Ministry for Primary Industries
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Quantifying Benthic Biodiversity: a factual voyage report from RV *Tangaroa* voyage TAN1701 to Chatham Rise 4 January – 2 February 2017

New Zealand Aquatic Environment and Biodiversity Report No. 185 *

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Bowden, D.A.; Davey, N.; Fenwick, M.; George, S.; Macpherson, D.; Ray, C.; Stewart, R.; Christensen-Field, C.; Gibson, K. (2017). Quantifying Benthic Biodiversity: a factual voyage report from RV Tangaroa voyage TAN1701 to Chatham Rise, 4 January – 2 February 2017.

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Uncertainty about the environmental effects of deep-sea resource use, including bottom trawling, is an escalating issue for New Zealand. Species-environment models, which use correlations between environmental variables and records of species' presence to predict distributions, are proposed increasingly to aid management of environmental risk in the deep sea. However, quantitative data on the distribution and abundance of seabed fauna are sparse in New Zealand waters. This situation has resulted in high levels of uncertainty associated with predictive models of communities and species distributions, which in turn have resulted in precautionary management decisions in relation to proposed seabed resource use. Key knowledge required to reduce uncertainty associated with such models is quantitative baseline information about the distribution and abundance of benthic habitats, communities, and species.

The survey reported here (RV *Tangaroa*, TAN1701) was designed to acquire quantitative data about benthic habitats and fauna across Chatham Rise, an oceanic rise extending to the east of New Zealand's South Island, using a towed camera system with high-definition digital video and still image cameras, and a multicorer. Effort was concentrated in areas substantially under-sampled in previous comparable surveys of the area, with the aim of generating data that would improve future predictive models of distributions. A secondary objective to collect seabed camera transects and sediment cores at the head of Kaikōura Canyon was included in the voyage programme in response to the November 2016 Kaikōura Earthquake.

Photographic transects, each of approximately 1 km seabed distance, were completed at 142 sites across Chatham Rise, in depths from 130 m to 1407 m. This effectively doubles the number of sites on Chatham Rise from which high-resolution seabed photographic data are available. Five additional sites were sampled in Kaikōura Canyon, with overall totals of 152 towed camera and 27 multicorer deployments completed successfully. The total seabed distance covered in photographic transects was 161.4 km (approximately 600 000 m^2 seabed area), with 152 hours of seabed video and 36 500 still images recorded, and more than 70 000 individual observations of fauna recorded to log files. Multicorer deployments yielded a total of 101 individual sediment cores, which will be processed for sediment properties (27 cores), macro-infauna (retained on 300 μm sieve, 49 cores), and meiofauna/genetics (un-sieved, 24 cores). Multibeam echosounder data and CTD data were also collected routinely throughout the voyage.

This report presents details of activities, timings, samples, and data collected during the survey, together with preliminary descriptions of seabed habitats and faunal distributions across the study area, and a catalogue of representative images from each site. Data from the voyage will take several months to analyse in detail, yielding finer-level taxonomic identifications and more precise population density estimates than were possible at sea. Meticulous auditing and cross-checking will then be required before these data can be combined with those from earlier surveys from Chatham Rise. When this work is complete, however, the combined dataset will provide a spatially extensive, taxonomically detailed, and internally consistent resource for further study of benthic faunal distributions in what is arguably the most commercially and ecologically important deep-sea area of New Zealand's Exclusive Economic Zone.

1. INTRODUCTION

Species-environment models (also known as species-distribution or habitat suitability models) that use correlations between environmental variables and records of species presence to predict distributions across broad areas are proposed increasingly to aid assessment and management of environmental risk in the deep sea (Reiss et al. 2015). However, quantitative data on the distribution and abundance of seabed fauna are sparse in New Zealand waters. This situation has resulted in high levels of uncertainty associated with predictive models of community and species distributions (e.g., Rowden et al. 2014), which in turn have resulted in precautionary management decisions in relation to proposed seabed resource use.

Uncertainty about the environmental effects of deep-sea resource use including bottom trawling is an escalating issue for New Zealand from a number of different angles. The Marine Stewardship Council has identified benthic effects as a topic that needs to be better addressed for eco-certification, and public concern about the effects of bottom trawling has been heightened with increased awareness of impacts on iconic seabed habitats such as cold-water coral thickets and reefs. Key knowledge required to understand and manage the ecosystem impacts of bottom-contact fishing and other seabed disturbances is quantitative baseline information about the distribution and abundance of benthic habitats, communities, and species. Because such information represents fundamental knowledge about biodiversity, it is also required by government agencies to meet New Zealand's Biodiversity Strategy and commitments under international agreements, including the Convention on Biodiversity Aichi Targets (www.cbd.int/sp/targets/) and New Zealand's Biodiversity Action Plan 2016 (http://www.doc.govt.nz/nature/biodiversity).

New Zealand's Ministry for Primary Industries (MPI) has initiated development of a benthic risk assessment for seabed habitats overlapped by mobile bottom fishing activities (MPI project BEN2014-01). This project will use Chatham Rise (Figure 1) as a case study area and its success depends on the identification of relevant candidate indicator taxa and development of reliable species and community distribution models. In August 2016, MPI met with NIWA scientists to discuss possible approaches to reducing uncertainty in predictive models of the distributions of seabed habitats and fauna, and thus provide an improved basis for development of a benthic risk assessment framework for bottom dwelling organisms. These discussions resulted in development of the present project (ZBD2016-11) with the objective of providing quantitative empirical data on benthic habitats and fauna and using these, in combination with existing data, to improve existing species-environment models that cover Chatham Rise (e.g., Compton et al. 2012). Reducing the uncertainty associated with such models will increase confidence in the results of the benthic risk assessment and support improved management of the effects of human activities.

The survey reported here (RV *Tangaroa*, TAN1701) was designed to acquire quantitative data about benthic habitats and fauna from areas substantially under-sampled in previous surveys of the Chatham Rise, generating data that would improve predictive models of distributions and thus best inform statistical frameworks planned for the benthic risk assessment.

The major earthquakes that struck the Kaikōura region of the South Island in November 2016 prompted MPI to add a secondary objective to voyage TAN1701, diverting up to one day of sampling time to a re-survey of sites in Kaikōura Canyon that were first recorded in 2006 by the National Institute of Water and Atmospheric Research (NIWA) working with colleagues from the USA (TAN0616 RENEWZ1, De Leo et al. 2010). De Leo et al., (2010) found benthic infaunal communities in muddy sediments at the head of the canyon to be of extraordinarily high biomass and speculated that a combination of topographic, oceanographic, and biological conditions in the canyon promotes very high productivity that propagates throughout the marine food web. The major uplift that occurred in coastal waters in Kaikōura, together with evidence of massive seabed turbidity flows along the canyon axis in deeper water, suggested that changes of similar magnitude may also have occurred in the areas of high productivity and biomass at the head of the canyon. Three months after the earthquake, voyage TAN1701 presented an opportunity to re-survey seabed camera transects initially run in 2006, using the

same camera system (NIWA's Deep Towed Imaging System, DTIS) and thus make an initial appraisal of the effects of the event on deep-sea benthic habitats in the canyon.

1.1 Objectives:

The overall objective of project ZBD201611 is '*to improve predictive models of seabed habitat, communities, and species across Chatham Rise'*, with an initial specific objective to '*collect quantitative data about seabed habitats and fauna by undertaking a survey of unsampled areas on Chatham Rise'*.

To address Specific Objective 1, a benthic sampling programme for a twenty-seven day research voyage (TAN1701, 4 Jan - 2 Feb 2017), was developed with two primary objectives:

1. *To collect quantitative data on the composition and distribution of seabed habitats and fauna on Chatham Rise that can be used in conjunction with data from earlier surveys to improve the performance of, and reduce uncertainty associated with, models of habitat and faunal distributions.*
2. *To re-survey the seabed sampling sites of De Leo et al., (2010) in Kaikōura Canyon.*

This report is a summary of sampling undertaken during voyage TAN1701, including details of methods and chronology, with preliminary results in the form of seabed imagery, descriptions of substrata and fauna present in each photographic transect, tables of benthic taxa recorded, and plots of their distributions across the study area.

2. METHODS

2.1 Survey area

Chatham Rise is a submarine ridge extending approximately 1500 km due east of the South Island, New Zealand. Its geology, seabed habitats, and benthic communities have been summarised by Nodder et al. (2012), from which the following overview has been adapted. The rise is clearly delineated by the 2000 m isobath and its 130 km-wide, essentially flat, crest lies at around 350–450 m below sea level. Three raised bank areas are prominent along the length of the crest: Mernoo Bank; Veryan Bank, and Reserve Bank, and the Chatham Islands rise above sea level at the eastern end of the crest. The northern flank is generally steeper than the southern flank. Chatham Rise underlies and partially constrains the highly productive Subtropical Front (STF), which is formed by the interaction between warm, highly saline, macronutrient-limited subtropical surface waters that are transported southwards along the eastern continental margin of the North Island (East Cape Current) and colder, less saline, macronutrient-rich, micronutrient-poor subantarctic surface waters associated with the flows along the eastern South Island (Southland Current). The STF on Chatham Rise is characterised by high water column biological production and associated high benthic biomass, and provides the basis of New Zealand's largest deep-water fisheries (Nodder, S D et al. 2012). Seabed habitats are impacted by bottom trawling across most parts of the rise, with major fisheries for orange roughy (*Hoplostethus atlanticus*), oreos (*Allocytus niger* and *Pseudocytus maculatus*) and alfonsino (*Beryx splendens*) on pinnacles and slope areas along the northern and eastern flanks, hoki (*Macruronus novaezealandiae*) over water depths of 500–800 m on the flanks, and scampi (*Metanephrops challengeri*), hake (*Merluccius australis*), and ling (*Geypterus blacodes*) on the crest of the rise.

New Zealand's *Fisheries (Benthic Protection Areas) Regulations 2007* define two Benthic Protection Areas (BPAs) on Chatham Rise; the Mid Chatham Rise BPA on the central crest of the rise, and the East Chatham Rise BPA to the east-northeast of the Chatham Islands at the eastern end of the rise (Figure 1). Use of bottom-contact fish trawls and dredges within these areas is prohibited.

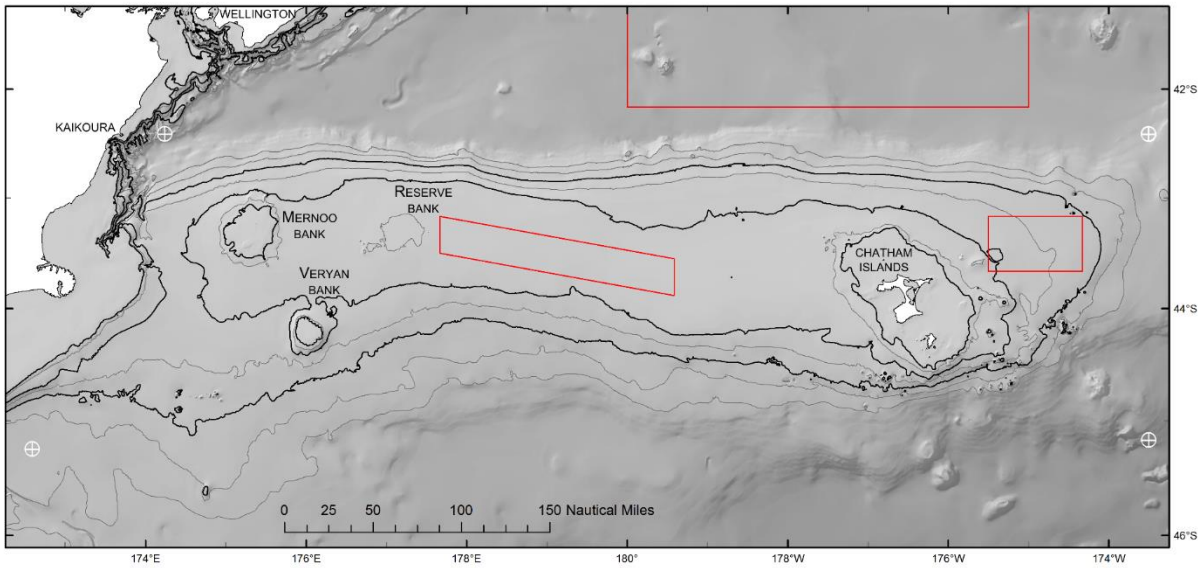

Figure 1: Chatham Rise, New Zealand, showing bathymetry (isobaths at 150 m then at 250 m intervals from 250 m depth, with 150 m, 500 m, and 1000 m shown in bold), shallow banks, and boundaries of Benthic Protection Areas (BPAs, red polygons, see text for details). White cross-in-circle markers indicate the maximum extent of the seabed sampling area approved by the Environmental Protection Agency (EPA) for TAN1701.

2.2 Survey design

Photographic transects are, arguably, the best available method for simultaneous collection of quantitative information about both seabed habitats and fauna at spatial scales appropriate for assessment of existing species-environment models and the effects of trawl fisheries. Because directly comparable photographic transect data were already available from more than 120 sites across Chatham Rise (Bowden, D.A. 2011, Bowden, D.A. et al. 2013a), concentrating on this method in the present voyage offered the potential to develop a fully-quantitative, internally-consistent data set with relatively fine spatial lag (small distance between sample points) across the study area.

The survey was designed to span the whole of Chatham Rise in depths down to 1500 m. A total of 130 sampling sites were included in initial planning, distributed using a composite design approach aimed at balancing four considerations: (a) achieving a target minimum of 8 sites per major stratum (after allowing for locations in which there were existing, comparable, data); (b) minimising the overall inter-site distance ('sample lag') for seabed photographic data across the rise, (c) targeting areas of specific interest arising from existing predictive models of benthic distributions (e.g., sensitive environments characterised by presence of the habitat-forming stony coral *Goniocorella dumosa*), and (d) minimising the overall sample lag for sediment composition data across the rise.

To achieve these aims, a combination of random and placed sampling sites was used. Approximately two-thirds of the total number of sites were allocated according to a stratified-random model based on the strata developed for the routine Chatham Rise research trawl surveys (Figure 2). These strata were selected because they have been developed on the basis of distinctions in demersal fish and invertebrate by-catch observed in research trawl data over many years and, thus, are likely to represent more general changes in seabed habitat. This scheme is also more pragmatic in use than the more ecologically-derived schemes, such as the Benthic-Optimised Marine Environment Classification (BOMEC, Leathwick et al. 2012), which tend to produce complex strata with convoluted boundaries (Bowden & Hewitt, 2012; Bowden et al., 2015).

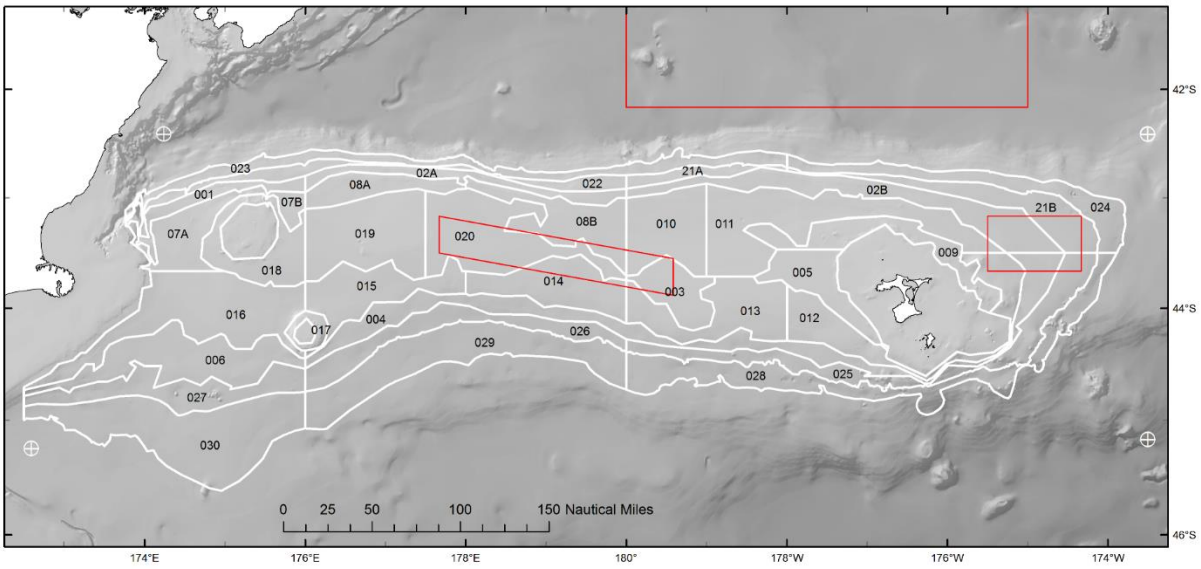

Figure 2: Chatham Rise – research trawl survey strata (white labelled polygons) as used during TAN1601. Red polygons show Benthic Protection Areas.

Random allocations were made using NIWA's *RandomStation* tool (contact Ian Doonan, NIWA) with the number of sites allocated equally across strata, regardless of differences in stratum size. This was because stratum size is, to some extent, a reflection of the steepness of environmental gradients; more strata being defined across regions of strong gradients. Thus, a larger stratum may be expected to encompass less-pronounced environmental gradients and the total number of samples required to characterise a stratum may be similar regardless of size. Randomly-assigned site locations that fell within 10 km of existing photographic transects (primarily those from the 2007 Ocean Survey 20/20 survey, TAN0705, Bowden, D.A. 2011, Nodder, S. D. 2007a) (Figure 3) were moved into the nearest available unsampled space. The remaining third of the total number of sites were assigned on the basis of minimising inter-site distances (sample lag) and targeting areas in which environmental gradients are steep, existing predictive distribution models (primarily those for *G. dumosa*) show high probabilities of occurrence, or where known seabed heterogeneity was evidently under-sampled by the random allocation process. An example of the latter criterion is on the southeast flank of the rise where background muddy sediment habitats are interspersed by numerous small knolls, which are individually too small to coincide with random sample points.

A central premise underlying the survey design was that reducing uncertainty in models is best achieved by increasing the spatial density of data, which in turn can be achieved in practice by reducing the number of different sampling methods used (Bowden, D. et al. 2015, Bowden, D.A. & Hewitt 2012). To this end, we planned to use only two gear types: a towed camera system to collect data on seabed habitats and fauna, and a sediment corer to collect data primarily on the physical and chemical properties of sediments. A single towed camera transect was to be run at each site included in the final survey design, as determined above. At a sub-set of 25 of the survey sites, seabed sediment samples were to be collected using a single deployment of a multicorer; the selection of corer sites being determined by reference to gaps in the existing sediment data record (Figure 4).

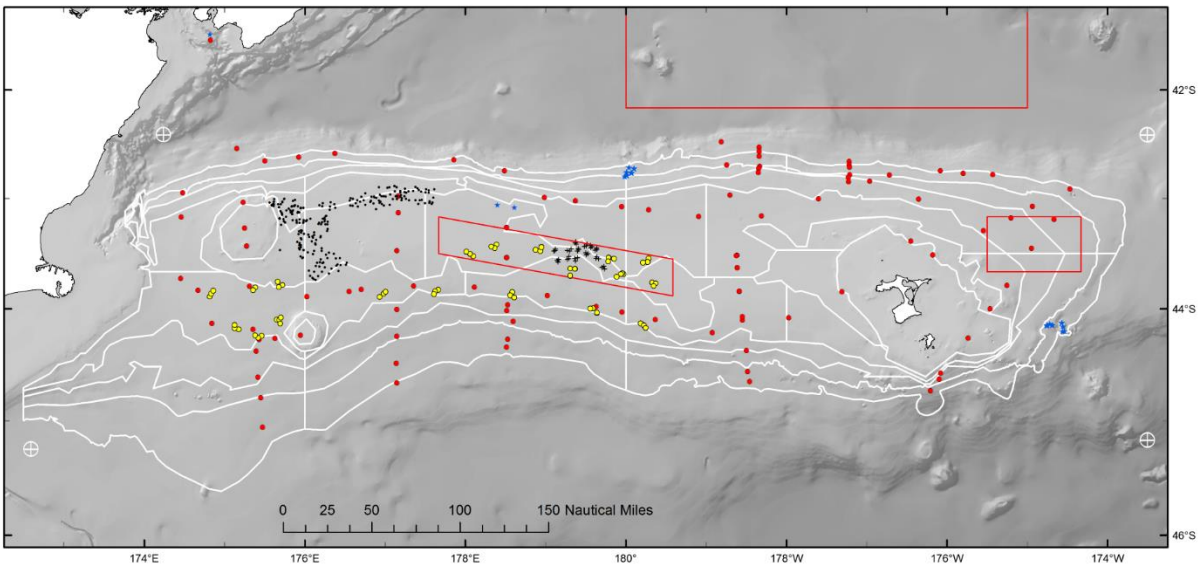

Figure 3: Existing digital-era photographic sample data across Chatham Rise prior to TAN1701: red, TAN0705; yellow, TAN1306; blue, TAN0905 and TAN1503; black points, scampi surveys; black crosses, CRP Ltd survey). Red polygons show Benthic Protection Areas, white polygons show research trawl survey strata.

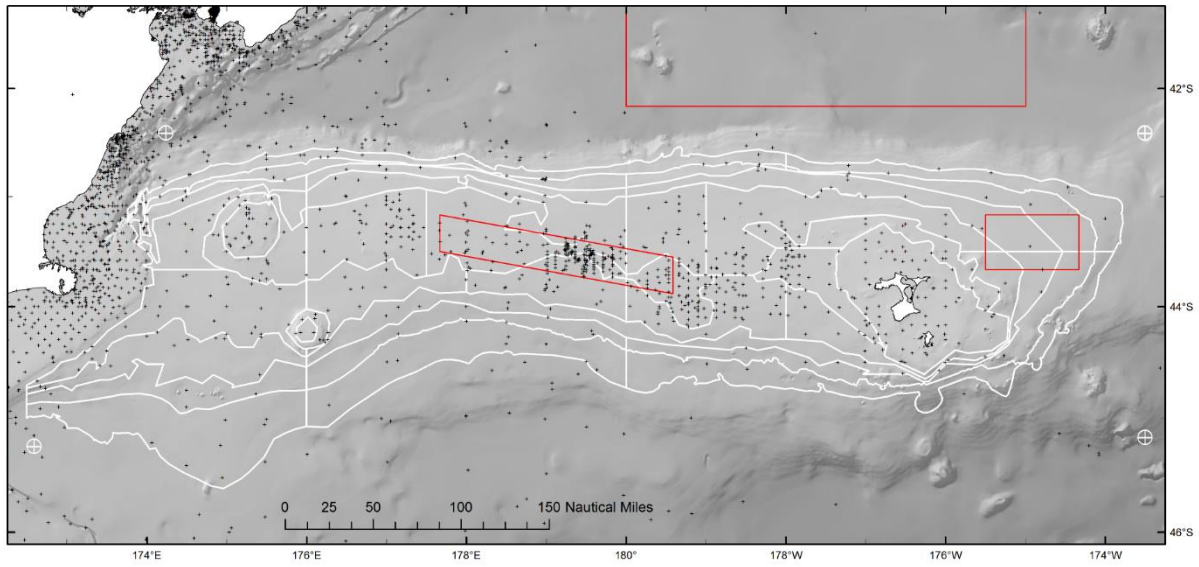

Figure 4: Existing sediment sample data across Chatham Rise (black crosses). Other details as for Figure 3.

2.3 Sampling

Towed camera system

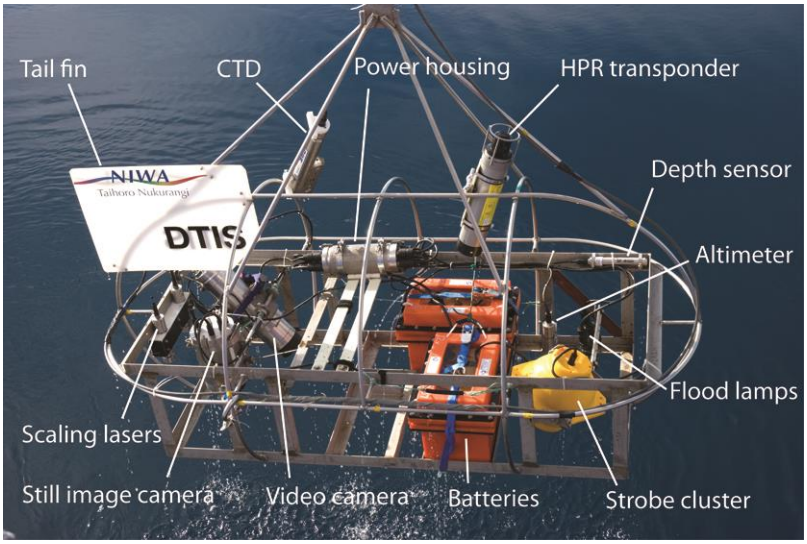

Figure 5: NIWA's Deep Towed Imaging System (DTIS). Note, this image shows an earlier configuration of the system; TAN1701 used up-dated video and still image camera systems but the only conspicuous outward change from the image above is in the strobe housing; the yellow strobe cluster housing being replaced by two individual strobe units, each in a titanium pressure housing.

NIWA's Deep Towed Imaging System (DTIS, Hill 2009) was the primary sampling tool for the voyage. This is the same system used in all Ocean Survey 20/20 benthic surveys since 2007 (Bowden, D.A. 2011, Bowden, D.A. et al. 2013a, Nodder, S. D. 2007a, Nodder, S. D. 2007b), as well as NIWA's Seamounts and Vulnerable Deep-Sea Communities research programmes (Bowden, D. A. et al. 2016, Clark et al. 2010), and thus its use on this voyage presented the opportunity to make a substantial addition to an already extensive benthic data set.

DTIS is a battery-powered towed camera frame deployed on a single-conductor cable with real-time video feed and control of camera and light functions via a modem link (Hill 2009). In its 2017 configuration, DTIS recorded continuous high definition digital video (Sony HDRP J790P, HD1080p), with high resolution digital still images (Nikon D3200 SLR, 24 megapixel JPEG) captured simultaneously at 15 second intervals throughout the transect. Video lighting was from two 150W LED floodlight units (Sealite Sphere 5105, Sea & Sea Inc.), and stills lighting from 2 x 330Ws strobe units (Develogic Gmbh).

DTIS transects were run for one hour at 0.6 knots (about 1 km seabed distance), at a target altitude of 2–3 m above the seafloor, using RV *Tangaroa*'s Dynamic Positioning system (DP) to maintain precise control of course and speed over the ground. Full resolution video and still images were recorded at the seabed and downloaded on return to the surface. The low-resolution video image transmitted to the surface in real time enabled control of camera altitude and initial evaluation of seabed substratum types and fauna. The seabed position of DTIS was monitored by an acoustic ultra-short baseline (USBL) transponder system (Kongsberg HiPAP) and plotted in real time using Ocean Floor Observation Protocol software (OFOP, http://www.ofop-by-sams.eu/). A Seabird CTD unit attached to the DTIS frame during each deployment recorded water column data (conductivity, temperature, and depth) that were also downloaded on deck.

Observations of seabed substrata and individual benthic and demersal fauna, including fishes, were recorded using OFOP throughout all camera deployments. These observations were made from the lower-resolution real-time DTIS video feed using standard procedures with three science staff: one

watching the screen and calling observations; one entering these observations in OFOP, and the third monitoring technical parameters of DTIS and communicating with the bridge officer and the winch driver to ensure consistent direction, speed, and altitude.

DTIS video was saved as uncompressed high definition (1080p) *.m2t files to a dedicated hard disc drive (DTIS HDD) and to the ship's server. Still images were downloaded from DTIS immediately on recovery of the vehicle, voyage-specific file names and metadata were written using the 'batch edit' tools in ACDSee Pro. A full duplicate set of the DTIS images was then created and geo-referencing information was written to the EXIF data fields of each image individually (Latitude and Longitude as DTIS USBL position harvested from the ship's Data Acquisition System via the OFOP protocol files) using NIWA's custom 'geotagger' tool (Vijay Paul and Brent Wood, NIWA). All images were then saved to the ship's server and backed up to the DTIS HDD. All OFOP log files were checked for completeness of navigational data, and accuracy and consistency of seabed observations after each deployment and saved to the ship's server. Ashore, all video, image, OFOP log files, and CTD data were uploaded to NIWA's secure archive servers.

After each DTIS transect, observation log files and high-resolution still images were evaluated for the existence of *sensitive marine benthic habitats*, as defined for the New Zealand Exclusive Economic Zone (EEZ) by MacDiarmid et al. (2013). Although detailed density estimates for benthic taxa associated with such habitats were not made at sea, sites where there was consensus among the survey team that thresholds indicating sensitive habitats were likely to have been exceeded were noted and reported to both MPI and the Environmental Protection Agency (EPA).

Sediment corer

Figure 6: Ocean Instruments MC-800 multicorer deployment from RV *Tangaroa* during TAN1701.

Sediment samples were collected using an Ocean Instruments MC-800 multicorer (Figure 6), capable of collecting up to eight individual sediment cores of 9.8 cm internal diameter by up to 60 cm depth. To ensure maximum penetration, the corer was deployed routinely with only four core tubes, with resulting samples allocated for sediment, macrofauna, or meiofauna analysis as shown in Table 1. Individual cores were considered useable if they contained at least 5 cm of undisturbed sediment. If fewer than four useable cores were recovered, the order of priority was: sediment > macrofauna 1 > meiofauna. As long as one useable core suitable for sediment analysis was recovered at a site, no repeat deployments were made.

The primary purpose of these samples was to generate data on the physical and chemical properties of seabed sediments (grain size distribution, calcium carbonate content, total organic content, chlorophyll *a*, and phaeo-pigments) to extend existing sediment data compilations across Chatham Rise (Nodder, S. D. et al. 2011). Samples for analysis of macro- and meio-infaunal taxa from the multicorer were also collected, processed, and preserved at sea but these samples will not be analysed as part of the present project. Sub-samples from the meiofauna cores were also preserved for use in detailed taxonomy work and a potential study of the use of environmental DNA (e-DNA) techniques for rapid characterisation of benthic community composition.

Processing of multicorer samples on deck followed standard protocols developed for other NIWA biodiversity surveys (e.g., Nodder, S. D. et al. 2011), as detailed in Table 1.

Table 1: Multicorer sample allocation: number of individual cores allocated to sediment, macrofauna, and meiofauna analyses.

Component	Number of cores	Priority	Processing
Sediment	1	1st	Full core sectioned at 1 cm intervals to the bottom of the core. Sections stored separately in pre-labelled 'whirl-pac' bags and frozen at -20°C.
Macrofauna	2	2nd (one core)	Cores sectioned at 0–5, 5–10, 10–15 cm intervals, with each section sieved separately at 300 μm and preserved in 4 % borax-buffered formalin.
Meiofauna (+ e-DNA)	1	3rd	Two 2.6 cm diameter sub-core(s) taken to 5 cm depth, sectioned at 0–1, 1–3, 3–5 cm intervals, and each section preserved intact in 4 % borax-buffered formalin (without Rose Bengal dye). Remainder of the upper 5 cm of surficial sediments from the meiofauna core bagged in bulk and frozen at -80°C.

Multibeam echosounder

RV *Tangaroa*'s multibeam echosounder (MBES, Kongsberg EM302) was used to map seafloor topography during transits between survey sites and at sites where detailed bathymetric mapping was required for safe deployment of DTIS and multicorer. Sound velocity profiles were harvested routinely from the DTIS CTD data (using a text editor to construct files in the required format for the multibeam software). The voyage personnel did not include specialist MBES operators, however, so data collected were not processed and cleaned at sea.

3. RESULTS

3.1 Voyage summary and timetable

Following a 12-hour transit from Wellington, sampling operations took place at sea from 6 January to 1 February 2017, commencing on the north-western flank of Chatham Rise at site S28, working clockwise around the rise and ending at Kaikōura Canyon at site K100 (Table 2, Figure 7). The start site was changed from the planned S20 (closest to Wellington) to S28 to ease the motion of the ship into a strong southerly wind and swell.

In total, 147 sites were sampled; 142 on Chatham Rise (Objective 1, "S" prefix sites) and five in Kaikōura Canyon (Objective 2, "K" prefix sites), with overall totals of 152 DTIS towed camera and 30 multicorer deployments completed successfully. Three additional multicorer deployments did not yield samples but all DTIS deployments were successful and there were no gear-related failures during the voyage. Operations were suspended for approximately 32 hours because of adverse conditions from 22–24 January but other than this there was no unscheduled down time. See Table 3 Appendix 1 – Station Records for full deployment details.

The total seabed distance covered in DTIS transects was 161.4 km (approximately 600 000 m^2 seabed area, based on mean measured video frame width of 3.8 m), with 152 hours of seabed video and 36 500 still images recorded, and more than 70 000 individual observations of fauna recorded in OFOP log files. For this report, initial summaries of at-sea OFOP observation data are shown to describe the distributions of substrata and selected taxa across the study area, and for each individual DTIS transect, representative seabed images, a brief text description of substrata and fauna, and a location map are presented in Appendix 3 – Site Summaries. In each of these site summaries, photographs are labelled A to D, indicating the sequence in which they are placed along the transect.

Multicorer deployments yielded a total of 101 individual sediment cores (93 from Chatham Rise, eight from Kaikōura Canyon), representing a total seabed area of 0.79 m^2 and total sediment volume of approximately 0.28 m^3. Cores were processed at sea for three research areas: sediment properties (27 cores); macro-infauna (retained on 300 μm sieve, 49 cores), and meiofauna/genetics (un-sieved, 24 cores).

Table 2: Voyage TAN1701, 4 Jan – 2 Feb 2017, summary log of voyage progress. DTIS; Deep-Towed Imaging System, MUC; multicorer. Weather observations are Beaufort scale (e.g. SW6 indicates Beaufort force 6 from the south-west), times are NZDT. Refer to Figure 7 for site locations and ship's track and Appendix 1 for station details.

Date	Activity
4 Jan	Mobilisation, Aotea wharf, Wellington
5 Jan	1200h Depart Aotea Wharf, Wellington. Transit to MERNOO study area. Weather S6, swell SW 3–5 m. Departure delayed by 2 h from plan to allow front to pass.
6 Jan	0030h arrive site S28, NW Chatham Rise. Weather S5, SW swell abating. 0108h commence DTIS operations, then working 6 sites with DTIS and one MUC to site S90.
7 Jan	Working 6 sites with DTIS, 2 with MUC, from S31 to S30. SW4–5, moderate SW swell.
8 Jan	Working 7 sites DTIS, 1 with MUC, from S35 to S92. WNW4, moderate SW swell.
9 Jan	Working 6 sites DTIS, 1 with MUC, from S37 to S30. SW7–8, 3–4m SW swell.
10 Jan	Working 5 sites DTIS, 2 with MUC, from S127 to S43. Becoming ENE1–2, SW swell abating.
11 Jan	Working 8 sites DTIS, none with MUC, from S39 to S131. WNW1–2, slight swell
12 Jan	Working 6 sites DTIS, 1 with MUC, from S10 to S12. NW4, slight swell.
13 Jan	Working 6 sites DTIS, 3 with MUC, from S13 to S56. Variable 2–3, confused sea.
14 Jan	Working 5 sites DTIS, 1 with MUC, from S56 to S52. SW3–4, slight swell.
15 Jan	Working 6 sites DTIS, 2 with MUC, from S118 to S50. NNE4–6, slight swell.
16 Jan	Working 4 sites DTIS, none with MUC, from S134 to S60. NNW6–7, moderate swell.
17 Jan	Working 7 sites DTIS, 1 with MUC, from S124 to S96. N2–3 slight swell.
18 Jan	Working 6 sites DTIS, 1 with MUC, from S135 to S16. N4–6 3–4 m swell.
19 Jan	Working 7 sites DTIS, none with MUC, from S4 to S137. N6–7, moderate swell.
20 Jan	Working 7 sites DTIS, 1 with MUC, from S122 to S138. SW4, 3–4m swell.
21 Jan	Working 6 sites DTIS, 2 with MUC, from S5 to S68. SW4–5, swell abating.
22 Jan	Working 2 sites DTIS, neither with MUC, from S71 to S106. NE6 becoming NE 8–9, 4–5 m swell developing. Dodging from 1600h.
23 Jan	Dodging all day; no deck operations. SW8–9, steep 5–6 m seas.
24 Jan	Resume operations at 0400h. Working 5 sites DTIS, 1 with MUC, from S74 to S81. Becoming SW4, moderate swell.
25 Jan	Working 4 sites DTIS, 1 with MUC, from S83 to S126. NE6–7 becoming SW8 for a time, moderate swell. Dodging for 2 h around midday.
26 Jan	Working 6 sites DTIS, 1 with MUC, from S114 to S103. NW2–3, swell abating.
27 Jan	Working 5 sites DTIS, 1 with MUC, from S89 to S125. ESE4–5, moderate swell.
28 Jan	Working 6 sites DTIS, none with MUC, from S108 to S140. NW3, slight swell.
29 Jan	Working 5 sites DTIS, 1 with MUC, from S80 to S77. NE6-7, moderate swell.
30 Jan	Working 7 sites DTIS, 2 with MUC, from S124 to S110. S3, slight swell.
31 Jan	Working 7 sites DTIS, none with MUC, from S102 to S19. NE4 slight swell.
1 Feb	0500h Arrive Kaikōura. MBES across sites of De Leo et al. (2010) at head of canyon. Working DTIS (5 transects). 1630h Permission received from Department of Conservation to core in Hikurangi Marine Reserve; 2030h two multicorer deployments completed, 2100h commence transit to Wellington.
2 Feb	0800h Alongside, Aotea Wharf, Wellington

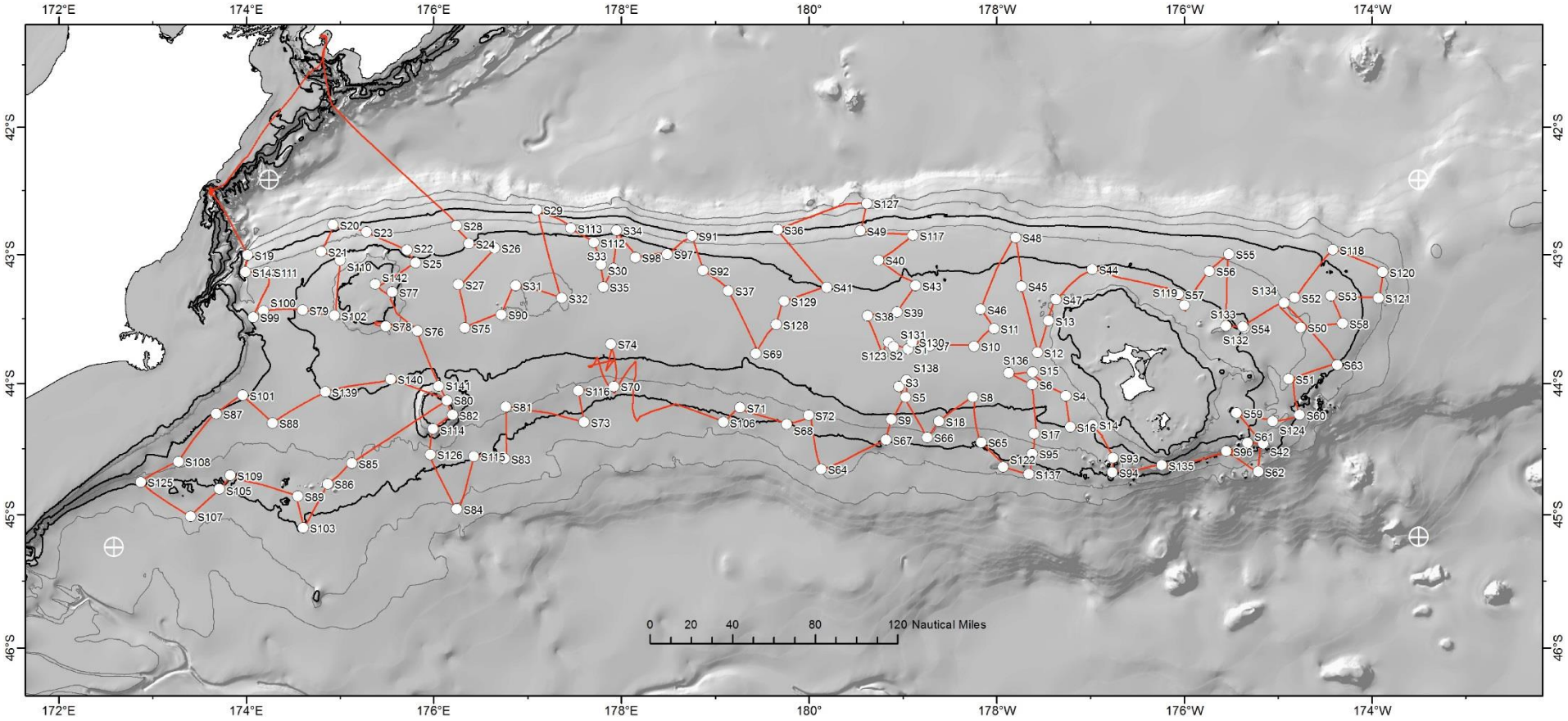

Figure 7: Sampling sites and track of *RV Tangaroa* during voyage TAN1701. Sites in Kaikōura Canyon are not shown because they overlie each other at the scale of this map. Isobath details as given for Figure 1.

3.2 Chatham Rise benthic habitats and fauna

Substrata

Observations of seabed substrata recorded in five broad categories (muddy sediments, sand, cobbles, boulders, and bedrock) during camera transects provide an outline map of how substrata vary across the study area (Figure 8), while the site summary pages in Appendix 3 (Appendix 3 – Site Summaries) include text summaries of substratum type from the OFOP log files together with representative images from the DTIS still image camera.

While muddy sediments predominated, especially in the western, north-western, and northern flanks of the rise, there was considerable heterogeneity, with variations in substrata broadly matching descriptions in Nodder et al. (2012). On Mernoo Bank, substrata were primarily of white, current-rippled sand, with high-relief outcrops of pale rock in places. In the vicinity of Reserve Bank, on the western central crest of the rise, substrata were of fine black sands overlaid by greenish mud, with patches of eroded chalk visible in places. Substrata on the summit of Veryan Bank were of coarse sand and shell-hash, with boulders, cobbles, shell hash, and outcropping rock on the flanks. To the west of Reserve Bank on the crest of the rise, muddy sand substrata changed progressively to be dominated by areas of exposed, cobble-sized rocks, with highest concentrations recorded between 178° W and 179° W from the crest southward towards the 500 m isobath. On the south-eastern flanks, especially to the south and southeast of the Chatham Islands, there were numerous knoll and seamount features with mixed substrata of bedrock, boulders, cobbles, and sand, with areas of coral rubble and barnacle plates in places. On the southwestern flanks, to the south and southwest of Veryan Bank, there were several small rocky knolls, with areas of large 'pockmark' and scarp features.

Benthic invertebrate fauna

A total of 74 972 individual observations of benthic invertebrate fauna were made during DTIS video transects and recorded in OFOP log files, providing a quantitative record of common faunal groupings seen on the seabed. Because these observations are made from the lower resolution real-time video image feed at sea, identifications are mostly at coarse taxonomic level (Phylum, Class, Order) but density estimates of these and particularly of distinctive fauna such as scampi (*Metanephrops challengeri*) or the regular urchin *Gracilechinus multidentatus* are likely to be reliable.

Across all sites, 76 benthic invertebrate taxa were recorded, representing 12 phyla (Table 4). Taxa recorded at highest overall abundances (top 15%) were echinoderms (echinoids, ophiuroids, and asteroids), sponges (Demospongiae), the quill worm *Hyalinoecia longibranchiata*, gastropod molluscs, the regular urchin *Gracilechinus multidentatus*, shrimps (natant decapods), sea pens (Pennatulacea), 'giant' foraminiferans (Xenophyophoroidea), cidaroid urchins (Cidaroidea), and stylasterid hydrocorals (Stylasteridae). Taxa with the widest distributions across the survey area (highest site-occupancy) were asteroids, gastropods, echinoids, sponges, anemones, holothuroids, and shrimps, all of which were present at 90 or more of the 146 sites sampled across Chatham Rise, while 11 taxa were recorded at only a single site and seven taxa were recorded only as a single individual.

Sensitive marine benthic habitats, *sensu* MacDiarmid et al. (2013), were recorded at 23 sites, with indicative fauna including variously, sponges, corals, sea-pens, brachiopods, and xenophyophores (Figure 9). Occurrences of selected taxa, primarily those that occurred in higher densities but including some distinctive but less common taxa such as the large conical sponge *Hyalascus* sp., are shown below (Figure 10 to Figure 18).

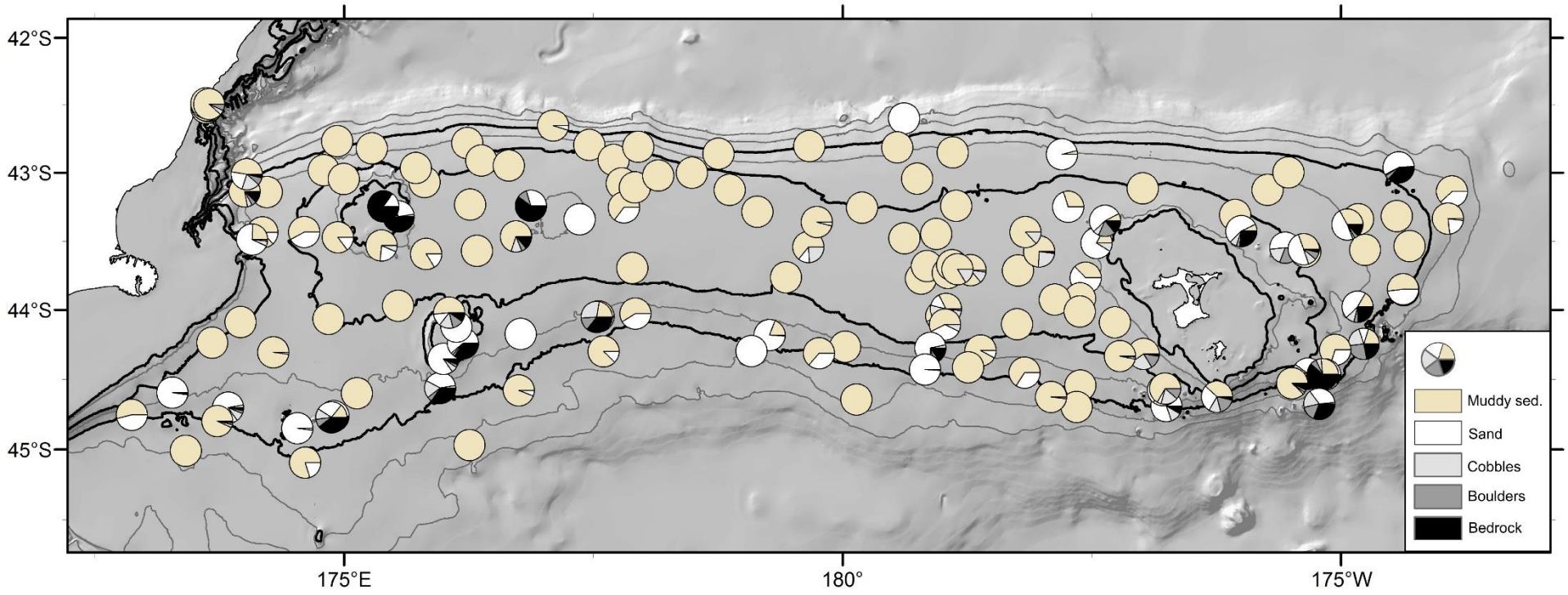

Figure 8: Seabed substrata as proportions of towed camera transect length in five broad categories: muddy sediments; sandy sediments; cobbles; boulders, and bedrock. Data are at-sea observations forward-filled at 1 s intervals through each transect and expressed as proportion of the full transect (after exclusion of any sections where the seabed was obscured in the video image). Isobath details as for Figure 1.

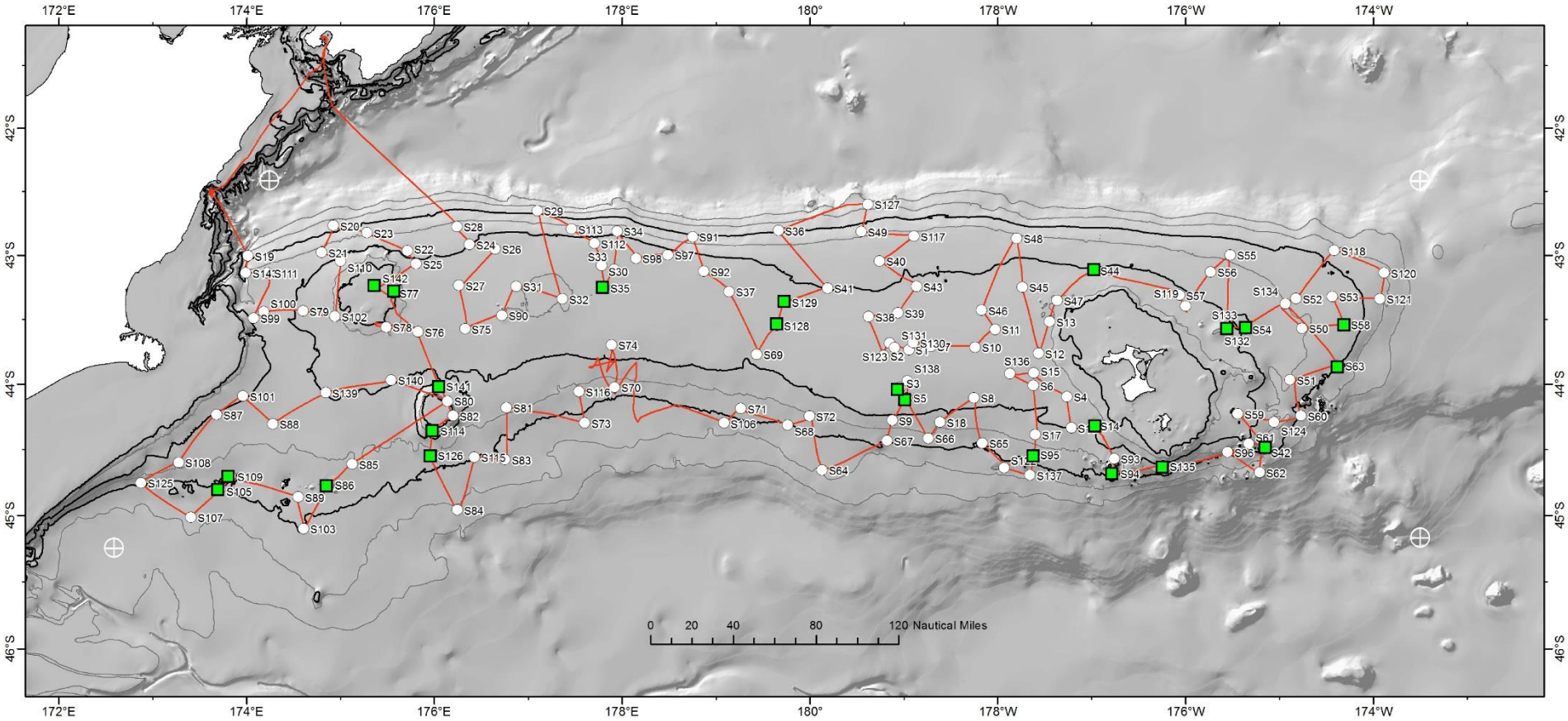

Figure 9: Survey sites (green squares) at which fauna indicative of sensitive marine benthic habitats (*sensu* MacDiarmid et al. 2013) were recorded during DTIS camera transects. See Appendix 1 and Appendix 3 for details of fauna and substrata, and representative images. Isobath details as for Figure 1

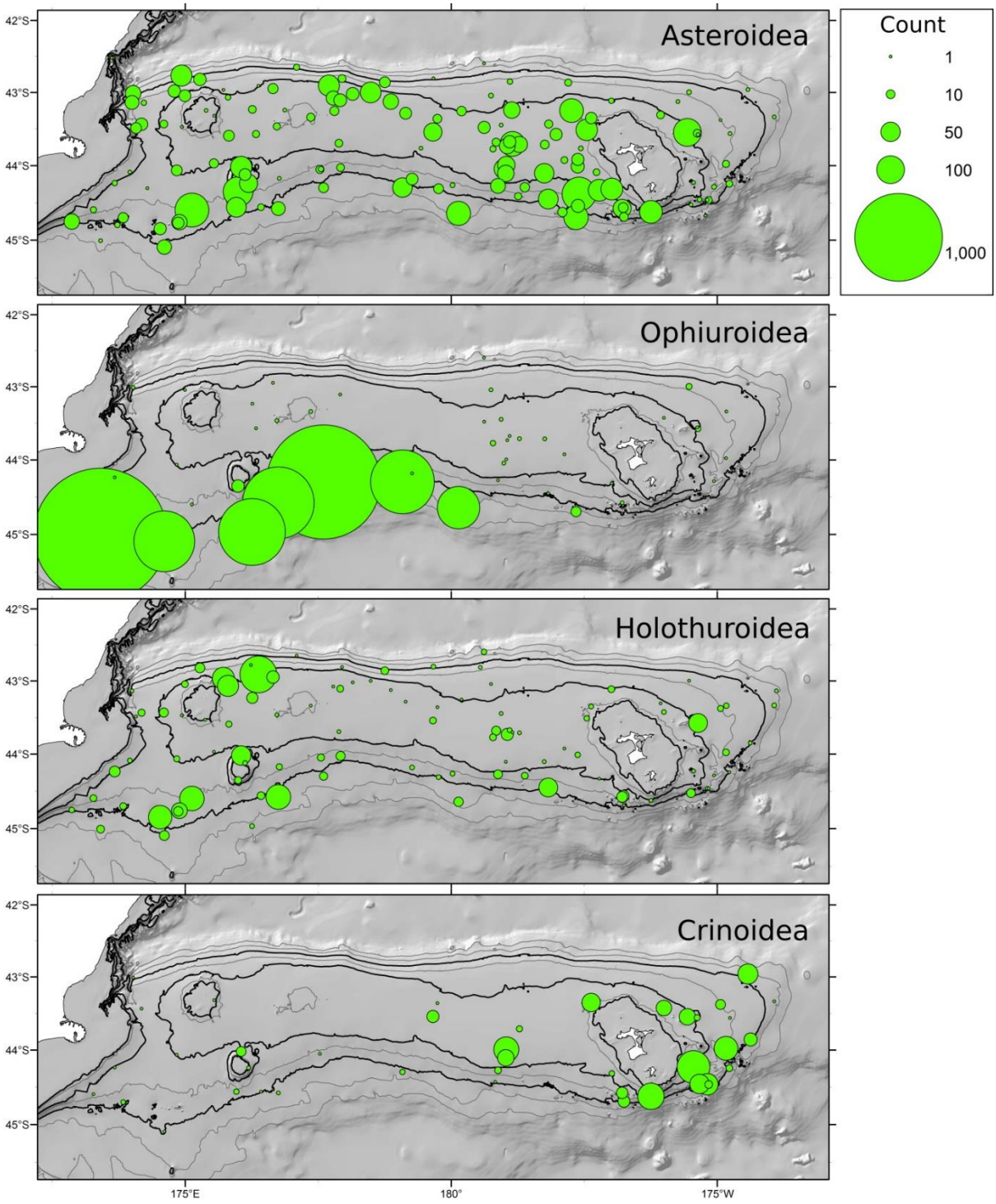

Figure 10: Occurrence and relative densities of four echinoderm taxa: Asteroidea; Ophiuroidea (high densities on the south and southwestern flanks of the rise are predominantly *Ophiomusium lymani*); Holothuroidea, and Crinoidea (motile), across the study area. Data are counts of individuals observed in real-time during DTIS video transects and the radius of expanding bubble symbols is proportional to number of individuals per transect (approximately 3800 m^2 seabed area). Isobath details as for Figure 1.

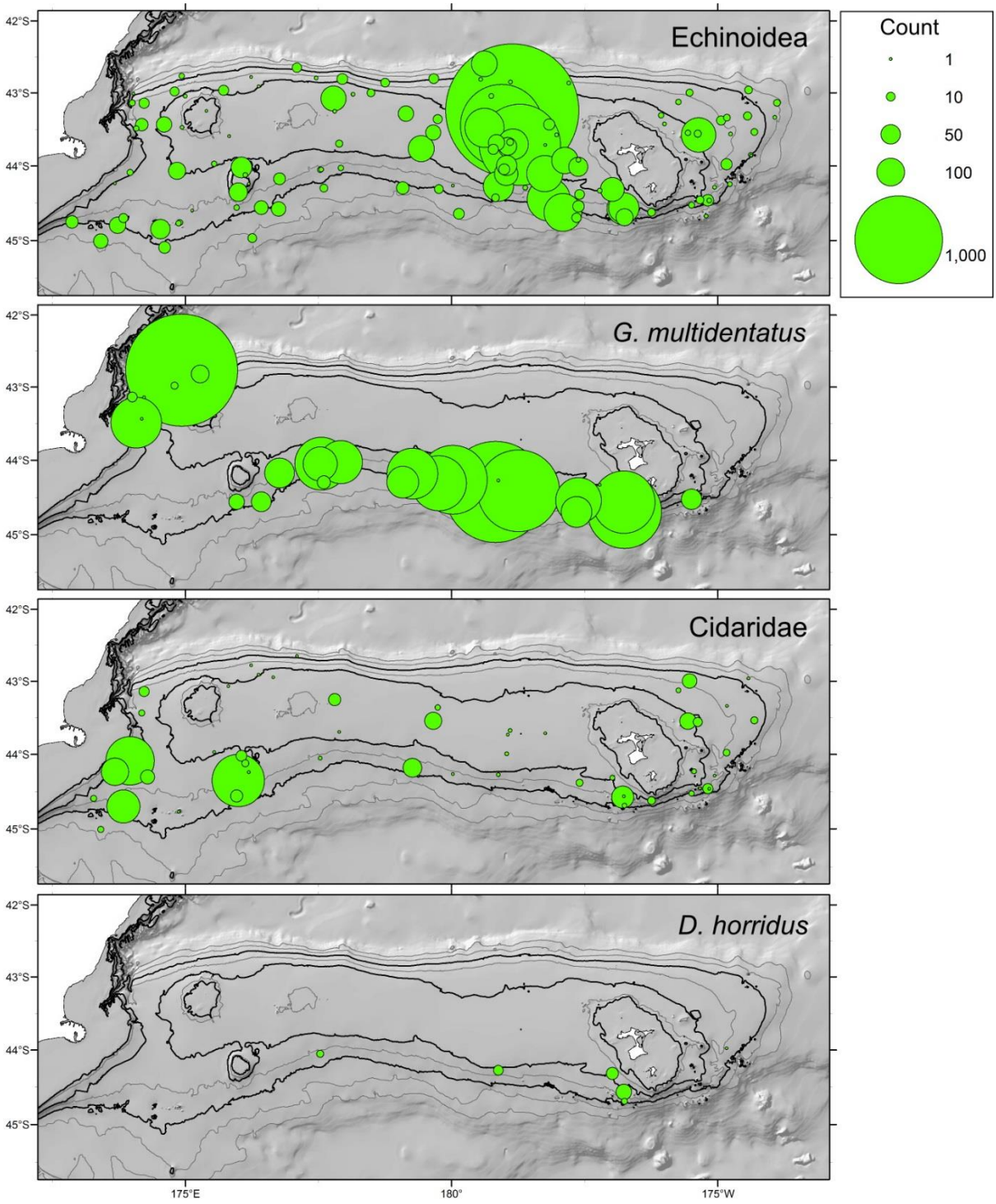

Figure 11: Occurrence and relative densities of echinoid taxa across the study area: Echinoidea (all echinoid taxa other than those identified in the lower three panels); *Gracilechinus multidentatus*; Cidaridae (pencil urchins), and *Dermechinus horridus*. Details as in previous figure.

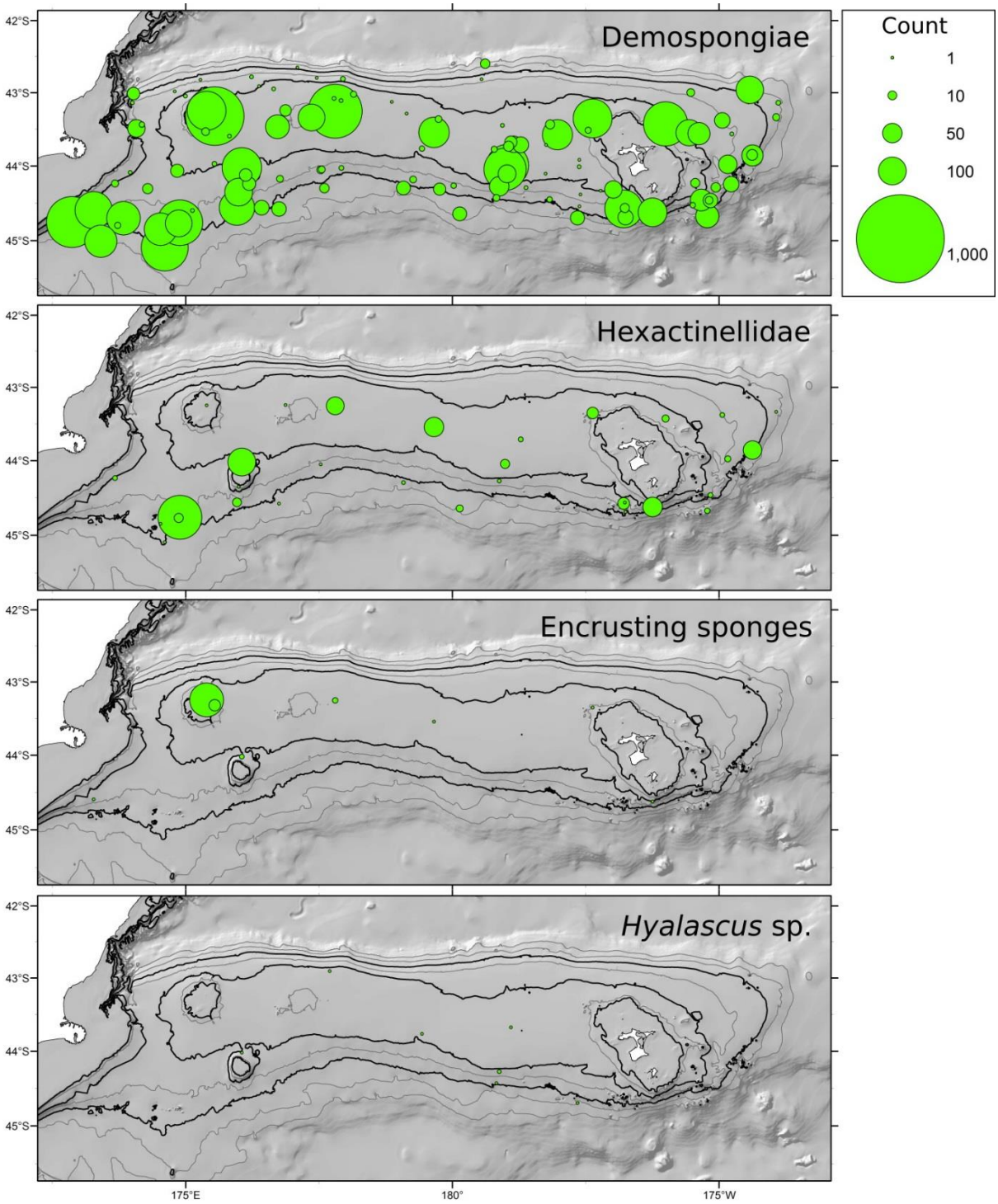

Figure 12: Occurrence and relative densities of sponge taxa across the study area: Demospongiae; Hexactinellidae; encrusting sponges (demospongiae not distinguishable as individual colonies), and *Hyalascus* sp. (large conical, free-living taxon). Details as in previous figure.

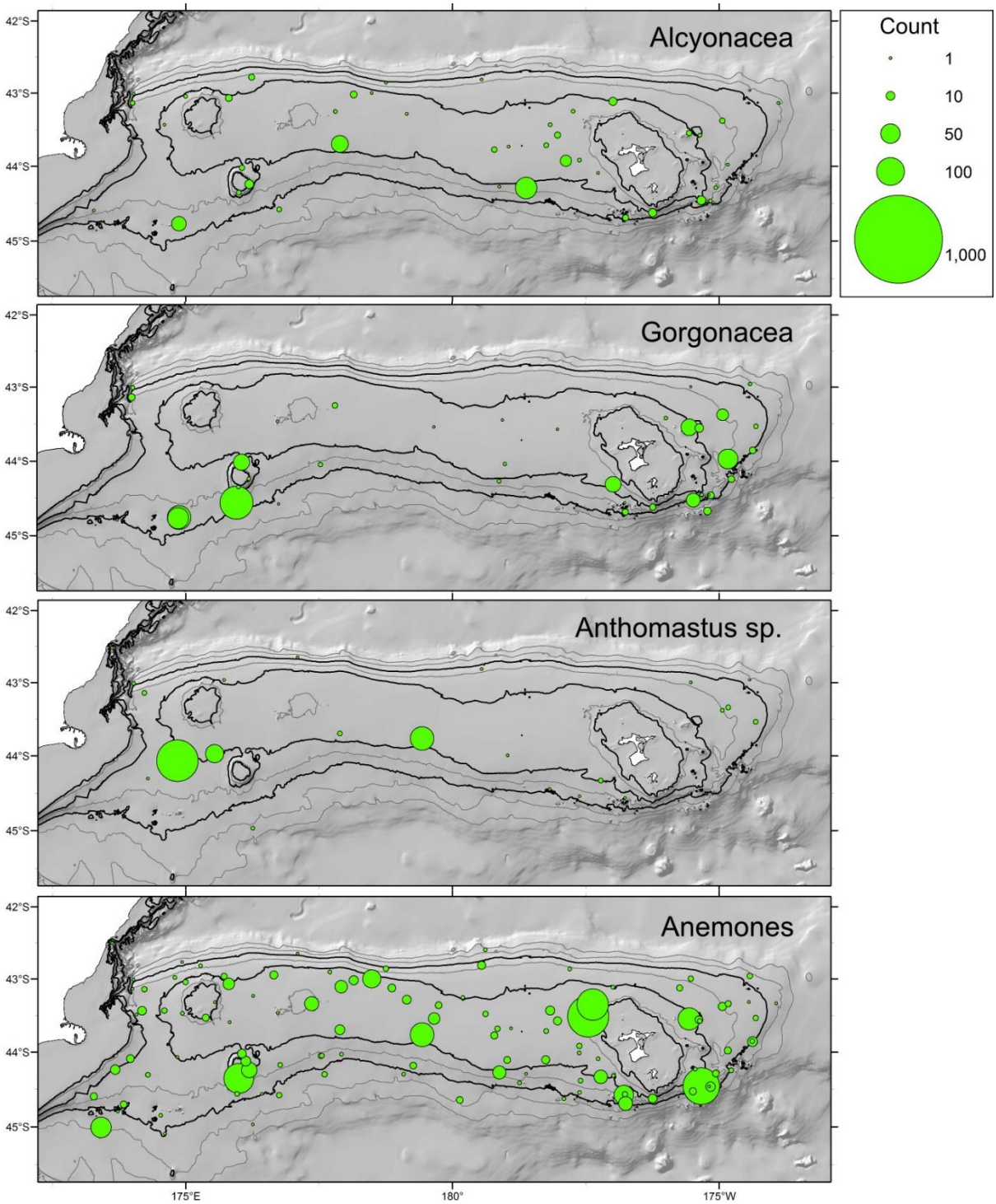

Figure 13: Occurrence and relative densities of cnidarian taxa across the study area: Alcyonacea (soft corals); Gorgonacea (primnoids and others); *Anthomastus* sp., and Anemones (all anemones and cerianthids). Details as in previous figure.

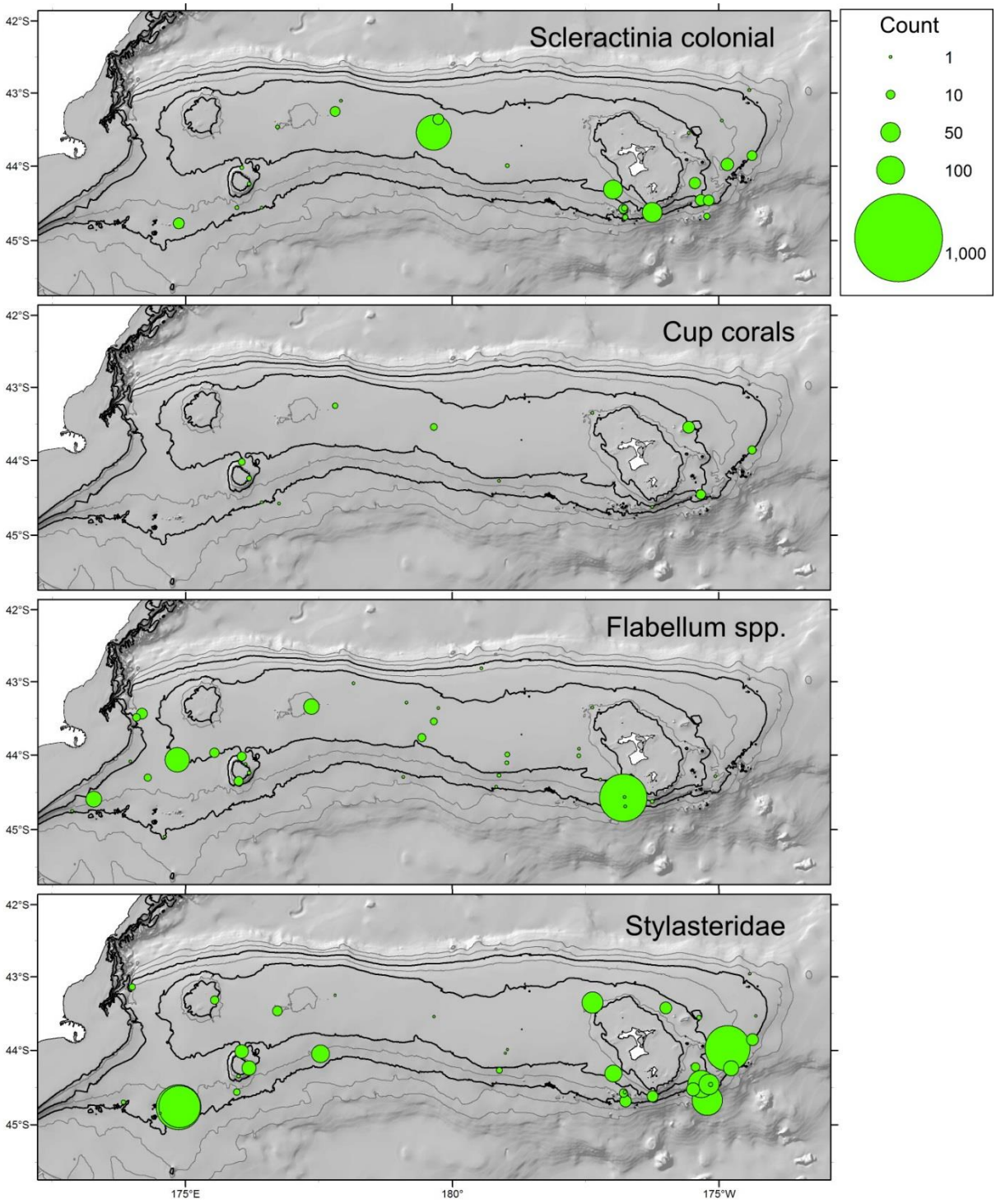

Figure 14: Occurrence and relative densities of cnidarian taxa across the study area: Scleractinia colonial (all thicket-forming stony corals); Cup corals (attached solitary corals); *Flabellum* spp. (free-living on sediments), and Stylasteridae (hydrocorals). Details as in previous figure.

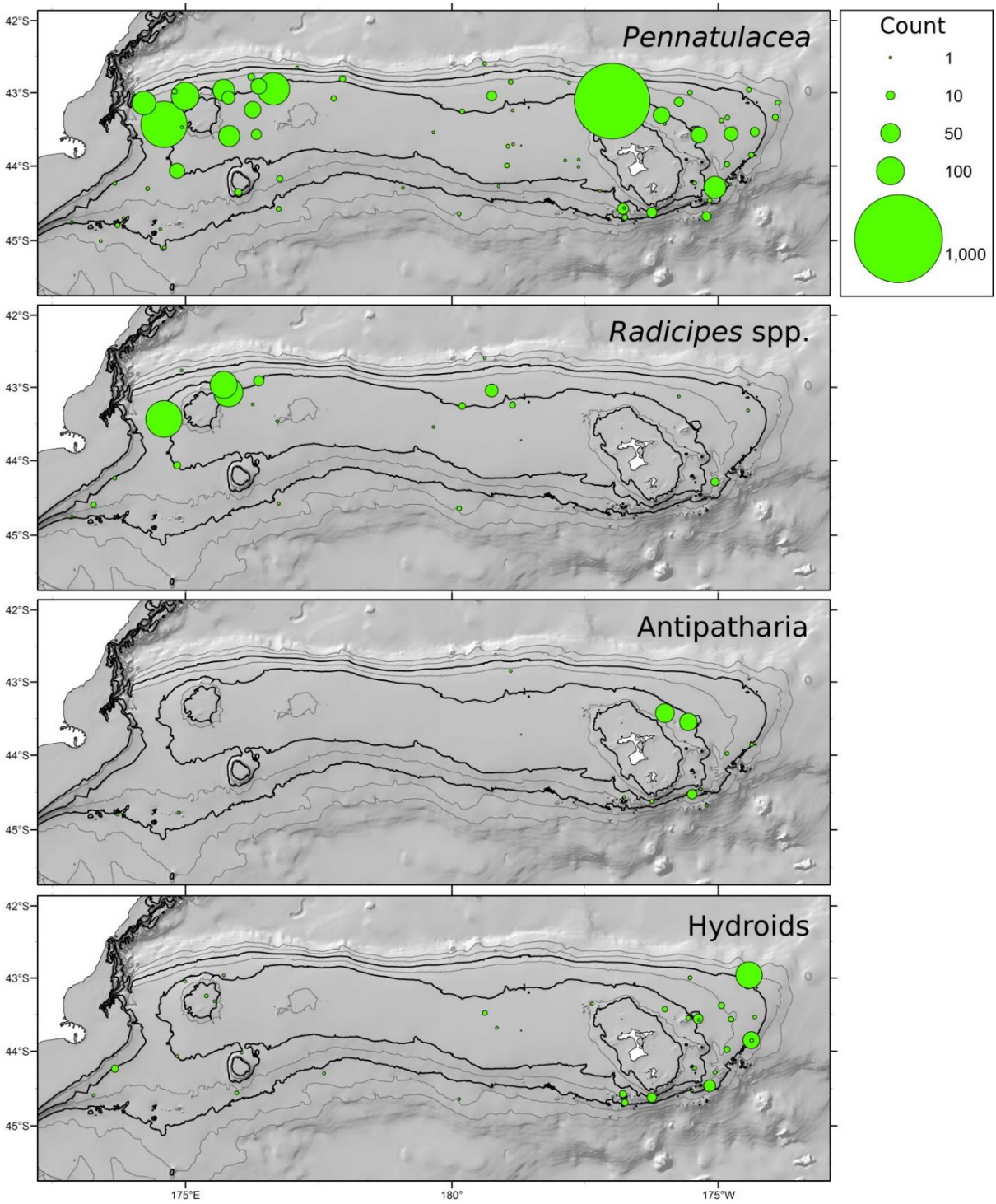

Figure 15: Occurrence and relative densities of cnidarian taxa across the study area: Pennatulacea (sea pens); *Radicipes* spp. (spiral-whip form – probably Pennatulacea); Antipatharia (black corals), and Hydroids (delicate bushy colonies; could include other taxa). Details as in previous figure.

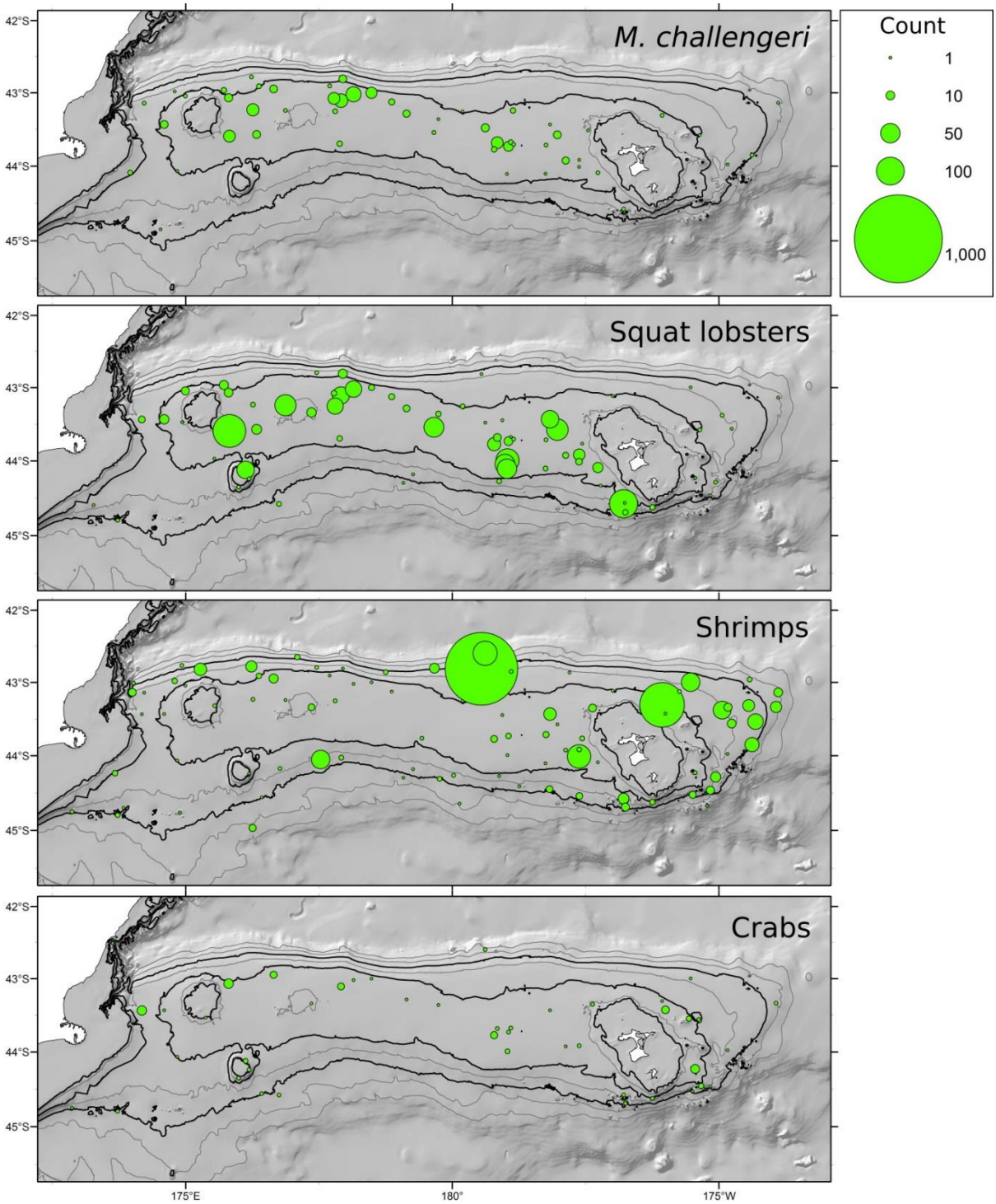

Figure 16: Occurrence and relative densities of crustacean taxa across the study area: *Metanephrops challengeri* (scampi); squat lobsters (*Munida gracilis* and others); shrimps (only larger taxa detected in real-time video, and crabs (most smaller taxa not detected in real-time video). Details as in previous figure.

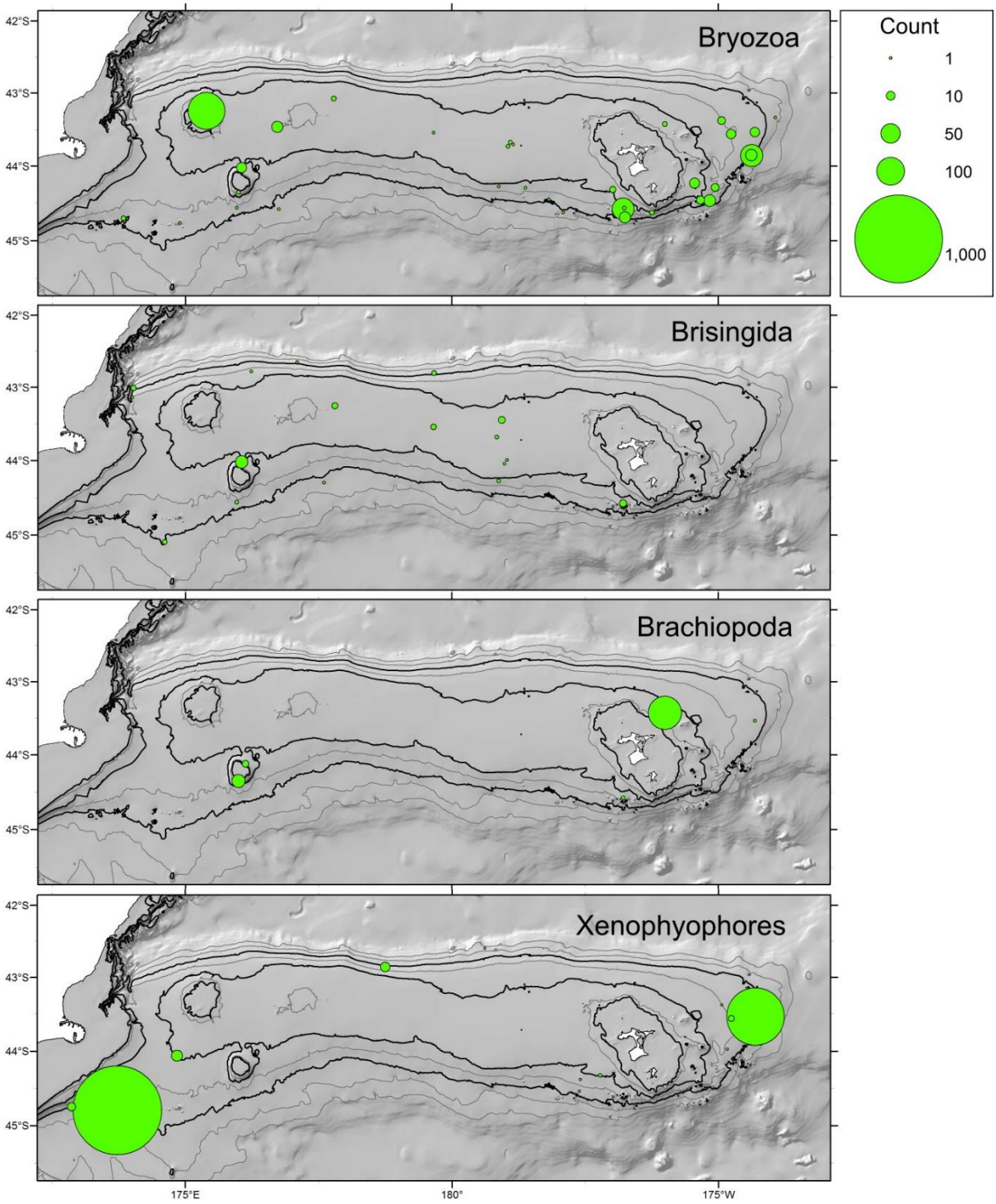

Figure 17: Occurrence and relative densities of Bryozoa, Brisingida (suspension-feeding asteroids), Brachiopods (lamp shells), and Xenophyophores ('Giant' Foraminifera) across the study area. Details as in previous figure.

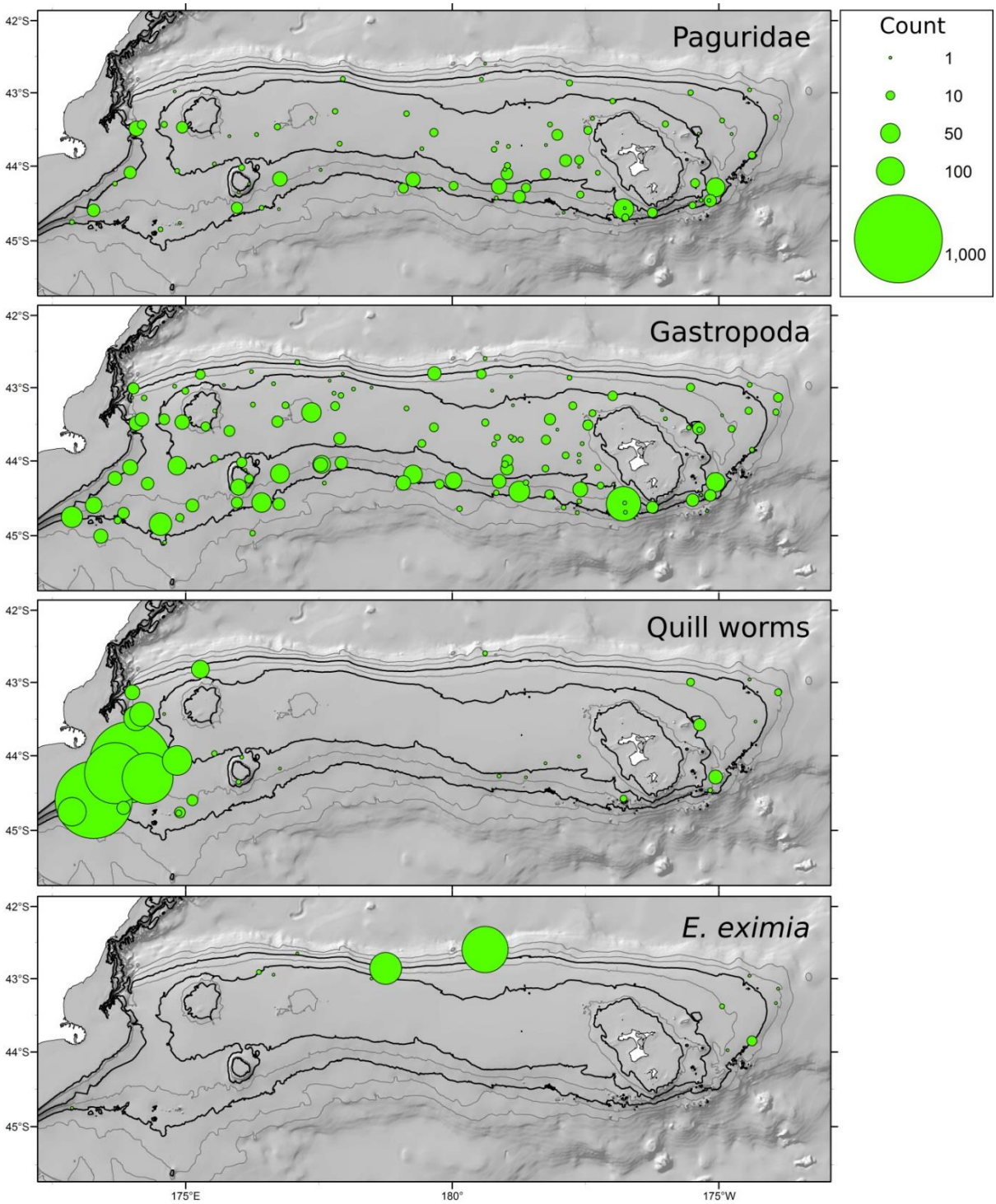

Figure 18: Occurrence and relative densities of Paguridae (hermit crabs), Gastropoda (primarily whelks), quill worms (*Hyalinoecia longibranchiata*), and *Enypniastes eximia* (swimming holothuroid) across the study area. Details as in previous figure.

3.3 Kaikōura Canyon benthic habitats and fauna

During the 16 hours of sampling time available at Kaikōura Canyon, an MBES survey was run across the head of the canyon, and five DTIS transects and two multicorer deployments were completed successfully, capturing 5 hours 50 minutes of seabed video (approximately 6 linear kilometres) with 1390 still images, and recovering eight sediment cores, respectively. DTIS transects were run as closely as possible along the seabed tracks of transects first surveyed in 2006, using ultra-short baseline (USBL) navigation data recorded in OFOP log files from voyage TAN0616 to guide deployments (Figure 19).

Seabed substrata throughout all transects were of uniformly featureless fine, pale sediments except in places were the camera traversed areas of hard substrata, which consisted for the most part of pale, sharply-outlined boulder and cobble-sized rocks, consistent with recent rock fall and mass wasting from slope instability. Grey and black patches observed in places, particularly in stations 178 and 179 (sites K104 and K097, respectively, see Appendix 3 – Site Summaries), appeared to be bacterial mats, similar to those seen in the vicinity of cold seep habitats on the Hikurangi Margin (Bowden, David A. et al. 2013b).

No benthic fauna or bioturbation markings indicating the presence of either infaunal or epifaunal organisms were recorded during any of the five transects, or detected in any of the high-resolution still images examined afterwards. However, fishes, primarily rattails, were present in moderate to high densities in all transects (see images in Appendix 3 – Site Summaries). In subsequent analyses, video and still imagery from these transects will be used in direct comparisons with those from TAN0616 to investigate effects of the November 2016 Kaikōura Earthquake on benthic faunal communities in the canyon.

Multicore samples showed a layer of very fine, pale brown sediment up to 15 cm thick overlying coarser black sediments with a strong odour of anoxic decay. This stratification with deeper anoxic layers was most pronounced in the second multicorer sample (station 182, site K104). Of the four cores recovered by each of the two multicorer deployments, one core was sealed and kept intact under refrigeration (4°C) for detailed geochemical analysis ashore by geologists from NIWA and GNS Science. Data from these two geochemistry cores will be used in conjunction with other material collected in the aftermath of the Kaikōura Earthquake to investigate the nature and extent of seabed sediment displacement caused by the event.

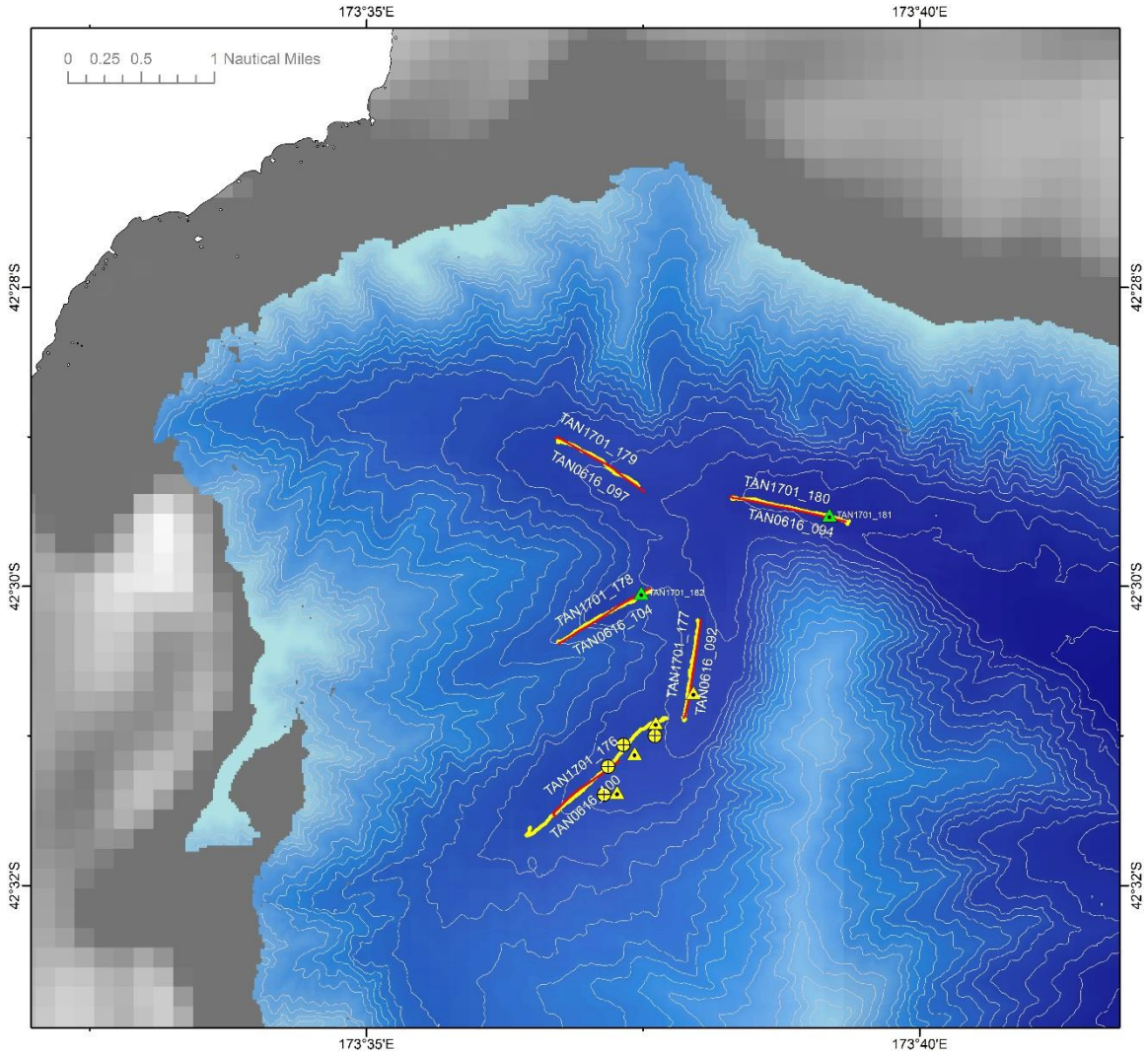

Figure 19: Kaikōura Canyon head, showing the location of: DTIS camera transects run during TAN1701 (red lines) and TAN0616 (yellow lines); multicore deployments during TAN1701 (green filled triangles) and TAN0616 (yellow filled triangles), and Van Veen grab samples collected during TAN0616 (yellow filled circles). Note, the multibeam bathymetry data used to illustrate seabed topography here are from earlier surveys and thus do not show changes resulting from the November 2016 Kaikōura Earthquake.

3.4 Multibeam and CTD

Multibeam echosounder data were collected only from station 39 (Site S38) onwards, primarily on transits between sampling sites but with some parallel survey lines being undertaken at topographically complex sites. Data include seabed topography, backscatter, and water column returns, and are stored in NIWA's Bathymetric Database (*BathyDataBase – BDB*).

Data from a total of 152 CTD casts were collected during DTIS deployments, each cast including the full dive profile from launch and down-cast, through the seabed transect, and then the up-cast recovery to the surface (see Figure 20 for representative downcast profiles). Data are stored on a dedicated database at NIWA, Greta Point, Wellington (contact Kevin Mackay), and uploaded to the World Ocean Circulation Experiment database, maintained by NOAA in the USA (WOCE, https://www.nodc.noaa.gov/woce/).

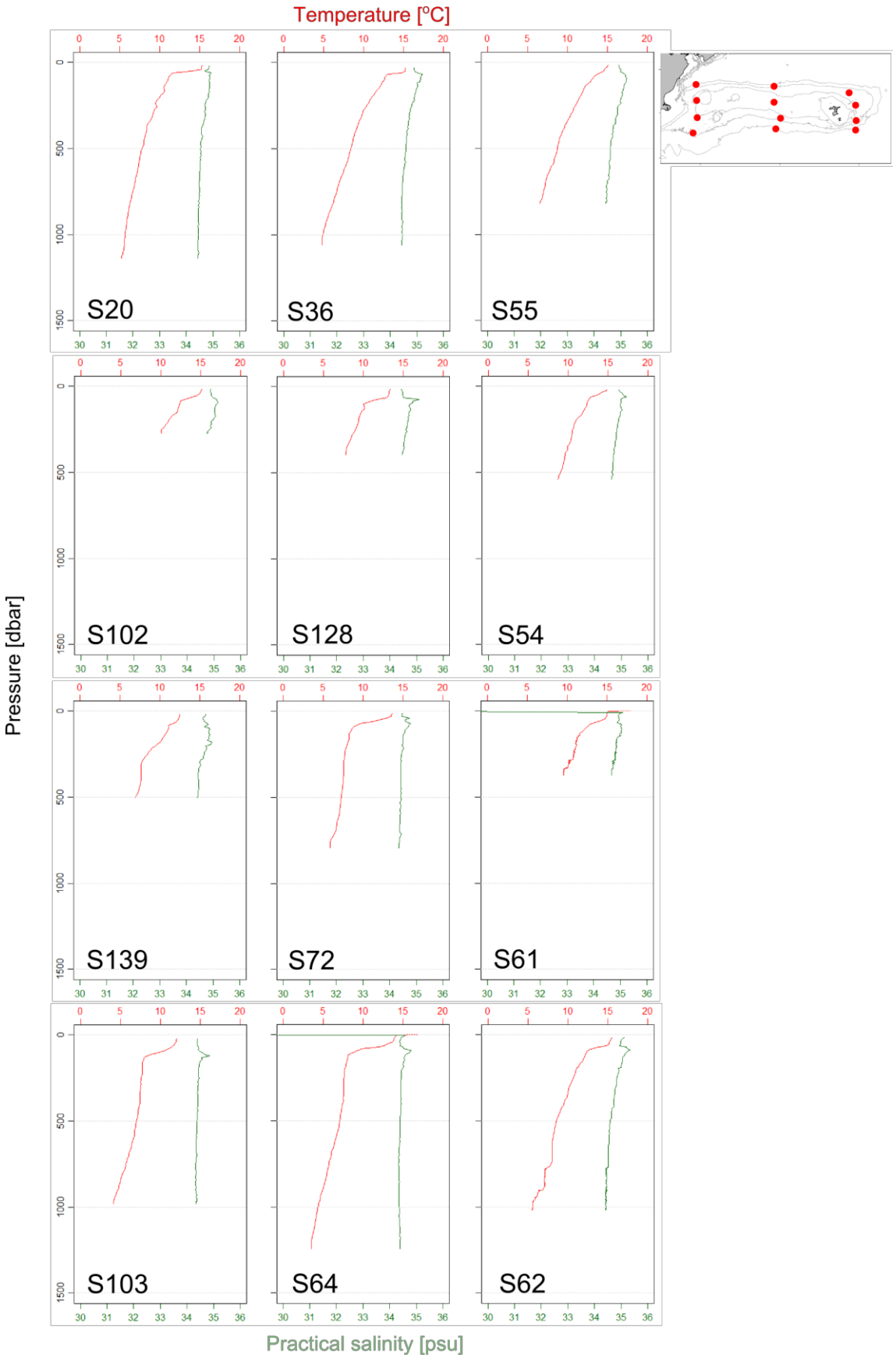

Figure 20: Example CTD profiles from twelve sites across Chatham Rise. Inset map shows site locations, with the arrangement of graphs following the geographical distribution of sites; S20 being the most north-westerly site and S62 the most south-easterly.

4. SUMMARY

The survey was remarkably successful, fully achieving both of the voyage objectives with a minimal proportion of weather down-time and gear failures. High-quality photographic transect data were collected from all 130 planned sites, with 12 additional sites added during the voyage. This effectively doubles the number of sites for which fully-quantitative photographic benthic community data are available in the study area and thus considerably extends knowledge of seabed habitats and fauna across Chatham Rise. Sediment data were collected from 25 sites across the rise in areas where existing data were sparse. These data will be added to a global database of deep-sea sediment characteristics and will contribute to development of fine-scale sediment GIS layers for the New Zealand region. Similarly, CTD and MBES data collected during the voyage will contribute to refining environmental information layers that are fundamental to developing understanding of oceanographic processes across the region and how these influence biological distributions.

The photographic transects will take several months to analyse in detail, yielding finer-level taxonomic identifications and more precise population density estimates than were possible at sea. Meticulous auditing and cross-checking will then be required before these data can be compared quantitatively with those from earlier surveys from Chatham Rise (primarily TAN0705). When this work is complete, however, there is potential for these datasets to be combined, for some taxa at least, providing a spatially extensive, taxonomically detailed, and internally consistent resource for further study of benthic faunal distributions in what is arguably the most commercially and ecologically important deep-sea area of New Zealand's EEZ.

The first application of new data from voyage TAN1701 under the present project (ZBD2016-11) will be its use as an independent test-set enabling objective evaluation of predictions from existing species-environment models (e.g., Compton et al. 2012, Rowden et al. 2014, Tracey et al. 2011). Such models have been developed using data from earlier photographic data, research trawl survey bycatch data, and museum records but objective evaluation of the reliability of their projections to date has been limited by the lack of available data.

When combined with existing data, the primary applications of the full dataset will be (1) to generate improved species-environment models for Chatham Rise, benefiting from the greater density of data available and the knowledge gained from the initial evaluations above (project ZBD2016-11), and (2) use in the development of a benthic risk assessment framework for Chatham Rise, with initial methods development taking place under MPI project BEN2016-1.

The success of the voyage in achieving its research aims lends support to the recommendation of Bowden & Hewitt (2012) that a strategy of increasing sampling density by deploying fewer gear types is likely to provide more useful data in broad-scale surveys of benthic biodiversity across New Zealand's EEZ. This success was strongly underpinned, however, by the professionalism and experience of the entire survey team, both science staff and vessel crew, and by the capability and reliability of the technical systems developed and maintained by NIWA.

5. ACKNOWLEDGMENTS

We thank the officers and crew of RV *Tangaroa* for their professionalism, skill, and enthusiasm throughout the voyage. Constructive discussions with Mary Livingston, Martin Cryer, Alistair Dunn, and Richard Ford from MPI at the initiation of project ZBD2016-11 helped define the overall science and management aims of the project, and thus the scope of the voyage, and we

thank Mary Livingston for continuing governance and oversight of the project. We are also indebted to the Department of Conservation for granting permission at short notice to collect sediment cores from within the Hikurangi Marine Reserve. Additional funding for development of this report were made available through NIWA SSIF project COES1701 – *Marine Foodweb Dynamics*. Finally, thanks to Ashley Rowden and Scott Nodder at NIWA for constructive and thorough reviews of this report prior to submission.

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7. Appendix 1 – Station Records

Table 3: TAN1701 station summary, showing: sequential station number (Stn); Site code (Site); gear (DTIS = Deep Towed Imaging System, MUC = multicorer); stratum code (Str); start time (New Zealand Standard Time); latitude (Lat. In degrees and decimal minutes, negative values are South) and longitude (lon. In degrees and decimal minutes, positive values are East, negative are West) of start and end positions; depth (m) of start and end positions; with length (Dist. (m)) and direction (Dir., in degrees true) of camera transects, and summary descriptions of transects and sediment samples.

Stn	Site	Date	Gear	Str	NZST	Lat. start	Lon. start	Lat. end	Lon. end	Depth start	Depth end	Dist. (m)	Dir.	Description
1	S28	6-Jan	DTIS	02A	0122	-42:46.65	176:14.33	-42:47.18	176:13.99	677	622	1085	205	Muddy sediment with burrows, mounds, pits. Shrimps, chimeras, galatheids, and rattails. Some trawl marks.
2	S24	6-Jan	DTIS	08A	0420	-42:54.35	176:22.71	-42:54.92	176:22.46	513	505	1109	198	Muddy sediments with burrows and mounds. Holothuroids abundant, some seapens.
3	S26	6-Jan	DTIS	08A	0714	-42:56.53	176:39.2	-42:57.06	176:38.84	423	425	1097	207	Muddy sediments with burrows and mounds. Seapens common, holothurians, some scampi, rattails and other fish.
4	S27	6-Jan	DTIS	19	1311	-43:14.04	176:16.16	-43:13.84	176:15.37	346	337	1132	289	Muddy sediments with dark mounds and tracks. Burrowing urchins common, also seapens, munida gracilis and scampi, asteroids, holothuroids, and some small octopi. Numerous small hoki in latter part of transect.
5	S75	6-Jan	DTIS	19	1552	-43:34.16	176:20.23	-43:34.45	176:19.49	379	384	1132	242	Muddy sediments with burrows, mounds, *Munida gracilis*, seapens.
6	S75	6-Jan	MUC	19	1745	-43:34.29	176:19.83	-43:34.29	176:19.83	376	376	0	NA	Four 31–43 cm cores of green-grey muddy sand
7	S90	6-Jan	DTIS	19	2048	-43:27.76	176:43.67	-43:28.24	176:43.19	259	259	1100	216	Dark, firm, sandy sediments with reticulated appearance, some patches of apparently black lava and chalk. Fauna of sponges, asteroids, tube worms, cup corals.
8	S31	7-Jan	DTIS	19	0108	-43:14.22	176:52.35	-43:14.83	176:52.57	280	273	1168	NA	Dark sand overlain by pale muddy sediment. Many mounds and burrows. *M. gracilis* abundant, some small sponges.
9	S32	7-Jan	DTIS	19	0416	-43:20.22	177:21.9	-43:20.73	177:21.42	248	247	1146	NA	Predominantly dark sand with areas of pale sand. Small sponges, gastropods, *M. gracilis*.
10	S29	7-Jan	DTIS	23	1014	-42:38.96	177:5.95	-42:39.23	177:5.53	1112	1092	761	229	Muddy sediment with burrows. High density of rattail fishes, some Echinothuroid urchins, a brisingid star, small rays.
11	S29	7-Jan	MUC	23	1300	-42:39.39	177:5.08	-42:39.39	177:5.08	1070	1070	0	NA	Four 30–40 cm cores of stiff green-grey muddy sand
12	S113	7-Jan	DTIS	225	1519	-42:47.52	177:27.78	-42:47.96	177:27.18	684	652	1155	225	Muddy sediments. At start, high density of burrows, mounds, pits. Later, extensive trawl tracks. Water turbid.
13	S112	7-Jan	DTIS	08A	1812	-42:54.12	177:42.48	-42:54.6	177:41.98	430	418	1119	217	Fine muddy sediment, many burrows, pits, and mounds. Scampi, asteroids, *M. gracilis*.
14	S112	7-Jan	MUC	08A	1944	-42:54.63	177:41.93	-42:54.63	177:41.93	411	411	0	NA	3 good cores greenish mud, 1 washed out (I x MAF dropped)
15	S30	7-Jan	DTIS	20	2147	-43:4.46	177:47.29	-43:4.89	177:46.77	328	329	1064	222	Dark sand sediments. Burrowing echinoids, scampi, *M. gracilis*, asteroids.

Stn	Site	Date	Gear	Str	NZST	Lat. start	Lon. start	Lat. end	Lon. end	Depth start	Depth end	Dist. (m)	Dir.	Description
16	S35	8-Jan	DTIS	20	0124	-43:14.99	177:48.62	-43:15.39	177:47.98	306	303	1140	229	!Sensitive Habitat! Greenish muddy sediments with areas of rock and boulder supporting diverse sessile communites: demosponges; Goniocorella dumosa; bryozoans and others. Rock appears to be conglomerate with chalk in places.
17	S33	8-Jan	DTIS	20	0301	-43:6.2	177:55.14	-43:6.73	177:54.71	386	382	1142	211	Fine greenish muddy sediment, many burrows, pits, and mounds. White holothuroids, scampi, asteroids, munida, anemones.
18	S34	8-Jan	DTIS	02A	0630	-42:48.32	177:57.21	-42:48.73	177:56.59	613	655	1136	228	Fine greenish muddy sediment with mounds, burrows, pits, and tracks. Trawl marks. Scampi, *Carcinoplax victoriensis*, rattails.
19	S98	8-Jan	DTIS	02A	0937	-43:0.98	178:9.21	-43:1.47	178:8.7	364	360	1142	217	Fine greenish muddy sediments overlying black sand. Burrows, pits, mounds and burrowing urchin tracks. Scampi, burrowing urchins, asteroids.
20	S98	8-Jan	MUC	02A	1204	-43:1.5	178:8.68	-43:1.5	178:8.68	356	356	0	NA	Four short cores (10–12 cm) greenish mud with fine black sand. one clean, three cores slightly disturbed; all useable.
21	S97	8-Jan	DTIS	08B	1433	-42:59.66	178:29.35	-43:0.22	178:28.98	408	385	1152	NA	Fine greenish muddy sediments overlying black sand. Burrows, pits, mounds and tracks. Scampi, asteroids, holothuroids, one large crab.
22	S91	8-Jan	DTIS	22	1650	-42:51.81	178:45.34	-42:51.33	178:44.92	920	944	1057	327	Level muddy sediments with burrows, current ripples, and trawl marks. *E. eximia* holothuroids, asteroids, rattails, oreos.
23	S92	8-Jan	DTIS	20	2008	-43:7.59	178:52.29	-43:7.43	178:51.56	384	381	1033	287	Muddy sediments with dark sand under. Burrows, mounds, pits, tracks.
24	S37	8-Jan	DTIS	08B	2318	-43:17.09	179:9.09	-43:17.06	179:8.25	442	440	1138	273	Muddy sediments with burrows, pits and mounds, scampi, Echinothuroid echinoids, galatheids. Some trawl marks.
25	S69	9-Jan	DTIS	14	0411	-43:45.54	179:26.02	-43:46.15	179:25.89	485	485	1143	189	Level muddy sediments with numerous small burrows. Anemones abundant, munida, *Flabellum*, anthomastus, one large *Hyalascus* sponge.
26	S128	9-Jan	DTIS	20	0730	-43:32.49	179:39.69	-43:32.79	179:38.99	399	388	1094	239	!Sensitive habitat! Muddy sediments with areas of phosphorite nodules with diverse sessile communites: Goniocorella dumosa, crinoids, sponges, bryozoans and others.
27	S129	9-Jan	DTIS	08B	1124	-43:21.53	179:44.87	-43:21.81	179:44.27	463	459	962	237	!Sensitive habitat! Muddy sediments burrows, mounds, and pits. One area of phosphorite nodules with diverse sessile communites: *Goniocorella dumosa*, crinoids, sponges, bryozoans and others.
28	S41	9-Jan	DTIS	10	1420	-43:15.14	-179:48.1	-43:15.59	-179:48.62	513	510	1091	220	Level muddy sediments with trawl marks throughout transect. Sparse fauna; echinothuroid urchins, rattails, brisingid stars.
29	S36	9-Jan	DTIS	22	2005	-42:48.14	179:40.35	-42:48.43	179:39.68	1055	1049	1060	240	Level muddy sediments with trawl marks throughout transect. Sparse fauna; echinothuroid urchins, rattails, brisingid stars.
30	S36	9-Jan	MUC	22	2147	-42:48.49	179:39.59	-42:48.49	179:39.59	1048	1048	0	NA	Four cores pale brown mud, 10–23 cm depth.
31	S127	10-Jan	DTIS	23	0346	-42:35.78	-179:22.7	-42:36.18	-179:23.25	1407	1407	1056	225	Current-rippled muddy sand sediment. Sparse fauna

Stn	Site	Date	Gear	Str	NZST	Lat. start	Lon. start	Lat. end	Lon. end	Depth start	Depth end	Dist. (m)	Dir.	Description
32	S127	10-Jan	MUC	23	0530	-42:36.10	-179:23.19	-42:36.10	-179:23.19	1378	0	111	NA	Four cores pale brown mud, 30-40cm cm depth. Sand at surface.
33	S49	10-Jan	DTIS	21A	0827	-42:48.6	-179:26.84	-42:48.97	-179:27.44	857	856	1067	230	Level muddy sediments, few burrows. Many shrimps, some whelks. Trawl marks in places.
34	S117	10-Jan	DTIS	02B	1252	-42:50.75	-178:53.55	-42:51.28	-178:53.89	669	647	1085	NA	Soft muddy sediments with burrows, pits, mounds.
35	S117	10-Jan	MUC	02B	1421	-42:51.39	-178:53.97	-42:51.39	-178:53.97	636	0	0	NA	Four deep cores (40–50 cm) soft pale brown mud.
36	S40	10-Jan	DTIS	10	1714	-43:2.37	-179:14.69	-43:2.66	-179:15.43	537	533	1139	242	Soft muddy sediments with pronounced pits, mounds, and burrows. Seapens, *Radicipes*, rattails, and a morid cod.
37	S43	10-Jan	DTIS	11	2057	-43:14.51	-178:51.26	-43:14.61	-178:52.03	485	482	1059	NA	Muddy sediments with pronounced pits, mounds, burrows. High densities of irregular echinoids on sediment surface through transect.
38	S39	11-Jan	DTIS	10	0017	-43:26.71	-179:3.54	-43:27.13	-179:4.01	459	458	1003	219	Muddy sediments with pronounced pits, mounds, burrows. High densities of irregular echinoids on sediment surface through first half of transect.
39	S38	11-Jan	DTIS	10	0315	-43:28.58	-179:22.29	-43:28.89	-179:23.05	443	438	1175	241	Muddy sediments with pronounced pits, mounds, burrows. High densities of irregular echinoids on sediment surface in some patches.
40	S2	11-Jan	DTIS	3	0642	-43:46.11	-179:12.68	-43:46.72	-179:12.86	378	369	1155	192	Level muddy sediments with burrows, pits, mounds. Sparse fauna.
41	S123	11-Jan	DTIS	10	0924	-43:40.9	-179:9.65	-43:40.8	-179:8.83	403	400	1117	80	Level muddy sediments with burrows, pits, mounds. Sparse fauna; white holothuroids.
42	S1	11-Jan	DTIS	3	1218	-43:44.19	-178:56.96	-43:43.72	-178:56.36	397	394	1186	43	Mostly muddy sediments with burrows, mounds and pits, but with areas of cobble, presumably phosphorite, in places. Sparse fauna. Some sponges on phosphorites, and echinoids, holothuroids, *Munida* sp., and scampi on muddy sediments. Numerous juvenile hoki.
43	S130	11-Jan	DTIS	11	1450	-43:40.73	-178:54.18	-43:40.19	-178:53.75	420	434	1155	30	Mostly muddy sediments with burrows, pits, mounds, and tracks but with some patches of cobble/phosphorite. Sparse epifauna, holothuroids, echinoids, scampi. Juvenile hoki.
44	S7	11-Jan	DTIS	11	1807	-43:42.96	-178:43	-43:42.38	-178:42.77	451	452	1118	16	Mostly muddy sediments with burrows, pits, mounds, and tracks but with some patches of cobble/phosphorite. Sparse epifauna, asteroids, locally high density of echinoids.
45	S131	11-Jan	DTIS	11	2059	-43:42.52	-178:50.96	-43:41.96	-178:50.73	408	413	1082	17	Muddy sediments with areas of cobble/phosphorite, sometimes extensive. Fauna sparse throughout; asteroids, echinoids, some sponges on hard substrata.
46	S10	12-Jan	DTIS	5	0112	-43:42.54	-178:14.24	-43:43.07	-178:14.65	384	380	1125	209	Muddy sediments, apparently rippled in places, with few burrows, pits, and mounds. Sparse fauna; *Munida* sp., asteroids.
47	S11	12-Jan	DTIS	5	0416	-43:34.62	-178:2.11	-43:34.54	-178:1.29	382	377	1114	82	Muddy sediments with extensive areas of cobble, pebble and boulder substrate with some outcropping of bedrock. Sparse fauna throughout; *Munida* sp., stylasterid corals, sponges, pagurid crabs. Hoki.

Stn	Site	Date	Gear	Str	NZST	Lat. start	Lon. start	Lat. end	Lon. end	Depth start	Depth end	Dist. (m)	Dir.	Description
48	S46	12-Jan	DTIS	9	0645	-43:26.28	-178:9.64	-43:25.85	-178:10.16	393	390	1061	NA	Muddy sediments with some burrows, mounds, and pits, with some patches of cobble. Sparse fauna; asteroids, shrimp, galatheids, and pagurids.
49	S48	12-Jan	DTIS	02B	1224	-42:52.14	-177:47.89	-42:51.6	-177:48.24	673	689	1108	335	Current-rippled muddy sand sediment. Very sparse fauna.
50	S48	12-Jan	MUC	02B	1354	-42:51.39	-177:48.33	-42:51.39	-177:48.33	690	690	0	NA	Four cores 30–50 cm, fine muddy sand.
51	S45	12-Jan	DTIS	11	1718	-43:15.12	-177:43.81	-43:14.9	-177:44.59	381	382	1132	NA	Rippled muddy sand. Very sparse fauna; a few asteroids, shrimps, small fishes.
52	S12	12-Jan	DTIS	5	2157	-43:46.3	-177:33.56	-43:45.73	-177:33.97	377	375	1190	332	Muddy sediments with mounds, pits, and few burrows. Sparse fauna.
53	S13	13-Jan	DTIS	5	0116	-43:30.91	-177:26.85	-43:30.68	-177:27.63	278	278	1134	292	Muddy sand sediments with some patches of cobble. Sparse fauna but anemones common hard substrata.
54	S47	13-Jan	DTIS	9	0344	-43:20.83	-177:22.13	-43:21.48	-177:22.12	212	181	1204	179	Rippled muddy sand at start becoming cobble, boulder, then outcropping rock. Sponges, anemones, crinoids on hard substrata, otherwise sparse fauna.
55	S44	13-Jan	DTIS	11	0743	-43:6.99	-176:59.07	-43:6.69	-176:59.78	477	473	1112	300	!Sensitive Habitat! Muddy sediments with seapens at moderate density throughout transect.
56	S44	13-Jan	MUC	11	0910	-43:6.63	-176:59.81	-43:6.63	-176:59.81	477	477	0	NA	Four cores muddy sand 12–20 cm long
57	S57	13-Jan	DTIS	11	1432	-43:18.72	-176:4.11	-43:18.25	-176:3.58	457	462	1127	39	Muddy sediments with burrows, mounds, pits, and tracks. Burrowing urchins, crabs, many juvenile fishes.
58	S119	13-Jan	DTIS	9	1715	-43:25.85	-175:59.87	-43:25.28	-176:0.22	177	201	1156	336	!Sensitive Habitat! Transect across the summit of a low rocky knoll. Shell hash, sand, and gravel on the flanks, patches of bare outcropping rock on the summit. Sponges and antipatharian and stylasterid corals on rock substrata, brachiopods recorded on gravel substrata.
59	S119	13-Jan	MUC	9	1848	-43:24.23	-176:0.24	-43:24.24	-176:0.25	408	408	23	216	Four cores muddy sand 30-42cm long. Core site to the NNW of the DTIS transect, to find soft sediment away from the knoll.
60	S56	13-Jan	DTIS	02B	2149	-43:7.8	-175:44.13	-43:7.35	-175:44.58	690	684	1033	324	Level muddy sediment with burrows, mounds, and tracks. Quill worms abundant. Oreos, halosaurs, dogfish.
61	S56	13-Jan	MUC	02B	2355	-43:7.49	-175:44.36	-43:7.53	-175:44.31	677	677	100	138	Four cores, 11–17 cm pale grey muddy sand.
62	S55	14-Jan	DTIS	21B	0212	-42:59.67	-175:31.39	-43:0.08	-175:31.96	820	807	1085	226	Level muddy sediments with high density of burrows and tracks. Some quill worms, ophiuroids, echinoids, macroalgae debris.
63	S132	14-Jan	DTIS	12	0827	-43:32.63	-175:33.41	-43:33.14	-175:33.9	280	269	1152	215	!Sensitive Habitat! Rippled muddy sand at start, then sand and shell hash with areas of cobble, boulder, and rock. Sponges, stylasterid corals, gorgonians, hydroids, and bryozoans on hard substrata.
64	S54	14-Jan	DTIS	12	1102	-43:34.32	-175:21.4	-43:34.89	-175:21.69	546	506	1125	200	Level muddy sand with burrows, tracks and weak current ripples. High density of cerianthid anemones, quill worms, burrowing urchins.
65	S54	14-Jan	MUC	12	1230	-43:44.94	-175:21.71	-43:44.94	-175:21.71	500	500	0	NA	Four cores 30–40 cm uniform green-grey muddy sand.

Stn	Site	Date	Gear	Str	NZST	Lat. start	Lon. start	Lat. end	Lon. end	Depth start	Depth end	Dist. (m)	Dir.	Description
66	S133	14-Jan	DTIS	12	1416	-43:33.84	-175:22.48	-43:33.27	-175:22.76	279	290	1121	NA	!Sensitive Habitat! Transect on bank north of S54. Rippled sand, boulders and bedrock in places, with sponges, stylasterid corals, bryozoans, and some small stony coral colonies.
67	S52	14-Jan	DTIS	02B	1836	-43:20.13	-174:49.48	-43:20.68	-174:49.77	849	843	1091	201	Level muddy sediment with numerous burrows and tracks. Ring-of-burrows common too. Small, feathery, bryozoans present throughout.
68	S118	14-Jan	DTIS	24	2355	-42:57.8	-174:25.09	-42:57.36	-174:25.36	908	1193	894	336	Seamount site "Smith's City". Heavily trawl impacted, some orange roughy over bedrock and coral rubble on summit, becoming boulders and sand at base.
69	S120	15-Jan	DTIS	24	0425	-43:8.5	-173:53.41	-43:7.94	-173:53.07	1204	1205	1135	24	Level muddy sediments with few burrows. Trawl marks, sparse fauna.
70	S121	15-Jan	DTIS	24	0800	-43:20.4	-173:55.84	-43:19.91	-173:55.59	1158	1159	968	20	Level muddy sediments with few burrows. Trawl marks, sparse fauna.
71	S121	15-Jan	MUC	24	0940	-43:19.73	-173:55.44	-43:19.73	-173:55.44	1164	1164	0	NA	Four cores 30–40 cm pale fine mud, brownish-orange in top 10 cm
72	S53	15-Jan	DTIS	21B	1348	-43:19.38	-174:26.31	-43:18.79	-174:26.42	874	873	1103	352	Level muddy sediments with many burrows.
73	S58	15-Jan	DTIS	25	1701	-43:32.55	-174:18.79	-43:31.94	-174:18.77	877	879	1130	NA	!Sensitive Habitat! Level muddy sediments with burrows. Many Xenophyophores throughout transect, some *Anthomastus*, shrimps, and bryozoans. Xenophyophore density possibly indicative of Sensitive Habitat.
74	S58	15-Jan	MUC	25	1836	-43:31.97	-174:18.77	-43:31.97	-174:18.77	880	880	0	NA	No sample: descent too slow at seabed.
75	S58	15-Jan	MUC	25	1919	-43:32	-174:18.77	-43:32	-174:18.77	880	880	0	NA	Small sample (5 and 10 cm) of pale firm mud in two cores, other two empty. Processed for sediment and macrofauna.
76	S50	15-Jan	DTIS	4	2236	-43:34.12	-174:45.58	-43:33.57	-174:45.7	756	753	1031	NA	Level muddy sediments with burrows
77	S134	16-Jan	DTIS	02B	0228	-43:22.53	-174:56.42	-43:22.84	-174:56.19	758	811	653	152	Targeting scarp feature seen in MBES SW of S52. Bare bedrock, boulders, and sand at top of scarp, becoming sand and muddy sand at base. Sparse fauna. [short transect partly because of vertical component].
78	S63	16-Jan	DTIS	28	0751	-43:51.48	-174:22.15	-43:51.37	-174:22.35	892	839	337	307	!Sensitive Habitat! Summit of knoll; rugged bedrock with intact scleractinian coral thickets *(S. variabilis* and *E. rostrata*), sponges, primnoids (*Narella* sp. and others). Transect stopped when video link lost after impact.
79	S63	16-Jan	DTIS	28	0908	-43:51.14	-174:22.58	-43:50.87	-174:22.76	1063	1056	555	334	Continuation of #78 from base of knoll on to flat. Level muddy sediments with little bioturbation. Sparse fauna, shrimps, some holothuroids.
80	S51	16-Jan	DTIS	4	1403	-43:58.42	-174:49.84	-43:58.82	-174:50.31	468	496	972	220	Small knoll with current-scoured moat. Bare bedrock substrata at summit, sand, gravel, cobbles on flank with lava outcrops. Crinoids, stylasterids, anemones, bryozoans,
81	S60	16-Jan	DTIS	28	1925	-44:14.33	-174:46.26	-44:14.89	-174:46.45	1045	1043	1068	194	Traversing base of a steep bluff. Rippled sand, shell hash and coral rubble with black lava boulders and rock. Sparse fauna.

Stn	Site	Date	Gear	Str	NZST	Lat. start	Lon. start	Lat. end	Lon. end	Depth start	Depth end	Dist. (m)	Dir.	Description
82	S124	16-Jan	DTIS	25	2249	-44:17.44	-175:3.51	-44:16.89	-175:3.49	731	729	1019	1	Level firm muddy sediments with little bioturbation. Some holothuroids
83	S124	17-Jan	MUC	25	0025	-44:16.78	-175:3.48	-44:16.78	-175:3.48	705	705	0	NA	Four cores light grey mud (20–35 cm)
84	S59	17-Jan	DTIS	0	0351	-44:13.85	-175:27.03	-44:13.55	-175:26.45	100	234	951	NA	Shallow knoll, from summit down to level seabed. Bedrock at summit, with diverse sessile fauna and flora; zoanthids, stylasterid corals, enrusting red algae, and fishes. Sand and shell hash deeper.
85	S42	17-Jan	DTIS	25	0729	-44:28.15	-175:9.33	-44:27.6	-175:9.7	900	761	1131	NA	Compacted gravel and barnacle plate hash, interspersed with areas of black boulders and bedrock, rippled sand towards end of transect. Sparse fauna, anemones,
86	S61	17-Jan	DTIS	25	1017	-44:27.72	-175:19.71	-44:27.24	-175:20.17	173	382	1078	326	Knoll summit out on to open sediments. Pale rock, cobbles, boulders and shell hash with anemones, sponges, stylasterids. Group of large hapuka following DTIS. Sand, shell hash, and cobbles with sponges and bryozoans deeper.
87	S42	17-Jan	DTIS	25	1250	-44:27.76	-175:11	-44:27.59	-175:11.29	513	690	497	309	Targeting small knolls seen in MBES just W of S42. Bedrock, boulders, some coral rubble and sand. Crinoids, small stony coral colonies (Solenosmilia?), stylasterid corals and sponges, white-spined cidarid urchins. Rippled sand and fine coral rubble at base.
88	S62	17-Jan	DTIS	28	1558	-44:40.52	-175:12.79	-44:40.4	-175:13.43	776	994	875	285	Little Chief seamount. Mostly rock and coral rubble near summit. Some trawl marks, many Baxter's dogfish. Rippled sand at base. Running onto ridge to the W, barnacles plates, lava, and many stylasterid corals.
89	S96	17-Jan	DTIS	25	2055	-44:31.96	-175:29.45	-44:31.37	-175:29.39	928	848	1096	4	Level firm muddy sediments with few burrows at start, low rocky outcrop at end. Trawl marks throughout. *Gracilechinus multidentatus* urchins common on sediment, some black corals and bryozoans on outcrop.
90	S135	18-Jan	DTIS	12	0226	-44:37.58	-176:14.49	-44:37.13	-176:15.01	294	425	1081	320	!Sensitive habitat! Coarse sand, brachiopod shell hash, and rock at start, with tube worms. Bedrock, boulders, cobbles in places, with sponges, bryozoans, stylasterid corals, crinoids, and brachiopods. Becoming muddy sediment at end.
91	S94	18-Jan	DTIS	25	0658	-44:41.74	-176:44.95	-44:41.19	-176:45.24	697	652	1088	339	!Sensitive habitat! Mostly muddy sediment with old coral rubble but with outcropping bedrock in places. Many shrimps, *G. multidentatus*, with some *Madrepora* sp. coral thickets.
92	S93	18-Jan	DTIS	4	0950	-44:34.86	-176:47.09	-44:34.26	-176:47.13	420	408	1113	357	Transect across flat-topped plateau west of target S93. Level firm mud-sand with scattered cobble and boulder. Diverse fauna with sponges, bryozoans, stony corals but all at low densities.
93	S93	18-Jan	DTIS	4	1155	-44:34.15	-176:45.59	-44:33.64	-176:45.99	622	538	1083	331	Level seabed at planned site. Muddy sand with no burrows, rising gently to gravel, cobbles at end.

Stn	Site	Date	Gear	Str	NZST	Lat. start	Lon. start	Lat. end	Lon. end	Depth start	Depth end	Dist. (m)	Dir.	Description
94	S93	18-Jan	MUC	4	1333	-44:33.96	-176:45.73	-44:33.96	-176:45.73	588	588	0	NA	Marginal coring site. Thin scrape of sandy sediment in tubes. Elected not to try again.
95	S14	18-Jan	DTIS	12	1729	-44:19.21	-176:58.57	-44:18.78	-176:59.01	416	422	988	324	!Sensitive habitat! Low plateau-knoll at 400 m. Sponges, G. dumosa, bryozoans, stylasterids on cobble and mud substrata at the plateau rim, burrowing urchins in muddy sediments of main plateau, *D. horridus*, brisingids on northern rim.
96	S16	18-Jan	DTIS	12	2029	-44:20.24	-177:12.84	-44:19.72	-177:13.23	504	495	1094	332	Level muddy sediment with burrows, mounds, and tracks. Old trawl marks in several places.
97	S4	18-Jan	DTIS	5	2339	-44:5.63	-177:15.79	-44:5.1	-177:16.21	381	376	1130	330	Muddy sand sediment with pits, fish feeding marks, burrows, mounds. *Munida* sp., scampi. [Note, 100 still images apparently lost during download/backup procedure].
98	S15	19-Jan	DTIS	12	0316	-43:55.26	-177:37.04	-43:54.65	-177:37.09	396	389	1132	357	Muddy sediments with many pits, fish-feeding marks, burrows, and mounds. Some asteroids, otherwise sparse epifauna.
99	S136	19-Jan	DTIS	12	0608	-43:55.71	-177:52.4	-43:55.08	-177:52.31	449	441	1173	6	Level muddy sand sediments with burrows and tracks. Some burrowing urchins and scampi.
100	S6	19-Jan	DTIS	12	0904	-44:0.83	-177:37.26	-44:0.23	-177:37.26	440	432	1111	NA	Level muddy sand sediments with burrows and tracks. Some burrowing urchins.
101	S17	19-Jan	DTIS	4	1301	-44:23.36	-177:35.85	-44:22.77	-177:35.85	654	633	1093	NA	Level muddy sand sediments with very few burrows. Asteroids, *G. multidenatatus*, pagurids.
102	S95	19-Jan	DTIS	25	1547	-44:32.82	-177:36.93	-44:32.33	-177:37.06	906	903	924	349	Level muddy sand sediments. Many *G. multidenatatus*, rattails. Manually-driven transect.
103	S137	19-Jan	DTIS	28	1835	-44:41.85	-177:38.81	-44:41.68	-177:39.63	1228	1215	1128	286	Transect across large sediment wave features. Firm muddy sand and gravel with little bioturbation. Sparse fauna, some *G. multidentatus*, *Benthodytes* sp. holothuroids, gastropods. Manual again.
104	S122	19-Jan	DTIS	28	2254	-44:37.71	-177:54.23	-44:37.34	-177:54.79	1169	1173	1009	313	Firm, level, muddy sand with some burrows. Sparse fauna, *G. multidentatus*, echinothuroid urchins, rattails.
105	S65	20-Jan	DTIS	25	0244	-44:26.94	-178:10.13	-44:27.19	-178:10.87	989	980	1085	245	Firm, level, muddy sand with few/no burrows. Sparse fauna, *G. multidentatus*, asteroids, rattails, high density of tiny holothuroids visible in still images.
106	S8	20-Jan	DTIS	13	0653	-44:5.97	-178:14.69	-44:6.24	-178:15.42	487	485	1095	243	Muddy sediments with numerous burrows, pits, mounds, and tracks. Sparse epifauna, a few echinoids.
107	S18	20-Jan	DTIS	4	1042	-44:17.34	-178:36.58	-44:17.59	-178:37.31	618	624	1076	245	Muddy sediments with burrows and old trawl marks. Many *Taiaroa tauhou* and forams (cf *Bathysiphon*), some holothuroids.
108	S18	20-Jan	MUC	4	1209	-44:17.36	-178:37.43	-44:17.36	-178:37.43	620	0	0	NA	Three good cores 20–30 cm dark green-black muddy sand, one core washed out.
109	S66	20-Jan	DTIS	25	1449	-44:24.76	-178:44.17	-44:24.88	-178:44.94	826	838	1046	258	Level muddy sand sediment with some burrows. *G. multidentatus* common, some oreo, little else observed.

Stn	Site	Date	Gear	Str	NZST	Lat. start	Lon. start	Lat. end	Lon. end	Depth start	Depth end	Dist. (m)	Dir.	Description
110	S3	20-Jan	DTIS	3	2013	-44:2.5	-179:0.38	-44:2.87	-179:1.01	329	328	1085	231	Cobbles embedded in soft sediment, black sand in places. Sponges common on cobbles, *Munida* sp., solitary corals, bryozoans, asteroids.
111	S138	20-Jan	DTIS	3	2251	-43:59.17	-178:57.63	-43:59.74	-178:58	346	331	1166	NA	Muddy sand (dark) with cobbles, pebbles and rock in places. *Munida* sp., and burrowing urchins in sediment, crinoids, sponges, and bryozoans on rocks.
112	S5	21-Jan	DTIS	3	0117	-44:6.1	-178:58.09	-44:6.41	-178:58.83	371	377	1142	NA	Muddy sand sediment (dark) with areas of cobble an pebbles. Some small *G. dumosa* colonies present on cobbles but not common. Crinoids and *Munida* sp. abundant.
113	S9	21-Jan	DTIS	13	0420	-44:16.21	-179:6.95	-44:16.59	-179:7.57	565	574	1084	NA	Mostly level green-black muddy sand but with patches of flat rock in places. *G. multidentatus* and *D. horridus* common on rocks, holothuroids and echinothurid urchins on soft sediment.
114	S67	21-Jan	DTIS	28	0715	-44:25.58	-179:10.12	-44:25.89	-179:10.7	964	969	960	233	Level muddy sand sediment with tracks but little other bioturbation. *G. multidentatus* common throughout, one large *Hyalascus* sp. Sponge, occasional cobbles with small sponges.
115	S64	21-Jan	DTIS	28	1306	-44:38.48	-179:51.32	-44:38.78	-179:51.98	1243	1217	1035	238	Level muddy sediments with small burrows and tracks. Sparse epifauna; ophiuroids, echinothurid urchins, one or two round sponges.
116	S64	21-Jan	MUC	28	1444	-44:38.82	-179:52.18	-44:38.82	-179:52.18	1221	0	0	NA	Three short cores (10 cm) of pale brown fine muddy sediment, watery at surface, clay-like from 5 cm. One tube washed out. Wire pay-out halted on contact with bottom; suspect triggered before tubes fully depressed into sediment.
117	S72	21-Jan	DTIS	4	1855	-44:15.94	-179:58.12	-44:15.66	-179:58.76	795	790	997	301	Level muddy sand sediment, black sand. Few burrows or other bioturbation, *G. multidentatus* throughout transect.
118	S72	21-Jan	MUC	4	2025	-44:15.58	-179:58.97	-44:15.58	-179:58.97	792	0	0	NA	Four cores 40–53 cm of fine greenish mud with black sand in top 10 cm.
119	S68	21-Jan	DTIS	29	2304	-44:18.98	179:45.69	-44:18.44	179:45.99	1031	1038	1077	22	Level muddy sand sediment, black sand. Few burrows or other bioturbation, *G. multidentatus* throughout transect, some asteroids, echinothurid urchins, and ball sponges.
120	S71	22-Jan	DTIS	26	0322	-44:11.08	179:15.89	-44:10.66	179:16.006	868	855	793	11	Level muddy sand sediment, black sand. Few burrows or other bioturbation, *G. multidentatus* throughout transect. [manually-driven transect]
121	S106	22-Jan	DTIS	29	0624	-44:18.07	179:5.28	-44:17.56	179:5.05	1177	1164	993	342	Level muddy sand sediment, black sand. Few burrows or other bioturbation, *Ophionotus lymani* throughout transect, some *G. multidentatus*, occasional sea-pens and sponges. [manually-driven transect]
122	S74	24-Jan	DTIS	15	0336	-43:41.74	177:53.76	-43:41.79	177:53.07	471	469	932	264	Muddy sediment, green-brown, with many burrows, including scampi burrows, tracks, and pits. Few epifauna seen; asteroids, *T. tauhou*, hydroids. Old trawl marks at one point. Marginal sea state for DTIS.

Stn	Site	Date	Gear	Str	NZST	Lat. start	Lon. start	Lat. end	Lon. end	Depth start	Depth end	Dist. (m)	Dir.	Description
123	S70	24-Jan	DTIS	26	0727	-44:1.26	177:55.44	-44:1.73	177:55.18	825	838	937	202	Level green-brown muddy sediments with burrows. Flocculated phytoplankton throughout transect. *G. multidentatus* common, and a few holothuroids.
124	S116	24-Jan	DTIS	26	1106	-44:2.41	177:32.77	-44:3.04	177:32.83	830	877	1170	176	Conspicuous C-shaped depression in MBES at site. Transect on raised seabed at east of depression. Level muddy sediments with few burrows. *G. multidentatus*, holothuroids, rattails.
125	S116	24-Jan	DTIS	26	1327	-44:3.13	177:32.08	-44:2.92	177:32.08	847	906	389	NA	30 min transect to investigate steep western rim of depression. Steep terraced rock drop-off with sparse sessile fauna at start, becoming level sediment substrata with *G. multidentatus*. One boulder with D. horridus and a large primnoid.
126	S73	24-Jan	DTIS	29	1629	-44:18.21	177:35.94	-44:17.66	177:36.2	1108	1093	1076	19	Level green-brown muddy sediments with few burrows. *O. lymani* abundant, some *G. multidentatus*, holothuroids, and spherical sponges.
127	S73	24-Jan	MUC	29	1802	-44:17.57	177:36.18	-44:17.57	177:36.18	1092	0	0	NA	Four cores fine green-grey mud 40–50 cm. Bifurcated forms at surface.
128	S81	24-Jan	DTIS	4	2329	-44:10.61	176:45.99	-44:10.01	176:46.26	673	661	1168	18	Level muddy sediment with few burrows. Sparse epifauna; *G. multidentatus*, holothuroids, some burrowing urchins.
129	S83	25-Jan	DTIS	29	0351	-44:34.96	176:45.09	-44:34.36	176:45.23	1063	1059	1127	NA	Level muddy sediments with phytoplankton detritus throughout. Few burrows. Sparse fauna, echinothuroid urchins, holothuroids, dogfish and rattails.
130	S115	25-Jan	DTIS	26	0734	-44:33.94	176:25.7	-44:33.39	176:25.49	1010	933	1056	345	Level muddy sediments with phytoplankton detritus throughout. Few burrows. Sparse fauna, *G. multidentatus*, holothuroids.
131	S84	25-Jan	DTIS	29	1340	-44:57.864	176:15.525	-44:58.35	176:15.52	1313	1319	900	180	Level pale brown muddy sediments with few burrows and many tracks, some rings-of-burrows. *O. lymani* common throughout, some *Benthodytes* holothuroids and echinothuroid urchins. Eels common.
132	S126	25-Jan	DTIS	27	1906	-44:33.92	175:57.8	-44:33.45	175:57.61	575	816	906	344	Steep knoll south of Veryan Bank. Bedrock and scleractinian coral rubble near summit and along ridge. High density of a type of pale pink-orange zoanthid soft coral on coral rubble, massive convoluted sponge on lower flank, and numerous plexaurid corals on lower flank and base.
133	S126	25-Jan	MUC	27	2042	-44:32.98	175:56.9	-44:32.98	175:56.9	865	0	0	NA	Sample from 0.5NM NW of knoll on level muddy sediment. Four cores 40 cm, fine greenish mud.
134	S114	26-Jan	DTIS	NA	0000	-44:20.87	175:59.13	-44:21.39	175:59.77	187	185	1285	139	Sand with areas of rock and cobble. Brachiopod shells and live brachiopods conspicuous throughout transect. Also anemones.
135	S82	26-Jan	DTIS	17	0314	-44:14.59	176:11.96	-44:14.24	176:11.12	150	142	1293	300	Video recording not on at start; transect extended to compensate. Bivalve shell hash, pale sand, patches of bedrock. Fauna of sponges, tube worms, anemones, stylasterids. Squid beak in image #157.

Stn	Site	Date	Gear	Str	NZST	Lat. start	Lon. start	Lat. end	Lon. end	Depth start	Depth end	Dist. (m)	Dir.	Description
136	S85	26-Jan	DTIS	6	1219	-44:36.26	175:7.59	-44:35.69	175:7.72	750	747	1070	9	Level muddy sediments, few burrows, small-scale biogenic structure. Holothuroids, quill worms, asteroids.
137	S85	26-Jan	MUC	6	1348	-44:35.64	175:7.71	-44:35.64	175:7.71	745	745	0	NA	Four cores 35–40 cm, fine greenish mud.
138	S86	26-Jan	DTIS	27	1704	-44:45.82	174:54.02	-44:45.62	174:53.23	509	637	1106	290	Across flat-topped knoll. Dark bedrock, boulders, cobbles, with sand. Stylasterids, large sponges, quill worms on sand. Large dead sponges in places.
139	S86	26-Jan	DTIS	27	1920	-44:46.15	174:52.59	-44:46.39	174:51.85	549	848	1073	246	Across small knoll WSW of #138. Altitude too high for latter half of transect due to steep drop-off. Volcanic rock, cobbles and sand on summit, becoming boulders, coral rubble, sand and gravel down flank. Stylasterids and bryozoans abundant on summit, soft corals/zoanthids abundant on flank. Coral rubble and some intact stony coral thickets but none confirmed live.
140	S103	27-Jan	DTIS	30	0006	-45:5.36	174:36.34	-45:5.82	174:36.76	972	978	1015	147	Level muddy sediment, few burrows. Xenophyophores, *O. lymani*, holothuroids, and some echinothuroid urchins.
141	S89	27-Jan	DTIS	27	0335	-44:50.96	174:32.29	-44:50.97	174:31.46	881	957	1094	269	Level muddy sediments, no burrows, fine-scale biogenic structure throughout. Holothuroids, echinoids, xenophyophores, asteroids; all at low densities.
142	S109	27-Jan	DTIS	27	0836	-44:42.27	173:49.91	-44:41.95	173:50.3	940	990	785	NA	Area with extensive 'sink-hole' topographic features. Level muddy sediments, few burrows, fine-scale biogenic structure. Rocky scarp and boulder and cobble substrata in places. Quill worms, xenophyophores, cidaroid and echinothuroid urchins, some asteroids. Xenophyophores at high density near end of transect.
143	S105	27-Jan	DTIS	30	1207	-44:47.57	173:43.77	-44:48.07	173:43.43	1027	1087	1029	206	Area with extensive 'sink-hole' topographic features. Level muddy sediments, few burrows, fine-scale biogenic structure. Rocky scarp and boulder and cobble substrata in places. Xenophyophores in high density in all level sediment areas.
144	S105	27-Jan	MUC	30	1350	-44:48.16	173:43.27	-44:48.16	173:43.27	1081	0	0	NA	Four cores 40–15cm fine greenish mud. Three cores had slipped down tubes by 10–15 cm but samples were intact.
145	S107	27-Jan	DTIS	30	1726	-45:0.37	173:24.93	-45:0.78	173:24.43	1198	1203	1004	221	Level muddy sediment with fine-scale biogenic structure. High density of *O. lymani*, some echinoids and holothurians.
146	S125	27-Jan	DTIS	27	2220	-44:45.18	172:52.46	-44:45.11	172:51.78	949	923	907	278	Level muddy sediments, no burrows, fine-scale biogenic structure throughout. Some quill worms, holothuroids, echinoids, xenophyophores, asteroids; all at low densities. Several small rays.

Stn	Site	Date	Gear	Str	NZST	Lat. start	Lon. start	Lat. end	Lon. end	Depth start	Depth end	Dist. (m)	Dir.	Description
147	S108	28-Jan	DTIS	6	0202	-44:35.73	173:16.98	-44:35.6	173:16.18	712	674	1086	283	MBES shows many pockmarks. Level muddy sediments, no burrows, little fine-scale biogenic structure. Some patches of coarser sediment with a few sponges on larger cobbles. Steep scarp towards end of transect. Very high density of quill worms, some xenophyophores and *Flabellum*.
148	S87	28-Jan	DTIS	16	0619	-44:14.09	173:40.99	-44:14.3	173:40.18	536	530	1146	250	Level muddy sediment, small burrows, little biogenic structure. High density of quill worms, some holothuroids and pagurids. Trawl marks throughout and pockmarks in MBES.
149	S101	28-Jan	DTIS	16	0925	-44:5.01	173:58.03	-44:5.39	173:57.38	517	519	1117	231	Level muddy sediment, few burrows, little biogenic structure. High density of quill worms, some pagurids and cidarid urchins. Trawl marks throughout and pockmarks in MBES.
150	S88	28-Jan	DTIS	6	1312	-44:18.28	174:17.68	-44:18.13	174:17.01	647	642	933	287	Level muddy sediment with burrows, tracks, mounds. High density of quill worms, few cidaroid urchins, *Flabellum* sp. and *Anthomastus* sp.
151	S139	28-Jan	DTIS	16	1735	-44:4.13	174:50.21	-44:3.7	174:50.8	505	496	1120	45	Level muddy sediment with burrows and tracks. Many *Anthomastus* sp., sea-pens (brown, bushy), echinoids, quill worms, flabellum.
152	S140	28-Jan	DTIS	16	2215	-43:58.44	175:32.45	-43:57.87	175:32.61	495	488	1077	11	Level muddy sediment. Some *Anthomastus* sp. and sea-pens (brown bushy). Visibility poor; trawler operating 2NM up-current.
153	S80	29-Jan	DTIS	17	0230	-44:7.6	176:7.5	-44:7.01	176:7.51	191	310	1093	1	Shell hash and worm tubes with brachipods, *Munida* sp., and some asteroids.. Numerous juvenile hoki.
154	S141	29-Jan	DTIS	15	0508	-44:1.39	176:3.22	-44:0.81	176:3.19	310	499	1075	358	Compacted coarse gravel, sand, cobbles and boulders, with many burrows in finer sediments. Becoming level sand at end of transect.. Diverse sessile community on hard substrata throughout; sponges, stylasterids, bryozoans, hydroids, large bivalves, crinoids, *Gorgonocephalus* sp., and some small stony coral colonies that appeared to be over-grown by soft corals. Juvenile hoki.
155	S76	29-Jan	DTIS	18	1020	-43:35.97	175:49.38	-43:35.37	175:49.25	296	291	1125	351	Black muddy sand with many deep pits, burrows, and mounds. Scampi, sea-pens (white, whip-like), and *Munida* sp. Common.
156	S78	29-Jan	DTIS	18	1412	-43:32.23	175:22.27	-43:31.75	175:22.27	157	138	889	NA	Shell hash, sand and gravel, rippled sand at end. Sparse fauna, one or two large blue sponges.
157	S76	29-Jan	MUC	18	1723	-43:35.51	175:49.34	-43:35.51	175:49.34	290	0	0	NA	Two cores black muddy sand 10–16 cm, two others no sample.
158	S77	29-Jan	DTIS	0	2050	-43:18.92	175:32.85	-43:19.5	175:32.65	87	130	1108	194	Shallow rocky outcrop on NE rim of Mernoo Bank. Bedrock then rippled sand. Diverse sponges, stylasterids. Cloud of mysids in floodlights through much of transect. No lasers.
159	S142	29-Jan	DTIS	0	2354	-43:14.55	175:23.77	-43:15.06	175:23.64	53	73	961	191	Shallow outcrop on plateau of Mernoo Bank. Rock with diverse sponge and other sessile fauna

Stn	Site	Date	Gear	Str	NZST	Lat. start	Lon. start	Lat. end	Lon. end	Depth start	Depth end	Dist. (m)	Dir.	Description
														community, sand in places. Mysid swarms throughout, and squid.
160	S25	30-Jan	DTIS	78	0326	-43:3.75	175:48.28	-43:4.33	175:48.4	487	484	1086	171	Pale muddy sediment with high density of burrows. *T. tauhou*, scampi, some spiral sea-pens ("*Radicipes*").
161	S25	30-Jan	MUC	78	0452	-43:4.32	175:48.38	-43:4.32	175:48.38	480	477	0	NA	Four long cores (40–51 cm) greenish fine muddy sand.
162	S22	30-Jan	DTIS	07B	0701	-42:57.7	175:43.5	-42:57.98	175:42.77	580	551	1120	242	Level muddy sediment with burrows, mounds, and pits. Low densities of sea-pens (brown whip-like) and a distinctive pale holothuroid with dorsal 'fringes'.
163	S23	30-Jan	DTIS	22	1048	-42:49.39	175:16.87	-42:49.01	175:16.34	829	847	1008	314	Level muddy sediment with few burrows. Sparse fauna; asteroids, quill worms, *G. multidentatus*, Brucerolis isopods.
164	S20	30-Jan	DTIS	23	1413	-42:46.15	174:55.57	-42:45.92	174:56.16	1125	1135	911	62	Level dark muddy sand sediment, no burrows. *G. multidentatus* in moderate to high density throughout, some asteroids.
165	S20	30-Jan	MUC	23	1551	-42:45.83	174:56.3	-42:45.83	174:56.3	1140	0	0	NA	No sample: small amount of black sand in one tube.
166	S20	30-Jan	MUC	23	1630	-42:45.77	174:56.24	-42:45.77	174:56.24	1140	0	0	NA	Four short cores (10–12 cm) dark muddy sand, black sand in top layers, coarser, irregular gravels and urchin spines deeper in core. Intact *G. multidentatus* in one tube.
167	S21	30-Jan	DTIS	1	1930	-42:59.01	174:47.55	-42:58.69	174:48.2	656	655	1064	56	Level muddy sediment with dark sand showing at mounds, pits, and burrows. Some sea-pens (brown whip-like), *G. multidentatus*, asteroids, echinoids, and pagurids.
168	S110	30-Jan	DTIS	07A	2205	-43:2.88	174:59.69	-43:2.39	175:0.1	410	416	1065	32	Level muddy sediments with burrows, mounds, pits, and tracks. Sea-pens (white whip) common.
169	S102	31-Jan	DTIS	18	0159	-43:28.64	174:56.04	-43:28.08	174:56.16	274	276	1050	9	Level muddy sand sediment with fine shell hash, no burrows, sparse fauna.
170	S79	31-Jan	DTIS	07A	0517	-43:26.26	174:36.2	-43:25.74	174:35.78	445	448	1117	330	Muddy sediments with dark sand. Burrows, tracks, mounds, pits. Seapens (white whip and spiral) common throughout, burrowing urchins, and scampi. Trawler operating up-current.
171	S100	31-Jan	DTIS	07A	0842	-43:26.49	174:10.71	-43:25.94	174:10.71	563	561	1019	NA	Level muddy sediments, few burrows. Some quill worms and *Munida* sp. But generally sparse fauna. Curved track and altitude high.
172	S99	31-Jan	DTIS	1	1146	-43:29.59	174:4.91	-43:29.12	174:4.37	669	600	1135	320	Current-rippled muddy black sand with shell/coral hash and patches of cobble and gravel in places. Quill worms, *G. multidentatus*.
173	S111	31-Jan	DTIS	1	1611	-43:8.78	174:13.69	-43:8.31	174:13.13	627	635	1155	319	Level muddy sediment with many burrows and fresh phytoplankton detritus. Some sea-pens (brown bushy) and *Flabellum* sp..
174	S143	31-Jan	DTIS	22	1908	-43:8.36	174:0.53	-43:8.1	173:59.83	795	1084	1064	297	Transect near canyon edge. Level muddy sediment with many trawl marks. At end, rocky scarp and boulders.

Stn	Site	Date	Gear	Str	NZST	Lat. start	Lon. start	Lat. end	Lon. end	Depth start	Depth end	Dist. (m)	Dir.	Description
175	S19	31-Jan	DTIS	23	2205	-43:0.64	174:1.8	-43:0.78	174:1.08	1082	1255	1012	255	Muddy sediment, probably firm or overlying rock, with biogenic structure. Few benthic fauna. Orange roughy.
176	K100	1-Feb	DTIS	NA	0427	-42:31.51	173:36.69	-42:31.16	173:37.28	1015	1042	1036	51	Smooth, pale, fine sediments with some pale cobbles and boulders. No burrows or other bioturbation. Rattails abundant
177	K92	1-Feb	DTIS	NA	0700	-42:30.86	173:37.86	-42:30.22	173:38	1070	1101	1200	9	Smooth, pale, fine sediments with some pale cobbles and boulders. No burrows or other bioturbation. Rattails abundant
178	K104	1-Feb	DTIS	NA	0946	-42:30.38	173:36.74	-42:30.01	173:37.57	912	1057	1327	59	Pale fine muddy sediment but with areas of fracture, chaotic rock and boulders. No benthos, no bioturbation. Some grey patches that could be bacterial mats?
179	K97	1-Feb	DTIS	NA	1303	-42:29.01	173:36.73	-42:29.36	173:37.49	1025	1088	1227	122	Smooth, pale, fine sediments with some pale cobbles and boulders. No burrows or other bioturbation. Rattails abundant
180	K94	1-Feb	DTIS	NA	1553	-42:29.41	173:38.3	-42:29.56	173:39.32	1150	1192	1425	101	Smooth, pale, fine sediments with some pale cobbles and boulders. No burrows or other bioturbation. Rattails abundant
181	K94	1-Feb	MUC	NA	1735	-42:29.53	173:39.18	-42:29.53	173:39.18	1171	0	0	NA	Four deep cores (55–65 cm) fluid brown mud at surface, increasing black sand with depth, anoxic at about 12 cm.
182	K100	1-Feb	MUC	NA	1735	-42:30.04	173:37.48	-42:30.04	173:37.48	1066	0	0	NA	Four deep cores (40–50 cm) fluid brown mud at surface, black foul-smelling anoxic layer at about 15–20 cm.

8. Appendix 2 – DTIS Video Taxa

Table 4: Benthic invertebrate taxa recorded during real-time observation of DTIS video transects, with summary data showing the total number of individuals recorded across all sites (Total inds.) and the number of sites at which each taxon was recorded (Total sites).

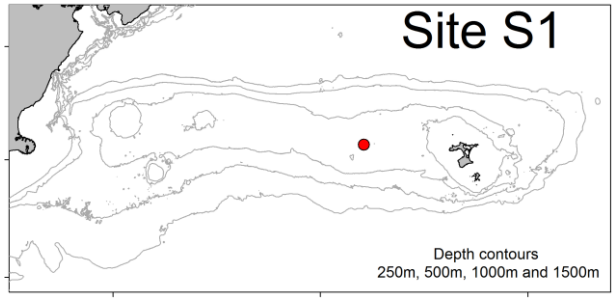
Phylum	Class	Sub class	Order	Family	Taxon	Total inds.	Total sites
					Worm (indeterminate)	7	5
Annelida	Polychaeta	Palpata	Aciculata	Onuphidae	Quill worm	3044	32
			Sabellida	Sabellidae	Sabellidae (fan worm)	398	4
					Tube worms	143	20
Arthropoda	Malacostraca	Eumalacostraca	Decapoda (Brachyura)		Crustacean (crab)	121	41
				Majidae	Majidae	4	4
			Decapoda (Achelata)		*Projasus parkeri*	1	1
			Decapoda (Anomura)	Paguridae	Crustacean (pagurid)	643	80
				Galatheidae	Crustacean (galatheid/Chirostylidae)	918	53
					Munida spp.	110	17
				Lithodidae	Lithodidae	1	1
			Decapoda (Caridea)		Crustacean (shrimp)	1632	90
			Decapoda (Astacidea)	Nephropidae	Crustacean (scampi)	295	50
			Isopoda		Isopoda	4	4
			Mysida		Mysidacea	161	2
	Maxillopoda	Thecastraca			Barnacles	1	1
	Pycnogonida		Pantopoda		Pycnogonid	32	1
Brachiopoda					Brachiopods	174	5
Bryozoa	Gymnolaemata		Cheilostomata		Bryozoan - filamentous form	32	3
					Bryozoan - erect cheilostome	9	6
					Bryozoan - bushy form	361	29
					Bryozoan - lacy fan forms	80	6
Chordata	Ascidiacea				Ascidians (clonal)	19	2
					Ascidians (solitary)	4	3
Cnidaria	Anthozoa	Hexacorallia	Actiniaria		Anemones	1456	107
			Corallimorpharia		Corallimorpharia	7	3
			Antipatharia		Antipatharia	110	12
			Scleractinia		Scleractinia	235	22

Phylum	Class	Sub class	Order	Family	Taxon	Total inds.	Total sites
				Caryophylliidae	*Solenosmillia variabilis*	1	1
					Goniocorella dumosa	177	4
					cup corals (stalked)	63	12
					cup corals (*Stephanocyathus*)	57	18
				Dendrophylliidae	*Enallopsammia* sp.	6	3
				Flabellidae	Flabellum	547	34
			Zoantharia	Epizoanthidae	*Epizoanthus* sp.	2	2
		Octocorallia	Alcyonacea		Alcyonacea	197	1
					Gorgonacea	565	38
				Alcyoniidae	*Anthomastus* sp.	369	20
				Primnoidae	Primnoid_whip-like	6	6
					Thouarella spp	3	1
				Isididae	Isididae	1	1
				Paragorgiidae	Paragorgiidae	3	3
				Chrysogorgiidae	Chrysogorgiidae	1	1
					Radicipes spp	461	21
			Pennatulacea		Pennatulacea	1939	70
		Ceriantharia	Spirularia	Cerianthidae	Ceriantharia	72	19
Echinodermata	Asteroidea				Asteroid	2834	134
			Brisingida	Brisingidae	Brisingidae	62	12
			Forcipulatida	Zoroasteridae/Asteriidae	Zoroasteridae/Asteriidae	103	10
			Spinulosida	Solasteridae	Solasteridae	16	5
	Crinoidea	Articulata	Bourgueticrinida		Crinoidea (stalked)	3	2
			Comatulida		Crinoidea (motile)	862	41
	Echinoidea	Cidaroidea	Cidaroida	Cidaridae	Cidaridae	1335	53
		Euechinoidea	Echinoida	Echinidae	*Gracilechinus multidentatus*	8371	27
				Echinidae	*Dermechinus horridus*	77	6
					Echinoid	7183	121
	Holothuroidea		Elasipodida	Psychropotidae	Holothurian purple (Benthodytes sp.)	12	5
			Elasipodida	Pelagothuriidae	*Enypniastes eximia*	439	13
					Holothurian	1142	99
	Ophiuroidea		Euryalinida	Gorgonocephalidae	Gorgonocephalidae	9	5
			Ophiurida		Ophiurida unspecified	2	2
					Ophiuroid	6576	44

Phylum	Class	Sub class	Order	Family	Taxon	Total inds.	Total sites
Echiura					Echiura	8	5
Foraminifera	Monothalamea			Xenophyphoroidea	Foram (giant)	1491	12
Hyrozoa	Hydrozoa	Hydroidolina	Anthoathecatae	Stylasteridae	Stylasteridae	1414	36
			Leptothecatae		Hydroids	242	33
Mollusca	Cephalopoda	Coleoidea	Teuthida		Mollusc (octopod)	25	21
	Gastropoda				Mollusc (gastropod)	1774	127
					Mollusc (opisthobranch)	4	1
					Scaphopoda	10	8
					Molluscs (bivalves)	12	6
Porifera	Demospongiae				Sponge (demospongiae)	6091	113
					Encrusting sponges	175	7
	Hexactinellida				Sponge (hexactinellidae)	652	30
		Hexasterophora	Lyssacinosida	Rossellidae	*Hyalascus* sp.	8	7
					Symplectella sp.	1	1

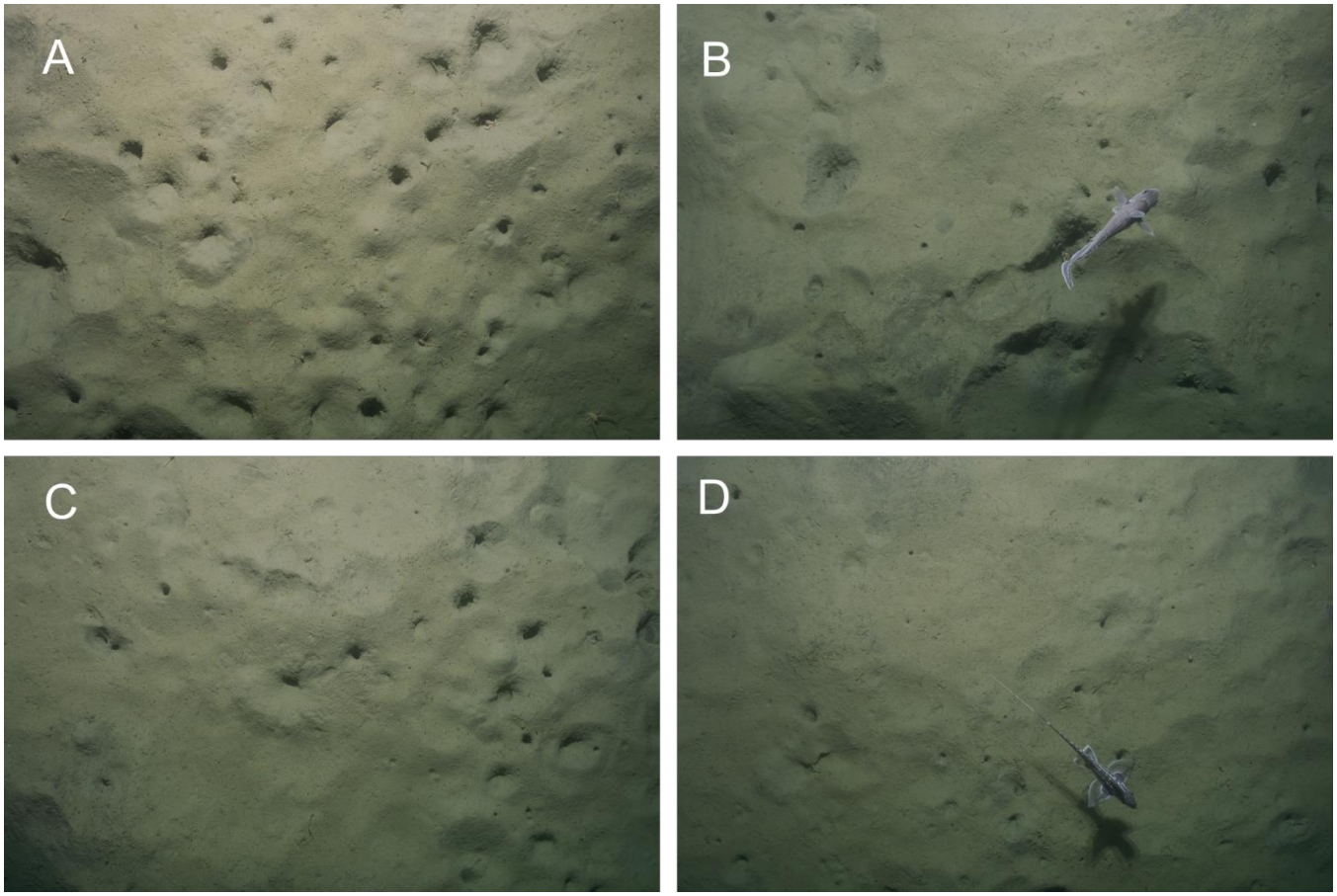
9. Appendix 3 – Site Summaries

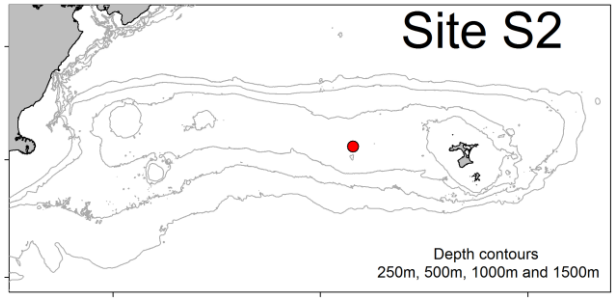
Representative site summary pages are shown here for sites S1 to S50. For all other sites, please see the Supplemental Material accompanying this report.



Station 042
Stratum 003

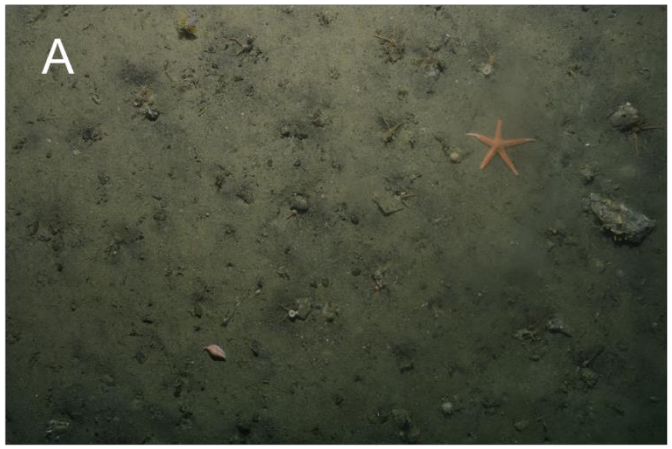
Mostly muddy sediments with burrows, mounds and pits, but with areas of cobble, possibly phosphorite, in places. Sparse epifauna. Some sponges on phosphorites, and echinoids, holothuroids, *Munida* sp., and scampi on muddy sediments. Numerous juvenile hoki.

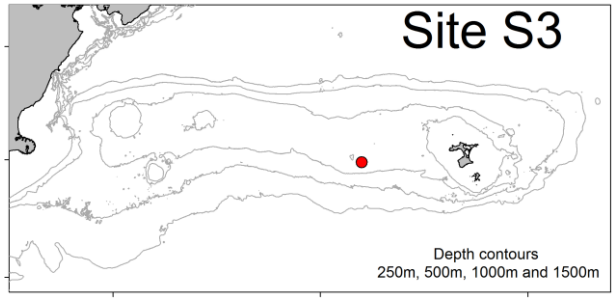




Station 040
Stratum 003

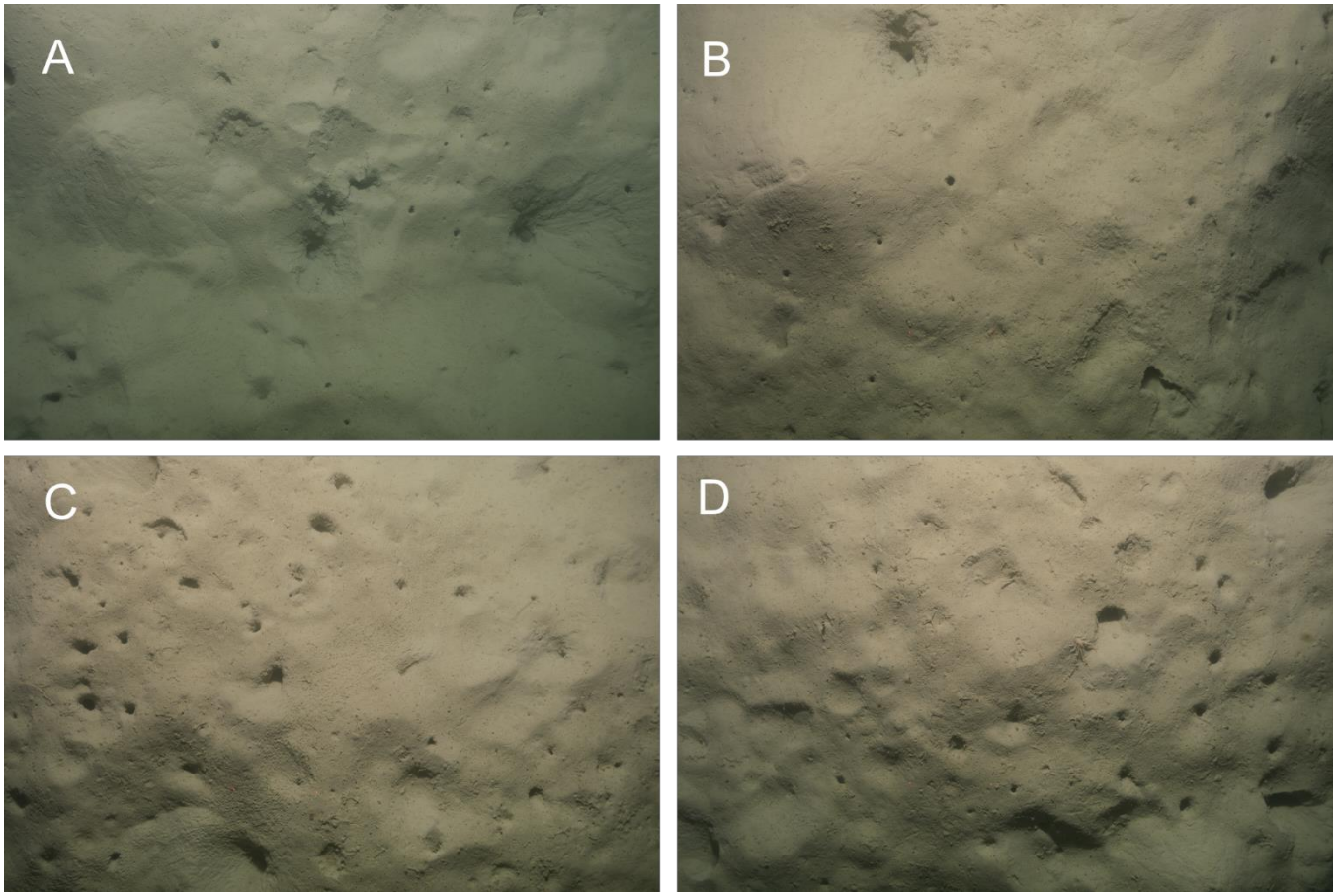
Level muddy sediments with burrows, pits, mounds. Sparse epifauna.

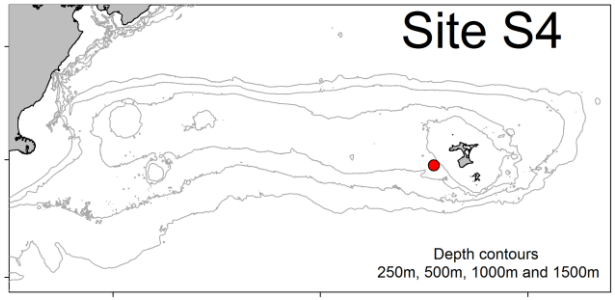




Station 110
Stratum 003

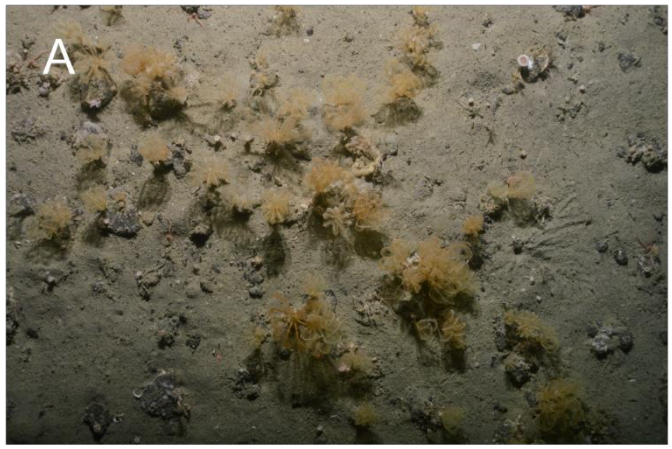
Cobble-boulder sized rocks embedded in soft sediment, black sand in places. Sponges common on cobbles, *Munida* sp., solitary corals, bryozoans, asteroids.

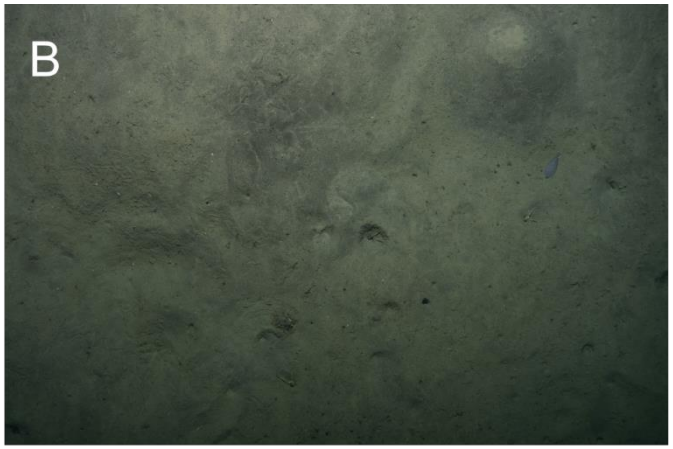


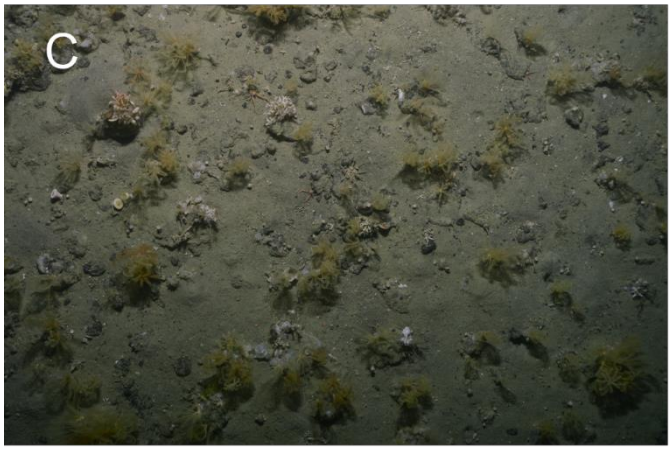


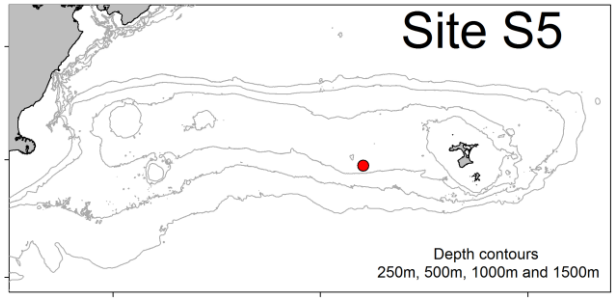
Station 097
Stratum 005

Muddy sand sediment with pits, fish feeding marks,burrows, mounds. *Munida* sp., scampi. [Note, 100 still images apparently lost during download/backup procedure].



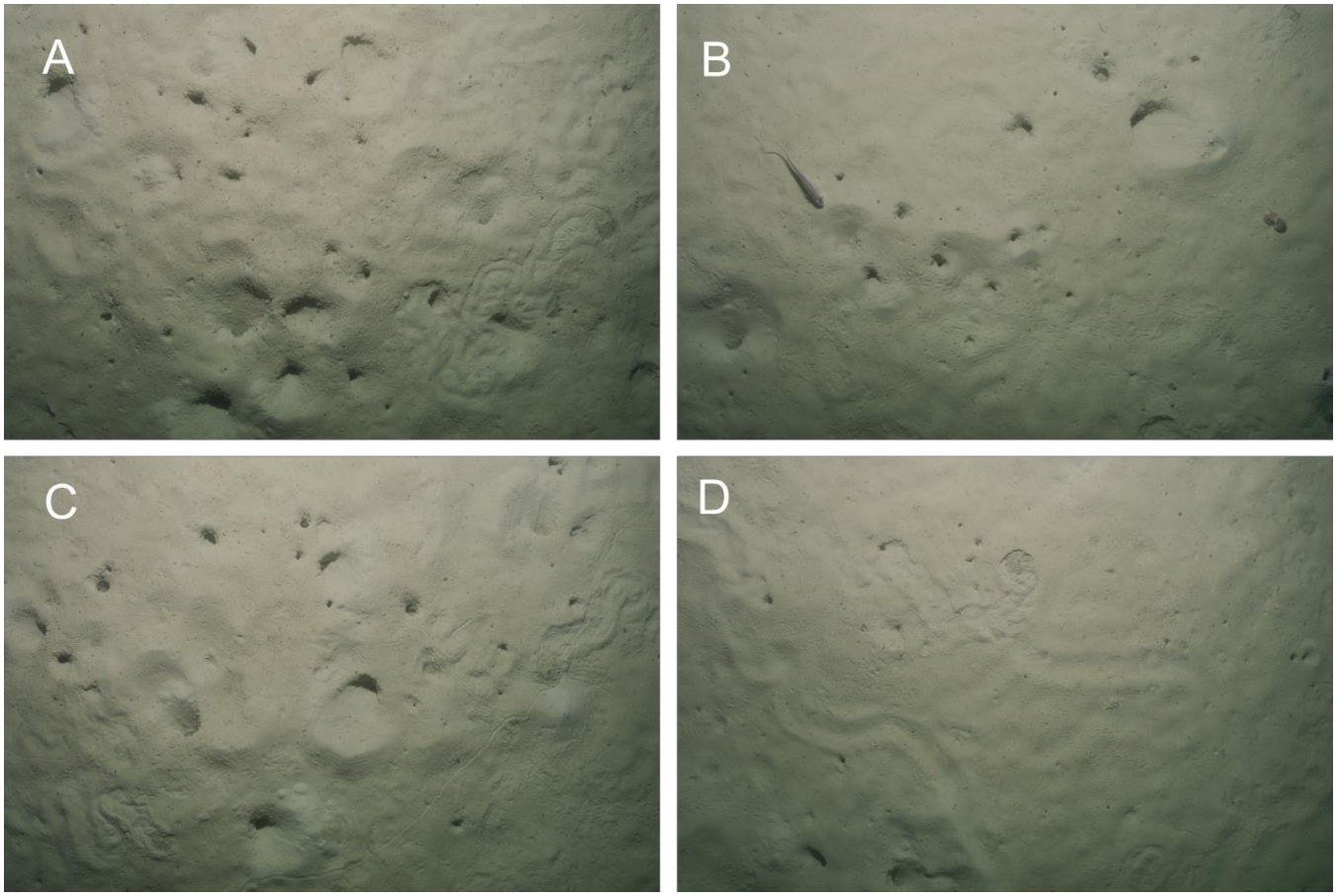


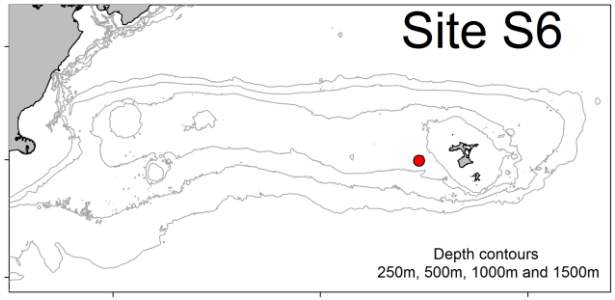




Station 112
Stratum 003

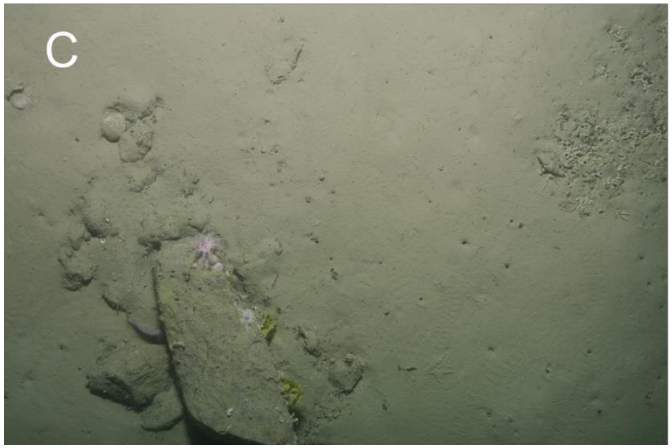
Muddy sand sediment (dark) with areas of cobble and pebbles. Some small *G.dumosa* colonies present on cobbles but not common. Crinoids and *Munida* sp. abundant.

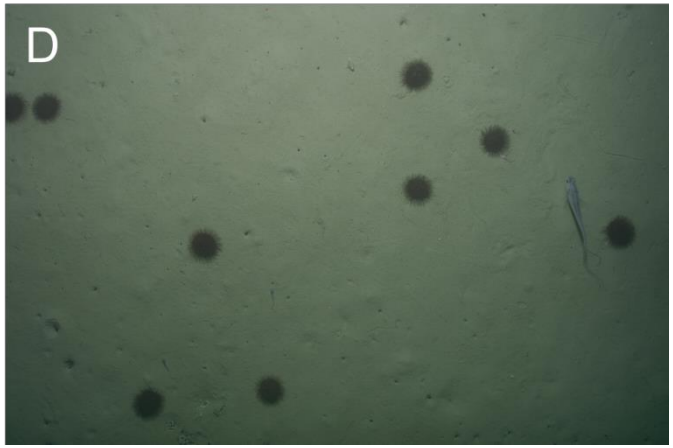


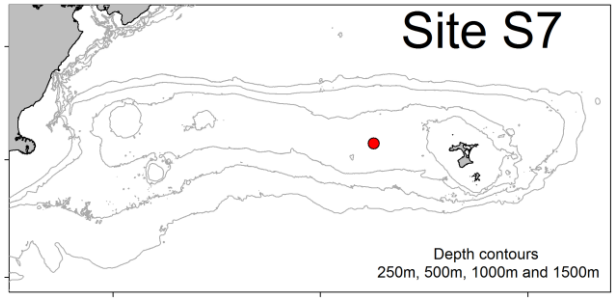


Station 100
Stratum 012

Level muddy sand sediments with burrows, tracks, and feeding pits. Some burrowing urchins.

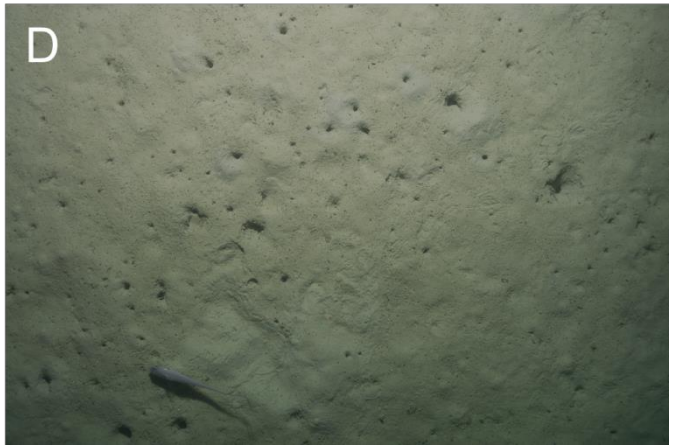


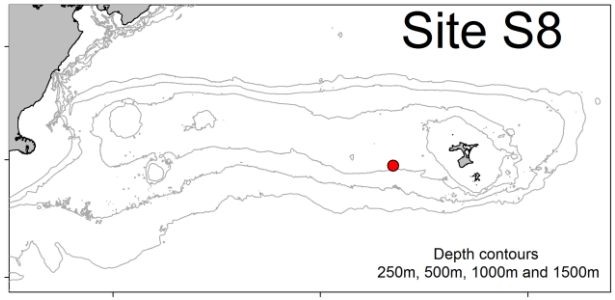




Station 044
Stratum 011

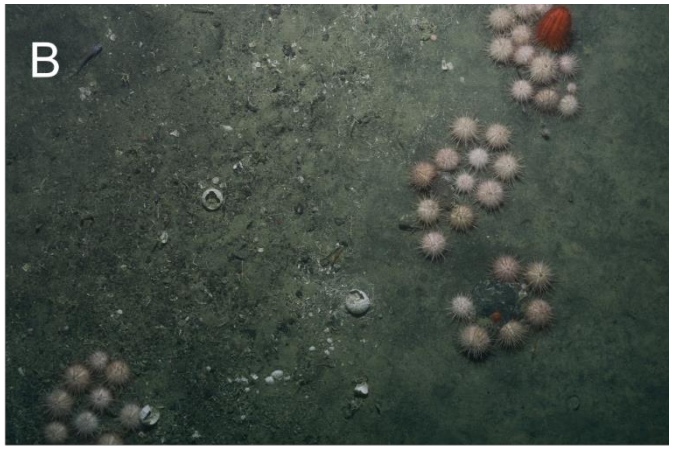
Mostly muddy sediments with burrows, pits, mounds, and tracks but with some patches of cobble/phosphorite. Sparse epifauna, asteroids, locally high density of echinoids.

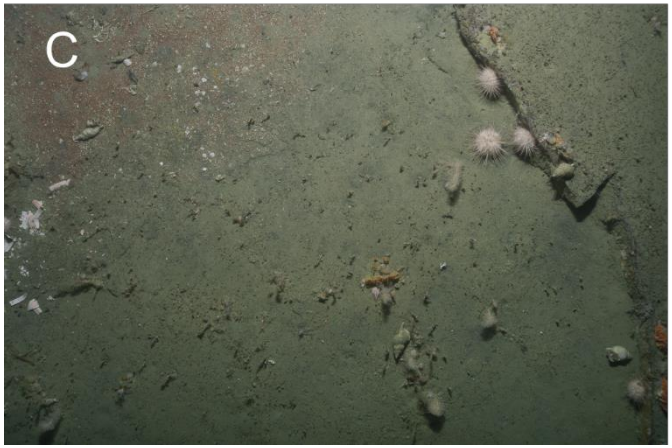


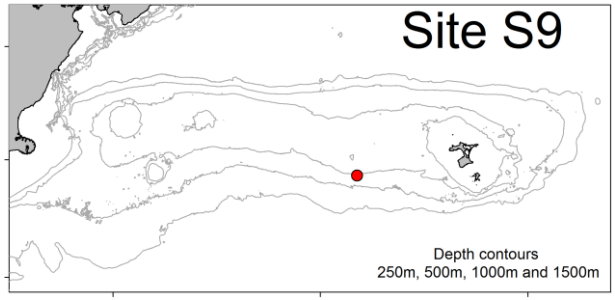


Station 106
Stratum 013

Muddy sediments with numerous burrows, pits, mounds, and tracks. Sparse epifauna, a few echinoids.

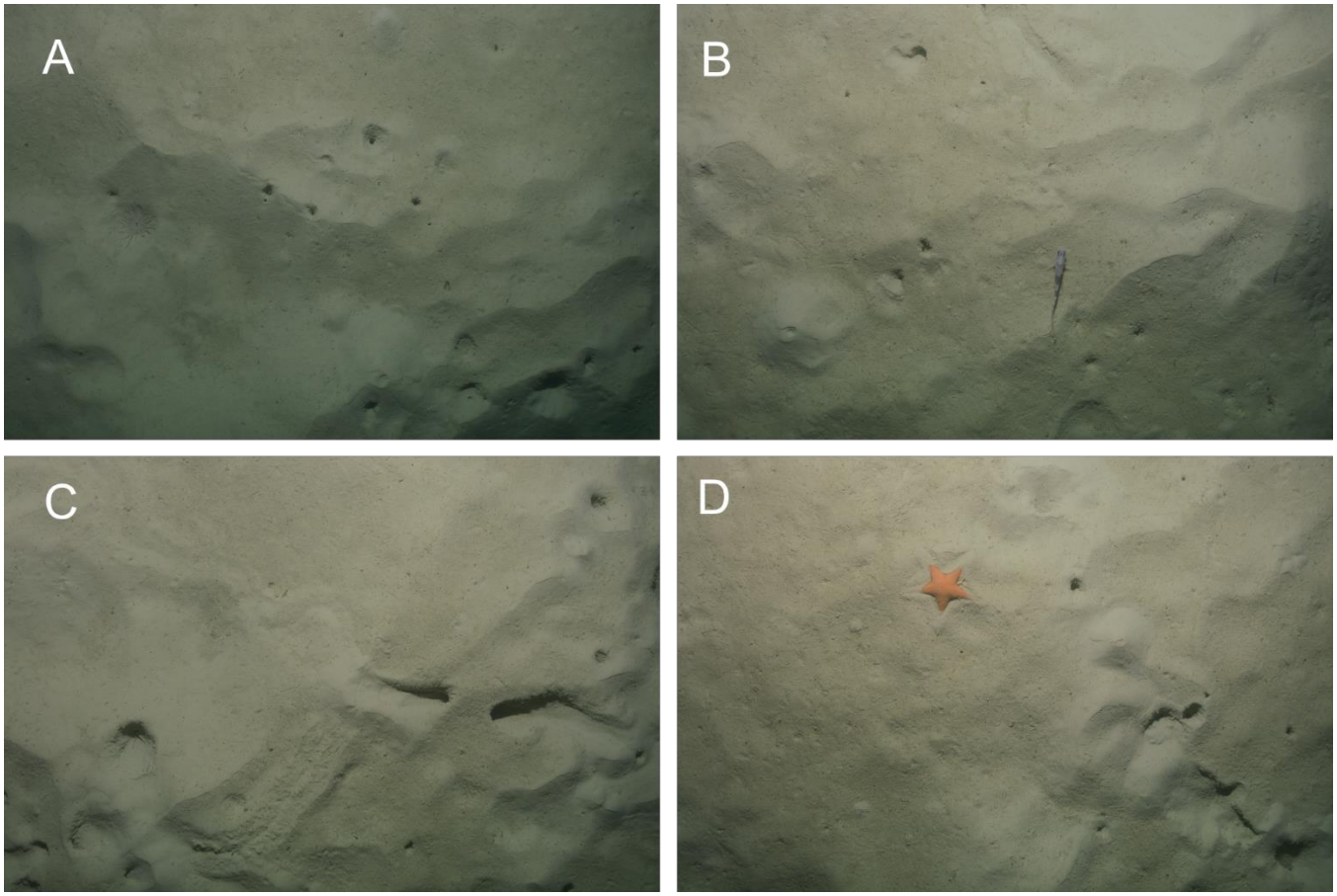


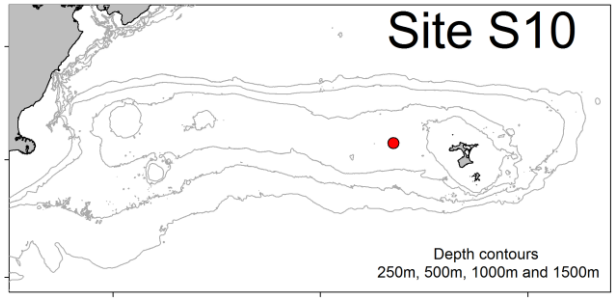




Station 113
Stratum 013

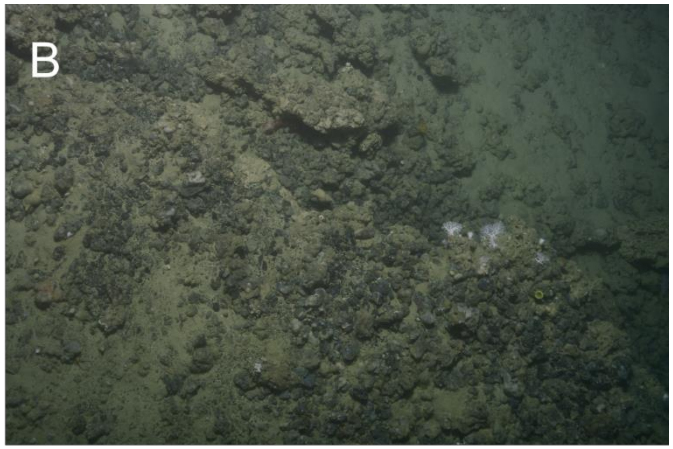
Mostly level green-black muddy sand but with patches of flat rock in places. *G. multidentatus* and *D. horridus* common on rocks, holothuroids and echinothuroid urchins on soft sediment.

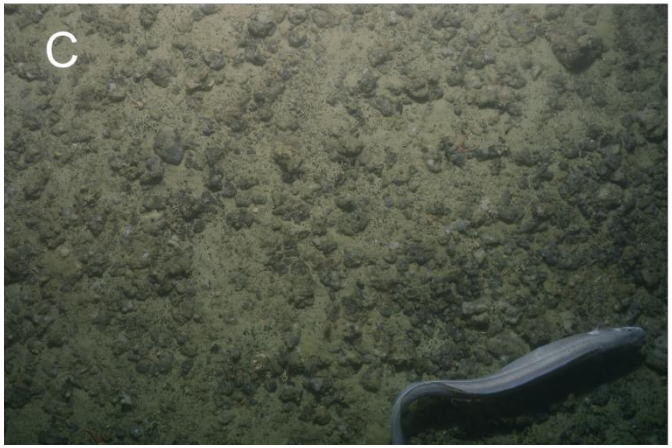


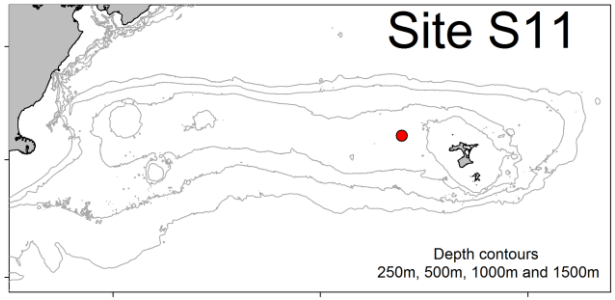


Station 046
Stratum 005

Muddy sediments, apparently rippled in places, with few burrows, pits, and mounds. Sparse epifauna; *Munida* sp., asteroids.

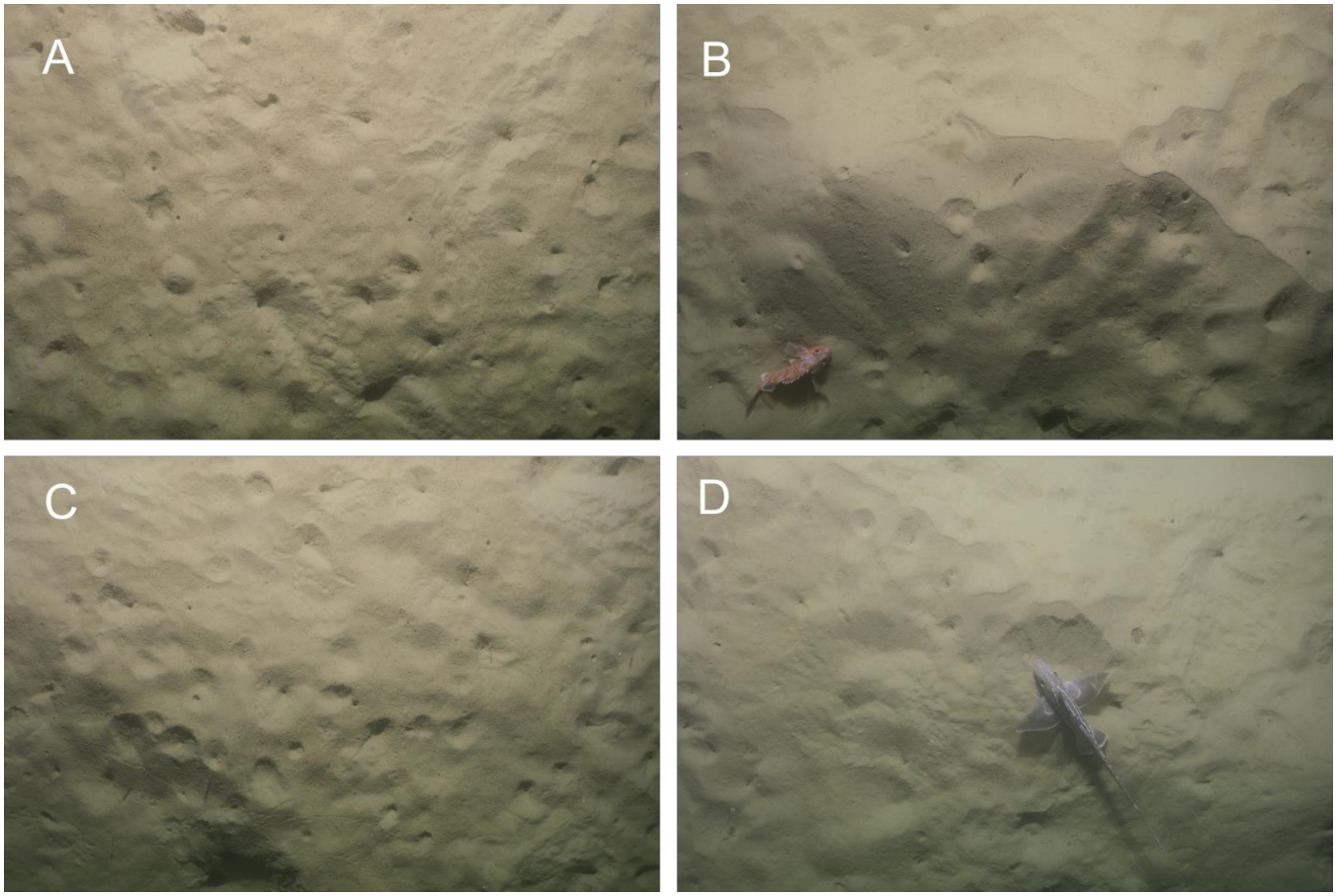


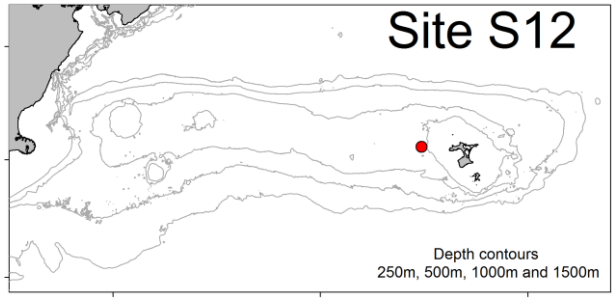




Station 047
Stratum 005

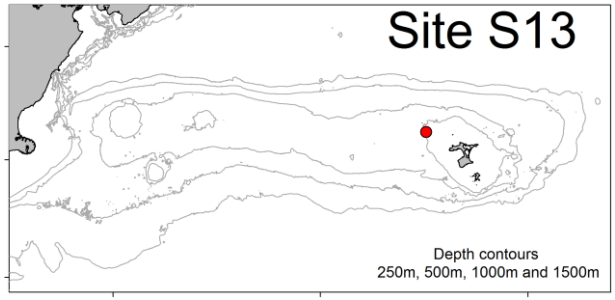
Muddy sediments with extensive areas of cobble, pebble, and boulder substrate with some outcropping of bedrock. Sparse epifauna throughout; *Munida* sp., stylasterid corals, sponges, pagurid crabs. Juvenile hoki.





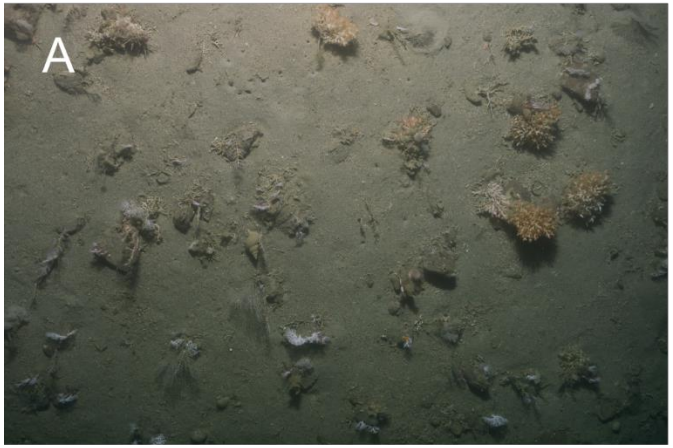
Station 052
Stratum 005

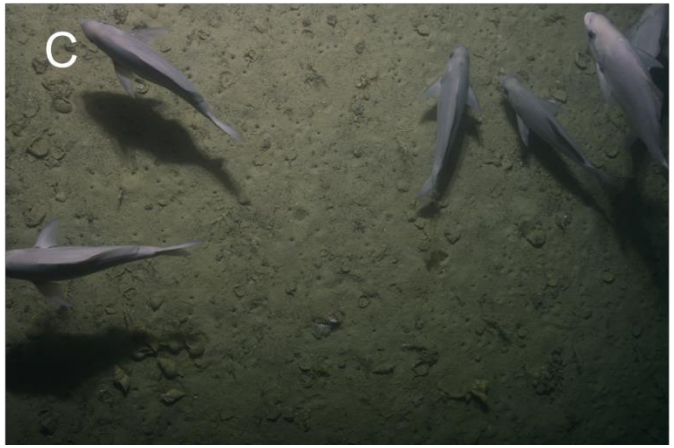
Muddy sediments with mounds, pits, and few burrows. Sparse epifauna.

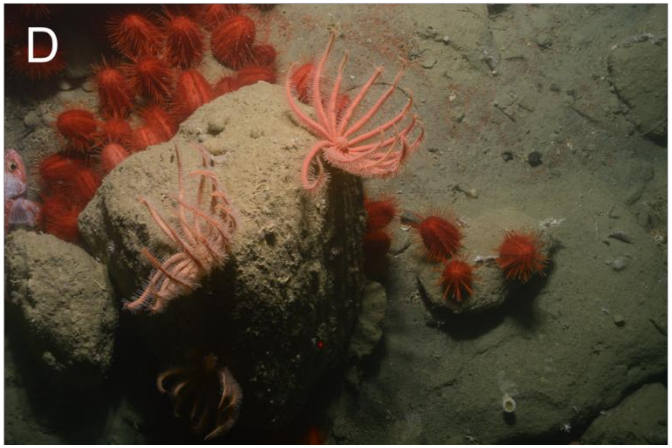


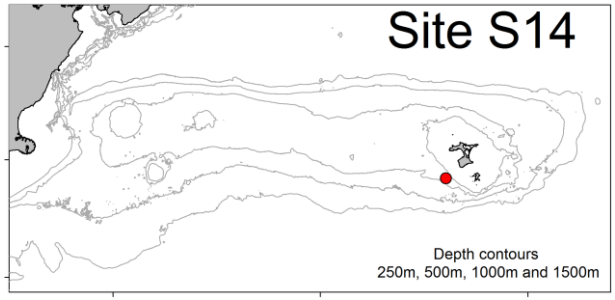
Station 053
Stratum 005

Muddy sand sediments with some patches of cobble. Sparse fauna but anemones common hard substrata.



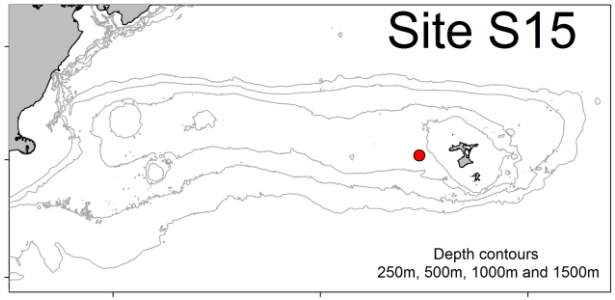






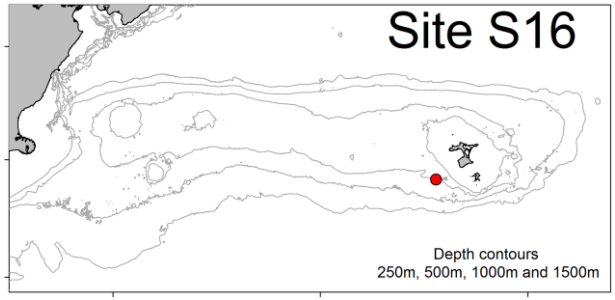
Station 095
Stratum 012

!Sensitive habitat! Low plateau-knoll at 400m. Sponges, *G. dumosa*, bryozoans, stylasterids on cobble and mud substrata at the plateau rim, burrowing urchins in muddy sediments of main plateau, *D. horridus*, brisingids on northern rim.



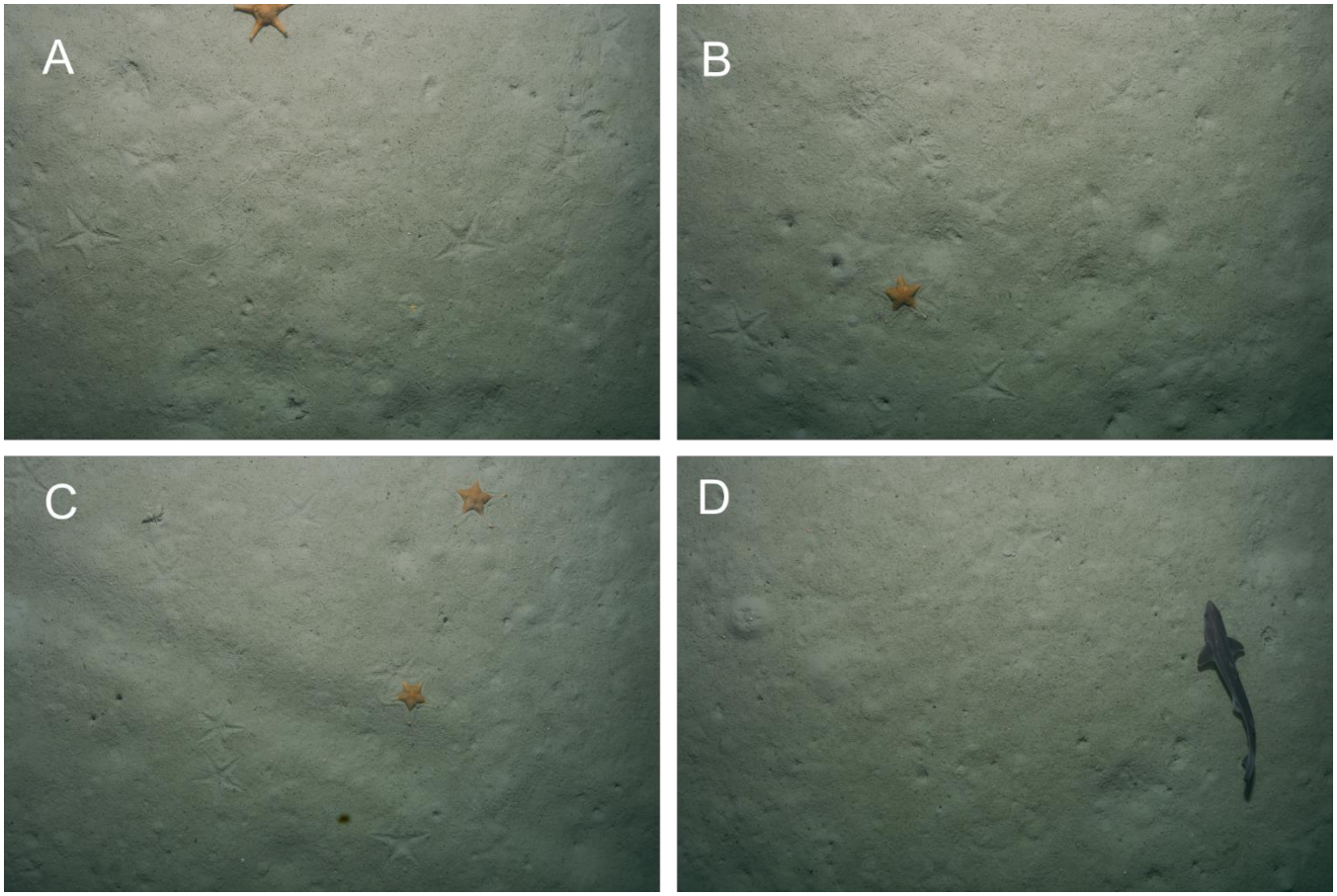
Station 098
Stratum 012

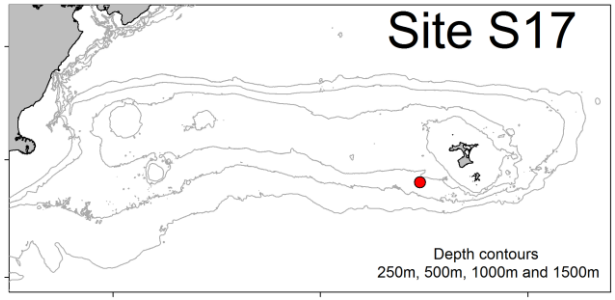
Muddy sediments with many pits, fish-feeding marks, burrows, and mounds. Some asteroids, otherwise sparse epifauna.



Station 096
Stratum 012

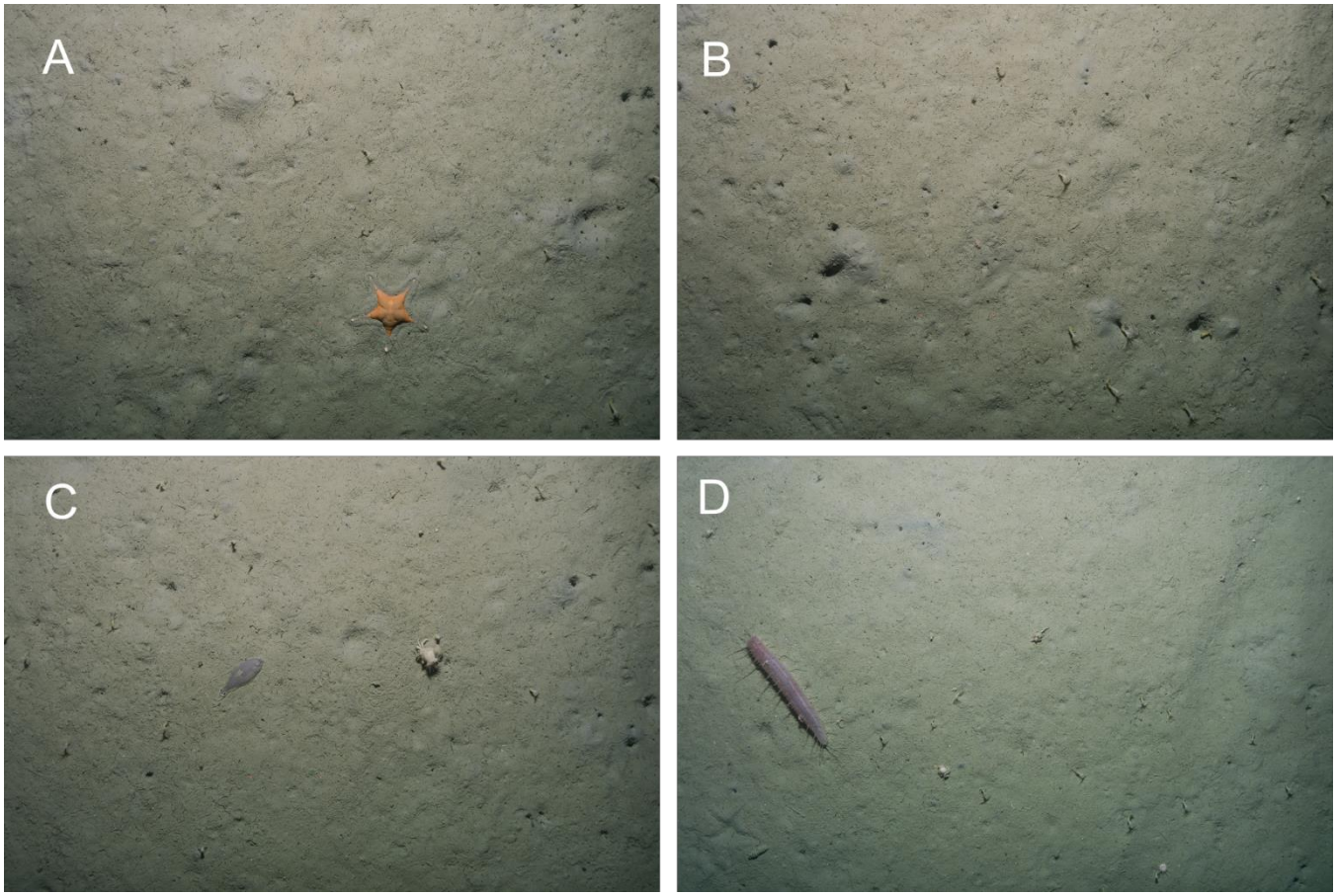
Level muddy sediment with burrows, mounds, and tracks. Old trawl marks in several places.

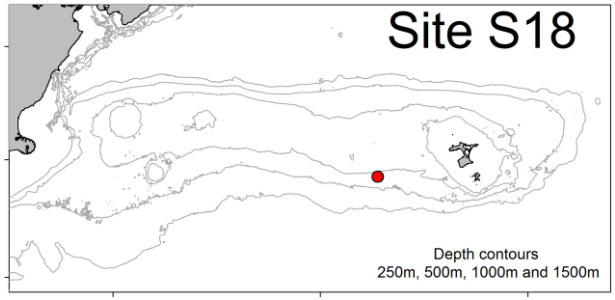




Station 101
Stratum 004

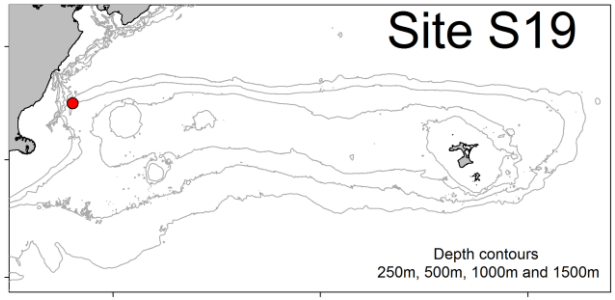
Level muddy sand sediments with very few burrows, occasional old trawl marks. Asteroids, some *G. multidenatatus*, pagurids.





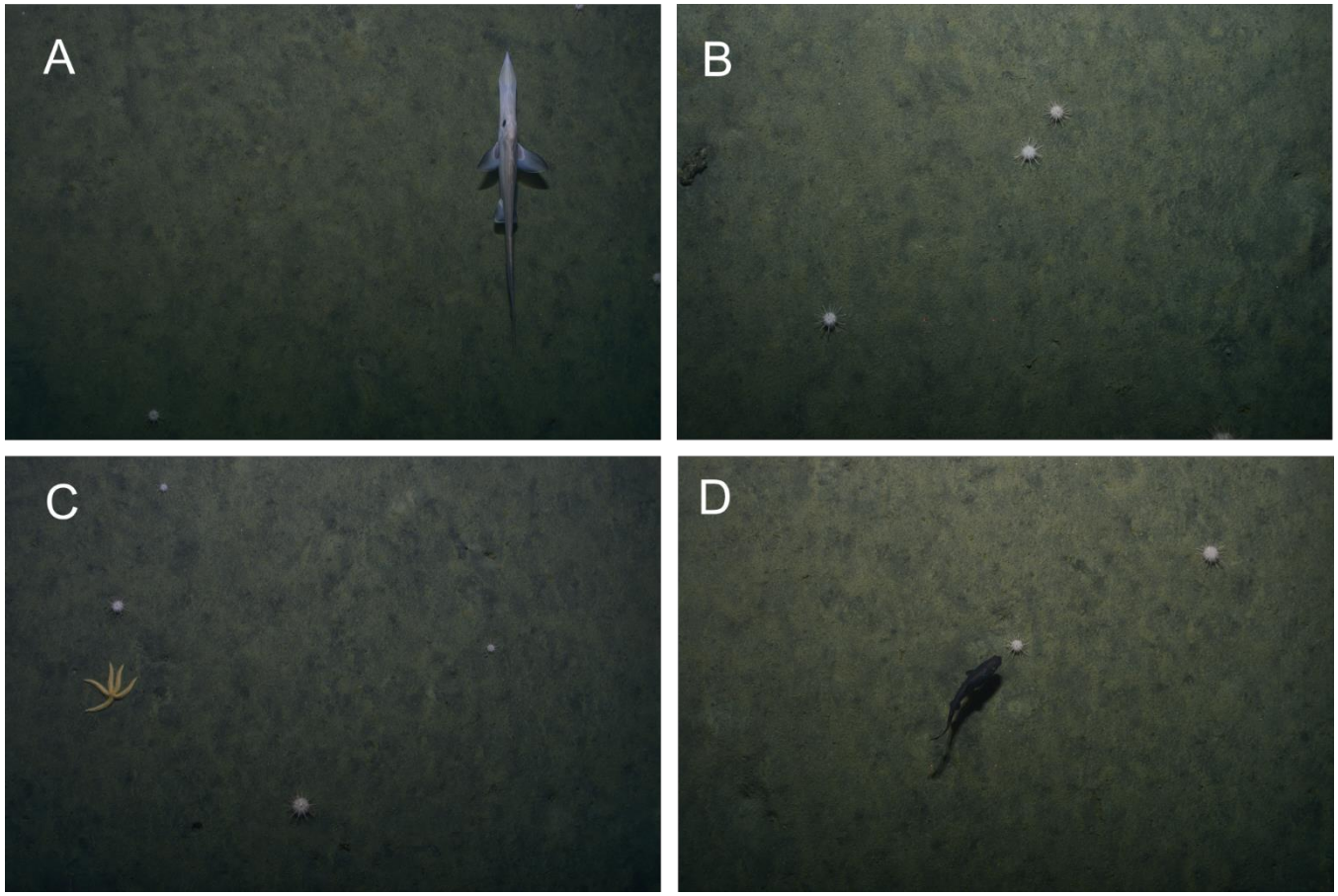
Station 107
Stratum 004

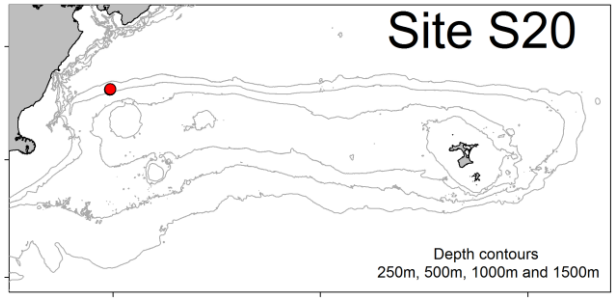
Muddy sediments with burrows and old trawl marks. Many *Taiaroa tauhou* and apparently foraminiferans (*cf Bathysiphon*), some holothuroids.



Station 175
Stratum 023

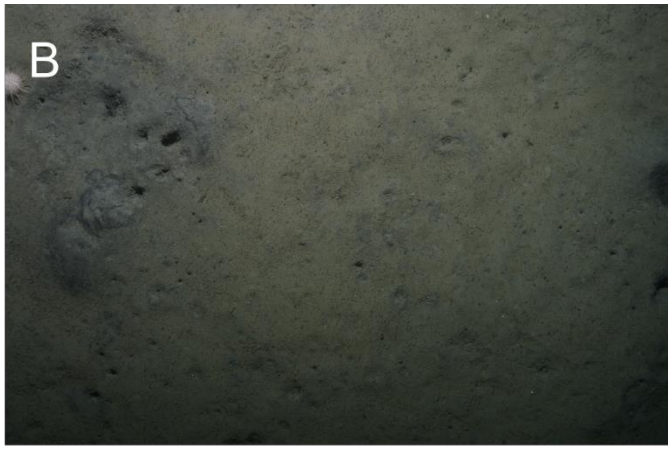
Muddy sediment, probably firm or overlying rock, with biogenic structure, smooth rock scarps later in transect. Few benthic fauna. Orange roughy, rat tails.

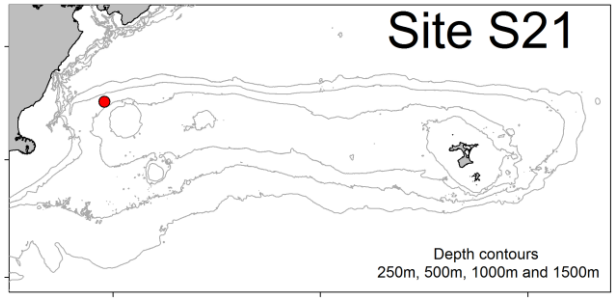




Station 164
Stratum 023

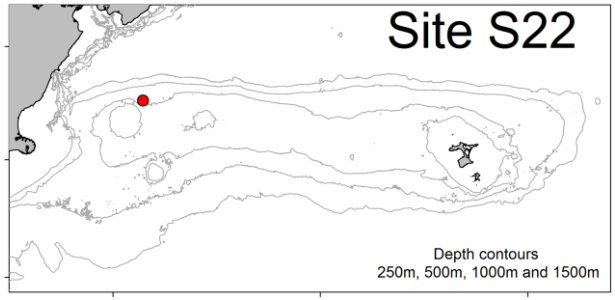
Level dark muddy sand sediment, no burrows. *G. multidentatus* in moderate to high density throughout, some asteroids.





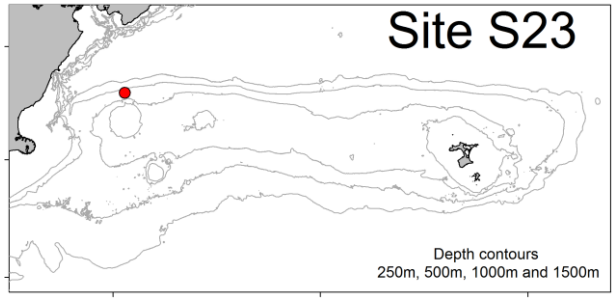
Station 167
Stratum 001

Level muddy sediment with dark sand showing at mounds, pits, and burrows. Some sea-pens (brown whip-like), *G. multidentatus*, asteroids, echinoids, and pagurids.



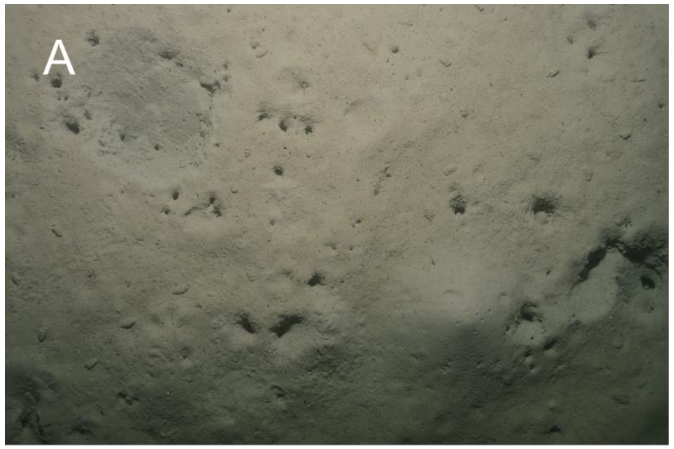
Station 162
Stratum 07B

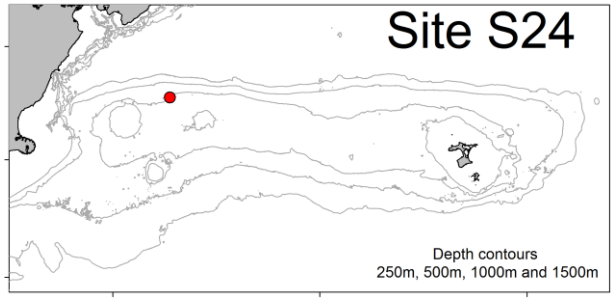
Level muddy sediment with burrows, mounds, and pits. Low densities of sea-pens (brown whip-like) and a distinctive pale holothuroid with dorsal 'fringes'.



Station 163
Stratum 022

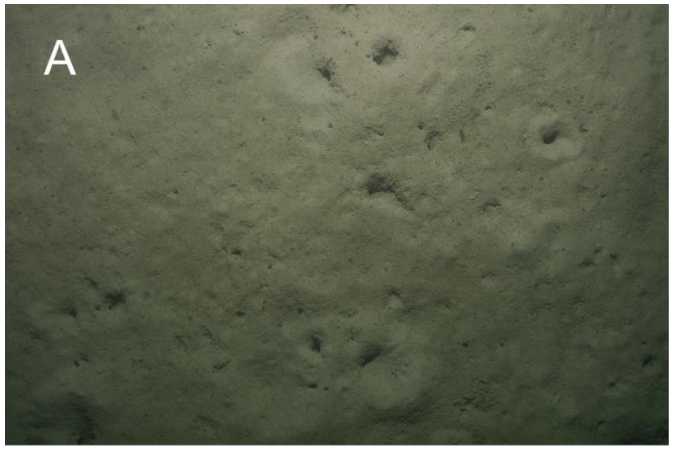
Level muddy sediment with few burrows. Sparse fauna; asteroids, quill worms, *G. multidentatus*, *Brucerolis* sp. isopods, some sponges.

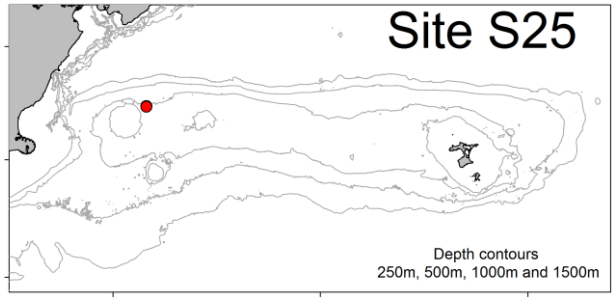




Station 002
Stratum 08A

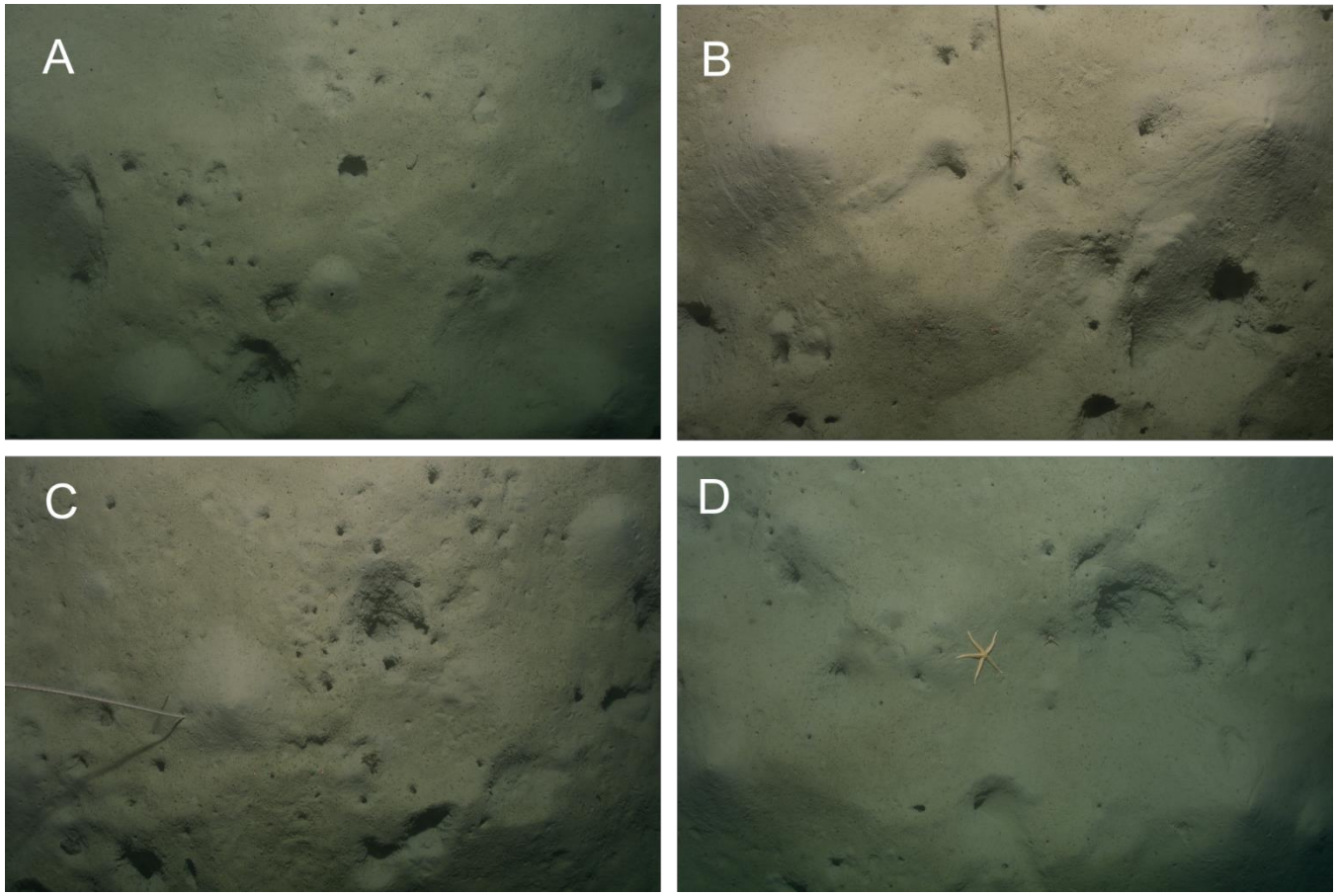
Muddy sediments with burrows and mounds.
Holothuroids, some seapens

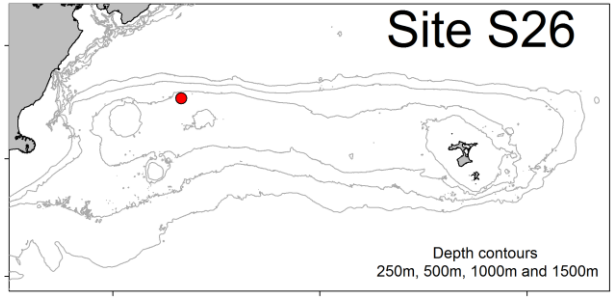




Station 160
Stratum 078

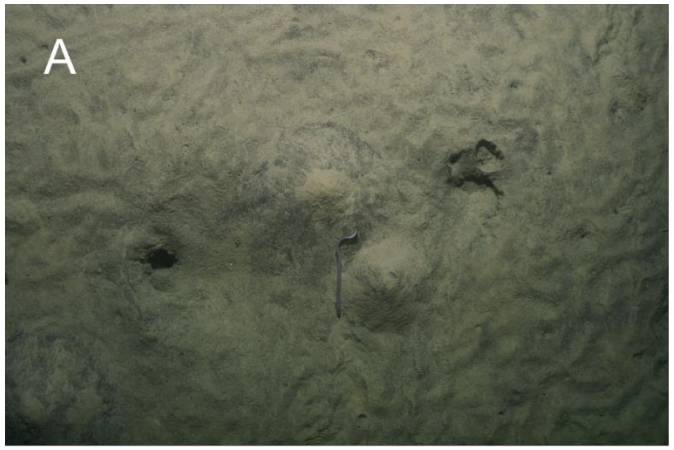
Pale muddy sediment with high density of burrows. *T. tauhou*, scampi, some spiral sea-pens (logged as "*Radicipes* sp.").

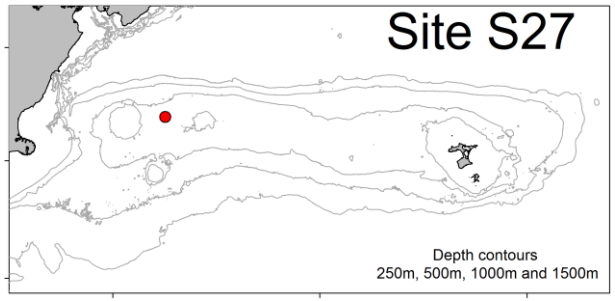




Station 003
Stratum 08A

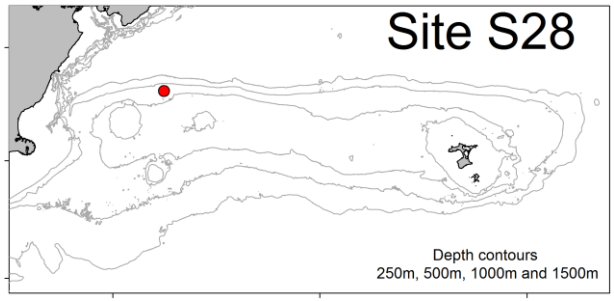
Muddy sediments with burrows and mounds. Seapens common, holothurians, scampi, rat tails and other fish.





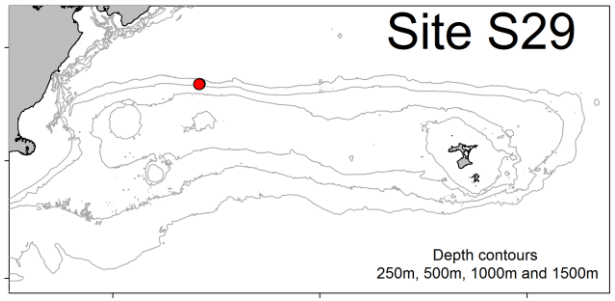
Station 004
Stratum 019

Muddy sediments with dark mounds and tracks. Burrowing urchins common, also seapens, munida gracilis and scampi, asteroids, holothuroids, and some small octopi. Numerous juvenile hoki in latter part of transect.



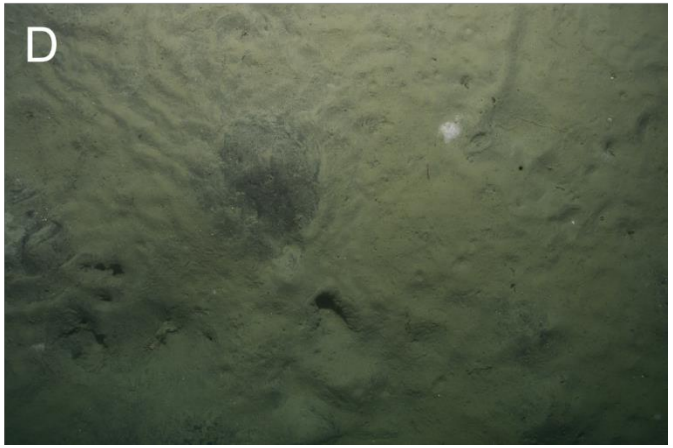
Station 001
Stratum 02A

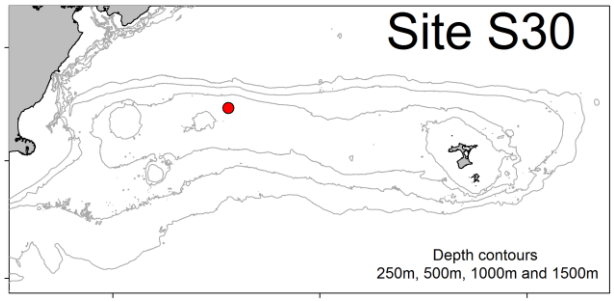
Muddy sediment with burrows, mounds, pits.
Shrimps, chimeras, galatheids, and rat tails.
Some trawl marks.



Station 010
Stratum 023

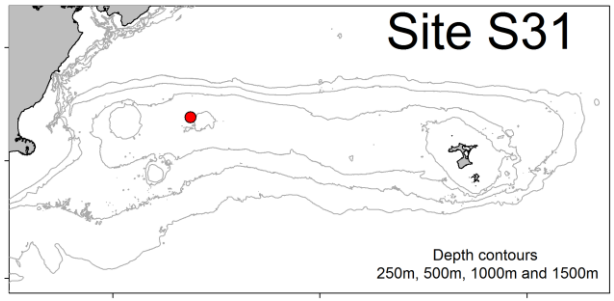
Muddy sediment with burrows. High density of rat-tail fishes, some Echinothuroid urchins, a brisingid star, small rays.





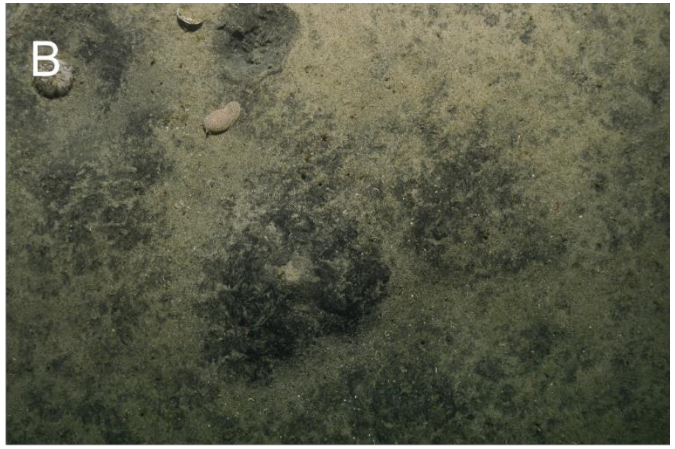
Station 015
Stratum 020

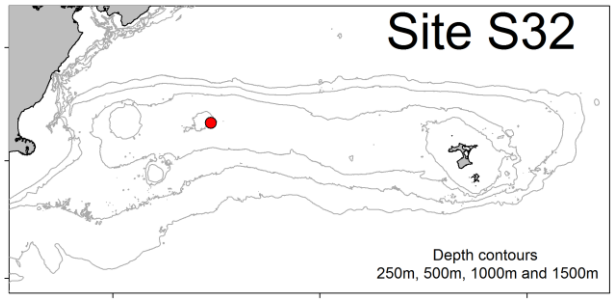
Dark sand sediments. Burrowing echinoids, scampi, *M. gracilis*, asteroids.



Station 008
Stratum 019

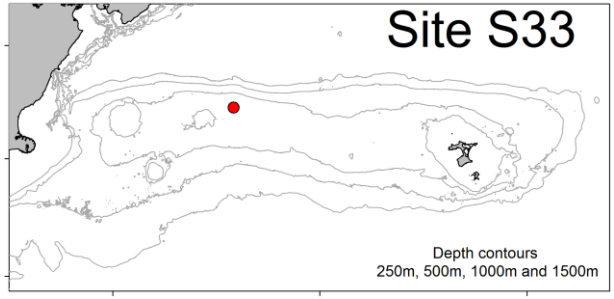
Dark sand overlain by pale muddy sediment. Many mounds and burrows. *M. gracilis* abundant, some small sponges.





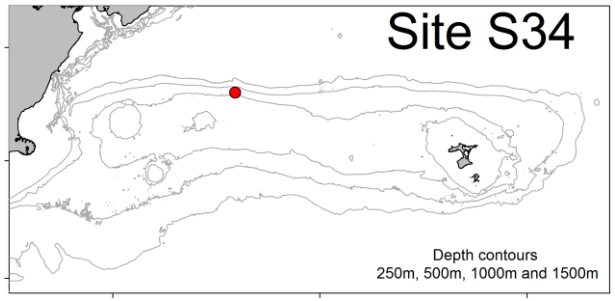
Station 009
Stratum 019

Predominantly dark sand with areas of pale sand. Small sponges, gastropods, *M. gracilis.*



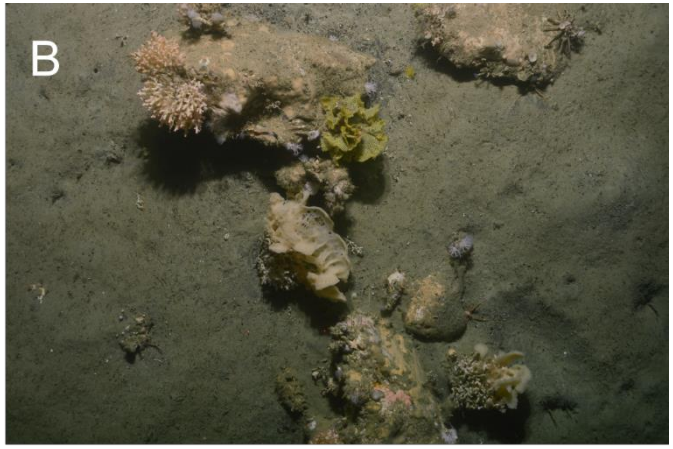
Station 017
Stratu 020

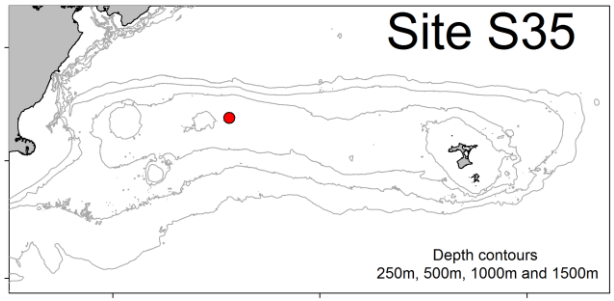
Fine greenish muddy sediment, many burrows, pits, and mounds. White holothuroids, scampi, asteroids, *M. gracilis*, anemones.



Station 018
Stratum 02A

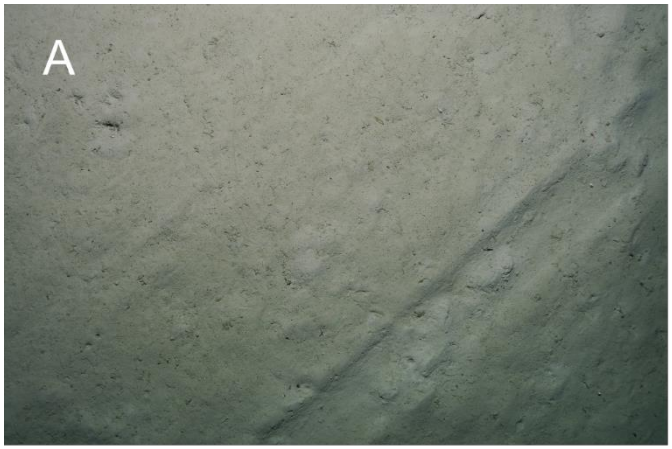
Fine greenish muddy sediment with mounds, burrows, pits, and tracks. Trawl marks. Scampi, *Carcinoplax victoriensis*, rat tails.

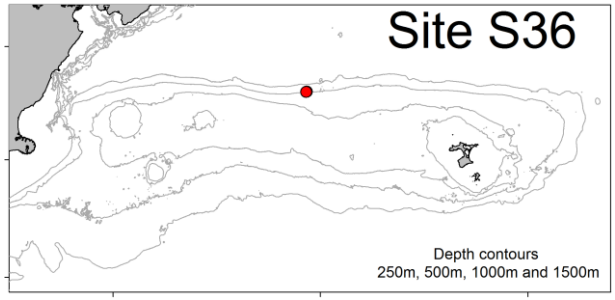




Station 016
Stratum 020

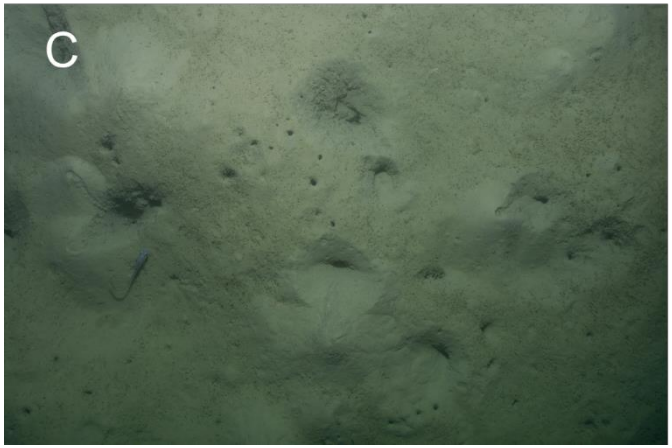
!Sensitive Habitat! Greenish muddy sediments with areas of rock and boulder supporting diverse sessile communites: demosponges; *Goniocorella dumosa;* bryozoans and others. Rock appears to be conglomerate with chalk in places.

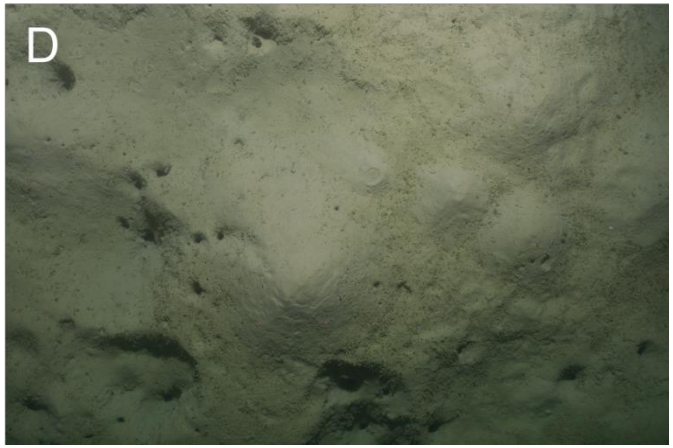


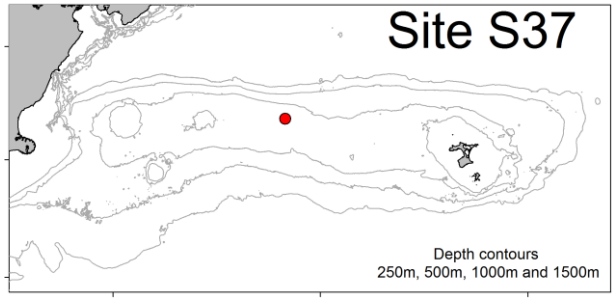


Station 029
Stratum 022

Level muddy sediments with trawl marks throughout transect. Sparse fauna; echinothuroid urchins, rattails, brisingid sea-stars.

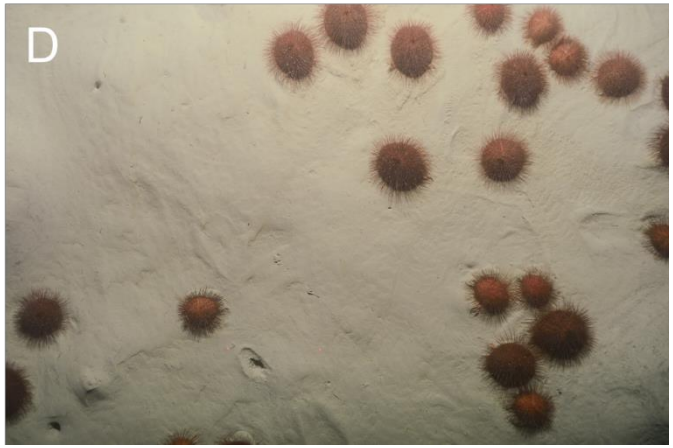


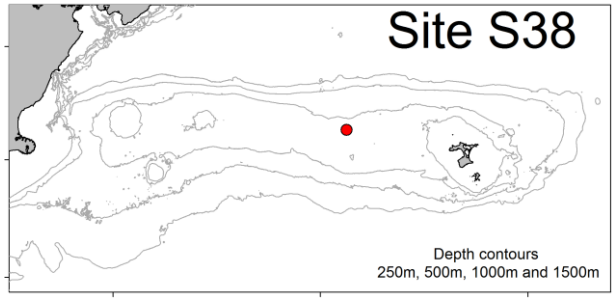




Station 024
Stratum 08B

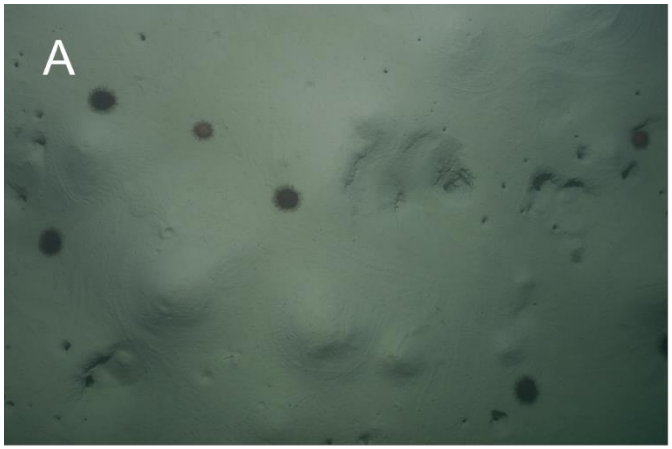
Muddy sediments with burrows, pits and mounds, scampi, Echinothuroid echinoids, galatheids. Some trawl marks.

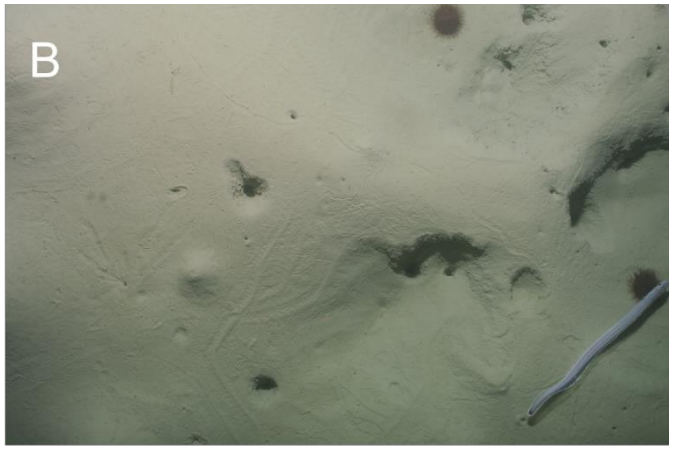


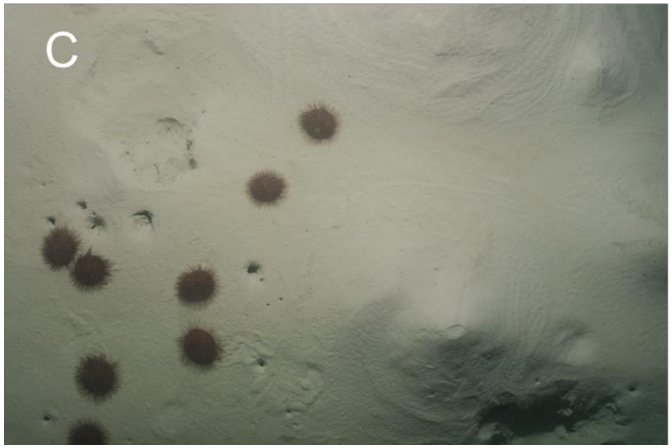


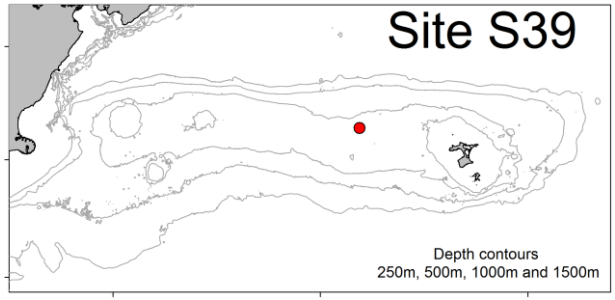
Station 039
Stratum 010

Muddy sediments with pronounced pits, mounds, burrows. High densities of irregular echinoids on sediment surface in some patches.



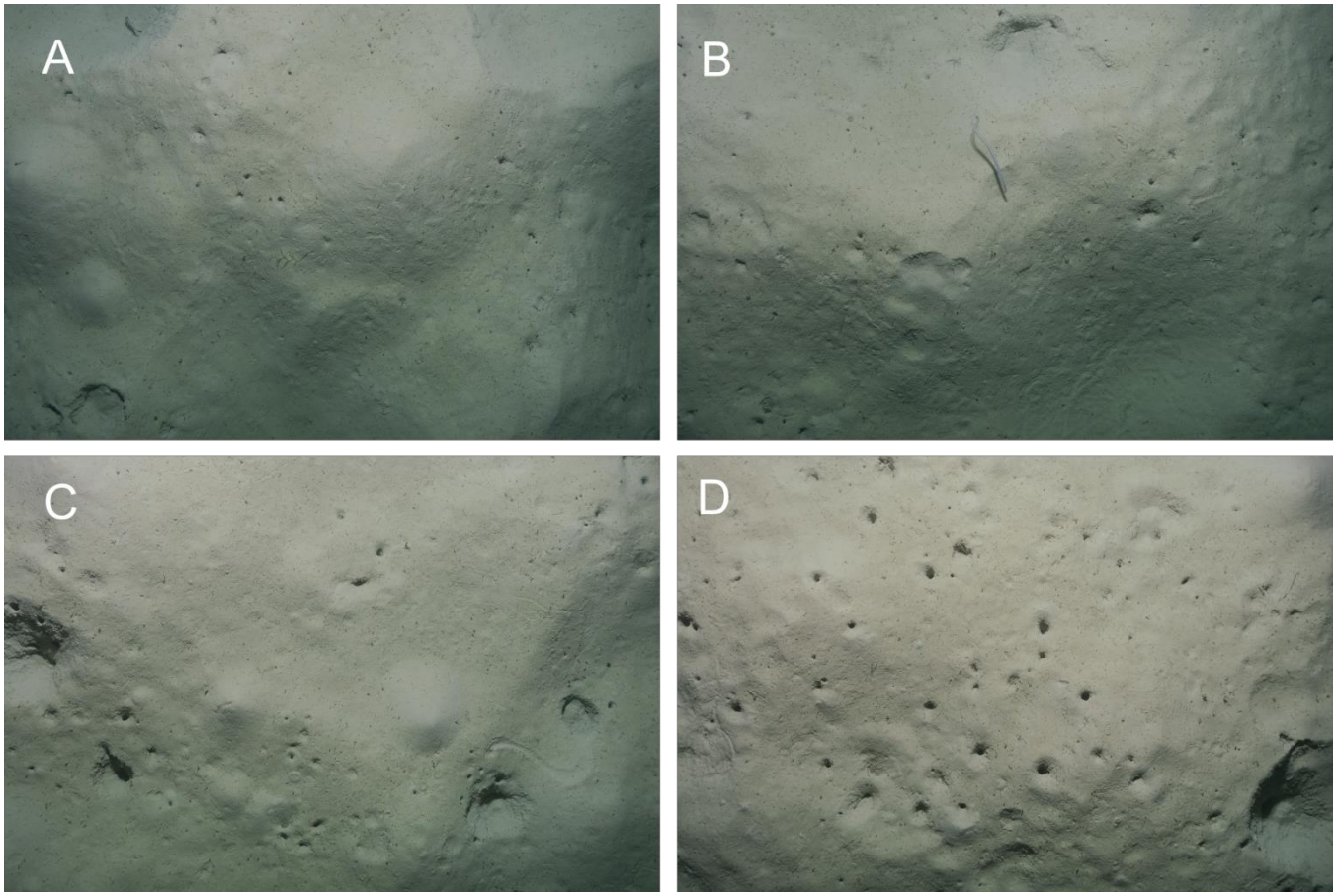


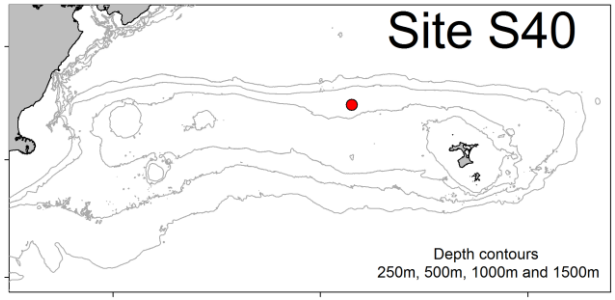




Station 038
Stratum 010

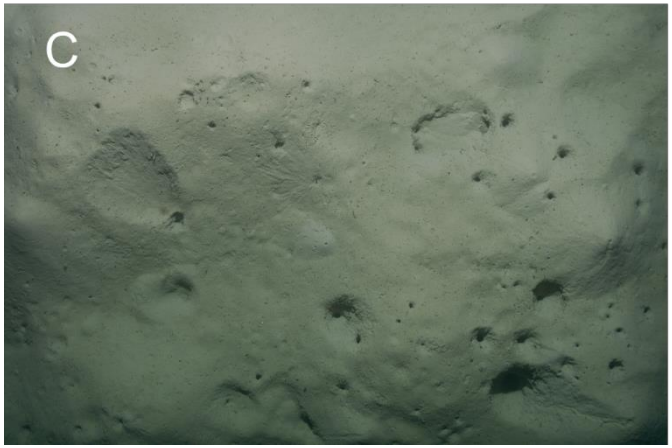
Muddy sediments with pronounced pits, mounds, burrows. High densities of irregular echinoids on sediment surface through first half of transect.

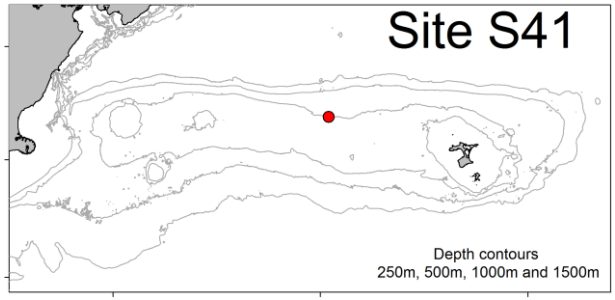




Station 036
Stratum 010

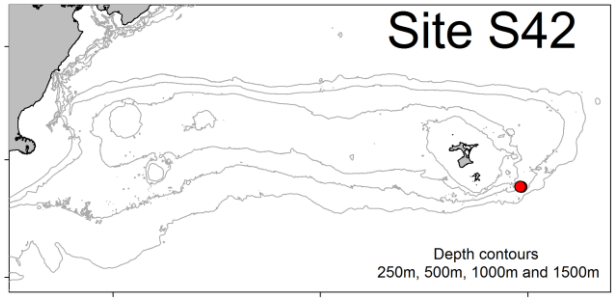
Soft muddy sediments with pronounced pits, mounds, and burrows. Sea pens, *Radicipes* sp., rat tails, and a morid cod.





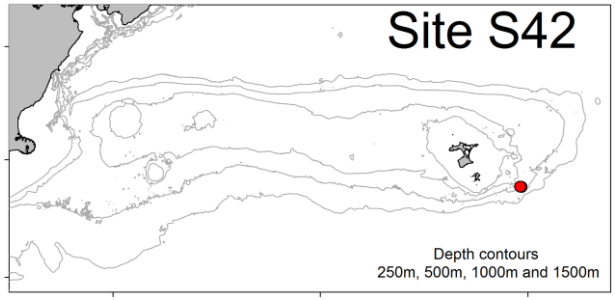
Station 028
Stratum 010

Muddy sediments with burrows, pits, mounds and fish feeding marks. Sparse epifauna.



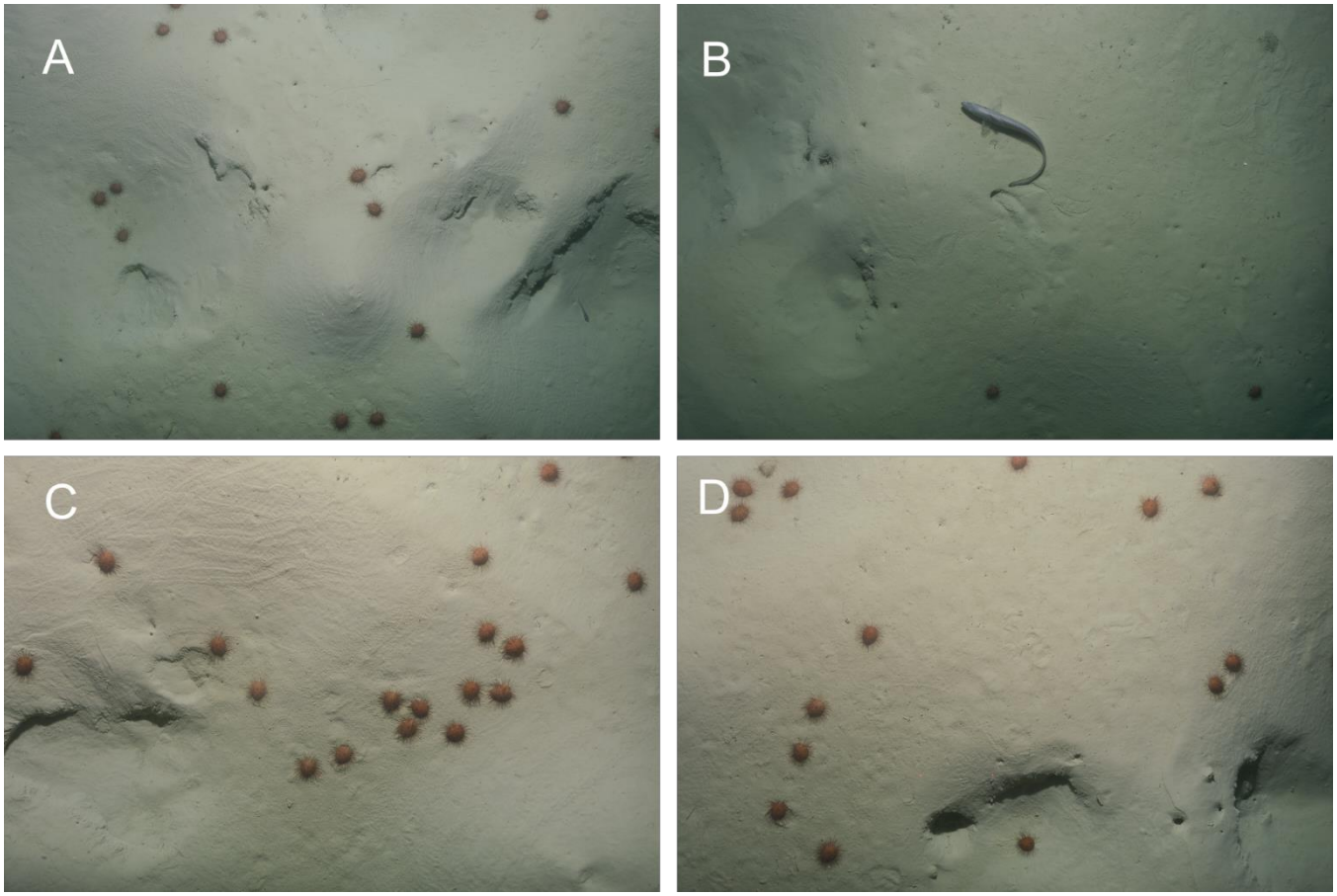
Station 085
Stratum 025

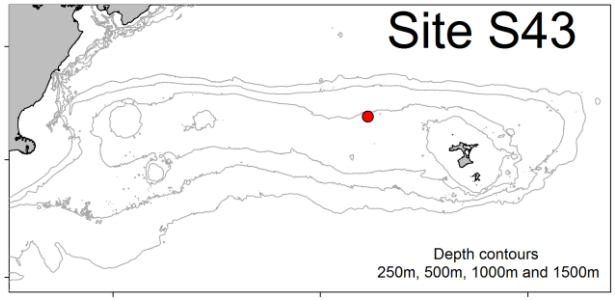
Compacted gravel and barnacle plate hash, interspersed with areas of black boulders and bedrock, rippled sand towards end of transect. Sparse fauna, anemones, sponges.



Station 087
Stratum 025

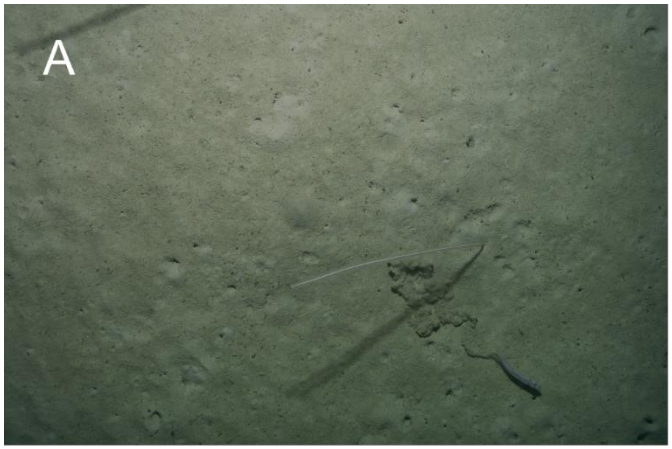
Targeting small knolls seen in MBES just W of S42. Bedrock, boulders, some coral rubble and sand. Crinoids, small stony coral colonies (*Solenosmilia*?), stylasterid corals and sponges, white-spined cidarid urchins. Rippled sand and fine coral rubble at base.

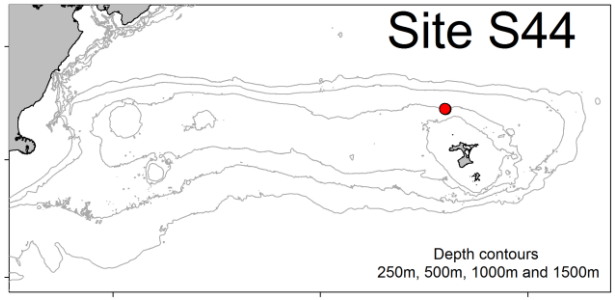




Station 037
Stratum 011

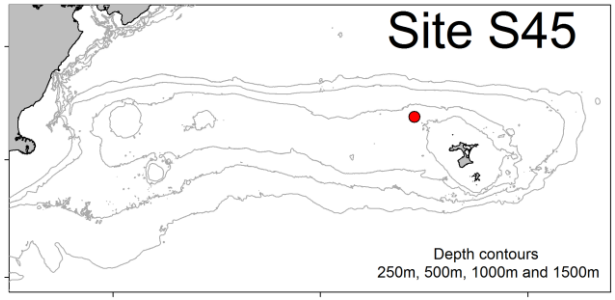
Muddy sediments with pronounced pits, mounds, burrows. High densities of irregular echinoids on sediment surface throughout transect.





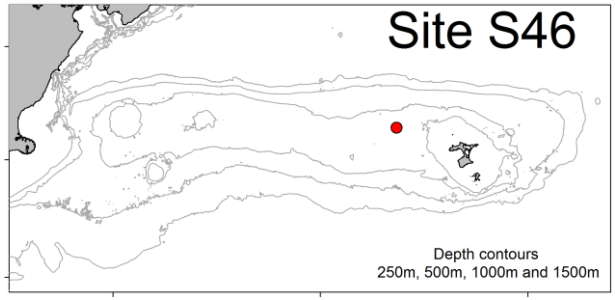
Station 055
Stratum 011

!Sensitive Habitat! Muddy sediments with sea pens at moderate density throughout transect.



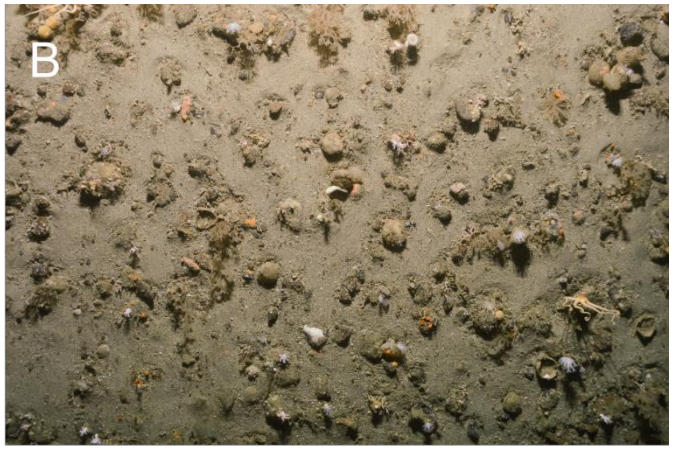
Station 051
Stratum 011

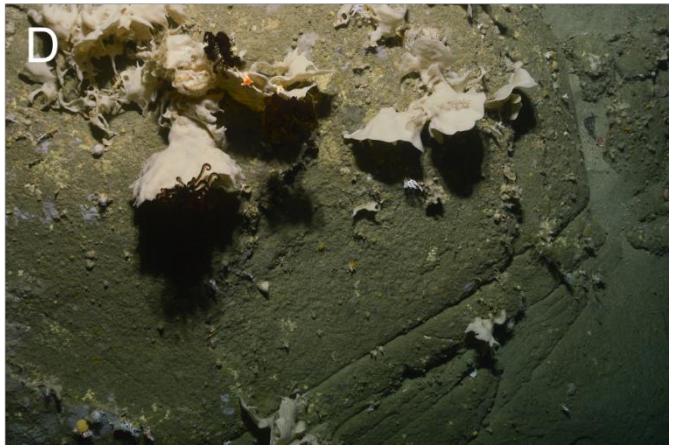
Rippled muddy sand. Very sparse epifauna; a few asteroids, shrimps, small fishes.

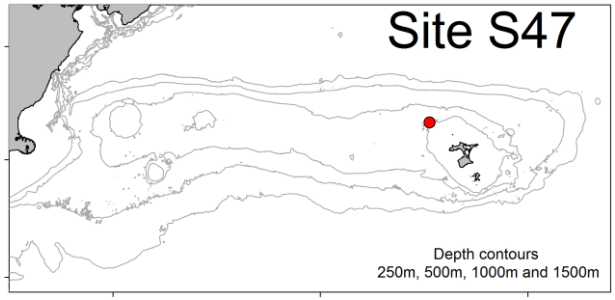


Station 048
Stratum 009

Muddy sediments with some burrows, mounds, and pits, with some patches of cobble. Sparse fauna; asteroids, shrimp, galatheids, and pagurids.

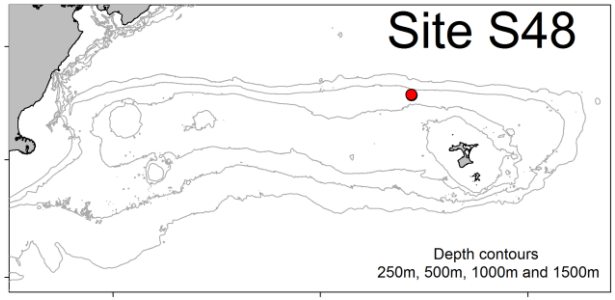






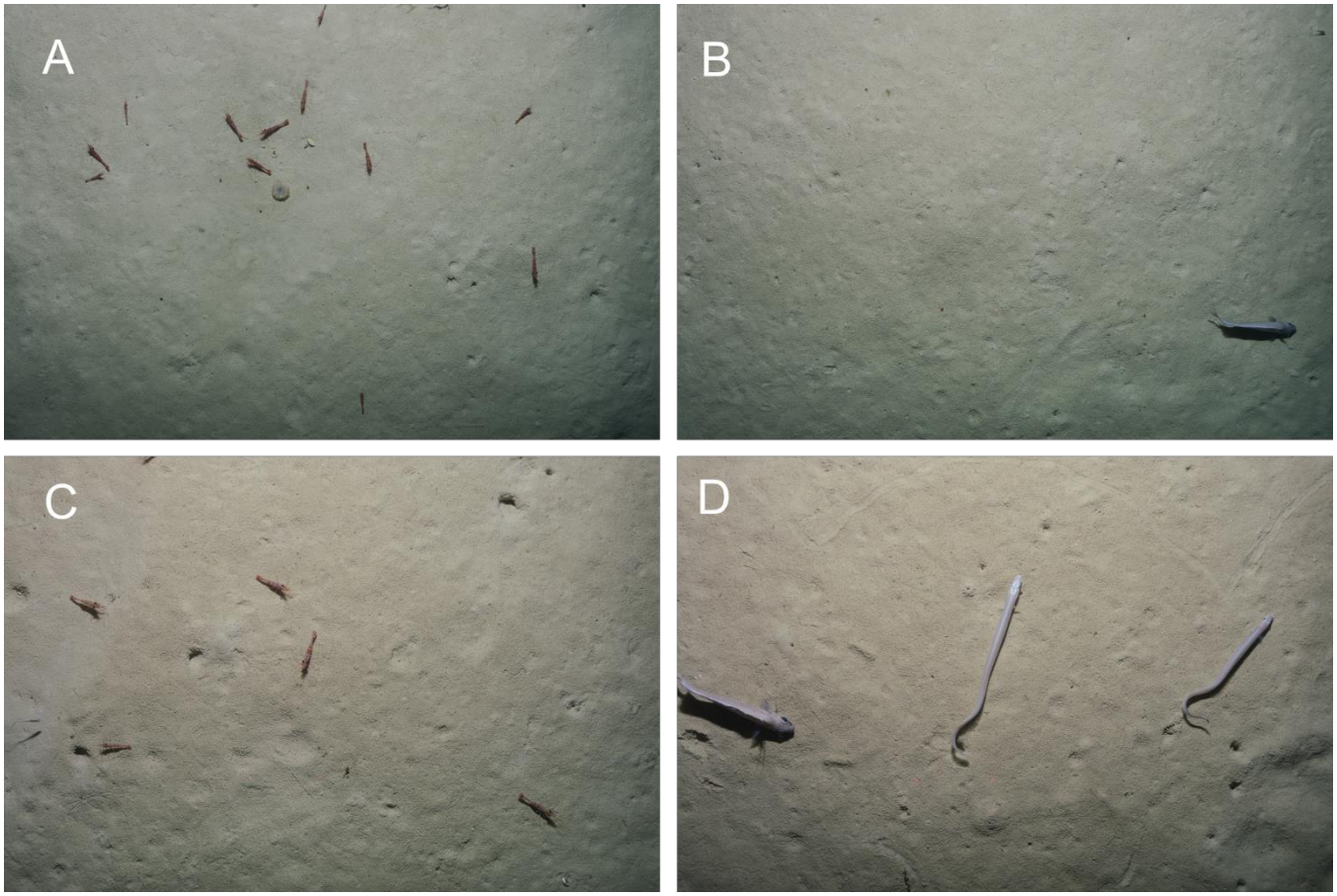
Station 054
Stratum 009

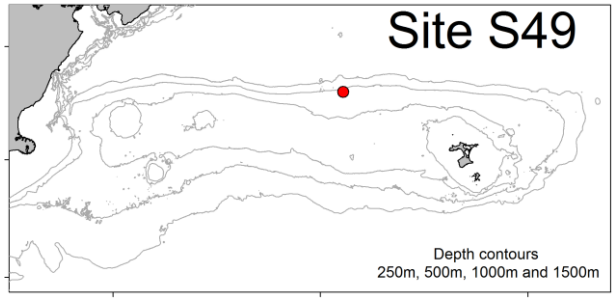
Rippled muddy sand at start becoming cobble, boulder, then outcropping rock. Sponges, anemones, crinoids on hard substrata, otherwise sparse fauna.



Station 049
Stratum 02B

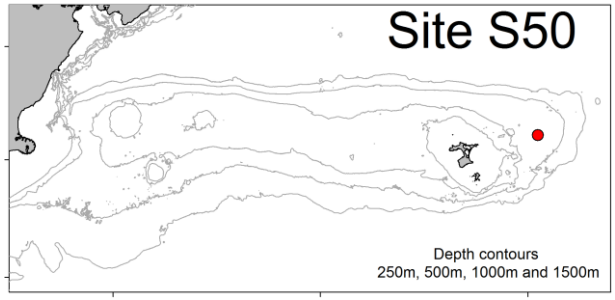
Current-rippled muddy sand sediment. Very sparse epifauna.





Station 033
Stratum 021A

Level muddy sediments, few burrows. Many shrimps, some whelks. Trawl marks in places.



Station 076
Stratum 004

Level muddy sediments with burrows.