Fisheries New Zealand
Tini a Tangaroa

Identification of benthic invertebrate samples from research trawls and observer trips 2021–24

New Zealand Aquatic Environment and Biodiversity Report No. 371

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PLAIN LANGUAGE SUMMARY

This project provided expert identification of non-coral benthic invertebrate bycatch collected by observers on commercial fishing vessels and fisheries research staff during research trawl surveys. This expert identification improves our knowledge of our marine biodiversity research and can inform the assessment of impact and risk of fishing on benthic habitats.

A total of 1398 benthic invertebrate samples, collected since 1985, were identified in this reporting period (1 July 2021 – 30 June 2024) and their revised expert identifications were then updated in Fisheries New Zealand catch databases. Samples were collected from 25 commercial target fisheries and across 11 Fisheries Management Areas with 42 samples processed from four High Seas regions. The samples covered 570 unique taxa across all major invertebrate groups and identified at least 32 undescribed species, two possible undescribed genera and a further 28 species and genera that were identified with a level of uncertainty that warrants further investigation. A further 551 specimens were also identified from 99 digital images of bycatch fauna taken by observers.

The continued discovery of undescribed taxa in observer and research trawl material being returned underscores both the ability of the ship-board staff to identify unusual organisms, and the value of this material for ongoing biodiscovery research of the New Zealand deep-sea fauna.

EXECUTIVE SUMMARY

Schnabel, K.E. [1]; Mills, V.S.; Connell, A.M.; Macpherson, D; Mitchell, M. [2]; Kelly, M.; Peart, R.A.; Bolstad, K.S.R. [3]; Braid, H.E.[3]; Hayward, L.; Clinchard, S.; Wood, C.R.; Yeoman, J. (2026). Identification of benthic invertebrate samples from research trawls and observer trips 2021–24.

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Accurate taxonomic identification of invertebrate bycatch samples collected by observers on commercial fishing vessels and fisheries research staff during research trawl surveys is useful for the determination of species distributions and benthic communities affected by fishing activities. Improved identification of benthic invertebrates also improves our understanding of biodiversity which can support predictive habitat suitability modelling and spatial planning, taxonomy, and the development of ecological risk assessments of fishing impacts on benthic habitats.

This report completes the Fisheries New Zealand Project BEN2021-03 and provides identification and enumeration of benthic invertebrate bycatch (excluding protected corals). A total of 1398 benthic invertebrate samples, collected since 1985, were authoritatively identified for this reporting period (1 July 2021 – 30 June 2024). These comprised 838 samples from 98 research trawl surveys, and 560 samples from 168 observer trips. Accumulated historical samples, collected prior to July 2021, from observers (309 samples) and research trawl surveys (780 samples), made up a significant portion of the identifications reported on. The relevant databases, National Institute of Water and Atmospheric Research (NIWA) Invertebrate Collection (NIC) database Specify (*niwainvert*), and Fisheries New Zealand *trawl* database and the Centralized Observer Database (*COD*), were updated as required with the revised expert identifications.

Samples were collected from 25 commercial target fisheries and across eleven Fisheries Management Areas (FMAs) with 42 samples processed from four High Seas regions. Bottom trawl fisheries targeting orange roughy (*Hoplostethus atlanticus*), arrow squid (*Nototodarus* spp), and hoki (*Macruronus novaezelandiae*), recorded the highest numbers of fishing events returning invertebrate samples. The highest number of observer-collected samples processed were taken from the Southland FMA 5 (41–85 sample identifications per year), South-East Chatham Rise (FMA 4, 18–45 samples), with smaller numbers processed from the southern FMAs South-East Coast (FMA 3) and Southern Offshore Islands (FMA 6A). Sample counts processed from northern FMAs and the high seas regions were low.

The Fisheries New Zealand target sample size of 315 was exceeded for this reporting period due to efforts from NIWA taxonomists as well as New Zealand and international experts. Identifications of bycatch fauna for 7261 specimens (570 unique taxa and operational taxonomic units) in 10 phyla are presented. These are: Arthropoda (crustaceans), Bryozoa (bryozoans), Chordata (tunicates), Cnidaria (anemones, hydroids, sea pens, and zoanthids, excluding the protected coral groups that are identified under a Department of Conservation Project), Echinodermata (seastars, brittlestars, urchins, and sea cucumbers), Mollusca (squid, octopus, snails and clams) and Porifera (sponges). The level of identification within these phyla ranges from species to order based on the expertise available or state of the collected sample. The fauna identified included at least 32 undescribed species, two possible undescribed genera and a further 28 species and genera that were identified with a level of uncertainty that warrants further investigation.

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A contract variation was approved for Year 2 to process digital images of invertebrates taken by observers at sea. As a trial, 99 images of bycatch fauna were processed and 551 specimens were identified, and a spreadsheet created to hold image metadata. The images were received via a DOC CSP project (INT2019-04 Identification and storage of cold-water coral bycatch specimens) because the subject of the image was initially thought to be of a coral. The specimens identified from the images were diverse and spanned 10 phyla, most were cnidarians (corals, anemones, hydroids, sea pens, zoantharians, corallimorpharians), bryozoans, and annelids (worms).

The continued discovery of undescribed taxa in observer and research trawl material being returned underscores both the ability of the ship-board staff to identify unusual organisms, and the value of this material for ongoing biodiscovery research of the New Zealand deepsea fauna.

1. INTRODUCTION

1.1 Background

Within the New Zealand region the recording of benthic invertebrate bycatch data during research trawls and by observers on fishing vessels targeting deepwater stocks provides an understanding of where benthic fauna are most at risk from interactions with fishing activities in the deep sea and improves our knowledge of the region's species diversity. A standard approach is followed at-sea to identify and apply a Fisheries New Zealand three-letter species code to marine organisms taken from research trawl and commercial fishing activities. Invertebrate bycatch unable to be identified at sea is retained and returned for identification by expert taxonomists ashore and these data can help inform several Government-funded projects monitoring these interactions.

The key reasons for retaining benthic bycatch specimens at sea are:

- where identification is uncertain,
- the specimen has been caught outside the depth range or distribution given in identification guides,
- samples are specifically requested by Fisheries New Zealand,
- the specimen is rare or unusual,
- where specimens have been requested for ongoing taxonomic or biological research.

Three Environment Outcomes of the eleven Management Objectives provided in the National Fisheries Plan for Deepwater and Middle-depth Fisheries (Fisheries New Zealand 2019) are relevant to the management of benthic systems and their fauna (including protected corals):

- **Environment Outcome 5:** Ensure that maintenance of biological diversity of the aquatic environment and protection of habitats of particular significance for fisheries management are explicitly considered in management.
- **Environment Outcome 7:** Manage deepwater and middle-depth fisheries to avoid, remedy or mitigate the adverse effects of these fisheries on the benthic habitat.
- **Environment Outcome 8:** Manage deepwater and middle-depth fisheries to avoid, remedy or mitigate the adverse effects of these fisheries on the long-term viability of endangered, threatened and protected species populations.

The processing and identification of benthic samples from inshore research trawl surveys is usually covered by the survey objectives of their respective projects. This project (BEN2021-03) provides for the identification and enumeration of benthic invertebrates, other than protected coral species, taken as incidental bycatch during deepwater and research trawls and by observers on deepwater fishing vessels.

Identification and storage of protected coral bycatch samples are progressed under a Department of Conservation (DOC) Conservation Services Programme (CSP) project. The DOC20303-INT2019-04 project has completed its three-year reporting period, see Macpherson et al. (2020, 2021); Mills et al. (2023), and the three-year project DOC23303-INT2022-03 commenced in early 2023 to continue the processing and identification of protected coral bycatch.

The samples to be identified in this project include those collected from both inside the New Zealand Exclusive Economic Zone (EEZ), as well as from the High Seas region where samples are collected as part of the South Pacific Regional Fisheries Management Organisation (SPRFMO) arrangement. Samples collected from fishing vessels in the Ross Sea as part of Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) requirements are not currently funded for further identification.

This report presents results for the three-year duration of the BEN2021-03 project.

1.2 Overall Objective

To taxonomically identify benthic invertebrates in samples taken during research trawls and by observers on fishing vessels.

1.3 Specific Objectives

1. To taxonomically identify deepwater benthic invertebrates to species level where possible in samples taken during research trawls and by observers on fishing vessels targeting deepwater stocks.
2. To update relevant databases recording the catch of invertebrates in research trawls and commercial fishing.
3. Variation: Process up to 50 digital images of invertebrates taken by Fisheries New Zealand Observers at sea.

2. METHODS

2.1 Methods for Specific Objective 1

A key objective for contracts tendered by NIWA for fisheries research trawl surveys is to preserve specimens of unidentified organisms taken during the survey and identify these ashore, as described by Bagley et al. (2013), O'Driscoll et al. (2010), MacGibbon et al. (2019), Stevens et al. (2018, 2021, 2023) and Schnabel et al. (2021). At each research trawl station, all items in the catch are sorted and weighed on motion-compensating electronic scales and, where possible, identified with the use of at-sea guides (Tracey et al. 2011; 2014; Williams et al. 2014), to the lowest taxonomic level possible using Fisheries New Zealand three-letter species codes. Unusual or unidentified organisms are inventoried, counted, and then frozen or preserved for later identification ashore.

Fisheries New Zealand observers collect information including specimen identification (also using Fisheries New Zealand three-letter species codes) and catch weight on board commercial fishing vessels. Data are recorded on 'Observer Benthic Materials Forms', and although observers have been able to identify an increasing proportion of such material at sea using field guides, material continues to be returned for identification at NIWA. Currently, the unidentified organisms including fish, squid, and invertebrates returned by observers are inventoried at NIWA under the Fisheries New Zealand *Data Custodianship Services* DAT2016-01P (physical specimen sorting and storage) and DAT2016-01E (electronic data services) projects. These projects include the requirements to assure storage and safekeeping of specimens by maintaining an accurate catalogue of the data which is provided to custodianship services and by delivering an Information Request and Specimen Provision service. The invertebrate specimens are subsequently identified by experts through the project described in this report (BEN2021-03).

Sampling Instructions

Under Objective 1, NIWA provides instructions for identifying invertebrates on research surveys and on observed commercial trips. Revised and updated instructions for refining sample collection at sea from research surveys and observer trips were provided to Fisheries New Zealand in June 2023 and are included as Appendices 2 & 3 and the updated instructions on the live status of corals is included as Appendix 4. The instructions complement those instructions in the deep-sea invertebrate guide (Tracey et al. 2011), the Tracey et al. (2022) guide sheet complement and the revised coral guide that includes unprotected coral fauna (Tracey et al. 2023) and comprise part of the specific voyage objectives for research trawl surveys. Every attempt has been made to continue to improve the at-sea data collection to enable efficient and accurate database updates.

Prior to sailing, all research trawl survey voyage leaders are provided with the instruction document referred to above; ‘Instructions to researchers when carrying out at-sea invertebrate data collection’, a spreadsheet for use at sea when recording retained benthic (and fish) sample data named ‘Specimen sheet for research trawl voyages’, and specimen sample labels. Voyages routinely follow the protocols for labelling, storage, and tallies of material.

The MPI Observer Services provided two opportunities (November 2023 and April 2024) for NIWA and DOC staff to host four groups of new and returning observers during their training workshops in Wellington. In addition to the provision of taxonomic training on common deep-sea invertebrates to the observers, the occasion to exchange experiences and feedback was incredibly valuable for both the observers and NIWA staff, and it is expected that these training workshops will continue regularly in the future.

‘Sample’ is defined as unidentified benthic and non-benthic (e.g., squid) invertebrate organisms. Most samples collected at sea were returned frozen for identification. Preservation is primarily by freezing although some groups of invertebrates need to be fixed at sea in formalin or ethanol to retain key taxonomic features needed for later identification. For example, for research voyages a protocol is now in place stating that for expert identification purposes all anemones collected on research trips should be fixed in formalin at sea where practical. All safety-at-sea requirements are provided for, e.g., if formalin is provided, they are accompanied by Material Safety Data Sheets (MSDS), fitted personal protective equipment, and instructions for safe handling. Specimens of unusual species collected are photographed at sea as time permits and photographs are to be made available for updates to identification guides.

Processing ashore

The benthic invertebrates returned by observers from commercial fishing voyages were thawed, sorted into main groups and identified to coarse taxonomic level (generally class/order level). These data were entered into the web-interfaced NIWA Observer Samples database (OSD), then returned to frozen storage, fixed in ethanol or formalin, or dried or discarded where appropriate (according to DAT2016-01P Fisheries New Zealand project tasks). OSD data was then imported into the NIWA Invertebrate Collection (NIC) *niwainvert* database (see below).

Research trawl samples were processed and registered directly into *niwainvert* in readiness for taxonomic identification under this BEN2021-03 project.

The annual target was to identify up to 315 samples returned by observers and research trawl trips between July 2021 and June 2024. Identifications were processed in the following order of priorities, with the most recently collected samples having the highest priority and progressively older ‘historical’ samples processed to clear a backlog where time permitted:

1. Samples collected during the period of July 1st to June 30th of each year 2021–2024 (current BEN2021-03 project)
2. Accumulated unidentified samples from previous Fisheries New Zealand projects between 2011–2020
3. Accumulated unidentified historical samples (pre-2011)
4. Up to 50 samples collected from outside the New Zealand EEZ (SPRFMO)

Curation and taxonomic identification of Observer and research survey material

The methods followed the procedures for identifying fauna and biological specimens housed in the NIC at NIWA. NIWA currently manages Fisheries New Zealand specimens according to the: “Guidelines for the care of natural history collections” (Society for the Preservation of Natural History Collections 1994). NIWA also has its own collection policy document: “NIWA Marine Invertebrate Collection Policy and Procedures”, which guided the process.

Due to their condition, some samples could only be identified to a higher level, e.g., order or phylum. After expert identifications were completed, the invertebrate specimens were curated and catalogued in the NIC Specify database *niwainvert*, and specimens stored permanently within the NIC in conditions/media appropriate for the specific taxon group. Bulk samples, samples in poor condition, and samples of more common invertebrates where there are already sufficient museum vouchers are permitted to be discarded. Specimens retained are held in stewardship for Fisheries New Zealand.

NIWA continues to hold the broadest invertebrate taxonomy capability in Aotearoa New Zealand despite retirements (e.g., Dennis Gordon, Di Tracey), overseas departure (Anne-Nina Lörz, Shane Ahyong, Andrew Hosie) or deceased (Colin McLay). By taking advantage of a well-established network of New Zealand and overseas taxonomic experts to identify material, we continue to cover most major invertebrate groups (Table 1). If required, samples were transferred to other sites within New Zealand e.g., Holothuroidea and ascidian samples were sent to Niki Davey and Mike Page (both NIWA Nelson) and sponges were sent to Michelle Kelly (NIWA Auckland).

External New Zealand capabilities are provided by Bruce Marshall at the National Museum of New Zealand Te Papa Tongarewa, Wellington who continues to identify non-cephalopod molluscs, and the NIC continues to host the Auckland University of Technology Lab for Cephalopod Ecology & Systematics (ALCES) team led by Dr. Kathrin Bolstad annually or semi-annually. Small numbers of samples continue to be identified by international experts from specimen photographs or through loans and are included here (contributing to ongoing work by overseas researchers Mandy Reid, Australia, Frederic Sinniger, Japan, and Greg Rouse, USA). A short visit by Andrew Hosie (Western Australian Museum, Perth) gave an opportunity to identify bycatch barnacles where we lack national taxonomic capability.

Deep-sea anemones have previously been identified as a major gap in our taxonomic expertise, with a 2020 deep-sea anemone workshop and visit by international expert Estefanía Rodríguez, Curator of Marine Invertebrates from the American Museum of Natural History (USA), addressing some of the accumulated material that remained unidentified (Mills et al. 2021). Dr. Rodríguez was unavailable, but a new collaboration with Dr. Michela Mitchell from the Museum of Tropical Queensland, Australia, has added significant taxonomic capacity with a focus on processing accumulated anemone specimens in Year 3 of this project (see taxonomic highlights section below).

Octocoral taxonomy has recently been revised by McFadden et al. (2022). Alcyonacea is no longer accepted as an order. Octocorallia has been elevated to class, and protected corals fall into two new orders: Scleralcyonacea and Malacalcyonacea. See Table 2 for a summary of higher-level changes to the Anthozoa group. We use this revised taxonomy for all corals in this report, however, data provided for Year 1 and Year 2 of project BEN2021-03 included the previously accepted taxonomic hierarchy of this group. These taxonomic terms have now been updated in the Fisheries New Zealand 'rdb' (reference) database which links to all relevant queries of invertebrate catch.

Table 1: List of experts available to identify benthic invertebrate fauna 2021–24. Experts are all affiliated with NIWA unless otherwise indicated.

Taxonomic group	Expert
Ascidians (sea squirts)	Mike Page
Annelida (bristle worms, sipunculans)	Geoff Read (Emeritus)
	Greg Rouse (Scripps Institution of Oceanography)
Bryozoa (lace corals)	Dennis Gordon (Emeritus)
Un-protected Cnidaria (soft corals)	Jaret Bilewitch
	Gustav Kessel (Royal Society Te Apārangi)
Un-protected Cnidaria: Hydrozoa (hydroids)	Diana Macpherson
Un-protected Cnidaria: sea pens	Kate Neill
Un-protected Cnidaria: zoanthids, anemones	Frederic Sinniger (University of Ryukyus, Japan)
	Yang Li (Chinese Academy of Sciences)
	Michela Mitchell (Museum Tropical Queensland)
Crustacea: Decapods and mysids	Kareen Schnabel, Jeff Forman
Crustacea: Amphipoda & Isopoda	Rachael Peart
Crustacea: Barnacles	Andrew Hosie (Western Australian Museum)
Sea spiders	Kate Neill
Echinodermata: Asteroidea (starfish)	Kate Neill
Echinodermata: Holothuroidea (sea cucumbers)	Niki Davey
Echinodermata: Ophiuroidea (brittle stars)	Sadie Mills
Echinodermata: Echinoidea (urchins)	Owen Anderson
Hemichordata	Dennis Gordon
Mollusca: squid, octopus	Kat Bolstad, Heather Braid, Jaever Santos (AUT), Mandy Reid (Australian Museum). Darren Stevens, Mark Fenwick (both NIWA),
Mollusca: gastropods and bivalves	Bruce Marshall (Te Papa), Jill Burnett
Porifera (sponges)	Michelle Kelly, Carina Sim-Smith (Clearsight Consulting)

Table 2: Summary of higher-level changes to Anthozoa group classification following McFadden et al. (2022).

Name	Old taxonomy	Current taxonomy
Anthozoa	Class	Sub-Phylum
Hexacorallia	Subclass	Class
Octocorallia	Subclass	Class
Malacalcyonacea	(Alcyonacea+Gorgonacea)	Order
Scleralcyonacea	(Alcyonacea+Gorgonacea)	Order
Alcyonacea	Order	(Malacalcyonacea+Scleralcyonacea)
Gorgonacea	Order	(Malacalcyonacea+Scleralcyonacea)
Pennatulacea	Order	Super-Family Pennatuloidea (w/in O. Scleralcyonacea)

2.2 Methods for Specific Objective 2

The *Specify* database *niwainvert* was updated with identifications using the scientific name and taxonomic hierarchy. Scientific names, and not Fisheries New Zealand species codes, are entered into *niwainvert*. A summary output dataset was then provided to the Fisheries New Zealand contracted Research Data Manager at NIWA to enable database updates to be made by appropriate database experts – observer samples onto the Fisheries New Zealand Centralised Observer Database (*COD*) and identifications for research trawl survey samples onto the Fisheries New Zealand Research Trawl Database (*trawl*). Both databases are maintained by NIWA for Fisheries New Zealand.

Column headings for the data exported from *niwainvert* included the fields listed below, and this information was provided to the *COD* and *trawl* database managers:

- Trip_code
- Station_no
- NIC catalogue number (Prefix-NIWA)
- OSD Number or Lot number if available
- Observer Initial ID label if available
- Best-match expert ID Fisheries New Zealand species code
- Phylum
- Order
- Family
- Genus
- Species
- Determiner - Expert identifiers name (most recent expert ID)
- Determined date
- Weight of sample if available
- Weight of catch if available
- Count
- Type status

The data extract is available on request (see Appendix 1), with some fields removed to protect data confidentiality.

The data, including species codes, weights, and sample numbers were loaded into tables in *COD* and *trawl* using the common link of trip number (or trip code) and station number. The data loading process is described in previous reports (e.g., Tracey & Mills 2016). Updates followed protocols in place to ensure any changes to the species identification include the apportioned catch-weights being adjusted to reflect the weight of a given species taken on a research trawl. Trip and station are the common links to load data into both *niwainvert* and *COD*. This enables subsequent *COD* updates to be made from *niwainvert* if a species revision occurs in later years. A comment is appended to each record with cross-reference to the *niwainvert* specimen catalogue number to aid future queries.

The following actions were carried out annually to check, update, or add new identifications into the *trawl* database:

- Each new identification was checked against the curr_spp (current species) table to determine if a species code existed and where possible obtain the current valid species code, otherwise a match was made to progressively higher-order codes.
- The trawl database catch and subcatch tables were checked to determine if the code was or was not entered in these tables. In some cases, default codes have been used for samples retained as identification was needed ashore (i.e., SQX for an unidentified squid).
- SQLs were written to either update the catch and subcatch tables where a code existed or insert a catch record into these two tables where a code was not recorded.
- A comment including the identification and determined date was added to the t_catch and t_subcatch tables per individual catch/subcatch row.

The *COD* database manager received samples annually from *niwainvert* to update *COD* for BEN2021-03. Updating catch records took place following that described in Tracey & Sanders (2010). Sample data are loaded into a *COD* database 'load' table, z_invertebrate_samples. The data is then used to update catch records in the stage and report tables, y_benthic, and x_fishing_event_catch. There are always some complexities when loading these data and the benthic identification and matching process continue to be refined.

A summary of samples including sample count by FMA and target commercial species is provided for the observer and research survey collected data by the *COD* and *trawl* database managers.

2.3 Processing digital images of invertebrates taken by observers at sea

A contract variation was approved for Year 2 to process digital images of invertebrates taken by observers at sea.

The variation proposed that images of non-coral invertebrates, up to 50 images for this trial, were processed and identified. Observer images taken onboard could be matched to a physical specimen retained at sea and returned to NIC, processed, and provided to the experts to aid in identification. Images that could not be matched to a physical specimen (i.e., because the specimen was discarded at sea) could supplement the annual target number of samples to be identified if there were not enough to meet the target (up to 315 samples). A fresh specimen image can provide important characters to aid identification. Ideally, the specimen would be retained at sea at the same time as an image is taken of it, however, over time an image alone may suffice for several characteristic faunal groups.

The images were received via a DOC CSP project (INT2019-04 Identification and storage of cold-water coral bycatch specimens) because the subject of the image was thought to be a coral. For DOC reporting period 1 July 2020 to 30 June 2021, 114 images of non-coral taxa were received and were set aside for this trial and 99 of them were used. The images were processed: grouped into taxa and distributed to respective experts for ID, and a spreadsheet created to hold metadata, some of which was also embedded in the image file. For further details of the image processing methodology, see Connell et al. (2023). The metadata included:

- expert ID in the form of taxonomic name (species, genus or family level)
- trip and tow number
- initial Observer ID and expert ID (three-letter MPI species code)
- specimen count
- specimen comments
- keywords relevant to the subject of the image
- the NIC catalogue number (where applicable)

- image rating (where the best rating is 1 (very good quality) and the worst is 5 (very poor quality))

3. RESULTS

3.1 *Niwainvert* summary

A summary of sample data including locality, numbers of specimens (count), identification and initial ID code is available separately for the observer and research survey collected data (see Appendix 1). Column headings for the data provided are as outlined in the methods for Specific Objective 2.

The target was to identify up to 315 samples returned by observers and research trawl trips each year. The number of samples that have been processed for collections during this reporting period (July 2021–June 2024) and historical samples (prior to July 2021) are summarised in Table 3. In each year, we prioritise sample identification with the highest priority (Priority 1) given to the samples collected within the project year and samples collected prior are classified as a lower priority (Priority 2).

A total of 1398 samples (7259 specimens) have been authoritatively identified from the New Zealand region over the three years between 2021 and 2024: a total of 385 samples in 2021/22 – Year 1 (271 research trawl and 114 observer samples, Table 3, Figures 1 & 2); 521 samples in 2022/23 – Year 2 (280 research trawl and 241 observer samples, Table 3, Figures 3 & 4); and 492 samples in 2023/24 – Year 3 (287 research trawl and 205 observer samples, Table 3, Figures 5 & 6). Hence, the target identification number of 315 has been exceeded each year.

The identified samples covered 726 stations/tows across 266 trips and surveys with the collection date ranging between August 1985 and October 2023. The maximum number of samples processed from a single station/tow under project BEN2021-03 was 26 samples (TRIP6533/40), however, for most stations, one sample was identified. While this project focusses on deep-sea fisheries, some specimens included inshore fishing events, and the samples cover depths from 10 m (1999 inshore trawl survey KAH9915) to 2102 m (North Chatham Rise trawl survey TAN1208). Most identifications covered historical collections (prior to July 2021, Table 3 & 4), representing both taxonomic updates and revisions of already identified material, registering unregistered samples into the *niwainvert* database and generally addressing a backlog of hitherto unidentified collections. It also reflects progressively declining returns of bycatch specimens from observers and some surveys, partly due to technical difficulties with shipping frozen specimens to the NIC in recent times (D. Stotter, NIWA, pers. comm.), potentially less bycatch being caught, or may also be considered an indication of increased confidence of observers to make accurate identifications of bycatch fauna.

Each year, up to 50 samples from observed vessels operating outside the New Zealand EEZ (SPRFMO area or High Seas) may be included in the expert identification process as these are difficult to identify as outside-the-zone specimens at the time of delivery for processing at NIWA. Between 11 (Year 2) and 18 (Year 3) samples are reported from the Tasmanian Ridge, the Lord Howe Rise, Wanganella Bank, and western Challenger Plateau (Table 3).

The total combined identified samples represent 570 unique taxa and operational taxonomic units from 10 phyla including: 60 Annelida (59 polychaete worms and one sipunculid); 377 Arthropoda (crustaceans: amphipods, isopods, decapod crabs, shrimp, barnacles and 13 sea spiders); 23 ascidians (sea squirts); 200 bryozoans (including an unidentifiable fossiliferous bryozoan limestone sample), 121 Cnidaria (e.g. anemones, soft corals, hydroids, seapens and zoanthids, but not including protected corals groups); 183 Echinodermata (sea stars, brittle stars, urchins and sea cucumbers); 330 Mollusca (gastropods, bivalves, octopus and squid), 101 Porifera (sponges), one new species of hemichordate (graptolite) and one unidentifiable sample of animal residue on pumice rock (Table 5). See section 3.5 Taxonomic highlights below which describes some of these finds in more detail.

The level of identification varies from species to family, based on the expertise available or condition of the sample. A total of 344 described species were identified, in addition to at least 32 undescribed species, two possible undescribed genera and a further 28 species and genera were identified with a level of uncertainty (inclusion of taxon qualifiers “cf.” or “aff”) that warrants further investigations (see section 3.5 below). One hundred and twenty-eight genera were identified without a more detailed species identification, 71 samples in 25 families were not identified any further, and often included the qualifier “indet.” indicating the sample was not in a condition to allow more detailed identification.

During the time period since July 2021, at least 15 species have been described based at least in part on bycatch specimens (see section 3.5 Taxonomic highlights below), however, these have mostly included specimens identified before the commencement of the current project.

Table 3: Number of samples identified during the three reporting years of BEN2021-03, Year 1 (2021–22), Year 2 (2022–23) and Year 3 (2023–24). Numbers indicate numbers of samples identified: during each reporting year, historical collections (collected before July 2021), and collections made from July 2021 onwards.

Reporting year	Total no. samples identified	Historical collections (pre-2021)	Collections post-July 2021	Trawl samples	Observer samples	High Seas samples processed
Year 1 (2021–22)	385	374	11	271	114	13
Year 2 (2022–23)	521	369	152	280	241	11
Year 3 (2023–24)	492	345	147	287	205	17
Total	1 398	1 088	310	838	560	42

Table 4: Collection dates of samples identified, during reporting Year 1 (2021–22), Year 2 (2022-23) and Year 3 (2023-24) under BEN2021-03.

	Trawl	Observer
Historical (pre-Jul 21)	780	308
Year 1 (Jul 21–Jun 22)	33	170
Year 2 (Jul 22–Jun 23)	25	75
Year 3 (Jul 23–Jun 24)	0	7
Total (Jul 21–Jun 24)	58	252
Combined total samples identified (n = 1398):	838	560

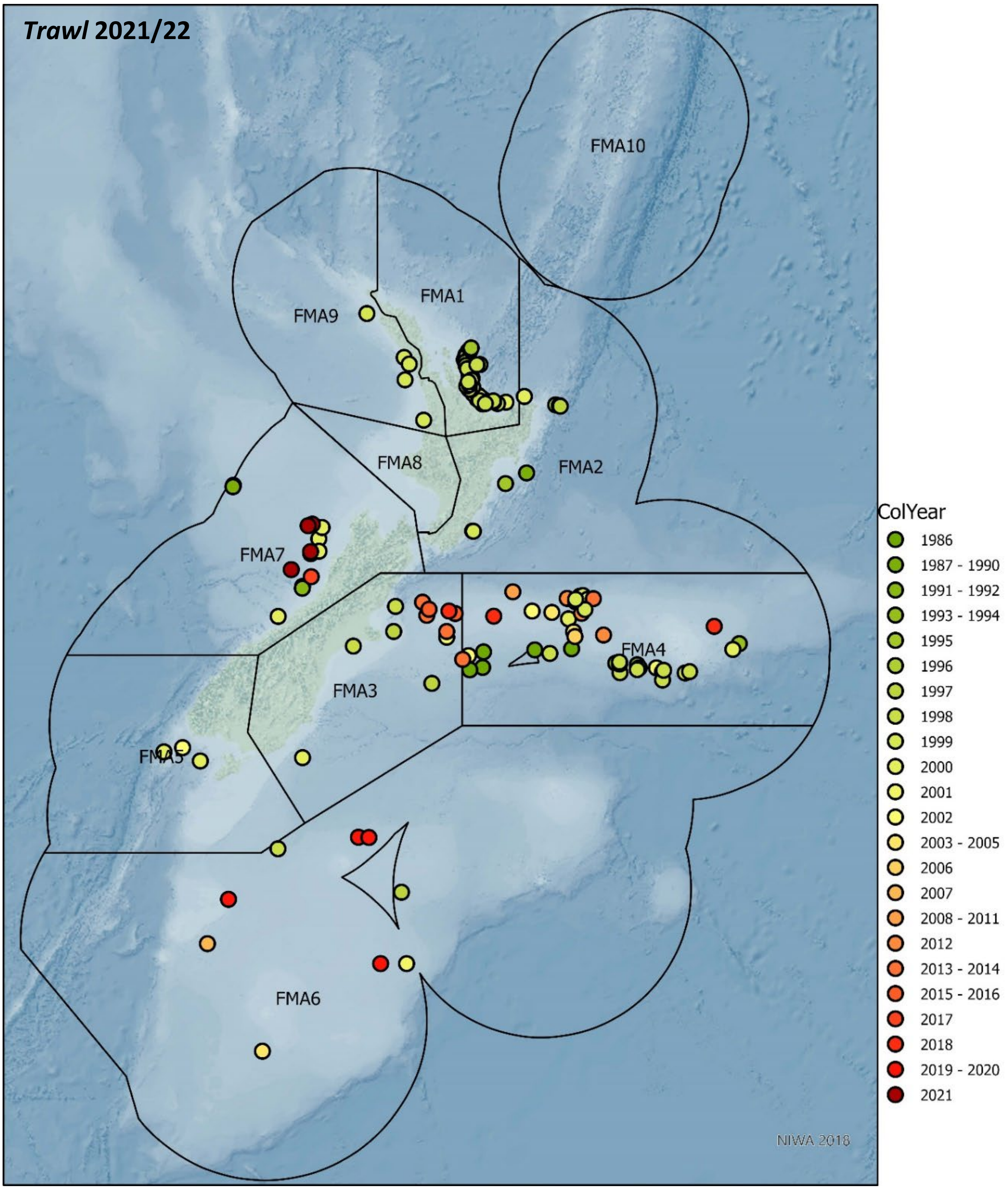

Figure 1: A plot of the location of invertebrate samples processed for YEAR 1 (2021/22) in the New Zealand region from research trawl surveys. Coloured dots are colour ramped according to collection year with the oldest samples in dark green, and the most recent in dark red. Fisheries Management Areas shown.

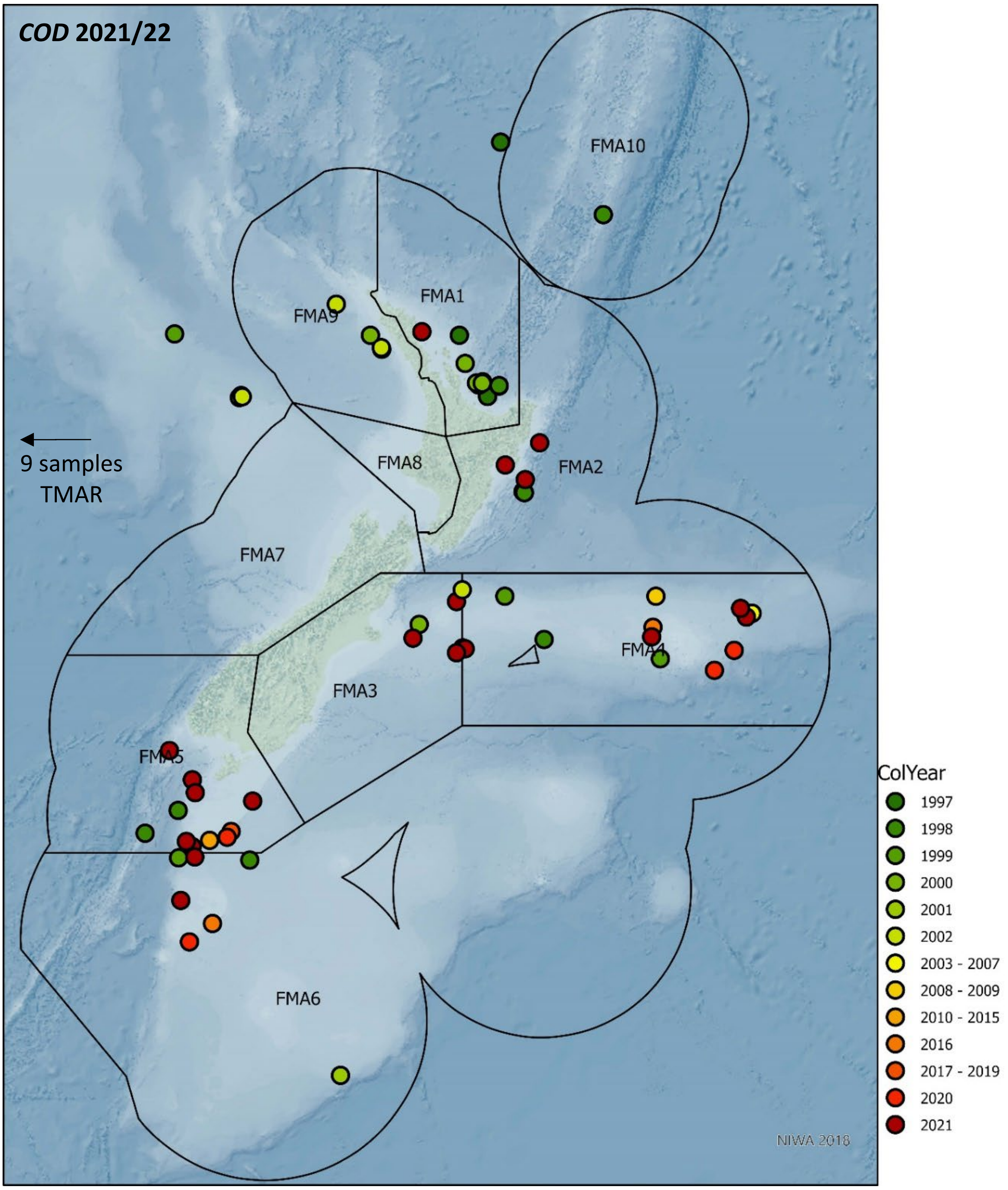

Figure 2: A plot of the location of invertebrate samples processed for YEAR 1 (2021/22 in the New Zealand region for samples returned from observers on commercial vessels. Coloured dots are colour ramped according to collection year with the oldest samples in dark green, and the most recent in dark red. Fisheries Management Areas are shown.

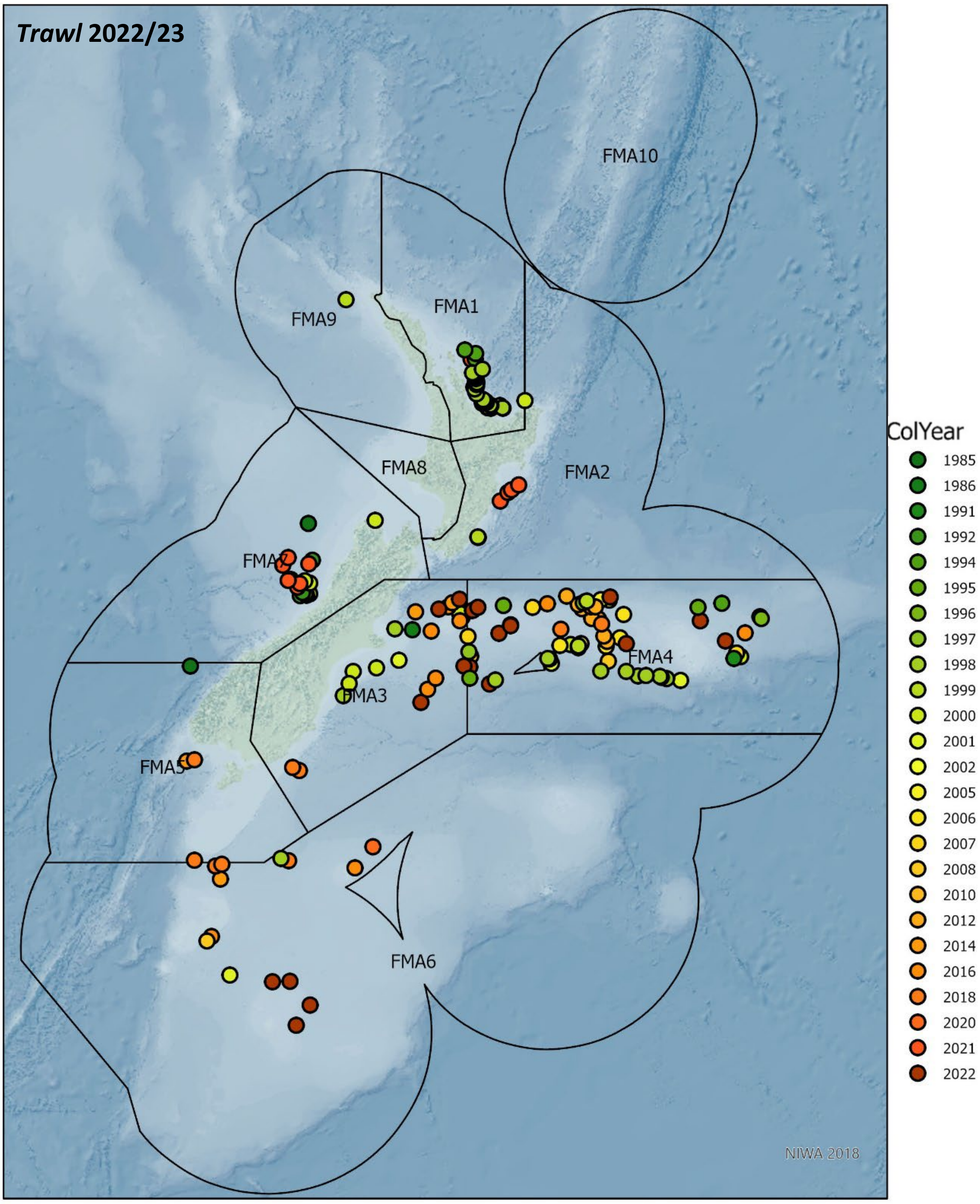

Figure 3: A plot of the location of invertebrate samples processed for YEAR 2 (2022/23) in the New Zealand region from research trawl surveys. Coloured dots are colour ramped according to collection year with the oldest samples in dark green, and the most recent in dark red. Fisheries Management Areas shown.

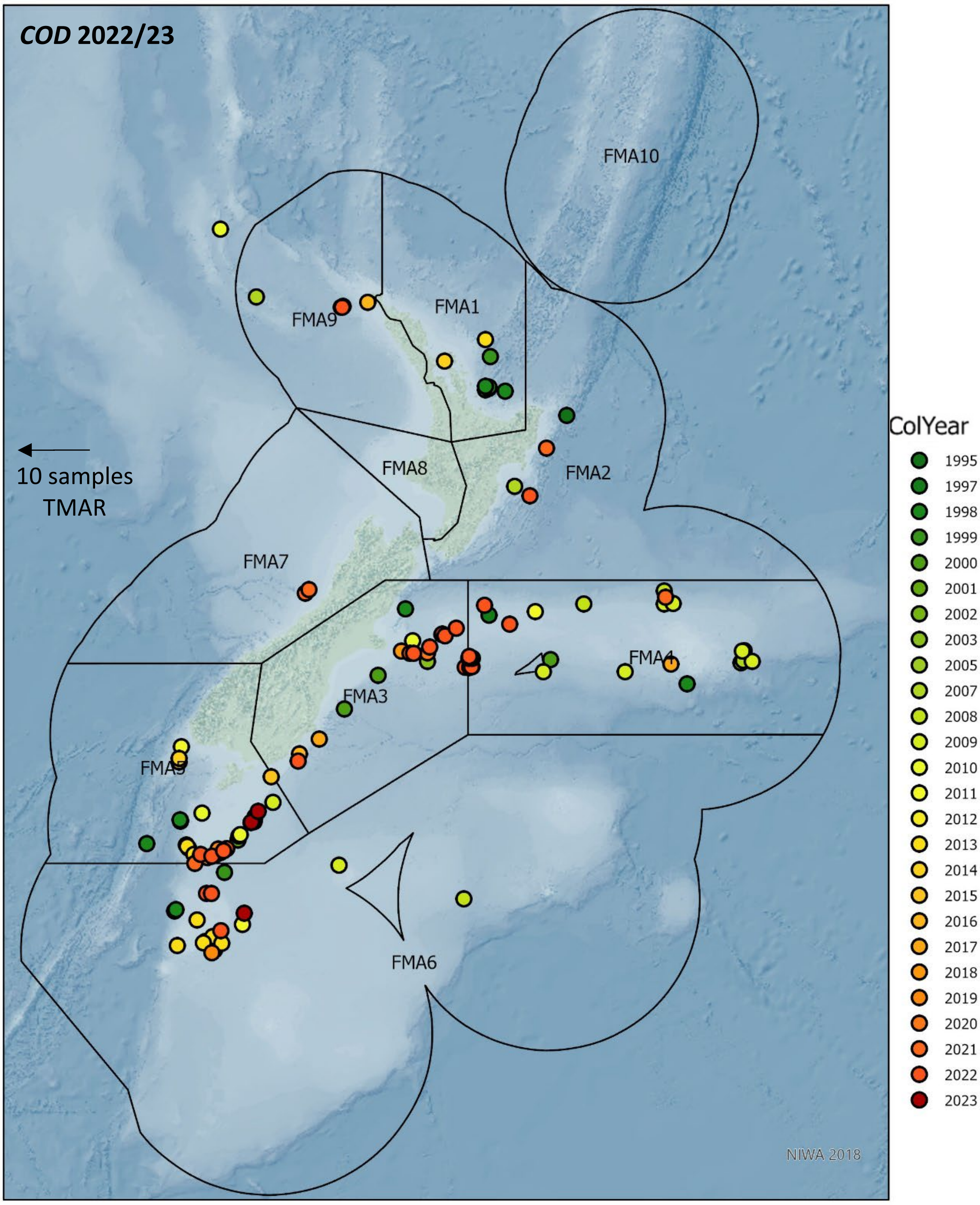

Figure 4: A plot of the location of invertebrate samples processed for YEAR 2 (2022/23) in the New Zealand region for samples returned from observers on commercial vessels. Coloured dots are colour ramped according to collection year with the oldest samples in dark green, and the most recent in dark red. Fisheries Management Areas are shown.

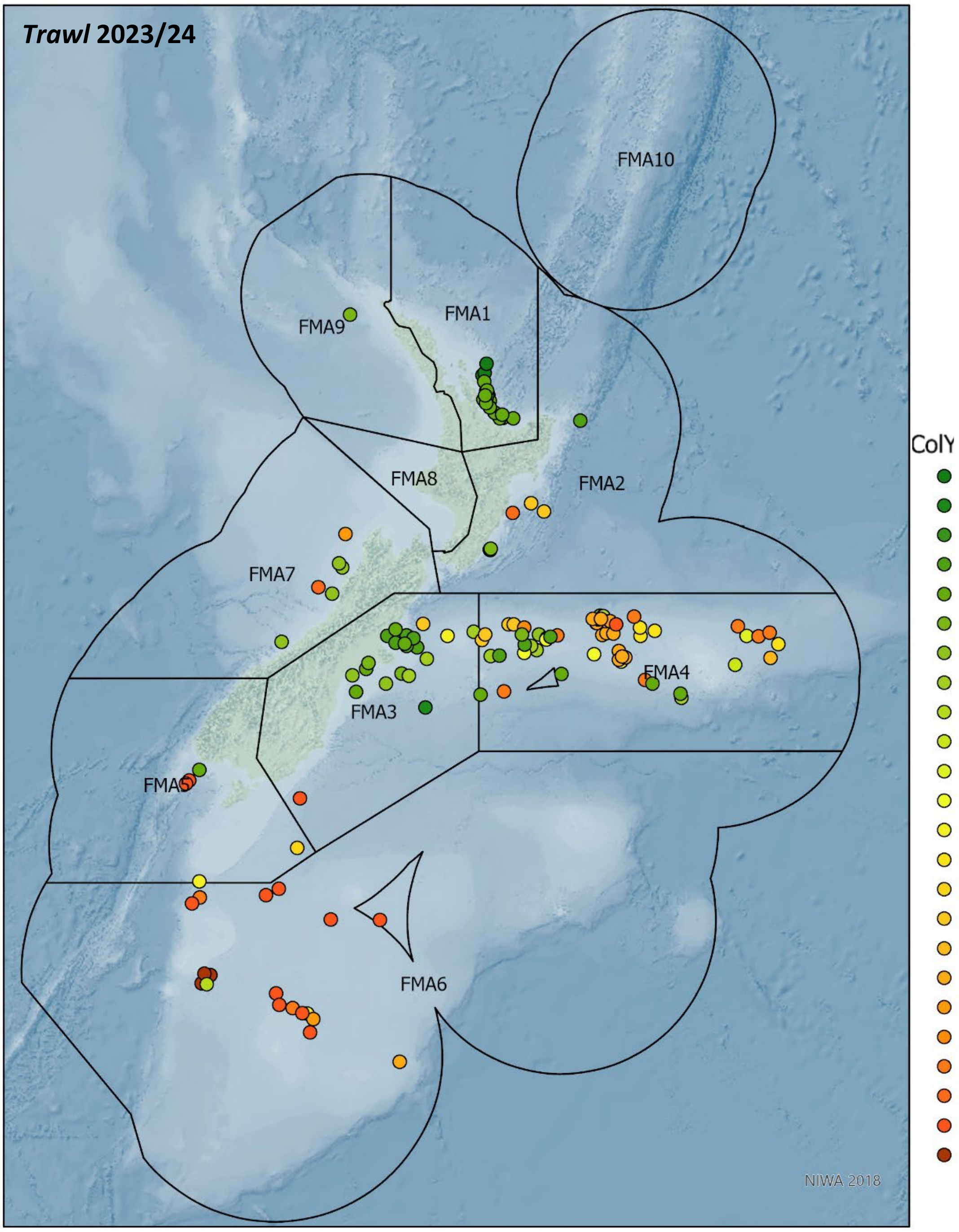

Figure 5: A plot of the location of invertebrate samples processed for YEAR 3 (2023/24) in the New Zealand region from research trawl surveys. Coloured dots are colour ramped according to collection year with the oldest samples in dark green, and the most recent in dark red. Fisheries Management Areas shown.

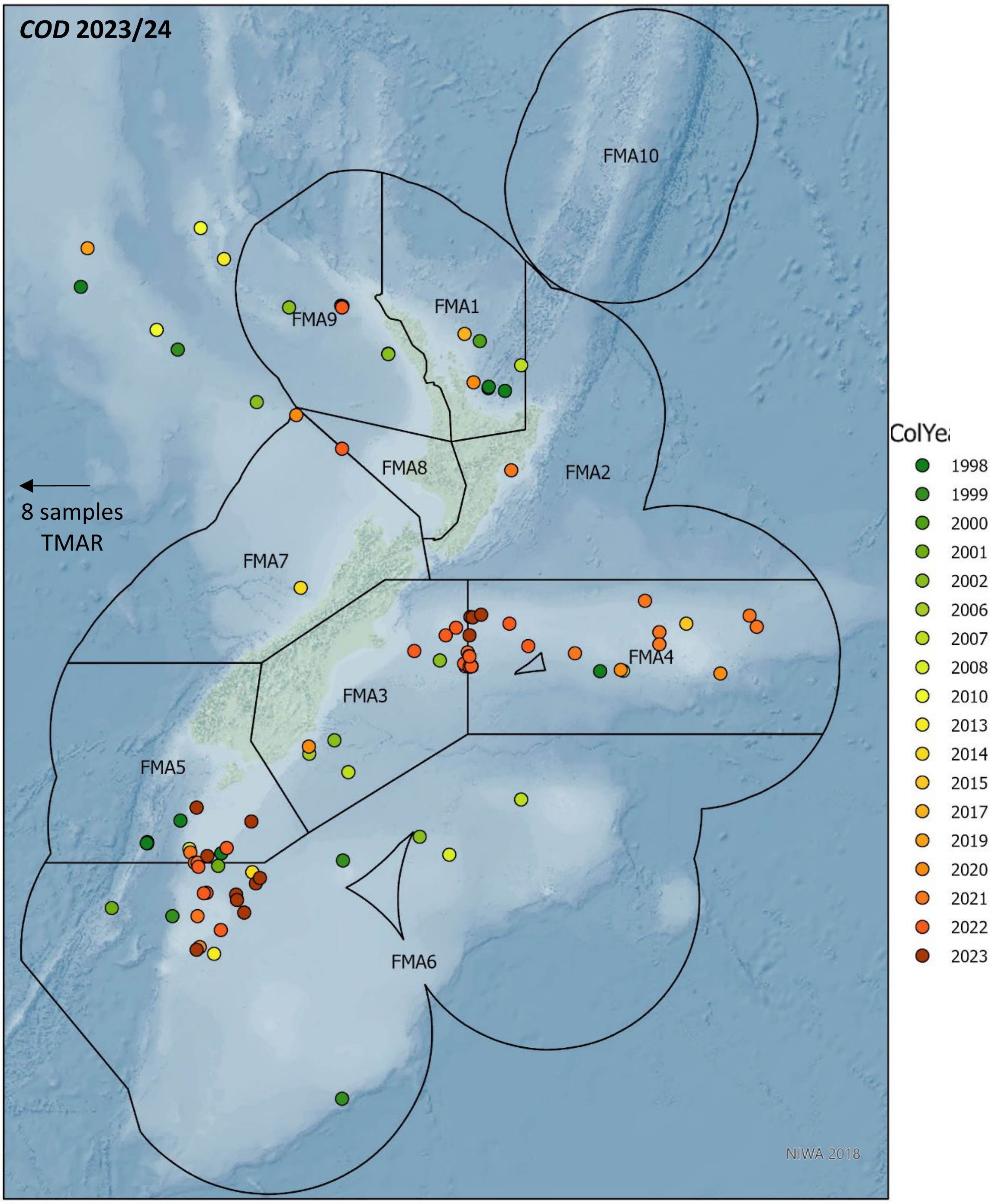

Figure 6: A plot of the location of invertebrate samples processed for YEAR 3 (2023/24) in the New Zealand region for samples returned from observers on commercial vessels. Coloured dots are colour ramped according to collection year with the oldest samples in dark green, and the most recent in dark red. Fisheries Management Areas are shown.

Table 5: Summary of the number of specimens and number of samples identified from the combined research trawl and observer collected material. This list summarises the taxa to family level.

Phylum	Class	Order	Family	No. of samples	No. of specimens
Annelida	***incertae sedis***	Sipuncula	Phascolosomatidae	1	9
	Polychaeta	Amphinomida	Amphinomidae	2	2
		Eunicida	Eunicidae	21	53
		Phyllodocida	Alciopidae	5	11
			Aphroditidae	2	5
			Nereididae	1	5
			Polynoidae	4	8
			Syllidae	2	5
		Sabellida	Serpulidae	4	19
			Siboglinidae	14	72
		Spionida	Chaetopteridae	3	16
		Terebellida	Terebellidae	1	2
Arthropoda	**Malacostraca**	Amphipoda	Ampeliscidae	1	3
			Aoridae	2	21
			Eusiridae	2	15
			Oedicerotidae	1	7
			Photidae	1	1
		Decapoda	Acanthephyridae	3	3
			Alpheidae	1	1
			Aristeidae	9	107
			Axiidae	13	18
			Campylonotidae	2	21
			Chirostylidae	5	11
			Crangonidae	1	1
			Diogenidae	30	112
			Galatheidae	7	14
			Geryonidae	4	4
			Glyphocrangonidae	1	1
			Goneplacidae	32	59
			Homolidae	1	1
			Hymenosomatidae	2	2
			Lipkiidae	1	1
			Majidae	13	24
			Munididae	6	14
			Munidopsidae	3	9
			Nematocarcinidae	4	6
			Nephropidae	19	104
			Oplophoridae	2	2
			Ovalipidae	5	42
			Paguridae	32	70
			Palinuridae	3	3
			Pandalidae	14	148
			Parapaguridae	39	59
			Pasiphaeidae	4	28
			Polychelidae	1	1
			Scyllaridae	32	200
			Sergestidae	2	4
			Solenoceridae	5	26
			Trapeziidae	1	1
		Isopoda	Aegidae	6	8

Phylum	Class	Order	Family	No. of samples	No. of specimens
			Anuropidae	1	1
			Cirolanidae	5	13
			Gnathiidae	1	1
			Idoteidae	2	4
			Janiridae	1	1
			Serolidae	11	92
		Lophogastrida (Mysidacea)	Lophogastridae	1	1
		Mysida	Petalophthalmidae	13	16
		Tanaidacea	unidentified	1	1
	Pycnogonida	Pantopoda	Colossendeidae	12	14
			Pycnogonidae	1	1
	Thecostraca	Balanomorpha	Balanidae	1	4
			Bathylasmatidae	2	9
			Pachylasmatidae	7	37
		Calanticomorpha	Calanticidae	3	13
		Scalpellomorpha	Heteralepadidae	2	39
			Lepadidae	1	400
			Scalpellidae	2	25
Bryozoa		Unidentified ‘fossiliferous limestone’		1	1
	Gymnolaemata	Cheilostomata	Adeonidae	3	3
			Aeteidae	2	2
			Arachnopusiidae	5	5
			Beaniidae	5	5
			Bitectiporidae	13	13
			Buffonellidae	4	4
			Bugulidae	4	4
			Calloporidae	5	5
			Candidae	4	4
			Catenicellidae	11	11
			Cellariidae	2	2
			Celleporidae	12	13
			Chaperiidae	13	13
			Chorizoporidae	5	6
			Crepidacanthidae	1	1
			Cribrilinidae	2	2
			Cyclicoporidae	1	1
			Ellisinidae	2	2
			Escharinidae	9	9
			Eurystomellidae	1	1
			Fenestrulinidae	5	5
			Flustridae	1	1
			Foveolariidae	6	6
			Hippothoidae	8	8
			Lacernidae	5	9
			Lekythoporidae?	1	1
			Lepraliellidae	2	2
			Microporellidae	8	8
			Microporidae	8	8
			Phidoloporidae	3	3
			Powellithecidae	1	1
			Romancheinidae	8	8
			Smittinidae	9	9

Phylum	Class	Order	Family	No. of samples	No. of specimens
		Ctenostomata	Pachyzoidae	1	3
	Stenolaemata	Cyclostomata	Annectocymidae	2	2
			Cerioporidae	1	1
			Cinctiporidae	2	2
			Crisiidae	2	2
			Diaperoeciidae	5	6
			Hastingsiidae	2	2
			Horneridae	1	1
			Lichenoporidae	3	3
			Oncousoeciidae	2	2
			Theonoidae	1	1
			Tubuliporidae	8	8
Chordata	**Ascidiacea**	Aplousobranchia	Polyclinidae	11	23
			Pseudodistomidae	1	5
		Stolidobranchia	Molgulidae	1	1
			Pyuridae	6	7
			Styelidae	4	7
Cnidaria	**Hexacorallia**	Actiniaria	Indet.	8	15
			Actiniidae	3	7
			Actinoscyphiidae	6	9
			Actinostolidae	7	9
			Hormathiidae	10	37
			Liponematidae	2	2
		Corallimorpharia	Corallimorphidae	2	2
		Zoantharia	Epizoanthidae	1	1
			Parazoanthidae	2	2
	Hydrozoa	Anthoathecata	Solanderiidae	1	1
		Leptothecata	Aglaopheniidae	1	1
			Lafoeidae	7	7
			Plumulariidae	2	2
			Sertulariidae	1	1
		Siphonophorae	Rhodaliidae	9	12
			Rhodaliidae?	2	2
	Octocorallia	Malacalcyonacea	Alcyoniidae	23	25
			Clavulariidae	5	75
			Nephtheidae	2	2
			Tubiporidae	9	114
		Scleralcyonacea	Balticinidae	6	6
			Funiculinidae	6	7
			Kophobelemnidae	1	1
			Pennatulidae	1	1
			Sarcodictyonidae	4	32
	Hexacorallia	Actiniaria	Indet.	8	15
			Actiniidae	3	7
			Actinoscyphiidae	6	9
			Actinostolidae	7	9
Echinodermata	**Asteroidea**	Brisingida	Brisingidae	2	2
		Forcipulatida	Asteriidae	1	2
		Notomyotida	Benthopectinidae	1	1
		Spinulosida	Echinasteridae	1	1
		Valvatida	Goniasteridae	5	6
			Solasteridae	1	1

Phylum	Class	Order	Family	No. of samples	No. of specimens
		Velatida	Pterasteridae	1	1
	Echinoidea	Camarodonta	Echinidae	5	5
			Temnopleuridae	1	1
			Trigonocidaridae	1	1
		Cidaroida	Cidaridae	58	1 851
			Histocidaridae	4	4
		Spatangoida	Eurypatagidae	2	2
	Holothuroidea	Aspidochirotida	Synallactidae	6	6
		Elasipodida	Laetmogonidae	2	25
	Ophiuroidea	Amphilepidida	Amphiuridae	6	11
			Ophiactidae	25	341
			Ophiotrichidae	1	2
		Euryalida	Euryalidae	3	21
			Gorgonocephalidae	6	9
		Ophiacanthida	Clarkcomidae	3	5
			Ophiacanthidae	34	166
			Ophiocamacidae	1	1
			Ophiomyxidae	4	4
			Ophiotomidae	4	20
		Ophiurida	Ophiopyrgidae	2	14
			Ophiuridae	3	99
Hemichordata	**Pterobranchia**	Rhabdopleuroidea	Rhabdopleuridae	1	1
Invertebrata			Indet.	1	1
Mollusca			Unidentified egg masses	3	231
	Bivalvia	Adeponta	Hiatellidae	1	1
		Arcida	Limopsidae	2	6
		Carditida	Carditidae	2	3
		Limida	Limidae	3	3
		Myida	Pholadidae	1	1
		Mytilida	Mytilidae	6	238
		Pectinida	Anomiidae	3	46
			Pectinidae	2	2
			Propeamussiidae	5	55
		Pholadomyida	Euciroidae	8	17
	Cephalopoda	Octopoda	unidentified	2	3
			Argonautidae	2	3
			Cirroctopodidae	1	1
			Enteroctopodidae	6	7
			Megaleledonidae	6	7
			Octopodidae	4	4
			Opisthoteuthidae	5	6
		Oegopsida	unidentified	1	1
			Ancistrocheiridae	1	1
			Architeuthidae	2	2
			Batoteuthidae	1	1
			Brachioteuthidae	4	6
			Chiroteuthidae	3	3
			Cranchiidae	5	5
			Cycloteuthidae	1	1
			Enoploteuthidae	2	2
			Histioteuthidae	25	27
			Mastigoteuthidae	2	2

Phylum	Class	Order	Family	No. of samples	No. of specimens
			Octopoteuthidae	6	6
			Ommastrephidae	3	24
			Onychoteuthidae	3	3
			Pholidoteuthidae	2	2
		Sepiida	Sepiadariidae	68	429
			Sepiolidae	3	5
		Spirulida	Spirulidae	1	1
	Gastropoda		Unidentified egg mass	1	1
		Caenogastropoda	Epitoniidae	1	1
		Cephalaspidea	Scaphandridae	12	93
		Cocculinida	Cocculinidae	3	150
		Lepetellida	Osteopeltidae	2	90
		Littorinimorpha	Cassidae	4	13
			Cymatiidae	1	1
			Ranellidae	10	49
		Littorinimorpha	Cassidae	1	6
			Ranellidae	1	1
		Neogastropoda	Ancillariidae	8	22
			Austrosiphonidae	8	9
			Belomitridae	1	1
			Borsoniidae	9	16
			Cominellidae	1	1
			Drilliidae	1	7
			Nassariidae	7	10
			Pseudomelatomidae	7	8
			Ptychatractidae	3	4
			Raphitomidae	4	5
			Tudiclidae	3	3
			Turbinellidae	11	19
			Turridae	1	13
			Volutidae	17	60
			Volutomitridae	1	2
		Neomphalida	Melanodrymiidae	1	30
		Nudibranchia	Dorididae	1	1
		Pleurobranchomorpha	Pleurobranchidae	1	3
		Pseudococculinida	Pseudococculinidae	1	50
		Thecosomata	Cavoliniidae	1	9
		Trochida	Calliostomatidae	2	4
			Solariellidae	5	12
		Incertae sedis	Naticidae	1	2
	Polyplacophora	Chitonida	Acanthochitonidae	1	1
	Scaphopoda	Dentaliida	Dentaliidae	1	1
			Laevidentaliidae	1	3
	Incertae sedis	Neogastropoda	Ancillariidae	1	2
Porifera			Indet.	1	1
	Demospongiae	Axinellida	Raspailiidae	1	1
		Dendroceratida	Darwinellidae	1	1
			Dictyodendrillidae	2	2
		Desmacellida	Desmacellidae	3	3
		Dictyoceratida	Irciniidae	2	2
			Thorectidae	1	1
		Haplosclerida	Callyspongiidae	8	8

Phylum	Class	Order	Family	No. of samples	No. of specimens
			Chalinidae	2	3
		Poecilosclerida		1	1
			Coelosphaeridae	3	3
			Crellidae	1	1
			Latrunculiidae	12	16
			Myxillidae	1	1
			Tedaniidae	2	2
		Suberitida	Suberitidae	17	37
		Tetractinellida	Ancorinidae	6	7
			Geodiidae	5	5
			Pachastrellidae	1	2
			Scleritodermidae	1	1
			Tetillidae	4	12
			Theneidae	1	1
			Vulcanellidae	2	2
	Hexactinellida		Indet.	1	1
		Amphidiscosida	Hyalonematidae	2	2
			Pheronematidae	6	8
		Lyssacinosida	Rossellidae	9	10
		Sceptrulophora	Euretidae	3	3
			Farreidae	1	1
			Tretodictyidae	1	1
Invertebrate (unidentifiable fragment)				1	1
Grand Total				**1 398**	**7 259**

The proportions of identified samples by major taxon group per year (between 2021–2024) is shown in Figure 7 and indicates that consistently large numbers of arthropods (nearly exclusively crustaceans) and molluscs (evenly split in cephalopod and non-cephalopod groups) were identified. As recently presented in the Kelly et al. (2023) updated marine biota inventory of Aotearoa New Zealand, these two groups represent the most diverse phyla, followed by cnidarians, poriferans, bryozoans, annelids and echinoderms, respectively (excluding fishes, foraminiferans and algae). Note that this report excludes the protected coral portion of the bycatch, which explains the relatively small numbers of cnidarians processed here (a reminder that the protected coral bycatch is reported on under a current DOC project).

It is important to note that the groups collected as bycatch and identified not only represent the largest, most species-rich and among the most abundant deep-sea invertebrates, but they are those groups where active national New Zealand research is accessible at present.

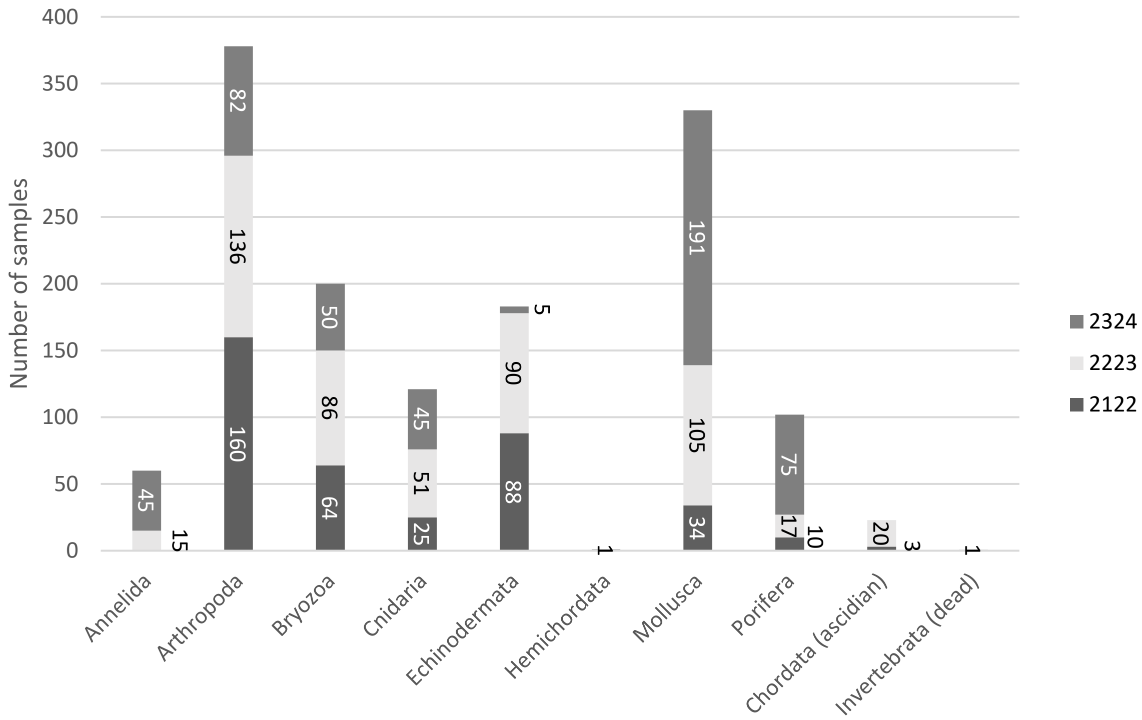

Figure 7: Number of identifications made by year (Year 1 – 2021/22, Year 2 – 2022/23, Year 3 – 2023/24) for each phylum group under the BEN2021-03 project.

3.2 *Trawl* database updates

A summary of the updates and additions of identifications into the *trawl* database are summarised in Table 6 and the sample distribution across the region and FMAs, as well as the range of years the samples have been collected for each of the three years are shown in Figures 1, 3, 5.

Table 6: *Trawl* database summary by year (Year 1 – 2021/22, Year 2 – 2022/23, Year 3 – 2023/24) under the BEN2021-03 project.

TRAWL summary	Year 1 (2021/22)	Year 2 (2022/23)	Year 3 (2023/24)
Total number of samples from research trawls queried	271	280	287
Existing catch and subcatch records had species codes updated (comments were also inserted per catch/subcatch entry, with identification details and date).	11	41	22
Records were inserted into the catch and subcatch tables	252	219	258
Existing catch and subcatch record did not require the species code to be updated, as the code used at sea was correct (though comments were added to the catch/subcatch entry, with identification details and date).	1	0	7
Records were not inserted as the trip_code/station_no does not exist in trawl.	7	20	0

3.3 *COD* database updates

A summary of the updates and additions of identifications into the *COD* database are summarised in Table 7 and the sample distribution across the region and FMAs, as well as the range of years the samples have been collected for each of the three years are shown in Figures 2, 4 & 6.

Table 7: *COD* database summary by year (Year 1 – 2021/22, Year 2 – 2022/23, Year 3 – 2023/24) under the BEN2021-03 project.

COD summary	Year 1 (2021/22)	Year 2 (2022/23)	Year 3 (2023/24)
Total number of samples from observers queried	114	241	201
Existing catch and subcatch records had species codes updated (comments were also inserted per catch/subcatch entry, with identification details and date).	30	74	58
Records were inserted into the catch and subcatch tables	78	166	125
Existing catch and subcatch record did not require the species code to be updated, as the code used at sea was correct (though comments were added to the catch/subcatch entry, with identification details and date).	6		15
Number of fishing events	67	139	128
Records not inserted as the trip_code/station_no does not exist in COD	0	1	4

The updated *COD* data extracts provide further information such as the FMA and target species of the tow (summarised in Table 8 & 9, respectively). Over the three years of project BEN2021-03, the identified samples have primarily been caught in the southern and central FMAs (Southland FMA 5, South-East Chatham Rise FMA 4) making up between 43–54% of the samples identified each year. Lesser numbers of samples have been derived from Southern Offshore Islands FMA 6A, the South-East Coast FMA 3, Auckland East FMA 1 and Auckland West FMA 9 that have made up a combined 24–35%. Less than 10 samples are generally processed from the remaining FMAs and the High Seas areas annually. This pattern is consistent with those reported for similar projects in previous years, e.g., Schnabel et al. (2019, 2021) and Mills et al. (2021).

Table 8: Count of observer collected samples by Fisheries Management Area (FMA) and High Seas (ET) regions by project (BEN2021-03) year. Sample counts represent samples collected during the reporting year as well as historical samples identified in that year.

Area	Description	Count of Samples (Year 1)	Count of Samples (Year 2)	Count of Samples (Year 3)
AKE	Auckland East (FMA 1)	15	12	7
CEE	Central East (FMA 2)	8	5	1
SEC	South-East Coast (FMA 3)	4	24	22
SOE	South-East Chatham Rise (FMA 4)	18	45	42
SOU	Southland (FMA 5)	41	85	44
SUB	Sub-Antarctic (FMA 6)	6	6	19
SOI	Southern Offshore Islands (FMA 6A)	4	36	31
CHA	Challenger/Central Plateau (FMA 7)	0	3	4
CEW	Central West (FMA 8)	0	0	1
AKW	Auckland West (FMA 9)	4	13	11
KER	Kermadec (FMA 10)	1	0	0
CET	Challenger Plateau (ET)	3	0	1
HOWE	Lord Howe Rise (ET)	1	0	5
TMAR	Tasmanian Ridge (ET)	9	10	8
WANB	Wanganella Bank (ET)	0	1	4
	TOTAL:	114	240	201

Bycatch invertebrates are derived from a total of 25 target commercial species bottom trawls and longlines (with very occasional records of potting or set net bycatch) (Table 9). The highest numbers of invertebrate bycatch were collected from fisheries targeting orange roughy, arrow squid, and hoki (65–77% of total identified bycatch samples), which is consistent with similar reports from previous years (as listed above).

Table 9: Target commercial species, fishing method and count of fishing events from which samples were collected by observers and identified for each project year. Fishing method codes: TWL = trawling (includes bottom trawl and mid-water trawl), BLL = bottom longline, SLL=surface longline, POT = potting, SN = set net.

Target Fishery (common name, Fisheries New Zealand code)	Fishing Method	Count of fishing events (Yr 1)	Count of fishing events (Yr 2)	Count of fishing events (Yr 3)
Orange roughy, ORH	TWL	26	24	28
Arrow squid, SQU	TWL	12	24	29
Hoki, HOK	TWL	12	12	14
Scampi, SCI	TWL	2	5	10
Smooth oreo, SSO	TWL		5	7
Oreos, OEO	TWL	3	2	8
Black oreo, BOE	TWL	1		2
Silver warehou, SWA	TWL	1	3	3
Barracouta, BAR	TWL	2	3	3
Bluenose, BNS	BLL	1		3
Alfonsino & long-finned beryx, BYX	TWL	1	1	2
Gurnard, GUR	TWL	1	1	1
Jack mackerel, JMA	TWL	1		1
Hake, HAK	TWL		2	4
Common Warehou, WAR	TWL		2	1
Ling, LIN	TWL, BLL, POT		3	3
Snapper, SNA	TWL, BLL	1		
Tarakihi, TAR	TWL	1		
Cardinalfish, CDL	TWL		1	
NZ southern arrow squid, NOS	TWL		2	
Hapuku & bass, HPB	BLL		1	
Southern bluefin tuna, STN	SLL		1	
School shark, SCH	SN		1	
Alfonsino, BYS	TWL			1
Bass, BAS	BLL			1
Patagonian toothfish, PTO	BLL			1

3.4 Digital image identification

As a proof of concept, and a contract variation in Year 2 only, 99 images were processed, and 551 specimens were identified. Some of these images (n = 20 images, 18 specimens) were identified via the DOC project because they were recorded as a coral taxon by the Observer, and this needed revision. Other images (n = 12 images, 7 specimens) corresponded to physical specimens received in the NIC so the physical specimen ID takes precedence. Sometimes there was more than one image of the same specimen, or there was more than one specimen showing in one image. The large difference in the number of images and the number of specimens is because one image can show between 1–100+ specimens (see examples in Figure 8).

Figure 8: a: Fish bin of mixed fauna (100+ specimens), mostly hard clumps of Bryozoa but also including a bellowsfish, a flat fish, a sea star arm, anemones and possibly some sponges, b: 11 goose neck barnacles attached to one black coral (*Leiopathes* sp.), c: Fish bin of anemones (100+ specimens), d: Fish bin of mixed fauna: Antipatharia black coral (left, n=1), Porifera (left; *Hyalascus*?, n=1), Plexauridae (on top of sponge, n=1), stalked crinoids (middle, n=8), Primnoidae (on top of crinoids, n=1), Ophiuroidea (loose middle and attached to *Paragorgia* right, n=7), *Paragorgia* (right, n=5). Image copyright: Ministry for Primary Industries.

The specimens identified from the images were diverse and spanned 10 phyla, including three specimens of seaweed (Figure 9, Table 10). Most of the specimens were cnidarians (corals, anemones, hydroids, sea pens, zoantharians, corallimorpharians), bryozoans, and annelids (worms). There was also a good representation of sponges and echinoderms (crinoids, echinoids and ophiuroids). Smaller numbers of brachiopods (lamp shells), ascidians (sea squirts), gastropods (sea snails) and arthropods (squat lobsters and goose neck barnacles) were also identified.

Figure 9: Examples of Observer images showing a variety of taxa. a: sponge, *Symplectella rowi*, b: zoantharian, c: a bryozoan belonging to the family Catenicellidae, d: hydroid *Cryptolaria* sp., e: squat lobster *Phylladiorhynchus* sp., f: sea pen. Image copyright: Ministry for Primary Industries.

Table 10: Sample identification and numbers of specimens identified from Observer images.

Phylum	Class	Order	Family	Genus	Species	No. of specimens
Annelida	**Polychaeta (undet.)**					105
Arthropoda	**Malacostraca**	Decapoda	Galatheidae	*Phylladiorhynchus*		1
	Thecostraca	Scalpellomorpha	Scalpellidae			12
Brachiopoda (undet.)						3
Bryozoa						107
	Gymnolaemata	Cheilostomatida	Catenicellidae			2
	Stenolaemata	Cyclostomatida	Cerioporidae	*Tetrocycloecia*	*neozelanica*	1
Chordata	**Ascidiacea (undet.)**					1
	Ascidiacea	Stolidobranchia	Pyuridae	*Pyura*		1
Cnidaria	**Hexacorallia**	Actiniaria (undet.)				188
		Antipatharia	Leiopathidae	*Leiopathes*		1
		Antipatharia	Schizopathidae	*Parantipathes*		1
		Corallimorpharia	Corallimorphidae	*Corynactis*	*australis*	1
		Scleractinia (undet.)				1
		Scleractinia	Caryophylliidae (undet.)			1
		Scleractinia	Caryophylliidae	*Goniocorella*	*dumosa*	1
		Scleralcyonacea	Superfamily: Pennatulacea (undet.)			1
		Zoantharia (undet.)				2
	Octocorallia	(undet.)				3
		Malacalcyonacea	Nephtheidae			1
		Malacalcyonacea	Plexauridae			4
		Scleralcyonacea	Paragorgiidae	*Paragorgia*		5
		Scleralcyonacea	Primnoidae			2
		Scleralcyonacea	Primnoidae	*Thouarella*		1
	Hydrozoa (undet.)					5
	Hydrozoa	Anthoathecata	Solanderiidae	*Solanderia*		2
		Leptothecata (undet.)				3
		Leptothecata	Plumulariidae	*Nemertesia*	*elongata*	1
			Zygophylacidae	*Cryptolaria*		4
			Zygophylacidae	*Cryptolaria*		4
Echinodermata	**Crinoidea (undet.)**					8
	Echinoidea (undet.)					9
	Ophiuroidea (undet.)					11
		Euryalida	Euryalidae	*Astrobrachion*	*constrictum*	1

Phylum	Class	Order	Family	Genus	Species	No. of specimens
Mollusca (undet.)						1
	Gastropoda (undet.)					1
		Nudibranchia (undet.)				1
Ochrophyta	**Phaeophyceae**	Laminariales (undet.)				3
Porifera (undet.)						24
	Demospongiae	Suberitida	Suberitidae	*Suberites*	*affinis*	2
		Tetractinellida	Scleritodermidae	*Aciculites*	*pulchra*	1
	Hexactinellida (undet.)					20
		Lyssacinosida	Rossellidae	n. gen.	et sp. indet	1
		Sceptrulophora	Farreidae (undet.)			2
				Farrea	*similaris*	1
Rock						4
Unidentifiable						1
Grand Total						**552**

Of the 99 images, only 13 showed a specimen label. Labels with trip and tow data and the Observer ID (three-letter MPI code) are required to retrieve accurate fishing and position details and so the specimen can be matched to a benthic record in *COD* (so that the expert ID can be entered). When labels were used, their data was recorded on scrap paper or plastic board although some proper labels were used (Figure 10). Also, the label data varied, and as mentioned above they should at least include the trip/tow and Observer ID for accurate data extraction and matching.

Figure 10: Examples of image labelling showing scrap paper (a & c), plastic board (d) and the proper specimen labels (b).

Due to the lack of sufficient labelling, position and fishing data were not requested from *COD* due to the time-consuming effort involved in trying to reconcile the tow number. If the tow numbers were provided, then the following *COD* data could be included in the image metadata spreadsheet:

- position (the start and end coordinates of the tow)
- depth (minimum and maximum depths)
- collected date
- fishing method
- target species
- Fisheries Management Area

The task of matching benthic records in *COD* to update them with the expert ID was not completed for this variation, partly because of the labelling problem already mentioned and because the database currently lacks the ability to allow for an image file name to be recorded and to be the basis of the specimen record. Additionally, some taxa were not formally identified by the respective expert due to funding constraints as this variation did not allow for the extra specimens to be identified along with physical specimens already identified by the project (when the image did not match a physical specimen in the NIC).

Nevertheless, the variation proved the image processing and identification is valuable, especially if expert IDs were matched and updated in *COD* which would update identification from protected coral taxa to other (non-protected) invertebrate taxa. It could be an efficient method of identifying many specimens and could be used to supplement the annual target number of samples to be identified for the project. It also utilises the photos taken by Observers in a productive way allowing further understanding of benthic fauna. A photo of a live specimen is also helpful when identifying a preserved specimen as it can show colours and morphology that hasn't been affected by preservative. However, image accessibility is difficult and Observer images are currently only available via the DOC CSP project. Image labelling requires improvement, trip and tow number should be included to allow for easy data requests from *COD* and benthic matching.

3.5 Taxonomic highlights

The BEN2021-03 project provided additional records of several interesting species, confirming and strengthening our understanding of their spatial distribution and geographic boundaries. Below are some of the taxonomic highlights which include both details of significant discoveries from samples identified between mid-2021–2024 and taxonomic publications that include fisheries samples published during the same period (these are typically the result of identifications predating this project). Every taxonomic expert acknowledges the provision of samples from the Fisheries New Zealand Observer Programme.

Hemichordata (Dennis Gordon, NIWA)

Colonial hemichordates in the class Pterobranchia are only represented by about 20 living species worldwide with only one described and one nominal species listed for the New Zealand region in the Gordon et al. (2009) biodiversity inventory. Gordon et al. (2024) reviewed all eight extant species of the pterobranch genus *Rhabdopleura* known worldwide and described four new species from New Zealand. One of these species, *Rhabdopleura decipula* Gordon, Quek & Huang, 2024 includes a paratype designated from an observer sample from a squid fishing trip (2577) to the southern Snares shelf (Figure 11).

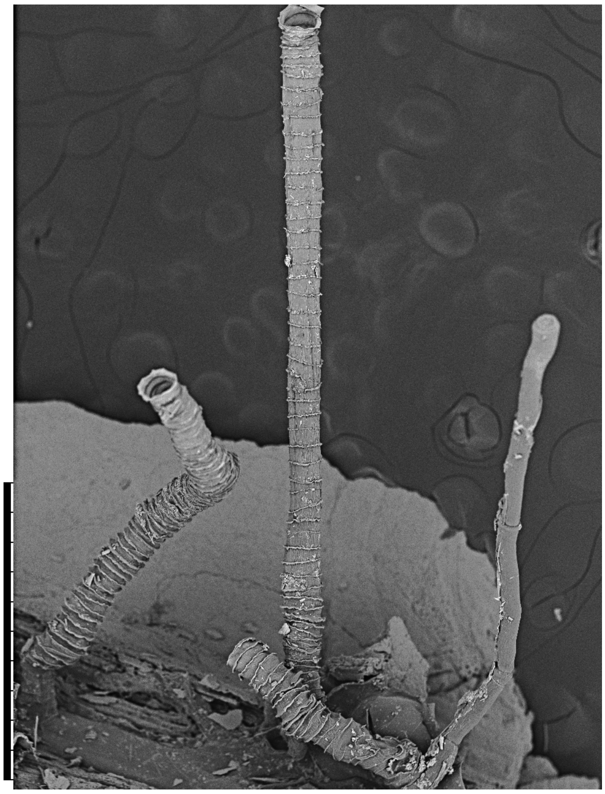

Figure 11: *Rhabdopleura decipula* Gordon, Quek & Huang, 2024, holotype 162592. Scale bar = 1 mm. Image credit: D. Gordon, NIWA.

Arthropoda – Peracarida (amphipods, isopods, mysids) (Rachael Peart, Jeff Forman, NIWA)

Peracarid crustaceans include amphipods (sand hoppers), isopods (slaters), mysids and tanaids. They are typically small-bodied and are not commonly caught as bycatch despite being species rich (>1300 species known in the New Zealand region according to Schnabel et al. (2023)). The majority of the 35 samples identified were isopods (27 samples, 77%), comprising known species of parasitic aegids and large cirolanid and serolids. Some, like *Aegapheles birubi* (Bruce, 2004) or the unusual *Anuropus australis* Schultz 1977 are valuable and rare in collections.

One undescribed species of amphipod in the genus *Ampelisca* (NIWA 114337) and two samples of large eusirid amphipods in the genera *Rhachotropis* and *Eusirus* are of taxonomic interest and valuable records that require further work to confirm a species identification.

Forman & Schnabel (2021) described two new species of mysids, *Ipirophthalmus crusulus* (Figure 12) and *Petalophthalmus lobatus*, first identified from a feeding study of common demersal fishes caught from stratified random research bottom trawl surveys on the Challenger Plateau and Chatham Rise. These species are too small to be collected in commercial fishing gear and were indirectly bycaught. Their taxonomic description, widespread distribution and occurrence in the guts of 15 common demersal fish provided valuable information on the biology of deep-water fishes.

Figure 12: *Ipirophthalmus crusulus* Forman & Schnabel, 2021, holotype female NIWA 135618 (4.9 mm carapace length, preserved in ethanol)

Arthropoda – Decapoda (Kareen Schnabel, NIWA)

A total of 66 crabs, shrimp, prawns, and lobster taxa across 297 samples were successfully identified, with a focus on capturing historical collections in the NIC that were either not identified or registered in the *niwainvert* database. Some species are easily recognised and shelved in the collection but have not had the appropriate curation to capture the data electronically. Hence the higher numbers of some of the more common species such as the two-spined crab (*Pycnoplax victoriensis*, 32 samples), prawn killer (*Ibacus alticrenatus*, 32 samples), hermit crabs (*Areopaguristes setosus* and *Parapagurus latimanus*, 28 and 24 samples, respectively), or the scampi (*Metanephrops challengeri*, 19 samples). Adding these data points in the database creates valuable reference information and expands our geographic and bathymetric range for species, which would otherwise be invisible.

The species identified represent a relatively small portion (about 10%) of the nearly 690 decapods currently known from New Zealand waters according to Schnabel et al. (2023). Nearly all samples were comprised of larger species that are well known and more typically captured by commercial fishing gear. Nevertheless, finds included an unusual squat lobster of the genus *Munidopsis* (NIWA 157718) found on a dried black coral (*Triadopathes*, NIWA 24193) and a rare record of a small trapeziid crab (*Calocarcinus africanus* Calman, 1909, NIWA 16837, Figure 13) collected by an observer from the central Kermadec Ridge in 1998. This latter group of crabs is considered associated with deep-water corals and other colonial cnidarians (Castro & Ahyong 2004).

Notably, a comprehensive review of the squat lobster group formerly combined under the genus *Munida* recently split the genus into numerous separate genera (Machordom et al. 2022). According to their new genus delimitations, New Zealand does not have any *Munida* sensu stricto species, e.g., the common species *Munida gracilis* has been transferred to *Scolonida gracilis*, *Munida isos* to *Curtonida isos* and *Munida gregaria* to *Grimothea gregaria.* It is recommended that the generic squat lobster code for *Munida* spp. (MNI, Figure 13) be applied at a family level (Munididae).

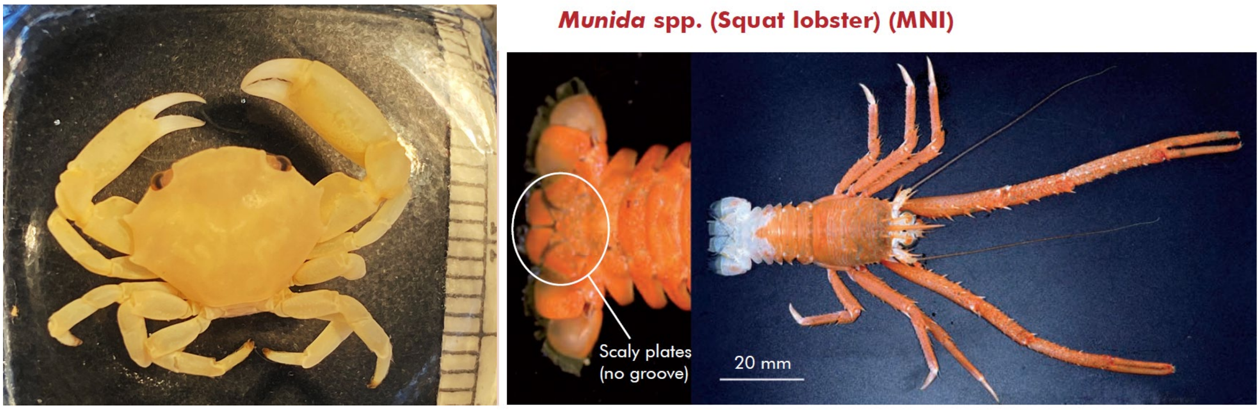

Figure 13: *Calocarcinus africanus* Calman, 1909, NIWA 16837, TRIP1099, central Kermadec Ridge (left). *Munida* spp. (Squat lobster) figure from Tracey et al. (2011) guide (right).

Bryozoa (Dennis Gordon, NIWA)

Bryozoans are incredibly diverse in the New Zealand region, with nearly 1200 extant species recently reported by Gordon (2023), of which over 800 (73%) are considered endemic. They are regionally important biogenic habitat forming organisms that have been linked to fish nursery areas and high benthic diversity (Morrison et al. 2014, Wood et al. 2013). As they can range from small encrusting to sometimes substantially sized free living colonies, and because they are difficult to identify by a layperson, they typically make up a significant portion of returned bycatch. They are nearly always catalogued on board as unidentified invertebrate (e.g. UNF or UNX), rock (ROK) or various coral codes (mostly generic unknown live or dead coral or rubble such as COU, CBB, CBR) but are also often found as encrusting organisms on larger hosts like corals or sponges. Many species can occupy a single substrate, with up to 26 separate species identified from a single specimen returned as an UNX ("any and all unidentified species" from TRIP6533/40, NIWA 147085).

In total, 126 unique bryozoan taxa in 45 families have been identified from 200 separate samples (Table54). Sixteen taxa (across 22 samples) represent undescribed species, all of them appear to be previously known, 12 taxa are of uncertain species affiliations (indicated by the inclusion of the qualifier 'cf.' or "?"). Only one bryozoan was reported as unidentifiable (NIWA 149868, TRIP6401/67); a fossiliferous bryozoan limestone that had undergone diagenesis (degradation of features and altered crystalline state), hence could not be identified with confidence. Specimens collected by observers and during research trawls continue to provide valuable data that aids ongoing taxonomic descriptions and inventories for the New Zealand region.

Schwaha & Gordon (2024) in their revision of the ctenostome bryozoan family Pachyzoidae described a new genus and species (*Pachyzoon grischenkoi*) from a TAN1208 deepwater fisheries survey (Figure 14).

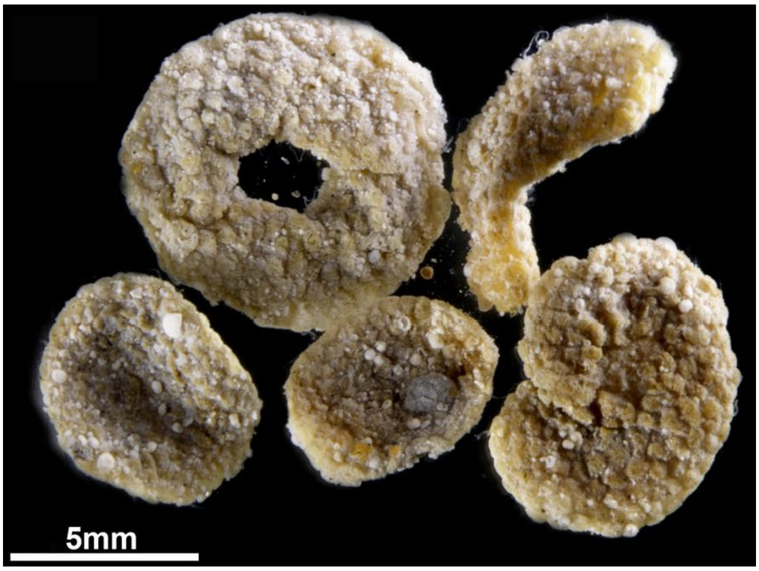

Figure 14: General overview and details of several pachyzoid colonies of *P. grischenkoi* Schwaha & Gordon, 2024 showing size and shape range. Image credit: Thomas Schwaha, University of Vienna.

Cnidaria – Actiniaria (Michela Mitchell, Queensland Museum)

Of the 72 samples of bycatch identified as Actiniaria and triaged for examination, 48 specimen lots (c. 100 individuals) were examined in detail, 38 of which were actiniarians (true sea anemones). The preservation quality of specimens varied and some specimens were so degraded they could not be identified beyond a broad taxonomic category and others were in an excellent condition which will enable taxonomic description. The quality of specimens can be affected by length of time on board prior to preservation, the depth from which specimens were extracted (pressure variation) causing internal structures to simply "melt" and become unidentifiable, freezing and subsequent type of preservation fluid.

Specimens that are so degraded that no further identification is possible have been listed as "indet." as the morphological features required for identification are no longer discernible. At some time in the future these specimens may be identifiable through DNA identification tools depending on their implied value. Please note that the typical 'barcoding' gene Cytochrome Oxidase 1 (CO1) is not an adequate gene to distinguish species of Cnidaria in general, current research instead focusses on using Ultra conserved elements (UCEs, recently reviewed in McFadden et al. 2021). Six specimens were non cnidarian, and an additional two specimens are corallimorpharians; misidentifications are not unusual, groups commonly misidentified include zoanthids and corallimorpharians. Specimens have been assigned to their correct higher classification where possible.

Deep-sea families of Actiniaria (true sea anemones) have been extensively documented from Aotearoa New Zealand, Australia and Antarctic waters (Dunn, 1983; Fautin, 1986; Tracey et al., 2011; MacIntosh et al. 2018; O'Hara et al. 2020; Macpherson et al. 2023): families include Hormathiidae, Actinostolidae, Actinernidae, Actiniidae, and Liponematiidae. These families are common amongst deep-sea fauna catalogued to date, however species composition appears to be markedly different between the eastern and southern coast of Australia (MacIntosh et al. 2018; O'Hara et al. 2020), compared to the eastern and southern deep-sea waters of New Zealand.

Whilst some specimens were left at a higher identification level due to time constraints, 10 genera of Actiniaria and Corallimorpharia were identified: *Hormathia*, *Actinoscyphia*, *Siciyonis* with hormathiids being the prominent group. At least two new genera have been identified as requiring taxonomic description (e.g. NIWA 145817 & 147190).

Of interest are the common symbiotic association of sea-anemones with mollusc shells, glass sponge spicules and bamboo coral substrate, e.g., one sea anemone (NIWA 87085) contained long “threads” (Figure 15) within a mesentery division (not acontia) and is not an anatomical structure of sea anemones. On closer inspection, by the parasitologist Dr. Jerusha Bennett, we could make a tentative identification as a parasitic worm. Tissue was sampled for COI analysis for confirmation. This may prove to be an important finding that documents a parasitic interaction with a sea anemone.

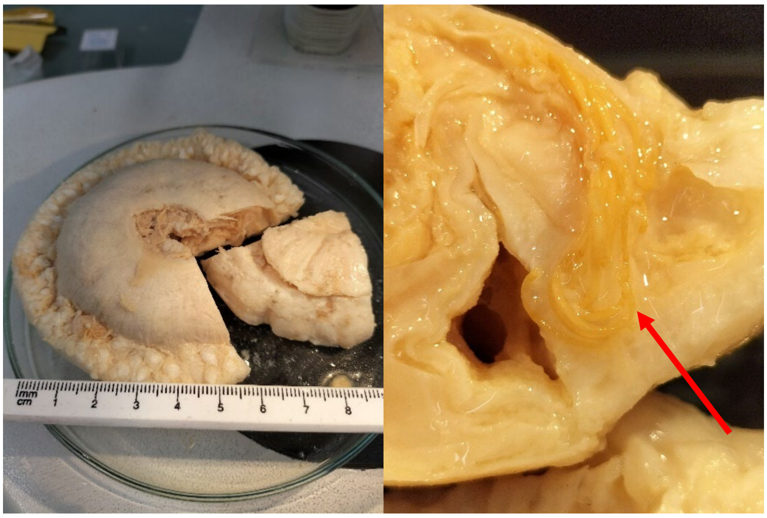

Figure 15: An unusual sea anemone, left, reveals parasite hosts on closer inspection, right (NIWA 87085, TRIP3751/66). Tentatively identified a parasitic worm (NIWA 87085).

Noticeably absent in the examined material was the distinctive *Actinernus* species, there is usually one found in any deep-sea research trawl.

Previous taxonomic examination and identification of NIWA actiniarian holdings focused on higher family level and it is timely to focus future identifications on finer taxonomic resolution (to genus and species), and to describe those samples identified as novel. One such example is a seemingly frequently caught species in bycatch that remains to be described, it was highlighted in a previous report by Mills et al. (2021) and is corroborated by more recent identifications. The new species has been preliminarily designated as Actiniidae sp. 1 (e.g. NIWA 172930, Figure 16), however there may be additional characters not yet observed which may place it in a different family. This is an important species to describe as this family predominantly inhabits shallower water, typically shallower than the observed 114 m this specimen was collected at. Examination of additional material will no doubt provide a better understanding of the depth range the animal inhabits. Additionally, it can be unequivocally confirmed that the species in question is not *Phlyctenanthus australis* nor does it belong to the genus as hypothesised in the previous report (Mills et al. 2021). It is recommended to develop a simple guide for the more commonly caught bycatch species of Actiniaria to genus level at least.

Figure 16: Undescribed anemone species tentatively assigned to the Family Actiniidae (NIWA 172930, KAH9917/58).

Mollusca – Bivalvia & Gastropoda (Bruce Marshall, NMNZ), Cephalopoda (Kat Bolstad and members of the AUT Lab for Cephalopod Ecology and Systematics (ALCES)), Amanda Reid (AM) & Darren Stevens and Mark Fenwick, NIWA)

Molluscs are the most diverse marine group in the New Zealand region, with nearly 4400 species recently reported by Walton et al. (2023), of which 80% are considered endemic. Many of these are small-bodied and are, hence, not typically caught as bycatch, but also include the giant squid *Architeuthis dux* Steenstrup, 1857 one of the largest known extant invertebrates.

The 171 samples of bivalves (clams), gastropods (snails), scaphopods (tusk shells) and polyplacophorans (chitons) identified represented 68 distinct taxa in 45 families and included a known undescribed pectinid (scallop) of the genus *Monia* and a known undescribed gastropod of the genus *Spergo*.

A similar volume of cephalopods was processed under this project: 159 samples in 64 separate squid and octopus taxa. These samples continue to contribute to ongoing research, such as formal taxonomic reviews and new descriptions of species at the Australian Museum (Reid 2021). Reid designated a specimen from a 1998 Bay of Plenty scampi survey as a paratype of the new species *Iridoteuthis merlini* and used fisheries research specimens to redescribe the hitherto poorly defined species *Stoloteuthis maoria* Dell, 1959.

Active research at the ALCES continues, e.g., ongoing work on the ecology of large deep-sea squids, including novel investigations of their vision and microbiome. An MSc thesis on the bottletail dumpling squid (Santos 2020) resulted in two formal species descriptions which included fisheries specimens (Santos et al. 2022, Figure 17 top).

A collaborative international study, including the ALCES team used an observer specimen (NIWA 125199, TRIP5271/5) to verify the first records for the oceanic squid genus *Thysanoteuthis* in the New Zealand region (Deville et al. 2024). While DNA sequenced tissue from a more-recently collected non-fisheries specimen revealed this specimen belonged to a species complex. The observer specimen will be part of the type series in a planned species description.

Verhoeff & O’Shea (2022) designated a specimen collected during a 2010 orange roughy survey (TAN1008) as the holotype of a new species *Grimpoteuthis angularis* with a proposed vernacular name of “Angle-shelled dumbo octopus” (Figure 17 bottom).

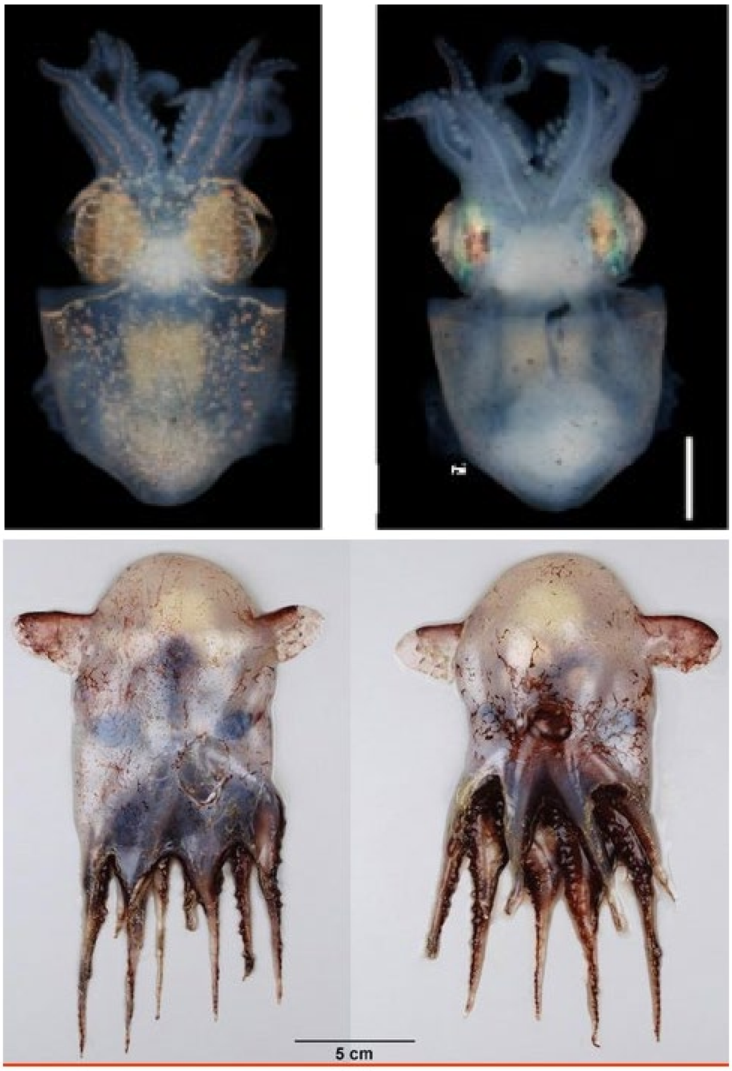

Figure 17: Top: Live specimen photo of the newly described species *Sepioloidea jaelae* Santos, Bolstad & Braid. 2022 bottletail squid (Photos by Rob Stewart, NIWA. Scale bar = 5 mm). Bottom: Pre-fixation photos of the holotype *Grimpoteuthis angularis* Verhoeff & O'Shea, 2022, NIWA 68993, TAN1008/54 (Photos by Darren Stevens, NIWA).

Annelida (Geoff Read, NIWA; Greg Rouse & Gabriella Berman, USA)

A third of the 60 polychaete and sipunculan samples identified from fisheries bycatch (20 samples) belonged to the large *Eunice* bristle worm genus. These worms form soft parchment-like tubes that they inhabit in hard substrates like rocky crevices or coral (Tracey & Hjorvarsdottir 2019). The remaining polychaetes are mainly comprised of known rock-encrusting serpulid and soft sediment species like the sea mouse (*Aphrodita*), chaetopterid tube worm or the fire worm (*Chloeia*).

One of the most notable finds were a community of undescribed bone-eating worms on a whale fall on the Pukaki Rise, collected during a hoki and middle depth fish survey (TAN1614). Two species of *Osedax* were described using genetic and morphological diagnostic tools, initially as a MSc thesis (Berman 2022) and formally described as *Osedax estcourti* and *O. traceyae* by Berman et al. (2024). These specimens and species remain the only samples known in New Zealand and provided a first record for this enigmatic group that is entirely specialised on feeding on sunken animal carcasses (Figure 18).

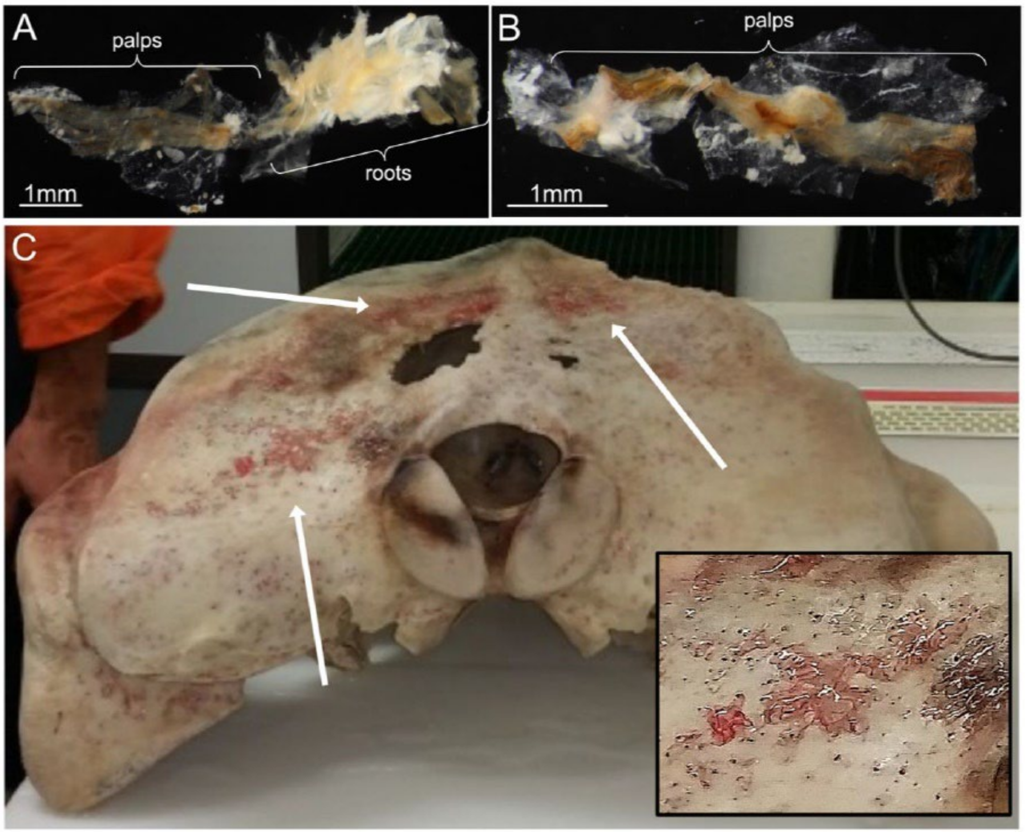

Figure 18: Whale skull trawled from ~390 m on the Pukaki Rise off New Zealand with an inset close-up of the *Osedax*: A. *Osedax estcourti* holotype (NIWA 159436). B. *Osedax traceyae* holotype (NIWA 159436). Arrows and inset point at *Osedax* patches. (From Berman et al. 2024)

Porifera – sponges (Michelle Kelly, NIWA)

Sponges form common benthic catch in the New Zealand region and beyond (high seas and CCAMLR region) but they are usually difficult for a layperson to identify. Kelly & Sim-Smith (2023) highlight both the contributions fisheries research have made to increasing our knowledge as well as the value that sponges provide as biogenic habitat-formers that support fisheries.

Just over 100 samples were identified from fisheries bycatch since October 2021 with a number of significant finds highlighted, e.g. rare specimens of yet undescribed species (*Jaspis* n. sp. 4, NIWA 157351, and *Myxilla* (*Burtonanchora*) n. sp. 1, NIWA 157346). Moreover, specimens have assisted with fixing the definition of a known New Zealand species, such as a sample of *Suberites affinis* Brøndsted, 1924 from close to the original type locality on the Campbell Plateau where it was collected in the early 20th century (NIWA 157350). Twenty-five samples (29 specimens) in 12 families were labelled with qualifiers indicating that they could represent undescribed species (or a new genus, such as reported for NIWA 146552 “Lanuginellinae n. gen. et sp. indet.”) and eight further specimens retained question marks indicating a level of uncertainty that warrants further work.

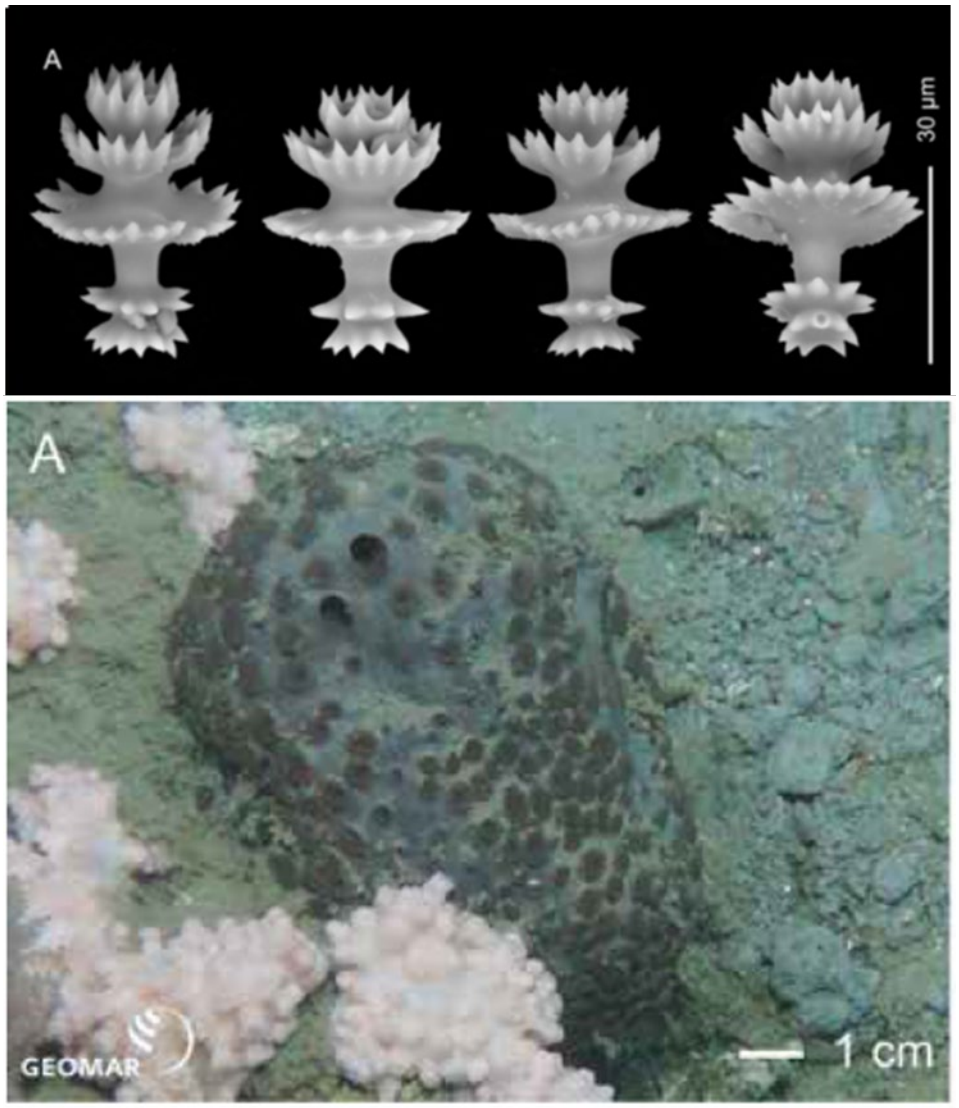

Figure 19: top: *Latrunculia* (*Latrunculia*) *morrisoni* Kelly & Sim-Smith, 2022, spicules (NIWA 49096) sponges, NIWA Stn TAN1602/026, off Auckland Island, 116–118 m, 14 Feb 2016. Bottom: *Latrunculia* (*Latrunculia*) *robertsoni* Kelly & Sim-Smith(In: Sim-Smith et al. 2022), NIWA 126240, *in situ* captured by GEOMAR ROV *Kiel 6000* onboard RV *Sonne* (voyage SO254), courtesy of Project *PoriBacNewZ*, GEOMAR & ICBM. (Both figures from Sim-Smith et al. 2022, reproduced with permission from NIWA)

Fisheries bycatch samples were designated type specimens and new collections listed for latrunculid sponges by Sim-Smith et al. (2022, Figure 19): 1) describing a single specimen collected by an observer during TRIP2704 off 90 Mile Beach as *Latrunculia* (*Latrunculia*) *morrisoni*; 2) designating the holotype of *L.* (*L.*) *roberstoni* (NIWA 44855) from a Chatham Rise hoki survey bycatch sample; 3) designating one of two known samples as a paratype of a new species *L.* (*L.*) *gracilis*. Bycatch samples provided valuable specimens for three further known species.

Kelly et al. (2023) described a new species of a carnivorous sponge *Abyssocladia lanceola* Kelly & Vacelet, 2023 using specimens collected from the Macquarie Ridge and a bycatch specimen from the South Tasman Rise (NIWA 127503, TRIP1137/6).

4. DISCUSSION

Scientific information about benthic invertebrate bycatch collected during research trawls and by observers on commercial fishing vessels is an important tool in expanding our understanding of the aquatic environment of our marine region. The latest three years of funding for the curation and identification of non-protected fisheries invertebrate bycatch has continued to contribute significant information on biodiversity, distribution, and target fisheries bycatch for the Fisheries Science Aquatic Environment and Biodiversity Research programme.

The data presented in this report is used to support a number of Fisheries New Zealand projects that monitor the effects of fishing and investigate impacts of fishing on benthic community structure and function. The project data primarily cover deepwater fisheries; however, the observer-collected samples are not focused on a particular target fishery or FMA.

The key reasons that benthic bycatch specimens have been retained at-sea would be where identification is uncertain, if the specimen has been caught outside the known depth range or distribution given in identification guides, or if the specimen is rare or unusual. The on-board expertise of personnel recording and identifying the bycatch is, as always, exceptional and the value of their ability to identify these unusual and unique specimens cannot be overstated.

This report covers over 7200 specimens from nearly 1400 samples collected between 1985 and 2023, from across the New Zealand Exclusive Economic Zone from inshore survey depths (10 m) to over 2100 m (Figure 20). It also includes a small number of High Seas samples. While the identification is incidental and opportunistic (e.g., taking advantage of visiting taxonomic experts), and not focussed regionally or with a fisheries target, consistently observed patterns may provide some insight into where benthic fauna are most at risk from interactions with deep sea fishing activities. Consistent with previous reports by Schnabel et al. (2019, 2021) and Mills et al. (2021) vessels targeting orange roughy, arrow squid and hoki returned the highest numbers of samples, as did fishing activities in the southern FMAs and Chatham Rise. This was similar to the pattern for protected coral bycatch (Connell et al. 2023, Macpherson et al. 2021), except that for corals oreo fisheries rather than squid fisheries ranked second after orange roughy. This may be because these fisheries use different gear types and have different amounts of contact with the sea floor (use of mid-water trawls versus demersal fish trawls).

Over the years, priority has been given to identifying the most recently collected samples, but this has not been exclusive. In this most recent period, fewer samples were received from observers. This may be a result of some recent issues with returning frozen specimens from the port-of-arrival to NIWA or because fewer bycatch specimens were collected, or even possibly an indication of the use of the invertebrate guide and increased confidence on the part of Scientific Observers to make accurate identifications of bycatch fauna at-sea. This means that in this project about two-thirds of the samples identified were collected prior to July 2021 (identified as historical samples, Table 4) which has allowed us to address the backlog of unidentified sample identifications and distributional records in the NIWA Invertebrate Collection and, in turn, Fisheries New Zealand catch databases.

The expert identification of a broad range of invertebrate bycatch samples collected by both fisheries observers and science staff on research trawl surveys has continued to produce new specimen data records and significant finds. These specimens are important vouchers on which new species descriptions have been based and from which several taxonomic descriptions have been published and have contributed significantly to our recent update of the New Zealand marine biota (Kelly et al. 2023). These publications highlight our improved understanding of the region's species diversity as well as the as yet undescribed biodiversity of benthic invertebrate fauna in the New Zealand region.

The accumulation of these data records from this and the earlier bycatch identification projects continue to contribute to filling knowledge gaps around spatial distribution of species and improve both predictive habitat suitability models and risk assessments for protected and non-protected invertebrates (e.g., most recently by Stephenson et al. (2023a, b), but see also references in previous reports).

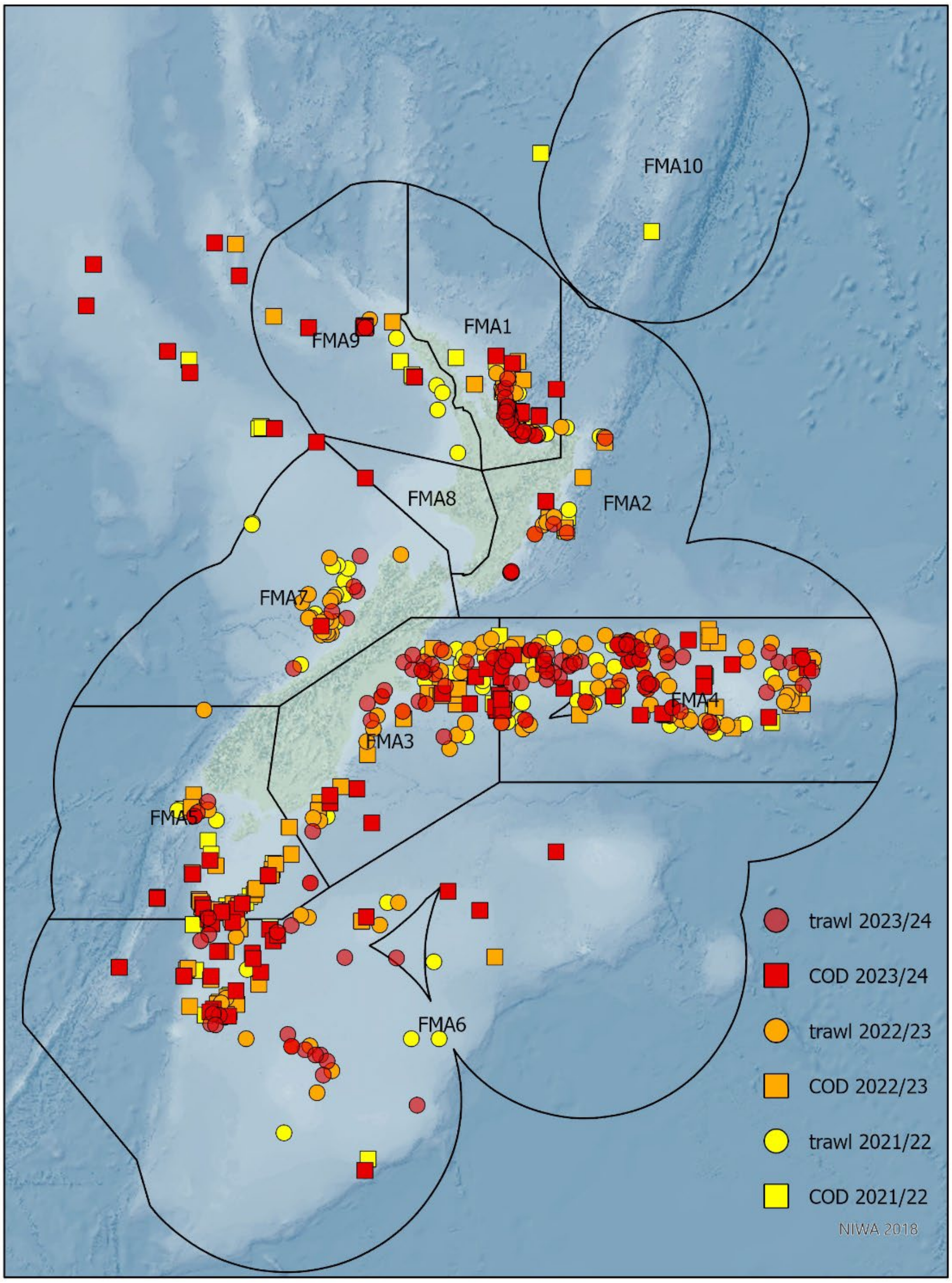

Figure 20: A summary plot of all the in-zone locations of the 1398 invertebrate samples processed for BEN2021-03 by reporting year, research trawl (circles) and observer (squares) collections. Fisheries Management Areas shown.

5. FURTHER RESEARCH

The 2019 National Fisheries Plan for Deepwater and Middle-depth Fisheries (Fisheries New Zealand 2019) describes several of the environmental outcomes relevant to the management of benthic systems and their fauna. These include ensuring that the maintenance of biological diversity of the aquatic environment and protection of habitats of particular significance for fisheries management are explicitly considered in management, to avoid, remedy, or mitigate the adverse effects of deepwater and middle-depth fisheries on the benthic habitat. The recording of benthic invertebrate bycatch data during research trawls and by observers on fishing vessels targeting deepwater stocks continues to improve knowledge of the region's species diversity and distribution and contributes to enhancing the understanding how fisheries activities interact with benthic fauna in the deep sea.

Recommendations for further research are listed below.

Training: We are continuing to refine and improve our processes and the flow of data from the observers, across the observer services and Fisheries New Zealand data services to NIWA, and the recent in-zone observer training workshops have provided additional communication and tools to improve our collaboration. We now conduct observer training for in-zone and CCAMLR observers, which we hope will continue, aligning our protocols and identifications. Fisheries New Zealand science group, Research Data Management (RDM), and Observer Services could further discuss improvements of data and information flow. This work would be separate to this project.

Adding species codes to enhance accuracy: A number of invertebrates do not have an assigned three-letter Fisheries New Zealand species code. New codes could be created for these taxa, to improve the accuracy of at-sea identifications and to help match data records. This task to obtain new codes is managed by the NIWA database manager (Lydia Hayworth) and Fisheries New Zealand RDM.

Developing invertebrate identification guides: Expansion and refinement of the existing deepwater invertebrate guide and the development of an inshore invertebrate guide have previously been discussed with Fisheries New Zealand and would support observers and fisheries researchers at sea. There is currently no comprehensive inshore fisheries invertebrate bycatch guide and there are a range of taxa that are not covered by existing guides (Tracey et al. 2011, 2022).

Improving database record matching: To aid the import and update of Specify *niwainvert* records to *COD* and *trawl*, data fields have recently been added that will map the MPI sample number from the specimen datasheet and OSD to the *niwainvert* data record and to allow an image file name to capture identifications from images. Receiving and matching photographs, however, remain difficult. A meeting of Fisheries New Zealand and NIWA database experts could be held to ensure database loading continues to be refined.

With an increased call for digital capturing and reporting of fisheries bycatch, through cameras on observed vessels or artificial intelligence, reviewing the current accuracy of bycatch reporting and recording (comparing on-board catch ID with expert ID) or piloting a study into the ability to assess invertebrate bycatch from cameras could be beneficial.

Backlog of unidentified samples: A portion of accumulated historical research trawl and observer samples held at NIWA remain unidentified. As at June 2024, 1344 registered fisheries bycatch samples in *niwainvert* await further identification or require verification of tentative field identifications, with 207 of these collected since 2011. The majority of these remain in the decapod crustaceans (393, most of these require verification), anemones (151 samples), starfish (244 samples) and cephalopods (65 samples). There also remain unregistered samples in the NIC that require registration and curation, although these numbers cannot by nature be queried in detail. As stated previously, the authors see the benefit of furthering the identification of the unregistered and registered historical samples in future years.

Focus on specific taxonomic groups: Examples of a targeted taxonomic focus with benefits to specified Fisheries New Zealand Environment Outcomes could include increasing the capacity to identify abundant and diverse anemone fauna. This would fill one of the largest taxonomic gaps currently in New Zealand, and we have now established a collaboration with anemone expert Dr. Michela Mitchell from Museum Tropical Queensland. In some periods, samples from specific areas could be prioritised (e.g., to support habitat suitability modelling, seafloor classification, and spatial management studies).

6. ACKNOWLEDGEMENTS

This work was funded by Fisheries New Zealand under the project BEN2021-03. Special thanks are extended to the research voyage staff and the Fisheries New Zealand and DOC CSP funded observers for sample collection. Dean Stotter and Mark Fenwick processed the samples under the DAT2016-01P project, and we acknowledge their efforts, enabling the smooth running of this project. We also thank the New Zealand and international experts for their identifications, particularly Di Tracey, Owen Anderson, Niki Davey, Jeff Forman, Dennis Gordon, Michelle Kelly, Kate Neill, Mike Page, Rachael Peart, Darren Stevens (all NIWA), NIC volunteer Jill Burnett, the ALCES team with Kat Bolstad, Heather Braid, Jaever Santos (AUT-ALCES), international taxonomists Mandy Reid (Australian Museum), and Frederic Sinniger (University of the Ryukyus, Japan). Contributing authors Diana Macpherson, Jeremy Yeoman, Samy Clinchard, Caroline Wood and Lydia Hayward (NIWA) updated the relevant databases and Darren Stevens (NIWA) reviewed this report. Finally, we thank Fisheries New Zealand, particularly Karen Tunley for their on-going support of this project.

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APPENDIX 1: *SPECIFY* DATABASE STRUCTURE OF SAMPLE DATA FILE PROVIDED

Sample data in *Specify* database format was provided for the Observer and Research collected data in the format set out below and available upon request from Science Officer Fisheries New Zealand (Science.Officer@mpi.govt.nz):

COD/TRAWL
NIWA Cat Num
OSD Num
MPI Sample No.
Observer code
Expert ID Code
Phylum
Class
Order
Family
Taxon Name
Count
Sample_Date
Latitude1
Longitude1
Depth 1
Depth 2
Type Status

APPENDIX 2: INSTRUCTIONS FOR OBSERVERS AT-SEA INVERTEBRATE COLLECTION 2022

Prepared by Di Tracey, Sadie Mills, Dean Stotter, Diana Macpherson, Kareen Schnabel (NIWA)
October 2022

Background

Consistent with the requirements of section 8 of the Fisheries Act and the NZ *Biodiversity Strategy* there has been a move in recent years to "*Collect data to underpin the development of assessment and monitoring capabilities for biodiversity and ecosystems',* and examine trends in the abundance of "associated or dependent species", i.e., non-target fish and invertebrate species associated with, or impacted by, commercial fishing. Analyses of benthic invertebrate incidental catch data have been shown to be useful for the determination of species distributions and benthic communities affected by trawl fisheries. Improved field identification facilitates these analyses but is also useful for predictive habitat suitability modelling studies and the development of accurate ecological risk assessments of fisheries' impacts on benthic habitats.

Instructions for refining sample collection at sea from observed trips were prepared at the beginning of the MPI's Deepwater Project in 2010 and have been revised in 2016, 2018 and in 2019. Here the instructions are updated and slightly revised to include image of updated labels and an example specimen photograph. The instructions complement what is already described in the 3rd edition of the Deepsea Invertebrate Guide (Tracey et al. 2011), under INSTRUCTIONS FOR COLLECTION AT SEA, Pages 5-6.

Also see **Instructions to Observers when carrying out at-sea protected coral data collection** Prepared by Di Tracey, Sadie Mills (NIWA). October 2022.

We thank all Observers for following these instructions

Invertebrate specimens should be retained under the following circumstances:

- identification is uncertain
- the specimen has been caught outside the given depth range or distribution
- they have been specifically requested
- are rare or unusual specimens

If you are not confident that you can identify the organism to species, genus, or family level, then we encourage the use of the higher taxonomic level codes. Then please retain any specimens you are not able to identify, or that appear different to the images in the guides, to enable verification and expert identification ashore.

Specimen handling instructions

- Separate the groups/species as well as possible as time allows.

- Place the sample or a representative sub-sample of the organism in a plastic bag.

- Populate the label with all details and ensure the label details match the benthic and samples form numbers Observers use to record benthic catch data.

- The total weight and sub-sample weight data are needed so that when the specimens are identified by experts the sub-sample weight can be correctly allocated and accurate database updates made. Any updates are made easier when we know what the total organism weight is. Keeping organisms separate and providing individual weight data, even if they are only estimated weights, aid in the database updates.

- Freeze immediately.

- If the organism is fragile (e.g., echinoid, crab or prawn), freeze it in a ziplock bag with enough seawater to cover it, or inside any small rigid container you have available (a box or recycled plastic container).

- Dead shells can be recorded (and or use the code FLL = shell hash) on catch forms (write status ‘dead’ on forms) and retained for taxonomists to identify later.

- Dead coral and coral rubble (code CBB, code CBD if dead) sub-samples can also be retained to confirm identification. **See separate instructions for protected corals.**

Labelling

Write on a waterproof label, **in pencil** (2B preferred):

- Area, [Stat area, FMA]
- trip number
- station number or tow/set number
- MPI Benthic Materials Form Sample ID number
- MPI Species Code

and place inside the bag facing outwards so that it can be read from the outside of the bag when frozen.

NAME:	AREA:
TRIP:	TOW/SET:
Observer Benthic Materials Form MFish sample ID:	(write in pencil) MFish Species Code:
Comments:	
(NIWA use only) NIWA ID:	
OSD:	Specify:

When a sub-sample is collected, please write ‘sub-sample’ on the label as well as on the Benthic Materials Form in the comments section and provide the estimated **total weight** of the organism(s).

Freighting samples

Please follow the Transport Instructions in the MPI Observer Manual, and send by frozen freight to:

NIWA, 301 Evans Bay Parade,
Hataitai, Wellington 6021
Attn: Dean Stotter

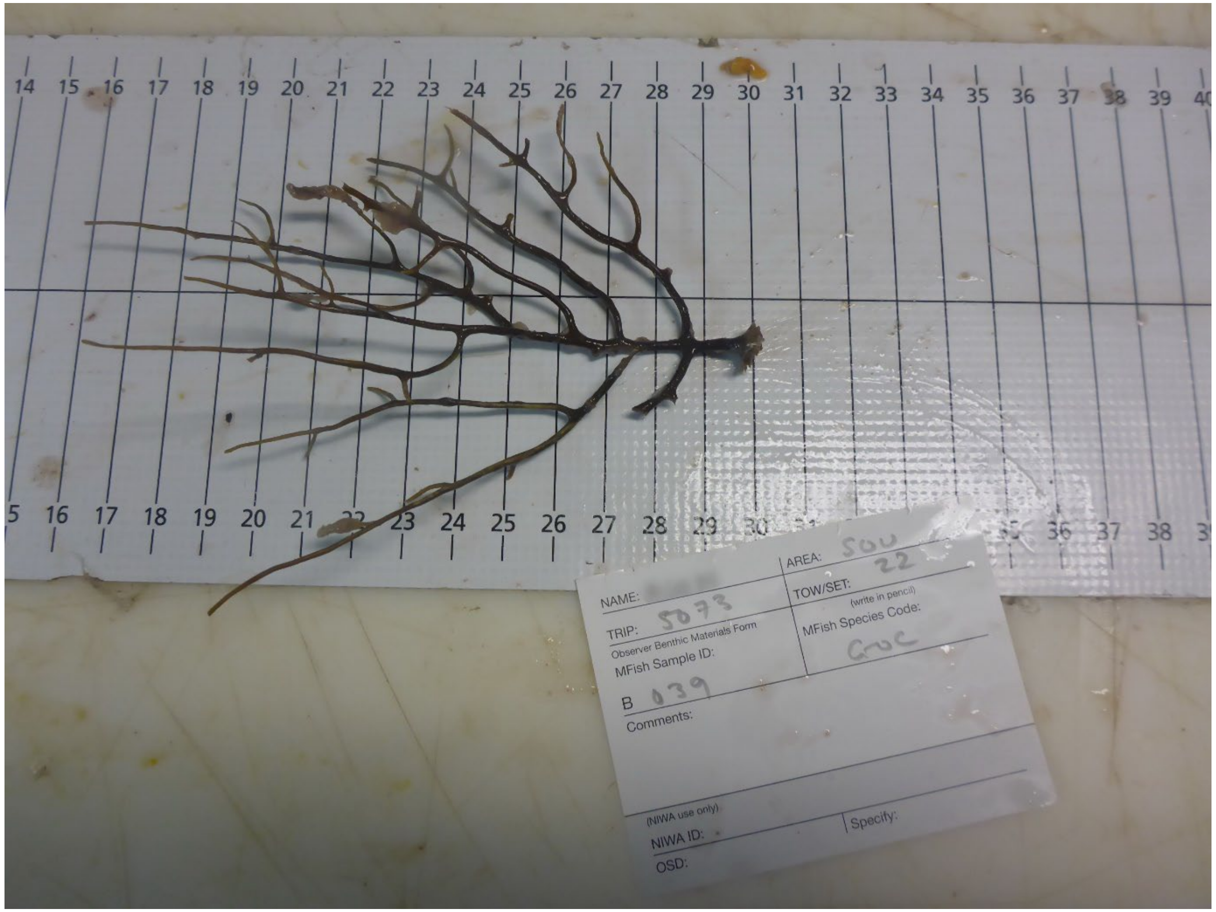
- Please check the Observer Manual for instructions regarding specific project requests for samples by DOC or MPI. In some projects, the destination of samples may be different from the address given above.
- CONSIGNMENT NOTE: Please write TRIP No. and Vessel No. on the consignment note and if time allows a brief description of what is in the shipment helps.
- SACK, BOX, BAG: Please write on the outside of the sample bag / sack / box to be freighted frozen to NIWA, the TRIP No. and if possible, the Consignment note No. This helps NIWA keep track of samples.
- It is also helpful to place one of the spare copies of the Observer Specimen and Sample Log sheet (in a sealed plastic bag), inside the sack/ box/ bag with the samples.

Digital collection of photographic images

The specimen images may be used to complement the returned specimens when they are being identified by experts, and they provide additional benthic data which is of value to MPI. Therefore, it is important that these instructions are followed to streamline processing and identifying the photographed specimens. Please see an exemplary photo shown below.

- Digital images should be taken to accompany the returned specimen, or when a specimen cannot be returned but requires confirmed identification.
- Separate the groups/species as well as possible and take images of one species at a time, i.e., avoid grouping many different species together within the same image as it becomes difficult to process the image later.
- Take one image of the whole specimen, and if deemed useful, capture a close-up image of a part of the specimen to provide more detail. Two good images maximum per specimen.
- Capture the image in good light and using a plain grey background if possible. Ensure the specimen is in focus.

- Ensure a size scale is included in the image.
- **<u>Ensure the specimen label (as shown above) is filled in and showing in the image.</u>** This is important ensures the returned specimen and the specimen photo can be matched later and when adding geo-reference data such as depth, latitude, longitude, to the image.
- Ensure the Observer’s name is provided as this is also important to include in the geo-referencing particularly for acknowledgements, feedback to the Observer, or if the images are used for other purposes, e.g., guide production).
- The images are to be stored in .jpg format.
- Please follow the Instructions in the MPI Observer Manual for taking digital images.



An example of a good specimen image showing an entire specimen with a scale and the MPI label with all required information filled in. Note the specimen is in focus and the lighting is adequate to aid identification.

Reference

Tracey, D.M.; Anderson, O.F.; Naylor, J. R. (Comps.) (2011). A guide to common deepsea invertebrates in New Zealand waters. *New Zealand Aquatic Environment and Biodiversity Report No*. 86. 317 p.

APPENDIX 3: REVISED INSTRUCTIONS FOR RESEACHERS (UPDATE 2023)

Revised by Di Tracey with input from Peter McMillan, Darren Stevens, Sadie Mills
June 2018 (revised June 2023)
Project BEN2021-03

Consistent with the requirements of section 8 of the Fisheries Act and the NZ *Biodiversity Strategy* there has been a move in recent years to "*Collect data to underpin the development of assessment and monitoring capabilities for biodiversity and ecosystems',* and examine trends in the abundance of "associated or dependent species", i.e., non-target fish and invertebrate species associated with, or impacted by, commercial fishing. Analyses of benthic invertebrate incidental catch data have been shown to be useful for the determination of species distributions and benthic communities affected by trawl fisheries. Improved field identification facilitates these analyses but is also useful for predictive habitat suitability modelling studies and the development of accurate ecological risk assessments of fisheries' impacts on benthic habitats.

Instructions for refining sample collection at sea from observed trips were prepared at the beginning of the Deepwater Project DAE201001 in 2010. Here the instructions are updated and slightly revised under Projects BEN202103. The instructions complement what is already described in the 3rd edition of the Deepsea Invertebrate Guide (Tracey et al. 2011), under INSTRUCTIONS FOR COLLECTION AT SEA, Pages 5–6.

Other useful resources to refine these instructions include the appended Live Status of Corals Report (Tracey et al. 2015) see pages 7 and 8 below; the revised Coral Identification Guide (Tracey et al 2014); the Black Coral Guide (Opresko et al. 2014); and the Sea Pen Guide (Williams et al. 2014). The intention of guides is to assist in the identification of the common deepsea benthic fauna in the New Zealand region. If not already provided, all guides are available from Di Tracey (NIWA), from MPI, or from DOC.

Biosecurity reporting guidelines for use on NIWA research vessels have been considered in this revised document. For ease of populating biosecurity tables, the Sample Collection Form (page 4), has been updated. Lot numbers are now required for the samples being returned to NIWA.

Specimens should be retained under the following circumstances:

- identification is uncertain
- the specimen has been caught outside the given depth range or distribution
- they have been specifically requested by the MPI
- rare or unusual specimens

Thanks to all Researchers for following these instructions

Handling instructions: Researchers
For research trawl surveys the instructions comprise part of the specific voyage objectives.
At each station all items in the catch are sorted and weighed on motion-compensating electronic scales and where possible, identified with the use of at-sea guides to the lowest taxon possible at sea.

Record species names using the 3-letter MPI species code, along with weight, count. New 3-letter species codes continue to be created to support this task (see **species_master table in *rdb*** database).

If you are <u>not</u> confident that you can identify the organism to species, genus, or family level, then we encourage the use of the higher taxonomic level codes. Retain any specimens you are not able to identify, or that appear different to the images in the guides, to enable verification and expert identification ashore.

When samples or subsamples are retained, they should be preserved according to the facilities and materials available, and the following instructions should be followed. Specifically, for the **research trawl survey samples,** managing specimens includes the following steps:

- Fixing and preserving samples – done at sea and usually involves freezing
- Documenting samples (station numbering, labelling) – done at sea
- Sorting (dividing samples into major or minor taxonomic groups (‘taxa’) – in the laboratory or at sea
- Maintaining an inventory of all samples/specimens using the Sample Collection Form, hard copy and also electronically in a spreadsheet (see page 4 below). Voyages routinely follow the protocols described in this Appendix for labelling, storage, and tallies of material. Prior to sailing all trawl survey voyage leaders are provided with:
    - a spreadsheet for use when recording retained benthic invertebrate (and fish) sample data (the Sample Collection Form)
    - sample labels.

The identification and taxonomic verification by experts and *trawl* database updates are made easier by the accurate at-sea data collection. The consistent use of the specimen label and the Sample Collection Form, aids the sample processing.

At sea

- Separate the groups/species as well as possible as time allows
- Place the benthic sample or a representative sub-sample of the organism in a plastic bag

• Write on a waterproof label, **in pencil**:

- Unique sample number or Lot number
- Trip number
- Station number
- MPI Species Code
- Weight of sample retained
- Total weight of sample (if sub-sampling)

and place inside the bag facing outwards so that it can be read from the outside of the bag when frozen.
• Freeze immediately. If there are large amounts/numbers of samples retained, keep each phylum in separately labelled boxes.

	NIWA	
Trip:		Stn:
ID:		
Lot no:		
No. kept:		
Sample wt:		
Total wt:		
		Photo E F Z

• When a sub-sample is collected please write 'subsample' on the label and provide the **total weight** of the organism(s) in catch, and the **sub-sample weight** on the label. The total weight and sub-sample weight data are needed so that when the specimens are identified by experts the sub-sample weight can be correctly allocated and accurate database updates made. Any updates are made easier when we know what the total organism weight is.

Inventory

An inventory of the benthic samples must be kept using the Sample Collection Form (**see page 4**), and data entered into an electronic spreadsheet when time allows. The data recorded on the Sample Collection Form includes: unique consecutive lot number for each sample, voyage number, station number, MPI 3-letter species code, code, count, weight of sample, total weight, as this information is helpful when later disseminating samples for identification purposes, for voyage report summaries, for biosecurity requirements, and most importantly for *trawl* database updates.

Photographs

Specimens of unusual species collected will be photographed at sea only as time permits. Please use a scale bar and include the specimen label (with the minimum information of voyage and station number written on the label) in the image. Photographs will then be available for updates to identification guides to ensure a standard approach is maintained.

Sample Collection Form for research trawl voyages

The Sample Collection Form is a paper copy form used in the wet lab or fish processing area to inventory samples.
Unique sample number = Lot number.
Carton numbers must be recorded.

Fisheries survey - invertebrate and fish sample collection form
(Use separate pages for fish and invertebrates)

Page ____ of ____

Trip code ____________

Area ____________ Target species ____________ *Punched* ✓ Y / N ________

Unique sample Lot No.	Station No.	MPI species code	Carton No.	Count	Sample weight or volume (g)	Total weight (g)	Preserve Code Z, F, E	Destination (if non-NIWA)	Comments
1									
2									
3									
4									
5									
6									
7									
8									
9									
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
0									

Preservation instructions for the invertebrate groups

A more detailed field guide to the preservation/fixation of marine invertebrate taxa produced by the NIWA Invertebrate Collection can be provided on request

- If the organism is fragile (e.g., a coral, crab, echinoid, or prawn), freeze animal in ziplock bag with enough seawater to cover the animal or place in a plastic container.
- Dead shells (and or shell fragments = code FLL), dead coral and coral rubble sub-samples must also be recorded on catch forms and retained for taxonomists to confirm identification.

Freeze benthic organisms (as above), or, if chemicals are available, carry out instructions for the relevant animal groups as described in more detail below. If large numbers of an organism are requested, freeze in bulk.

- Different fixation and preservation methods are used depending on the purpose, e.g.:
    - samples for DNA analysis must be frozen or preserved in 99% ethanol (EtOH), specimens fixed in formalin are almost useless for DNA studies
    - hard bodied animals, such as crustaceans and corals are preserved in 99% EtOH.
    - Jelly- or worm-like, soft bodied animals are fixed in 5-10 % formalin.

- Use a liquid volume at least 5-10 times that of the animal because water released from the body and tissues of the animal will dilute the fixative or preservative. For large specimens, use a syringe or knife to help fixative or preservative penetrate the tissue.
- For all chemical use please follow appropriate Health and Safety Guidelines provided for the voyage. Material Safety Data Sheets (MSDS) and instructions for safe handling must accompany the chemicals.
- Specific instructions for preserving or fixing each taxonomic group are listed below where you have access to chemicals onboard:

• Cnidaria

Scleractinian stony corals, gorgonian octocorals (sea fans, sea whips), black corals, hydrocorals, sea pens, soft corals: – fix in 99% ethanol. For bulk, freeze all or a sub-sample, e.g., if 30 kg of stony branching corals (CBR) are collected, only keep a subsample. If the organism appears dead still record code and weight on catch forms, dead specimens can be retained for taxonomists. Coral that appears rubble like but comprises both dead and alive pieces would ideally be recorded using the most appropriate code e.g., SIA, CBR, CUP or if you can go to species – MOC, SVA etc.

Anemones: – place anemone in a bucket of seawater, add 2-3 crystals of crystals of menthol. Keep in bucket for 24 hrs. Once anemone is relaxed, remove from seawater and fix in 10% formalin (it is essential to inject the body cavity with the fixative). More than one specimen can go into a single bucket if each specimen is individually labelled and kept in a separate bag with holes made in the plastic bag to enable fixing.

- Porifera

  Sponges: Freeze or preserve in 99% ethanol.

- Annelida

  Bristle worms, sea worms – fix in 10% formalin.

- Mollusca

  Shelled forms, including chitons: – freeze

  Sea slugs: – ideally photograph when captured to capture live colouration, then freeze or relax in seawater with 2-3 menthol crystals for 24 hours before fixing in 5-10% formalin.

  Octopus and squid: – Freeze or tissue subsample into ethanol then fix in 5-10% formalin (essential to inject body cavity!).

- Arthropoda

  Prawns, lobsters, barnacles, isopods, amphipods, sea spiders: – fix in 99% ethanol.

- Echinodermata

  Sea-stars, brittle stars, sea urchins, sea cucumbers, feather stars, sea lilies: – preserve in 99% ethanol.

- Tunicata

  Ascidians or sea squirts: – Colonial: relax in seawater with a pinch of menthol crystals then fix in 10% formalin. Solitary: fix in 99% ethanol.

References

Opresko, D.; Tracey, D.; Mackay, E. (2014). ANTIPATHARIA (BLACK CORALS) FOR THE NEW ZEALAND REGION. A field guide of commonly sampled New Zealand black corals including illustrations highlighting technical terms and black coral morphology. *New Zealand Aquatic Environment and Biodiversity Report No*. 136. 20 p.

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Tracey, D.; Mackay, E.; Gordon D.; Alderslade, P.; Cairns, S.; Opresko, D.; Sanchez, J.; Williams, G. (2014). Revised Coral Identification Guide. Report prepared for Marine Species and Threats, Department of Conservation — Te Papa Atawhai, Wellington. DOC14305 Project. 16 p.

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Tracey, D.; Mills, S. (2015); Contributing authors: Forman, J.; Gordon, D.; Kelly, M.; Sim-Smith, C.; Stevens, D.; Thomas, H.; Wei , F.; Willan, R. Identification of benthic invertebrate samples from research trawls and observer trips 2014-2015. *Final Research Report for Ministry for Primary Industries Project DAE201001D.* 73 p.

Tracey, D.; Mills, S. (2014). Identification of benthic invertebrate samples from research trawls and observer trips 2013-2014. Final Research Report for Ministry for Primary Industries Project DAE201001C. 61 p.

Williams, G.; Tracey, D.; Mackay, E. (2014). PENNATULACEA (SEA PENS) DESCRIPTIONS FOR THE NEW ZEALAND REGION. A field guide of commonly sampled New Zealand sea pens including illustrations highlighting technical terms and sea pen morphology. *New Zealand Aquatic Environment and Biodiversity Report* No. 135. 22 p.

APPENDIX 4: LIVE STATUS OF CORALS

Report prepared by: Di Tracey with input from Sadie Mills, Diana MacPherson, and Rob Stewart (all NIWA).
For: Christopher Dick, Senior Data Analyst | Data Management team (MPI): Job number: CD10266
20 October 2015.

Live status of corals:

Current options to record life status on the MPI benthic capture form are:
1 = Appeared Alive
2 = Non - biological or Dead (showing no signs of life)
4 = Decomposing
5 = Unknown (e.g. not recovered).

Additional descriptive text for 'Live status of corals' in italics, provided as requested to supplement the options on the MPI Benthic Form.

1 = Appeared Alive

*Appearance of colour on the skeleton / parts of the skeleton including pink, red, purple, yellow, grey, white, brown. Fleshy material often visible inside the cups although the soft fleshy tentacles retract into the small polyp (cup) on the branching form and live material can be hard to discern (**stony corals*** – branching and cup forms);*

*Polyps and live tissue visible on branchlets / branches. Polyp colours include red, orange, white, brown, brown-grey, yellow. Branch metallic, shiny, lustrous black (**black corals**);*

*Polyps and live tissue visible on branchlets / branches / trunk. Colours vary and includes red, orange, yellow, purple, brown polyps as well as some branches for some genera (**gorgonian corals**);*

*Fleshy and large single polyp coloured red, cream, orange. Tube form joined by runners, fleshy and coloured red, white, yellow (**soft corals**);*

*Fleshy stalk and polyp leaves. Polyps at the top or along the side of the animal visible. Colour red, cream, brown, orange, grey (**sea pens**);*

*Colony colour strong throughout the skeleton for pink, red forms. Colour even and white all over for other genera. All have the pore-like apertures visible (**hydrocorals**). The feathery non calcified forms (**hydroids**) brown, grey. Alive if you could see the polyps or even the tentacles of the polyps – but this is only easily carried out on larger specimens).*

2 = Non - biological or Dead (showing no signs of life)

*No colour on the skeleton, appear white and bleached, grey, or black (ferrous oxide coating occurs in some NZ regions). No flesh visible, crumbling and brittle (**stony corals**);*

*No polyps visible on any part of branches / trunk. Branch lacks lustre, can be brittle (**black corals**);*

*No live polyps or tissue visible on branchlets / branches / trunk. Colour washed out, white and brittle (**gorgonian corals**);*

*Animal remains fleshy but decomposing and faded colour (**soft corals**);*

*Fleshy but washed out colour, naked brittle stalk, decomposing (**sea pens**);*

*Brown, grey in colour, no pore-like apertures visible, (**hydrocorals**). Hydroid form would be brittle and hard if dead with* no tissue, naked with no hydranths/polyps*).*

4 = Decomposing
Most likely a state only for the soft corals and some sea pens – smell a key here and the animal would be crumbling / disintegrating. Not often seen in this state.

5 = Unknown (e.g. not recovered).
NA

***3-D matrix forming stony branching corals:**
Coral reef comprises live coral growing on the top of the recently dead, and long dead stony branching coral 3-D matrix. The coral grows to form colonies and then a reef structure. The healthy growing portion of the colony, often measuring several metres in diameter, need substrate such as the matrix structure, to grow. There is often debate about the 'live status' of the stony coral reef. Where does the live coral end and the 'building blocks' matrix of the reef begin.

Trawling can impact the coral reef matrix and it becomes broken and scattered. Often this occurs when the live abundant colonies often seen on the top of seamounts or on rocky out-crops are impacted and the coral becomes dispersed. This impacted coral often builds up at the base of the seamount, in clumps behind boulders along the seamount flank, or on the slope. The once intact reef turns into coral rubble. Trawling can return all parts of the reef – in this instance, one would record 'live' coral on the form if live material is present, 'dead' if the coral is clearly all rubble.

References:

Tracey, D.; Baird, S.J.; Sanders, B.; Smith, M.H. (2011). Distribution of protected corals in relation to fishing effort and assessment of accuracy of observer identification. NIWA Client Report WLG2011-33 prepared for Marine Conservation Services (MCS) Department of Conservation/Te Papa Atawhai, 70 p. http://www.doc.govt.nz/documents/conservation/marine-and-coastal/marine-conservation-services/mcsint2010-03-coral-by-catch-final-report.PDF

Tracey, D.; Mills, S. (2015); Contributing authors: Forman, J.; Gordon, D.; Kelly, M.; Sim-Smith, C.; Stevens, D.; Thomas, H.; Wei, F.; Willan, R. Identification of benthic invertebrate samples from research trawls and observer trips 2014-2015. Final Research Report for Ministry for Primary Industries Project DAE201001D. 73 p.