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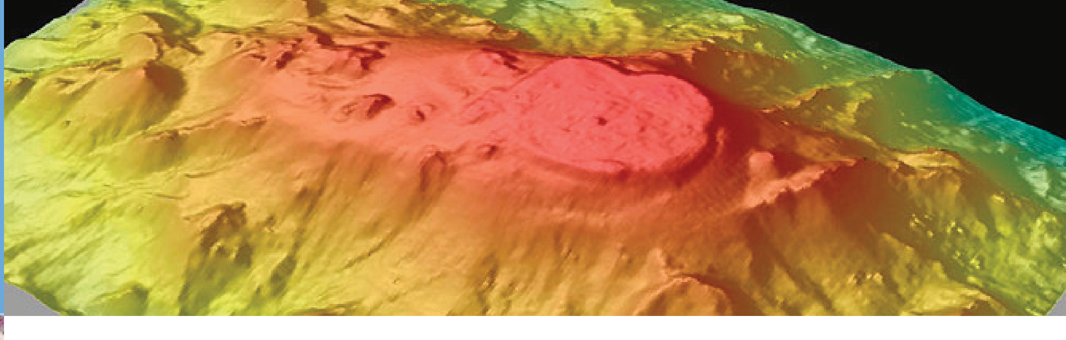

Fish and invertebrate biodiversity on the Norfolk Ridge and Lord Howe Rise, Tasman Sea (NORFANZ voyage, 2003)

Malcolm R. Clark
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Explore lost worlds of the deep
NORFANZ VOYAGE
10 MAY TO 8 JUNE 2003

Ministry of Fisheries
Te Tautiaki i nga tini a Tangaroa

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EXECUTIVE SUMMARY

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A survey of biodiversity of fishes and benthic invertebrates was carried out on the Lord Howe Rise and Norfolk Ridge in May-June 2003. The principal objectives of the "NORFANZ" programme were to survey, sample, and document the marine biodiversity from seamounts and slopes on the Norfolk Ridge and Lord Howe Rise, to support biosystematic research projects, to assess faunal uniqueness and conservation values, and to relate observed distribution patterns with measured biological and physical parameters.

Fourteen seamount and slope sites were sampled, 10 on the Norfolk Ridge, and 4 on the Lord Howe Rise. A total of 168 stations was completed, consisting of 144 trawl-sled-dredge shots, 15 casts to measure oceanographic conditions, and 9 camera drops to photograph fauna on the seafloor. Trawl depths ranged from less than 100 m to over 2000 m. A mixture of gear was used, including bottom trawls, a midwater trawl, beam trawl, epibenthic sleds, and rock and pipe dredges.

In total, 590 fish species, and 1305 macro-invertebrate species, were provisionally identified onboard. This is regarded as a minimum estimate of biodiversity present, as sampling intensity on individual seamounts was not sufficient to measure the complete faunal composition. Post-voyage identification of invertebrate species numbers have risen to over 1600 and further increases are envisaged as the collections of samples are researched more thoroughly. It may take researchers around the world several years to fully examine the material, especially the invertebrates, and describe the unknown species. About 12% of the invertebrates identified since the survey are confirmed as being new species, and as many as 20% of the fish species are likely to be either new species, or new records for the region.

The main invertebrate phyla caught were malacostracan Crustacea (e.g., crabs, shrimps, squat lobsters) (405 "species"), sponges (368 "species"), echinoderms (299 "species") and corals and anemones (232 "species"). Diversity varied between sites, and these differences were due to a combination of depth, and geographical location. With fishes, the orders Perciformes (88 "species") and Gadiformes (84 "species") dominated the species diversity. Depth was again a major factor in determining species similarity between sites, and there were indications of a latitudinal effect, where the northern sections of the Norfolk Ridge and Lord Howe Rise differed from the southern parts of the Ridge and the Lord Howe Plateau. These differences are attributable in part to the pattern of water mass distribution in the northern Tasman Sea. Distribution patterns of fishes are described in detail, with four main types identified: widespread, southern, Norfolk Ridge, and restricted to between one and three sites. Fish species with a southern distribution were very common and were mainly deepwater species that share affinities with the New Zealand fauna. Many other fish and invertebrate species were recorded from only one or two stations, but sampling intensity was too low to draw confident conclusions about levels of endemism.

There is still a lot more work required to update species identifications and more fully describe the biodiversity. However, data and results of analyses carried out to date from the NORFANZ survey have already been used to help assess the conservation value of the Norfolk Island seamount area in the context of developing an Australian system of Marine Protected Areas.

1. INTRODUCTION

1.1 Overview

The Norfolk Ridge forms a prominent bathymetric feature connecting New Zealand and New Caledonia at depths of 1000–1200 m (Figure 1). A considerable area of relatively shallow seabed, comprising chains of seamounts and plateaus rising from 3500 m to depths of 200–1200 m, provides large areas of accessible and diverse habitats (Richer de Forges 1990). The ridge was once part of the coastline of Gondwana, so most of it has existed in one form or another for over 80 million years (Stevens 1980, Eade 1988). Before the Miocene, when the ridge subsided by over 400 m, most seamounts were emergent and New Zealand and New Caledonia were contiguous at 1000 m depth or less (Stevens 1980, Roberts 1993).

The marine fauna of the Norfolk Ridge and Lord Howe Rise is not well known. Samples were taken during fisheries surveys of the Wanganella Bank, on the southern Norfolk Ridge, by FV *Wanaka* in 1986 (Clark 1988) and by the Japan Fishery Agency vessel *Fukuyoshi Maru No. 26* in 1989 (Yano 1991). More extensive exploratory work was carried out in the northern part of the Norfolk Ridge and Lord Howe Rise by ORSTOM (now IRD) Nouméa in a series of research cruises to 800 m depth targeting both fishes and invertebrates (e.g., Richer de Forges 1990, Grandperrin & Lehodey 1992, Lehodey et al. 1993). In 1996, the NIWA vessel RV *Tangaroa* was chartered by the New Caledonian ZoNéCo Programme to survey seamounts and adjacent areas down to 1800 m in the southern Exclusive Economic Zone (EEZ) (Grandperrin et al. 1997a, 1997b). Deepwater fishes from the Australian EEZ, centred on Norfolk Island and Lord Howe Island, remain largely unexplored except for unresearched collections made by the Japan Fishery Agency vessel *Kaiyo Maru* in 1976 (Japan Fishery Agency 1976, 1977), and occasional exploratory ventures by small Australian and New Zealand vessels.

The invertebrate biodiversity data available suggests that in some localities the Norfolk Ridge and Lord Howe Rise support marine seamount and slope communities that are particularly rich and diverse, some characterised by high levels of endemism, and some with genera and species that are new to science (e.g., Grandperrin & Lehodey 1992, Lehodey et al. 1993, Séret 1997, Richer de Forges et al. 2000). Richer de Forges et al. (2000) recorded strong differences in the species composition of seamounts on the Lord Howe Rise (four seamounts sampled) and Norfolk Ridge (six seamounts). Some of these are ancient or relict taxa, such as the stalked crinoid *Gymnocrinus richeri* thought to be extinct 140 MYBP; several species of silicious sponges; and gastropods *Perotrochus* spp. (Grandperrin et al. 1997a). Elements of the benthic invertebrate fauna are thought to be similar to that which originally inhabited the margin of Gondwana (Richer de Forges 1990). Some of these benthic communities are dominated by long-lived species, such as some macro-corals and habitat-forming sponges living for 100s of years (Grandperrin et al. 1997b, Richer de Forges 1990).

Distribution patterns of fishes are generally poorly known, but in a few areas that have been well sampled (e.g., southern New Caledonian EEZ) some rare and endemic species appear confined to individual seamounts (e.g., Eucla cod *Euclichthys polynemus* and the morid cod *Tripterophycis svetovidovi*, Paulin & Roberts 1997). Differences in faunal composition, dominant benthos and substratum have been observed between adjacent seamounts in this area (Richer de Forges 1990, Lehodey et al. 1993), but in general faunal variability is not well documented or understood (Roberts & Paulin 1997a). Biogeographic analysis of the macrourid fish fauna of the New Caledonian region showed close relationships with New Zealand, New South Wales, and Western Australia, but 30% of the species were new to science despite some being common (Merrett & Iwamoto 2000). It is believed that at least 20 deepwater fish species are endemic to the Norfolk Ridge and adjacent areas around New Zealand and New Caledonia. These include the catshark *Gollum attenuatus*, yellowhead conger *Myroconger prolixus*, rattail *Caelorinchus cylindricus*, and giant sawbelly *Hoplostethus* sp. nov. (Roberts 1993). Comparison of the fish fauna between New Zealand and New Caledonia shows that over 240 species are common to both regions, of which 22% are deepwater, demersal, or benthic. Some occur seasonally on northern seamounts (e.g., bluenose (*Hyperoglyphe Antarctica*), golden snapper (*Centroberyx affinis*)), indicating that the Norfolk Ridge acts like a "biological highway" connecting New Zealand and New Caledonia (Roberts 1993). The sandfish, *Gonorynchus forsteri*, appears to migrate from New Zealand along the Norfolk Ridge to spawn in New Caledonian waters (Roberts & Grande 1999).

Research in Australia and New Zealand has found distinct assemblages of demersal fishes at upper (500 m) and mid-slope depths (800–1200 m) each with distinct depth related sub-communities (Koslow et al. 1994, Francis et al. 2002). The dominant mid-slope fish fauna was thought to comprise an identifiable community within a biogeographic province that extends at least from the Great Australian Bight to the Chatham Rise, a distance of 5000 km (Koslow et al. 1994). However, for deep sea fauna (including non-commercial or bycatch species of both fishes and invertebrates), knowledge is more limited, and it is uncertain whether discrete communities exist across the plateaux, ridges, and seamounts of the Tasman Sea between Australia and New Zealand.

Commercial fishing interest and activity on these seamounts is increasing (e.g., Grandperrin et al. 1997b), and especially on the West Norfolk Ridge there has been a rapid expansion of effort for orange roughy since 2002 (Clark 2004). There is increasing concern about the impact of this exploitation (as well as mineral exploration) on the deep-sea environment, particularly because the rate of exploitation is often faster than the development of biological knowledge to guide sustainable management. This is particularly true in deep-sea fisheries, which have expanded rapidly in the last 25 years. In some cases these have caused rapid depletion of target species and destruction of associated faunas and their habitats, particularly on seamounts (Koslow et al 2001, Clark & O'Driscoll 2003, Lack et al. 2003). It is recognised that there is an increasing need for the conservation and management of deep-sea biodiversity at both national and international levels, and associated research to provide accurate biodiversity data on which to base effective management strategies (Probert 1999, Gislason et al. 2000).

Over the last decade in fisheries science there has been a shift in emphasis from target commercial species to a broad and more comprehensive approach to deep-sea biodiversity research in Australasia (e.g., the New Zealand Biodiversity Strategy 2000, the Australian Oceans Policy 1998, and fisheries legislation embodying the "ecosystem approach"). From this scientific interest, combined with an increasing recognition by Australia and New Zealand of the advantages of international cooperation to evaluate common resources in the Tasman Sea region, came the idea of the "NORFANZ" project. This was an ambitious plan to survey the fauna of areas in the northern Tasman Sea, and provide baseline biodiversity data for diverse habitats along the Norfolk Ridge and Lord Howe Rise.

In this report we describe the operation of the survey, and present results of general analyses on fish and invertebrate biodiversity. This report expands the initial voyage report (Clark et al. 2003) and preliminary results on fish biodiversity (Roberts & Clark 2004), and complements a more detailed account by Williams et al. (2006a).

1.2 Objectives

There were several layers of objectives within the programme, from an overarching "overall objective" through several general programme objectives, to the survey objectives which detailed specific tasks and data sets to be collected.

The overall objective was:
"To describe the marine biodiversity of selected Norfolk Ridge and Lord Howe Rise seamount communities."

There were four programme objectives:

1) To survey, sample and document the marine biodiversity and environmental data from seamounts on the Norfolk Ridge and Lord Howe Rise to a depth of at least 1000 m depth.
2) To preserve samples of fishes and invertebrates and hold these in accessible curated museum collections to support biosystematic research projects.
3) To provide specimens to support projects which research the identity, diversity, relationships, distributions, and assess uniqueness and conservation value of the marine life.
4) To correlate observed distribution patterns, especially areas of high diversity and areas of endemism, with measured biological and physical parameters.

The technical survey objectives (nine of them) are listed in the voyage report (Clark et al. 2003) (Appendix 1).

The results of the survey that relate to objectives 1 and 4 are the main subjects of this report, with less detailed reference to objectives 2 and 3.

2. METHODS

2.1 Survey area

The survey covered seamount and slope sites along the Reinga Ridge near New Zealand, Norfolk Ridge, and Lord Howe Rise (Figure 1).

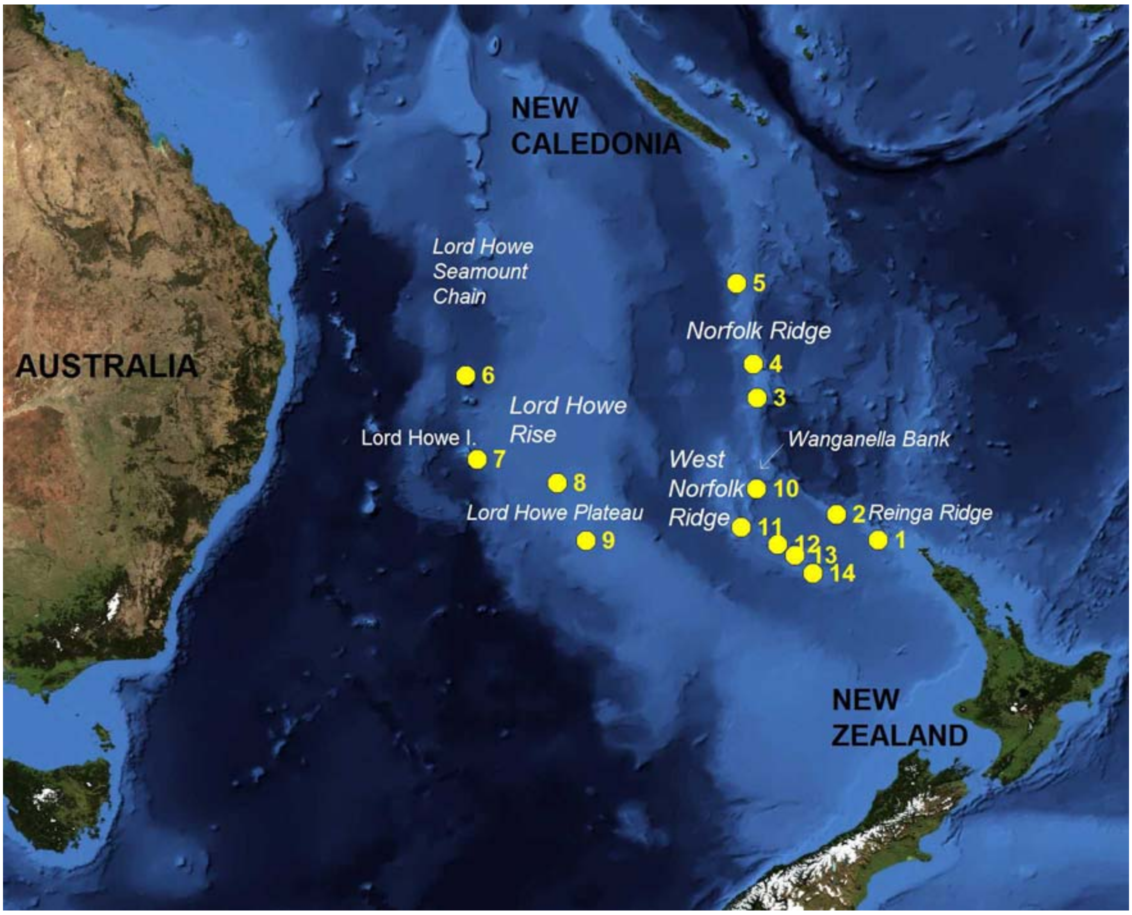


Figure 1: The northern Tasman Sea, showing the NORFANZ survey area and location of sampling sites.

2.2 Sampling gear

Sampling for fishes and invertebrates was carried out operating a range of sampling tools, including three kinds of bottom trawl, a midwater trawl, two types of epibenthic sleds, a rock dredge, and a pipe dredge. A greater number of gear types were operated than is usual in fisheries surveys, because the main focus was to sample biodiversity, not commercial species. This sacrificed the accurate replication of sampling effort between stations, but maximised the number and range of species sizes and types captured.

Orange roughy type rough bottom trawl ("ORH trawl")

This commercial-style net has a proven record in New Zealand on rough bottom, including seamounts. Parameters and specifications include: 5 to 8 m headline height; 24–26 m wingspread; cut away lower wings; 12 inch mesh in fore part of the trawl; 60 mm (full inside mesh) codend; heavy duty 600 mm high ground gear, comprising steel and rubber bobbins; 50 m sweeps and 50 m bridles. Small cone nets were attached to the upper bridles of the trawl to sample small animals. Speed of towing was about 3 knots. Previous biodiversity sampling with this trawl has shown it is very selective for the larger mobile fauna, missing some of the benthic and smaller species that get swept over by the bobbin rig and under the wings (which do not have lower panels).

Full wing bottom trawl ("Ratcatcher")

This small mesh wing trawl was originally designed for sampling juvenile orange roughy. It is primarily a soft flat bottom trawl, which is easily damaged on rough terrain. It has full wings, and a finer mesh structure than the ORH trawl, and in general will catch a lot more small-bodied species. Parameters and specifications include: full wing trawl with about 25 m of wingspread; 4–6 m headline height; 6 inch mesh in wings; light rubber ground rope 200 mm high; 40 mm (full inside mesh) codends; 50 m sweeps and 50 m bridles. Speed of towing was about 3 knots.

Beam trawl

This is a traditional beam trawl, based on the North Sea *Le Drezen* design and used extensively in deep-sea biodiversity surveys in New Caledonian waters. It comprised a wooden beam 430 cm long and about 20 cm in diameter, with two 15 cm wide metal skids at each end giving a 400 cm opening. To this is attached a 4.8 m long net with 12 cm mesh ending with a 3 m codend of 5 cm mesh, protected by a rough bottom sheet. Nets and skids were supplied by IRD Nouméa. It is operated with one winch and tow warp connected to a sacrificial wire (which takes most of the wear against the seafloor). Speed of towing was about 2 knots.

"Sherman" sled

Sherman is a heavily-built epibenthic sled (supplied by CSIRO Marine, Hobart) used successfully on rough ground and seamounts around Australia. It weighs 1.4 tonne, and has dimensions of width 1.9 m, length 2.2 m, and height 0.8 m. It is operated with one winch and tow warp connected to a sacrificial wire; and has a breakaway system to ensure recovery if the sled comes fast on the seafloor. Speed of towing was about 2 knots.

Details and photographs of these, and other types of gear used during NORFANZ, were given by Clark et al. (2003) (see Appendix 5).

2.3 Survey design

2.3.1 Depth strata

Seamount and slope sites were sampled in three main depth strata: 0–500 m; 500–1000 m; and 1000–1500 m

At least two stations (one demersal, one benthic, see descriptions below) were completed at each depth stratum. Exploratory sampling at greater depths (to 2000 m) was carried out on five occasions, where time and conditions allowed.

2.3.2 Sampling methods

The main sampling method was the demersal ORH trawl which was used consistently on all seamounts, with three trawls per seamount (where the depth range was appropriate). This enables some comparison both within and between seamounts. The second method employed one or more of a number of gear types designed to sample the smaller fishes and invertebrate benthic fauna. This included the epibenthic sled, full wing trawl, and beam trawl. The gear used varied between shots and with bottom type, as it was intended to increase the range of biodiversity sampled rather than provide comparative data between sites.

At each seamount, we applied a similar survey sequence.

1) At depths of 1000–1200 m, an SVP-CTD drop was completed. This was important for the accuracy of the multibeam data, and also gave data on water mass characteristics.
2) A multibeam survey of bathymetry of the seamount was carried out in the areas to be sampled. Multibeam information was also used to identify trawlable ground, and to direct sampling where possible to span soft and hard bottom (heavy and light reflectivity). On several occasions, almost the entire feature was surveyed.
3) The trawling/sled sequence depended upon the nature of the bottom, and trawl gear rigged at the time. Initial station location was determined by a random direction from the peak of the seamount, and targeting depths of 250 m, 750 m, and 1200 m, towards the middle of the three depth strata boundaries. Tow duration times depended upon the bottom, but where possible ORH trawl and wing trawl duration was 30–60 minutes, and Sherman/NIWA sled/ beam trawl duration was 15–30 minutes.
4) Fish trawl and benthic sampling methods were generally carried out close together. On several occasions, ORH trawl, wing trawl, and beam trawl tows were completed alongside each other to enable some comparison in the selectivity of each gear type. Where more than two tows were possible in each stratum, a combination of gear types was used to sample the range of biodiversity.
5) A vertical camera drop was carried out on the summit of most seamounts.

2.3.3 Photographic transects

A camera system mounted on the headline of the trawl net (the CSIRO PhotoSea system) was used on a number of trawl shots (until the frame was badly damaged during a tow where much of one net was lost). The self-contained system took 35 mm slides at short pre-determined intervals as the net moved along the seabed. In addition, specific photographic transects were carried out on most seamounts. The NIWA Benthos camera system (and later the PhotoSea camera) was mounted in a rigid protective frame, and towed slowly at a height of 2–3 m above the bottom, and activated with the use of a bottom weight trigger or at regular intervals.

2.3.4 Biological sampling

The catch from each tow was sorted by species, identified, and weighed on motion-compensating scales where possible (regularly for fishes, estimated weight for small invertebrates). More detailed measurements (e.g., individual weight, length) were made on some commercial species (orange roughy, warty oreo (*Allocyttus verrucosus*), southern boarfish (*Pseudopentaceros richardsoni*), bluenose). Much of the catch was retained (most fixed onboard, some frozen) for more detailed taxonomic work onshore. Preservation for most fishes and squids was in 10% formalin (some very large specimens and a selection of small specimens were frozen). Most invertebrates were preserved in 70% ethanol (EtOH). Individual specimens or samples were identified to the lowest possible taxon and registered (separately for each museum collection). Many rare and new species were encountered, and identification to species level was not always possible. These “problematic” specimens were allocated OTU (operational taxonomic unit) names for labels and database recording and tracking. The order of reliability of identification of each species/OTU was provided by using a five level classification system in standard use in Australian fish collections (Williams et al. 1996). It considers the taxonomic experience of the identifier, their knowledge of the group, and the amount of effort in making the identification.

2.3.5 Digital photography

At least one voucher specimen (but often two or more: male, female, juvenile) for each species/OTU was prepared (e.g., fishes had fins pinned out and painted with formalin) for photography (head facing left, Kodak colour chart and grey scale, station number, registration number). Digital photographs were taken of each species of fish and invertebrate captured, showing fresh colour and form before preservation. These photographs, with associated station data, were printed onboard to compile a working guide to the fish and macro-invertebrate fauna to ensure consistent identification and naming of specimens.

2.3.6 Database recording

Station data were recorded for each trawl, photographic, or sled shot. Catch information was compiled on specially designed NORFANZ forms for entry into a central database. Datasets describing physical and environmental details, catches, specimens, tissue samples, and photographs were maintained. Australian CAAB codes were used to describe the specimens.

2.3.7 Genetic sampling

Tissue samples and whole specimens were collected and preserved from a variety of fish and invertebrate species. Specimens were dissected and tissues stored in 90% ethanol. Tissue samples were coded to cross-reference with the original specimens, which were routinely preserved in formalin for fishes (some whole specimens were frozen) or 70% ethanol for invertebrates.

2.3.8 Bathymetry

The study sites were generally surveyed first with the EM 300 multibeam swath system. This provided detailed and highly accurate bathymetric data for each seamount, as well as information on how hard the bottom was. Depth and positional data were also logged using “Seaplot” navigational software. An SVP (sound-velocity profile) and CTD (conductivity-temperature-depth) cast was made in the vicinity of each seamount. A hull-mounted Acoustic Doppler Current-Profiler (ADCP) was also run continuously during the survey.

2.3.9 Faunal community analyses

Sites were grouped for some analyses based on their geographical distribution. This involved a combination of sites into “Area” and then “Area” into larger “Regions” (Table 1).

Table 1: Abbreviations of NORFANZ regions, areas and sites sampled.

Abbr.	Location	Areas	Sites
Regions			
NAT	NORFANZ Area Total	All	1-14
NNA	Northern NORFANZ Area	NNR+LHI	3,4,5,6,7
SNA	Southern NORFANZ Area	SNR+WNR+LHP	1,2,8,9,10,11,12,13,14
NRT	Norfolk Ridge Total Area	WNR+WNR+NNR	1,2,3,4,5,10,11,12,13,14
LHR	Lord Howe Rise Total Area	LHP+LHI	6,7,8,9
Areas			
WNR	Western Norfolk Ridge	WNR	10,11,12,13,14
SNR	Southern Norfolk Ridge	SNR	1,2
NNR	Northern Norfolk Ridge	NNR	3,4,5
LHI/LHR	Lord Howe Island Area	LHI/LHR	6,7
LHP	Lord Howe Plateau	LHP	8,9

Several analyses presented in this report have been provided by CSIRO, and are essentially repeated from Williams et al. (2006a) who analysed multispecies distribution patterns using ”Cluster” and “MDS” procedures in the PRIMER software package (Clarke & Gorley 2001). Classification (hierarchical agglomerative and unweighted arithmetic average clustering) and ordination (non-metric multidimensional scaling) were based on the non-metric Bray-Curtis 'percent difference' measure. For fishes, numerical abundance data were standardised to a 1 hour trawl at 3 knots speed and transformed before analysis using a double square root, while invertebrates were measured only as being present or absent (due to the difficulty of consistently weighing or counting taxa). Data reduction was necessary to eliminate some gear types, poor samples, and pelagic taxa from particular analyses.

Results were examined in relation to depth strata (a: < 500 m, b: 500–1000 m, c: > 1000 m), and in relation to *a priori* groupings by geographically defined ridges (similar to those in Table 1).

3 RESULTS

3.1 Description of sites and habitats

A total of 14 seamount/ridge sites was sampled (Figure 1). Five sites occur on the Norfolk Ridge (1, 2 on Reinga Ridge; 3, 4, 5 on northern Norfolk Ridge); five sites on the West Norfolk Ridge (10, 11, 12, 13, 14); and four sites on the Lord Howe Rise/Lord Howe Seamount Chain (6, 7, 8, 9). In addition, a further nine deep biological stations were carried out between these sites, using the bottom wing trawl (five stations to 2000 m) and a midwater pelagic trawl (four stations to 2000 m).

A brief description of each site, complemented with multibeam maps showing sampling locations, is given below and in Figure 2. A range of seafloor types observed during camera drops on these sites is given in Figure 3.

Site 1: Southwestern side of the Reinga Ridge (Figure 2a). Stations 1–9.
This site included sections of continental shelf and slope. There was undulating bottom between 300 and 500 m, with relatively smooth and firm sediment. Below 800 m depth the slope became steep and irregular, being pitted and scoured with transverse ridges. The deeper seafloor was hard.

Site 2: Western Reinga Ridge (Figure 2b). Stations 124–136
The seafloor at this site was complex and rugged. The upper slope area comprised a flat-topped rocky plateau, broken up by numerous valley-like systems with steep cliffs on the edge up to 100 m high. The lower area from depths of 700 m to 1000 m was rough and hard. Trawling was carried out on the top of one of the platforms, and in gullies down the flanks (see also Table 2).

Site 3: Southern Norfolk Ridge (Figure 2c). Stations 11–22.
This site was part of an irregular seamount feature south of Norfolk Island. It consisted of a plateau at 850 m, separated by depths of 1500 m from the elevated Norfolk Island Plateau at about 350 m. The southwestern part of the site was hard and rugged (fish trawls could not be done), becoming smoother in northeastern slope areas (although still hard and rocky, and several shots came fast – see Table 2).

Site 4: Northern Norfolk Ridge (Figure 2d). Stations 24–36.
This site was at the northern end of the Norfolk Island Plateau. It comprised a larger seamount in the southeast with two peaks at 100–200 m, and a ridge-like feature to the northwest which had a small peak at 600 m rising steeply from 1000 m. Shallower strata at the site occurred further north. The seamounts were hard and several of the fish trawls came fast (Table 2).

Site 5: Northern Norfolk Ridge (Figure 2e). Stations 37–44
This was a region of small conical volcanic peaks arising from 700–900 m base to summit depths of 500–360 m. A number of these had caldera features which made the seamounts difficult to trawl, and most tows (see Table 2) were completed on the hard, but smooth, slope between the cones.

Site 6: Lord Howe Rise, north of Middleton Reef (Figure 2f). Stations 48–59.
This was a single, relatively large and very rugged seamount. It is flat-topped at 280–290 m, with steep sides. The seafloor was hard, and irregular making it difficult to sample. Sleds worked, but most fish trawls performed poorly (Table 2).

Site 7: Lord Howe Island and Ball’s Pyramid area (Figure 2g). Stations 60–70.
Lord Howe Island Island and Ball’s Pyramid are surrounded by a relatively broad platform at 50–100 m depth. This shelf area was flat, but comprised hard coral and rubble bottom. The slope was steep down to 600 m, but then more gradual out to beyond 1500 m. The flanks to the south were

rough, but smoother to the west and east. Several stations were close to, but outside, the Conservation Area.

Site 8: Northern Lord Howe Plateau (Figure 2h). Stations 73–80.
This was a region of gradual slope on the western side of the Lord Howe Rise. The bottom was smooth and relatively soft (enabling wing and beam trawls, Table 2).

Site 9: Southern Lord Howe Plateau (Figure 2i). Stations 81–92.
This was an elevated rise, with numerous small volcanic peaks. These arose from a base of about 800 m to summit depths of 500–600 m. A number of the seamounts were small, and steep, with hard calderas. Two were able to be trawled, and the seafloor between the seamounts was smooth.

Site 10: West Norfolk Ridge, Wanganella Bank (Figure 2j). Stations 105–123.
The eastern arm of the Wanganella bank is large and elongate, with its summit at depths about 120 m. The top of the bank is smooth, but moderately hard. In the northern area of the site the bottom was rough and irregular. Most tows occurred in a broad band of good slope trending eastwards to depths of 1400 m (Table 2).

Site 11: West Norfolk Ridge (Figure 2k). Stations 93–104.
This site is a broad rise on the central part of the West Norfolk Ridge, with a flat plateau on the top of the seamount at 250 m. The western slopes are rough and steep, with patchy areas of trawlable bottom. The central area has scattered small knolls and hills. The eastern slopes are steep down to 1300 m, after which the bottom is relatively smooth and soft.

Site 12: West Norfolk Ridge (Figure 2l). Stations 137–147.
This site is on an elevated ridge feature with an elongated rocky plateau at 370 m. The summit area is flat, but hard with rough patches. There is a steep escarpment on the western side which drops rapidly to 1200 m, but slopes are more gradual to the east where there was good bottom at depths between 800 m and 1100 m.

Site 13: West Norfolk Ridge (Figure 2m). Stations 148–156.
This site is on an elongated ridge top, with a summit plateau at 530–540 m. The plateau has steep escarpments to the north (250 m high) and south (1000 m high). The seafloor is generally hard on the fractured and irregular slopes, but softer sediment occurred in the broad valley, where trawling was successful (Table 2).

Site 14: West Norfolk Ridge (Figure 2n). Stations 157–166.
This was a large rounded seamount with a broad top at 750 m. The top of the rise was hard, but the western flank was trawlable over firm sandy rippled bottom between 800 and 1000 m. The northern flank was broken and irregular at depths above 1200 m.

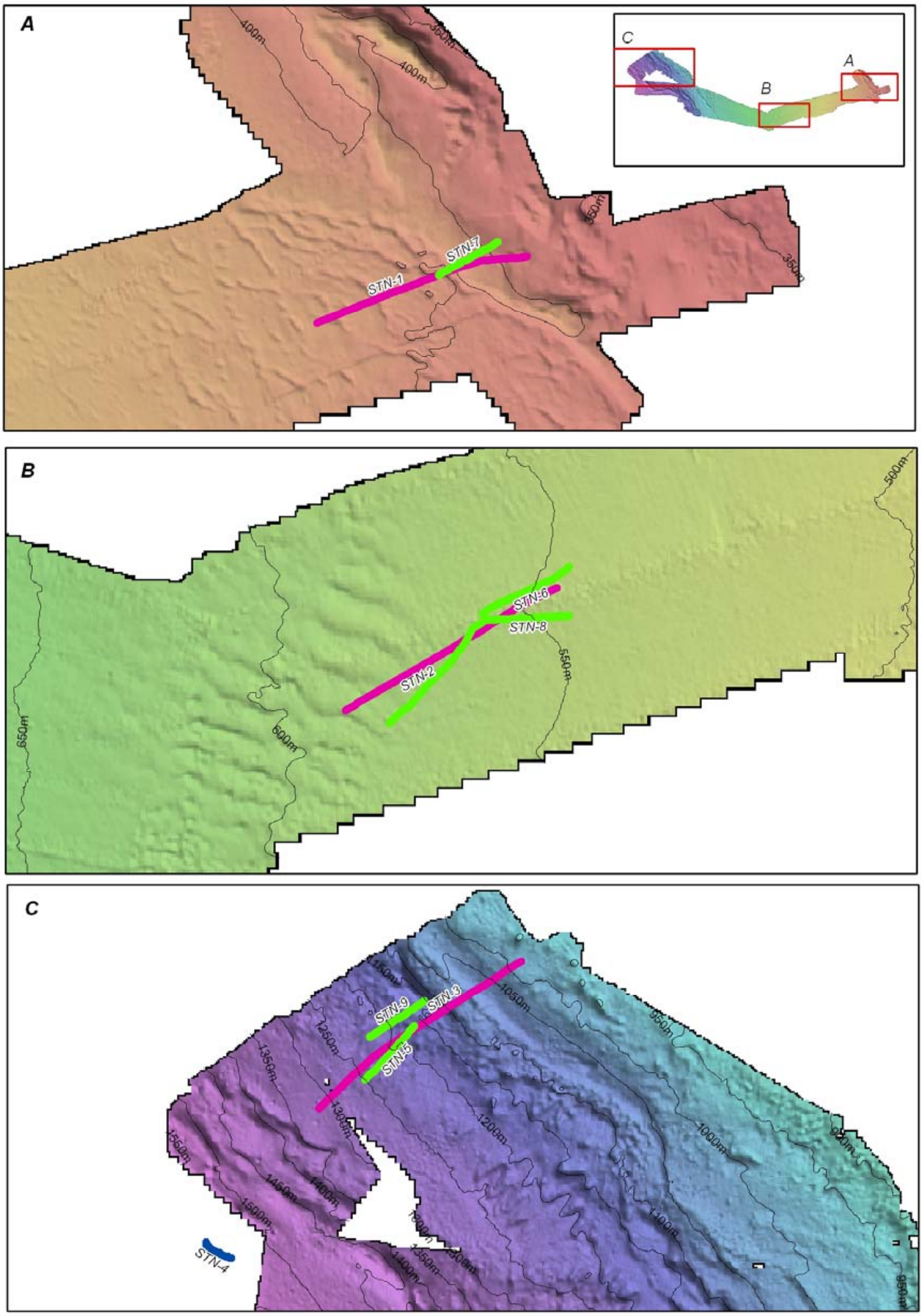


Figure 2a: Site 1, SW Reinga Ridge, multibeam bathymetry, showing station tracks and sampling locations (purple, ORH trawl; light green, Sherman sled; dark blue, CTD cast).

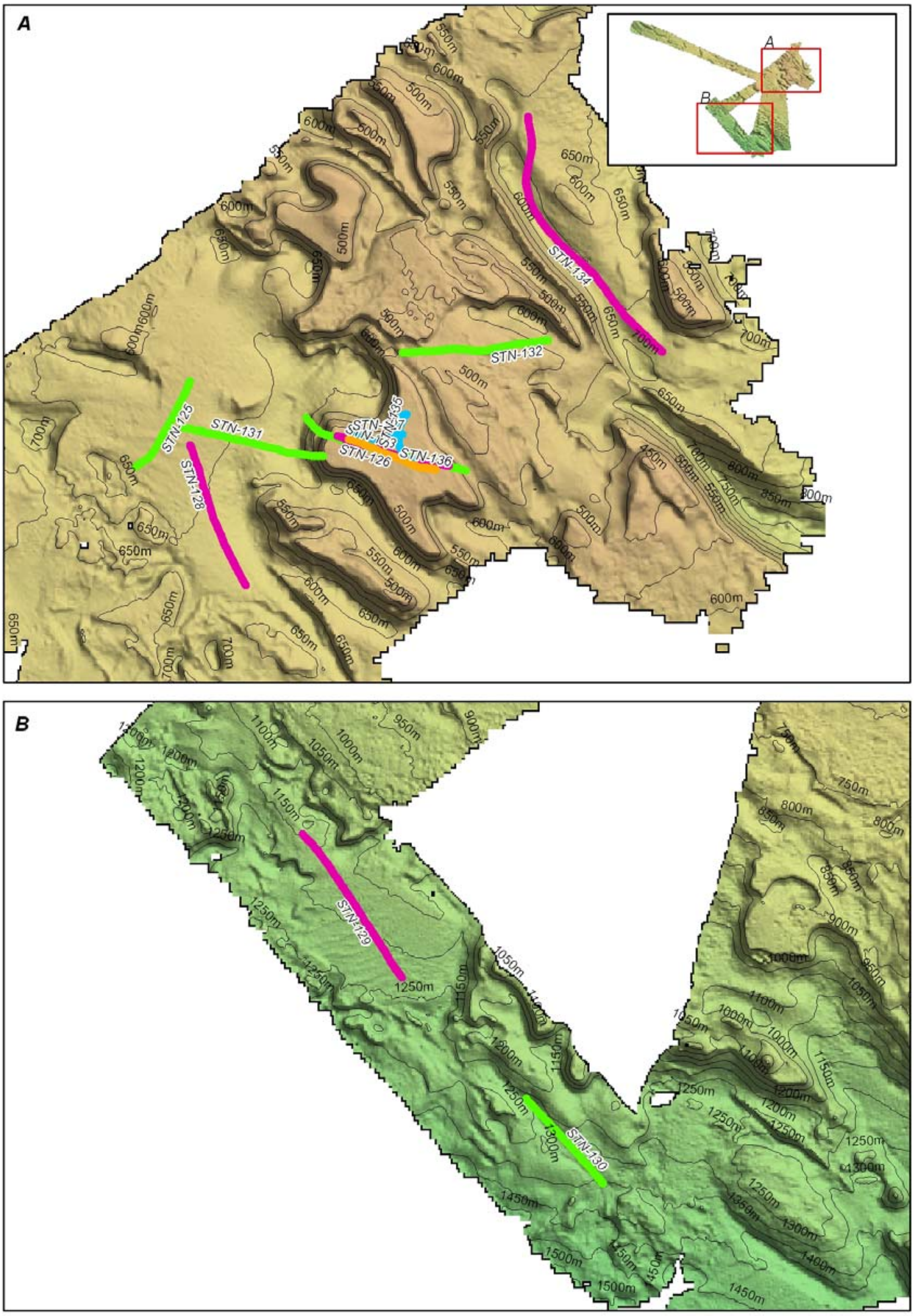


Figure 2b: Site 2, western Reinga Ridge, multibeam bathymetry, showing station tracks and sampling locations (purple, ORH trawl; orange, beam trawl; light green, Sherman sled; light blue, camera).

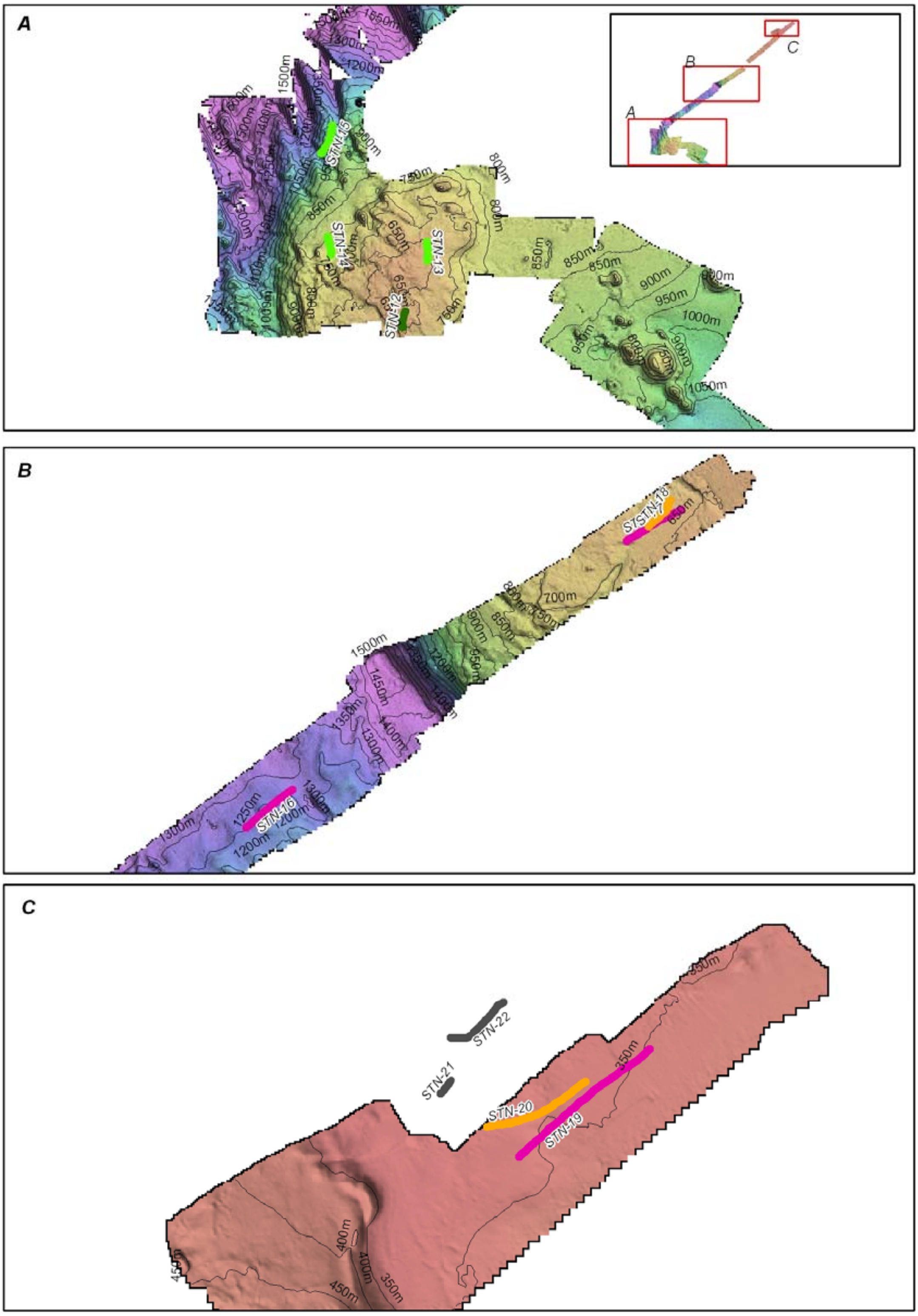
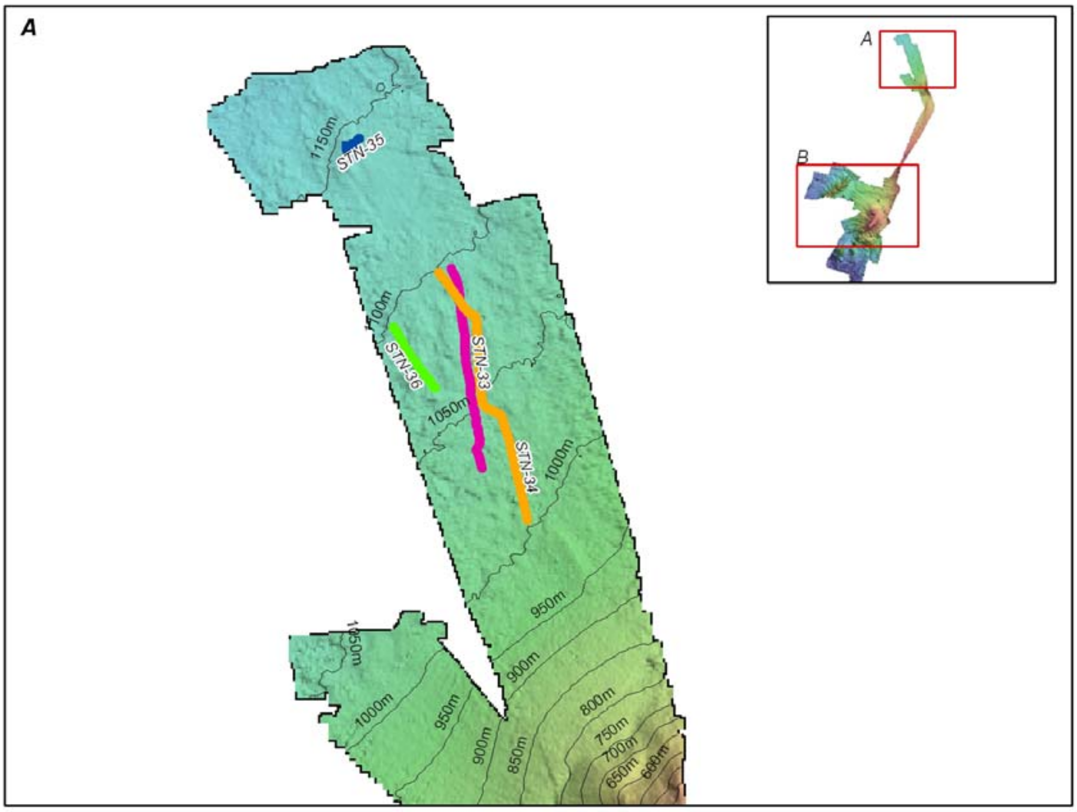


Figure 2c: Site 3, southern Norfolk Ridge, multibeam bathymetry, showing station tracks and sampling locations (purple, ORH trawl; orange, beam trawl; light green, Sherman sled; dark grey, pipe dredge; dark blue, CTD cast).



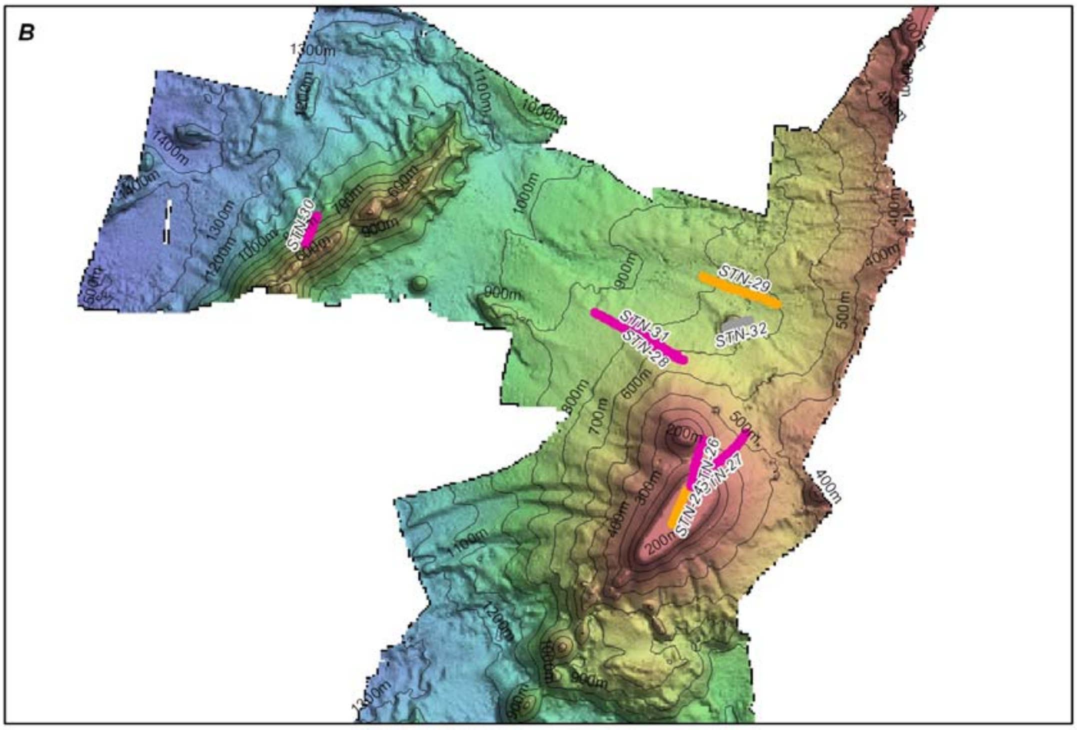


Figure 2d: Site 4, northern Norfolk Ridge, multibeam bathymetry, showing station tracks and sampling locations (purple, ORH trawl; orange, beam trawl; light green, Sherman sled; light grey, rock dredge; dark blue, CTD cast).

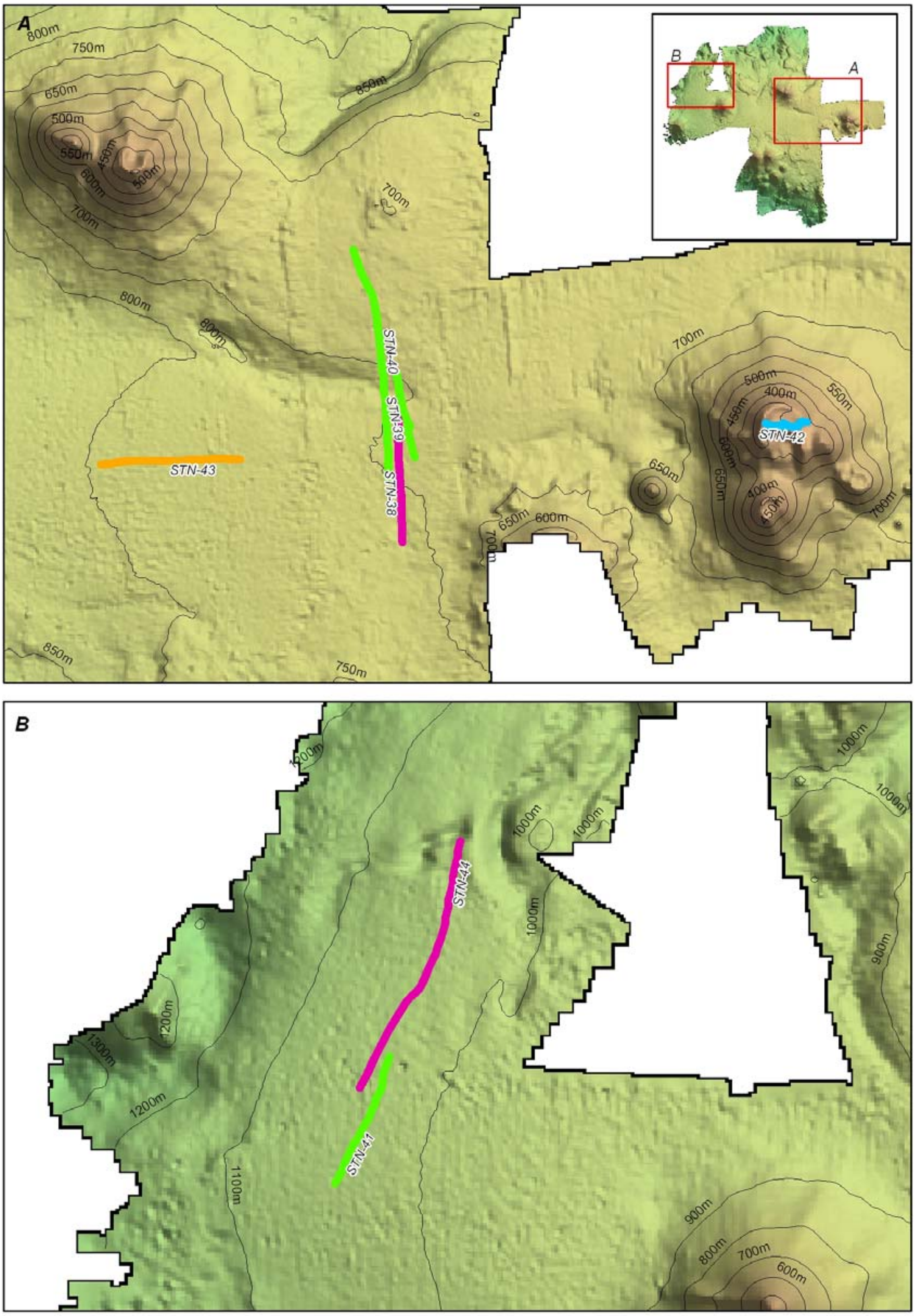


Figure 2e: Site 5, northern Norfolk Ridge, multibeam bathymetry, showing station tracks and sampling locations (purple, ORH trawl; orange, beam trawl; light green, Sherman sled; light blue, camera).

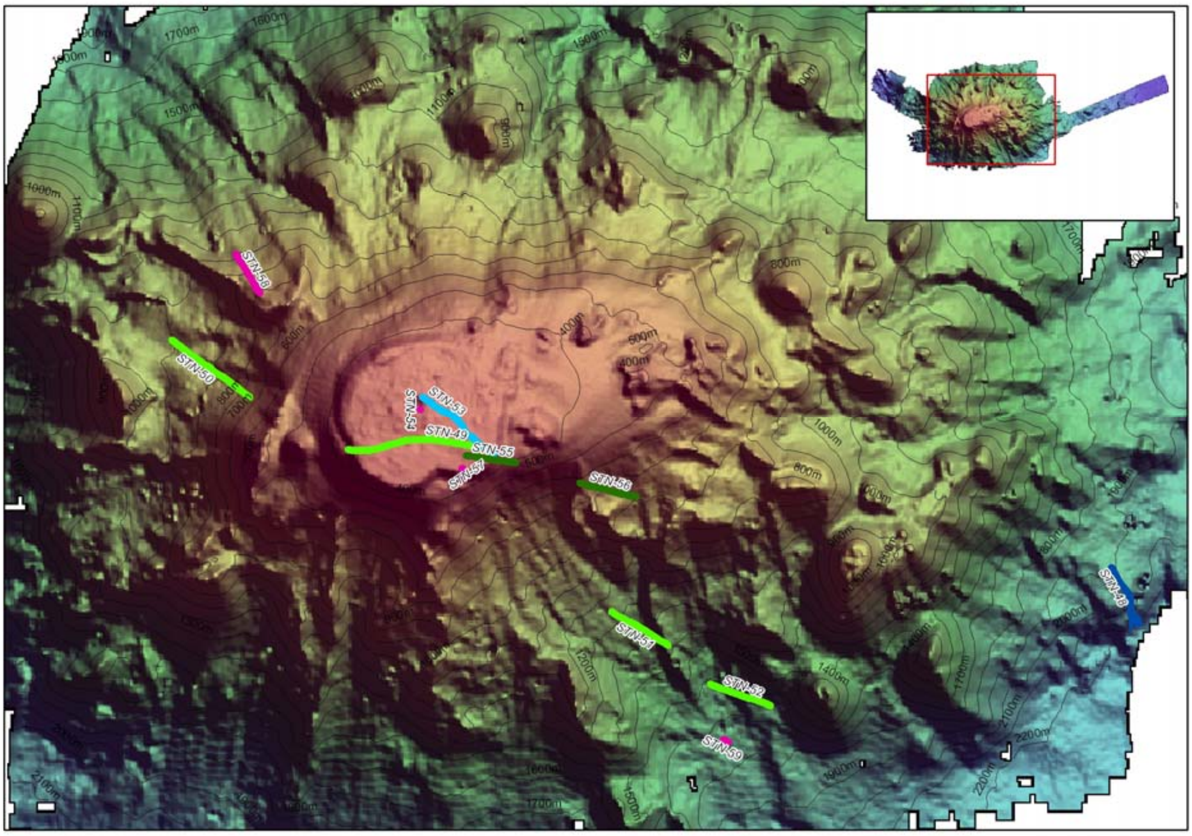


Figure 2f: Site 6, Lord Howe Rise, multibeam bathymetry, showing station tracks and sampling locations (purple, ORH trawl; light green, Sherman sled; dark green, NIWA sled; light blue, camera; dark blue, CTD cast).

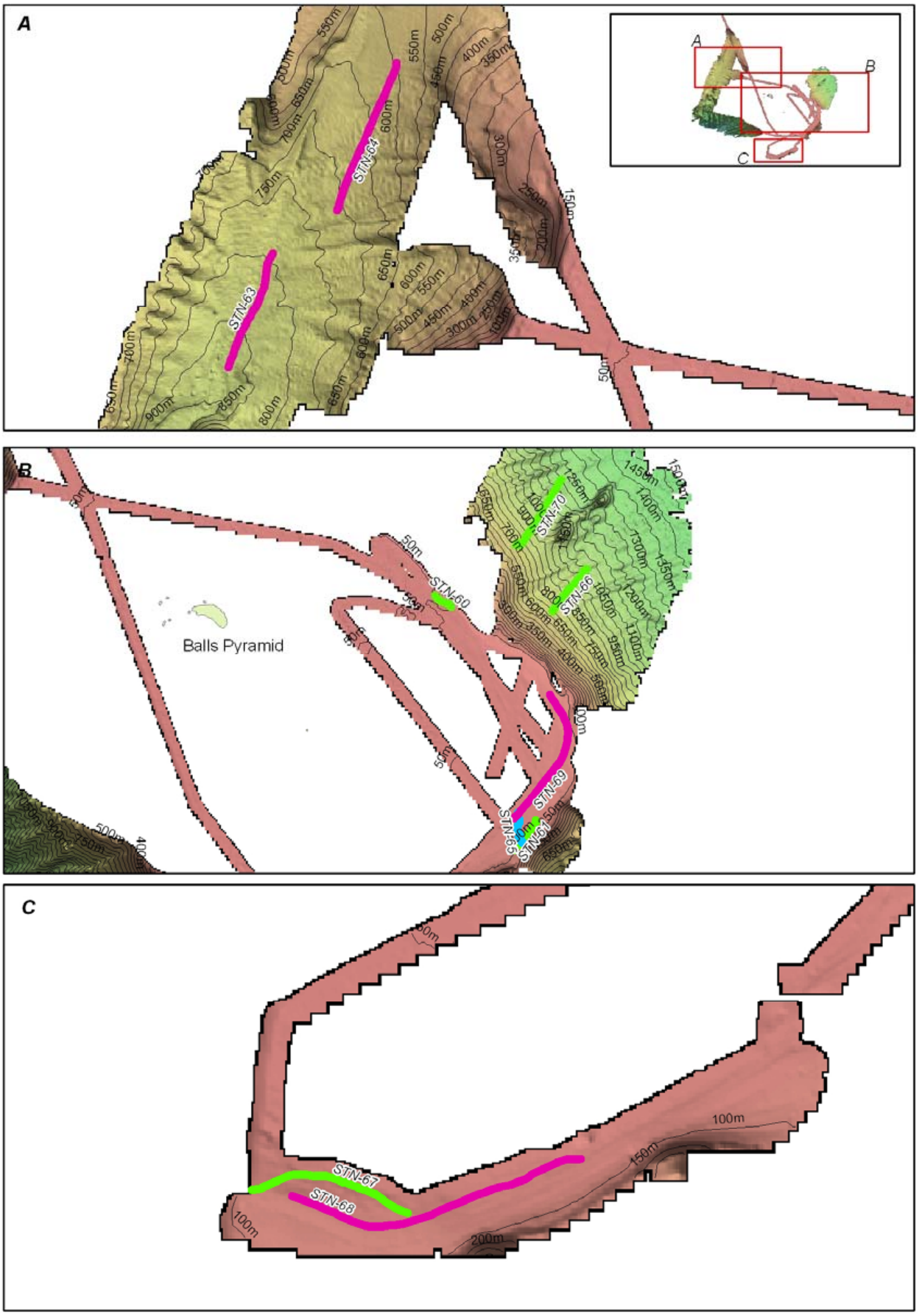


Figure 2g: Site 7, Lord Howe Island, multibeam bathymetry, showing station tracks and sampling locations (purple, ORH trawl; light green, Sherman sled; light blue, camera).

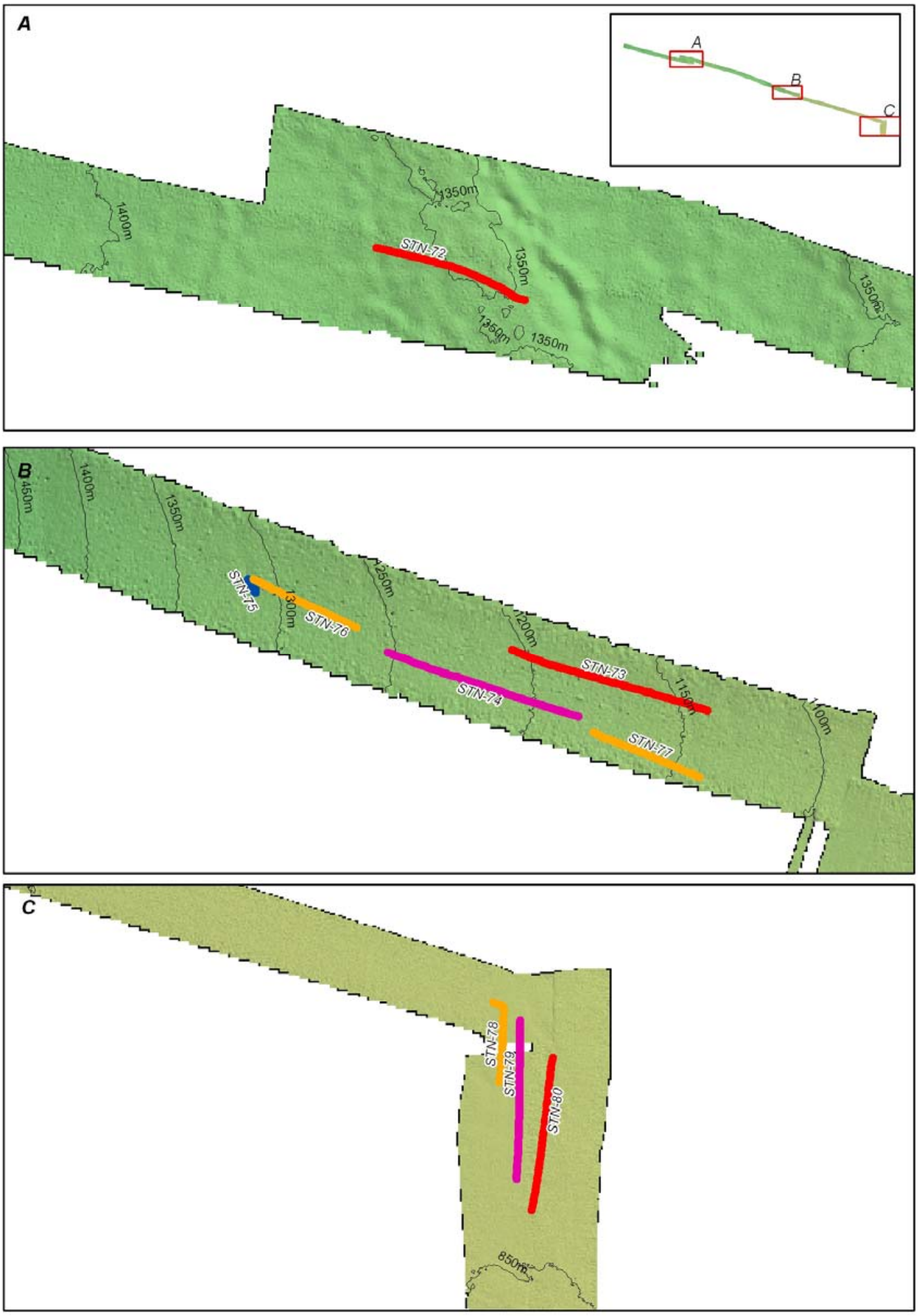


Figure 2h: Site 8, Lord Howe Plateau, multibeam bathymetry, showing station tracks and sampling locations (purple, ORH trawl; red, wing trawl; orange, beam trawl; dark blue, CTD cast).

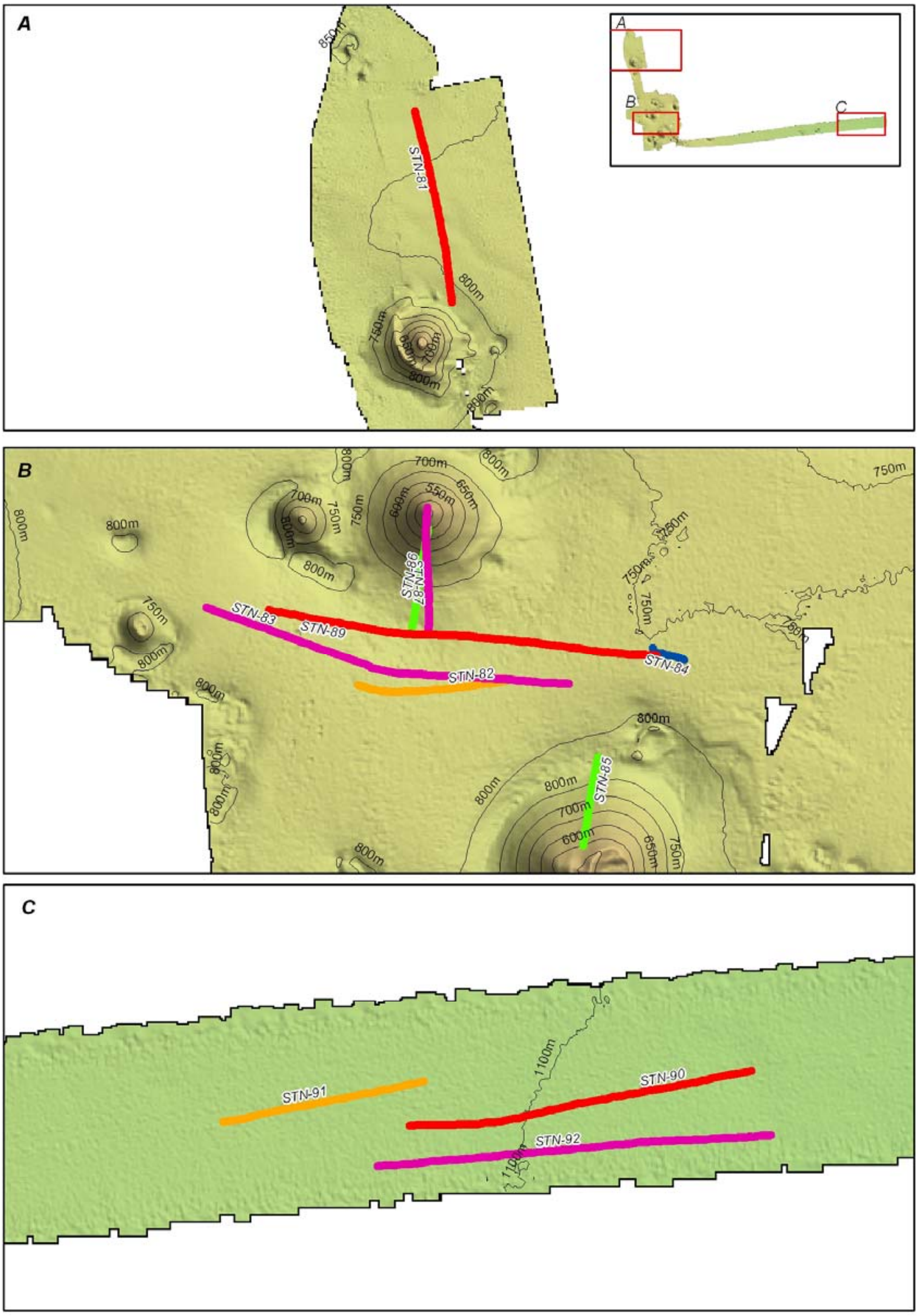


Figure 2i: Site 9, Lord Howe Plateau, multibeam bathymetry, showing station tracks and sampling locations (purple, ORH trawl; red, wing trawl; orange, beam trawl; light green, Sherman sled; dark blue, CTD cast).

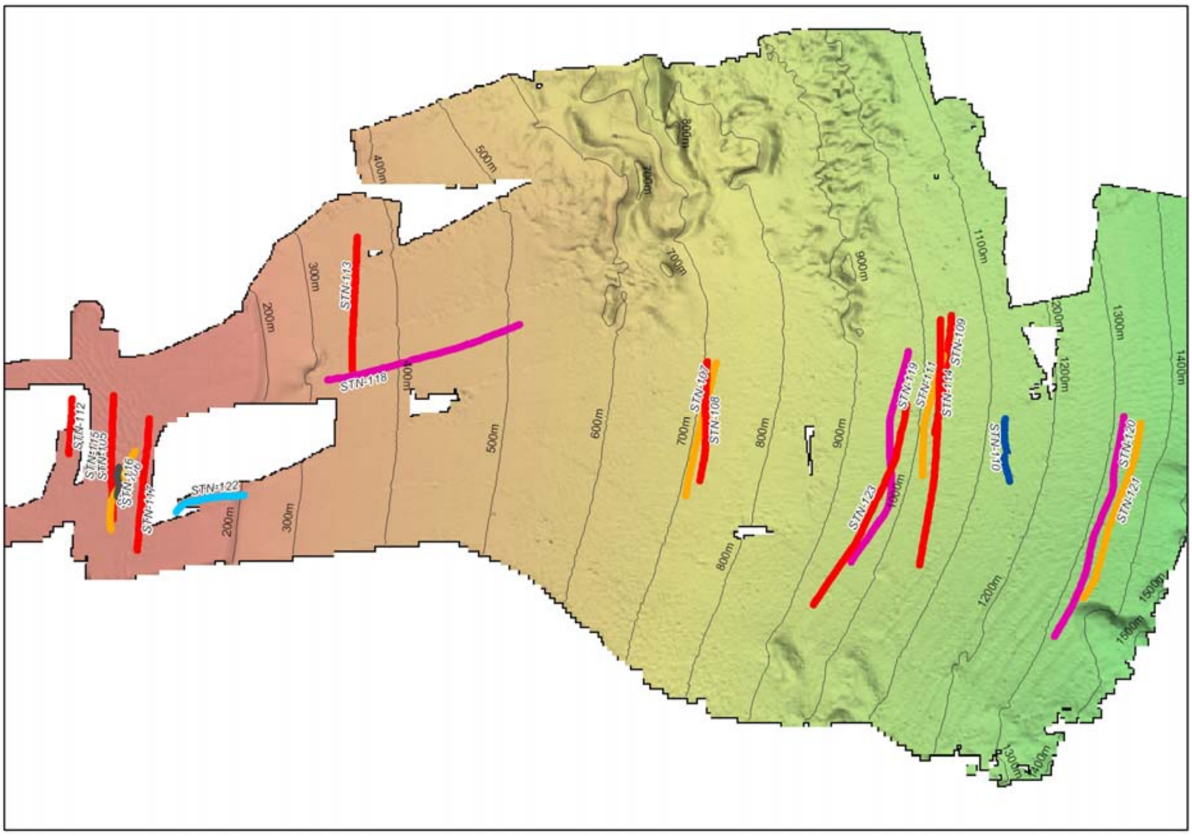


Figure 2j: Site 10, Wanganella Bank, multibeam bathymetry, showing station tracks and sampling locations (purple, ORH trawl; red, wing trawl; orange, beam trawl; dark grey, pipe dredge; light blue, camera; dark blue, CTD cast).

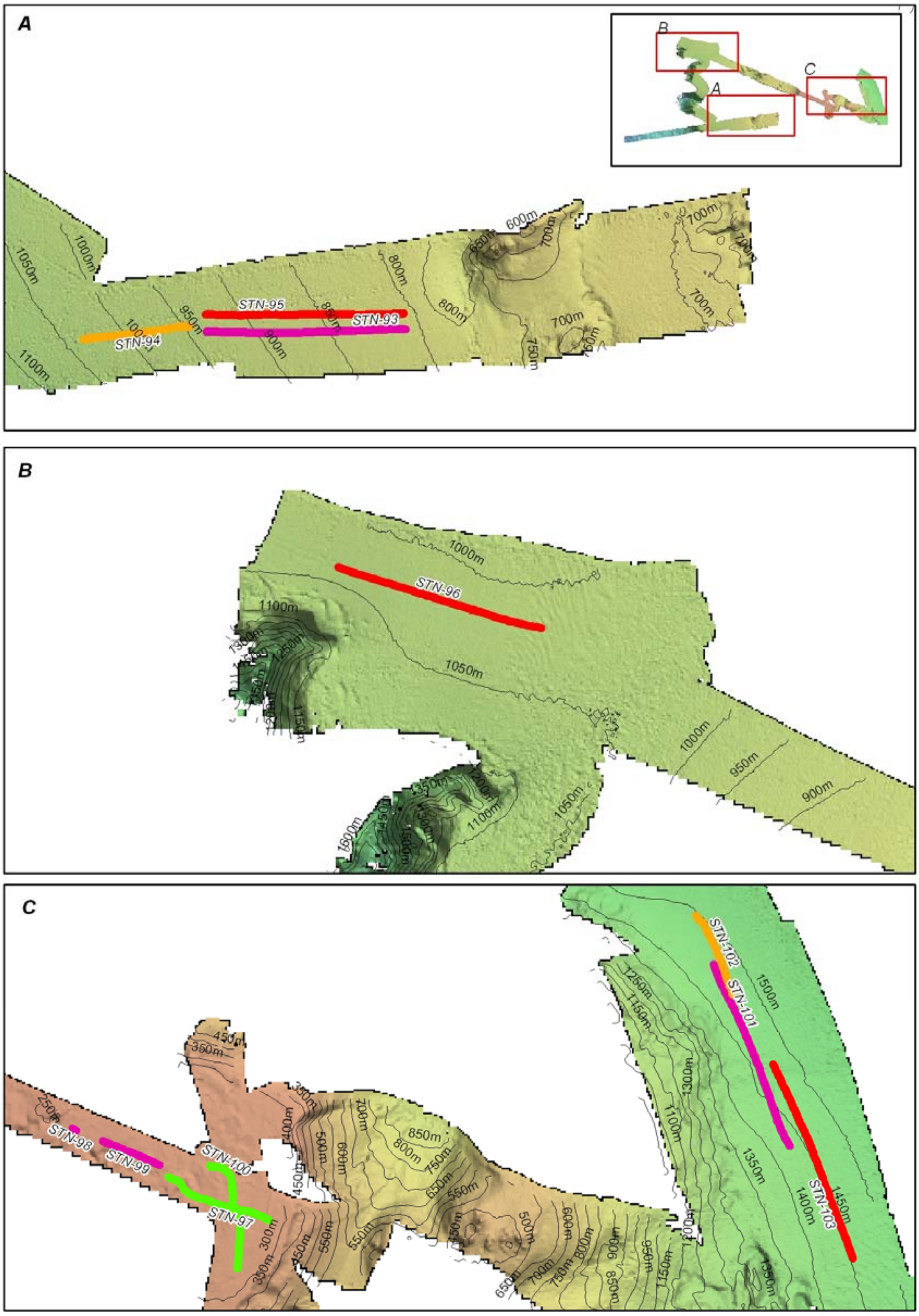


Figure 2k: Site 11, West Norfolk Ridge, multibeam bathymetry, showing station tracks and sampling locations (purple, ORH trawl; red, wing trawl; orange, beam trawl; light green, Sherman sled).

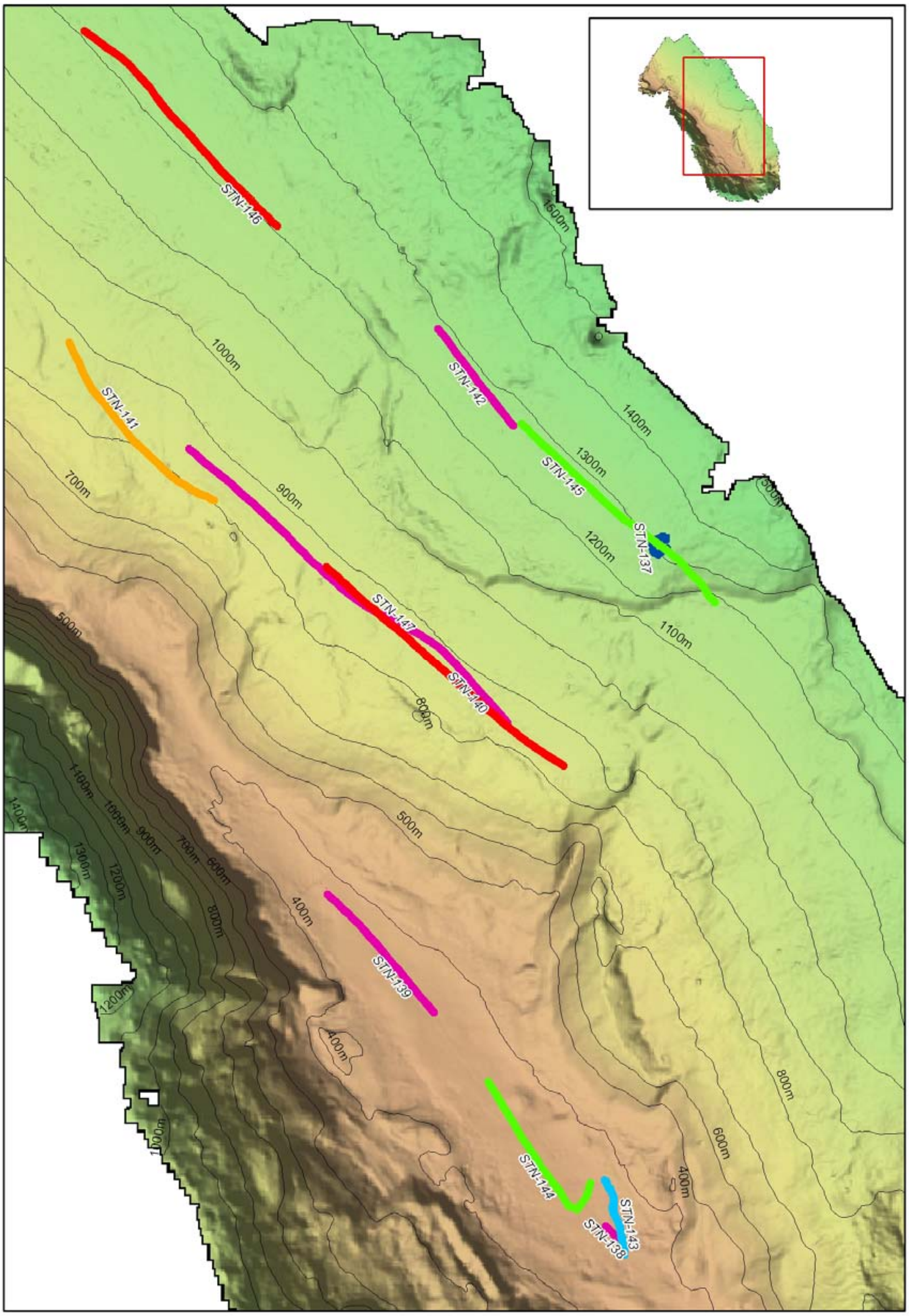


Figure 2l: Site 12, West Norfolk Ridge, multibeam bathymetry, showing station tracks and sampling locations (purple, ORH trawl; red, wing trawl; orange, beam trawl; light green, Sherman sled; light blue, camera; dark blue, CTD cast).

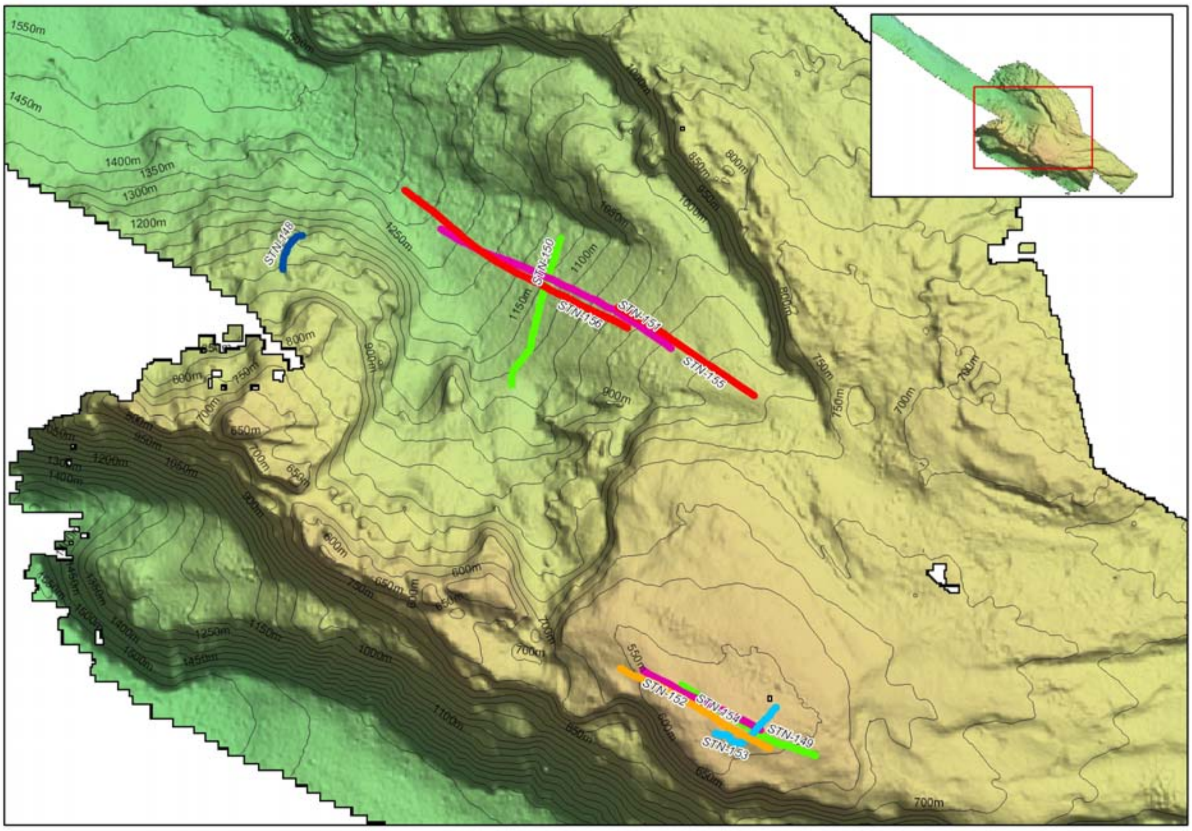


Figure 2m: Site 13, West Norfolk Ridge, multibeam bathymetry, showing station tracks and sampling locations (purple, ORH trawl; red, wing trawl; orange, beam trawl; light green, Sherman sled; light blue, camera; dark blue, CTD cast).

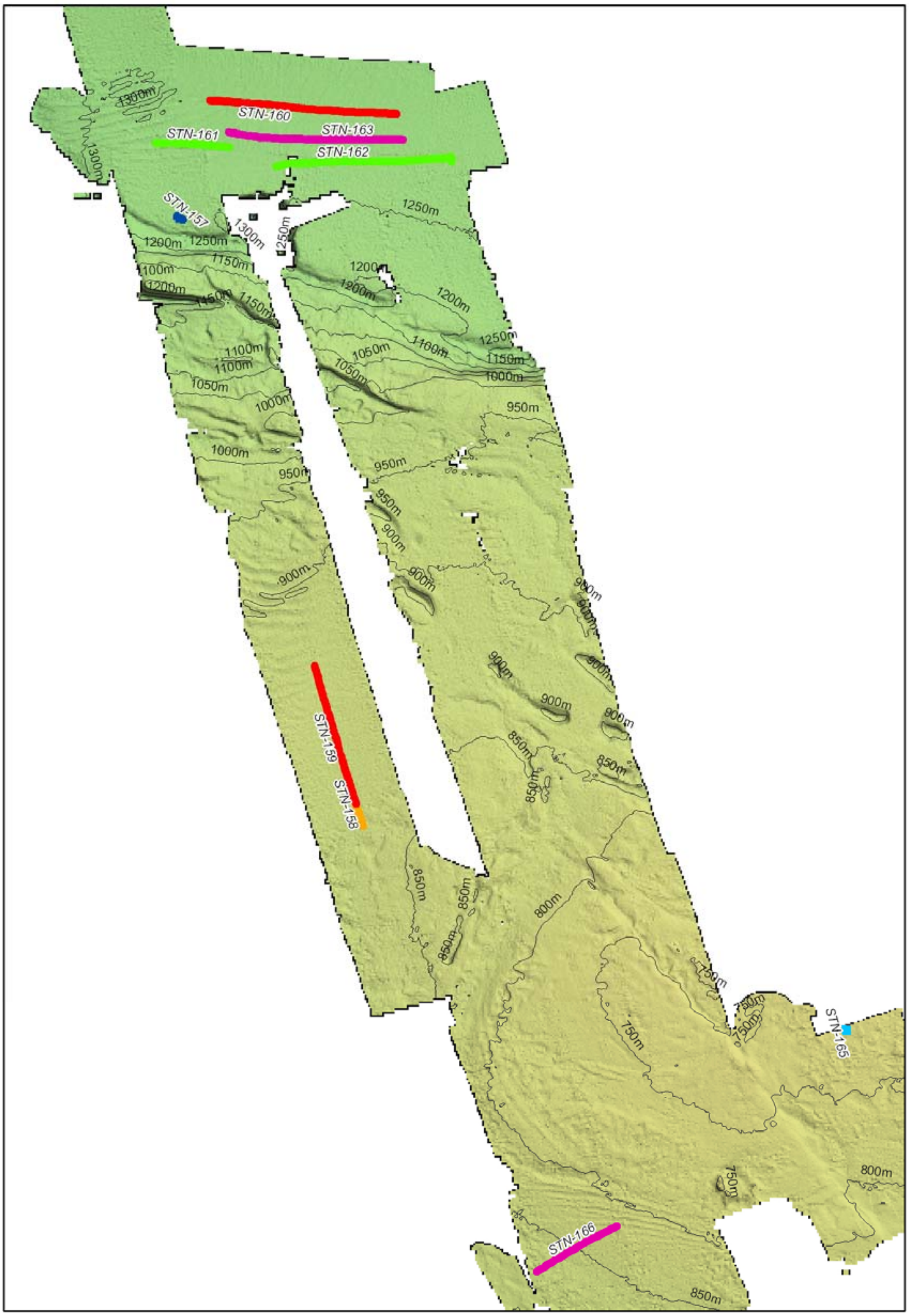


Figure 2n: Site 14, West Norfolk Ridge, multibeam bathymetry, showing station tracks and sampling locations (purple, ORH trawl; red, wing trawl; orange, beam trawl; light green, Sherman sled; light blue, camera; dark blue, CTD cast).

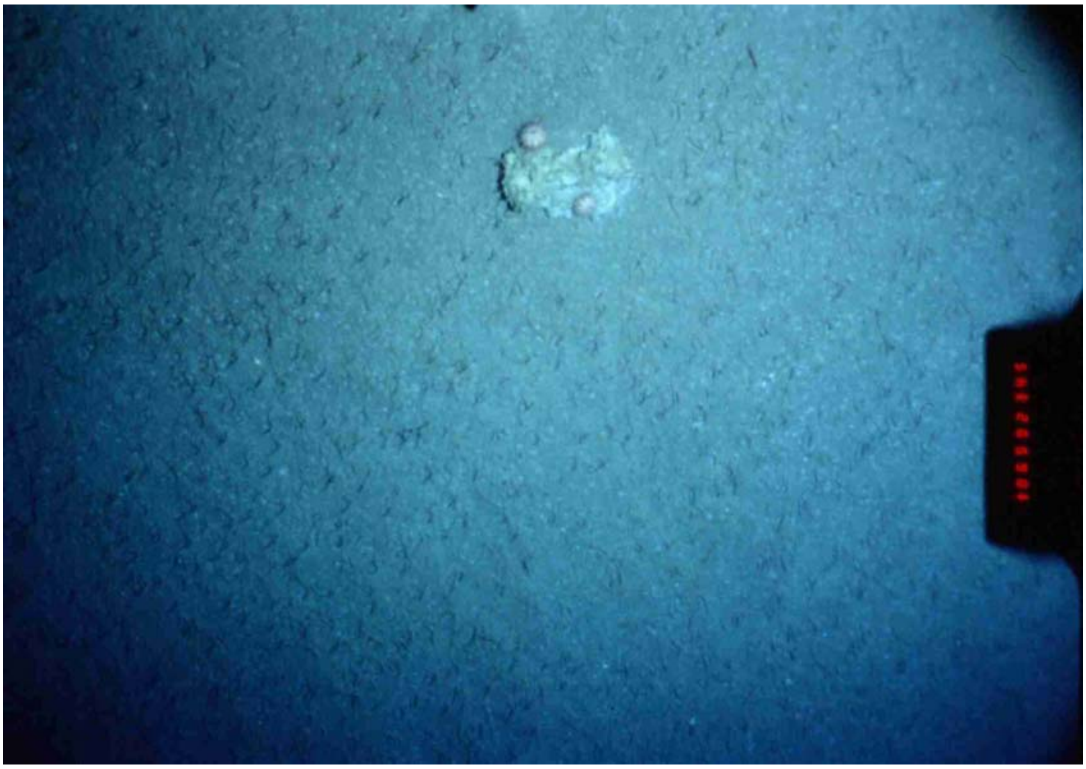


Figure 3a: Seafloor at Site 2 on the Reinga Ridge, 470 m. Soft sediment, with the bottom almost carpeted in brittle stars. Several small urchins also visible.

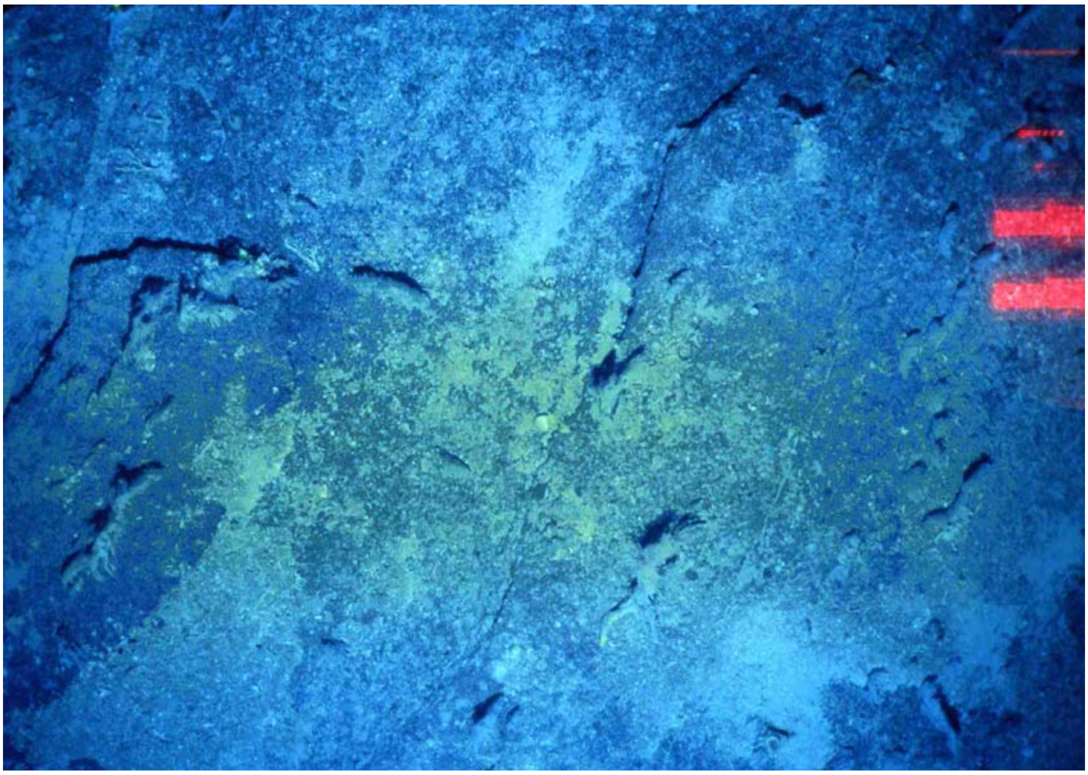


Figure 3b: Seafloor at Site 5, northern Norfolk Ridge, 400 m. Summit of seamount. Hard fractured volcanic rock.

Figure 3c: The summit of Site 6, Lord Howe Rise, 280 m, with large boulders encrusted with sponges and corals. Sampling was difficult at this site.

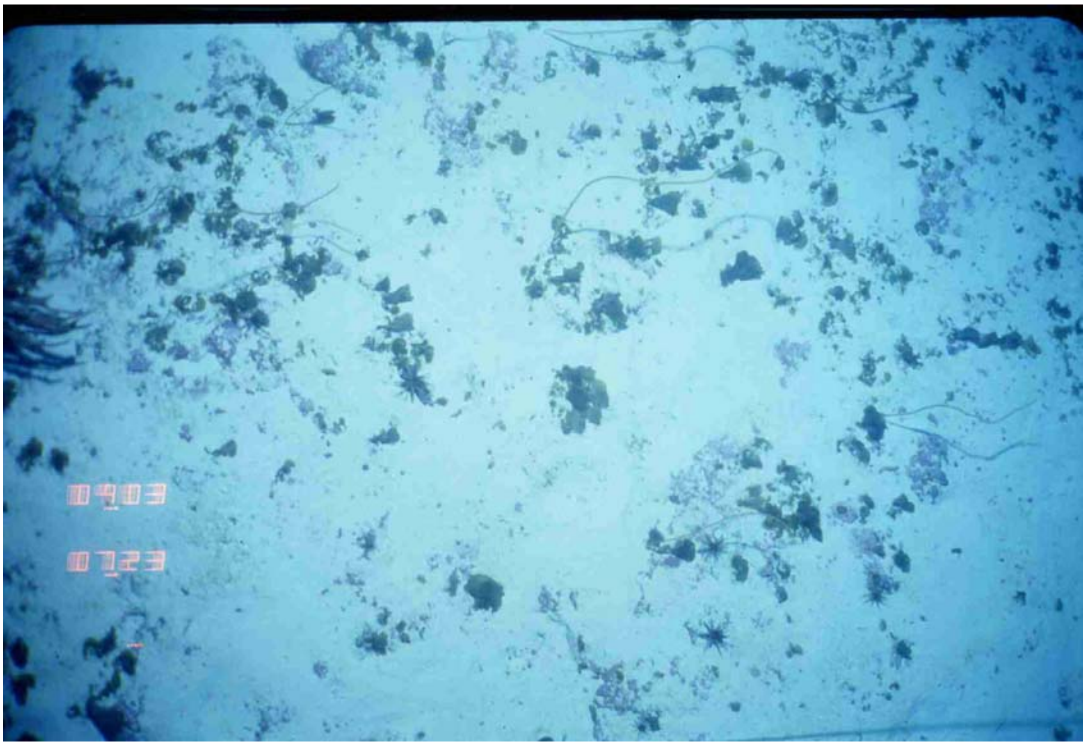


Figure 3d: Site 7, near Lord Howe Island, 70 m depth. This section of seafloor had a layer of soft sediment with small sponges and larger seawhips prominent.

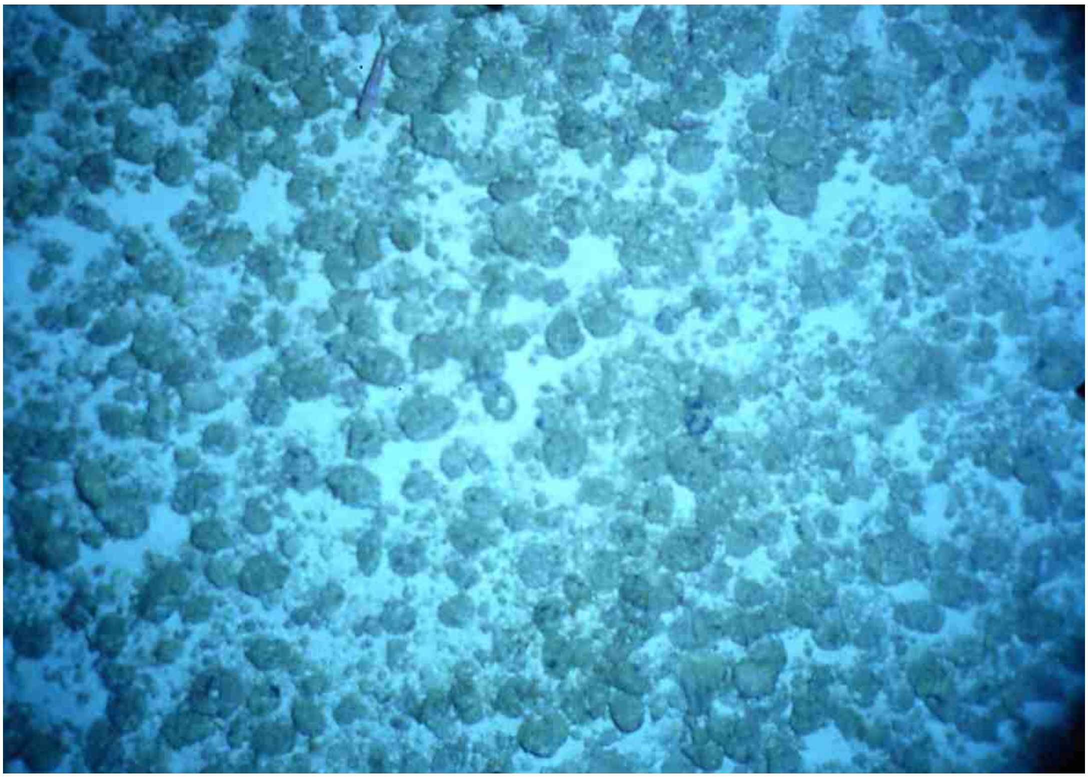


Figure 3e: Site 10. The summit of the Wanganella Bank, at 218 m, with cobbles and pebbles and small sponges.

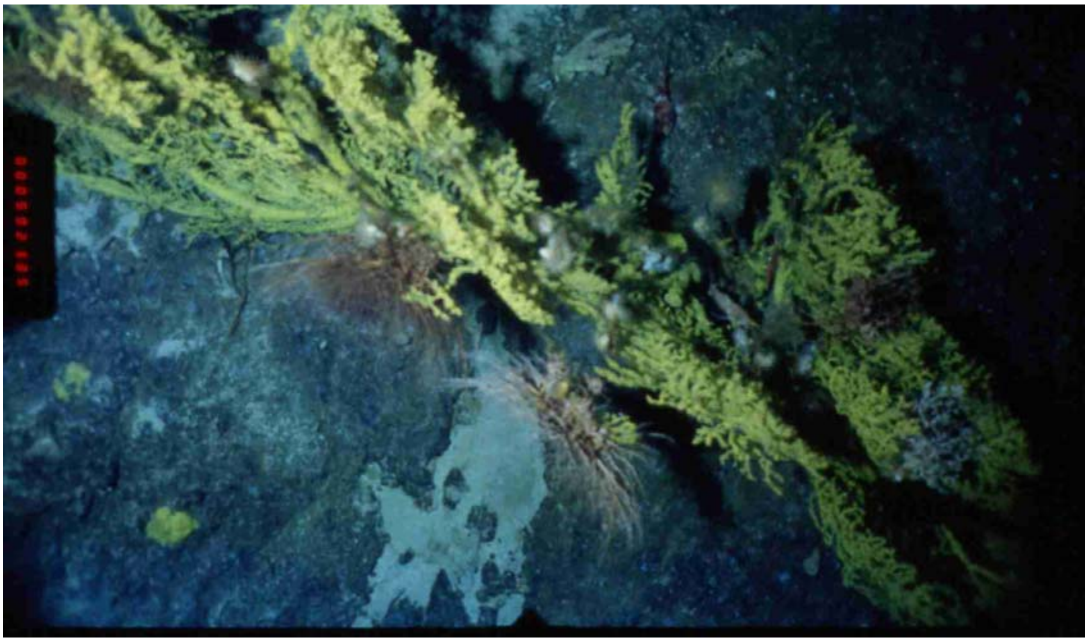


Figure 3f: Site 12, the summit area, at a depth of 390 m, of a ridge on the West Norfolk Ridge. Corals were common on the exposed bedrock and large boulders which occurred in places at this site.

Figure 3g: Site 13, West Norfolk Ridge, 525 m. Hard rock and lava on the summit of this seamount, northern side.

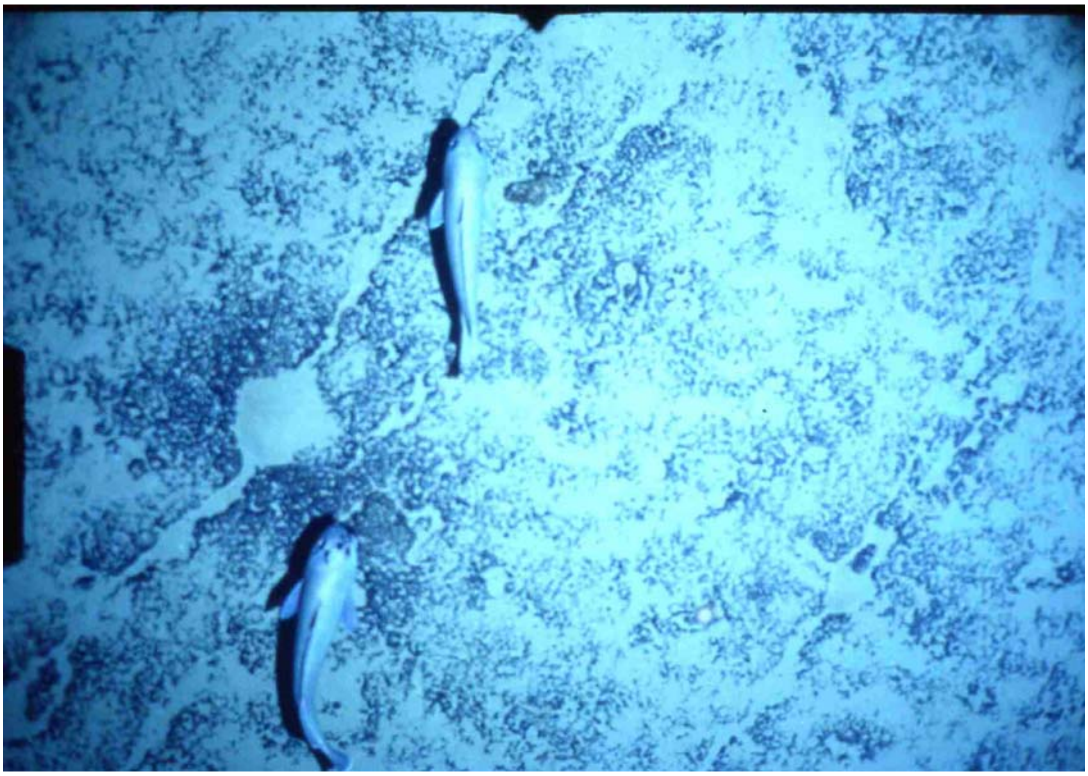


Figure 3h: Site 14, West Norfolk Ridge, 730 m, on the broad summit area of the seamount. This area was relatively flat, but hard, as seen here with the bedrock covered only by a very thin layer of sediment in places.

3.2 Sample collection

A total of 136 bottom trawl or sled stations was completed at the 14 sites, each site with 6–17 stations. The distribution of gear type and depth for these is summarised in Table 2.

Table 2: Details of biological sampling at each site: depths range, numbers of tows and distance in parentheses (n.mile) of each sampling gear deployed* (the first 4 are described in detail earlier). ([ ] no. shots with poor gear performance)

Site	Depth range (m)	ORH trawl	Sherman sled	Beam trawl	Wing trawl	Mid water trawl	Camera
1	351–1332	3 (4.35)	5 (3.49)				
2	465–1230	4 (7.29)	5[1] (3.94)	1 (0.55)			2
3	314–1285	3[1] (4.11)	3[2] (1.18)	2 (1.44)			
4	110–1116	6[2] (6.83)	1 (0.76)	2 (2.49)			
5	714–1035	2[1] (2.40)	3[1] (2.49)	1 (1.10)			1
6	280–1600	4[3] (0.33)	4 (2.31)				1
7	48–1292	4 (7.17)	4 (2.99)				1
8	850–1288	2 (6.09)		3 (2.61)	2 (6.08)		
9	430–1120	4[2] (6.85)	2 (1.19)	2 (1.77)	3 (9.80)		
10	116–1345	3 (7.70)		4 (5.33)	7[1] (14.56)		1
11	248–1478	4[1] (6.45)	2 (2.59)	2 (2.05)	3 (8.60)		
12	373–1268	4[1] (5.30)	2 (2.34)	1 (0.85)	2 (4.18)		1
13	508–1350	2 (2.67)	2 (2.44)	1 (1.0)	2 (2.84)		1
14	771–1294	3[1] (4.33)	2[1] (0.99)	1 (0.47)	2 (5.23)		1
Deep benthic	1342–1934				5 (13.5)		
Deep pelagic	1200–2000					4 (24.4)	

* In addition, there were two tows at site 6 with a small epibenthic sled ("NIWA sled") covering 0.86 n.mile, four pipe dredges (2 at site 3: 0.57 n.mile) and two at site 10: 0.52 n.mile), and one rock dredge at site 4: 0.43 n.mile)

A detailed summary of individual station data is given in Appendix 1.

A total of 1895 species/OTUs of fishes and invertebrates were identified on board. About 590 species of fishes were collected, comprising 5000 individual fish with a total weight of 12.7 t. Over 1300 invertebrate species/OTUs were recorded. Most invertebrates were not weighed onboard due to the small size of many of the taxa, so the total weight of the samples is unkown but estimated at over 3 t. Invertebrate and fish specimens have been distributed to accessible museum collections in New Zealand, Australia, France, and the USA (Museum of New Zealand Te Papa Tongarewa (Wellington), NIWA (Wellington), Australian Museum (Sydney), CSIRO (Hobart), Museum Victoria (Melbourne), Northern Territories Museum (Darwin), Queensland Museum (Brisbane), Western Australian Museum (Perth), Museum National d'Histoire Naturelle (Paris), California Academy of Sciences (San Francisco)).

In addition, rock samples were collected from 31 stations and are under investigation by Australian (Geosciences Australia) and New Zealand geologists (Institute of Geological and Nuclear Sciences). Some preliminary results are given in Appendix 2, and samples from the survey have been used by Mortimer et al. (2008).

3.3 Taxonomic identification

Voucher specimens of all taxa collected and recorded have been deposited with accessible permanent collections for verification and ongoing taxonomic research. These preserved specimens are essential to validate the identifications and checklists produced both during the NORFANZ voyage and subsequently.

In general, the NORFANZ invertebrates were difficult to identify accurately on board, even by specialists in particular groups. Many were simply identified to family level and given a nominal identification (OTU) to separate them from similar taxa. This simple approach enabled over 1300 species/OTUs to be recorded, but this number is likely to increase substantially as the collections are studied (as seen with more recent data used here and published by Williams et al. 2006a). Similarly with fishes, species-level identifications were difficult at times. The fish fauna of the area had not previously been well researched. The taxonomic understanding of Australian fishes has only just begun for some groups, especially those occurring in the continental slope regions (Paxton et al. 1989). The New Zealand fish fauna is also still incompletely known, especially on seamounts and oceanic ridges, with over 100 species awaiting scientific description–even the fishes already described are often poorly diagnosed and identification is difficult even for some commercially important species (Roberts & Paulin 1997b).

Consistent identification, irrespective of the taxonomic accuracy, was ensured by the production of onboard identification guides and detailed colour photographs that were updated continuously throughout the voyage. From a total of 2030 NORFANZ fish identifications, the reliability levels recorded on the voyage database were:
Level 1: Highly reliable – 17.7%.
Level 2: A high degree of confidence – 47.0%.
Level 3: High confidence to genus, not species – 30.2%.
Level 4: Limited confidence – 2.1%.
Level 5: Superficial or unrecorded – 2.9%.

Therefore, nearly 65% of fish identifications were considered reliable, and almost 95% were accurate to genus-level. However, it is important to note that reliable identifications (levels 1 & 2) included numbers of OTUs requiring further research and in many cases formal description (e.g., *Apristurus* sp. A; *Deania* cf. *calcea*; *Dipturus* NFZ1, *Caelorinchus* sp. NFZ3; *Hoplostethus* ?*mediterraneus*; *Zenion* sp. B; *Nemadactylus* sp.; *Parapercis* sp. NFZ1; *Kathetostoma* sp. (NZ n.sp.); *Benthodesmus* ?*tuckeri*)..

Taxonomic research on voucher specimens of some of these OTUs have been identified post-voyage as species new to science, rare species, or species not previously known from the area. For example:

- CAAB 231-801 (stn. 091), eelpout *Ophthalmolicus* sp. = *Lycenchelys polyodon* sp. nov., family Zoarcidae (Anderson & Møller 2007);
- CAAB code 255-001/801 (stns. 081, 131, etc.), silver roughy *Hoplostethus ?mediterraneus* and *H. ?intermedius* = *Hoplostethus mediterraneus* Cuvier, 1829, family Trachichthyidae (Smith & Roberts 2004).
- CAAB code 287-809 (stn. 067), red gurnard perch *Maxillicosta* sp. NFZ1 = *Maxillacosta raoulensis* Eschmeyer & Poss, 1976, family Scorpaenidae, an 1,800 km trans-Tasman Sea range extension and first description of fresh colour (Motomura et al. 2005a).
- CAAB 287-802 (stns. 024, 061, 067), bullhead scorpionfish *Scorpaena* ?*cookii* = *Scorpaena bulacephala* sp. nov., family Scorpaenidae (Motomura et al. 2005b).
- CAAB 287-103 (stns. 081, 089, 147), deepsea scorpionfish *Trachyscorpia* sp. = *Trachyscorpia (Mesoscorpia) carnomagula* sp. nov., family Scorpaenidae (Motomura et al. 2007).
- CAAB 377-013 (stn. 069), morwong *Cheilodactylus vittatus* = *Cheilodactylus francisi* sp. nov., family Cheilodactylidae (Burridge 2004).
- CAAB 384-801 (stn. 024), pigfish *Bodianus* sp. A = *Bodianus masudai* Araga & Yoshino, 1975, family Labridae, new record for Tasman Sea (Gomon 2006).

- CAAB 390-802 (stns. 024, 061), sandperch *Parapercis* sp. A = *Parapercis colemani* Randall & Francis, 1993, family Pinguipedidae, rare species (Johnson 2006).
- CAAB 402-801/802 (stns. 114, 120), swallower *Kali* sp. A and *Kali macrodon* = *K. colubrina* sp. nov., family Chiasmodontidae (Melo 2008).

3.4 Biodiversity of benthic macroinvertebrates

3.4.1 Taxonomic diversity

Macro-invertebrate diversity onboard was represented by 229 families, and over 1300 species/OTUs. The total number identified has since increased to over 1600 (Williams et al. 2006a). Sponges, sea spiders, brittlestars, octocorals, and various molluscan groups have all been substantially revised. The state of this dataset (June 2006) is summarised in Table 3.

The most diverse phyla were the Crustacea (Malacostraca) with over 400 species/OTUs, which was 25% of all invertebrate species. Sponges (368 species), echinoderms (299 species) and corals/anemones (232 species) were the other main taxonomic groups. Together these 4 accounted for 80% of the recorded species/OTUs.

Table 3: Taxonomic diversity of macro-invertebrates.

Phyla/Subphyla/Order		Species/OTUs	%
Porifera		368	22.7
Hydrozoa/Cnideria		232	14.3
Platyhelminthes		1	0.1
Nemertea		5	0.3
Chaetognatha/Priapulida		5	0.3
Sipuncula		5	0.3
Brachiopoda		8	0.5
Bryozoa		15	0.9
Annelida		37	2.3
Mollusca (non-Gastropoda)		93	5.7
Mollusca (Gastropoda)		82	5.0
Echinodermata		299	18.4
Crustacea (Copepoda, Ostracoda etc)		36	2.2
Crustacea (Malacostraca)		405	25.0
Pycnogonida		15	0.9
Urochordata (Ascidia)		15	0.9
Hemichordata		1	0.1
Totals	**17** phyla	1622	

A checklist of all macro-invertebrate taxa is given in Appendix 3.

3.4.2 Distribution

The diversity of taxa differed between sites. With a large number of OTUs, a detailed analysis of invertebrate distributions is not presented. However, some general notes on number of species/OTUs, and the main taxa, by site are given in Table 4. Species diversity ranged between 82 and 225 species/OTUs per site. Greatest diversity (over 200 spp./site, but not adjusted for effort) was within the southern Norfolk Ridge area at sites 2 and 11, and on the Lord Howe Rise at sites 6, 7, and 9 (Figure 4).

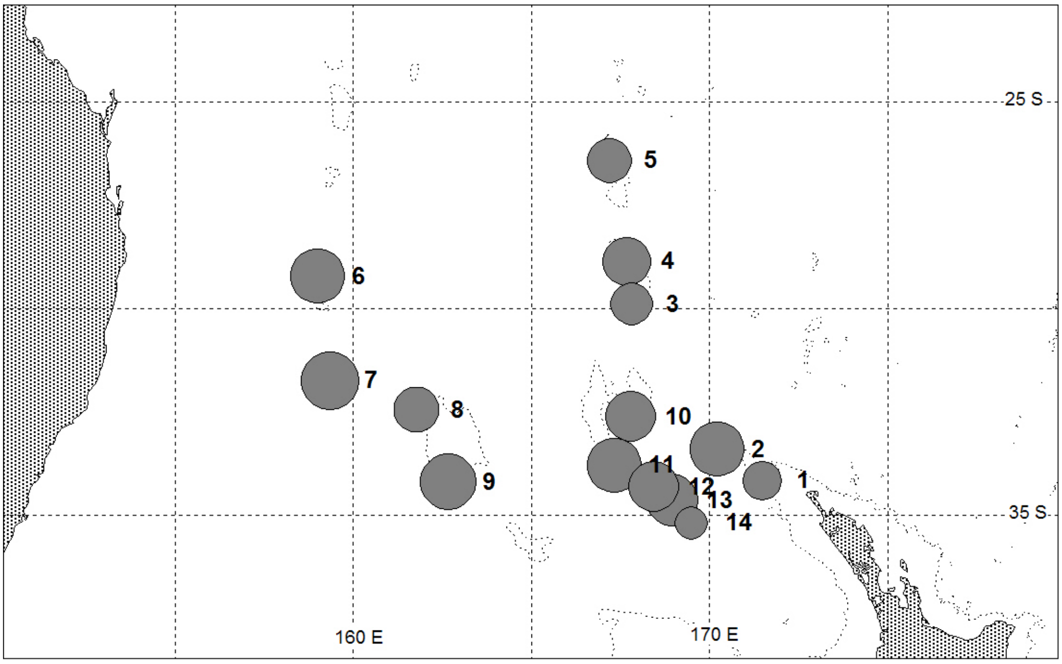


Figure 4: Invertebrate diversity (number of species/OTUs) by site (labelled). The circle area is proportional to the number of species (maximum = 225 at site 7)

Table 4: Summary of invertebrate biodiversity by site (MWT, midwater trawl; DWT, deep wing trawl).

Site	No. species/OTU	Description of main invertebrate taxa (no. spp/OTUs)
1	116	Sponges (45), crustaceans (30), echinoderms (13), and cniderians (11)
2	211	Crustaceans (Malacostraca) (69), hydrozoa/cniderians (50) (especially gorgonian corals, black coral, anemones), echinoderms (38) and sponges (26). One station with thousands of the brittle star *Ophiomitrella* cf. *fidelis*.
3	127	Crustaceans (40), sponges (31), echinoderms (23) (*Paxillosides* sp., *Ophiacantha* sp.1).
4	171	Cniderians (48) (gorgonian corals), sponges (39), crustaceans (28), and echinoderms (22).
5	142	Crustaceans (diverse range of isopods, amphipods, crabs, squat lobsters, prawns) (35), sponges (29), cniderians (22), and echinoderms (23).
6	210	Sponges very diverse (73), cniderians (45), echinoderms (40), crustaceans (28). High diversity, low numbers of individual species.
7	225	Echinoderms (50), crustaceans (49), sponges (47), molluscs (non-gastropods (21), gastropods (18)), cniderians (20). Samples of *Lithothamnion* sp., only algae caught. Most diverse site.
8	152	Crustaceans (38) (prawns, the rare opossum shrimp), echinoderms (28), cniderians (19), sponges (18). Holothurians very common at station 78.
9	219	Crustaceans (63), echinoderms (62) (especially common were the urchins *Dermechinus horridus* and *Gracilechinus multidentatus*), cniderians (38) and sponges (15).
10	175	Crustaceans (76) very diverse, echinoderms (35), gastropods (18) and cniderians (17). The coral *Flabellum* sp., urchin *G. multidentatus*, very abundant in places.
11	210	Crustaceans (51), echinoderms (51), cniderians (41), sponges (28), majid crab *Vitjazmaia latidactyla* common.
12	176	Crustaceans (68) (especially squat lobsters *Munida* spp.), echinoderms (45), cniderians (17), sponges (15). Crab *Lithodes murrayi* and lobster *Projasus parkeri* new records in north Tasman Sea. Post voyage, micromollucs were examined, and 610 species were found at station 141, of which over 400 are thought new species.
13	187	Crustaceans (65), echinoderms (49), cniderians (22) and sponges (20). Common fauna included stalked barnacles, polychaetes, the echinoderm *Asteroceros kermadecensis* and prawn *Sicyonia* sp.
14	82	Crustaceans (47) (abundant were prawn *Aristaeomorpha foliacea*, crab *Vitjazmaia latidactyla*), and echinoderms (16) only diverse groups.
MWT	56	Small catches. Mainly cephalopods and prawns.
DWT	115	Diverse fauna, varied between tows. Echinoderms very common at some stations, especially brittlestar *Opiomusium lymani*.

Images of a variety of invertebrate taxa and many of the species referred to above are given in Figure 5.

The pattern of diversity changes when species totals are corrected for sampling effort (Table 5). Mean number of species per site ranges from 10 to 27, and number per n.mile towed from 6 to 60. These values include all sampling gear types, and so are not accurately standardised given the selectivities of the different gear types, but give an indication of “relative diversity” of the invertebrate taxa.


Stn049 sponges


Stn049-lithistid

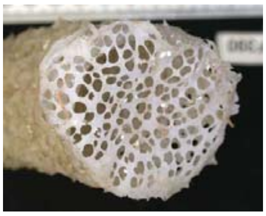

Stn055-halichondrichthyid.


Stn069-sponge


Stn056-hexactinellid


Stn068-Niphatidae


Stn154-*Callyspongia*


Stn126-hexactinellid


Stn132-hydroid


Stn144-stylasterid


Stn063-black coral


Stn024-*Acanthogorgia*


Stn154-*Chrysogorgia*


Stn097-Rhodelinda


Stn133-Keratoisis


Stn068-*Dendronephthya*


Stn049-*Lepidomuricea*


Stn126-Primnoid


Stn126-Primnoid


Stn081-sea pen


Stn078-anemone


Stn061-anemone


Stn097-anemone


Stn034-zoanthid

Figure 5: A selection of images of invertebrate taxa and species taken during NORFANZ.


Stn071-*Caryophyllum*


Stn100-*Dendrophyllum*


Stn106-*Flabellum*.


Stn154-Nemertean


Stn061-Brachiopod

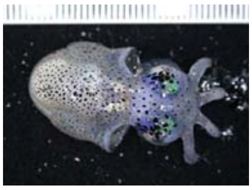

Stn033-Bryozoa


Stn06-Amphinomidae


Stn133-Eunicidae


Stn057-Leptochiton


Stn040-*Cuspidaria*


Stn060-*Euprymna*


Stn103-*Histioteuthis*


Stn168-Cranchiid squid


Stn092-*Opisthoteuthis*


Stn154-Calliostomid


Stn097-*Ranellida*


Stn020-Crinoid

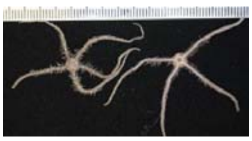

Stn138-*Dipsacaster*


Stn158-*Ceramaster*


Stn100-*Scleraster*


Stn052-*Ophiomusium*


Stn144-*Ophiacantha*


Stn100-*Ophiomitrella*


Stn099-*Ophiocreas*

Figure 5 (cont).

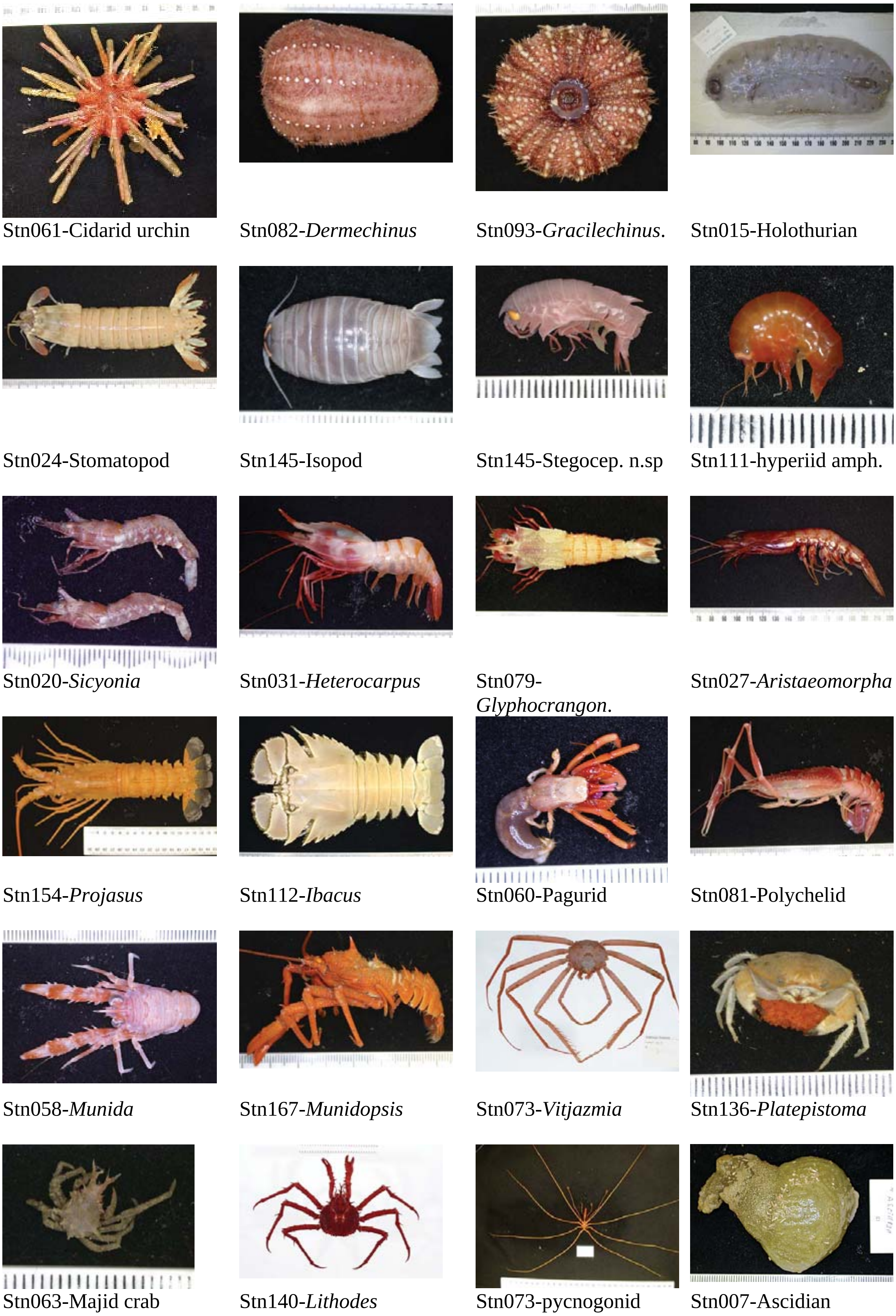


Figure 5 (cont).

Table 5: Summary of diversity by site, with adjustment for sampling effort.

Site	No. OTUs	No. stns	Distance	OTUs/stn	OTUs/n.mile
1	116	8	7.84	14.5	14.8
2	211	10	11.78	21.1	17.9
3	127	11	7.54	11.5	16.8
4	171	11	11.20	15.5	15.3
5	142	6	5.99	23.7	23.7
6	210	11	3.50	19.1	60.0
7	225	9	10.16	25.0	22.1
8	152	7	14.84	21.7	10.2
9	219	11	19.61	19.9	11.2
10	175	17	28.11	10.3	6.2
11	210	11	19.69	19.1	10.7
12	176	9	12.67	19.6	13.9
13	187	7	8.95	26.7	20.9
14	82	8	11.02	10.2	7.4

Crustacean (Malacostraca) diversity was relatively even throughout the survey area (Figure 6). The greatest number of species was at site 10, but diversity was also high (over 50 species/OTUs) at sites 2, 9, 11, 12, and 13. The lowest counts were at sites 4 and 6 on the northern Norfolk Ridge (28 species/site), but these were also difficult sites to sample adequately.

Sponge diversity was less even, with consistently high numbers of species (regularly more than 30) in northern sites, with site 2 also giving good catches (Figure 7). Numbers of species were markedly lower on the Wanganella Bank (site 10, three species) and the southern end of the West Norfolk Ridge (site 14, one species). This may, to an extent, be related to the type of substrate sampled, as these sites were also less diverse for cniderians which also require hard substrate for attachment.

Echinoderm diversity was, in contrast, relatively consistent throughout the survey area (Figure 8). The highest diversity (62 species/OTU) was at site 9, but all other sites except 1 and 14 had more than 20 species/site.

The diversity of Hydrozoa/Cnideria (the corals, anemones etc) was variable through the area (Figure 9), with large numbers of species at sites 2, 4, 6, 9 and 11 (all over, 35 species/site). Other sites generally had between 10 and 20 species, except for Site 14 where only six were recorded.

3.4.3 Community analysis

The four gear types that were commonly used during the NORFANZ survey all caught most of the invertebrate phyla, but the relative proportions of some taxa differed (Figure 10). The fish trawls, not unexpectedly, appeared less efficient at catching or retaining sponges, small animal groups hard on the bottom like Bryozoa, Brachiopoda, annelid worms, and gastropods. Larger bodied taxa (e.g., echinoderms, malacostracan crustaceans such as crabs, prawns, lobsters) were sampled relatively evenly among the four gear types. However, the selectivity for some groups meant that subsequent biodiversity analyses here are presented for only the Sherman sled, as that was used at most sites.

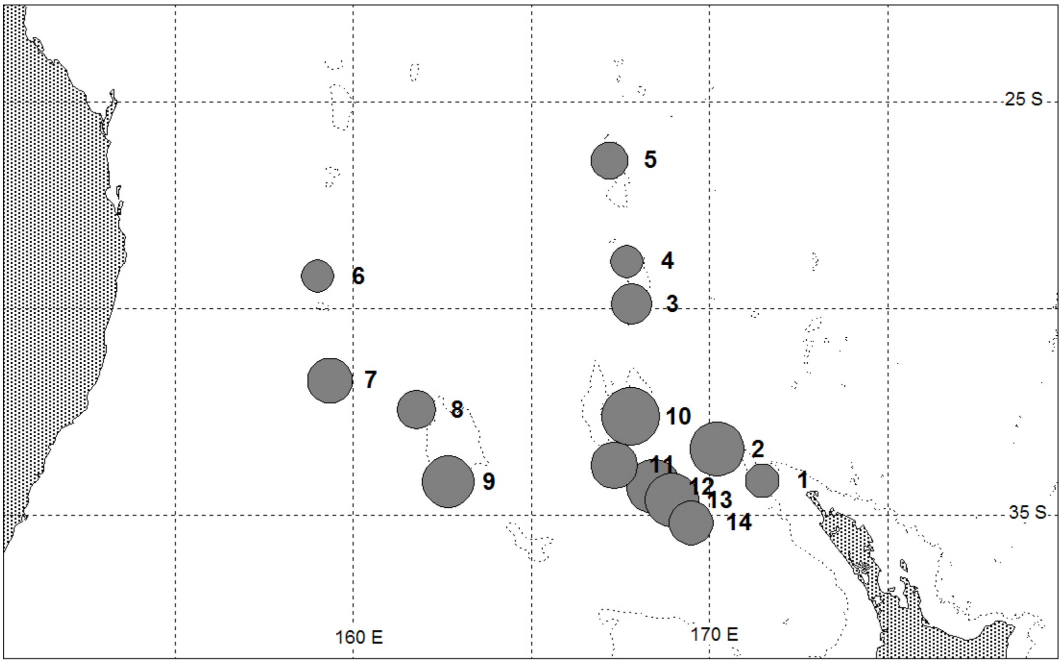


Figure 6: Crustacean (Malacostraca) diversity (number of species/OTUs) by site (labelled). The circle area is proportional to the number of species (maximum = 76 at site 10).

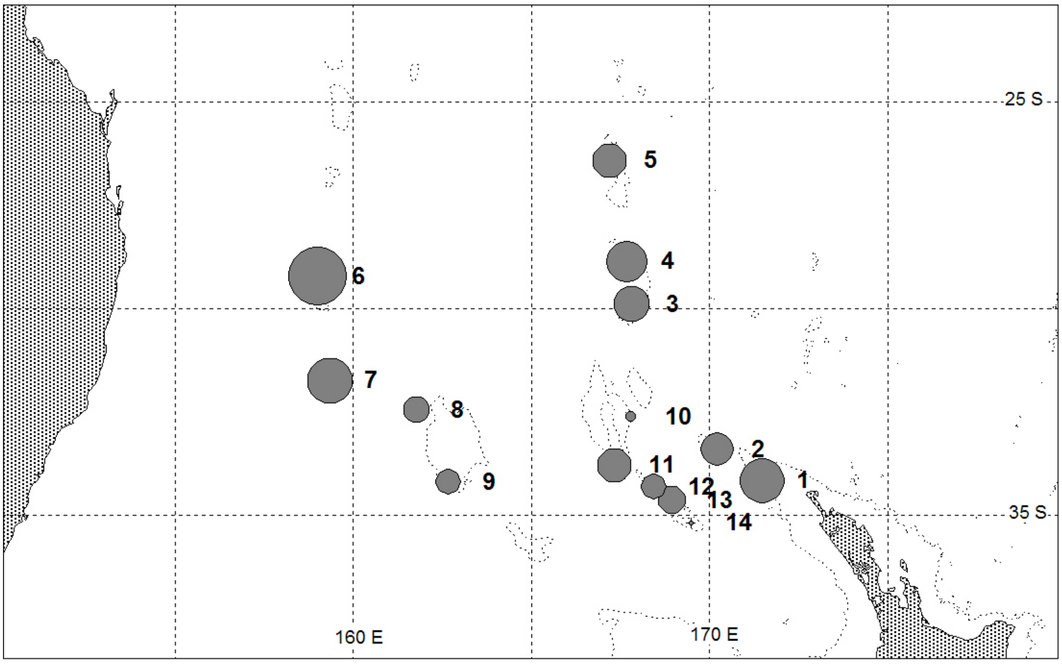


Figure 7: Sponge diversity (number of species/OTUs) by site (labelled). The circle area is proportional to the number of species (maximum = 73 at site 6).

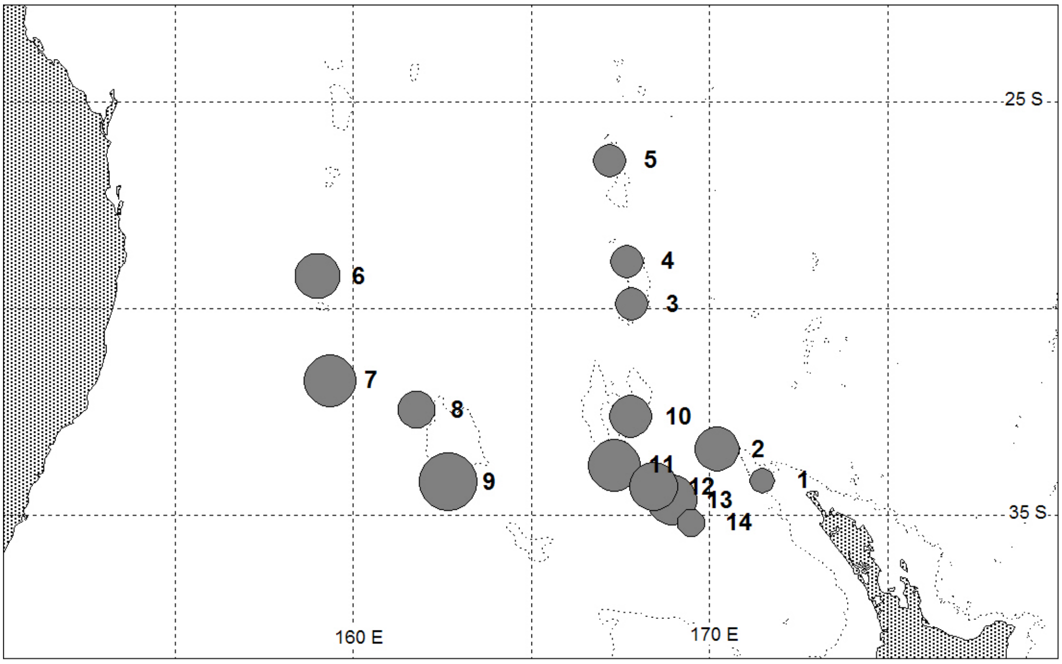


Figure 8: Echinoderm diversity (number of species/OTUs) by site (labelled). The circle area is proportional to the number of species (maximum = 62 at site 9).

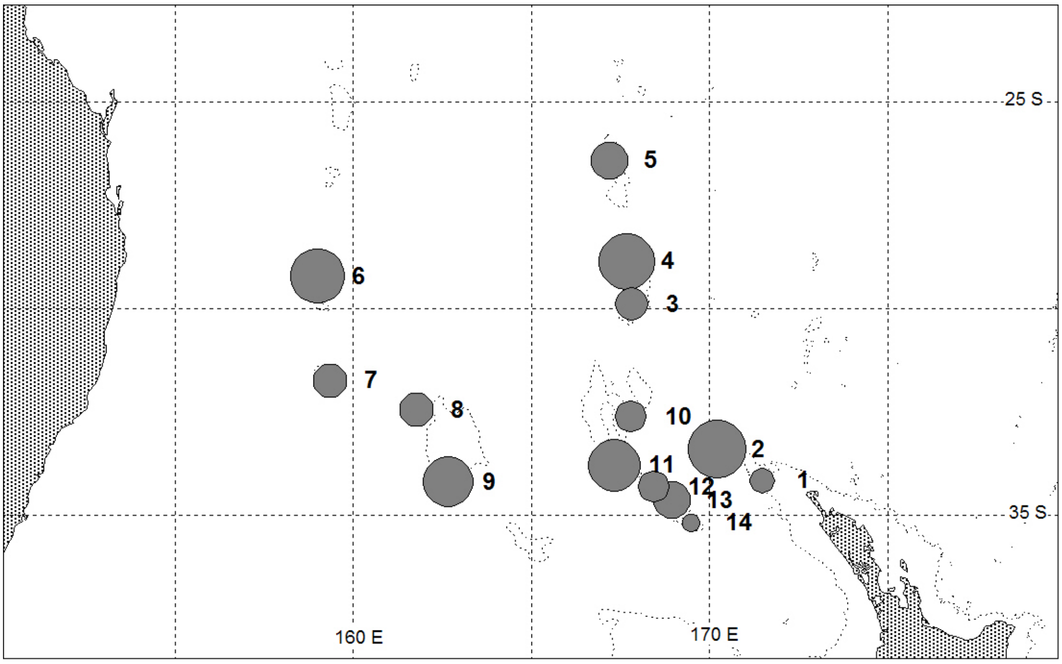


Figure 9: Coral and anemone diversity (number of species/OTUs) by site (labelled). The circle area is proportional to the number of species (maximum = 50 at site 2).

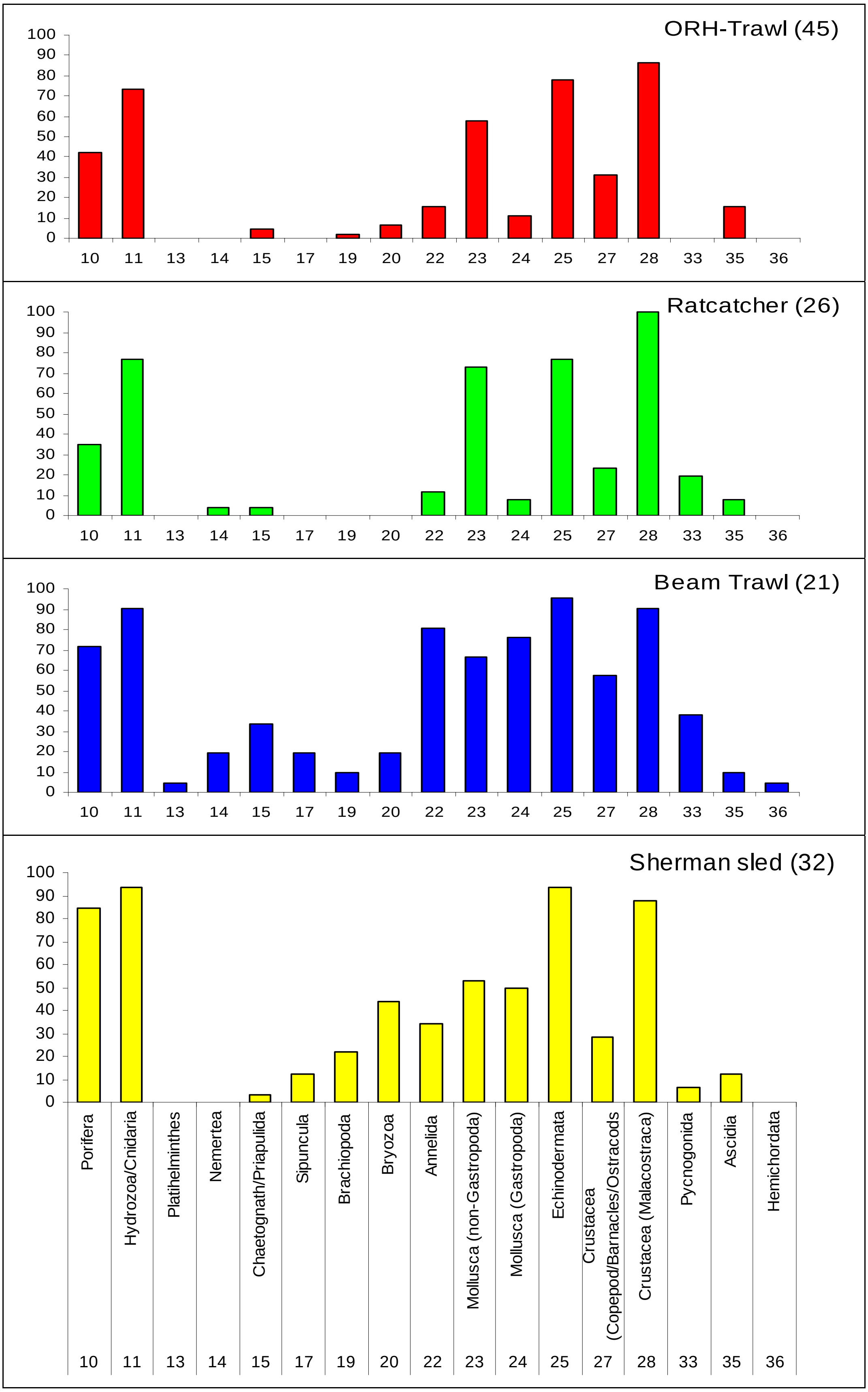


Figure 10: Selectivity of the 4 main gear types (note, "Ratcatcher" = wing trawl). The histograms show the percentage of stations where each phylum was caught (from Williams et al. 2006a).

Sherman sled catches comprised 32 samples and 679 OTUs. Multivariate analyses separated the northern Norfolk Ridge and the Lord Howe Rise from the Lord Howe Plateau and southern Norfolk Ridge areas (Figure 11). The red line shows the major break in this dendrogram between the areas. This north-south split corresponds to differing oceanographic conditions where the southern areas are in subtropical water (and the Tasman Front), while those to the north are in more tropical waters.

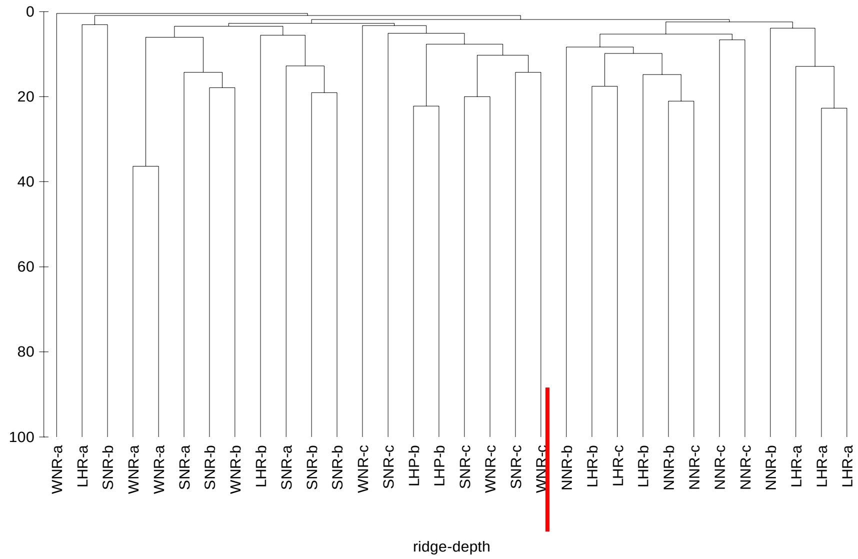


Figure 11: Dendrogram showing between-sample similarity based on data from all invertebrate OTUs from the Sherman sled samples (stations with <5 species were excluded). The area codes are further labelled with depth (a=<500 m; b=500–1000 m; c=>1000 m). From Williams et al. (2006a).

Depth was another major factor affecting community structure. The secondary splits in the Figure 11 dendrogram correspond closely with sample depth. Williams et al. (2006a) used maximum depth of each sample to clearly show the split in clusters at about 700 m (Figure 12). This is shown by the green lines drawn on the dendrogram.

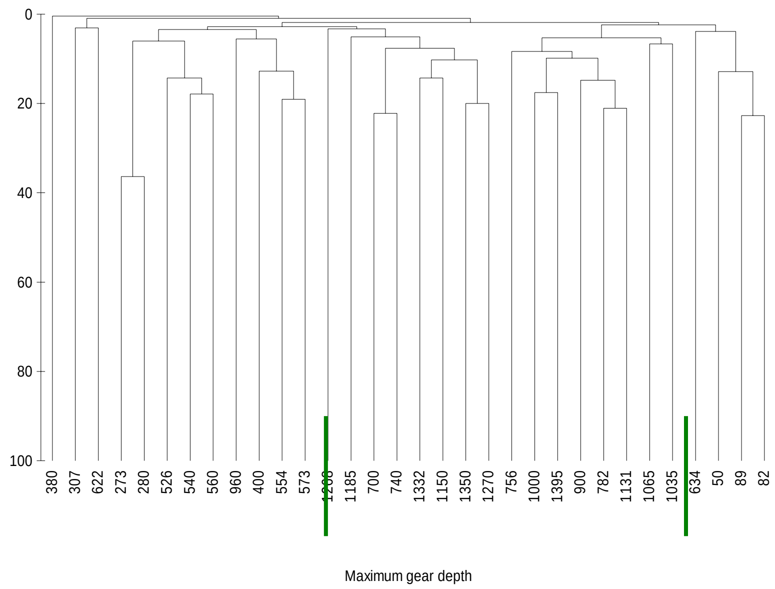


Figure 12: Dendrogram showing between-sample similarity based on data for all invertebrate OTUs from the Sherman sled samples (stations with <5 species excluded). Samples are labelled with maximum gear depth. From Williams et al. (2006a).

These two results are combined in an MDS plot where points are coded by ridge system, and bubble size represents depth (Figure 13). This plot uses the previous red and green lines to show the relationships. Williams et al. (2006a) further used the BIO-ENV and ANOSIM routines in PRIMER to determine which physical variables best explained the overall pattern. Depth and latitude were the main explanatory variables, but the correlation values were low.

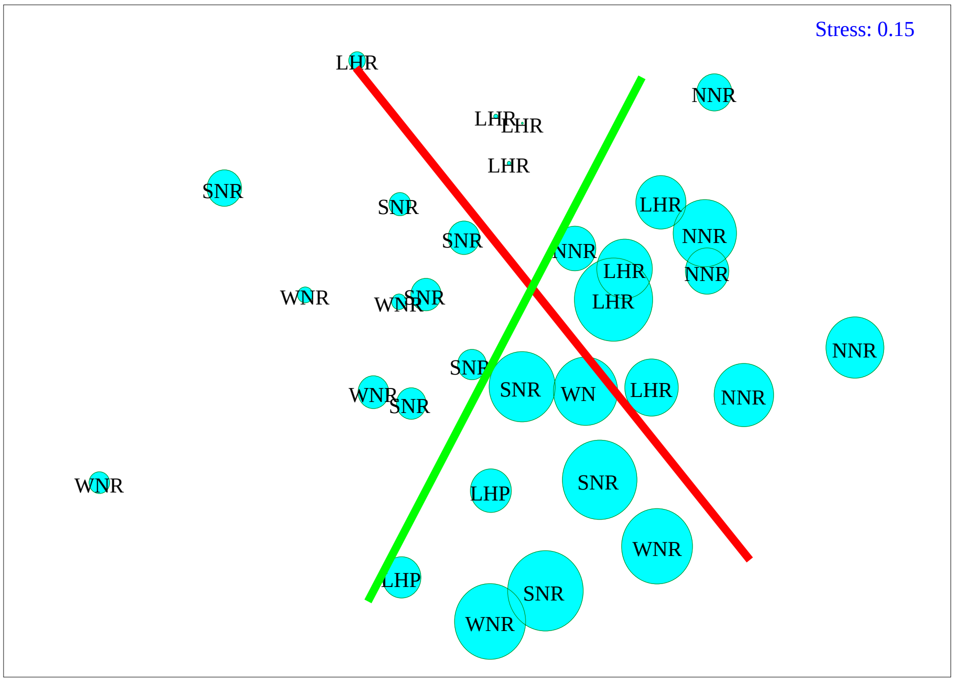


Figure 13: MDS plot showing between-sample similarity for invertebrate data from Sherman sled catches. Points are coded for area, and the size of the bubble is proportional to depth (larger the bubble, greater the depth). From Williams et al. (2006a).

3.5 Biodiversity of fishes

3.5.1 Taxonomic diversity

Fish diversity totalled 29 orders, 120 families, 326 genera, and 590 species (Table 6). Groups with the highest diversity, in terms of species number, were the Perciformes and Gadiformes, together making up almost 30% of the total number of reported species.

A checklist of fish species recorded onboard is given as Appendix 4.

Species diversity recorded by the survey is a minimum estimate. Fish species "accumulation curves" show no indication of an asymptote, either when raw data were plotted by depth strata, or when randomised and plotted by region (Figure 14). Although there is a correlation between area and diversity, which is not accounted for here, no site showed any tendency to approach a maximum. Therefore the species diversity shown by the fish samples are not an accurate measure of actual diversity. More intensive sampling would be required at these 14 sites to describe the true level of biodiversity.

Gear differences also affect estimates of biodiversity. It was known at the outset that the various gear used had biases with respect to the type of fauna they sampled. Species number by gear type are summarised in Table 7. The wing trawl was the most effective trawl for sampling fishes. The total number of fish species caught was similar between the ORH and wing trawls, but the mean number of species per station was much higher for the latter.

Table 6: Taxonomic diversity of fishes identified during NORFANZ voyage (*n* = 590). Ordinal classification follows Eschmeyer (1998), familial classification taken from CAAB family codes.

Order		No. Families	%	No. Genera	%	No. Species	%
Perciformes		27	22.5	61	18.7	88	14.9
Gadiformes		3	2.5	30	9.2	84	14.2
Stomiiformes		8	6.7	31	9.5	66	11.2
Myctophiformes		2	1.7	19	5.8	52	8.8
Osmeriformes		4	3.3	19	5.8	34	5.8
Squaliformes		2	1.7	10	3.1	28	4.7
Aulopiformes		12	10.0	19	5.8	28	4.7
Scorpaeniformes		6	5.0	17	5.2	28	4.7
Anguilliformes		7	5.8	18	5.5	27	4.6
Lophiiformes		9	7.5	15	4.6	24	4.1
Tetraodontiformes		4	3.3	14	4.3	19	3.2
Beryciformes		5	4.2	9	2.8	17	2.9
Carchariniformes		3	2.5	6	1.8	14	2.4
Stephanoberyciformes		1	0.8	6	1.8	12	2.0
Rajiformes		2	1.7	7	2.1	11	1.9
Zeiformes		5	4.2	8	2.5	11	1.9
Chimaeriformes		2	1.7	4	1.2	9	1.5
Ophidiiformes		2	1.7	9	2.8	9	1.5
Pleuronectiformes		3	2.5	6	1.8	8	1.4
Notacanthiformes		2	1.7	5	1.5	7	1.2
Syngnathiformes		3	2.5	5	1.5	6	1.0
Hexanchiformes		1	0.8	1	0.3	1	0.2
Torpediniformes		1	0.8	1	0.3	1	0.2
Saccopharyngiformes		1	0.8	1	0.3	1	0.2
Gonorynchiformes		1	0.8	1	0.3	1	0.2
Siluriformes		1	0.8	1	0.3	1	0.2
Lampriformes		1	0.8	1	0.3	1	0.2
Gobiesociformes		1	0.8	1	0.3	1	0.2
Cetomimiformes		1	0.8	1	0.3	1	0.2
Totals	29 orders	120		326		590	

Table 7: Comparative effectiveness of sampling gear type for fish species

	ORH trawl	Wing trawl	Beam trawl	Sherman	MWT
Stations	48	27	21	36	4
Max spp/stn	35	46	35	13	64
Min spp/stn	0	12	0	0	40
Mean spp/stn	13.8	31.3	10.7	2.8	48.0
Total no. species	293	291	152	78	123
Total no. specimens	6 152	35 650	2 921	161	1 328

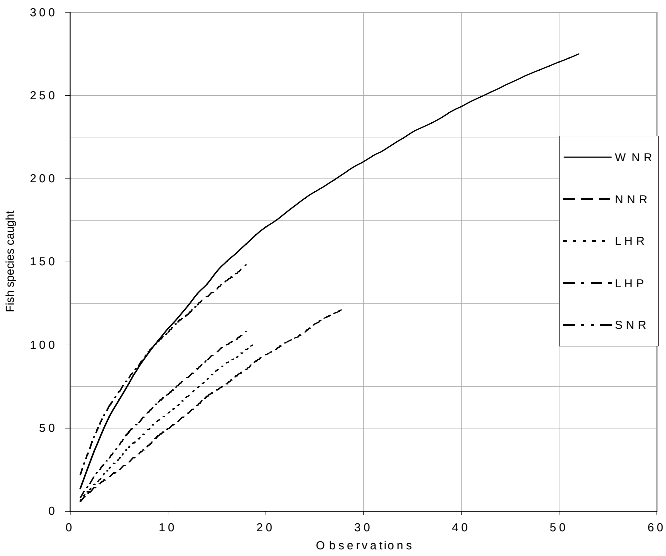


Figure 14: Cumulative species curves for fish by region (data randomised).

The relative abundance of fish species varied widely. Three species accounted for 33% of the total catch, with more than 1 t of each being caught (Table 8). These were shovelnose dogfish (*Deania calcea*), the slickhead *Rouleina attrita*, and southern boarfish (*Pseudopentaceros richardsoni*). Ribaldo (*Mora moro*) and redbait (*Emmelichthys nitidus*) were also sampled in relatively large quantities, with total catches over 500 kg.

This uneven abundance was reflected in two further statistics where over 30% of the fish species were represented by a single specimen (Figure 15), and a large proportion of the species were recorded at only one station (Figure 16).

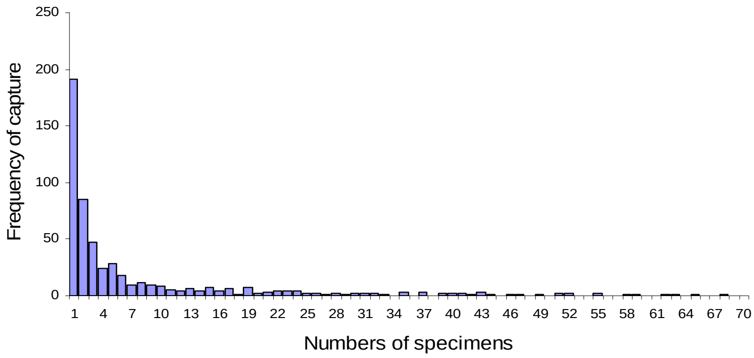


Figure 15: Number of fish specimens per species sampled

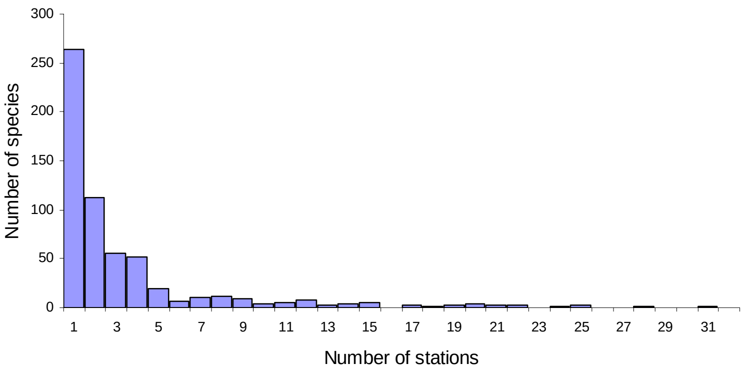


Figure 16: Frequency of capture of fish species

Table 8: Summary of number and weight of the most abundant fish species sampled.

Species name	No. specimens	Total wt. (kg)
Caelorinchus acanthiger	68	18.9
Caelorinchus ?cookianus (juvs)	72	1.02
Centroscymnus (cf owstoni) sp NFZ1	74	240.1
Chauliodus ?sloani	77	2.66
Hoplostethus ?mediterraneus (= *?intermedius*)	82	9.25
Cyclothone spp	87	0.06
Caelorinchus celaenostomus	87	74.3
Apristurus spA [in Last & Stevens 1994]	88	42.8
Antimora rostrata	92	23.3
Diaphus termophilus	94	0.34
Caelorinchus cookianus	99	4.75
Halosaurus pectoralis	102	21.31
Bathypterois longifilis	103	21.7
Coryphaenoides striaturus	111	20.66
Chauliodus sloani	112	2.25
Trachonurus gagates	116	26.3
Zenopsis nebulosus	117	123.9
Etmopterus lucifer	138	34.7
Hoplostethus atlanticus	149	116.2
Rouleina guentheri	180	26.2
Rouleina eucla	200	63.9
Coryphaenoides serrulatus	204	44.88
Beryx splendens	211	96.4
Halargyreus johnsonii	214	151.8
Gadomus aoteanus	215	33.6
Alepocephalus ?antipodianus	245	262.1
Pterygotrigla pauli	292	69.5
Scopelopsis multipunctatus	299	1.1
Bathygadus cottoides	312	8.11
Rexea antefurcata	339	54.3
Zenion spB	350	2.5
Caprodon spC	357	34.7
Helicolenus barathri	404	98.35
Pseudopentaceros richardsoni	437	1187.4
Deania cf calcea	546	1568.9
Diaphus spB	547	16.7
Caelorinchus innotabilis	561	27.08
Mora moro	594	740.11
Allocyttus verrucosus	641	356.4
Diastobranchus capensis	698	496.8
Allomycterus pilatus	710	521.5
Caelorinchus mycterismus	712	147.3
Neoscopelus macrolepidotus	742	58.13
Alepocephalus australis	855	431.31
Cetonurus globiceps	1 164	224.5
Rouleina attrita	2 789	1 491.91
Hoplostethus intermedius	5 109	628
Macroramphosus scolopax	5 140	79.7
Emmelichthys nitidus	15 091	645.05

3.5.2 Distribution

The diversity of taxa differed between sites. General notes on number of species/OTUs, and the main taxa, by site are given in Table 9. Species diversity ranged between 15 and 154 species/OTUs per site. Greatest diversity was on the Wanganella Bank (site 10), with the southern sites of both Lord Howe (sites 7, 8, 9) and Norfolk Ridges (sites 11-14) having higher species diversity than northern sites (Figure 17).

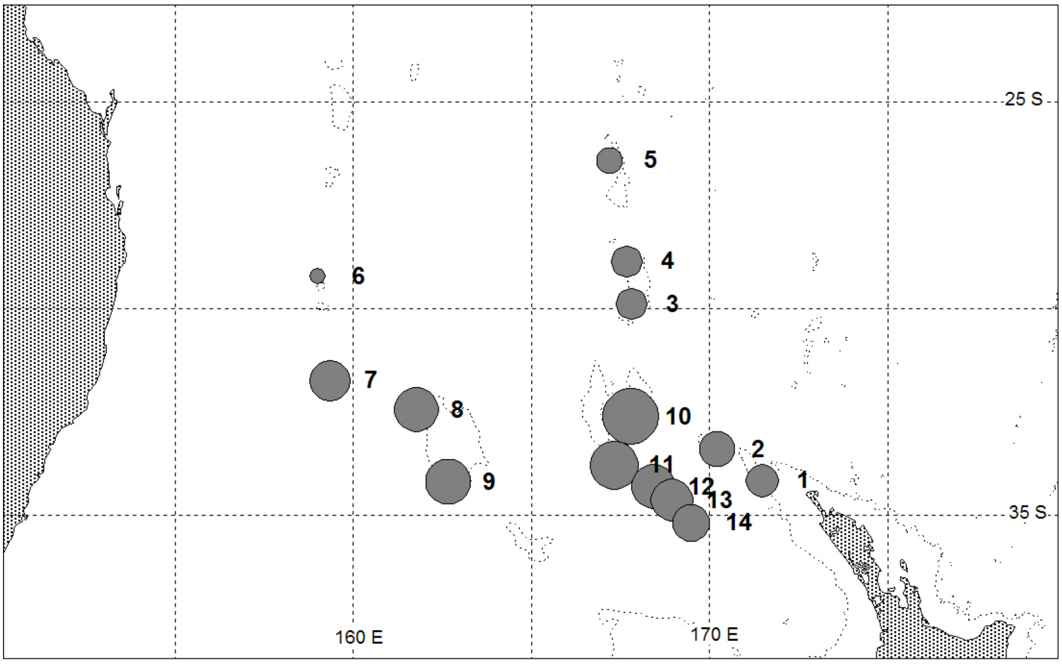


Figure 17: Fish diversity (number of species/OTUs) by site (labelled). The circle area is proportional to the number of species (maximum = 154 at site 10).

The pattern of diversity changes when species totals are corrected for sampling effort (Table 10). Mean number of species per station per site ranges from less than 1 to over 13, and number per n.mile towed from 4 to 10. Overall site 12 was the most diverse. These values include all sampling gear types, and give only a general indication of "relative diversity" of the taxa.

Table 10: Summary of fish species diversity by site, with adjustment for sampling effort.

Site	No. OTUs	No. stns	Distance	OTUs/stn	OTUs/n.mile
				6.9	7.0
1	55	8	7.84	6.5	5.5
2	65	10	11.78	4.8	7.0
3	53	11	7.54	4.7	4.6
4	52	11	11.20	6.2	6.2
5	37	6	5.99	1.4	4.3
6	15	11	3.50	9.6	8.5
7	86	9	10.16	13.4	6.3
8	94	7	14.84	9.3	5.2
9	102	11	19.61	9.1	5.5
10	154	17	28.11	10.5	5.8
11	115	11	19.69	10.8	7.7
12	97	9	12.67	13.3	10.4
13	93	7	8.95	8.9	6.4
14	71	8	11.02	6.9	7.0

Table 9: Summary of fish biodiversity by site.

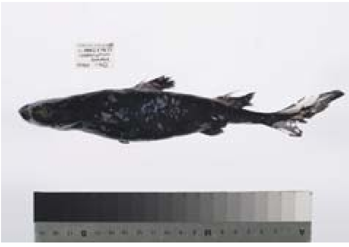
Site	No. species/OTU (weight kg)	Fishes description, most abundant species.
1	55 (152)	Most abundant: slickhead *Rouleinia eucla*, silver roughy *Hoplostethus ?mediterraneus* and rubyfish *Plageiogenion rubiginosus*. Probable new species: *Bathygadus.*
2	65 (409)	Silver roughy, *Rexea antefurcata*, *Helicolenus barathri*, *Lepidopus caudatus*, *Rouleina attrita*. Probable new species: *Chimaera*, paraulopid.
3	53 (110)	Slickheads *Alepocephalus antipodianus* and *Rouleina attrita.* Probable new species: *Paraulopus*, *Halieutaea*, *Caelorinchus*, *Hypoplectrodes*.
4	52 (101)	Small catches, possible new species: *Plectranthias.*
5	37 (15)	Small catches, trawling difficult. Probable new species: *Dibranchus* sp. A.
6	15 (5)	Rare species: *Parinoberyx horridus* (known previously only from holotype taken at Kelso Bank). Probable new species: *Malthopsis* sp. A, *Physiculus* spp., *Hoplostethus cf. gigas*, *Plectranthias* spp.
7	86 (282)	Redfish *Centroberyx* sp. B, *Polyplacapros tyleri*. Probable new species: *Mustelus*, *Chaunax* spp., *Malthopsis*, *Centroberyx*, *Maxillocosta*, *Plectranthias*.
8	94 (743)	Rattails *Cetonurus globiceps* and *Caelorinchus innotabilis.* Probable new species: *Notoraja*, Rajiidae ngen, *Chimaera*, *Chaunax* spp.
9	102 (1215)	Diverse site. Silver roughy, basketwork eel *Diastobranchus capensis*, alfonsino *Beryx splendens*, slickhead *Alepocephalus australis*. Probable new species: Rajidae ngen, *Physiculus*, *Euclichthys*, *Tripterophycis* spp. *Symphurus* spp.
10	154 (3893)	Most diverse site overall. Redbait *Emmelichthys nitidus*, spikefish *Macroramphosus scolopax*, *Rouleina attrita*, pufferfish *Allomycterus pilatus*. Probable new species: *Cephaloscylium*, *Mustelus*, *Deania*, Rajidae ngen, *Chimaera*, *Hime*, *Caprodon*, *Parapercis* spp., *Lophonectes*.
11	115 (1458)	Most abundant: silver roughy, warty oreo *Allocyttus verrucosus*, blackchin *Neoscopelus macrolepidotus*, shovelnose dogfish, rattail *Caelorinchus mycterismus*. Probable new species: Rajidae ngen, *Dipturus*, *Dibranchus*, *Psychrolutes*, *Psednos*, *Kali*.
12	97 (1457)	Most abundant: ribaldo *Mora moro*, blackchin, rattail *C. mycterismus*, shovelnose dogfish, silver dory *Zenopsis nebulosus*. Probable new species: *Deania*, Rajidae ngen nspp., *Chimaera*, *Chaunax*, *Caelorinchus*, *Psychrolutes*, *Symphurus*.
13	93 (2014)	Most abundant: boarfish *Pseudopentaceros richardsoni*, blackchin, seaperch *Helicolenus barathri*, rattail *C. mycterismus*. Probable new species: *Parmaturus*, Rajidae ngen nspp., *Chimaera* spp., *Chaunax* spp., *Tripterophycis*, *Caelorinchus*, *Psychrolutes*, *Symphurus*.
14	71 (560)	Most abundant: shovelnose dogfish *Deania cf. calcea*, slickheads *Alepocephalus australis*, *Rouleinia guentheri*, blackchin, rattails *Cetonurus globiceps* and *C. innotabilis*. Probable new species: Rajidae ngen nspp., *Leptoderma*, *Chaunax* spp.
MWT	123 (12)	Common: *Scopelopsis multipunctatus*, *Diaphus termophilus*, *Nannobrachium* spp. Rare species: *Pelagocephalus marki (?= coheni)* previously known only from type specimens. Probable new species: *Bonapartia, Eustomias*, *Melanostomias*, *Leptostomias*, *Caelorinchus*.
DWT	98 (352)	Most abundant: basketwork eel, slickheads *Alepocephalus australis*, *Rouleina attrita* and *Narcetes stomias*, rattails *Coryphaenoides striaturus* and *Bathygadus cottoides*. Probable new species: *Bathyraja*, Alepocephalidae and *Psychrolutes*.

A selection of images of many of these and other fish species referred to in the following section is given in Figure 18.

Stn016-*Apristurus* sp E

Stn3-*Deania* cf *calcea*

Stn073-*Centroscymnus owstoni*



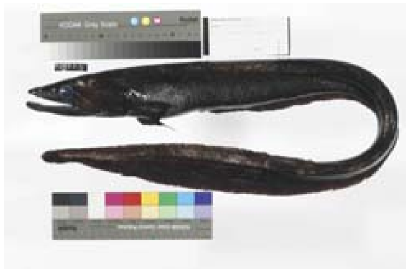
Stn160-*Centroscyllium kam.*

Stn119-*Apristurus* cf *herklotsi*

Stn105-*Dipturus* NFZ

Stn003-*Hydrolagus* sp A

Stn079-*Chimaera* sp NFZ1



Stn003-*Diastobranchus*

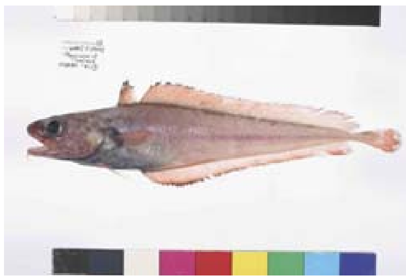
Stn047-*Bathysaurus ferox*

Stn-003-*Alepocephalus australis*

Stn080-*Rouleina eucla*

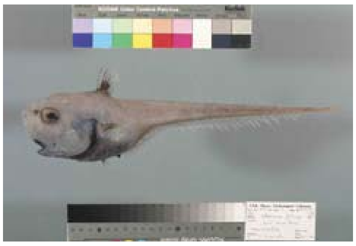
Stn081-Ribaldo *Mora moro*

Stn154-*Tripterophycis gilchristi*



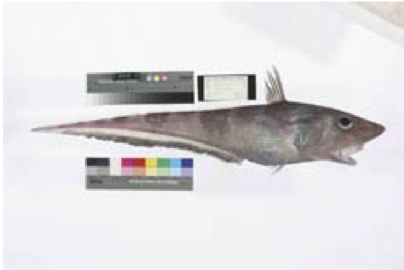
Stn133-*Physiculus* cf *luminosus*

Figure 18: A selection of images of fish species taken during NORFANZ.



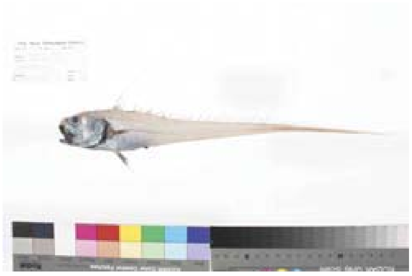
Stn072-*Cetonurus globiceps*

Stn016-*Nezumia coheni*

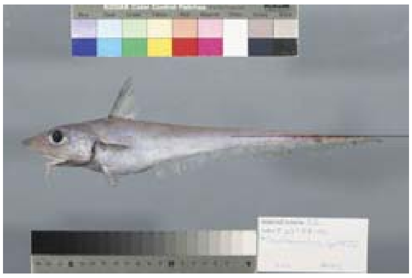


Stn017-*Caelorinchus* sp1

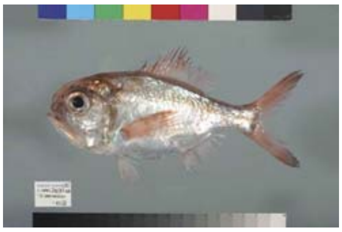
Stn029-*Nezumia propinqua*



Stn070-*Gadomus aoteanus*



Stn113-*Caelorinchus* sp NFZ2



Stn081-*Hoplostethus* int/med

Stn079-*Hoplostethus atlanticus*

Stn068-*Centroberyx* spA

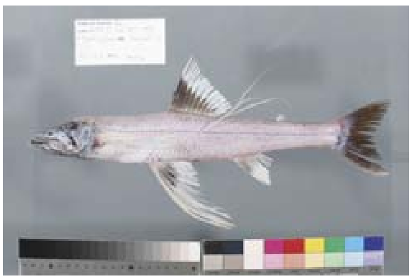
Stn074-*Allocyttus verrucosus*

Stn019-*Antigonia* sp1

Stn061-*Plectranthias* sp C

Stn023-*Pelagocephalus ?marki*

Stn103-*Aldrovandia affinis*

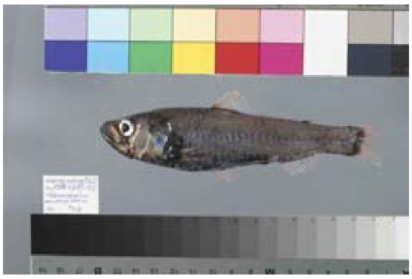


Stn114-*Bathypterois longifilis*

Figure 18 (cont).


Stn123-Rajidae n.gen n.sp


Stn068-*Allomycterus pilatus*


Stn063-*Neoscopelus*

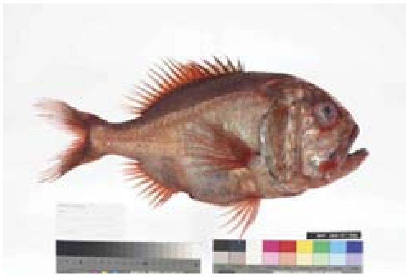

Stn064-*Chaunax* spB

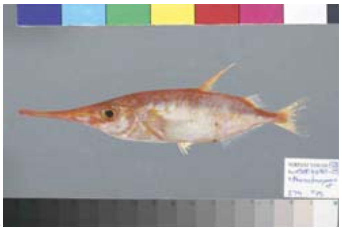

Stn043-*Dibranchus* spD


Stn066-*Malthopsis* sp.

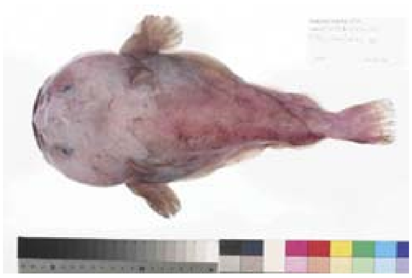

Stn090-*Halargyreus johnsonii*

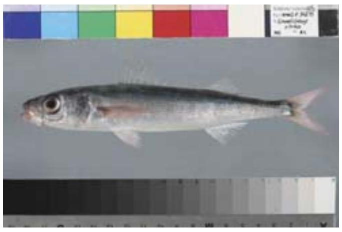

Stn049-*Parinoberyx horridus*


Stn058-*Hoplostethus* cf *gigas*


Stn105-*Macroramphosus*


Stn079-*Trachyscorpia capensis*


Stn096-*Psychrolutes* sp


Stn105-*Emmelichthys nitidus*


Stn001-*Plagiogenion rubiginosus*


Stn128-*Pseudopentaceros richardsoni*

Figure 18 (cont).

In general, the southern half of the survey area was richer in total numbers of fish species than the northern half. However, there was a strong positive correlation between number of species sampled and sampling intensity (measured variously as number of trawl stations, distance towed, hours towed, and area swept) (Table 10). The more effort that was put into a site, generally the higher the number of species sampled. Hence, site 10 (Wanganella Bank) had the greatest number of fish species (154), but also the greatest number of biological stations (17). When species diversity was corrected for effort, the patterns of diversity changed, and some areas were richer in terms of species per sampling effort (Figure 19). However, this result is confounded by the bottom at northern stations (Northern Norfolk Ridge, Middleton Reef seamount,) being too rough for trawl nets to work effectively.

Comparison of mean numbers of species per site indicated that the southern NORFANZ area was richer than the northern (SNA>NNA, t-test, $p<0.01$), but there was no significant difference between the Norfolk Ridge (NRT) and Lord Howe Rise (LHR).

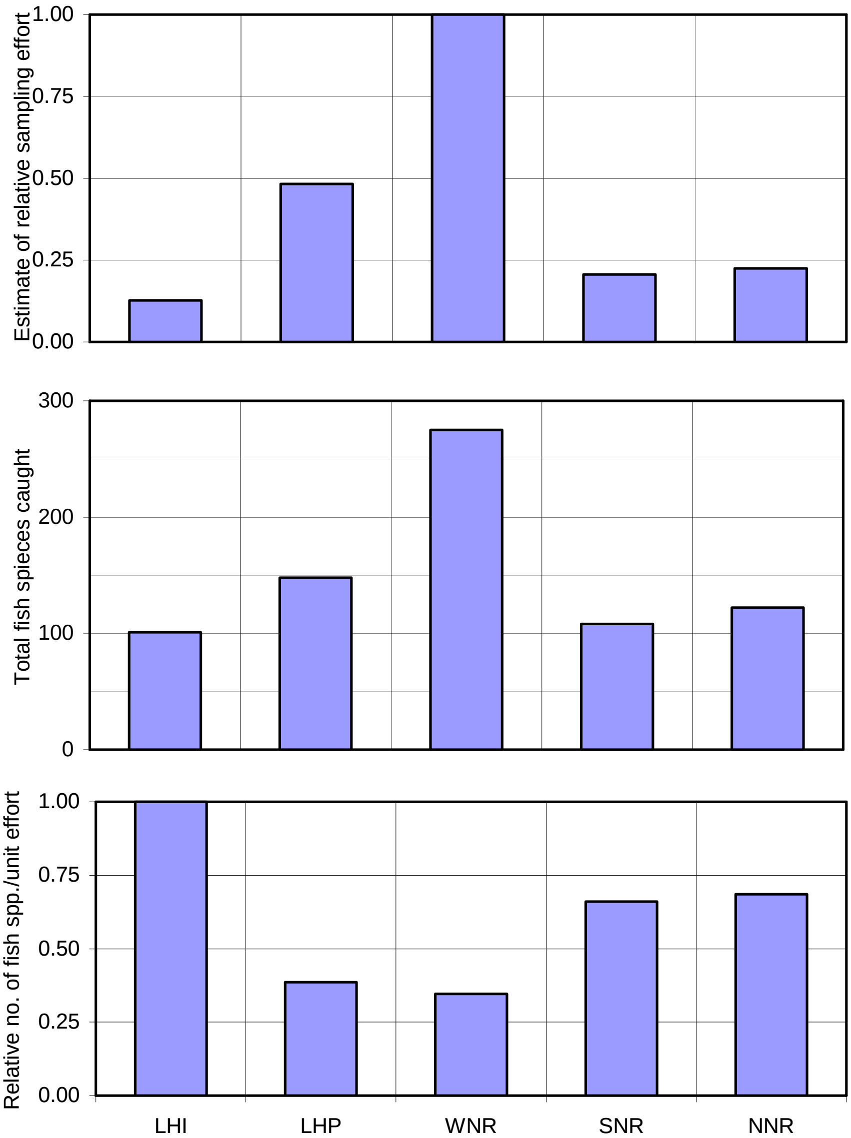


Figure 19: Relationship between number of fish species caught and sampling effort in the five main areas of the NORFANZ voyage. Number of biological sample stations for each area are: LHI, 16; LHP, 18; WNR, 44; SNR, 18; NNR, 20.

Four main distribution patterns amongst fishes can be recognised: 1) widespread; 2) southern; 3) Norfolk Ridge; and 4) restricted.

Widespread species distributions: Fish species which were recorded from 10 or more stations are listed in Table 11. These 49 species vary in their distribution and abundance, with some being frequently caught in large numbers, while others occurred in low abundance.

The most widespread species collected was the basketwork eel, *Diastobranchus capensis* (Figure 20). It occurred at depths between 785 and 1789 m on the Reinga Ridge, West Norfolk Ridge, and Lord Howe Plateau, extending northwards as far as Norfolk Island, the seamount north of Middleton Reef, and station 47 (deep trawl) at 28°29'S, 161°15'E. It was absent from all stations north of Norfolk Island and all stations at Lord Howe Island. Some of these were too shallow for this deepwater species, but nine stations along the northern Norfolk Ridge sampled the bottom at over 800 m in depth. Most of these stations were on very hard rocky bottoms, so this absence may reflect a habitat preference. Alternatively, the species may be at its northern limit since it is not recorded from New Caledonian waters (Rivaton et al. 1989).

Several other fish species have similar distributions to the basketwork eel, but none are as abundant. Examples of scattered widespread distributions are: halosaur (*Aldrovandia affinis*) taken at depths of 1132-1530 m throughout West Norfolk Ridge, on the Lord Howe Plateau and east of Lord Howe Island (Figure 21); rattail (*Nezumia propinqua*) (690–1000 m depth) extending from the Western Norfolk Ridge to the northern Norfolk Ridge, site 6 and the Lord Howe Plateau (Figure 22); slickhead (*Rouleina attrita*) (1158–1789 m depth), occurring from the southern Norfolk Ridge to south of Norfolk Island and across to station 47 (northeast of Middleton Reef) and the Lord Howe Plateau (Figure 23). Less frequently caught, but widespread, were the deepsea lizardfish (*Bathysaurus ferox*) (1082–1934 m depth) from the southern West Norfolk Ridge to Lord Howe Plateau, Lord Howe island slope and station 47; and morid cod (*Tripterophycis gilchristi*) (521–938 m) occurring at the West Norfolk Ridge and site 6 north of Middleton Reef. These species are all deepwater fishes that occur in both New Zealand and Australian slope waters, but appear to be absent from the New Caledonian EEZ.

Southern species distributions: The shovelnose dogfish (*Deania* cf. *calcea*) has a southern distribution at depths of 750 to 1350 m. It occurs throughout the West Norfolk Ridge and the Lord Howe Plateau (Figure 24), and is an important bycatch (if the same as *Deania calcea*) in Australian and New Zealand deepwater fisheries. It is not recorded from New Caledonian waters, so is probably at its northern limit in this southern NORFANZ area.

Other elasmobranchs with southern distributions include a shovelnose dogfish of uncertain identity, *Deania* sp. NFZ1, taken at depths of 698–1117 m depth on the West Norfolk Ridge and Lord Howe Plateau (Figure 25). This species is not known outside the area. *Chimaera* NFZ1 (518–1000 m depth) occurred on the Reinga Ridge, West Norfolk Ridge and Lord Howe Plateau (Figure 26). It is also not known outside the area. Black ghostshark (*Hydrolagus* sp. A) was caught at 1051–1345 m depth on the Reinga Ridge, West Norfolk Ridge and Lord Howe Plateau. These stations form a trans-Tasman link for the species, which occurs widely in slope waters of New Zealand and southeastern Australia (including Cascade Plateau and South Tasman Rise) (Last & Stevens 1994).

Silver roughy (*Hoplostethus ?intermedius/H.?mediterraneus*) are probably the same species (Smith & Roberts 2004). Australian ichthyologists name this fish *H. intermedius*, whereas New Zealand ichthyologists name it *H. mediterraneus*, so the distribution (Figure 27) reflects the usage of this nomenclature. It has a wide depth distribution between 435 and 1340 m. The distribution extends from the New Zealand shelf to the Reinga Ridge, West Norfolk Ridge and southern Lord Howe Plateau. Outside the survey area it is distributed widely in New Zealand and southeast Australian outer shelf and slope waters.

Table 11: Widespread fish species, that occurred at 10 or more stations.

Species name	No. stations	Total weight. (kg)
Nezumia namatahi	10	2.1
Trachyscorpia sp. [in ISR Munro collection]	10	18.3
Hymenocephalus nascens	10	1.2
Centroscymnus crepidater	10	35.2
Notacanthus sexspinis	11	4.6
Chaunax spC	11	0.4
Nezumia coheni	11	6.4
Malacocephalus laevis	11	17.5
Sigmops bathyphilum	11	0.6
Sigmops elongatum	12	1.3
Serrivomer spA (silver)	12	0.9
Caelorinchus trachycarus	12	8.4
Caelorinchus acanthiger	12	18.9
Chauliodus ?sloani	12	2.7
Trachonurus gagates	12	26.3
Rouleina eucla	12	63.9
Rouleina attrita	12	1 491.9
Centroscymnus (cf owstoni) sp NFZ1	13	240.1
Caelorinchus cookianus	13	4.8
Malacosteus ?spA	14	0.7
Apristurus spA [in Last & Stevens 1994]	14	42.8
Rouleina guentheri	14	26.2
Helicolenus barathri	14	98.4
Eurypharynx pelecanoides	15	2.3
Etmopterus spB [in Last & Stevens 1994]	15	39.5
Nezumia propinqua	15	1.7
Antimora rostrata	15	23.3
Etmopterus lucifer	15	34.7
Avocettina spA	17	0.8
Synaphobranchus affinis	17	7.2
Neoscopelus macrolepidotus	17	58.1
Coryphaenoides serrulatus	18	44.9
Coryphaenoides striaturus	19	20.7
Hoplostethus atlanticus	19	116.2
Cetonurus globiceps	19	224.5
Bathypterois longifilis	20	21.7
Halargyreus johnsonii	20	151.8
Bathygadus cottoides	20	8.1
Caelorinchus mycterismus	20	147.3
Alepocephalus ?antipodianus	21	262.1
Deania cf calcea	21	1 568.9
Hoplostethus intermedius	21	628.0
Caelorinchus innotabilis	22	27.1
Allocyttus verrucosus	22	356.4
Mora moro	24	740.1
Chauliodus sloani	25	2.3
Alepocephalus australis	25	431.3
Gadomus aoteanus	28	33.6
Diastobranchus capensis	31	496.8

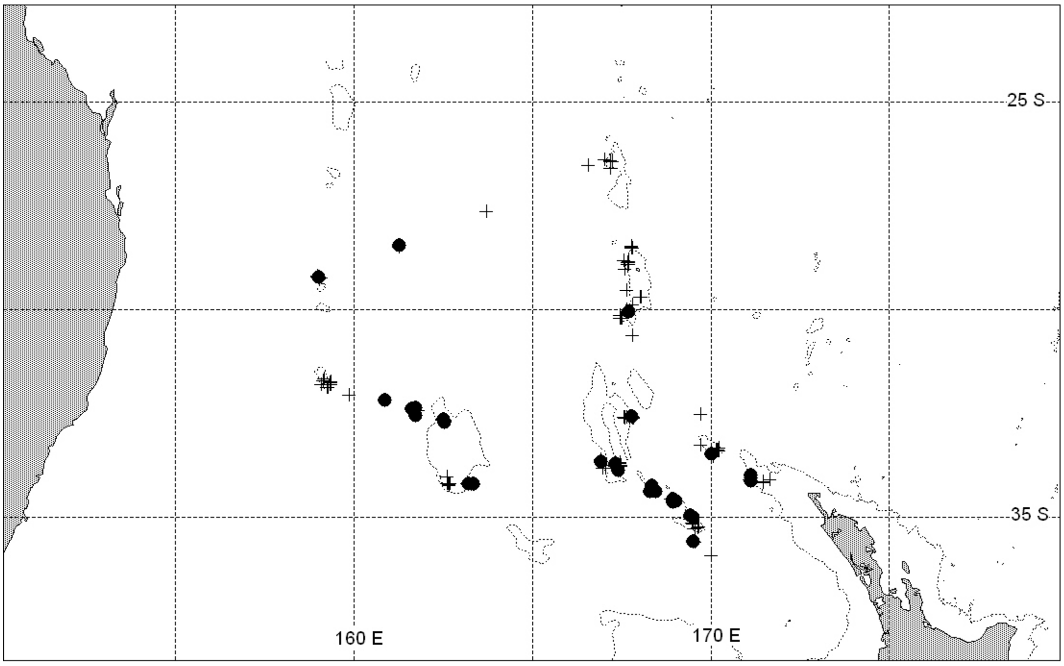


Figure 20: Distribution of basketwork eel (*Diastobranchus capensis*) (●), a widely distributed species (+ = location of sampling station)

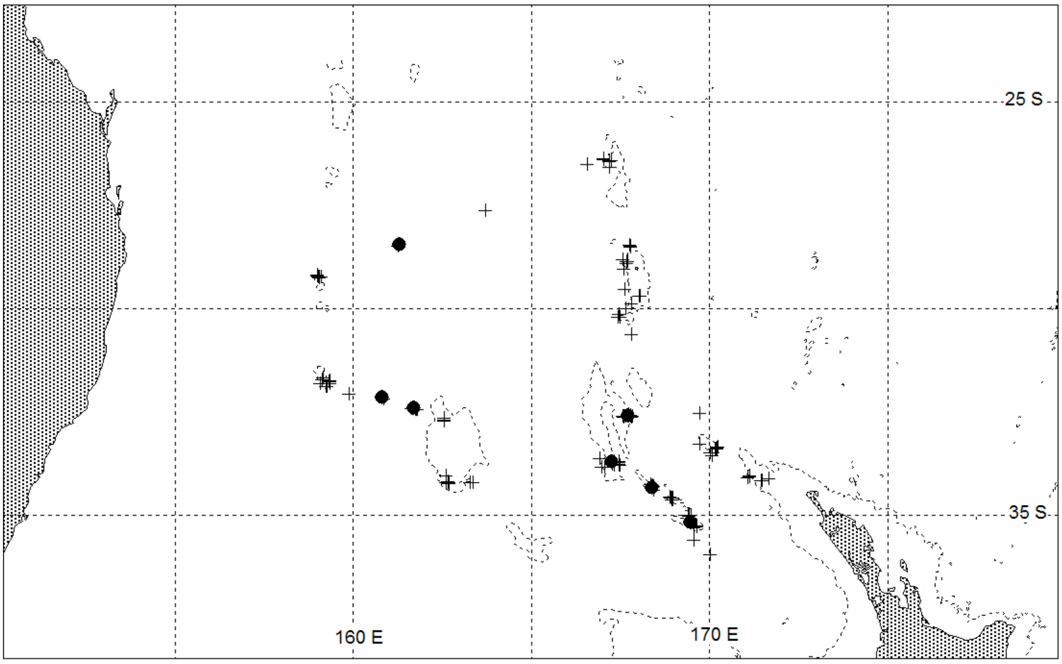


Figure 21: Distribution of halosaur (*Aldrovandia affinis*) (●), a widely distributed species (+ = location of sampling station)

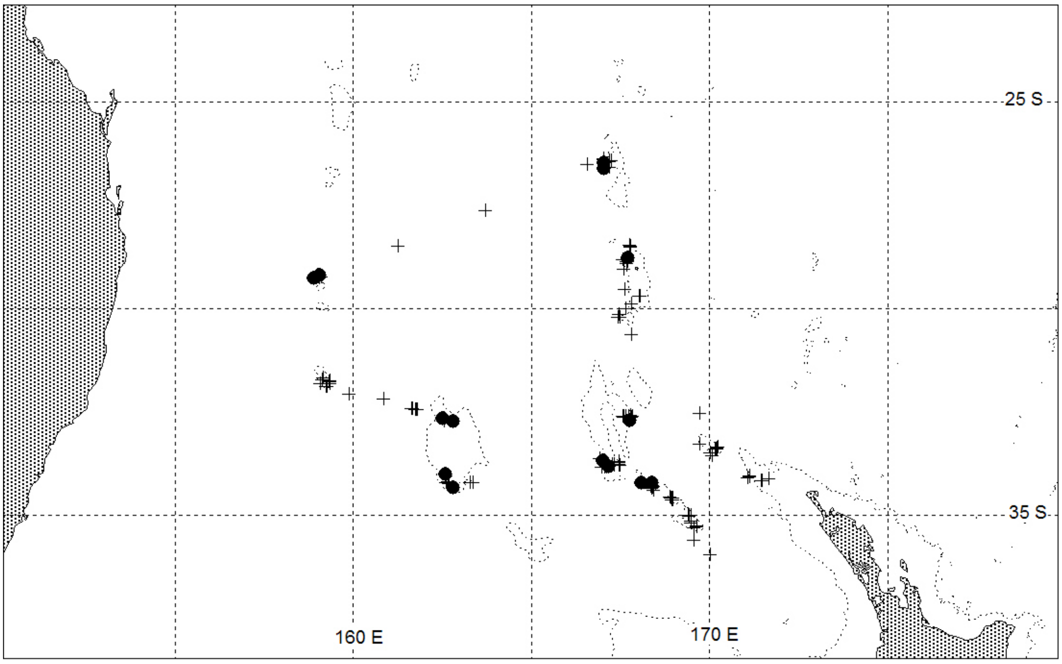


Figure 22: Distribution of the rattail (*Nezumia propinqua*) (●), a widely distributed species (+ = location of sampling station)

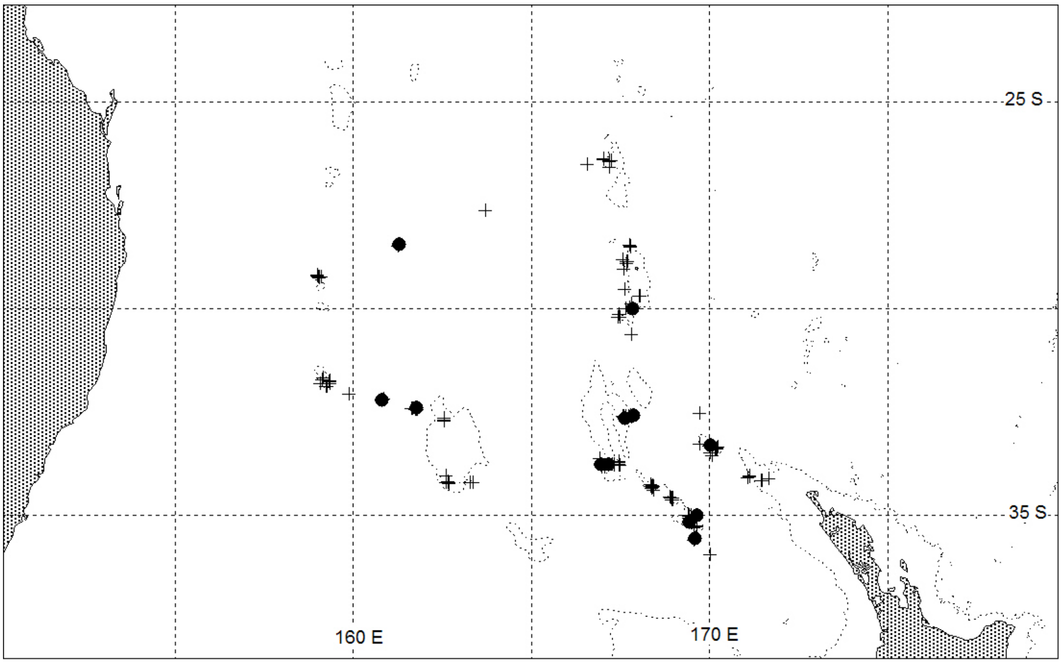


Figure 23: Distribution of the slickhead (*Rouleina attrita*) (●), a widely distributed species (+ = location of sampling station)

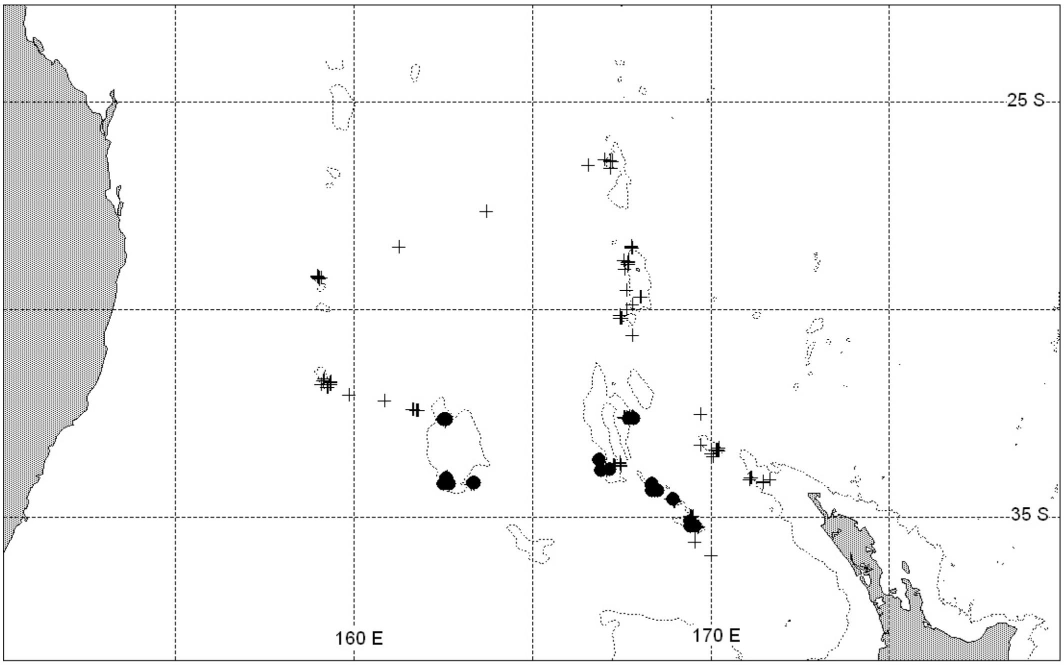


Figure 24: Distribution of shovelnose dogfish (*Deania* cf *calcea*) (●), a southern species.

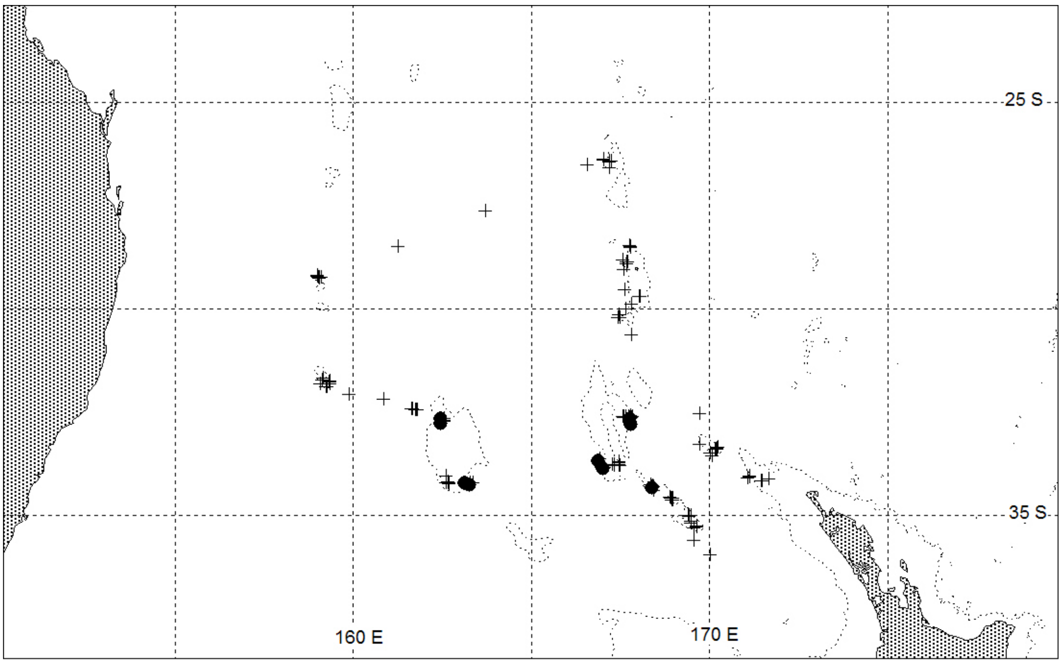


Figure 25: Distribution of shovelnose dogfish (*Deania* sp NFZ1) (●), a southern species.

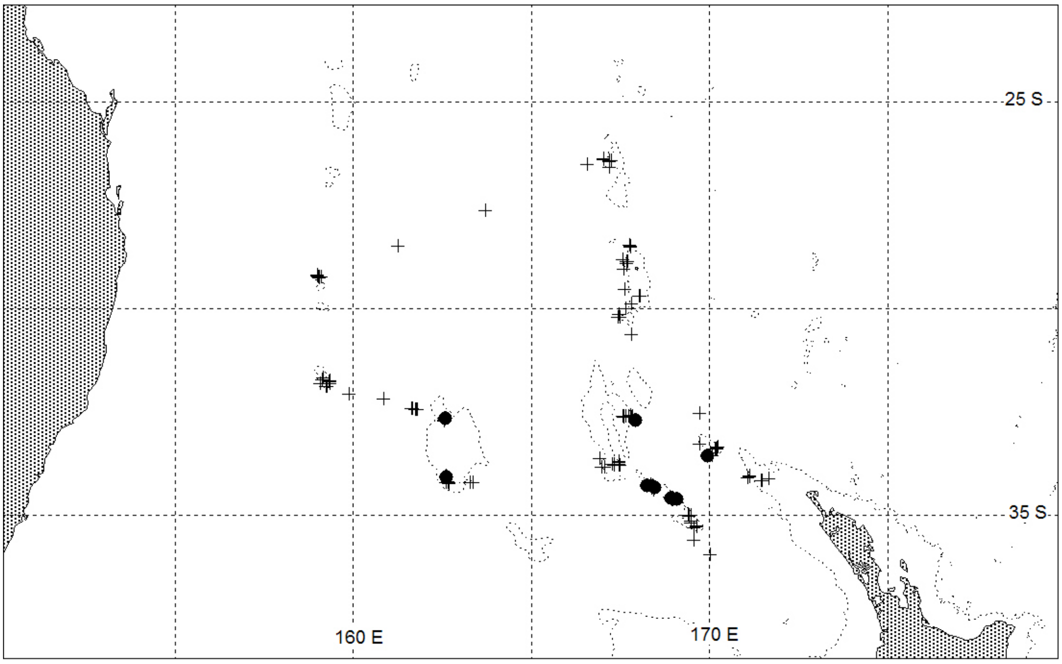


Figure 26: Distribution of the chimaerid (*Chimaera* sp. NFZ1) (●), a southern species.

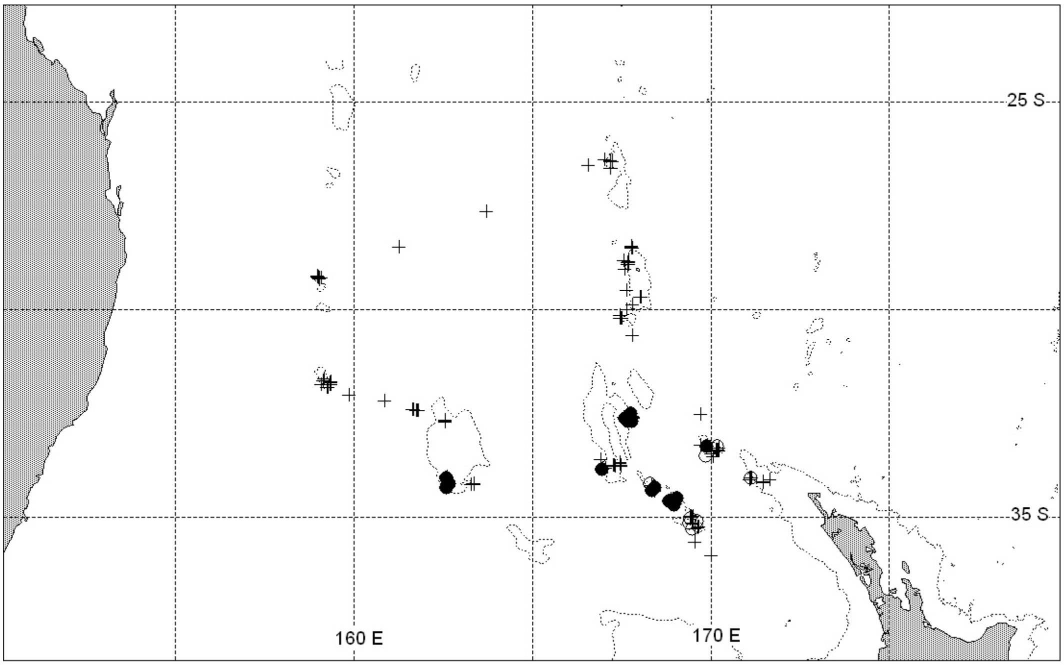


Figure 27: Distribution of silver roughy, (*Hoplostethus ?intermedius*) (●), and *H. ?mediterraneus* (○) (probably the same species), a southern species.

Orange roughy (*Hoplostethus atlanticus*) shows a similar distribution to silver roughy (Figure 28) on the West Norfolk Ridge and Lord Howe Plateau. Orange roughy is widely distributed throughout southern Australian and New Zealand slopes and seamounts. It is not recorded from New Caledonia (Rivaton et al. 1989, Grandperrin et al. 1997a). It appears the southwest Pacific populations are at the northern limit of distribution in the southern NORFANZ area.

The filamentous rattail (*Gadomus aoteanus*) is distributed on Reinga Ridge, West Norfolk Ridge, Lord Howe Plateau, and Lord Howe Island slope at 805-1470 m depth (Figure 29). It is known widely off the North Island of New Zealand, but is absent from New Caledonia and Australian waters. The rattail is at its northern and western limits in the NORFANZ area.

Other examples of southern distributions include ribaldo (*Mora moro*), the feelerfish (*Bathypterois longifilis*) (565–1259 m on the West Norfolk Ridge, Lord Howe Plateau and Lord Howe Island slope), the three slickheads (*Rouleinia eucla* (748–1320 m), *R. guentheri* (804–1350 m) and *Talismania longifilis* (813–1350 m)) on the Reinga Ridge (except *T. longifilis*), West Norfolk Ridge and Lord Howe Plateau), coffinfishes (*Chaunax* spp.) (587–1147 m on the West Norfolk Ridge, Lord Howe Plateau and Lord Howe Island slope), and two deepsea scorpionfishes (*Trachyscorpia* spp.) (515–1117 m on the West Norfolk Ridge and Lord Howe Plateau). Except for the coffinfishes (which lack accurate scientific names), all members of this group of southern species also occur in New Zealand and Australia.

Southern distributions are strongly represented among the NORFANZ fish fauna and largely comprise deepwater species from within the two strata 500–1000 and 1000–1500 m, a few extending deeper, but none shallower. Most also occur widely outside the NORFANZ survey area and are documented here at their northern limits of distribution. This limit is demarcated by a band at latitude 30–32ºS, which is the approximate position of the tropical convergence (Tasman Front), a recognised biogeographic barrier that forms strongly during summer months (Ridgeway & Dunn 2003).

Norfolk Ridge species distributions (NNR; SNR): These distributions are shown by several fish species that appear to be restricted to the Norfolk Ridge, or some part of the Norfolk Ridge. Two notable subgroupings comprise northern ridge species (NNR = plateaux, slope, and seamounts around Norfolk Island) or southern ridge species (SNR = plateaux, slopes and seamounts on the West Norfolk Ridge and Reinga Ridge).

Wide Norfolk Ridge distributions are shown by at least four species. These include Cohen’s rattail (*Nezumia coheni*) (1013–1345 m depth) on the Reinga Ridge, West Norfolk Ridge, and around Norfolk Island (Figure 30). Outside the NORFANZ area this species is known from the Norfolk and Loyalty Ridges (south of New Caledonia), off the Kermadec Islands, and mid-slope grounds off NSW, Australia (Iwamoto & Graham 2001). Morid cod (*Physiculus* cf. *luminosus*) (322–560 m depth) was collected from four sites on the Reinga Ridge, West Norfolk Ridge, and just south of Norfolk Island (Figure 31). The species appears distinct from *Physiculus luminosus* from shelf and slope areas off New Zealand, New Caledonia, and Australia. The bulldog catshark (*Apristurus* sp. E) was caught at five sites along the West Norfolk Ridge and one (site 3) on the NNR at 1013–1460 m; but also one specimen at a deep site (station 71) at 1920–1934 m, southeast of Lord Howe Island. Outside the area, it is known from the continental slope off southeast Australia (Last & Stevens 1994). Finally, the bareskin dogfish (*Centroscyllium kamoharai*) (1013–1294 m depth) was recorded from two sites on the West Norfolk Ridge and one (site 3) on the NNR (Figure 32). Outside the area, it is reported from continental slopes off southeast and Western Australia and Japan (Last & Stevens 1994).

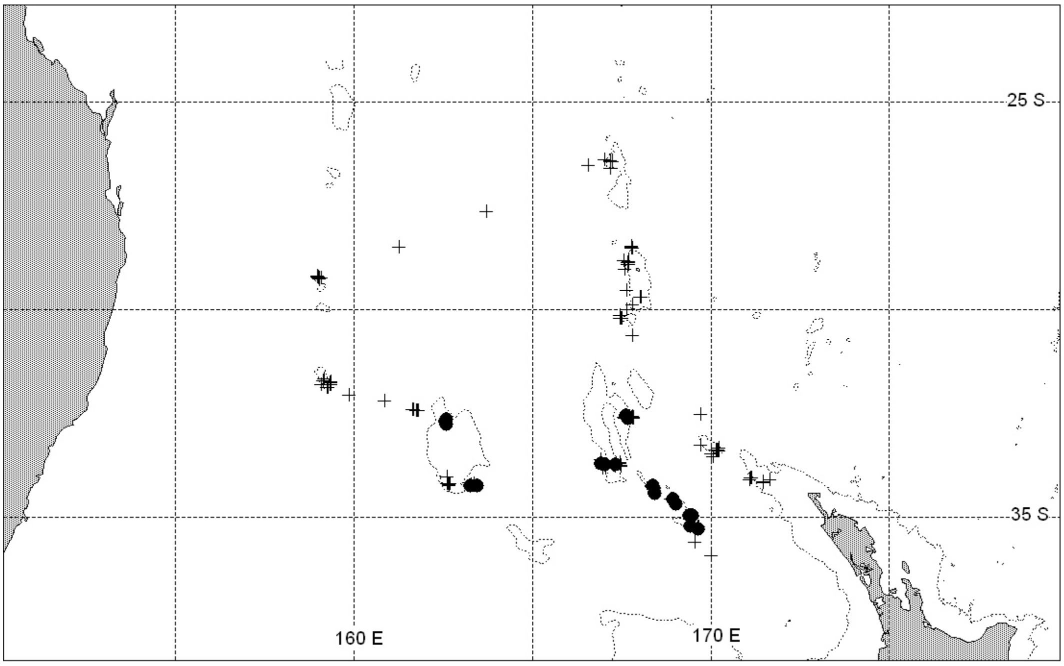


Figure 28: Distribution of orange roughy (*Hoplostethus atlanticus*) (●), a southern species (+ = location of sampling stations).

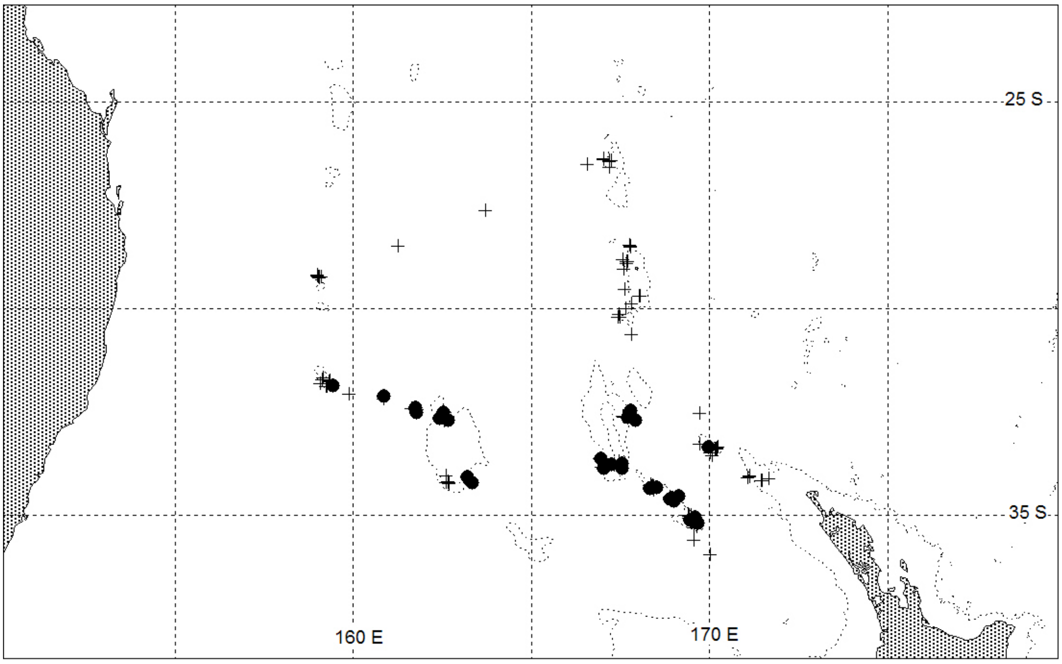


Figure 29: Distribution of filamentous rattail (*Gadomus aoteanus*) (●), a southern species (+ = location of sampling stations).

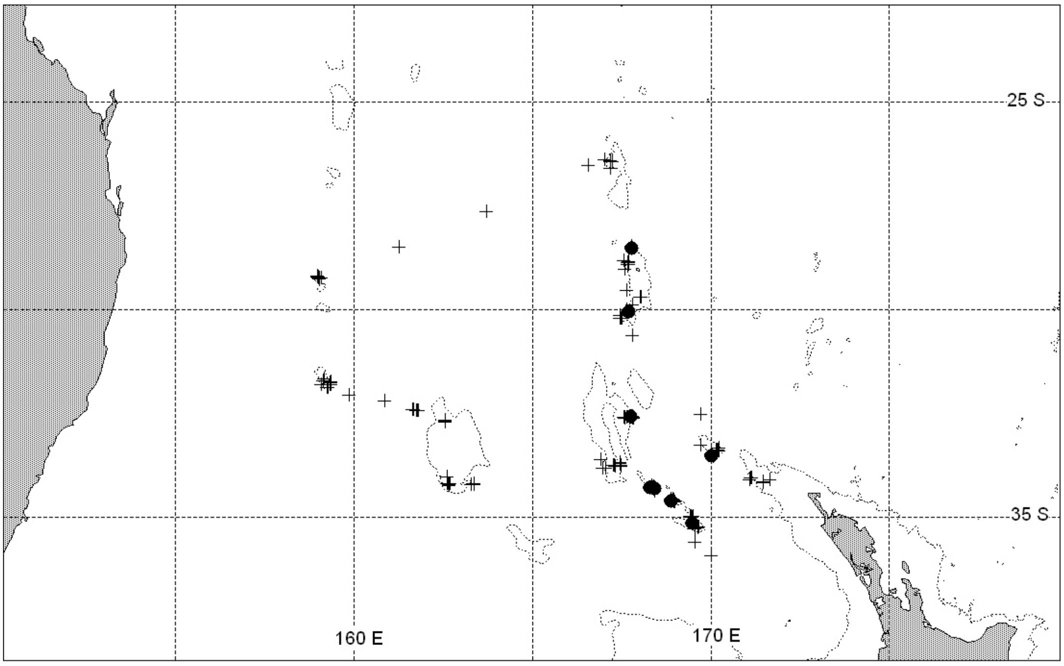


Figure 30: Distribution of the rattail (*Nezumia coheni*) (●), a Norfolk Ridge species (+ = location of sampling stations).

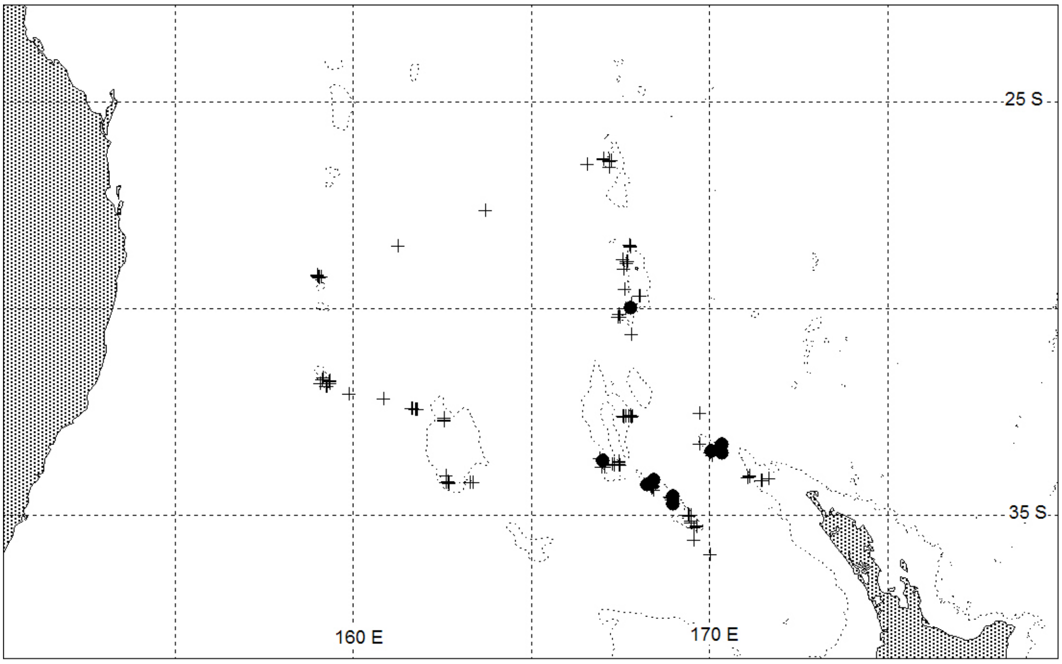


Figure 31: Distribution of the morid cod (*Physiculus* cf. *luminosus*) (●), a Norfolk Ridge species (+ = location of sampling stations).

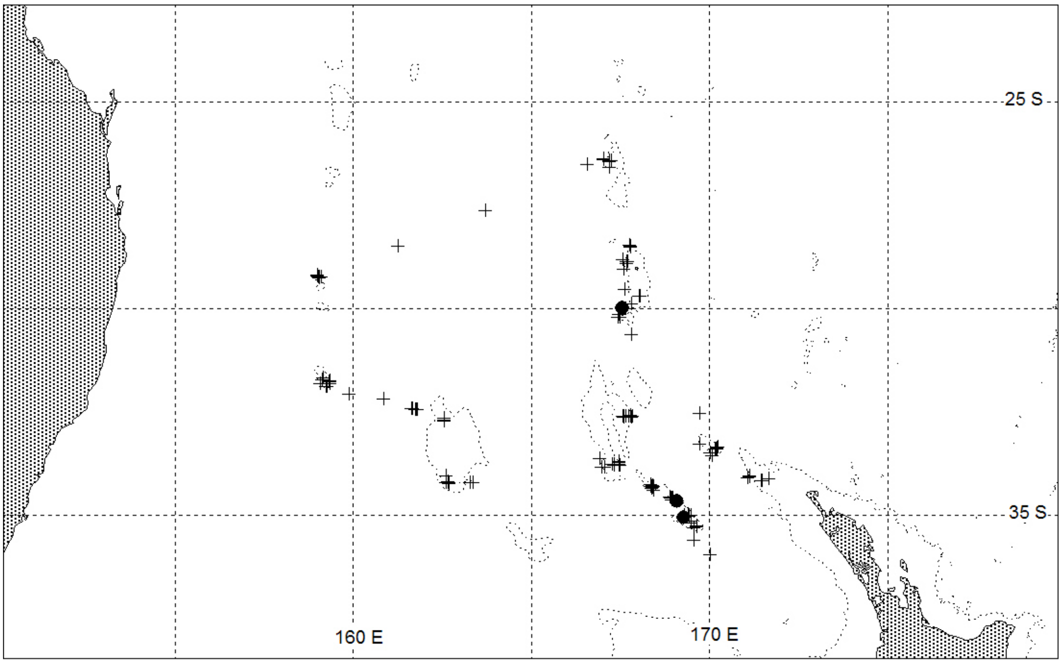


Figure 32: Distribution of the bareskin dogfish (*Centroscyllium kamoharai*) (●), a Norfolk Ridge species (+ = location of sampling stations).

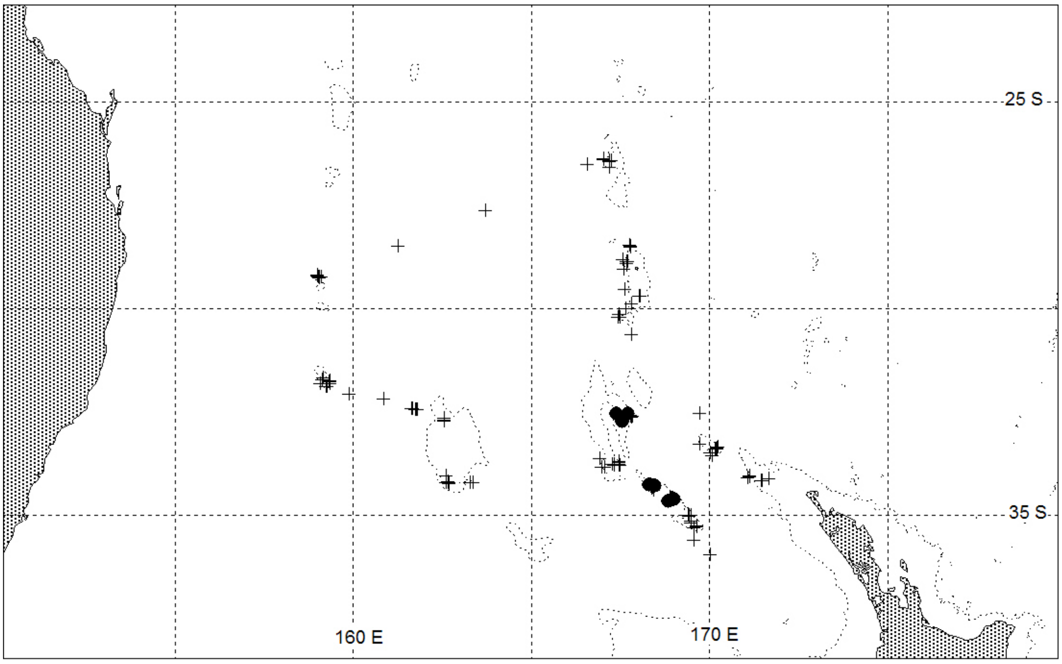


Figure 33: Distribution of the catshark (*Apristurus* cf. *herklotsi*) (●), a southern Norfolk Ridge species (+ = location of sampling stations).

Northern Norfolk Ridge (NNR) fishes comprise three species, including two boarfishes *Antigonia* spp. collected from sites 3 and 4 to the south and north of Norfolk Island; and the pelagic puffer (*Pelagocephalus ?marki*) at sites 3 and 5. The relatively few NNR species collected probably reflects the low numbers of fishes captured from the NNR sites owing to the difficult nature of the seafloor for trawling.

Southern Norfolk Ridge (SNR) fishes are the more common component of Norfolk Ridge distributions, possibly reflecting the greater sampling effort there, and comprise five species, including the catshark (*Apristurus cf. herklotsi*) (809–1340 m depth) collected from three sites on the West Norfolk Ridge (WNR) (Figure 33). Three new skates were also recorded (*Dipturus* NFZ1) (at 116–969 m depth on the WNR), Rajiidae new genus new species C (Wanganella Bank and two seamounts on WNR), and Rajiidae new genus species D (at 868–1313 m depth on Wanganella Bank and two seamounts on WNR), and a new rattail species, *Caelorinchus* NFZ3. Further evaluation of taxonomic status and distribution is needed for these species.

Restricted species distributions: These distributions are those where the species was found on only one, two, or three adjacent sites. They include at least 135 fish species, which represents 22.9% of the total number of fish species sampled (*n* = 590) during the voyage.

Many of the species with restricted distributions (*n* = 75, 55.6%) are not known outside the survey area and this may indicate discrete areas of endemism (e.g. rattails *Caelorinchus* sp. 1, one station; redfishes or golden snappers *Centroberyx* species A, B, and C (Figure 34); perchlets *Plectranthias* species B and C, one station). However, all of these species/OTUs are new, rare, or poorly known, so their known areas of distribution may increase as taxonomic research enables more accurate identification.

A portion of restricted species (*n* = 60, 44.4%) is known outside the survey area, including species that are widely recognised and have well recorded, globally extensive distributions (e.g., spookfish (*Harriotta raleighana*); ling (*Genypterus blacodes*); flutemouth (*Fistularia commersoni*); red lionfish (*Pterois volitans*); John dory (*Zeus faber*); bass (*Polyprion americanus*)). Either this group is comprised of species that are surprisingly rare within the survey area, or the fishes have not been adequately sampled to reflect their real occurrence (which seems more likely).

Overall distribution patterns: Distribution patterns found within the survey area and the affinities of species distributed outside the area indicate faunal relationships that differ substantially between locations in the northern Tasman Sea (Figure 35). The fish fauna on the Lord Howe Rise near Lord Howe Island and north of Middleton Reef are distinct from the rest of the survey area, and exhibit eastern Australian and northern (Coral Sea) affinities. The fishes on the Three Kings Ridge, West Norfolk Ridge, and Lord Howe Plateau have distinct faunal elements, but also share some common species. In addition, southern regions of the NORFANZ survey area typically have a substantial overlap with elements of the New Zealand fish fauna.

The strongest faunal relationships based on affinities of fish species are: (1) Three Kings shelf, Reinga Ridge, West Norfolk Ridge, and Lord Howe Plateau, with the northern New Zealand region (see next section); (2) Norfolk Ridge with northern New Zealand region; (3) northern Norfolk Ridge with New Caledonia and Coral Sea; (4) Lord Howe Island shelf with Australian shelf; and (5) seamount 6 north of Middleton Reef with Queensland shelf and Lord Howe Seamount chain.

Potential sites of localised endemism in the northern Tasman Sea survey area include: (1) seamount 6, north of Middleton reef; (2) Lord Howe Island shelf and slope; (3) Norfolk Island shelf; (4) Norfolk Ridge, Wanganella Bank, and Reinga Ridge. However, further taxonomic research is required to confirm the validity of these initial observations.

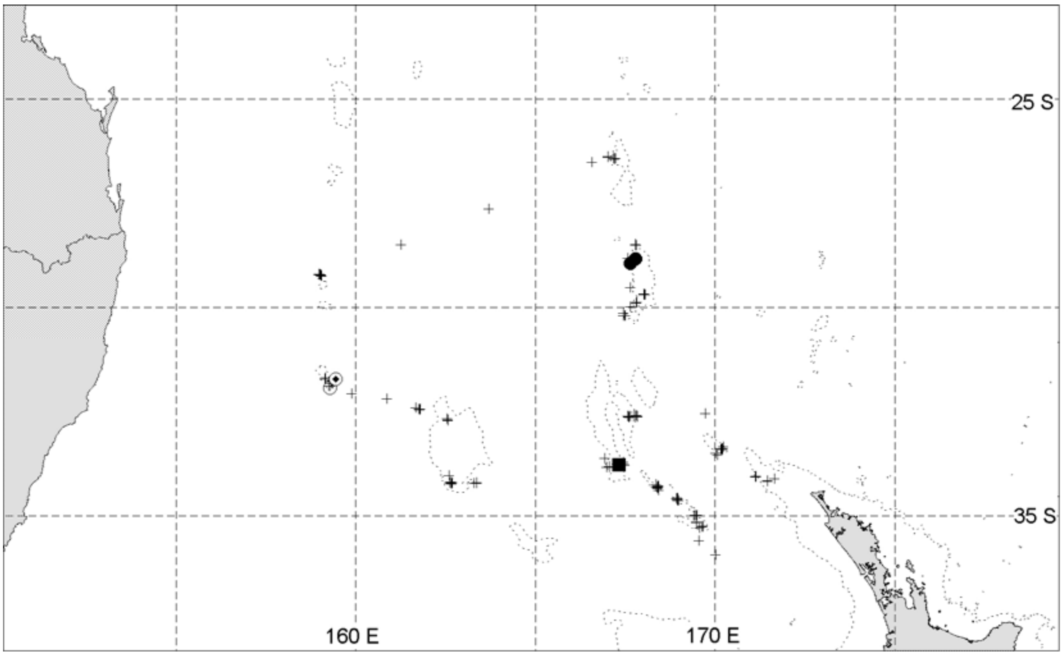


Figure 34: Distribution patterns of redfishes (golden snappers), *Centroberyx* species (4 species: 1 each at Wanganella Bk., Norfolk I., and 2 at Lord Howe I.): *C. affinis* (■); *C.* sp. A (●); *C.* sp. B (○); *C.* sp. C (⊙). Restricted distribution species.

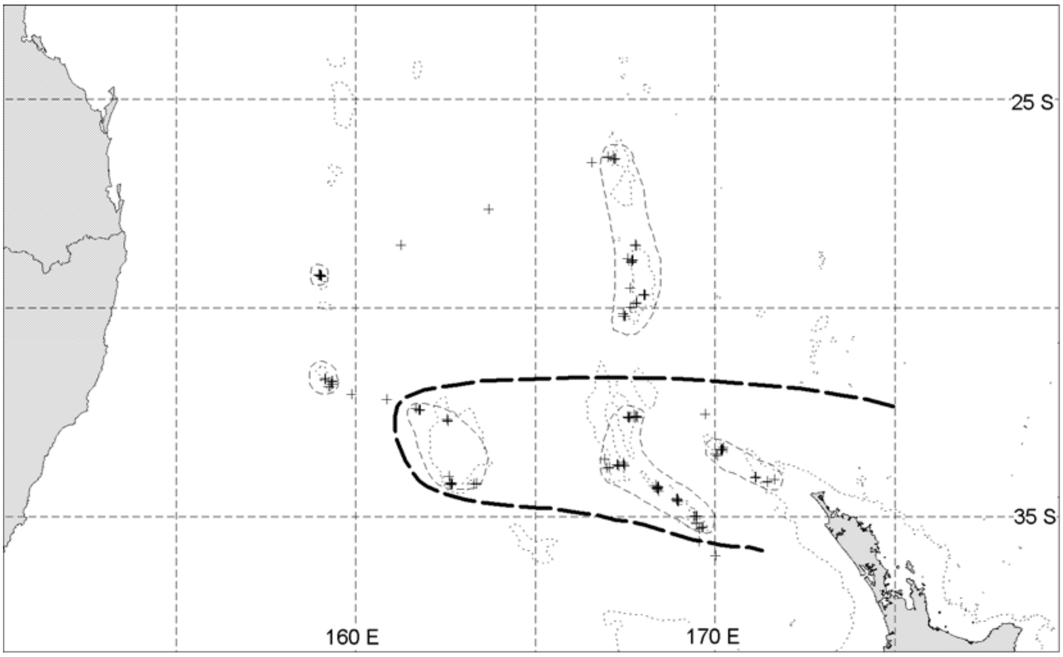


Figure 35: Generalised area relationships based on fish faunal composition compared by area and fish species distributions. Bold dashed line, area with main affinity with northern New Zealand. Light dashed lines, areas with distinct faunal elements.

3.5.3 Community analysis

The ORH trawl was used throughout the survey area. Cluster analysis of fish species data indicated a strong separation by depth (Figure 36). In this dendrogram, many of the a, b, and c symbols (representing the three depth strata) are generally adjacent within chains. ANOSIM results confirmed a statistically significant separation by depth (Williams et al. 2006a).

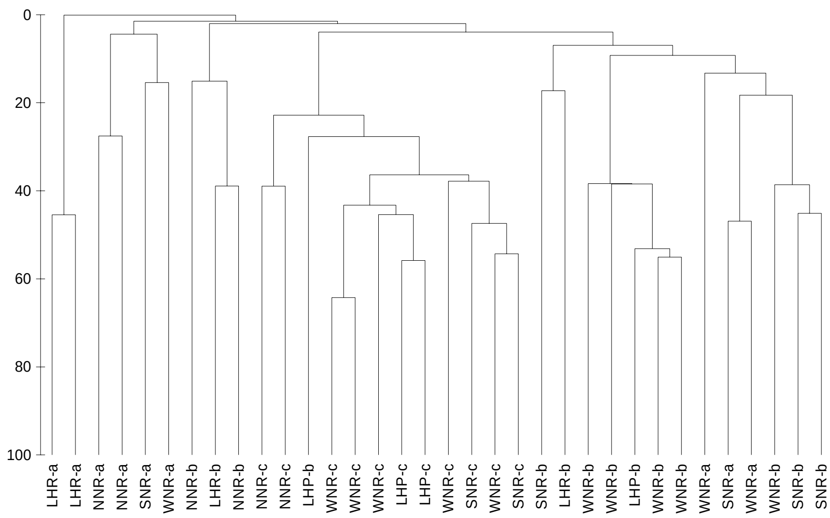


Figure 36: Dendrogram showing between-sample similarity based on demersal fish data from the ORH trawl. Stations with <5 species are excluded. Samples are labelled with area depth strata (a, <500m; b, 500–1000 m; c, >1000 m). From Williams et al. (2006a).

Area had an effect also. A combined depth-area MDS plot (Figure 37) shows shallow samples from the Lord Howe Island/Rise area were distinct from all other samples, and the ridges tended to separate in all depth strata. A 2-way crossed ANOSIM was performed by Williams et al. (2006a) in which the differences between depth/area groups are calculated and averaged across the other factor. This analysis confirmed the importance of depth, and also showed a significant difference between southern (SNR, WNR) and northern (NNR, LHR) areas, and between NNR and LHR in the north.

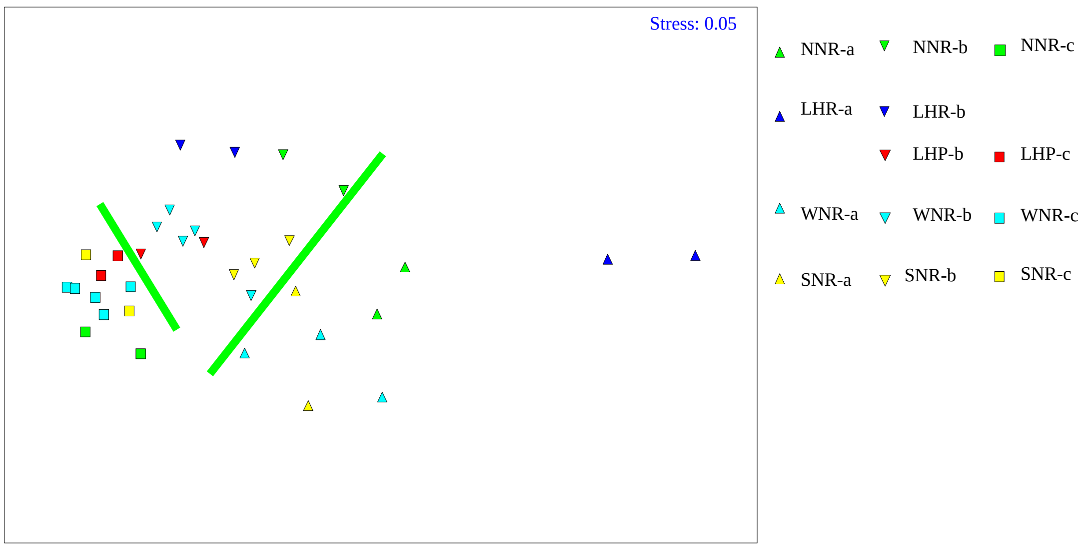


Figure 37: MDS plot showing between-sample similarity with points coded for area and depth stratum (a, <500m; b, 500–1000 m; c, >1000 m). From Williams et al. (2006a).

Data on species that were common between areas were examined in detail. Although the northern most area produced relatively few (15–52) fish species per site (cf. southern sites at 53–154 species), many fishes were unique, rare, or new species that strongly indicated the presence of a very distinct fish fauna compared to the southern most area. In terms of similarity between areas (measured as percentage species shared), the most similar areas were West Norfolk Ridge and Lord Howe Plateau (30.0% shared), and West Norfolk Ridge and Southern Norfolk Ridge (23.5% shared) (Figure 38). Least similar areas were: Lord Howe Island and all other areas (4.5–10.0%), and Northern Norfolk Ridge and all other areas (10.0–13.0%). In general, all areas were surprisingly dissimilar (70.0–95.5% not shared). Of note are some adjacent areas that had very few species in common, e.g., Southern Norfolk Ridge and Northern Norfolk Ridge (only 13.0% shared), and Lord Howe Island and Lord Howe Plateau (only 8.0% shared).

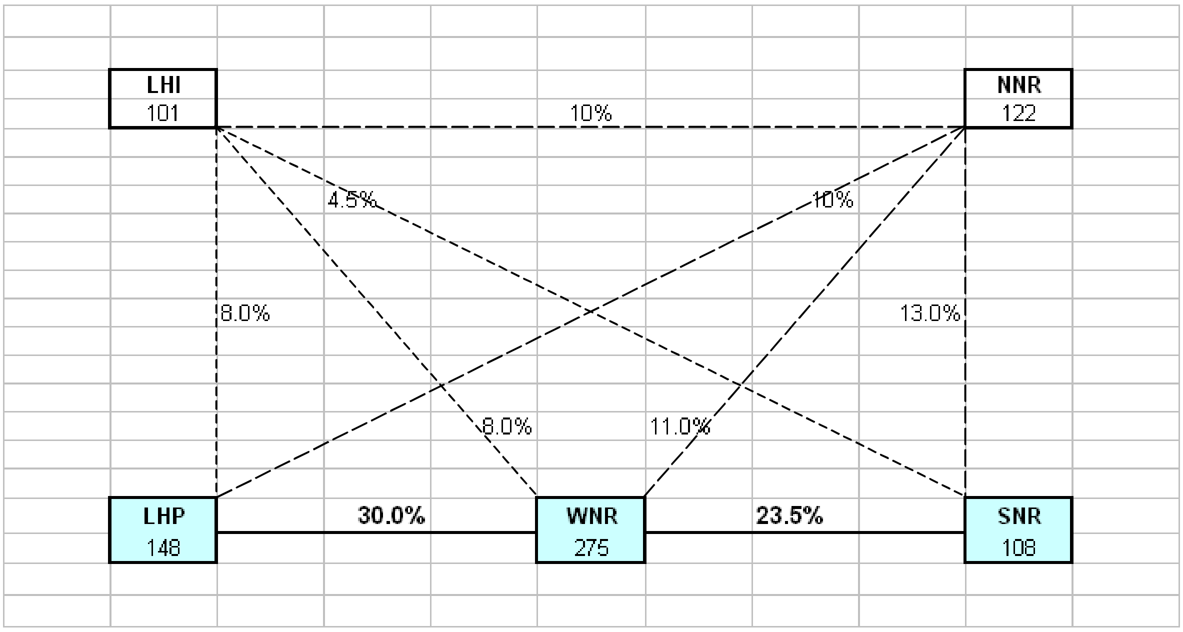


Figure 38: Relational diagram showing percentage similarity of fish species between areas. Numbers in area squares are number of species sampled.

5. DISCUSSION

The main objective of the NORFANZ survey was to describe the benthic fish and invertebrate fauna of the Norfolk Ridge-Lord Howe Rise area. The survey made a lot of progress towards achieving this ambitious goal. The 14 seamount and ridge sites sampled comprised a wide variety of habitat types, and a large number of species or OTUs were recorded which substantially improve our understanding of the region's biodiversity.

5.1 Taxonomy

An accurate account of the taxonomic diversity will not be fully known for several years to come. Samples need to be examined, new species described and published, and taxa updated and revised. The preliminary list of onboard identifications included 590 fish species and 1300 macro-invertebrates. The fish records have been slightly updated, but not very much relative to the invertebrate fauna. This reflects the higher standard of taxonomic knowledge for fishes in the waters around Australia, New Zealand, and New Caledonia, and hence many of the fish could immediately be recognised as known, or new. The number of fish "experts" onboard was also high. Invertebrate fauna are more problematic, as the knowledge of deepwater seamount fauna is relatively poor. There is also a greater number of highly diverse groups that need specialists in those taxa to be able to do an adequate job onboard.

The NORFANZ collection as of 2006 comprises over 1600 macro-invertebrate species/OTUs. Of these 860 have been examined by taxonomic experts and upgraded to species level. Over 100 of the upgraded species have been confirmed as new species (12%). A total of 35 have been identified as new records for Australian waters (Lord Howe Island area) by Williams et al. (2006a). Williams et al. (2006a) reported several changes in taxonomy from the onboard OTUs for fishes used in the present report. However, there was little effect on overall biodiversity statistics, with their total being 588 OTUs from 122 families. They noted 29 new species, and one as a new record for the Australian region. Roberts & Clark (2004) commented that as many as 20% of the fishes sampled during NORFANZ could be new species, or new records for the Tasman Sea region. Lastly, micro-invertebrates were not a target of the NORFANZ survey, but several samples of bottom sediment and rubble were examined at Te Papa, and over 1200 OTUs of micro-molluscs were identified, of which 600 were thought new species (B. Marshall, Te Papa, pers. comm.).

5.2 Biodiversity

Knowledge of seamount benthic faunal biodiversity is increasing rapidly in the southwest Pacific Ocean. Rogers (1994) carried out a review of global seamount studies and found that only 597 invertebrate species had been recorded since direct sampling began at the end of the nineteenth century, although Rogers noted that there had been relatively little sampling effort on seamounts. However, a recent study by Richer de Forges et al. (2000) sampled seamounts off New Caledonia and Tasmania. They reported over 850 macrofaunal species (both fishes and invertebrates), of which 16–36% were deemed both new to science and potentially endemic to seamounts. In this study, sampling of seamounts on the Norfolk Ridge recorded 516 macrofaunal species, 4 seamounts on Lord Howe Rise produced 108 species records, and 297 species were found on 14 seamounts southeast of Tasmania. The combined fish and invertebrate biodiversity recorded by NORFANZ of about 1900 species/OTUs is a considerable advance on the results of this previous research.

Recent seamount research around New Zealand using small epibenthic sleds has yielded relatively large numbers of invertebrate species, and gives some figures to compare broadly with the NORFANZ results. A total of 414 macro-invertebrate species, distributed among 14 phyla, were recorded from 42 epibenthic sled stations on eight seamounts on the Chatham Rise (Rowden et al. 2002), a total of 308 species were recorded from 52 samples on three seamounts on a more northerly portion of the southern Kermadec arc (Rowden et al. 2003), 396 species from 13 phyla were recorded from 25 samples on two seamounts on the Northland Plateau (Rowden et al. 2004), and 483 species were identified from 69 sled samples taken on seven seamounts in the Bay of Plenty (Rowden & Clark, in press). A crude comparison of average numbers of invertebrate species per seamount (= site in NORFANZ) indicate that the Norfolk Ridge/Lord Howe area (114) is more diverse than the Chatham Rise (51) and Bay of Plenty (69) seamounts, about the same as the southern Kermadec seamounts (100), and less diverse than the Northland Plateau (198). However, biodiversity levels are more similar when numbers of species per tow are compared. NORFANZ results were 11.8 species per tow, with the comparative figures being 15.8 for Northland, 9.8 for the Chatham Rise, 7.0 for Bay of Plenty, and 5.9 for southern Kermadec seamounts. It must be noted that NORFANZ was the only survey using fish trawl gear as well as epibenthic sleds, and this will catch more larger and mobile fauna than the small epibenthic sleds used in the other surveys. All the surveys, though, reported species accumulation curves that were still increasing, implying that sampling intensity was insufficient to describe the faunal composition adequately. Analyses of fish species accumulation curves from NORFANZ indicated that at least another similar survey (136 bottom samples at 14 sites) would need to be done to achieve this goal.

5.3 Biogeographic patterns

Depth was the most important variable identified in determining the assemblage composition for both fishes and invertebrates. This was expected, as depth is known to be an important determinant of biodiversity in the Australasian region (Koslow et al. 1994, Francis et al. 2002), and also a likely factor in seamount classification (Rowden et al. 2005). The effect of geographical location was less clear, although north-south differences appeared to be more important than longitudinal variation between the Lord Howe Rise and Norfolk Ridge. This is consistent with the pattern of water masses in the area. The Tasman Front divides the NORFANZ study area into the warmer Coral Sea to the north and the cooler Tasman Sea to the south and marks the path of components of the East Australian Current. Antarctic Intermediate Water at depths of 600–700 m is represented by different ‘arms’ in the Tasman and Coral Seas that oppose each other along the path of the Tasman Front. This effectively separates the NORFANZ region into north (northern Norfolk Ridge and Lord Howe Rise sites) and south (west and south Norfolk Ridge sites), with some sites (Lord Howe Plateau and the Wanganella Bank) overlain by the Tasman Front (Ridgeway & Dunn 2003).

Patterns of fish distribution were dominated by a large number of species with a marked “southern” distribution. Many of these predominantly deepwater species have a strong affinity with the northern New Zealand fauna. The survey identified a number of fish species that are at their northern limit in the survey area. Biogeographic relationships between adjacent sites or groups of sites (areas) were not as clear.

A notable feature of both invertebrate and fish biodiversity was that a high percentage of species occurred in only one or few samples, and that apparent endemism is high. Based on the high number of restricted species that are unknown outside the survey area, it is possible that individual seamounts or slope sites surveyed support their own unique suite of species, such as found on some parts of the Norfolk Ridge and Loyalty Island Ridge in New Caledonian waters (Roberts & Paulin 1997a, Richer de Forges et al. 2000). However, the analyses presented in this report indicate that while many species may have restricted distributions, there are too few data to confirm the level of true endemicity at the level of sub-areas (ridges or individual seamounts). There is also considerable variability between sites, with a range (3–21) of species unique to the voyage present in each area. Sampling adjacent non-seamount habitat is also required to evaluate true levels of seamount faunal endemism (e.g., Samadi et al. 2006, O’Hara 2007).

5.4 Biodiversity survey design

The NORFANZ survey was the first on this scale in the Tasman Sea with its focus on broad-scale biodiversity, and not driven by fisheries stock assessment or localised research or management objectives. A number of key factors have been identified in contributing to the success of the survey (Clark et al. 2003, Williams et al. 2006a).

- There was a high level of cooperation between all parties involved in NORFANZ. The joint funding by the New Zealand Ministry of Fisheries and the Australian National Oceans Office, and the shared scientific input from NIWA, CSIRO, and the New Zealand and Australian universities and museums, saw unprecedented trans-Tasman cooperation at political, managerial, and scientific levels. A strong international team of specialists, including scientists from France and the USA, was assembled, with a wide range of skills and experience that was openly shared.
- A variety of gear types were deployed from *Tangaroa* during the survey. Bottom trawls, midwater trawl, beam trawl, epibenthic sleds, rock and pipe dredges each sampled different assemblages, and gave a much greater appreciation of faunal diversity than would be gained from using just one or two types of gear. Camera-drops to the seafloor and the headline camera unit further added to information on the nature of benthic habitats, and instruments were deployed to sample the oceanographic characteristics. The cooperation mentioned above extended to equipment sharing as well, and several institutes contributed expensive trawls, sleds, or camera gear, in the knowledge that they could well be damaged or lost.
- Multibeam data were used to determine bathymetry, and to investigate geological structures, but in addition, interpretation of backscatter with bathymetry enabled successful trawling in rough terrain.
- A voyage-specific system of data recording, electronic data capture, verification, and search was developed to capture detailed catch composition and to track the allocation of specimens to research institutes globally. Incorporation and extension of the Australian CAAB code system worked well. The use of upgradeable photographic guides provided an immediate record of every fish and invertebrate species with fresh coloration, and helped ensure consistency of identification.
- A specific survey website, which featured daily updates, and articles on unusual or interesting aspects of the survey proved very popular with the public, and was an excellent education and outreach tool.

However, there were also problems with some aspects of the survey, and Williams et al. (2006a) noted the need in future for more discussion amongst specialists on sampling design; a higher level of post-survey resources to ensure that post-voyage taxonomy, data management, and data analysis are adequately supported; post-survey work needs to be carefully mapped out in advance; and a plan for ensuring timely publication of results is required. Additional data collection could also be considered in future surveys of this type including acoustics and regular seabird/marine mammal recording.

5.5 Management implications

The survey was not designed (nor intended) to address issues of fisheries stock assessment such as commercial fish species abundance. However, it did serve to extend knowledge of the distribution of species such as alfonsino, ribaldo, orange roughy, and cardinalfish which are commercially fished in New Zealand and Australian waters. These data have been included in GIS layers produced by the New Zealand Ministry of Fisheries under the NABIS project. Hence, there is an indirect link to fisheries management through knowledge of the distributional characteristics and extent of commercial species. No aggregations of any commercial species were fished (or seen on the vessel's echosounders), but catch composition from the ORH trawl gives an indication of the likely bycatch if fishers are trawling generally on seamounts (as they often do) without targeting specific concentrations. The relative abundance of the shovelnose dogfish (*Deania* cf. *calcea*), being the most abundant species by weight in the catches, may have management implications, as elasmobranchs have low fecundity, may be long-lived, and hence vulnerable to overfishing as a bycatch of targeted commercial species. Seamounts where such species are common may need regulations limiting bycatch to reduce this risk.

The main use of NORFANZ data and results of analyses to date for management relate to assessing conservation values of the area. This includes identifying rare or unusual components of the fauna, those with very limited distributions, those with low productivity that may be vulnerable to human disturbance (fishing, mining), or defining areas which contain representative fauna. The data were used by Williams et al. (2006b) in a study of the Norfolk Seamounts region in the context of developing Australia's National Representative System of Marine Protected Areas (NRSMPA). They found that the Norfolk Seamounts region possesses biodiversity values worthy of protection, and would contribute to the representativeness and comprehensiveness of the NRSMPA. Williams et al. (2006b) suggested that this could be part of a larger Tasman Sea deep sea biodiversity conservation initiative, and NORFANZ data would be an important input for this.

The general biogeographic results found in this study indicate that northern and southern fauna differ, and there are smaller differences between the ridge systems and individual sites. Management strategies need to address issues of scale as well as geographical location, and hence any conservation strategy would need to include a north-south component, depth, and also small seamount features where there are indications of highly localised distributions or endemic species. The NORFANZ project as a whole provides an important overview of the fauna and its biogeographic structure enabling more informed marine planning decisions to be taken.

5.6 Recommendations

The survey generated a lot of data and samples which have still not been examined by appropriate taxonomists. This should be supported to ensure the data are as comprehensive and complete as possible. Only then can robust analyses evaluate full assemblage composition and structure. This is likely to require government funding targeted to relevant museums and institutes.

Post-survey, the data and its updates were coordinated largely by CSIRO. However, there are currently various databases and datasets that contain data in different stages of update and in different forms between spreadsheet and full relational databases. For example, NIWA holds the database compiled onboard *Tangaroa*, but this has not been updated with Australian taxonomic efforts. It is recommended that a central database be supported to manage the NORFANZ data, and that this is the single source of data analysed by any of the Founding Parties contacts.

The data, when complete, also need to be added to other databases where these hold information from a wider area or even on a global scale. NORFANZ data are not at present part of the "Seamounts database" compiled at NIWA and provided to the Ministry of Fisheries. The data are also not part of Seamounts Online (http://seamounts.sdsc.edu), a global database supported by the Census of Marine Life Programme on Seamounts (Censeam-http://censeam.niwa.co.nz). NORFANZ data have been used in analyses being undertaken by CenSeam, but these are in the form of spreadsheets and text files, and only for selected taxa where the taxonomy has been consistent and authoritative.

Once complete data are available, more robust and/or generalised analyses will be able to be undertaken. These will enable a clearer understanding of biodiversity patterns in the area, and highlight regions of particular importance that may require further sampling and study. The survey has provided a general baseline dataset, but it is acknowledged that this is not likely to be detailed enough to address specific management issues on a small scale.

The relationships between fauna and environmental conditions have not been examined. Oceanographic data collected on the survey have not been fully processed or incorporated into any analysis. This was part of Programme Objective 4, and should be progressed along with the compilation of other datasets and analyses.

At the time of the survey, there was discussion about a survey-specific volume of scientific papers being prepared which would include aspects such as key taxonomic findings, biogeographic patterns, environmental conditions (bathymetry, oceanography) and their relevance to management and conservation. Although the survey is now 4 years past, this could still be considered, as such compilations of regional datasets and analyses can be much more accessible and interpretable than a large number of scattered papers in the scientific literature.

The survey design and operation highlighted effective methods, and various deficiencies. The lessons from NORFANZ should be incorporated into seamount sampling protocols being developed by CenSeam. This will help design future biodiversity surveys. Consideration should also be given to sampling methods that enable faunal description of hard, broken, and steeply inclined seafloor as this was one of the main limitations of the NORFANZ survey sampling. Such difficult habitats are likely among the most diverse and richest, as well as the most inaccessible.

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Appendix 1 Summary station data from the NORFANZ survey

(gear codes: 10=ORH trawl, 11=wing trawl, 13=beam trawl, 20=NIWA sled, 21=Sherman, 22=rock dredge, 23=pipe dredge, 53=midwater trawl, 72=camera drop, 82=SVP/CTD. Performance codes: 1,2 = good; 3,4=poor performance (fast, ripped nets etc))

No	Region	Site	date	time	latitude	longitude	min_dep	max_dep	Gear	Perf	dist(nm)
1	SNR	1	11-May-03	1349	34 06.68	171 39.66	351	400	10	2	1.35
2	SNR	1	11-May-03	1615	34 09.37	171 27.79	544	584	10	1	1.47
3	SNR	1	11-May-03	1937	34 03.21	171 08.1	1051	1320	10	3	1.53
4	SNR	1	11-May-03	2117	34 05.57	171 05.21	0	1500	82		0.33
5	SNR	1	11-May-03	2309	34 03.74	171 07.39	1228	1332	21	3	1.42
6	SNR	1	12-May-03	0206	34 09.14	171 27.95	542	554	21	3	0.55
7	SNR	1	12-May-03	0414	34 06.71	171 39.73	394	400	21	2	0.25
8	SNR	1	12-May-03	0622	34 09.75	171 27.33	558	573	21	2	0.66
9	SNR	1	12-May-03	0911	34 02.88	171 08.18	1145	1185	21	2	0.61
10	SNR		12-May-03	1918	32 32.25	169 43.56	0	1275	53	1	6.45
11	NNR	3	13-May-03	0951	30 37.18	167 48.83	0	1000	82	1	
12	NNR	3	13-May-03	2030	30 12.62	167 29.45	606	620	20	4	0.24
13	NNR	3	13-May-03	2227	30 12.67	167 29.9	630	634	21	3	0.33
14	NNR	3	14-May-03	0355	30 12.22	167 26.83	755	782	21	3	0.39
15	NNR	3	14-May-03	0532	30 08.96	167 26.86	1032	1131	21	2	0.46
16	NNR	3	14-May-03	0959	29 59.62	167 38.73	1245	1285	10	2	1.29
17	NNR	3	14-May-03	1232	29 53.11	167 49.04	650	666	10	2	1.26
18	NNR	3	14-May-03	1414	29 53.39	167 48.44	653	656	13	3	0.55
19	NNR	3	14-May-03	1652	29 41.46	168 03.48	339	344	10	1	1.56
20	NNR	3	14-May-03	1926	29 41.84	168 02.62	322	337	13	1	0.89
21	NNR	3	14-May-03	2121	29 41.83	168 01.33	314	327	23	2	0.16
22	NNR	3	14-May-03	2158	29 41.35	168 01.46	337	338	23	2	0.41
23	NNR	3	15-May-03	0350	29 31.75	167 38.05	200	1200	53	2	4.5
24	NNR	4	15-May-03	1015	28 54.39	167 41.05	111	115	13	1	0.69
25	NNR	4	15-May-03	1143	29 02.24	167 35.96	0	1200	82		
26	NNR	4	15-May-03	1642	28 54.34	167 41.14	110	304	10	2	0.58
27	NNR	4	15-May-03	1907	28 54.47	167 41.04	110	441	10	1	1.18
28	NNR	4	15-May-03	2121	28 51.94	167 40.59	718	859	10	3	1.08
29	NNR	4	15-May-03	2345	28 51.21	167 42.53	690	812	13	2	1.01
30	NNR	4	16-May-03	0519	28 49.56	167 34.11	1020	1045	10	3	0.26
31	NNR	4	16-May-03	1128	28 52.21	167 40.96	648	854	10	2	1.57
32	NNR	4	16-May-03	1318	28 51.66	167 41.26	600	773	22	2	0.43
33	NNR	4	16-May-03	1853	28 29.37	167 47.15	1056	1116	10	2	2.16
34	NNR	4	16-May-03	2142	28 30.71	167 47.71	1040	1090	13	3	1.48
35	NNR	4	16-May-03	2324	28 28.03	167 46.11	0	1000	82		
36	NNR	4	17-May-03	0052	28 31.22	167 47.38	1035	1065	21	1	0.76
37	NNR	5	17-May-03	1320	26 35.40	167 11.80	0	1100	82		
38	NNR	5	17-May-03	1601	26 25.56	167 11.35	734	754	10	2	0.96
39	NNR	5	17-May-03	1740	26 26.55	167 11.64	733	740	21	3	0.68
40	NNR	5	17-May-03	1855	26 25.28	167 11.26	714	756	21	1	1
41	NNR	5	18-May-03	0259	26 22.80	167 01.53	1017	1035	21	2	0.81
42	NNR	5	18-May-03	0833	26 25.72	167 14.49	356	422	72	2	0.25
43	NNR	5	18-May-03	1031	26 25.94	167 10.87	750	774	13	2	1.1
44	NNR	5	18-May-03	1250	26 23.53	167 01.21	1019	1030	10	2	1.44
45			18-May-03	1635	26 31.42	166 34.42	0	2000	53	2	6.88
46			19-May-03	1111	27 38.57	163 42.73	1635	1749	11	3	3.1

Appendix 1 (*cont*).

No	Region	Site	date	time	latitude	longitude	min_dep	max_dep	Gear	Perf	dist(nm)
47			20-May-03	0227	28 29.88	161 15.56	1530	1530	11	2	2.88
48	LHR	6	20-May-03	1536	29 14.05	159 06.09	0	1442	82		
49	LHR	6	20-May-03	2309	29 13.09	158 59.85	298	307	21	2	0.76
50	LHR	6	21-May-03	0329	29 12.88	158 59.05	505	900	21	2	0.67
51	LHR	6	21-May-03	0526	29 13.67	159 01.15	810	1000	21	2	0.47
52	LHR	6	21-May-03	0656	29 14.35	159 02.09	1210	1395	21	2	0.41
53	LHR	6	21-May-03	0843	29 12.76	159 00.29	280	310	72	2	0.69
54	LHR	6	21-May-03	1031	29 12.80	159 00.25	290	290	10	4	0
55	LHR	6	21-May-03	1237	29 13.12	159 00.45	292	330	20	2	0.39
56	LHR	6	21-May-03	1349	29 13.61	159 02.49	740	800	20	3	0.47
57	LHR	6	21-May-03	1532	29 13.07	159 00.43	300	300	10	4	0
58	LHR	6	21-May-03	1741	29 11.93	158 58.97	728	826	10	3	0.27
59	LHR	6	21-May-03	1922	29 14.97	159 02.72	1600	1600	10	4	0.06
60	LHR	7	22-May-03	2010	31 45.33	159 19.05	48	50	21	1	0.38
61	LHR	7	22-May-03	2133	31 49.11	159 20.74	86	89	21	1	0.44
62	LHR	7	22-May-03	2333	31 48.02	159 04.92	0	1100	82		
63	LHR	7	23-May-03	0307	31 42.53	159 07.93	798	880	10	2	1.45
64	LHR	7	23-May-03	0518	31 40.55	159 09.43	587	700	10	2	1.68
65	LHR	7	23-May-03	0903	31 48.80	159 20.52	58	90	72	2	0.54
66	LHR	7	23-May-03	1054	31 45.73	159 20.93	565	960	21	2	0.53
67	LHR	7	23-May-03	1316	31 52.44	159 14.43	72	82	21	2	0.89
68	LHR	7	23-May-03	1443	31 52.28	159 16.61	68	91	10	1	1.84
69	LHR	7	23-May-03	1625	31 48.60	159 20.74	66	88	10	2	2.2
70	LHR	7	23-May-03	1855	31 44.03	159 20.80	1012	1292	21	1	0.75
71	LHR		24-May-03	0030	32 03.98	159 52.80	1920	1934	11	2	2.24
72	LHP	8	24-May-03	0740	32 11.59	160 51.66	1342	1361	11	1	2.63
73	LHP	8	24-May-03	1434	32 25.94	161 47.62	1132	1197	11	1	2.92
74	LHP	8	24-May-03	1906	32 26.08	161 45.36	1171	1259	10	1	2.94
75	LHP	8	24-May-03	2049	32 24.22	161 38.94	0	1050	82		
76	LHP	8	24-May-03	2214	32 24.34	161 40.64	1257	1288	13	4	1
77	LHP	8	25-May-03	0020	32 26.70	161 46.95	1130	1147	13	2	0.86
78	LHP	8	25-May-03	0455	32 39.33	162 33.11	864	870	13	2	0.81
79	LHP	8	25-May-03	0653	32 41.80	162 33.47	855	874	10	2	3.15
80	LHP	8	25-May-03	0954	32 42.50	162 33.86	850	872	11	2	3.16
81	LHP	9	25-May-03	1916	34 01.95	162 35.96	780	818	11	1	2.91
82	LHP	9	26-May-03	0106	34 12.44	162 39.50	758	760	13	2	0.81
83	LHP	9	26-May-03	0320	34 11.83	162 37.10	761	765	10	2	2.84
84	LHP	9	26-May-03	0456	34 12.20	162 41.55	0	740	82	2	
85	LHP	9	26-May-03	0616	34 13.89	162 40.59	515	700	21	2	0.62
86	LHP	9	26-May-03	0833	34 11.06	162 39.19	430	740	21	2	0.57
87	LHP	9	26-May-03	1028	34 11.09	162 39.17	450	740	10	3	0.57
88	LHP	9	26-May-03	1156	34 11.04	162 39.18	435	440	10	4	0.02
89	LHP	9	26-May-03	1349	34 12.18	162 41.18	748	772	11	2	3.08
90	LHP	9	26-May-03	1951	34 12.17	163 21.36	1090	1117	11	1	3.81
91	LHP	9	26-May-03	2217	34 12.41	163 17.20	1076	1083	13	1	0.96
92	LHP	9	27-May-03	0038	34 12.70	163 21.59	1082	1120	10	1	3.42
93	WNR	11	27-May-03	1854	33 49.47	167 03.45	804	944	10	1	2.93
94	WNR	11	27-May-03	2124	33 49.50	166 58.80	950	987	13	1	0.87

Appendix 1 (*cont*).

No	Region	Site	date	time	latitude	longitude	min_dep	max_dep	Gear	Perf	dist(nm)
95	WNR	11	27-May-03	2326	33 49.24	167 03.35	805	938	11	1	2.96
96	WNR	11	28-May-03	0433	33 37.10	166 55.50	1017	1042	11	2	2.98
97	WNR	11	28-May-03	0949	33 46.26	167 19.50	260	273	21	2	1.33
98	WNR	11	28-May-03	1150	33 45.11	167 16.59	248	250	10	4	0.03
99	WNR	11	28-May-03	1248	33 45.26	167 17.07	254	259	10	3	0.84
100	WNR	11	28-May-03	1514	33 46.78	167 19.24	265	280	21	1	1.26
101	WNR	11	28-May-03	1922	33 45.20	167 28.30	1410	1470	10	1	2.65
102	WNR	11	28-May-03	2220	33 42.45	167 27.03	1451	1478	13	1	1.18
103	WNR	11	29-May-03	0055	33 46.55	167 29.28	1431	1460	11	1	2.66
104	WNR	11	29-May-03	0248	33 41.44	167 27.71	0	1200	82		
105	WNR	10	29-May-03	0946	32 36.07	167 35.21	116	122	11	2	1.69
106	WNR	10	29-May-03	1100	32 37.38	167 35.17	121	126	13	2	0.98
107	WNR	10	29-May-03	1405	32 36.49	167 43.98	699	707	13	2	1.04
108	WNR	10	29-May-03	1547	32 35.67	167 44.12	698	724	11	1	1.5
109	WNR	10	29-May-03	1758	32 35.01	167 47.75	1023	1045	11	4	1.44
110	WNR	10	29-May-03	2056	32 37.06	167 48.68	0	1050	82		
111	WNR	10	29-May-03	2307	32 36.30	167 47.44	1008	1029	13	1	0.9
112	WNR	10	30-May-03	0158	32 36.05	167 34.60	116	119	11	1	0.78
113	WNR	10	30-May-03	0440	32 35.57	167 38.81	348	362	11	1	1.66
114	WNR	10	30-May-03	0641	32 35.22	167 47.66	1021	1052	11	2	3.02
115	WNR	10	30-May-03	0917	32 36.65	167 35.05	120	124	23	3	0.24
116	WNR	10	30-May-03	0951	32 37.25	167 35.27	125	126	23	2	0.28
117	WNR	10	30-May-03	1043	32 36.34	167 35.73	120	127	11	2	1.73
118	WNR	10	30-May-03	1254	32 35.79	167 38.55	325	497	10	2	2.36
119	WNR	10	30-May-03	1501	32 35.65	167 47.05	957	977	10	1	2.51
120	WNR	10	30-May-03	1747	32 36.57	167 50.33	1303	1313	10	2	2.83
121	WNR	10	30-May-03	2132	32 36.39	167 50.59	1331	1345	13	2	2.41
122	WNR	10	31-May-03	0020	32 37.46	167 36.19	0	218	72		0.9
123	WNR	10	31-May-03	0249	32 36.23	167 47.09	926	969	11	2	2.74
124	SNR	2	31-May-03	1256	33 15.95	169 43.36	0	1000	82		
125	SNR	2	31-May-03	1832	33 23.60	170 09.53	605	622	21	3	0.69
126	SNR	2	31-May-03	1931	33 23.41	170 11.58	469	526	21	2	
127	SNR	2	31-May-03	2121	33 23.47	170 11.91	477	483	72		0.49
128	SNR	2	31-May-03	2314	33 23.57	170 09.95	627	662	10	1	1.45
129	SNR	2	1-Jun-03	0450	33 29.24	170 00.71	1158	1230	10	2	2.1
130	SNR	2	1-Jun-03	0704	33 32.62	170 04.13	1270	1350	21	2	1.17
131	SNR	2	1-Jun-03	0933	33 23.56	170 10.99	617	670	21	2	0.97
132	SNR	2	1-Jun-03	1057	33 22.61	170 12.70	514	540	21	2	1.11
133	SNR	2	1-Jun-03	1317	33 23.74	170 13.03	465	490	10	2	1.26
134	SNR	2	1-Jun-03	1516	33 20.51	170 13.98	614	675	10	1	2.48
135	SNR	2	1-Jun-03	1717	33 23.65	170 12.51	463	470	72	1	0.45
136	SNR	2	1-Jun-03	1828	33 23.60	170 12.38	469	490	13	1	0.55
137	WNR	12	2-Jun-03	0350	34 18.01	168 26.14	0	1100	82	2	
138	WNR	12	2-Jun-03	0822	34 22.98	168 25.66	373	374	10	3	0.14
139	WNR	12	2-Jun-03	1002	34 20.50	168 23.19	382	390	10	2	1.2
140	WNR	12	2-Jun-03	1403	34 19.14	168 24.63	831	846	10	1	3.01
141	WNR	12	2-Jun-03	1611	34 17.09	168 21.50	785	800	13	1	0.85
142	WNR	12	2-Jun-03	1903	34 16.49	168 24.08	1246	1249	10	2	0.95

Appendix 1 (*cont*).

No	Region	Site	date	time	latitude	longitude	min_dep	max_dep	Gear	Perf	dist(nm)
143	WNR	12	2-Jun-03	2055	34 23.14	168 25.79	381	390	72	1	0.56
144	WNR	12	2-Jun-03	2211	34 22.58	168 25.14	376	380	21	2	1.05
145	WNR	12	2-Jun-03	2346	34 17.84	168 25.82	1251	1268	21	1	1.29
146	WNR	12	3-Jun-03	0306	34 14.33	168 21.18	1195	1202	11	2	1.87
147	WNR	12	3-Jun-03	0523	34 18.14	168 23.18	809	857	11	2	2.31
148	WNR	13	3-Jun-03	0856	34 33.59	168 53.51	0	980	82		
149	WNR	13	3-Jun-03	1212	34 37.81	168 58.59	508	560	21	2	1.21
150	WNR	13	3-Jun-03	1346	34 34.99	168 55.54	1000	1150	21	2	1.23
151	WNR	13	3-Jun-03	1641	34 34.13	168 56.48	1013	1340	10	2	1.61
152	WNR	13	3-Jun-03	1907	34 37.53	168 57.95	518	531	10	1	1.06
153	WNR	13	3-Jun-03	2042	34 37.36	168 58.08	514	536	72		0.35
154	WNR	13	3-Jun-03	2232	34 37.20	168 57.03	521	539	13	1	1
155	WNR	13	4-Jun-03	0035	34 34.81	168 57.79	813	1000	11	1	1.14
156	WNR	13	4-Jun-03	0241	34 34.26	168 56.53	1013	1350	11	2	1.7
157	WNR	14	4-Jun-03	0802	35 00.59	169 25.59	0	1100	82		
158	WNR	14	4-Jun-03	1055	35 10.27	169 29.24	867	869	13	2	0.47
159	WNR	14	4-Jun-03	1228	35 08.12	169 28.37	868	872	11	2	2.43
160	WNR	14	4-Jun-03	1735	34 58.85	169 29.60	1288	1294	11	1	2.8
161	WNR	14	4-Jun-03	1935	34 59.38	169 24.39	1287	1289	21	4	
162	WNR	14	4-Jun-03	2133	34 59.64	169 28.92	1266	1270	21	1	0.99
163	WNR	14	4-Jun-03	2353	34 59.13	169 26.50	1278	1287	10	1	3.04
164	WNR	14	5-Jun-03	0409	35 15.70	169 38.25	771	772	10	4	0.03
165	WNR	14	5-Jun-03	0552	35 14.22	169 39.22	727	735	72	2	0.1
166	WNR	14	5-Jun-03	0734	35 17.17	169 33.63	815	867	10	2	1.26
167	WNR		5-Jun-03	1200	35 35.83	169 33.43	1760	1789	11	2	2.6
168	WNR		5-Jun-03	1614	35 56.46	170 01.01	0	1975	53	2	6.6

Appendix 2: Preliminary analysis of NORFANZ rock samples

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Introduction

Although the main aims of the NORFANZ cruise were to sample biological specimens (Clark et al. 2003), a considerable number of rock types from over 30 stations were sampled using various trawls and sledges. Here we document the rock types recovered, provide some scientific context and suggest what further work that can be done on them. All samples were initially examined and classified by the authors at Te Papa in Wellington on 29 July 2003, then subsequently examined in more detail in GNS laboratories.

Preliminary results

A total of 44 different rock samples were recovered from 31 stations using various trawls and sledges (see Figure 1). Samples of all material have been lodged at GNS Lower Hutt and sets of representative samples have been deposited with NIWA (Wellington), CSIRO Marine Sciences (Hobart), and GeoScience Australia (Canberra).

NORFANZ rocks can be divided into four main groups: sedimentary rocks, volcanic rocks, basement samples, and transported rocks. These are each treated below.

Sedimentary rocks: Hard, cemented, varitextured bioclastic limestones containing a rich diversity of macrofauna and/or Foraminifera (forams), were obtained from stations 9, 126, 130, 132 (Reinga Ridge), 24, 29, 34 (Norfolk Island area), 55, 58, 60, 85 (Lord Howe Rise) and 142, 145 and 155 (West Norfolk Ridge-Wanganella Bank area).

Phosphatised limestones, of possibly older geological age than the unphosphatised ones, were recovered from stations 12, 13 (South of Norfolk Island), 97, 99 (West Norfolk Ridge-Wanganella Bank area) and 130 (Reinga Ridge).

Softish to moderately hard sandstones were obtained from stations 30, 34, 36 near Norfolk Island. The sandstones are mainly volcaniclastic and an origin associated with the Pliocene volcanics of Norfolk Island (Jones & McDougall 1973) is likely. A soft, grey-white clay was obtained from station 142 in the West Norfolk Ridge-Wanganella Bank area. Breccias and conglomerates are discussed under volcanic rocks below.

Volcanic rocks: Volcanic and coarse volcaniclastic rocks were obtained from stations 5 (Reinga Ridge), 32 (Norfolk Island area), 49, 52, 55, 57, 58 (Middleton Reef area) and 85 (Lord Howe Rise).

Station 5 is about 60 km west of the Three Kings Islands. The hard, unweathered sample of lava recovered from there is an olivine-clinopyroxene-plagioclase basaltic to andesitic lava (Figure 2A) in which secondary chlorite and quartz are present. The rock is from the main New Zealand continental shelf. Possible correlatives are with the Mt Camel Volcanics of the Three Kings Islands, the Tangihua Complex, or (perhaps less likely) Miocene arc lavas (see Mortimer et al. 1998).

The station 32 olivine basalt is probably related to the Pliocene intraplate alkaline lavas exposed on Norfolk Island (Jones & McDougall 1973).

The lavas from stations 49 to 58 near Middleton Reef are variably weathered but include some very fresh samples. The station 58 sample is an altered volcanic breccia with foram limestone matrix (Figure 2B); other stations gave only lava samples. Lavas appear aphyric in hand specimen but thin sections show very rare (<0.5%) olivine phenocrysts (e.g., Figure 2C). Probably the lavas are trachybasalts or trachyandesites. Middleton Reef and the nearby seamount sampled apparently lie on the Lord Howe volcanic hotspot track, the eruptive age of which is predicted to increase to the north. Lord Howe Island lavas have beed K-Ar dated at 7 Ma and Middleton Reef lavas are predicted to be 10–11 Ma in age (McDougall et al. 1981, McDougall & Duncan 1988). No lavas are exposed on the surficial part of Middleton Reef proper and, to our knowledge, the NORFANZ samples are the first lavas to be obtained anywhere on the northern trace of the Lord Howe seamount chain.

A large sample of zeolite-cemented, moderately sorted, red volcanic breccia was obtained from station 85 on the Lord Howe Rise. Clasts are dominated by altered olivine basalt (Figure 2D). Volcanic seamounts are known to be scattered over the Rise (Bentz 1974) and alkaline intraplate olivine basalt and breccias, broadly similar to the NORFANZ station 85 rock, have been dredged from the nearby ORSTOM site GO357 (Figure 1) (Monzier & Vallot 1983, Mortimer in press).

Basement samples: Approximately 5% of the fragments in the station 85 breccia are of non-volcanic origin and consist of quartzofeldspathic, muscovite-bearing greywacke, low grade greyschist (Figure 2D; probably a metamorphosed variety of the greywacke), siliceous volcanic rocks, hornfelsed limestones, quartz vein chips and altered cataclasites (provisional identifications). The largest fragment is only about 5 mm across. One breccia clast is composed of both olivine basalt and exotic rock so it is probable that all of the metasedimentary and siliceous rocks were entrained as xenoliths in an erupting lava flow and were subsequently incorporated in the breccia.

The Lord Howe Rise alkali basalt from site GO357 also contains basement xenoliths, in that case a gabbro (Mortimer in press).

Transported rocks: It is likely that all the aforementioned rocks were in situ samples of seafloor bedrock. This is not the case for the pumice and coal samples.

Pumice was recovered at stations 30, 34, 36 (near Norfolk Island), 71, 77, 78, 91 (Lord Howe Rise) 102 (Wanganella Bank) and 130 (Reinga Ridge). In all these cases, the pumice is fresh and glassy but seamounts are known to be extinct. The pumice is therefore not of local origin but probably derived from eruptions many hundreds or thousands of kilometres distant.

Two small samples of bituminous coal were obtained at stations 82 and 102. Carbonaceous mudstones, accompanied by sandstone, have previously been recovered from the West Norfolk Ridge (Herzer et al. 1999), a few tens of kilometres SW of station 102 (Figure 1). However, the total lack of any other obviously *in situ* rock types (e.g., other sedimentary rocks) at either NORFANZ station leads to the likelihood that in both cases the coal is not in place but was ship-derived.

Further work

GNS will undertake thin sectioning and basic petrologic characterisation (e.g., X-ray fluorescence analyses) of the lavas obtained from near Middleton Reef and Norfolk Island. International collaborators, including Australian GeoSciences, will be needed to extend the lava studies to include Ar-Ar radiometric dating and Sr, Nd, and Pb tracer isotopic studies. This detailed work will be necessary to test the Lord Howe hotspot age predictions for the Middleton Reef area.

The basement rock clasts in the station 85 volcanic breccia are very small and it is uncertain just how much petrologic and dating work can be done on such a limited quantity of material. GNS is about to commence a targeted study of basement correlations between New Zealand and Queensland, and will further assess the station 85 material as part of this work.

The limestones obtained from the NORFANZ cruise will be sectioned and divided between GNS and Australian paleontologists, according to taxon specialty.

Conclusions

The NORFANZ voyage has recovered three very important sets of rock.

1) Shallow water, fossiliferous limestones from a wide area on the Reinga and Norfolk Ridges and on the Lord Howe Rise. Dating and paleoenvironmental analysis of these limestones will contribute to a new subsidence history for the ridges of the SW Pacific Ocean, with implications for land bridges, island chains, and faunal and floral migration between Australia, New Caledonia and New Zealand.
2) The first sampling of lavas from the Lord Howe Seamount Chain, bar those from Lord Howe Island itself. If global plate tectonic models of fixed mantle hotspots are correct, the Middleton Reef lavas should have ages of 10–11 Ma. The lava from station 32 is probably related to the Norfolk Island hotspot.
3) Only the third sampling of basement rock of the Lord Howe Rise. Earlier samples of gabbro xenoliths (GO357) and rhyolite (DSDP207) are igneous rocks probably related to the Cretaceous breakup of Gondwana (McDougall & van der Lingen 1974, Mortimer in press). The station 85 xenoliths are much more diverse and potentially provide critical information on the pre-Cretaceous basement terranes, which cut obliquely across the Lord Howe Rise and Dampier Ridge between New Zealand and Queensland (McDougall et al. 1994).

Despite the high scientific value of the samples, we do not believe they have any implications for the extension of Australian or New Zealand Exclusive Economic Zones. They do not alter any previous interpretations of the location and extent of continental crust or of intraplate volcanic seamounts.

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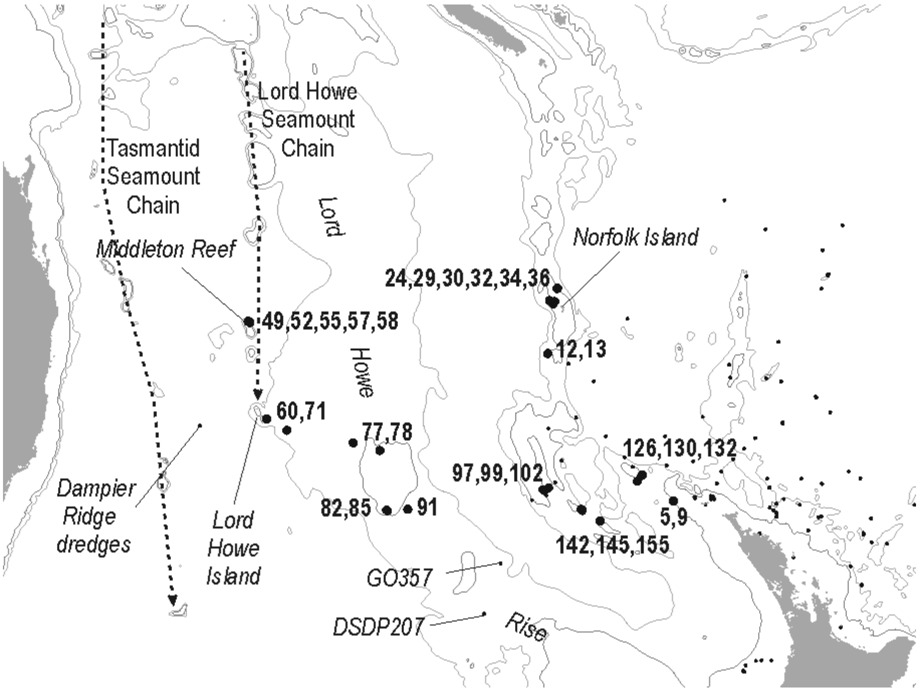

Figure 1. Map showing location of the NORFANZ rock samples (large black dots, with station numbers) in relation to other offshore samples (small black dots). Also shown are approximate positions of Tasman Sea hotspot volcano tracks.

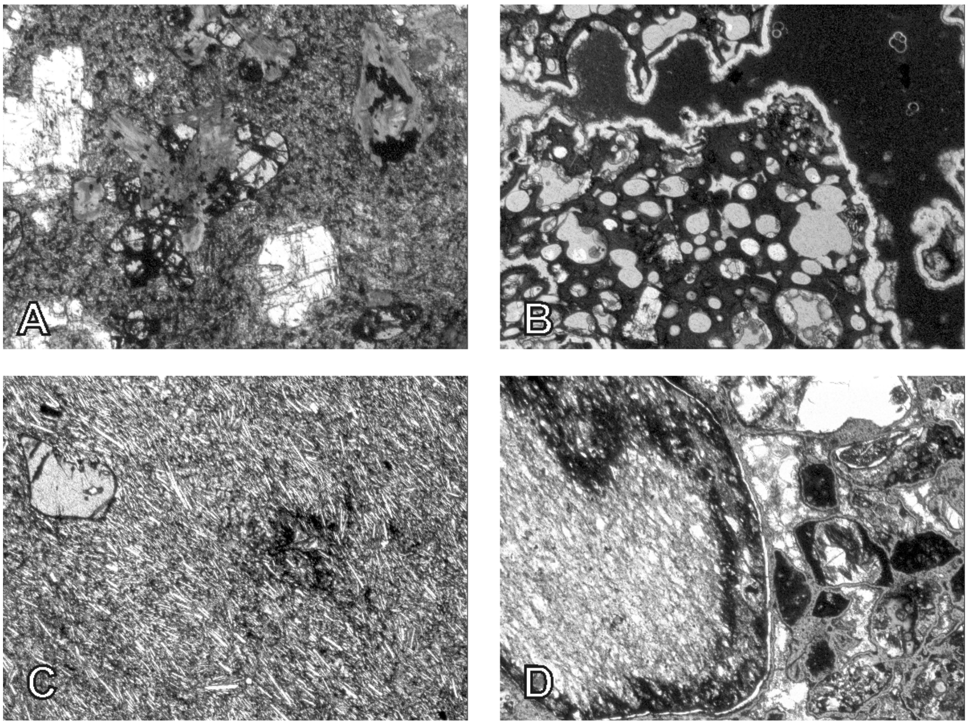

Figure 2. Thin section images of selected NORFANZ rocks. A. Station 5 basaltic andesite (GNS P69767) showing phenocrysts of olivine (altered), and plagioclase and clinopyroxene (both fresh). B. Middleton Reef area volcanic breccia (station 58, P69776) showing highly vesicular and altered volcanic fragments set in fine-grained limestone matrix. Note forams in matrix near top right corner. C. Middleton Reef area trachybasalt (station 49, P69772) with rare (fresh) olivine phenocryst. D. Lord Howe Rise volcanic breccia (station 85, P69782) showing schist fragment (rounded, left hand side of image) that was probably entrained as a xenolith in the erupted lavas. All images width of view 3mm, taken in plane polarised light.

Appendix 3: Checklist of macro-invertebrate taxa collected during NORFANZ, upgraded from taxonomic information received to December 2004 (based on Williams et al. 2006a).

CAAB	Family	Genus	Species	CAAB	Family	Genus	Species
10000000	Porifera	Porifera	undifferentiated	10010003	Calthropellidae	Pachastrissa	sp. 3882
10000800	unidentified		sp. 75	10012801	Geodiidae	Pachymatisma	sp. 1
10000806	sponge	sponge	6	10012802	Geodiidae	Isops	sp. 1
10000822	sponge	sponge	22	10012803	Geodiidae	Caminus	sp. 1
10000830	sponge	sponge	30	10012804	Geodiidae	Geodia	sp. 1
10000844	sponge	Hexactinellida		10013005	Pachastrellidae	Poecillastra	sp. 3899
10000857	Lithistid	Lithistid sponge	MF113	10013006	Pachastrellidae	Poecillastra	sp. 3883
10000861	Hexachnellid	Hexachnellid MF131		10013007	Pachastrellidae	Pachastrella	sp. 3890
10000865	Siphonophorida	Siphonophorida	tettilidae MF139	10013008	Pachastrellidae	Characella	sp. 3888
10000885	unidentified		sp. 94	10013009	Pachastrellidae	Poecillastra	sp. 3885
10000910	unidentified		sp. 93	10013010	Pachastrellidae	Pachastrella	sp. 3889
10000911	unidentified		sp. 90	10013011	Pachastrellidae	Poecillastra	sp. 3884
10000912	unidentified		sp. 95	10013012	Pachastrellidae	Characella	sp. 3886
10000913	unidentified		sp. 68	10013013	Pachastrellidae	Thenea	sp. 3904
10000914	unidentified		sp. 91	10013014	Pachastrellidae	Stoeba	sp. 3908
10000915	unidentified		sp. 134	10013015	Pachastrellidae	Poecillastra	sp. 3901
10001012	Plakinidae	Corticium	sp. 3876	10013016	Pachastrellidae	Poecillastra	sp. 3898
10001013	Plakinidae	Oscarella	sp. 3169	10013017	Pachastrellidae	Poecillastra	sp. 3900
10001801	Plakinidae	Plakortis	sp. 1	10013018	Pachastrellidae	Characella	sp. 3887
10004021	Tetillidae	Craniella	sp. 3878	10013019	Pachastrellidae	Stoeba	sp. 3906
10004023	Tetillidae	Cinachyrella	sp. 2048	10013020	Pachastrellidae	Stoeba	sp. 3907
10004024	Tetillidae	Cinachyrella	sp. 3877	10013021	Pachastrellidae	Poecillastra	sp. 3902
10004803	Tetillidae	Craniella	sp. 3879	10013022	Pachastrellidae	Poecillastra	sp. 3880
10009801	Astrophorida	Ancorinidae	MF452	10013023	Pachastrellidae	Characella	sp. 3905
10009802	Ancorinidae	Stelletta	sp. 1	10013024	Pachastrellidae	Poecillastra	sp. 3903
10009803	Ancorinidae	Stelletta	sp. 3	10013801	Pachastrellidae	Poecillastra	sp. 3899
10009804	Ancorinidae	Melophlus	sp. 1	10020801	Chondrillidae	Chondrilla	sp. 1
10009805	Ancorinidae	Ecionemia	sp. 1	10022004	Hemiasterellidae	Hemiasterella	sp 3891
10009806	Ancorinidae	unidentified	sp. A	10025019	Polymastiidae	Spinularia	australis
10009807	Ancorinidae	Stryphnus	sp. 1	10025020	Polymastiidae	Tentorium	sp. 3894
10009808	Ancorinidae	Stelletta	sp. 6	10025021	Polymastiidae	Radiella	sp. 3892
10009809	Ancorinidae	Stelletta	sp. 7	10025022	Polymastiidae	Trachyteleia	sp. 3893
10009810	Ancorinidae	Melophlus	sp. 2	10026028	Spirastrellidae	Spirastrella	sp. 3895
10009811	Ancorinidae	Asteropus	sp. 1	10026029	Spirastrellidae	Spirastrella	sp. 3896
10009812	Ancorinidae	Stelletta	sp. 4	10026801	Spirastrellidae	Spirastrella	sp. 2
10009813	Ancorinidae	Stelletta	sp. 2	10028035	Suberitidae	Suberites	sp. 3909
10009814	Ancorinidae	Stelletta	sp. 5	10028801	Suberitidae	Suberites	sp. 1
10009815	Ancorinidae	Ancorina	sp. 1	10028802	Suberitidae	Aaptos	sp. 1
10010002	Calthropellidae	Pachataxa	sp. 3881	10029023	Tethyidae	Tethya	sp. 3911

CAAB	Family	Genus	Species	CAAB	Family	Genus	Species
10037001	Scleritodermatidae	Microscleroderma	herdmani	10075009	Crellidae	Crella (Yvesia)	sp. 3929
10037801	Scleritodermatidae	Scleritoderma	sp. 1	10075801	Crellidae	Crella (Yvesia)	sp. 1
10037802	Scleritodermatidae	Scleritoderma	sp. 2	10076016	Hymedesmiidae	Phorbas	sp. 3932
10037803	Scleritodermatidae	Scleritoderma	sp. 3	10077062	Myxillidae	Stelodoryx	sp. 3922
10038001	Corallistidae	Corallistes	fulvodesmus	10078056	Chondropsidae	Psammoclema	sp. 3920
10038801	Corallistidae	Herengeria	sp. 1	10078057	Chondropsidae	Chondropsis	sp. 3921
10038801	sponge	sponge MF362	sp. 1	10078058	Chondropsidae	Psammoclema	sp. 3919
10038802	Corallistidae	Neoschrammeniella	sp. 2	10079017	Tedaniidae	Tedania	sp. 3937
10038803	Corallistidae	Neophrissospongia	sp. 1	10079818	Tedaniidae	Tedania (Tedaniopsis)	sp. 3938
10038804	Corallistidae	Neoschrammeniella	sp. 1	10080855			
10038805	Corallistidae	Corallistes	sp. 1	10082006	Cladorhizidae	Chondrocladia	pulvinata
10039001	Pleromidae	Pleroma	menoui	10082007	Cladorhizidae	Chondrocladia	concrescens
10039002	Pleromidae	Pleroma	turbinatum	10082008	Cladorhizidae	Chondrocladia	sp. 3941
10040801	Theonellidae	Theonella	sp. 1	10082009	Cladorhizidae	Chondrocladia	sp. 3939
10040802	Theonellidae	Discodermia	sp. 1	10082010	Cladorhizidae	Chondrocladia	sp. 3940
10040803	Theonellidae	Discodermia	sp. 2	10084020	Desmacellidae	Desmacella	sp. 3943
10045801	Neopeltidae	Homophymia	sp 1	10085001	Hamacanthidae	Hamacantha (Vomerula)	sp. 3944
10048001	Isoraphiniidae	Costifer	sp. 1	10086050	Mycalidae	Phlyctaenopora (Barbozia)	sp. 3945
10049801	Azoricidae	Leiodermatium	sp. 1	10086051	Mycalidae	Mycale (Oxymycale)	sp. 3319
10049802	Azoricidae	Leiodermatium	sp. 2	10086802	Mycalidae	Mycale (Mycale)	sp. 1
10055801	Verticillititiidae	Vaceletia	sp. 1	10088001	Podospongiidae	Podospongia	sp. 3897
10065801	Acarnidae	Zyzzya	sp. 3912	10090175	Axinellidae	Phakellia	sp. 3345
10066196	Microcionidae	Antho (Antho)	sp. 3914	10090801	Axinellidae	Phakellia	sp. 3
10066197	Microcionidae	Clathria (Clathria)	sp. 3917	10090805	Axinellidae	Phakellia	sp. 4
10066198	Microcionidae	Clathria (Clathria)	sp. 3913	10090806	Axinellidae	Phakellia	sp. 2
10066199	Microcionidae	Clathria (Axosuberites)	sp. 3916	10090807	Axinellidae	Phakellia	sp. 5
10066200	Microcionidae	Antho (Antho)	sp. 3915	10090808	Axinellidae	Axinella	sp. 1
10067102	Raspailiidae	Aulospongus	sp. 3918	10090809	Axinellidae	Axinella	sp. 2
10067801	Raspailiidae	Lithoplocamia	sp. 1	10091008	Desmoxyidae	Parahigginsia	phakelloides
10070001	Dendoricellidae	Pyloderma	sp. 3930	10091009	Desmoxyidae	Parahigginsia	sp. 3659
10070002	Dendoricellidae	Dendoricella	sp. 3931	10092801	Dictyonellidae	Raphoxya	sp. 1
10071003	Phellodermidae	Echinostylinos	sp. 3936	10092802	Dictyonellidae	Dictyonella	sp. 1
10071004	Phellodermidae	Echinostylinos	sp. 3933	10093000	Halichondriidae	Halichondriidae	undifferentiated
10071005	Phellodermidae	Echinostylinos	sp. 3935	10093046	Halichondriidae	Topsentia	sp. 3352
10071006	Phellodermidae	Echinostylinos	sp. 3934	10093834	Halichondriidae	Halichondria (Halichondria)	sp. 4
10073033	Coelosphaeridae	Lissodendoryx (Acanthodoryx)	sp. 3924	10093836	Halichondriidae	Topsentia	sp. 1
10073034	Coelosphaeridae	Lissodendoryx (Lissodendoryx)	sp. 3927	10093837	Halichondriidae	Axinyssa	sp. 1
10073035	Coelosphaeridae	Lissodendoryx (Ectyodoryx)	sp. 3925	10093838	Halichondriidae	Halichondria (Halichondria)	sp. 3
10073036	Coelosphaeridae	Lissodendoryx (Acanthodoryx)	sp. 3923	10093839	Halichondriidae	Topsentia	sp. 1
10073037	Coelosphaeridae	Lissodendoryx (Ectyodoryx)	sp. 3926	10093840	Halichondriidae	Axinyssa	sp. 3
10073801	Coelosphaeridae	Lissodendoryx (Lissodendoryx)	sp. 3	10093841	Halichondriidae	Topsentia	sp. 2
10074003	Crambeidae	Monanchora	sp. 3928	10093842	Halichondriidae	Halichondria (Halichondria)	sp. 2
10074004	Crambeidae	Monanchora	sp. 3435	10093843	Halichondriidae	Axinyssa	sp. 2

CAAB	Family	Genus	Species
10093844	Halichondriidae	Halichondria (Halichondria)	sp. 5
10093845	Halichondriidae	Halichondria (Halichondria)	sp. 1
10098806	Callyspongiidae	Callyspongiidae MF289	
10098808	Callyspongiidae	Callyspongia (Callyspongia)	sp. 1
10098809	Callyspongiidae	Arenosclera	sp. 1
10099801	Chalinidae	Haliclona (Reniera)	sp. 3
10099802	Chalinidae	Cladocroce	sp. 1
10099803	Chalinidae	Haliclona (Reniera)	sp. 2
10099804	Chalinidae	Haliclona (Reniera)	sp. 1
10100803	Niphatidae	Amphimedon	sp. 3
10100804	Niphatidae	Niphates	sp. 2
10100805	Niphatidae	Niphates	sp. 1
10100806	Niphatidae	Amphimedon	sp. 1
10100807	Niphatidae	Amphimedon	sp. 2
10101801	Phloeodictyidae	Oceanapia	sp. 11
10101802	Phloeodictyidae	Pachypellina	sp. 2
10101803	Phloeodictyidae	Oceanapia	sp. 1
10101804	Phloeodictyidae	Oceanapia	sp. 2
10101805	Phloeodictyidae	Aka	sp. 1
10101806	Phloeodictyidae	Oceanapia	sp. 4
10101807	Phloeodictyidae	Pachypellina	sp. 3
10101808	Phloeodictyidae	Oceanapia	sp. 9
10101809	Phloeodictyidae	Oceanapia	sp. 10
10101810	Phloeodictyidae	Oceanapia	sp. 13
10101811	Phloeodictyidae	Oceanapia	sp. 15
10101812	Phloeodictyidae	Oceanapia	sp. 7
10101813	Phloeodictyidae	Oceanapia	sp. 8
10101814	Phloeodictyidae	Oceanapia	sp. 12
10101815	Phloeodictyidae	Pachypellina	sp. 1
10101816	Phloeodictyidae	Oceanapia	sp. 3
10101817	Phloeodictyidae	Oceanapia	sp. 6
10101818	Phloeodictyidae	Oceanapia	sp. 5
10101819	Phloeodictyidae	Oceanapia	sp. 17
10101820	Phloeodictyidae	Oceanapia	sp. 16
10102015	Petrosiidae	Petrosia	punctata
10102802	Petrosiidae	Xestospongia	sp. 6
10102803	Petrosiidae	Petrosia	sp. 2
10102804	Petrosiidae	Petrosia (Strongyliphora)	sp. 1
10102805	Petrosiidae	Xestospongia	sp. 4
10102806	Petrosiidae	Petrosia	sp. 6
10102807	Petrosiidae	Xestospongia	sp. 1
10102808	Petrosiidae	Xestospongia	sp. 7
10102809	Petrosiidae	Petrosia	sp. 4

CAAB	Family	Genus	Species
10102810	Petrosiidae	Petrosia	sp. 5
10102811	Petrosiidae	Petrosia	sp. 3
10102812	Petrosiidae	Xestospongia	sp. 5
10102813	Petrosiidae	Xestospongia	sp. 2
10102814	Petrosiidae	Xestospongia	sp. 3
10112801	Irciniidae	Irciniidae	
10112802	Irciniidae	Psammocinia	sp. 2
10112808	Irciniidae	Ircinia	sp. 1
10112809	Ircinidae	Ircinidae MF297	
10113802	Thorectidae	Luffariella	sp. 1
10113803	Thorectidae	Dactylospongia	sp. 2
10113804	Thorectidae	Dactylospongia	sp. 1
10114801	Spongiidae	Spongia	sp. 1
10114802	Spongiidae	Spongia	sp. 2
10114803	Spongiidae	Spongia	sp. 3
10114804	Spongiidae	Coscinoderma	sp. 3
10114805	Spongiidae	Coscinoderma	sp. 1
10114806	Spongiidae	Coscinoderma	sp. 2
10119802	Dysideidae	Lamellodysidea	sp. 1
10120801	Darwinellidae	Chelonaplysilla	sp. 1
10125801	Aplysinidae	Aplysina	sp. 1
10180815	Hadromenida	Hadromenida MF270	
10180820	Demospongiae		sp. 78
10180838	Lithistid	Lithistid MF351	
10180839	Lithistid	Lithistid MF350	
10200803	Calcarea		sp 87
10200804	Calcarea		sp 83
10200805	Calcarea		sp 66
10200806	Calcarea		sp 65
10300000	Class	Hexactinellida -MF150	
10300801		glass	glass sponge
10300802	Hexactinellida		sp 136
10300803	Hexactinellida		sp 23
10300804	Hexactinellida		sp 102
10300805	Hexactinellida		sp 144
10300807	Hexactinellid	Hexactinellid MF134	
10300809	Hexachnellid	Hexachnellid MF158	
10300811	Hexactinellida		sp 53
10300812	Hexachnellid	Hexachnellid sponge MF192	
10300814	Hexactinellida		sp 135
10300815	Hexachnellid	Hexachnellid sponge	MF 197
10300819	Hexactinellida		sp 48
10300820	Hexactinellida		sp 138

CAAB	Family	Genus	Species	CAAB	Family	Genus	Species
10300821	Hexactinellida		sp 120	10300871	Hexactinellida		sp 6
10300822	Hexactinellida		sp 112	10300872	Hexactinellida		sp 86
10300823	Pheronema	Pheronema globosum		10300873	Hexactinellida		sp 118
10300825	Hexactinellida		sp 49	10300874	Hexactinellida		sp 33
10300826	Hexachnellid	Hexachnellid MF240		10300875	Hexactinellida		sp 119
10300831	Hexactinellida		sp 143	10300876	Hexactinellida		sp 123
10300834	Hexactinellida		sp 42	10300877	Hexactinellida		sp 109
10300836	Hexactinellida		sp 85	10300878	Hexactinellida		sp 81
10300837	Hexactinellida		sp 74	10300879	Hexactinellida		sp 62
10300838	Hexactinellida		sp 70	10300880	Hexactinellida		sp 105
10300839	Hexactinellida		sp 58	10300881	Hexactinellida		sp 101
10300840	Hexactinellida		sp 99	10300882	Hexactinellida		sp 72
10300841	Hexactinellida		sp 88	10300883	Hexactinellida		sp 97
10300842	Hexactinellida		sp 71	10300884	Hexactinellida		sp 15
10300843	Hexactinellida		sp 80	10300885	Hexactinellida		sp 51
10300844	Hexactinellida		sp 60	10300886	Hexactinellida		sp 134
10300845	Hexactinellida		sp 82	10300887	Hexactinellida		sp 43
10300845		Hexactinellid	MF326	10300888	Hexactinellida		sp 22
10300846	Hexactinellida		sp 84	10300889	Hexactinellida		sp 28
10300847	Hexactinellida		sp 98	10300890	Hexactinellida		sp 30
10300847		Hexactinellid	MF332	10300891	Hexactinellida		sp 37
10300848	Hexactinellida		sp 12	10300892	Hexactinellida		sp 89
10300849	Hexactinellida		sp 57	10300893	Hexactinellida		sp 35
10300850	Hexactinellida		sp 108	10300894	Hexactinellida		sp 44
10300851	Hexactinellida		sp 69	10300895	Hexactinellida		sp 127
10300853	Hexactinellida		sp 59	10300896	Hexactinellida		sp 20
10300854	Hexactinellida		sp 73	10300897	Hexactinellida		sp 26
10300855	Hexactinellida		sp 50	10300898	Hexactinellida		sp 114
10300856	Hexactinellida		sp 29	10300899	Hexactinellida		sp 32
10300856	Hexactinellid	Hexactinellid MF425		10300910	Hexactinellida		sp 124 & sp 31
10300857	Hexactinellida		sp 76	10300912	Hexactinellida		sp 27
10300859	Hexactinellida		sp 34	10300913	Hexactinellida		sp 17
10300860	Hexactinellida		sp 46	10300914	Hexactinellida		sp 117
10300861	Hexactinellida		sp 8	10300915	Hexactinellida		sp 36
10300862	Hexactinellida		sp 106	10300916	Hexactinellida		sp 7
10300863	Hexactinellida		sp 122	10300917	Hexactinellida		sp 142
10300864	Hexactinellida		sp 100	10300918	Hexactinellida		sp 11
10300865	Hexactinellida		sp 121	10300919	Hexactinellida		sp 111
10300866	Hexactinellida		sp 103	10300920	Hexactinellida		sp 96
10300867	Hexactinellida		sp 126	10300921	Hexactinellida		sp 110
10300868	Hexactinellida		sp 52	10300922	Hexactinellida		sp 25
10300869	Hexactinellida		sp 107	10300923	Hexactinellida		sp 63
10300870	Hexactinellida		sp 141	10300924	Hexactinellida		sp 67

CAAB	Family	Genus	Species	CAAB	Family	Genus	Species
10300925	Hexactinellida		sp 64	11077810		Stylasteridae	sp10
10300926	Hexactinellida		sp 56	11077811		Stylasteridae	sp11
10300927	Hexactinellida		sp 45	11077812		Stylasteridae	sp12
10300928	Hexactinellida		sp 54	11077813		Stylasteridae	sp13
10300929	Hexactinellida		sp 92	11077814		Stylasteridae	sp14
10300930	Hexactinellida		sp 18	11097001		Physalia	Physalia physalis
10300931	Hexactinellida		sp 47	11100804		Black	bottle brush
10300932	Hexactinellida		sp 10	11120000		Scyphozoa	all spp.
10300933	Hexactinellida		sp 55	11120801		Jellyfish	Jellyfish 1
10300934	Hexactinellida		sp 16	11120802		Jellyfish	Jellyfish sp 2
10300935	Hexactinellida		sp 137	11120803		Jellyfish	Jellyfish 3
10300936	Hexactinellida		sp 40	11160801		Black	Black coral
10300937	Hexactinellida		sp 14	11160802		Black	feather
10300938	Hexactinellida		sp 9	11160803		Black	broom
10300939	Hexactinellida		sp 79	11160804		Antipatharian	bottle brush
10300940	Hexactinellida		sp 125	11160805		Black	bottlebrush sp2
10300941	Hexactinellida		sp 21	11160806		Black	flat & bushy
10300942	Hexactinellida		sp 39	11160807		Black	bushy tree
10300943	Hexactinellida		sp 77	11160808		Antipatharian	meshwork black coral
10300944	Hexactinellida		sp 41	11160809		Black	feather (red brown polyp) sp2
10300945	Hexactinellida		sp 104	11160810		Black	bushy tree
10300946	Hexactinellida		sp 61	11160811		Black	broom 2 (green)
10300947	Hexactinellida		sp 38	11160812		Black	open pale planar
10300948	Hexactinellida		sp 24	11160813		Black	open red planar
10301801	Hyalonematidae	Hyalonema (Hyalonema)	sp 1	11160814		Black	planar pink one sided
10303801	Pheronematidae	Pheronema	sp. 1	11160815		Planar	Planar black coral fan
10303802	Pheronematidae	Pheronema	sp. 2	11161000		Antipathidae	undifferentiated
10303803	Pheronematidae	Pheronema	sp. 3	11161801		Cirrhipathes	sp - spiral
10303804	Pheronematidae	Pheronema	sp. 5	11161802		Cirripathes	sp2
10308001	Aphrocallistidae	Aphrocallistes	beatrix	11173814		Gorgonian	Gorgonian sp8
10312802	Farreidae	Farrea	sp. 2	11173816		?ASCIDIAN	
10312803	Farreidae	Farrea	cf. occa	11175801	Acanthogorgiidae	Acanthogorgia	sp. 1
11001000		Order Hydroida	undifferentiated	11175802	Acanthogorgiidae	Acanthogorgia	sp. 5
11077000		Stylasteridae	undifferentiated	11175803	Acanthogorgiidae	Acanthogorgia	sp. 2
11077801	Stylasteridae	Conopora	Conopora sp.	11175804	Acanthogorgiidae	Anthogorgia	sp. 1
11077802		Stylasteridae	sp2	11175805	Acanthogorgiidae	Acanthogorgia	sp. 8
11077803		Stylasteridae	sp3	11175806	Acanthogorgiidae	Acanthogorgia	sp. 4
11077804		Stylasteridae	sp4	11175807	Acanthogorgiidae	Acanthogorgia	sp. 7
11077805		Stylasterid	sp5	11176801	Alcyoniidae	Anthomastus	sp. 1
11077806		Stylasterid	sp6	11177801	Anthothelidae	Victorogorgia	n. sp.1
11077807	stylasterid	stylasterid (pink)	sp7	11177802	Anthothelidae	Icillogorgia	n. sp. 1
11077808		Stylasterid	sp8	11180000	Chrysogorgiidae	undifferentiated	
11077809		Stylasterid	sp9 (orange)	11180001	Chrysogorgiidae	Isidoides	armata

CAAB	Family	Genus	Species	CAAB	Family	Genus	Species
11180802	Chrysogorgiidae	Chrysogorgia	sp. 1 & sp. 2	11191803	Nephtheidae	Dendronephthya	sp. 1
11180804	Chrysogorgiidae	Chrysogorgia	sp. 3	11191804	Nephtheidae	Dendronephthya	sp. 2
11180805	Chrysogorgiidae	Radicipes	sp. 1	11191805	Nephtheidae	cf. Duva	n. sp. 1
11180807	Chrysogorgiidae	Chrysogorgia	sp. 4	11192801	Nidaliidae	Chironephthya	sp. 1
11180808	Chrysogorgiidae	Chrysogorgia	sp. 5	11192802	Nidaliidae	Chironephthya	sp. 2 (orange, pink, violet)
11180809	Chrysogorgiidae	Chrysogorgia	sp. 6	11192803	Nidaliidae	Chironepthya	sp. 3
11180810	Chrysogorgiidae	Chrysogorgia	sp. 7	11192804	Nidaliidae	Chironephthya	sp. 4
11180813	Chrysogorgiidae	Metallogorgia	sp. 1	11192805	Nidaliidae	Chironephthya	sp. 5
11180814	Chrysogorgiidae	Radicipes	sp. 2	11192806	Nidaliidae	Chironephthya	sp. 6
11181801	Clavulariidae	n. gen.	n. sp. 1	11196000	Plexauridae	umndifferentiated	
11181801		Clavulariidae	(?New Genus)	11196801	Plexauridae	n. gen. 1	n. sp.1
11181802	Clavulariidae	Telestula	n. sp. 1	11196802	Plexauridae	Astrogorgia	sp. 1
11181803	Clavulariidae	Rhodelinda	n. sp. 1	11196803	Plexauridae	Villogorgia	sp. 1
11183801	Coralliidae	Corallium	sp. 1	11196804	Plexauridae	Villogorgia	sp. 2
11185801	Ellisellidae	Nicella	sp. 1	11196805	Plexauridae	Astrogorgia	sp. 2
11185802	Ellisellidae	Viminella	sp. 2	11196807	Plexauridae	Lepidomuricea	n. sp. 1
11185803	Ellisellidae	Nicella	sp. 2	11196808	Plexauridae	Paracis	cf. squamata
11185804	Ellisellidae	Nicella	sp. 3	11196809	Plexauridae	Bebryce	n. sp. 1
11185805	Ellisellidae	Verrucella	sp. 1	11196810	Plexauridae	Cyclomuricea	n. sp. 1
11185806	Ellisellidae	Viminella	sp. 1	11196812	Plexauridae	Muriceides	n. sp. 1
11185807	Ellisellidae	Viminella	sp. 3	11196813	Plexauridae	Swiftia	n. sp. 1
11185808	Ellisellidae	Viminella	sp. 4	11196814		Plexauridae	sp4
11188000	Isididae	undifferentiated		11196815	Plexauridae	Villogorgia	sp. 3
11188026	Isididae	Myriozotisis	heatherae	11196816	Plexauridae	Villogorgia	sp. 4
11188039	Isididae	Orstomisis	crosnieri	11196817	Plexauridae	n. gen. 2	n. sp. 1
11188801	Isididae	Primnoisis	sp1	11196818	Plexauridae	Muriceides	n. sp. 2
11188802	Isididae	Lepidisis	sp. 1	11196819	Plexauridae	Muriceides	n. sp. 3
11188803	Isididae	Lepidisis	sp. 2	11196820	Plexauridae	n. gen. 3	n. sp. 1
11188804	Isididae	n. gen.	n. sp. 1	11197003	Primnoidae	Callogorgia	sertosa
11188805	Isididae	Keratoisis	sp. 2	11197004	Primnoidae	Callogorgia	formosa
11188806	Isididae	Keratoisis	sp. 1	11197005	Primnoidae	Dasystenella	acanthina
11188807	Isididae	Minuisis	n. sp. 1	11197006	Primnoidae	Calyptrophora	trilepis
11188808	Isididae	Gorgonisis	n. sp. 1	11197007	Primnoidae	Perissogorgia	colossus
11188809	Isididae	Lepidisis	sp. 4	11197801	Primnoidae	Thouarella	sp. 1
11188812	Isididae	Keratoisis	sp. 3	11197802		Primnoidae	pink
11188813	Isididae	Keratoisis	sp. 4	11197804	Primnoidae	Thouarella	sp. 2
11188814	Isididae	Lepidisis	sp. 3	11197805	Primnoidae	Narella	sp. 1
11188815	Isididae	Lepidisis	sp. 5	11197806	Primnoidae	Thouarella	sp. 3
11188816	Isididae	Lepidisis	sp. 6	11197807	Primnoidae	Pseudoplumarella	n. sp. 1
11188817	Isididae	Lepidisis	sp. 7	11197809	Primnoidae	Narella	sp. 2
11188818	Isididae	Lepidisis	undifferentiated	11197811		Primnoidne	sp3
11189001	Keroeididae	Keroeides	gracilis	11197812		Primnoidae	sp4
11191801	Nephtheidae	Scleronephthya	cf. macrospiculata	11197813		Primnoidae	sp5

CAAB	Family	Genus	Species	CAAB	Family	Genus	Species
11197814	Primnoidae	Narella	sp. 3	11229818		Anemone	Anemone #18
11197815	Primnoidae	Fannyella	n. sp. 1	11229819		Anemone	Anemone #19
11197816	Primnoidae	Plumarella	sp. 1	11229820		Anemone	Anemone sp20
11197817	Primnoidae	Thouarella	sp. 4	11229821		Anemones	in sponge MF348
11208000	Pennatulacea	undifferentiated		11229822		Anemone	Anemone sp22
11208801		elongate	elongate sea pen	11229823		Anemone	Anemone sp23
11208803	Pennuatulidae	Pennatula	sp	11229824		Anemone	Anemone sp24
11210001	Anthoptilidae	Anthoptilum	grandiflorum	11229825		Anemone	Anemone sp25
11210002	Anthoptilidae	Anthoptilum	murrayi	11229826		Anemone	Anemone sp26
11210801	Anthoptilidae	Anthoptilum	n. sp. 1	11229828		Anemone	Anemone sp28
11214801	Halipteridae	Halipteris	cf. finmarchica	11229829		Anemone	Anemone sp27
11215001	Kophobelemnidae	Kophobelemnon	macrospinosum	11284000		Order Zoanthiniaria	undifferentiated
11216801	Umbellulidae	Umbellula	sp. 1	11284801		Zooanthid	Zooanthid
11216802	Umbellulidae	Umbellula	sp. 3	11284802		Zoanthids	Zoanthids
11216803	Umbellulidae	Umbellula	sp. 2	11284803		Zooanthids	on gorgonian skeleton
11217801	Pennatulidae	Pennatula	sp. 1	11284804		Zoanthid	Zoanthid sp4
11217802	Pennatulidae	Pennatula	sp. 2	11284805		Zoanthid	Zoanthid sp5
11217803	Pennatulidae	Pennatula	sp. 4	11284806		Zoanthid	Zoanthid sp6
11217804	Pennatulidae	Pennatula	sp. 5	11290000		Order Scleractinia	undifferentiated
11218001	Protoptilidae	Distichoptilum	gracile	11290801		solitary	solitary coral
11218801	Protoptilidae	Protoptilum	n. sp. 1	11290802		solitary	Orange trumpet coral
11219005	Pteroeididae	Gyrophyllum	sibogae	11290803		solitary	solitary coral
11219801	Pteroeididae	Gyrophyllum	n. sp. 1	11290804		solitary	Solitary corals
11219802	Pteroeididae	Pteroeides	sp. 1	11290805		solitary	green/white sp4
11229000		Order Actinaria	undifferentiated	11290806		solitary	solitary coral b/w sp5
11229323				11290807		solitary	Solitary coral sp6
11229801		Anemone	Anemone	11290808		solitary	Solitary coral sp7
11229802		Anemones	Anemones	11290809		solitary	solitary coral sp8
11229803		Anemone	on stalk	11290810		Scleratcinian	yellow colonial coral
11229804		Anemone	Anemone #4	11290811		solitary	Solitary coral sp9
11229805		Anemone	Anemone	11290812		solitary	Solitary coral sp10
11229806		Anemone	purple	11290813		solitary	Solitary coral sp11
11229807		Anemone	Anemone - orange white	11290814		Caryophyllidae	sp12
11229808		Anemone	sp. 8 & White anemone	11314000		Caryophylliidae	undifferentiated
11229809		Red	red anemone	11314031		Solenosmilia	Solenosmilia variabilis
11229810		Anemone	Anemone 10	11314801		Caryophyllia	sp
11229811		Orange	orange on sponge	11314802		Deltocyathus	sp
11229812		Anemone	Anemone sp12	11314803		Stephanocyathus	sp
11229813		Anemone	Anemone sp13	11314804		Caryophyllia	sp2
11229814		Anemone	Anemone #14	11314805		Caryophylliidae	sp1
11229815		Anemone	Anemone #15	11320801		Dendrophylliidae	
11229816		Anemone	Anemone #16	11328801		Flabellum	Flabellum sp1
11229817		Anemone	solitary,disc like sp17	11328802		Flabellum	Flabellum sp2

CAAB	Family	Genus	Species	CAAB	Family	Genus	Species
11328803		Flabellum	Flabellum	20487801		Fenestrate bryozoan	Phidoloporidae
11328804		Flabellum	Flabellum sp	20487802		Phidoloporidae	Phidoloporidae sp2
11328805		Flabelum	Flabelum sp5	22000000		Polychaete	undifferentiated
11328806		Flabellum	Flabellum sp6	22000801		Polychaete	Polychaete
11328807		Flabellum	Flabellum sp7	22000802		Polychaetes	in sponge
11328808		Flabellum	Flabellum sp8	22000803		Polychaete	Polychaete #3
13000801		Platyhelminthe	sp1	22000805		Polychaete	Polychaete sp5
14000000		Phylum Nemertea	undifferentaited	22000806		Polychate	Polychate sp6
14000801		Nemertean	Pelagic nemertean	22000807		Polychaete	Polychaete sp7
14000802		Nemerteum	Nemerteum sp2	22000808		Polychaete	Polychaete sp8
14000803		Nemertean	Nemertean sp3	22000809		Polychaete	Polychaete sp9
14000804		Nemertean	Nemertean sp4	22000810		Polychaete	Polychaete sp10
15000801		Pogonophora?	Pogonophora?	22000811		Polychaetes	Polychaetes sp11
15000802		Chaetognath	Chaetognath sp1	22000812		Polychaete	Polychaete sp12
15400801		Priapulid	Priapulid sp1	22000813		Polychaete	Polychaete sp13
15400802		Priapulida	Priapulida #2	22021801		Amphinomidae	Amphinomidae
15400803		Priapulid	Priapulid sp3	22021802		Amphinomidae	Amphinomidae sp2
17000000	Phylum Sipuncula		undifferentiated	22021803		Amphinomidae	Amphinomidae sp3
17000801		Sipunculan	Sipunculan sp1	22021804		Amphinomidae	Amphinomidae sp4
17000802		Sipunculan	Sipunculan	22024000		Eunicidae	undifferentiated
17000803		Sipunculan	Sipunculan sp1	22024801		Eunicidae	Eunicidae sp
17000804		Sipunculan	Sipunculan sp2	22030000		Onuphidae	undifferentiated
19000000	Phylum Kamptozoa		- undifferentiated	22030801		Onuphidae	Onuphidae
19000802		Sipunculid	Sipunculid sp2	22030802		Onuphidae	Hyalinoecia sp
19020000	Phylum Phoronida			22043000		Aphroditidae	undifferentiated
19100000	Phylum Brachiopoda		undifferentiated	22056000		Nereididae	undifferentiated
19100801		Brachiopods	Brachiopods	22056801		Nereididae	Nereididae sp1
19100802		Brachiopod	Thecedellina sp	22056802		Nereidiidae	Nereidiidae #2
19100803		Brachiopod	Brachiopod sp2	22059000		Phyllodocidae	undifferentiated
19100804		Brachiopod	Brachiopod (red) sp3	22062000		Polynoidae	undifferentiated
20000000		Bryozoa	undifferentiated	22062801		Polychaete	Polynoidae
20000802		Bryozoans	Bryozoans	22062802		Polynoid	Polynoid sp2
20000803		Bryozoa	Bryozoa	22062803		Polynoid	Polynoid sp3
20000804		Bryozoan	Bryozoan	22062804		Polynoid	Polynoid sp4
20000805		Bryozoan	Bryozoan	22085000		Serpulidae	undifferentiated
20000806		Bryozoan	Bryozoan sp6	22085801		Serpulid	Serpulid tube
20000807		Bryozoan	Bryozoan sp7	22085802		Polychaete	Serpulid 2
20000808		Bryozoa	Bryozoa sp8	22085803		Serpulid	Serpulid worms
20000809		Bryozoan	Bryozoan #9	22092801		Chaetopterid	Chaetopterid tubes
20000810		Bryozoan	Bryozoan (encrusting)	23101801		Leptochiton	Leptochiton sp
20332801		Bryozoan	Red - Candidae	23118801		Chitonidae	Chitonidae
20405801		Bryozoan-	Adeonidae	23199000		Class	Class Bivalvia
20405802		Bryozoan,	Adeonidae sp2	23199801		Bivalve	Bivalve

CAAB	Family	Genus	Species	CAAB	Family	Genus	Species
23199802		Bivalve	Bivalve on Urchin spine	23615000		Order Teuthoidea	undifferentiated
23199803		Bivalve	Bivalve sp3	23620001	Lycoteuthidae	Lycoteuthis	lorigera
23199804		Bivalve	bivalve sp4	23621008	Ancistrocheiridae	Acncistrocheirus	lesueurii
23220801		Mytilidae	Mytilidae -green sp1	23621801	Enoploteuthidae	Abraliopsis	undifferentiated
23220802		Mytilid	Mytilid sp2	23621802	Pyroteuthidae	Pyroteuthis	undifferentiated
23226801		Areidae	Areidae - bivalve mollusc	23623006	Onychoteuthidae	Onykia	robsoni
23226802		Arcidae	Arcidae hairy sp2	23623801	Onychoteuthidae	Onykia	undifferentiated
23228801		Noetiidae	Noetiidae sp1	23623802	Onychoteuthidae	Onychoteuthis	sp. 1
23230000		Limopsidae	undifferentiated	23630000	Histioteuthidae	Histioteuthidae	undifferentiated
23230801		Limopsidae	Limopsidae sp1	23630002	Histioteuthidae	Histioteuthis	bonnellii
23236004		Pteria	Pteria penguin	23630006	Histioteuthidae	Histioteuthis	miranda
23236801		Pteria	Pteria sp	23636000	Ommastrephidae	Ommastrephidae	undifferentiated
23236802		Pteria	Pteria sp 2	23636001	Ommastrephidae	Eucleoteuthis	luminosa
23237801		Malleus	Malleus sp	23636006	Ommastrephidae	Nototodarus	sloani
23250801		Limidae	Limidae sp 1	23636008	Ommastrephidae	Ornithoteuthis	volatalis
23257801		Oyster	Oyster sp1	23636011	Ommastrephidae	Todarodes	fillipovae
23257802		Oyster	Oyster sp2	23636801	Chiroteuthidae	Chiroteuthis	cf imperator
23257803		Bivalve	Bivalve Oyster sp3	23639000	Mastigoteuthidae	Mastigoteuthidae	undifferentiated
23270801		Pectinidae	Pectinidae Chlamys sp	23639002	Mastigoteuthidae	Mastogoteuthis	cordiformis
23271000		Propeamussiidae	undifferentiated	23639003	Mastigoteuthidae	Mastogoteuthis	magna
23271801		Propeamussiidae	sp1	23643000	Cranchiidae	Cranchiidae	undifferentiated
23271802		Propriamussidae	sp2	23643001	Vampyroteuthidae	Vampyroteuthis	infernalis
23272801		Spondyus	Spondyus sp	23643002	Cranchiidae	Cranchia	scabra
23272802		Spandylus	Spandylus sp2	23643003	Cranchiidae	Helicocranchia	pfefferi
23275801		Anomiidae	Anomiidae sp1	23643014	Cranchiidae	Teuthowenia	pellucida
23301801		Chama	Chama sp	23643015	Cranchiidae	Galiteuthis	pacifica
23305801		Lucinidae?	Lucinidae? sp2	23643806	Cranchiidae	Galiteuthis	sp. 1
23305802		Lucinidae?	Lucinidae? sp2	23643807	Cranchiidae	subfamily Taoniinae	sp. 1
23335801		Cardiidae	Cardiidae	23643808	Cranchiidae	subfamily Cranchiinae	sp. 1
23395801		Hiatella	Hiatella sp1	23643809	Cranchiidae	Teuthowenia	sp. 1
23435000		Cuspidariidae	undifferentiated	23643810	Cranchiidae	Teuthowenia	sp. 2
23435801		Cuspidaria	Cuspidaria sp1	23643812	Cranchiidae	subfamily Cranchiinae	sp. 2
23435802		Cuspidaria	Cuspidaria sp2	23643813	Cranchiidae	subfamily Cranchiinae	sp. 3
23499000		Class	Class Scaphopoda	23643814	Cranchiidae	subfamily Cranchiinae	sp. 4
23499801		Scaphopoda	Scaphopoda	23643815	Cranchiidae	Leachia	sp. 1
23499802		Scaphopod	Scaphopod sp2	23650000	order	Order Octopoda	undifferentiated
23590000	Class	Class Cephalopoda		23653801	Opisthoteuthidae	Opisthoteuthis	sp. 1
23606001	Spirulidae	Spirula	spirula	23653802	Opisthoteuthidae	Opisthoteuthis	sp. 2
23607000	Sepiidae	Sepiidae	undifferentiated	23653803	Opisthoteuthidae	Opisthoteuthis	sp. 3
23609000	Sepiolidae	Sepiolidae	undifferentiated	23653804	Grimpoteuthidae	Grimpoteuthis	sp. 1
23609801	Sepiolidae	Heteroteuthis	sp. 1	23655003	Bolitaenidae	Bolitaena	pygmaea
23609802	Sepiolidae	Euprymna	sp. 1	23656801	Amphitretidae	Amphitretus	sp. 1
23609803	Sepiolidae	Stoloteuthis	sp. 1	23659000	Octopodidae	Octopodidae	undifferentiated

CAAB	Family	Genus	Species
23659801	Octopodidae	Scaeurgus	sp. 1
23659802	Octopodidae	Benthoctopus	sp. 1
24000000		Class Gastropoda	
24000801		Gastropod	Gastropod
24000802		Gastropod	naticiform-vanikoridae?
24000803		Firola	(heteropod mollusc)
24000804		Gastropod	Gastropod sp3
24040801		Fissurellidae	Fissurellidae
24045801		Fistralium	Fistralium sp1
24045802		Turbinidae	Astralium sp2
24046000		Trochidae	undifferentiated
24046801		Trochidae	Trochidae
24047801		Callistomidae	Callistomidae
24047802		Calliostomatidae	sp2
24047803		Calliostomatidae	sp3
24047804		Calliostomatidae	sp4
24047805		Calliostomatidae	sp5
24050801		Segunziidae	Gastropod
24079801		Turritellidae	Turritellidae sp1
24145801		Xenophora	Xenophora sp
24145802		Xenophora	Xenophora sp2
24156801		Pedicularia	Pedicularia pacifica
24161801	Velutinidae	Mysticoncha	sp. 1
24165801		Naticidae	Naticidae sp1
24176001	Ranellidae	Fusitriton	magellanicus retiolus
24176801		Ranellidae	Ranellidae sp1
24176802		Ranellidae	Ranellidae sp2
24176803		Rouellidae	Rouellidae sp3
24176804		Ranellidae	Ranellidae sp4
24191801		Epitoniidae	Epitoniidae sp1
24191802		Epitoniidae	Epitoniidae sp2
24191803		Epitoniidae	Epitoniidae sp3
24195000		Eulimidae	undifferentiated
24195801		Eulimidae	Eulimidae
24195802		Eulinid	Eulinid (on white urchin)
24195803		Eulima	Eulima ex sm seastar
24195804		Eulimidae	Eulimidae sp 4
24195805		Eulimidae	Eulimidae sp5
24200801		Pterynotus	Pterynotus sp
24200802		Corralinophilinae	Corralinophilinae
24200803		Coralliphilidae	Coralliphilidae sp2
24200804		Coralliphilidae	Coralliphilidae sp3
24200805		Coralliophilinae	Coralliophilinae sp4

CAAB	Family	Genus	Species
24200806		Gastropod	Papaninae sp1
24200807		Gastropod-	Muricidae sp1
24200808		Muriadae	Trophoninae sp1
24200810		Trophorinae	Trophorinae sp3
24202801		Nassariidae	Nassariidae
24202802		Gastropod	Fasciolarinae Bucccinidae
24202803		Fasciolariinae	Fasciolariinae
24202804		Buccinidae	Buccinidae sp1
24202805		Buccinidae	Buccinidae sp2
24202806		Buccinidae	Buccinidae sp3
24202807		Buccinidae	Buccinidae
24202808		Buccinidae	Buccinidae sp5
24207801		Volutidae	Volutidae sp1
24211801		Mitridde	Mitridde sp1
24211802		Mitridae	Mitridae sp2
24213801		Costellariidae	Gastropod
24220000		Turridae	undifferentiated
24220801		Turridae	Turridae sp1
24220802		Turridae	Turridae sp2
24220803		Turridae	Turridae #3
24220804		Turridae	Turridae #4
24220805		Turridae	Turridae sp5
24222000		Conidae	undifferentiated
24222801		Conus	Conus sp1
24222802		Conus	Conus sp2
24222803		Conidae	Conidae sp3
24299802	Bubble	Bubble shell- Bulla sp1	
24299804	Opisthobranch	Opisthobranch sp2	
24299807	Opisthobranch	Opisthobranch sp5	
24322002	Philinidae	Philine	angasi
24322801	Philinidae	Philine	sp. 1
24324801	Aglajidae	Melanochlamys	sp. 1
24388002	Aplysiidae	Dolabella	auricularia
24392001	Umbraculidae	Umbraculum	umbraculum
24395001	Pleurobranchidae	Pleurobranchaea	maculata
24420803	Nudibranch	Nudibranch	
24431801	Dorididae	Austrodoris	sp. 1
24431802	Dorididae	Halgerda	sp. 1
24433801	Dendrodorididae	Doriopsilla	sp. 1
24440801	Tritoniidae	Tritonia	sp. 1
24450801	Arminidae	Armina	sp. 1
25001000		Crinoidea	undifferentiated
25001801		Crinoid	Crinoid

CAAB	Family	Genus	Species	CAAB	Family	Genus	Species
25001802		Crinoid	Crinoid	25115803		Benthopecten	sp1 (Asteroid)
25001803		Bathycrinid	Bathycrinid stem	25115804		Cheriraster	sp2
25001804		Crinoid	Crinoid sp3	25115805		Benthopecten	sp2
25001805		Crinoid	Crinoid sp4	25115806		Cheiraster	sp3
25001806		Crinoid	Crinoid sp5	25122000		Goniasteridae	undifferentiated
25001807		Crinoid	Crinoid (on black coral)	25122801		Rosaster	Rosaster sp1
25001808		Crinoid	Crinoid (b/w striped) sp 7	25122802		Mediaster	Mediaster sp1
25021000		Pentacrinitidae	undifferentiated	25122803		Mediaster	Mediaster sp
25021801		stalked	stalked crinoid	25122804		Astroceramus	sp nov
25030000		Comasteridae	undifferentiated	25122805		Goniasteridae	unident sp1
25030801		Comatulid	Comatulid crinoid	25122806		Goniasteridae	spB
25050000		Charitometridae	undifferentiated	25122807		Pseudarchaster	sp1? (Asteroid)
25060000		Antedonidae	undifferentiated	25122808		Pillsburiaster	sp1
25102000		Class Asteroidea	undifferentiated	25122809		Pseudarchaster	macdougalli
25102801			Small seastar (long arm)	25122810		Tosia	Tosia sp1
25102802		Asteroid	Asteroid #2	25122811		Gilbertaster	Gilbertaster sp1
25102803		Dytaster	Dytaster sp	25122812		Ceramaster	Ceramaster sp1
25102804		unidentified	Unidentified starfish	25125801		Ophidiosteridae	Ophidiosteridae
25102805		Tarachaster	Tarachaster sp1	25125802		Ophiuraster	Ophiuraster sp
25102806		Unknown	Unknown starfish sp4	25125803		Tamaria	Tamaria sp1
25102807		Seastar	Seastar (?Tanaie) sp7	25128001		Asterodiscides	truncatus
25102808		Seastar	sp 6 orange mottled	25136801		Solasteridae	Solasteridae
25102809		Seastar	sp7 thin mottled	25139000		Pterasteridae	undifferentiated
25102810		Hymenaster	Hymenaster sp1	25139801		Pteraster	Pteraster sp
25102811		Asthenactis	Asthenactis sp1	25139802		Pteraster	Pteraster sp3
25102812		Podosphaeraster	sp1	25139803		Pteraster	Pteraster sp2
25102813		Leilaster	Leilaster sp	25140000		Asterinidae	undifferentiated
25105801		Ludia	Ludia sp	25140801		Anserapoda	Anserapoda sp1
25105802		Luidia	Luidia sp 2	25140802		Nepaithia	Nepaithia sp1
25110801		Paxillosida	Paxillosida	25143801		Henricia	Henricia sp
25111009		Astropecten	polyacanthus	25143802		Echinasteridae	Echinasteridae sp1
25111020		Dipsacaster	magnificus	25143803		Henricia	Henricia sp3
25111021		Psilaster	acuminatus	25151000		Brisingidae	undifferentiated
25111801		Astromesites	sp	25151801		Brisingiidae-	Asteroid
25111802		Pluonaster	sp1	25152801		Zoroaster	Zoroaster sp
25111803		Pilaster	sp1	25152802		Zoroaster	Zoroaster sp2
25111804		Astropecten	sp1	25154801		Sclerasterias	Sclerasterias sp1
25111805		Psilaster	sp2	25154802		Coronaster	Coronaster sp1
25111806		Dipsacaster	sp1	25154803		Cosmasterias	Cosmasterias sp
25111807		Persephonaster	sp1	25160000	Class	Class Ophiuroidea	undifferentiated
25111808		Astopectiidae	sp1	25160802	Ophiuroid	Ophiuroid	
25115801		Pectinastor	sp	25162001	Ophiocanopidae	Ophiocanops	fulgiens
25115802		Cheiraster	sp1	25166004	Ophiomyxidae	Ophiomyxa	brevirima

CAAB	Family	Genus	Species
25166801	Ophiomyxa	Ophiomyxa sp	
25170002	Euryalidae	Astroceras	pleiades
25171002	Gorgonocephalidae	Astrothorax	waitei
25171003	Gorgonocephalidae	Asteroporpa (Asteroporpa)	australiensis
25171005	Gorgonocephalidae	Asteroporpa (Austromoana)	reticulata
25171021	Gorgonocephalidae	Astrothrombus	vercors
25171023	Gorgonocephalidae	Gorgonocephalus	pustulatum
25171801	Gorgonocephalidae	Gorgonocephalidae	
25172001	Asteroschematidae	Ophiocreas	sibogae
25172006	Asteroschematidae	Ophiocreas	oedipus
25172007	Asteroschematidae	Asteroschema	bidwillae
25172008	Asteroschematidae	Ophiocreas	mortenseni
25172009	Asteroschematidae	Ophiocreas	willsi
25172801	Astrobrachion	Astrobrachion sp1	
25172807	Asteoschema	Asteoschema bidwillae	
25173001	Asteronychidae	Asteronyx	loveni
25176000	Ophiuridae	Ophiomusium	undifferentiated (juv)
25176000	Ophiuridae	Ophiuridae	undifferentiated
25176007	Ophiuridae	Ophiomusium	lymani
25176008	Amphiophiura	Amphiophiura	insolita
25176022	Ophiomastus	Ophiomastus	tegulitius
25176028	Ophiuridae	Ophiomusium	scalare
25176029	Ophiuridae	Ophiomusium	simplex
25176034	Ophiuridae	Ophiozonella	bispinosa
25176039	Ophiura	Ophiura ooplax	
25176042	Ophiuridae	Amphiophiura	pertusa
25176043	Ophiuridae	Amphiophiura	turgida
25176044	Ophiuridae	Ophiomusium	relictum
25176045	Ophiuridae	Ophiozonoida	picta
25176057	Ophiuridae	subfamily Ophiolepidinae	sp. MoV 4891
25176801	Ophiomusium	Ophiomusium sp1	
25176802	Ophiuridae	Ophiuridae sp	
25176803	Ophiuroid-	Ophiuroid- Amphiophiura	sp
25176804	Amphiophiura	Amphiophiura	sp2
25176806	Ophiophiuroglypha	Ophiophiuroglypha	irrorata
25176807	Ophiura	Ophiura	spA
25176808	Ophiura	Ophiura	spB
25176809	Ophiuroglypha	Ophiuroglypha	spB
25176810	Amphiophiura	Amphiophiura	sp2
25176812	Ophiuridae	Ophiuridae	unident sp3
25176813	Ophiura	Ophiura	spC
25176814	Ophiomusium	Ophiomusium	sp2
25176815	Amphiophiura	Amphiophiura	sp4

CAAB	Family	Genus	Species
25176816	Amphiophiura	Amphiophiura	sp5
25176817	Ophiura	Ophiura	spD
25176818	Ophiura	Ophiura	spE
25176819	Ophiozonella	Ophiozonella	sp
25176820	Ophiura	Ophiura	spF
25176821	Amphiophiura	Amphiophiura	sp6
25176822	Ophiura	Ophiura	spG
25176823	Ophiuridae	Ophiuridae	sp4
25177003	Ophioleucidae	Ophioleuce	seminudum
25177004	Ophioleucidae	Ophiopallas	paradoxa
25177006	Ophioleucidae	Ophiernus	adspersus
25177007	Ophioleucidae	Ophioleuce	brevispinum
25179011	Ophionereididae	Ophionereis	terba
25179017	Ophionereididae	Ophiochiton	sp. MoV 4886
25179018	Ophionereididae	Ophiochiton	sp. MoV 4887
25179019	Ophionereididae	Ophionereis	sp. MoV 4888
25180001	Ophiodermatidae	Bathypectinura	heros
25180801	Ophiodermatidae	Ophiodermatidae	
25180802	Ophiodermatidae	Ophiopeza	sp. 1
25185000	Ophiacanthidae	Ophiacanthidae	undifferentiated
25185001	Ophiacanthidae	Ophiacantha	rosea
25185017	Ophiacanthidae	Ophiacantha	fidelis
25185021	Ophiacantha	Ophiacantha	serrata
25185027	Ophiacanthidae	Ophiomyces	delata
25185029	Ophiacanthidae	Ophiophthalmus	relictus
25185036	Ophiacanthidae	Ophiacantha	fuscina
25185037	Ophiacanthidae	Ophientrema	scolopendrica
25185038	Ophiacanthidae	Ophiocamax	vitrea
25185039	Ophiacanthidae	Ophiolimna	antarctica
25185040	Ophiacanthidae	Ophiolimna	perfida
25185041	Ophiacanthidae	Ophioplinthaca	defensor
25185042	Ophiacanthidae	Ophioplinthaca	plicata
25185043	Ophiacanthidae	Ophiotrema	tertium
25185044	Ophiacanthidae	Ophiotreta	valenciennesi
25185045	Ophiacanthidae	Ophiurothamnus	clausa
25185050	Ophiacanthidae	Ophiocamax	sp. MoV 4884
25185051	Ophiacanthidae	Ophiomitrella	sp. MoV 4885
25185801	Ophiacantha	Ophiacantha sp1	
25185802	Ophiacantha	Ophiacantha sp2	
25185804	Ophiacantha	Ophiacantha sp3	
25185805	Ophiomelina	Ophiomelina	sp (on black coral)
25185808	Ophiotreta	Ophiotreta	stimulea
25185810	?Ophiopristis	?Ophiopristis	sp

CAAB	Family	Genus	Species	CAAB	Family	Genus	Species
25185817	Ophiacanthidae	Ophiacanthidae	sp1	25202001		Goniocidaris	parasol
25186002	Hemieuryalidae	Ophiomoeris	obstricta	25202801		Histocidaris	Histocidaris sp1
25190001	Ophiactidae	Ophiactis	plana	25202802		Prionocidarus	sp2
25190002	Ophiactidae	Ophiactis	abyssicola	25202803		Cidaridae	sp1 (flat spined urchin)
25190003	Ophiactidae	Ophiactis	hirta	25202804		Cidaridae	Cidaridae sp2
25190009	Ophiactidae	Ophiactis	macrolepidota	25202805		Salenocidaris	Salenocidaris sp
25190013	Ophiactidae	Ophiactis	resiliens	25202806		Phyllacanthus	sp1
25190020	Ophiactidae	Ophiactis	definita	25202807		Urchin-	long thick spines
25190801	Ophiactis	Ophiactis	sp1	25202808		Cidaridae	Histiocidaris sp2
25190802	Ophiachs	Ophiachs	sp2	25202809		Cidaridae	Goniocidaris sp1
25190803	Ophiactidae	Ophiactis	sp. T2	25205000		Echinothuriidae	undifferentiated
25190804	Ophiactidae	Ophiactis	sp. T1	25205208		Echinothunidae	sp2
25191031	Amphiuridae	Amphiura (Amphiura)	magellanica	25205801		Asthenosomatidae	
25191059	Amphiuridae	Amphioplus	sp. MoV 4890	25205802		Echinothuridae	uniden sp2
25191801	Amphiuridae	Ophiocentrus	sp. 1	25205803		Echinothuridae	Echinothuridae sp3
25191805	Amphiuridae	Amphiura	sp. 1	25205804		Echinothuridae	Echinothuridae sp4
25191806	Amphiuridae	Amphiura	sp. 2	25205805		Araeosoma	Araeosoma sp
25192001	Ophiotrichidae	Ophiothrix (Ophiothrix)	aristulata	25205806		Echinothuriidae	Echinothuriidae sp5
25192036	Ophiotrichidae	Ophiothrix (Ophiothrix)	ciliaris	25206801		Phormosoma	Phormosoma sp1
25192048	Ophiotrichidae	Ophiothrix (Acanthophiothrix)	lepidus	25211007		Diadema	palmeri
25192051	Ophiotrichidae	Ophiothrix (Acanthophiothrix)	purpurea	25214001		Aspidodiadema	tonsum
25192803	Ophiotrichidae	Ophiothrix	sp. 1	25214801		Aspidodiadema	sp.
25192805	Ophiotrichidae	Ophiothrix	sp. 2	25220002		Caenopedina	novaezelandiae
25192807	Ophiotrichidae	Ophiothela	sp. 1	25220801		Caenopedina	sp (urchin)
25192808	Ophiotrichidae	Ophiothela	sp. 2	25220802		Caenopedina	sp2
25192809	Ophiotrichidae	Ophiothela	sp. 3	25220803		Caenopedina	sp3
25200000		Class Echinoidea	undifferentiated	25242011		Tripneustes	gratilla
25200802		Heart	Heart urchins	25246001		Dermechinus	horridus
25200803		Sand	Sand dollar	25246002		Gracilechinus	multidentatus
25200804		Large	Large irregular urchin	25246801		Echinidae	Echinidae sp
25200805		irregular	irregular urchin	25262001		Clypeaster	(Anomalanthus) tumidus
25200806		irregular	irregular urchin	25262004		Clypeaster	(Rhaphidoclypus) australasiae
25200808		White	White urchin sp8	25262801		Clypeaster	Clypeaster sp1
25200809		Urchin	Urchin sp9	25265801		Fibulariidae	(echinoid)
25200810		Echinoid	Echinoid	25266000		Laganidae	undifferentiated
25200811		Small	small red urchin	25266801		Peronella	Peronella sp1
25200812		green	green urchin	25307000		Spatangidae	undifferentiated
25200813		Large	large red urchin	25307801		Spatangus	Spatangus sp
25200814		Echinoid	(regular) sp14	25308801		Lovenia	Lovenia sp1
25200815		Echinoid	Echinoid sp15	25309801		Heterobrissus	Heterobrissus sp
25200816		Sea	Sea urchin sp16	25400000		Class Holothuroidea	undifferentiated
25200817		Sea	Sea urchin sp17	25400801		Holothurian	Holothurian
25200818		Sea	Sea urchin sp18	25400802		Holothurian	Holothurian sp2

CAAB	Family	Genus	Species	CAAB	Family	Genus	Species
25400803		Holothurian	Holothurian sp3	27200804		Copepod	Brittle star parasites -sp4
25400804		Holothurian	Holothurian	27200805		Copepod	Copepod
25400805		Holothurian	Holothurian 5	27200806		Copepod	Copepod sp5
25400806		Holothurian	Holothurian 6	27500000		Class Cirripedia	undifferentiated
25400807		Holothurian	Holothurian 7	27500801		Barnacles	(ex Histiocidarus spines)
25400808		Holothurian	Holothurian 8	27500802		Barnacles	Barnacles
25400809		Holothurian	Holothurian sp9	27500803		Cirriped	Cirriped
25400810		Holothurian	Holothurian #10	27500804		Cirriped	Cirriped
25400811		Holothuria	Holothuria #11	27500805		Cirriped	on sponge
25400812		Holothurian	(round pelagic gel cover sp12)	27500806		Cirrepeda	Cirrepeda sp6
25400813		Holothurian	Holothurian #13	27500807		Cirripeda	Cirripeda sp7
25400814		Holothurian	Holothurian #14	27500808		Barnacles	Barnacles sp8
25400815		Holothurian	Holothurian #15	27500809		Barnacles	Barnacles
25400816		Holothurian	Sand holothurian	27500810		Barnacle	Barnacle sp10
25400817		Holouthurian	(thin walled) sp17	27500811		Barnacle	Barnacle sp11
25400818		Holothurian	Holothurian sp 18	27500812		Barnacles	Barnacles
25400819		Holothurian	Orange sp19	27500813		Barnacle	Barnacle sp13
25400820		Holothurian	(sm pink sponge spicules)	27500814		Barnacle	Coloured stalked sp14
25400821		Holothurian	sp21 (pink knobbly)	27500815		Barnacle	Barnacle No15
25400822		Holothurian	Holothurian sp22	27500816		Barnacle	Barnacle no16
25400823		Holothurian	Holothurian sp23	27500817		Barnacle	Barnacle sp17
25400824		Holothurian	Holothurian sp24	27500818		Barnacles	Barnacles sp18
25400825		Holothurian	Holothurian sp25	27500819		Barnacle	Lidded barnacle sp19
25400826		Holothurian	transparent	27500820		Barnacle	Barnacle sp20
25400827		Holothurian	Holothurian sp27	27500821		Barnacle	Barnacle sp21
25400828		Holothurian	Holothurian sp28	27524801		Arcoscalpellum	sp1 (goose barnacle)
25400829		Holothurian	Holothurian sp29	27524802		Scalpellidae	Scalpellidae spA
25404000		Psolidae	undifferentiated	27524803		Scapellidae	Scapellidae spB
25404801		Holothurian	Psolidae	27524804		Scalpellidae	Scalpellidae spC
25408000		Cucumariidae	undifferentiated	27524805		Scalpellidae	Scalpellidae spD
25408018		Neocnus	bimarsupiis	27566801		Sacculina	Sacculina sp1
25408801		Cucumoriidae	Cucumoriidae	28037001	Hemisquillidae	Hemisquilla	australiensis
25408802		Cucumariid	Cucumariid sp2	28038005	Odontodactylidae	Odontodactylus	hawaiiensis
25411801		Ysilothuridae	Ysilothuridae	28079000		Order Mysidacea	undifferentiated
25418801		Synallactidae	sp1 (holothurian purple)	28081000		Lophogastridae	undifferentiated
25421000		Deimatidae	undifferentiated	28081001		Gnathophausia	ingens
25436801		Mopadiidae	Mopadiidae sp1	28081801		Lophogastridae	Lophogastridae sp1
25436802		Molpadidae	Molpadidae sp1	28081802		Lophogaster	Lophogaster sp1
27100801		Ostracoda	Ostracoda sp1	28081803		Neognathophausia	sp2
27200000		Subclass Copepoda	undifferentiated	28081804		Gnathophausia	zoea
27200801		Copepod	ex Coryphenoides serrulatus	28086000		Mysidae	undifferentiated
27200802		Copepod	Copepod parasite sp2	28086801		Hansenomysis	sp? (mysid)
27200803		Copepod	Parasitic sp3 (in slickhead)	28086802		Mysidacea	Mysidacea sp1

CAAB	Family	Genus	Species	CAAB	Family	Genus	Species
28086803		Mysidacea	Mysidacea sp2	28405803	Lysianassidae	subfamily Tryphosinae	sp. 1
28086804		Mysidacea	big-eye sp3	28405805	Eurytheneidae	Eurythenes	n. sp. 1
28086805		Mysidacea	big-eye sp4	28406002	Cyphocaridae	Cyphocaris	faurei
28086806		Mysidae	Mysidae sp5	28406004	Cyphocaridae	Cyphocaris	richardi
28086807		Mysidae	Mysidae sp6	28406005	Cyphocaridae	Cyphocaris	n. sp. 98
28115802		Syciona	Syciona Sp2	28406006	Cyphocaridae	Cyphocaris	n. sp. 518
28170805		Sergestes	Sergestes spC	28412004	Trischizostomatidae	Trischizostoma	n. sp. 520
28200000		Order Isopoda	undifferentiated	28445801	Eusiridae	unidentified	sp. 1
28200801		Isopoda	Isopoda	28451801	Amathillopsidae	Amathillopsis	n. sp. 1
28200802		Isopod	Isopod sp2	28455801	Oedicerotidae	unidentified	sp. 1
28200803		Isopod	Isopod sp3	28455802	Oedicerotidae	unidentified	sp. 2
28200804		Isopods	Isopods sp4	28455803	Oedicerotidae	unidentified	sp. 3
28200805		Isopods	Isopods (small) sp5	28455804	Oedicerotidae	unidentified	sp. 4
28200806		Isopod	sp 6 - parasite	28455805	Oedicerotidae	unidentified	sp. 5
28200807		Acturidae	Acturidae sp1	28455806	Oedicerotidae	unidentified	sp. 6
28200808		Isopod	Isopod (yellow) sp7	28490801	Stegocephalidae	Stegocephaloides	n. sp. 1
28200809		Isopod	Isopod sp8	28502801	Pardaliscidae	unidentified	sp. 1
28200810		Isopopd	Isopopd sp9	28525801	Ampeliscidae	Ampelisca	sp. 1
28200811		Isopod	Isopod sp10	28547801	Ischyroceridae	unidentified	sp. 1
28200812		Isopod	Isopod sp11	28551000	Corophiidae	undifferentiated	
28200813		Isopod	Isopod sp12	28553801	Ampithoidae	Ampithoe	sp. 1
28220000		Cirolanidae	undifferentiated	28555003	Lanceolidae	Lanceola	sayana
28223801		Cymothoidae	Cymothoidae sp1	28555004	Lanceolidae	Megalanceola	stephenseni
28225000		Serolidae	undifferentiated	28573002	Phrosinidae	Phrosina	semilunata
28225801		Serolidae	Serolidae sp1	28580801	Pronoidae	unidentified	sp. 1
28226000		Sphaeromatidae	undifferentiated	28585801	Parascelidae	unidentified	sp. 1
28226801		Sphaeromatidae	Sphaeromatidae sp1	28594801	SubO Caprellidea	unidentified	sp. 1
28226802		Sphaeromatidae	Sphaeromatidae sp2	28702006	Euphausiidae	Euphausia	recurva
28399000	order	Order Amphipoda	undifferentiated	28702007	Euphausiidae	Euphausia	similis
28399801	Amphipoda	Amphipoda Hyperiidae		28702009	Euphausiidae	Euphausia	spinifera
28399803	Amphipod	Amphipod		28702011	Euphausiidae	Nematobrachion	boopis
28399805	Amphipod	Amphipod	sp1	28702015	Euphausiidae	Nematoscelis	megalops
28399811	Cyphocais	Cyphocaris	sp2	28702019	Euphausiidae	Stylocheiron	abbreviatum
28399817	Hyperiid	Hyperiid amphipod	sp5	28702029	Euphausiidae	Euphausia	monacantha
28399822	Hyperiid	Hyperiid amphipod	sp9	28702031	Euphausiidae	Thysanopoda	orientalis
28399823	Hyperiid	Hyperiid amphipod	sp10	28702032	Euphausiidae	Thysanoessa	pectinata
28400000	Suborder	Suborder Gammaridea	undifferentiated	28702805	Euphausiidae	Thysanopoda	cf. egregia
28400801	Epimeriidae	Epimeria	n. sp. 1	28708000	order	Order Decapoda	undifferentiated
28400803	Rakiroidae	Rakiroa	n. sp. 1	28710000	Penaeoidea	Penaeoidea and Caridea	undifferentiated
28401801	Phoxocephalidae	unidentified	sp. 1	28711000	Penaeidae	Penaeidae	
28401802	Phoxocephalidae	unidentified	sp. 2	28711007	Penaeidae	Funchalia	villosa
28404801	Amaryllididae	?n. gen. 1	sp. 1	28711073	Penaeidae	Metapenaeopsis	velutina
28405042	Lysianassidae	?Hippomedon	n. sp. 522	28711802	Penaeidae	Penaeidae	

CAAB	Family	Genus	Species
28712001	Aristeidae	Aristaeomorpha	foliacea
28712002	Aristeidae	Aristeus	mabahissae
28712003	Aristeidae	Aristeus	virilis
28712005	Aristeidae	Hepomadus	tener
28712008	Aristeidae	Aristaeopsis	edwardsianus
28712008	Aristaeopsis	Aristaeopsis	edwardsiana
28712009	Aristeidae	Austropenaeus	nitidus
28712801	Aristeus	Aristeus	sp
28712802	Aristeus	Aristeus	sp2
28712803	Aristeus	Aristeus	sp3
28712805	Aristaeopsis	Aristaeopsis	sp1
28713001	Benthesicymidae	Benthesicymus	investigatoris
28713007	Benthesicymidae	Gennadas	gilchristi
28713009	Benthesicymidae	Gennadas	kempi
28713017	Benthesicymidae	Benthesicymus	urinator howensis
28713801	Gennadas	Gennadas	sp1
28713802	Gennadus	Gennadus	sp2
28713803	Benthesicymus	Benthesicymus	sp1
28713804	Carid	Carid - Benthesicymus	sp2
28714000	Solenoceridae	Solenoceridae	undifferentiated
28714003	Solenoceridae	Hadropenaeus	lucasii
28714005	Solenoceridae	Haliporoides	sibogae
28714017	Solenoceridae	Gordonella	kensleyi
28714023	Solenoceridae	Solenocera	comata
28714031	Solenoceridae	Hymenopenaeus	neptunus
28714033	Solenoceridae	Hymenopenaeus	obliquirostris
28714801	Solenocera	Solenocera	spA
28714802	Solenoceridae	Solenoceridae	spB
28714803	Solenocendae	Solenocendae	spC
28714805	Solenoceridae	Hymenopenaeus	n. sp. 1
28714805	Haliporoides	Haliporoides	sp
28714807	Haliporus	Haliporus	sp2
28714808	Hymenopenaeus	Hymenopenaeus	sp1
28714811	Solenoceridae	Hymenopenaeus	undifferentiated
28715000		Sicyoniidae	undifferentiated
28715009	Sicyoniidae	Sicyonia	parafallax
28715804	Sicyonia	Sicyonia	sp4
28717801	Carid,	Carid	unidentified 2
28720000	Sergestidae		(unidentifiable)
28720000	Sergestidae	Sergestidae	undifferentiated
28720023	Sergestidae	Sergestes	diapontius
28720801	Sergestes	Sergestes	spE
28720802	Sergestes	Sergestes	

CAAB	Family	Genus	Species
28720803	Sergestes	Sergestes	spA (decapod)
28720804	Sergestes	Sergestes	spB (decapod)
28720805	Sergestes	Sergestes	spC (decapod)
28720806	Sergestes	Sergestes	spD (decapod)
28720807	Sergestes	Sergestes	spE
28720808	Sergestidae	Sergestes	cf.curvatus
28720808	Prawn	Sergestidae	
28720810	Sergestes	Sergestes	spJ
28724801	Spongicaridae	Spongicaridae	sp1
28724802	Spongiocaris	Spongiocaris	sp1
28730000	Infraorder	Infraorder Caridea	undifferentiated
28735000	Oplophoridae	Oplophoridae	undifferentiated
28735005	Acanthephyra	Acanthephyra	sica
28735007	Acanthephyra	Acanthephyra	quadrispinosa
28735014	Oplophorus	Oplophorus	novaezelandiae
28735016	Oplophorus	Oplophorus	spinosus
28735018	Systellaspis	Systellaspis	debilis
28735028	Notostomus	Notostomus	auriculatus
28735801	Meningodora	Meningodora	sp (decapod)
28735802	Systellaspis	Systellaspis	sp1 oplophoridae
28735803	Oplophoridae	Oplophoridae	
28735804	Acanthephyra	Acanthephyra	trispinosa
28735805	Acanthephyra	Acanthephyra	sp
28735806	Acanthephyra	Acanthephyra	sp2
28735807	Kemphyra	Kemphyra	corallina
28737000	Nematocarcinidae	Nematocarcinidae	undifferentiated
28737801	Nematocarcinus	Nematocarcinus	sp1
28737802	Nematocarcinus	Nematocarcinus	sp2
28737803	Nematocarcinus	Nematocarcinus	sp3
28740000	Stylodactylidae	Stylodactylidae	undifferentiated
28740801	Stylodactilidae	Stylodactilidae	
28740802	Stylodactylus	Stylodactylus	sp
28740803	Stylodactylus	Stylodactylus	spB
28745000	Pasiphaeidae	Pasiphaeidae	undifferentiated
28745001	Eupasiphae	Eupasiphae	gilesii
28745801	Pasiphaea	Pasiphaea	sp
28745802	Eupasiphae	Eupasiphae	sp
28745803	Pasiphaea	Pasiphaea	spA
28745804	Prawn	Prawn - Pasiphaeidae	
28745805	Pasiphaea	Pasiphaea	cf barnardi
28745806	Glyphus	Glyphus	sp
28745807	Parapasiphae	Parapasiphae	sp1
28745808	Pasiphea	Pasiphea	spC

CAAB	Family	Genus	Species	CAAB	Family	Genus	Species
28745809	Pesiphaea	Pesiphaea	spD	28780804	Glyphocrangon	Glyphocrangon	sp4
28745810	Pasiphaea	Pasiphaea	spE	28780806	Glyphocrangon	Glyphocrangon	sp6
28745811	Pasiphaea	Pasiphaea	spF	28780807	Glyphocrangoi	Glyphocrangoi	sp7
28745812	Parapasiphae	Parapasiphae	sp2	28780808	Glyphocrangon	Glyphocrangon	sp8 (carapace only)
28754801	Bathypalaemonella	Bathypalaemonella	sp1	28781801	Pontophilus	Pontophilus	sp1
28756218	Palaemonidae	Hamiger	novaezealandiae	28781802	Crangonidae	Crangonidae	spB
28756801	Paleamonid	Paleamonid shrimp		28781803	Pontophilus	Pontophilus	sp2
28756802	Paraemonidae	Paraemonidae	spB	28781804	Crangonidae	Crangonidae	spC
28756803	Processidae	unidentified	sp. 1	28781805	Crangonidae	Crangonidae	spD
28756804	Palaemonid	Palaemonid	spD	28786801	Nephropsis	Nephropsis	sp
28756806	Palaemomidae	Palaemomidae	spE	28801801	Axiidae	Axiidae	
28756807	Palaemonidae	Palaemonidae	spF	28805801	Upogebiidae	Upogebiidae	
28765801	Alpheidae	Alpheidae	sp1	28810801	Phyllosoma	Phyllosoma	
28765802	Alpheidae	Alpheidae	sp2	28815000	Polychelidae	undifferentiated	(juvenile)
28765803	Alpheidae	Alpheidae	sp3	28815000	Polychelidae	Polychelidae	undifferentiated
28767000	Hippolytidae	Hippolytidae	undifferentiated	28815004	Polychelidae	Polycheles	enthrix
28767801	Hippolytidae	Hippolytidae	sp1	28815005	Polychelidae	Pentacheles	laevis
28767802	Hippolytidae	Hippolytidae	sp2	28815005	Pentacheles	Pentacheles	laevis
28768802	Processidae	Processidae	spB	28815009	Polychelidae	Polycheles	sculptus
28770000	Pandalidae	Pandalidae	undifferentiated	28815010	Polychelidae	Polycheles	suhmi
28770005	Heterocarpus	Heterocarpus	sibogae	28815012	Polychelidae	Pentacheles	validus
28770021	Plesionika	Plesionika	grahami	28815801	Polychelidae	Polychelidae	
28770801	Pandalidae	Pandalidae	spB	28815803	Polycheles	Polycheles	sp 3
28770802	Pandalidae	Pandalidae	spC	28820014	Palinuridae	Projasus	parkeri
28770803	Pandalidae	Pandalidae	spA	28821010	Scyllaridae	Ibacus	brucei
28770804	Heterocarpus	Heterocarpus	sp	28821801	Scyllaridae	Galearctus	n. sp. 1
28770805	Pandalidae	Pandalidae	spD	28821801	Scyllarus	Scyllarus	sp1
28770806	Pandalidae	Pandalidae	spE	28830000	Pylochelidae	Pylochelidae	undifferentiated
28770807	Pandalidae	Pandalidae	spF	28830801	Pylochelidae	Pylochelidae	scaphopod shell
28770808	Pandalidae	Pandalidae	spG	28830802	Pylochelidae	Pylochelidae	sp2
28770809	Dorodotes	Dorodotes	sp	28835801	Hermits	Hermits - Paguridae	sp1
28770810	Pandalidae	Pandalidae	spH	28835802	Hermits	Hermits Paguridae	sp2
28770811	Pandalidae	Pandalidae	spJ	28835803	Hermits	Hermits Paguridae	sp3
28770812	Pandalidae	Pandalidae	spK	28835804	Paguridae	Paguridae (hermit crab)	sp4
28770813	Pandalidae	Pandalidae	spL	28835805	Paguridae	Paguridae	sp5
28770814	Plesionika	Plesionika	sp M	28835806	Pagurid	Pagurid	sp6
28770815	Pandalidae	Pandalidae	spN	28835807	Diogenid	Diogenid	sp1
28770816	Pandalidae	Pandalidae	spP	28835808	Paguridae	Paguridae	sp8
28770817	Pandalidae	Pandalidae	spQ	28836005	Lithodidae	Lithodes	murrayi
28770901	Plesionika	Plesionika	spp	28836008	Lithodidae	Neolithodes	vinogradovi
28780801	Glyphocrangon	Glyphocrangon	sp	28836802	Lithodidae	Neolithodes	sp. 2
28780802	Glyphocrangon	Glyphocrangon	sp 2	28837801	Parapagurid	Parapagurid	
28780803	Glyphocrangon	Glyphocrangon	sp3	28837802	Parapaguridae	Parapaguridae	sp2

CAAB	Family	Genus	Species	CAAB	Family	Genus	Species
28837803	Panguroidma	Panguroidma		28840821	Munida	Munida	sp20
28837804	Parapaguridae	Parapaguridae	sp4	28840822	Munida	Munida	sp21
28837805	Parapagurus	Parapagurus	sp5	28840823	Munida	Munida	sp22
28837806	Parapaguridae	Parapaguridae	sp6	28840825	Munida	Munida	sp23
28837807	Parapaguridae	Parapaguridae	sp7	28840826	Munida	Munida	sp24
28837808	Parapaguridae	Parapaguridae	sp8 (in Ancilla)	28840827	Munida	Munida	sp25
28837809	Parapaguriidae	Parapaguriidae	sp9	28840828	Munida	Munida	sp26
28837810	Parapaguridae	Parapaguridae	sp10	28842000	Chirostylidae	Chirostylidae	undifferentiated
28837811	Parapaguridae	Parapaguridae	sp11	28842801	Chirostyllidae	Chirostyllidae	
28837812	Parapaguridae	Parapaguridae	sp12	28842802	Chirostylidae	Chirostylidae	sp2
28837813	Parapaguridae	Parapaguridae	sp13	28842803	Uroptychus	Uroptychus	sp
28837814	Parapaguridae	Parapaguridae	sp14	28842804	Chirostylidae	Uroptychus	sp2
28837815	Parapaguridae	Parapaguridae	sp15	28842805	Chirostylidae	Chirostylidae	sp3
28837816	Parapaguridae	Parapaguridae	sp16	28842806	Munidopsis	Munidopsis	sp1
28837817	Parapaguridae	Parapaguridae	sp17	28842807	Munidopsis	Munidopsis	sp2
28837818	Parapaguridae	Parapaguridae	sp18	28842808	Uroptychus	Uroptychus	sp3
28837819	Parapaguridae	Parapaguridae	sp19	28842809	Munidopsis	Munidopsis	sp3
28837820	Parapagurid	Parapagurid	sp20	28842810	Chirostylidae	Chirostylidae	sp4
28837821	Parapaguridae	Parapaguridae	sp21	28842811	Uroptychus	Uroptychus	sp4
28837822	Parapaguridae	Parapaguridae	sp22	28842812	Chirostylidae	Chirostylidae	sp5
28837823	Parapaguridae	Parapaguridae	sp23	28842813	Uroptychus	Uroptychus	sp5
28840000	Galatheidae	Galatheidae	undifferentiated	28842814	Chiostylidae	Chiostylidae	sp6
28840004	Allogalathea	Allogalathea	elegans	28842815	Chirostylidae	Chirostylidae	sp7
28840801	Munida	Munida	sp	28842816	Chiostylidae	Chiostylidae	sp8
28840802	Munida	Munida	sp2	28842817	Munidopsis	Munidopsis	sp 4
28840803	Galatheidae:	Galatheidae: Munida	sp3	28842818	Uroptychus	Uroptychus	sp6
28840804	Munida	Munida - Galatheidae	sp4	28842819	Uroptychus	Uroptychus	sp7
28840805	Galathea	Galathea Munida	sp5	28842820	Chirostylidae	Chirostylidae	sp8
28840806	Munida	Munida	sp6	28842821	Chirostylidae	Chirostylidae	sp9
28840807	Munida	Munida	sp7	28842822	Chirostylidae	Chirostylidae	sp10
28840808	Munida	Munida	sp8	28842823	Munidopsis	Munidopsis	sp5
28840809	Munida	Munida	sp9	28850000	Infraorder Bracyura	undifferentiated	
28840810	Munida	Munida	sp10	28852009	Dromiidae	Homalodromia	coppingeri
28840811	Munida	Munida	sp11	28855003	Cyclodorippidae	Krangalangia	spinosa
28840812	Munida	Munida	sp12	28860001	Homolidae	Dagnaudus	petterdi
28840813	Munida	Munida	sp13	28860002	Homola	Homola	orientalis
28840814	Munida	Munida	sp14	28860003	Homolidae	Homolochunia	kullar
28840815	Munida	Munida	sp15	28860009	Homolidae	Homologenus	levii
28840816	Munida	Munida	sp16	28860010	Homolidae	Homola	ranunculis
28840817	Munida	Munida	sp17	28860801	Homologenus	Homologenus	sp
28840818	Munida	Munida	sp18	28861801	Latreilliidae	Latreillia	sp. 1
28840819	Munida	Munida	sp19	28870801	Dorippidae	Ethusina	sp. 1
28840820	Eumunida	Eumunida	sp1	28876801	Leucosiidae	unidentified	sp. 1
28880000	Majidae	undifferentiated		28922803	Goneplacidae	Carcinoplax	sp. 2

CAAB	Family	Genus	Species
28880025	Majidae	Platymaia	maoria
28880159	Majidae	Cyrtomaia	hispida
28880160	Majidae	Vitjazmaia	latidactyla
28880801	Majidae	Platymaia	sp. 1
28880803	Majidae	unidentified	sp. 2
28880804	Majidae	unidentified	sp. 1
28880805	Majidae	unidentified	sp. 3
28880806	Majidae	unidentified	sp. 4
28880807	Majidae	unidentified	sp. 5
28880808	Majidae	Macropodia	sp. 1
28880809	Majidae	unidentified	sp. 6
28880810	Majidae	unidentified	sp. 7
28880811	Majidae	unidentified	sp. 8
28880812	Majidae	unidentified	sp. 9
28880813	Majidae	unidentified	sp. 10
28880814	Majidae	unidentified	sp. 11
28880815	Vitjazmaia	Vitjazmaia (Majidae)	sp
28880816	Majidae	unidentified	sp. 12
28880817	Majidae	Platymaia	sp. 2
28880818	Majidae	Platymaia	sp. 3
28880819	Majidae	Chlorinoides	sp. 1
28880820	Majidae	Achaeus	sp. 1
28880821	Majidae	Crytomaia	sp. 1
28880822	Majidae	Leptomithrax	sp. 1
28880823	Majidae	Platymaia	sp. 4
28880824	Majidae	unidentified	sp. 13
28880825	Majidae	Cyrtomaia	sp. 2
28895801	Parthenopidae	unidentified	sp. 1
28895802	Parthenopidae	unidentified	sp. 2
28895803	Parthenopidae	Pseudolambrus	sp. 1
28911020	Portunidae	Ovalipes	molleri
28911091	Portunidae	Thalamita	gatavakensis
28911094	Portunidae	Thalamita	macropus
28911103	Portunidae	Lupocyclus	quinquedentatus
28911104	Portunidae	Portunus	dubius
28914002	Cancridae	Platepistoma	nanum
28920173	Xanthidae	Alainodaeus	rimatara
28920174	Xanthidae	Meractaea	brucei
28920175	Xanthidae	Paramedaeus	globosus
28922000	Goneplacidae	undifferentiated	
28922801	Goneplacidae	Carcinoplax	sp. 1
28922802	Goneplacidae	Neopilumnoplax	sp. 1

CAAB	Family	Genus	Species
28926801	Pilumnidae	unidentified	sp. 1
28926802	Pilumnidae	unidentified	sp. 2
28926803	Pilumnidae	Actumnus	sp. 1
28935006	Plagusiidae	Miersiograpsus	australiensis
28962010	Palicidae	Pseudopalicus	acanthodactylus
33000801	Pycnogonids	Pycnogonids	sp1
33000802	Pycnogonid	Pycnogonid	sp2
33000803	Pycnogonid	Pycnogonid	sp3
33012801	Ammotheidae	Ascorhynchus	sp. 1
33012802	Ammotheidae	Ascorhynchus	sp. 2
33012803	Ammotheidae	Bathyzetes	sp. 1
33014005	Colossendeidae	Colossendeis	macerrima
33014019	Colossendeidae	Colossendeis	colossea
33014804	Colossendeidae	Colossendeis	sp. 1
33014805	Colossendeidae	Rhopalorhynchus	sp. 1
33015037	Pallenopsidae	Pallenopsis (Pallenopsis)	virgata
33015801	Pallenopsidae	Pallenopsis (Pallenopsis)	sp. 1
33015802	Pallenopsidae	Pallenopsis (Bathypallenopsis)	sp. 1
33015803	Pallenopsidae	Pallenopsis (Pallenopsis)	sp. 2
33015804	Pallenopsidae	Pallenopsis (Bathypallenopsis)	sp. 2
35000000	Ascidiacea	undifferentiated (empty test)	
35000000	Ascidiacea	Ascidiacea -	undifferentiated
35000801	Compound	Compound ascidian in sand	NOT ascidian - sponge
35000802	Ascidian	Ascidian	
35000804	Ascidian	Ascidian compound	
35000805	Ascidian	Ascidian	sp5
35013801	Ascidean	Ascidean Didemnidae	sp1
35018041	Polycitoridae	Polycitor	giganteus
35033103	Styelidae	Cnemidocarpa	bicornuta
35101000	Pyrosomatidae	Pyrosomatidae	undifferentiated
35101001	Pyrosoma	Pyrosoma	atlanticum
35101801	Pyrosome	Pyrosome	red salp
35101802	Pyrosome	Pyrosome	(colonial ascidian?)
35103000	Salpidae	Salpidae	undifferentiated
35103022	Salpidae	Thetys	vagina
36100802		Hemichordata	Hemichordata sp1
99110001		solitary	Solitary corals
99110002		misc	misc solitary corals
99230004		Gastropod	Gastropod egg cases
99230047		Cavolinia	(Pterobranchia)
99250002		irregular	irregular echinoids
99999999		Lithothamnion	(algae)

Appendix 4: List of fish species identified during NORFANZ. Ordinal classification follows Eschmeyer (1998), so some CAAB codes are not in sequence.

CAAB Fam	CAAB sp	Species	No.	Min depth	Max depth	Total wt kg
		Hexanchiformes				
5	1	*Heptranchias perlo*	2	116	344	11.0
		Carchariniformes				
15	804	*Apristurus cf herklotsi*	37	809	1340	8.6
15	802	*Apristurus cf sp.G*	1	698	724	0.4
15	806	*Apristurus cf spD*	1	1760	1789	0.5
15	801	*Apristurus cf spE*	3	1056	1230	1.7
15	807	*Apristurus sp (egg case)*	1	957	977	0.0
15	14	*Apristurus sp. A [in Last & Stevens, 1994]*	88	805	1350	42.8
15	15	*Apristurus sp. B [in Last & Stevens, 1994]*	15	926	1345	2.5
15	16	*Apristurus sp. C [in Last & Stevens, 1994]*	4	1132	1361	1.8
15	18	*Apristurus sp. E [in Last & Stevens, 1994]*	26	1013	1934	19.0
15	803	*Cephaloscyllium NFZ 1*	1	325	497	8.2
15	801	*Gollum cf attenuatus*	3	465	490	6.8
15	805	*Parmaturus sp NFZ1*	1	1013	1350	0.6
17	801	*Mustelus sp.NFZ1*	4	66	127	11.7
18	40	*Carcharhinus galapagensis*	19	66	91	107.9
		Squaliformes				
20	807	*Centrophorus cf squamosus*	2	850	874	18.8
20	9	*Centrophorus squamosus*	5	780	938	45.8
20	24	*Centroscyllium kamoharai*	6	1013	1350	1.5
20	805	*Centroscymnus (cf owstoni) sp.NFZ1*	74	805	1460	140.1
20	809	*Centroscymnus cf coelolepis NZ*	52	813	1460	209.4
20	802	*Centroscymnus cf plunketi*	1	1056	1116	0.4
20	12	*Centroscymnus crepidater*	63	804	1350	35.2
20	19	*Centroscymnus owstoni*	4	868	1197	23.2
20	13	*Centroscymnus plunketi*	5	805	938	26.3
20	2	*Dalatias licha*	9	325	969	52.9
20	3	*Deania calcea*	2	1013	1340	1.7
20	808	*Deania cf calcea*	546	748	1350	1568.9
20	804	*Deania cf. quadrispinosa*	1	1132	1197	1.0
20	4	*Deania quadrispinosa*	1	1056	1116	0.5
20	806	*Deania sp NFZ1*	31	698	1117	62.7
20	810	*Etmopterus baxteri*	3	1331	1345	8.3
20	801	*Etmopterus cf sp. B*	15	1051	1320	14.4
20	21	*Etmopterus granulosus*	6	1017	1042	0.6
20	5	*Etmopterus lucifer*	138	614	1000	34.7
20	33	*Etmopterus molleri*	33	348	724	6.1
20	15	*Etmopterus pusillus*	8	805	938	2.8
20	22	*Etmopterus sp. B [in Last & Stevens, 1994]*	41	855	1460	39.5
20	14	*Isistius brasiliensis*	1	200	1200	0.3
20	803	*Squalus cf spB [of Last & Stevens]*	4	325	700	9.3

CAAB Fam	CAAB sp	Species	No	Min depth	Max depth	Total wt kg
20	811	*Squalus sp cf griffini*	1	809	857	7.5
20	38	*Squalus sp. B [in Last & Stevens, 1994]*	12	254	490	18.4
20	42	*Zameus squamulosus*	2	1195	1749	1.6
21	1	*Oxynotus bruniensis*	5	614	1000	16.7
		Torpediniformes				
28	3	*Torpedo macneilli*	2	116	700	16.1
		Rajiformes				
31	811	*Bathyraja sp*	1	1760	1789	10.0
31	801	*Bathyraja spA*	1	1530	1530	0.2
31	804	*Dipturus NFZ1*	4	116	969	26.7
31	802	*Notoraja sp. NFZ 1*	1	1132	1197	0.2
31	810	*Rajidae (egg cases)*	2	1076	1083	0.0
31	803	*Rajidae NG sp. B*	5	1017	1117	0.5
31	807	*Rajidae ng spD*	5	868	1313	0.9
31	809	*Rajidae NG spF*	2	813	1000	0.4
31	808	*Rajidae ngen nspE*	3	809	1147	0.0
31	806	*Rajidae NGspC*	15	926	1350	4.9
35	2	*Dasyatis thetidis*	2	68	91	25.0
		Chimaeriformes				
42	803	*Chimaera NFZ2*	3	1090	1117	6.0
42	802	*Chimaera sp NFZ1*	12	518	1000	57.6
42	805	*Chimaera sp NFZ3*	1	1013	1340	4.9
42	6	*Chimaera sp. B [in Last & Stevens, 1994]*	1	1013	1350	3.1
42	10	*Hydrolagus sp. A [in Last & Stevens, 1994]*	13	1051	1345	39.6
42	801	*Hydrolagus trolli*	28	1013	1789	98.8
44	801	*Harriotta NFZ1*	1	1082	1120	1.9
44	1	*Harriotta raleighana*	1	1020	1045	3.4
44	2	*Rhinochimaera pacifica*	9	805	1460	36.9
		Notacanthiformes				
81	4	*Aldrovandia affinis*	55	1132	1530	14.8
81	801	*Aldrovandia cf phalacra*	1	1530	1530	0.1
81	3	*Halosauropsis macrochir*	43	1132	1934	9.0
81	2	*Halosaurus pectoralis*	102	748	938	21.3
83	1	*Notacanthus sexspinis*	22	748	1361	4.6
83	802	*Notocanthus ?abbotti*	1	521	539	0.0
83	801	*Polyacanthonotus rissoanus*	1	1410	1470	0.1
		Anguilliformes				
60	65	*Gymnothorax nubilus*	1	86	89	0.2
65	802	*Nettastoma sp*	1	850	872	0.1
65	803	*Nettastoma spB*	1	805	938	0.1
65	0	*Nettastomatidae - undifferentiated*	2	810	1042	0.2
65	801	*Venefica spA*	15	0	1975	1.3

CAAB Fam	CAAB sp	Species	No.	Min depth	Max depth	Total wt kg
67	12	*Bassanago bulbiceps*	5	780	938	3.0
67	13	*Bassanago hirsutus*	2	748	818	2.4
67	0	*Congridae - undifferentiated*	1	121	126	0.0
70	802	*cf Ilyophus spB*	1	1132	1197	0.3
70	1	*Diastobranchus capensis*	698	785	1789	496.8
70	801	*Ilyophis spA*	1	1342	1361	0.0
70	5	*Simenchelys parasitica*	2	1082	1120	0.2
70	3	*Synaphobranchus affinis*	51	690	1292	7.2
70	4	*Synaphobranchus brevidorsalis*	2	950	987	0.1
70	8	*Synaphobranchus kaupii*	10	805	1052	1.3
73	801	*Derichthys serpentinus*	1	200	1200	0.0
73	2	*Nessorhamphus ingolfianus*	3	1017	1197	0.6
73	802	*Nessorhamphus sp*	1	850	872	0.1
75	801	*Serrivomer sp*	29	0	1789	0.5
75	802	*Serrivomer spA (silver)*	35	0	2000	0.9
75	803	*Serrivomer spB (black)*	17	0	2000	0.5
75	0	*Serrivomeridae - undifferentiated*	3	1056	1116	0.1
76	801	*Avocettina spA*	32	0	1975	0.8
76	0	*Nemichthyidae - undifferentiated*	2	0	2000	0.0
76	5	*Nemichthys scolopaceus*	4	339	1749	0.0
76	802	*Nemichthys sp cf scolopaceus*	2	1051	1320	0.0
76	803	*Nemichthys spB*	2	1130	1197	0.0
		Saccopharyngiformes				
79	1	*Eurypharynx pelecanoides*	37	0	2000	2.3
		Gonorynchiformes				
141	1	*Gonorynchus greyi*	19	72	127	5.0
		Siluriformes				
192	2	*Plotosus lineatus*	10	66	88	1.1
		Osmeriformes				
97	801	*Glossanodon spA*	14	348	362	0.2
98	802	*Bathylagidae sp.A*	1	1130	1147	1.0
98	804	*Bathylagus sp (pale)*	1	0	1975	0.0
98	801	*Bathylagus sp.A*	2	1171	1345	0.2
98	803	*Bathylagus sp3*	1	1017	1042	0.1
114	0	*Alepocephalidae - undifferentiated*	2	926	1934	0.5
114	802	*Alepocephalidae gen. sp 1*	2	1530	1789	10.1
114	803	*Alepocephalidae sp B*	1	1920	1934	0.1
114	13	*Alepocephalus antipodianus?*	245	813	1934	262.1
114	14	*Alepocephalus australis*	855	809	1789	431.3
114	43	*Alepocephalus longirostris*	2	1056	1116	0.7
114	42	*Alepocephalus owstoni*	1	1530	1530	0.0
114	4	*Asquamiceps hjorti*	2	1090	1117	0.5
114	27	*Bathytroctes squamosus*	1	1530	1530	0.2
114	801	*Conocara werneri*	20	1228	1530	18.8
114	806	*Leptoderma sp NFZ1*	5	1013	1350	0.2
114	808	*Leptoderma spB*	1	0	1975	0.0

CAAB Fam	CAAB sp	Species	No	Min depth	Max depth	Total wt kg
114	15	*Mirognathus normani*	1	1303	1313	0.2
114	16	*Narcetes lloydi*	5	1056	1285	12.7
114	26	*Narcetes stomias*	24	1530	1934	25.7
114	8	*Rouleina attrita*	2789	1158	1789	1491.9
114	804	*Rouleina cf guentheri*	1	804	944	0.1
114	23	*Rouleina eucla*	200	748	1320	63.9
114	24	*Rouleina guentheri*	180	804	1350	26.2
114	807	*Rouleina sp*	2	855	874	0.5
114	12	*Talismania longifilis*	25	813	1350	7.1
114	805	*Xendoermichthys sp*	1	926	969	0.5
114	2	*Xenodermichthys copei*	6	867	1340	0.1
115	803	*?Pellisolus longirostris*	1	0	2000	0.1
115	801	*?Tragularius mesalirus*	6	0	2000	1.1
115	2	*Holtbyrnia laticauda*	1	0	1975	0.0
115	802	*Holtbyrnia sp1*	1	0	1275	0.0
115	1	*Persparsia kopua*	2	0	1975	0.2
115	4	*Platytroctes apus*	5	0	2000	0.3
		Stomiiformes				
106	802	*Bonapartia sp nov?*	2	0	2000	0.0
106	18	*Cyclothone pallida*	1	1246	1249	0.0
106	803	*Cyclothone spp*	87	0	1749	0.1
106	801	*Iccthyococcus cf ovatus*	2	0	1275	0.0
106	806	*Ichthyococcus sp*	1	617	670	0.0
106	2	*Phosichthys argenteus*	7	809	1460	0.4
106	805	*Photichthys argenteus*	3	1342	1934	0.3
106	20	*Sigmops bathyphilum*	65	0	1975	0.6
106	4	*Sigmops elongatum*	22	0	1975	1.3
106	5	*Vinciguerria attenuata*	1	1051	1320	0.0
107	4	*Argyripnus iridescens*	16	348	675	0.2
107	1	*Argyropelecus aculeatus*	2	734	1934	0.2
107	809	*Argyropelecus cf aculeatus*	3	1051	1361	0.0
107	5	*Argyropelecus gigas*	4	809	1120	0.4
107	6	*Argyropelecus hemigymnus*	10	0	1975	0.2
107	803	*Argyropelecus olfersi*	17	0	2000	0.1
107	13	*Argyropelecus sladeni*	1	200	1200	0.0
107	805	*Argyropelecus sp*	6	0	1275	0.1
107	2	*Maurolicus australis*	4	351	584	0.0
107	806	*Maurolicus spp*	1	200	1200	0.0
107	808	*Polyipnus ?unispinus*	1	0	2000	0.0
107	15	*Polyipnus kiwiensis*	28	348	675	0.8
107	801	*Polyipnus parini*	2	544	724	0.1
107	802	*Polyipnus sp*	1	1245	1285	0.0
107	810	*Polyipnus spA*	1	1017	1042	0.0
107	811	*Polyipnus spC*	6	465	675	0.2
107	3	*Polyipnus tridentifer*	1	348	362	0.1
107	0	*Sternoptychidae - undifferentiated*	14	200	1200	0.0

CAAB Fam	CAAB sp	Species	No.	Min depth	Max depth	Total wt kg
107	807	*Sternoptyx ?diaphana*	2	0	2000	0.0
107	9	*Sternoptyx diaphana*	52	0	1975	0.1
107	804	*Sternoptyx sp*	23	200	1789	0.1
108	1	*Astronesthes bilobatus*	1	0	2000	0.0
108	802	*Astronesthes cf gemmifer*	1	761	765	0.0
108	8	*Astronesthes psychrolutes*	1	0	1275	0.1
108	803	*Astronesthes sp*	1	0	1975	0.0
108	13	*Neonesthes capensis*	2	0	1975	0.0
109	812	*Bathophilus ? filifer*	1	1431	1460	0.0
109	1	*Bathophilus abarbatus*	7	200	1470	0.0
109	810	*Bathophilus spA*	3	382	880	0.1
109	6	*Echiostoma barbatum*	5	0	1975	0.1
109	813	*Eustomias sp*	1	0	1975	0.0
109	809	*Eustomias sp nov?*	1	0	2000	0.0
109	21	*Flagellostomias boureei*	1	1132	1197	0.1
109	804	*Leptostomias cf spA*	2	0	2000	0.1
109	803	*Leptostomias sp A*	6	200	1749	0.1
109	802	*Melanostomias sp A*	3	0	1530	0.2
109	806	*Melanostomias sp B (twin bulb)*	1	1051	1320	0.0
109	805	*Melanostomias sp D*	1	1530	1530	0.1
109	807	*Melanostomias sp. C*	1	1530	1530	0.1
109	0	*Melanostomiidae - undifferentiated*	1	867	869	0.1
109	28	*Opostomias micripnus*	1	1410	1470	1.1
109	29	*Pachystomias microdon*	2	0	2000	0.3
109	808	*Photonectes (Trachinostomias) spA*	2	1171	1530	0.2
109	31	*Photonectes braueri*	2	200	1200	0.0
109	811	*Photostomias sp.B*	1	1132	1197	0.1
109	801	*Thysanactis sp. A*	1	1245	1285	0.0
110	0	*Malacosteidae - undifferentiated*	4	748	1116	0.2
110	1	*Malacosteus niger*	7	200	1749	0.1
110	801	*Malacosteus? sp A*	22	0	2000	0.7
111	801	*Chauliodus ?sloani*	77	0	2000	2.7
111	1	*Chauliodus sloani*	112	0	1975	2.3
112	2	*Stomias boa*	5	957	1202	0.1
112	3	*Stomias longibarbatus*	2	0	1975	0.0
113	801	*Idiacanthis sp*	1	1530	1530	0.1
113	2	*Idiacanthus atlanticus*	5	0	1975	0.1
113	1	*Idiacanthus fasciola*	1	1410	1470	0.1
		Aulopiformes				
117	801	*Hime NFZ 1*	5	116	127	0.2
118	19	*Bathysaurus ferox*	10	1082	1934	7.3
118	802	*Synodus cf. rubromarmoratus*	4	116	127	0.6
118	805	*Synodus doaki*	1	111	115	0.1
118	7	*Synodus similis*	1	68	91	0.1
120	806	*Bathysauropsis gracilis*	5	1530	1934	0.5
120	805	*Chlorophthalmus albatrossis*	2	514	774	0.2

CAAB Fam	CAAB sp	Species	No	Min depth	Max depth	Total wt kg
120	807	*Paraulopid spA*	2	469	539	0.0
120	802	*Paraulopus cf novazeelandiae*	1	322	337	0.0
120	804	*Paraulopus legandi*	6	322	337	0.1
120	801	*Paraulopus okamurai*	40	325	497	10.3
120	803	*Paraulopus spA (not Gomon)*	1	322	337	0.1
123	801	*Bathypterois cf longifilis*	6	850	872	1.4
123	802	*Bathypterois filiferus*	2	750	1035	0.2
123	2	*Bathypterois longifilis*	103	565	1259	21.7
123	803	*Bathyterois cf filiferus*	1	1530	1530	0.1
125	803	*Ahliesaurus brevis*	1	1760	1789	0.0
125	3	*Luciosudis normani*	2	200	1749	0.0
125	801	*Scopelosaurus spA*	2	200	1200	0.2
125	802	*Scopelosaurus spB*	1	1635	1749	0.0
126	801	*Macroparalepis sp*	1	0	1975	0.0
126	5	*Notolepis risso*	8	0	2000	0.1
127	1	*Omosudis lowei*	4	0	2000	0.1
128	2	*Alepisaurus brevirostris*	17	0	2000	0.2
129	801	*Anotopterus cf. pharoa*	1	1635	1749	0.0
130	2	*Evermannella balbo*	2	1019	1934	0.1
130	801	*Odontostomops normalops*	3	1410	1749	0.2
132	801	*Cetomimidae spA*	1	734	754	0.0
139	0	*Giganturidae - undifferentiated*	1	1635	1749	0.0
		Myctophiformes				
121	1	*Neoscopelus macrolepidotus*	742	690	1052	58.1
122	25	*Bolinichthys longipes*	1	200	1200	0.0
122	26	*Bolinichthys nikolayi*	1	0	1275	0.0
122	28	*Bolinichthys supralateralis*	9	0	1975	0.0
122	21	*Ceratoscopelus warmingii*	13	0	2000	0.0
122	805	*Diaphus adenomus*	2	850	1030	0.0
122	32	*Diaphus brachycephalus*	16	0	2000	0.0
122	811	*Diaphus cf lucidus*	8	0	1975	0.0
122	34	*Diaphus fragilis*	1	200	1200	0.0
122	61	*Diaphus hudsoni*	2	0	1975	0.0
122	73	*Diaphus kapalae*	2	200	1200	0.0
122	86	*Diaphus lucidus*	3	0	2000	0.0
122	36	*Diaphus meadi*	5	0	1275	0.0
122	37	*Diaphus metopoclampus*	5	0	1275	0.0
122	38	*Diaphus mollis*	24	0	2000	0.0
122	39	*Diaphus parri*	3	0	2000	0.0
122	8	*Diaphus perspicillatus*	11	0	2000	0.0
122	803	*Diaphus similis?*	2	734	754	0.1
122	802	*Diaphus sp*	1	1245	1285	0.0
122	807	*Diaphus spA (GR 7+1+14)*	2	0	2000	0.0
122	809	*Diaphus spB*	547	348	362	16.7
122	41	*Diaphus termophilus*	94	0	2000	0.3
122	13	*Diaphus watasei*	1	648	854	0.1

CAAB Fam	CAAB sp	Species	No.	Min depth	Max depth	Total wt kg
122	43	*Electrona risso*	43	0	1975	0.3
122	44	*Gonichthys barnesi*	1	758	760	0.0
122	4	*Hygophum hygomii*	16	0	2000	0.0
122	23	*Hygophum proximum*	1	1303	1313	0.0
122	46	*Hygophum reinhardtii*	1	200	1200	0.0
122	94	*Lampadena luminosa*	1	0	2000	0.0
122	47	*Lampadena notialis*	2	0	1975	0.1
122	806	*Lampanychus cf festivus*	12	0	2000	0.5
122	2	*Lampanyctodes hectoris*	11	544	584	0.0
122	19	*Lampanyctus australis*	2	0	1320	0.0
122	50	*Lampanyctus festivus*	7	200	1749	0.4
122	20	*Lampanyctus intricarius*	4	0	1275	0.1
122	52	*Lampanyctus pusillus*	1	0	1275	0.0
122	64	*Lampanyctus sp. [Paxton, pers comm]*	3	1342	1361	0.1
122	53	*Lobianchia dofleini*	42	0	1275	0.1
122	54	*Lobianchia gemellarii*	5	0	2000	0.0
122	0	*Myctophidae - undifferentiated*	59	0	1975	0.1
122	9	*Myctophum asperum*	3	0	2000	0.0
122	56	*Myctophum nitidulum*	2	200	1200	0.0
122	3	*Myctophum phengodes*	17	0	1975	0.0
122	96	*Nannobrachium achirus*	1	1171	1259	0.1
122	49	*Nannobrachium atrum*	6	0	2000	0.0
122	804	*Nannobrachium cf atrum*	1	1019	1030	0.0
122	801	*Nannobrachium spp*	62	0	1530	0.4
122	70	*Notoscopelus caudispinosus*	1	0	2000	0.0
122	22	*Notoscopelus resplendens*	9	0	2000	0.1
122	5	*Scopelopsis multipunctatus*	299	0	2000	1.1
122	810	*Symbolophorus sp*	2	521	1000	0.0
122	69	*Taaningichthys bathyphilus*	4	0	2000	0.0
		Lampriformes				
269	1	*Metavelifer multiradiatus*	23	66	122	10.4
		Gadiformes				
224	8	*Antimora rostrata*	92	1076	1934	23.3
224	805	*Euclichthys sp NFZ1*	2	430	960	0.2
224	804	*Gadella norops*	8	565	960	0.6
224	9	*Halargyreus johnsonii*	214	804	1350	151.8
224	806	*Laemonema sp*	1	565	960	0.1
224	18	*Lepidion inosimae*	9	785	1350	17.5
224	10	*Lepidion microcephalus*	19	867	1230	4.2
224	17	*Lepidion schmidti*	3	1331	1789	15.7
224	15	*Melanonus gracilis*	4	1021	1530	0.1
224	16	*Melanonus zugmayeri*	3	0	1975	0.1
224	2	*Mora moro*	594	605	1120	740.1
224	801	*Physiculus cf luminosa*	27	322	560	0.7
224	12	*Physiculus luminosa*	1	265	280	0.0
224	802	*Physiculus spA*	6	298	700	0.7

CAAB Fam	CAAB sp	Species	No	Min depth	Max depth	Total wt kg
224	803	*Physiculus spB*	1	505	900	0.1
224	21	*Physiculus therosideros*	1	565	960	0.0
224	4	*Tripterophycis gilchristi*	6	521	938	0.2
224	807	*Tripterophycis spA*	1	515	700	0.1
224	808	*Trypterophycius spB*	8	469	772	0.8
227	3	*Lyconus sp. [in Paxton et al, 1989]*	1	200	1200	0.2
227	1	*Macruronus novaezelandiae*	6	544	846	24.1
232	38	*Asthenomacrurus victoris*	1	1760	1789	0.0
232	30	*Bathygadus cottoides*	312	926	1789	8.1
232	807	*Bathygadus sp1*	1	1051	1320	0.0
232	77	*Bathygadus spongiceps*	10	1056	1460	3.7
232	821	*Caelorinchus ?cookianus (juvs)*	72	469	800	1.0
232	42	*Caelorinchus acanthiger*	68	815	1345	18.9
232	816	*Caelorinchus celaenostomus*	87	614	1000	74.3
232	814	*Caelorinchus cookianus*	99	450	800	4.8
232	820	*Caelorinchus cylindricus*	26	469	539	0.2
232	815	*Caelorinchus horribilis*	8	748	1230	0.5
232	14	*Caelorinchus innotabilis*	561	587	1350	27.1
232	40	*Caelorinchus kermadecus*	15	1019	1285	12.8
232	17	*Caelorinchus matamuus*	3	868	872	1.0
232	45	*Caelorinchus maurofasciatus*	8	394	724	1.6
232	817	*Caelorinchus melanobranchus*	7	348	362	1.1
232	112	*Caelorinchus mycterismus*	712	698	1350	147.3
232	822	*Caelorinchus mystax*	1	465	490	0.1
232	824	*Caelorinchus sp (Juvs too small to id)*	2	469	869	0.0
232	819	*Caelorinchus sp NFZ3*	14	1013	1350	2.7
232	802	*Caelorinchus sp1 (sp nov)*	1	650	666	1.4
232	809	*Caelorinchus sp2*	1	0	1275	0.0
232	118	*Caelorinchus spathulatus*	21	650	754	1.0
232	116	*Caelorinchus supernasutus*	25	648	977	15.4
232	80	*Caelorinchus trachycarus*	43	1013	1789	8.4
232	29	*Cetonurus globiceps*	1164	850	1470	224.5
232	39	*Coryphaenoides dossenus*	6	868	1268	1.8
232	811	*Coryphaenoides filicauda*	40	1760	1934	2.1
232	50	*Coryphaenoides grahami*	19	1013	1789	2.3
232	51	*Coryphaenoides mcmillani*	35	1013	1460	2.0
232	19	*Coryphaenoides rudis*	7	1171	1789	41.2
232	15	*Coryphaenoides serrulatus*	204	805	1350	44.9
232	53	*Coryphaenoides striaturus*	111	1013	1934	20.7
232	16	*Coryphaenoides subserrulatus*	5	813	1340	0.5
232	810	*Gadomus aoteanus*	215	805	1470	33.6
232	804	*Gadomus colletti*	2	750	938	0.3
232	808	*Hymenocephalus ?megalops*	2	558	573	0.0
232	56	*Hymenocephalus gracilis*	2	322	490	0.0
232	58	*Hymenocephalus longibarbis*	1	558	573	0.0
232	100	*Hymenocephalus megalops*	58	430	869	0.5

CAAB Fam	CAAB sp	Species	No.	Min depth	Max depth	Total wt kg
232	82	*Hymenocephalus nascens*	49	690	1000	1.2
232	823	*Hymenocephalus sp (cf aterrimus)*	3	1195	1202	0.3
232	812	*Hymenocephalus spA*	1	864	870	0.0
232	801	*Hymenocephalus striatissimus*	1	544	584	0.0
232	61	*Kuronezumia bubonis*	3	748	872	1.2
232	4	*Lepidorhynchus denticulatus*	1	544	584	0.5
232	5	*Lucigadus nigromaculatus*	5	430	772	0.1
232	0	*Macrouridae - undifferentiated*	7	565	1350	0.1
232	7	*Malacocephalus laevis*	55	435	846	17.5
232	35	*Mesobius antipodum*	19	957	1350	13.5
232	102	*Nezumia coheni*	35	1013	1345	6.4
232	75	*Nezumia kapala*	2	1410	1470	0.3
232	66	*Nezumia namatahi*	17	850	1460	2.1
232	67	*Nezumia propinqua*	46	690	1000	1.7
232	69	*Sphagemacrurus pumiliceps*	11	1132	1530	0.9
232	103	*Sphagemacrurus richardi*	32	805	1460	2.5
232	70	*Squalogadus modificatus*	10	1245	1530	8.1
232	76	*Trachonurus gagates*	116	850	1259	26.3
232	818	*Trachonurus sp NFZ 1*	2	1303	1345	0.3
232	71	*Trachonurus villosus*	24	1013	1470	2.0
232	806	*Ventrifossa atherodon*	1	750	774	0.0
232	73	*Ventrifossa johnboborum*	3	565	960	0.3
232	805	*Ventrifossa macropogon*	2	750	774	0.2
232	96	*Ventrifossa paxtoni*	1	1056	1116	0.4
		Ophidiiformes				
228	14	*Aphyonus gelatinosus*	1	1920	1934	0.1
228	53	*Bassozetus robustus*	3	1530	1530	2.7
228	2	*Genypterus blacodes*	1	544	584	6.3
228	803	*Sciadonus sp.A*	1	1130	1147	0.0
228	802	*Spectrunculus grandis*	5	1760	1934	3.6
229	0	*Carapidae - undifferentiated*	2	322	707	0.0
229	801	*Carapus sp*	3	66	91	0.0
229	8	*Eurypleuron owasianum*	1	690	812	0.0
229	11	*Pyramodon punctatus*	1	627	662	0.3
		Lophiiformes				
210	801	*Antennariidae spA*	1	72	82	0.0
211	805	*Channax spE fat lure, red toes*	19	867	872	3.7
211	806	*Channax spF (thin lure, red toes)*	39	867	872	4.5
211	803	*Chaunax sp.C*	23	699	1147	0.4
211	801	*Chaunax spA*	4	587	880	1.9
211	802	*Chaunax spB white pect filaments*	4	587	1000	0.3
211	804	*Chaunax spD narrow lure*	5	813	1000	0.8
212	806	*Dibranchus NFZ 1*	4	1017	1197	0.2
212	803	*Dibranchus spA*	1	750	774	0.1
212	801	*Halieutaea spA*	2	322	337	0.2
212	802	*Malthopsis cf mitrigea*	1	714	756	0.0

CAAB Fam	CAAB sp	Species	No	Min depth	Max depth	Total wt kg
212	805	*Malthopsis sp NFZ3*	1	565	960	0.1
212	804	*Malthopsis spA (yellow spots)*	1	298	307	0.0
213	801	*Ceratoidei (male;D14)*	1	0	2000	0.0
213	1	*Melanocetus johnsoni*	6	0	1975	0.6
213	2	*Melanocetus murrayi*	1	0	1975	0.0
216	801	*Chaenophryne longiceps*	1	1635	1749	0.1
216	802	*Oneirodes sp*	1	1278	1287	0.2
216	803	*Spinophryne gladisfenae*	1	0	1975	0.0
217	1	*Gigantactis paxtoni*	1	0	1275	0.3
220	0	*Ceratiidae - undifferentiated*	1	1635	1749	0.0
220	1	*Cryptopsaras couesii*	4	200	1361	0.7
221	1	*Caulophryne jordani*	1	957	977	0.1
222	1	*Haplophryne mollis*	1	200	1200	0.0
		Gobiesociformes				
206	801	*Kopua spA*	1	322	337	0.0
		Stephanoberyciformes				
251	805	*Melamphaes (red rakers)*	1	0	2000	0.1
251	803	*Melamphaes cf indicus*	2	0	2000	0.0
251	804	*Melamphaes polylepis*	2	0	2000	0.0
251	802	*Melamphaes sp*	3	200	1530	0.1
251	0	*Melamphaidae - undifferentiated*	13	0	2000	0.0
251	801	*Poromitra cf megalops*	2	0	1275	0.0
251	4	*Poromitra crassiceps*	8	0	2000	0.9
251	806	*Poromitra sp*	1	1013	1350	0.1
251	1	*Scopeloberyx microlepis*	1	1303	1313	0.0
251	5	*Scopelogadus beanii*	9	0	1460	0.1
251	6	*Scopelogadus mizolepis*	4	1760	1934	0.1
		Beryciformes				
254	1	*Diretmichthys parini*	13	780	1287	11.6
254	2	*Diretmus argenteus*	5	0	1275	0.1
255	801	*Hoplostethus ?mediterraneus/?intermedius*	82	465	872	9.3
255	9	*Hoplostethus atlanticus*	149	805	1460	116.2
255	804	*Hoplostethus cf gigas (E.Aust species)*	1	728	826	1.6
255	1	*Hoplostethus intermedius*	5109	435	1340	628.0
255	802	*Paratrachichthys trailli*	2	351	400	0.4
255	803	*Parinoberyx horridus*	1	298	307	0.3
257	1	*Anoplogaster cornuta*	5	0	1934	0.6
258	1	*Beryx decadactylus*	59	465	854	59.1
258	803	*Beryx sp NFZ1 (cf splendens)*	3	748	772	2.6
258	2	*Beryx splendens*	211	435	772	96.4
258	3	*Centroberyx affinis*	15	254	259	20.3
258	801	*Centroberyx spA*	4	68	441	0.2
258	802	*Centroberyx spB*	21	66	88	24.2
258	802	*Centroberyx spC*	2	110	441	2.0
259	1	*Cleidopus gloriamaris*	1	68	91	0.2
		Cetomimiformes				

CAAB Fam	CAAB sp	Species	No.	Min depth	Max depth	Total wt kg
133	1	*Rondeletia loricata*	2	0	2000	0.2
		Zeiformes				
263	801	*Zenion spA*	1	544	584	0.0
263	802	*Zenion spB*	350	348	362	2.5
264	10	*Cyttopsis roseus*	5	382	490	0.6
264	3	*Zenopsis nebulosus*	117	325	497	123.9
264	4	*Zeus faber*	1	120	127	0.5
265	1	*Grammicolepis brachiusculus*	18	450	826	12.6
266	4	*Allocyttus verrucosus*	641	805	1460	356.4
266	1	*Neocyttus rhomboidalis*	13	804	944	3.9
267	801	*Antigonia spA (big)*	11	110	441	3.2
267	802	*Antigonia spB cf malayana (small)*	13	110	441	0.7
267	803	*Antigonia spC*	3	72	89	0.1
		Syngnathiformes				
278	1	*Fistularia commersonii*	1	66	88	0.1
278	2	*Fistularia petimba*	6	66	91	1.9
279	1	*Centriscops humerosus*	9	382	490	1.4
279	2	*Macroramphosus scolopax*	5140	116	127	79.7
279	5	*Notopogon xenosoma*	14	254	490	1.1
282	98	*Solegnathus dunckeri*	3	66	91	0.3
		Scorpaeniformes				
287	806	*?Phaenacoscorpia megalops*	1	298	307	0.0
287	807	*cf Sebastiscus spA*	1	48	50	0.1
287	808	*Dendrochirus cf zebra*	2	86	89	0.0
287	93	*Helicolenus barathri*	404	325	1230	98.4
287	1	*Helicolenus percoides*	30	254	400	30.0
287	809	*Maxillicosta sp NFZ1*	2	72	82	0.1
287	811	*Neomerinthe sp*	2	521	539	0.1
287	40	*Pterois volitans*	3	66	88	2.1
287	801	*Scorpaena gibbifrons ?*	1	322	337	0.0
287	803	*Scorpaena spA*	1	110	441	0.3
287	802	*Scorpaena? cookii*	17	66	337	1.6
287	0	*Scorpaenidae - undifferentiated*	3	72	539	0.0
287	804	*Setarches cf longimanus*	5	734	774	0.3
287	46	*Trachyscorpia capensis*	10	850	1117	9.9
287	103	*Trachyscorpia sp. [in ISR Munro collection]*	44	515	1000	18.3
288	5	*Pterygotrigla andertoni*	1	116	119	0.0
288	802	*Pterygotrigla pauli*	292	116	362	69.5
288	801	*Pterygotrigla spA*	1	110	441	0.2
296	801	*Onigocia pedimacula*	1	111	115	0.0
297	2	*Hoplichthys citrinus*	2	322	337	0.0
297	801	*Hoplichthys gilberti*	4	322	337	0.0
305	804	*Psychrolutes microporos*	2	1013	1340	1.7
305	801	*Psychrolutes spA*	3	748	1042	0.6
305	802	*Psychrolutes spB*	3	926	1789	12.2
305	803	*Psychrolutes spC*	3	926	1350	1.8

CAAB Fam	CAAB sp	Species	No	Min depth	Max depth	Total wt kg
307	802	*(Paraparidae) Psednos spA*	1	1017	1042	0.1
307	0	*Cyclopteridae - undifferentiated*	1	1158	1230	0.0
307	801	*Paraliparis sp.*	1	1635	1749	0.0
		Perciformes				
311	55	*Callanthias australis*	47	120	259	9.1
311	812	*Caprodon sp C*	357	116	127	34.7
311	808	*Caprodon spA*	1	68	91	0.5
311	809	*Caprodon spB*	1	66	88	1.0
311	803	*Chelidoperca lecromi*	2	111	115	0.0
311	147	*Epinephelus ergastularius*	1	110	304	16.0
311	86	*Epinephelus undulatostriatus*	1	66	88	5.2
311	802	*Hypoplectodes spA*	2	322	337	0.0
311	801	*Lepidoperca aurantia*	3	351	400	1.3
311	811	*Lepidoperca inornata*	39	254	280	6.0
311	103	*Lepidoperca magna*	37	254	344	14.9
311	807	*Ostracoberyx dorygenys*	2	587	700	0.1
311	107	*Plectranthias maculicauda*	3	265	330	0.2
311	804	*Plectranthias spA*	3	111	307	0.0
311	805	*Plectranthias spB*	1	298	307	0.0
311	806	*Plectranthias spC*	3	86	89	0.1
311	170	*Polyprion americanus*	1	373	374	12.2
311	54	*Synagrops japonicus*	2	648	854	0.3
311	28	*Synagrops philippinensis*	4	348	362	0.4
327	803	*?Apogonichthys sp*	5	86	89	0.1
327	801	*Bathysphyrenops sp (Howella?)*	1	0	1275	0.0
327	10	*Epigonus denticulatus*	9	348	772	0.2
327	1	*Epigonus lenimen*	1	518	531	0.1
327	35	*Epigonus telescopus*	12	761	1000	23.4
327	36	*Howella sherboni*	2	0	1975	0.0
327	802	*Howellidae*	2	200	1200	0.0
337	62	*Pseudocaranx dentex*	1	120	127	0.0
337	6	*Seriola lalandi*	2	110	304	28.7
337	2	*Trachurus declivis*	22	116	362	3.2
337	3	*Trachurus novaezelandiae*	23	116	127	0.3
338	1	*Coryphaena hippurus*	1	0	1500	2.5
342	1	*Brama brama*	1	1013	1350	0.1
345	1	*Emmelichthys nitidus*	15091	116	362	645.1
345	3	*Plagiogeneion rubiginosus*	51	254	400	76.6
346	32	*Pristipomoides filamentosus*	3	66	304	25.5
346	801	*Pterocaesio spA*	1	110	441	0.3
351	801	*Wattsia spA*	1	66	88	0.0
358	801	*Bathyclupea ?gracilis*	31	648	854	7.5
365	20	*Amphichaetodon howensis*	2	68	115	0.2
365	39	*Chaetodon guentheri*	1	66	88	0.1
365	63	*Chaetodontoplus ballinae*	3	68	91	0.4
367	801	*Parazanclistius spA*	5	66	91	2.7

CAAB Fam	CAAB sp	Species	No.	Min depth	Max depth	Total wt kg
367	4	*Pentaceros decacanthus*	8	339	490	4.6
367	9	*Pseudopentaceros richardsoni*	437	382	662	1187.4
367	5	*Zanclistius elevatus*	4	116	122	2.3
372	31	*Chromis abyssicola*	1	86	89	0.1
377	13	*Cheilodactylus vittatus*	3	66	88	1.2
377	14	*Nemadactylus sp. [see Smith et al, 1996]*	24	116	259	20.5
384	801	*Bodianus spA*	1	111	115	0.0
384	61	*Bodianus unimaculatus*	7	68	115	0.5
384	63	*Oxycheilinus bimaculatus*	1	72	82	0.0
384	802	*Suezichthys spA*	1	48	50	0.1
231	1	*Melanostigma gelatinosum*	1	1303	1313	0.0
231	802	*Melanostigma spA*	1	1195	1202	0.0
231	801	*Ophthalmolycus sp. A*	1	1076	1083	0.1
390	803	*Parapercis sp NFZ1*	8	121	126	0.1
390	802	*Parapercis spA*	3	86	115	0.1
390	804	*Parapercis spB*	2	120	127	0.8
393	803	*?Pteropsaron spA*	1	111	115	0.0
393	801	*Acanthaphritis grandisquama*	10	322	337	0.0
393	802	*Percophidae gen spA*	1	111	115	0.0
400	802	*Kathetostoma sp. (NZ n.sp.)*	16	116	497	25.4
400	5	*Pleuroscopus pseudodorsalis*	8	450	938	26.3
400	801	*Uranoscopus spA*	1	322	337	0.3
401	5	*Champsodon guentheri*	1	750	774	0.1
401	801	*Champsodon sp*	1	505	900	0.1
402	1	*Chiasmodon niger*	3	0	1975	0.0
402	802	*Kali macrodon*	4	1303	1313	0.0
402	801	*Kali spA*	2	1017	1052	0.1
425	801	*Ammodytoides sp A*	2	116	127	0.1
427	801	*Centrodraco cf rubellus*	1	521	539	0.0
437	34	*Prionurus maculatus*	3	66	88	11.8
439	17	*Diplospinus multistriatus*	3	1019	1749	0.1
439	13	*Promethichtys prometheus*	1	734	754	0.5
439	9	*Rexea antefurcata*	339	110	1350	54.3
439	2	*Rexea solandri*	1	325	497	0.6
440	803	*Benthodesmus cf pacificus*	2	748	818	1.1
440	1	*Benthodesmus elongatus*	3	627	754	0.8
440	801	*Benthodesmus spA*	3	544	584	0.2
440	11	*Benthodesmus tuckeri*	11	698	977	1.7
440	802	*Benthodesmus? tuckeri*	9	200	1200	2.0
440	2	*Lepidopus caudatus*	59	348	675	88.4
445	4	*Centrolophus niger*	1	748	772	5.0
445	1	*Hyperoglyphe antarctica*	20	351	675	63.4
446	6	*Cubiceps baxteri*	2	850	1197	0.3
446	10	*Cubiceps caeruleus*	2	698	724	0.5
446	801	*Cubiceps cf. capesis*	1	1132	1197	0.1
446	8	*Cubiceps pauciradiatus*	1	110	441	0.2

CAAB Fam	CAAB sp	Species	No	Min depth	Max depth	Total wt kg
		Pleuronectiformes				
460	0	*Both-Achiropsett-Paralichthyidae - undif*	1	121	126	0.0
460	802	*Bothus spA*	1	86	89	0.0
460	803	*Lophonectes NFZ 1*	19	116	127	0.7
460	801	*Psettina spA*	2	111	115	0.0
461	801	*Azygopus cf pinnifasciatus*	1	521	539	0.0
463	802	*(Cyanogfossidae) Symphurus spB*	15	565	960	0.1
463	801	*Symphurus sp*	1	750	774	0.0
463	803	*Symphurus sp. C*	7	699	1150	0.1
		Tetraodontiformes				
465	22	*Aluterus monoceros*	1	66	88	1.8
465	5	*Meuschenia scaber*	6	116	127	3.2
465	84	*Thamnaconus analis*	21	66	91	1.4
465	802	*Thamnaconus cf modestoides*	8	66	91	6.4
465	801	*Thamnaconus spA*	1	86	89	0.0
466	18	*Lactoria fornasini*	1	66	88	0.1
466	8	*Lactoria reipublicae*	3	68	91	2.1
466	803	*Lactoria var2*	1	68	91	0.1
466	802	*Lactotia var1*	5	66	91	1.8
466	801	*Ostracion cf cubicus*	1	86	89	0.0
466	21	*Polyplacapros tyleri*	41	66	127	8.2
467	38	*Canthigaster callisterna*	30	66	126	2.9
467	801	*Pelagocephalus marki? = (coheni?)*	6	0	2000	0.0
467	4	*Sphoeroides pachygaster*	2	116	127	1.3
467	804	*Torquigener spA*	1	120	127	0.0
469	2	*Allomycterus pilatus*	710	68	127	521.5
469	14	*Chilomycterus reticulatus*	2	66	91	6.5
469	5	*Diodon holocanthus*	1	66	88	0.5
469	0	*Diodontidae - undifferentiated*	1	521	539	0.0

Appendix 5: Voyage report from NORFANZ. Note that Station and catch data appendices have been excluded as they are updated in the main report.

Explore lost worlds of the deep

NORFANZ VOYAGE

10 MAY TO 8 JUNE 2003

VOYAGE REPORT OF A BIODIVERSITY SURVEY OF SEAMOUNTS AND SLOPES OF THE NORFOLK RIDGE AND LORD HOWE RISE (NORFANZ), MAY-JUNE 2003

Malcolm Clark (NIWA)
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Balls Pyramid, Lord Howe Rise.

EXECUTIVE SUMMARY

A survey of the biodiversity of fishes and benthic invertebrates was carried out on the Lord Howe Rise and Norfolk Ridge in May-June 2003. The “NORFANZ” programme has principal objectives to survey, sample and document the marine biodiversity from seamounts and slopes on the Norfolk Ridge and Lord Howe Rise, to support biosystematics research projects, to assess the faunal uniqueness and conservation value, and to relate observed distribution patterns with measured biological and physical parameters.

An international team of scientists was involved in the 4 week long survey on the NIWA research vessel *Tangaroa*. Fourteen seamount and slope sites were sampled, 10 on the Norfolk Ridge, and 4 on the Lord Howe Rise. A total of 168 stations were completed, consisting of 144 trawl-sled-dredge shots, 15 casts to measure oceanographic conditions, and 9 camera drops to photograph fauna on the seafloor. Trawl depths ranged from less than 100 m to over 2000 m. A mixture of gear was used, including bottom trawls, a midwater trawl, beam trawl, epibenthic sleds, rock and pipe dredges.

Over 500 fish species, and 1300 macro-invertebrate species, were provisionally identified onboard. This is regarded as a minimum estimate of biodiversity, as sampling intensity on individual seamounts was not sufficient to measure the complete faunal composition. About 20% of the fish species are likely to be either new records for the region, or new to science. It may take researchers around the world several years to examine fully the material, especially the invertebrates, and describe the unknown species.

There were a number of special features of the survey that contributed to its success. There was a very high level of collaboration and cooperation between the New Zealand and Australian funding agencies, and all the scientific institutes and museums. The team of international scientists covered a wide range of skills and experience, and this enabled a lot to be achieved during the survey. The variety of gear types deployed during the survey were able to sample different components of the fauna, and will contribute to a better understanding of the structure of the benthic community. The multibeam system used by *Tangaroa* enabled bathymetry and bottom type to be rapidly assessed, and was a valuable aid to planning the trawling. Photographs were taken of every species caught, and used as a reference guide throughout the survey to ensure accuracy and consistency of identifications. Overall, there were very strong and productive synergies developed between scientists from various disciplines, and this was coupled with the experience of the officers and crew, to produce an excellent survey result.

VOYAGE REPORT TAN0308 (NORFANZ)

Project title: Marine biodiversity of Norfolk Ridge and Lord Howe Rise seamount communities.

Project code: ZBD2002/16 (New Zealand Ministry of Fisheries)
(National Oceans Office of Australia)

Vessel: R.V. *Tangaroa*

Area: Norfolk Ridge, Lord Howe Rise

Period: 9 May 2003 to 7 June 2003

Voyage staff:

New Zealand:
Clive Roberts (Te Papa, Chief Scientist), Malcolm Clark (NIWA, Voyage Leader NZ), Andrew Stewart (Te Papa), Rick Webber (Te Papa), Robin McPhee (Te Papa), Peter McMillan (NIWA), Don McKnight (NIWA), Kevin MacKay (NIWA), Neil Bagley (NIWA), Brent Wood (NIWA), Richard Garlick (NIWA), Miles Dunkin (NIWA).

Australia: Leg 1
Alan Williams (CSIRO, AUS voyage leader), Mark Lewis (CSIRO), John Paxton (Australian Museum), Mark McGrouther (Australian Museum), Di Bray (Museum Victoria), Robin Wilson (Museum Victoria), Philip Alderslade (NT Museum), Spikey Riddoch (CSIRO), Karen Miller (University of Tasmania).
Leg 2
Peter Last (CSIRO, AUS voyage leader), Martin Gomon (Museum Victoria), Mark Norman (Museum Victoria), Dan Gledhill (CSIRO), Bruce Barker (CSIRO), Peter Davie (Queensland Museum), Tim O'Hara (Museum Victoria), Penny Berents (Australian Museum). All leg 2.
Legs 1 & 2
Alastair Graham (CSIRO), Karen Gowlett-Holmes (CSIRO), Ken Graham (NSW Fisheries), Mathilde Richer de Forges (Qld Museum).

France:
Leg 1
Bertrand Richer de Forges (IRD Noumea)
Leg 2
Bernard Seret (MNHN Paris)

U.S.A:
Tomio Iwamoto (California Acad. Sciences)

OBJECTIVES:

Programme objectives:

1) To survey, sample and document the marine biodiversity and environmental data from seamounts and slopes on the Norfolk Ridge and Lord Howe Rise to a depth of at least 1500m depth.

2) To preserve samples of fishes and invertebrates and hold these in accessible curated museum collections to support biosystematics research projects;

3) To provide specimens to support projects which research their identity, diversity, relationships, distributions, and assess its uniqueness and conservation value.

4) To correlate observed distribution patterns, especially diversity hotspots and pockets of endemism, with measured biological and physical parameters.

Survey objectives

1) To collect fishes and invertebrates from seamounts and slopes of the Norfolk Ridge and Lord Howe Rise, using trawls and benthic sleds.

2) To identify collected fauna on board to the highest taxonomic resolution possible, and record species composition, location and other data on a database.

3) To compile a photographic record of all fish and macro-invertebrate species caught.

4) To preserve specimens of the fauna for later identification or more detailed scientific study.

5) To collect tissue samples from selected taxa for genetic studies to aid taxonomic identification and understanding of stock relationships.

6) To collect hydrographic data, by regular deployment of conductivity-temperature-depth and sound-velocity instruments.

7) To record a bathymetric profile of seamounts where practicable, by use of *Tangaroa*'s EM300 multi-beam echo-sounder.

8) To collect sediment and rock samples for examination of microfauna, and later analysis.

9) To collect photographic data of the benthic fauna *in situ* by deployment of underwater camera equipment.

BACKGROUND:

The Norfolk Ridge and Lord Howe Rise are prominent bathymetric features of the Tasman Sea region between New Zealand and Australia. They once formed part of the old coastline of Gondwanaland, and have since existed in one form or another for over 70 million years. The ridges include considerable areas of relatively shallow seabed, comprising chains of seamounts and plateaus rising to depths of 200–1200 m below the sea surface. Limited biodiversity research has shown that in some localities the Norfolk Ridge supports marine communities that are particularly rich and diverse, characterised by high levels of endemism, and support a remarkably high number of species and genera that are new to science. Some of these are likely to be ancient taxa. Age and growth studies have shown that these complex yet fragile communities are dominated by long-lived species, some attaining ages of well over 100 years. Known distribution patterns indicate that some rare and endemic species are confined to individual seamounts, while others may be distributed more widely, perhaps representing a “biological highway” connecting New Zealand and New Caledonia. Commercial fishing interest and activity on these seamounts is increasing, and heavy bottom trawls risk damaging or destroying benthic communities. There is increasing interest in oil and mineral extraction, which also has the potential to damage these communities.

The Norfolk Ridge runs through the EEZs of three countries (Australia, New Zealand and New Caledonia), with some areas occurring in international waters. The NORFANZ project has received strong support from the New Zealand and Australian government departments, and was well supported by specialist scientists from these countries, plus France and the U.S.A.

This project contributes to objectives of New Zealand's Biodiversity Strategy, and conservation assessment and regional marine planning under Australia’s Oceans Policy. Research based on data generated by the survey will provide a major increase in our knowledge of marine biodiversity in this region of the Tasman Sea. The project will for the first time provide baseline biodiversity data for the most diverse habitats along the Norfolk Ridge, including the high priority, species rich, seamounts at depths of around 200–1500 m. Identification keys, species descriptions, and accurate names for fishes and invertebrates will be assembled based on these collections. These outputs will improve our understanding and underpin the sustainable management and conservation of these fragile communities. Results will be published in scientific journals and popular articles, and it is anticipated that key discoveries will be displayed in museum biodiversity exhibitions in New Zealand, Australia and France.

SURVEY DESIGN AND METHODS

Survey area

The survey covered 14 seamount and slope sites in the general region of the Norfolk Ridge and Lord Howe Rise (see Figure). Several positions were changed from the original schedule, where either features were not present as charted, or where a slightly different geographical distribution was appropriate.

Region	*Site number*	*Latitude S*	*Longitude E*
S. Norfolk Ridge	2	34 07’	171 36'
	3	33 22'	170 11'
N. Norfolk Ridge	4	30 11'	167 28'
	5	28 49'	167 35'
	6	26 25'	167 09'
Lord Howe Rise	7	29 13'	159 01'
	8	31 46'	159 15'
Lord Howe Plateau	9	32 40'	162 33'
	10	34 12'	162 39'
W. Norfolk Ridge	11	33 46'	167 18'
	12	34 19'	168 24'
	13	34 35'	168 56'
	14	35 11'	169 31'
	15	32 36’	167 35’

Depth strata

Seamount and slope sites were sampled in three main depth strata, from the peak to 1500 m.

(1) 0–500 m
(2) 500–1000 m
(3) 1000–1500 m

At least 2 stations were completed per depth stratum.

Sampling at greater depths (to 2000 m) was carried out on 5 occasions, where time and conditions allowed.

Sampling methods

At each site, several methods were applied. Two types (“fish” and “benthic”) were carried out on all occasions, with other sampling methods used at times.

The first routine sampling method was a NIWA rough-bottom orange roughy trawl, which was used consistently on all seamounts, with 3 trawls per seamount (where the depth range was appropriate). This enables comparison both within, and between, seamounts. This gear predominantly sampled large demersal fishes.

The second method employed one or more of a number of gear types, designed to sample the smaller demersal fishes and benthic invertebrate fauna. This included 2 types of epibenthic sled, a full wing-trawl, and beam trawl. The gear used varied between shots, as it was intended to increase the range of biodiversity sampled rather than provide comparative data.

A midwater trawl was shot on several occasions, at depths greater than 1000 m. Originally it was intended that this would occur between each seamount site, but there was not enough time for this to happen. Cone nets were also deployed off the wing-ends of the rough-bottom trawl.

Photographic transects

A camera system mounted on the headline of the trawl net (CSIRO's PhotoSea system) was used on a number of trawl shots. The self-contained system took 35 mm photographic slides at short pre-determined intervals as the net moved along the seabed. Films were processed on board immediately after each shot, and a selection of individual images digitized to evaluate habitats.

In addition, specific photographic transects were carried out on most seamounts. The NIWA Benthos camera system was mounted in a rigid protective frame, and towed slowly along the transect at a height of about 2–3 m above the bottom, and activated with the use of a bottom weight trigger.

Following difficulties with the headline system (the frame was badly damaged during a tow where much of one net was lost), and problems with charging batteries for the Benthos camera, the PhotoSea was mounted in the Benthos frame for the camera transects.

Biological sampling

The catch from each tow was sorted by species, identified, and weighed on motion-compensated scales where possible. More detailed measurements (e.g. individual weight, length) were made on some commercial species where appropriate (e.g. orange roughy, warty oreo, southern boarfish, bluenose). Much of the catch was retained (most fixed onboard, some frozen) for further taxonomic work onshore.

Photographs were taken of each species, and a working guide to the fish and macro-invertebrate fauna compiled onboard to ensure consistent identification and naming of specimens.

Station data were entered into *Tangaroa*'s Trawl Coordinator system for each trawl, photographic, or sled shot. Catch information was compiled on special NORFANZ forms for compilation and entry into the central database. The database allowed full integration of the variety of data being collected during the survey.

Database recording

Datasets describing physical and environmental details, catches, specimens, tissue samples and photographs were maintained. Data were generally recorded in various logs kept by the scientific staff, then transcribed onto forms for keyboard data entry into relational database tables. These data then underwent a variety of validation checks, with summaries being made available to scientific staff to reconcile with their information before the final version was saved.

During discussions between Australian and New Zealand staff prior to the survey it was agreed that the Australian CAAB codes would be more appropriate for a survey of this nature than the NIWA species codes. A custom form for recording catch and specimen information, as well as specimen allocation, was designed and printed for the survey. A further form was designed during the survey to record various tissue samples being taken. Fish and invertebrate photograph databases were maintained independently.

More detailed notes on database table structures and content have been prepared to accompany any copies of the database or extracts from it.

Genetic sampling

Tissue samples and whole specimens were collected and preserved from a variety of fish and invertebrate species. Specimens were dissected and tissues stored in ethanol. The whole specimens for genetic studies were generally frozen. Tissue samples were coded to cross-reference with the original specimens which were routinely preserved in formalin.

Bathymetry

The study areas were generally surveyed first with the EM 300 multi-beam swath system. This provided detailed and highly accurate bathymetric data for each seamount, as well as information on how hard the bottom was. Depth and positional data were also logged using “Seaplot”. An SVP (sound-velocity profile) and CTD (conductivity-temperature-depth) cast was made in the vicinity of each seamount. The *Tangaroa*’s Acoustic Doppler Current-Profiler (ADCP) was also run continuously during the survey.

Sampling operations

At each seamount, we applied a similar survey sequence:

6) At depths of 1000–1200 m, an SVP-CTD drop was completed. This was important for the accuracy of the multi-beam data, and also gave data on water mass characteristics near each site.
7) A multi-beam survey of bathymetry of the seamount was carried out in the areas to be sampled. Initial station location was determined by a random direction from the peak of the seamount, and targetting depths of 250 m, 750 m, and 1200 m, towards the middle of the 3 depth strata boundaries. Multibeam information was also used to identify trawlable ground, and to direct sampling where possible to span soft and hard bottom (heavy and light reflectivity).
8) The trawling/sled sequence depended upon the nature of the bottom, and trawl gear rigged at the time. Tow duration times depended upon the bottom, but where possible: Rough-bottom orange roughy and ratcatcher trawl duration was 30–60 minutes on the bottom in each depth stratum. Sherman/NIWA sled/ beam trawl duration was 15–30 minutes.
9) Fish trawl and benthic sampling methods were generally carried out close together. On several occasions, ORH trawl, ratcatcher, and beam trawl tows were completed alongside each other to enable some comparison in the selectivity of each gear type. Where more than 2 tows were possible in each stratum, a combination of gear types was used to sample the range of biodiversity.
10) A vertical camera drop was carried out on most seamounts. This was generally done on the summit of the seamount.

Figure 1 shows some of the gear types used during NORFANZ.

RESULTS

Voyage timetable and narrative

May 8	Loading gear on vessel
May 9	Complete loading gear on vessel. Sail 2000.
May 10	Transit up west coast North Island towards Site 2.
May 11	Arrive Site 2, 3 ORH trawls, CTD, 1 Sherman, small catches.
May 12	Continue Site 2, 4 Sherman tows. Steam towards Site 4, do midwater trawl at 1200 m in transit.
May 13	CTD at Site 4, search for seamount feature on bathy chart, but doesn't exist. Move to new site. Bottom is rough, lose a NIWA sled, 1 Sherman shot came fast.
May 14	Continue Site 4. 2 Sherman, head NE towards Norfolk Plateau, 3 ORH, 2 beam, 2 pipe dredge shots
May 15	Midwater shot to 1200 m, steam to Site 5. Shallow top plateau, good beam trawls, plus 3 ORH, SVP.
May 16	Continue Site 5 with ORH, beam and rock dredge tows. CTD.
May 17	Complete Site 5, steam to Site 6, repair ORH and beam trawl nets. CTD, 2 Sherman, 1 ORH trawl. Weather 30-35 kn.
May 18	Sherman, beam, ORH trawl complete Site 6, good camera drop. Steam for Lord Howe Rise, deep midwater shot 2000 m.
May 19	Deep ratcatcher shot (1700 m), no catch
May 20	Deep ratcatcher (1500 m) good catch. Site 7 is rough, so swath extensively before fishing. CTD, 1 Sherman, some damage.
May 21	3 Sherman, 2 NIWA, 4 ORH tows, come fast often, lose ORH net and bobbin rig. Camera drop on top of seamount.
May 22	Exchange some scientific staff at Lord Howe. Steam to Balls Pyramid Site 8. 2 Sherman tows, lots of coral and sponge. CTD.
May 23	4 ORH trawls, no trawlable ground >1000 m, 3 Sherman tows, CTD. Very diverse catches. Steam east towards Site 9.
May 24	Ratcatcher 1900 m. Arrive Site 9, gradual slope on flanks of Lord Howe Plateau. 2 ratcatcher,1 ORH, 1 beam, and CTD drop.
May 25	Complete 2 beam, 1 ORH, 1 ratcatcher at Site 9, head for Site 10.

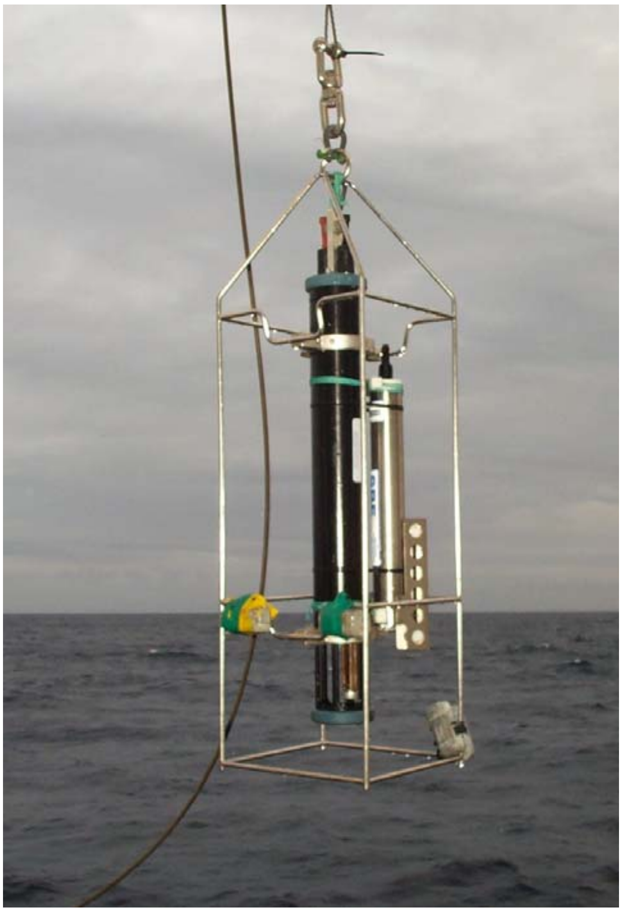


Figure 1: A selection of the fish trawls, beam trawl, epibenthic sled, and CTD equipment used during NORFANZ.

May 26	Site 10 bathymetry complex, swath extensively as many small volcanic cones.3 ORH trawls, 2 Sherman, 1 beam, 2 ratcatcher.
May 27	Steam for Site 11, southern Wanganella Bank. 4 trawls.
May 28	Continue Site 11, 3 ORH (2 fast), 1 ratcatcher, 1 beam, 2 Sherman tows.
May 29	Beam trawl and CTD to complete 11, head to Site 15 on northern Wanganella Bank. Good bottom, 3 ratcatcher, 3 beam, CTD.
May 30	Site 15 gives diverse catches and because of central location, is sampled more intensively. 4 ratcatcher, 2 pipe, 3 ORH, 1 beam trawl. Pufferfish, snipefish, redbait shallow. Lots of rattails.
May 31	Complete Site 15 with camera drop and ratcatcher. Steam to Site 3, CTD.2 Sherman, 1 ORH, camera drop.
June 1	Hard bottom. 3 ORH, 3 Sherman, 1 beam, camera drop.
June 2	Site 12, CTD, then swath a long narrow ridge. 4 ORH trawls (1 fast), 1 beam, 3 Sherman, camera drop on top in rough.
June 3	Complete 2 ratcatcher shots, short steam to Site 13. CTD, 2 Sherman tows, 2 ORH. Catch of boarfish and alfonsino. Good camera drop, and beam trawl with large sponges.
June 4	2 ratcatcher tows complete Site 13, steam to Site 14. CTD, 1 beam, 2 ratcatcher,2 Sherman, 1 ORH trawl shot.
June 5	Rip belly of ORH trawl, do camera drop, then final ORH tow at Site 14. Deep ratcatcher (1770 m), and deep (2000 m) midwater trawl shots to finish the survey.
June 6	Transit to Wellington
June 7	Arrive Wellington. Begin unloading vessel.

The total distance covered Wellington-Wellington was over 9000 km. A fuller description of daily events was recorded for the “Daily Diary” posted on the NOO website. Please refer to: www.oceans.gov.au/norfanz

Survey area

The survey covered parts of the Reinga Ridge, southern and central regions of the Norfolk Ridge, central areas of the Lord Howe Rise, and the West Norfolk Ridge (Figure 2). A total of 14 sites was sampled, comprising seamounts/banks (sites 6, 7, 8, 11, 12, 13, 14, 15), slope areas (sites 2, 9, 10), and a combination of both (sites 3, 4, 5). Summit depths of these features ranged from 40 m to 850 m.

Sampling

The total number of stations completed was 168. These comprised:

		No	% of total	% of biological
Orange roughy trawl		48	29	35
Ratcatcher trawl		27	16	19
Midwater trawl		4	2	3
Epibenthic sled	Sherman	36	21	26
	NIWA	3	2	2
Beam trawl		21	13	15
Pipe dredge		4	2	
Rock dredge		1	1	
CTD/SVP		15	9	
Camera drops		9	5	

Details of these stations, including location, time, depth range and distance are given in Table 1. Their positions are plotted in Figure 3.

Trawl stations

A total of 132 bottom shots was completed at the 14 sites, using either the orange roughy trawl, ratcatcher, beam trawl, or sled. These were fairly evenly distributed between depth strata, although several sites did not rise to less than 500 m (Table 2). The bottom was very rough and hard at some sites, making trawling difficult. The trawl nets often snagged on the bottom, or were ripped. This was indicated by a gear performance of 3 or 4 in Table 1, and occurred on 24 occasions. These tows still generally had a catch, and were therefore acceptable for species composition, but not for catch rate analyses.

Additional bottom trawl shots were carried out on 3 occasions in deeper water (1530 m–1930 m) between sites. Four deep midwater trawl shots (1200 m–2000 m) were also completed.

Onboard, 590 fish species were provisionally identified. These are listed in Table 3, together with total number, weight, and frequency of occurrence. The fish catch amounted to 12 700 kg, with the dogfish *Deania* cf. *calcea*, slickhead *Rouleina attrita*, and boarfish *Pseudopentaceros richardsoni* each contributing over 1 000 kg. However, the species most frequently caught (in 31 tows) was the basketwork eel *Diastobranchus capensis*.

The invertebrate catch could not be identified as well onboard. The high diversity of groups caught, the small size of many species (requiring very careful microscope examination), and the poor knowledge of invertebrate taxonomy in deepwater, made classification to species groups difficult. Over 1300 “species” were separated onboard, and a further several hundred have since been sorted from sediment samples taken during the survey. At this stage, only a list of invertebrate family groups is provided (Table 4), together with their frequency of occurrence. Numbers have not been included, as this is not meaningful when there are colonial forms, or large numbers of very small individuals which were not counted. A large number of families of Porifera (sponges), Cnidaria (corals), Mollusca (including squids), Echinodermata (starfish, urchins), and Crustacea (crabs and prawns) were caught. Crustaceans (especially a number of prawn families) were frequently taken, occurring in over 40 tows.

The fish and invertebrate material is currently being sorted further at a number of institutes, and will be described in greater detail in future reports.

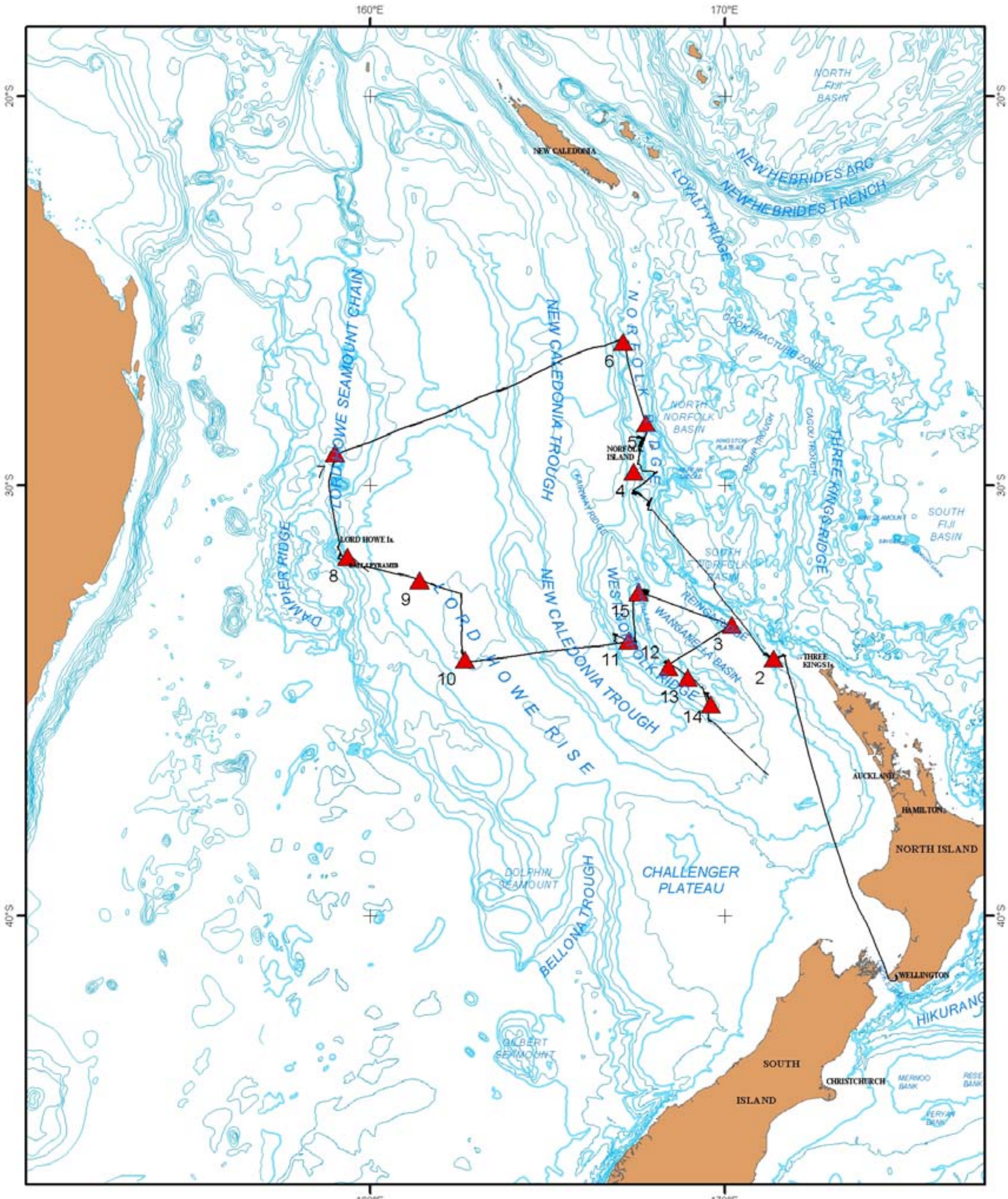


Figure 2: Cruise track and location of sampling sites during the survey.

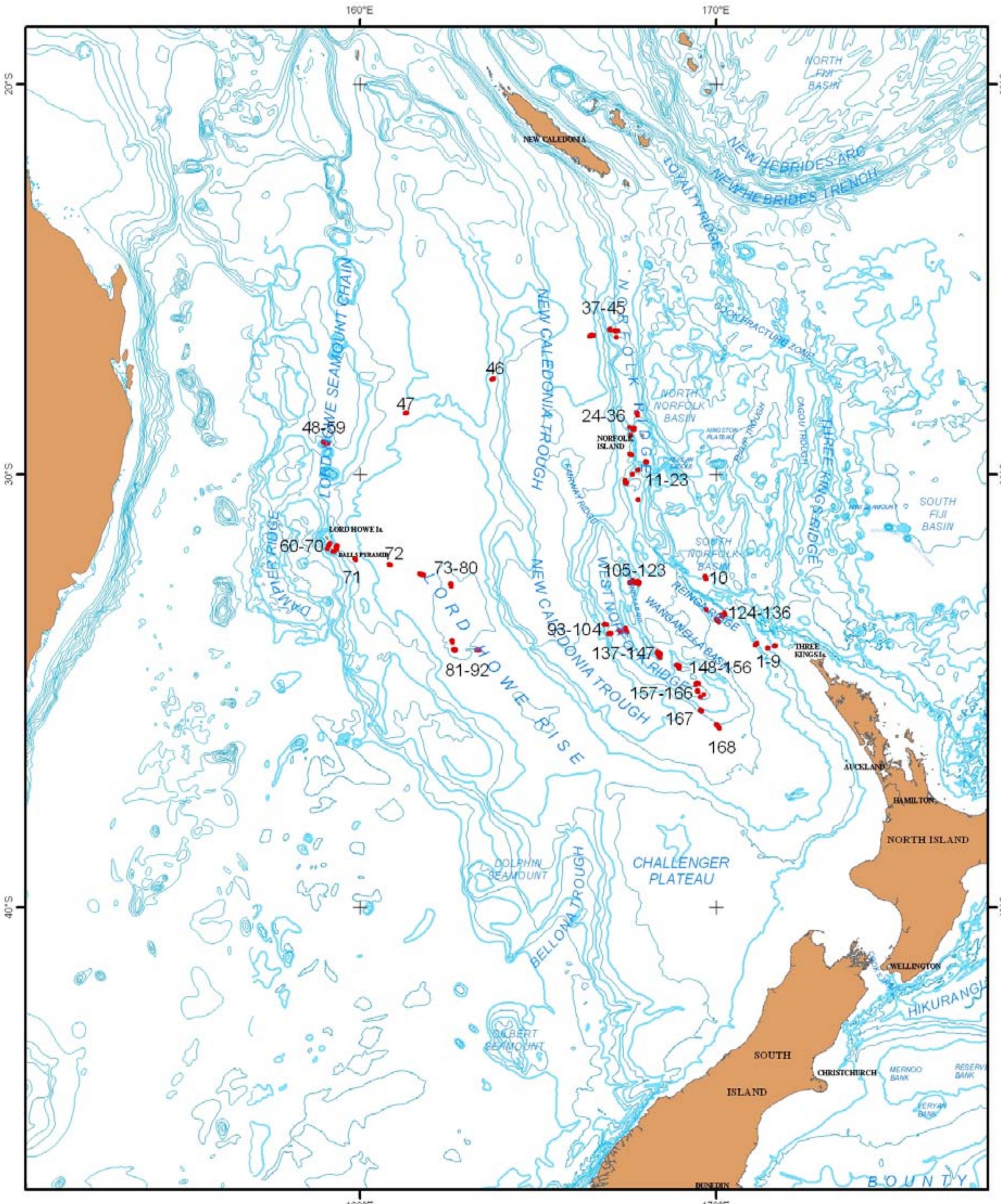


Figure 3: Position and number of sample tows carried out during the survey. Refer to Table 1 for more details.

Tissue samples were taken from a wide range of invertebrate and fish species for more detailed genetic study to assist taxonomic separation, as well as for studies of stock structure and dispersal.

Rock samples were also retained from trawl and sled catches, and kept for several institutes.

Specimen photographs

A photographic database was compiled onboard. The catch from a tow was sorted, and digital photographs taken of each previously unrecorded species caught. Notes were added on distinctive characteristics of the species. Thus, throughout the survey a comprehensive photographic reference collection was built up of all the fish and invertebrate fauna taken. Hard copies were printed and collated in folders to aid scientists when separating similar animals, and also to ensure consistency between the two watches where different scientists were identifying the catch.

The fish and invertebrate photographs were assembled by taxonomic grouping, and the digital files copied to CD. In addition, the fish photographs were loaded into an ACCESS database.

Examples of some of the specimen photography are given in Figure 4.

Camera stations

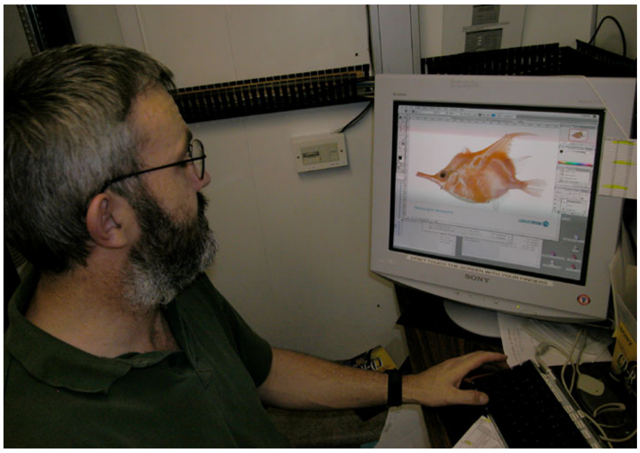
The headline camera unit (Figure 5) was regularly deployed with the orange roughy net during the first half of the survey. On the second half, the frame was rebuilt after severe damage on tow 59. It required several tows to get the angle of the unit, and the focal length set correctly, after which the camera gave good information. The camera automatically fired at a preset interval (10–30 seconds) after nearing the bottom. Useable photographs were obtained from 19 stations. These have not yet been examined in detail, but should give data on bottom sediments and macro-benthic faunal composition. Examples of the type of photographs obtained from the system are given in Figure 5.

The vertical-drop camera stations yielded higher resolution photographs. Nine drops were made, at sites 3 (2 drops), 6, 7, 8, 12, 13, 14, and 15. The vessel drifted slowly during each drop, and transect lengths ranged from 0.1 to 0.9 n.mile. The camera set-up, and examples of images, are given in Figure 6.

Bathymetry

Bathymetric data were collected from 3 sources during the survey:

(1) The Tangaroa’s EM 300 multibeam system ran almost continuously. Data were logged on transit lines when steaming between sites, and given the settled weather, the



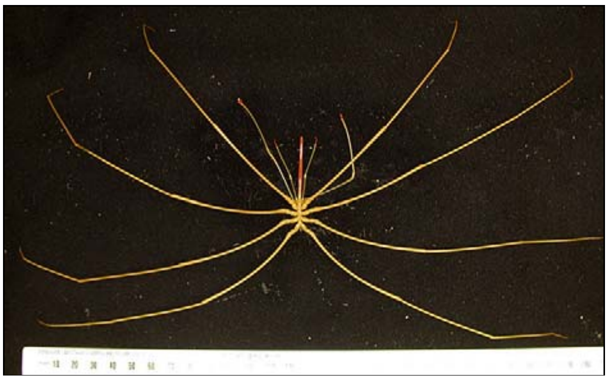


Figure 4: Examples of specimen preparation and photography, together with the header page of the photographic database.

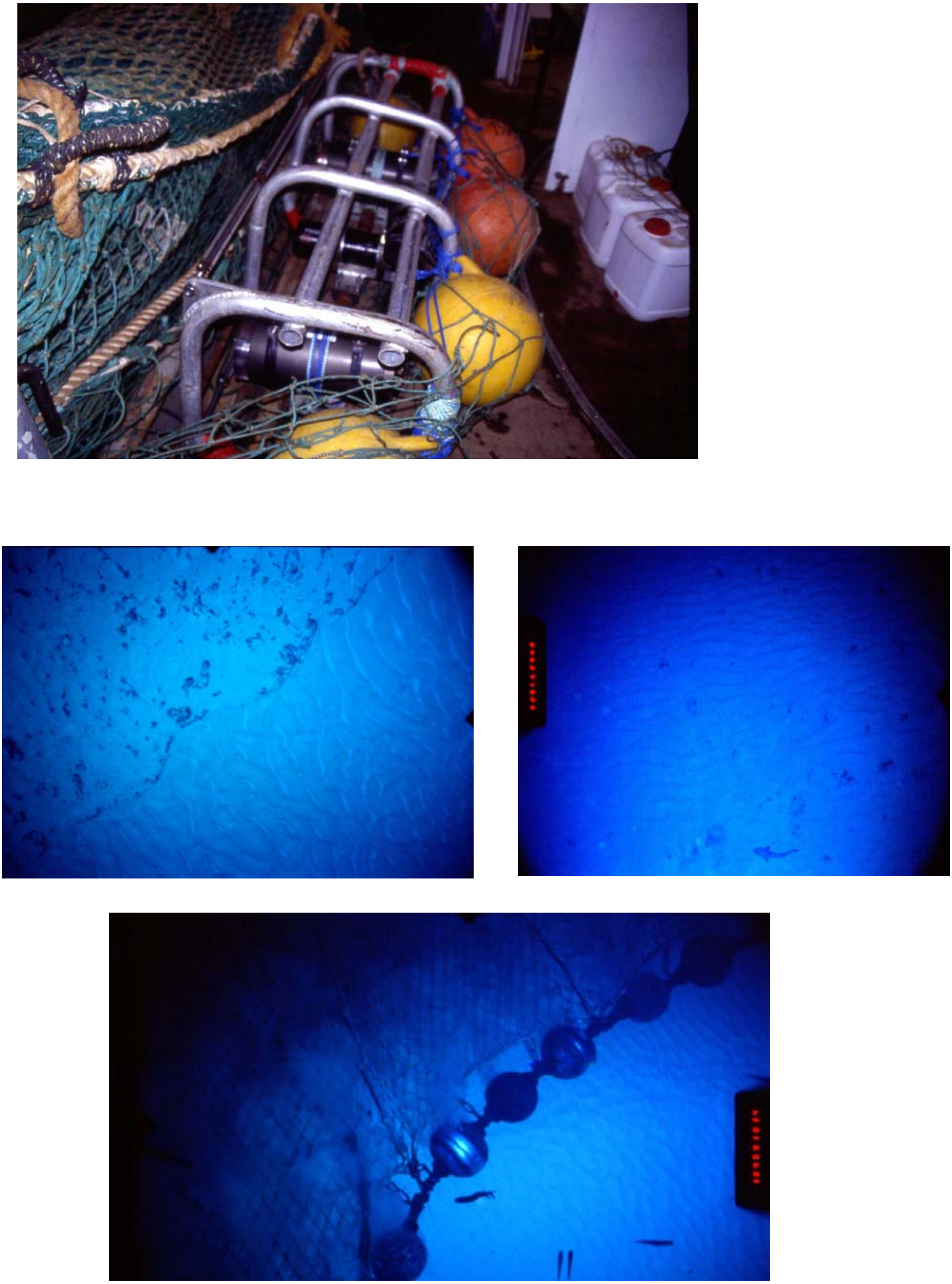


Figure 5: The headline camera unit deployed on the orange roughy trawl, and examples of photographs of the sea floor and trawl net.

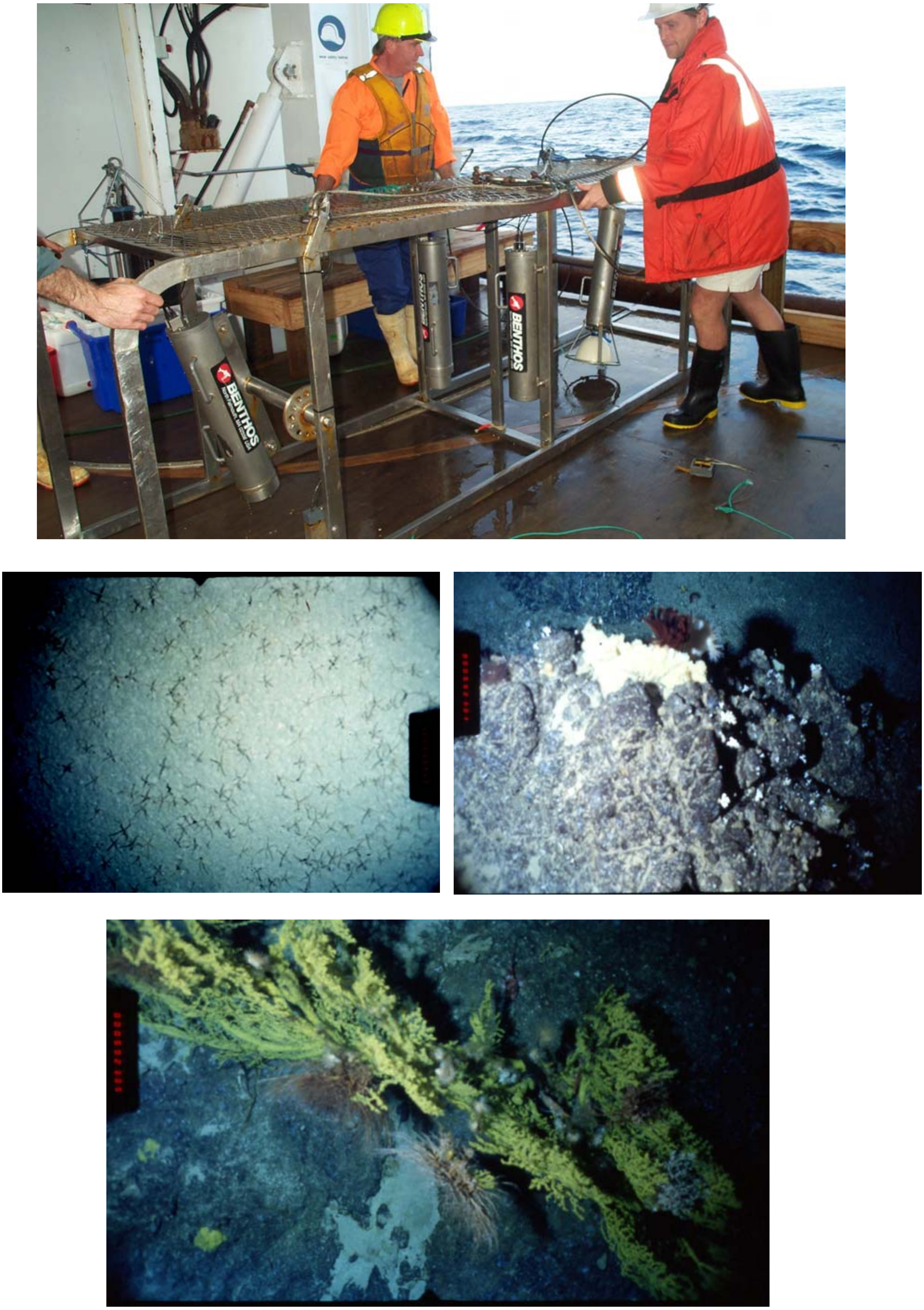


Figure 6: The drop-camera system, and examples of seafloor photographs.

data quality was acceptable at speeds up to 12–13 knots. A more detailed survey pattern at a speed of about 8 knots was instituted at each site. The coverage varied between only a few transect lines where the bottom was sloping gently and was relatively uniform, to a larger number if an entire seamount or cluster of small pinnacles needed surveying.

The existing charts of the region proved to be adequate on a large scale, indicating the approximate position of ridge or seamount structures. However, on the smaller scale of an individual feature, the depth, size, and shape of a seamount were often poorly charted. The seafloor features were often hard, rugged, and contorted, and the multibeam output proved essential to the success of fishing several of the sites. The width of seafloor swept was 6 times the water depth, and so at 1000 m depth the bathymetry was determined 3 km either side of the vessel. This enabled rapid evaluation of the shape of the seabed. This information, combined with the backscatter intensity acting as an indicator of substrate hardness, was used to plan trawling operations with less risk to the trawl gear. It also gave us data on the type of sediment and habitat which may be used later in analyses of community structure.

Examples of the multibeam output are given in Figure 7, showing a true scale Digital Elevation Model of Site 7, the backscatter imagery, and the location of various types of sampling on the seamount.

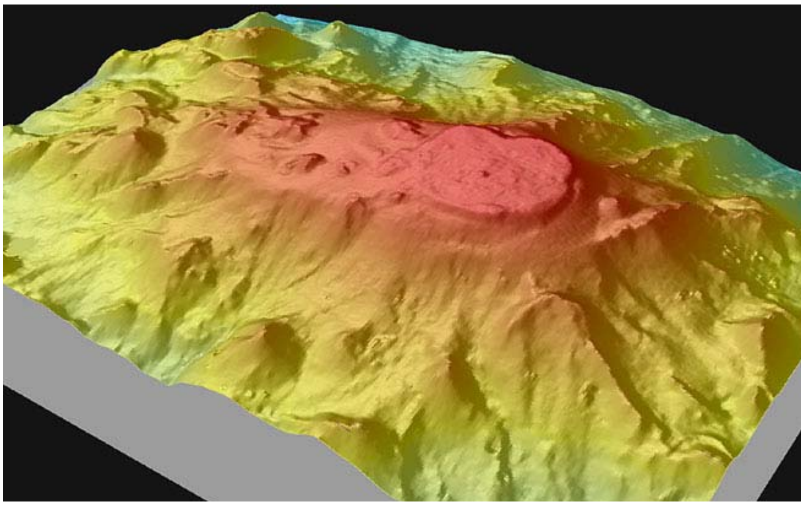
Bathymetric data were collected continuously from the vessel’s other echosounders, and logged in the *Tangaroa* Data Acquisition System, filed in Seaplot software on the main navigation computer, and acoustic data were downloaded from the Simrad ES60 sounder.

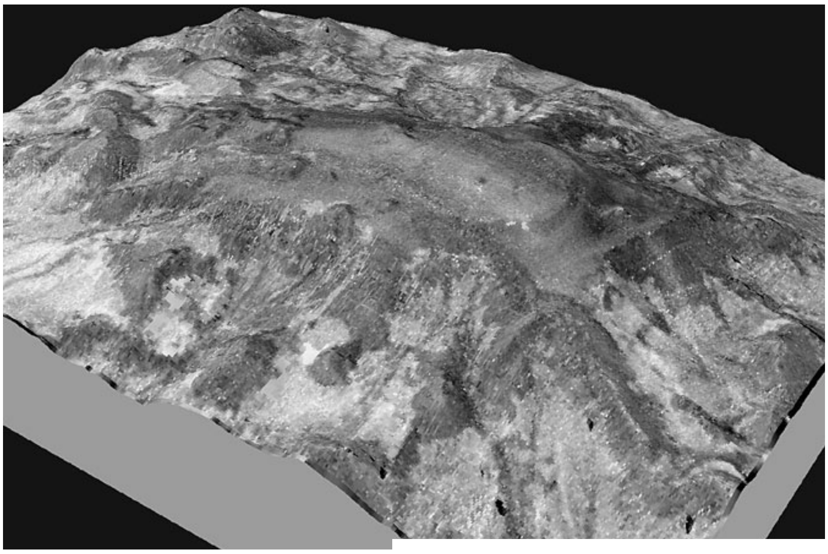
Oceanographic data were collected from 15 CTD/SVP casts. These were made at each site to calibrate the multibeam system, and give data on the water mass characteristics.

Conclusions

The survey was very successful. The original plan to cover such a large area was ambitious, but was achieved. The original plan of 6 tows per seamount at each of the 14 sites was often exceeded – a total of 139 tows was completed with faunal sampling gear.

The diversity of fish and invertebrate fauna will not be fully known for several years to come. Samples need to be examined, new species described and published, and taxa updated and revised. The preliminary list including over 500 fish species and 1300 macro-invertebrates is high, but not surprising. Many of these are either new records for the Tasman Sea area, New Zealand, Australia, or completely new species to science.





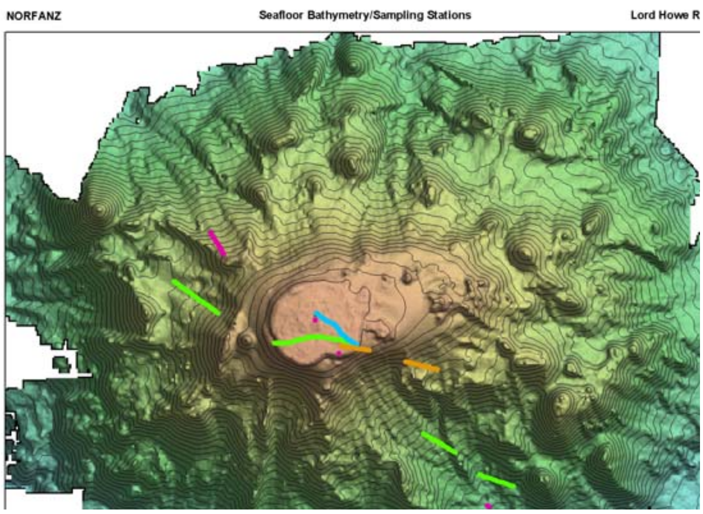


Figure 7: Multibeam maps from Site 7, showing the relief, the backscatter, and the location of sampling.

There were several key factors that significantly contributed to the overall success of the survey:

- Collaboration: There was very strong, cooperation between all parties involved in NORFANZ. The joint funding by MFish and NOO, and the shared scientific input from NIWA, CSIRO, and the New Zealand and Australian universities and museums, saw unprecedented trans-Tasman cooperation at political, managerial, and scientific levels. A strong international team of specialists, including scientists from France and the USA was assembled, with a wide range of skills and experience, that was openly shared.
- Range of sampling gear: A wide variety of gear types was deployed from *Tangaroa* during the survey. Bottom trawls, a midwater trawl, a beam trawl, epibenthic sleds, rock and pipe dredges each sampled different assemblages, and gave a much greater appreciation of faunal diversity than would be gained from using just one or two types of gear. Camera drops to the seafloor, and the headline camera unit further added to information on the nature of benthic habitats, and instruments were deployed to sample the oceanographic characteristics. The research cooperation extended to equipment sharing as well, and several institutes contributed expensive trawls, sleds or camera gear, in the knowledge that they could be damaged or lost.
- Seafloor mapping: Multibeam data have commonly been used to determine bathymetry, and to investigate geological structures. This was an important use of the swath data during NORFANZ as well, but in addition, interpretation of backscatter with bathymetry enabled successful trawling in rough terrain.
- Database development: Substantial effort by NIWA went into the establishment of onboard databases. A completely new system was required for this type of survey, to capture catch composition, and track the allocation of specimens to institutes. As well as the station-catch data, a new database was established to hold the photographic record. The use of upgradable photographic guides proved invaluable during the survey, providing an immediate record of every fish and invertebrate species with fresh colouration, and ensuring consistency of identification between different sites, scientists, and shifts. The sharing of ideas and methods between staff on the survey also resulted in the entry of the fish images into a database to allow rapid and easy searches to be made.

A short survey of this nature will not fully describe the biodiversity of the Norfolk Ridge and Lord Howe Rise. However, it will provide an important overview of the fauna and its biogeographic structure enabling more informed marine planning decisions to be taken. A preliminary examination of the data suggests that the Norfolk Ridge and Lord Howe Rise elements of the fauna differ to an extent, and may need to be managed as separate biogeographic units. Also, several seamounts appear to have endemic elements. This survey and its outputs will also provide an invaluable biological and physical baseline for generating hypotheses and for planning and conducting further surveys in the region.