assemblage composition. These results of the formal test present further support for the energy-diversity hypotheses tested, in that assemblages from the area of the seabed beneath the most productive waters are often most different from those beneath the least productive waters, or the seabed receiving most and least of overlying surface productivity – as indicated by the proxy measures of surface chl *a* and sediment chl *a* content, respectively. The SIMPER results present some further support for the hypothesis even though the contributions of individual species to dissimilarities between pairwise comparisons were small, and no species from any assemblage type stood out as particular good discriminating species for the pairwise comparisons between transects 5 and 3 and 5 and 2.

The relative frequency of occurrence of the bryozoan *Tracheloptyx antarctica* contributed most to the measure of dissimilarity between the infaunal assemblages of transects 5 and 3, and the polychaete *Scoloplos marginatus mcleani* between transects 5 and 2. The bryozoan species was only marginally more frequent a member of the assemblage of transect 5 than of transect 3 (note that this species is not strictly infaunal, rather it is an epifauna species incidentally sampled by the grab – presumably on rock pebbles), nonetheless its relative occurrence could be a response to an environment with a potentially better food supply for these suspension feeding organisms. Similarly, the dominance of the infaunal deposit feeding orbinid *Scoloplos marginatus mcleani* in the assemblage of transect 5, and its discriminatory role in the dissimilarity observed between this transect and transect 2 (where it occurred much less frequently and sediment chl *a* content was low), could thus be a response to a greater food resource for deposit-feeding fauna along the southernmost transect as indicated by the higher chl *a* content. Hilbig et al. (2006) concluded from a study of polychaete assemblages on the Weddell Sea shelf that the low presence of infaunal deposit feeders could be a result of short and episodic periods of primary production in the overlying water column.

For the epifauna component, two ophiuroids made the single largest contribution to the dissimilarity measured between the assemblages of transects 5 and 3 and 5 and 2. *Ophiacantha antarctica and Ophioceres incipien* are found more often at transect 5 than transects 3 and 2, respectively. The former species is likely to be a suspension-feeder capable of switching to detritus feeding (inferred from what is known about a related Arctic species *O. bidentata*, Gallagher et al. 1998) and therefore is another species that will gain from the apparently increased availability of food at transect 5. The other ophiuroid, *O. incipien,* is a predatory brittlestar (Jarre-Tiechmann et al. 1997); the reason for it being a discriminatory species for the epifaunal assemblages is not immediately obvious, although it is possible that this species could gain from the more frequent occurrence of potential prey items in the assemblages at the more productive transect.

The pycnogonids *Ammothea carolinesis* and *Colossendeis notalis* were the two species that came closest to being discriminatory species between the mega-epifauna assemblage composition of transect 5 and transects 3 and 2, respectively. These species were only found at transect 5. Little is known about the ecology of Antarctic pycnogonids (Jarre-Tiechmann et al. 1997) but the aforementioned species are considered to be predators of anemones, hydroids and small polychaetes (Arrango & Brodie 2003) and therefore could be benefiting from the increased availability of their potential prey items among the epifauna assemblage at transect 5.

4.4.2.2 Disturbance-diversity hypothesis

The multivariate analysis revealed that overall there are significant differences in assemblage composition among the depth strata sampled. For the infaunal assemblages, the differences among depth strata were nearly as weak as among transects, whilst for the epifauna depth-related differences in assemblage composition were stronger than differences among transects. For the mega-epifauna depth-related compositional differences were slightly less pronounced than differences among transects. Pairwise analysis revealed that for all three assemblage types differences between the shallow (least disturbed by icebergs) and the deep (iceberg disturbed) strata are significant, and the largest. However, only the epifaunal assemblages also show significant differences in composition between the middle stratum (the most disturbed by icebergs) and the shallow stratum. Thus, only for this assemblages type is there initial support for the disturbance-diversity hypothesis.

It is perhaps understandable that the epifauna, relative to the other two assemblage components, would be more susceptible to disturbance from iceberg scour. The infaunal assemblage as a whole would be likely to recover relatively rapidly post disturbance because some components of the infauna would be unlikely to be directly affected by scour disturbance and colonisation would include immediate local migration of motile species. The mega-epifauna assemblage includes organisms that would be able to physically avoid the iceberg, and because these organisms have a generally more dispersed distribution the impact upon this assemblage would be less obvious. On the other hand, the epifauna which contains a large proportion of sessile organisms will be more likely to be directly affected by the passage of icebergs, and the assemblage will take some time to recover completely from such a disturbance. Estimates of recovery from iceberg scour range from less than50 years (Conlan et al. 1998 for Arctic macrofauna) to 250–500 years (Gutt & Starmans 2001 for Antarctic shelf megafauna). Thus overall, the patterns of epifauna assemblage composition on the northwestern Ross Sea shelf are likely to be more closely controlled by iceberg disturbance than those of the other two assemblage types.

Additional support for the disturbance hypothesis, with respect to all three assemblage types, comes from the results of other analyses. The similarity level (a measure of β-diversity whereby low similarity equals high species turnover or high β-diversity) of the assemblages from the two deepest strata were lower (14.7–23.7%) than of the assemblages from the shallowest stratum (25.2–37.4%). Low similarity is expected among samples from areas where assemblages are patchily disturbed (Warwick & Clarke 1993), as is the case for samples taken from those depth strata where iceberg scours with paths tens of metres wide and several kilometres long are distributed over 5–6% of the strata area. This result is reflected in the measure of relative dispersion which was also used to assess the possible effect of the iceberg disturbance. The pattern of dispersion, or apparent disturbance, with regard to depth strata was consistent among the three assemblage types. Highest variability in assemblage composition is seen in the two deeper strata and the least variability in the shallow stratum. However, the deepest stratum had the highest values for dispersion. The reason for this latter observation could be independent of disturbance, as high levels of dispersion are relatively common among benthic samples where the patchy availability of food is thought to be responsible for low levels of similarity among assemblages.

Considering the result of the formal ANOSIM test and the ambiguity of the dispersion result, it is prudent to consider further the evidence in support of the disturbance-diversity hypothesis only for the epifauna assemblage type. The SIMPER analysis for this assemblage type revealed that individual species contributions to dissimilarities between depth strata were small. However, the relative occurrence of some species did identify them as good discriminating species between the composition of the assemblages from the least (shallow) and most (middle and deep) disturbed strata. The sabellid polychaete *Perkinsiana littoralis* occurred frequently in the shallow (where it was identified as the only typifying species for this assemblage type), occasionally in the middle but not at all in the deep stratum and thus proved to be a particularly good discriminating species for the epifauna assemblages. In addition, the motile polynoid polychaete *Harmothoe fuligineum* and the ophiuroid *Ophiosteira echinulata* were also identified (but less so) as discriminating species between the epifaunal assemblages of the shallow and deep strata, being found more frequently in the former stratum. It is reasonable to propose that slow-growing, sessile, filter-feeding organisms would, because of their life habit, occur more often in undisturbed than disturbed environments. Indeed the study of Gerdes et al. (2003), that compared the macroinvertebrate fauna of young and old iceberg scours and undisturbed areas in the Weddell Sea, found that sessile, filter-feeding polychaete species did not occur at scour sites. *P. littoralis* belongs to the most abundant species in shallow to moderate depths of the Ross Sea, but has not been recorded from deeper waters (Knox & Cameron 1998). It is possible that the difference in the distribution of this typifying species could at least in part be a result of the relative across-shelf differences in iceberg disturbance. However, it should be noted that Teixidóet al. (2004) list sessile epifaunal species with sheet-like growth-forms such as sabellids (*Perkinsiana* spp.) as taxa characteristic of early recovery stages from iceberg scour in relatively shallow water (117–265 m). It should be remembered that the present study did not specifically target the sampling of iceberg scours (no samples were taken from inside a scour) and that, considering the relatively low number of samples per stratum, it is not surprising that the results are not as clear-cut as those of Gerdes et al. (2003) or Teixidóet al. (2004). It is also reasonable to propose that in areas were there is little or no iceberg disturbance epifaunal assemblages are dominated by sessile species, whilst in areas were icebergs have disturbed the seabed sessile species and those organisms that can associate with them are less abundant. Thus, the pattern of relative occurrence of motile species, such as *H. fuligineum*, which is a scavenger, and *O. echinulata,* that would presumably benefit either directly (e.g., physical habitat, predation refuge) or indirectly (e.g., food entrapment) from the structure provided by sessile fauna, such as *P. littoralis,* could also be explained at least partly by the affect of disturbance on assemblage composition.

4.4.2.3 Habitat heterogeneity-diversity hypothesis

Differences in measures of the sediment sorting coefficient (an index of local habitat heterogeneity provided by the sediment itself) between stations across the study area were relatively small, and this local scale variable was not identified by the present correlation analysis as being of importance for the infaunal assemblages. The structural heterogeneity of a habitat has often previously been invoked as an important factor influencing the composition of associated communities; a more complex habitat providing a wider range of niches and thus a higher number and wider array of species that can potentially occupy that habitat within a given area (MacArthur 1972). In marine sediments, Whitlacht (1981) and Etter & Grassle (1992) observed a relationship between sediment particle diversity (another measure of the habitat heterogeneity of the sediment) and the diversity of benthic assemblages. In Antarctic waters Siciński (2004) showed that for the coastal polychaete assemblages of King George Island (South Shetland Islands) the sorting coefficient is, amongst other sediment characteristics, an important structuring factor. A separate examination of the polychaete component of the infaunal assemblage sampled by the BioRoss study also indicated that this measure of habitat heterogeneity was a structuring agent (Kröger & Rowden 2008). It is of interest to note that the other measure of local habitat heterogeneity (biogenic habitat complexity) included in the present analysis did not feature in the results as an important environmental variable for the fauna sampled by the grab. With respect to findings of previous studies for benthic fauna in Antarctic shelf environments (see references cited in Introduction) this was contrary to expectation. However, the failure of the present study to determine any statistical link between an index (derived from images of the seabed surface) of the structure provided by living (and once living) benthic biota and the sampled assemblages is not entirely surprising given that the organisms sampled by the grab were mainly infaunal (see also Kröger & Rowden 2008). It is reasonable to expect that the composition of the epifaunal and mega-epifaunal components of the invertebrate fauna (sampled by the epibenthic sled and trawl) would be more closely controlled by the biogenic habitat complexity; unfortunately no suitable photographic image recovery was associated with sampling by sled or trawl that could have been used to derive complexity indices.

The intermediate scale measure of iceberg disturbance used in the present study, iceberg scour intensity within a one kilometre radius of a station, was also not correlated to the biological pattern for the macroinvertebrate assemblages sampled (see also Kröger & Rowden 2008). The role of iceberg scouring at similar and smaller spatial scales has been demonstrated previously as being important in structuring benthic assemblages in polar regions (Gerdes et al. 2003, Conlan & Kvitek 2005). The failure of the present study to demonstrate any linkage between this scale of disturbance and the composition of macroinvertebrate assemblages is likely to be a result of a sampling artefact. That is, the small number of replicates taken within each sampling strata are probably insufficient to encompass the level of variability imposed upon the benthic assemblages by the iceberg disturbance (e.g., none of the random samples were taken within a scour). However, the results of ANOSIM/SIMPER did reveal that iceberg disturbance is likely to be playing some part in the structuring of the epifaunal assemblages on the northwestern Ross Sea shelf. It is worth also considering that some of the among transect differences in assemblage composition could be the result of differences in iceberg-related disturbance along the shelf as well as across it. In particular, the results indicate that differences between assemblages in shallow and deeper (mid and deep depth strata) water are in part explained by generally lower levels of iceberg disturbance received by the seabed in water depths less than 250 m, most notably for stations from off Cape McCormick and north (transects 1, 2 and 3). The direction of the prevailing currents along the Ross shelf is thought to be responsible for transporting icebergs in a northerly direction (see Thrush et al. 2006 for explanation). As icebergs travel to the northernmost reaches of the shelf study area the shelf narrows, and the currents and the shelf topography together are likely to be responsible for constraining the transport of icebergs through the area of deeper water. Hence the influence of iceberg scour disturbance would not only be greater in the deeper strata than the shallow stratum, but the *difference* in the density of scours on the seabed between coastal and deeper waters would increase in a northerly direction and this too would be likely to be reflected in along-shelf spatial differences in the benthic assemblages. Results from the present study indicate that for transect 1 (the most northerly) and 5 (the most southerly) the percentage seabed scoured for the mid and deep strata compared to the shallow strata is 38 and 5 times greater, respectively. This difference in the level of iceberg scouring across the shelf could partly explain the finding that the *R*-value for the ANOSIM pair-wise comparison of compositional dissimilarity between the epifauna assemblages of transect 1 and 5 was the highest of any of the pair-wise comparisons among transects. The mechanisms by which iceberg scour influences macroinvertebrate assemblages could include direct removal of fauna (creation of space), modifications to the seafloor topography, changes in sediment characteristics through the ploughing of the sediment, changes in local current patterns and therefore also in sedimentation patterns (e.g., Conlan et al. 1998, Barnes & Conlan 2007), and even levels of primary production (Arrigo & van Dijken 2004).

4.4.2.3 Other drivers

There is some support from the ANOSIM and SIMPER results for the contention that large-scale differences in both productivity and iceberg disturbance influence the composition of macroinvertebrate assemblages on the northwestern shelf of the Ross Sea. However, it is clear from these results (including the fact that other pairwise comparisons between the sampling groupings showed significant differences in assemblage composition) and the BVSTEP analyses, that a number of factors operating on potentially different spatial scales influence the distribution of the benthos. The results of the BVSTEP correlation analysis between all of the environmental variables measured and the pattern of infaunal assemblage composition for the entire shelf study area indicate that a combination of three environmental variables, the mean ice cover in spring and in summer and the sponge spicule content, are particularly important. For the epifauna a combination of water depth and the mean ice cover in summer best explained the observed assemblage patterns. For the mega-epifauna a combination of maximum current speed (or mean current speed), mean surface chl *a* in summer, the mean ice cover in spring and the mean annual ice cover proved to be the combination with the best explanatory power. For all three assemblage types, variables associated with the productivity were consistently implicated in the correlation analysis. Ice cover, be it for spring, summer or the annual mean was the measured environmental variable that best correlated with the overall pattern of assemblage composition. This result suggests that ice conditions, which can affect the amount of surface water primary productivity, and hence the subsequent availability of organic matter to the benthos (Cattaneo-Vietti et al. 1999), have a primary influence on the large scale assemblage pattern for benthic macroinvertebrates on the northwestern Ross Sea shelf. Other studies in the Antarctic have suggested links between spatial differences in the composition of benthic assemblages and the productivity of the overlying water, and its transfer as organic matter to the seabed (see Gutt 2000). In the Ross Sea, Cummings et al. (2006) found that latitude (used as a proxy for ice cover) was the most important factor controlling community composition in shallow waters (less than 25 m). In contrast, a study by Barry et al. (2003) in deeper water (270–1137 m) in the southwestern Ross Sea found that the distribution of benthic assemblages was “largely unrelated to the distribution of sea ice” and there was only a “relatively weak link with upper ocean productivity”. The studies of De Domenico et al. (2006) and Schiaparelli et al. (2006) that included samples from water depths (65–1538 m) which encompass the previously cited study, and the depth range of the present study, found that latitude (as a surrogate for unnamed environmental drivers) was a relatively unimportant factor in their analysis of data for an area of the shelf off Victoria Land (which included the northwestern shelf of the Ross Sea). However, it should be noted that all the studies discussed above were either examining patterns over larger or smaller spatial scales (including latitudinal scale) and/or of different components of the fauna than the present study. In addition, the links between productivity and assemblage composition were examined by the use of primary productivity proxies more distant than the ones used in the present study. Certainly the failure of two of the studies to correlate latitude with assemblage composition is not surprising, given that latitude *per se* is not an environmental variable and it is not a particularly good large-scale proxy for productivity in the Ross Sea.

The BVSTEP result for the infauna suggests that the sponge spicule content of the sediment also plays a part in influencing the composition of these assemblages on the northwestern Ross Sea shelf. The likely importance of sponge spicules in influencing the composition of benthic assemblages in the Antarctic on shelf-wide scales has long and frequently been noted (Bullivant 1967b, Barthel & Gutt 1992). The present results indicate that the influence of relatively high densities of sponge spicules in the sediment on infaunal assemblages can potentially operate at large scales in the northwestern Ross Sea. That is, assemblages from stations on transect 5 that were relatively similar to one another occurred where sponge spicule content of the sediment was generally high. However, sponge spicule density was high at some other stations that clustered with or towards the transect 5 stations, notably two stations from the deep stratum of transect 3 and one deep station from transect 1. Thus, it is likely that local differences in sponge spicule content can also determine small spatial scale differences in infaunal assemblage composition since the presence of sponge spicules in sediments provides for a wider range of niches for sessile and motile polychaetes (Knox & Cameron 1998) and presumably other infaunal taxa. It is possible that sponge spicules influence the composition of the infaunal assemblage in other ways, e.g., only certain species can tolerate their presumably abrasive quality, or the spicules act as a surface on which bacteria or microphytobenthic organisms (potential food for some infaunal species) can proliferate or become ‘trapped’ by (a relationship between sponge spicule content and sediment chl *a* was observed in the present study). However, these contentions are at present only speculative.

Although water depth is identified by the BVSTEP analysis as a contributory variable for the epifauna assemblage pattern, it is worth remembering that depth *per se* does not directly influence benthic organisms, rather it is variables which co-correlate with this factor that are likely to structure the composition of assemblages. For example, changes with depth will influence the amount and quality of organic material that arrives at the sea bed (Fabiano et al. 1997). Thus, depth may here be acting as a proxy for the amount of initial food (energy) that is supplied and utilised by the epifaunal assemblage.

Overall, the results of the present study demonstrate, via an examination of three components of macroinvertebrate assemblage composition on the northwestern Ross Sea shelf, that a number of environmental drivers operating at different spatial scales are responsible for structuring benthic communities. As has already been noted, at the time the present study was initiated the influence of multiple drivers working at varying scales had already been inferred for Antarctic shelf communities (Gutt 2000), and has subsequently been supported by studies similar to the one reported here albeit on somewhat different spatial scales (e.g., Barry et al. 2003, Cummings et al. 2006). It seems then that the paradigms that are beginning to solidify for the environmental control of coastal communities in the Ross Sea (Cummings et al. 2006, Thrush et al. 2006) may be partially extended into the offshore realms of the shelf.

However, the results of the present study do not provide support for the extent of decoupling between pelagic and benthic systems suggested by the research of Barry et al. (2003) for the deeper waters of the southwestern Ross Sea. That is, contrary to the findings of Barry et al. (2003) for “megafauna” (identified from video images), there are strong indications from the BioRoss study that large-scale oceanographic and local habitat variables are both responsible controlling patterns of benthic communities, without the latter being of particular importance, for the patterns of assemblage composition observed in the northwestern Ross Sea. It is possible that the findings of Barry et al. (2003) are either particular to the component of the fauna they examined (although the patterns for mega-epifauna revealed by the present study tend to contradict such a suggestion) or the region examined (substrate parameters vary considerably in the southwestern area, whereas in the northwestern area the sediment type is relatively homogenous). It is probable that the relative strength of the benthic-pelagic coupling could change along the shelf of the northwestern Ross Sea. That is, because it is likely that the benthos of the deeper waters are partly dependent upon the lateral transport of organic material from coastal waters (Isla et al. 2006), with the decrease in shelf width northwards the relative linkage between pelagic processes and benthic assemblage composition could be higher in the north than in the south of the shelf region studied. This contention remains to be tested for the northwestern Ross Sea shelf, although there is some evidence that such factors may influence the strength of bentho-pelagic coupling and ultimately assemblage composition (Smith et al. 2006).

Spatial differences in the dominance of certain factors among the suite of factors that control benthic assemblages were acknowledged by Beaman & Harris (2005) for their study of the King George V shelf in eastern Antarctica. These authors noted that in areas protected from iceberg disturbance (in their case outer shelf banks and slope rather than inshore areas) the direction and speed of currents were the likely dominant factors, whilst where the seabed was directly influenced by iceberg scouring (in less than 500m water depth) disturbance would limit the macrofauna distribution. At depths below iceberg scouring, substrate type (particularly the mud content of sediments) was thought to be the primary agent controlling assemblage composition (e.g., in deep basins).

4.5 Fish assemblages

4.5.1 Univariate analysis

4.5.1.1 Energy-diversity hypothesis

The measures of AvTD and VarTD for the fish assemblages of the transect strata were not significantly different from one another. Thus the results do not directly support the hypothesis that primary productivity influences the diversity (as measured using TD indices) of the fish assemblages along the northwestern Ross Sea shelf. However, there were some noticeable differences in taxonomic structure between the assemblages. As predicted, where productivity was lowest (as measured by surface water and sediment chl *a*) at transect 3 the mean measure of VarTD was the highest observed. However, at this transect the mean AvTD value was, contrary to prediction, also relatively high. Also contrary to the initial predictions, mean values of AvTD were lowest where productivity levels as measured by both surface water and sediment chl *a* were highest, at transects 5 and 1. Mean measures of VarTD were somewhat lower for fish assemblages at these same transects (i.e., in the direction of the prediction), but values were not the lowest recorded among all transects. The reason for the lack of an overall pattern consistent with the initial predictions for the relationship between fish diversity and productivity is likely to reside in part in the relative weakness, for the fish assemblages, of the proxy measures used. Other possible reasons for the observed pattern in biodiversity among transects are discussed below (in the multivariate section).

4.5.1.2 Disturbance-diversity hypothesis

The measures of AvTD for the fish assemblages of the depth strata were significantly different from one another, however, the mean values for VarTD were not significantly different among strata. As predicted the mean values of AvTD were higher for fish assemblages from the presumed intermediate level disturbed mid and deep strata, and lower for the least disturbed (as measured by percentage iceberg scouring) shallow stratum. However, the converse prediction for VarTD was not supported by the results. In addition, the measures of AvTD appear to increase linearly with increasing depth which is not in complete support of the initial prediction (which would have the measures for the two deeper strata being similar). Thus the results provide only partial support for the hypothesis that disturbance influences the diversity (as measured using TD indices) of the fish assemblages across the northwestern Ross Sea shelf. The relationship of increasing AvTD and VarTD with increasing depth most probably relates to factors other than simply differences in iceberg scouring between the shallowest and deepest water (see further discussion in multivariate section below).

4.5.2 Multivariate analysis

4.5.2.1 Energy-diversity hypothesis

Despite the lack of the expected latitudinal gradient in the proxy measures of productivity, the results of the multivariate analysis of fish data, with respect to the examinations conducted by transect grouping, provide partial support for the energy-diversity hypothesis. Formal pairwise comparisons between transects revealed large differences in composition between fish assemblages of transect 5 and transects 3 and 2, with a significant though lesser difference in assemblage composition also being observed between transects 3 and 1 (note that transect 4 was not included in the analysis of fish data). Measures of surface water and sediment chl *a* are highest in the present study for transect 5 and lowest for transect 3. Thus, the difference in composition between fish assemblages of transect 5 and 3 could be related to differences in the two proxy productivity measures. However, the two proxy measures did not exhibit a similar between-transect pattern. Whilst the relative differences in the mean measure of sediment chl *a* content between transect 5 and 2, and 3 and 1 could perhaps account for the differences observed in assemblage composition between these two pairs of transects, the lack of an obvious difference in the measure of surface water chl *a* between transects 5 and 2 somewhat confounds this contention. Nonetheless, sediment chl *a* content is a better proxy measure of the primary productivity available for exploitation by benthic invertebrate and therefore probably a more reliable indicator of the potential control of productivity upon assemblage composition. An examination of the SIMPER results for fish may give some support to the productivity-diversity hypothesis. That is, whilst the rattail *Macrourus whitsoni* was not identified as a discriminating species, it did not occur in the assemblage of transect 5 but did at both transects 2 and 3. It is difficult to know whether its absence from the assemblage of the transect potentially most influenced by the high supply of sediment chl *a* is related to that, or an indication of the patchy distribution of fish species reported by several authors from the Ross Sea (e.g., Eastman & Hubold 1999). It was the relative occurrence of the icefish *Chinodraco hamatus* and the more frequent occurrence of the small nototheniid *Trematomus lepidorhinus* in transect 5 compared to transects 2 and 3, that made them good discriminating species and contributors to the high dissimilarity observed between the assemblages in these transects. These two species are among the most abundant of their families in the Ross Sea. Both are eurybathic, able to live at a wide range of depths. Channichthyids, including species of *Chinodraco,* are generally thought to be active bentho-pelagic predators, which move up and down in the water column regularly where they feed on euphausiiids, hyperid amphipods, mysids and fish (e.g., Kock 2005). They do not appear to feed on infauna or epifauna hard on the sea floor. The feeding ecology of species of *Trematomus* is also variable, although the fish are typically more demersal than the icefishes, and do not undertake such pronounced vertical migrations. They commonly predate amphipods (including gammarids), euphausiids, isopods, small fishes, polychaetes, gastropods and bivalves (e.g., Tarverdiyera & Pinskaya 1980, Takahashi 1983, Casaux et al. 2003) The diet of *T. lepidorhinus* is not well known, but the species may also forage off the bottom, as hyperiid amphipods have been found in stomachs (Takahashi & Nemoto 1984, Schwarzbach 1988, Eastman & DeVries 1982). Whilst it is difficult to explain why *Chinodraco hamatus* is a discriminating assemblage species in this transect comparison case, perhaps the more frequent occurrence of *Trematous lepidorhinus* as part of the transect 5 assemblage is related to its ability to exploit both pelagic and benthic invertebrates as food which are presumably more abundant in the area of higher productivity. However, considering the lack of an ideal proxy measure of productivity, as it relates most directly to the fish assemblage sampled, it is perhaps not surprising that the present results provide only equivocal indications that productivity is a structuring force on the composition of fish assemblages.

4.5.2.2 Disturbance-diversity hypothesis

The similarity level (*β*-diversity) of fish assemblages from the mid-depth stratum is lower (29%) than the assemblages from the other two depth strata (53%, 55%). These levels of similarity are reflected in the measures of relative dispersion, which are highest for the middle depth stratum assemblage and somewhat lower for the deep and shallow strata assemblages. Low similarity (and high dispersion) is expected among samples from areas where assemblages are patchily disturbed (Warwick & Clarke 1993), as is the case for samples taken from the middle stratum where iceberg scours with paths tens of metres wide and several kilometres long are distributed over approximately 6% of the stratum area. These results seem to support the disturbance-diversity hypothesis, however, the deep stratum is apparently disturbed by icebergs to almost the same level and hence the cause-effect linkage is unclear. Similarily, the results of the formal ANOSIM test do not provide strong support for the disturbance-diversity hypothesis. Whilst a significant difference in composition is observed between all comparisons of the fish assemblages between depth strata, and the greatest difference is between the shallow (least disturbed) stratum and the deep (one of the most disturbed) stratum, the difference in assemblage composition between the shallow and middle strata (highest relative difference in iceberg disturbance), and the deep and middle strata (lowest relative difference in iceberg disturbance) are on a par. An examination of the SIMPER results also questions the contention that iceberg disturbance has a major influence on fish assemblage composition across the northwestern Ross Sea shelf. That is, the benthic sharp-spined nototheniid *Trematomus pennellii,* a species found to be associated with high iceberg disturbance levels in the Weddell Sea (Brenner et al. 2001), only occurs in the relatively undisturbed shallow stratum and is a discriminating species between the assemblages of this stratum and the two deeper more disturbed strata. Another notothenid, *T. lepidorhinus,* which occurs less frequently in the shallow and more often in the deep stratum, has previously been associated with areas undisturbed by iceberg scour (Brenner et al. 2001). Considering the relative mobility of species that were sampled, it is perhaps not surprising that the present results indicate that iceberg disturbance is apparently not a structuring force on the composition of fish assemblages at the spatial scale examined.

4.5.2.3 Habitat heterogeneity-diversity hypothesis

As already noted in the Methods, this hypothesis was not tested for the fish assemblages because no appropriate measure of habitat heterogeneity was obtained for this taxonomic group.

4.5.2.4 Other drivers

The influence of other environmental variables on the fish assemblage composition of the northwestern Ross Sea shelf was considered through the correlation analysis conducted. The results of this analysis suggest that mean annual ice cover and depth together explain up to 50% of the pattern observed. Even alone, the variable depth has the same explanatory power for the overall assemblage compositional pattern. However, water depth *per se* is not an environmental factor that directly affects fish, rather it is suite of co-correlated variables that are likely to be controlling the composition. The SIMPER analysis conducted as part of the examination of the disturbance-diversity hypothesis has the potential to provide a hint as to what depth-related variable structures the fish assemblages of the shelf. The species that discriminate between the assemblages of the shallowest and deepest strata (which were the most dissimilar) are the nototheniid *Trematomus pennellii* which occur only in the assemblage of the shallow stratum, and the rattail *Macrourus whitsoni* which only occurs in the two deepest strata. These two species were also good discrimators, respectively, between the assemblages of the shallow and the mid, and the deep and mid depth strata. Antarctic fishes are well known for the wide range of depths a particular species can live at. Many of the groups do not have swim bladders, enabling them to cope with different depths and therefore pressures. Such adaptations towards neutral buoyancy include a high lipid content in the flesh, and reduced levels of calcification of the skeleton (see summary in Eastman 1990). Both *T. pennellii* and *M. whitsoni* do not have swim bladders and therefore depth related pressure changes are unlikely to affect their distribution. It is possible, though it is difficult to verify directly, that changes in preferred prey availability may influence the differences in fish assemblage composition with depth. For example, *M. whitsoni* feeds extensively on *Pleuragramma antarticum* in the Ross Sea (NIWA unpublished data) and this species of small fish occurs more frequently in the assemblages of the two deepest depth strata than in the shallow stratum. Despite their being no clear indication which depth-related variable could explain why *T. pennelli* and *M. whitsoni* are good discriminating species for assemblages from the shallower and deeper depth strata, their distribution determined during the present study does compare well with the results of previous surveys. Notothenioid fishes, such as *T. pennelli,* are both highly diverse and abundant in coastal Antarctic waters. *Trematomus pennellii* is widely distributed through the western Ross Sea, found down to at least 300 m (Eastman & Hubold 1999) and in the southeastern Ross Sea at 240 m (Donnelly et al 2004), although it has a recorded depth range from around the Antarctic Peninsula down to 730 m (Gon & Heemstra 1990). Macrourids on the other hand are a diverse and abundant group in deeper waters of the slope and abyss throughout the worlds oceans (e.g., Merrett & Haedrich 1997). However, they are generally not diverse in the very high latitudes, and only four species are known from the Ross Sea: *Coryphaenoides ferrieri*, *C. Lecointei*, *Cynomacrourus piriei*, and *Macrourus whitsoni*. *Macrourus whitsoni* has a recorded depth range of 400 m to 3185 m, although is most commonly found at depths of 600–1500 m (Gon & Heemstra 1990). It appears to be restricted to the northern parts of the Ross Sea south of the Antarctic Convergence (Gon & Heemstra 1990), and was not caught in surveys of the eastern Ross Sea (Donnelly et al 2004) nor the southwestern Ross Sea below Coulman Island (Eastman & Hubold 1999).

The identification of ice cover as a potentially important structuring agent of fish assemblage composition on the northwestern Ross Sea shelf seems reasonable. It is intuitive that the amount of ice cover should influence the distribution of fish on a seasonal basis, although some are adapted to live under permanent ice (Lutjeharms 1990). This seasonality is likely to be linked to the timing of surface production, the lifecycle of important prey items for fish (e.g., krill larve, copepods) and its fall-out to the seafloor (see references in Knox 2007). However, it needs to be remembered that sampling during the present study only occurred during the relatively brief period when the Ross Sea polyna forms, and hence it is only a “snap-shot” of abundance and distribution. This restriction on understanding also applies to previous studies which are based on trawling carried out in December-February (e.g., Iwami & Abe 1981, Eastman & Hubold 1999, Donnelly et al. 2004).

The survey in the northwestern Ross Sea recorded 43 species of fish in 9 families taken in 31 trawls. No new species have been confirmed, although 2 “onboard species” of muraenolepid have yet to be identified. However, the trawling was the most intense undertaken in that region of the Ross Sea, and so has enabled a robust description of the fish component of the demersal fauna. The sampling design and replication within strata also provided a strong dataset to describe assemblages in geographic space and by depth. Overall, the species richness per trawling effort was lower than that reported over larger areas of the Ross Sea by Eastman & Hubold (1990, 10 trawls, 47 species) and Donnelly et al. (2004, 6 trawls, 37 species).

Many of the common species sampled during the survey have a circum-Antarctic distribution (see Gon & Heemstra 1990) although some have not been frequently collected (e.g., *Artedidraco orianae*, *Trematomus nicolai*). The present sampling has extended the known distribution of the zoarcid *Lycodichthys dearborni* beyond the southern inshore areas of the Ross Sea (Anderson 1990, Eastman & Hubold 1999, Donnelly et al 2004). The majority of the fish fauna are typical of the “East Antarctic” assemblage (Kock 1992, Eastman 1993) which is dominated by the notothenid genus *Trematomus*, with artedidraconids, bathydraconids and channichtyids. A notable absence in the present survey were the liparids (Family Cycloteridae). Six species of *Careproctus*, six of *Paraliparis*, and one of *Edentoliparis* are known from the Ross Sea. These are generally small-bodied species, but would likely have been retained by the trawls and nets used during the present study. The depth distribution of many liparid species starts towards the lower end of the sampling conducted, and their absence is most likely due to the low number of deep trawls.

The “patchiness” of the fish assemblage composition and distribution observed in geographic space (i.e. between transects) is commonly reported in other studies in the Ross Sea. Donnelly et al. (2004) recorded several large single catches of particular species, and commented on the variable nature of benthic fish assemblages due to localised hydrographic, habitat, or trophic, conditions. The present study sheds some light on the environmental conditions underlying this irregular distribution. Depth differences in Antarctic fish fauna are well documented from the western Ross Sea (e.g., Eastman & Hubold 1999), and seen also in the eastern Ross Sea (Donnelly et al. 2004) and the Weddell Sea (e.g., Ekau 1990). The depth-related findings of the present study are consistent with the results of these previous studies.

5. FUTURE RESEARCH

The BioRoss Survey represents one of the more comprehensive large-scale studies of the macrofauna shelf communities in the Antarctic. Therefore, as research on other available data is completed and reported upon it is likely that these findings will contribute greatly to furthering understanding of which (and how) environmental drivers influence benthic biodiversity, particularly for the Ross Sea region. However, in the future it will be necessary to continue to undertake research on benthic communities in Antarctica, and particular suggestions for future studies (as they relate to the hypotheses examined by the present study) are briefly detailed below. In addition, some broad suggestions are also made in relation to the wider interests of those who are charged with implementing research in support of New Zealand's Biodiversity Strategy. More specific suggestions regarding the use of samples taken during the BioRoss study, but not processed (e.g., meiofauna and bacteria material for trophic food web studies), and the further utilisation of preserved/archived material (e.g., for population genetic studies, biomass measurements for trophic food web studies) have already been made to the Ministry via other routes, some of which have already been implemented.

5.1 Future research in relation to hyptheses tested

The measures of habitat heterogeneity utilised in the present study, though reasonably effective for examining this variable at two spatial scales primarily for the infauna, were relatively simplistic. In order to progress understanding of the role of habitat heterogeneity (particularly biogenic) in structuring benthic assemblages it is important that imaging devices (still and video cameras) are utilised to capture images at a number of spatial scales (ideally simultaneously). In addition, there is some need for improvement in the techniques for accurately quantifying structure using images and direct samples of the seabed. It is also of relevance to conduct analyses that will be able to determine the relative importance of biogenic structure for different components of the fauna. By addressing these topics it should be possible to better assess the validity of the current belief that habitat heterogeneity is a major driver of Antarctic diversity.

As Thrush et al. (2006) have noted, there is need in the Ross Sea to undertake “a detailed comparison of iceberg disturbance-frequency regimes and benthic communities” for this would allow an “assessment of iceberg impacts and recovery processes across spatial scales” that have yet to be examined. Such studies are becoming more pertinent because climate change is thought to impact upon the frequency of iceberg calving elsewhere in the Antarctic (Scambos et al. 2000), although whether this is the case for the Ross Sea is currently unclear (Oppenheimer 1998). Future studies could conceivably involve the satellite tracking of particular icebergs and benthic samples could be taken in scoured areas. It is important that such a project takes place over a long time scale since growth rates of Antarctic species are low (Heilmeyer et at 2004, Clarke et al. 2005, Barnes et al. 2007) and community recovery is predicted to take from several decades (Peck et al. 1999) to several hundred years (Gutt & Starmans 2001). A project of such scale will call for international collaboration since it is unlikely that a single research team could return to sample the iceberg scours at somewhat regular intervals. As has already been noted by others, climate change is not only likely to influence iceberg frequency but there will be an associated impact on primary production and the export of this production (see Isla et al. 2006 and references therein).

As evidenced from the present study there is a need for future research, that attempts to examine the links between primary production and the benthos, to not only obtain more realistic measures of this variable and its products (rather than relying on sometimes dubious proxies) but to also include direct measures or models that can quantify or indicate the likely source of the organic matter that is utilised by benthic organisms. That is, the use of sediment traps, current/particle models, isotopic and tracer techniques could significantly improve understanding of the transport and fate of organic matter and therefore the importance of primary production in structuring benthic communities of Antarctic shelves (see Mincks et al. 2005 for a recent example of the sorts of detailed study required).

5.2 Future research in relation to other areas of interest

5.2.1 Tourism/invasive species

The impact of human activities on Antarctic marine systems is of growing concern. Studies have demonstrated that the presence of humans at even small scientific bases can, through activities such as waste disposal, influence the composition of benthic assemblages (e.g., Stark et al. 2003). Although such impacts appear to be spatially restricted to the vicinity of the base, other human impacts could be much wider reaching. Concern about the impacts of tourism on Antarctica ecosystems are many (Anon. 2004), and include fears about the effect of invasive (alien) species (Frenot et al. 2005) which may be transported to the region by an increasing number of tourist expeditions, some of which originate in the Northern Hemisphere. Research has been ongoing in many parts of the world into the spread of marine non-indigenous species, the effects of biological invasions on benthic communities (including New Zealand) and the means by which to eliminate or mitigate these effects. However, as yet no such research has been undertaken in the Ross Sea or Balleny Islands region of Antarctica. Clearly considering the physical and biological particularities of the environment, research carried out elsewhere is not necessarily going to be applicable to the Antarctic. Thus, it would be sensible to establish research priorities to address any Antarctic marine biosecurity risks, especially from hull fouling on tourist (and fishing) vessels.

5.2.2 Fishing

Similarly, concerns about fishing activity in Antarctica are many and this is considered to be one of the greatest threats facing this polar environment (Clarke & Harris 2003). Of specific relevance to the Ross Sea and impacts on deepwater benthic communities is the emerging toothfish longline fishery. The results of the present study and others like it will assist in addressing any non-target species impacts, and may be used by CCAMLR in the management and mitigation of such impacts (e.g. data can be used to identify so-called Vulnerable Marine Ecosystems).

5.2.3 Environmental management

With the need to manage the environment more effectively and efficiently, those charged to do so are utilising a range of fairly recently developed data products and tools to select areas which can be protected or conserved in some way. There now exists a range of software tools that can identify in a sophisticated and largely objective manner, areas which alone or together will best preserve the feature of concern (e.g., Leathwick et al. 2008). However, the strength of these tools ultimately relies on the quality of those data or data products (layers) that are incorporated into the mathematical selection procedure. One of the primary data products ideally included in the selection process is an environmental classification which captures an integrated picture of both (or either) of the physical and biological components of the environment. Classifications are many in name and no common method or form has emerged as a standard. Nonetheless, among the numerous schemes there are national classifications for the Australian and New Zealand marine environments (the Benthic Marine Bioregionalisation of Australia by Heap et al. 2005, the Marine Environment Classification (MEC) of New Zealand of Snelder et al. 2006,), both of which are still undergoing development/extension (e.g. a fish focused MEC by Leathwick et al 2006 and a benthic focused MEC in prep.). Australia has already extended its effort beyond its national EEZ to include a classification of the King George V shelf in Antarctica (Beaman & Harris 2005), and considering the usefulness of such classification for environmental management it would seem sensible for a classification of the Ross Sea area to also be undertaken. Obviously, data gathered during the BioRoss study along with data from other voyages will now make such an endeavour achievable and worthwhile. In addition to applying a version of the MEC scheme to the region, consideration should be given to undertaking a classification based on the Australian Bioregionalisation scheme. As Beaman & Harris (2005) note their “hierarchical method of benthic habitat mapping could be applied circum-Antarctic for comparison against other geographic areas, and would assist authorities responsible for developing ecosystem-based plans by identifying the different types of marine habitats and their associated biological communities at varying scales on the Antarctic shelf."

5.2.4 Climate change

The impact of climate change on Antarctic marine systems has already been mentioned in this report, and perhaps it is fitting to end this report with a verbatim portion of text from the recent review of Antarctic macro-zoobenthic communities by Gutt (2007). This quote captures the perceived need among scientists for studies such as the BioRoss project.

"The urgent need for prediction of ecosystem response to large-scale environmental changes makes a continuation of surveys at the community level particularly necessary. Only these kinds of studies can provide information on regional species richness, abundance, biomass, dominance, as well as spatial patterns, and can cover the full range of all larger ecological guilds and/or systematic groups and their dynamics. This information provides the basis for further physiological, genetic, flux, or life history studies on representative components of the ecosystem. Ongoing and nearly finished projects will reveal valuable additional results, e.g., BENTART (Spain), FOODBANKS (USA), IBMANT (Arntz et al. 2005), BIOROSS (New Zealand), LGP (Berkman et al. 2005), EBA (SCAR), CAML (Sloan Foundation), further studies under the Amery Ice Shelf, and other IPY approved projects. A considerable step forward, however, is only possible if such approaches are coordinated, sampling and measurement strategies are standardized, if more attempts to correlate biological and physical results are included, and if long-term ecological processes and developments are considered. The use of faunistic and ecological data banks such as SCAR MarBIN (http://www.scarmarbin.be/) or PANGAEA (http://www.pangaea.de/) can also help improve our understanding of ecological and evolutionary processes if the presence-absence problem is solved and if data from the past can be included." (from Gutt 2007)

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The first author of this report (AAR) wrote the funding proposal for the BioRoss Survey, designed the sampling strategy, led the project, and contributed to the data analysis and the writing of the report. The second author (KK) participated in the BioRoss voyage, sorted and identified the polychate fauna, collated data (all faunal and environmental), undertook the data analysis, and contributed to the writing of the report. KK acknowledges the receipt of a NIWA post-doctoral fellowship (Non-Specific Outcome Fund project NPDL053 and Capability Fund project CPDD063) which allowed her to progress the shipboard identifications of the polychaetes. The third author of this report (MRC) contributed text to the funding proposal, contributed to sampling strategy planning, led the biodiversity team during the BioRoss voyage, and contributed to the writing of the report.

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APPENDICES

Appendix 1: Main gear types and gear codes used during sampling of the northwestern Ross Sea shelf and the Balleny Islands seamounts (voyage TAN0402).

Gear name: large Van Veen Grab

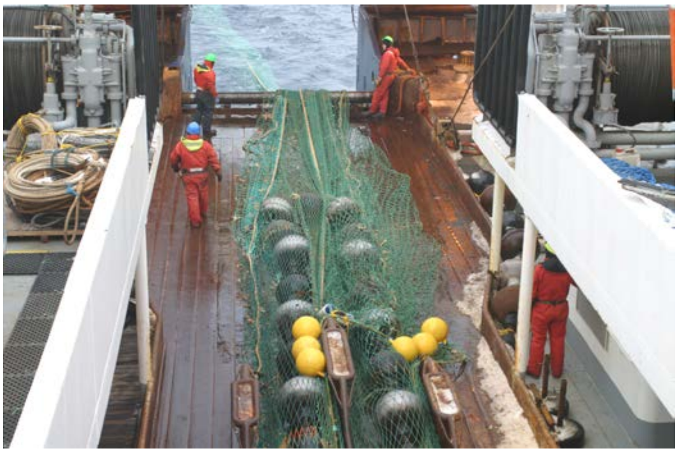
Gear code: GVVL

Target assemblage: infauna

Gear name: large epibenthic sled

Gear code: SEL

Target assemblage: epifauna and fish



Gear name: Orange Roughy Trawl

Gear code: ORH

Target assemblage: mega-epifauna and fish with wider distribution

Appendix 2: Summary of station and sample data for northwestern Ross Sea shelf (voyage TAN0402). Code to gear methods: SVP = sound-velocity probe and CTD; GVVL = large Van Veen grab; SEL = large epibenthic sled; ORH = orange roughy trawl; BEAM = beam trawl.

Station	Transect	Gear method	Date	Time	Latitude °	Latitude min	Longitude °	Longitude min	W /E	Start depth (m)	Finish depth (m)	Sample volume and content	**Comment**
1	Adare	SVP	03-Feb	1714	70	69.84	170	36.79	E	0	1000		
2	3	SVP	04-Feb	1416	71	50.80	171	4.73	E	0	233		
3	3	GVVL	04-Feb	1812	71	41.52	172	3.47	E	634	634	90 l mud, soft	
4	3	SEL	04-Feb	1846	71	41.23	172	3.50	E	644	651	100 kg mud, shell sediment	
5	3	GVVL	04-Feb	1953	71	41.96	172	1.60	E	623	623	40 l ,mud with shell and worms	
6	3	SEL	04-Feb	2029	71	41.41	172	0.46	E	628	631	30 kg rock, shell fragments	
7	3	GVVL	04-Feb	2145	71	42.98	171	49.67	E	536	536	30 l, gravel-silt, shells	
8	3	SEL	04-Feb	2227	71	42.84	171	49.61	E	537	541	15 kg broken shell, fragments	camera on
9	3	ORH	05-Feb	11	71	41.80	172	4.42	E	647	627	450 kg ; *M. whitsoni*, TOA, skates, asteroids	
10	3	ORH	05-Feb	133	71	42.66	172	2.68	E	636	621	400 kg *M. whitsoni*, 3 t mud, small invertebrates	
11	3	ORH	05-Feb	432	71	42.72	171	48.64	E	530	532	10 kg mixed fish, gorgonians, asteroids	short tow
12	3	GVVL	05-Feb	533	71	43.51	171	48.18	E	536	536	45 l	
13	3	SEL	05-Feb	625	71	42.59	171	49.64	E	535	532	40 kg shell and rubble	
14	3	GVVL	05-Feb	724	71	43.88	171	45.00	E	451	451	5 l gravel, small stones, shell, coral	
15	3	SEL	05-Feb	759	71	43.67	171	44.12	E	466	438	60 kg rock, rubble, shell, mixed invertebrates	
16	3	GVVL	05-Feb	930	71	44.36	171	39.47	E	411	411	30 l silt/gravel, some shell fragments	
17	3	SEL	05-Feb	1004	71	44.39	171	39.27	E	420	422	30 kg rubble, shell, mixed invertebrates	
18	3	ORH	05-Feb	1136	71	43.63	171	46.88	E	522	530	20 kg *M. whitsoni*	
19	3	ORH	05-Feb	1332	71	44.11	171	44.00	E	429	454	fish, sponge	small catch
20	3	ORH	05-Feb	1446	71	44.44	171	38.64	E	400	415	20 kg fish ,sponge	

21	3	GVVL	09-Feb	1212	71	47.97	170	56.92	E	168	168	rocks, 10 l gravel + pebble, ascidians, echinoderms	
22	3	SEL	09-Feb	1238	71	48.06	170	56.48	E	151	180	30 kg rocks + rubble, 50 kg ascidians	
23	3	GVVL	09-Feb	1325	71	47.82	170	56.44	E	127	127	5 kg rocks	
24	3	GVVL	09-Feb	1357	71	47.87	170	56.46	E	119	119	20 l gravel + pebbles, bryozoa	
25	3	SEL	09-Feb	1419	71	47.92	170	55.97	E	127	140	100 kg rubble + sediment, 70 kg rocks	
26	3	ORH	09-Feb	1554	71	46.69	170	57.83	E	230	219	20 kg kelp, ascidians, asteroids, mixed fish	
27	3	ORH	09-Feb	1846	71	43.64	171	34.03	E	337	336	10 kg ascidians, kelp	
28	3	ORH	09-Feb	1936	71	43.12	171	30.17	E	305	324	30 kg ascidians, asteroids, icefish	
29	3	ORH	09-Feb	2117	71	45.36	171	15.81	E	270	275	10 kg icefish, 20 kg kelp, ascidians	
30	3	GVVL	09-Feb	2223	71	44.78	171	17.48	E	277	277	15 l silt + gravel +shell, gorgonians, ascidians	
31	3	SEL	09-Feb	2317	71	44.81	171	33.30	E	343	340	20 kg shell + gravel	
32	3	GVVL	10-Feb	52	71	44.48	171	33.85	E	340	340	15 l black gravel, dead shells	
33	3	SEL	10-Feb	125	71	45.28	171	25.02	E	282	278	350 kg rubble, shell, gorgonians	
34	3	GVVL	10-Feb	312	71	46.11	171	6.07	E	235	235	5 l gravel+stones, algae, bryozoa, ascidians	
35	3	SEL	10-Feb	328	71	46.05	171	6.55	E	241	238	240 kg stones, +rubble, echinoderms, gorgonians	
36	3	ORH	10-Feb	439	71	46.37	171	8.93	E	236	240	50 kg algae + kelp, holothurians, asteroids, ascidians	
37	3	ORH	10-Feb	551	71	45.95	171	10.03	E	245	249	20 kg icefish, algae, mixed invertebrates	
38	3	GVVL	10-Feb	733	71	45.26	171	8.59	E	226	226	4 l fine gravel, ascidians, asteroids	
39	3	SEL	10-Feb	757	71	45.30	171	8.85	E	250	250	240 kg mixed rubble, coral, sponge, ascidians	
40		SVP	10-Feb	905	71	42.42	171	21.49	E	0	277		
41		SVP	10-Feb	1910	71	29.78	171	2.29	E	0	310		
42		SVP	11-Feb	1309	71	21.54	170	47.54	E	0	357		
43	Poss.I.	line	12-Feb		71	53.70	171	9.60	E	10	10	5 fish	small catch
44	5	GVVL	12-Feb	2121	72	19.39	170	21.92	E	124	124		rock jammed in jaws
45	5	GVVL	12-Feb	2137	72	19.14	170	21.79	E	114	114		failed to fire
46	5	GVVL	12-Feb	2149	72	18.91	170	21.33	E	124	124		failed to fire
47	5	GVVL	12-Feb	2202	72	18.92	170	21.66	E	130	130	9 l, coarse sand, gravel, bryozoa, ascidians	
48	5	SEL	12-Feb	2218	72	19.00	170	21.74	E	132	130	350 kg gravel, stones, gorgonians, crinoids, ascidians	
49	5	GVVL	12-Feb	2256	72	19.80	170	23.60	E	158	158		failed to fire
50	5	GVVL	12-Feb	2314	72	19.78	170	23.65	E	159	159		failed to fire

51	5	GVVL	12-Feb	2329	72	19.96	170	23.34	E	152	152	7 l mud, coarse gravel, rubble, bryozoans	
52	5	SEL	12-Feb	2354	72	20.21	170	23.65	E	154	153	50 kg rocks ,400 kg rubble + mixed invertebrates	
53	5	GVVL	13-Feb	41	72	19.86	170	25.67	E	197	197	5 l mud-sand with some pebbles	
54	5	SEL	13-Feb	104	72	19.49	170	25.66	E	206	199	100 kg rock, 300 kg rubble, gorgonians, coral, bryozoans	
55	5	ORH	13-Feb	216	72	18.47	170	21.46	E	130	123	100 kg ascidians, asteroids, few fish	
56	5	ORH	13-Feb	314	72	18.56	170	22.68	E	150	134	150 kg, ascidians, crinoids, asteroids, mixed fish	
57	5	ORH	13-Feb	539	72	20.51	170	26.58	E	203	206	50 kg, mixed invertebrates and fish	
58	5	GVVL	13-Feb	706	72	19.90	170	27.64	E	230	230	3 l mud-sand, a few pebbles	
59	5	SEL	13-Feb	736	72	19.58	170	27.48	E	236	231	400 kg gravel, rubble, mixed invertebrates	
60	5	GVVL	13-Feb	827	72	19.79	170	29.51	E	309	309		rock jammed in jaws
61	5	GVVL	13-Feb	854	72	19.60	170	29.09	E	298	298		failed to fire
62	5	GVVL	13-Feb	935	72	19.51	170	29.11	E	300	300		failed to fire
63	5	SEL	13-Feb	954	72	19.30	170	28.72	E	303	293	400 kg coarse rubble, rocks, mixed invertebrates	
64	5	GVVL	13-Feb	1039	72	19.82	170	29.48	E	314	314	15 l silt-gravel-pebbles	
65	5	SEL	13-Feb	1102	72	20.11	170	30.04	E	328	318	80 kg rock, 300kg rubble, echinoderms	
66	5	GVVL	13-Feb	1145	72	19.45	170	28.64	E	280	280	8 l silty gravel and pebbles.	
67	5	ORH	13-Feb	1237	72	19.26	170	28.51	E	272	286	60 kg sponge, ophiuroids, 10 kg fish	
68	5	ORH	13-Feb	1339	72	20.59	170	29.89	E	311	319	10 kg rock	small catch
69	5	GVVL	13-Feb	2038	72	3.58	173	21.18	E	750	750	10 l coarse sand, pebbles	
70	5	SEL	13-Feb	2123	72	3.02	173	19.19	E	760	750	100 kg coral and shells	
71	5	GVVL	13-Feb	2233	72	3.83	173	15.80	E	630	630	10 l sand, coral-shell	
72	5	SEL	13-Feb	2302	72	3.68	173	14.73	E	620	622	250 kg coral, shells, dead	
73	5	GVVL	14-Feb	9	72	5.00	173	8.51	E	536	536	30 l shell-coral, some mud	
74	5	SEL	14-Feb	42	72	4.40	173	8.16	E	538	537	50 kg corals	rock in mouth
75	5	ORH	14-Feb	208	72	4.62	172	56.09	E	526	525	skates	small catch
76	5	ORH	14-Feb	420	72	7.68	172	42.04	E	496	501		fast at end; muddy
77	5	GVVL	14-Feb	529	72	7.80	172	42.79	E	499	499	50 l mud, coral and shell	
78	5	SEL	14-Feb	556	72	7.02	172	41.91	E	495	496	100 kg coral, fine sediment	
79	5	GVVL	14-Feb	729	72	3.88	172	54.54	E	527	527		grab failed to fire

80	5	GVVL	14-Feb	758	72	3.82	172	53.91	E	528	528		grab failed to fire
81	5	GVVL	14-Feb	837	72	3.82	172	54.65	E	528	528		fired, but very small catch
82	5	SEL	14-Feb	903	72	3.63	172	54.23	E	526	527	20 kg rock, 375 kg coral rubble, gorgonians	
83	5	SEL	14-Feb	1001	72	4.37	173	7.95	E	543	537	80 kg rock, 200 kg coral, dead	
84	5	ORH	14-Feb	1119	72	4.95	173	8.33	E	539	542	mixed fish	small catch
85	5	ORH	14-Feb	1240	72	2.20	173	14.93	E	770	866	100 kg, TOA, skates, mixed invertebrates	
86	5	GVVL	14-Feb	1428	72	5.85	172	58.58	E	518	518		grab failed to fire
87	5	GVVL	14-Feb	1452	72	5.96	172	57.42	E	514	514		grab failed to fire
88	5	GVVL	14-Feb	1523	72	5.86	172	55.81	E	515	515	30 l, muddy silt, coral	
89	5	ORH	14-Feb	1844	72	16.73	171	24.82	E	415	420	mixed fish, sponges	ripped belly
90	5	GVVL	14-Feb	1940	72	16.46	171	27.84	E	423	423	6 l silty gravel, dead shell, coral	
91	5	SEL	14-Feb	2003	72	16.61	171	26.94	E	414	409	250 kg silty gravel/rubble, 50 kg rocks, few animals	
92		SVP	14-Feb	2203	72	14.61	170	41.75	E	0	425		
93		SVP	15-Feb	1947	71	29.28	171	5.38	E	0	334		
94	Adare	BEAM	17-Feb	1157	71	31.80	170	6.66	E	220	191	2t, mud and great fish and invertebrates	
95	1	GVVL	17-Feb	2341	71	11.88	171	0.18	E	740	740	20 l fine sand, shell	
96	1	SEL	18-Feb	21	71	11.32	170	58.63	E	719	736	300 kg shells, pebbles, mixed invertebrates	
97	1	GVVL	18-Feb	127	71	11.84	170	57.89	E	630	630	10 l sand, dead coral, few rocks	
98	1	SEL	18-Feb	200	71	11.45	170	56.49	E	614	614	240 kg mixed catch, 1 large rock.	
99	1	GVVL	18-Feb	302	71	11.84	170	57.19	E	603	603		grab failed to fire
100	1	GVVL	18-Feb	351	71	12.09	170	56.89	E	585	585	20 l fine sand/mud, dead bryozoa and coral shell	
101	1	SEL	18-Feb	412	71	12.07	170	56.43	E	565	571	100 kg pebble/stone, some big rocks	
102	1	GVVL	18-Feb	552	71	15.20	170	44.21	E	536	536	18 l fine black sand, rubble	
103	1	SEL	18-Feb	702	71	14.36	170	42.43	E	555	546	250 kg, coarse pebbles and stones	
104	1	GVVL	18-Feb	746	71	16.02	170	39.49	E	461	461	45l black sand, pebbles, barnacle shell	
105	1	SEL	18-Feb	829	71	15.45	170	38.08	E	470	462	300 kg gravel, several big rocks, coral	
106	1	GVVL	18-Feb	909	71	16.48	170	36.36	E	404	404		rock jammed in jaws
107	1	GVVL	18-Feb	940	71	16.63	170	36.13	E	400	400	2 l sand/silt	
108	1	SEL	18-Feb	1014	71	16.31	170	35.98	E	400	405	400 kg, pebbles, rock, mixed invertebrates	
109	1	GVVL	18-Feb	1106	71	17.50	170	34.34	E	347	347	2 l pebble/sponge	rock jammed in jaws

110	1	GVVL	18-Feb	1139	71	17.97	170	35.60	E	352	352	2 l pebble	rock jammed in jaws
111	1	GVVL	18-Feb	1203	71	18.27	170	37.08	E	357	357	7 l sand, gravel, pebbles	
112	1	SEL	18-Feb	1236	71	17.61	170	34.60	E	346	351	350 kg rubble, sponge, coral, echinoderms, 2 big rocks	
113	1	GVVL	18-Feb	1330	71	17.98	170	32.59	E	313	313		grab failed to fire
114	1	GVVL	18-Feb	1346	71	18.06	170	33.20	E	320	320		grab closed, but no sediment
115	1	GVVL	18-Feb	1407	71	18.27	170	34.05	E	322	322		rock jammed in jaws
116	1	SEL	18-Feb	1433	71	17.93	170	32.43	E	312	315	300 kg rubble/mixed invertebrates, 200 kg rock/mud	
117	1	GVVL	18-Feb	1513	71	18.59	170	34.33	E	314	314	8 l coarse sand & gravel	
118	1	ORH	18-Feb	1614	71	17.95	170	32.19	E	312	323	50 kg rubble, 20 kg fish, 100 kg mixed sponge and invertebrates	
119	1	ORH	18-Feb	1830	71	11.39	170	56.93	E	621	675	50kg *M. whitsoni*, 20 kg mixed sponge, jellyfish	
120	1	ORH	18-Feb	2012	71	11.29	170	58.77	E	713	737	15 kg fish, 30 kg jellyfish/invertebrates	
121	1	ORH	18-Feb	2154	71	14.27	170	42.67	E	556	547	Fish, jellyfish	small catch
122	1	ORH	18-Feb	2308	71	16.33	170	35.64	E	395	400	20 kg fish, mixed invertebrates	
123	1	GVVL	19-Feb	24	71	18.79	170	30.06	E	243	243	4 l sand, few pebbles	
124	1	SEL	19-Feb	49	71	18.59	170	28.63	E	212	236	300 kg rubble, ascidians, algae	
125	1	GVVL	19-Feb	140	71	18.99	170	27.94	E	163	163	3 l sand, gravel, rubble	
126	1	SEL	19-Feb	159	71	18.55	170	27.02	E	161	159	220 kg black ascidians, few stones	
127	1	GVVL	19-Feb	442	71	19.42	170	24.54	E	85	85	4 l gravel-pebbles, some ascidians, bryozoans	
128	1	SEL	19-Feb	449	71	19.57	170	24.83	E	85	93	300 kg ascidians, no rocks	
129	1	GVVL	19-Feb	525	71	19.61	170	27.09	E	120	120	4 l gravel, ascidians, some shell	
130	1	SEL	19-Feb	536	71	19.80	170	27.56	E	120	126	400 kg pebbles, ascidians	good invertebrates
131		SVP	19-Feb	1140	71	35.93	170	9.01	E	0	345		
132	Adare	SEL	23-Feb	1304	71	38.86	170	10.81	E	162	172	300 kg, mud, small invertebrates	
133	Adare	SEL	23-Feb	1404	71	38.68	170	13.13	E	249	252	200 kg, mud, small invertebrates	
134	Adare	SEL	23-Feb	1451	71	38.50	170	9.15	E	65	64	350 kg, mud, small invertebrates	
135		SVP	23-Feb	2021	71	11.13	170	4.98	E	0	332		
136	Poss.I.	0	25-Feb	1400	71	52.78	171	9.60	E	38	24	kelp, few fish	grapnel line
137		SVP	25-Feb	1854	71	53.71	171	23.82	E	0	317		
138	4	GVVL	26-Feb	104	72	0.82	170	46.45	E	230	230		grab failed to fire

139	4	GVVL	26-Feb	117	72	0.84	170	46.55	E	236	236	10 l fine sand, small pebbles	
140	4	SEL	26-Feb	128	72	0.81	170	46.47	E	231	240	300 kg rubble	
141	4	GVVL	26-Feb	253	72	1.12	170	48.13	E	300	300		grab failed to fire
142	4	GVVL	26-Feb	316	72	1.10	170	48.49	E	302	302	5 l sand/pebble, a few ascidians	
143	4	SEL	26-Feb	332	72	1.35	170	48.15	E	317	323	400 kg rubble	good small invertebrates
144	4	GVVL	26-Feb	419	72	2.06	170	54.86	E	273	273	3 l gravel/pebbles	
145	4	SEL	26-Feb	436	72	1.88	170	54.32	E	270	280	350 kg rubble/mixed invertebrates	
146	4	GVVL	26-Feb	625	72	7.72	171	27.25	E	372	372		rock jammed in jaws
147	4	GVVL	26-Feb	657	72	8.35	171	26.20	E	406	396	40 l coarse sand/barnacle shell fragments	
148	4	SEL	26-Feb	731	72	8.04	171	26.92	E	397	389	300 kg coral/rubble/mixed invertebrates	
149	4	GVVL	26-Feb	1011	71	58.87	171	57.99	E	456	461	40 l stylasterid coral	
150	4	SEL	26-Feb	1044	71	58.77	171	58.09	E	480	461	200 kg, coral fragments	
151	4	GVVL	26-Feb	1158	71	59.83	172	7.44	E	512	512	30 l, coral, some hydroids	
152	4	SEL	26-Feb	1231	71	59.68	172	8.05	E	515	494	250 kg coral rubble	
153	4	GVVL	26-Feb	1353	72	0.51	172	13.36	E	540	540	50 l stylasterid coral	
154	4	SEL	26-Feb	1421	72	0.08	172	13.34	E	536	586	135 kg, mainly coral	
155	4	GVVL	26-Feb	1513	71	59.68	172	13.17	E	675	675		grab failed to fire
156	4	GVVL	26-Feb	1641	71	59.56	172	12.42	E	675	675	10 l silt/shell fragments, 1 rock	
157	4	SEL	26-Feb	1607	71	59.12	172	10.71	E	737	718	150 kg coral, mixed invertebrates	
158	2	GVVL	26-Feb	2013	71	28.49	171	59.94	E	746	748		rock jammed in jaws
159	2	GVVL	26-Feb	2050	71	28.29	171	59.91	E	727	727		rock jammed in jaws
160	2	SEL	26-Feb	2146	71	27.81	171	59.81	E	693	709	200 kg, dead coral and shell	
161	2	GVVL	26-Feb	2218	71	28.56	171	59.86	E	745	745		rock jammed in jaws
162	2	GVVL	26-Feb	2248	71	28.52	171	59.83	E	738	738	14 l sand, coral	
163	2	GVVL	26-Feb	2347	71	28.28	171	58.89	E	670	670		grab failed to fire
164	2	GVVL	27-Feb	15	71	28.34	171	58.90	E	671	671		rock jammed in jaws
165	2	SEL	27-Feb	49	71	28.22	171	58.49	E	666	678	50 kg, rocks, rubble, dead coral	
166	2	GVVL	27-Feb	149	71	28.54	171	58.71	E	675	675		not closed
167	2	GVVL	27-Feb	222	71	28.46	171	58.78	E	674	674		not closed
168	2	GVVL	27-Feb	303	71	28.70	171	56.57	E	614	614	60 l fine sand and mud	

169	2	SEL	27-Feb	325	71	28.75	171	55.77	E	612	597	300 kg, muddy, few animals	
170	2	GVVL	27-Feb	414	71	29.26	171	52.72	E	565	565	35 l, gritty black sand	
171	2	SEL	27-Feb	433	71	29.25	171	51.74	E	564	561	40 kg shell and rubble	
172	2	ORH	27-Feb	604	71	29.81	171	48.27	E	549	540	40 kg mixed fish & invertebrates	
173	2	ORH	27-Feb	757	71	28.85	171	57.86	E	644	635	100 kg *M. whitsoni*	little else
174	2	ORH	27-Feb	942	71	29.62	171	36.25	E	485	483	50 kg *M. whitsoni*, skate, mixed	
175	2	ORH	27-Feb	1121	71	31.84	171	18.03	E	348	345	200 kg rock, mixed fish, ascidians, kelp	
176	2	GVVL	27-Feb	1212	71	31.86	171	18.72	E	353	353		fired, no catch
177	2	GVVL	27-Feb	1241	71	31.78	171	18.05	E	350	350	35 l dark gravel/pebbles	
178	2	SEL	27-Feb	1258	71	31.89	171	18.31	E	348	345	170 kg, gravel, good mixed invertebrates	
179	2	GVVL	27-Feb	1351	71	31.72	171	25.73	E	382	382		rock jammed in jaws
180	2	GVVL	27-Feb	1408	71	31.59	171	25.49	E	385	385	30 l black silty gravel, some pebbles	
181	2	SEL	27-Feb	1433	71	31.76	171	26.20	E	385	385		wires twisted
182	2	SEL	27-Feb	1512	71	31.55	171	24.58	E	385	382		small catch, good variety invertebrates
183	2	GVVL	27-Feb	1615	71	31.01	171	38.44	E	487	487	40 l black silt/gravel, shells	
184	2	SEL	27-Feb	1721	71	30.03	171	36.42	E	480	491	100 kg rocks, 100 kg mud/small invertebrates	
185	2	BEAM	27-Feb	1846	71	29.32	171	56.58	E	600	596	60 kg mixed rubble and invertebrates	
186	2	BEAM	27-Feb	2019	71	30.72	171	25.51	E	390	389	60 kg, lots of ascidians, pantopods	
187	2	GVVL	27-Feb	2130	71	32.73	171	6.13	E	287	287	30 l black silt/gravel	
188	2	SEL	27-Feb	2153	71	32.85	171	6.67	E	286	280	50 kg gravel/mixed invertebrates, 50 kg rock	
189	2	GVVL	27-Feb	2255	71	34.49	170	52.24	E	231	231	20 l black sand and pebbles	
190	2	SEL	27-Feb	2318	71	34.75	170	52.37	E	230	230	200 kg rubble,100 kg rocks	
191	2	GVVL	28-Feb	5	71	36.02	170	52.34	E	217	217		grab failed to fire
192	2	GVVL	28-Feb	27	71	36.08	170	52.56	E	220	220	3 l pebbles, rock	
193	2	SEL	28-Feb	51	71	36.09	170	52.83	E	228	226	300 kg rubble, mixed invertebrates, 40 kg rock	
194	2	GVVL	28-Feb	130	71	37.29	170	55.57	E	246	246	20 l black coarse sand, some pebbles	
195	2	SEL	28-Feb	151	71	37.32	170	55.38	E	244	246	400 kg, black ascidians, rubble, rocks	
196	2	GVVL	28-Feb	240	71	37.28	170	52.00	E	198	198		rock jammed in jaws
197	2	SEL	28-Feb	247	71	37.24	170	51.99	E	198	211	300 kg, ascidians, rocks, bryozoa	

198	2	GVVL	28-Feb	316	71	37.04	170	53.61	E	222	222	5 l pebbles, some sand	
199	2	ORH	28-Feb	442	71	37.45	170	54.41	E	240	238	icefish, holothurians, medusae	
200		SVP	28-Feb	931	71	20.71	170	45.76	E	0	360		
201		SVP	28-Feb	1855	71	10.97	170	4.33	E	0	400		
202	1	ORH	29-Feb	1813	71	9.32	171	5.54	E	930	940	TOA, sponge	3 min tow
203	1	ORH	29-Feb	1953	71	9.37	171	10.45	E	1165	1158		fast, small fish catch
204	1	GVVL	29-Feb	2109	71	9.48	171	10.53	E	1138	1138	10 l silt, coral, rock	
205	1	GVVL	29-Feb	2301	71	9.79	171	2.86	E	1014	1014	3 l pebbles, some coral & shell	
206	1	SEL	01-Mar	48	71	9.85	171	2.91	E	975	940	200 kg pebbles, 140 kg rocks	few invertebrates

Appendix 3: List of taxonomists and parataxonomists who identified (or confirmed onboard identifications) the biological material obtained during the BioRoss study of the northwestern Ross Sea. Also given is the number of potentially new species.

Taxonomist	Taxa	Affiliation	No. of potentially new species
Álvaro L. Peña Cantero	Hydrozoa	Instituto Cavanilles de Biodiversidad y Biología Evolutiva Universidad de Valencia Apdo. Correos 22085 46071 Valencia, Spain	
Alberto Lindner	Stylasteridae	Biology Department Duke University Box 90338 Durham, NC 27708 USA	none; no new records for Ross Sea area
Stephen D. Cairns	Scleractinia, Stylasteridae	Smithsonian Institution P. O. Box 37012 NMNH, W-329, MRC-0163 Washington, D. C. 20013-7012 USA	
Estefania Rodríguez, Pablo J. López-González	Actinaria, Octocoralia	Biodiversidad y Ecología de Invertebrados Marinos Depto. Fisiología y Zoología Facultad de Biología Universidad de Sevilla Reina Mercedes 6 41012 – Sevilla, Spain	2 sea anemones 2 octocorals 1 new genus of octocorals
Katrin Linse	Gastropoda, Bivalvia	British Antarctic Survey, Oxford, UK	
Stefano Schiaparelli	Gastropoda, Bivalvia	Università di Genova Corso Europa, 26 16132 Genova, Italy	
Johanna Nielsen	Pantopoda	Auckland University of Technology	
Steve O'Shea	Cephalopoda	Auckland University of Technology	
Peter Rehm	Cumacea	Alfred Wegener Institute for Polar and Marine Research Benthic Ecosystems Comparativ Ecosystem Research Columbusstrasse D-27568 Bremerhaven	
Luitfried Salvini-Plawen	Solenogastres	Institut für Zoologie Universität Wien Althanstrasze 14 A-1090 Wien, Austria	
Andrei Yu. Utevsky	Hirudinea	Department of Zoology and Animal Ecology Kharkov National University, Kharkov Ukraine	
Oliver Coleman	Iphimediidae (Amphipoda)	Museum für Naturkunde Berlin Institut für Systematische Zoologie Invalidenstraße 43 D-10115 Berlin F.R.G.	
Mariachiara Chiantore Francesca de Domenico Maria Paola Ferranti	Echinodermata	Dip.Te.Ris. Università di Genova Corso Europa, 26 16132 Genova, Italy	

Serena Ghione			
Sabrina Buongiovanni			
Carlotta Ghirardo			
Giada Ciribilli			
John Buckeridge	Cirripedia	Head of School of Civil & Chemical Engineering RMIT University Melbourne, Vic 3001 Australia	
Andrew Hosie	Cirripedia	NIWA Wellington	
Graham Bird	Tanaidacea	not affiliated at present	
Stephen Eager	Ostracoda	Victoria University Wellington	
Sven Thatje	Decapoda	NOC Southampton	
Shane Ahyong	Decapoda	NIWA - Wellington	*Neolithodes yaldwyn*
Jeff Robinson	Brachiopoda	University of Auckland	
Daphne Lee	Brachiopoda	University of Otago, Dunedin	
Michelle Kelly	Porifera	NIWA-Auckland	
Mike Page	Ascidians	NIWA - Nelson	
Anna Bradley	Ascidians	NIWA - Nelson	
Kerstin Kröger	Polychaeta,	NIWA - Wellington	
Geoff Read	Polychaeta, Sipuncula, Priapulida, Echiurida	NIWA - Wellington	
Anne-Nina Lörz	Amphipoda	NIWA - Wellington	*Epimeria schiaparelli*
Graham Fenwick	Amphipoda	NIWA - Christchurch	
Janet Grieve	Ostracoda	NIWA - Wellington	
Dennis Gordon	Bryozoa	NIWA - Wellington	
Niel Bruce	Isopoda	NIWA - Wellington	*Cirolana mclaughlinae* (Cirolanidae)
Angelika Brandt	Isopoda	Universität Hamburg, Germany	*Ediotia tangaroa* (Idoteidae)
Peter McMillan	Fish	NIWA - Wellington	
Inigo Everson	Fish	Senior Visiting Research Fellow Anglia Ruskin University, Cambridge, UK	

Appendix 4: Additional information on taxonomic distinctness biodiversity metrics and use in hypotheses testing

A wider understanding of the usefulness of measures of taxonomic distinctness as biodiversity metrics

Since arguments were made for the use of taxonomic distinctness as a biodiversity metric for the present study (see Introduction) such measures have been used in a plethora of studies that have extended their use beyond studies of fish and benthic invertebrates of intertidal and shallow water habitats to those of other groups of organisms (e.g., microflora Spatharis et al. 2007, macroalgae Bates et al. 2005), and other habitats (freshwater Heino et al. 2005, deep-sea Olabarria 2006). Such studies have allowed further evaluation of the usefulness of taxonomic distinctness measures and a number of issues have been raised by the results of these studies, some of which potentially impact upon the validity of using the taxonomic distinctness metrics in the present study. Considering that the Ministry of Fisheries (at that time) was particular keen to support the use of measures of taxonomic distinctness in the BioRoss study, it is thought appropriate to consider these issues here before discussing the results that involve the use of these metrics.

Taxonomic distinctness versus other metrics

Whilst the potential usefulness of taxonomic distinctness as a biodiversity metric has been largely accepted (Magurran 2004), studies show that taxonomic distinctness is not consistently related to other diversity indices and thus it is not a straightforward substitute for other diversity measures (Ellingsen et al. 2005). Nonetheless, in those cases where a thorough evaluation of the relationship between the taxonomic distinctness metrics and other indices reveals a consistent and concurrent pattern for a variety of spatial and temporal scenarios, taxonomic distinctness metrics can have a singular applicability. For example, Leonard et al. (2006) demonstrated convincingly the general utility of measures of taxonomic distinctness for national marine biodiversity assessment programmes in the United Kingdom. However, the aforementioned appears to be the exception (see Salas et al. 2006 for an alternative conclusion for the European Community’s Water Framework Directive), and taxonomic distinctness indices are now seen largely as complementary indices which used with other metrics provide a more complete understanding of biodiversity patterns (e.g., Labrune et al. 2006, Cusson et al. 2007, Merigot et al. 2007). Although this is now considered desirable, it is not always possible to employ multiple indices, largely because of the differences in sampling effort that would be involved in large-scale studies of biodiversity. This situation was the case for the BioRoss study, where different gears were employed which sampled essentially in a qualitative way, and the number of samples varied slightly between sampling strata. Thus, taxonomic distinctness indices are the sole univariate measure of biodiversity used in this study.

Multi-taxa versus phylum by phylum

After the first use of taxonomic distinctness measures it became apparent that different taxa displayed different patterns of taxonomic distinctness in response to the same environmental gradients (Shin & Ellingsen 2004). This finding is not entirely surprising, and as well as questioning the surrogacy of one taxon for others, the concern was raised that some of the differences between taxa could be attributable to the different taxonomic structures used for classifying different phyla. Thus, if any general understanding was to be achieved about biodiversity pattern the suggestion was made that taxonomic distinctness measures should be applied to single phyla rather than to a combination of taxa (Ellingsen et al. 2005). Despite this sensible call studies have continued to calculate taxonomic distinctness measures for ‘whole assemblages’, perhaps in order to avoid the additional computation, reporting and discussion required, or most likely in order to maintain a consistent approach within a study (other diversity indices calculated for whole assemblages). For the BioRoss study taxonomic distinctness measures were separately calculated for fish, but for a combination of macroinvertebrate taxa. This approach was taken in order to maintain consistency with the multivariate analysis of biodiversity pattern. However, in the future/elsewhere it will be worth exploring in greater detail the response of the different phyla to the environmental variables measured in the present study.

Appendix 5: List of sampling stations and environmental data obtained from the northwestern Ross Sea shelf. Stations excluded from multivariate analyses due to not being part of the *a priori* sampling design, containing no more than one invertebrate or fish species, being invalid or being beamtrawl stations are indicated. No ice cover data are available for stations 131–134 due to their proximity to land.

Station	Gear	Transect	Depth stratum (m)	Max depth (m)	Mean speed (cm/s)	Max speed (cm/s)	Mean direction (compass)	Surface chl *a* spring (mg/m^3)	Surface chl *a* summer (mg/m^3)	Mean ice cover spring (%)	Mean ice cover summer (%)	Mean ice cover autumn (%)	Mean ice cover winter (%)	Mean annual ice cover (%)	Station excluded
3	GVVL	3	500–750	634	5.09	10.80	351.27	0.28	0.29	79.70	16.93	55.30	79.43	57.84	
4	SEL	3	500–750	651	5.09	10.80	351.27	0.25	0.28	79.70	16.93	55.30	79.43	57.84	≤1 invert. sp
5	GVVL	3	500–750	623	5.09	10.80	351.27	0.28	0.29	79.70	16.93	55.30	79.43	57.84	
6	SEL	3	500–750	633	5.09	10.80	351.27	0.28	0.29	79.70	16.93	55.30	79.43	57.84	
7	GVVL	3	500–750	536	9.39	20.42	346.40	0.31	0.25	79.70	16.93	55.30	79.43	57.84	
8	SEL	3	500–750	541	9.39	20.42	346.40	0.31	0.25	79.70	16.93	55.30	79.43	57.84	≤1 fish sp
9	ORH	3	500–750	647	5.09	10.80	351.27	0.28	0.29	79.70	16.93	55.30	79.43	57.84	
10	ORH	3	500–750	636	5.09	10.80	351.27	0.28	0.29	79.70	16.93	55.30	79.43	57.84	
11	ORH	3	500–750	532	9.39	20.42	346.40	0.31	0.25	79.70	16.93	55.30	79.43	57.84	
12	GVVL	3	500–750	536	9.39	20.42	346.40	0.31	0.25	79.70	16.93	55.30	79.43	57.84	
13	SEL	3	500–750	535	9.39	20.42	346.40	0.31	0.25	79.70	16.93	55.30	79.43	57.84	
14	GVVL	3	250–500	451	9.39	20.42	346.40	0.31	0.25	79.70	16.93	55.30	79.43	57.84	
15	SEL	3	250–500	467	9.39	20.42	346.40	0.31	0.25	79.70	16.93	55.30	79.43	57.84	≤1 fish sp
16	GVVL	3	250–500	411	9.39	20.42	346.40	0.18	0.31	79.00	19.13	57.77	78.10	58.50	
17	SEL	3	250–500	409	9.39	20.42	346.40	0.18	0.31	79.00	19.13	57.77	78.10	58.50	
18	ORH	3	500–750	530	9.39	20.42	346.40	0.31	0.25	79.70	16.93	55.30	79.43	57.84	
19	ORH	3	250–500	454	9.39	20.42	346.40	0.31	0.25	79.70	16.93	55.30	79.43	57.84	
20	ORH	3	250–500	415	9.39	20.42	346.40	0.18	0.31	79.00	19.13	57.77	78.10	58.50	
21	GVVL	3	50–250	168	6.25	24.41	334.38	66.83	0.32	76.03	32.30	61.30	75.60	61.31	

22	SEL	3	50–250	181	6.25	24.41	334.38	66.83	0.32	76.03	32.30	61.30	75.60	61.31	
23	GVVL	3	50–250	127	6.25	24.41	334.38	66.83	0.32	76.03	32.30	61.30	75.60	61.31	invalid
24	GVVL	3	50–250	119	6.25	24.41	334.38	66.83	0.32	76.03	32.30	61.30	75.60	61.31	
25	SEL	3	50–250	140	6.25	24.41	334.38	66.83	0.32	76.03	32.30	61.30	75.60	61.31	≤1 fish sp
26	ORH	3	50–250	230	6.25	24.41	334.38	66.83	0.32	76.03	32.30	61.30	75.60	61.31	
27	ORH	3	50–250	337	9.39	20.42	346.40	0.18	0.31	79.00	19.13	57.77	78.10	58.50	invalid
28	ORH	3	50–250	324	9.39	20.42	346.40	0.18	0.31	79.00	19.13	57.77	78.10	58.50	
29	ORH	3	250–500	275	8.27	23.71	337.83	66.83	0.35	76.03	32.30	61.30	75.60	61.31	
30	GVVL	3	250–500	277	8.27	23.71	337.83	66.83	0.35	77.33	28.10	58.47	77.13	60.26	
31	SEL	3	250–500	344	9.39	20.42	346.40	0.18	0.31	79.00	19.13	57.77	78.10	58.50	
32	GVVL	3	250–500	340	9.39	20.42	346.40	0.18	0.31	79.00	19.13	57.77	78.10	58.50	
33	SEL	3	250–500	289	7.94	18.52	340.24	66.83	0.35	79.00	19.13	57.77	78.10	58.50	
34	GVVL	3	50–250	235	8.27	23.71	337.83	66.83	0.29	76.03	32.30	61.30	75.60	61.31	
35	SEL	3	50–250	242	8.27	23.71	337.83	66.83	0.29	76.03	32.30	61.30	75.60	61.31	≤1 fish sp
36	ORH	3	50–250	240	8.27	23.71	337.83	66.83	0.34	76.03	32.30	61.30	75.60	61.31	
37	ORH	3	50–250	249	8.27	23.71	337.83	66.83	0.29	76.03	32.30	61.30	75.60	61.31	
38	GVVL	3	50–250	226	8.27	23.71	337.83	66.83	0.29	76.03	32.30	61.30	75.60	61.31	
39	SEL	3	250–500	253	8.27	23.71	337.83	66.83	0.29	76.03	32.30	61.30	75.60	61.31	≤1 fish sp
43	LINE	Poss Isl.	<10	10	5.49	22.26	343.15	66.83	0.46	76.03	32.30	61.30	75.60	61.31	line
44	GVVL	5	50–250	124	1.05	6.05	106.21	66.83	0.78	78.30	35.40	67.97	76.93	64.65	invalid
45	GVVL	5	50–250	114	1.05	6.05	106.21	66.83	0.78	78.30	35.40	67.97	76.93	64.65	invalid
46	GVVL	5	50–250	124	1.05	6.05	106.21	66.83	0.78	78.30	35.40	67.97	76.93	64.65	invalid
47	GVVL	5	50–250	130	1.05	6.05	106.21	66.83	0.78	78.30	35.40	67.97	76.93	64.65	
48	SEL	5	50–250	132	1.05	6.05	106.21	66.83	0.78	78.30	35.40	67.97	76.93	64.65	≤1 fish sp
49	GVVL	5	50–250	158	1.05	6.05	106.21	66.83	0.78	78.30	35.40	67.97	76.93	64.65	invalid
50	GVVL	5	50–250	159	1.05	6.05	106.21	66.83	0.78	78.30	35.40	67.97	76.93	64.65	invalid
51	GVVL	5	50–250	152	1.05	6.05	106.21	66.83	0.78	78.30	35.40	67.97	76.93	64.65	
52	SEL	5	50–250	154	1.05	6.05	106.21	66.83	0.78	78.30	35.40	67.97	76.93	64.65	
53	GVVL	5	50–250	197	1.05	6.05	106.21	66.83	0.78	78.30	35.40	67.97	76.93	64.65	
54	SEL	5	50–250	206	1.05	6.05	106.21	66.83	0.78	78.30	35.40	67.97	76.93	64.65	
55	ORH	5	50–250	130	1.05	6.05	106.21	66.83	0.78	78.30	35.40	67.97	76.93	64.65	

56	ORH	5	50–250	150	1.05	6.05	106.21	66.83	0.78	78.30	35.40	67.97	76.93	64.65	
57	ORH	5	50–250	206	1.05	6.05	106.21	66.83	0.78	78.30	35.40	67.97	76.93	64.65	
58	GVVL	5	50–250	230	1.05	6.05	106.21	66.83	0.78	78.30	35.40	67.97	76.93	64.65	
59	SEL	5	50–250	236	1.05	6.05	106.21	66.83	0.78	78.30	35.40	67.97	76.93	64.65	
60	GVVL	5	50–250	309	1.05	6.05	106.21	66.83	0.78	78.30	35.40	67.97	76.93	64.65	invalid
61	GVVL	5	50–250	298	1.05	6.05	106.21	66.83	0.78	78.30	35.40	67.97	76.93	64.65	invalid
62	GVVL	5	50–250	300	1.05	6.05	106.21	66.83	0.78	78.30	35.40	67.97	76.93	64.65	invalid
63	SEL	5	250–500	303	1.05	6.05	106.21	66.83	0.78	78.30	35.40	67.97	76.93	64.65	≤1 fish sp
64	GVVL	5	250–500	312	1.05	6.05	106.21	66.83	0.78	78.30	35.40	67.97	76.93	64.65	
65	SEL	5	250–500	328	1.05	6.05	106.21	66.83	0.78	78.30	35.40	67.97	76.93	64.65	
66	GVVL	5	250–500	280	1.05	6.05	106.21	66.83	0.78	78.30	35.40	67.97	76.93	64.65	
67	ORH	5	250–500	286	1.05	6.05	106.21	66.83	0.78	78.30	35.40	67.97	76.93	64.65	
68	ORH	5	250–500	319	1.05	6.05	106.21	66.83	0.78	78.30	35.40	67.97	76.93	64.65	outlier; ≤1 fish sp
69	GVVL	5	500–750	750	5.15	7.91	348.91	0.18	0.26	82.77	14.07	56.87	82.23	58.98	
70	SEL	5	500–750	760	5.15	7.91	348.91	0.18	0.26	82.90	14.00	55.60	82.13	58.66	
71	GVVL	5	500–750	630	5.15	7.91	348.91	0.18	0.26	82.77	14.07	56.87	82.23	58.98	
72	SEL	5	500–750	622	5.15	7.91	348.91	0.18	0.26	82.77	14.07	56.87	82.23	58.98	
73	GVVL	5	500–750	536	5.18	9.25	354.16	0.16	0.28	82.77	14.07	56.87	82.23	58.98	
74	SEL	5	500–750	538	5.18	9.25	354.16	0.16	0.28	82.77	14.07	56.87	82.23	58.98	invalid
75	ORH	5	500–750	526	5.08	9.89	323.67	0.16	0.28	82.77	14.07	56.87	82.23	58.98	
76	ORH	5	500–750	506	6.34	13.22	339.77	0.22	0.46	82.77	14.07	56.87	82.23	58.98	
77	GVVL	5	250–500	499	6.34	13.22	339.77	0.22	0.46	82.77	14.07	56.87	82.23	58.98	
78	SEL	5	250–500	497	6.34	13.22	339.77	0.22	0.46	82.77	14.07	56.87	82.23	58.98	
79	GVVL	5	500–750	527	5.08	9.89	323.67	0.16	0.28	82.77	14.07	56.87	82.23	58.98	invalid
80	GVVL	5	500–750	528	5.08	9.89	323.67	0.16	0.28	82.77	14.07	56.87	82.23	58.98	invalid
81	GVVL	5	500–750	528	5.08	9.89	323.67	0.16	0.28	82.77	14.07	56.87	82.23	58.98	invalid
82	SEL	5	500–750	527	5.08	9.89	323.67	0.16	0.28	82.77	14.07	56.87	82.23	58.98	
83	SEL	5	500–750	540	5.18	9.25	354.16	0.16	0.28	82.77	14.07	56.87	82.23	58.98	
84	ORH	5	500–750	542	5.18	9.25	354.16	0.16	0.28	82.77	14.07	56.87	82.23	58.98	
85	ORH	5	>750	866	5.15	7.91	348.91	0.18	0.26	82.90	14.00	55.60	82.13	58.66	>750 m
86	GVVL	5	500–750	518	4.80	10.69	336.70	0.16	0.28	82.77	14.07	56.87	82.23	58.98	invalid
87	GVVL	5	500–750	514	5.08	9.89	323.67	0.16	0.28	82.77	14.07	56.87	82.23	58.98	invalid
88	GVVL	5	500–750	515	5.08	9.89	323.67	0.16	0.28	82.77	14.07	56.87	82.23	58.98	
89	ORH	5	250–500	420	1.10	10.86	75.11	66.83	0.80	83.90	27.87	67.00	81.87	65.16	invalid
90	GVVL	5	250–500	423	1.10	10.86	75.11	0.20	0.92	83.90	27.87	67.00	81.87	65.16	
91	SEL	5	250–500	414	1.10	10.86	75.11	0.20	0.92	83.90	27.87	67.00	81.87	65.16	
94	BEAM	Adare	50–250	220	3.29	8.88	348.03	66.83	66.83	75.57	31.60	57.60	76.00	60.19	beam
95	GVVL	1	500–750	740	3.62	6.53	307.21	0.27	0.40	80.60	21.40	55.97	80.87	59.71	
96	SEL	1	500–750	736	6.34	15.25	348.46	0.26	0.55	84.00	17.60	53.87	83.97	59.86	≤1 fish sp

97	GVVL	1	500–750	630	6.34	15.25	348.46	0.27	0.40	80.60	21.40	55.97	80.87	59.71	
98	SEL	1	500–750	617	6.34	15.25	348.46	0.26	0.55	84.00	17.60	53.87	83.97	59.86	
99	GVVL	1	500–750	603	6.34	15.25	348.46	0.27	0.40	80.60	21.40	55.97	80.87	59.71	invalid
100	GVVL	1	500–750	585	6.34	15.25	348.46	0.27	0.40	80.60	21.40	55.97	80.87	59.71	
101	SEL	1	500–750	571	6.34	15.25	348.46	0.27	0.40	80.60	21.40	55.97	80.87	59.71	
102	GVVL	1	500–750	536	9.78	22.07	338.43	0.17	0.35	84.43	24.73	56.63	84.23	62.51	
103	SEL	1	500–750	555	9.78	22.07	338.43	0.17	0.35	84.43	24.73	56.63	84.23	62.51	≤1 fish sp
104	GVVL	1	250–500	461	9.78	22.07	338.43	0.17	0.35	84.43	24.73	56.63	84.23	62.51	
105	SEL	1	250–500	470	9.78	22.07	338.43	0.17	0.35	84.43	24.73	56.63	84.23	62.51	
106	GVVL	1	250–500	404	9.78	22.07	338.43	0.19	0.65	80.30	30.03	58.07	80.03	62.11	invalid
107	GVVL	1	250–500	400	9.78	22.07	338.43	66.83	0.36	80.30	30.03	58.07	80.03	62.11	
108	SEL	1	250–500	405	9.78	22.07	338.43	0.19	0.65	80.30	30.03	58.07	80.03	62.11	≤1 fish sp
109	GVVL	1	250–500	347	9.78	22.07	338.43	66.83	0.36	80.30	30.03	58.07	80.03	62.11	invalid
110	GVVL	1	250–500	352	9.78	22.07	338.43	66.83	0.36	80.30	30.03	58.07	80.03	62.11	invalid
111	GVVL	1	250–500	357	9.78	22.07	338.43	0.17	0.63	80.30	30.03	58.07	80.03	62.11	invalid
112	SEL	1	250–500	351	9.78	22.07	338.43	66.83	0.36	80.30	30.03	58.07	80.03	62.11	≤1 fish sp
113	GVVL	1	250–500	313	9.78	22.07	338.43	66.83	0.36	80.30	30.03	58.07	80.03	62.11	invalid
114	GVVL	1	250–500	320	9.78	22.07	338.43	66.83	0.36	80.30	30.03	58.07	80.03	62.11	invalid
115	GVVL	1	250–500	322	9.78	22.07	338.43	66.83	0.36	80.30	30.03	58.07	80.03	62.11	invalid
116	SEL	1	250–500	317	9.78	22.07	338.43	66.83	0.36	80.30	30.03	58.07	80.03	62.11	
117	GVVL	1	250–500	314	9.78	22.07	338.43	66.83	0.36	80.30	30.03	58.07	80.03	62.11	
118	ORH	1	250–500	323	9.78	22.07	338.43	66.83	0.36	80.30	30.03	58.07	80.03	62.11	
119	ORH	1	500–750	675	6.34	15.25	348.46	0.26	0.55	84.00	17.60	53.87	83.97	59.86	
120	ORH	1	500–750	737	6.34	15.25	348.46	0.26	0.55	84.00	17.60	53.87	83.97	59.86	
121	ORH	1	500–750	556	9.78	22.07	338.43	0.17	0.35	84.43	24.73	56.63	84.23	62.51	
122	ORH	1	250–500	404	9.78	22.07	338.43	0.19	0.65	80.30	30.03	58.07	80.03	62.11	
123	GVVL	1	50–250	243	9.78	22.07	338.43	66.83	0.36	80.30	30.03	58.07	80.03	62.11	
124	SEL	1	50–250	236	9.78	22.07	338.43	66.83	0.36	80.30	30.03	58.07	80.03	62.11	
125	GVVL	1	50–250	163	9.78	22.07	338.43	66.83	0.36	80.30	30.03	58.07	80.03	62.11	
126	SEL	1	50–250	161	9.78	22.07	338.43	66.83	0.36	80.30	30.03	58.07	80.03	62.11	≤1 fish sp
127	GVVL	1	50–250	85	9.78	22.07	338.43	66.83	0.36	80.30	30.03	58.07	80.03	62.11	
128	SEL	1	50–250	93	9.78	22.07	338.43	66.83	0.36	80.30	30.03	58.07	80.03	62.11	
129	GVVL	1	50–250	120	9.78	22.07	338.43	66.83	0.36	80.30	30.03	58.07	80.03	62.11	invalid
130	SEL	1	50–250	126	9.78	22.07	338.43	66.83	0.36	80.30	30.03	58.07	80.03	62.11	
132	SEL	Adare	50–250	172	0.59	3.90	0.15	66.83	66.83	-	-	-	-	-	Adare
133	SEL	Adare	250–500	252	0.59	3.90	0.15	66.83	66.83	-	-	-	-	-	Adare
134	SEL	Adare	50–250	65	0.59	3.90	0.15	66.83	66.83	-	-	-	-	-	Adare
136	Grapnel	Poss I.	<50	38	5.49	22.26	343.15	66.83	0.46	76.03	32.30	61.30	75.60	61.31	line
138	GVVL	4	50–250	230	1.07	6.32	175.31	66.83	0.86	76.37	32.87	64.03	75.30	62.14	invalid

139	GVVL	4	50–250	236	1.07	6.32	175.31	66.83	0.86	76.37	32.87	64.03	75.30	62.14	
140	SEL	4	50–250	240	1.07	6.32	175.31	66.83	0.86	76.37	32.87	64.03	75.30	62.14	
141	GVVL	4	250–500	300	1.07	6.32	175.31	66.83	0.51	76.37	32.87	64.03	75.30	62.14	invalid
142	GVVL	4	250–500	302	1.07	6.32	175.31	66.83	0.86	76.37	32.87	64.03	75.30	62.14	
143	SEL	4	250–500	323	1.07	6.32	175.31	66.83	0.51	76.37	32.87	64.03	75.30	62.14	
144	GVVL	4	250–500	273	1.07	6.32	175.31	66.83	0.51	76.37	32.87	64.03	75.30	62.14	
145	SEL	4	250–500	280	1.07	6.32	175.31	66.83	0.51	76.37	32.87	64.03	75.30	62.14	≤1 fish sp
146	GVVL	4	250–500	372	1.55	13.38	330.84	0.18	0.51	83.90	27.87	67.00	81.87	65.16	invalid
147	GVVL	4	250–500	406	1.55	13.38	330.84	0.18	0.51	83.90	27.87	67.00	81.87	65.16	
148	SEL	4	250–500	397	1.55	13.38	330.84	0.18	0.51	83.90	27.87	67.00	81.87	65.16	≤1 fish sp
149	GVVL	4	250–500	461	26.15	49.74	345.53	0.22	0.28	82.33	17.33	59.37	81.43	60.12	≤1 fish sp
150	SEL	4	250–500	480	26.15	49.74	345.53	0.22	0.28	82.33	17.33	59.37	81.43	60.12	
151	GVVL	4	500–750	512	5.83	11.54	353.10	0.22	0.32	82.33	17.33	59.37	81.43	60.12	
152	SEL	4	500–750	515	5.83	11.54	353.10	0.22	0.32	82.33	17.33	59.37	81.43	60.12	
153	GVVL	4	500–750	540	2.60	6.79	344.90	0.22	0.32	82.33	17.33	59.37	81.43	60.12	
154	SEL	4	500–750	586	2.60	6.79	344.90	0.22	0.32	82.33	17.33	59.37	81.43	60.12	
155	GVVL	4	500–750	675	5.83	11.54	353.10	0.22	0.32	82.33	17.33	59.37	81.43	60.12	invalid
156	GVVL	4	500–750	675	5.83	11.54	353.10	0.22	0.32	82.33	17.33	59.37	81.43	60.12	
157	SEL	4	500–750	737	5.83	11.54	353.10	0.22	0.32	82.33	17.33	59.37	81.43	60.12	
158	GVVL	2	500–750	748	2.67	5.89	353.79	0.26	0.40	82.20	15.50	53.83	82.07	58.40	invalid
159	GVVL	2	500–750	727	2.67	5.89	353.79	0.26	0.40	82.20	15.50	53.83	82.07	58.40	invalid
160	SEL	2	500–750	709	2.67	5.89	353.79	0.26	0.40	82.20	15.50	53.83	82.07	58.40	
161	GVVL	2	500–750	745	2.67	5.89	353.79	0.26	0.40	82.20	15.50	53.83	82.07	58.40	invalid
162	GVVL	2	500–750	738	2.67	5.89	353.79	0.26	0.40	82.20	15.50	53.83	82.07	58.40	
163	GVVL	2	500–750	670	2.67	5.89	353.79	0.26	0.40	82.20	15.50	53.83	82.07	58.40	invalid
164	GVVL	2	500–750	671	2.67	5.89	353.79	0.26	0.40	82.20	15.50	53.83	82.07	58.40	invalid
165	SEL	2	500–750	678	2.67	5.89	353.79	0.26	0.40	82.20	15.50	53.83	82.07	58.40	
166	GVVL	2	500–750	675	2.67	5.89	353.79	0.26	0.40	82.20	15.50	53.83	82.07	58.40	invalid
167	GVVL	2	500–750	674	2.67	5.89	353.79	0.26	0.40	82.20	15.50	53.83	82.07	58.40	invalid
168	GVVL	2	500–750	614	2.67	5.89	353.79	0.26	0.40	82.20	15.50	53.83	82.07	58.40	
169	SEL	2	500–750	612	2.67	5.89	353.79	0.26	0.40	82.20	15.50	53.83	82.07	58.40	
170	GVVL	2	500–750	565	2.67	5.89	353.79	0.26	0.40	82.20	15.50	53.83	82.07	58.40	
171	SEL	2	500–750	564	2.67	5.89	353.79	0.26	0.40	82.20	15.50	53.83	82.07	58.40	
172	ORH	2	500–750	549	2.67	5.89	353.79	0.26	0.40	79.70	16.93	55.30	79.43	57.84	
173	ORH	2	500–750	644	2.67	5.89	353.79	0.26	0.40	82.20	15.50	53.83	82.07	58.40	
174	ORH	2	250–500	485	4.06	10.09	346.34	0.31	0.51	79.70	16.93	55.30	79.43	57.84	
175	ORH	2	250–500	348	7.26	15.28	355.00	0.18	0.65	77.33	28.10	58.47	77.13	60.26	
176	GVVL	2	250–500	353	7.26	15.28	355.00	0.18	0.65	77.33	28.10	58.47	77.13	60.26	invalid
177	GVVL	2	250–500	350	7.26	15.28	355.00	0.18	0.65	77.33	28.10	58.47	77.13	60.26	

178	SEL	2	250–500	348	7.26	15.28	355.00	0.18	0.65	77.33	28.10	58.47	77.13	60.26	
179	GVVL	2	250–500	382	7.26	15.28	355.00	0.18	0.65	77.33	28.10	58.47	77.13	60.26	invalid
180	GVVL	2	250–500	385	7.26	15.28	355.00	0.18	0.65	77.33	28.10	58.47	77.13	60.26	
181	SEL	2	250–500	385	7.26	15.28	355.00	0.18	0.65	79.70	16.93	55.30	79.43	57.84	invalid
182	SEL	2	250–500	385	7.26	15.28	355.00	0.18	0.65	77.33	28.10	58.47	77.13	60.26	≤1 fish sp
183	GVVL	2	250–500	487	4.06	10.09	346.34	0.31	0.51	79.70	16.93	55.30	79.43	57.84	
184	SEL	2	250–500	492	4.06	10.09	346.34	0.31	0.51	79.70	16.93	55.30	79.43	57.84	
185	BEAM	2	500–750	600	2.67	5.89	353.79	0.26	0.40	82.20	15.50	53.83	82.07	58.40	beam
186	BEAM	2	250–500	390	7.26	15.28	355.00	0.21	0.32	80.60	21.40	55.97	80.87	59.71	beam
187	GVVL	2	250–500	287	11.06	24.59	332.11	66.83	0.31	77.33	28.10	58.47	77.13	60.26	
188	SEL	2	250–500	286	11.06	24.59	332.11	66.83	0.31	77.33	28.10	58.47	77.13	60.26	
189	GVVL	2	50–250	231	14.20	35.85	332.76	66.83	0.35	77.33	28.10	58.47	77.13	60.26	
190	SEL	2	50–250	231	14.20	35.85	332.76	66.83	0.35	77.33	28.10	58.47	77.13	60.26	
191	GVVL	2	50–250	217	14.20	35.85	332.76	66.83	0.35	77.33	28.10	58.47	77.13	60.26	invalid
192	GVVL	2	50–250	220	14.20	35.85	332.76	66.83	0.35	77.33	28.10	58.47	77.13	60.26	
193	SEL	2	50–250	228	14.20	35.85	332.76	66.83	0.35	77.33	28.10	58.47	77.13	60.26	
194	GVVL	2	50–250	246	14.20	35.85	332.76	66.83	1.17	77.33	28.10	58.47	77.13	60.26	
195	SEL	2	50–250	246	14.20	35.85	332.76	66.83	1.17	77.33	28.10	58.47	77.13	60.26	
196	GVVL	2	50–250	198	14.20	35.85	332.76	66.83	1.17	77.33	28.10	58.47	77.13	60.26	invalid
197	SEL	2	50–250	211	14.20	35.85	332.76	66.83	1.17	77.33	28.10	58.47	77.13	60.26	
198	GVVL	2	50–250	222	14.20	35.85	332.76	66.83	1.17	77.33	28.10	58.47	77.13	60.26	
199	ORH	2	50–250	240	14.20	35.85	332.76	66.83	1.17	77.33	28.10	58.47	77.13	60.26	
202	ORH	1	>750	940	3.82	6.26	308.94	0.26	0.55	84.00	17.60	53.87	83.97	59.86	invalid
203	ORH	1	>750	1165	3.82	6.26	308.94	0.26	0.55	84.00	17.60	53.87	83.97	59.86	invalid
204	GVVL	1	>750	1138	3.82	6.26	308.94	0.26	0.55	84.00	17.60	53.87	83.97	59.86	>750 m
205	GVVL	1	>750	1014	3.82	6.26	308.94	0.26	0.55	84.00	17.60	53.87	83.97	59.86	>750 m
206	SEL	1	>750	975	3.82	6.26	308.94	0.26	0.55	84.00	17.60	53.87	83.97	59.86	>750 m

Appendix 6: Sediment characteristics and Biological Habitat Complex Index (BHC) for grab samples obtained on the northwestern Ross Sea shelf (- no data available).

Stn	Transect	Sponge spicule/ 100 g	PN (%)	POC (%)	Chl a (ng/g)	Median (phi)	Mean (phi)	Sort. coeff.	<63mm (fines) (%)	>4mm (pebbles) (%)	BHC
3	3	2652	<0.02	0.25	0.53	2.5	3.25	4.31	40.05	5.08	0.23
5	3	9176	<0.02	0.34	0.16	4	4	3.92	49.79	3.59	0.18
7	3	13	<0.02	0.27	0.12	0.5	0.5	1.23	0.00	6.50	0.63
12	3	1	<0.02	0.17	0.05	-0.5	-0.5	1.36	0.00	36.66	-
14	3	0	<0.02	0.14	0.10	-0.75	-1	1.28	0.13	15.40	-
16	3	64	<0.02	0.03	0.43	0	-0.25	1.58	0.48	18.20	1.83
21	3	1	<0.02	0.04	0.32	-2	-0.5	1.52	0.07	51.02	-
24	3	42	<0.02	0.05	0.45	-0.75	-0.75	1.32	0.60	27.18	1.15
30	3	4	<0.02	0.08	0.07	-0.5	-0.5	1.44	0.00	29.38	2.78
32	3	0	<0.02	0.02	0.01	-0.25	-0.5	1.44	0.08	34.54	0.55
34	3	0	<0.02	0.06	0.09	-2	-1.25	1.08	0.00	50.64	0.00
38	3	0	<0.02	0.05	0.05	0	-0.5	1.44	0.00	26.74	-
47	5	5050	<0.02	0.19	1.93	-2	-0.5	2.19	6.34	57.94	-
51	5	497	<0.02	0.32	1.33	-2	-1.25	1.61	5.50	65.26	36.40
53	5	873	<0.02	0.18	0.94	-1.5	-1	1.7	5.16	43.01	21.48
58	5	325	<0.02	0.22	0.45	-1.25	-1	1.05	0.72	17.74	0.00
64	5	378	<0.02	0.27	0.47	0	0	2.54	11.07	18.89	0.00
66	5	1832	<0.02	0.12	0.44	2	1	2.84	16.14	16.08	3.00
69	5	72	<0.02	0.09	0.16	-0.25	-0.5	1.63	3.57	16.90	-
71	5	3	<0.02	0.09	0.42	-2	-1.75	0.55	0.48	67.04	2.70
73	5	972	<0.02	0.13	0.33	-1.5	-1	1.81	6.91	37.75	-
77	5	2384	0.06	0.70	0.73	5	5	4.04	59.21	5.31	21.70
88	5	1316	<0.02	0.48	1.59	0.75	1	3.4	23.94	9.79	-
90	5	1372	0.05	0.36	0.78	-2	-1.75	1.38	3.65	50.30	0.00
95	1	25	<0.02	0.09	0.18	1.25	0	1.86	0.10	14.67	1.20
97	1	14	<0.02	0.12	0.31	1.5	1.5	1.69	0.32	10.14	0.60
100	1	2580	<0.02	0.09	0.30	1.5	0.5	2.68	10.43	23.95	0.13
102	1	0	<0.02	0.42	0.06	1.25	0.75	1.56	0.19	13.08	0.13
104	1	0	<0.02	0.02	0.03	-0.5	-0.25	1.48	0.00	26.65	0.00
107	1	80	<0.02	0.05	0.61	-1.5	-0.5	1.62	0.08	38.17	-
111	1	22	<0.02	0.08	0.47	1.5	1	1.57	0.76	6.87	-
117	1	228	<0.02	0.09	0.59	-2	-1.25	1.27	0.40	49.28	32.50
123	1	91	<0.02	0.04	0.84	1	0.5	1.69	0.75	6.46	-
125	1	24	<0.02	0.28	0.33	-1.5	-1	1.36	0.06	44.74	0.00
127	1	55	<0.02	0.03	0.99	-1.5	-1	1.15	0.30	41.00	4.80
129	1	133	<0.02	0.04	0.62	-1.5	-0.5	1.43	0.45	43.05	64.30
139	4	80	<0.02	0.08	0.45	-2	-0.75	1.42	0.39	49.58	5.92
142	4	1	<0.02	0.03	0.26	-2	-1	1.15	0.16	50.86	-
144	4	4	<0.02	0.03	0.05	-2	-0.75	1.32	0.04	50.33	6.00
147	4	3	<0.02	0.02	0.06	-1	-1	1.36	0.00	13.99	0.00
149	4	-	-	-	-	-	-	-	-	-	81.11
151	4	-	-	-	-	-	-	-	-	-	96.70
153	4	-	-	-	-	-	-	-	-	-	41.80
156	4	3	-	-	-	-2	-1.5	0.79	0.27	60.23	-
162	2	12	<0.02	0.14	0.26	1	1	1.03	0.53	1.86	1.00
168	2	156	<0.02	0.05	0.29	1.25	1.25	1.95	6.76	8.09	-
170	2	22	<0.02	0.06	0.17	1	0.75	1.47	0.00	10.23	0.00
177	2	0	<0.02	<0.01	0.09	-0.75	-0.5	1.48	0.00	27.81	0.00
180	2	-	<0.02	<0.01	0.07	-	-	-	-	-	0.00
183	2	0	<0.02	0.02	0.06	0.25	0	1.49	0.29	2.14	0.00
187	2	0	<0.02	<0.01	0.11	-1	-0.5	1.48	0.00	30.45	0.00
189	2	6046	<0.02	0.04	0.97	-2	-1.5	0.93	0.16	62.18	26.80
192	2	0	<0.02	0.02	0.13	-2	-1.25	1.02	0.00	53.96	0.00
194	2	2	<0.02	<0.01	0.27	0.25	-0.25	1.38	0.06	12.89	2.68
196	2	-	-	-	-	-	-	-	-	-	-
198	2	-	<0.02	0.01	0.35	-	-	-	-	-	5.09

Appendix 7: List of macroinvertebrate species used for quantitative analyses from samples obtained on the northwestern Ross Sea shelf.

Species	Family	Order	Class	Phylum
Grantia scotti (Jenkin, 1908)	Grantiidae	Leucosolenida	Calcarea	Porifera
Leucetta antarctica Dendy, 1918	Leucettidae	Clathrinida	Calcarea	Porifera
Leucetta mawsoni (Dendy, 1918) cf	Leucettidae	Clathrinida	Calcarea	Porifera
Megapodon pollicaris Jenkin, 1908	Achramorphidae	Leucosolenida	Calcarea	Porifera
Petrobiona n. sp. 1 (mushroom)	Petrobionidae	Lithonida	Calcarea	Porifera
Sycon longstaffi (Jenkin, 1908) cf	Sycettidae	Leucosolenida	Calcarea	Porifera
Acanthorhabdus fragilis Burton, 1929	Acarnidae	Poecilosclerida	Demospongiae	Porifera
Artemisina apollinis (Ridley & Dendy, 1886)	Microcionidae	Poecilosclerida	Demospongiae	Porifera
Artemisina jovis Dendy, 1924	Microcionidae	Poecilosclerida	Demospongiae	Porifera
Artemisina plumosa Hentschel, 1914	Microcionidae	Poecilosclerida	Demospongiae	Porifera
Artemisina plumosa Hentschel, 1914 cf	Microcionidae	Poecilosclerida	Demospongiae	Porifera
Artemisina tubulosa Koltun, 1964	Microcionidae	Poecilosclerida	Demospongiae	Porifera
Asbestopluma obae Koltun, 1964 cf	Cladorhizidae	Poecilosclerida	Demospongiae	Porifera
Axociella niditifera (Kirkpatrick, 1907)	Microcionidae	Poecilosclerida	Demospongiae	Porifera
Calyx arcuarius (Topsent, 1913)	Phloeodictyidae	Haplosclerida	Demospongiae	Porifera
Cercidochela lankasteri Kirkpatrick, 1907	Myxillidae	Poecilosclerida	Demospongiae	Porifera
Cinachyra antarctica (Carter, 1872)	Tetillidae	Spirophorida	Demospongiae	Porifera
Cinachyra barbata Sollas, 1888	Tetillidae	Spirophorida	Demospongiae	Porifera
Cinachyra monticularis Kirkpatrick, 1908	Tetillidae	Spirophorida	Demospongiae	Porifera
Cinachyra vertex Lendenfeld, 1907	Tetillidae	Spirophorida	Demospongiae	Porifera
Clathria (Microciona) pauper Brondsted, 1926	Microcionidae	Poecilosclerida	Demospongiae	Porifera
Clathria (Microciona) toxifera (Topsent, 1913)	Microcionidae	Poecilosclerida	Demospongiae	Porifera
Clathria (Microciona) toxifera (Topsent, 1913) cf	Microcionidae	Poecilosclerida	Demospongiae	Porifera
Craniella microsigma Kirkpatrick, 1908	Tetillidae	Spirophorida	Demospongiae	Porifera
Craniella microsigma Kirkpatrick, 1908 cf	Tetillidae	Spirophorida	Demospongiae	Porifera
Desmacidon meandrina Kirkpatrick, 1907	Desmacididae	Poecilosclerida	Demospongiae	Porifera
Ectyomyxilla mariana (Ridley & Dendy, 1887)	Myxillidae	Poecilosclerida	Demospongiae	Porifera
Ectyomyxilla mariana (Ridley & Dendy, 1887) cf	Myxillidae	Poecilosclerida	Demospongiae	Porifera
Gellius pilosus Kirkpatrick, 1907	Chalinidae	Haplosclerida	Demospongiae	Porifera
Guitarra fimbriata Carter, 1874	Guitarridae	Poecilosclerida	Demospongiae	Porifera
Haliclona altera (Topsent, 1902) cf	Chalinidae	Haplosclerida	Demospongiae	Porifera
Haliclona dancoi (Topsent, 1901) ?	Chalinidae	Haplosclerida	Demospongiae	Porifera
Haliclona phakellioides	Chalinidae	Haplosclerida	Demospongiae	Porifera

(Kirkpatrick, 1907) cf				
Haliclona sp. 1 (thin-walled tube, oxeas 250)	Chalinidae	Haplosclerida	Demospongiae	Porifera
Homaxinella balfourensis (Ridley & Dendy, 1887)	Suberitidae	Hadromerida	Demospongiae	Porifera
Homaxinella balfourensis (Ridley & Dendy, 1887) cf	Suberitidae	Hadromerida	Demospongiae	Porifera
Homaxinella n. sp. 1 (hollow whip)	Suberitidae	Hadromerida	Demospongiae	Porifera
Inflatella coelosphaeroides Koltun, 1964	Coelosphaeridae	Poecilosclerida	Demospongiae	Porifera
Iophon flabellodigitatus Kirkpatrick, 1907	Acarnidae	Poecilosclerida	Demospongiae	Porifera
Iophon n. sp. 1 (spongey, large clawed bipocilli)	Acarnidae	Poecilosclerida	Demospongiae	Porifera
Iophon spatulatus Kirkpatrick, 1907	Acarnidae	Poecilosclerida	Demospongiae	Porifera
Iophon spatulatus Kirkpatrick, 1907 cf	Acarnidae	Poecilosclerida	Demospongiae	Porifera
Isodictya cactoides (Kirkpatrick, 1908)	Isodictyidae	Poecilosclerida	Demospongiae	Porifera
Isodictya erinacea (Topsent, 1916)	Isodictyidae	Poecilosclerida	Demospongiae	Porifera
Isodictya kerguelensis (Ridley & Dendy, 1886) cf	Isodictyidae	Poecilosclerida	Demospongiae	Porifera
Isodictya setifer (Topsent, 1901)	Isodictyidae	Poecilosclerida	Demospongiae	Porifera
Isodictya spinigera (Kirkpatrick, 1907)	Isodictyidae	Poecilosclerida	Demospongiae	Porifera
Isodictya spingera (Kirkpatrick, 1907) ?	Isodictyidae	Poecilosclerida	Demospongiae	Porifera
Kirkpatrickia variolosa (Kirkpatrick, 1907)	Hymedesmiidae	Poecilosclerida	Demospongiae	Porifera
Latrunculia basalis Ridley & Dendy, 1887	Latrunculiidae	Poecilosclerida	Demospongiae	Porifera
Latrunculia biformis (Ridley & Dendy,1887)	Latrunculiidae	Poecilosclerida	Demospongiae	Porifera
Latrunculia brevis Ridley & Dendy, 1887	Latrunculiidae	Poecilosclerida	Demospongiae	Porifera
Lissodendoryx flabellata Burton, 1929	Coelosphaeridae	Poecilosclerida	Demospongiae	Porifera
Microxina simplex (Topsent, 1901)	Chalinidae	Haplosclerida	Demospongiae	Porifera
Mycale (Oxymycale) acerata Kirkpatrick, 1907	Mycalidae	Poecilosclerida	Demospongiae	Porifera
Mycale (Oxymycale) acerata Kirkpatrick, 1907 cf	Mycalidae	Poecilosclerida	Demospongiae	Porifera
Mycale tylotornota Koltun, 1964 cf	Mycalidae	Poecilosclerida	Demospongiae	Porifera
Myxilla (Burtonanchora) sp 1 (blackish green rough sponge)	Myxillidae	Poecilosclerida	Demospongiae	Porifera
Myxilla lissostyla Burton, 1938	Myxillidae	Poecilosclerida	Demospongiae	Porifera
Myxilla mollis Ridley & Dendy, 1886	Myxillidae	Poecilosclerida	Demospongiae	Porifera
Myxilla mollis Ridley & Dendy, 1886 cf	Myxillidae	Poecilosclerida	Demospongiae	Porifera
Myxodoryx hantischi (Kirkpatrick, 1907) ?	Hymedesmiidae	Poecilosclerida	Demospongiae	Porifera
Petrosia fistulata Kirkpatrick, 1907	Petrosiidae	Haplosclerida	Demospongiae	Porifera
Petrosia fistulata Kirkpatrick, 1907 cf	Petrosiidae	Haplosclerida	Demospongiae	Porifera
Phorbas (Anchinoe) glaberrima (Topsent, 1917)	Hymedesmiidae	Poecilosclerida	Demospongiae	Porifera
Plakina trilopha Schulze, 1880 sensu Koltun (1964)	Plakinidae	Homosclerophorida	Demospongiae	Porifera

Polymastia invaginata Kirkpatrick, 1908	Polymastiidae	Hadromerida	Demospongiae	Porifera
Polymastia invaginata Kirkpatrick, 1908 cf	Polymastiidae	Hadromerida	Demospongiae	Porifera
Polymastia isidis Thiele, 1905	Polymastiidae	Hadromerida	Demospongiae	Porifera
Pseudosuberites antarcticus (Carter, 1876) cf sensu Boury-Esnault & Bevern (1982)	Suberitidae	Hadromerida	Demospongiae	Porifera
Pseudosuberites hyalinus (Ridley & Dendy, 1887) cf	Suberitidae	Hadromerida	Demospongiae	Porifera
Pseudosuberites nudus Koltun, 1964	Suberitidae	Hadromerida	Demospongiae	Porifera
Reniera scotti Kirkpatrick, 1907	Chalinidae	Haplosclerida	Demospongiae	Porifera
Sigmaxinella n. sp. 1 (orange tufted rod)	Desmacellidae	Poecilosclerida	Demospongiae	Porifera
Sphaerotylus antarcticus Kirkpatrick, 1907	Polymastiidae	Hadromerida	Demospongiae	Porifera
Sphaerotylus capitatus (Vosmaer, 1885)	Polymastiidae	Hadromerida	Demospongiae	Porifera
Sphaerotylus n. sp. 1 (smooth clubostyles)	Polymastiidae	Hadromerida	Demospongiae	Porifera
Spongionella n. sp. 1 (clear translucent cushion)	Dictyodendrillidae	Dendroceratida	Demospongiae	Porifera
Stylocordyla borealis (Loven, 1868)	Stylocordylidae	Hadromerida	Demospongiae	Porifera
Stylocordyla borealis (Loven, 1868) ?	Stylocordylidae	Hadromerida	Demospongiae	Porifera
Suberites (Laxosuberella) topsenti Burton, 1929 cf	Suberitidae	Hadromerida	Demospongiae	Porifera
Suberites caminatus Ridley & Dendy, 1887	Suberitidae	Hadromerida	Demospongiae	Porifera
Suberites caminatus Ridley & Dendy, 1887 cf	Suberitidae	Hadromerida	Demospongiae	Porifera
Suberites microstomus Ridley & Dendy sensu Kirkpatrick, 1908 cf	Suberitidae	Hadromerida	Demospongiae	Porifera
Suberites papillatus Kirkpatrick, 1908	Suberitidae	Hadromerida	Demospongiae	Porifera
Tedania (Hemitedania) oxeata Topsent, 1916	Tedaniidae	Poecilosclerida	Demospongiae	Porifera
Tedania (Tedaniopsis) triraphis Koltun, 1964	Tedaniidae	Poecilosclerida	Demospongiae	Porifera
Tedania (Tedaniopsis) triraphis Koltun, 1964 cf	Tedaniidae	Poecilosclerida	Demospongiae	Porifera
Tedania tantula (Kirkpatrick, 1908)	Tedaniidae	Poecilosclerida	Demospongiae	Porifera
Tentorium n. sp. 1 (huge strongyloxeas, conical)	Polymastiidae	Hadromerida	Demospongiae	Porifera
Tentorium papillatum (Kirkpatrick, 1907)	Polymastiidae	Hadromerida	Demospongiae	Porifera
Tentorium semisuberites (Schmidt, 1870) sensu Boury-Esnault & Bevern (1982)	Polymastiidae	Hadromerida	Demospongiae	Porifera
Tethyopsis bondstedi Burton, 1929	Ancorinidae	Astrophorida	Demospongiae	Porifera
Tethyopsis longispinna (Lendenfeld, 1907)	Ancorinidae	Astrophorida	Demospongiae	Porifera
Tethyopsis n. sp. 1 (tiny agglutinator, dichotriaenes)	Ancorinidae	Astrophorida	Demospongiae	Porifera
Tetilla leptoderma Sollas, 1888	Tetillidae	Spirophorida	Demospongiae	Porifera
Tetilla metaclada (Lendenfeld, 1907)	Tetillidae	Spirophorida	Demospongiae	Porifera
Tetilla metaclada (Lendenfeld, 1907) ?	Tetillidae	Spirophorida	Demospongiae	Porifera
Anoxycalyx ijima Kirkpatrick, 1907	Rossellidae	Lyssacinosida	Hexactinellida	Porifera

Anoxycalyx ijima Kirkpatrick, 1907 cf	Rossellidae	Lyssacinosida	Hexactinellida	Porifera
Aulorossella levis Kirkpatrick, 1907 cf	Rossellidae	Lyssacinosida	Hexactinellida	Porifera
Hyalascus hodgsoni Kirkpatrick, 1907	Rossellidae	Lyssacinosida	Hexactinellida	Porifera
Hyalascus hodgsoni Kirkpatrick, 1907 ?	Rossellidae	Lyssacinosida	Hexactinellida	Porifera
Hyalascus hodgsoni Kirkpatrick, 1907 cf	Rossellidae	Lyssacinosida	Hexactinellida	Porifera
Rossella antarctica Carter, 1872	Rossellidae	Lyssacinosida	Hexactinellida	Porifera
Rossella antarctica Carter, 1872 ?	Rossellidae	Lyssacinosida	Hexactinellida	Porifera
Rossella antarctica Carter, 1872 cf	Rossellidae	Lyssacinosida	Hexactinellida	Porifera
Rossella nuda Topsent, 1901	Rossellidae	Lyssacinosida	Hexactinellida	Porifera
Rossella nuda Topsent, 1901 ?	Rossellidae	Lyssacinosida	Hexactinellida	Porifera
Rossella podogrosa Kirkpatrick, 1902	Rossellidae	Lyssacinosida	Hexactinellida	Porifera
Rossella podogrosa Kirkpatrick, 1902 ?	Rossellidae	Lyssacinosida	Hexactinellida	Porifera
Rossella podogrosa Kirkpatrick, 1907 cf	Rossellidae	Lyssacinosida	Hexactinellida	Porifera
Rossella racovitzae Topsent, 1901	Rossellidae	Lyssacinosida	Hexactinellida	Porifera
Rossella racovitzae Topsent, 1901 cf	Rossellidae	Lyssacinosida	Hexactinellida	Porifera
Rossella villosa Burton, 1929	Rossellidae	Lyssacinosida	Hexactinellida	Porifera
Rossella villosa Burton, 1929 cf	Rossellidae	Lyssacinosida	Hexactinellida	Porifera
Rossellidae sp 1 (short fat acanthose cross)	Rossellidae	Lyssacinosida	Hexactinellida	Porifera
Alcyonium sp. 1	Alcyoniidae	Alcyonacea	Anthozoa	Cnidaria
Alcyonium sp. 2	Alcyoniidae	Alcyonacea	Anthozoa	Cnidaria
Alcyonium sp. 3	Alcyoniidae	Alcyonacea	Anthozoa	Cnidaria
Alcyonium sp. 4	Alcyoniidae	Alcyonacea	Anthozoa	Cnidaria
Alcyonium sp. 5	Alcyoniidae	Alcyonacea	Anthozoa	Cnidaria
Sphaeralcyon sp.	Alcyoniidae	Alcyonacea	Anthozoa	Cnidaria
Echinisis sp	Isididae	Gorgonacea	Anthozoa	Cnidaria
Notisis sp. 1	Isididae	Gorgonacea	Anthozoa	Cnidaria
Notisis sp. 2	Isididae	Gorgonacea	Anthozoa	Cnidaria
Primnoisis sp. 1	Isididae	Gorgonacea	Anthozoa	Cnidaria
Primnoisis sp. 2	Isididae	Gorgonacea	Anthozoa	Cnidaria
Isididae sp.	Isididae	Gorgonacea	Anthozoa	Cnidaria
Arntzia gracilis	Primnoidae	Gorgonacea	Anthozoa	Cnidaria
Dasystenella sp.	Primnoidae	Gorgonacea	Anthozoa	Cnidaria
Fannyella rossii	Primnoidae	Gorgonacea	Anthozoa	Cnidaria
Fannyella spinosa	Primnoidae	Gorgonacea	Anthozoa	Cnidaria
Fannyella sp. 1	Primnoidae	Gorgonacea	Anthozoa	Cnidaria
Fannyella sp. 2	Primnoidae	Gorgonacea	Anthozoa	Cnidaria
Fannyella sp. 3	Primnoidae	Gorgonacea	Anthozoa	Cnidaria
Ophidiogorgia sp.	Primnoidae	Gorgonacea	Anthozoa	Cnidaria
Primnoella cf. antarctica	Primnoidae	Gorgonacea	Anthozoa	Cnidaria
Primnoella sp. 1	Primnoidae	Gorgonacea	Anthozoa	Cnidaria
Primnoella sp. 3	Primnoidae	Gorgonacea	Anthozoa	Cnidaria
Thouarella sp. 1	Primnoidae	Gorgonacea	Anthozoa	Cnidaria
Thouarella sp. 2	Primnoidae	Gorgonacea	Anthozoa	Cnidaria
Thouarella sp. 3	Primnoidae	Gorgonacea	Anthozoa	Cnidaria
Thouarella sp. 4	Primnoidae	Gorgonacea	Anthozoa	Cnidaria
Umbellula sp. 1	Umbellulidae	Pennatulacea	Anthozoa	Cnidaria
Aulactinia sp.	Actiniidae	Actiniaria	Anthozoa	Cnidaria
Epiactis sp.	Actiniidae	Actiniaria	Anthozoa	Cnidaria
Glyphoperidium sp.	Actiniidae	Actiniaria	Anthozoa	Cnidaria
Isotealia sp.	Actiniidae	Actiniaria	Anthozoa	Cnidaria
Actinidae sp.	Actiniidae	Actiniaria	Anthozoa	Cnidaria
Stomphia sp.	Actinostolidae	Actiniaria	Anthozoa	Cnidaria

Actinostolidae sp. 1	Actinostolidae	Actiniaria	Anthozoa	Cnidaria
Actinostolidae sp. 2	Actinostolidae	Actiniaria	Anthozoa	Cnidaria
Actinostolidae sp. 3	Actinostolidae	Actiniaria	Anthozoa	Cnidaria
Actinostolidae sp. 4	Actinostolidae	Actiniaria	Anthozoa	Cnidaria
Bathyphelliidae sp. 1	Bathyphelliidae	Actiniaria	Anthozoa	Cnidaria
Bathyphelliidae sp. 2	Bathyphelliidae	Actiniaria	Anthozoa	Cnidaria
Capnea sp.	Capneidae	Actiniaria	Anthozoa	Cnidaria
Halcampella sp.	Halcampoididae	Actiniaria	Anthozoa	Cnidaria
Sagartiidae sp.	Sagartiidae	Actiniaria	Anthozoa	Cnidaria
"Atenaria" sp. 3	"Atenaria" fam.	Actiniaria	Anthozoa	Cnidaria
Paraconotrochus antarcticus	Caryophylliidae	Scleractinia	Anthozoa	Cnidaria
Caryophyllia antarctica	Caryophylliidae	Scleractinia	Anthozoa	Cnidaria
Crispatotrochus n. sp.	Caryophylliidae	Scleractinia	Anthozoa	Cnidaria
?Crispatotrochus sp. A sensu Cairns	Caryophylliidae	Scleractinia	Anthozoa	Cnidaria
Flabellum impensum	Flabellidae	Scleractinia	Anthozoa	Cnidaria
Flabellum n. sp.	Flabellidae	Scleractinia	Anthozoa	Cnidaria
Flabellum flexuosum	Flabellidae	Scleractinia	Anthozoa	Cnidaria
Errina fissurata	Stylasteridae	Filifera	Anthozoa	Cnidaria
Errina gracilis	Stylasteridae	Filifera	Anthozoa	Cnidaria
Errina laterorifa	Stylasteridae	Filifera	Anthozoa	Cnidaria
Errina spp.	Stylasteridae	Filifera	Anthozoa	Cnidaria
Inferiolabiata labiata	Stylasteridae	Filifera	Anthozoa	Cnidaria
Clathrozoella drygalski	Clathrozoellidae	Anthoathecata	Hydrozoa	Cnidaria
Clathrozoella medeae	Clathrozoellidae	Anthoathecata	Hydrozoa	Cnidaria
Clathrozoella sp.	Clathrozoellidae	Anthoathecata	Hydrozoa	Cnidaria
Bouillonia sp.	Tubulariidae	Anthoathecata	Hydrozoa	Cnidaria
Monocaulus sp.	Corymorphidae	Anthoathecata	Hydrozoa	Cnidaria
Tubularia sp.	Tubulariidae	Anthoathecata	Hydrozoa	Cnidaria
Abietinella operculata	Lafoeidae	Leptothecata	Hydrozoa	Cnidaria
Halecium delicatulum	Haleciidae	Leptothecata	Hydrozoa	Cnidaria
Halecium incertus	Haleciidae	Leptothecata	Hydrozoa	Cnidaria
Halecium jaederholmi	Haleciidae	Leptothecata	Hydrozoa	Cnidaria
Halecium pallens	Haleciidae	Leptothecata	Hydrozoa	Cnidaria
Halecium sp.	Haleciidae	Leptothecata	Hydrozoa	Cnidaria
Hydrodendron arboreum	Haleciidae	Leptothecata	Hydrozoa	Cnidaria
Schizotricha falcata	Halopterididae	Leptothecata	Hydrozoa	Cnidaria
Schizotricha nana	Halopterididae	Leptothecata	Hydrozoa	Cnidaria
Schizotricha turqueti	Halopterididae	Leptothecata	Hydrozoa	Cnidaria
Schizotricha sp.	Halopterididae	Leptothecata	Hydrozoa	Cnidaria
Oswaldella grandis	Kirchenpaueriidae	Leptothecata	Hydrozoa	Cnidaria
Oswaldella stepanjantsae	Kirchenpaueriidae	Leptothecata	Hydrozoa	Cnidaria
Oswaldella terranovae	Kirchenpaueriidae	Leptothecata	Hydrozoa	Cnidaria
Oswaldella sp.	Kirchenpaueriidae	Leptothecata	Hydrozoa	Cnidaria
Antarctoscyphus admirabilis	Sertulariidae	Leptothecata	Hydrozoa	Cnidaria
Antarctoscyphus grandis	Sertulariidae	Leptothecata	Hydrozoa	Cnidaria
Antarctoscyphus spiralis	Sertulariidae	Leptothecata	Hydrozoa	Cnidaria
Staurotheca antarctica	Sertulariidae	Leptothecata	Hydrozoa	Cnidaria
Staurotheca compressa	Sertulariidae	Leptothecata	Hydrozoa	Cnidaria
Staurotheca densa	Sertulariidae	Leptothecata	Hydrozoa	Cnidaria
Staurotheca dichotoma	Sertulariidae	Leptothecata	Hydrozoa	Cnidaria
Staurotheca nonscripta	Sertulariidae	Leptothecata	Hydrozoa	Cnidaria
Staurotheca pachyclada	Sertulariidae	Leptothecata	Hydrozoa	Cnidaria
Staurotheca polarsterni	Sertulariidae	Leptothecata	Hydrozoa	Cnidaria
Staurotheca vanhoeffeni	Sertulariidae	Leptothecata	Hydrozoa	Cnidaria
Symplectoscyphus anae	Sertulariidae	Leptothecata	Hydrozoa	Cnidaria
Symplectoscyphus curvatus	Sertulariidae	Leptothecata	Hydrozoa	Cnidaria
Symplectoscyphus liouvillei	Sertulariidae	Leptothecata	Hydrozoa	Cnidaria
Symplectoscyphus vanhoeffeni	Sertulariidae	Leptothecata	Hydrozoa	Cnidaria
Billardia subrufa	Campanulariidae	Leptothecata	Hydrozoa	Cnidaria
Euphrosine armadilloides	Euphrosinidae	Amphinomida	Polychaeta	Annelida
Euphrosinella cirratoformis	Euphrosinidae	Amphinomida	Polychaeta	Annelida
Protodorvillea cf. kefersteini	Dorvilleidae	Eunicida	Polychaeta	Annelida
Dorvilleidae sp. 1	Dorvilleidae	Eunicida	Polychaeta	Annelida
Augeneria tentaculata	Lumbrineridae	Eunicida	Polychaeta	Annelida
Glycera kerguelensis	Glyceridae	Phyllodocida	Polychaeta	Annelida
Gyptis sp.	Hesionidae	Phyllodocida	Polychaeta	Annelida

Ophiodromus incomptus	Hesionidae	Phyllodocida	Polychaeta	Annelida
Syllidia inermis	Hesionidae	Phyllodocida	Polychaeta	Annelida
Lacydonia oculata	Lacydoniidae	Phyllodocida	Polychaeta	Annelida
Aglaophamus trissophyllus	Nephtyidae	Phyllodocida	Polychaeta	Annelida
Nicon maculata	Nereidae	Phyllodocida	Polychaeta	Annelida
Neanthes aff. kerguelensis	Nereidae	Phyllodocida	Polychaeta	Annelida
Anaitides longipes	Phyllodocidae	Phyllodocida	Polychaeta	Annelida
Anaitides sp. A	Phyllodocidae	Phyllodocida	Polychaeta	Annelida
Steggoa hunteri	Phyllodocidae	Phyllodocida	Polychaeta	Annelida
Steggoa magalhensis	Phyllodocidae	Phyllodocida	Polychaeta	Annelida
Laetmonice producta	Aphroditidae	Phyllodocida	Polychaeta	Annelida
Antinoella setobarba	Polynoidea	Phyllodocida	Polychaeta	Annelida
Barrukia cristata	Polynoidea	Phyllodocida	Polychaeta	Annelida
Eucranta mollis	Polynoidea	Phyllodocida	Polychaeta	Annelida
Eulagisca gigantea	Polynoidea	Phyllodocida	Polychaeta	Annelida
Eulagisca uschakovi	Polynoidea	Phyllodocida	Polychaeta	Annelida
Eunoe hartmanae	Polynoidea	Phyllodocida	Polychaeta	Annelida
Harmothoe acuminata	Polynoidea	Phyllodocida	Polychaeta	Annelida
Harmothoe crosetensis	Polynoidea	Phyllodocida	Polychaeta	Annelida
Harmothoe fuligineum	Polynoidea	Phyllodocida	Polychaeta	Annelida
Harmothoe magellanica	Polynoidea	Phyllodocida	Polychaeta	Annelida
Gorekia crassicirrus	Polynoidea	Phyllodocida	Polychaeta	Annelida
Antarctinoe ferox	Polynoidae	Phyllodocida	Polychaeta	Annelida
Polynoe laevis	Polynoidae	Phyllodocida	Polychaeta	Annelida
Polynoe antarctica	Polynoidae	Phyllodocida	Polychaeta	Annelida
?Sphaerodorum indet.	Sphaerodoridae	Phyllodocida	Polychaeta	Annelida
Ephesiopsis indet.	Sphaerodoridae	Phyllodocida	Polychaeta	Annelida
Autolytus charcoti	Syllidae	Phyllodocida	Polychaeta	Annelida
Autolytus longstaffi	Syllidae	Phyllodocida	Polychaeta	Annelida
Eusyllis kerguelensis	Syllidae	Phyllodocida	Polychaeta	Annelida
Typosyllis armillaris	Syllidae	Phyllodocida	Polychaeta	Annelida
Typosyllis sp. 1	Syllidae	Phyllodocida	Polychaeta	Annelida
Typosyllis sp. 2	Syllidae	Phyllodocida	Polychaeta	Annelida
Typosyllis sp. 3	Syllidae	Phyllodocida	Polychaeta	Annelida
Trypanosyllis gigantea	Syllidae	Phyllodocida	Polychaeta	Annelida
Exogone cf. heterosetosa	Syllidae	Phyllodocida	Polychaeta	Annelida
Sphaerosyllis sp. 1	Syllidae	Phyllodocida	Polychaeta	Annelida
Syllidae sp. 1	Syllidae	Phyllodocida	Polychaeta	Annelida
Syllidae sp. 2	Syllidae	Phyllodocida	Polychaeta	Annelida
Myriochele sp. 1	Oweniidae	Sabellida	Polychaeta	Annelida
Euchone pallida	Sabellidae	Sabellida	Polychaeta	Annelida
Oriopsis magna	Sabellidae	Sabellida	Polychaeta	Annelida
Perkinsiana littoralis	Sabellidae	Sabellida	Polychaeta	Annelida
Perkinsiana borsibrunoi	Sabellidae	Sabellida	Polychaeta	Annelida
Potamethus scotiae	Sabellidae	Sabellida	Polychaeta	Annelida
Serpula narconensis	Serpulidae	Sabellida	Polychaeta	Annelida
Notomastus latericeus	Capitellidae	Scolecida	Polychaeta	Annelida
Isocirrus yungi	Maldanidae	Scolecida	Polychaeta	Annelida
Praxillella kerguelensis	Maldanidae	Scolecida	Polychaeta	Annelida
Maldane sarsi antarctica	Maldanidae	Scolecida	Polychaeta	Annelida
Rhodine intermedia	Maldanidae	Scolecida	Polychaeta	Annelida
Notoproctus oculatus antarcticus	Maldanidae	Scolecida	Polychaeta	Annelida
Micromaldane indet.	Maldanidae	Scolecida	Polychaeta	Annelida
Ophelia breviata	Opheliidae	Scolecida	Polychaeta	Annelida
Scoloplos marginatus mcleani	Orbiniidae	Scolecida	Polychaeta	Annelida
Leitoscoloplos kerguelensis	Orbiniidae	Scolecida	Polychaeta	Annelida
Paraonis belgicae	Paraonidae	Scolecida	Polychaeta	Annelida
Travisia breviata	Scalibregmatidae	Scolecida	Polychaeta	Annelida
Travisia kerguelensis	Scalibregmatidae	Scolecida	Polychaeta	Annelida
Scalibregma inflatum	Scalibregmatidae	Scolecida	Polychaeta	Annelida
Laonice weddelia	Spionidae	Spionida	Polychaeta	Annelida
Laonice aff. antarctica	Spionidae	Spionida	Polychaeta	Annelida
Scolelepis eltaninae	Spionidae	Spionida	Polychaeta	Annelida
Spiophanes tchernai	Spionidae	Spionida	Polychaeta	Annelida
Ampharete kerguelensis	Ampharetidae	Terebellida	Polychaeta	Annelida
Amphicteis gunneri antarctica	Ampharetidae	Terebellida	Polychaeta	Annelida

Neosabellides elongatus	Ampharetidae	Terebellida	Polychaeta	Annelida
Phyllocomus crocea	Ampharetidae	Terebellida	Polychaeta	Annelida
Caulleriella sp.	Cirratulidae	Terebellida	Polychaeta	Annelida
Piromis sp.	Flabelligeridae	Terebellida	Polychaeta	Annelida
Amphitrite kerguelensis	Terebellidae	Terebellida	Polychaeta	Annelida
Lanicides bilobata	Terebellidae	Terebellida	Polychaeta	Annelida
Pista corrientis	Terebellidae	Terebellida	Polychaeta	Annelida
Pista mirabilis	Terebellidae	Terebellida	Polychaeta	Annelida
Lysilla loveni macintoshi	Terebellidae	Terebellida	Polychaeta	Annelida
Polycirrinae sp. 1	Terebellidae	Terebellida	Polychaeta	Annelida
Terebella ehlersi	Terebellidae	Terebellida	Polychaeta	Annelida
Thelepus cincinnatus	Terebellidae	Terebellida	Polychaeta	Annelida
Thelepides koehleri	Terebellidae	Terebellida	Polychaeta	Annelida
Terebellides stroemi kerguelensis	Trichobranchiidae	Terebellida	Polychaeta	Annelida
Trichobranchus glacialis antarcticus	Trichobranchiidae	Terebellida	Polychaeta	Annelida
Megaliobdella szidati Meyer & Burreson, 1990	Piscicolidae	Rhynchobdellida	Hirudinea	Annelida
Pleurobdella varituberculata (Moore, 1938) (?)	Piscicolidae	Rhynchobdellida	Hirudinea	Annelida
Trulliobdella capitis Brinkmann, 1948	Piscicolidae	Rhynchobdellida	Hirudinea	Annelida
Mooreobdellina biannulata	Piscicolidae	Rhynchobdellida	Hirudinea	Annelida
Golfingia margaritacea	Golfingiidae	Sipunculiformes	Sipunculidea	Sipuncula
Nephasoma diaphanes	Golfingiidae	Sipunculiformes	Sipunculidea	Sipuncula
Nephasoma sp.2	Golfingiidae	Sipunculiformes	Sipunculidea	Sipuncula
Maxmuelleria sp.	Bonelliidae	Echiuroidea	Echiuroida	Echiura
Psychoroteuthis glacialis	Psychroteuthidae	Teuthida	Cephalopoda	Mollusca
Thaumeledone cf. brevis	Octopodiade	Octopoda	Cephalopoda	Mollusca
Pareledone cf. charcoti	Octopodiade	Octopoda	Cephalopoda	Mollusca
Pareledone sp. 2	Octopodiade	Octopoda	Cephalopoda	Mollusca
Pareledone sp. 3	Octopodiade	Octopoda	Cephalopoda	Mollusca
Pareledone sp. 4	Octopodiade	Octopoda	Cephalopoda	Mollusca
Pareledone sp. 5	Octopodiade	Octopoda	Cephalopoda	Mollusca
Pareledone sp. 6	Octopodiade	Octopoda	Cephalopoda	Mollusca
Benthoctopus sp. 1	Octopodiade	Octopoda	Cephalopoda	Mollusca
Adacnarca nitens	Philobryidae	Arcoida	Bivalvia	Mollusca
Adacnarca sp.	Philobryidae	Arcoida	Bivalvia	Mollusca
Astarte longirostris	Astartidae	Veneroida	Bivalvia	Mollusca
Cyamiomactra laminifera	Cyamiidae	Veneroida	Bivalvia	Mollusca
Cyclocardia astartoides	Carditidae	Veneroida	Bivalvia	Mollusca
Kellia simulans	Kelliidae	Veneroida	Bivalvia	Mollusca
Laternula elliptica	Laternulidae	Anomalodesmata	Bivalvia	Mollusca
Limatula cf. hodgsoni Smith, 1907	Limidae	Pteriomorpha	Bivalvia	Mollusca
Limatula simillima	Limidae	Pteriomorpha	Bivalvia	Mollusca
Limopsis lilliei	Limopsidae	Pteriomorpha	Bivalvia	Mollusca
Limopsis marionensis	Limopsidae	Pteriomorpha	Bivalvia	Mollusca
Lissarca notocardensis	Phylobridae	Arcoida	Bivalvia	Mollusca
Lyonsia arcaeformis	Lyonsiidae	Anomalodesmata	Bivalvia	Mollusca
Mysella cf. charchoti	Montacutidae	Veneroida	Bivalvia	Mollusca
Philobrya sublaevis	Philobryidae	Veneroida	Bivalvia	Mollusca
Philobrya wandelensis	Philobryidae	Arcoida	Bivalvia	Mollusca
Pseudokellia gradata	Kelliidae	Veneroida	Bivalvia	Mollusca
Thracia meridionalis	Thraciidae	Anomalodesmata	Bivalvia	Mollusca
Aegires albus	Aegiretidae	Nudibranchia	Gastropoda	Mollusca
Amauropsis anderssoni	Naticidae	Caenogastropoda	Gastropoda	Mollusca
Amauropsis rossiana	Naticidae	Caenogastropoda	Gastropoda	Mollusca
Amauropsis sp.	Naticidae	Caenogastropoda	Gastropoda	Mollusca
Anatoma euglypta	Scissurellidae	Vetigastropoda	Gastropoda	Mollusca
Antarctoneptunea aurora	Buccinidae	Caenogastropoda	Gastropoda	Mollusca
Antimargarita dulcis	Trochidae	Vetigastropoda	Gastropoda	Mollusca
Asperiscala eltanini	Epitoniidae	Caenogastropoda	Gastropoda	Mollusca
Austrodoris kerguelensis	Doridae	Nudibranchia	Gastropoda	Mollusca
Bathyberthella antarctica	Pleurobranchidae	Notaspidea	Gastropoda	Mollusca
Bathyberthella sp nov	Pleurobranchidae	Notaspidea	Gastropoda	Mollusca

Bathydoris clavigera	Bathydorididae	Nudibranchia	Gastropoda	Mollusca
Belaturricula turrita	Turridae	Caenogastropoda	Gastropoda	Mollusca
Cerithiella "erecta"	Cerithiopsidae	Caenogastropoda	Gastropoda	Mollusca
Chlanidota lamyi	Buccinidae	Caenogastropoda	Gastropoda	Mollusca
Cylichna gelida	Cylichnidae	Cephalaspidea	Gastropoda	Mollusca
Doto antarctica	Dotidae	Nudibranchia	Gastropoda	Mollusca
Doto sp.nov.	Dotidae	Nudibranchia	Gastropoda	Mollusca
Eatoniella cf. kerguelensis	Eatoniellidae	Caenogastropoda	Gastropoda	Mollusca
Eumetula strebeli	Cerithiopsidae	Caenogastropoda	Gastropoda	Mollusca
Falsilunatia falklandica	Naticidae	Caenogastropoda	Gastropoda	Mollusca
Falsilunatia fartilis	Naticidae	Caenogastropoda	Gastropoda	Mollusca
Falsimargarita gemma	Trochidae	Vetigastropoda	Gastropoda	Mollusca
Falsimargarita thielei	Trochidae	Vetigastropoda	Gastropoda	Mollusca
Harpovoluta charcoti	Volutidae	Caenogastropoda	Gastropoda	Mollusca
Iothia coppingeri	Lepetidae	Docoglossa	Gastropoda	Mollusca
Laevilittorina antartica	Littoriniidae	Caenogastropoda	Gastropoda	Mollusca
Leptocollonia innocens	Turbinidae	Vetigastropoda	Gastropoda	Mollusca
Leucosyrinx badenpowelli	Turridae	Caenogastropoda	Gastropoda	Mollusca
Margarites crebrilirulata	Trochidae	Vetigastropoda	Gastropoda	Mollusca
Margarites refulgens	Trochidae	Vetigastropoda	Gastropoda	Mollusca
Marginella ealesae	Marginellidae	Caenogastropoda	Gastropoda	Mollusca
Marginella hyalina	Marginellidae	Caenogastropoda	Gastropoda	Mollusca
Marseniopsis mollis	Lamellariidae	Caenogastropoda	Gastropoda	Mollusca
Marseniopsis sp	Lamellariidae	Caenogastropoda	Gastropoda	Mollusca
Melanella antarctica	Eulimidae	Caenogastropoda	Gastropoda	Mollusca
Melanella convexa	Eulimidae	Caenogastropoda	Gastropoda	Mollusca
Melanella sp.	Eulimidae	Caenogastropoda	Gastropoda	Mollusca
Nothoadmete delicatula (Smith, 1907)	Cancellariidae	Caenogastropoda	Gastropoda	Mollusca
Onoba kergueleni	Rissoidae	Caenogastropoda	Gastropoda	Mollusca
Paradmete fragillima	Volutidae	Caenogastropoda	Gastropoda	Mollusca
Paradmete cf. fragillima	Volutidae	Caenogastropoda	Gastropoda	Mollusca
Paradmete sp.	Volutidae	Caenogastropoda	Gastropoda	Mollusca
Pareuthria innocens	Buccinidae	Caenogastropoda	Gastropoda	Mollusca
Pareuthria plicatula	Buccinidae	Caenogastropoda	Gastropoda	Mollusca
Parmophorella mawsoni	Fissurelliidae	Vetigastropoda	Gastropoda	Mollusca
Pontiothauma ergata	Turridae	Caenogastropoda	Gastropoda	Mollusca
Probuccinum costatum	Buccinidae	Caenogastropoda	Gastropoda	Mollusca
Probuccinum tenerum	Buccinidae	Caenogastropoda	Gastropoda	Mollusca
Probuccinum tenuistriatum	Buccinidae	Caenogastropoda	Gastropoda	Mollusca
Prosipho cancellatus	Buccinidae	Caenogastropoda	Gastropoda	Mollusca
Prosipho cf. mundus	Buccinidae	Caenogastropoda	Gastropoda	Mollusca
Prosipho contrarius	Buccinidae	Caenogastropoda	Gastropoda	Mollusca
Prosipho crassicostatus	Buccinidae	Caenogastropoda	Gastropoda	Mollusca
Prosipho glacialis	Buccinidae	Caenogastropoda	Gastropoda	Mollusca
Prosipho hunteri	Buccinidae	Caenogastropoda	Gastropoda	Mollusca
Prosipho pusillus	Buccinidae	Caenogastropoda	Gastropoda	Mollusca
Prosipho spiralis	Buccinidae	Caenogastropoda	Gastropoda	Mollusca
Puncturella spinigera	Fissurellidae	Vetigastropoda	Gastropoda	Mollusca
Sinuber microstriatum	Naticidae	Caenogastropoda	Gastropoda	Mollusca
Skenella paludinoides	Cingulopsidae	Caenogastropoda	Gastropoda	Mollusca
Toledonia major	Diaphanidae	Cephalaspidea	Gastropoda	Mollusca
Toledonia sp. A	Diaphanidae	Cephalaspidea	Gastropoda	Mollusca
Toledonia sp. B	Diaphanidae	Cephalaspidea	Gastropoda	Mollusca
Toledonia striata	Diaphanidae	Cephalaspidea	Gastropoda	Mollusca
Torellia exilis	Capulidae	Caenogastropoda	Gastropoda	Mollusca
Torellia smithi	Capulidae	Caenogastropoda	Gastropoda	Mollusca
Tritonia challengeriana	Tritoniidae	Nudibranchia	Gastropoda	Mollusca
Trophon coulmanensis	Muricidae	Caenogastropoda	Gastropoda	Mollusca
Trophon minutus	Muricidae	Caenogastropoda	Gastropoda	Mollusca
Trophon shackletoni shackletoni	Muricidae	Caenogastropoda	Gastropoda	Mollusca
Turridae sp. A	Turridae	Caenogastropoda	Gastropoda	Mollusca
Turridae sp.	Turridae	Caenogastropoda	Gastropoda	Mollusca
Typhlodaphne innocentia	Turridae	Caenogastropoda	Gastropoda	Mollusca
Callochiton cf. steinenii	Callochitonidae	Neoloricata	Polyplacophora	Mollusca
Callochiton bouveti	Callochitonidae	Neoloricata	Polyplacophora	Mollusca

Callochiton steinenii	Callochitonidae	Neoloricata	Polyplacophora	Mollusca
Leptochiton kerguelensis	Lepidopleuridae	Neoloricata	Polyplacophora	Mollusca
Nuttallochiton mirandus	Callistoplacidae	Neoloricata	Polyplacophora	Mollusca
Cavibelonia sp. 1		Cavibelonia	Aplacophora	Mollusca
Cavibelonia sp. 3	Amphimeniidae	Cavibelonia	Aplacophora	Mollusca
Cavibelonia sp. 3?		Cavibelonia	Aplacophora	Mollusca
Cavibelonia sp. 5 "Dorymenia tricarinata"?	?Proneomeniidae or Ropalomeniidae	Cavibelonia	Aplacophora	Mollusca
Cavibelonia sp. 6 "carinata"	?Proneomeniidae or Ropalomeniidae	Cavibelonia	Aplacophora	Mollusca
Cavibelonia sp. 7 "cristata"	?Proneomeniidae or Ropalomeniidae	Cavibelonia	Aplacophora	Mollusca
Cavibelonia sp. 10	?Proneomeniidae	Cavibelonia	Aplacophora	Mollusca
Accalathura gigantissima	Leptanthuridae	Isopoda	Malacostraca	Arthropoda
Leptanthura glacialis	Leptanthuridae	Isopoda	Malacostraca	Arthropoda
Aega glacialis	Aegidae	Isopoda	Malacostraca	Arthropoda
Aega antarctica	Cirolanidae	Isopoda	Malacostraca	Arthropoda
Cirolana mclaughlinae n.sp.	Cirolanidae	Isopoda	Malacostraca	Arthropoda
Natatolana meridionalis	Cirolanidae	Isopoda	Malacostraca	Arthropoda
Caecognathia antarctica	Gnathiidae	Isopoda	Malacostraca	Arthropoda
Caecognathia calva	Gnathiidae	Isopoda	Malacostraca	Arthropoda
Cymodocella tubicauda	Sphaeromatidae	Isopoda	Malacostraca	Arthropoda
Ceratoserolis sp. nov. 1 (aff. trilobitoides)	Serolidae	Isopoda	Malacostraca	Arthropoda
Antarcturus cf. spinacoronatus	Antarcturidae	Isopoda	Malacostraca	Arthropoda
Antarcturus sp. A	Antarcturidae	Isopoda	Malacostraca	Arthropoda
Chaetarcturus cf. bovinus	Antarcturidae	Isopoda	Malacostraca	Arthropoda
Litarcturus sp	Antarcturidae	Isopoda	Malacostraca	Arthropoda
Antarcturidae sp. B	Antarcturidae	Isopoda	Malacostraca	Arthropoda
aff. Maoridotea sp. nov.	Chaetiliidae	Isopoda	Malacostraca	Arthropoda
Glyptonotus antarcticus	Chaetiliidae	Isopoda	Malacostraca	Arthropoda
Edotia tangaroa sp. nov.	Idoteidae	Isopoda	Malacostraca	Arthropoda
Pseudidotea sp. nov.	Idoteidae	Isopoda	Malacostraca	Arthropoda
Ianthopsis sp.	Acanthaspidiidae	Isopoda	Malacostraca	Arthropoda
Austrofilius sp.	Janiridae	Isopoda	Malacostraca	Arthropoda
Ectias sp.	Janiridae	Isopoda	Malacostraca	Arthropoda
Joeropsis sp.	Joeropsidae	Isopoda	Malacostraca	Arthropoda
Notopais sp. B	Munnopsididae	Isopoda	Malacostraca	Arthropoda
Munna aff. antarctica	Munnidae	Isopoda	Malacostraca	Arthropoda
Austrosignum sp.	Paramunnidae	Isopoda	Malacostraca	Arthropoda
Stenetriidae sp. Tenupedunculus sp. nov.	Stenetriidae	Isopoda	Malacostraca	Arthropoda
Acanthonotozomoides oatesi	Acanthonotozomellidae	Amphipoda	Malacostraca	Arthropoda
Anchiphimedia dorsalis	Iphimediidae	Amphipoda	Malacostraca	Arthropoda
Echiniphimedia echinata	Iphimediidae	Amphipoda	Malacostraca	Arthropoda
Echiniphimedia waegelei	Iphimediidae	Amphipoda	Malacostraca	Arthropoda
Epimeria grandirostris	Epimeriidae	Amphipoda	Malacostraca	Arthropoda
Epimeria inermis	Epimeriidae	Amphipoda	Malacostraca	Arthropoda
Epimeria rimicarinata	Epimeriidae	Amphipoda	Malacostraca	Arthropoda
Epimeria robusta	Epimeriidae	Amphipoda	Malacostraca	Arthropoda
Epimeria schiaparelli	Epimeriidae	Amphipoda	Malacostraca	Arthropoda
Epimeria similis	Epimeriidae	Amphipoda	Malacostraca	Arthropoda
Epimeriella walkeri	Epimeriidae	Amphipoda	Malacostraca	Arthropoda
Eusirus antarcticus	Eusiridae	Amphipoda	Malacostraca	Arthropoda
Eusirus laticarpus	Eusiridae	Amphipoda	Malacostraca	Arthropoda
Eusirus perdentatus	Eusiridae	Amphipoda	Malacostraca	Arthropoda
Gnathiphimedia mandibularis	Iphimediidae	Amphipoda	Malacostraca	Arthropoda
Iphimediella cyclogena	Iphimediidae	Amphipoda	Malacostraca	Arthropoda
Iphimediella georgei	Iphimediidae	Amphipoda	Malacostraca	Arthropoda
Iphimediella microdentata	Iphimediidae	Amphipoda	Malacostraca	Arthropoda
Iphimediella rigida	Iphimediidae	Amphipoda	Malacostraca	Arthropoda
Leucothoe spinicarpa	Leucothoidae	Amphipoda	Malacostraca	Arthropoda
Liljeborgia georgiana	Liljeborgiidae	Amphipoda	Malacostraca	Arthropoda
Maxilliphimedia longipes	Iphimediidae	Amphipoda	Malacostraca	Arthropoda
Oediceroides calmani	Oedicerotidae	Amphipoda	Malacostraca	Arthropoda
Oradarea tridentata	Calliopiidae	Amphipoda	Malacostraca	Arthropoda
Oradarea walkeri	Calliopiidae	Amphipoda	Malacostraca	Arthropoda

Paragammaropsis prenes	Paragammaropsidae	Amphipoda	Malacostraca	Arthropoda
Podocerus septemcarinatus	Podoceridae	Amphipoda	Malacostraca	Arthropoda
Chorismus antarcticus, Bate 1888	Hippolytidae	Decapoda	Malacostraca	Arthropoda
Euphausia (superba?) sp. 1	Euphausiacea	Decapoda	Malacostraca	Arthropoda
Nototanais dimorphus (Hodgson, 1902)	Nototanaidae	Tanaidacea	Eumalacostraca	Arthropoda
Mirandotanais vorax	Colletteidae	Tanaidacea	Eumalacostraca	Arthropoda
Akanthophoreus antarcticus (Vanhoeffen, 1914)	Anarthruridae	Tanaidacea	Eumalacostraca	Arthropoda
Tanaella sp.RS#1	Tanaellidae	Tanaidacea	Eumalacostraca	Arthropoda
Typhlotanais ?greenwichensis Shiino, 1970	Typhlotanaidae	Tanaidacea	Eumalacostraca	Arthropoda
Typhlotanoides rostralis (Tzareva, 1982)	Typhlotanaidae	Tanaidacea	Eumalacostraca	Arthropoda
Philomedes assimilis (Brady)	Philomedidae	Myodocopida	Ostracoda	Arthropoda
Bathylasma corolliforme (Hoek, 1883)	Bathylasmatidae	Sessilia	Maxillopoda	Arthropoda
Weltnerium weltneri (Gruvel, 1907)	Scalpellidae	Pedunculata	Maxillopoda	Arthropoda
Weltnerium sp. cf. W. weltneri (Gruvel, 1907)	Scalpellidae	Pedunculata	Maxillopoda	Arthropoda
Scalpelliforme		Scalpelliformes	Maxillopoda	Arthropoda
Colossendeis australis	Colossendeidae	Pantopoda	Pycnogonida	Arthropoda
Colossendeis notalis	Colossendeidae	Pantopoda	Pycnogonida	Arthropoda
Decolopoda australis	Colossendeidae	Pantopoda	Pycnogonida	Arthropoda
Nymphon australe sp.	Nymphonidae	Pantopoda	Pycnogonida	Arthropoda
Nymphon charcoti	Nymphonidae	Pantopoda	Pycnogonida	Arthropoda
Nymphon longicoxa	Nymphonidae	Pantopoda	Pycnogonida	Arthropoda
Pentanymphon antarcticum	Nymphonidae	Pantopoda	Pycnogonida	Arthropoda
Ammothea carolinesis	Ammotheidae	Pantopoda	Pycnogonida	Arthropoda
Ammothea longispina	Ammotheidae	Pantopoda	Pycnogonida	Arthropoda
Ammothea galcialis	Ammotheidae	Pantopoda	Pycnogonida	Arthropoda
Ammothea calmani	Ammotheidae	Pantopoda	Pycnogonida	Arthropoda
Austroraptus calcaratus	Ammotheidae	Pantopoda	Pycnogonida	Arthropoda
Pycnogonum gaini	Pycnogonidae	Pantopoda	Pycnogonida	Arthropoda
Pycnogonum rhinoceros	Pycnogonidae	Pantopoda	Pycnogonida	Arthropoda
Pentapycnon bouvieri	Pycnogonidae	Pantopoda	Pycnogonida	Arthropoda
Pallenopsis vanhoffeni	Callipallenidae	Pantopoda	Pycnogonida	Arthropoda
Pallenopsis patagonica	Callipallenidae	Pantopoda	Pycnogonida	Arthropoda
Austropallene cornigera	Callipallenidae	Pantopoda	Pycnogonida	Arthropoda
Achelia spicata	Ammotheidae	Pantopoda	Pycnogonida	Arthropoda
Austrodecus frigorifugum	Austrodecidae	Pantopoda	Pycnogonida	Arthropoda
Pantopipetta australis	Austrodecidae	Pantopoda	Pycnogonida	Arthropoda
Rhyncothorax australis	Rhyncothoracidae	Pantopoda	Pycnogonida	Arthropoda
Acodontaster conspicuus	Odontasteridae	Phanerozonida	Asterozoa	Echinodermata
Acodontaster sp. 1	Odontasteridae	Phanerozonida	Asterozoa	Echinodermata
Bathyblaster loripes obesus	Astropectinidae	Phanerozonida	Asterozoa	Echinodermata
Crossaster canopus	Solasteridae	Spinulosida	Asterozoa	Echinodermata
Diplasterias brucei	Asteriidae	Forcipulatida	Asterozoa	Echinodermata
Kampylaster incurvatus	Asterinidae	Spinulosida	Asterozoa	Echinodermata
Labidiaster annulatus	Asteriidae	Forcipulatida	Asterozoa	Echinodermata
Lysasterias adeliae	Asteriidae	Forcipulatida	Asterozoa	Echinodermata
Macroptychaster accrescens	Astropectinidae	Phanerozonida	Asterozoa	Echinodermata
Myoraster antarcticus	Solasteridae	Spinulosida	Asterozoa	Echinodermata
Notasterias armata	Asteriidae	Forcipulatida	Asterozoa	Echinodermata
Notasterias stolophora	Asteriidae	Forcipulatida	Asterozoa	Echinodermata
Odontaster meridionalis	Odontasteridae	Phanerozonida	Asterozoa	Echinodermata
Odontaster validus	Odontasteridae	Phanerozonida	Asterozoa	Echinodermata
Pergamaster triseriatus	Goniasteridae	Phanerozonida	Asterozoa	Echinodermata
Perknaster densus	Echinasteridae	Spinulosida	Asterozoa	Echinodermata
Perknaster fuscus antacticus	Echinasteridae	Spinulosida	Asterozoa	Echinodermata
Perknaster sladeni	Echinasteridae	Spinulosida	Asterozoa	Echinodermata
Peribolaster macleani	Korethrasteridae	Spinulosida	Asterozoa	Echinodermata
Peribolaster powelli	Korethrasteridae	Spinulosida	Asterozoa	Echinodermata
Porania antarctica	Poranidae	Phanerozonida	Asterozoa	Echinodermata
Porania antarctica glabra	Poranidae	Phanerozonida	Asterozoa	Echinodermata

Psalidaster mordax	Asteridae	Forcipulatida	Asterozoa	Echinodermata
Psilaster charcoti	Astropectinidae	Phanerozonida	Asterozoa	Echinodermata
Pteraster stellifer	Pterasteridae	Spinulosida	Asterozoa	Echinodermata
Saliasterias brachiata	Asteriidae	Forcipulatida	Asterozoa	Echinodermata
Promachocrinus kerguelensis	Antedonidae	Articulata	Crinoidea	Echinodermata
Anthometra plumularia	Antedonidae	Articulata	Crinoidea	Echinodermata
Anthedonidae sp.1	Antedonidae	Articulata	Crinoidea	Echinodermata
Abatus shacketoni	Schizasteridae	Spatangoida	Echinoidea	Echinodermata
Abatus sp.	Schizasteridae	Spatangoida	Echinoidea	Echinodermata
Aporocidaris milleri	Cidaridae	Cidaroida	Echinoidea	Echinodermata
Austrocidaris canaliculata	Cidaridae	Cidaroida	Echinoidea	Echinodermata
Ctenocidaris geliberti	Cidaridae	Cidaroida	Echinoidea	Echinodermata
Ctenocidaris gigantea	Cidaridae	Cidaroida	Echinoidea	Echinodermata
Ctenocidaris rugosa	Cidaridae	Cidaroida	Echinoidea	Echinodermata
Ctenocidaris spinosa	Cidaridae	Cidaroida	Echinoidea	Echinodermata
Notocidaris mortensi	Cidaridae	Cidaroida	Echinoidea	Echinodermata
Sterechinus antarcticus	Echinidae	Echinoida	Echinoidea	Echinodermata
Sterechinus neumayeri	Echinidae	Echinoida	Echinoidea	Echinodermata
Amphiura joubini	Amphiuridae	Ophiurida	Asterozoa	Echinodermata
Amphiura algida	Amphiuridae	Ophiurida	Asterozoa	Echinodermata
Amphiura belgicae	Amphiuridae	Ophiurida	Asterozoa	Echinodermata
Astrochlamys bruneus	Gorgonocephalidae	Ophiurida	Asterozoa	Echinodermata
Astrohamma tuberculatum	Gorgonocephalidae	Ophiurida	Asterozoa	Echinodermata
Astrotoma agassizii	Gorgonocephalidae	Ophiurida	Asterozoa	Echinodermata
Glaciacantha jason	Ophiacanthidae	Ophiurida	Asterozoa	Echinodermata
Ophiacantha antarctica	Ophiacanthidae	Ophiurida	Asterozoa	Echinodermata
Ophiacantha pentactis	Ophiacanthidae	Ophiurida	Asterozoa	Echinodermata
Ophiacantha vivipara	Ophiacanthidae	Ophiurida	Asterozoa	Echinodermata
Ophioceres incipiens	Ophiuridae	Ophiurida	Asterozoa	Echinodermata
Ophionotus victoriae	Ophiuridae	Ophiurida	Asterozoa	Echinodermata
Ophiopyren regularis	Ophioleucidae	Ophiurida	Asterozoa	Echinodermata
Ophiosteira antarctica	Ophiuridae	Ophiurida	Asterozoa	Echinodermata
Ophiosteira bullivanti	Ophiuridae	Ophiurida	Asterozoa	Echinodermata
Ophiosteira echinulata	Ophiuridae	Ophiurida	Asterozoa	Echinodermata
Ophiosteira sp.1	Ophiuridae	Ophiurida	Asterozoa	Echinodermata
Ophiura ambigua	Ophiuridae	Ophiurida	Asterozoa	Echinodermata
Ophiuroglypha carinifera	Ophiuridae	Ophiurida	Asterozoa	Echinodermata
Ophiurolepis gelida	Ophiuridae	Ophiurida	Asterozoa	Echinodermata
Toporkovia antarctica	Ophiodermathidae	Ophiurida	Asterozoa	Echinodermata
Abyssocucumis liouvillei	Cucumariidae	Dendrochirotida	Holothuridea	Echinodermata
Abyssocucumis sp. A	Cucumariidae	Dendrochirotida	Holothuridea	Echinodermata
Abyssocucumis sp. B	Cucumariidae	Dendrochirotida	Holothuridea	Echinodermata
Abyssocucumis sp. C	Cucumariidae	Dendrochirotida	Holothuridea	Echinodermata
Abyssocucumis sp. D	Cucumariidae	Dendrochirotida	Holothuridea	Echinodermata
Bathyplotes sp. A	Synallactidae	Aspidochirotida	Holothuridea	Echinodermata
Echinopsolus sp.	Psolidae	Psolida	Holothuridea	Echinodermata
Ekmocucumis steineni	Cucumariidae	Dendrochirotida	Holothuridea	Echinodermata
fam. Cucumaridae sp. A	Cucumariidae	Dendrochirotida	Holothuridea	Echinodermata
fam. Cucumaridae sp. B	Cucumariidae	Dendrochirotida	Holothuridea	Echinodermata
fam. Cucumaridae sp. C	Cucumariidae	Dendrochirotida	Holothuridea	Echinodermata
fam. Cucumaridae sp. D	Cucumariidae	Dendrochirotida	Holothuridea	Echinodermata
fam. Cucumaridae sp. E	Cucumariidae	Dendrochirotida	Holothuridea	Echinodermata
fam. Cucumaridae sp. F	Cucumariidae	Dendrochirotida	Holothuridea	Echinodermata
fam. Molpadiidae	Molpatidae	Molpadida	Holothuridea	Echinodermata
Laetmogone sp.	Laetmogonidae	Elasipodida	Holothuridea	Echinodermata
Psolidium sp. A	Psolidae	Psolida	Holothuridea	Echinodermata
Psolus dubiosus	Psolidae	Psolida	Holothuridea	Echinodermata
Psolus sp. A	Psolidae	Psolida	Holothuridea	Echinodermata
Trachythyone sp. A	Cucumariidae	Dendrochirotida	Holothuridea	Echinodermata
Trachythyone sp. B	Cucumariidae	Dendrochirotida	Holothuridea	Echinodermata
Ypsilocucumis sp.	Paracucumidae	Dendrochirotida	Holothuridea	Echinodermata
Compsothyris racovitzae Smith, 1908	Laqueidae	Terrebratulida	Articulata	Brachiopoda
Liothyrella sp.	Terebratellidae	Terrebratulida	Articulata	Brachiopoda
Magellania fragilis Smith, 1908	Terebratellidae	Terrebratulida	Articulata	Brachiopoda
Magellania joubini	Terebratellidae	Terrebratulida	Articulata	Brachiopoda

Magellania sp.	Terebratellidae	Terrebratulida	Articulata	Brachiopoda
Macandrevia vanhoeffeni Blochmann, 1907	Laqueidae	Terrebratulida	Articulata	Brachiopoda
Macandrevia sp.	Laqueidae	Terrebratulida	Articulata	Brachiopoda
Acanthophragma polaris	Lepraliellidae	Cheilostomata	Gymnolaemata	Bryozoa
Adelascopora jeqolqa	Microporellidae	Cheilostomata	Gymnolaemata	Bryozoa
Aimulosia antarctica	Buffonellodidae	Cheilostomata	Gymnolaemata	Bryozoa
Alcyonidium sp.	Alcyonidiidae	Ctenostomata	Gymnolaemata	Bryozoa
Amastigia cabereoides	Candidae	Cheilostomata	Gymnolaemata	Bryozoa
Amphiblestrum inermis	Calloporidae	Cheilostomata	Gymnolaemata	Bryozoa
Amphiblestrum rossi	Calloporidae	Cheilostomata	Gymnolaemata	Bryozoa
Annectocyma sp.	Annectocymidae	Cyclostomata	Stenolaemata	Bryozoa
Apiophragma hyalina	Calloporidae	Cheilostomata	Gymnolaemata	Bryozoa
Arachnopusia decipiens	Arachnopusiidae	Cheilostomata	Gymnolaemata	Bryozoa
Arachnopusia sp.	Arachnopusiidae	Cheilostomata	Gymnolaemata	Bryozoa
Aspidostoma coronatum	Aspidostomatidae	Cheilostomata	Gymnolaemata	Bryozoa
Austroflustra vulgaris	Flustridae	Cheilostomata	Gymnolaemata	Bryozoa
Beania erecta	Beaniidae	Cheilostomata	Gymnolaemata	Bryozoa
Bicrisia biciliata	Crisiidae	Cyclostomata	Stenolaemata	Bryozoa
Bicrisia edwardsiana	Crisiidae	Cyclostomata	Stenolaemata	Bryozoa
Buffonellaria frigida	Celleporidae	Cheilostomata	Gymnolaemata	Bryozoa
Buffonellodes antarctica	Buffonellodidae	Cheilostomata	Gymnolaemata	Bryozoa
Buffonellodes rimosa	Buffonellodidae	Cheilostomata	Gymnolaemata	Bryozoa
Buffonellodes sp.	Buffonellodidae	Cheilostomata	Gymnolaemata	Bryozoa
Bugulella klugei	Bugulidae	Cheilostomata	Gymnolaemata	Bryozoa
Caberea darwinii	Candidae	Cheilostomata	Gymnolaemata	Bryozoa
Camptoplites bicornis	Bugulidae	Cheilostomata	Gymnolaemata	Bryozoa
Camptoplites giganteus	Bugulidae	Cheilostomata	Gymnolaemata	Bryozoa
Camptoplites latus	Bugulidae	Cheilostomata	Gymnolaemata	Bryozoa
Camptoplites retiformis	Bugulidae	Cheilostomata	Gymnolaemata	Bryozoa
Camptoplites tricornis	Bugulidae	Cheilostomata	Gymnolaemata	Bryozoa
Carbasea curva	Flustridae	Cheilostomata	Gymnolaemata	Bryozoa
Cellaria aurorae	Cellariidae	Cheilostomata	Gymnolaemata	Bryozoa
Cellaria clavata	Cellariidae	Cheilostomata	Gymnolaemata	Bryozoa
Cellaria coronata	Cellariidae	Cheilostomata	Gymnolaemata	Bryozoa
Cellaria diversa	Cellariidae	Cheilostomata	Gymnolaemata	Bryozoa
Cellaria moniliorata	Cellariidae	Cheilostomata	Gymnolaemata	Bryozoa
Cellarinella dubia	Cellarinellidae	Cheilostomata	Gymnolaemata	Bryozoa
Cellarinella laytoni	Cellarinellidae	Cheilostomata	Gymnolaemata	Bryozoa
Cellarinella njegovanae	Cellarinellidae	Cheilostomata	Gymnolaemata	Bryozoa
Cellarinella nodulata	Sclerodomidae	Cheilostomata	Gymnolaemata	Bryozoa
Cellarinella nutti	Cellarinellidae	Cheilostomata	Gymnolaemata	Bryozoa
Cellarinella rogickae	Cellarinellidae	Cheilostomata	Gymnolaemata	Bryozoa
Cellarinella virgula	Sclerodomidae	Cheilostomata	Gymnolaemata	Bryozoa
Cellarinella rossi	Cellarinellidae	Cheilostomata	Gymnolaemata	Bryozoa
Cellarinella watersi	Cellarinellidae	Cheilostomata	Gymnolaemata	Bryozoa
Cellarinella sp.	Cellarinellidae	Cheilostomata	Gymnolaemata	Bryozoa
Celleporella antarctica	Hippothoidae	Cheilostomata	Gymnolaemata	Bryozoa
Celleporella bougainvillei	Hippothoidae	Cheilostomata	Gymnolaemata	Bryozoa
Celleporella calculosa	Hippothoidae	Cheilostomata	Gymnolaemata	Bryozoa
Celleporella dictyota	Hippothoidae	Cheilostomata	Gymnolaemata	Bryozoa
Celleporella sp. (glassy)	Hippothoidae	Cheilostomata	Gymnolaemata	Bryozoa
Celleporella sp. (uniserial)	Hippothoidae	Cheilostomata	Gymnolaemata	Bryozoa
Chaperiopsis cervicornis	Chaperiidae	Cheilostomata	Gymnolaemata	Bryozoa
Chaperiopsis protecta	Chaperiidae	Cheilostomata	Gymnolaemata	Bryozoa
Chaperiopsis signyensis	Chaperiidae	Cheilostomata	Gymnolaemata	Bryozoa
Chaperiopsis sp. 1	Chaperiidae	Cheilostomata	Gymnolaemata	Bryozoa
Chaperiopsis sp. 2	Chaperiidae	Cheilostomata	Gymnolaemata	Bryozoa
Chondriovelum adeliense	Onychocellidae	Cheilostomata	Gymnolaemata	Bryozoa
Clavopora sp.	Clavoporidae	Ctenostomata	Gymnolaemata	Bryozoa
Cornucopina ovalis	Bugulidae	Cheilostomata	Gymnolaemata	Bryozoa
Cornucopina pectogemma	Bugulidae	Cheilostomata	Gymnolaemata	Bryozoa
Cornucopina polymorpha	Bugulidae	Cheilostomata	Gymnolaemata	Bryozoa
Crassimarginatella inconstantia	Calloporidae	Cheilostomata	Gymnolaemata	Bryozoa
Crassimarginatella sp.	Calloporidae	Cheilostomata	Gymnolaemata	Bryozoa
Crisia sinclarensis	Crisiidae	Cyclostomata	Stenolaemata	Bryozoa

Crisia sp.	Crisiidae	Cyclostomata	Stenolaemata	Bryozoa
Crisidia delicatissima	Crisiidae	Cyclostomata	Stenolaemata	Bryozoa
Dakariella dabrowni	Schizoporellidae	Cheilostomata	Gymnolaemata	Bryozoa
Dakariella concinna	Smittinidae	Cheilostomata	Gymnolaemata	Bryozoa
Dartevellia sp.	Lichenoporidae	Cyclostomata	Stenolaemata	Bryozoa
Dendroperistoma projecta	Cribrilinidae	Cheilostomata	Gymnolaemata	Bryozoa
Diaperoecia buski	Diaperoeciidae	Cyclostomata	Stenolaemata	Bryozoa
Disporella canaliculata	Lichenoporidae	Cyclostomata	Stenolaemata	Bryozoa
Disporella octoradiata	Lichenoporidae	Cyclostomata	Stenolaemata	Bryozoa
Ellisina antarctica	Calloporidae	Cheilostomata	Gymnolaemata	Bryozoa
Ellisina constantia	Calloporidae	Cheilostomata	Gymnolaemata	Bryozoa
Entalophoroecia sp.	Annectocymidae	Cyclostomata	Stenolaemata	Bryozoa
Escharella mamillata	Romancheinidae	Cheilostomata	Gymnolaemata	Bryozoa
Escharella watersi	Romancheinidae	Cheilostomata	Gymnolaemata	Bryozoa
Escharoides praestita	Romancheinidae	Cheilostomata	Gymnolaemata	Bryozoa
Escharoides tridens	Romancheinidae	Cheilostomata	Gymnolaemata	Bryozoa
Eurystrotos sp.	Diastoporidae	Cyclostomata	Stenolaemata	Bryozoa
Exidmonea arcuata	Tubuliporidae	Cyclostomata	Stenolaemata	Bryozoa
Exochella avicularis	Romancheinidae	Cheilostomata	Gymnolaemata	Bryozoa
Exochella elegans	Romancheinidae	Cheilostomata	Gymnolaemata	Bryozoa
Exochella hymanae	Romancheinidae	Cheilostomata	Gymnolaemata	Bryozoa
Exochella umbonata	Romancheinidae	Cheilostomata	Gymnolaemata	Bryozoa
Exochella torquata	Romancheinidae	Cheilostomata	Gymnolaemata	Bryozoa
Fasciculipora maeandrina	Fascigeridae	Cyclostomata	Stenolaemata	Bryozoa
Fasciculipora ramosa	Fascigeridae	Cyclostomata	Stenolaemata	Bryozoa
Fenestrulina antarctica	Microporellidae	Cheilostomata	Gymnolaemata	Bryozoa
Fenestrulina cervicornis	Microporellidae	Cheilostomata	Gymnolaemata	Bryozoa
Fenestrulina crystallina	Microporellidae	Cheilostomata	Gymnolaemata	Bryozoa
Fenestrulina exigua	Microporellidae	Cheilostomata	Gymnolaemata	Bryozoa
Fenestrulina parvipora	Microporellidae	Cheilostomata	Gymnolaemata	Bryozoa
Fenestrulina proxima	Microporellidae	Cheilostomata	Gymnolaemata	Bryozoa
Filaguria spatulata	Cribrilinidae	Cheilostomata	Gymnolaemata	Bryozoa
Harpecia spinosissima	Electridae	Cheilostomata	Gymnolaemata	Bryozoa
Harpago sp.	Lekythoporidae	Cheilostomata	Gymnolaemata	Bryozoa
Hastingsia gracilis	Hastingsiidae	Cyclostomata	Stenolaemata	Bryozoa
Hastingsia pygmaea	Hastingsiidae	Cyclostomata	Stenolaemata	Bryozoa
Himantozoum antarcticum	Bugulidae	Cheilostomata	Gymnolaemata	Bryozoa
Hippomonavella pellucidula	Bitectiporidae	Cheilostomata	Gymnolaemata	Bryozoa
Hippomonavella sp.	Bitectiporidae	Cheilostomata	Gymnolaemata	Bryozoa
Hippothoa flagellum	Hippothoidae	Cheilostomata	Gymnolaemata	Bryozoa
Hornera antarctica	Horneridae	Cyclostomata	Stenolaemata	Bryozoa
Hornera falklandica	Horneridae	Cyclostomata	Stenolaemata	Bryozoa
Hornera lasarevi	Horneridae	Cyclostomata	Stenolaemata	Bryozoa
Hornera smitti	Horneridae	Cyclostomata	Stenolaemata	Bryozoa
Icelozoon dichotomum	Chaperiidae	Cheilostomata	Gymnolaemata	Bryozoa
Icelozoon lepralioides	Chaperiidae	Cheilostomata	Gymnolaemata	Bryozoa
Idmidronea curvata	Tubuliporidae	Cyclostomata	Stenolaemata	Bryozoa
Inversiula nutrix	Inversiulidae	Cheilostomata	Gymnolaemata	Bryozoa
Isoschizoporella secunda	Eminoeciidae	Cheilostomata	Gymnolaemata	Bryozoa
Isoschizoporella similis	Eminoeciidae	Cheilostomata	Gymnolaemata	Bryozoa
Isoschizoporella tricuspis	Eminoeciidae	Cheilostomata	Gymnolaemata	Bryozoa
Isosecuriflustra angusta	Flustridae	Cheilostomata	Gymnolaemata	Bryozoa
Isosecuriflustra tenuis	Flustridae	Cheilostomata	Gymnolaemata	Bryozoa
Klugeflustra antarctica	Flustridae	Cheilostomata	Gymnolaemata	Bryozoa
Klugerella antarctica	Cribrilinidae	Cheilostomata	Gymnolaemata	Bryozoa
Kymella polaris	Incertae sedis	Cheilostomata	Gymnolaemata	Bryozoa
Lacerna eatoni	Lacernidae	Cheilostomata	Gymnolaemata	Bryozoa
Lacerna hosteensis	Lacernidae	Cheilostomata	Gymnolaemata	Bryozoa
Larvapora mawsoni	Aspidostomatidae	Cheilostomata	Gymnolaemata	Bryozoa
Lichenopora sp.	Lichenoporidae	Cyclostomata	Stenolaemata	Bryozoa
Liripora sp.	Diastoporidae	Cyclostomata	Stenolaemata	Bryozoa
Melicerita latilaminata	Cellariidae	Cheilostomata	Gymnolaemata	Bryozoa
Micropora brevissima	Microporidae	Cheilostomata	Gymnolaemata	Bryozoa
Microporella stenoporta	Microporellidae	Cheilostomata	Gymnolaemata	Bryozoa
Nematoflustra flagellata	Flustridae	Cheilostomata	Gymnolaemata	Bryozoa
Neofungella claviformis	Incertae sedis	Cyclostomata	Stenolaemata	Bryozoa
Nimba sp.	Lacernidae	Cheilostomata	Gymnolaemata	Bryozoa

Nimba n. sp.	Lacernidae	Cheilostomata	Gymnolaemata	Bryozoa
Notoplites drygalskii	Candidae	Cheilostomata	Gymnolaemata	Bryozoa
Notoplites klugei	Candidae	Cheilostomata	Gymnolaemata	Bryozoa
Notoplites tenuis	Candidae	Cheilostomata	Gymnolaemata	Bryozoa
Notoplites uniserialis	Candidae	Cheilostomata	Gymnolaemata	Bryozoa
Notoplites vanhoffeni	Candidae	Cheilostomata	Gymnolaemata	Bryozoa
Notoplites watersi	Candidae	Cheilostomata	Gymnolaemata	Bryozoa
Oncousoecia sp.	Oncousoeciidae	Cyclostomata	Stenolaemata	Bryozoa
Orthoporidra brachyrhyncha	Lekythoporidae	Cheilostomata	Gymnolaemata	Bryozoa
Orthoporidra compacta	Lekythoporidae	Cheilostomata	Gymnolaemata	Bryozoa
Orthoporidra stenorhyncha	Lekythoporidae	Cheilostomata	Gymnolaemata	Bryozoa
Osthimosia bicornis	Celleporidae	Cheilostomata	Gymnolaemata	Bryozoa
Osthimosia clavata	Celleporidae	Cheilostomata	Gymnolaemata	Bryozoa
Osthimosia claviformis	Celleporidae	Cheilostomata	Gymnolaemata	Bryozoa
Osthimosia fusticula	Celleporidae	Cheilostomata	Gymnolaemata	Bryozoa
Osthimosia malingae	Celleporidae	Cheilostomata	Gymnolaemata	Bryozoa
Osthimosia notialis	Celleporidae	Cheilostomata	Gymnolaemata	Bryozoa
Paracellaria calveti	Cellariidae	Cheilostomata	Gymnolaemata	Bryozoa
Paracellaria wandeli	Cellariidae	Cheilostomata	Gymnolaemata	Bryozoa
Phonicosia sp.	Lacernidae	Cheilostomata	Gymnolaemata	Bryozoa
Plagioecia sp.	Plagioeciidae	Cyclostomata	Stenolaemata	Bryozoa
Polirhabdotos inclusum	Metrarabdotosidae	Cheilostomata	Gymnolaemata	Bryozoa
Prenantia (?) sp.	Smittinidae	Cheilostomata	Gymnolaemata	Bryozoa
Pyriporoides uniserialis	Calloporidae	Cheilostomata	Gymnolaemata	Bryozoa
Ralepria conforma	Lacernidae	Cheilostomata	Gymnolaemata	Bryozoa
Reteporella antarctica	Phidoloporidae	Cheilostomata	Gymnolaemata	Bryozoa
Reteporella erugata	Phidoloporidae	Cheilostomata	Gymnolaemata	Bryozoa
Reteporella frigida	Phidoloporidae	Cheilostomata	Gymnolaemata	Bryozoa
Reteporella gelida	Phidoloporidae	Cheilostomata	Gymnolaemata	Bryozoa
Reteporella hippocrepis	Phidoloporidae	Cheilostomata	Gymnolaemata	Bryozoa
Reteporella parva	Phidoloporidae	Cheilostomata	Gymnolaemata	Bryozoa
Reteporella sp. 1	Phidoloporidae	Cheilostomata	Gymnolaemata	Bryozoa
Romancheina asymmetrica	Romancheinidae	Cheilostomata	Gymnolaemata	Bryozoa
Romancheina barica	Romancheinidae	Cheilostomata	Gymnolaemata	Bryozoa
Smittina abditavicularis	Smittinidae	Cheilostomata	Gymnolaemata	Bryozoa
Smittina anecdota	Smittinidae	Cheilostomata	Gymnolaemata	Bryozoa
Smittina antarctica	Smittinidae	Cheilostomata	Gymnolaemata	Bryozoa
Smittina glebula	Smittinidae	Cheilostomata	Gymnolaemata	Bryozoa
Smittina incernicula	Smittinidae	Cheilostomata	Gymnolaemata	Bryozoa
Smittina sp.	Smittinidae	Cheilostomata	Gymnolaemata	Bryozoa
Smittoidea albula	Smittinidae	Cheilostomata	Gymnolaemata	Bryozoa
Smittoidea conspicua	Smittinidae	Cheilostomata	Gymnolaemata	Bryozoa
Smittoidea malleata	Smittinidae	Cheilostomata	Gymnolaemata	Bryozoa
Smittoidea pugiuncula	Smittinidae	Cheilostomata	Gymnolaemata	Bryozoa
Spigaleos horneroides	Celleporidae	Cheilostomata	Gymnolaemata	Bryozoa
Stomatopora sp.	Oncousoeciidae	Cyclostomata	Stenolaemata	Bryozoa
Stomhypselosaria watersi	Cellariidae	Cheilostomata	Gymnolaemata	Bryozoa
Swanomia belgica	Cellariidae	Cheilostomata	Gymnolaemata	Bryozoa
Swanomia brevimandibulata	Cellariidae	Cheilostomata	Gymnolaemata	Bryozoa
Systenopora contracta	Cellarinellidae	Cheilostomata	Gymnolaemata	Bryozoa
Thrypticocirrus phylactelloides	Smittinidae	Cheilostomata	Gymnolaemata	Bryozoa
Thrypticocirrus rogickae	Smittinidae	Cheilostomata	Gymnolaemata	Bryozoa
Toretocheilum absidatum	Lacernidae	Cheilostomata	Gymnolaemata	Bryozoa
Toretocheilum turbinatum	Lacernidae	Cheilostomata	Gymnolaemata	Bryozoa
Tracheloptyx antarctica	Smittinidae	Cheilostomata	Gymnolaemata	Bryozoa
Trilaminopora trinervis	Arachnopusiidae	Cheilostomata	Gymnolaemata	Bryozoa
Trilochites biformatus	Hippodinidae	Cheilostomata	Gymnolaemata	Bryozoa
Tubulipora carinata	Tubuliporidae	Cyclostomata	Stenolaemata	Bryozoa
Tubulipora gracillima	Tubuliporidae	Cyclostomata	Stenolaemata	Bryozoa
Tubulipora tubigera	Tubuliporidae	Cyclostomata	Stenolaemata	Bryozoa
Valdemunitella lata	Calloporidae	Cheilostomata	Gymnolaemata	Bryozoa
Xylochotridens rangifer	Calloporidae	Cheilostomata	Gymnolaemata	Bryozoa
Synoicum adareanum	Polyclinidae	Enterogona	Ascidiacea	Chordata
Synoicum georgiana	Polyclinidae	Enterogona	Ascidiacea	Chordata
Synoicum pererratum	Polyclinidae	Enterogona	Ascidiacea	Chordata
Synoicum sp.	Polyclinidae	Enterogona	Ascidiacea	Chordata
Aplidium caeruleum	Polyclinidae	Enterogona	Ascidiacea	Chordata

Aplidium circumvolutum	Polyclinidae	Enterogona	Ascidiacea	Chordata
Aplidium fuegiense	Polyclinidae	Enterogona	Ascidiacea	Chordata
Aplidium radiatum	Polyclinidae	Enterogona	Ascidiacea	Chordata
Aplidium stanleyi	Polyclinidae	Enterogona	Ascidiacea	Chordata
Aplidium sp.	Polyclinidae	Enterogona	Ascidiacea	Chordata
Aplidiopsis georgianum	Polyclinidae	Enterogona	Ascidiacea	Chordata
Tylobranchion speciosum	Polyclinidae	Enterogona	Ascidiacea	Chordata
Distaplia colligians	Clavelinidae	Enterogona	Ascidiacea	Chordata
Distaplia cylindrica	Clavelinidae	Enterogona	Ascidiacea	Chordata
Cystodytes antarcticus	Polycitoridae	Enterogona	Ascidiacea	Chordata
Sigillina sp.	Polycitoridae	Enterogona	Ascidiacea	Chordata
Polycitor glareosus	Polycitoridae	Enterogona	Ascidiacea	Chordata
Didemnum biglans	Didemnidae	Enterogona	Ascidiacea	Chordata
Didemnum sp.	Didemnidae	Enterogona	Ascidiacea	Chordata
Ascidia challengeri	Ascidiidae	Enterogona	Ascidiacea	Chordata
Pyura discoveryi	Pyuridae	Pleurogona	Ascidiacea	Chordata
Pyura georgiana	Pyuridae	Pleurogona	Ascidiacea	Chordata
Pyura obesa	Pyuridae	Pleurogona	Ascidiacea	Chordata
Bathypera splendens	Pyuridae	Pleurogona	Ascidiacea	Chordata
Cnemidocarpa verrucosa	Styelidae	Pleurogona	Ascidiacea	Chordata
Styela nordenskjöldi	Styelidae	Pleurogona	Ascidiacea	Chordata
Styela schmitti	Styelidae	Pleurogona	Ascidiacea	Chordata
Bathyoncus herdmani	Styelidae	Pleurogona	Ascidiacea	Chordata
Mogula gigantea	Mogulidae	Pleurogona	Ascidiacea	Chordata
Mogula malvinensis	Mogulidae	Pleurogona	Ascidiacea	Chordata
Mogula pyriformis	Mogulidae	Pleurogona	Ascidiacea	Chordata
Mogula sp.	Mogulidae	Pleurogona	Ascidiacea	Chordata

Appendix 8: Number of solitary and colonial species, total species number (*S*) and number of individuals (*N*) (solitary taxa only) per station for macroinvertebrate assemblages and number of species and individuals per station for fish assemblages sampled on the northwestern Ross Sea shelf. Only stations included in assemblage composition analysis are listed.

		Macroinvertebrates				Fish	
Stn	Gear	*S* solitary	*S* colonial	*S* total	*N* solitary taxa	*S*	*N*
3	GVVL	9	40	49	12		
5	GVVL	6	39	45	12		
6	SEL	0	6	6	0		
7	GVVL	21	23	44	50		
8	SEL	23	4	27	104		
9	ORH	14	11	25	29	8	154
10	ORH	21	7	28	46	13	120
11	ORH	9	6	15	12	3	4
12	GVVL	4	4	8	4		
13	SEL	7	4	11	7		
14	GVVL	27	59	86	73		
15	SEL	47	9	56	154		
16	GVVL	27	30	57	79		
17	SEL	25	25	50	70		
18	ORH	20	11	31	36	5	54
19	ORH	13	7	20	31	3	4
20	ORH	14	18	32	27	7	16
21	GVVL	49	19	68	267		
22	SEL	40	11	51	177	2	2
24	GVVL	34	20	54	179		
25	SEL	33	26	59	185		
26	ORH	21	23	44	113	8	48
28	ORH	14	9	23	69	5	13
29	ORH	11	14	25	74	3	14
30	GVVL	18	19	37	46		
31	SEL	4	1	5	5		
32	GVVL	8	9	17	17		
33	SEL	31	3	34	94		
34	GVVL	17	22	39	46		
35	SEL	16	6	22	223		
36	ORH	24	14	38	111	9	78
37	ORH	14	10	24	21	7	17
38	GVVL	16	20	36	26		
39	SEL	24	32	56	93		
47	GVVL	40	28	68	109		
48	SEL	33	50	83	122		
51	GVVL	40	22	62	83		
52	SEL	46	31	77	123	4	4
53	GVVL	27	83	110	57		
54	SEL	31	40	71	66	2	3
55	ORH	21	34	55	75	7	39
56	ORH	14	2	16	36	8	35
57	ORH	21	32	53	51	10	17
58	GVVL	14	20	34	24		
59	SEL	17	6	23	38		
63	SEL	38	18	56	181		
64	GVVL	11	9	20	26		
65	SEL	34	13	47	255		
66	GVVL	11	21	32	17		
67	ORH	29	45	74	73	9	37
68	ORH	2	0	2	2		
69	GVVL	5	1	6	7		
70	SEL	5	5	10	17		

71	GVVL	13	1	14	16		
72	SEL	10	4	14	10		
73	GVVL	0	16	16	0		
75	ORH	8	7	15	11	6	9
76	ORH	10	0	10	38	5	70
77	GVVL	27	10	37	69		
78	SEL	8	4	12	99		
82	SEL	14	3	17	38		
83	SEL	8	3	11	13		
84	ORH	7	4	11	8	6	17
88	GVVL	38	40	78	78		
90	GVVL	31	85	116	122		
91	SEL	15	13	28	76		
95	GVVL	10	27	37	12		
96	SEL	18	9	27	28		
97	GVVL	19	21	40	31		
98	SEL	11	9	20	12		
100	GVVL	7	16	23	8		
101	SEL	15	13	28	18		
102	GVVL	12	2	14	24		
103	SEL	8	3	11	11		
104	GVVL	4	0	4	34		
105	SEL	39	19	58	248		
107	GVVL	38	32	70	78		
108	SEL	42	20	62	372		
112	SEL	43	20	63	172		
116	SEL	38	11	49	177	2	2
117	GVVL	40	32	72	86		
118	ORH	26	18	44	324	4	40
119	ORH	8	6	14	16	3	22
120	ORH	3	12	15	5	2	3
121	ORH	4	4	8	7	3	16
122	ORH	8	9	17	12	5	808
123	GVVL	45	24	69	108		
124	SEL	37	14	51	300	2	4
125	GVVL	32	20	52	78		
126	SEL	26	14	40	63		
127	GVVL	32	14	46	194		
128	SEL	23	5	28	52	4	4
130	SEL	46	11	57	257	4	8
139	GVVL	49	60	109	143		
140	SEL	57	15	72	310	2	2
142	GVVL	27	27	54	58		
143	SEL	29	13	42	157		
144	GVVL	5	5	10	6		
145	SEL	11	9	20	18		
147	GVVL	4	6	10	6		
148	SEL	23	11	34	56		
149	GVVL	18	12	30	49		
150	SEL	31	12	43	202		
151	GVVL	17	8	25	84		
152	SEL	29	11	40	178		
153	GVVL	20	8	28	227		
154	SEL	24	6	30	271		
156	GVVL	23	16	39	159		
157	SEL	25	8	33	640		
160	SEL	12	3	15	25		
162	GVVL	16	33	49	39		
165	SEL	3	8	11	4		
168	GVVL	3	3	6	3		

169	SEL	2	2	4	2		
170	GVVL	5	6	11	10		
171	SEL	3	5	8	3		
172	ORH	3	3	6	5	4	11
173	ORH	14	12	26	24	3	85
174	ORH	15	1	16	365	4	20
175	ORH	11	10	21	18	4	15
177	GVVL	1	1	2	1		
178	SEL	26	16	42	64		
180	GVVL	7	0	7	42		
182	SEL	24	7	31	87		
183	GVVL	3	0	3	6		
184	SEL	43	11	54	300	2	2
187	GVVL	8	6	14	15		
188	SEL	25	12	37	115		
189	GVVL	18	23	41	39		
190	SEL	33	9	42	190	2	5
192	GVVL	11	12	23	28		
193	SEL	25	15	40	95		
194	GVVL	16	26	42	32		
195	SEL	21	24	45	65	5	9
197	SEL	37	26	63	227		
198	GVVL	27	26	53	105		
199	ORH	7	1	8	43	6	19

Appendix 9: Northwestern Ross Sea shelf macroinvertebrate assemblages. Breakdown of average similarity within sample grouping transect for each of three assemblage types into contributions from each species. Only the five species contributing most or species with AvDis/SD ≥1.3 are listed. Av. Abund=average abundance – for presence/absence data equates to frequency of occurrence, Av. Sim=average similarity (%), SD=standard deviation of average similarity, Contrib %=contribution to similarity, Cum %=cumulative similarity. ANT=Actinaria, APH=Amphipoda, ASC=Ascidia, ASR=Asteroidea, BRN=Barnacles, COR=Stylasteridae, COZ=Bryozoa, CRI=Crinoidea, ECN=Echinoidea, GOC=Gorgonacea, HTH=Holothuroidea, NAT=Natantia, POL=Polychaeta, PTU=Pennatulacea, PYC=Pycnogonida, OCT=Octopoda, ONG=Porifera, OPH=Ophiuroidea.

Sample Grouping	Species	Taxa	Av. Abund.	Av. Sim.	Av. Sim/ SD	Contrib %	Cum %
							Infauna
1	*Glycera kerguelensis*	POL	0.80	1.55	1.01	7.08	7.08
	Micropora brevissima	COZ	0.80	1.33	1.02	6.07	13.15
	Microporella stenoporta	COZ	0.70	1.01	0.75	4.63	17.78
	Fenestrulina parvipora	COZ	0.50	0.88	0.64	4.00	21.78
	Hippothoa flagellum	COZ	0.60	0.88	0.64	4.00	25.78
2	*Glycera kerguelensis*	POL	0.91	9.01	0.85	38.46	38.46
	Scolelepis eltaninae	POL	0.36	2.58	0.44	11.01	49.47
	Myriochele sp. 1	POL	0.36	1.17	0.38	5.00	54.47
3	*Lacerna hosteensis*	COZ	0.92	1.97	1.73	5.91	5.91
	Glycera kerguelensis	POL	0.83	1.66	1.34	4.98	10.89
	Kymella polaris	COZ	0.67	1.44	1.24	4.34	15.23
	Aimulosia antarctica	COZ	0.75	1.37	0.97	4.13	19.36
	Micropora brevissima	COZ	0.83	1.34	1.32	4.03	23.39
4	*Glycera kerguelensis*	POL	0.63	1.81	0.54	13.01	13.01
	Errina fissurata	COR	0.75	1.36	0.82	9.82	22.83
	Nicon maculata	POL	0.38	1.10	0.66	7.91	30.75
	Ophiacantha vivipara	OPH	0.63	1.10	0.66	7.91	38.66
	Ophioceres incipiens	OPH	0.63	1.10	0.66	7.91	46.57
5	*Scoloplos marginatus mcleani*	POL	0.75	1.69	0.69	8.54	8.54
	Augeneria tentaculata	POL	0.75	1.01	0.92	5.07	13.60
	Ellisina antarctica	COZ	0.75	1.00	0.92	5.06	18.66
	Lacerna hosteensis	COZ	0.58	0.88	0.82	4.46	23.12
	Micropora brevissima	COZ	0.67	0.88	0.82	4.46	27.58
							Epifauna
1	*Psolus dubiosus*	HTH	0.67	1.35	1.30	5.26	5.26
	Phyllocomus crocea	POL	0.58	1.00	0.93	3.90	9.16
	Errina fissurata	COR	0.58	0.96	0.62	3.76	12.92
	Polynoe laevis	POL	0.42	0.92	0.50	3.58	16.50
	Nymphon australe sp.	PYC	0.33	0.78	0.43	3.03	19.53
2	*Ophiacantha antarctica*	OPH	0.75	1.65	0.85	7.16	7.16
	Harmothoe fuligineum	POL	0.50	0.83	0.77	10.75	10.75
	Synoicum adareanum	ASC	0.42	0.82	0.68	3.59	14.34
	Mogula gigantea	ASC	0.33	0.68	0.68	3.59	17.92
	Ophiacantha vivipara	OPH	0.50	0.82	0.42	3.57	21.49
3	*Abyssocucumis liouvillei*	HTH	0.82	1.10	1.10	9.71	9.71
	fam. Molpadiidae	HTH	0.55	1.18	0.71	5.89	15.60
	Bathylasma corolliforme	BRN	0.55	1.01	0.88	5.04	20.64
	Thouarella sp. 1	GOC	0.36	0.71	0.45	3.55	24.19
	Epimeria similis	APH	0.45	0.70	0.49	3.52	27.71
4	*Polynoe laevis*	POL	1.00	7.08	7.08	9.00	9.00
	Ophiacantha pentactis	OPH	1.00	2.94	7.08	9.00	18.00
	Errina fissurata	COR	0.88	1.82	1.32	5.56	23.56
	Ophiacantha vivipara	OPH	0.88	1.82	1.32	5.56	29.13

	Thouarella sp. 2	GOC	0.75	1.33	4.06	4.06	33.19
5	*Ophiacantha antarctica*	OPH	0.75	3.15	0.90	16.08	16.08
	Ophioceres incipiens	OPH	0.58	1.80	0.58	9.16	25.24
	Ctenocidaris geliberti	ECN	0.50	0.69	0.67	3.53	28.77
	Ophiacantha vivipara	OPH	0.58	0.68	0.61	3.45	32.22
	Errina fissurata	COR	0.42	0.65	0.29	3.30	35.52
							Mega-epifauna
1	*Tedania (Hemitedania) oxeata*	ONG	0.60	6.17	1.46	33.49	33.49
	Rossella villosa	ONG	0.40	2.27	0.50	12.33	45.82
	Diplasterias brucei	ASR	0.60	2.27	0.50	12.33	58.15
2	*Umbellula* sp. 1	PTU	0.40	3.03	0.58	19.97	19.97
	Thouarella sp. 1	GOC	0.60	2.47	0.58	16.27	36.24
	Psychoroteuthis glacialis	OCP	0.60	2.47	0.58	16.27	52.51
3	*Ammothea carolinesis*	PYC	0.73	2.17	1.12	7.64	7.64
	Thouarella sp. 1	GOC	0.64	1.95	0.89	6.85	14.48
	Colossendeis australis	PYC	0.73	1.84	0.99	6.48	20.96
	Homaxinella n. sp. 1	ONG	0.36	1.65	0.78	5.80	26.76
	Umbellula sp. 1	PTU	0.36	1.65	0.78	5.80	32.57
5	*Stomphia* sp.	ANT	0.63	1.36	0.47	11.46	11.46
	Pareledone sp. 4	OCP	0.38	1.36	0.38	11.43	22.89
	Colossendeis australis	PYC	0.50	1.36	0.38	11.43	34.32
	Thouarella sp. 1	GOC	0.50	1.10	0.38	9.23	43.56
	Chorismus antarcticus	NAT	0.63	1.08	0.78	9.08	52.64

Appendix 10: Northwestern Ross Sea shelf macroinvertebrate assemblages. Breakdown of average similarity within sample grouping depth stratum for each of three assemblage types into contributions from each species. Only the five species contributing most or species with AvDis/SD ≥1.3 are listed. Av. Abund.=average abundance – for presence/absence data equates to frequency of occurrence, Av. Sim.=average similarity (%), SD=standard deviation of average similarity, Contrib. %=contribution to similarity, Cum. %=cumulative similarity. Abbreviation for taxa as in Appendix 9.

Sample Grouping	Species	Taxa	Av. Abund.	Av. Sim.	Av. Sim/ SD	Contrib. %	Cum. %
							Infauna
50–250 m	*Lacerna hosteensis*	COZ	1.00	1.94	3.80	5.19	5.19
	Micropora brevissima	COZ	1.00	1.94	3.80	5.19	10.38
	Glycera kerguelensis	POL	0.87	1.53	1.46	4.09	14.47
	Achelia spicata	PYC	0.87	1.49	1.43	3.98	18.45
	Kymella polaris	COZ	0.87	1.49	1.43	3.98	22.44
250–500 m	*Glycera kerguelensis*	POL	0.85	5.56	0.65	30.23	30.23
	Scolelepis eltaninae	POL	0.20	1.33	0.30	7.24	37.46
	Lacerna hosteensis	COZ	0.65	0.91	0.70	4.97	42.43
	Microporella stenoporta	COZ	0.65	0.91	0.70	4.97	47.40
	Scoloplos marginatus mcleani	POL	0.45	0.66	0.57	3.58	50.98
500–750 m	*Celleporella calculosa*	COZ	0.61	1.43	0.55	7.25	7.25
	Myriochele sp. 1	POL	0.39	1.01	0.39	5.10	12.34
	Tracheloptyx antarctica	COZ	0.50	1.00	0.66	5.04	17.38
	Glycera kerguelensis	POL	0.56	0.82	0.55	4.17	21.55
	Micropora brevissima	COZ	0.56	0.80	0.61	4.06	25.62
							Epifauna
50–250 m	*Perkinsiana littoralis*	POL	0.88	1.55	1.60	5.38	5.38
	Ophiosteira echinulata	OPH	0.76	1.25	1.19	4.32	9.70
	Harmothoe fuligineum	POL	0.76	1.09	1.00	3.78	13.48
	Phyllocomus crocea	POL	0.71	1.08	0.95	3.74	17.22
	Ophiacantha antarctica	OPH	0.71	0.91	0.86	3.14	20.36
250–500 m	*Ophiacantha antarctica*	OPH	0.65	0.96	0.83	4.13	4.13
	Ophiacantha vivipara	OPH	0.65	0.91	0.77	3.91	8.04
	Thouarella sp. 1	GOC	0.55	0.72	0.55	3.08	11.12
	Mogula gigantea	ASC	0.35	0.71	0.64	3.06	11.12
	Synoicum	ASC	0.50	0.68	0.63	2.91	11.12

	adareanum						
500–750 m	*Ophiacantha antarctica*	OPH	0.67	2.79	0.80	15.50	15.50
	Errina fissurata	COR	0.50	1.26	0.54	7.02	15.50
	Ophioceres incipiens	OPH	0.33	1.00	0.37	5.57	15.50
	Polynoe laevis	POL	0.44	0.95	0.54	5.28	38.64
	Nymphon australe sp.	PYC	0.39	0.95	0.54	5.28	42.45
							Mega-epifauna
50–250 m	*Colossendeis australis*	PYC	0.63	2.13	1.28	8.43	8.43
	Ammothea carolinesis	PYC	0.50	2.13	1.28	8.43	16.86
	Psolus dubiosus	HTH	0.63	2.13	1.28	8.43	25.29
	Chorismus antarcticus	NAT	0.75	1.81	1.28	7.17	32.46
	Sterechinus neumayeri	ECN	0.63	1.28	0.83	5.08	37.54
250–500 m	*Thouarella* sp. 1	GOC	0.50	1.48	0.52	10.08	10.08
	Abyssocucumis sp. B	HTH	0.40	1.47	0.72	10.04	20.12
	Colossendeis australis	PYC	0.60	1.16	0.53	7.87	27.98
	Umbellula sp. 1	PTU	0.20	1.14	0.35	7.73	35.72
	Psychoroteuthis glacialis	OCT	0.20	0.93	0.35	6.30	42.02
500–750 m	*Thouarella* sp. 1	GOC	0.64	2.70	1.03	11.4	11.40
	Homaxinella n. sp. 1	ONG	0.64	2.06	0.94	8.70	20.10
	Umbellula sp. 1	PTU	0.36	2.06	0.94	8.70	28.80
	Tedania (Hemitedania) oxeata	ONG	0.55	2.06	0.55	8.68	37.48
	Colossendeis australis	PYC	0.55	1.18	0.40	4.99	42.47

Appendix 11: Northwestern Ross Sea shelf macroinvertebrate assemblages. Breakdown of average dissimilarity between sampling group transect for each of three assemblage types into contributions from each species. Only the five species contributing most or species with AvDis/SD ≥1.3 are listed. Av. Abund=average abundance – for presence/absence data equates to frequency of occurrence, Av. Diss.=average dissimilarity (%), SD=standard deviation of average dissimilarity, Contrib %=contribution to dissimilarity, Cum %=cumulative dissimilarity. Abbreviation for taxa as in Appendix 9.

Groups compared	Species	Taxa	*Group 1* Av. Abund.	*Group 2* Av. Abund.	Av. Diss.	Av. Diss./ SD	Con-trib. %	Cum. %
								Infauna
3, 2	*Lacerna hosteensis*	COZ	0.92	0.45	1.22	0.69	1.57	1.57
	Microporella stenoporta	COZ	0.75	0.45	1.12	0.85	1.45	3.02
	Smittina anecdota	COZ	0.50	0.18	1.09	0.80	1.40	4.42
	Osthimosia fusticula		0.42	0.00	1.07	0.78	1.38	5.79
	Celleporella dictyota	COZ	0.67	0.36	1.05	0.76	1.36	7.15
3, 4	*Tracheloptyx antarctica*	COZ	0.58	0.25	1.14	1.46	1.34	1.34
	Aimulosia antarctica	COZ	0.75	0.38	1.04	1.07	1.23	2.57
	Errina fissurata	COR	0.08	0.75	1.02	1.27	1.20	3.77
	Smittina anecdota		0.50	0.13	1.01	1.03	1.19	4.96
	Celleporella dictyota	COZ	0.67	0.00	0.99	0.97	1.16	6.12
3, 5	*Tracheloptyx antarctica*	COZ	0.58	0.50	0.95	0.76	1.18	1.18
	Aimulosia antarctica	COZ	0.75	0.25	0.95	0.76	1.18	2.36
	Celleporella dictyota	COZ	0.67	0.00	0.87	1.15	1.08	3.43
	Augeneria tentaculata	POL	0.17	0.75	0.86	1.01	1.07	4.50
	Scoloplos marginatus mcleani	POL	0.25	0.75	0.80	0.62	0.99	5.49
5, 2	*Scoloplos marginatus mcleani*	POL	0.75	0.09	1.80	1.00	2.06	2.06
	Myriochele sp. 1	POL	0.42	0.36	1.72	0.91	1.96	4.02
	Augeneria tentaculata	POL	0.75	0.00	1.34	0.98	1.53	5.55
	Micropora brevissima	COZ	0.67	0.55	1.24	0.66	1.42	6.97
	Ellisina antarctica	COZ	0.75	0.09	1.23	0.90	1.41	8.38
								Epifauna
1, 4	*Ophiacantha pentactis*	OPH	0.08	1.00	1.21	1.91	1.51	1.51
	Iphimediella georgei	APH	0.25	0.38	1.08	1.45	1.35	2.86
	Myoraster antarcticus	ASR	0.42	0.50	1.01	1.43	1.26	4.12
	Errina laterorifa	COR	0.08	0.63	1.00	1.26	1.25	5.37
	Astrochlamys bruneus	CRI	0.17	0.63	0.97	1.19	1.21	6.58
3, 1	*Abyssocucumis liouvillei*	HTH	0.82	0.17	1.14	1.14	1.40	1.40
	Thouarella sp. 1	GOC	0.45	0.42	1.01	0.97	1.24	2.64
	Polynoe laevis	POL	0.27	0.42	0.95	0.70	1.16	3.80
	Errina fissurata	COR	0.18	0.58	0.87	0.79	1.06	4.86
	Nymphon australe sp.	PYC	0.27	0.33	0.82	0.62	1.01	5.87
3, 4	*Ophiacantha pentactis*	OPH	0.09	1.00	1.52	1.62	1.77	1.77
	Polynoe laevis	POL	0.27	1.00	1.41	1.41	1.65	3.42
	Errina fissurata	COR	0.18	0.88	1.25	1.32	1.45	4.88
	Antarctinoe ferox	POL	0.09	0.75	1.19	1.29	1.39	6.27
	Errina laterorifa	COR	0.18	0.63	1.16	1.27	1.35	7.61
3, 5	*Ophiacantha antarctica*	OPH	0.55	0.75	1.36	0.76	1.55	1.55
	Abyssocucumis liouvillei	HTH	0.82	0.25	1.29	0.87	1.48	3.03
	Ophioceres incipiens	OPH	0.18	0.58	1.29	0.69	1.47	4.50
	Bathylasma corolliforme	BRN	0.36	0.25	1.15	0.70	1.32	5.82
	Errina fissurata	COR	0.18	0.42	1.15	0.66	1.32	7.13
4, 2	*Ophiacantha pentactis*	OPH	1.00	0.17	1.49	1.74	1.78	1.78
	Antarctinoe ferox	POL	0.75	0.17	1.31	1.37	1.57	3.35
	Nymphon australe sp.	PYC	0.50	0.25	1.30	1.29	1.56	4.91
	Errina fissurata	COR	0.88	0.08	1.26	1.40	1.50	6.41

	Astrochlamys bruneus	CRI	0.63	0.08	1.24	1.22	1.48	7.89
5, 1	*Ophioceres incipiens*	OPH	0.58	0.08	1.01	0.78	1.20	1.20
	Ophiacantha antarctica	OPH	0.75	0.58	1.01	0.76	1.20	2.39
	Nymphon australe sp.	PYC	0.17	0.33	0.95	0.69	1.12	3.51
	Errina fissurata	COR	0.42	0.58	0.91	0.78	1.08	4.59
	Thouarella sp. 1	GOC	0.42	0.42	0.91	0.81	1.07	5.66
5, 2	*Ophioceres incipiens*	OPH	0.58	0.17	1.40	0.69	1.70	1.70
	Ophiacantha antarctica	OPH	0.75	0.75	1.35	0.67	1.63	3.34
	Errina fissurata	COR	0.42	0.08	1.20	0.62	1.45	4.79
	Sterechinus neumayeri	ECN	0.50	0.50	1.17	0.70	1.42	6.21
	Ophiacantha vivipara	OPH	0.58	0.50	1.12	0.73	1.36	7.58
5, 4	*Ophiacantha pentactis*	OPH	0.25	1.00	1.33	1.41	1.60	1.60
	Polynoe laevis	POL	0.25	1.00	1.31	1.42	1.57	3.17
	Antarctinoe ferox	POL	0.42	0.75	1.25	1.31	1.49	4.66
	Thouarella sp. 2	GOC	0.08	0.75	1.23	1.28	1.47	6.13
	Nymphon australe sp.	PYC	0.17	0.50	1.17	1.19	1.41	7.54
							Mega-epifauna	
3, 1	*Thouarella* sp. 1	GOC	0.64	0.00	2.32	2.16	2.67	2.67
	Umbellula sp. 1	PTU	0.36	0.00	1.87	1.29	2.15	4.81
	Ammothea carolinesis	PYC	0.73	0.00	1.72	1.13	1.98	6.79
	Tedania (Hemitedania) oxeata	ONG	0.45	0.60	1.70	1.12	1.95	8.74
	Homaxinella balfourensis	ONG	0.00	0.60	1.68	1.15	1.93	10.67
3, 2	*Ctenocidaris gigantea*	ECN	0.45	0.20	1.60	1.32	1.83	14.40
	Abyssocucumis sp. B	HTH	0.36	0.20	1.87	1.39	2.22	2.22
	Sterechinus neumayeri	ECN	0.55	0.00	1.50	1.09	1.78	4.00
	Colossendeis australis	PYC	0.73	0.60	1.49	1.08	1.77	5.77
	Synoicum adareanum	ASC	0.64	0.20	1.48	1.07	1.76	7.53
3, 5	*Umbellula* sp. 1	PTU	0.36	0.40	1.47	1.08	1.75	9.28
	Ammothea carolinesis	PYC	0.73	0.00	1.68	1.28	1.98	1.98
	Stomphia sp.	ANT	0.27	0.63	1.30	0.99	1.53	3.50
	Colossendeis australis	PYC	0.73	0.50	1.26	0.95	1.49	4.99
	Ctenocidaris gigantea	ECN	0.45	0.38	1.20	0.85	1.41	6.41
5, 2	*Colossendeis notalis*	PYC	0.55	0.00	1.20	0.95	1.41	7.82
	Umbellula sp. 1	PTU	0.36	0.00	1.13	0.78	1.33	9.14
	Psychoroteuthis glacialis	OCT	0.00	0.60	2.26	0.64	2.42	2.42
	Acodontaster conspicuus	ASR	0.25	0.00	2.00	0.52	2.15	4.57
	Turridae sp.	GAS	0.13	0.00	1.87	0.48	2.00	6.58
	Thouarella sp. 1	GOC	0.50	0.60	1.86	0.51	2.00	8.58
	Pareledone sp. 4	OCT	0.38	0.20	1.74	0.49	1.87	10.44

Appendix 12. Northwestern Ross Sea shelf macroinvertebrate assemblages. Breakdown of average dissimilarity within sample grouping depth stratum for each of three assemblage types into contributions from each species. Only the five species contributing most or species with AvDis/SD ≥1.3 are listed. Av. Abund.=average abundance – for presence/absence data equates to frequency of occurrence, Av. Sim.=average similarity (%), SD=standard deviation of average similarity, Contrib. %=contribution to similarity, Cum. %=cumulative similarity. Abbreviation for taxa as in Appendix 9.

Groups compared	Species	Taxa	*Group 1* Av. Abund.	*Group 2* Av. Abund.	Av. Diss.	Av. Diss./ SD	Con-trib. %	Cum. %
								Infauna
500–750, 50–250	*Kymella polaris*	COZ	0.00	0.87	1.10	1.60	1.30	1.30
	Lacerna hosteensis	COZ	0.22	1.00	1.02	1.33	1.21	2.51
	Achelia spicata	PYC	0.06	0.87	1.02	1.38	1.21	3.72
	Myriochele sp. 1	POL	0.39	0.40	0.94	1.14	1.11	4.83
	Phyllocomus crocea	POL	0.06	0.73	0.94	1.19	1.11	5.94
	Austrodecus frigorifugum	PYC	0.17	0.87	0.92	1.32	1.08	8.12
	Harmothoe fuligineum	POL	0.06	0.73	0.91	1.39	1.08	9.20
								Epifauna
500–750, 250–500	*Ophiacantha antarctica*	OPH	0.67	0.65	1.16	0.97	1.33	1.33
	Colossendeis australis	PYC	0.11	0.55	1.16	0.78	1.32	2.65
	Thouarella sp. 1	GOC	0.33	0.55	1.16	0.77	1.32	3.97
	Nymphon australe sp.	PYC	0.39	0.35	1.04	1.09	1.19	5.16
	Ophiacantha vivipara	OPH	0.44	0.65	1.01	0.89	1.16	6.31
500–750, 50–250	*Perkinsiana littoralis*	POL	0.00	0.88	1.43	2.05	1.59	1.59
	Ophiosteira echinulata	OPH	0.06	0.76	1.21	1.31	1.35	2.93
	Harmothoe fuligineum	POL	0.11	0.76	1.11	1.45	1.23	4.16
	Phyllocomus crocea	POL	0.06	0.71	1.08	1.27	1.20	5.36
	Cucumaridae sp. C	HTH	0.11	0.65	1.02	1.08	1.13	6.49
250–500, 50–250	*Perkinsiana littoralis*	POL	0.20	0.88	0.85	1.47	1.05	1.05
	Diplasterias brucei	ASR	0.25	0.53	0.77	1.22	0.95	2.01
	Epimeria rimicarinata	APH	0.30	0.47	0.74	1.10	0.92	2.92
	Ophiosteira echinulata	OPH	0.30	0.76	0.70	0.92	0.86	3.79
	Synoicum adareanum	ASC	0.50	0.59	0.68	0.88	0.84	4.63
								Mega-epifauna
500–750, 250–500	*Ophiacantha antarctica*	OPH	0.67	0.65	1.16	0.97	1.33	1.33
	Colossendeis australis	PYC	0.11	0.55	1.16	0.78	1.32	2.65
	Thouarella sp. 1	GOC	0.33	0.55	1.16	0.77	1.32	3.97
	Nymphon australe sp.	PYC	0.39	0.35	1.04	1.09	1.19	5.16
	Ophiacantha vivipara	OPH	0.44	0.65	1.01	0.89	1.16	6.31
500–750, 50–250	*Perkinsiana littoralis*	POL	0.00	0.88	1.43	2.05	1.59	1.59
	Ophiosteira echinulata	OPH	0.06	0.76	1.21	1.31	1.35	2.93
	Harmothoe fuligineum	POL	0.11	0.76	1.11	1.45	1.23	4.16
	Phyllocomus crocea	POL	0.06	0.71	1.08	1.27	1.20	5.36
	Cucumaridae sp. C	HTH	0.11	0.65	1.02	1.08	1.13	6.49

Appendix 13: Fish species list for the northwestern Ross Sea shelf.

Species	Family	Order	Class
Rajidae – undiff. *	Chondrichthyes	Rajiformes	Rajidae
Bathyraja eatonii	Chondrichthyes	Rajiformes	Rajidae
Bathyraja maccaini	Chondrichthyes	Rajiformes	Rajidae
Bathyraja sp.	Chondrichthyes	Rajiformes	Rajidae
Notolepis coatsi	Osteichthyes	Aulopiformes	Paralepididae
Muraenolepididae – undiff. *	Osteichthyes	Gadiformes	Muraenolepididae
Muraenolepis sp 1	Osteichthyes	Gadiformes	Muraenolepididae
Muraenolepis sp 2	Osteichthyes	Gadiformes	Muraenolepididae
Lycodichthys dearborni	Osteichthyes	Perciformes	Zoarcidae
Pachycara brachycephalum	Osteichthyes	Perciformes	Zoarcidae
Zoarcid sp 1	Osteichthyes	Perciformes	Zoarcidae
Zoarcid sp 2	Osteichthyes	Perciformes	Zoarcidae
Macrourus whitsoni	Osteichthyes	Gadiformes	Macrouridae
Trematomus bernacchii	Osteichthyes	Perciformes	Nototheniidae
Trematomus hansonii	Osteichthyes	Perciformes	Nototheniidae
Trematomus lepidorhinus	Osteichthyes	Perciformes	Nototheniidae
Trematomus loennbergii	Osteichthyes	Perciformes	Nototheniidae
Trematomus newnesi	Osteichthyes	Perciformes	Nototheniidae
Trematomus nicolai	Osteichthyes	Perciformes	Nototheniidae
Trematomus pennellii	Osteichthyes	Perciformes	Nototheniidae
Trematomus scotti	Osteichthyes	Perciformes	Nototheniidae
Trematomus tokarevi	Osteichthyes	Perciformes	Nototheniidae
Pleuragramma antarcticum	Osteichthyes	Perciformes	Nototheniidae
Trematomus eulepidotus	Osteichthyes	Perciformes	Nototheniidae
Aethotaxis mitopteryx	Osteichthyes	Perciformes	Nototheniidae
*Dissostichus eleginoides**	Osteichthyes	Perciformes	Nototheniidae
Dissostichus mawsoni	Osteichthyes	Perciformes	Nototheniidae
Notothenia coriiceps	Osteichthyes	Perciformes	Nototheniidae
Lepidontothen kempi	Osteichthyes	Perciformes	Nototheniidae
Artedidraco loennbergi	Osteichthyes	Perciformes	Artedidraconidae
Artedidraco orianae	Osteichthyes	Perciformes	Artedidraconidae
Artedidraco shackletoni	Osteichthyes	Perciformes	Artedidraconidae
Artedidraco skottsbergi	Osteichthyes	Perciformes	Artedidraconidae
Pogonophryne marmorata	Osteichthyes	Perciformes	Artedidraconidae
Pogonophryne scotti	Osteichthyes	Perciformes	Artedidraconidae
Bathydraco marri	Osteichthyes	Perciformes	Bathydraconidae
Cygnodraco mawsoni	Osteichthyes	Perciformes	Bathydraconidae
Gymnodraco acuticeps	Osteichthyes	Perciformes	Bathydraconidae
Prionodraco evansii	Osteichthyes	Perciformes	Bathydraconidae
Racovitzia glacialis	Osteichthyes	Perciformes	Bathydraconidae
Pagetopsis macropterus	Osteichthyes	Perciformes	Channichthyidae
Chinodraco antarcticus	Osteichthyes	Perciformes	Channichthyidae
Chinodraco hamatus	Osteichthyes	Perciformes	Channichthyidae
Chinodraco myersi	Osteichthyes	Perciformes	Channichthyidae
Neopagetopsis ionah	Osteichthyes	Perciformes	Channichthyidae

***Fish species not used in analyses.**