NIWA
Taihoro Nukurangi

Review of deep rocky and biogenic reefs (50 – 300 metres water depth) knowledge in New Zealand

Biodiversity description, location, and threats

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Executive summary

Reef ecosystems below 30 m depth around the world are poorly known scientifically and under-protected despite harbouring unique biological communities and providing essential ecosystem services. New Zealand's deep reefs are no exception to this. They have received very limited research and management attention. Even their locations and extents remain largely unknown, except for a few areas comprehensively mapped using multibeam sonar. This report establishes a baseline for improving our understanding of these ecosystems by reviewing and mapping potential proxies for reefs located between 50 to 300 m depth throughout the Territorial Sea and Exclusive Economic Zone.

Data sets explored included commercial fisheries catch and effort, fisheries observer bycatch records, NIWA's invertebrate collections database, research trawl catches, nautical chart annotations, published Local Ecological Knowledge (LEK) and DOCs putative reef polygons (limited to 100 m depth). Species were assessed for their habitat specificities, and those considered to be strongly reef-associated were defined as 'reef-indicator' species. A total of 2,575 unique 'reef-indicator' taxa were identified and their catch weights and species richness mapped for 13 regions around New Zealand.

In areas where multibeam sonar coverage was available (e.g., East Northland, part of outer Hauraki Gulf), there was good agreement between reef-indicator species and reef spatial occurrence. This provided confidence that these data were good proxies for reef presence elsewhere. The results indicate deep reefs are likely to be widespread around New Zealand on the continental shelf edge and adjacent slope.

Regions with the largest extent of reef indicated in the 50 to 300 m depth range were Taranaki, Golden, Stewart and Campbell. Wairarapa and Fiordland had the smallest areas. Reef-indicator species richness declined with increasing latitude reflecting the decline in diversity of warm-temperate reef-indicator fishes in southern regions.

This work identifies what can be inferred about deep reefs from existing national data sets, anthropogenic threats to these ecosystems and regions where further survey and research effort is required. Further analysis of the data collected during the 2009–10 LINZ OS2020 Bay of Islands programme, including benthic terrain mapping and statistical analysis of benthic assemblages, would provide a much better understanding of the ecological significance of East Northland's deep reef ecosystems.

1 Introduction

Deeper reef ecosystems around the world are underexplored and under-protected despite harbouring unique biological communities and providing essential ecosystem services. In particular, those located between the lower limit of SCUBA diving (30 m) and the upper limit of the "deep-sea" have often been overlooked, as exploration of ecosystems deeper than 300 m is frequently prioritised for reasons of scientific interest and cost-efficiency.

These deeper regions encompass far larger spatial extents than their shallower counterparts, and typically have high biodiversity and fisheries values. Knowledge of deeper reef ecosystems' spatial locations and compositions is very limited, with most remaining uncharted, and known only to those who fish them for the valuable fish species associated with them. Effective management of these ecosystems requires a better understanding of where they occur and the species assemblages they support.

The Department of Conservation's (DOC) deep water responsibilities include management of 17 marine reserves that contain extensive areas of reef habitats below 30 m depth, and the Offshore Islands Regional Coastal Plan (Kermadec and Subantarctic Islands). Maximum recorded depths in these areas range from 86–3043 metres. DOC's conservation advocacy role also includes submission and advice on consent applications for activities affecting deep water habitats in the Territorial Sea (TS) and the Exclusive Economic Zone (EEZ) (e.g., recent examples an application to mine phosphate on the Chatham Rise, and Northland Regional Council's 'Northland Plan').

In the last decade, the use of remotely operated vehicles (ROVs) and towed camera systems has greatly increased the amount of visual information collected between 50–300 m depth in New Zealand waters. This report provides an integrated review and description of existing datasets and imagery for New Zealand deep reefs, and a first qualitative examination of regional and/or national datasets for species that may act as proxies for reef presence. It does not include any predictive spatial habitat modelling, or statistical characterisation of deep reef assemblages. This information is integrated into a series of Geographical Information System (GIS) maps and representative high-definition seafloor imagery is used to illustrate reef topography, habitat types, and the associated fauna and flora.

2 Methods

Deep reef habitats were defined as follows:

Reef: Except for small cobble and pebble fields and coarse gravels any area of seafloor containing rock was accepted as reef. Boulder and carbonate rubble fields were included, including where they were mosaiced with soft sediments. Basement rock covered by thin veneers of sediment was also classed as reef as these habitats often support sponge gardens and corals attached to the underlying rock.

Deeper reef ecosystems (50-300 m): for the purpose of this investigation, we solely focus on reefs and biogenic reef ecosystems located between 50 and 300 metres depth.

Biogenic reef: the Joint Nature Conservation Council (JNCC) of the United Kingdom defines these as "*Solid, massive structures which are created by accumulations of organisms, usually rising from the seabed, or at least clearly forming a substantial, discrete community or habitat which is very different from the surrounding seabed. The structure of the reef may be composed almost entirely of the reef building organism and its tubes or shells, or it may to some degree be composed of sediments, stones and shells bound together by the organisms*" (Holt et al. 1998).

Accordingly, species such the bryozoan *Celleporina agglutinans* and the calcareous tubeworm *Galeolaria hystrix* were included as indicators of biogenic reefs because they produce solid, massive structures. We excluded species such as dog cockles because although their dead shells form a biogenic habitat they do not form a solid structure rising from the seabed.

A range of spatial datasets considered to be proxies for reef presence were assembled, groomed, analysed, and mapped out by geographic region. Conservative estimates were made of the likely spatial extent of deep reefs both regionally and nationally using reef-associated taxa as a proxy for reef presence. Conservative is used here in the sense that only spatial grid cells that returned reef-associated taxa were counted as being 'reef' cells. No allowance was made for cells that had no sampling effort (commercial fishing and/or research) but may have held reef.

Secondly, seafloor camera imagery collected over deep reefs was collated and examined by specialists in each of the major taxonomic groups. A master list of 'reef-indicator' species/taxa was generated and used to create a narrative for each camera site sampled.

Analysis of multibeam sonar data to identify and map rocky and biogenic reefs was beyond the scope of the project.

2.1 Spatial data proxies of where deep reefs may occur

We focussed on data that indicated a reef might be present, rather than data that indicated an absence of reef habitat. The rationale for this was two-fold. Firstly, reefs are inherently patchy and easily missed at the spatial scales the data were recorded at. For example, a trawler might pass very near a reef but only encounter open soft sediment seafloor and capture only non-reef-trait species. Secondly, data volumes for some sources were very large and beyond the capacity of this project to analyse (e.g., all reported fishing events in the 50–300 m depth range).

2.1.1 Data sources

Seafloor substrates as marked on nautical charts

Relevant geo-referenced charts were downloaded from the LINZ website and digitised for all marker symbols indicating the presence of reef or rock at a specific point (i.e., R, Rock; Co, cobbles; bkCO,

broken cobbles). This included some areas that also had soft sediment components present (e.g., S, sands; bkSh, broken shell). These chart symbols do not hold information on the relative contributions of each component at a sampled point but are evidence of rock substrates being present. Although the number of such records was limited for most regions they were mapped to provide contextual information.

Department of Conservation shallow rocky reefs GIS layer

The Department of Conservation's national rocky reefs GIS layer was developed in 2008 and used depth and substrate information from navigational charts to infer the location of rocky reefs to a maximum depth of 100 m. Within the Hauraki Gulf Marine Park more detailed depth information obtained from hydrographic faring sheets was used to infer the location of low relief reefs on the mid – outer shelf. These putative reef polygons have not been ground-truthed and not all mapped features are reefs (e.g., some are sand banks), however they were included as they provide contextual information showing potential ecological linkages between shallow and deeper reef ecosystems and in some cases additional evidence of deep reef habitats.

Local Ecological Knowledge (LEK)

Jones et al. (2018) interviewed around 50 retired fishers (mainly from trawlers) for a project on the occurrence of biogenic habitats on the continental shelf around New Zealand. While rocky reefs were the focus, various areas of 'foul' were marked on charts by some fishers, as well as many putative biogenic habitat polygons. These LEK polygons were mapped to provide further contextual information.

Trawl survey gear hook-ups / damage from the seafloor

Trawl survey data stored on NIWA's 'TRAWL' database extended back to the 1950s. We extracted all unsuccessful research trawl tows where the start and/or end tow positions occurred within the target depth range.

Unsuccessful tows, those where the net hooked up on the seafloor, the net was damaged in some way or were considered to have failed for other reasons, were examined for explanatory comments and details of catch (where recorded). Those with evidence of encountering rough ground (e.g., vessel abruptly stopped while towing, significant net damage, presence of multiple reef-trait species) were scored as potential reef sites. The end position of the vessel was taken as the best estimate of where the reef lay. Unsuccessful tows with no ancillary information were discarded.

Sediment chart sources

NIWA has integrated all recent and historical soft sediment grain size records into regional and national scale seafloor sediment maps (Bostock et al. 2018a, b). Unfortunately, those maps do not include harder reef components. Instead, the grain size records have been interpolated across the seafloor to provide indicative distributions of mud, sand, gravel, and carbonate percentage contributions (i.e., rock/reefs are 'invisible'). They are mentioned here for completeness.

2.1.2 Reef associated species

For all data sources containing biological information, we assigned each species/taxon present to a habitat-association category according to their degree of association with reefs. Taxonomists and field biologists were asked to assign species/taxa they had expertise on to one or more of the following categories:

- Reef-associated: Species that occur in close association with reef structures/rock.
- Biogenic-reefs associated: Species that occur in close association with biogenic reefs (as defined previously).
- Hard surfaces occurring in soft sediments: Species that can use hard surface components in soft sediments as habitat, e.g., carbonate gravels, dead shell drift surfaces, and horse mussel shells. Examples include some sponge, bivalve, brachiopod, gastropod, starfish and urchin species.
- Soft sediments only: Species that can live in soft sediments without any hard surfaces. Includes many worm, bivalve, starfish, sea cucumber and gastropod species.

Only species categorised as being reef and/or biogenic reef-associated (the first two classes) were classified as 'reef-trait' taxa. Purely pelagic species were excluded from the analyses.

NIWA's National Invertebrate Collection (NIC) database

NIWA maintains a nationally significant marine invertebrate collection and associated database (SPECIFY). We extracted records of all taxa (2,575 unique taxa) from all collecting sites that fell within the 30 to 300 m depth range. These records were distributed to the relevant taxonomic experts and assigned habitat-trait scores. Only records scored as purely 'reef-trait' species were retained for further use.

The following important caveats apply to the use of SPECIFY data. Specimens contributed to the invertebrate collection are not necessarily representative of what was caught at any given sampling site. Specimens are retained for the collection from many different sources in a very *ad hoc* way, depending on who is collecting them and the purpose of the collection. For example, only a few interesting species may have been retained and the rest discarded without record. In many cases only a few individuals of a given species may be kept, regardless of how many were caught (often unrecorded), and common species already in the collection may be ignored. Singletons of unusual specimens are also sent in by fishers and researchers. Retention of taxa may also vary over time. Taxa initially considered 'rare' may be collected less frequently or cease to be retained as they become better known. These confounding factors mean SPECIFY data are not quantitative and cannot be used to infer species presence/absence. For this report, we use them as putative indicators of reef presence only i.e., they indicate that reef habitat may be present and contribute to a weight-of-evidence approach.

Commerical fisheries catch/effort data

Due to confidentiality constraints on the level of spatial reporting we only report on species richness and fisheries observer bycatch data.

We initially requested a list of all (QMS) species present in Fisheries New Zealand's (FNZ) commercial catch/effort database within the 50–300 m depth range for the period 01 January 2015 – 31 December 2020. This period was chosen to maximise the inclusion of newer species codes added to fisheries catch reporting. All species present were assigned to habitat-association categories as

above, and 'reef-trait' only species identified. This deliberately conservative approach excluded several well-known fish species that occur in high abundances over both rocky reefs and soft sediment systems. Examples included snapper (*Pagrus auratus*), tarakihi (*Nemadactylus macropterus*), kingfish (*Seriola lalandi*), trevally (*Pseudocaranx dentex*) and John dory (*Zeus faber*). The resulting 'reef-trait' only list held 79 species (fishes and invertebrates).

Using this 79 reef-trait species list, FNZ then extracted all data for fishing events where one or more of these species was recorded in the catch, for all fishing methods likely to contact or fish close to the seafloor. These methods included a range of bottom trawl, bottom longline, set net, and potting method codes. To account for the change in FNZ data collection that occurred with the introduction of the Electronic Database System (EDS) in 2017, data extracts were made for both the pre- and post-EDS data series. All data from the period 1 October 2007 to 30 March 2021 were extracted. As water depth was often not reported on the QMS fisheries forms all catch records of a given species were extracted regardless of water depth.

Catch/effort reporting under the Quota Management System (QMS) requires fishers record only the weight of the main QMS species taken in each 'fishing event'. For trawling, longlining and set netting a fishing event is defined as each set of the gear. For gears such as pots it encompasses multiple sets at a time. Weights are visually estimated by the fisher for each of the top five QMS species in the catch (recently increased to the top eight species). Catches of other species are not recorded at the fishing event scale. As catch mixes and weights vary from fishing event to fishing event some species may be recorded for some fishing events but not in others. For example, even if a given species was caught in the same weights across multiple events it's catch weight (and presence) would not be recorded for any sets where it ranked lower than the top five or eight species. As many reef-associated species are not necessarily targeted they may represent a small proportion of each catch, meaning these data are not a consistent measure of species presence and abundance.

All retained catch is weighed by species upon delivery to licenced fish receivers. This provides accurate catch weights for each species at the fishing trip level. However, as an aggregate weight of multiple fishing events (e.g., trawl tows) undertaken across a fishing trip it lacks the fine scale spatial resolution needed to identify putative reef locations.

Ideally the sum of the visually estimated weights for a fishing trip should equal the weights recorded at the fish receiving facility. However, discrepancies often arise between the two. As a result, a standard procedure for Catch Per Unit Effort (CPUE) data grooming (Richard Bian, NIWA, pers. comm.) was used to estimate fishing event catch-weights for each species more accurately (the spatial scale needed for putative reef detection). This involved summing the visual weight estimates to calculate the percentage contribution of each species to the catch (with a total sum of 100 %), then using those percentages to pro-rate the true overall catch back into individual fishing event weights.

A problem with this approach is that if a species never occurred in the top five or eight species in any of the fishing events then no visual weight estimation would be made for that species at all. In such situations no pro-rating is possible and catch weights (both raw and pro-rated) are unable to be assigned at the fishing event level. This is also a potential issue for situations where a species was recorded in the top five species in one fishing event but not in another. This would result in catches not being correctly assigned to their capture locations (i.e., all catch for a species would be assigned to the one site with an estimated weight). In the first circumstance, the data for species with no fishing event estimates were excluded from the analyses. The second circumstance was undetectable (i.e., there was no way to 'see' it in the data). The first circumstance was a minor and uncommon occurrence in the data sets used here.

No attempt was made to standardise catches as catch rates because the wide range of methods (both active and static, fisheries species targets, and individual fishing gear set-ups) made standardisation problematic. As the focus was on using reef-trait species as proxies for reef presence, the raw (pro-rated) catch weights were a key metric. No attempt was made to groom the data to correct any positional errors due to the large number of fishing records and potentially many subjective decisions required. Catch data without associated latitude and longitude were discarded. Where both a start and end position were recorded for a fishing event the associated catch was assigned to the mid-point of the event. Where only a start position was recorded catch weights were assigned to that position. As catch was usually reported at the spatial resolution of geographic seconds, this was used as the native resolution of the data for both plotting and aggregating to minimise any loss of spatial precision in putative reef positions.

Catch data were plotted as basic exploratory maps in GIS and species' distributions and relative abundances were visually assessed to see if these were consistent with what might be expected for 'reef-trait' species. Using areas where reef distributions were better known (Hauraki Gulf and middle east coast South Island) several fishes were identified as being more wide-spread than would be expected for reef-specific species. These were dropped from use in species richness metrics (see following section) but several that had most of their catch weights taken over putative reefs were retained for use in the weight metrics (see following section). To better discriminate potential reef areas, the data retained for use were assigned one of three broad fishing methods: trawling (including single and pair trawling, Precision Seafood Harvesting and Danish seining); lining (including long-lines, drop lines, and Dahn lines); and set netting.

All blue cod potting data were dropped as few fishing events recorded latitude and longitude, and almost all catch was from less than 50 m depth (recorded catch positions were assessed against national scale bathymetry contours). Almost all crayfish potting catch data was also from less than 50 m depth.

2.1.3 Commercial fisheries observer bycatch data

Fisheries observers are allocated by FNZ across a range of commercial fisheries around New Zealand, usually on larger vessels operating in deepwater fisheries. Shallower water fisheries are less comprehensively covered but also provide valuable data. Fisheries observers identify all species caught (both QMS and non-QMS species) to the finest practical taxonomic level, and record catch weights for each. We extracted all species records from the Commercial Observer Database (COD) for the 30 to 300 m depth range. This returned 1,101,776 records, across 841 groups (seaweeds, invertebrates, fishes, birds, mammals and non-living items such as rocks and stones). These records were filtered for reef-trait fishes and invertebrate species, using the lists generated from the FNZ catch species and the SPECIFY invertebrate database. Additional species not previously recorded from those two sources were allocated to habitat association categories and 'reef-trait' species retained. While catch was also occasionally recorded for a few larger brown algae (*Ecklonia*, *Lessonia*, *Durvillaea* and *Macrocystis*) these taxa were excluded because it was not possible to determine whether they were attached plants or drift . No pro-rating of catch weights was needed for these data (all recorded site by site). No catch rate standardisation was attempted.

It should be noted that there is some overlap between these data and the fisher reported commercial catch data. To avoid double-counting, these two data sources were assessed separately to each other (see metrics section). Similarly, specimens of some of the species caught were retained by observers and subsequently added to NIWA's invertebrate collection and SPECIFY database. This was also addressed by treating these two data sources separately from each other.

2.1.4 Research TRAWL data

NIWA and other research organisations undertake a wide range of regional trawl surveys that are partially or wholly inclusive of the target 50 to 300 m depth range. These data are stored in the research database TRAWL and extend back in time to the 1950s. Data for all survey tows made within the 30 to 300 m depth range were extracted for use; where one or both start/end points fell within the target depth zone (as recorded in the field). For all successfully completed tows, all catches of reef-trait species (fishes and invertebrate) were retained and used in their raw data form. As for the commercial fisheries, and fisheries observer catch data the raw catch weights were used for data exploration and mapping. No catch standardisation was attempted. The raw catch weights were used for data exploration and mapping.

2.2 Derived metrics

The assembled data sets varied widely in spatial coverage, sampling intensities, and internal consistency making it difficult to develop any sort of integrated metric/s. Several data sets were sporadic and very patchy at the national scale (e.g., the SPECIFY invertebrate records), while others included relatively dense sampling within specific areas (e.g., Hauraki Gulf and east coast South Island TRAWL data). The data set with by far the best national scale coverage and intensity was commercial catch/effort (commercial fisheries observer data for some areas was nested within this). Even for these data, there was no estimate of the level of fishing effort for any given spatial area due to a number of factors, including: the inability to standardise catch rates across different fishing methods, vessels and operators; and the extraction of data for only fishing events/catches containing at least one reef-trait species (the great majority of fishing events had no reef-trait species catch recorded).

Two approaches were adopted to generate the most robust reef-presence metrics possible, with the least number of assumptions, and retaining the native spatial resolution of the data. A one-second grid was overlain over the data series, centred so that most of the commercial catch positional data were aligned to the centre of each grid cell (see Figure 2-1). As this geographic projection (seconds) is directly based on latitude and longitude, the dimensions of individual grid cells vary with latitude, with width and size decreasing with increasing latitude. For example, in the Hauraki Gulf the cells are roughly a nautical mile (around 1800 m) in width, making each cell a little under 2 x 2 km in size (Figure 2-1). In Foveaux Strait cell width is reduced by around 300 m (about 15 % smaller). All commercial catch data were assigned to the unique grid cell into which its coordinates fell.

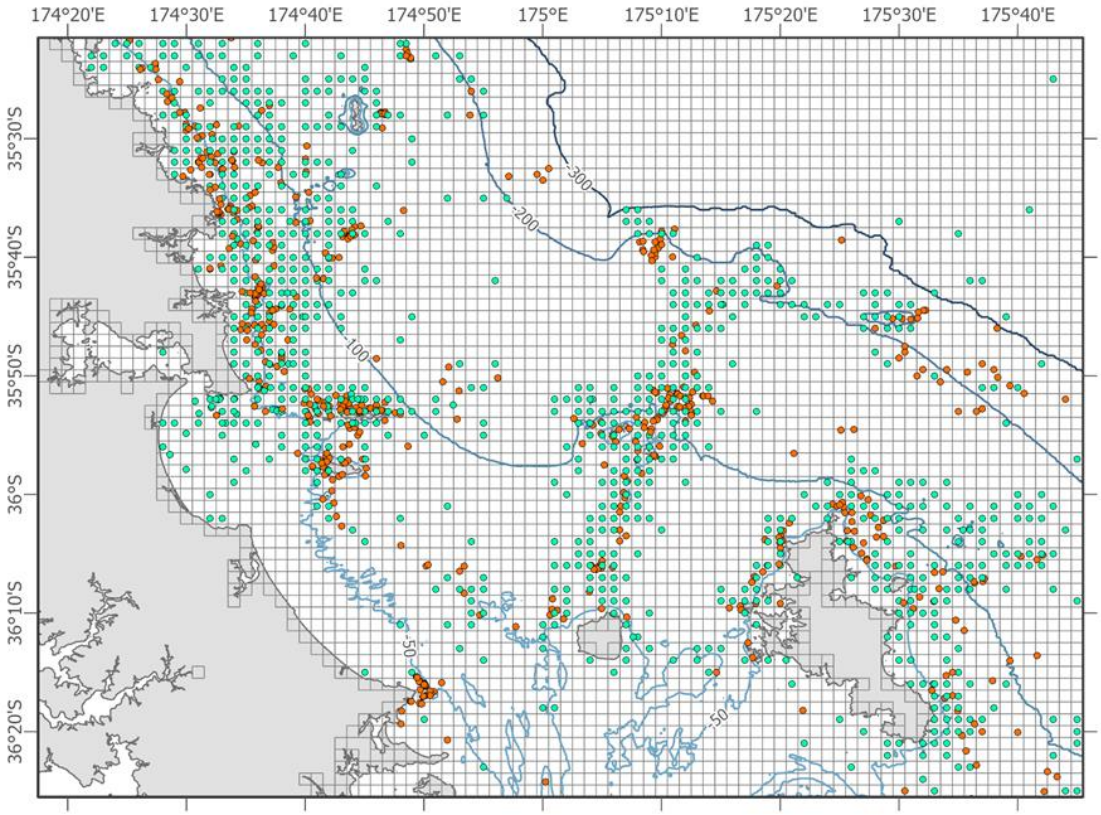

Figure 2-1: Example of a one-second data aggregation grid. Overlain on Hauraki Gulf fishing event locations where at least one reef-indicator species was caught. Note that many individual fishing events may fall in any given grid centre. Green symbols show the midpoint of events where both the start and end positions were recorded, while orange symbols show events where only the start position was recorded.

2.2.1 Species richness

For all fishing events that fell within a given grid cell, a list was created of all reef-trait species caught in that cell, regardless of method. Each species present was assigned a score of 1, regardless of how much was caught, or how many times it occurred across different fishing events. The sum of these scores was calculated as a species richness metric (i.e., how many different reef-trait species were present within any given grid cell). Only the commercial catch data had sufficient data to generate this species richness metric at the grid cell scale. It is important to note the caveat that these data were not able to be corrected for sampling effort, so some confounding will be present (e.g., rare species are more likely to be caught with increasing fishing effort).

For the Fisheries Observer, SPECIFY invertebrates and research TRAWL data reef-trait species richness was assessed at the individual event/site level. These were not summed into one second cells as the data were too sparse for this. The Fisheries Observer data included both target QMS species recorded in the wider fisher reported commercial catch data, and a relatively high number of non QMS species not recorded by fishers.

2.2.2 Combined weight metric provided in confidence to DOC due to MPI confidentiality restrictions

For the commercial catch data, all reef-trait species catch weights that fell within a given grid cell were summed for:

A. The fishing method groups of trawl, lining, and set-netting; and

B. All methods combined.

This was done both by individual species, and all reef-traits species combined. While the various reef-trait species varied widely in body size (e.g., red scorpion fish, versus bluenose), there was no basis on which to break catches into finer sub-groups. These summed weights are a crude proxy of reef-trait species fished biomass supported by deep reef systems (all things being equal), and as a metric of putative deep reef presence, with higher values suggestive of more extensive reef systems.

There were strong geographic gradients of presence and catch abundance of many species. Potential drivers of these include latitude, coast (east/west), and water depth, possibly all proxies for water temperature. Some of these potential drivers also appeared to interact with each other, e.g., species with close to national-scale distributions occurred in shallower water depths at more southern (colder) latitudes, relative to more northern (warmer) latitudes. Many species did not have national scale distributions, especially warm-temperate species. These multiple spatial gradients precluded the use of the above metrics to make spatially meaningful comparisons between larger geographic regions (i.e., they strongly confounded any potential national scale metrics using species presence/absence data).

To minimise the impact of these large-scale confounding gradients on data interpretation, and to allow the maps presented in this report to be viewed at a readable scale, New Zealand was divided into thirteen geographic regions (Figure 2-2), collectively covering the 50 – 300 m water depth zone.

The large number of reef-trait species involved meant that it was not possible to provide maps for all species presence/absence and spatial abundance (weight) patterns in this report. Rather, the focus was on how the summed 'reef-trait' species data inferred the spatial presence of reefs. To maximise information content, each map was treated independently, using data bins that matched the data range present within each region. This prevented high weight catches in any one region obscuring the visualisation of lower catch weights in another region.

The relatively diverse and geographically complex array of spatial data made presentation and synthesis a challenge. For a consistent map presentation approach across the thirteen regions, we organised the presentation of spatial data into the following plot series, created and presented in the same order for each region:

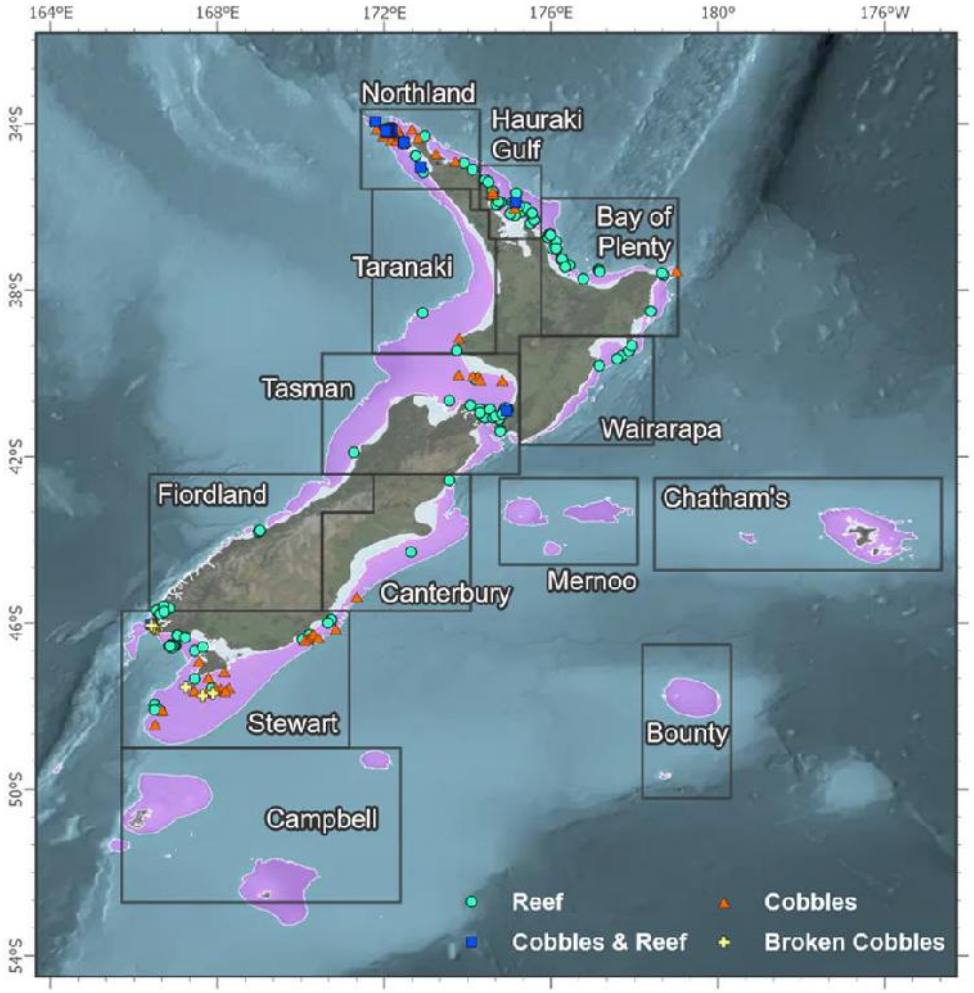

Figure 2-2: Division of New Zealand into 13 regions. The 50 – 300 m water depth areas are shown as purple polygons. Seafloor chart markers that show harder seafloor are also plotted.

1. General chart with place names and the trawl intensity footprint (Baird et al. 2014).
2. Commerical catch reef-indicator species richness in one-second cells (all methods combined).
3. Commercial fisheries observer bycatch and research TRAWL catches of individual species.
4. Chart sediment types, fisher LEK polygons, DOC putative reef polygons, research survey foul ground polygons, and 'foul' research TRAWL tows.
5. Commercial fisheries observer, research TRAWL, and SPECIFY invertebrate's species richness.
6. Selected seafloor fauna and flora imagery from video surveys where available.
7. **Restricted to DOC internal use.** Commercial fisheries catch weight plots for trawl, lining, setnet, and all methods combined:
   - By individual species at the fishing event level; and
   - By individual species, summed in one-second grid cells.

2.3 Qualitative description of reef form and associated epifaunal biodiversity from towed video

Of the limited video/still camera imagery collected on New Zealand's deep reefs only a small subset has been post-processed and had its biological assemblages statistically analysed and formally reported on. Examples include the LINZ OS2020 programme (Morrison et al. 2010) where a subset of sites were analysed at a broad taxonomic resolution (Bowden et al. 2010), and the national scale Biogenic Habitats on the Shelf programme, where three target areas were analysed in detail (Jones et al. 2018). Imagery from these and other surveys are included in this report to provide a qualitative regional and national overview of what these deep reef systems look like.

Past NIWA surveys that included camera deployments over deep reefs were identified, and sites where either or both the start and end points of video tows fell within the 50 – 300 m depth range selected. For some tows this included segments in less than 50 m or deeper than 300 m water depth. Resourcing did not permit explicit depth estimation for each image used but depth ranges are given at the site level. The surveys and their details are given in Table 2-1.

Continuous high definition digital video and photographic stills were available from NIWA's Deep Towed Imagery System (DTIS) and CoastCam systems. Only the still images were examined due to time constraints. Still images were taken every 15 seconds and are roughly 7 to 10 m apart (the DTIS is towed at up to one knot). Anything falling between these snapshots was invisible to the still camera (though captured by the video camera). Most of the DTIS imagery was underpinned by multibeam echosounder mapping but assessment of those data was outside the scope of this report. For video surveys where no still images were available the video footage was systemically viewed, and relevant screen-grabs taken. All imagery was systematically worked through to identify the species present, as well as the reef forms and configurations present.

All selected images were pasted into PowerPoint files, and species for identification marked with text arrows. Multiple examples of each putative epifaunal species were included (as available) to assist identification. Taxonomic specialists identified the marked organisms to the lowest practical level: sometimes to species level, but other times to higher levels such as Genus/Family/Order. Some species could only be assigned to a general group (e.g., anemones and some bryozoa). Where biological specimens had been collected at DTIS sites as part of the associated surveys these helped inform species identifications. Identifications were annotated directly onto the PowerPoint images by taxonomists. Taxonomists also made additional notes where a taxon was notable, e.g., never previously photographed in situ, or a range extension.

An overall master list of unique taxon names was extracted from the annotated images, with each taxon assigned a unique number (invertebrates/macroalgae) or letter (finfish) code. This master list was used for all imagery taxa identifications in this report. A subset of the still camera images marked up by the taxonomists was chosen for use in this report. This selection was made to maximise the number of species shown and/or the range of reef topography per image, while keeping the number of images used to a manageable level. Thus, it is important to note that these images were not randomly selected; and do not reflect the actual proportions of each reef type, or species densities at a site.

Table 2-1: Field surveys where unprocessed camera imagery was available for visual qualitative assessment. The number of sites given only includes those in the target 50 – 300 m depth range containing reef/s; it excludes sites outside the target zone. Survey trip codes are given for R.V. Tangaroa (TAN), R.V. Kaharoa (KAH) and R.V. Ikatere surveys.

Region	Year	Method	No. of reef sites	Reference
Mernoo Bank/Chatham's (TAN0705)	2007	DTIS	4	No report available.
Hauraki Gulf DOC reef survey	2008	Lower resolution drop/drift camera	7	Generally low grainy resolution, diffuse lighting (Drury 2008, metadata only report)
Bay of Islands OS2020 (Bowden et al. 2010) (KAH0907, TAN0906)	2009	DTIS	41	All reef sites, including those analysed with broad taxonomic groupings by Bowden et al. (2009)
Biogenic habitats on the continental shelf (TAN1105, TAN1108)	2011	DTIS	60	Areas around New Zealand; Ranfurly Bank and North Taranaki shelf edge analysed by Jones et al. (2018)
Stewart Island/Auckland Islands (TAN1602)	2016	DTIS	9	Sea lion feeding project, brief voyage report by Roberts (2016)
Hauraki Gulf	2016	CoastCam	2	Two patch reefs opportunistically imaged (Morrison et al. 2016)
Chatham Rise (TAN1701)	2017	DTIS	15	Representative imagery, by site, given in Bowden et al. (2017)
Hauraki Gulf	2020	Towed camera	1	Video drop made while transiting past deep reef site 'the Coral Patch' (MBIE Juvenile fish habitat bottlenecks programme CO1X1618)

For each site, a visual assessment was made of how much reef was covered by finer sediments. As many reefs consisted of mosaics of different topographies (e.g., pavements, boulders, ledges, slopes, and vertical faces), as well as being interspersed with soft sediment patches, this was done at the site scale. A categorical scale of 1 through 5 was used to assign each site a score, as per Table 2-2. An estimate of visual water clarity was also made, also on a categorical score of 1 through 5. Caveats to quantifying water clarity include that ambient light conditions were often very low and almost all camera surveys used artificial lights to illuminate the seafloor, several surveys were conducted during the hours of darkness, and some of the northeastern sites were surveyed immediately after a large storm event. Observed water clarity may be affected by the strength and angle of the artificial lighting systems, as may the ability to detect fine sediment on the seafloor.

An approximate visual estimate of the extent of reef surface covered by fauna was used with a value from 1 to 5, representing 20 % cover bins (i.e., a value of 1 corresponds with 0 to 20 % cover, and a value of 5 corresponds with 80 to 100 % cover).

Table 2-2: Categorical scores for fine sediment reef loads and water clarity.

Habitat score	Value	Description
Fine sediment cover	1	Seafloor completely devoid of fine sediments, rock surface seen where not covered by organisms or coarser sediments (e.g., shell hash)
	2	Very slight sprinkling of fine sediments on some surfaces, requires careful searching to see
	3	Fine sediments are present across most of the seafloor surface, sometimes as pockets, coating some objects
	4	Fine sediments are a dominant part of the reef cover
	5	Thick veneer of soft sediment draped on reef surface, no bare rock surface at all, fine sediment forms a surface that has its own micro-topography
Water clarity	1	Exceptionally clear water, hard to see that water is even present
	2	Seafloor objects are easily seen, fine material in water can also be seen
	3	Seafloor objects identifiable, but slight colour tinge from the water column
	4	Must fly cameras closer to the seafloor to get clear image of seafloor objects, lots of material in water column, quality of imagery varies, water colour tinges of green, brown, or grey that degrade visual acuity
	5	Very poor visibility, dark, objects on seafloor hard to make out and identify, strong glare feed-back from camera lighting

3 Results

Due to their large number, all tables and figures from this point on are placed in Appendix A (tables) and Appendix B (figures).

3.1 Reef-indicator species

3.1.1 Invertebrates

The SPECIFY database contained records of 619 invertebrate taxa associated with rocky reefs only, and a further 321 species associated with both rocky and biogenic reefs (for the 50 – 300 m depth range). Overall, this provided 940 reef-trait species. No species were identified as being exclusively associated with biogenic reefs. These rocky reef and rocky reef-biogenic reef taxa included: Annelida (12, 16), Arthropoda (13, 37), Bryozoa (22, 50), Chordata (3, 42), Cnidaria (98, 182), Echinodermata (17, 42), Mollusca (133, 28), and Porifera (31, 223). Most reef-trait taxa were represented in relatively low lot numbers (number of sampling sites) and number of specimens. Overall, 389 taxa were collected from one site only, 434 collected from 2 – 10 sites, and 117 from >10 sites (maximum 204 for the small endemic bivalve *Cardita distorta*). A total of 833 SPECIFY sites contained records of one of more reef-trait species. The commercial fisheries observer data added a further nine reef-trait taxa not recorded in SPECIFY (7 reef, 2 reef-biogenic associated species). Table A-1 summarises the 56 reef-trait taxa present in the observer bycatch records, and the equivalent SPECIFY invertebrate taxa records (44) (some individuals may be counted across both sources). The remaining 893 SPECIFY invertebrate taxa are not dealt with further at the taxa level in this report. However, they contribute to the species richness metric, and limited commentary on some species is provided in the regional sections.

For the commercial fisheries catch records (excluding potting), four QMS invertebrate reef-trait species were recorded: red rock lobster (*Jasus edwardsii*), packhorse crayfish (*Sagmariasus verreauxi*), Spanish lobster (*Arctides antipodarum*) and red rock crabs (*Guinusia chabrus*) (Table A-1). Research TRAWL data returned 23 reef-trait invertebrate species, dominated by the starfish *Sclerasterias mollis* (49 kg across 176 sites), coral (unspecified) (199 kg, 49 sites) and bushy hard coral (*Goniocorella dumosa*) (42 kg, 18 sites), with other species present only in low numbers (Table A-1).

3.1.2 Fishes

A total of 71 reef-trait taxa were initially identified from the commercial catch, observer bycatch, and research TRAWL datasets (Table A-2). There was insufficient knowledge of the fish fauna of biogenic reefs to assign finfish to this habitat association alone. Of the 71 taxa, 61 were identified to species level. Exploratory examination of the GIS plots identified 6 species as being more widespread than expected if they were restricted to reef habitats. These were: blue moki (*Latridopsis ciliaris*), leatherjacket (*Meuschenia scaber*), blue cod (*Parapercis colias*), hapuku (*Polyprion oxygeneios*), sea perch (*Helicolenus percoides*), common roughy (*Paratrachichthys trailli*), and porae (*Nemadactylus douglasii*). This was not an entirely unexpected finding for the first five species, because although they have substantial populations on rocky reefs they are also known to occur over soft sediments during migrations (blue moki, hapuka), or associate with non-reef forming biogenic habitats (leatherjacket, blue cod, sea perch). However, within SCUBA depths (<30 m) divers generally see common roughy and porae strongly associated with rocky reefs (although it should be noted that SCUBA diving is also strongly associated with rocky reefs). Abundance plots for areas where soft sediment versus reef areas were relatively well known showed that hapuka and porae weight

distributions strongly favoured reef areas, while non-reef area occurrences had weights consistent with occasional catches of one or a few fish.

Based on this information, all seven species above were dropped from inclusion in the species richness metrics, but hapuka and porae were retained as 'reef-trait' species for the combined weight metrics. Most reef-trait species unsurprisingly were caught only occasionally and in low numbers with trawling but were more common in the lining and setnet catch data (methods fishable over reefs/foul ground). Some shallower water species appeared to be at the outer edge of their depth distribution at around 50 m depth, e.g., butterfish (*Odax pullus*), marblefish (*Aplodactylus arctidens*), blue maomao (*Scorpis violacea*), and red moki (*Cheilodactylus spectabilis*). These species exhibited a clear break in the commercial catch at that depth. Some deeper water species appeared to be at the inner edge of their depth distribution at 300 m, e.g., alfonsino (*Beryx splendens*), long-finned beryx (*B. decadactylus*), bluenose (*Hyperoglyphe antarctica*), black cardinalfish (*Epigonus telescopus*), hapuka and bass (*P. americanus*). Some of these species became more abundant or were caught at shallower depths with increasing latitude, possibly due to lower water temperatures.

For the 50 – 300 m depth zone, the number of commercial catch sites containing one or more reef-trait species was 33 times (n = 55143) greater than for research TRAWL sites (n = 1664), while the observer sites (a subset of the commercial sites), were 6 times greater in number (n = 10168) than those of research TRAWL. The observer records held the highest number of reef-trait taxa (68), while the commercial catch (45) and research trawl (47) numbers were similar (Table A-1). The commercial catch records spanned all New Zealand, whereas the observer bycatch and research TRAWL sites were concentrated in some areas and absent from others. The commercial catch data is therefore considered the best source of proxies for reef presence.

3.1.3 Seafloor imaging

Identification of taxa in video and still camera images returned 368 different Operational Taxonomic Units (OTUs), with many identifications to species level (Table A-3). It should be noted that identification of taxa from images varies in levels of certainty as no physical specimens can be examined. The inability to examine specimens also partially explains why many taxa were identified to higher levels only (e.g., genus, order, or family). Sponge taxa dominated the imagery, with 205 OTUs recorded (56 % of all OTUs). As well as the master list given in Table A-3, seafloor imagery included in this report has been annotated with species/taxon identifications.

3.2 Regional summaries

3.2.1 NORTHLAND

Reef presence proxies

This region extended from the Bay of Islands north to the Three Kings Islands and Middlesex and King Banks, and down the west coast to Hokianga Harbour, spanning two distinctively different coasts (Figure B-1). The high intensity trawl footprint areas on the east coast were largely focused in the 100 – 200 m depth zone from the Bay of Islands up to Rangaunu Bay, off Parengarenga Harbour in 10 – 100 m, and north-west from North Cape along the 100 – 200 m depth zone. There was little trawling between North Cape and Cape Reinga and the extensive area north of these, including the Three Kings Islands shelf, and North (including Middlesex Bank) and South Maria (including King Bank) Ridges. On the west coast, most of the 10 – 100 m depth zone off Ninety Mile Beach south to Hokianga Harbour was trawled, except for North and South Ahipara Banks (known reef systems). Further offshore from Ninety Mile Beach trawling occurred in several long ellipses, with little to no trawling of the seafloor between them (Figure B-1). The reason for these fishing patterns is unknown.

Possible reasons include low abundance of QMS species, or the presence of foul ground prevents fishing there.

The commercial catch data contained eight reef-trait species of sufficient abundance for discussion. Northern bastard cod (*Pseudophycis breviuscula*) catches were concentrated along the east coast largely in less than 100 m depth. These were almost entirely taken by lining and set-netting. There was also some deeper catch (100 – 200 m) in northern Great Exhibition Bay, and on an adjacent bank/knoll feature further to the east that rises out of deeper water to less than 300 m depth. A few low weight trawl catches were taken in 200 – 300 m depth along the east coast and north-west of North Cape. On the west coast, few catches were made in less than 200 m for any method, and only small catches in the 200 – 300 m zone off northern Ninety Mile Beach. Larger catches were made along the shelf edge along the South and North Maria ridges, and to a lesser extent around the Three Kings.

Southern bastard cod (*Pseudophycis barbata*) was only reported by lining, and while caught at fewer sites and at lower weights than northern bastard cod, it had a very similar distribution to that species. It is unclear how well separated the catch reporting of these two species was. As sister species they look very similar, and the complete absence of set-net caught southern bastard cod in areas where they were often caught by lining suggests misidentification may be occurring.

Red snapper (*Centroberyx affinis*) also occurred along both coasts but was particularly common in the 50 – 100 m zone along the east coast, being caught by set-net and lining. Trawling caught them further out in 100 – 300 m, especially along the shelf edge northwest of North Cape. On the west coast, most catch was taken by trawl in the 100 – 200 m zone, in three broadly separate bands (driven by trawl fishing intensities) running along the depth contours. Further north, clusters of lining catch occurred along the sides of Middlesex and King Bank, and north of the Three Kings. Red scorpion fish (*Scorpaena cardinalis/S. papillosus*) were largely restricted to the east coast, with a few west coast records. On the east coast they were common right along the coast, from shallow waters out to around 100 m, as well as extending around North Cape to the immediate west. A few small trawl catches were made in Great Exhibition Bay.

Sea perch showed a very similar distribution to red scorpion fish but were only reported from lining. In northern Great Exhibition Bay higher weight catches were apparent in 100 – 200 m depth, relative to shallower adjacent waters. Some limited catch was also reported north of North Cape, around North Maria Ridge, and the Three Kings.

Pink maomao (*Caprodon longimanus*) had a similar distribution to red snapper on the east coast through to Middlesex Bank but were essentially absent from the west coast. Denser lining and set-net catches occurred offshore of Whangaroa Harbour and northeast of Cape Karikari. Three clusters of trawl catch sites were present in northern Great Exhibition Bay, in 100 – 200 m, as well as along the shelf edge northwest of North Cape. Lining catches were also taken at the Maria ridges and the Three Kings. Moray eel catches (species not recorded) were entirely restricted to lining along the east coast and around North Cape, with almost all taken in less than 50 m water depth. Blue maomao (*Scorpis violacea*) were also essentially restricted to less than 50 m depth along the east coast, but also were reported as occasional occurrences along Ninety Mile Beach on the west coast. Of note were three trawl clusters off Parengarenga Harbour, which although in shallower water, sat adjacent to the three pink maomao trawl weight clusters in slightly deeper water. Moray, blue maomao and several other reef-trait species showed a cut-off at around 50 m depth.

The commercial catch reef-trait species richness metric showed a large continuous band of higher values from Cape Brett (south side of Bay of Islands) through to North Cape, in the 50 – 150 m depth

range (Figure B-2). This matches the extensive area of deep rocky reef mapped by multibeam echosounder along this coastline by the LINZ OS2020 BOI programme (Morrison et al. 2010). Higher value patches also occurred further offshore, including an area in 200 – 300 m depth off Whangaroa Harbour, and the large knoll feature north of Cape Karikari referred to earlier. Higher values also extended north along the shelf edge (200 – 300 m), inclusive of North and South Maria Banks. Species richness values on the west coast were much lower and more spatially restricted, and largely retracted to values of 1 where present. Some clusters of higher values occurred around the 200 m depth contour off northern Ninety Mile Beach, and to a lesser extent in several clusters west of Ahipara/Tauroa Point in 100 – 200 m depth.

Nautical chart seafloor substrate codes showed a few rock and cobble substrate markers between the Bay of Islands and North Cape, then largely cobble markers offshore of Spirits Bay to the Three Kings Islands (Figure B-3). The immediate area around the Three Kings had the highest sampling density of seafloor chart substate markers indicating rock/cobble seafloor anywhere in New Zealand. Along the west coast, three rock symbols were present: one west of Pandora Bank, one off the Bluff, and one at Ahipara Banks. The fisher LEK polygons indicated east coast foul ground areas between the Bay of Islands and Whangaroa Harbour (a large extent), and two areas in Great Exhibition Bay, along with several coral (reef-trait species) catch polygons. Coral polygons also occurred around and east of Cape Reinga, as well as on South Maria Ridge (Middlesex Bank). LEK also marked Ahipara Banks as foul, as did a research TRAWL foul ground polygon. Reef is present around Ahipara Banks to at least 70 m depth (seen on trawler depth sounder, M.M., pers. obs.). Further offshore to the west at around 150 m, three foul TRAWL tows also indicate the presence of reef, suggesting a large reef area complex overall. A further foul TRAWL tow occurred several kilometres northwest at a similar depth. Another cluster of five foul TRAWL tows occurred in a line in 150 m depth off northern Ninety Mile Beach, suggestive of another reef system. On the east coast, 3 foul TRAWL tows were present. East Northland FNZ research trawl surveys were abandoned after 1992 due to extensive, unmapped reef areas limiting trawlable survey extent (Morrison et al. 2015).

The reef-trait species richness indices for observer bycatch, research TRAWL and SPECIFY invertebrates all showed clustering indicative of reef presence (Figure B-4). Along the east Northland coast high observer bycatch richness values occurred between Whangaroa Harbour and Houhora Harbour, consistent with extensive offshore reef areas shown by multibeam mapping in the LINZ OS2020 Bay of Islands programme (Morrison et al. 2010). These high values also extended along a line running northeast from North Cape along the 100 m contour, ending as a wider cluster where the 100 m contour turns to the west. This is a known trawl corridor that is fished between reefs to either side (Jones et al. 2016). There were few research TRAWL or SPECIFY points for this region due to low sampling effort along this coast (excluding LINZ OS2020 Bay of Islands work, whose taxonomic collections remain to be processed for this northern area for sponges, and so are absent from Specify). Spirits Bay was an exception, with a dense cluster of SPECIFY sites created by past and ongoing FNZ work to characterise and monitor the high invertebrate biodiversity values known to occur there (Cryer et al. 1999).

On the west coast, a scattering of lower species richness sites were present along Ninety Mile Beach in 30 – 100 m depth, possibly related to small patch reefs (anon. fisher, per. comm. to M.M.). Four clusters of higher species richness were present north-west of the Ahipara Banks, and potentially represent an extension of that reef complex (Figure B-2). The distributions of the more common reef-trait species (commercial fisheries, observer and research TRAWL) were also consistent with this possibility. Catches of rocks and stones were made in this area (Figure B-5), as well as along Ninety Mile Beach. Packhorse crayfish captures were also reported in less than 100 m depth from Hokianga Harbour and along Ninety Mile Beach at weights likely to represent single individuals. Whether these

were resident animals or migrating north to their spawning grounds off North Cape is unknown. On the east coast, higher and more clustered packhorse crayfish catches were recorded southeast of the Cavalli Islands, off Cape Karikari and east of Parengarenga Harbour. A cluster of coral (unspecified) bycatch (max. weight 2 kg) was present just north of the Three Kings, and another cluster to the east, which also held rock/stones, black coral, red pigfish (*Bodianus unimaculatus*), and *Oculina virgosa* (coral) bycatch. Aside from rocks and stones (maximum catch of 2000 kg off Cape Brett in 200 m depth), reef-trait taxa bycatch/TRAWL weights were low (1 – 10 kg range).

Video imagery

The NORTH region has a relatively large number of video tow sites over deep reefs in the target 50 – 300 depth range (Figure B-3), largely through two dedicated R.V. Tangaroa voyages; one along the East Northland coast (50 – 200 m) in 2009 as part of the LINZ OS2020 Bay of Islands programme (Morrison et al 2010, Bowden et al 2010); and one in 2011 as part of the FNZ/MBIE/DOC/NIWA resourced 'Biogenic Habitats on the Continental Shelf programme (50 – 250+ m) (Jones et al. 2018).

East Northland

Thirty-one DTIS sites were collected over reef habitats along this coast, from north of Cape Brett, to north of North Cape. The OS2020 DTIS sites (n = 26) were allocated using multibeam sonar data collected in an earlier R.V. Tangaroa OS2020 voyage, to encompass different seafloor rugosity and hardness classes derived from the multibeam data (NB: these maps are working drafts only, no finalised versions were produced because OS2020 was a data collection only initiative). The Biogenic Habitat sites (n = 5) were allocated using fisher LEK polygons (Jones et al. 2016) as a rough site placement guide, and targeted biogenic habitats rather than rocky reefs (Jones et al. 2018). Within those LEK polygons, small blocks were multibeam sonar mapped, followed by DTIS tows targeting the variability of seafloor bedforms the following night.

Selected seafloor images from these 31 sites are shown in Figure B-6 to Figure B-31, annotated with epifaunal and epifloral identifications. Summary seafloor information is given in Table A-4.

At least three bedrock geology types were present in this area. The more rugged and variable bathymetry reef habitats, including low ridges, raised basement surfaces, outcrops, walls, boulders, and over-hangs were composed of harder looking rock. Linear fractures were sometimes present in these reefs (e.g., E224, Figure B-11), as well as a 'blocky' appearance (e.g., E241, Figure B-8) (see also reef imagery from the adjacent Hauraki Gulf region). A second bedrock type was a carbonate form, structured as low, patchy, 'pillow-like' mounds with smooth surfaces. Figure B-26 shows a small piece of this rock, broken off and retrieved in a rock dredge sample in 2009. It appears to be fossilised material, possibly bryozoan reefs or other organisms producing calcified structures (no age estimate available). This rock type was present at sites E67, E66, E100, E88, E85, E180, E182, B7, and B14 (Table A-4, e.g., Figure B-7). These sites were clustered around the Cavalli Islands area (five sites in 112 – 130 m, one at 66 – 67 m), and North Cape (three sites, 120 – 165 m). A third rock type was soft mudstone/sandstone seen as a basement at E59 (Figure B-6).

There was a general pattern of increasing water clarity, less fine sediment and increasing epibiota cover of reef surfaces from south to north (Table A-4). Although within-site variation appeared driven by a mix of local reef topography and height above the seafloor. Encrusting coralline algae, as an indicator of light levels, were present from the shallowest site (E160, minimum depth 42 m) to a maximum depth of 78 m (E165). Coralline algae crust dominated reef was found at E97 (55 – 68 m), which also contained areas of rhodolith cobbles (both alive and dead) sitting on coarse sand (Figure B-9). Generally, these deep East Northland reefs were dominated by sponges, several species of which had not been seen since their initial collection a century ago, and never previously

photographed in situ (M.K., pers. obs.). Other species records represented range extensions (e.g., several glass sponge species). Corals were observed at 16 sites (Table A-4), and included *Perissogorgia vitrea*, Oculina virgosa, black corals (Antipatharia), *Antipathella fiordensis*, *Lillipathes lilliei*, *Stylopathes tenuispina*, spiral whip forms (Family Ellisellidae, or an undescribed genus in a sister family), *Narella* sp., Plexauridae, red coral (*Errina* sp.) and *Metafannyella moseleyi*. Coral occurrence and taxa diversity increased from south to north. The richest, densest, and most visually striking sponge and other sessile invertebrate assemblages were seen at B28, north-west of North Cape and at the far end of the East Northland gradient (Figure B-25). A feature of many of the reefs along the East Northland coast was 'fuzzy' small filamentous cover on many of the reef surfaces, especially at sites with higher sedimentation scores. The very small height of these forms made them hard to distinguish on images, and they were not retrieved during rock dredge sampling. They were possibly small bryozoan and/or tubeworm species.

Cape Reinga, Three Kings Islands, and Middlesex Bank (South Maria ridge)

Three DTIS sites west of Cape Reinga targeted deeper reefs seen on multibeam imagery (see Figure 13, Jones et al. 2018), in depths of 88 – 120 m (B61, B62, B64, Figure B-27 and Figure B-28). The water clarity here was extremely good, as were all the other sites further north. Rock surfaces were heavily encrusted by epifauna, including a variety of cup and plate forming sponges, as well as ascidians, hydroids, zooanthids, and small white bryozoans Stylasteridae fans. B64 also held colonies of the coral *Oculina virgosa* (white and orange forms), clustered on a steep rock wall on one side of a large rocky outcrop, along with an emergent red rock lobster (site sampled at night).

Around the Three Kings Islands, seven DTIS sites (40 – 88 m) were deployed over reefs on the island's slopes with mosaics of bedrock, small rocks, fragmented cobbles and pebbles, and coralline algae encrusted rock (Figure B-29 and Figure B-30). Species diversity was very high, with a dense cover over bedrock surfaces, including sponge, corals, hydroids, bryozoans (calcified and soft), zooanthids, green algae (*Caulerpa* sp.), *Ecklonia radiata* and *Sargassum johnsoni* (in shallower depth zones). Rock fragment / cobble fields were also common interspersed and adjacent to the bedrock areas, and often supported varied bryozoan species colonies.

At Middlesex Bank, four sites (B44, B45, B47, B49, 95 – 170 m, Figure B-31) encountered deep reefs, composed of low ridge and outcrop features, as well as some reef areas under a thin veneer of coarse white carbonate sands. Plexaurid fans and *Perissogorgia vitrea*, as well as large sponges and bushy hydroids were the visually dominant sessile taxa on these deep reefs (Figure B-31).

3.2.2 HAURAKI GULF

This region extends from Cape Brett (southern outer Bay of Islands) across Bream Bay and the Hauraki Gulf proper, including Little and Great Barrier Islands, stopping just west of Great Mercury Island (Figure B-32). High intensity trawling occurred inside the 100 m contour, from Bream Head through to Great Mercury Island, stopping inshore at the trawl exclusion lines in the Gulf and off the east Coromandel Peninsula. The no-trawl Spark Cableway Zone runs past the western side of Great Barrier and Mokohinau Islands and encompasses North-west Reef (less than 50 m depth). Trawling is also absent from the southern inshore bays of Great Barrier Island, and extensive deep reef areas and a military exclusion zone prevent trawling off much of the east coast. In the northeast, little trawling occurs inside the 100 m contour between the Poor Knights Islands and Cape Brett due to extensive deep reef. More trawling occurs in the 100 – 300 m depth zone, though not intensively, with a noticeable band from west of the Poor Knights to the Cape Brett at around 150 m, and a second along the 200 m contour. East of the Poor Knights Islands a similar trawling pattern is present in the 100 – 250 m zone up to the Cableway. East of the Cableway extensive deep reefs from the Mokohinau Islands (which extend out to at least 300 m there) extend to the east and through the

area off north-west of Great Barrier Island (as shown by charts and some multibeam sonar data), limiting trawling. More intensive trawling occurs out deeper along the 200 m contour (Figure B-32).

The commercial catch data contained seven reef-trait species of sufficient abundance to warrant discussion. Porae (*Nemadactylus douglasii*) were caught through the region in less than 100 m depth, and slightly deeper in some areas (set-net). Catches going north from Bream Head to Cape Brett were largely taken by lining (with set-netting clusters around the Hen & Chicken Islands, and off eastern Ngunguru Bay), as well as around the Mokohinau Islands, and northern Great Barrier Island, including two clusters deeper out to the east. Trawling caught porae through the central 30 – 100 m zone of the outer Gulf, with around 11 higher weight clusters within that zone. Red perch catches were much more spatially restricted and all taken by lining, with the largest area of catches occurring from Bream Head to Cape Brett, from inshore to out beyond 100 m, with higher catch weights in deeper depths. They were also caught in lesser amounts in a broad band from Little Barrier Island, north through the Mokohinau Islands, as well as off north-western Great Barrier Island.

As with the (east) Northland area, blue maomao were almost exclusively caught in less than 50 m depth by lining and set-net. Catches were clustered around east Ngunguru Bay, the Hen and Chickens Islands and the Mokohinau Islands. Pink maomao were caught largely deeper than 50 m, from Bream Bay up to Cape Brett (with catch clusters east of the Poor Knights and around Cape Brett), broadly around the Mokohinau Islands and off north-west Great Barrier Island. Catches of northern bastard cod by lining were common between Bream Head and Cape Brett, with clusters of set-netting catches around the Hen and Chicken Islands and off eastern Ngunguru Bay. Smaller catches were also taken (largely by lining) around Little Barrier, Great Barrier and Mokohinau islands. Southern bastard cod showed the same general spatial catch patterns as northern bastard cod but with lower catch weights (noting the potential misidentification issue between these two very similar species). Red snapper catches showed the same general spatial pattern as northern bastard cod but with a more pronounced line of catches extending from north of Little Barrier, through the Mokohinau Islands and out to 200 m depth, as well as two separate clusters west and east to either side of that 200 m water depth extension.

The commercial catch reef-trait species richness metric showed a continuous band of higher values along the coast from the Hen and Chick Island to Cape Brett, in depths of 50 – 170 m. Some high value clusters were also present around the Poor Knight Islands (outside the reserve boundaries) and further east in 200 – 300 m depth (Figure B-32).

A second band of higher species richness values ran along an axis from Little Barrier Island to north of the Mokohinau Islands, with higher value patches to the west and east in 200 – 300 m water depth, suggesting reef knolls. A third band of higher values was present around Great Barrier Island, except for its south-eastern coast; these high values also extended out into deeper water (100 – 200 m) to the east of the island (Figure B-32).

Nautical chart seafloor substrate codes for rock were focused on the Hen & Chickens, Little Barrier, Great Barrier and the Mokohinau Islands, along with several along the northern coast from Ngunguru Bay to Home Point (Figure B-33). Cobbles were marked for several Ngunguru Bay sites. The fisher LEK polygons indicated an extensive area of foul ground and coral east of the Poor Knights Islands, as well as on the east sides of the Little Barrier and Mokohinau islands, and off north-western Great Barrier Island. A band of foul was also marked between Little Barrier and Mokohinau islands. There were five foul TRAWL tows for the region, with two associated with LEK foul polygons.

The reef-trait species richness indices for observer bycatch, research TRAWL, and SPECIFY invertebrates were widely dispersed across the region (Figure B-33). In the central gulf area, most of

the observer bycatch index values were low but spatially widespread in less than 100 m (driven by trawling effort), with broad clusters including one west of the Cableway running roughly along its side, another on the eastern outer side of the Colville Channel, and another in less than 50 m inside the Gulf proper. A broad band also extended between Little Barrier and Mokohinau islands, along with a tight cluster on the Horn Rock area. A noticeable broad cluster of higher species richness values was present north of the Mokohinau Islands around 200 m depth. Research TRAWL records were less informative, showing a few higher values around the Mokohinau Islands, and a minor cluster in the east Coville Channel. SPECIFY invertebrate indices were more common from Ngunguru Bay to Cape Brett, with larger values consistent with the extensive reef systems present there.

The observer and research TRAWL bycatch records largely occurred in less than 100 m and were concentrated between Bream Head and the Colville Channel (Figure B-34). Most observer bycatch records were less than 10 kg in weight for any given taxa, and included 9 fish species, 6 coral taxa, packhorse crayfish, and rocks/stones. Most sites recorded only one reef-trait taxa (of the species plotted). A notable pattern was a cluster of spiny lace coral catches west of the Colville Channel. Research Trawl reef-trait taxa occurrence records were too few to add further context to this region (Figure B-34).

Video Imagery

Poor Knights to Cape Brett

Ten of the LINZ OS2020 DTIS sites over reef fell in the northern part of the GULF region, from near the Poor Knights Islands to Cape Brett (Figure B-33). Only the harder bedrock type (as seen further north along this coast) was present, forming low ridge and platform reef features, with the most northern site off Cape Brett having more rugged and raised outcrops (Figure B-35 to Figure B-44, Table A-4). Depths ranged from 57 – 147 m, with water clarity and reef sediment scores consistent along the coast. Coral taxa were seen at four of the deeper sites in the northern half of the site range (Stylasteridae, sites E19, E27; *Oculina virgosa*, sites E31, E61) (Table A-4). Large cup and plate sponges (e.g., *Ecoinemia alata*, *Calyx imperialis*, *Stelletta crater*, *Aciculites pulchra*), the rambling finger sponge (*Clathria scotti*) and glass sponges (*Symplectella rowi*, *Rossella ijimai*) were common. Small colonies of the reef-building bryozoan *Celleporaria agglutinans* were occasionally observed attached to finger sponges or reef but they never formed biogenic reef structures as seen on soft sediments at some South Island locations.

Hauraki Gulf

Three opportunistically sampled deep reef sites were present (Table A-4, Figure B-33). A short DTIS tow (O70) over a very rugged reef in 130 m just northwest of the Mokohinau Islands found a sponge dominated assemblage (especially of the glass sponge *Symplectella rowi*) along with several black coral (*Antipathella fiordensis*) colonies and associated commensal ophiuroids (*Astrobrachion constrictum*) (Figure B-45). Pink maomao and butterfly perch were commonly observed sleeping on the reef (site sampled at night).

A second shallower DTIS tow (O64) encountered a very small patch reef surrounded by fine sand just west of Little Barrier, in 50 m, with very clear water (Figure B-45). As well as dominant rambling sponges, this patch also held mixed red algae including *Rhodymenia*, *Gracilaria* or *Sarcodia*, and possibly *Callophyllis* sp. Sleeping butterfly perch (*Caesioperca lepidoptera*) were also present (this site was also sampled at night).

A third site was sampled in 2020 across a large deep reef (known as The Coral Patch) to the north of Little Barrier Island, in 64 – 70 m (Figure B-46). This reef was dominated by sponge species, along with several colonies of the black coral *A. fiordensis* with commensal ophiuroids (*A. constrictum*),

including a smaller (newer recruit) colony. Crinoids were also present (*Anneissia benhami* and/or *Cenolia novaezelandiae*). This reef was sampled during the day in low light conditions, so few fish were seen.

3.2.3 BAY OF PLENTY

This region extends from the Mercury Islands across the Bay of Plenty to East Cape, and south to Mahia Peninsula. Higher intensity trawling covers most of this region, except for the shelf north of the Mercury Islands, a zone around the Alderman Islands, around some islands of the central Bay, an aquaculture area off Opotiki, Ranfurly Bank and some of the shelf off the east coast deeper than 150 m. The commercial catch data contained nine reef-trait species of sufficient abundance to warrant discussion.

Blue maomao were restricted to waters less than 50 m deep in the western half of the region, and around White Island and Volker Rocks. Pink maomao were caught more often and in larger weights beyond 50 m depth. Catch clusters were apparent around the Alderman Islands and east and west of the Mercury Islands, Major Island, and a deep water rise northwest of White Island. A line of catches was also present on Ranfurly Bank.

Northern bastard red cod catches were predominantly from the west of the region, with many lining catches around the eastern Mercury Islands, the Alderman Islands, and along the coast (as lower catch weights). A deeper water cluster also occurred inside 300 m depth north of the Mercury Islands. Lining and set net clusters were present around Major Island. There was a line of smaller catches to the east just beyond the 50 m isobath, as well as scattered catches in shallow water off eastern Tauranga Harbour. A set net cluster was present around White Island and Volker Rocks, as well as a small lining cluster south of Ranfurly Bank in 200 – 300 m, and some scattered catches along the edge of the shelf off Gisborne. Southern bastard cod clusters occurred in less than 100 m depth around Great Mercury, Alderman, Major and Motiti Islands. A few catches were present around Ranfurly Bank, and a deep-water feature off Tokomaru Bay.

Red snapper were widespread in the Bay of Plenty, with numerous lining catches along the east Coromandel coast out to 100 m and set net catches off Mayor Island and Volker Rocks. Trawl catch clusters were present right along the 200 m contour, with clusters east of the Mercury Islands, off Major Island and offshore of Whakatane. A shallower water cluster also occurred in a little over 150 m depth west of Cape Runaway. Trawl catch of red snapper continued along the 100 m contour from inside of Ranfurly Bank down to north of Mahia Peninsula, with catches extending into 50 m in the lower half of this area. A lining cluster was present on the northern Ranfurly Bank, in 100 – 300 m.

Red scorpion fish catches were strongly clustered in the far west of the region in less than 100 m depth, with lining clusters around the Mercury and Alderman Islands, and off the adjacent coast. A lining and setnet cluster was present at White Island and Volker Rocks, and one line catch was recorded from the top of Ranfurly Bank. Red perch catches were also largely restricted to lining in the western half of the region, with scattered catches around the 50 m contour off Whitianga, and clusters east of Mayor Island, and around Motiti Island and some deeper areas beyond 300 m depth. Trumpeter (*Latris lineata*) catches were rare west of East Cape but became common at Ranfurly Banks down to Mahia Peninsula. At Ranfurly Bank they were caught by lining right around the bank out to 300 m depth. Catches further south extended along the shelf edge in 200 – 300 m depth. Some trawl catch was also taken, mostly beyond 100 m depth off Tolaga Bay and northeast of Mahia Peninsula. Bass (*Polyprion americanus*) were mainly caught by lining and set net in waters more than 300 m deep inside the Bay of Plenty. However, from Ranfurly Bank to Mahia Peninsula they occurred

slightly shallower, mostly just inside the 300 m contour. Bass catches in the Northland and Hauraki Gulf regions were all beyond 300 m depth and so fell outside the target depth range.

The combined reef-trait catch weight metric (in 1 second grid resolution) for trawling showed largely low, or no catches of reef-trait species, except for a small cluster running southeast from Mayor Island along the 200 m contour (Figure B-47). Better defined but small clusters were present on a deeper water feature north of White Island, on a small 300 m bathymetric spur offshore of Tokomaru Bay and a deeper feature slightly north of this. The lining weight metric showed diffuse clusters east of the Mercury Islands, around the Alderman Islands and north of Mayor Island. More sharply defined clusters were present around 300 m depth well north of the Mercury Islands, on deeper features around the White Island and Volkner Rocks, on each side of the ridge connecting Ranfurly Bank to East Cape, and around the bathymetric spur and deeper water feature out at 300 m depth off Tokomaru Bay. Higher catches were also made along the 300 m isobath south of the latter features. The set net combined weight metric showed clusters east of Mayor Island and around White Island, with occasional higher values off Whitianga, Mayor Island, Tokomaru Bay and Gisborne. The combined weights metric emphasised two of the clusters north of the Mercury Islands, as well as Mayor Island, White Island and the surrounding bathymetric rises, and the spur and deeper water feature off Tokomaru Bay. The combined species richness metric also highlighted these areas but also showed strong clusters off the eastern Mercury Islands, the Alderman Islands and adjacent coast, a band along the 50 m contour near Motiti Island, the north and south sides of Ranfurly Bank, and the shelf break from Tolaga Bay to Mahia Peninsula (Figure B-47).

Nautical chart seafloor substrate codes for rock were focused on the western Bay of Plenty (12 markers), with two around White Island, two off East Cape and one southeast of Tolaga Bay (Figure B-48). A cobble marker was present on Ranfurly Bank. The fisher LEK polygons indicated extensive foul ground on and around Ranfurly Bank, as well as along the shelf down to Gisborne. Two foul TRAWL tows were associated with these polygons, with another four in the western Bay of Plenty and one adjacent to Cuvier Island (Figure B-48).

The reef-trait species richness indices for observer bycatch, research TRAWL, and SPECIFY invertebrates were widely dispersed across the region (Figure B-48). Most of the SPECIFY invertebrate sites were scattered along the 200 – 300 m depth zone in the western Bay of Plenty, around White Island area (where recorded richness was higher), and on Ranfurly Bank. Research TRAWL sites were more widespread, with several higher richness scores off Coromandel Peninsula. Observer bycatch sites occurred throughout the region, with greater numbers in deeper water. Higher richness scores were more common off Coromandel Peninsula, and well north of Great Mercury Island (Figure B-49). Individual catches of fisheries observer reef-trait species were dominated by fish species (10), with few coral (2) and sponge (1) taxa reported. The maximum catch weight for most species was less than 5 kg. Catches of rock and stones were made at 147 sites.

Video imagery

Northeast of the Mercury Islands

Some lower resolution video imagery was available from a small DOC project conducted in 2008 to validate putative reef polygons derived from hydrographic faring sheets (Drury 2008; Middleton 2018). Six sites fell over reefs in the 45 – 97 metre range (Table A-4). Underwater visibility was slightly less than sites in the NORTH and GULF regions, though the low resolution and weaker lighting of the video system used makes this comparison somewhat tenuous. Rock bottom types across the sites included boulder fields, low bedrock pavements, often covered with a sediment veneer, small boulders embedded in fine sand, low bedrock mound outcrops as large mounds, and pavement

bedrock (Figure B-50 to Figure B-52). Low covers of sponge species dominated the fauna, with the black coral *Antipathella fiordensis* present at D9 (65 m).

Ranfurly Bank (East Cape) to Mahia Peninsula north

Ranfurly Bank was relatively intensively sampled by Jones et al. (2018). This bank is essentially a large rock pile with areas of exposed and sediment-covered basement rock, as well as extensive areas of soft sediment (Figure B-53 to Figure B-58). The top of the bank is exposed to strong swells and currents. There appears to be a mix of harder and softer rock types. The soft rock type may be a form of mudstone. There was clear evidence of this rock being fractured and breaking free in the horizontal plane, as well as evidence of movements of coarse sediment covering and uncovering flat reef surfaces. Probably as a consequence of this the bank is relatively devoid of larger sessile organisms, and is instead dominated by non-geniculate coralline algae, soft bryozoans and patches of green algae (*Caulerpa* spp.) to about 60 m depth. The notable exception is the occurrence of large *Ecklonia radiata* forests, present as the 'deep-water' form, characterised by an elongated stipe up to 3 m long (Figure B-53). These cover several km^2. Attached *E. radiata* were present to at least 70 m depth. Below this areas of exposed bed rock occur as low ridges and outcrops, including a high rock outcrop sampled on the north-western corner of the bank dominated by corals, and a much larger area of deep rock outcrop on the north-eastern side of the bank. Refer to Jones et al. (2018) for detailed descriptions of Ranfurly Bank and its ecological assemblages.

Gisborne coastline sites

An unnamed rocky ridge composed of mixed bedrock and embedded cobble fields, supported a low encrusting assemblage of corallines, small bryozoans, and red algae (Figure B-59). Occasional clusters of small *Ecoinemia alata* sponges were also present.

Three DTIS sites off Ariel Bank found poorer quality reef areas in deeper water (80 m) with reduced water clarity and sedimented rock surfaces (Figure B-60). The two shallower water sites (50 m) had better clarity, less obvious sedimentation and had a greater level of biological cover, although much of it was low encrusting sponges, bryozoans and non-geniculate coralline algae. The kelp *Ecklonia radiata* was present in shallower areas of reef as scattered clusters.

North of Mahia Peninsula, sampling of a complex reef structure of alternating fault ridges and soft sediments found the deeper reefs areas to be heavily sedimented, with large epifauna mostly restricted to the tops of the ridges (Figure B-61).

3.2.4 WAIRARAPA

This region extends from the Mahia Peninsula to Cape Turnagain, with trawling occurring across most of the shelf (Figure B-62). Many of the warm temperate reef fishes distributions end north of this region (e.g., blue and pink maomao, red scorpion fish, northern bastard red cod, and moray eels), whereas colder water species start to appear (e.g., orange perch *Lepidoperca aurantia*). Species found in deeper water further north also start to occur in shallower water (e.g., bluenose, hapuka, cardinal fish), while others become more abundant with increasing latitude (e.g., trumpeter).

The commercial catch data contained five reef-trait species of sufficient abundance to warrant discussion. Orange perch, absent to the north, appeared in limited catch weights at a low number of sites. There were some lining catches off south-eastern Mahia Peninsula, including Ritchie Banks, and a small cluster of trawl catches in 100 – 200 m depth southeast of Pōrangahau and on the northern end of North Madden Bank. Trumpeter catches and weights increased relative to further north (Mahia Peninsula to Ranfurly Bank). Lining catches extended in a dense arc along the 200 m contour on Lachlan Ridge, paralleled by a less dense arc of trawl catches inshore of the lining area. Further

south trawl catches were clustered between 100 – 200 m depth off Pourerere, southeast of Pōrangahau, and southeast of Flat Point. Several lining clusters were also apparent east of Castlepoint and further south. Bluenose were widely caught, with multiple lining and setnet catch clusters along the edge of the shelf below 200 m depth. All methods had strong catch clusters on deep bank features, including at less than 300 m depth on the Ritchie, North Madden and South Madden Banks. Hapuka were also caught often on these banks by lining, as well as in clusters along the shelf edge off Mahia Peninsula, along the Lachlan Ridge shallower than 200 m, and south of Castlepoint in 200 to 300 m depth. Small trawl catches were widespread across the region in 50 – 150 m depth as far south as Flat Point. The commercial catch data does not include fish lengths, so it is unknown whether these lower weight catches represent juvenile hapuka ('pups') that school over soft sediments prior to taking up residence on reefs. Cardinal fish catches were almost exclusively caught deeper than 300 m but did indicate that reef-trait species could be used to identify reefs below that depth.

The combined reef-trait catch weight metric (in 1 second grid resolution) for trawling showed only a few quite discrete clusters, with four on the Ritchie and Madden banks and two associated with the shelf edge. The lining catch metric also showed these bank clusters and one of the shelf edge clusters (doubling the size of that cluster). Additional clusters were present along the shelf edge east of Mahia Peninsula and at the southern end of the region. The set netting weight metric showed a linear cluster extending south of Mahia Peninsula and suggested the presence of a few smaller reef systems in individual grid cells with higher reported weights. The combined weights metric emphasised the clusters driven by trawl catches. The combined species richness metric also highlighted these areas, but also picked up two areas of dense clustering on the shelf edge east and south of Mahia Peninsula, off Pōrangahau, and in the far south of the region (Figure B-63).

Nautical chart seafloor substrate codes for rock in the region were concentrated in a line of four sites on Lachlan Bank and one site south of Cape Kidnappers. The fisher LEK polygons showed coral to be present on Lachlan Bank, while the lower east coast North Island trawl review indicated foul ground in broad areas around the bank. That review also indicated offshore foul ground extending from Cape Turnagain to Castle Point, as well as some smaller extents further south. Two foul TRAWL tows were associated with one of the smaller southern polygons (Figure B-64).

The reef-trait species richness indices for observer bycatch, research TRAWL, and SPECIFY invertebrates were dispersed across the region (Figure B-65). Few SPECIFY invertebrate sites were present, with one notable richness score of 9 on the southern Ritchie Banks. Higher richness scores for research Trawl and observer bycatch occurred from Cape Turnagain to the south of the region in 100 – 300 m depth, although maximum scores were low (2 and 4 respectively). Lower scoring sites were found off Mahia Peninsula and along Lachlan Bank. Higher observer bycatch scores were also found for a limited number of sites on the Ritchie and Madden Banks.

At the individual taxon level, the observer bycatch data was dominated by six fish species and included four catches of small coral (unspecified), hard bushy coral and sea-fans (56.1 kg combined) (Figure B-66). Research TRAWL reef-trait species catch was relatively low, with five fish species and one rock lobster catch (at 0.5 kg, likely one individual).

Video imagery

No seafloor imagery was available for this region.

3.2.5 TARANAKI

This region extends from south of the Hokianga Harbour to the North Taranaki Bight (Figure B-67). Most of the shelf from Hokianga Harbour to Manukau Harbour is trawled, except for a communications cable exclusion zone (the trawling pattern backdrops used in this report do not reflect more recent area closures to protect Maui dolphins). South of Manukau Harbour, higher intensity trawling split into a shallower zone inside 50 m depth, and an offshore zone between 100 – 250 m depth, which then split north of New Plymouth into a main band running through the central area of North Taranaki Bight, and as a narrower band inside the 200 m contour. Less trawling effort occurred between these two bands. A large portion of the inner Taranaki Bight and the 50 – 100 m depth zone immediately to the north received relatively little trawling effort. As with the WAIRARAPA region, many of the warm temperate reef fishes (e.g., blue maomao, pink maomao, red scorpion fish, moray eels) were rare or absent from this region. Northern bastard cod were present but uncommon in commercial catches.

The commercial catch data contained five reef-trait species of sufficient abundance to warrant discussion. Southern bastard cod were caught by all fishing methods, with adjacent catch clusters for trawl, lining and set-netting along the 50 – 100 m zone off New Plymouth. Scattered catches were also made to the north by setnet, and adjacent to the shelf edge by trawl. Red snapper were also caught by all three methods, with a setnet catch cluster off New Plymouth and a series of catches further offshore inside the shelf break at 200 m (deeper for some line catches). Low scattered catch weights from trawling were also recorded north to Hokianga Harbour, largely in the 100 – 200 m zone. Trumpeter were mainly caught by lining around the North Taranaki Bight shelf edge (200 – 300 m). Butterfly perch were widely caught by trawling slightly inshore of the shelf edge in a band extending from northwest of New Plymouth to southwest of Manukau Harbour. Copper moki (*Latridopsis forsteri*) also appeared in commercial catches in this region, with a set net catch cluster along the northern Mount Taranaki coast, dominated by larger catches around the 50 m contour.

The combined reef-trait catch weight metric (in 1 second grid resolution) for trawling displayed clusters inside the shelf edge offshore of New Plymouth, as well as a lesser weight cluster around the 50 m contour adjacent to New Plymouth. The lining weight metric showed an essentially continuous distribution of high catch weights between 200 – 300 m along the shelf edge off New Plymouth. The weight metric for set netting showed three to four clusters in 50 – 100 m depth adjacent to New Plymouth; as well as several higher catch grid cells to the north (possibly small reefs). The all-methods weight metric showed all the clusters from the different methods well, as did the species richness metric, with a sharper spatial focussing of higher value clusters.

Nautical chart seafloor substrate codes for rock in the region were rare, with two rock sites (one towards the shelf edge, one inshore south of Mount Taranaki) and one cobble site close inshore near New Plymouth (Figure B-68). The fisher LEK polygons showed an inshore area of foul off New Plymouth, and two larger polygons on the North Taranaki Bight shelf edge and adjacent seafloor, along with a large sponge polygon that partially overlapped them. One foul TRAWL tow fell within the sponge polygon, with a further four tows close to the North Taranaki coast, and two offshore of the Manukau Harbour, in 50 to 100 m (Figure B-68).

The reef-trait species richness indices for observer bycatch, research TRAWL, and SPECIFY invertebrates were dispersed across the region, but more intensive and with higher values in deeper water (Figure B-68), driven by a large number of observer bycatch sites. SPECIFY invertebrate sites were sparse, with the four highest scoring sites along the shelf edge coming from the Biogenic Habitats on the Shelf survey, which specifically targeted LEK polygons considered to hold species associated with biogenic-habitat forming species (sponges and associated rock in this area, Jones et

al. 2018). Research Trawl sites with reef-trait species were scattered, with generally low richness scores (Figure B-68).

At the individual taxon level, the observer bycatch was dominated by nine fish species, with some having maximum catches exceeding several hundred kg (common roughy, orange perch and splendid perches). Three coral taxa were recorded across 8 events, with most catch weights less than 5 kg except for one 100 kg catch of coral (unspecified species) on the shelf edge north-west of New Plymouth. Low weight catches of packhorse crayfish (29 events, 1 – 3 kg) were an occurred in the 50 – 100 m zone from Manukau Harbour to Hokianga Harbour (Figure B-69). As with the pattern seen off Ninety Mile Beach, these catches are probably of individual lobsters. Research TRAWL reef-trait species catches were uncommon and included five reef fish species, as well as three low weight packhorse crayfish catches.

Video imagery

The Biogenic Habitats TAN1105 voyage deployed DTIS sites at several canyon heads and continental shelf edge sites off Kaipara Harbour and the North Taranaki Bight. Where reefs were encountered (seven sites, 162–254 m) they were largely formed of carbonate rubble fields, often in the shape of small broken pillars and slabs. Occasional patches of bedrock were also present. These are thought to be the remains of biogenic geophysical processes when seafloor levels were lower during the ice ages, with these features later eroding out of soft surrounding materials, to form discrete rubble fields. These were usually found on the side slopes of the canyons as discrete patches and were detectable by multibeam sonar (Jones et al. 2018). Occasional outcrops of bedrock were also seen in adjacent small areas. The fauna of these reef systems was generally smaller and less conspicuous, including several rock sponges previously considered rare, glass sponges, crinoids, and anemones, with some patches of larger sponges and whip corals (Figure B-70 to Figure B-73).

3.2.6 TASMAN (GOLDEN) BAY

This region included the top of the South Island and the South Taranaki Bight (Figure B-74). Trawling spatial patterns are complicated in this region, with some relatively large areas of the South Taranaki Bight and mid-shelf off the west coast of South Island having low trawling intensity.

The commercial catch data contained few reef-trait species of sufficient abundance to warrant discussion. Trumpeter catch clusters occurred in three areas. A lining catch cluster occurred east of Cape Foulwind in 200 – 300 m depth. A smaller cluster of all three fishing methods occurred offshore of Kahurangi Shoals around 150 m depth, and three clusters extended along the 150 m contour off the upper east coast South Island. The southern-most of the latter was a set netting cluster, the middle one was formed by lining, and the northern one by trawling and lining. Orange perch catches were sporadic and restricted to the southern half of the region, with a limited cluster in 200 – 300 m depth southwest of Cape Foulwind. Butterfly perch catches were even more spatially restricted, with a series of set netting catches around Wellington's shallow reefs and a tighter cluster of larger catch weights around Kapiti Island. Catches of two shallow reef fishes (butterfish *Odax pullus* and marblefish *Aplodactylus arctidens*) were caught in numerous set-net events around western D'Urville Island, outer Marlborough Sounds and the Wellington area. The catch depth distributions of these species were essentially restricted to depths less than 50 m.

The reef-trait catch weight metric (in 1 second grid resolution) for trawling displayed a single higher weight cluster on a bathymetric spur on the shelf edge east of Cape Campbell, with several small grid cell patches with higher values off the Wellington coast. The lining weight metric identified a higher value cluster adjacent to the trawl cluster (a thin zone along the shelf edge off Wellington), some smaller patches associated with four west coast South Island canyon heads, and a loose collection of

higher value grid cells further south between 200 – 300 m depth. The set-net weight metric showed limited higher value clusters around Kapiti Island and northeastern D'Urville Island along with some less pronounced higher value grid cells groups off the south Wellington coast and just beyond the 100 m contour along the shelf north of Kaikoura. The all-methods weight metric was dominated by the trawl weight contributions and showed the same higher weight clusters as seen in the trawl weight metric. The combined methods species richness metric was more balanced, reflecting all three method contributions, as well as identifying two additional higher species richness clusters at the heads of the Cook Strait canyons (Figure B-75).

Nautical chart seafloor substrate codes for the region included a series of rock sites from Mana and Kapiti islands across to the Marlborough Sounds, one in outer Tasman Bay, and one south of the Rolling Grounds on the Patea Banks (Figure B-76). Five rock/cobble site markers were present along a long east-west line just north of the latter. The fisher LEK polygons show foul ground inshore of the Patea Bank (less than 50 m), an area known to hold many small rocky patch reefs, several of which were mapped using multibeam sonar in 2020 (Morrison et al. 2022). Other LEK foul polygons were present south of Palliser Bay and down the east coast of the South Island (Figure B-76). A large sponge polygon was present off the south Wellington coast, along with a large coral polygon east of Farewell Spit and a smaller one east of D'Urville Island (known to have been a large area of bryozoan reefs that was eliminated by intensive scallop dredging in the 1970s). Five foul TRAWL tows were present on the South Taranaki Bight, as well as one off eastern D'Urville Island, one off Wellington and two off the east coast of the South Island (Figure B-76).

The reef-trait species richness indices for observer bycatch, research TRAWL, and SPECIFY invertebrates were broadly arrayed as a large arc extending from the lower east coast South Island to south of the Patea Banks (ignoring values in the 30 – 50 m depth zone) (Figure B-77). Clustering was also apparent in central Cook Strait and along the shelf edge east of Cape Campbell. Most of the higher SPECIFY invertebrate richness values occurred south of the Patea Banks, in 50 – 100 m depth. This included two of the foul TRAWL tow sites, which encountered reef on the seafloor and returned catches of reef-associated sponge species that were kept for taxonomy (E.J., pers. Obs.). Off the west coast of the South Island, a large area of denser and higher value observer bycatch species richness values was present in 200 – 300 m depth. Between the North and South Islands these values were lower (dominated by values of 1 = one reef-trait species present) and more scattered. Research TRAWL species richness values were also higher off the lower west coast of the South Island, although several higher values areas occurred inshore of the commercial catch cluster. A line of higher research TRAWL species values was also present on the shelf edge southeast of Cape Campbell on the east coast.

At the individual taxon level, the observer bycatch data was dominated by 9 reef-trait fishes (Figure B-78) and eight invertebrates (Figure B-79). Common roughy were one of the most common contributors, particularly between the North and South Islands, and down the lower west coast of the South Island. Orange perch were also present in the latter area, with one notable catch of more than 2 tonnes.

Video imagery

Several deeper reef systems near the Chetwode Banks, off Pelorus Sound, have been targeted for towed camera work (video only) as part of the MBIE-Endeavour Fund 'Juvenile fish habitat bottlenecks' programme. One of these reefs, on the eastern side of the Rangitoto Islands between 40 – 60 m depth, has been surveyed to-date. It was very rugged with high stacks, that were heavily encrusted with sponges, an unusually high cover of ascidians, soft bushy hydroids and zooanthids (Figure B-80).

3.2.7 CANTERBURY

This region extends from Kaikoura to just north of the Otago Peninsula (Figure B-81). Trawling intensity is aligned in zones running along the depth contours with distinct bands of higher and lower effort. Areas of lower intensity fishing include midway between the 50 – 100 m contours in the South Canterbury Bight, and midway between the 100 and 200 m contours. In the most southern part of the region areas shallower than 50 m are not trawled due to the presence of extensive reefs. There is also an area of low effort inshore of Cornish Head Canyon.

The commercial catch data contained four reef-trait species of sufficient abundance to warrant discussion. Orange perch catches were restricted to the northern and southern areas of the region. In the north, set-net catches were taken along the edge of the shelf around the Kaikoura Canyon and along the Conway Ridge, while trawl catches were made in the 100 – 200 m zone along the Conway Ridge and on either side of the Pegasus Canyon. In the south, set net catches clustered around the side of the Conway Head Canyon and directly north of it in 100 – 200 m depth. Trumpeter had a similar distribution, with a broader spatial spread in each area. In the north, set-net catches were clustered around the edge of the Kaikoura Canyon, along Conway Ridge and at the head of the Pegasus Canyon. A separate cluster occurred east of Banks Peninsula at about 80 m depth. In the south, set-net catches were widely distributed and weighed less than those in the north. There were clusters at the top of Cornish Head Canyon and slightly north around 100 m depth, and a third off Oamaru in less than 50 m. Bluenose catches also clustered in the north and south of this region. Set net and some lining catches extended as a band around the edge of the Kaikoura Canyon and along Conway Ridge. A lining cluster dominated the southern and western side of the Pegasus Canyon, with some scattered trawl catches here and more broadly along and past the shelf edge. In the south set net catch clusters extended from Cornish Head Canyon along the shelf edge, with an inshore extension just over halfway between that Canyon and The Crack (the large incision in the shelf edge). Lining catches also contributed to this cluster, including on the sides of Cornish Head Canyon and around the Crack. Copper moki catches were restricted to set-netting and formed a very clear cluster in the 50 – 100 m depth zone around the western edge of the Kaikoura Canyon, including Bushett Rocks/Bushett Shoal.

The combined reef-trait catch weight metric (in 1 second grid resolution) for trawling did not reveal any large clusters. There were small groups of higher value grid cells on Conway Ridge east of Pegasus Canyon in 100 – 200 m depth, and slightly north of Cornish Head Canyon inside the 100 m contour. The lining combined weight metric also highlighted similar sized groups of cells at the end of Conway Ridge, the southern ends of Kaikoura and Pegasus Canyons, and a small area east of Banks Peninsula on the shelf around 80 m depth. In the south, a long narrow ribbon of higher catch weights extended along the 200 – 300 m contour from Cornish Head Canyon to over halfway towards the Crack. There were also higher value cells along the western side of the Crack. The set net weight metric showed similar patterns to lining but with additional clusters on the northern and western sides of Kaikoura Canyon, a larger cluster on the Conway Ridge, and more scattered higher value cells in the south. The all methods combined weights metric captured the three methods clusters well, while the combined species richness metric emphasised the shelf edges, especially around the Kaikoura Canyon (potentially due to the particularly steep depth gradients there which result in species with different depth preferences occurring in close proximity to each other)(Figure B-81).

Nautical chart seafloor substrate codes for rock in the region were rare. Rock sites were indicated off Haumuri Bluffs and south of Lake Ellesmere, and a cobble site off Oamaru (Figure B-82). The fisher LEK included several foul ground polygons off Banks Peninsula, and two FNZ blue cod survey strata (targeting deep reef) were located east of Banks Peninsula. There were three foul TRAWL tows in the region, all in the north, with one falling within an LEK foul polygon and another in one of the blue cod

foul ground polygons. The third was located north of Pegasus Canyon, inside the 100 m isobath (Figure B-82).

The reef-trait species richness indices for observer bycatch, research TRAWL and SPECIFY invertebrates showed a long arc along the shelf edge, most prominent from the east side of the Pegasus Canyon extending to south of Banks Peninsula (wider in its northern part), then a large gap until becoming more prominent again off Oamaru (note this dominance in the north may be in part an artefact of more intensive fisheries observer coverage there) (Figure B-82). Higher values were also present along the Conway Ridge, and on the north and south sides of Kaikoura Canyon. The South Canterbury Bight had only scattered low value research TRAWL cells with the exception of one small area in the centre of the Bight that was also marked as a small foul area by LEK and had four rock lobster potting events on it. On the chart this is marked as a feature rising to 44 m from the surrounding seafloor at about 70 m depth. Trumpeter catches were associated with this feature and it is distinguishable as a low intensity spatial feature in the lining and setnet weight metrics, and the combined methods species richness metric.

At the individual taxon level, the observer bycatch was dominated by 12 reef-trait fishes and 11 invertebrate taxa (Figure B-83). Most of these records were between a point east of Pegasus Canyon and to the shelf south of Banks Peninsula. There were almost no records further south than this. As noted above, this is probably an artefact of intensive fisheries observer coverage in this specific area. Catch weights and event number of reef-trait invertebrates were generally low (dominated by rock lobsters with 130 events) as were those for fish (with a few larger individual catches, e.g. orange perch to 990 kg). Coral taxa were uncommon. The research trawl catch of individual reef-trait species showed a general scattering of low weight catches, of three reef-trait fish, and eight invertebrate taxa (Figure B-84). Of note was a cluster of girdled wrasse (*Notolabrus cinctus*) catches around one of the FNZ blue cod ground survey polygons, southeast of Banks Peninsula.

Video imagery

The Biogenic Habitats programmes second R.V. Tangaroa voyage sampled two rocky reef and four biogenic reef (bryozoan fields) sites in this region (Table A-4).

Conway Ridge

Only a few DTIS images were recorded at H7 before a camera failure. Several small boulders/outcrops were seen, with a solid cover of finger sponges (Figure B-85).

Cornish Head Canyon and the adjacent shelf

A LEK polygon marked up as sponges adjacent to Cornish Head Canyon was sampled by several DTIS transects. These showed a mixture of bryozoan and wireweed (polychaete tubeworms) dominated seafloor assemblages. Only the bryozoan areas qualified as biogenic reefs. The bryozoan dominated site (H139) occurred at 93 m depth and was visually similar to the better known bryozoan fields south of Otago Peninsula, although densities and coverage were less extensive. Associated species included sponges, anemones, dredge oysters (*Ostrea chilensis*), starfish and horse mussels (Figure B-85).

DTIS video transects down the side of Cornish Head Canyon targeted areas of bedrock identified by multibeam sonar. These revealed a mixture of bedrock outcrops and blocks, and sediment pockets and slopes. Anemones and sponges were present on some of the rock surfaces, and some areas had clusters of large colonies of the bryozoan *Hippomenella vellicata* (Figure B-86). Several large crayfish (*Jasus edwardsii*) were seen in close association with these large colonies. Aggregations of the crab *Leptomithrax longipes* were observed in the deeper part of the transect.

3.2.8 FIORDLAND

This region extends from Greymouth to Breaksea Sound, west coast South Island. Most of the shelf was well trawled, with highest intensities inside the 50 m contour (Figure B-87). The commercial catch data contained three reef-trait species of sufficient abundance to warrant plotting.

Orange perch catches were limited to the northern half of the region, with trawl catch clusters north of Otorokua Point along the shelf edge at 200 – 300 m depth, and on the eastern side of the Hokitika Canyon. A few low weight lining catches were made along the shelf edge in 200 – 300 m depth. Trumpeter were caught more widely, with trawl catch clusters associated with the canyon heads and sides, and along the shelf edge. Lining catches were also recorded at Hokitika Canyon and along the narrow shelf edge south from Jackson Bay. Bluenose were caught in a continuous band along the shelf edge, including canyon edges. The southern half of the region was dominated by lining catches. While trawl catches occurred in a band in the north below 300 m depth, as well as a in Hokianga Canyon, where some lining and set-net catch clusters occurred each side of the trawling cluster.

The combined reef-trait catch weight metric (in 1 second grid resolution) for trawling did not reveal any large clusters, with scattered higher value grid cells associated with Hokitika Canyon and several canyons further south. The line weight metric was more informative, with a clear cluster on the outer north side of Kaikoura Canyon and several clusters associated with bathymetric spurs between Jackson Bay and Milford Sound. This included one unmapped feature where fishers recorded bottom depths of 300 m or less across multiple fishing events in an area that published bathymetric data indicate is deeper than that. The set net weight metric showed one small group of higher value cells at the head of Hokitika Canyon. The all-methods combined weight metric emphasised the higher lining weight contributions, while the combined species richness metric emphasized clusters around the heads and sides of canyons, and shelf edge bathymetric spurs (Figure B-88).

Nautical chart seafloor substrate codes in the region were rare, with two rock sites marked in shallow water west of Heretaniwha Point (Figure B-89). Between this point and Jackson Head the DOC reef polygons (which generically extend to 100 m depth) and the chart indicated a series of reefs/pinnacles to be present inshore to around 500 m depth (the latter having a pinnacle feature rising to 139 m). The fisher LEK polygons showed an area of foul ground on the shelf edge in the far north of the region. In the south, a coral polygon was present close to the coast north of Awarua Bay. Three foul research TRAWL tows were recorded, one just off the pinnacles north of Jackson Head, one immediately adjacent to the northern LEK foul polygon, and one off Abut Head (Figure B-89).

The reef-trait species richness indices for observer bycatch and research TRAWL largely occurred in the northern third of the region, with higher values on the shelf edge (Figure B-90). The SPECIFY invertebrate metrics were more widely distributed, reflecting sampling effort inside the fiords and along the adjacent coast, although the highest score was only three species. Observer bycatch and research TRAWL individual reef-trait species catches were uncommon but included 10 rock lobster catches in the north, and a small cluster of southern bastard catch in 200 – 300 m depth west of Hokitika Canyon (Figure B-91).

Video imagery

No deep reef seafloor video imagery was available for this region.

3.2.9 STEWART

This region extends around the bottom of the South Island from Dusky Sound to Otago Peninsula, including Stewart Island and the Snares shelf and islands (Figure B-92). Trawling effort in this region occurs as multiple intensively trawled areas, surrounded by areas of little trawling.

The commercial catch data contained four reef-trait species of sufficient abundance to warrant discussion. Orange perch catches were intermittently present along the shelf edge in 200 – 300 m depth, with a cluster north of the Snares Islands containing two large catches (maximum 9369 kg) and another more extensive cluster on the southern end of the Snares Plateau. Trumpeter catches were much more widespread but concentrated in waters less than 100 m depth. An exception to this were some lining catches around 200 m depth on the west side of Puyseger Plateau. Most trawl catches were recorded in a band along the 50 m contour from south of Otago Peninsula to Nugget Point on the east coast. Set-net catch clusters occurred around Stewart Island and in three areas in Foveaux Strait including around Ruapuke Island, all wholly or largely in less than 50 m depth. Scattered set-net catches were also recorded in 50 – 100 m depth off the east coast, and from west of Te Waewae Bay to Chalky Inlet off the south coast. Southern bastard cod catches were limited, with occasional trawl catches along the shelf edge and a low density cluster on the eastern edge of Mason Canyon. Red rock lobster were also caught in reasonable abundances by trawl and set-netting, with a zone of trawl catches down the east coast largely inside of the 50 m contour, and west and east of Stewart Island. As large marches of rock lobster are a feature of rock lobster ecology in this region, it is possible these catches occurred over soft sediments. Set-net catches fell in the western half of the region, with clusters south of Codfish Island, around Solander Island and along the coast from Te Waewae Bay to Dusky Sound. Most catches were in less than 50 m depth but some extended to or past the 100 m contour.

The combined reef-trait catch weight metric (in 1 second grid resolution) for trawling showed scattered higher values at the south end of Snares Plateau, as well as small groups of higher value grid cells north of Snares Islands and midway between Solander Island and Mason Canyon. All were associated with the shelf edge. Those higher value cells north of the Snares Islands largely occurred in depths greater than 300 m according to the national bathymetric grid but fishers recorded either the start or end positions (or both) as 300 m depth or less. It is therefore possible that the seafloor here is less than 301 m deep, or that fishers towed up or down the depth gradient (such tows would need to be long to explain the sites' distances from the 300 m contour). The lining weight metric showed higher value clusters off Dusky Sound, on the west side of Puysegur Plateau, off south Solander Island, along the east side of Mason Canyon, and east of Nugget Point on the east coast. All were narrowly focussed around the 300 m depth contour. The set net weight metric returned a shallow cluster on the north side of Solander Island in 50 – 200 m depth, as well as scattered higher value grid cells off Dusky Sound and Preservation Inlet, southwestern Stewart Island, and along the east coast. All in 50 – 100 m depth. The all-methods weight metric reflected the contributions of all three methods groups, as did the combined species richness metric (Figure B-93).

Nautical chart seafloor substrate codes showed multiple rock seafloor sites around Solander Island, Snares Islands, west and south of Stewart Island, and along the east coast (Figure B-94). Cobble/rock sites were present east and south of Snares Islands, east and south of Stewart Island, and along the east coast. Broken cobbles, a symbol class rare on New Zealand charts, were recorded at seven sites off Chalky and Preservation Inlets. The fisher LEK polygons showed a large and extensive area of foul across much of the Snares Plateau, with smaller polygons between Te Waewae Bay, east (including the head of Mason Canyon) and west of Stewart Island, and north of Nugget Point on the east coast. The extensive bryozoan fields off the Otago Peninsula were also marked as polygons, as was an area of unusual rocks south-west of the bryozoan fields. Coral polygons were marked over the Puysegur Plateau and a small area at the very south-western end of the Snares Plateau. Multiple foul research TRAWL tows were recorded, particularly east of the North and South Trap reef fields (3 tows) and the eastern side of the Snares Plateau (9 tows). There were also two on the Puysegur Plateau, two east and west of Solander Island, one north of the Snares Islands, and one adjacent the LEK unusual rocks polygon on the east coast (Figure B-94).

The reef-trait species richness indices for observer bycatch and research TRAWL occurred as a series of clusters mostly associated with the shelf edge (Figure B-95). Clear shelf edge clusters were apparent around Puysegur Bank, along the shelf west of Stewart Island, and as a large almost continuous arc running from the south-western end of the Snares Plateau north to a point southeast of Otago Peninsula. Higher value research TRAWL sites inside the Solander Island trawl cluster also suggest a higher value band along the 100 – 200 m zone in that area. A cluster of observer bycatch records was also evident off the east side of Foveaux Strait in 70 – 120 m depth. The nautical chart shows one small discrete bathymetric feature rising to 99 m from a surrounding seafloor depth of about 110 m in this area. SPECIFY Invertebrate species richness sites were sparse but showed higher values at Mason Canyon (deep reef habitats sampled by rock dredge during the Biogenic Habitats programme) and east of Otago Peninsula (also sampled by beam trawl for its bryozoan biogenic reefs) (Jones et al. 2018).

Observer bycatch and research TRAWL individual reef-trait species catches were common in this region (Figure B-96 to Figure B-98). For the observer data, this probably reflects higher intensity coverage of this area. Fisheries observer catches of fish included 13 species of reef-trait species, with several of these recorded from 100 sites or more. Orange perch (1056 sites) and southern bastard cod (715 sites) were the most caught species. Southern bastard cod were not often recorded in the general commercial catch data for this region, suggesting that they usually do not rank in the top five by weight in commercial catches. Fisheries observers recorded catch weights of this species between 1 to 84 kg (Figure B-96). Notable catches included a single 250 kg catch of scarlet wrasse (strongly associated with rocky and biogenic reefs) on the Snares Plateau halfway between the Snares and Stewart islands, and the appearance of small-scaled cod (*Notothenia microlepidoptera*) (97 sites, 1 – 50 kg), a southern cold-water species. The fisheries observer data also recorded a relatively large number of coral taxa (19) from diverse coral groups, including relatively high weights for some taxa (e.g., coral unspecified, 103 sites, 0.1 – 700 kg; coral rubble, 90 sites, 0.1 – 1000 kg; *Dendrobathypathes* spp., 41 sites, 0.1 – 300 kg) (Figure B-97). Most of the coral catches were recorded from the southern edge of the Snares Plateau, with smaller clusters on the southeast edge of Puyseger Plateau, and southeast of Otago Peninsula. The fisheries observer data also included 9 other non-coral invertebrate species, including four sponge species (with a 600 kg catch of golden-brown crater sponge) and two deepwater lobsters (*Projasus parkeri*). The reef-trait catch cluster seen east of Foveaux Strait (Figure B-98) included individual species contributions of pentagonal tooth-stars (*Odontaster* spp.), the starfish *Cosmasterias dyscrita* and Cooks turban shell (*Cookia sulcata*). (NB: as *Cookia sulcata* is a shallow, inshore species, seldom observed alive below 10 m depth, it is highly unlikely that these identifications were correct). The research trawl individual reef-trait species catches included 9 reef fish species, two coral and one sponge species, and red rock lobster (19 sites, 0.3 – 40 kg). Scarlet wrasse were the most widely caught species (114 sites, 0.1 – 139 kg) and were clustered at Dusky Sound, Puysegur Plateau, to the east of Solander Island, and on the east coast shelf. Notably, the largest catch of 139 kg was taken on the Snares Plateau, south of where the large (250 kg) observer reported catch was made (Figure B-99).

An additional feature of the fisheries observer data for this region was the large number of sites at which rocks and stones were caught (Figure B-100). Trawl accounted for all except three (one set net, two lines) of the 2750 of these sites, with weights ranging up to 12.6 tons. The highest recorded weight occurred on the Snares Plateau on the side of an intensively trawled area. Most of the rocks and stones bycatch was from the edges of east Puyseger Plateau, the southern and eastern Snares Plateau, and the shelf south of Otago Peninsula.

Video imagery

Otago bryozoan colonies

The R.V. Tangaroa Biogenic Habitats voyage deployed six DTIS sites over the LEK bryozoan patch off Otago Peninsula. Three of these revealed dense bryozoan colony fields dominated by *Cinctipora elegans*. A diverse range of bryozoans, sponges and mobile invertebrates (especially starfish, brittle stars and ophiuroids) were closely associated with the relic pebble fields (Figure B-101) deposited here by rivers when the sea level was lower. Juvenile blue cod, including 0+ fish, were sampled among the bryozoan colonies, indicating that these biogenic reefs provide fish nursery habitat.

Stewart Island area

Eight DTIS sites within this area were located over deep reef habitats; five from the Biogenic Habitat voyage and three from another R.V. Tangaroa voyage in 2016 investigating the distribution of sea lion prey (briefly summarised in Roberts et al. 2016) (Table A-4).

Site S107 situated just east of Stewart Island was the shallowest (45 – 50 m). The substrate was broken rugged bedrock with no signs of sedimentation (Figure B-102), and was densely covered with sponges, ascidians, soft bushy bryozoans, and coralline algae. Being at the shallow end of the target deep range (50 m), this reef and its associated fauna and flora were visually very similar to slightly shallower rocky reefs (30 – 45 m) to the east (Jones et al. 2018).

Site S118 located west of Stewart Island in 73 – 84 m depth. The reef was composed of large extents of bedrock, broken into large angular blocks in some parts (Figure B-102). It had an encrusting fauna of sponges, ascidian, and bushy bryozoans, less pronounced that those of S107. Site S112 was located to the south of Stewart Island in 129 – 132 m. Bedrock ridges and large slab boulders at this site were encrusted with fauna dominated by sponges, especially small plate forming species (Figure B-103).

The five Biogenic Habitat DTIS sites were located at the head of Mason Canyon and the shelf edge immediately adjacent to it. The large patchy areas of bedrock reef included raised flat pavements, rocky outcrops, slab boulders, and low reef partially embedded in sand. A diverse and relatively dense fauna was present, including rambling finger sponges, glass sponges, bushy hydroids, ascidians, and black corals (Figure B-104 to Figure B-105).

3.2.10 CAMPBELL

This region extends around the Auckland Islands, Campbell Island and Pukaki Bank, each with an associated shelf area around them (Pukaki Bank rises to 60 m depth at its shallowest charted point) (Figure B-106). No trawl effort data was available for this region.

The commercial catch data contained two reef-trait species of sufficient abundance to warrant plotting. There was no catch for Campbell Island. Small-scaled cod were caught only by trawling and were recorded along narrow bands on the east and west shelf edges of the Auckland Islands, and in a small cluster (3 sites) around 110 m depth northeast of the island. Limited catches were also recorded in 100 – 200 m depth on Pukaki Bank, as well as in a line in deeper water slightly to the west (possibly an uncharted feature less than 301 m deep). Yellow cod (*Parapercis gilliesi*), a species likely to be associated with reef edges and biogenic habitats, were only recorded by trawling from the Auckland Islands. Scattered catches were closely associated with the eastern shelf edge, while a broader cluster was present on the western side above 200 m depth. With only two species, the combined reef-trait catch weight metric (in 1 second grid resolution) for trawling reflected these same patterns, with loose groups of higher value grid cells at the Auckland Islands and Pukaki Bank.

The reef-trait species richness map added little, with almost all grid cells with catch returning a uniform value of one (Figure B-107).

There were seafloor substrate codes on nautical charts for the region, but the fisher LEK project did not extend this far south (Jones et al. 2016). On the shelf area north of the Auckland Islands the chart showed three separate bathymetric features as pinnacles rising to about 93 m depth, from a general seafloor depth of 102 – 137 m (Figure B-108). Three pinnacles were also shown to the northwest. These rising to 177 – 181 m from 200 – 400 m general seafloor depth. Pinnacles and small banks rising from 500 m depth or more were also present south and further east of the islands. Pinnacles were also present at Campbell Island and south of Pukaki Bank. Five foul research TRAWL tows were recorded on the central shelf area of the Auckland Islands, four of them in a line suggestive of the presence of foul ground along this axis (Figure B-108).

The reef-trait species richness indices for observer bycatch formed two discrete clusters at the Auckland Islands, one following the eastern shelf edge, the other as a broader wedge extending east from the western shelf edge onto the outer shelf (Figure B-108). This cluster included the three pinnacles marked on the chart for this area. There was also a cluster extending across Pukaki Bank. Research TRAWL sites with reef-trait taxa bycatch were rare in this region and only had a maximum score of two. SPECIFY invertebrate sites were also uncommon and largely focussed on shallower waters around the Auckland and Campbell islands. However, there were two sites on Pukaki Bank. One of the higher scoring sites (richness of 5) appeared to be on one of the pinnacles east of Auckland Islands (Figure B-108).

Observer reported catches of reef-trait species were common in this region (Figure B-109 to Figure B-111), probably reflecting higher levels of coverage of the Auckland Islands area related to sea lion bycatch. Observer bycatch records included seven reef fishes. The most abundant of these was small-scaled cod which was reported from 690 sites (1 – 750 kg). Five reef-trait non-coral invertebrate species were recorded. Rock lobster occurred at 133 sites (1 – 600 kg), along with low numbers of two sponge, one gastropod (Cooks Turban) (a misidentification as *Cookia sulcata* does not occur in the subantarctic islands), and one starfish species (one 1 kg catch of *Cosmasterias dyscrita*) (Figure 175). Coral bycatch included 7 taxa, mostly at low weights (less than 5 kg) across a few sites. Rock and stones were recorded more often (447 sites, 0.1 – 1000 kg). These records were generally concordant with the distribution of reef-trait species captures. Research TRAWL species richness was limited due to the low number of sites sampled. It included five catches of pink ice egg sponge (*Rhabdastrella* sp.) at the Auckland Islands, with four of these catches close to the foul research TRAWL tows and the largest catch (136 kg) east of those sites, on the shelf edge. Small catches of small-scaled cod were also taken from the northeastern shelf edge of Campbell Island at 300 m depth.

Video imagery

Six DTIS sites were located over deep reefs in 100 – 174 m depth near the Auckland Islands as part of the sea lion prey survey (Bowden 2016). These very small, patchy reefs occur within large areas of soft sediments, dominated by white carbonate sands. Site S26 had a small spot where low basement rock was exposed, with a few attached sponges (Figure B-112). Site S26 had a small area of bedrock covered with sand veneer and some associated sponges, and Site S34 had a few low basement rock patches within large fields of broken bryozoan skeletons (Figure B-112). Sites S26 and S19 had slightly more reef. These were mostly covered with a thin sediment veneer and supported a more diverse sponge fauna dominated by mound formers, including *Polymastia* species, as well as southern spider crabs (*Jacquinotia edwardsii*). Site S67 was the shallowest (100 – 102 m), had slightly higher relief

reefs than those of the other sites and the most diverse and abundant encrusting fauna (Figure B-113). Crabs were also common at this site.

3.2.11 BOUNTY

This region includes the Bounty and Antipodes Islands. Bounty Islands are surrounded by a relative broad insular shelf, whereas the seafloor around Antipodes Islands drops away sharply on all sides to more than 1000 m depth, aside from a small ridge extending southwest and a small bank slightly north which rises to 155 m (Figure B-114). No significant commercial catches of reef-trait species were reported from this region (trawling and lining at the Bounty Islands only). There was very little difference between the combined catch weight from lining and all-methods combined catch weights (essentially the addition of four trawl grid cells). The associated commercial catch species richness scores were all one.

There were no nautical chart seafloor substrate codes in the region, and the fisher LEK project did not extend this far southeast (Jones et al. 2016). No trawling effort summary was available. The reef-trait species richness indices for observer bycatch formed a broad cluster around the Bounty Islands, with the highest values (of two) reported at several sites on the eastern side (). The few research TRAWL sites on the southern side all had a value of one. SPECIFY Invertebrate reef-trait sites were predominantly clustered on the top of Pukaki Bank and close to the Antipodes Islands. Those around the Antipodes generally had higher scores than those around Pukaki Bank (most scoring one).

Observer bycatch individual reef-trait species data were only available from Pukaki Bank. Four species were recorded: two fish species and two coral taxa (Figure B-114). Coral (unspecified) was mainly caught on the top of the bank (78 sites, 1 – 18 kg), as well as hydrocorals in the southwest quadrat (20 sites, 1 – 10 kg). Small-scaled cod were mainly caught on the eastern edge of the bank as a cluster in 200 – 300 m depth (largest catch 1130 kg). Research TRAWL individual reef-trait species catch was largely of small-scaled cod, at seven sites, four of which fell just south of the commercial catch cluster for this species (Figure B-114).

Video imagery

No seafloor imagery was available from this region.

3.2.12 MERNOO

This region extends across Mernoo Bank, Veryan Bank and the shallower part of the central Chatham Rise, with each of these bank features separated from each other by areas of seafloor deeper than 300 m (Figure B-115). Mernoo Bank rises to 49 m depth at its shallowest charted point and falls away on all sides to 200 m as a roughly circular shape with five pinnacle features (rising to 59 – 99 m) in 100 – 200 m depth. Two further bathymetric features are present to the north and south-east rising to 190 and 150 m depth from the surrounding seafloor at 300 – 500 m deep. Veryan Bank is charted as an oblong feature at 200 m depth, with three pinnacles rising to 70 – 99 m. To the east of the Chatham Rise the area less than 300 m deep is more extensive, with one small bathymetric feature rising to 175 m depth in the central area (this feature does not appear in the national bathymetry contours held by NIWA).

The commercial catch data contained four reef-trait species of sufficient abundance to warrant discussion. Northern bastard cod were recorded from lining only, with a small catch cluster on the north-western side of Mernoo Bank. Orange perch were more commonly caught and widely distributed, with a maximum catch of 5.3 tons. Taken only by trawling, catch clusters were present around the 200 m contour on the east side of Mernoo Bank, and as a larger cluster with higher catch weights on the west side of the shallow Chatham Rise, as well as several large catches east of this

cluster. Scattered catch was also recorded on the west side of Mernoo Bank along the 200 m and at three sites with small catch weights on Veryan Bank. Trumpeter were caught by lining at many sites across Mernoo Bank, with at least six catch clusters apparent, largely between 100 – 200 m depth. A lining catch cluster was also present on the top of Veryan Bank, as well as a looser scattering of catch in the mid area of the shallow Chatham Rise (notably spatially disjunct from the orange perch catch cluster taken by trawling on the west side of the Rise). Some trumpeter catches were also taken by trawling on Mernoo Bank, again notable spatially disjunct from the lining catch clusters. Hapuka were also caught by lining, with a higher catch weight cluster on the southern Mernoo Bank in 50 – 200 m depth, and another cluster with lower catch weights to the northwest inside the 200 m contour. A cluster of higher catch weights was also present on the top of Veryan Bank. Several other clusters were present in depths greater than 300 m on Mernoo Bank and the shallow Chatham Rise.

Bluenose catches, largely taken by lining, also showed a series of catch weight clusters that fell at depths greater than 300 m. They are mentioned here to illustrate how some reef-trait species distributed widely along latitudinal gradients show associated depth range shifts with latitude (e.g., contrast with Figure B-96 for the Stewart Island region where fisheries observers recorded 587 catch events in 300 m or less).

The combined reef-trait catch weight metric (in 1 second grid resolution) for trawling showed loose clusters of higher value grid cells on the west side of Mernoo Bank adjacent to the 200 m contour, and on the eastern side of the shallow Chatham Rise. The combined weight metric for lining catches showed higher catch clusters right around Mernoo Bank, within a wider matrix of lower catch weight grid cells. Two clusters fell on small pinnacle features north/east of the bank, with a further two clusters on bathymetric spurs at 300 m depth. A higher catch weight cluster also extended over the top of Veryan Bank, as well as a second cluster to the east below 300 m depth (but note previous comment about fishers recording shallower depths). Set net reef-trait species catches were rare, a total of four occupied grid cells on the eastern side of Mernoo Bank. The all-methods combined weight metric reflected the trawl and lining catch weight clusters well, while the combined species richness metric strongly emphasised two larger clusters at 200 – 300 m depth on the north side of Mernoo Bank, several smaller grid groups on the wider bank and scattered higher value individual grid cells on shallow Chatham Rise (Figure B-116).

There were no nautical chart seafloor substrate codes in the region, and the fisher LEK project did not extend this far east (Jones et al. 2016). Eight foul research TRAWL tows were recorded, 6 across Mernoo Bank and two on shallow Chatham Rise (Figure B-117). The reef-trait species richness indices for observer bycatch formed a three-quarter circle around Mernoo Bank in the 100 – 300 m depth, with higher scores on the western side. A similar half-circle was present around the northern side of Veryan Bank. On shallow Chatham Rise a less well-defined squarer shaped pattern was present, with higher and more frequent values on its southern side. Research TRAWL species richness showed a broader spatial range for shallow Chatham Rise than the observer bycatch sites, sitting largely outside those and also extending further to the east (this could be an artefact of fisheries observer coverage not extending into that eastern area) (Figure B-117). Research TRAWL sites on Mernoo Bank extended the observer arc at its northern extent, with several high richness scores there (congruent with the higher species richness found there in the commercial catch data). SPECIFY invertebrate reef-trait species richness sites were not common, with three higher value clusters on Mernoo Bank, and a few scattered sites on Veryan Bank and the shallow Chatham Rise (Figure B-117).

Observer bycatch individual reef-trait recorded species catches were common in this region (Figure B-118 to Figure B-120). Commercial bycatch data reported nine reef-trait fish species, dominated by trumpeter (193 sites, 1 – 1800 kg), common roughy (182 sites, 1 – 8200 kg) and orange perch (165

sites, 1 – 3094 kg) (Figure B-118). A notable catch was a single 4 kg catch of putatively grey brotula (*Bidenicthys consobrinus*), the only fisheries observer record for this species in the 50 – 300 m depth range for New Zealand (none are recorded in the TRAWL database for this depth range). However, *Bidenichthys consobrinus* is a very small (max. length 93 mm), highly cryptic species that is mainly found from Cook Strait north, with a maximum confirmed depth record of only 30 m (pers. comm., Clinton Duffy, DOC scientist). Almost all confirmed records of the species come from rotenone sites. This record is most likely the brown cusk/brown brotula (*Cataetyx niki*), given its larger size, and superficial resemblance to *Bidenichthys* (although its reported depth range is 600–1600 m) (pers. comm., Clinton Duffy, DOC scientist).

Research TRAWL tows returned seven reef-trait fish species, with catches dominated by common roughy (67 sites, 0.1 – 1200 kg). Coral taxa observer bycatch recorded 11 taxa (including coral rubble and coral rubble-dead records), while research TRAWL recorded 6 taxa (including coral rubble-dead and coral (unspecified)). Most catch weights were less than 5 kg, although the observer bycatch included a 100 kg catch for *Desmophyllum dianthus*, and 50 kg catches for bushy hard coral and deepwater branching coral (*Enallopsammia rostrata*). Most of the coral catch was from Veryan Bank and the shallow Chatham Rise, where three broad clusters of sites containing coral were apparent (Figure B-119).

Catches of other non-coral invertebrates included five observer bycatch species (a sponge, an urchin, a scallop, a starfish, and deepwater rock lobster). Rocks and stones were also recorded from 183 sites, with catch weights ranging from 0.1 – 2 tons (Figure B-120). A cluster of these sites occurred as a half-circle on the northern side of Veryan Bank, with scattered catches on the eastern half of shallow Chatham Rise (including the 2-ton catch).

Video imagery

Mernoo Bank

Nine DTIS sites were available for this region in the target depth range (Table A-4). Three from a geophysical voyage (TAN0705), and seven from a general biodiversity survey in 2017 (TAN1701, documented as an AEBR report with representative DTIS images and a descriptive paragraph for each site) (Bowden et al 2017). The latter surveyed rock and soft sediment sites surveyed across the Chatham Rise and found diverse faunas at multiple reef sites beyond 300 m depth.

Four sites were located on Mernoo Bank. The two shallowest ones descended from the top of the bank. Site CH159 (53 – 73 m) traversed continuous bedrock, with sand pockets in places (Figure B-121). A rich fauna of sponges, bushy hydroids and coralline algae covered the bedrock, with larger sponges appearing to be more common in the deeper part of the transect. Site T284 (42 – 598 m) traversed a more mosaicked seafloor, with mixtures of bedrock, large slab boulders, raised outcrops, walls and overhangs (Figure B-122 to Figure B-123). The fauna included pink encrusting bryozoan sheets, sponges, zooanthids, anemones, occasional small *Celleporaria agglutinans* colonies and bushy bryozoans, with stylasterid corals and finger sponges appearing at the deeper end of the transect.

Site CH158 (87 – 130 m) traversed rugged bedrock with ridges and outcrops for the first part of the transect. A diverse fauna was present including sponges, stylasterids, zooanthids and fan-worms (Figure B-121). Site CH156 (138 – 157 m) was devoid of any rock structure, aside from one tiny flat patched covered by a large blue cup sponge (Figure B-124). Bowden et al. (2017) reported several of these sponges were captured on the larger video footage footprint at this site.

Veryan Bank

Three DTIS sites were present on this bank (Table A-4). The shallowest site T30 (115 – 124 m) traversed down a bedrock slope, split by large crevasses. A rich fauna included multiple sponge species, zooanthids, red corals, stylasterid corals and others, with one rich close-up image also revealing many scallops (*Talochlamys gemmulata*), as well the gastropods *Buccinulum pertinax*, *Maurea waikanae* and *Astraea heliotropium* (Figure B-123).

Site CH135 (142 – 150 m) was in slightly deeper water, and covered patches of low pavement rock, partially veneered with sand (Figure B-124). Associated fauna included several sponge species, and some stylasterid corals. Site CH134 (185 – 187 m) traversed similar looking flat rock pavement but that pavement was only occasionally present, and only just broke through the sediment (Figure B-124). Site CH7 (255 m) contained a small area of chalky looking rock with large holes but no visible epifauna (Figure B-124).

Shallow Chatham Rise

Two DTIS sites contained small amounts of rock. Site T266 (246 – 250 m) was largely coarse sand but a few small patches of flat bedrock just broke the surface in some places (Figure B-123). Clusters of white ascidians and small corals (*Caryophyllia* spp.) were present on exposed rock. Site CH7 (259 – 259 m) was also almost entirely covered by coarse sands, with several very limited patches of chalky looking rock just breaking through as low pavement. Several large burrows appeared to have been excavated into these from the side (Figure B-124).

3.2.13 CHATHAMS

This region extends across the eastern Chatham Rise, inclusive of the Chatham Islands (Figure B-125) and an area between 56 – 300 m water depth west of the Chatham Islands. Numerous pinnacles are marked as present around the Chatham Islands inside the 50 – 300 m depth target zone, along with four pinnacles just beyond 300 m on the north-western edge. The latter rise from around 300 – 400 m to between 182 – 200 m depth.

The commercial catch data contained three reef-trait species of sufficient abundance to warrant discussion. Orange perch were only caught by trawling and had higher weight clusters on the central West bank feature and two areas on the western shelf edge of the Chatham Islands, a northern one on the 300 m contour with higher weights and a southern one on the 200 m contour with lower catch weights. Trumpeter catches were largely taken by lining, with a series of catch clusters largely encircling the Chatham Islands from 100 – 300 m depth (to 200 m depth only on most of the western side). A cluster of trawl catch sites was present on the north-western side of the islands, presumably as one of the few areas clear for trawling. Hapuka were caught at fewer sites and at lower catch weights by lining than trumpeter, with a broader catch cluster in depths of less than 100 m on the north side of the islands, and multiple smaller clusters on the eastern side in depths of 100 m and greater.

As with the adjacent MERNOO region, clusters of bluenose catch weights were common, by lining and trawling, but largely fell in depths beyond 300 m, although some occurred just inside the 300 m contour.

The combined reef-trait catch weight metric (in 1 second grid resolution) for trawling showed three small higher weight clusters southeast of the Chatham Islands, in waters depths of more than 300 m (noting again that for these records to appear in the plots, the fishers will have recorded depths of 300 m or less in their catch reporting). The combined weight for lining metric showed weight cluster mosaics of higher values on the northeastern and southwestern sides of the Chatham Islands in 100

to 300 m depth, as well as on the bathymetric spurs east of the islands. The all-methods combined weight metric was dominated by the trawl weight clusters. The combined species richness metric was largely uninformative, with only scattered higher scoring grid cells (Figure B-126).

There were no nautical chart seafloor substrate codes in the region, and the fisher LEK project did not extend this far east (Jones et al. 2016). One foul research TRAWL tow was recorded on the shelf edge on the north side of the Chatham Islands (Figure B-127). The reef-trait species richness indices for observer bycatch formed a broken circle around the Chatham Islands, concentrated in the 200 – 300 m depth zone. The research TRAWL species richness reinforced this pattern, especially along the south-western side of the islands. Both the observer and TRAWL indices also clustered on the West bank feature. Several higher value SPECIFY invertebrate sites were also present on this bank, as well as in a number of sites around the Chatham Islands, including several higher scoring sites to the north and east (Figure B-127).

Observer bycatch individual reef-trait species catches for this region included 6 fish species, 5 coral taxa and rock lobster. Fish catches were dominated by common roughy (261 sites, 1 – 27361 kg), trumpeter (222 sites, 2 – 820 kg) and orange perch (156 species, 1 – 1956 kg). There were few coral catches, with all 1 kg or less in weight. Sixteen sites returned catches of rocks and stones (1 – 500 kg) (Figure B-128). Research TRAWL reef-trait species catch included 6 fish, 2 sponges, 2 starfish, 3 coral taxa and rock lobster (28 sites, 1 – 33 kg) (Figure B-129). These species were caught at only a few sites, with low catch weights. The fish species catch was dominated by orange perch (74 sites, 0.2 – 2500 kg) and common roughy (35 sites, 0.1 – 20000 kg) (Figure B-129).

Video imagery

Eight DTIS sites were located around the Chatham Islands, one from the TAN0705 survey and seven from the TAN1701 survey (Table A-4). Site CH54 (181 – 212 m) was located on the north-western shelf edge and was a mixture of smooth bedrock and broken rock forming irregular boulder fields (Figure B-130). The water was exceptionally clear. The fauna included fan corals, crinoids, and stylasterid corals. Site CH58 (177 – 201) traversed the summit of a low rocky knoll covered with patchy bedrock and boulders (Bowden et al. 2017). Sponges, antipatharian and stylasterid corals were present (Figure B-130). Site CH68 (269 – 280 m), a seamount known as “Smiths City” and considered heavily trawl impacted by Bowden et al. (2017), was characterised by very distinctive black lava rock. Fauna on the rock were sparse but included some corals. Bowden et al. (2017) reported coral rubble on the summit and orange roughy were present (Figure B-131) .

Site CH63 (269 – 280 m) also had black lava rock with some associated sponges, stylasterid corals, gorgonians, hydroids and bryozoans (Figure B-132). Site CH66 (279 – 290 m) had a few patches of boulders and low bedrock, with some associated sponges, stylasterid corals, bryozoans, anemones and small stony corals (Figure B-132). Site CH84 (100 – 234 m) was described as a shallow knoll by Bowden et al. (2017). The DTIS transect ran from the summit to the surrounding seafloor. Bedrock at the summit held a diverse, dense fauna that included stylasterid corals, encrusting red algae, zooanthids and crinoids towards the base (Figure B-133). Bryozoan colonies were present on the soft sediments adjacent to the knoll.

Site CH86 (173 – 382 m) had rocky outcrops and areas of boulders. The DTIS tow was traversed down the summit of the knoll and out onto open sediments (Figure B-134) (Bowden et al. 2017). Anemones, stylasterid corals and sponges were present. Several large hapuka followed the DTIS and three trumpeter were photographed in one of the still images (Figure B-134) (Bowden et al. 2017). Site CH90 (294 – 425 m) contained both rock outcrops and boulders, as well as some cobbles (Figure B-135). The associated fauna included sponges, bryozoans, stylasterid corals, crinoids and brachiopods.

The shallowest site (T114, 85 – 186 m) was on the south side of the islands and contained bedrock and fragmented cobble fields (Figure B-136). Bryozoans were a dominant part of the fauna and included calcified and bushy taxa.

3.3 National summary of the presence and extent of rocky and biogenic reefs in 50 – 300 metres

Figure B-137 shows the number of 1-minute cells holding one or more reef-trait species across the 13 geographic regions (commercial fisheries catch data). The north-east North Island (East Northland, Hauraki Gulf, Bay of Plenty) had broader reef-trait species distributions, with grid cells having maximum species richness values of eleven, eight, and eleven respectively. This was driven by the presence of warm-temperate reef fishes, which reached the southern limit of their distributions off the northern Wairarapa region on the east coast, and south of Cape Reinga on the west coast. While some cold water species appeared further south (e.g., orange perch) and some deep water species distributions became shallower with increasing latitude (e.g., bluenose, hapuka), reef-trait species richness still declined in southern regions. In the south, most reef-trait species richness values were between one and three.

Figure B-138 and Table B-1 show the number of one-minute cells present in the 50 – 300 m depth range in each of the thirteen geographic regions; and within those, the number of cells occupied by one or more, and two or more reef-trait species. Each one-minute cell can be roughly considered to occupy around 4 km^2 in the north, decreasing in area with increasing latitude to approximately 15 % in the more southern regions. The regions holding larger depth zone extents are Taranaki, Golden, Stewart and Campbell (greater than 10,000 grid cells), while the smallest extents are present in the Wairarapa and Fiordland (less than 3,500 grid cells). Of the 110,065 cells in total at the national scale 14,756 (13.4 %) hold one or more reef-trait species, and 5,471 (5.0 %) hold two or more reef-trait species. At the geographic areas scale the highest absolute extents of cells containing reef-trait species are found in East Northland, Bay of Plenty and the Chathams. The lowest are in the Campbell and Bounty regions. A caveat to keep in mind while assessing these numbers is that they rely on commercial catch as a proxy for reef presence, and that fishing patterns and intensities vary around New Zealand due to a range of factors. Not all grid cells will have received fishing effort (been sampled) and the range of methods used will be partially dependent on climate, travel distances, the economic values of the target species, and fishers' skills in targeting higher density areas.

If the grid cells containing two or more reef-trait species are considered more robust indicators of reef presence than those only containing one, then deep reefs are a relatively small component of seafloor habitats in the 50 – 300 m depth zone, occupying around 5 % of the overall area.

4 Discussion

The data assembled and presented in this report provide a regional and national scale view of where deeper water reefs are known or are likely to be present. Of the various proxies used to indicate the presence of reefs the commercial catch records far exceeded the spatial coverage and intensity of all other data. These catch data matched well with known reef areas e.g., the deep reef band from Little Barrier to the Mokohinau Islands in the Hauraki Gulf, and the extensive areas of deeper reef off the East Northland coast. This provides confidence that higher weight catches and species richness metrics are also good proxies for reef presence in other less well-known areas.

Of note is that the spatial accuracy of these data depends on the fishing methods and strategies used by fishers. For example, trawl tows may extend over relatively long distances and a catch of reef-trait species may have been taken anywhere along the path of that tow. Tows are also not necessarily straight lines, and the one-second resolution of the data gives a spatial resolution of around two kilometres in northern New Zealand (a little less in southern regions). In contrast, lining and set netting are static methods and can also be fished directly over reefs, depending on their nature and the rigging of the fishing gears. However, while fishing catches of reef-trait species provide good proxies for reef presence, not all areas receive equal fishing effort and an absence of reef-trait species catch does not necessarily equate to an absence of deep reefs. Where people fish is also affected by factors other than fish abundance, including travel distance and associated fuel and time costs, effort to reduce conflicts with other fishers and fishing methods, and prevailing weather conditions.

Commercial catch data consistently highlighted the continental shelf edge and adjacent slope right around the country as potential locations of large areas of deep reef. The fisheries observer data, a more detailed subset of the commercial catch, was also useful in highlighting such potential reefs, although this data was more spatially restricted. The research TRAWL data was less useful, with considerably fewer sites, and survey extents not covering all areas of the continental shelf. The SPECIFY invertebrate data, while containing 940 reef-trait species, was of limited value due to the low overall number of sites at the national scale, and the haphazard nature of what was collected and retained.

There was no way to standardise and combine the different data sources into national scale metrics or maps of reef presence. Numerous caveats and shortfalls of the data are outlined in the methods section, and the simple use of raw data for basic metrics is the most that can be done with these data. One key issue is that even if some form of standardised metric could be developed, it would not be ‘spatially stable’ beyond regional scales. The contributing reef-trait species exhibit a range of biogeographic and depth distributional patterns, which also interact with each other. For example, northeastern New Zealand holds a greater number of temperate reef fishes that are rare or absent from colder areas of New Zealand (e.g., pink and blue maomao, red scorpion fish and porae). Conversely, some cold-water species such as orange perch and small-scaled cod are only found further south. Species with more widespread distributions also show a shallowing of their inner depth distributions from north to south (e.g., bass, hapuka and trumpeter). These spatial patterns would have a strong confounding influence on any more advanced metrics performance, with a lack of detailed species habitat distribution models precluding any attempt at using correction factors for these. We minimised such effects by only using basic metrics at a regional scale and avoiding their use and interpretation at larger national scales.

4.1 Likely threats and stressors

Putting aside more global issues such as warming sea temperatures and ocean acidification, the key threats to deep-water reefs appear to be land-based sedimentation and the impacts of fishing. Sedimentation impacts on deep reefs remain poorly understood but reefs closer to the mainland, where large rivers empty to the sea and adjacent land catchments are more erodible, are at increased risk. Putative gradients of land-derived sedimentation are present along the East Northland coast, and the Mahia Peninsula to East Cape coast, with evidence of more fine sediments sitting on reefs and lower biodiversity along the inner parts of these gradients. Very large but rare storm events have the potential to deposit huge volumes of fine sediment onto coastal deep water reefs, the impacts of which may last for several decades. In 1988 Cyclone Bola, a 100-year storm, hit northern and central New Zealand, with up to 900 mm of rain fall in 72 hours (Singleton et al. 1989a, Sinclair 1993). This resulted in rivers discharging several times their mean annual loads (Foster & Carter 1997). The heaviest rainfall was over steep hill country composed of highly erodible, soft Tertiary (65 – 1.8 million years old) siltstones and mudstones (Singleton et al. 1989b). Severe erosion caused river systems to aggrade rapidly, resulting in flooding of surrounding areas (Singleton et al. 1989). Analysis of satellite imagery estimated 10 – 20 % of the hill country in the east coast–Gisborne region experienced severe land-slides (Trotter 1988). During the six days of the cyclone an estimated 40 million tonnes of fine sediment was transported into the marine environment via the Waipaoa River, one of the largest in the region (Adams 1980, Miller 1981, Griffiths & Glasby 1985). As described by Foster & Carter (1997), "*the continental shelf off Poverty Bay was inundated with mud*". The suspended sediment concentrations were such that it was thought to have formed a subsurface plume that moved and dispersed under the influence of gravity and shelf currents (Foster & Carter 1997). Subsequent observations by fishers and divers suggested that this layer, up to 2 m thick, as measured against a shipwreck and lobster pot lines, extended out to the middle Poverty Bay shelf. This layer was mobile, with observations of (shallow) reef areas being covered and uncovered. It smothered the resident benthic assemblages and had a strong negative effect on species richness and diversity (Battershill 1993). On a longer time-scale the modern rates of sedimentation to the seafloor in this region are now almost five times higher than before European deforestation in the late 19th century.

Deep reefs well away from land may be at much lesser risk. No visual evidence of (putatively) land-derived fine sediments was observed in shelf areas well away from the mainland (e.g., off North Cape, Three Kings Islands, Middlesex Bank, the Snares Plateau, the North Taranaki Bight shelf edge, and the Chatham Rise), with these areas also having exceptionally clear water relative to more coastal areas.

Fishing impacts are a more universal risk. Trawling has been undertaken for over 100 years in New Zealand, with ongoing technological advances in navigation and sonar making the placing of fishing gear ever more precise. While trawling over rugged reefs is obviously problematic, fishing over low, flat basement reef (which can support high biodiversity) is more tractable. Anecdotal accounts exist of fishers pushing trawl gears close to reefs to target their associated fish aggregations and being able to fish over low ridge features where the rock layers all slope the same way (these allow fishing gear to be towed in one direction but not the other). The fisheries observer catch records of considerable catches of rocks and stones in some regions confirms trawling does interact with some kinds of deep reef habitats.

Lost heavy grade ropes have also been observed on deep reefs. For example, in the 2011 Biogenic Habitats survey a DTIS tow over a high relief rock outcrop on north-western Ranfurly Bank revealed a 'new' looking rope running along the outcrops base. On the wall above the rope were dense coral colonies. Conversely, some well-known and long-used trawl paths/corridors exist between some reef

system areas, such as north of North Cape, and by the Cabbage Patch reef north of Mahia Peninsula (Jones et al 2016). What was present in such areas prior to trawling is unknown.

Lining, while more benign, may also have impacts, particularly when lines are being retrieved and may be pulled sideways by tide and wind effects on the fishing vessel. This increases the probability of contact with and damage to upright raised organisms such as sponges and corals. Lost heavy nylon lines are often seen in DTIS imagery on deep reefs, especially in areas of more rugged topography. This includes DTIS images of lost lines immediately adjacent to glass sponges, corals gorgonians and other inflexible fauna. Set-netting can entangle, breaks and detach sessile epifauna resulting in mortality. Lost set-nets may also continue to fish for a period, adversely affecting mobile fauna. Potting is currently a low threat to deep reefs, purely because available fishing records suggest that crayfish and blue cod potting effort is largely restricted to shallow water (less than 50 m depth). Some limited blue cod potting occurs in the small deep reef area (60 – 70 m) east of Banks Peninsula, Canterbury.

This report provides a regional and national scale spatial framework on which to advance deep reef research and management decisions. Where to focus such effort will depend on what objectives and priorities different agencies have.

4.2 Recommendations for Phase 2 of the deep reef programme

Field research is relatively expensive, especially in more remote locations, and it makes sense to fully utilise data already collected for deep reefs. Data collected during the LINZ OS2020 Bay of Islands programme remains to be analysed, as well as that for some areas sampled during Biogenic Habitats 2011 survey. Both have the strong advantage of being underpinned by multibeam sonar seafloor mapping data. For East Northland, that multibeam sonar mapping covers the entire 50 – 200 m depth zone from the Poor Knights Islands to North Cape. The Biogenic Habitats 2011 survey covers smaller seafloor areas within which the DTIS sites fell. Collectively, these two data sources provide a good spread of DTIS sites along the East Northland coast and associated environmental gradients.

Multibeam sonar is the 'gold standard' for the mapping of reef systems, particularly when combined with good ground-truthing for seafloor types. DTIS imagery provides that ground-truthing, as well as high resolution data on the larger fauna and flora assemblages present on the seafloor. It also allows for fine scale characterisation of the reef components that different species use e.g., walls, slopes, bedrock boulders; reef edges or interiors; mosaiced or uniform habitat patches, and complex or simple reef surfaces.

It is suggested that the LINZ OS2020 Bay of Islands multibeam sonar data should be worked up into seafloor landscape classes using Benthic Terrain Mapping (BTM) software tools. The DTIS sites should be quantified for seafloor habitat types (as segments along the transect lines), along with counts/covers made of the associated fauna and flora. A combined analysis of these data will provide a better spatial understanding of how East Northland's deep reefs are structured from both a geological and ecological point of view.

The spatial data sources and metrics presented in this report (and the finer spatial scale fisheries catch records unable to be publicly shown for confidentially reasons) could also be overlain on the landscape habitat maps created, to gain a better perspective of how fisheries catches may be driven by the underlying habitat landscape. The findings might be meaningfully applied to other New Zealand regions, e.g., what multibeam reef map features and components are associated with higher catches of different species; or where would we predict to find higher fish and invertebrate species richness / biodiversity across different reef types and components. While the specific reef-trait

species mix of East Northland does not extend beyond the north-east North Island, more generic predicable patterns of assemblage use of different sub-habitats are likely to be spatially transferable.

Future surveys of deep reef areas anywhere in New Zealand (aside from East Northland which is already well surveyed) would be of high value. Where to direct survey effort is both a science and management question that can be informed by the maps in this report. To encompass the full range of biodiversity and biogeography, effort should be targeted at little studied regions, and remote areas well away from land-based sedimentation impacts. Examples of little studied regions include the entire Wairarapa coast and the upper west coast of South Island. Examples of areas subject to low terrigenous inputs include King Bank north of the Three Kings Islands, the Madden and Ritchie Banks off Hawke's Bay, off Fiordland and the Snares platform. A focus on the management of human impacts might direct survey effort to regions thought to be adversely affected by sedimentation, fishing and other impacts such as the lower east coast North Island (sedimentation) or areas of shelf edge off Taranaki and the south-east Stewart region (intensively fished).

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Appendix A Tables

This section includes all tables referred to in the text from Section 3 onwards.

Table A-1: Summary of reef-indicator invertebrate data. Fishing/sample events and catch weights for commercial catches, and commercial fisheries observer bycatch. SPECIFY invertebrate's data are shown as Lots (number of different sample locations), and No. (total number of individuals held). Note that commercial events and catches are for all depths, while the bycatch and TRAWL records fall within the target 50–300 m depth zone only. NW; no weights available. A* Alcyonacea, Gorgonacea, Scleractinia, Antipatharia (Orders) & Stylasteridae (Family); B* Dendrophylliidae, Oculinidae (Families) and some spp. in Caryophyllidae (Family); 4* (excluding Henricia compacta), 14* (excluding Callogorgia, Calyptrophora, Narella, Primnoa, Thouarella species), 5*, excluding Keraroisis spp., 9* (excluding Oculina virgosa, Madrepora oculata, Calyphyllia species, Desmophyllum dianthus, and Solenosmilia variabilis).

				Comm.		Bycatch		TRAWL		SPECIFY				
Group	FNZ	Common name	Taxa name	Events	kg	Events	Weight	Events	kg	Lots	No.	R-Lots	R-No.	R-Taxa
Lobster	CRA	Rock lobster	*Jasus edwardsii*	1102	35 120	547	3 253	-	-	2	2			
Starfish	SMO	Cross-fish	*Sclerasterias mollis*	-	-	1 114	4 603	176	49	159	840			
Lobster	PHC	Packhorse lobster	*Sagmariasus verreauxi*	218	2 023	136	324	-	-	-	-			
Coral	COU	Coral (unspecified)	A*	-	-	260	1 539	49	199	-	-	-	-	-
Coral	COB	Black coral	Antipatharia	-	-	63	63	3	<1	34	163	-	-	-
Urchin	PSN	Sea urchin	*Pseudechinus novaezealandiae*	-	-	1	1	-	-	68	437			
Coral	GDU	Bushy hard coral	*Goniocorella dumosa*	-	-	15	144	18	42	34	67			
Coral	GOC	Gorgonian coral	Gorgonacea	-	-	59	48	5	<1	-	-	-	-	-
Coral	COR	Hydrocorals	Stylasteridae	-	-	31	51	2	11	25	61	-	-	-
Starfish	ODT	Pentagonal tooth-star	*Odontaster* spp.	-	-	45	60	7	2	-	-	84	312	
Coral	THO		*Thouarella* spp.	-	-	41	56	1	<1	10	11	1	1	1
Coral	DDI		*Desmophyllum dianthus*	-	-	17	140	4	<1	31	244			
Starfish	CDY		*Cosmasterias dyscrita*	-	-	28	34	19	4	1	1			
Gastropod	CTU	Cooks turban shell	*Cookia sulcata*	-	-	39	59	8	2	-	-			
Sea fans	PLE	Sea fans	Plexauridae	-	-	4	1	3	5	40	124	57	164	26
Sponge	PHB	Grey fibrous massive sponge	*Phorbas* spp.	-	-	45	266	-	-	-	-	7	7	2
Coral	DEN		*Dendrobathypathes* spp.	-	-	44	2 768	-	-	-	-	-	-	-
Sponge	APU	Maroon pimpled ear sponge	*Aciculites pulchra*	-	-	8	9	-	-	36	59			

				Comm.		Bycatch		TRAWL		SPECIFY				
Group	FNZ	Common name	Taxa name	Events	kg	Events	Weight	Events	kg	Lots	No.	R-Lots	R-No.	R-Taxa
Starfish	PEP		*Pentagonaster pulchellus*	-	-		NW	9	28	35	122			
Gastropod	SLG	Sea slug	*Scutus breviculus*	-	-	42	122	-	-	-	-			
Lobster	SLA	Spanish lobster	*Arctides antipodarum*	2	96	33	75	3	1	-	-			
Starfish	ALI		*Allostichaster insignis*	-	-	1	6	-	-	31	48			
Crab	REC	Red rock crab	*Guinusia chabrus*	29	79	0	0		NW	-	-			4*
Coral	CAY		*Caryophyllia* spp.	-	-	8	6	1	<1	15	44	126	456	10
Coral	TLO	Encrusting long polyps, coral	*Telesto* spp.	-	-	8	5	-	-	12	34	2	3	2
Coral	ERR	Red coral	*Errina* spp.	-	-	2	1	1	1	17	28	86	129	15
Coral	STI		*Stichopathes* spp.	-	-	2	2	2	0	15	34	33	140	5
Coral	OVI		*Oculina virgosa*	-	-	2	60	-	-	16	48			
Coral	PRI		Primnoidae	-	-	4	0		NW	13	14	138	605	14*
Coral	AHL		*Antipathella* spp.	-	-	2	6	-	-	15	20	15	20	1
Urchin	HEC		*Henricia compacta*	-	-	5	5	-	-	9	11			
Coral	MOC		*Madrepora oculata*	-	-	1	5	-	-	13	55			
Sponge	RHA	Pink ice egg sponge	*Rhabdastrella* sp.	-	-	6	5	7	207	-	-	2	3	1
Urchin	ECS		Echinasteridae	-	-		NW	0	NW	13	14	46	138	
Coral	TLA	Encrusting polyps, coral	*Telestula* spp.	-	-	10	4	-	-	-	-	0	0	
Coral	SVA		*Solenosmilia variabilis*	-	-	6	4	2	2	2	2			
Coral	ISI	Bamboo corals	Isididae	-	-	4	4	-	-	6	8	10	12	5*
Bivalve	DFO	Scallop	*Delectopecten fosterianus*	-	-	9	18	-	-	-	-			
Coral	LPT	Spiny lace coral	*Lepidotheca* spp.	-	-	7	31	-	-	2	2	5	5	3
Coral	CBR	Stony branching corals	B*	-	-	7	12	-	-	2	7	20	23	9*
Coral	ERO	Deepwater	*Enallopsammia rostrata*	-	-	6	157	-	-	3	9			

				Comm.		Bycatch		TRAWL		SPECIFY				
Group	FNZ	Common name	Taxa name	Events	kg	Events	Weight	Events	kg	Lots	No.	R-Lots	R-No.	R-Taxa
		branching coral												
Coral	CRE	White hydrocoral	*Calyptopora reticulata*	-	-	5	2	-	-	4	4			
Coral	ATP		*Antipathes* spp.	-	-	7	7	-	-	-	-	20	29	8
Coral	CLL	Precious coral	*Corallium* spp.	-	-	2	0	-	-	5	5	4	4	3
Urchin	CRO	Purple urchin	*Centrostephanus rodgersii*	-	-	4	73	-	-	1	1			
Lobster	PPA	Deepwater rock lobster	*Projasus parkeri*	-	-	4	5	1	<1	-	-			
Coral	CLG		*Callogorgia* spp.	-	-	1	1	-	-	4	4	7	12	4
Coral	BOO	Bamboo coral	*Keratoisis* spp.	-	-	1	0	-	-	4	4	-	-	-
Coral	DDP		*Dendropathes* spp.	-	-	4	1	-	-	-	-	-	-	-
Coral	CAN	Bushy bamboo coral	*Acanella* spp.	-	-	3	23	-	-	1	1	-	-	-
Coral	PAB	Bubble-gum coral	*Paragorgia* spp.	-	-	3	2	-	-	-	-	-	-	-
Urchin	CAL	Giant purple pedinid	*Caenopedina porphyrogigas*	-	-	2	2	-	-	1	1			
Coral	NAR	Rasta coral	*Narella* spp.	-	-	1	1	-	-	2	13	11	13	3
Coral	PMN		*Primnoa* spp.	-	-	1	0	-	-	-	-	1	1	1
Coral	BTP		*Bathypathes* spp.	-	-	1	0	-	-	2	2	1	1	1
Sponge	IRC	Grey sponge	*Ircinia* spp.	-	-	2	2	-	-	-	-	17	41	11
Coral	LSE		*Leiopathes secunda*	-	-	2	1	-	-	-	-			
Coral	LLE	Bamboo coral	*Lepidisis* spp.	-	-	1	1	1	<1	-	-	-	-	-
Coral	LIL		*Lillipathes* spp.	-	-	1	0	-	-	1	1	1	2	1
Sea pen	AGH	Rock pen	*Anthoptilum gowlettholmesae*	-	-	1	1	-	-	0	0	0	0	
Sponge	ERE	Basket-weave horn sponge	*Euplectella regalis*	-	-	1	1	-	-	0	0			
Coral	CTP		*Calyptrophora* spp.	-	-		NW	-	-	1	1	-	-	-
Bivalve	ASG	Lesser giant file shell	*Acesta saginata*	-	-		NW	-	-	-	-			

				Comm.		Bycatch		TRAWL		SPECIFY				
Group	FNZ	Common name	Taxa name	Events	kg	Events	Weight	Events	kg	Lots	No.	R-Lots	R-No.	R-Taxa
Rocks	ROC	Rocks stones	Geological specimens	-	-	3 806	385 052	10	113					
Coral	CBD	Coral rubble - dead		-	-	137	10 986	2	2					
Coral	CBB	Coral rubble		-	-	119	5 694	-	-					

Table A-2: Summary of reef-associated fish species data. Fishing/events sample sites and catch/effort weight for commercial catches, commercial fisheries observer bycatch, and research TRAWL. Species assessed as being more wide-ranging than just reefs in their habitat use are bolded in their FNZ code and were excluded from inclusion as 'reef-indicator' species. An exception was made for hapuka and porae, for the reef-indicator catch weights metric (but not for species richness metric). Note that commercial catch sums are for all catches regardless of depth, while the bycatch and TRAWL records fall within the target 50–300 m depth zone only.

			Catch / effort		Bycatch		TRAWL	
FNZ Code	Common name	Species name	Events	Weight	Events	Weight	Events	Weight
BYX	Alfonsino & Long-finned beryx	Epigonidae	34 139	38 134 649	219	27 105	30	833
BNS	Bluenose	*Hyperoglyphe antarctica*	66 699	17 015 127	1 437	76 184	102	4 334
CDL	Cardinal fish	Epigonidae	6 568	10 510 898	36	676	-	1 fish
MOK	Blue moki	*Latridopsis ciliaris*	82 819	7 512 155	1 132	24 253	181	4 301
LEA	Leatherjacket	*Meuschenia scaber*	96 816	5 459 238	4 166	96 951	859	9687
RHY	Common roughy	*Paratrachichthys trailli*	6 514	2 055 579	1 371	241 624	246	43 979
BCO	Blue cod	*Parapercis colias*	47 881	1 412 698	3 658	109 695	1 972	17 516
HAP	Hapuku	*Polyprion oxygeneios*	7 578	607 868	17 742	738 710	2 365	55 299
TRU	Trumpeter	*Latris lineata*	14 326	982 874	775	25 989	123	1 517
BUT	Butterfish	*Odax pullus*	5 341	979 095	1	31		
POR	Porae	*Nemadactylus douglasii*	27 648	734 547	939	22 828	59	225
RSN	Red snapper	*Centroberyx affinis*	16 105	647 516	739	32 581	14	113
OPE	Orange perch	*Lepidoperca aurantia*	1 793	388 709	1 890	110 884	359	19 481
RRC	Red scorpion fish	*Scorpaena cardinalis/S. papillosus*	10 905	328 112	374	276	10	40
BAS	Bass	*Polyprion americanus*	3 796	224 357	936	61 048	15	395
PMA	Pink maomao	*Caprodon longimanus*	4 497	105 761	221	27 578	3	5
BOA	Sowfish	*Paristiopterus labiosus*	3 306	113 428	364	2 760	43	243
BRC	Northern bastard cod	*Pseudophycis breviuscula*	6 639	84 739	375	1 635	77	199
GTR	Marblefish	*Aplodactylus arctidens*	1 726	79 598	-	-	1	2
RPE	Red perch	Unspecified	3 700	56 352	26	119	6	32
APG / BYS	Alfonsino	*Beryx splendens*	-	-	222	47 513	129	3 203
SCD	Small scaled cod	*Notothenia microlepidota*	160	35 186	805	14 720	13	136

			Catch / effort		Bycatch		TRAWL	
FNZ Code	Common name	Species name	Events	Weight	Events	Weight	Events	Weight
BMA	Blue maomao	*Scorpis violacea*	1 231	39 095	12	347	3	2
BPE	Butterfly perch	*Caesioperca lepidoptera*	516	9 116	382	14 071	53	1 394
SBR	Southern bastard cod	*Pseudophycis barbata*	1 420	15 625	1 050	5 090	16	82
YCO	Yellow cod	*Parapercis gilliesi*	435	5 430	3 112	13 853	147	177
WSE	Wrasses		970	16 984	145	723	4	12
LFB	Long-finned boarfish	*Zanclistius elevatus*	1 322	11 216	905	3 027	90	176
CMO	Copper moki	*Latridopsis forsteri*	1 122	7 134	17	88		1 fish
RCK	Rock cod	*Acanthoclinidae*	-	-	34	549	14	5 262
RMO	Red moki	*Cheilodactylus spectabilis*	662	4 967	6	19	-	-
SPF	Scarlet wrasse	*Pseudolabrus miles*	95	3 092	144	497	172	352
MOR	Moray eel	Muraenidae	279	3 164	13	25	-	-
BPF	Banded wrasse	*Notolabrus fucicola*	207	2 849	26	103	2	0
ROC	Rock fish	*Lotella rhacinus*	66	1 117	4	809	1	0
TRS	Cape scorpionfish	*Trachyscorpia eschmeyeri*	76	1 698	4	38	-	-
GPF	Girdled wrasse	*Notolabrus cinctus*	2	6	252	739	98	70
SPP	Splendid perch	*Callanthias* spp.	7	37	67	988	12	37
POT	Parrotfish		87	802	8	35	5	16
RMU	Red mullet	*Upeneichthys lineatus*	182	394	32	66	36	155
RPI	Red pigfish	*Bodianus unimaculatus*	87	356	44	199	5	3
FOX	Fox fish	*Bodianus flavipinnis*	74	329	34	92	6	8
RBP	Red banded perch	*Hypoplectrodes huntii*	116	338	16	30	1	6
RSC	Red scorpion fish	*Scorpaena cardinalis/S. papillosus*	22	138	130	85	4	1
TEL	Telescope fish	*Mendosoma lineatum*	13	307	3	22	1	1
EPL	Bigeye cardinalfish	*Epigonus lenimen*	-	-	36	270	6	5
WLP	Wavy line perch	*Lepidoperca tasmanica*	-	-	57	119	5	1
MAO	Maomao (Unspecified)	*Scorpis violacea/Caprodon longimanus*	4	6	13	158	-	-

			Catch / effort		Bycatch		TRAWL	
FNZ Code	Common name	Species name	Events	Weight	Events	Weight	Events	Weight
NSP	Northern splendid perch	*Callanthias australis*	-	-	2	62	1	1
YBP	Yellow-banded perch	*Acanthistius cinctus*	-	-	12	53	-	-
TRA	Roughies		-	-	-		2	62
CGR	Convict groper	*Epinephelus octofasciatus*	-	-	5	57	-	-
KEL	Kelpfish	*Chironemus marmoratus*	-	-	2	50	-	-
BYD	Longfinned beryx	*Beryx decadactylus*	-	-	6	27	-	-
GGP	Giant groper	*Epinephelus lanceolatus*	-	-	1	30	-	-
SWE	Sweep	*Scorpis lineolatus*	2	16	2	2	2	1
SLR	Slender roughy	*Optivus elongatus*	-	-	1	22	1	0
MOY	Yellow moray eel	*Gymnothorax prasinus*	-	-	6	9	-	-
DRU	Silver drummer	*Kyphosus sydneyanus*	-	-	1	10	-	-
SWR	Sandagers wrasse	*Coris sandageri*	-	-	3	6	-	-
STB	Striped boarfish	*Evistias acutirostris*	-	-	2	5	-	-
BLU	Bluefish	*Girella cyanea*	-	-	1	5	-	-
OWR	Orange wrasse	*Pseudolabrus luculentus*	-	-	1	5	-	-
ETE	Ruby snapper	*Etelis coruscans*	-	-	2	4	-	-
SDP	Southern splendid perch	*Callanthias allporti*	-	-	1	1	3	1
GBR	Grey brotula	*Bidenicthys consobrinus*	-	-	1	4	-	-
SDL	Red rock cod	*Scorpaena cardinalis*	-	-	1	1	-	-
SIT	Silver trumpeter	*Latris* sp.	-	-	1	1	-	-
TRG	Triggerfish	*Thamnaconus analis*	-	-	1	1	-	-
DEM	Demoiselles	*Chromis* spp.	-	-	-	-	1	1
EBP	Eyebrow seaperch	*Hypoplectrodes coronatus*	-	-	-	-	-	-

Table A-3: List of taxa recorded in analysed seafloor imagery. Each taxon was assigned a unique number (No.) for use in annotating images with taxonomic identifications.

Group	No.	Taxa	Group	No.	Taxa
Algae	1	Coralline algae	Sponge	201	*Haliclona* sp. Indet.
Sponge	2	*Iophon laevistylus*	Sponge	202	Hexactinellida, family Euretidae
Starfish	3	*Henricia* sp.	Sponge	203	*Darwinella oxeata*
Sponge	4	*Ciocalypta* cf. *penicillus*/Haplosclerida (Chalinidae)	Gastropod	204	*Buccinulum pertinax*
Sponge	5	*Isodictya cavicornuta*	Gastropod	205	*Maurea waikanae*
Sponge	6	*Ecoinemia alata*	Gastropod	206	*Astraea heliotropium*
Gorgonian	7	*Perissogorgia vitrea*	Bivalve	207	*Talochlamys gemmulata*
Sponge	8	*Dendrilla* sp. Indet.	Coral	208	*Caryophyllia* spp.
Sponge	9	*Stelletta crater*, with a) *Desmacella dendyi* encrusting (orange)	Sponge	209	Unidentifiable poecilosclerida, possibly family Hymedesmiidae/Microcionidae)
Sponge	10	*Stelletta columna*	Bryozoan	210	*Cinctipora elegans*
Sponge	11	*Iophon minor*	Ascidian	211	*Polyclinum novaezelandiae*
Sponge	12	*Myxilla columna*	Sponge	212	*Poecillastra laminaris*
Sponge	13	*Leucettusa lancifer*	Sponge	213	*Geodia margarita*
Sponge	14	*Axinella australiensis*	Sponge	214	*Ancorina diplococcus*
Sponge	15	*Clathria macrotoxa*/orange poecilosclerida	Ascidian	215	Didemnid ascidian (multiple white clusters)
Sponge	16	*Trachycladus stylifer*	Sponge	216	*Erylus niger*
Sponge	17	Poecilosclerida (orange)	Sponge	217	*Neopetrosia* n. sp. 2 (tan oscules)
Sponge	18	*Clathria scotti*	Crayfish	218	*Jasus edwardsii*
Sponge	19	*Pleroma menoui/turbinatum*	Ascidian	219	*Pycnoclavella kottae*
Sponge	20	*Aciculites pulchra*	Ascidian	220	*Clavelina claviformis*
Sponge	21	*Dendrilla rosea*	Macroalgae	221	*Ecklonia radiata* (brown kelp)
Ascidian	22	*Hypsistozoa fasmeriana*	Macroalgae	222	*Caulerpa* sp.
Coral	23	*Monomyces rubrum*	Macroalgae	223	*Caulerpa flexilis*

Group	No.	Taxa	Group	No.	Taxa
Sponge	24	*Callyspongia* sp.	Macroalgae	224	*Caulerpa geminate*
Sponge	25	*Symplectella rowi*	Sponge	225	*Penares molli*
Hydroid	26	*Aglaophenia sp*	Coral (red)	226	*Errina* sp.
Hydroid	27	*Lytocarpia* sp.	Bryozoan	227	*Galeopsis polyporus*
Starfish	28	*Asterodiscides truncatus*	Sponge	228	*Holoxea* n. sp. 2 (Blue)
Sponge	29	*Psammocina* sp. Indet	Bryozoan	229	*Steginoporella perplexa*
Sponge	30	*Axinella australiensis*	Bryozoan	230	Cellariidae
Bryozoan	31	*Celleporaria agglutinans*	Bryozoan	231	Tubuliporidae
Sponge	32	*Callyspongia ramosa*	Urchin	232	*Centrostephanus rodgersii*
Sponge	33	*Leucettusa tubulosa*	Soft coral	233	Alcyoniidae
Sponge	34	Dictyoceratida (family Spongiidae/Irciniidae)	Macroalgae	234	*Palmophyllum* sp.
Sponge	35	Order Axinellidae	Hydroid	235	*Nemertesia cilata*
Sponge	36	Family Raspailiidae	Hydroid	236	*Nemertesia elongata*
Sponge	37	*Reidispongia coerulea*	Ascidian	237	Aplousobranchia
Bryozoan	38	*Hornera* (Cyclostomata)	Sponge	238	*Mycale* (*Aegogropila*) *flagelliformis*
Sponge	39	*Herengeria vasiformis*	Coral	239	Primnoidae
Bryozoan	*40*	*Reteporella Cheilostomata*	Sponge	240	*Parahigginsia phakelloides*
Sponge	41	*Haliclona* (*Gellius*) *regia*	Bryozoan	241	*Amathia* sp.
Coral	42	Stylasteridae	Sponge	242	*Clathria* (*Clathria*) *scotti*
Sponge	43	*Neoschrammeniella fulvodesmus*	Sponge	243	Xestospongia corallodies
Sponge	44	*Stryphnus ariena*	Sponge	244	*Coscinoderma*. sp. 2
Sponge	45	*Calyx imperialis*	Ophiuroid	245	*Astrobrachion constrictum*
Sponge	46	*Tedania diversirhaphidiophora*	Ascidian	246	Didemnum sp.
Starfish	47	*Ophidiaster macknighti*	Sponge	247	Poecilosclerida sp.
Sponge	48	Dictyoceratida (family Irciniidae)	Sponge	248	*Spongia* sp. Indet.

Group	No.	Taxa	Group	No.	Taxa
Sponge	49	*Antho* (*Antho*) *brondstedi*	Sponge	249	*Neopetrosia* n sp. 3 (big oscules)
Sponge	50	*Tedania* (or ascidian)	Sponge	250	*Callyspongia latituba*
Sponge	51	*Taonura marginalis*	Bryozoan	251	Cheilostomata
Sponge	52	*Stryphnus* sp.	Sponge	252	*Polymastia aurantia*
Soft coral	53	Alcyoniidae sp 1.	Anemone	253	Ceriantharia (tube dwelling anemones)
Sponge	54	*Stryphnus levis*	Starfish	254	*Sclerasterias mollis*
Sponge	55	*Rossella ijimai*	Sponge	255	*Aciculites pulchra*
Urchin	56	*Araeosoma thetidis*	Coral	256	Dendrophylliia (unidentified cup coral)
Gorgonian	57	*Metafannyella moseleyi*	Sponge	257	*Leucettusa lancifer*
Coral	58	*Antipathella fiordensis*	Sponge	258	*Poecillastra laminaris*
Ophiuroid	59	*Astrobrachion contrictum*	Sponge	259	*Pleroma menoui*
Crab	60	Hermit crab	Tubeworm	260	*Protula bispiralis*
Urchin	61	*Diadema palmeri*	Sponge	261	*Psammocina amodes* (or new species)
Sponge	62	Haplosclerida, possibly Calyx	Coral	262	*Stylopathes* sp
Brachiopod	63	*Liothyrella* sp.	Coral	263	*Lepidisis* sp. (bamboo coral)
Sponge	64	Haplosclerida, family Petrosiidae	Ophiuroid	264	*Ophiopsammus assimilis*
Bryozoan	65	Candidae Cheilostomata	Sponge	265	*Calyx* n sp. 5
Sponge	66	*Haliclona* (*Gellius) petrocalyx*	Bryozoan	267	*Hippomenella vellicata*
Coral	67	*Oculina virgosa*	Crab	268	*Leptomithrax longipes*
Sponge	68	*Petrosia cf hebes*	Sponge	269	*Mycale* (*Paraesperella*) n sp 4
Sponge	69	*Acanthella dendyi*	Sponge	270	*Hymeniacidon* n sp 4
Anemone	70	Anemone	Bryozoan	280	*Cinctipora elegans*
Coral	71	*Antipathella* sp.	Starfish	281	*Pentagonaster pulchellus*
Hydroid	72	Hydroid	Sponge	282	*Dysidea* n sp. 11
Hydroid	73	Aglaopheniidae	Sponge	283	*Dendrilla* n. sp. 2 (yellow clump

Group	No.	Taxa	Group	No.	Taxa
Bryozoan	74	*Heteropora neozelanica*	Sponge	284	*Callyspongia* (Callyspongia) n sp. 11
Starfish	75	*Knightaster* sp.	Ophiuroid	285	*Ophiopsammus maculata*
Sponge	76	*Acanthella dendyi*	Sponge	286	Mycale (Paraesperella) n sp 4
Crinoid	77	Comatulida	Bryozoan	287	*Hornera* sp. 2
Sea cucumber	78	*Holothuria integra*	Bryozoan	288	*Hornera robusta*
Bryozoan	79	*Iodictyum yaldwyni*	Ascidian	289	*Diplosoma velatum*
Bryozoan	80	*Galeopsi*s sp.	Ophiuroid	290	*Clarkcoma bollonsi*
Bryozoan	81	*Reteporella* sp. 2	Bivalve	291	*Atrina zelandica*
Sponge	82	*Antho* (*Antho*) *brondstedi*	Sponge	292	*Lissodendoryx* (*Ectyodoryx*) n sp 4 (ropey pad)
Bryozoan	83	Cheilostome	Sponge	293	*Cymbastela lamellata*
Sponge	84	Haplosclerida, family Chalinidae	Ascidian	294	*Didemnum lithostrotum*
Sponge	85	*Tethya fastigata*	Ascidian	295	Didemnidae
Sponge	86	*Poecillastra laminaris*	Ascidian	296	*Leptoclinides* sp.
Sponge	87	*Psammocina beresfordae*	Sponge	297	*Chondropsis* sp. indet.
Algae	88	Drift brown algae	Sponge	298	*Latrunculia kaakaariki*
Sponge	89	*Chondropsis kirkii*	Hydroid	299	*Nemertesia pinnatifida*
Algae	90	*Palmophyllum umbracola*	Coral	300	*Primnoella* sp.
Algae	91	Distromium	Sea cucumber	301	*Stichopus mollis*
Algae	92	Rhodoliths	Oyster	302	*Ostrea chilensis*
Algae	93	Small red and green algae species	Tubeworm	303	*Protula* sp.
Sponge	94	*Neopetrosia* n. sp	Bivalve	304	*Tucetona laticostatus*
Gorgonian	95	Family Ellisellidae (or undescribed genus)	Gastropod	305	*Semicassis pyrum*
Unknown	96	Tube-like small forms	Gastropod	306	*Maurea foveauxana*

Group	No.	Taxa	Group	No.	Taxa
Bryozoan	97	Bryozoan	Crab	307	*Jacquinotia edwardsii*
Bryozoan	98	*Reteporella* Phidoloporidae	Crab	308	*Nectocarcinus* sp.
Sponge	99	Ball sponge	Worm	309	Sabellidae
Sponge	100	Geodiidae	Urchin	310	*Goniocidaris parasol*
Sponge	101	*Siphonochalina* sp. (Haplosclerida)	Coral	311	*Desmophyllum dianthus*
Hydroid	102	Zygophylacidae*; Cryptolaria prima*	Shrimp	312	*Nematocarcinus* sp.
Sponge	103	Raspailia (Raspaxilla) inaequalis	Bryozoan	313	*Diaperoecia purpurascens*
Sponge	104	Order Dendroceratida sp 1.	Gastropod	314	*Fusitriton laudandus*
Sponge	105	*Petrosia* (*Strongylophora*) n. sp. (golden)	Urchin	315	Cidaroid urchin
Sponge	106	*Clathria terraenovae*	Coral	316	Antipatharian
Sponge	107	*Stelletta maori*	Starfish	317	*Diplodontias* sp.
Soft coral	108	Eleutherobia	Gastropod	318	*Maurea* sp.
Sponge	109	*Psammocinia hawere*	Coral	319	Alcyonacea (gorgonian)
Sponge	110	*Geodia regina*	Coral	320	*Alcyonacea (soft coral)*
Sponge	111	*Ancorina stalagmoides*	Gastropod	321	*Ranella australasia*
Sponge	112	*Polymastia hirsuta*	Ascidian	322	*Pseudodistoma cereum*
Sponge	113	*Xestospongia novaezelandiae*	Ascidian	323	*Molgula*
Gorgonian	114	Plexauridae	Ascidian	324	*Synoicum otagoensis*
Coral	115	Isididae (bamboo coral)	Sponge	325	*Raspailia* sp. indet.
Sponge	116	Haliconia sp. (Haplosclerida, family Chalinidae)	Sponge	326	*Awhiowhio unda*
Sponge	117	*Tethyopsis mortenseni*	Sponge	327	*Stelletta conulosa*
Sponge	118	Hexatinellid glass sponge sp. 1	Sponge	328	*Desmacella mammilatum*
Sponge	119	*Podospongia virga*	Sponge	329	*Hymeniacidon* cf *perlevis*
Sponge	120	Tetractinellidae, family Ancorinidae	Sponge	330	*Dragmacidon mammilatium*
Sponge	121	*Geodia vestigifera*	Sponge	331	*Aaptos globosa*

Group	No.	Taxa	Group	No.	Taxa
Sponge	122	*Mycale novaezelandiae* (or ascidian)	Sponge	332	*Iophon* sp. indet
Sponge	123	*Pleroma turbinatum*	Sponge	333	*Petrosia* sp. indet.?
Sponge	124	*Callyspongia latituba*	Sponge	334	*Polymastia massalis*?
Bryozoan	125	Cornucopina sp. (Bugulidae)	Sponge	335	Haplosclerida sp. indet. (peach)
Bryozoan	126	*Steginoporella neozelanica*	Sponge	336	*Psammocinia* cf *beresfordae*
Bryozoan	127	*Margaretta barbata*	Sponge	337	*Psammoclema* sp. indet. ?
Sponge	128	*Tethya fastigata*	Sponge	338	*Coscinoderma* sp. indet. ?
Hydroid	129	*Cryptolaria* sp. (Zygophylacidae)	Sponge	339	*Psammoclemma* sp. indet
Sponge	130	*Darwinella cf gardineri*	Sponge	340	*Topsentia* sp. indet
Sponge	131	*Psammocinia* sp. indet.	Sponge	341	Neopetrosia sp. indet.
Algae	132	*Carpophyllum maschalocarpum* (drift)	Sponge	342	Haplosclerida sp. indet. ?
Algae	133	*Marginariella* (?) (drift)	Sponge	343	Poecilosclerida sp. indet. ?
Sponge	134	*Crella incrustans*	Sponge	344	*Lissodendoryx* sp.
Hydroid	135	*Lytocarpia spiralis*	Sponge	345	Chalinidae sp. indet.?
Sponge	136	Hymeniacidon sp	Sponge	346	*Grantia ramulosa* (calcareous sponge)
Sponge	137	*Latrunculia* (*Biannulata*) *kaakaariki*	Sponge	347	*Stelletta* sp. indet
Sponge	138	*Polymastia* sp.	Sponge	348	*Crella incrustans*
Sponge	139	*Tetilla australis*	Sponge	349	*Penares* sp. indet.
Sponge	140	*Polymastia cf crocea*	Sponge	350	Pleroma sp
Sponge	141	*Geodia rex*	Sponge	351	*Callyspongia* sp. indet.
Coral	142	Zoanthid growing on sponge	Sponge	352	Leucosolenia rosea (calcareous sponge)
Gorgonian	143	Primnoidae sp. 1	Sponge	353	Poecilosclerida spp. indet. ?
Sponge	144	*Polymastia aurantia*	Sponge	354	*Polymastia* sp. indet.
Sponge	145	*Myxilla novaezelandiae*	Sponge	355	*Fasciospongia turgida*
Sponge	146	*Pararhaphoxya sinclairii*	Sponge	356	*Strongylacidon conulosum*

Group	No.	Taxa	Group	No.	Taxa
Sponge	147	*Raspailia topsenti*	Sponge	357	*Lissodendoryx* (Ectyodoryx) cf *bifacialis*
Sponge	148	Melithaeidae?	Sponge	358	*Lamellomorpha australis*
Coral	149	*Lillipathes lilliei*	Sponge	359	*Latrunculia* sp.
Coral	150	*Stylopathes tenuispina*	Sponge	360	Farreidae (Hexactinellida) spp.
Sponge	151	Demosponge - carnivorous sponge (?)	Sponge	361	*Myxilla* spp.
Soft coral	152	*Eleutherobia cf. splendens*	Sponge	362	*Ecionemia novaezelandiae*
Coral	153	*Stichopathes* sp.	Sponge	363	*Stryphnus* sp. indet.
Gorgonian	154	*Perissogorgia* sp.	Sponge	364	*Ircinia* sp. indet
Soft coral	155	*Alcyonium* sp.	Sponge	365	*Psammopemma* sp. indet.
Ophiuroid	156	*Astroceras elegans*	Sponge	366	*Tedania* sp. indet.
Sponge	157	Plumularioidea (Superfamily)	Sponge	367	Suberitidae
Hydroid	158	*Clathria* (*Thalysias*) *coriocrassus*	Sponge	368	Chondropsidae gen. et sp. Indet
Sponge	159	*Polymastia massalis*	Sponge	369	Suberitida, family Halichondriidae gen et sp. indet.
Sponge	160	*Myxilla* (*Ectyomyxilla*) *ramosa*	Sponge	370	*Topsentia* sp. indet
Sponge	161	*Cinachyrella* sp.	Sponge	371	Demospongiae sp. indet.
Sponge	162	*Chondropsis* sp.	Sponge	372	Chondrosiidae sp. indet
Sponge	163	Dysidea sp.	Sponge	373	*Awhiowhio sepulchrum*
Sponge	164	*Axinella* sp	Sponge	374	*Desmacidon* sp. indet.
Sponge	165	*Dactylia varia*	Sponge	375	*Esperiopsis* sp. indet. (raggedy fan)?
Sponge	166	*Acanthella dendyi*	Sponge	376	Antarctotetilla leptoderma ?
Sponge	167	*Hymedesmia* (*Stylopus*) *australis*	Sponge	377	Hexactinellida (Lanuginelinae sp. indet.) ?
Sponge	168	*Biemna rufescens*	Sponge	378	*Lissodendoryx* sp. (yellow slimy)
Coral	169	*Narella* sp.			
Sponge	170	Order Haplosclerida, family Phloeodictyidae?	Fish	A	Butterfly perch
Bryozoan	171	*Reteporella* sp 1.	Fish	B	Leatherjacket

Group	No.	Taxa	Group	No.	Taxa
Sponge	172	Multiple colonial ascidian species	Fish	C	Red scorpion fish
Ascidian	173	*Cliona* cf *celata*, with zooanthids on surface	Fish	D	Roughy
Ascidian	174	*Aplidium knoxi* (orange colonial ascidian)	Fish	E	Pink maomao
Anemones	175	*Corynactis australis*	Fish	F	Red-banded perch
Ascidian	176	*Didemnum jucundum* (black ascidian)	Fish	G	Splendid perch
Zoonanthid	177	Epizoanthus sp.	Fish	H	Red bandfish
Bryozoan	178	Catenicellidae	Fish	I	Blue cod
Sponge	179	Calcarea (lemon colour)	Fish	J	Unidentified flatfish
Ascidian	180	*Leptoclinides novaezelandiae*	Fish	K	Morid cod (?)
Algae	181	Non-geniculate corallines	Fish	L	Mottled moray *Gymnothorax prionodon*
Sponge	182	*Homaxinella erecta*	Fish	M	Conger eel *Conger* sp.
Sponge	183	*Awhiowhio osheai*	Fish	N	Pigfish sp.
Sponge	184	*Aciculites pulchra*	Fish	O	Orange roughy *Hoplostethus atlanticus*
Sponge	185	*Raspailia* (*Raspaxilla*) *flaccida*	Fish	P	Hapuka *Polyprion oxygeneios*
Sponge	186	*Petromica* sp.	Fish	Q	Trumpeter *Latris lineata*
Sponge	187	*Callyspongia cf annulata*			
Crinoid	188	*Anneissia benhami*			
Crinoid	189	*Cenolia novaezelandiae*			
Sponge	190	*Suberites* sp. indet			
Ascidian	191	*Didemnum densum*			
Sponge	192	*Xestospongia* sp. (Haplosclerida)			
Sponge	193	*Neopetrosia* sp. (Haplosclerida)			
Ascidian	194	Ascidian			
Ophiuroid	195	*Ophiopsammus* sp.			
Zooanthids	196	*Parazoanthus* sp.			

Group	No.	Taxa	Group	No.	Taxa
Sea slug	197	Sea slug			
Urchin	198	*Pseudechinus huttoni*			
Starfish	199	*Odontaster* sp.			
Bryozoan	200	Celleporid bryozoans on hydroids			

Table A-4: Available video/still camera imagery for New Zealand's deep reefs (50 - 300 m depth), as held by NIWA. For DTIS and CoastCam sites, only the still images were qualitatively assessed for this report (the digital video was not viewed due to the many hours of footage). Screen-grabs were taken from older, lower resolution, video camera only (no stills) sites in the GULF and BAY of PLENTY. Given here are the site code, depth range, sediment and water visibility scores (see Table 2-2), whether hard corals were present (in the stills only, and excluding cup coral), the relative cover of fauna, whether encrusting coralline algae was present (Cor.), and a short description of the seafloor. For some of the MERNOO and CHATHAM sites, site descriptions by those who collected these video sites are given in square brackets as verbatim italicised text, from Bowden et al. (2017). Note that those descriptions are from viewing the full videos, as well as the still images.

Region	Site	Depth	Sed.	Vis.	Coral	Fauna	Cor.	Description
NORTH								
	E59	91–97	1	1	-	3	-	Descended a steep bank feature, which had underlying seafloor of soft erodible mudstone largely covered by sand. Some limited bare base rock exposed at bank bottom, scattered boulders on this for short distance. Boulders had intermediate cover of finger sponges, bryozoans, and hydroids
	E170	40–43	2	2	Y	2–3	Y	Raised bedrock outcrops, with some irregular boulder areas. On fine sand. *Perissogorgia vitrea*
	E169	40–46	2	2	Y	2–3	Y	Raised bedrock outcrops and flat platforms. On fine sand. *Perissogorgia vitrea*
	E58	54–56	3	2	Y	1, 4	Y	Bedrock as low block reefs, with areas of boulder slabs. Low fauna extent on most, some more diverse patches on low ridge features with gorgonian *Perissogorgia vitrea*. Onto a find sand seafloor.
	E44	91–102	3	2	-	2	-	Bedrock as elevated large blocks with some walls and overhangs, onto a fine sand seafloor
	E67	112–112	3	2	-	1–2	-	Low lying bedrock patches, carbonate with rounded pillow like forms, onto fine sand.
	E66	114–114	3	2	-	2–3	-	Low lying bedrock patches, carbonate with rounded pillow like forms, onto fine sand.
	E241	89–93	3	2	Y	1–3	-	Low bedrock ridges on fine sand. *Oculina virgosa* coral colonies.
	E104	57–59	3	2	-	2	Y	Low bedrock sheets with cover of small rock slabs, and sediment.
	E98	53–62	3	2	-	2	Y	Low bedrock sheets with cover of small rock slabs, and sediment.
	E97	55–68	2	2	-	Algal crusts	Y	Lumpy bedrock dominated by coralline algae crusts; areas of rhodoliths cobbles sitting on coarse sand, some raised blocks with high and diverse faunal cover (100%)
	E100	67–68	3	2	-	Algal crusts	-	Sparse low-lying bedrock patches (limited), carbonate with rounded pillow like forms, onto fine sand.
	E82	114–119	3	2	-	2	-	Sparse low-lying bedrock patches (limited), carbonate with rounded pillow like forms, onto fine sand.

Region	Site	Depth	Sed.	Vis.	Coral	Fauna	Cor.	Description
NORTH								
	E224	106–107	3	2	Y	1– 3	-	Bedrock as low ridges and blocks with fracture lines, angular slab boulders, onto fine sand.
	E85	129–130	2	1	-	3	-	Small patches of carbonate bedrock embedded in sand. One small non-carbonate boulder sitting on top of fine sand, possibly a fishing vessel catch discard from elsewhere.
	E145	104–107	N/A	N/A	Y	3	-	Bedrock, poor visibility due to large storm event having just passed through the area. Black coral
	E202	79–87	N/A	N/A	-	2–4	-	Bedrock as raised slabs, onto fine sand. Water still clearing from large storm event
	E180	120–124	2	1	Y	3–4	-	Bedrock outcrops, both carbonate and non-carbonate, on fine sand. Coral
	E165	69–78	1	1	Y	3	Y	Bedrock as raised outcrops and angular boulders, on coarse dark sand with shell.
	E168	124–153	N/A	1	Y	2	-	Bedrock buried under a thin sediment veneer. Sponge, hydroids, and soft corals present.
	E179	118–119	1	1	Y	3–4	-	Bedrock buried under a thin sediment veneer. Sponge and hydroids present. Also, some raised bedrock outcrops with walls and overhangs.
	E167	124–135	N/A	1	Y	3	-	Bedrock buried under a thin sediment veneer. Sponge, hydroids, and soft corals present.
	E156	45–62	1	2	-	3–4	Y	Solid bedrock as low ridges, on coarse dark sand with some shell
	E160	42–81	1	1	-	4	Y	Small bedrock patches on fine dark gravel
	E187	65–76	1	1	-	4	-	Small bedrock patches on coarse sand with some shell. Plexauridae.
	E171	57–76	1	1	Y	3–4	-	Low bedrock embedded in fine sand with some shell. Sponge dominated. Primnoidae sp. 1
	E150	89–90	N/A	2	-	3–4	-	Bedrock buried under a thin sediment veneer. Sponge and hydroid dominated
	E182		N/A	2	Y	1–2	-	Soft-looking flaky carbonate bedrock under a thin sediment veneer, as well as some small mounds, with fine sand patches. *Antipathella* sp., Isididae (bamboo coral), *Lillipathes lilliei, Stylopathes tenuispina*, Family Ellisellidae (or an undescribed genus in a sister family).
	B5	136	N/A	1	Y	2–3	-	Bedrock buried under a thin sediment veneer. Plexauridae, *Stichopathes* sp., *Perissogorgia* sp.
	B7	165	1	1	Y	1–4	-	Bedrock buried under a thin sediment veneer. Some low carbonate reef slabs with pillowy appearance. *Perissogorgia* sp.
	B10	136	1	1	Y	1–4	-	Bedrock buried under a thin sediment veneer, some patches just above surface as flat pavement. *Lillipathes lilliei*, *Stylopathes tenuispina*, *Perissogorgia* sp., *Narella* sp.

Region	Site	Depth	Sed.	Vis.	Coral	Fauna	Cor.	Description
NORTH								
	B14	120	1	1	Y	2–3	-	Bedrock buried under a thin sediment veneer. Some low carbonate reef slabs with pillowy appearance. *Metafannyella moseleyi*
	B28	66	1	1	Y	5	-	Low bedrock pavement embedded in coarse shelly sand. Dominated by diversity of sponges. Plexauridae, *Perissogorgia* sp.;
	B61	88	1	1	-	4–5	-	Large bedrock outcrops on coarse sand with shell
	B62	98	1	1	-	4–5	-	Large bedrock outcrops on coarse sand with shell
	B64	100–120	1	1	Y	4–5	-	Large high bedrock outcrops with walls and overhangs. *Oculina virgosa*
	B33	40–56	1	1		5	Y	Crustose algae cobbles on white carbonate sand
	B34	44–54	1	1		5	Y	Bedrock, bedrock overlain with white carbonate sand
	B36	60–67	1	1	Y	5	Y	Bedrock. Red coral *Errina* sp.
	B37	83– 88	1	1	Y	3–5	Y	Cobble and angular pebble fields, with small bedrock outcrops Red coral *Errina* sp. Bryozoan rosette fields in parts
	B39	78	1	1		3–4	Y	Bedrock covered in areas with white carbonate sand
	B40	68	1	1		5	Y	Bedrock
	B44	170	1	1	Y	3–5	-	Bedrock overlain with veneer of white carbonate sand
	B45	95	1	1	Y	3–5	-	Raised bedrock outcrops on white carbonate sand
	B47	100–115	1	1	Y	3–5	-	Raised bedrock outcrops on white carbonate sand
	B49	125–135	1	1	Y	3–5	-	Raised bedrock outcrops on white carbonate sand
GULF								
	E11	61–64	2	3	-	1–3	Y	Low bedrock, with some ridges and boulder areas
	E10	106–108	2	2	-	2	-	Limited low bedrock patches embedded in sediment
	E26	57–63	2	1	-	2–3	-	Low bedrock ridges and platforms on fine sand
	E19	121–127	2	2	Y	1–3	-	Low bedrock ridges and platforms on fine sand. Stylasteridae
	E27	133–137	2	2	Y	3	-	Limited low bedrock ridges and platforms on/embedded fine sand. Stylasteridae
	E29	91–107	2	2	-	1–2	-	Low bedrock pavement with some ridges, some embedded in fine sand

Region	Site	Depth	Sed.	Vis.	Coral	Fauna	Cor.	Description
NORTH								
	E32	138–147	2	1	-	1–3	-	Low bedrock pavement with some higher ridges, some embedded in fine sand
	E41	103–116	1	2	-	2	-	Low bedrock pavement with some higher ridges, some embedded in fine sand
	E31	100–114	2	2	Y	1–2	-	Low bedrock, and irregular boulders embedded in fine sand. *Oculina virgosa*.
	E61	120–132	1	2	Y	3–5	-	Large bedrock outcrops with high walls and overhangs, some platforms, on fine sand with shell. Stylasteridae, *Oculina virgosa*
	O70	50	2	3	Y	3–4	-	Very rugose single large outcrop. CoastCam footage taken at night. *Antipathella fiordensis*.
	O64	170	1	1	-	5	-	Very limited low bedrock patch reef in medium sand
	O1	64–70	2	3	Y	2–3	-	Broken bedrock large reef on fine sand, broken ridges bisected with cracks with sand floors. *Antipathella fiordensis*.
BOP								
	D2	75	3	3	-	1–2	-	Boulder field
	D3	97	N/A	3	-	3–4	-	Low bedrock pavement, most covered with a sediment veneer.
	D7	78	N/A	3	-	2	-	Small boulders embedded in fine sand
	D9	65	2	2	-	2–3	-	Low bedrock outcrops as large mounds, on coarse sand
	D15	45	1	3	-	3	-	Pavement bedrock
	H240	40–50	1	1	Y	2	-	Bedrock with coarse sand cover
	H241	70	1	1	-	3	-	Sand, boulders, bedrock, sponge, turfing, coralline algae
	H243	94	1	1	-	1	-	Sand overlying bedrock, bryozoans, hydroids, sponges
	H245	80–106	1	1	-	2–3	-	Sand, gravel overlying bedrock, bryozoans, hydroids, sponges
	H251	120	1	1	Y	1	Y?	Bedrock with sponges, gorgonians, black corals lots of pink maomao
	H254	100-130	1	1	-	1	-	Sand/ cobbles with gorgonians, sponges, bedrock outcrops
	H256	120	1	1	Y	1	Y	Sand/ cobbles with gorgonians, sponges, soft coral
	H260	107–110	1	1	Y	1	Y?	Sand, gravel, crinoids, bryozoans, sea pens
	H264	120–130	1	1	-	2–3	-	Sand with sea pens + bedrock (wall?) with smeary sponge, crinoids

Region	Site	Depth	Sed.	Vis.	Coral	Fauna	Cor.	Description
NORTH								
	H266	160–180	1	1	-	2–3	-	Sand with sea pens + bedrock with smeary sponge, crinoids
	H269	84–100	1	1	-	3–4	-	Sand/gravel, reef outcrop with cup and encrusting sponges
	H272	160–170	1	1	-	1	-	Sand, sediments, crinoids
	H273	122	1	1	Y	1	-	Sand, low relief bedrock, crinoids, sea pens, sponges
	H276	150–160	1	1	Y	1	-	Dog cockle bed, sand, bedrock, sponges
	H204	80	1	1	-	2	Y	Mixture of low relief bedrock and cobble fields
	H194	80	3	3	-	1	-	Sedimented low reef
	H196	50	1	1	-	3	Y	Bedrock
	H199	50	2	2	-	2	Y	Bedrock and gravel
	H182	58	2	2	-	2	-	Sand, mud, live cup corals attached to occasional low rocks in sediment
	H184	60	N/A	2	N/A	N/A	N/A	Sand with occasional rock outcrops (no reef captured on stills)
	H186	114–123	2	2	-	1	-	Sand with occasional rock outcrops
	H191	36	2	2	Y	2	-	Top of reef ridges
TARANAKI								
	B77	200–240	1	1	-	1–3	-	Carbonate rubble rock patches including column and angular form, on canyon side
	B79	210–220	1	1	-	1–3	-	Carbonate rubble rock patches including column and angular form, on canyon side
	B103	162	1	1	-	1–3	-	Carbonate rubble rock patches including column and angular form, on canyon side. Some bedrock
	B108	192	1	1	-	1–3	-	Carbonate rubble rock patches including column and angular form, on canyon side. Some bedrock
	B123	173	1	1	-	1–3	-	Carbonate rubble rock patches including column and angular form, on canyon side. Some bedrock
	B125	265	1	1		1–3	-	Carbonate rubble rock patches including column and angular form, on canyon side. Some bedrock
	B126	507	1	1	Y	1–3	-	Carbonate rubble rock patches including column and angular form, on canyon side. Some

Region	Site	Depth	Sed.	Vis.	Coral	Fauna	Cor.	Description
NORTH								
								bedrock
	B127	257	1	1	Y	1–4	-	Carbonate rubble rock patches including column and angular form, on canyon side. Some bedrock
GOLDEN								
	M1	40–60	1	2	-	5	-	Rugged high reef with large stacks
CANTERBURY								
	H7	87	N/A	1	-	5	-	Bedrock boulders (small) on sand
	H139	93	N/A	1	-	3	-	Bryozoan patch reefs (small) and sponge gardens on fine sand. Wireweed polychaetes also dominant.
	H146	170–350	1–2	2–3	-	1–3	-	Transect over the shelf edge and down the side of the canyon. Bedrock outcrops and pavements
	H147	200–325	1–2	2–3	-	1–3	-	Transect over the shelf edge and down the side of the canyon. Bedrock outcrops and pavements
STEWART	H106	70	N/A	1	-	3–4	-	Bryozoan fields on pebbles with sand
	H111	82	N/A	1	-	3–4	-	Bryozoan fields on pebbles with sand
	H113	73	N/A	1	-	3–4	-	Bryozoan fields on pebbles with sand
	S118	73–74	1	2	-	3 – 5	-	Bedrock reef and boulders on coarse sand and gravel.
	S107	45–50	1	1	-	3–5	-	Bedrock reef undulating, on coarse sand.
	S112	129–132	1	1	-	5	-	Bedrock with ridges, walls, and boulders, on coarse sand
	H94	121	1	1	Y	4	-	Raised bedrock patches on the edge of the canyon, some embedded in coarse sand.
	H95	195	1	1	-	4	-	Raised bedrock patches on the edge of the canyon, some embedded in coarse sand.
	H99	178	1	1	-	4	-	Raised bedrock patches on the edge of the canyon, some embedded in coarse sand.
	H100	151	1	1	-	4	-	Raised bedrock patches on the edge of the canyon, some embedded in coarse sand.
	H103	130	1	1	-	4	-	Raised bedrock patches on the edge of the canyon, some embedded in coarse sand.
	H104	130	1	1	Y	5	-	Raised bedrock patches on the edge of the canyon, some embedded in coarse sand.

Region	Site	Depth	Sed.	Vis.	Coral	Fauna	Cor.	Description
NORTH								
SNARES								
	S36	158–159	1	1	-	N/A	-	Two very small, low pavement patch reefs, surrounded by sand and carbonate grit (probably bryozoans)
	S62	141–146	1	1	-	N/A	-	One small, low pavement reef, veneered with and surrounded by sand and carbonate grit (probably bryozoans)
	S26	116–118	1	1	-	3	-	Very limited patches of slightly raised, and flat basement rock, veneered with and surrounded by white carbonate sand.
	S44	152–174	1	1	-	2	-	Limited low chalky pavement rock, amongst dense bryozoan drifts and sand
	S19	141–146	1	1	-	2–3	-	Occasional slightly raised pavement rock, often veneered in coarse sand
	S67	100–102	1	1	-	3–4	-	One patch reef of raised, broken pavement, with intermittent coarse sand cover
MERNOO								
	E159	53–73	1	1	-	4–5	Y	Continuous bedrock. [*Shallow outcrop on plateau of Mernoo Bank. Rock with diverse sponge and other sessile fauna community, sand in places. Mysid swarms throughout, squid over sand substrata*].
	E158	87–130	1	1	Y	4–5	-	Continuous bedrock. [*Shallow rocky outcrop on E rim of Mernoo Bank. Bedrock then rippled sand. Diverse sponges, stylasterids. Cloud of mysids in floodlights through much of transect. No lasers*].
	T284	42–58	1	1	Y	2–5	Y	Dropping down a slope, with a mixture of large bedrock outcrops, pavement, and irregular boulders. Intermittent coarse carbonate sand. Stylasteridae, *Caryophyllia* spp.
	T30	115–124	1	1		4–5	-	Bed rock on a slope, large open crevasses. Stylasteridae, red coral E*rrina* sp.
	E156	138–157	1	1	-	1	-	Solitary large cup sponge sitting on rock patch < 1 m^2, in a transect of fine sand. [*Shell hash, muddy sand and gravel, rippled sand at end. Sparse fauna, few large blue sponges*].
	E135	142–150	1	1	Y	4	-	Occasional low pavement reef embedded in sand. Stylasteridae. [*Veryan Bank. Video recording not on at start; transect extended to compensate. Bivalve shell hash, pale sand, patches of bedrock. Fauna of sponges, tube worms, anemones, stylasterids.*].
	E134	185–187	1	1	-	2	-	Low soft rock mounds. [*Veryan Bank summit plateau and rim. Sand with areas of rock and cobble. Brachiopod shells and live brachiopods conspicuous throughout transect. Also,*

Region	Site	Depth	Sed.	Vis.	Coral	Fauna	Cor.	Description
NORTH								
								anemones.].
	E7	259–259	1	1	-	1	-	Sand, with a few rare patches of chalky rock, with large burrows. [*Dark, firm, sandy sediments with reticulated appearance, some patches of black sand with chalk in places. Fauna of sponges, asteroids,* *tube worms, cup corals*].
	T266	245–250	1	1	Y	N/A	-	A small patch where rock sits just below the surface, as indicated by encrusting white ascidian colonies, within a general transect of coarse sand.
CHATHAM								
	E54	181–212	1	1	Y	3–4	-	Broken boulder fields and smooth bedrock walls. Stylasteridae [No entry for Bowden et al. 2017].
	E58	177–201	1	1	Y	3–4	-	Patchy bedrock and boulder habitat. Stylasteridae. [*Sensitive Habitat! Transect across the summit* *of a low rocky knoll. Shell hash, sand, and gravel on the flanks, patches of bare outcropping rock on the summit. Sponges and antipatharian and stylasterid corals on rock substrata, brachiopods recorded on gravel substrata.*].
	E68	269–280 check	1	1	Y	1–2	-	Black lava rock, several orange roughy. Stylasteridae. [*Seamount site "Smith's City". Heavily trawl impacted, some orange roughy over bedrock and coral rubble on summit, becoming lava,* *boulders, and sand on lower flanks.*].
	E63	269–280 check	1	1	-	1	-	Black lava bedrock. [*Sensitive Habitat! Rippled muddy sand at start, then sand and shell hash with areas of cobble,* boulder, and rock. Sponges, stylasterid corals, gorgonians, hydroids, and bryozoans on hard substrata].
	E66	279–290	1	1	Y	1		Small patch reefs, Stylasteridae. [*Sensitive Habitat! Transect on bank north of S54. Rippled sand, boulders, and bedrock in places, with sponges, stylasterid corals, bryozoans, and some small stony coral colonies*].
	E84	100–234	1	1	Y	5	-	Bedrock reef. Stylasteridae. [*Shallow knoll, from summit down to level seabed. Bedrock at summit, with diverse sessile fauna and flora; zoanthids(?), stylasterid corals, encrusting red algae, and fishes. Sand and shell hash deeper*].
	E86	173–382	1	1	Y	2–3	-	Rock outcrops. Stylasteridae. [*Knoll summit out on to open sediments. Pale rock, cobbles, boulders and shell hash with anemones, sponges, stylasterids. Group of large hapuka*

Region	Site	Depth	Sed.	Vis.	Coral	Fauna	Cor.	Description
NORTH								
								following DTIS. Sand, shell hash, and cobbles with sponges and bryozoans deeper].
	E90	294–425	1	1	Y	3–4	-	Rock outcrops. Stylasteridae. [*Sensitive habitat! Coarse sand, brachiopod shell hash and rock at start, with large tube worms. Bedrock, boulders, cobbles in places, with sponges, bryozoans, stylasterid corals, crinoids, and brachiopods. Becoming muddy sediment at end*].
	T114	85–186						

Appendix B Figures

This section includes all figures referred to in the text from Section 3 onwards.

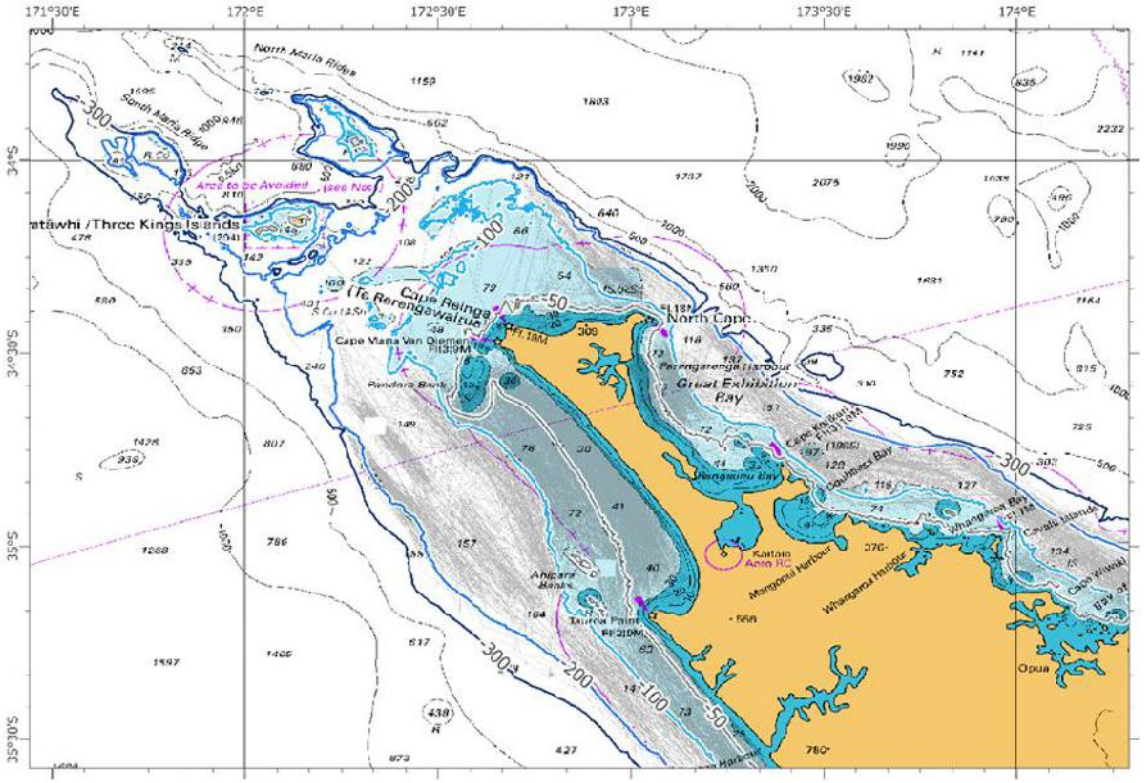

Figure B-1: Northland nautical chart with place names, bathymetry contours, and commercial trawl footprint (2003 – 2014). Bathymetry contours are denoted by: 300 m depth contour (dark blue line), 200 m contour (medium blue line), 100 m contour (light blue line). Grey lines represent individual tows from the commercial trawl footprint. Pink line with cross-bars indicates the territorial sea boundary (twelve nautical miles).

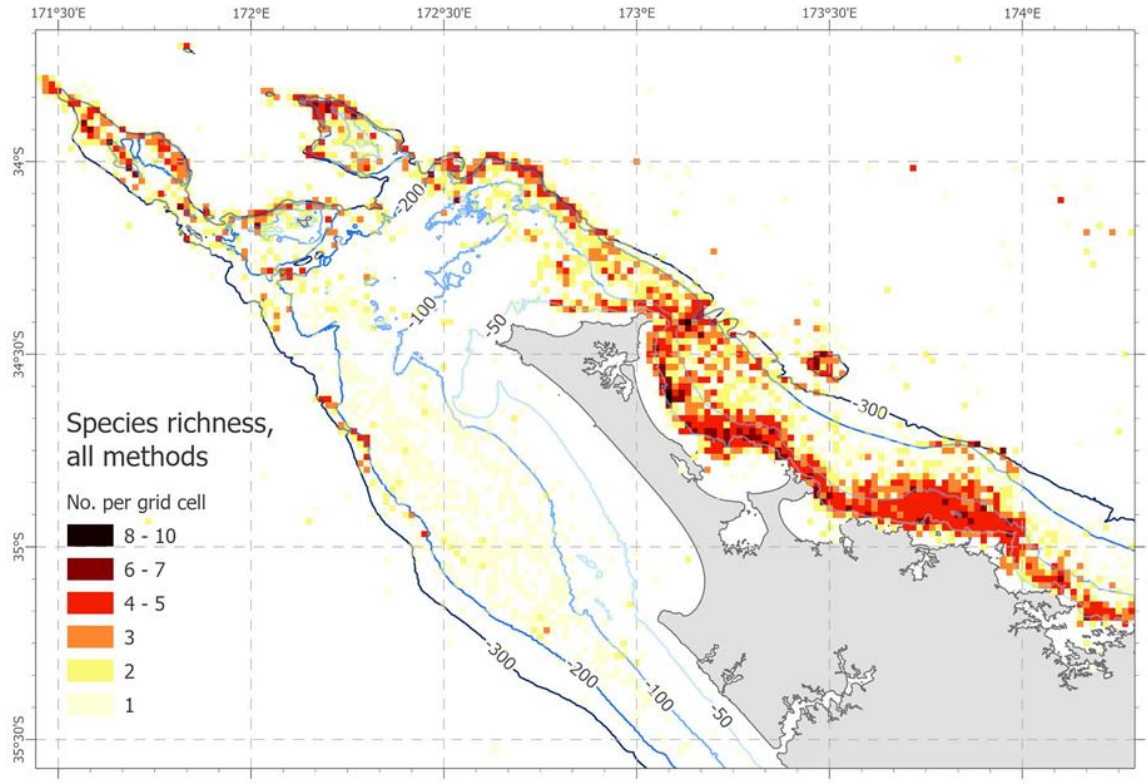

Figure B-2: Northland commercial catch of reef-indicator fish species: species richness.

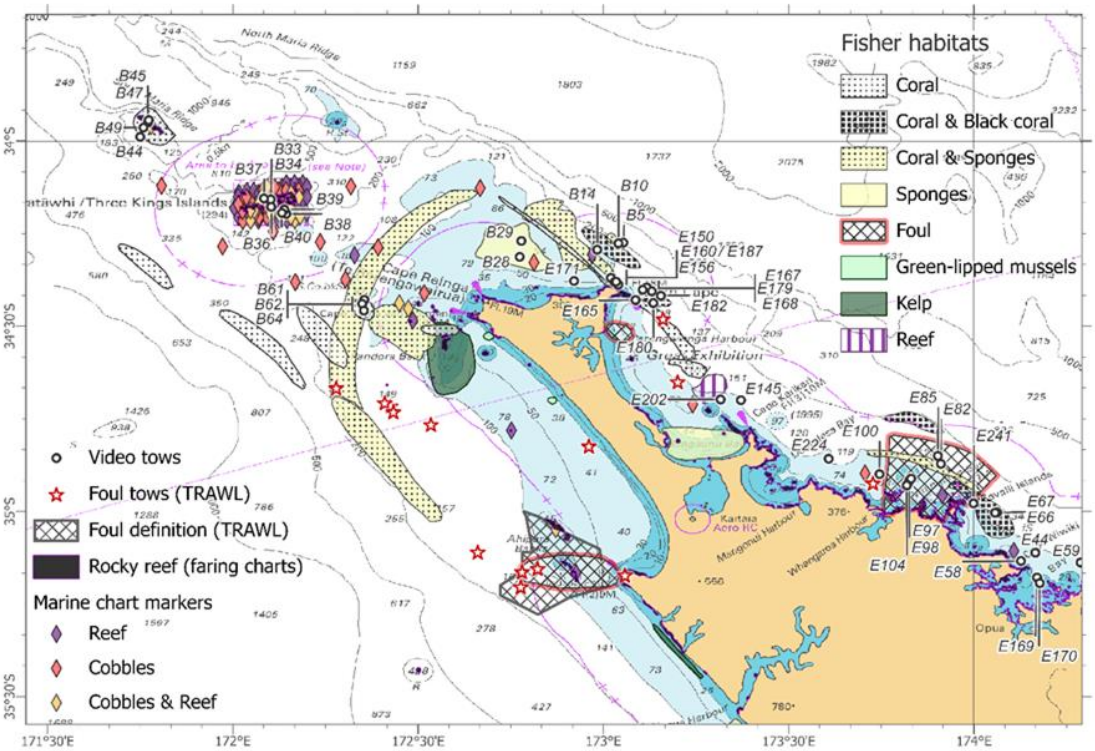

Figure B-3: Northland fisher habitats, underwater video tows, foul definition and rocky reef areas, and marine chart markers. Fisher habitats are shown by LEK polygons. Foul trawl tows and foul definition areas

are from research trawling. DOC putative rocky reef polygons (<100 m water depth) are shown by the purple coloured polygons.

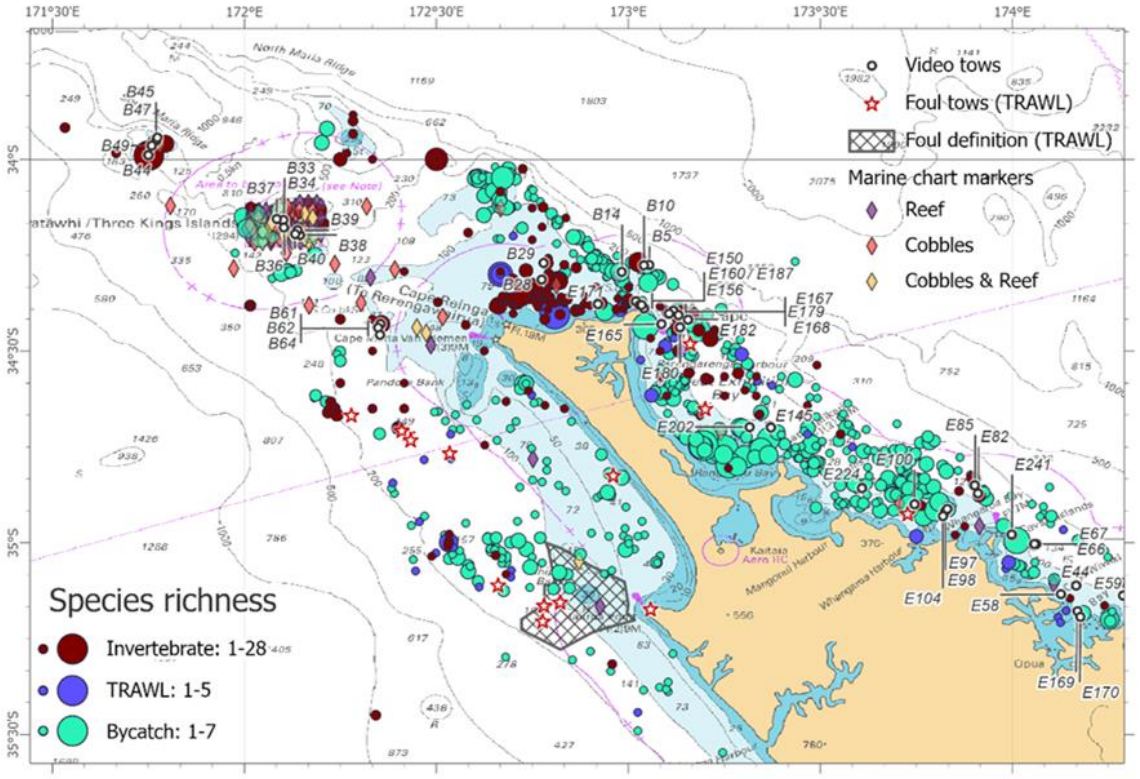

Figure B-4: Northland reef-indicator species richness for SPECIFY invertebrate, research TRAWL, and fisheries observer bycatch.

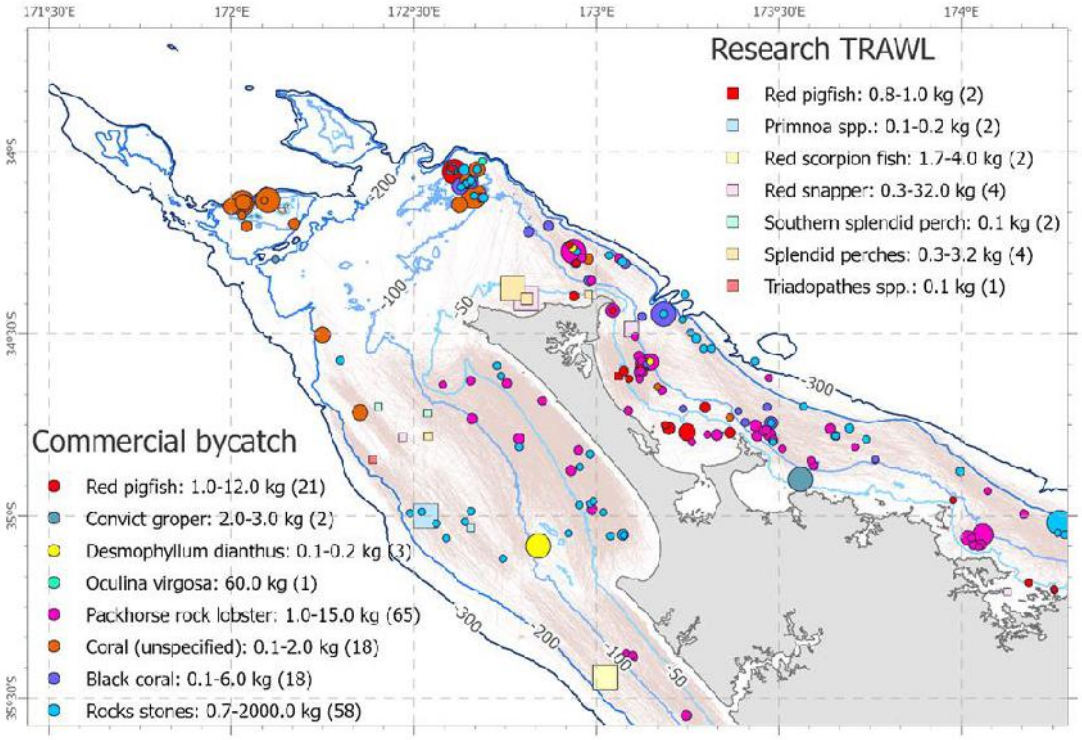

Figure B-5: Northland commercial fisheries observer catch and research TRAWL reef-indicator species catch (kg). The number of sites each species was present at are given in brackets.

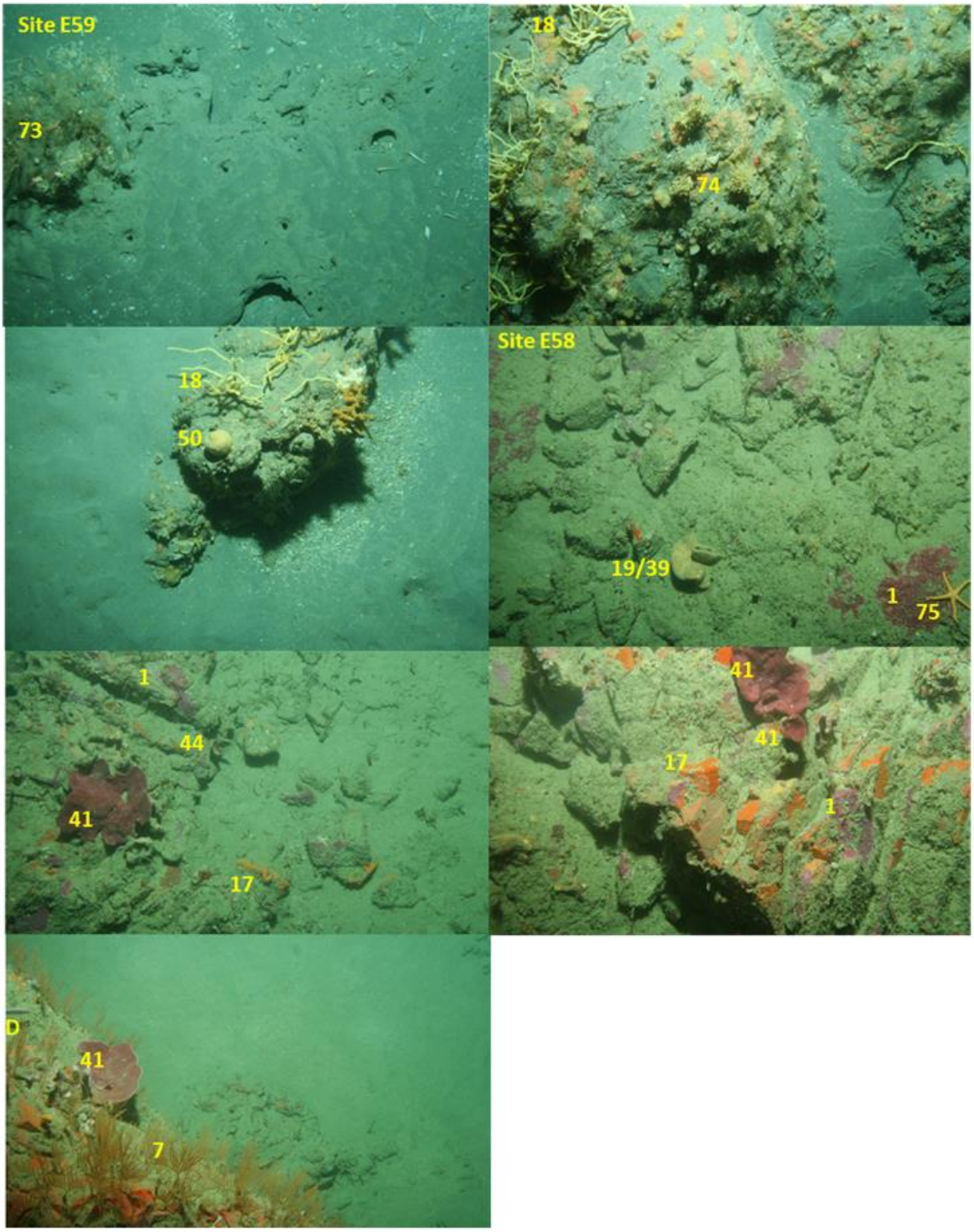

Figure B-6: NORTH, TAN0906, sites E59 (91–97 m), E58 (54–56 m). Image order runs left to right. Sponges, 17) Poecilosclerida (orange), 18) *Clathria scotti*, 19) *Pleroma menoui/turbinatum*, 39) *Herengeria vasiormis*, 41) *Haliclona (Gellius) regia*, 44) *Stryphnus ariena*, 50) *Tedania* (Order Poecilosclerida, family Tedaniidae) (or alternatively an ascidian 68), *Petrosia* cf *hebes*; Gorgonians, 7) *Perissogorgia vitrea*; Hydroids, 73) Aglaopheniidae; Bryozoans, 74) *Heteropora neozelanica*; Mobile invertebrates, starfish, 75) *Knightaster* sp.; Fish, D) roughy; Algae 1) Coralline algae.

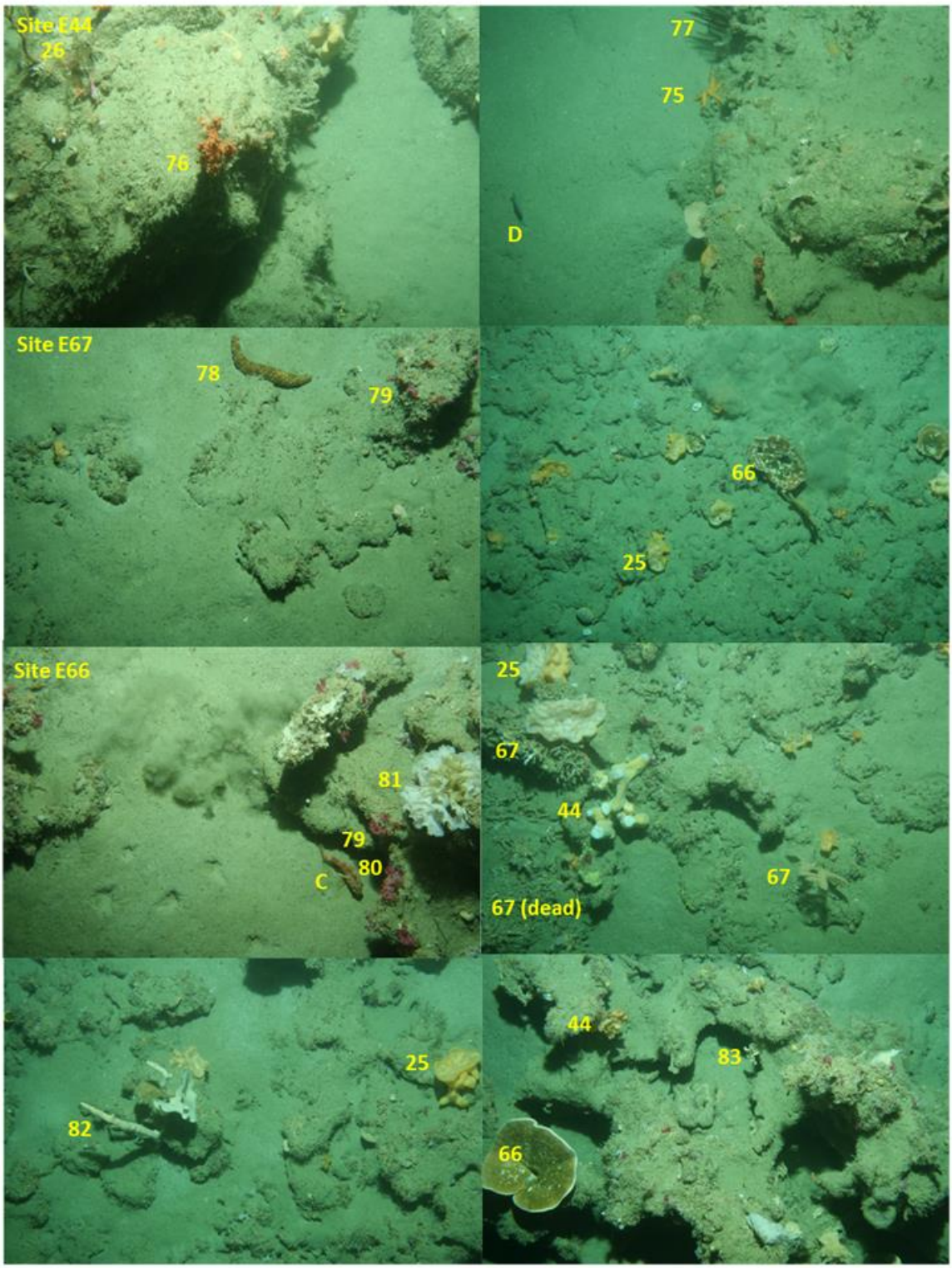

Figure B-7: NORTH, TAN0906, sites E44 (91–102 m), E67 (112–112 m), sites E66 (114–114 m). Image order runs left to right. Sponges 25) *Symplectella rowi*, 44) *Stryphnus ariena*, 66) *Haliclona (Gellius) petrocalyx*, 76) *Acanthella dendyi*; 82) *Antho (Antho) brondstedi*; Corals, 57) *Metafannyella moseleyi*, 67) *Oculina virgosa* (dead); Hydroids 26) *Aglaophenia* sp.; Crinoids, 77) Comatulidae; Bryozoans, 79) *Iodictyum yaldwyni*, 80) *Galeopsis* sp., 81) *Reteporella* sp. 2, 83) *Cheilostome*; Mobile invertebrates, Starfish 75) *Knightaster* sp.; Sea cucumbers 78) *Holothuria integra*. Fish, C) red scorpion fish, D) roughy.

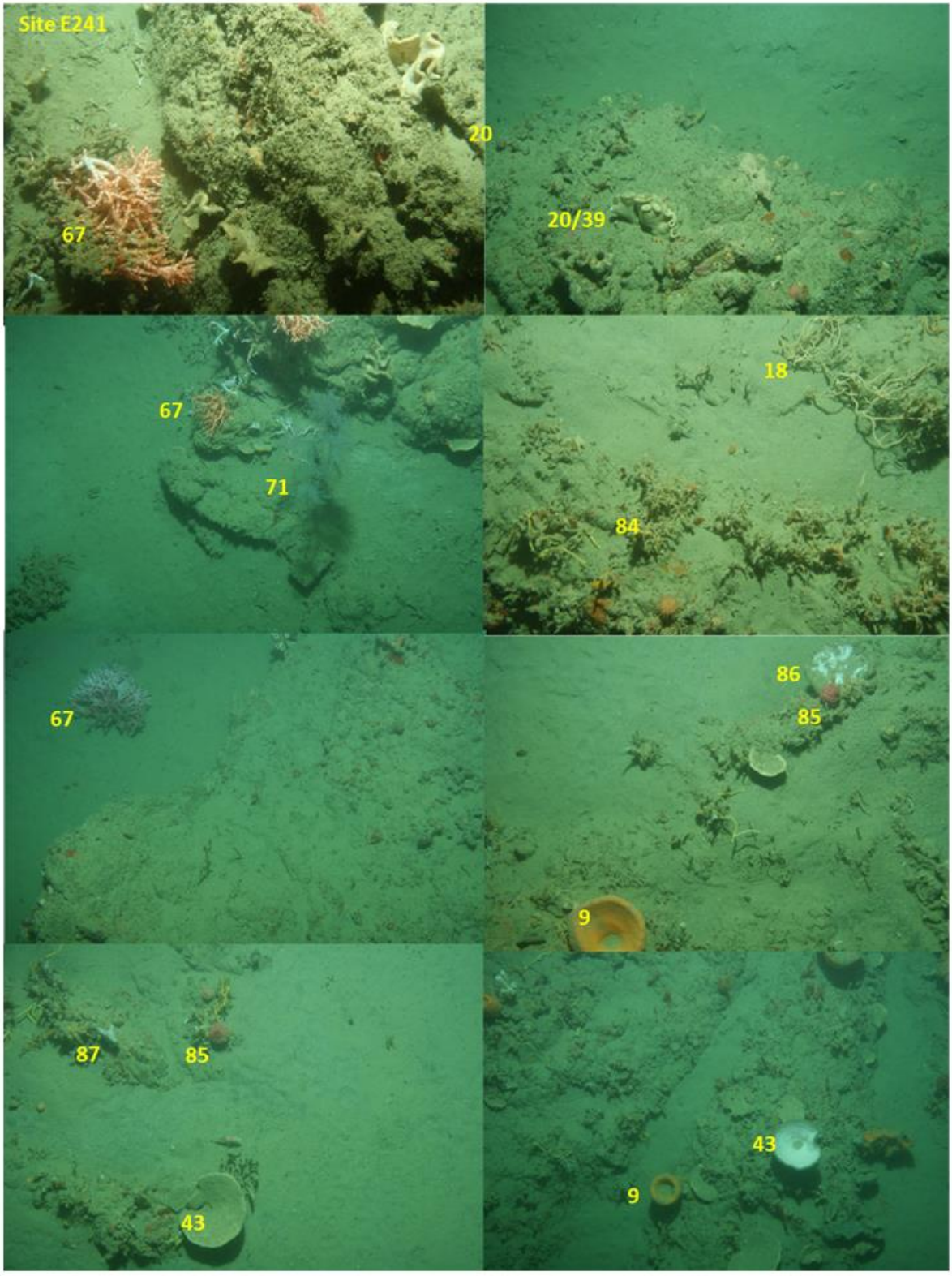

Figure B-8: NORTH, TAN0906, site E241 (89–93 m). Image order runs left to right. Sponges 9) *Stelletta crater*, 18) *Clathria scotti*, 20) *Aciculites pulchra*, 39) *Herengeria vasiormis*, 43) *Neoschrammeniella fulvodesmus*, 85) *Tethya fastigata*, 86*) Poecillastra laminaris*, 87) *Psammocina beresfordae*; Corals, 67) *Oculina virgosa*, 71) *Antipathella* sp.

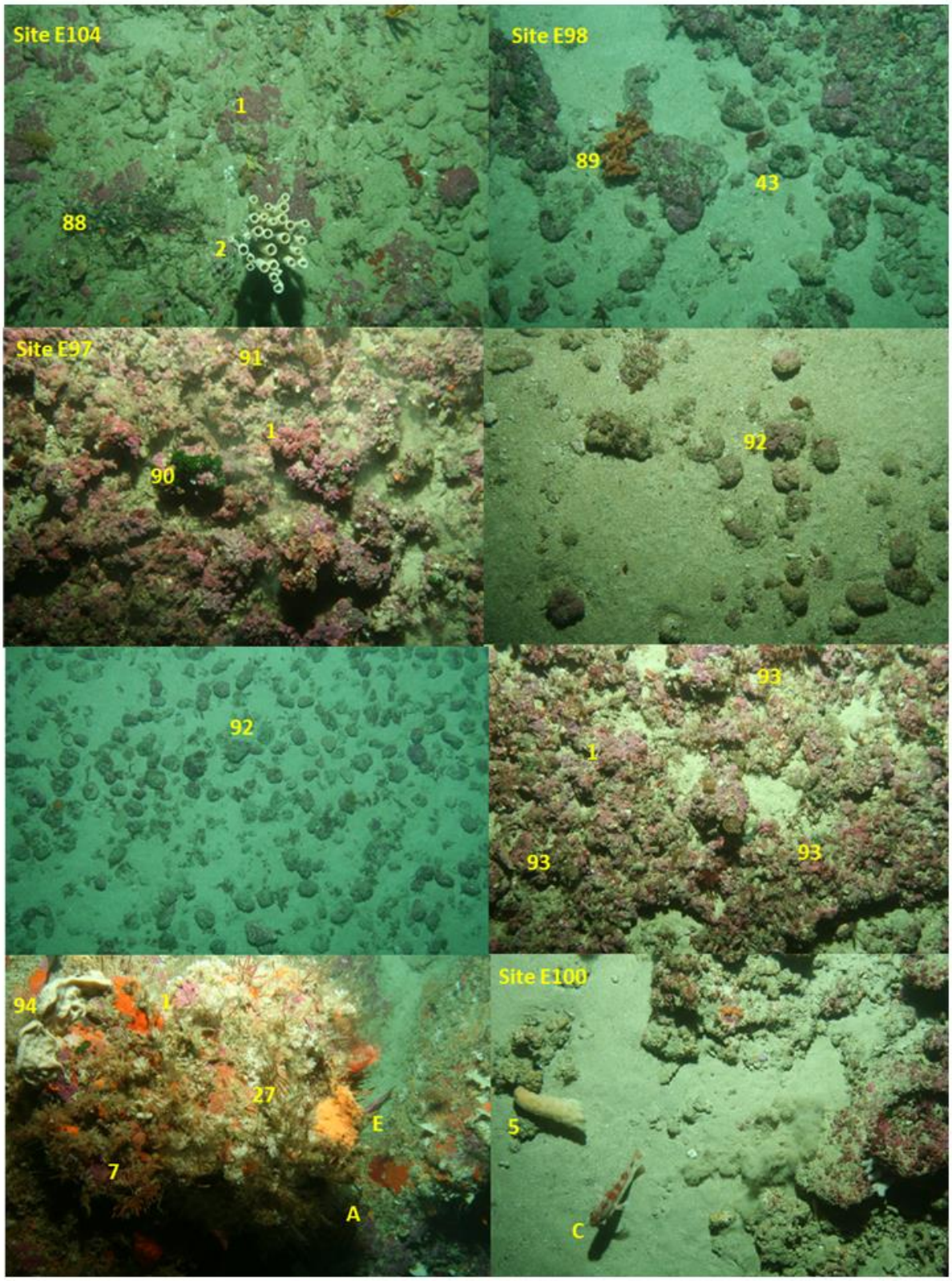

Figure B-9: NORTH, TAN0806, sites E104 (57–59 m), E98 (53–62 m), E97 (55–68 m), E100 (67–68 m). Image order runs left to right. Sponges 2) *Iophon laevistylus*, 5) *Isodictya cavicornuta*, 43) *Neoschrammeniella fulvodesmus*, 89) *Chondropsis kirkii*, 94) *Neopetrosia* n. sp.; Gorgonian 7) *Perissogorgia vitrea*; Hydroids 27) *Lytocarpia* sp.; Algae 1) Coralline algae, 88) drift brown algae, 90) *Palmophyllum umbracola*, 91) Distromium, 92) rhodoliths, 93) Small red and green algae species; Fish A) butterfly perch, E) pink maomao.

Figure B-10: NORTH, TAN0906, site E82 (114–119 m). Image order runs left to right. Sponges 45) *Calyx imperialis*; Gorgonians 95) Family Ellisellidae (or an undescribed genus in a sister family); Bryozoans 97) bryozoan, 98) Reteporella, Phidoloporidae; Unknown 96) Tube-like small forms.

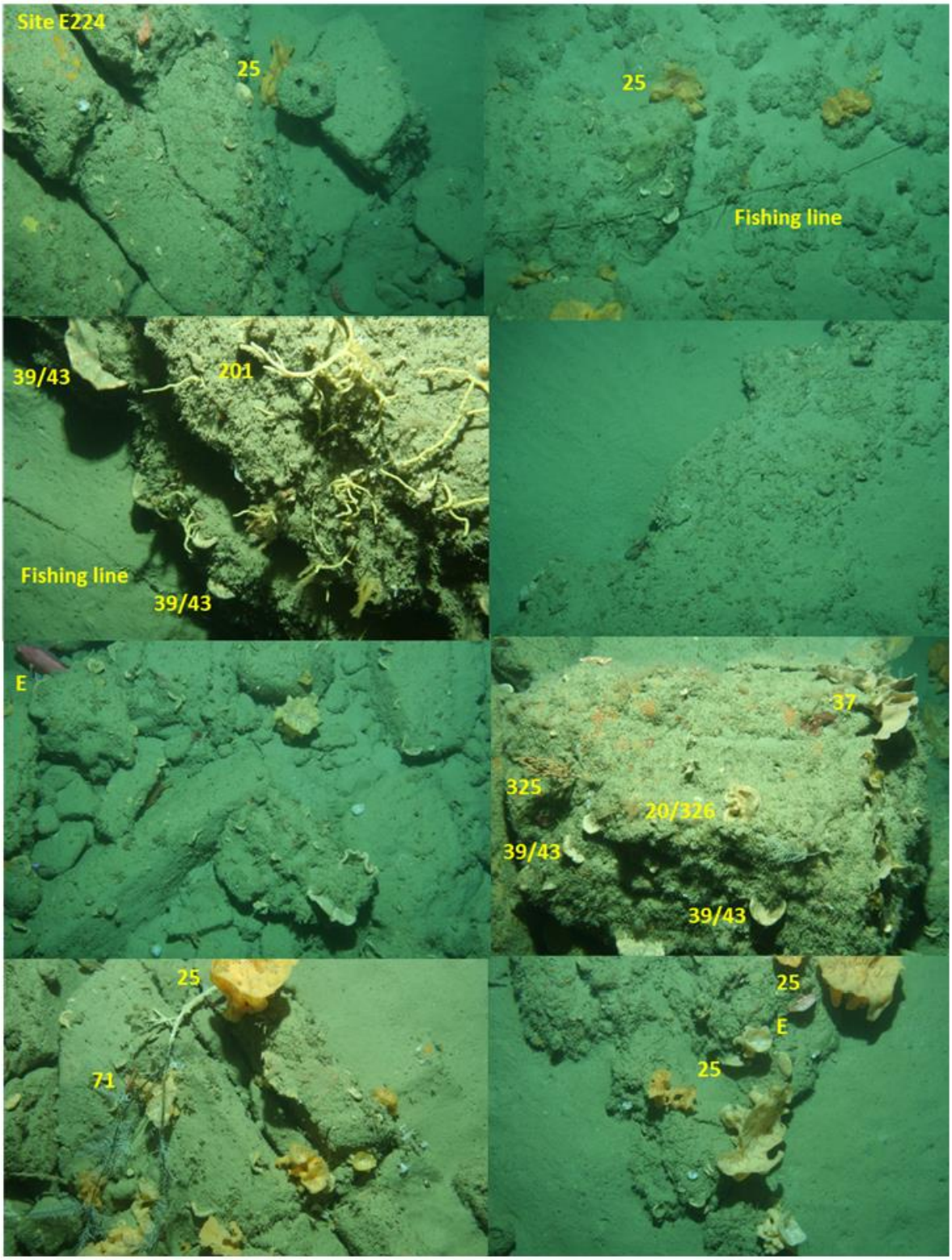

Figure B-11: NORTH, TAN0906, site E224 (106–107 m). Image order runs left to right. Sponges 20/326) *Aciculites pulchra*/*Awhiowhio unda*, 25) *Symplectella rowi*; 37) *Reidispongia coerulea*, 39/43) *Herengeria vasiformis* / *Neoschrammeniella fulvodesmus*, 201) *Haliclona* sp. ?, 325) *Raspailia* sp. indet. Fish, E) pink maomao.

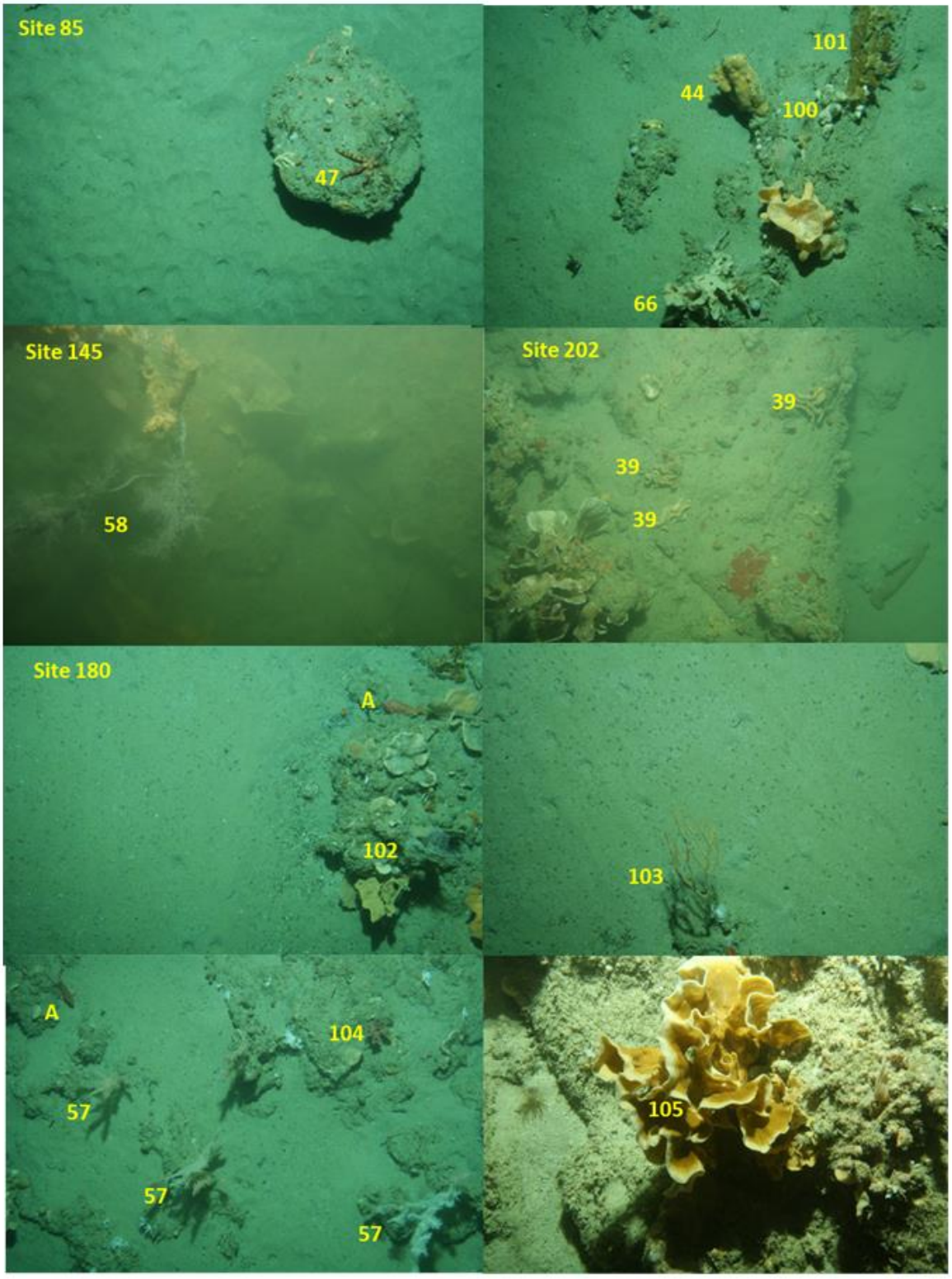

Figure B-12: NORTH, TAN0906, Sites E85 (129–130 m), E145 (104–107 m), E202 (79–87 m), E180 (120–124 m). .

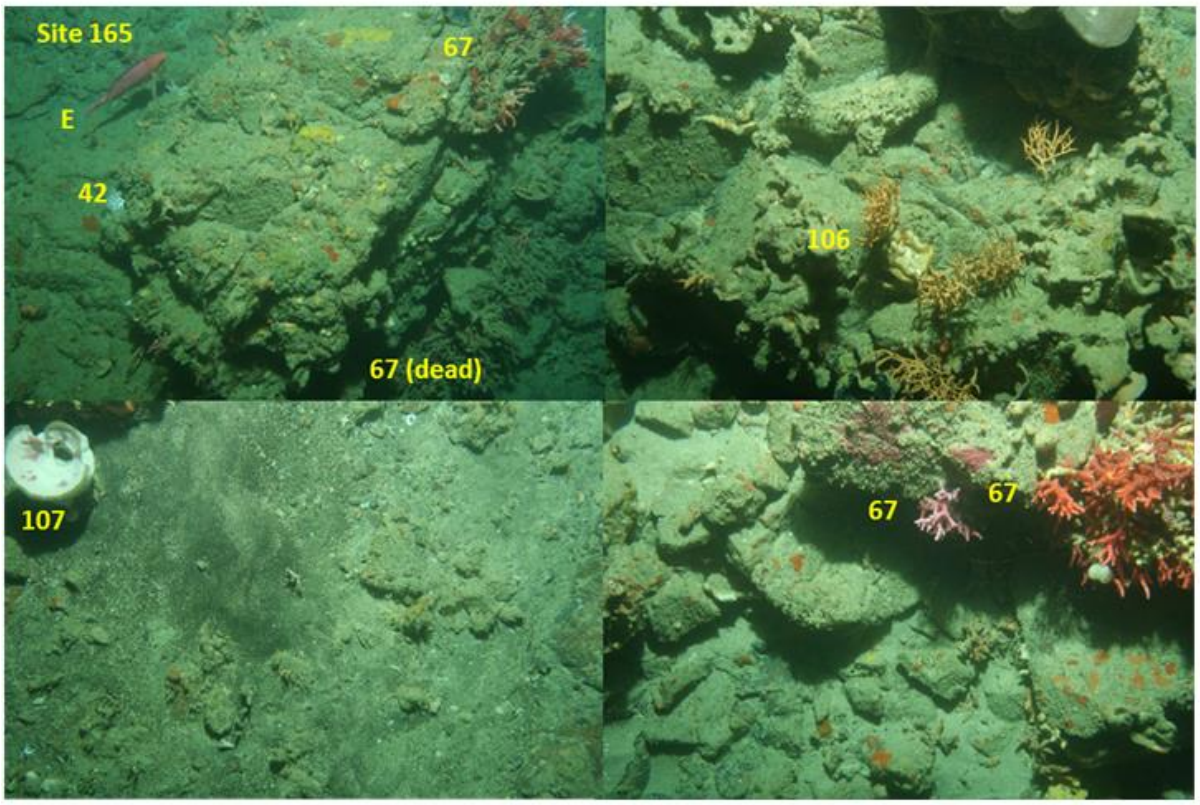

Figure B-13: NORTH, TAN0906, Site E165 (69–78 m). .

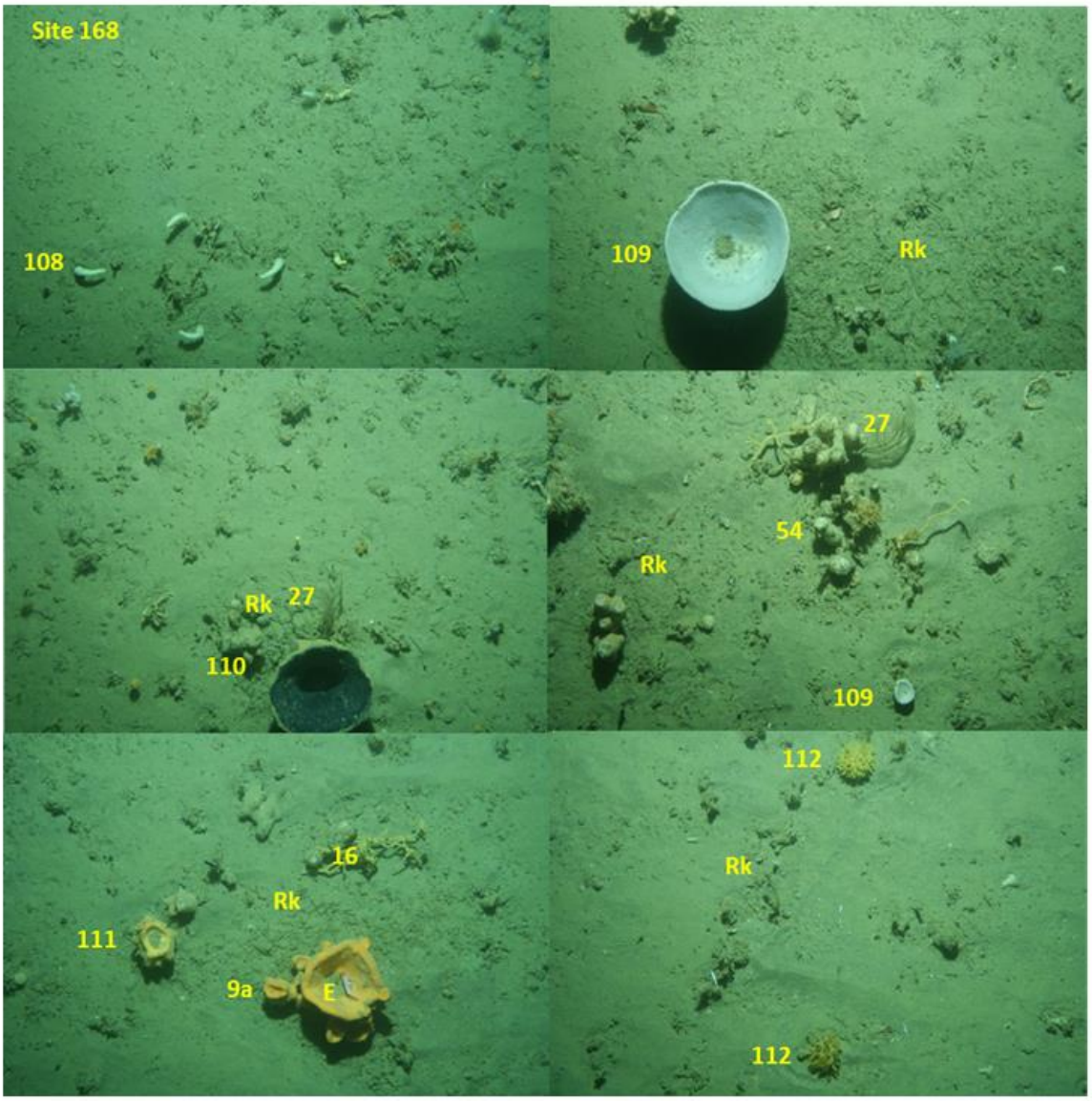

Figure B-14: NORTH, TAN0906, Site E168 (124–153 m). .

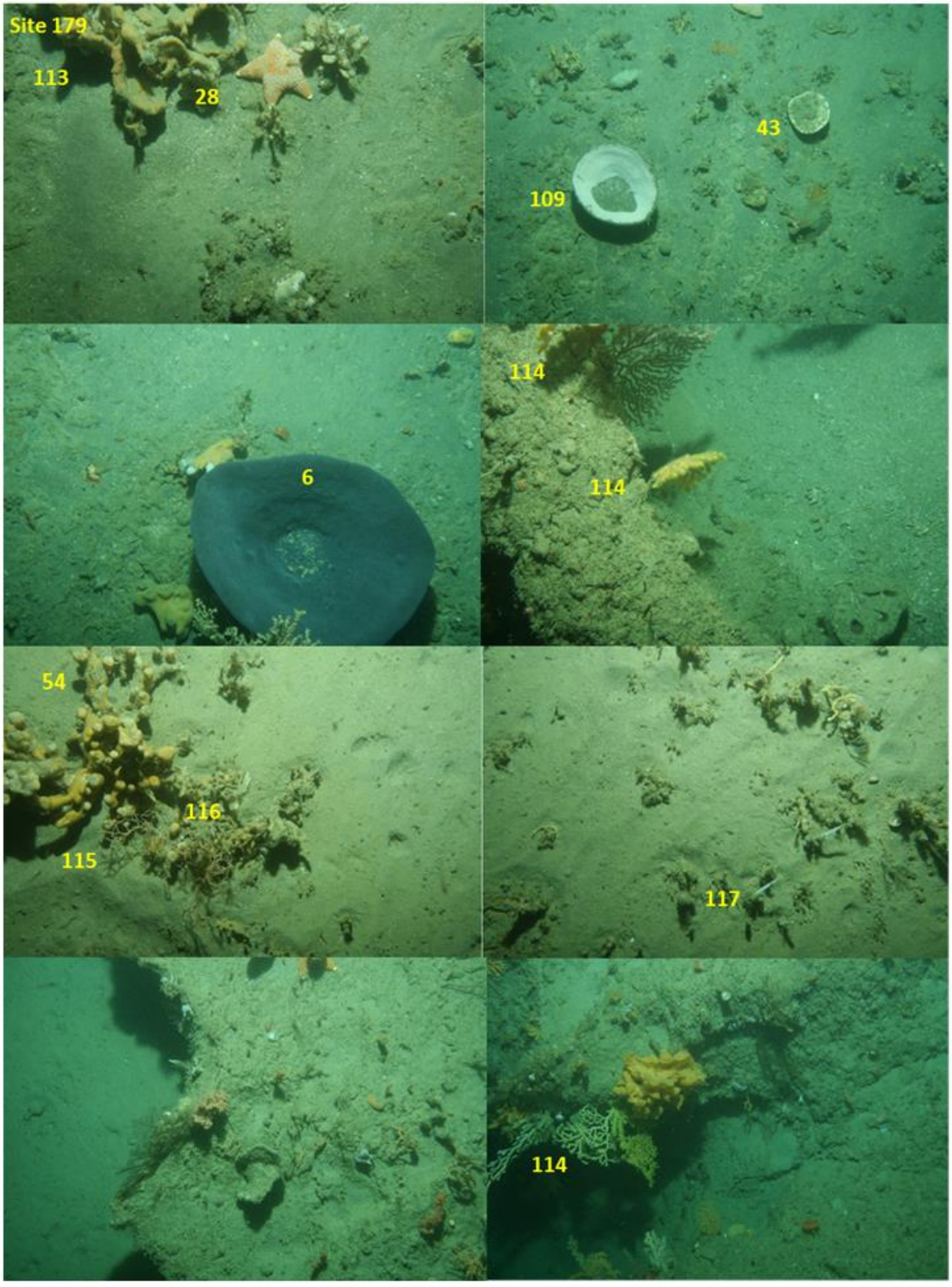

Figure B-15: North, TAN0906, Site E179 (118–119 m). .

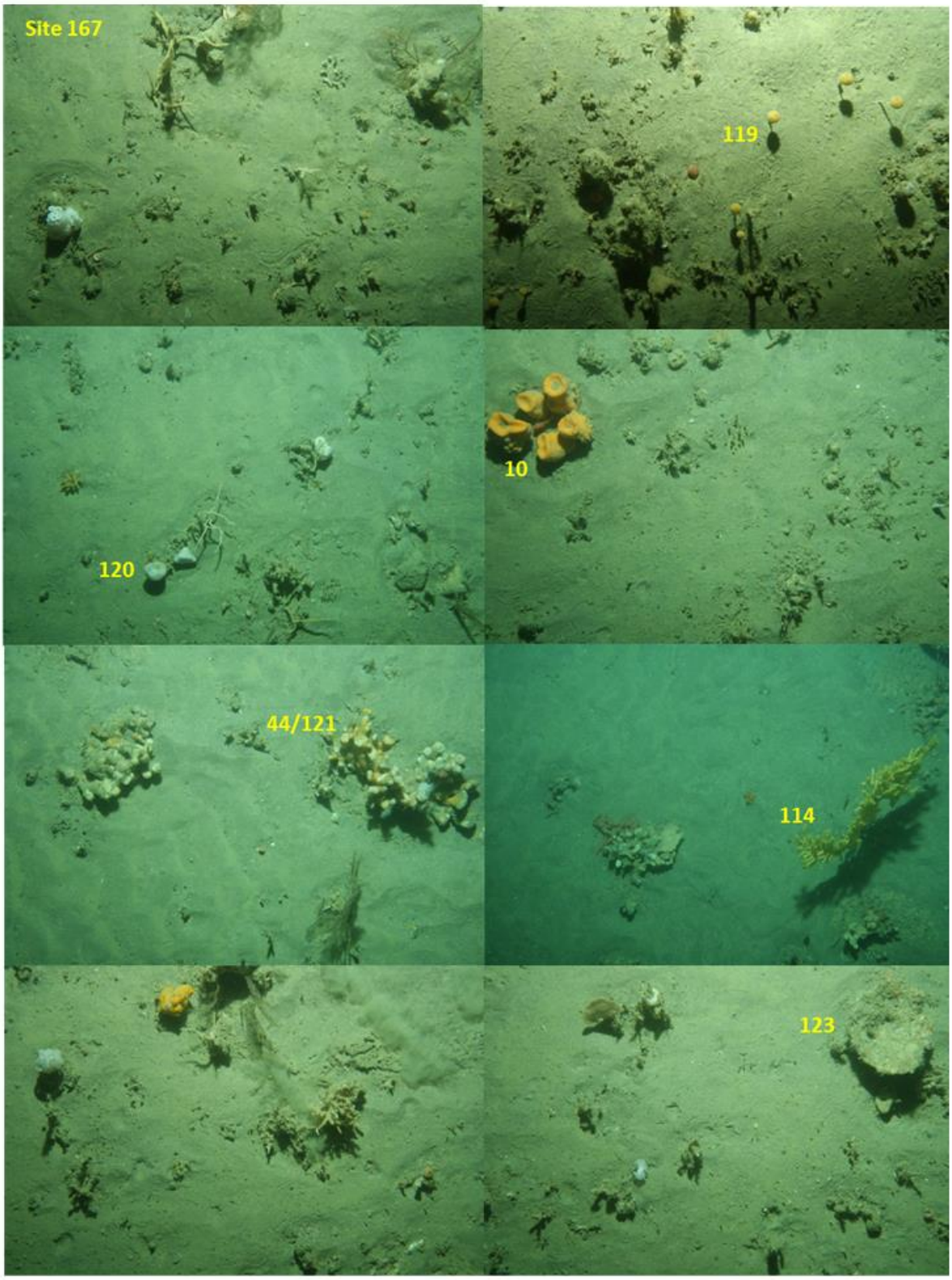

Figure B-16: NORTH, TAN0906, Site E167 (124–135 m). .

Figure B-17: NORTH, TAN0906, site E156 (45–62 m). Sponges 5) *Isodictya cavicornuta*, 6) *Ecionemia alata*, , 11) *Iophon minor*, 107) *Stelletta maori*, 124) *Callyspongia latituba*.

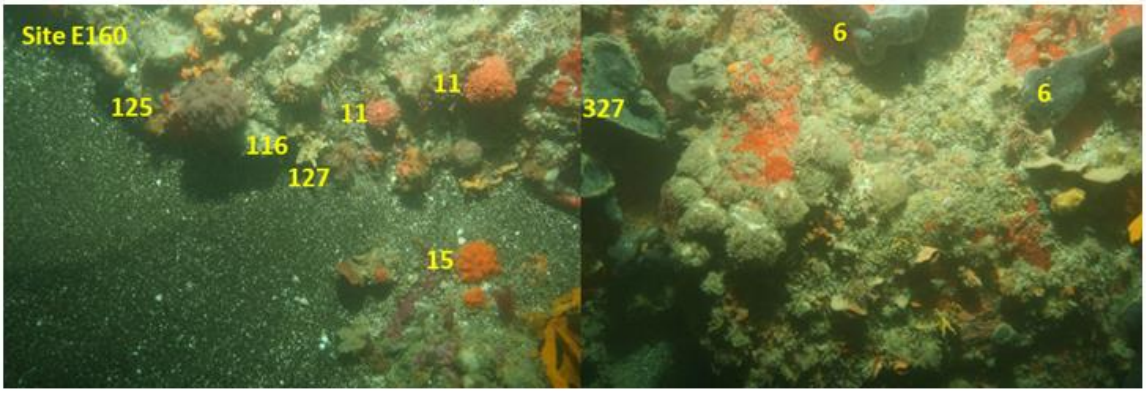

Figure B-18: NORTH, TAN0906, site E160 (42–81 m). Sponges 6) *Ecionemia alata*, 15) *Clathria macrotoxa* (?), 85) *Tethya fastigata*, 116) *Haliconia* sp. (Haplosclerida, family Chalinidae), 327) *Stelletta conulosa* (?); Bryozoans 125) *Cornucopina* sp. (Bugulidae), 126) *Steginoporella neozelanica*, 127) *Margaretta barbata*.

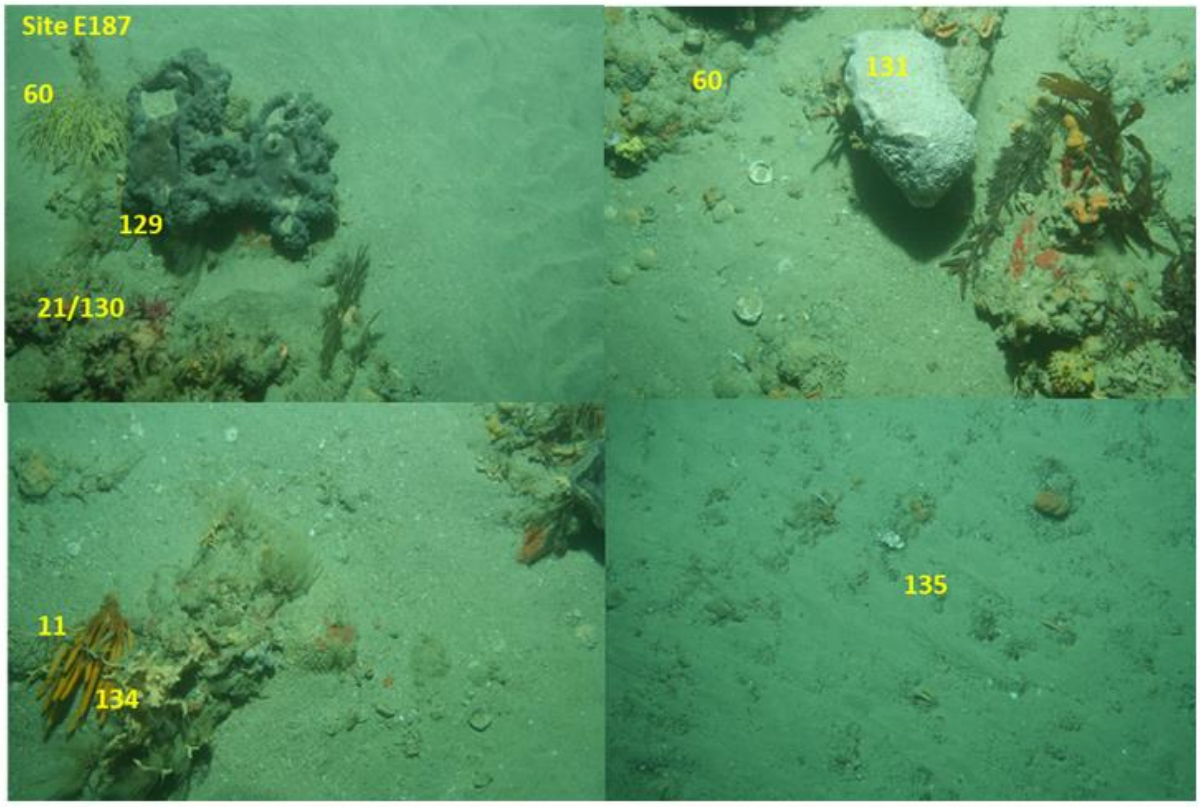

Figure B-19: NORTH, TAN0906, site E187 (65–76 m). Sponges 11) *Iophon minor*, 21) *Dendrilla rosea*, 128) *Tethya fastigata*, 130) *Darwinella* cf *gardineri*, 131) *Psammocinia* sp. indet., 134) *Crella incrustans*; Corals 114) Plexauridae, Hydroids 129) *Cryptolaria* sp. (Zygophylacidae), 135) *Lytocarpia spiralis* (long wispy); Algae 132) *Carpophyllum maschalocarpum* (drift), 133) *Marginariella* (?) (drift).

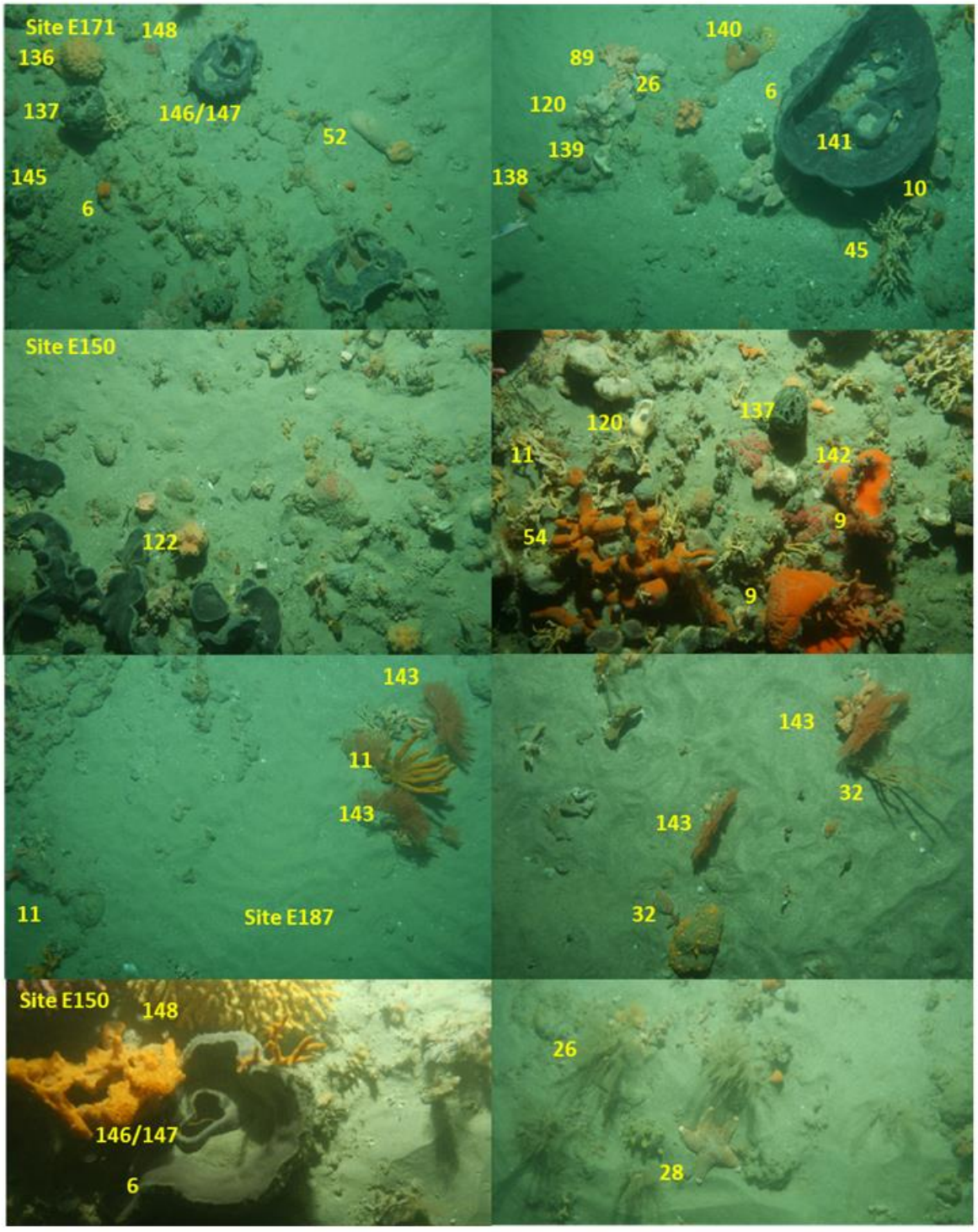

Figure B-20: NORTH, TAN0906, sites E171 (57–76 m) and E150 (89–90 m). Sponges 6) *Ecionemia alata*, 9) *Stelletta crater* with *Desmacella dendyi* encrusting the surface (orange), 10) *Stelletta columna*, 11) *Iophon minor*, 32) *Callyspongia ramosa*, 45) *Calyx imperialis*, 52) *Stryphnus* sp., 54) *Stryphnus levis*, 136) *Hymeniacidon* sp., 89) *Chondropsis kirkii*, 120) Tetractinellidae, family Ancorinidae, 122) *Mycale novaezelandiae* (or ascidian), 137*) Latrunculia* (*Biannulata*) *kaakaariki*, 138) *Polymastia* sp., 139) *Tetilla australis*, 140) *Polymastia* cf *crocea*, 141) *Geodia rex*, 144) *Polymastia aurantia*, 145) *Myxilla novaezelandiae*, 146) *Pararhaphoxya sinclairii*, 147) *Raspailia topsenti*, 148) Melithaeidae(?); Zoanthids; Gorgonian 143) Primnoidae sp. 1, Coral 142) Zoanthid growing on sponge; Hydroids 26) *Aglaophenia* sp.; Mobile invertebrates, Starfish 28) *Asterodiscides truncatus*.

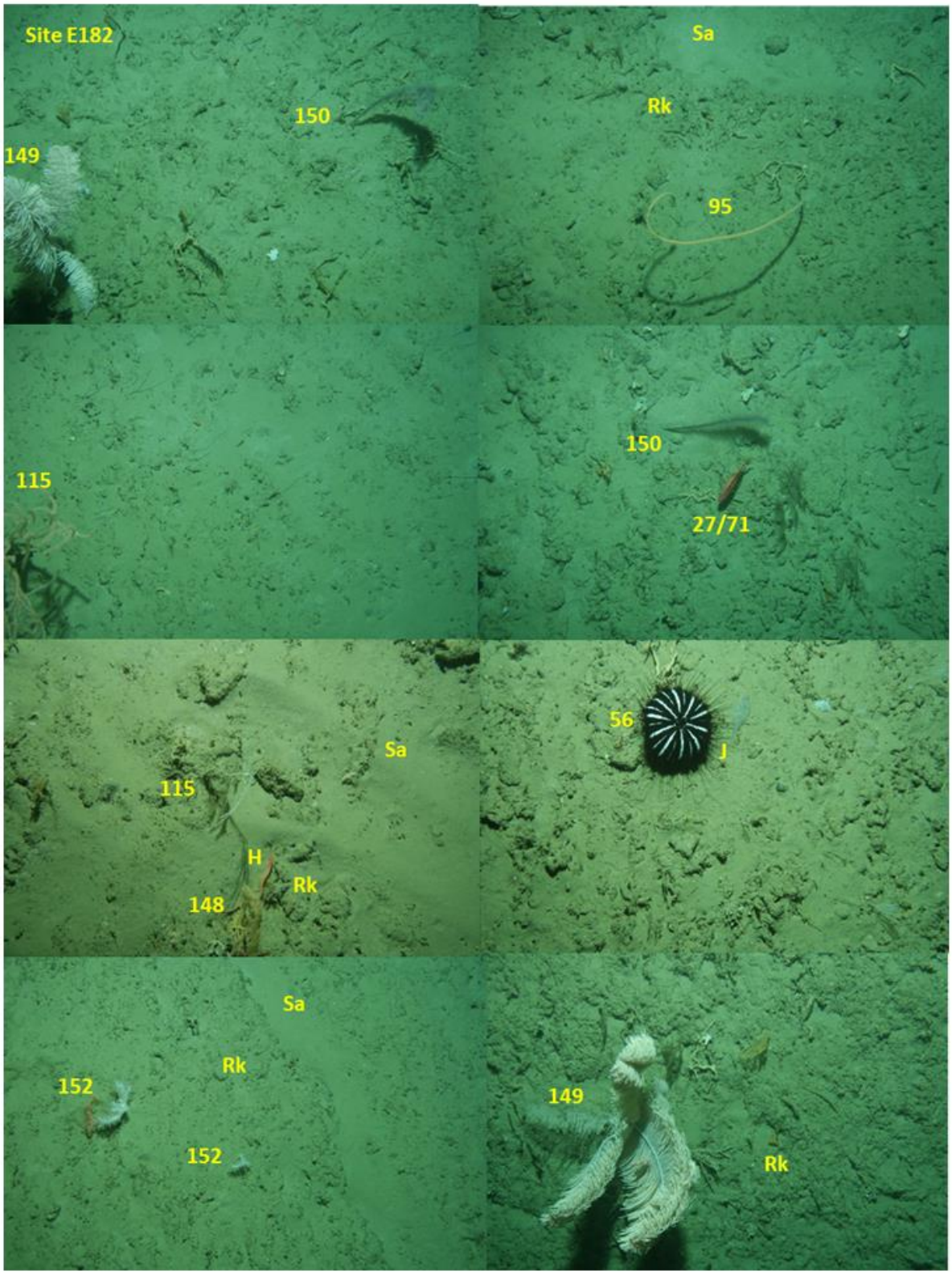

Figure B-21: NORTH, TAN0906, site E182 (161 m). Sponges 151) Demosponge - carnivorous sponge (?); Corals 71) *Antipathella* sp., 115) Isididae (bamboo coral), 149) *Lillipathes lilliei*, 150) *Stylopathes tenuispina*, Gorgonians, 95) Family Ellisellidae (or an undescribed genus in a sister family); Soft corals 152) *Eleutherobia* cf. *splendens*; Hydroids 27) *Lytocarpia* sp; Mobile invertebrates, Urchin 56) *Araeosoma thetidis*. 114) Plexauridae; Fish, H) Red bandfish. Substrate, Rk, Rock; Sa, Sand.

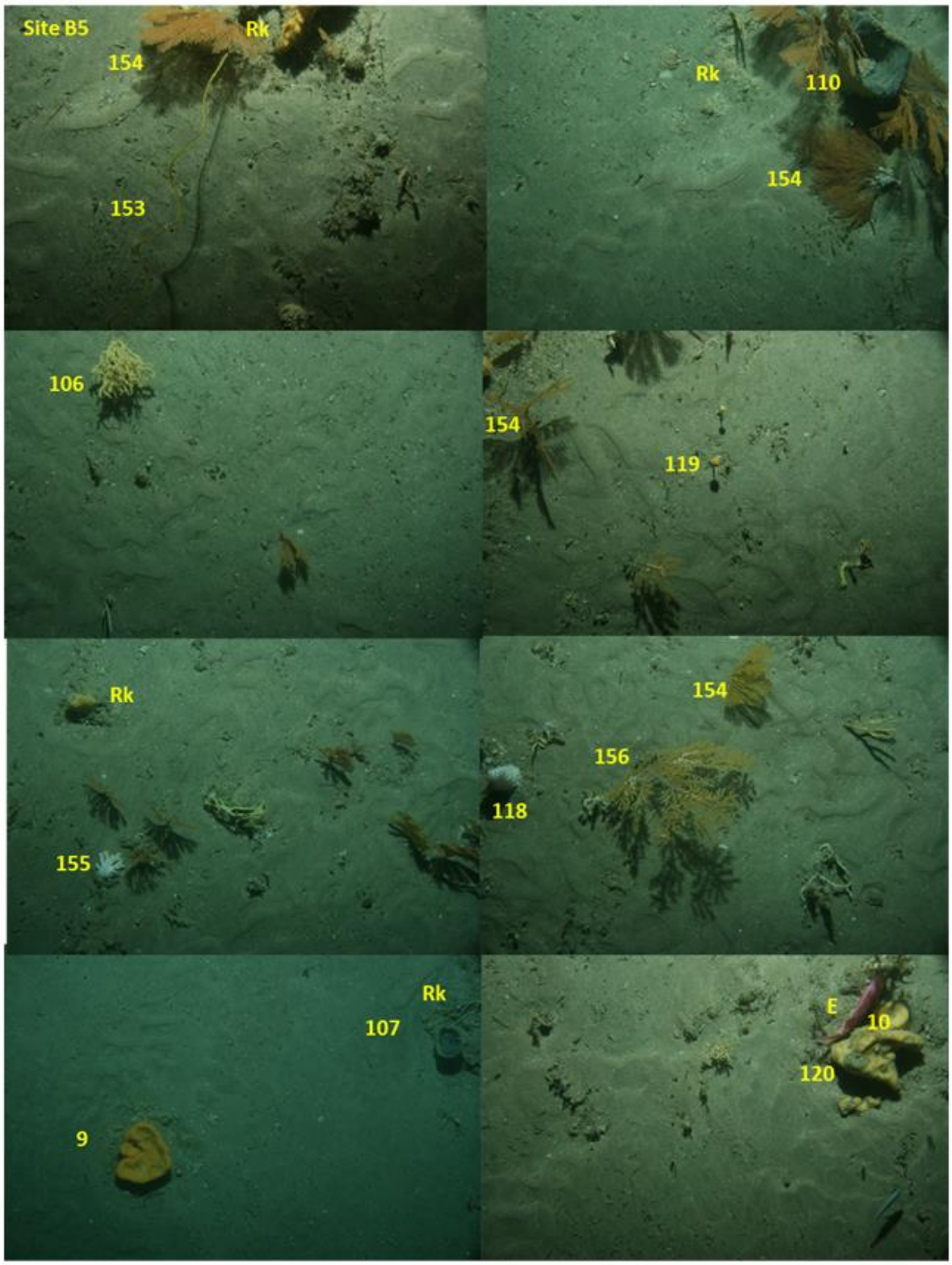

Figure B-22: NORTH, TAN1105, Site B5 (136 m depth). Sponges 9) *Stelletta crater*, 10) *Stelletta columna*, 106) *Clathria terraenovae*, 107) *Stelletta maori*, 110) *Geodia regina*, 118) Hexatinellid glass sponge sp. 1, 119) *Podospongia virga*, 120) Tetractinellidae, family Ancorinidae; Corals 114) Plexauridae, 153) *Stichopathes* sp., Gorgonians, 154) *Perissogorgia* sp.; Soft corals 155) *Alcyonium* sp.; Ophiuroids 156) *Astroceras elegans*. Fish, E) pink maomao. Rk, rock.

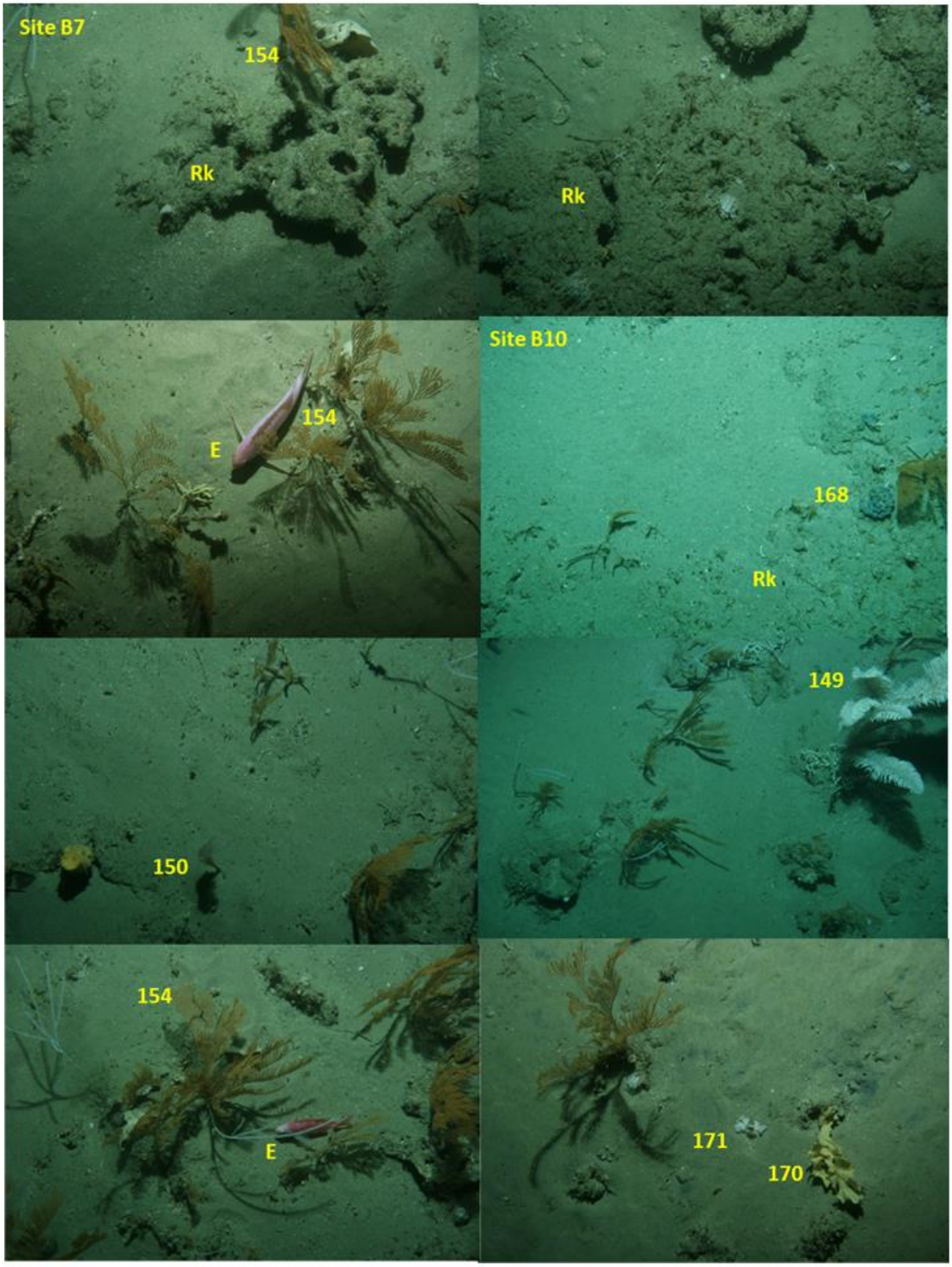

Figure B-23: NORTH, TAN1105, Sites B7 (165 m) and B10 (136 m). Sponges 168) *Biemna rufescens*, 170) Order Haplosclerida, family Phloeodictyidae? (ragged fan); Corals 149) *Lillipathes lilliei*, 150) *Stylopathes tenuispina*, 154) *Perissogorgia* sp.; 169) *Narella* sp.; 171) Bryozoans, *Reteporella* sp 1. Fish, E) pink maomao. 171).

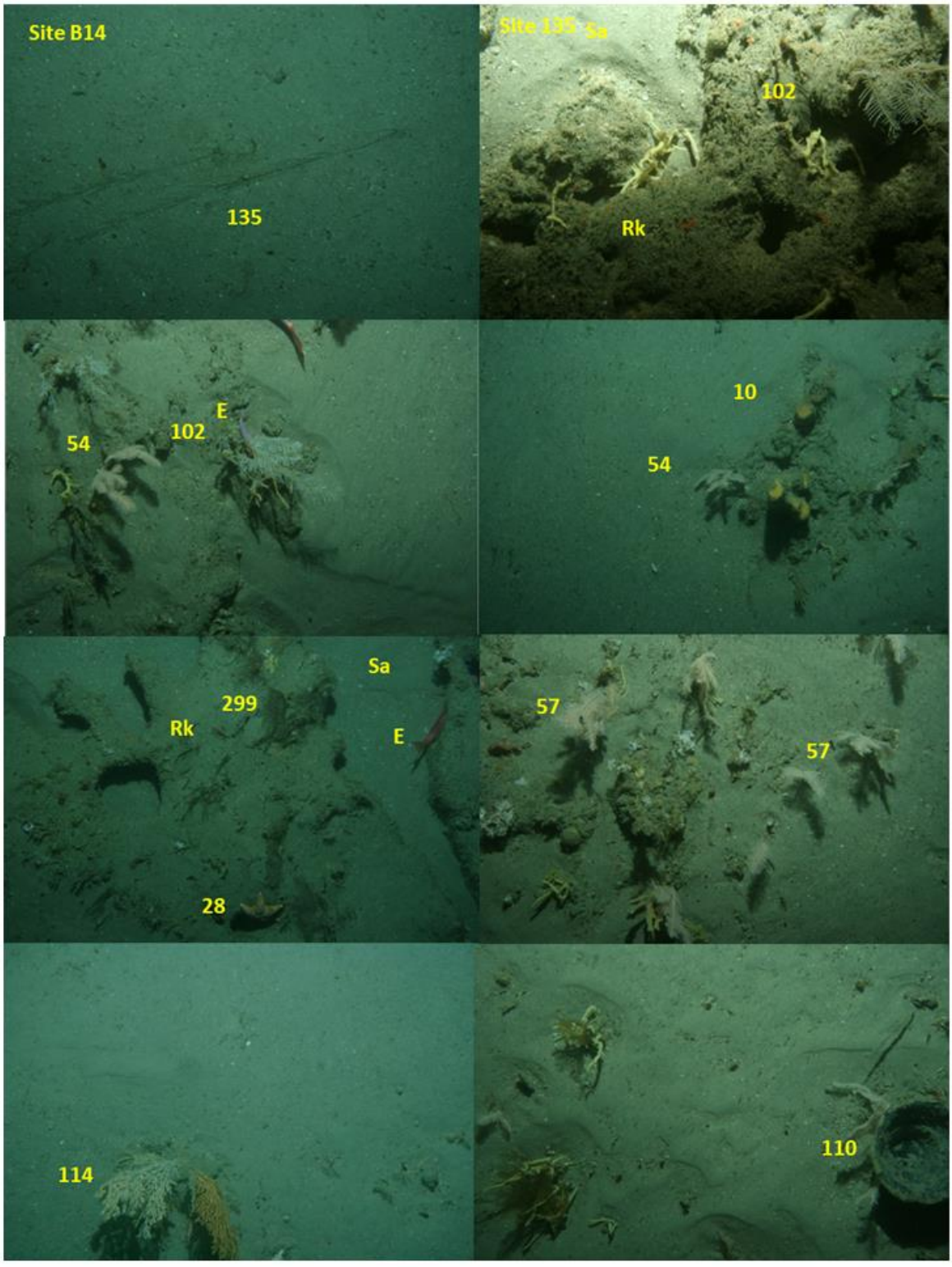

Figure B-24: NORTH, TAN1105, Sites B14 (120 m). Sponges 10) *Stelletta columna*, 110) *Geodia regina*; Corals, 57) *Metafannyella moseleyi*, ; Hydroids, 102) *Cryptolaria prima*, 135) *Lytocarpia spiralis*, 299*) Nemertesia pinnatifida* (?); Bryozoans 171) *Reteporella* sp. 1. Mobile invertebrates, starfish 28*) Asterodiscides truncatus*. Fish, E) pink maomao. Rk, rock; Sa, sand.

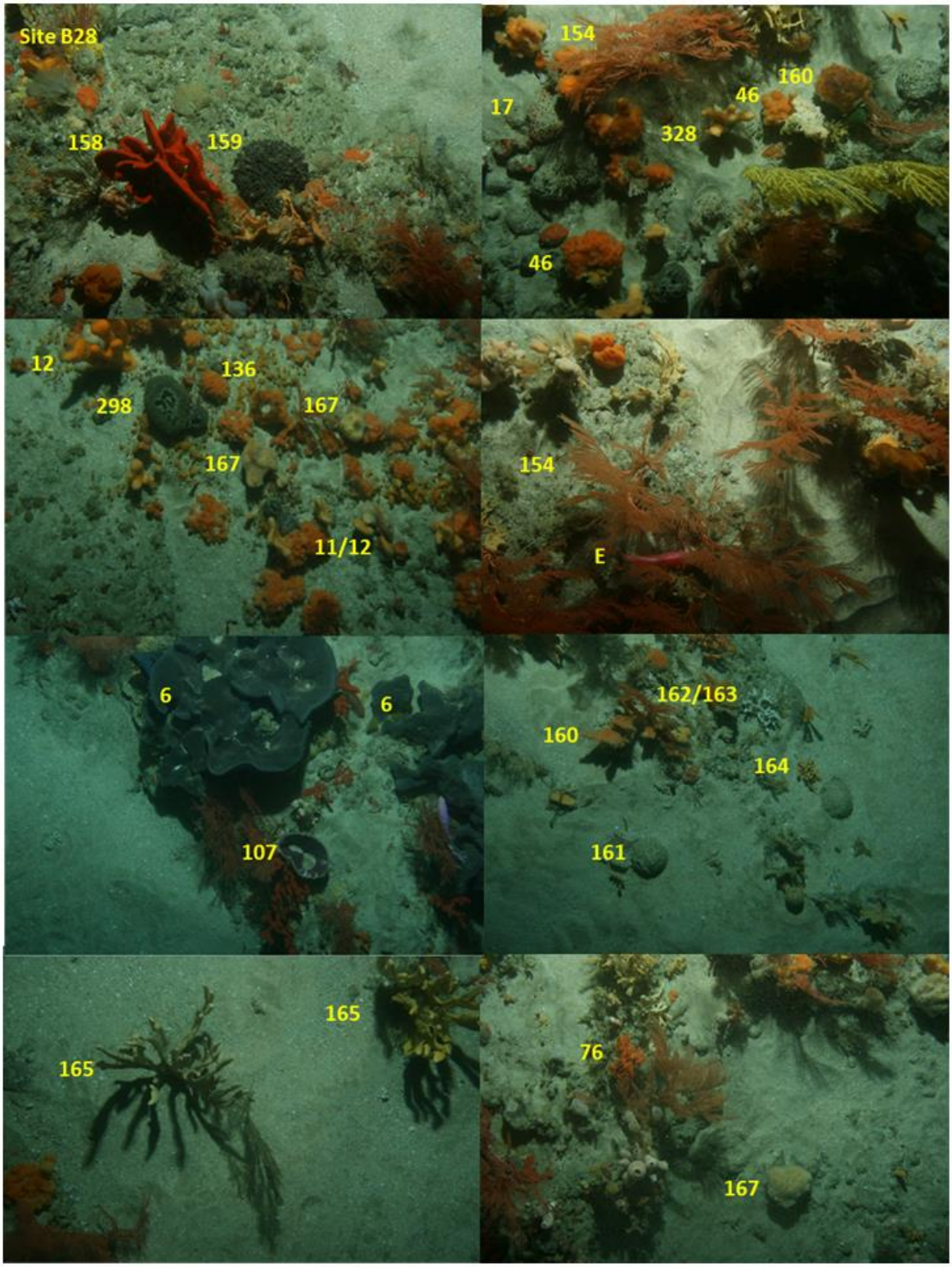

Figure B-25: NORTH, TAN1105, Sites B28 (66 m depth). Sponges 6) *Ecionemia alata*, 11) *Iophon minor*, 12) *Myxilla columna*, 17) Poecilosclerida (orange), 46) *Tedania diversirhaphidiophora* (?), 76) *Acanthella dendyi*, 107) *Stelletta maori*, 136) *Hymeniacidon* sp (?) (siphon clusters), 146) *Pararhaphoxya sinclairii*, 158) *Clathria* (*Thalysias*) *coriocrassus*, (first time seen since described) 159) *Polymastia massalis*, 160) *Myxilla* (*Ectyomyxilla*) *ramosa*, 161) *Cinachyrella* sp., 164) *Axinella* sp., 165) *Dactylia varia*, 167) *Hymedesmia* (*Stylopus*) *australis*; 298) *Latrunculia kaakaariki*, 328) *Desmacella mammilatum* (?); Corals 114) Plexauridae, 154) *Perissogorgia* sp.; Hydroids 157) Plumularioidea (Superfamily); Fish, E) pink maomao.

Figure B-26: Rock fragment of carbonate reef, retrieved by rock dredge from a carbonate reef site off East Northland. (Image; Stuart Mackay, NIWA).

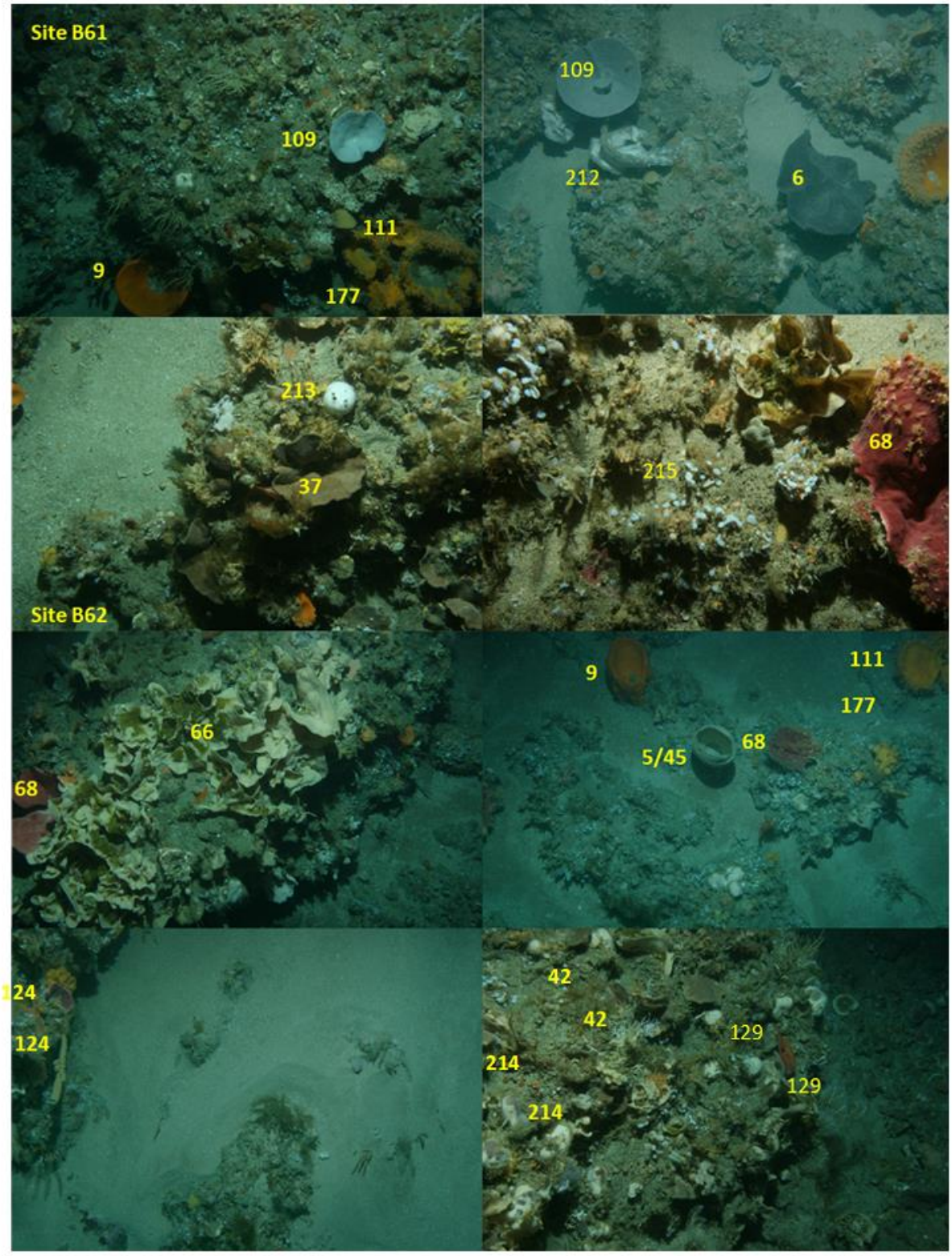

Figure B-27: Northland, TAN1105, Cape Reinga, sites B61 (88 m) and B62 (98 m). High relief rocky reef sponge habitat. Sponges 5) *Isodictya cavicornuta*, 6) *Ecionemia alata*, 9) *Stelletta crater*, 37) *Reidispongia coerulea*, 45) *Calyx* sp. indet., 66) *Haliclona* (*Gellius*) *petrocalyx*, 68) *Petrosia* cf *hebes*, 109) *Psammocina hawere*, 111) *Ancorina stalagmoides* (not seen since described), 124) *Callyspongia latituba*, 212) *Poecillastra laminaris*, 213) *Geodia margarita*, 214) *Ancorina diplococcus*; Corals, 42) Stylasteridae; Hydroids, 129) *Cryptolaria prima* (?); Ascidian, 215) Didemnid ascidian; Zoonanthid, 177) Epizoanthus sp.

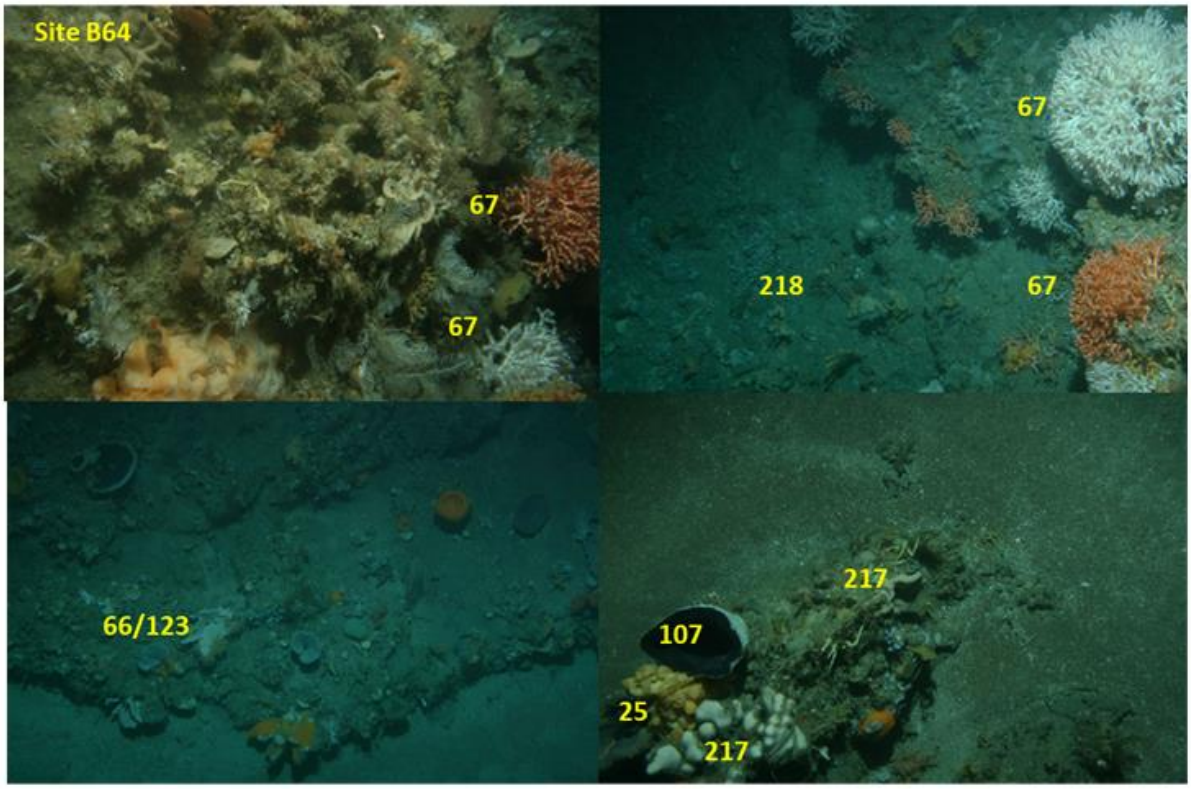

Figure B-28: Northland, TAN1105, Cape Reinga, site B64 (100–120 m). High relief rocky reef sponge habitat. Sponges, 25) *Symplectella rowi*, 66) *Haliclona* (*Gellius*) *petrocalyx*, 107) *Stelletta maori*, 123) *Pleroma turbinatum*, 216) *Erylus niger* (or other Geodiidae), 217) *Neopetrosia* n. sp. 2 (tan oscules); Coral, 67) *Oculina virgosa*. Mobile invertebrates, 218) red rock lobster *Jasus edwardsii*.

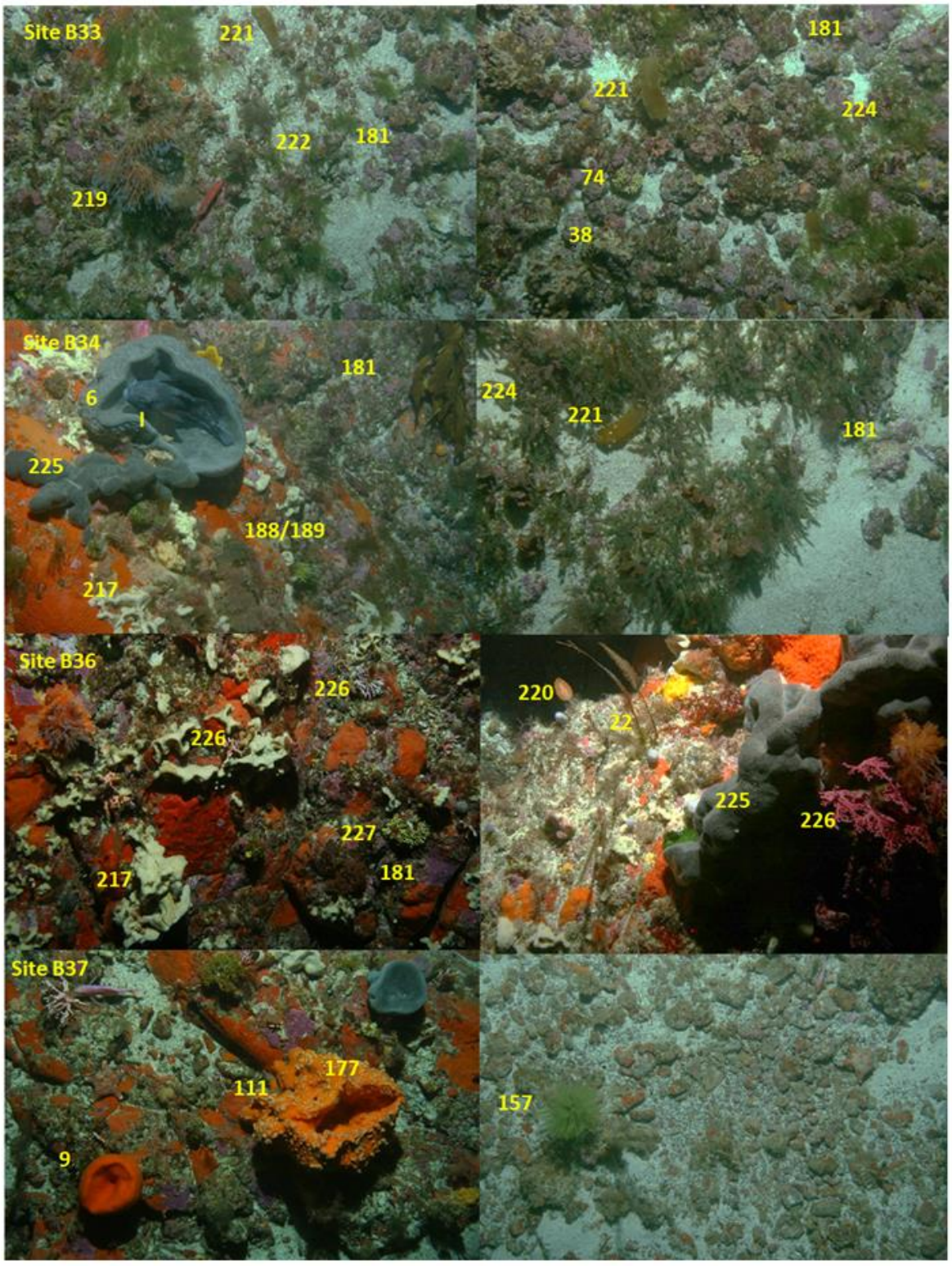

Figure B-29: NORTH, TAN1105, Three Kings Islands slopes, sites B33 (40–56 m), B34 (44–54), B36 (60–67), B37 (83–88 m). .

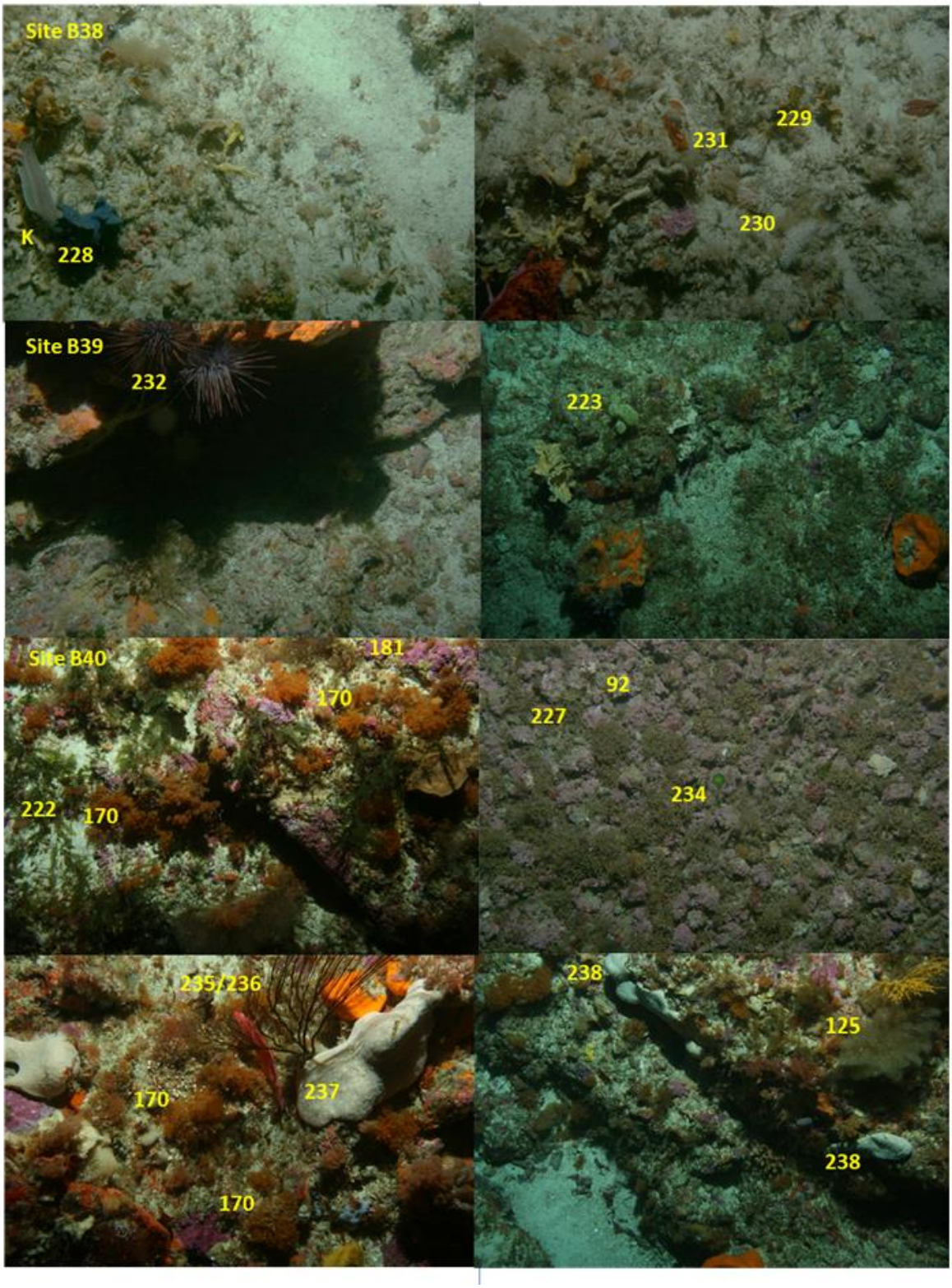

Figure B-30: NORTH, TAN1105, Three Kings Islands slopes, sites B38 (- m), B39 (78 m), B40 (68 m). Sponges, 228) *Holoxea* n. sp. 2 (Blue) (Very unusual sponge, typically blue in life, only found North Cape region), 238) *Mycale* (*Aegogropila*) *flagelliformis*; Corals, 223) Alcyoniidae (soft coral); Bryozoans, 125) *Cornucopina* sp., 170) Catenicellidae (bushy orange), 227) 229) *Steginoporella perplexa*, 230) Cellariidae, 231) Tubuliporidae; Algae, 92) Rhodoliths, 234) urchins, 232) *Centrostephanus rodgersii*.

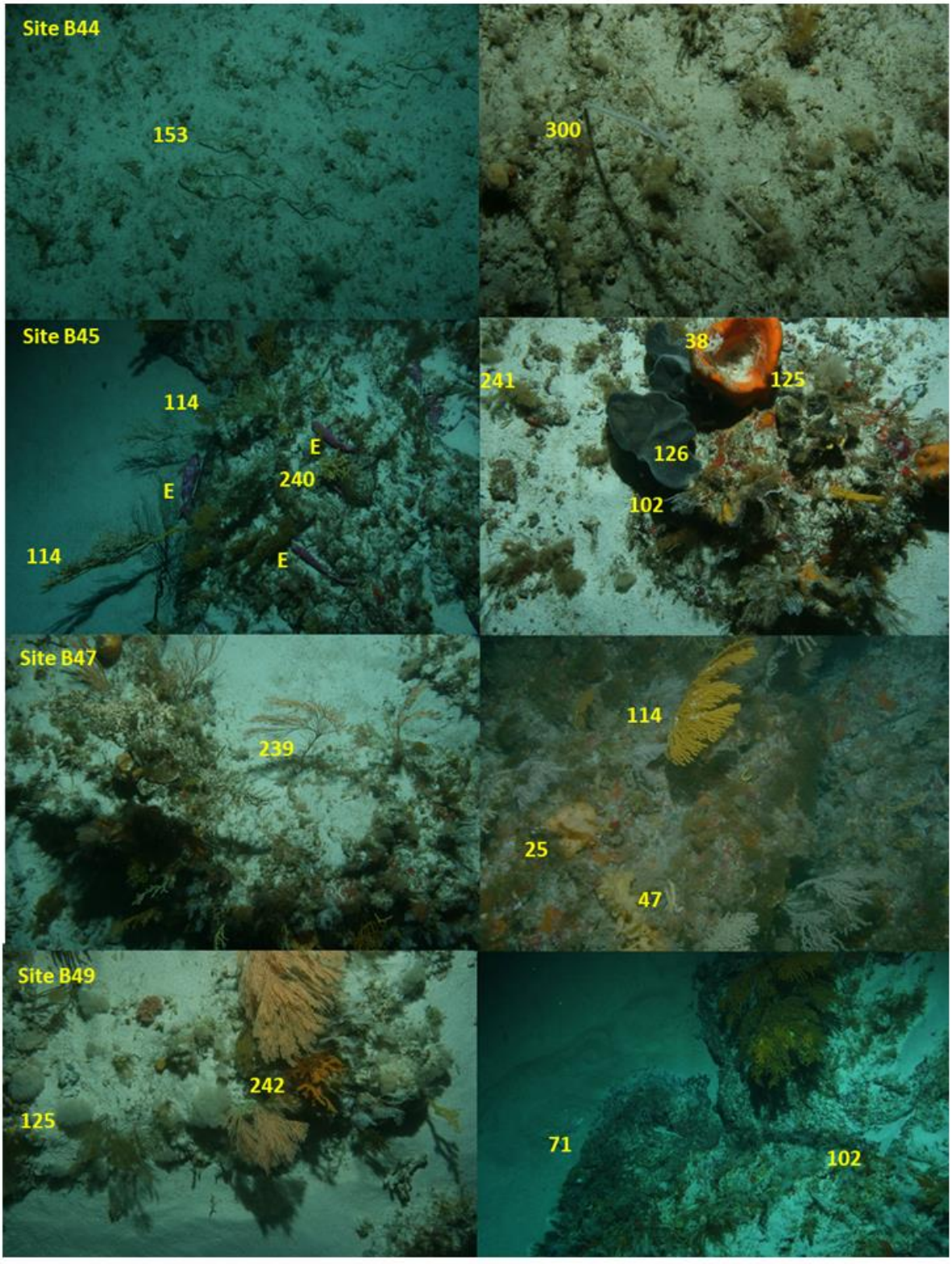

Figure B-31: NORTH, TAN1105, Middlesex Bank, sites B44 (170 m), B45 (95 m), Site B47 (100–115 m), B49 (125–135 m). Corals, 71) *Antipathella* sp., 114) Plexauridae, 153) *Stichopathes* sp., 239) Primnoidae, 300) *Primnoella* sp.; Hydroids, 102) *Cryptolaria prima* (?); 47) *Ophidiaster macknighti*.

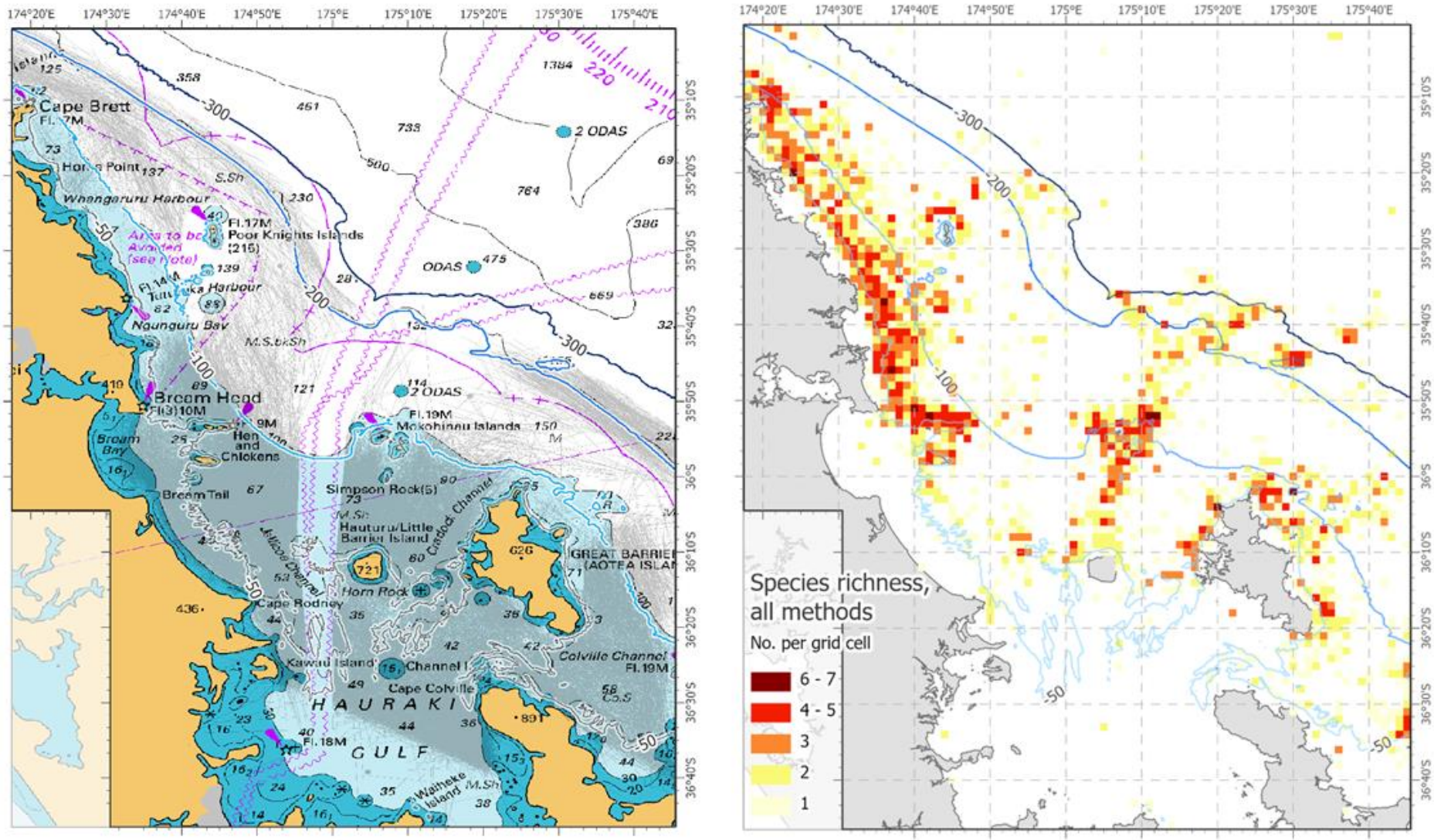

Figure B-32: Hauraki Gulf, left) nautical chart and right) commercial catch of reef-indicator species: species diversity (richness). Nautical chart includes bathymetry contours (dark blue line 300m depth contour; medium blue line 200 m contour; light blue line 100 m contour; grey line 50 m contour), and commercial trawl footprint (2003–2014) (grey lines are individual tows). Pink line with cross bars, territorial sea boundary (twelve nautical miles).

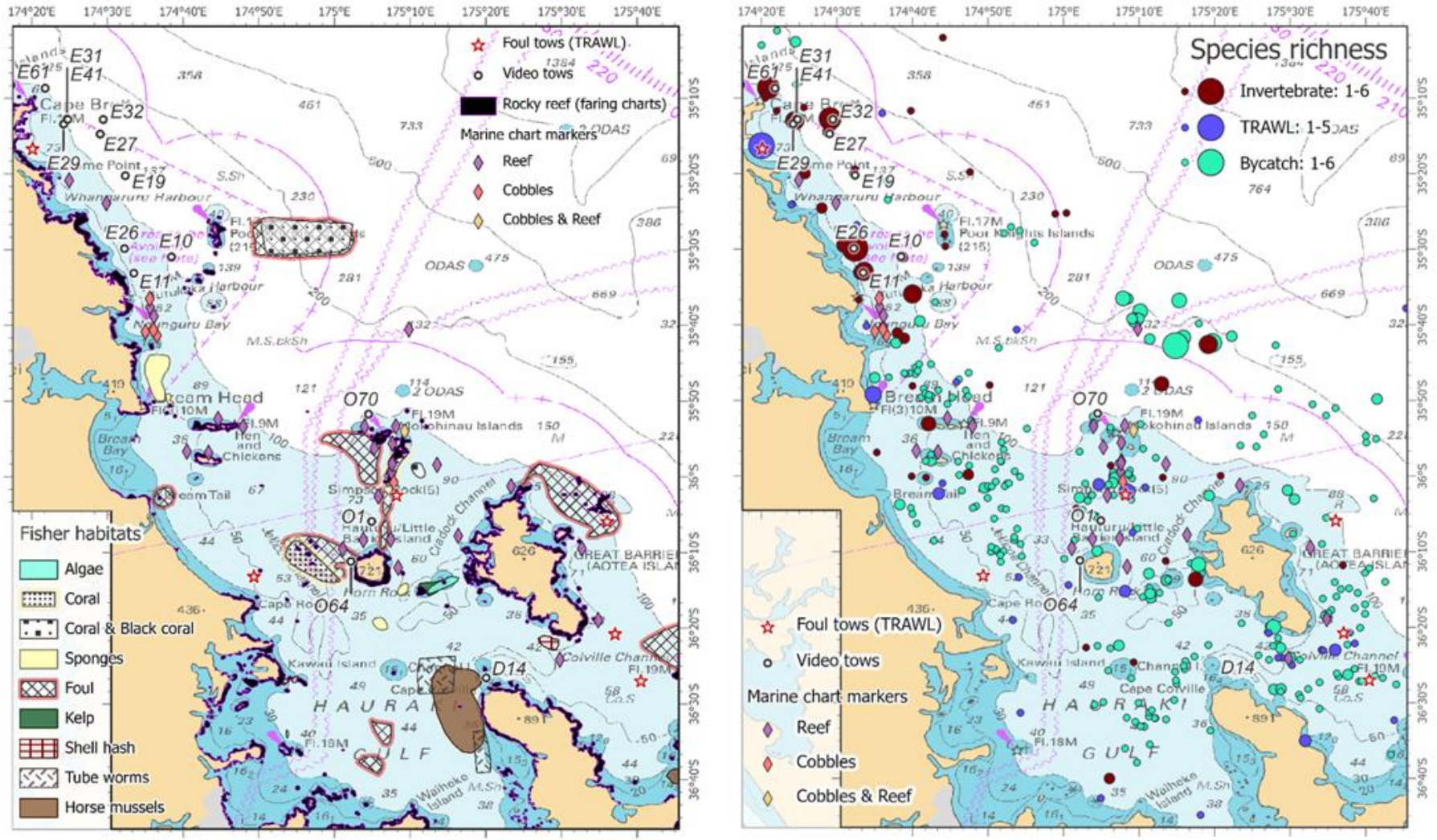

Figure B-33: Hauraki Gulf, left) fisher habitats and right) reef-indicator species richness for SPECIFY invertebrate, research TRAWL, and fisheries observer bycatch. Fisher habitats (LEK polygons) includes underwater video tows, foul trawl tows (from research trawling), foul definition areas (from research trawling), rocky reef (from charts), marine chart markers for sediment types (reef, cobble, cobbles and reef), DOC putative rocky reef polygons (<100 m water depth, purple coloured polygons).

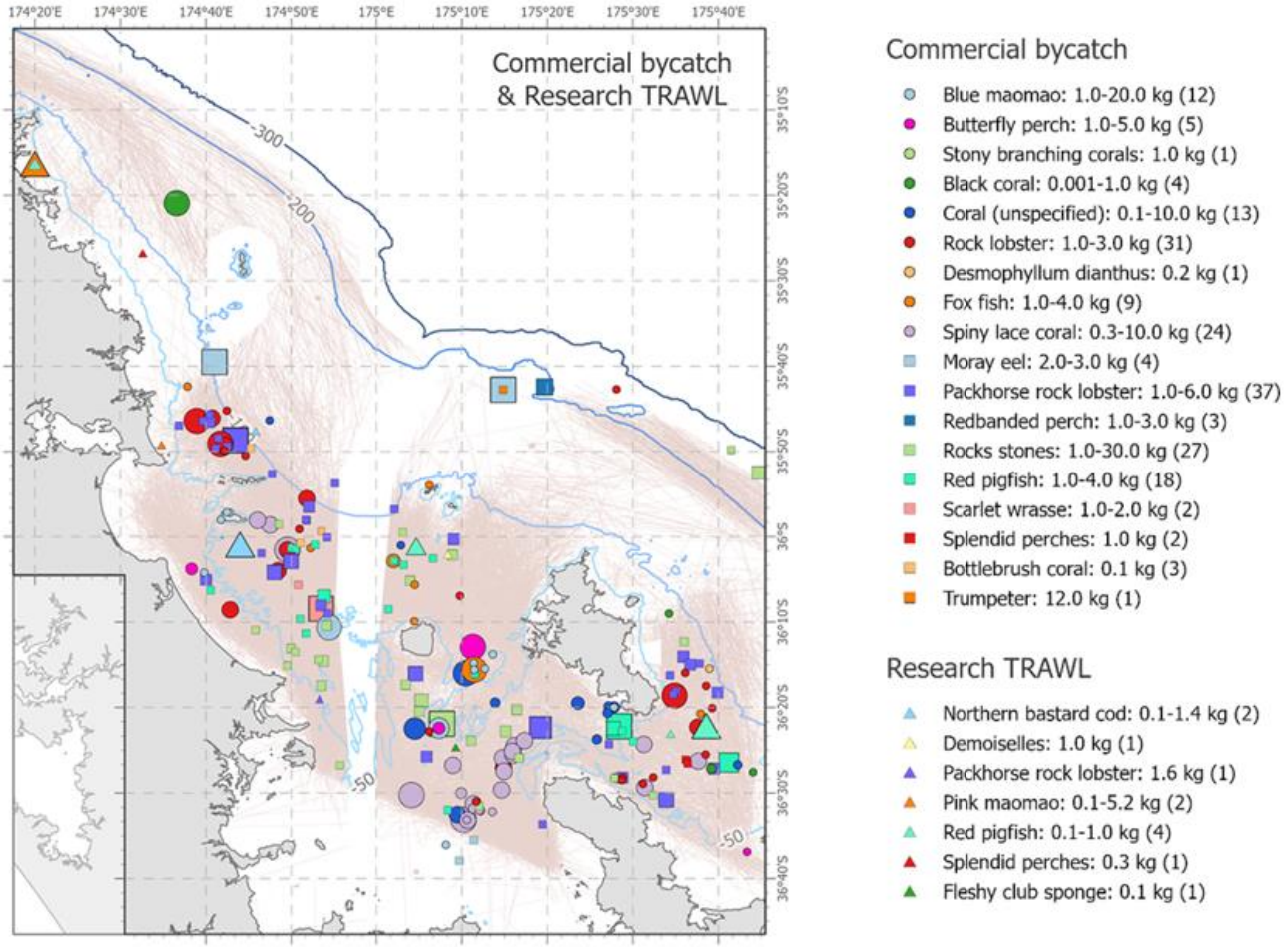

Figure B-34: Hauraki Gulf, commercial fisheries observer catch and research TRAWL reef-indicator species catch (kg). The number of sites each species was present at are given in brackets.

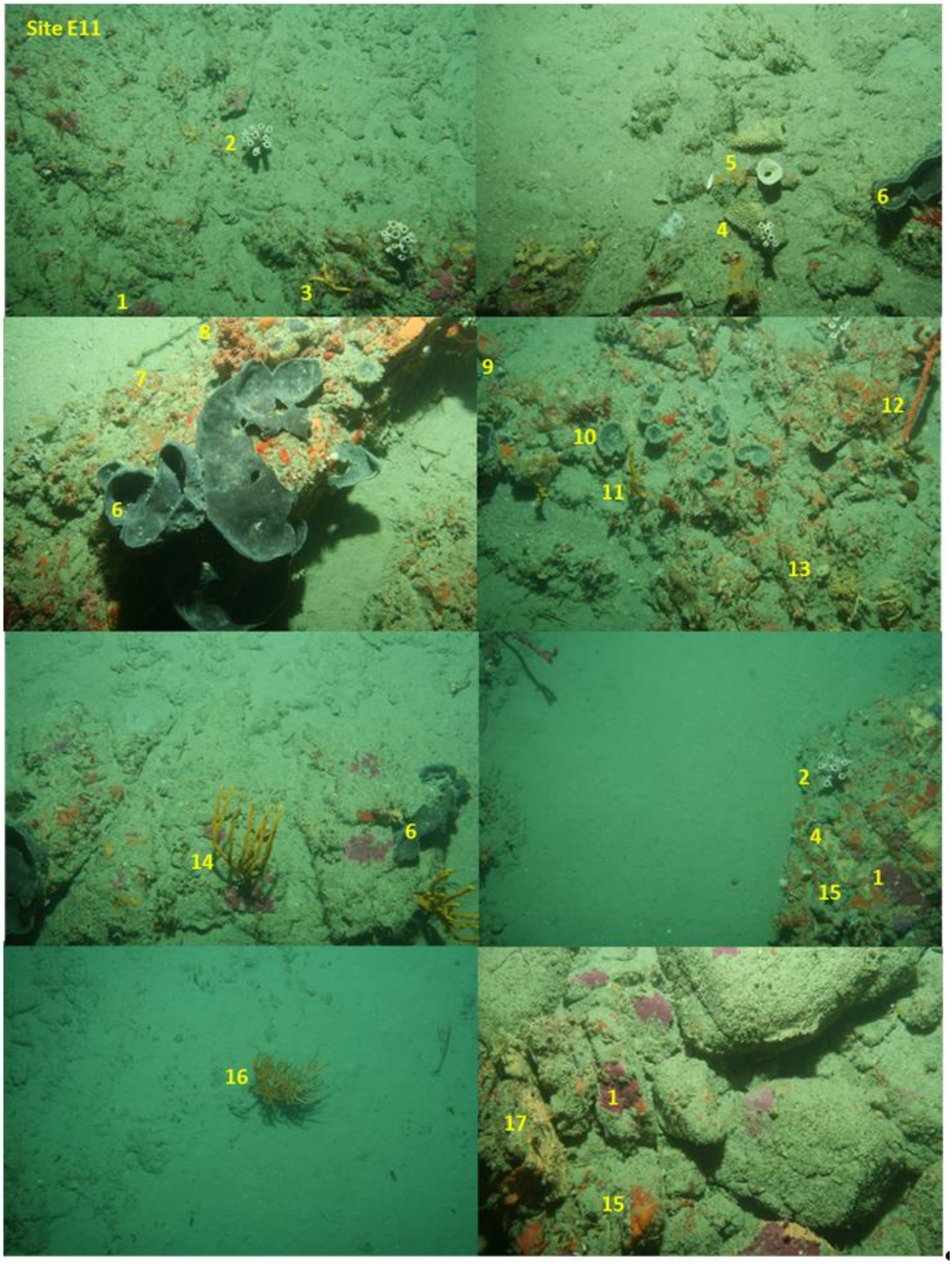

Figure B-35: Hauraki Gulf, TAN0906, Site E11 (61–61 m). Sponges; 1) *Iophon laevistylus*, 4) *Ciocalypta* cf. *penicillus* / *Haplosclerida* (Chalinidae), 5) *Isodictya cavicornuta* (or immature *Calyx imperialis*), 6) *Ecoinemia alata*, 8) *Dendrilla* sp. Indet., 9) *Stelletta* crater, with *Desmacella dendyi* encrusting (orange), 10) *Stelletta columna*, 11) *Iophon minor*, 12) *Myxilla columna*, 13) *Leucettusa lancifer*, 14) *Axinella australiensis*, 15) *Clathria macrotoxa*/orange poecilosclerida, 16) *Trachycladus stylifer*, 17) Poecilosclerida (orange); Mobile invertebrates, 3) *Henricia* sp.; Algae, 1) Coralline algae.

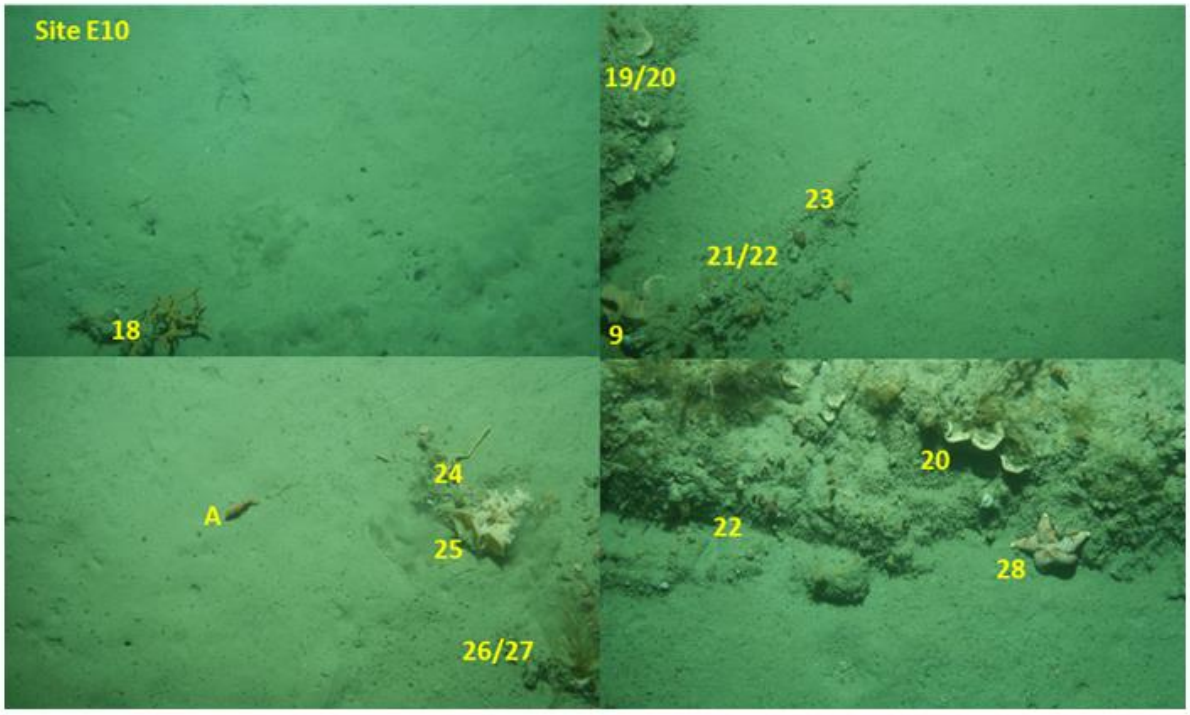

Figure B-36: Hauraki Gulf, TAN0906, Site E10 (106–108 m). Sponges, 9) *Stelletta crater*, with *Desmacella dendyi* encrusting (orange), 18) *Clathria scotti*, 19) *Pleroma menoui/turbinatum*, 20) *Aciculites pulchra*, 21) *Dendrilla rosea*, 24) *Callyspongia* sp, 25) *Symplectella rowi*; Corals, 23) *Monomyces rubrum*; Ascidians, 22) *Hypsistozoa fasmeriana*; Hydrozoans, 26) *Aglaophenia* sp, 27) *Lytocarpia* sp.; Starfish, *Asterodiscides truncatus*.

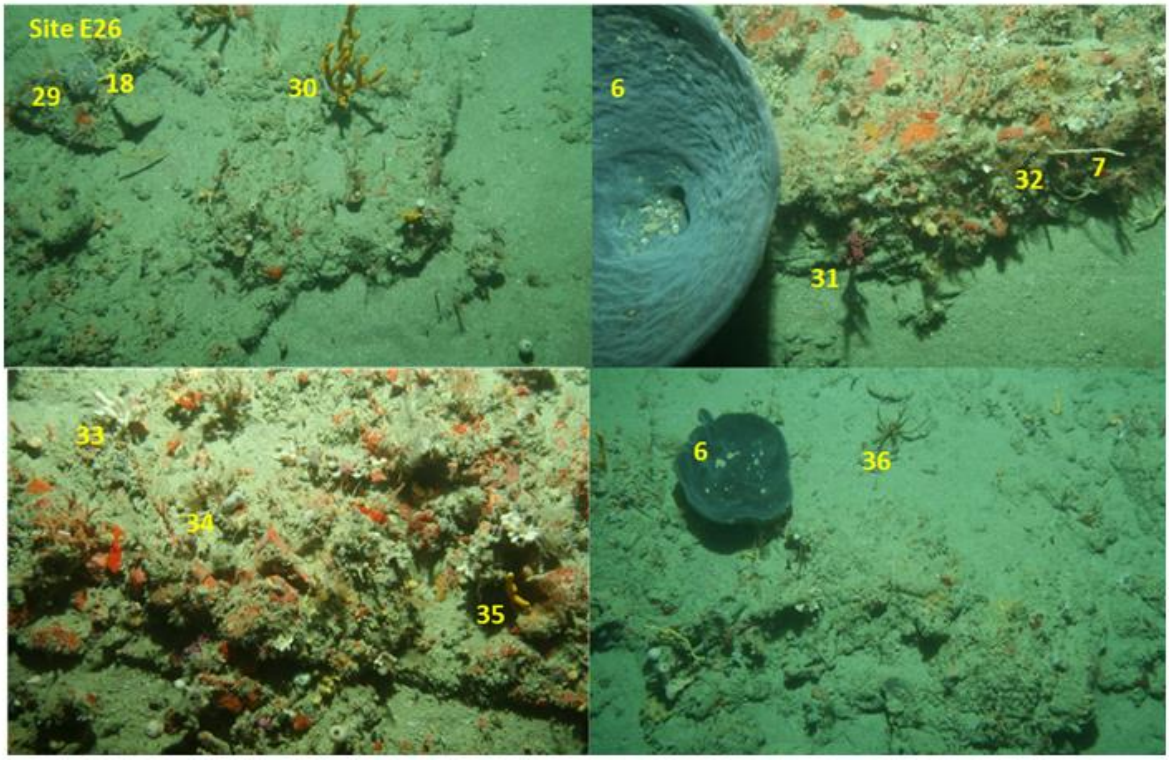

Figure B-37: Hauraki Gulf, TAN0906, Site E26 (57–63 m). Sponges, 6) *Ecionemia alata*, 18) *Clathria scotti*, 29) *Psammocina* sp. Indet, 30) *Axinella australiensis*, 32) *Callyspongia ramosa*, 33) *Leucettusa tubulosa*, 34) Dictyoceratida (Family Spongiidae / Irciniidae) 35), Order Axinellidae, 36) Family Raspailiidae; Gorgonians, 7) P. vitrea; Bryozoans, 31) *Celleporaria agglutinans*. Fish, A) butterfly perch.

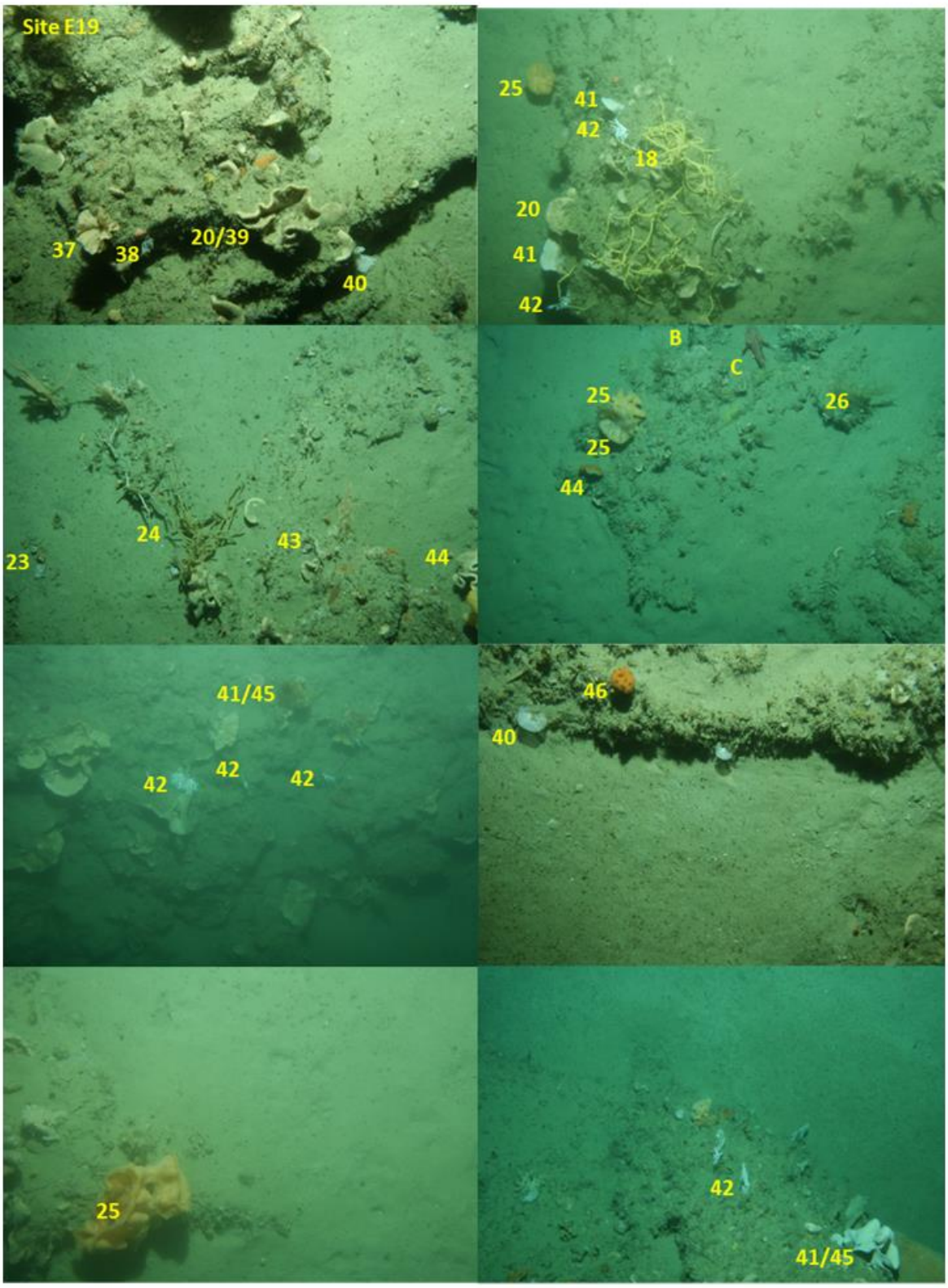

Figure B-38: Hauraki Gulf, TAN0906, Site E19 (121–127 m). Sponges 20) *Aciculites pulchra*, 24) *Callyspongia* sp, 25) *Symplectella rowi*, 37) *Reidispongia coerulea*, 39) *Herengeria vasiormis*, 41) *Haliclona* (*Gellius*) *regia*, 43) *Neoschrammeniella fulvodesmus*, 44) *Herengeria vasiformis*, 45) *Stryphnus ariena*, 46) *Tedania diversirhaphidiophora*; Bryozoans, 38) Hornera (Cyclostomata), 40) Reteporella (Cheilostomata); Corals; 23) *Monomyces rubrum*, 42) Stylasteridae. Fish, B) leatherjacket, C) red scorpion fish.

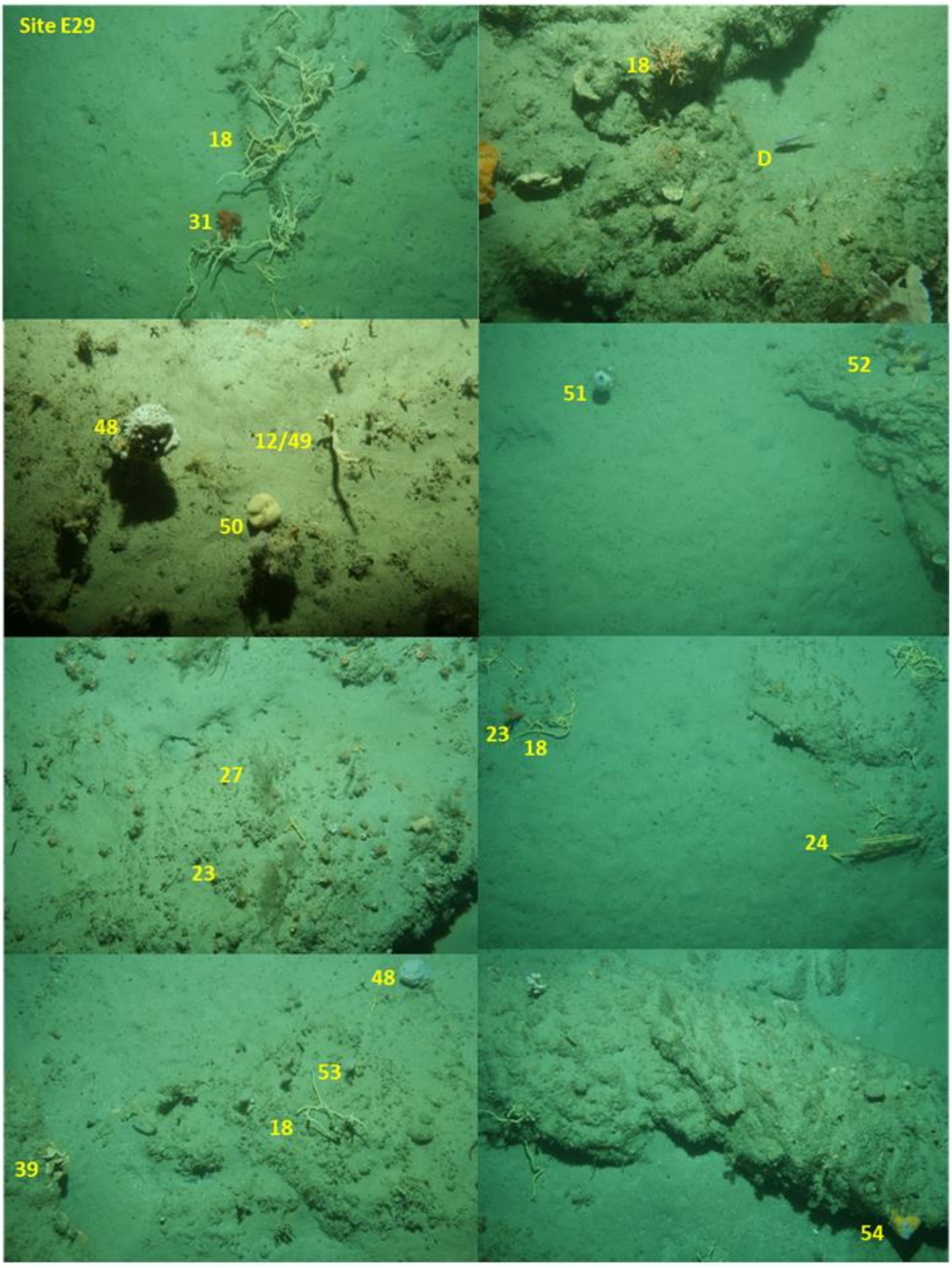

Figure B-39: Hauraki Gulf, TAN0906 Site E29 (91–107 m). Sponges 18) *Clathria scotti*, 24) *Callyspongia* sp., 39) *Herengeria vasiormis*, 45) *Calyx imperialis*, 48) Dictyoceratida (family Irciniidae), 49) *Antho* (*Antho) brondstedi*, 50) Tedania (Order Poecilosclerida, family Tedaniidae) (or ascidian), 51) *Taonura marginalis*, 52) *Stryphnus* sp., 54) *Stryphnus levis*; Hydrozoans 27) *Lytocarpia* sp., Bryozoans, 31) *Celleporaria agglutinans*; Corals, 23) *Monomyces rubrum*, Soft corals, 53) Alcyoniidae sp 1.; Fish D) roughy.

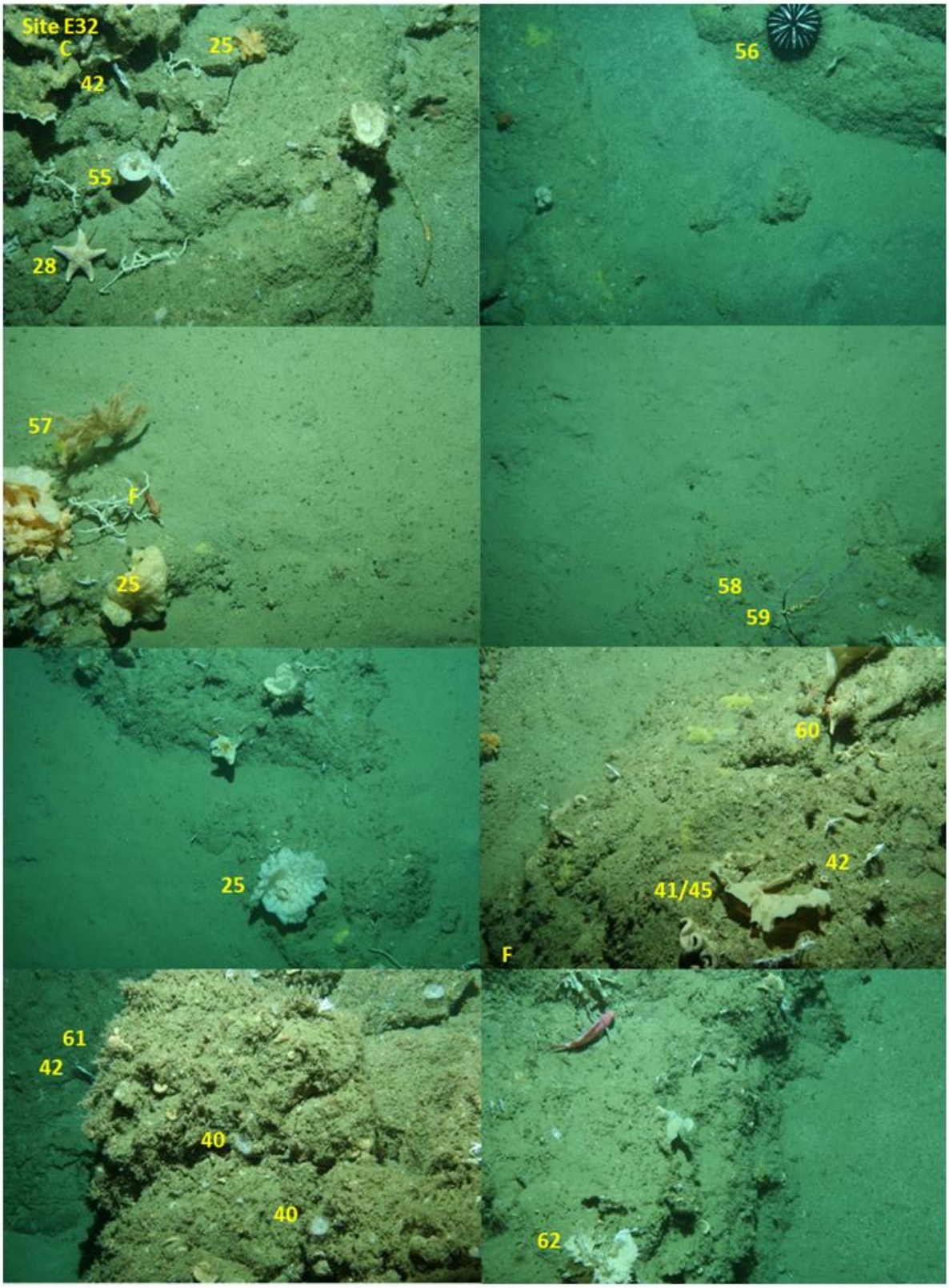

Figure B-40: Hauraki Gulf, TAN0906, Site E32 (138–147 m). Sponges 25) *Symplectella rowi*, 41) *Haliclona* (*Gellius*) *regia*, 45) *Calyx imperialis*, 55) *Rossella ijimai*, 62) Haplosclerida, possibly Calyx; Corals, 42) Stylasteridae, 57) *Metafannyella moseleyi*, 58) *Antipathella fiordensis*; Bryozoans, 40) Reteporella Cheilostomata. Mobile invertebrates: starfish, 28) *Asterodiscides truncatus*; urchins, 56) *Araeosoma thetidis*, Urchins, 61) *Diadema palmeri*; Ophiuroids, 59) *Astrobrachion contrictum*; Crabs, 60) Hermit crab. Fish, F) pink maomao.

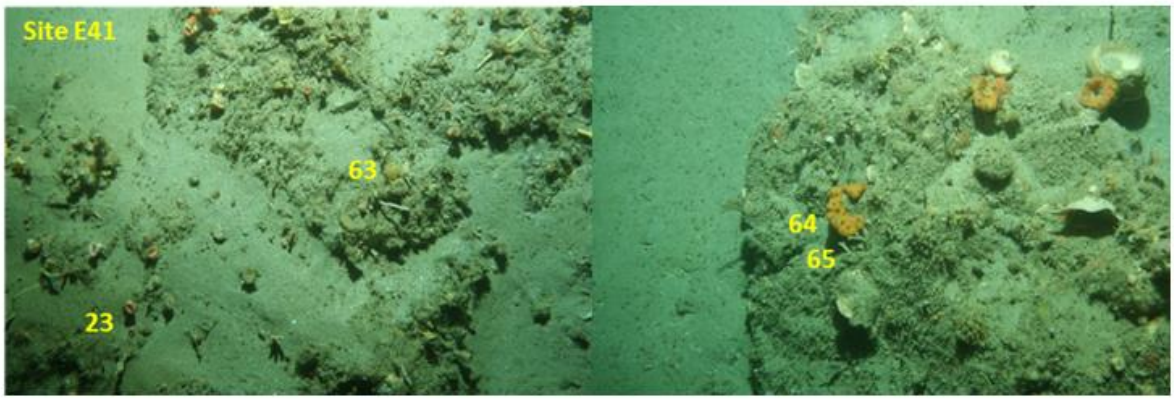

Figure B-41: Hauraki Gulf, TAN0906, Sites E41 (103–116 m). Sponges, 64) Haplosclerida, family Petrosiidae; Corals, 23) *Monomyces rubrum*; Brachiopods, 63) *Liothyrella* sp., Bryozoans, 65) Candidae Cheilostomata.

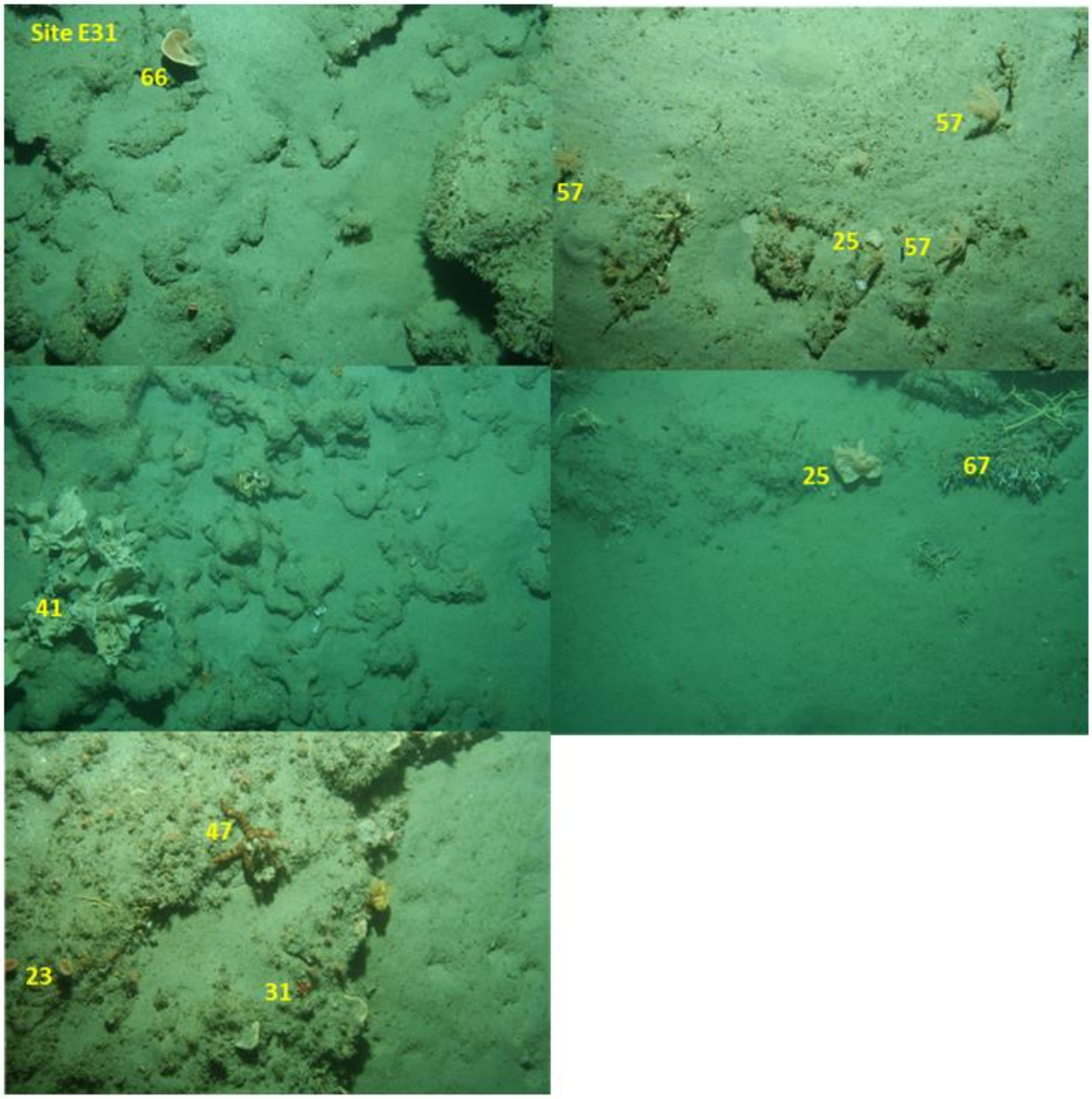

Figure B-42: Hauraki Gulf, TAN0906, Sites E31 (100–114 m). Sponges 25) *Symplectella rowi*, 41) *Haliclona* (*Gellius*) *regia*; 66) *Haliclona* (*Gellius*) *petrocalyx*; Corals, 23) *Monomyces rubrum*, 57) *Metafannyella moseleyi*, 67) *Oculina virgosa*, Bryozoans, 31) *Celleporaria agglutinans*; Mobile invertebrates, Starfish, 47) *Ophidiaster macknighti*.

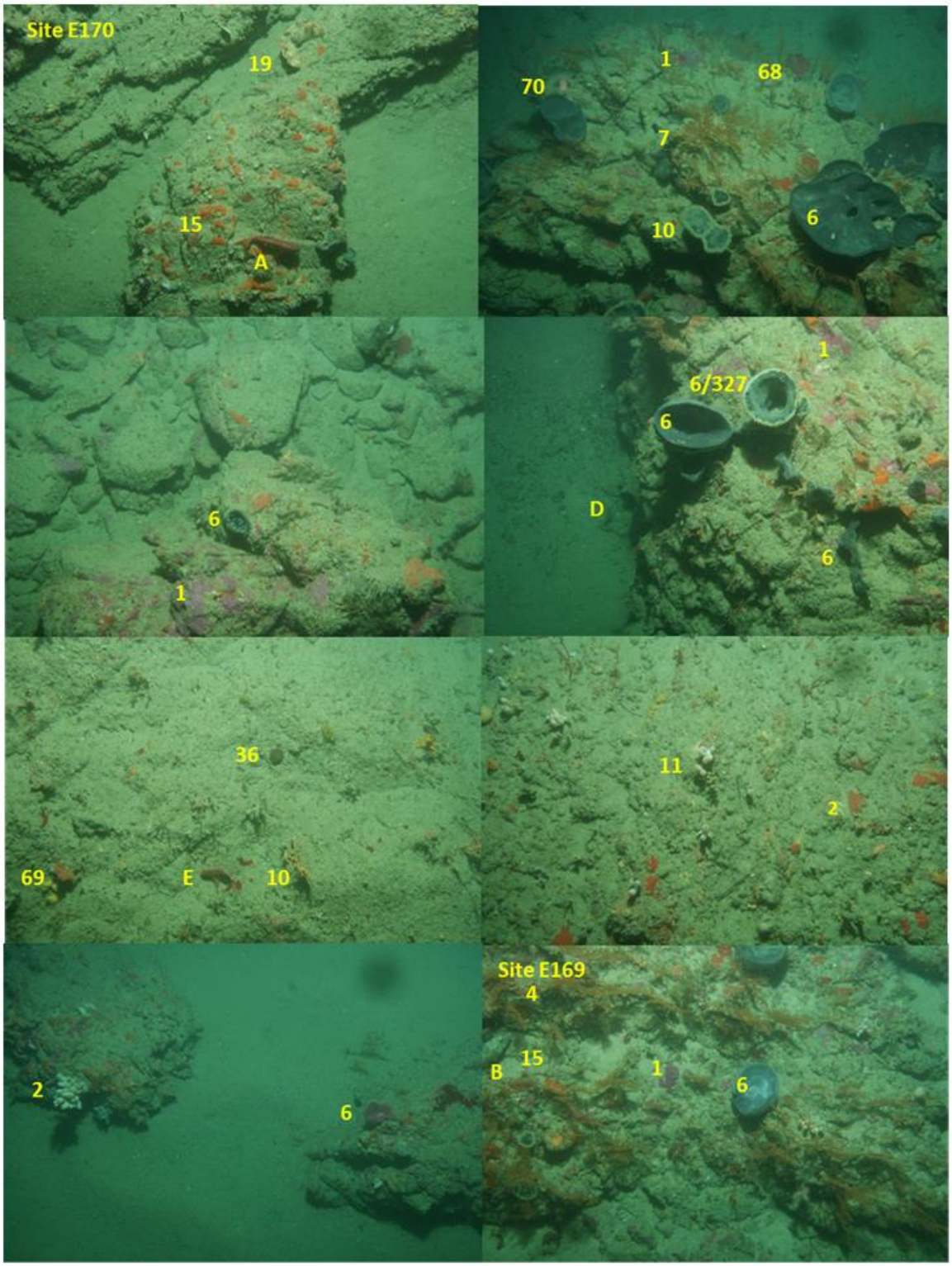

Figure B-43: Hauraki Gulf, TAN0906, Sites E170 (40–43 m) and E169 (40–46 m). Sponges; 2) *Iophon laevistylus*, 6) *Ecoinemia alata*, 10) *Stelletta columna*, 11) *Iophon minor*, 13) *Leucettusa lancifer*, 15) *Clathria macrotoxa*/orange poecilosclerida, 19) *Pleroma turbinatum*/ *P*. menoui, 36) *Tedania diversirhaphidiophora*, 68) *Petrosia* cf *hebes*, 69) *Acanthella dendyi*, 327) *Stelletta conulosa*; Gorgonians, 7) *Perissogorgia vitrea*; Mobile invertebrates; 70) anemone; Algae, 1) coralline algae. Fish, A) butterfly perch, B) leatherjacket, D) roughy sp., E) pink maomao.

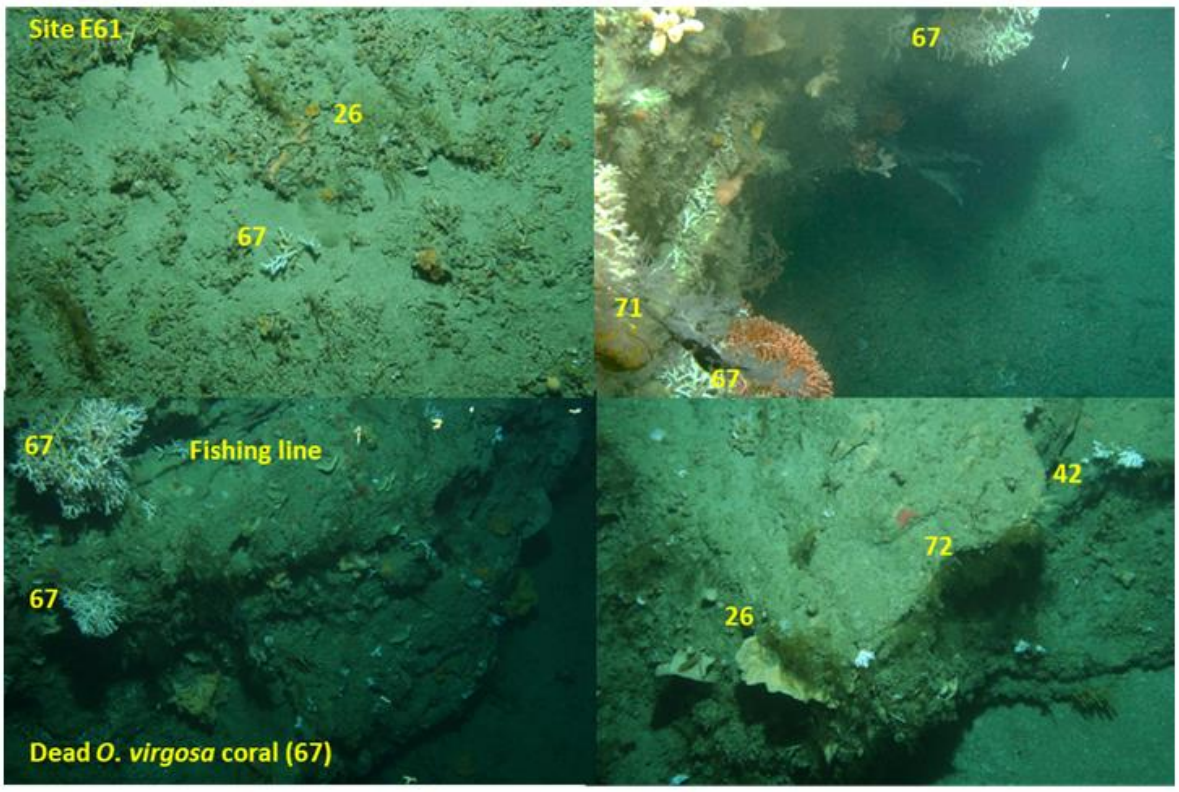

Figure B-44: Hauraki Gulf, TAN0906, Site E61 (120–132 m). Corals, 42) Stylasteridae, 67) *Oculina virgosa*; Hydroids, 26) *Aglaophenia* sp., 72) hydroid.

Figure B-45: Site O70 (50 m), Site O64 (170 m). Sponges 2) *Iophon laevistylus*, 6) *Ecionemia alata*, 9) *Stelleta crater*, 10) *Stelletta columna*, 11) *Iophon minor*, 25) *Symplectella rowi*, 66) *Haliclona* (*Gellius*) *petrocalyx*, 84) Haplosclerida, family Chalinidae 107) *Stelletta maori*, 134) *Crella incrustans*, 162) *Chondropsis* sp., 165) *Dactylia varia*, 329) *Hymeniacidon* cf *perlevis*; Corals 58) *Antipathella fiordensis*; Hydroids 102) *Cryptolaria prima*; Fish A) butterfly perch, E) pink maomao. Mixed red algae) includes Rhodymenia, Gracilaria or Sarcodia, and possibly *Callophyllis* sp.

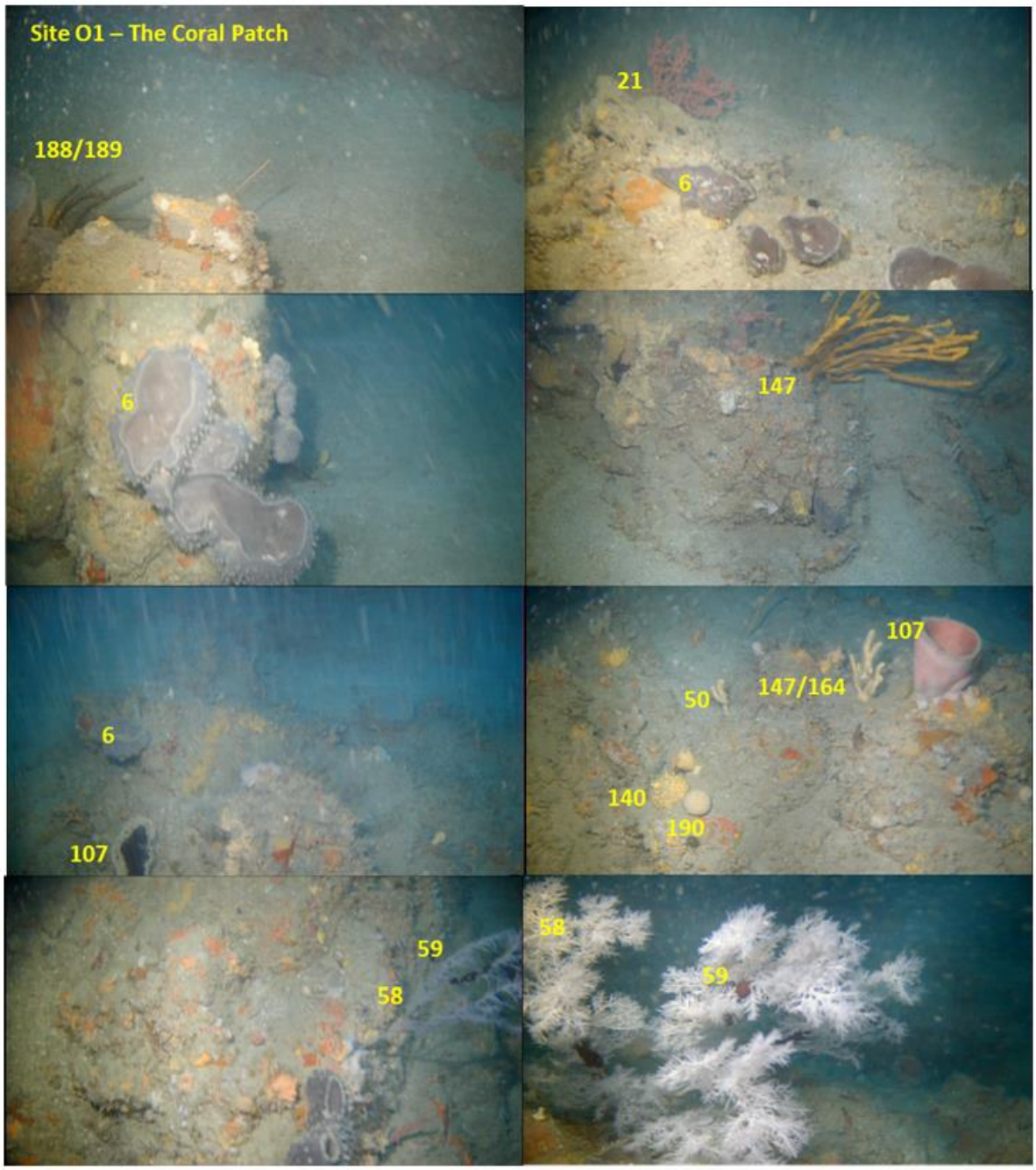

Figure B-46: GULF, Site O1 (64–70 m) (The Coral Patch). Sponges; 6) *Ecionemia alata*, 21) *Dendrilla rosea*, 50) Tedania (Order Poecilosclerida, family Tedaniidae), 107) *Stelletta maori*, 140) *Polymastia crocea*, 147) *Raspailia topsenti*, 164) *Axinella* sp., 190) *Suberites* sp. indet.; Corals 58) *Antipathella fiordensis*; Mobile invertebrates Crinoids 188) *Anneissia benhami*, 189) *Cenolia novaezelandiae*; Ophiuroids 59) *Astrobrachion constrictum*.

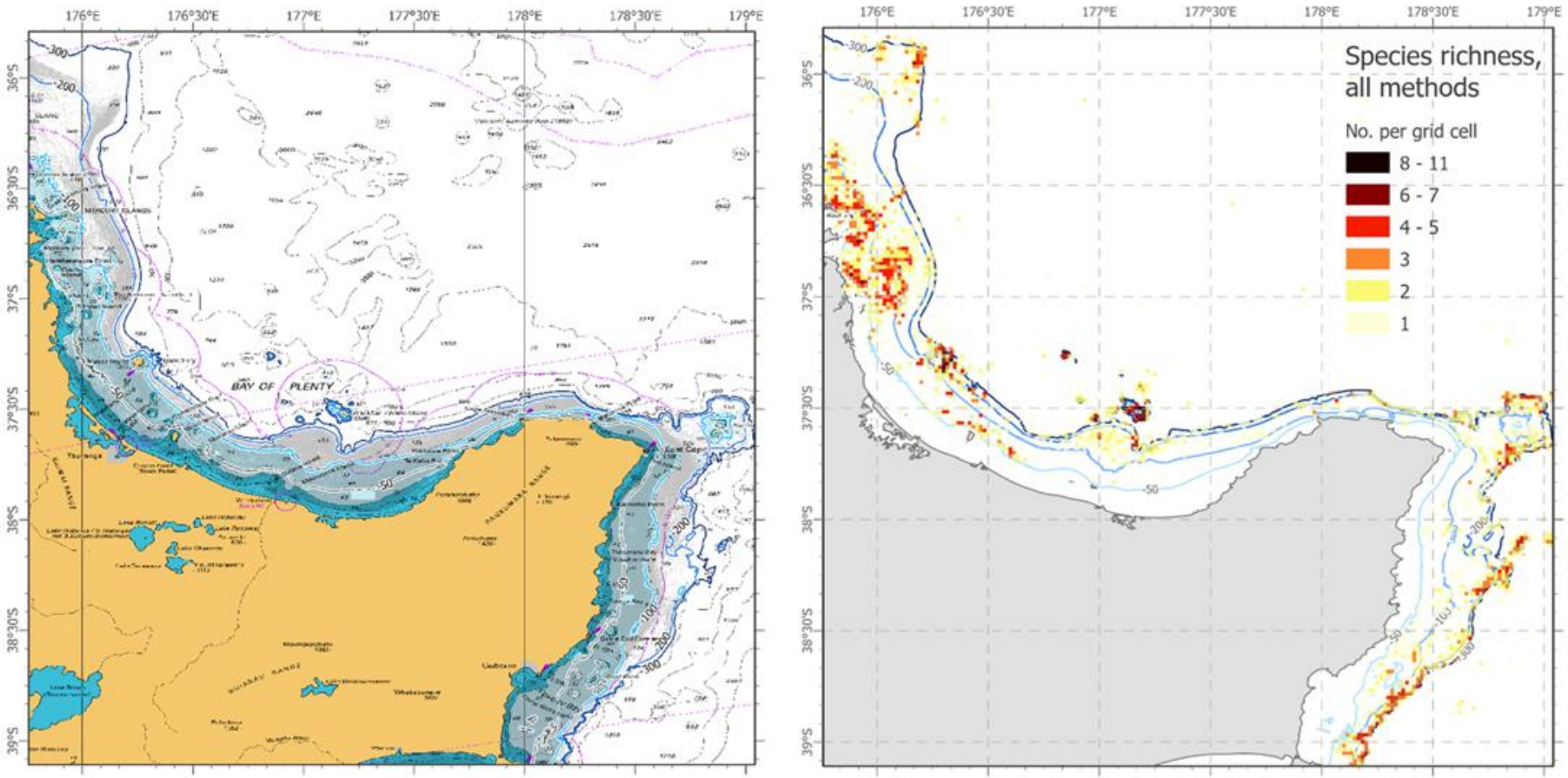

Figure B-47: Bay of Plenty, left) nautical chart and right) commercial catch of reef-indicator species: species richness. Nautical chart includes bathymetry contours (dark blue line 300m depth contour; medium blue line 200 m contour; light blue line 100 m contour; grey line 50 m contour), and commercial trawl footprint (2003–2014) (grey lines are individual tows). Pink line with cross bars, territorial sea boundary (twelve nautical miles).

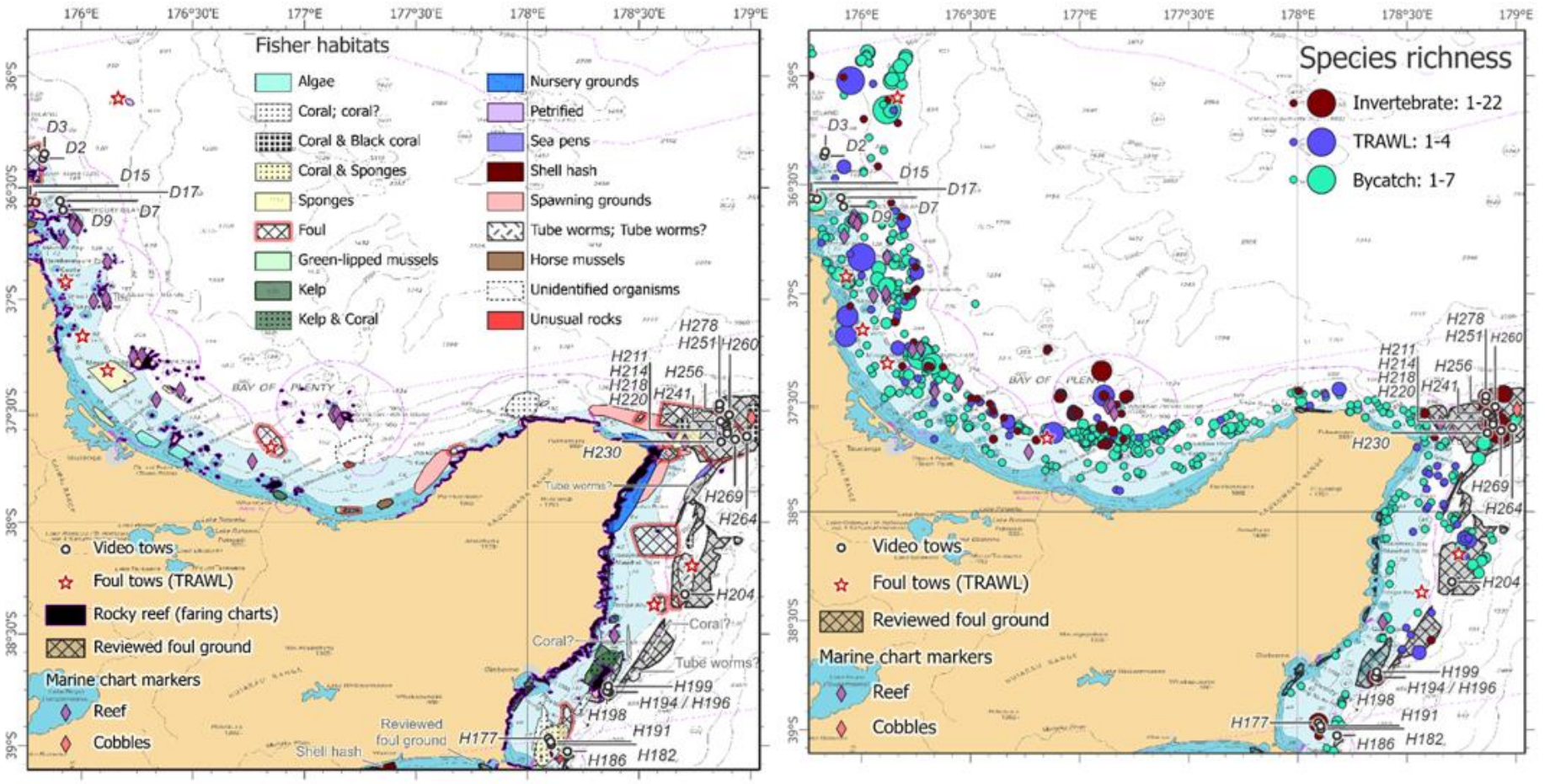

Figure B-48: Bay of Plenty, left) fisher habitats and right) reef-indicator species richness for SPECIFY invertebrate, research TRAWL, and fisheries observer bycatch. Fisher habitats (LEK polygons) includes underwater video tows, foul trawl tows (from research trawling), foul definition areas (from research trawling), rocky reef (from charts), marine chart markers for sediment types (reef, cobble, cobbles and reef), DOC putative rocky reef polygons (<100 m water depth, purple coloured polygons).

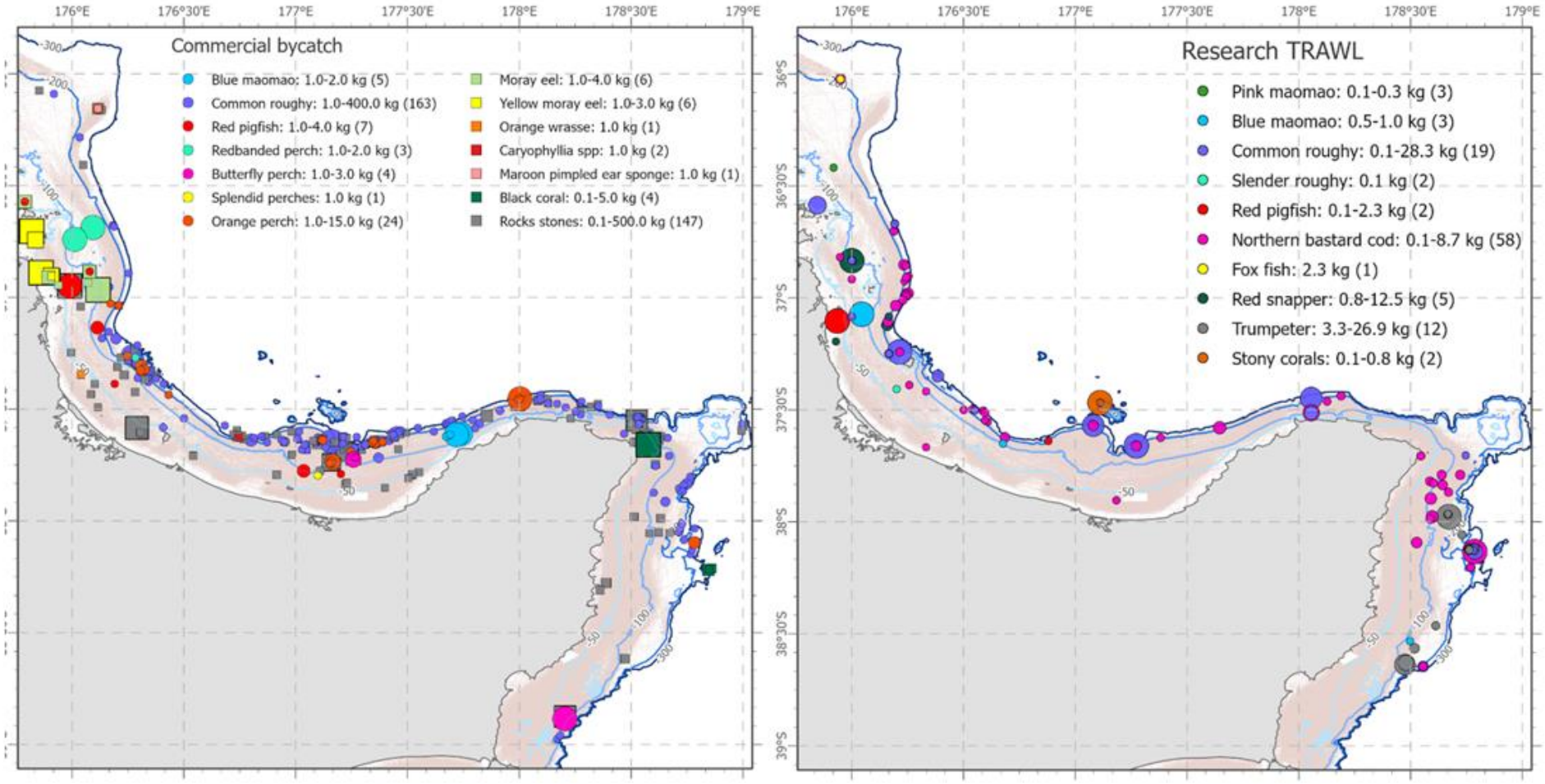

Figure B-49: Bay of Plenty, left) commercial fisheries observer catch reef-indicator species catch (kg) and right) research TRAWL catch (kg) of reef-indicator species catch. The number of sites each species was present at are given in brackets.

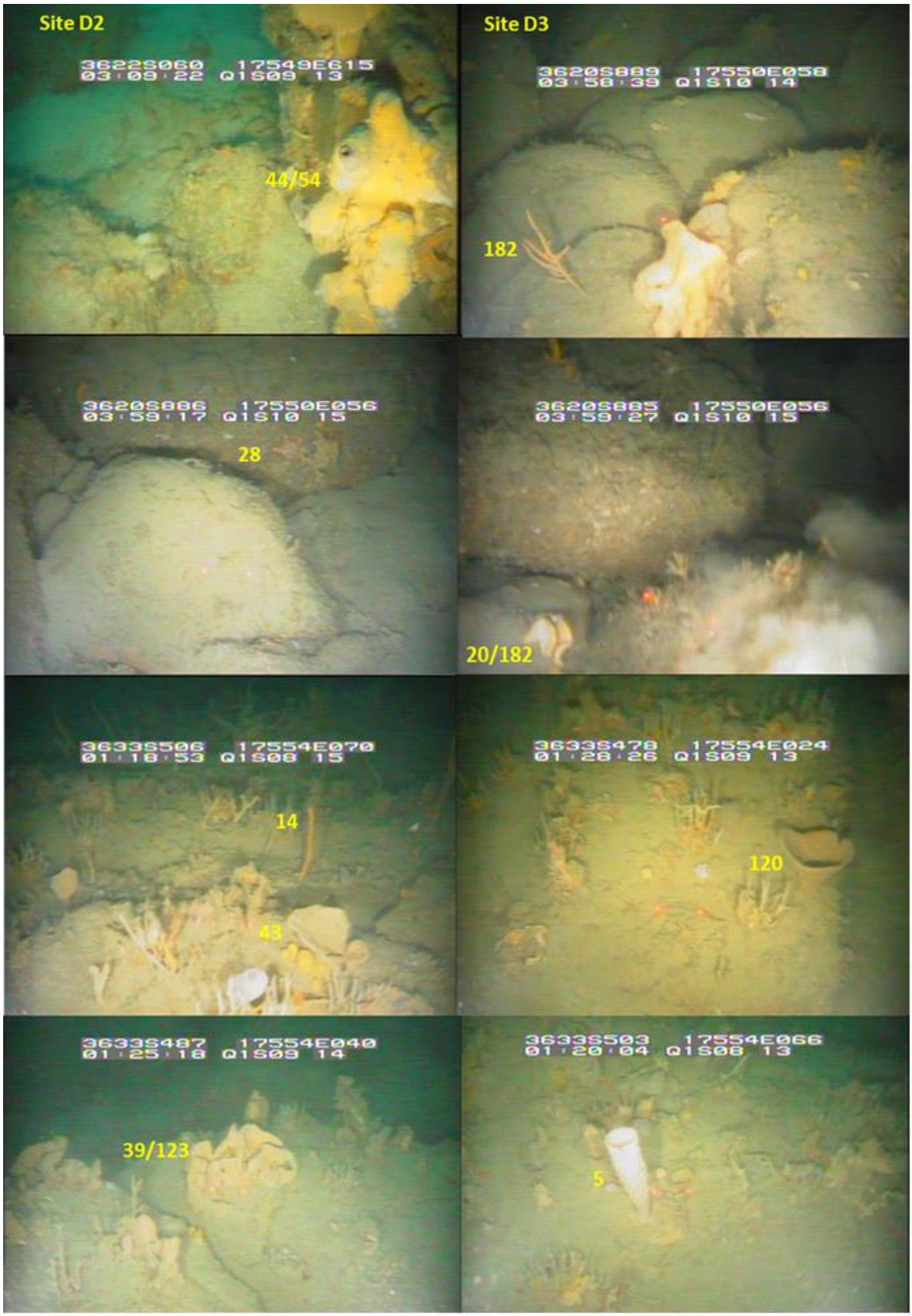

Figure B-50: Bay of Plenty, Sites D2 (75 m), D3 (97 m). Sponges 5) *Isodictya cavicornuta*, 14) *Axinella australiensis*, 20) *Aciculites pulchra*, 39) *Herengeria vasiormis*, 43) *Neoschrammeniella fulvodesmus*, 44) *Stryphnus ariena*, 54) *Stryphnus levis*, 68) *Petrosia* cf *hebes*, 120) Tetractinellidae, family Ancorinidae, 123)

Pleroma turbinatum, 182) *Homaxinella erecta*, 184) *Aciculites pulchra*; Mobile invertebrates, Starfish, 28) *Asterodiscides truncatus*.

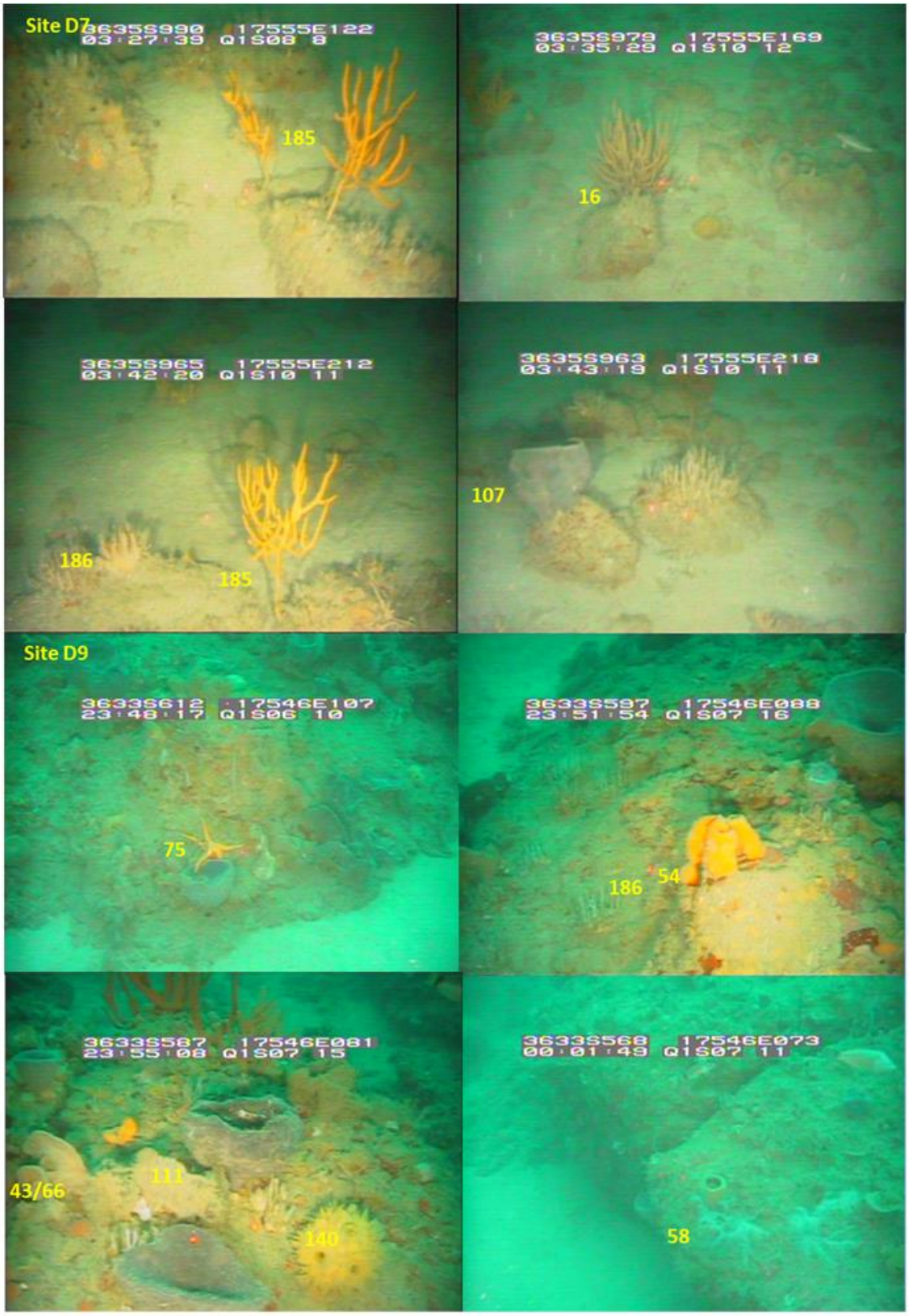

Figure B-51: Bay of Plenty, sites D7 (78 m), D9 (65 m). Sponges 16) *Trachycladus stylifer*, 43) *Neoschrammeniella fulvodesmus*, 54) *Stryphnus levis*, 66) *Haliclona* (*Gellius*) *petrocalyx*, 107) *Stelletta maori*,

111) *Ancorina stalagmoides*, 140) *Polymastia crocea*, 185) *Raspailia* (Raspaxilla*) flaccida*, 186) *Petromica* sp.; Corals, 58) *Antipathella fiordensis*; Mobile invertebrates starfish 75) *Knightaster* sp.; Fish, l) blue cod.

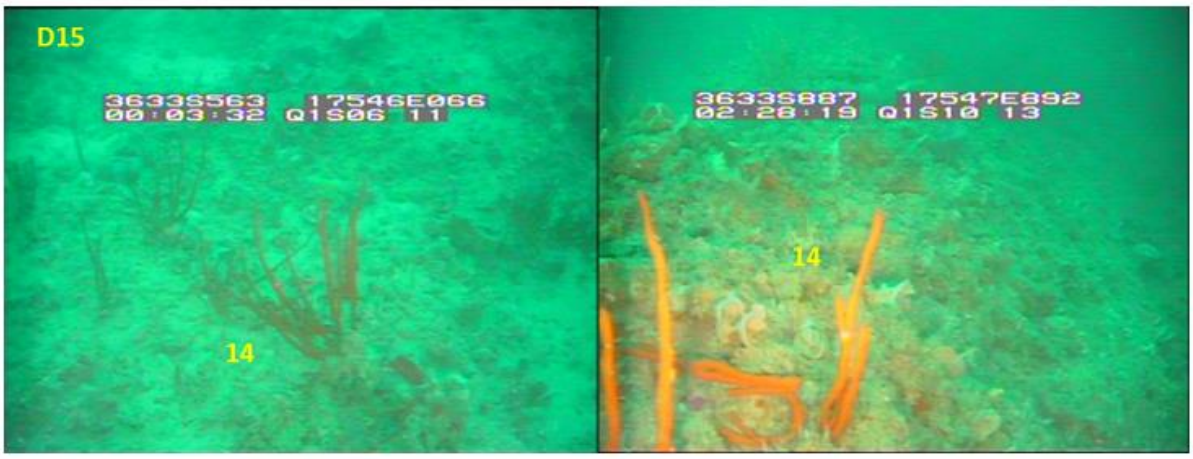

Figure B-52: Bay of Plenty, Site D15 (45 m). Sponges 14) *Axinella australiensis*, 32) *Callyspongia ramosa*.

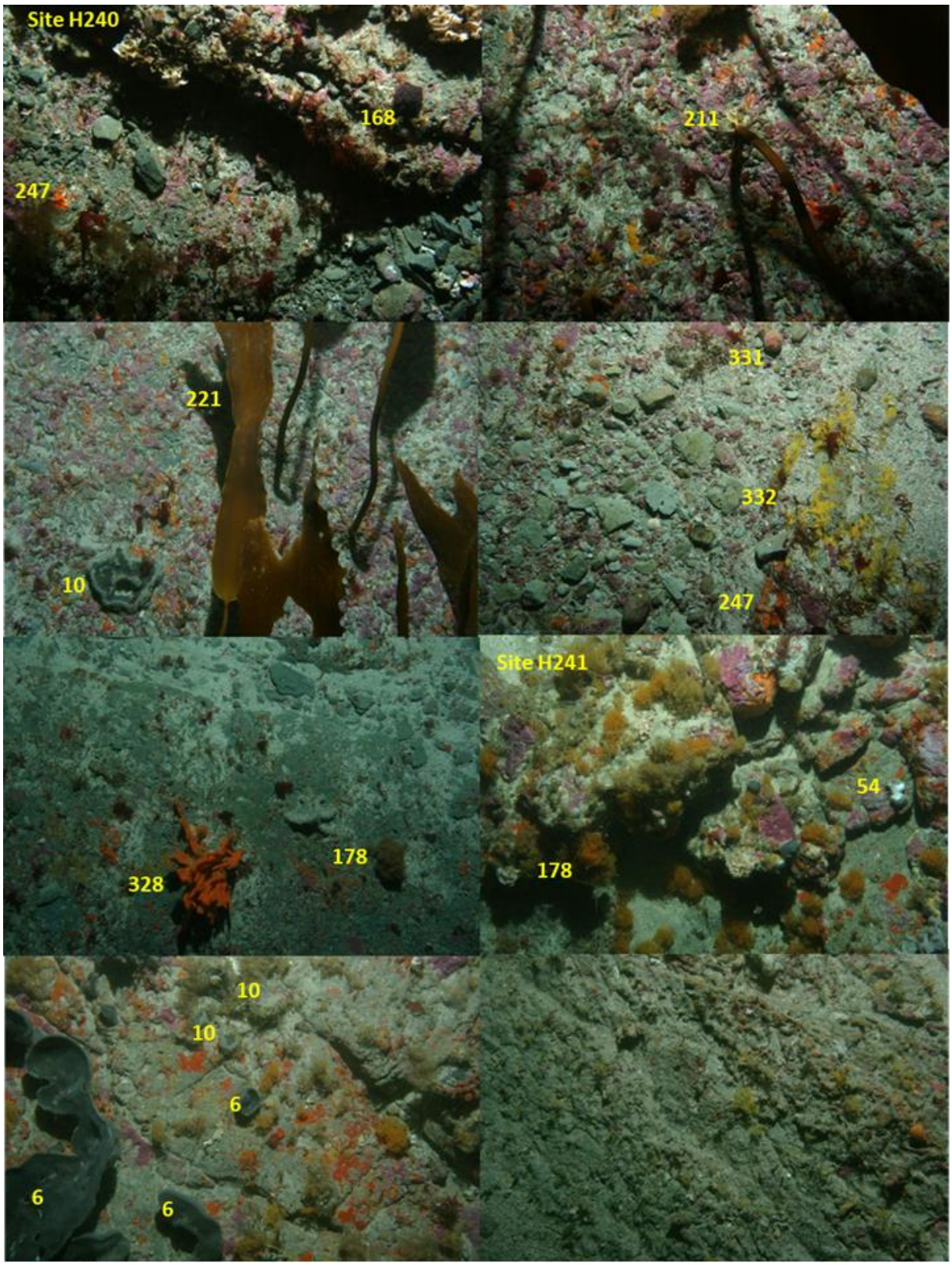

Figure B-53: Bay of Plenty, TAN1108, Ranfurly Bank, sites H240 (40–50 m), H241 (70 m), H243 (94 m). Sponges, 6) *Ecoinemia alata*, 10) *Stelletta columna*, 54) *Stryphnus levis*, 168) *Biemna rufescens* (?), 247) Poecilosclerida sp., 328) *Dragmacidon mammilatium*, 331) *Aaptos globosa*, 332) *Iophon* sp. indet., Bryozoans, 178) Catenicellidae; Macroalgae, 221) *Ecklonia radiata* (deep water form).

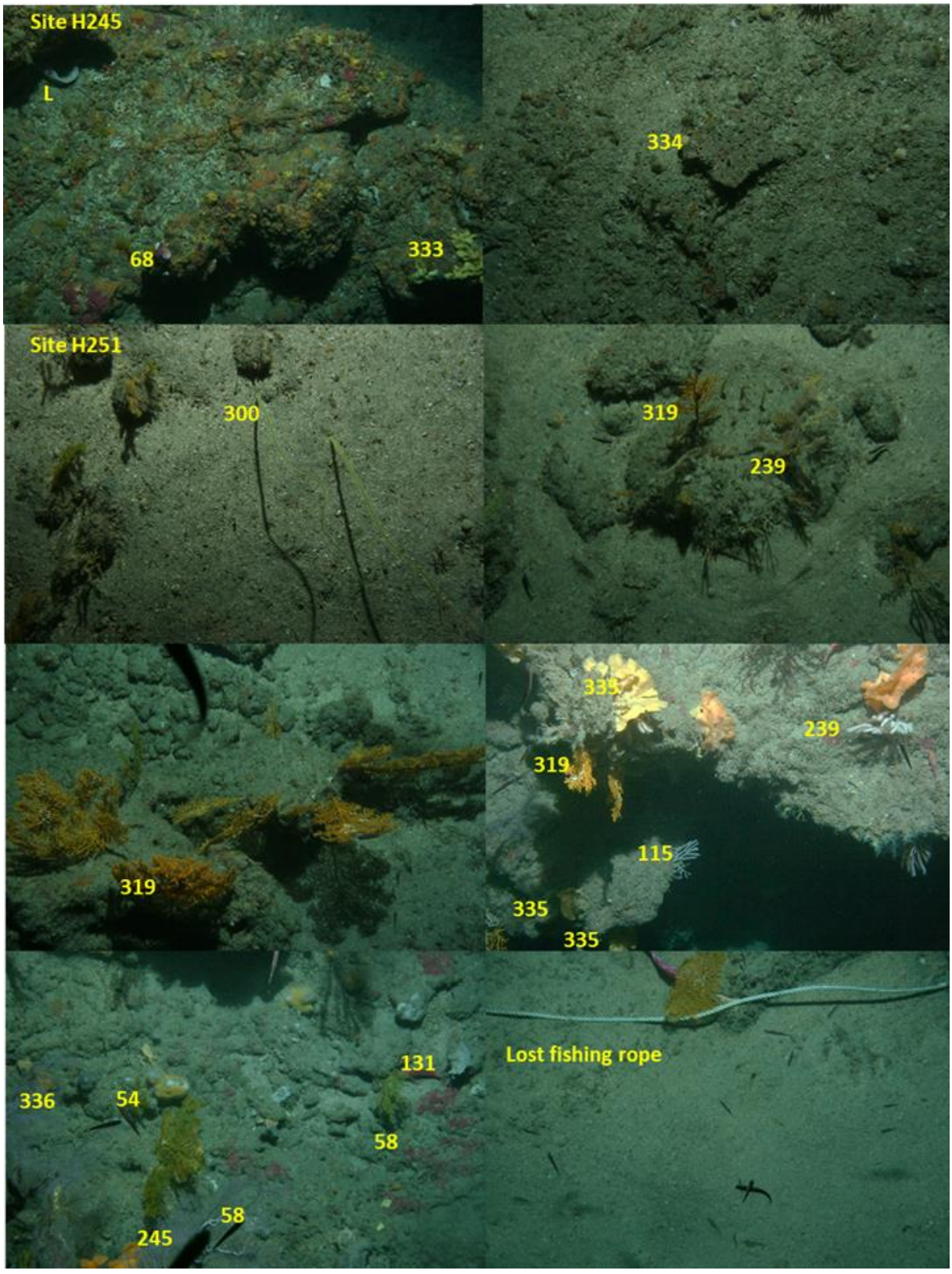

Figure B-54: Bay of Plenty, TAN1108, Ranfurly Bank, sites H245 (90–106 m), H251 (120 m). Sponges, 54) *Stryphnus levis*, 68) *Petrosia* cf *hebes*; 131) *Psammocinia* sp. indet. (?), 333) *Petrosia* sp. indet.?, 334) *Polymastia massalis* (?), 335) Haplosclerida sp. indet. (peach), 336) *Psammocinia* cf *beresfordae*; Coral, 58) *Antipathella fiordensis*, 115) Isididae (bamboo coral), 239) Primnoidae, 300) *Primnoella* sp., 319) Alcyonacea (gorgonian); Mobile invertebrates, 245) *Astrobrachion constrictum*. Fish, L) mottled moray.

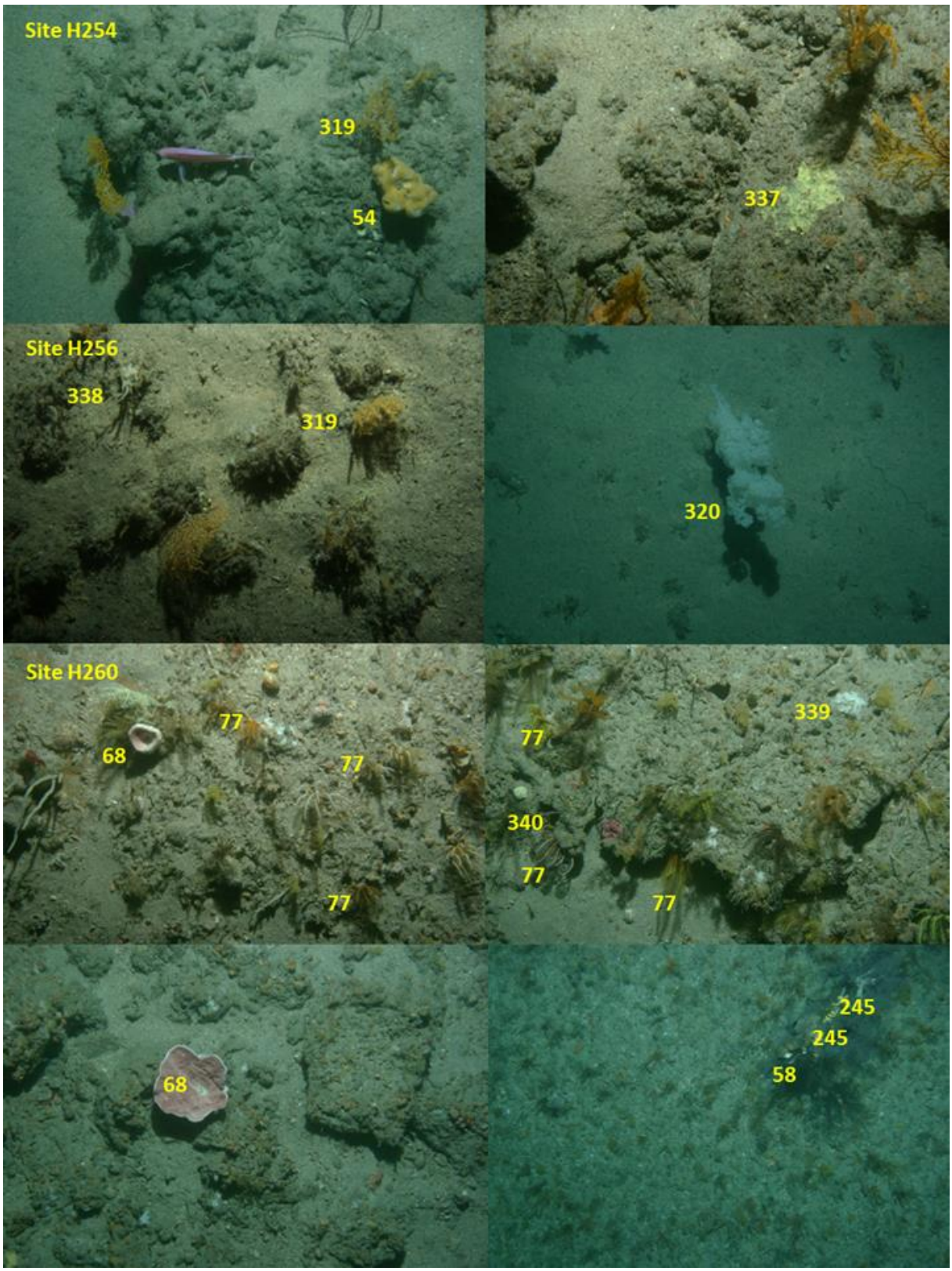

Figure B-55: Bay of Plenty, TAN1108, Ranfurly Bank, sites H254 (100–130 m), H256 (120 m), H260 (107–110 m). 54) *Stryphnus levis*, 68) *Petrosia* cf *hebes*, 165) *Dactylia varia* (?), 337) *Psammoclema* sp. indet. (?), 338) *Coscinoderma* sp. indet. (?), 339) *Psammoclemma* sp. indet. (?), 340) *Topsentia* sp. indet; Coral, 58) *Antipathella fiordensis*, 319) Alcyonacea (gorgonian), 320) Alcyonacea (soft coral); Mobile invertebrates, Ophiuroids, 245) *Astrobrachion constrictum* (both yellow and white forms); Crinoids, 77) Comatulidae.

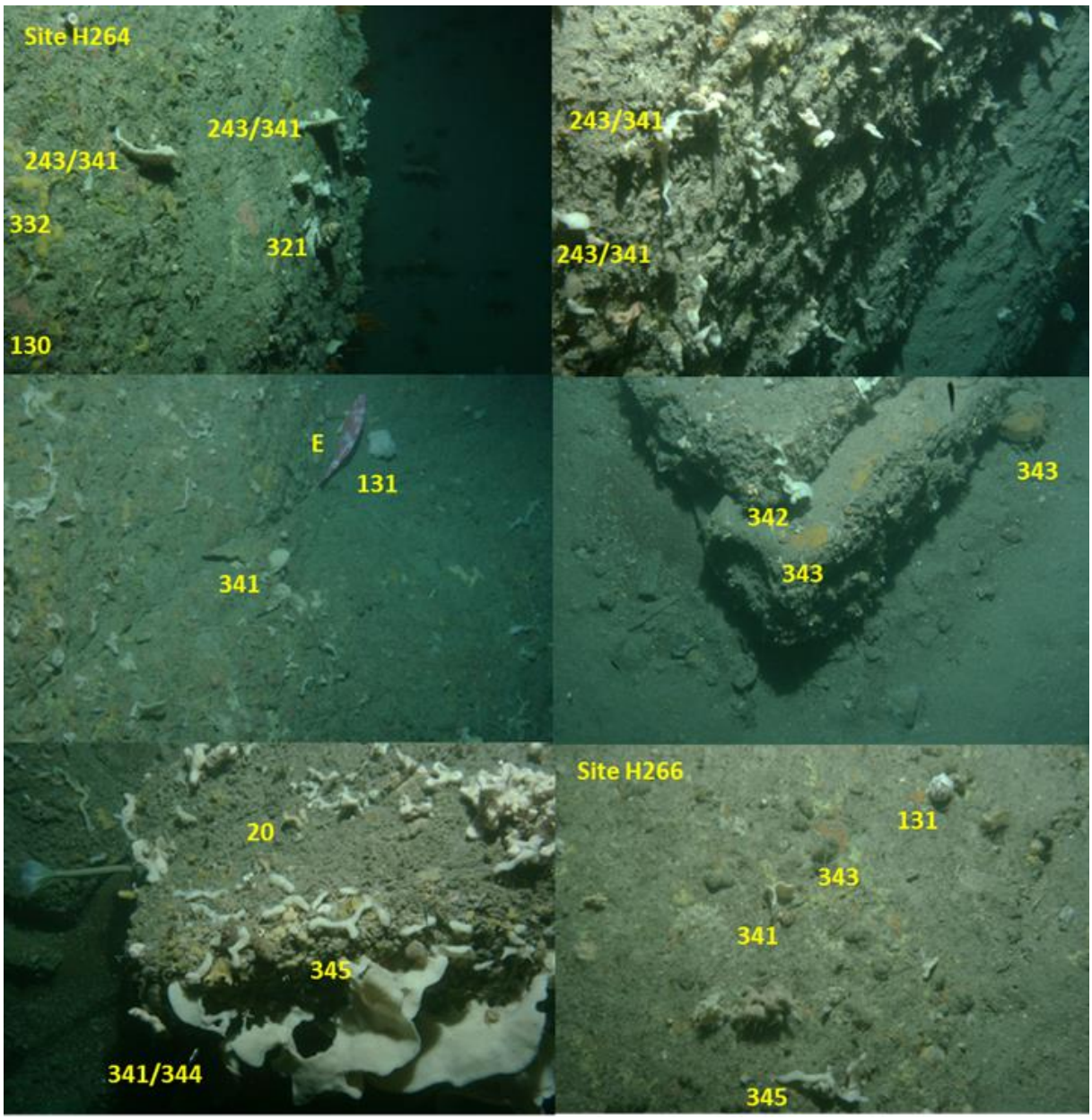

Figure B-56: Bay of Plenty, TAN1108, Ranfurly Bank, sites H264 (120–130 m), H266 (160–180 m). Sponges 20) *Aciculites pulchra* (?), 130) *Darwinella* cf *gardineri*, 131) *Psammocinia* sp. indet. (?), 243) *Xestospongia* cf *corallodies*, 332) *Iophon* sp. indet., 341) *Neopetrosia* sp. indet., 342) *Haplosclerida* sp. indet. (?), 343) *Poecilosclerida* sp. indet. (?), 344) *Lissodendoryx* sp., 345) Chalinidae sp. indet.?; Ascidians, 323) *Molgula* sp.; Worms, 309) Sabellidae; Mobile invertebrates, gastropods, 321) *Ranella australasia* (laying eggs). Fish, E) pink maomao.

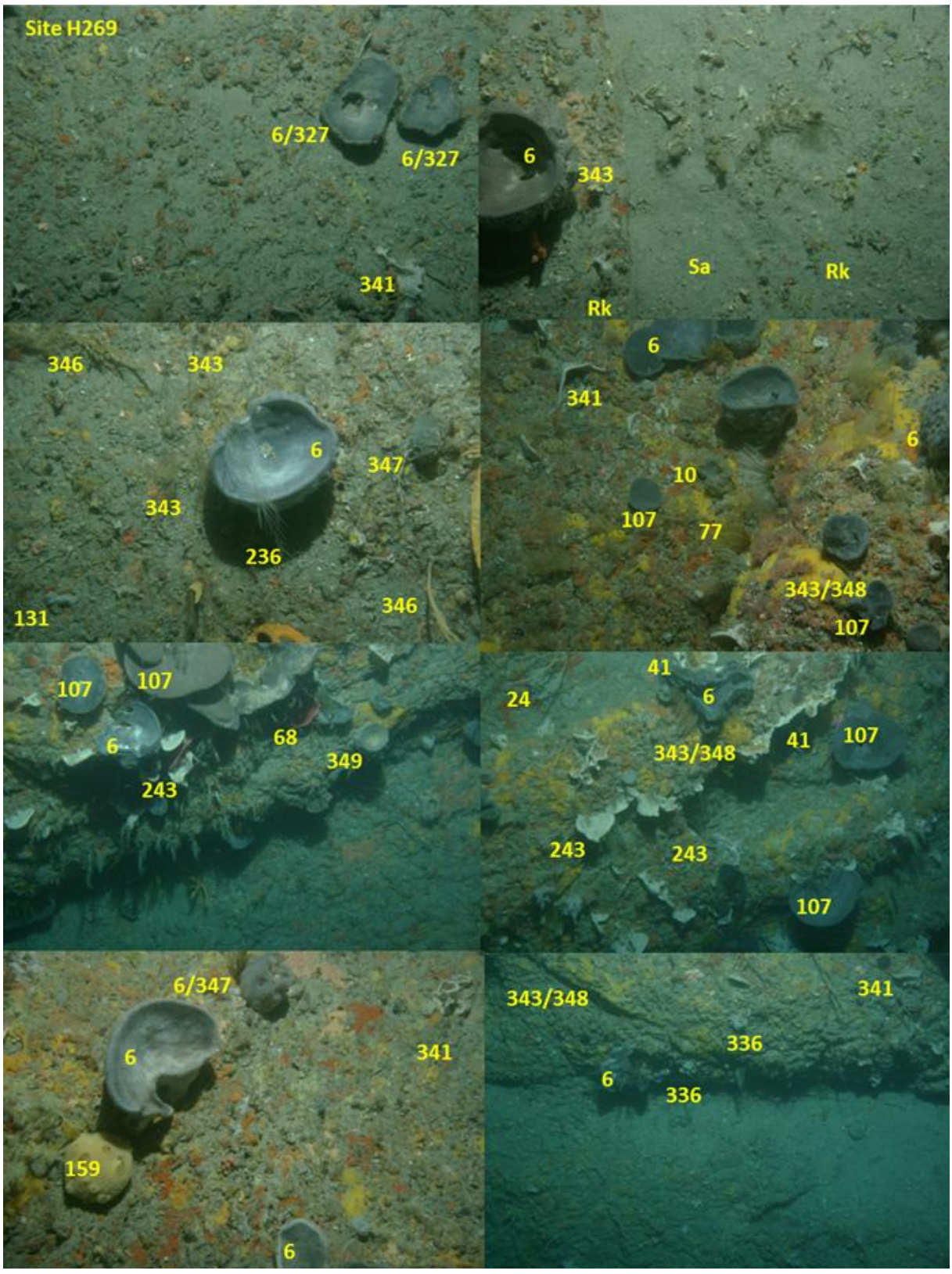

Figure B-57: Bay of Plenty, TAN1108, Ranfurly Bank, sites H269 (84–100 m). Sponges 6) *Ecionemia alata*, 10) *Stelletta columna*, 24) *Callyspongia* sp., 41*) Haliclona* (*Gellius*) *regia*, 68) *Petrosia* cf *hebes*, 107) *Stelletta maori*, 131) *Psammocinia* sp. indet., 159) *Polymastia massalis*, 243) *Xestospongia* cf *corallodies*, 327) *Stelletta conulosa*, 336*) Psammocinia* cf *beresfordae*, 341) *Neopetrosia* sp. indet., 343) Poecilosclerida sp. indet., 346) *Grantia ramulosa* (calcareous sponge), 347) *Stelletta* sp. indet., 348) *Crella incrustans*, 349) *Penares* sp. indet.; Hydroids, 236) *Nemertesia elongata*; Mobile invertebrates Crinoids, 77) Comatulidae.

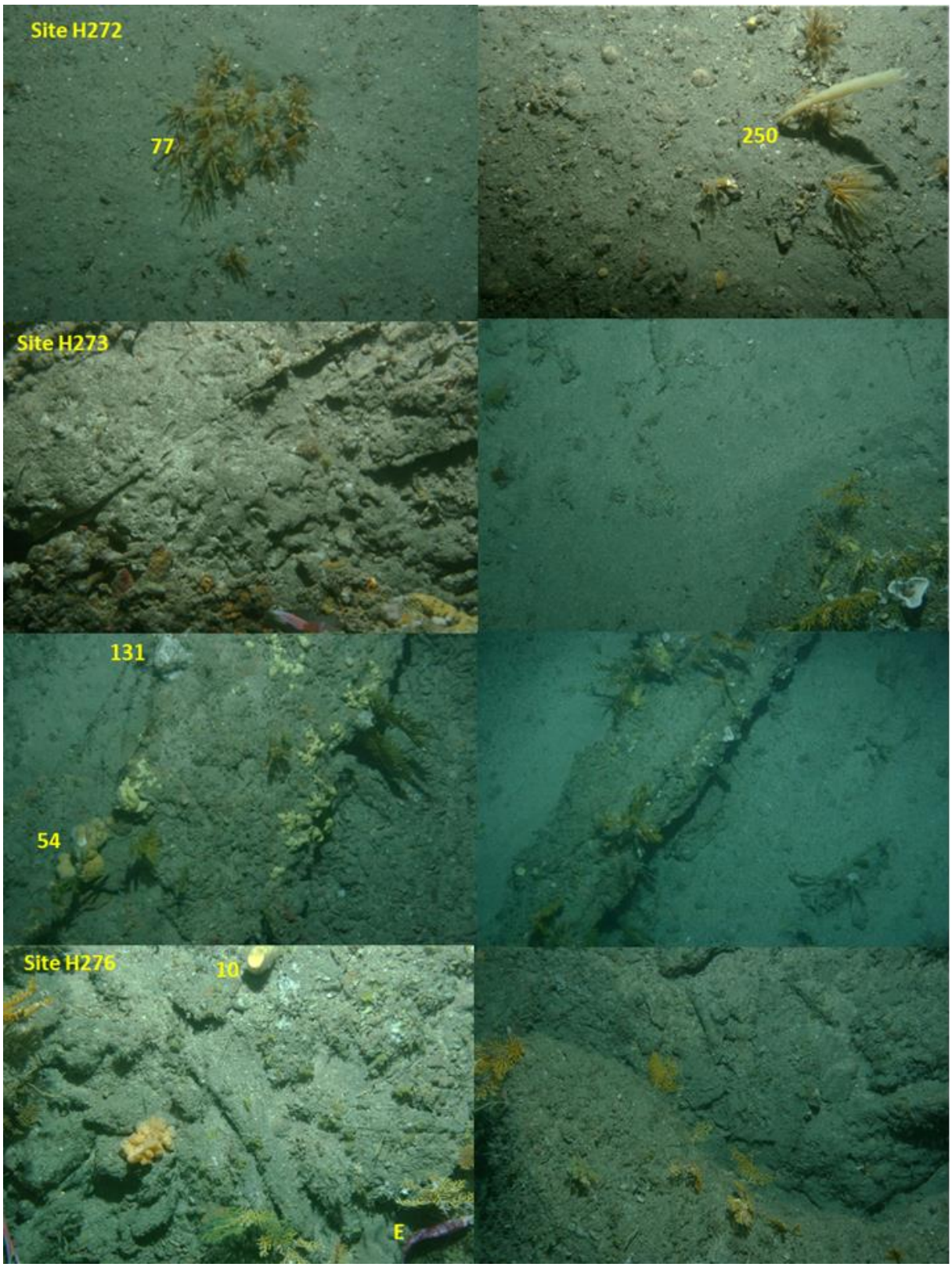

Figure B-58: Bay of Plenty, TAN1108, Ranfurly Bank, s. Mobile invertebrates Crinoids, 77) Comatulidae.

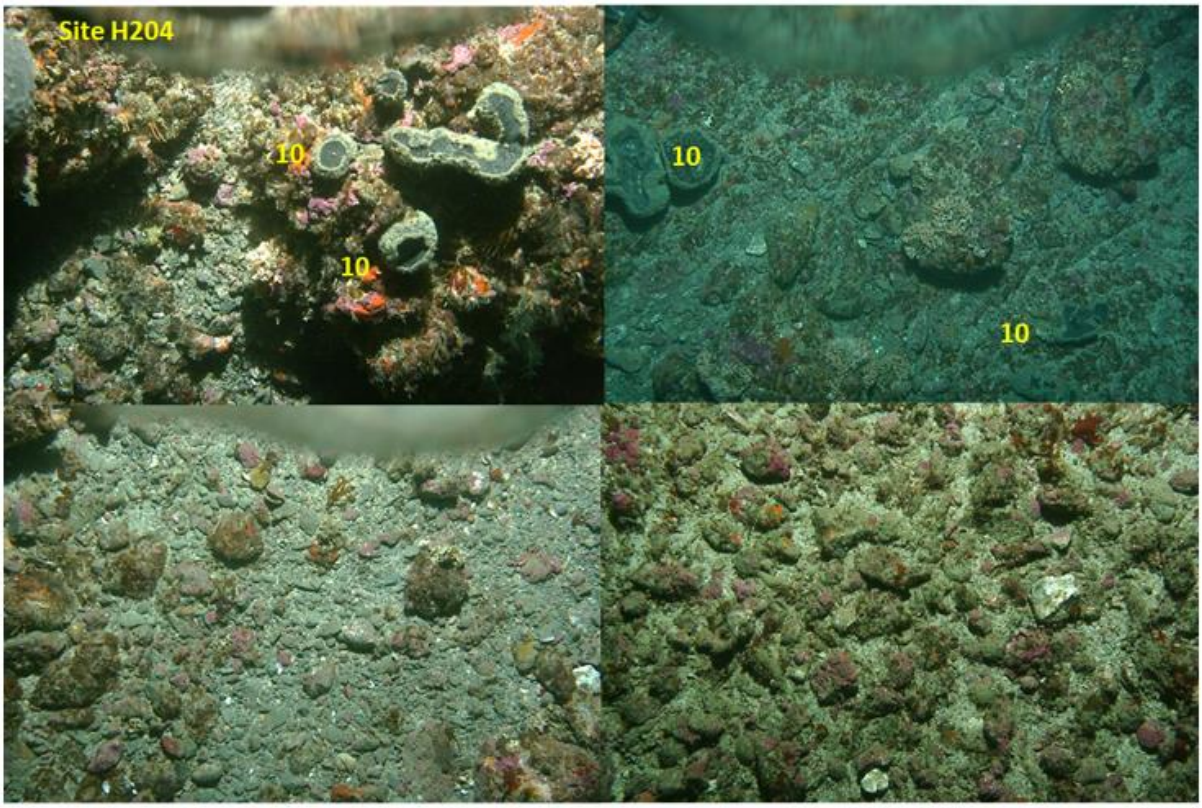

Figure B-59: Bay of Plenty, TAN1108, unnamed rocky ridge, Site H204 (80 m). Some images contain an air bubble artefact. .

Figure B-60: Bay of Plenty, TAN1108, Ariel Bank, Sites H194 (80 m), H196 (50 m), H199 (50 m). Sponges, 6) *Ecoinemia alata*, 68) *Petrosia* cf *hebes*, 249) *Neopetrosia* n sp. 3 (big oscules), 250) *Callyspongia latituba*, 252) *Polymastia aurantia*; Bryozoans 251) Cheilostomata sp.; Algae, 1) coralline algae, 181) non-geniculate corallines, 221) *Ecklonia radiata*, 222) *Caulerpa* sp. Fish, E) Pink maomao.

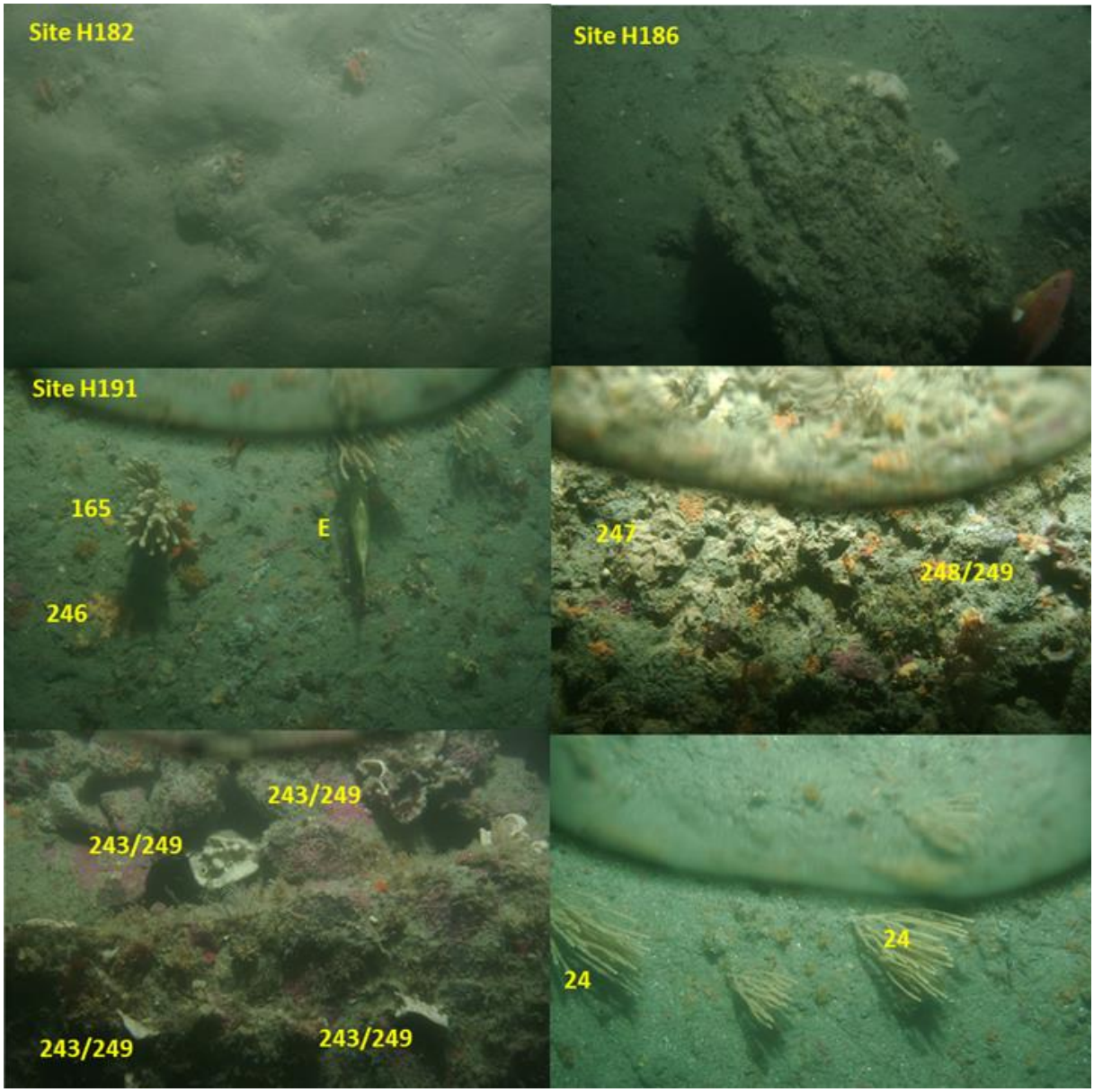

Figure B-61: Bay of Plenty, Table Cape, off Mahia Peninsula), TAN1108, Sites H182 (58 m), H186 (114–123 m) H191 (36 m). There is an air-bubble artefact in some images. Sponges 24) *Callyspongia* sp., 165) *Dactylia varia*, 247) Poecilosclerida sp., 243) *Xestospongia* cf *corallodies*, 248) *Spongia* sp. Indet., 249) *Neopetrosia* n sp. 3 (big oscules); Bryozoans, 246) *Didemnum* sp. Fish, B) Leatherjacket. Little fauna was seen in deeper reef ~~station~~site<u>s</u> in this area, which were heavily sedimented (Jones et al. 2018), note that ~~station~~site H191 shown is only 36 metres water depth, included here as deeper ~~station~~site<u>s</u> reef stills were largely absent in this area.

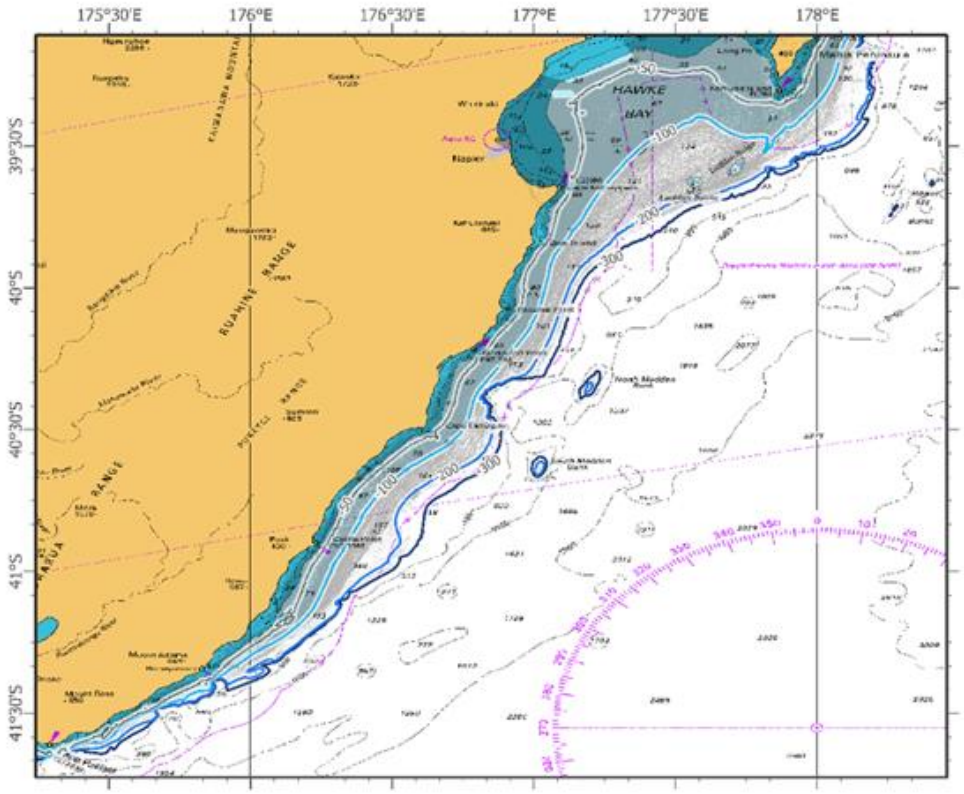

Figure B-62: Wairarapa, nautical chart. Includes place names, bathymetry contours (dark blue line 300m depth contour; medium blue line 200 m contour; light blue line 100 m contour; grey line 50 m contour), and commercial trawl footprint (2003–2014) (grey lines are individual tows). Pink line with cross bars, territorial sea boundary (twelve nautical miles).

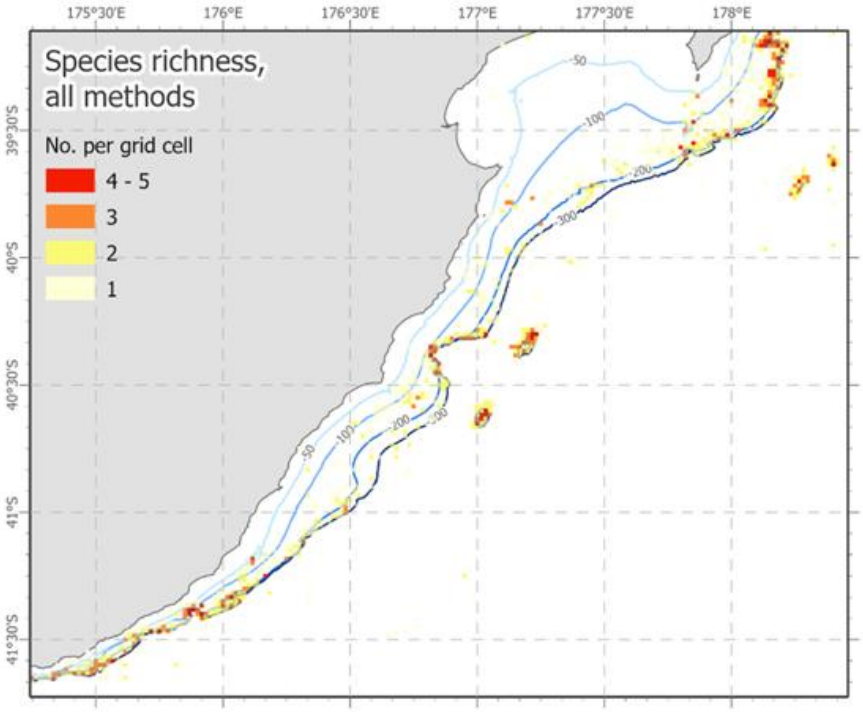

Figure B-63: Wairarapa, commercial catch of reef-indicator species: species richness.

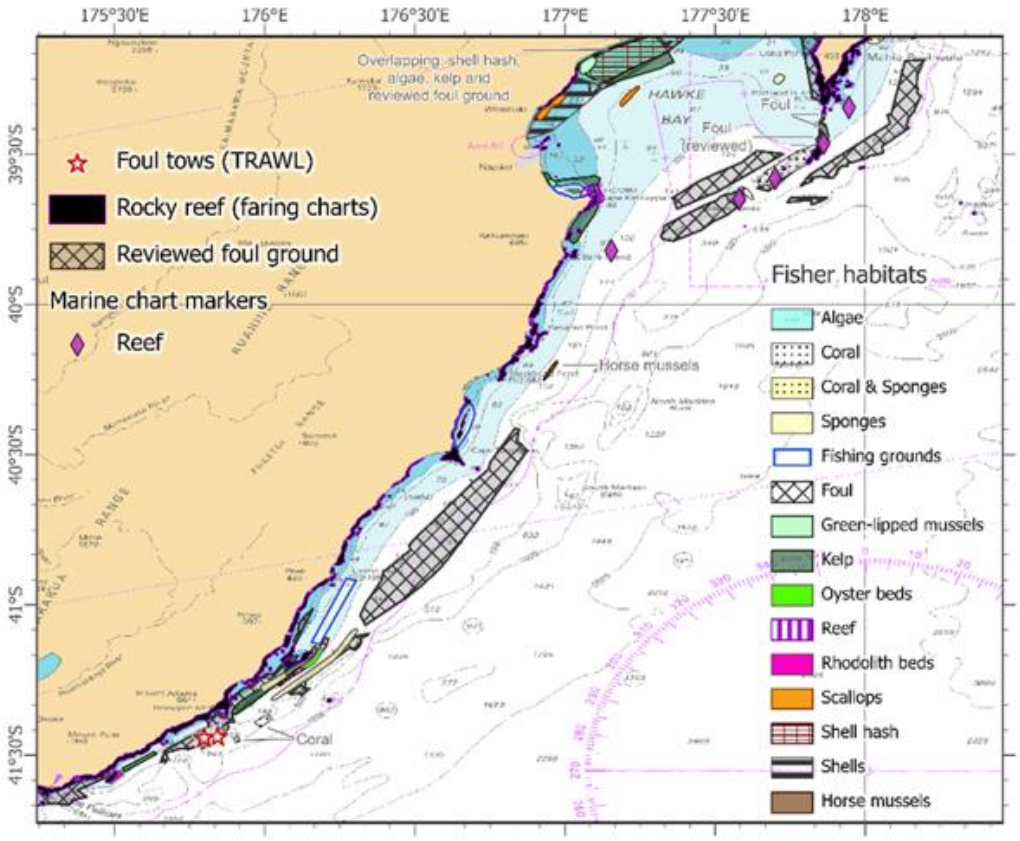

Figure B-64: Wairarapa, fisher habitats. Fisher habitats (LEK polygons) includes foul trawl tows (from research trawling), foul definition areas (from research trawling), rocky reef (from charts), marine chart markers for sediment types (reef, cobble, cobbles and reef), DOC putative rocky reef polygons (<100 m water depth, purple coloured polygons).

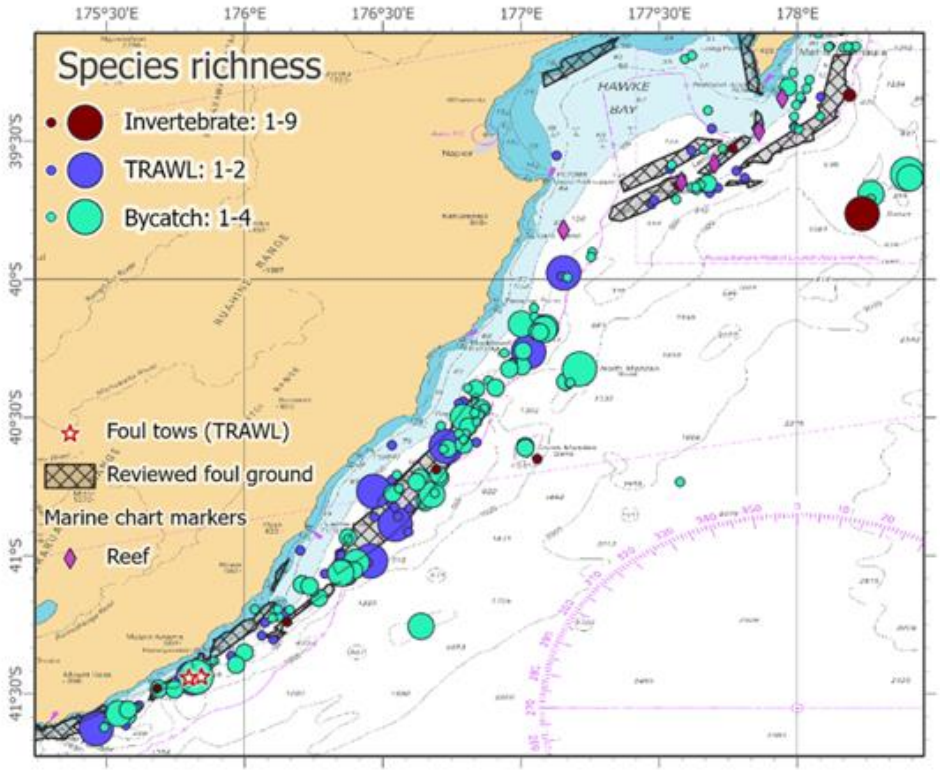

Figure B-65: Wairarapa, reef-indicator species richness for SPECIFY invertebrate, research TRAWL, and fisheries observer bycatch.

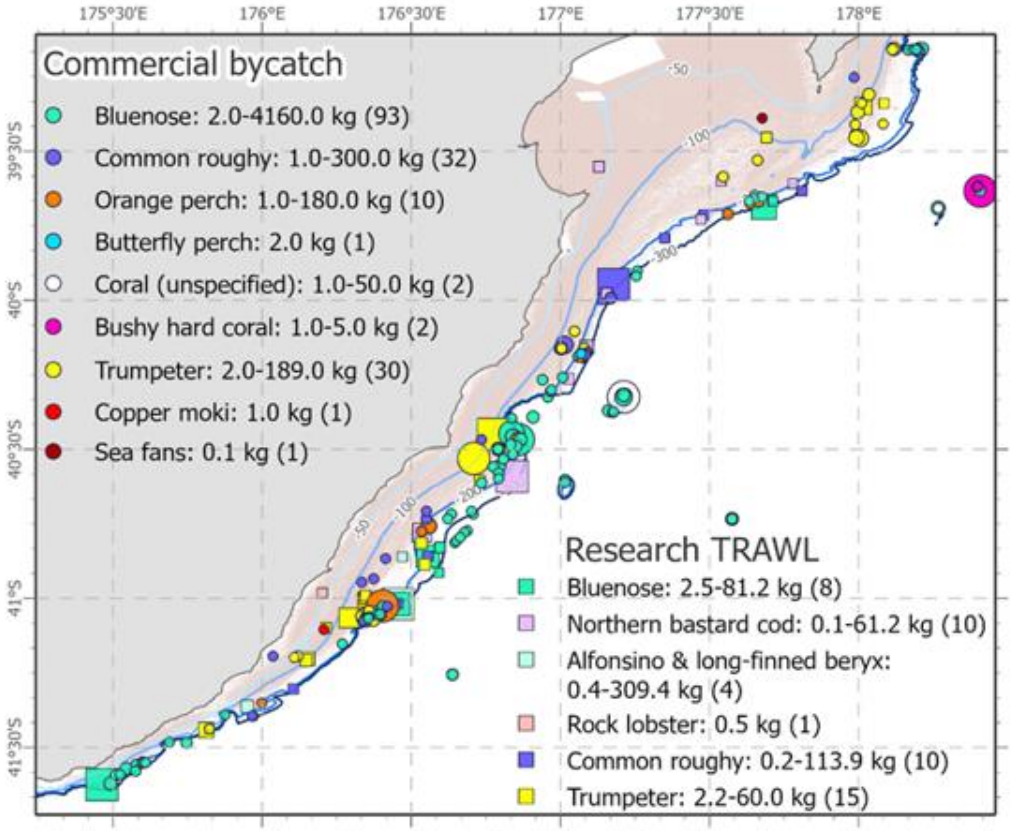

Figure B-66: Wairarapa, commercial fisheries observer bycatch and research TRAWL reef-indicator species catch (kg). The number of sites each species was present at are given in brackets.

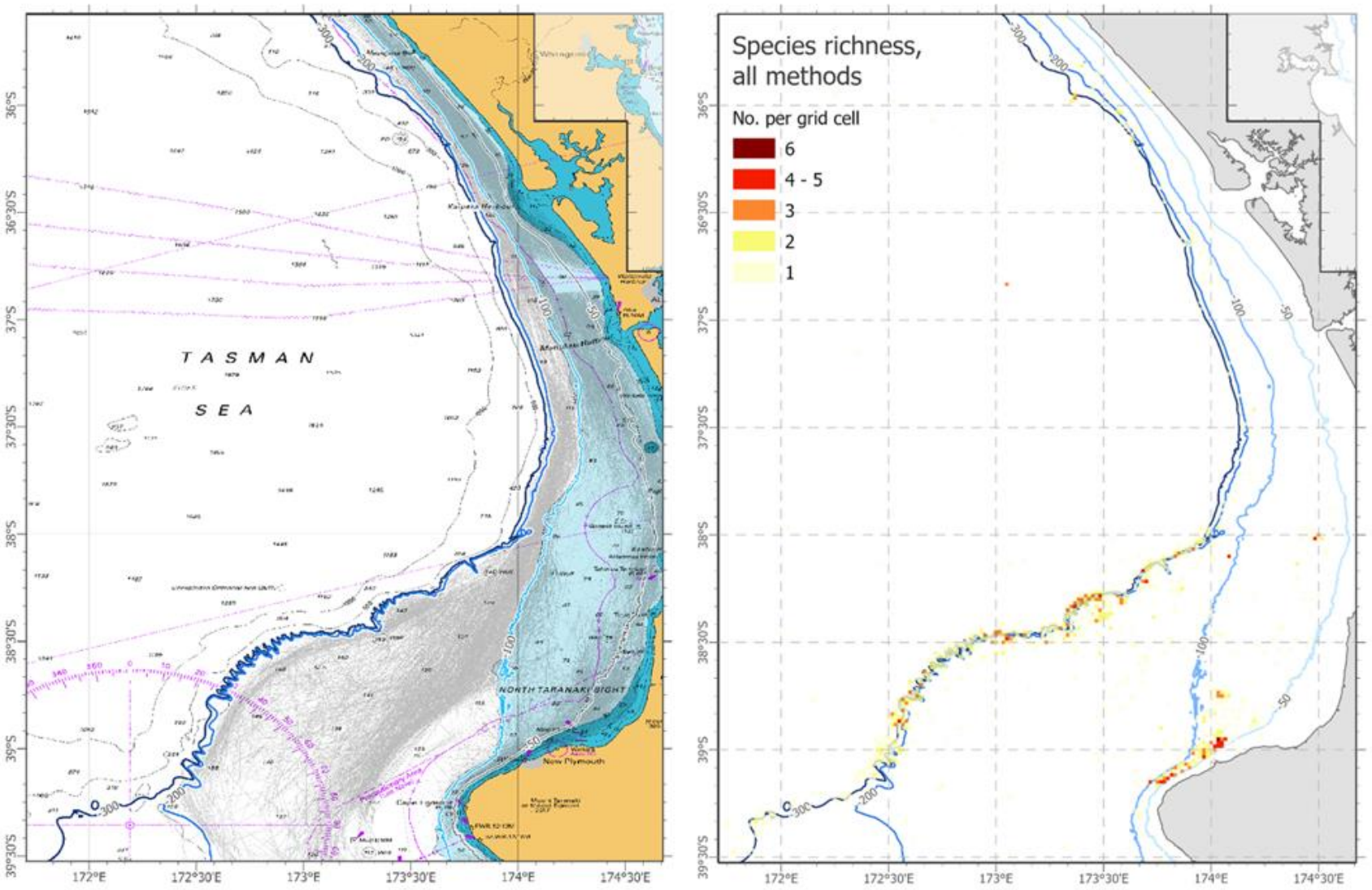

Figure B-67: Taranaki, left) nautical chart and right) commercial catch reef-indicator species diversity (richness). Nautical chart includes place names, bathymetry contours (dark blue line 300m depth contour; medium blue line 200 m contour; light blue line 100 m contour; grey line 50 m contour), and commercial trawl footprint (2003–2014) (grey lines are individual tows). Pink line with cross bars, territorial sea boundary (twelve nautical miles).

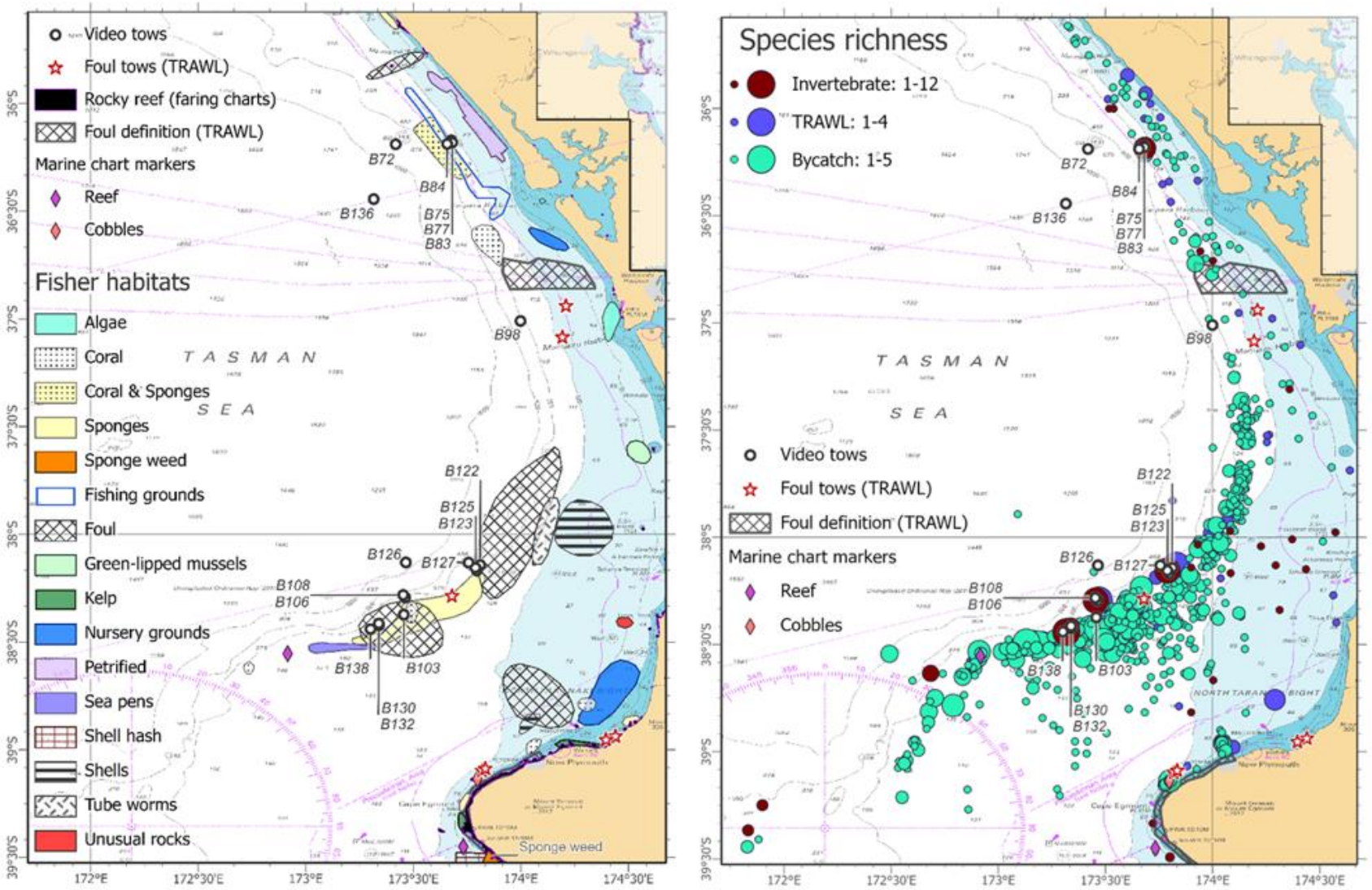

Figure B-68: Taranaki, left) fisher habitats and right) reef-indicator species richness for SPECIFY invertebrate, research TRAWL, and fisheries observer bycatch. Fisher habitats (LEK polygons) includes underwater video tows, foul trawl tows (from research trawling), foul definition areas (from research trawling), rocky reef (from charts), marine chart markers for sediment types (reef, cobble, cobbles and reef), DOC putative rocky reef polygons (<100 m water depth, purple coloured polygons).

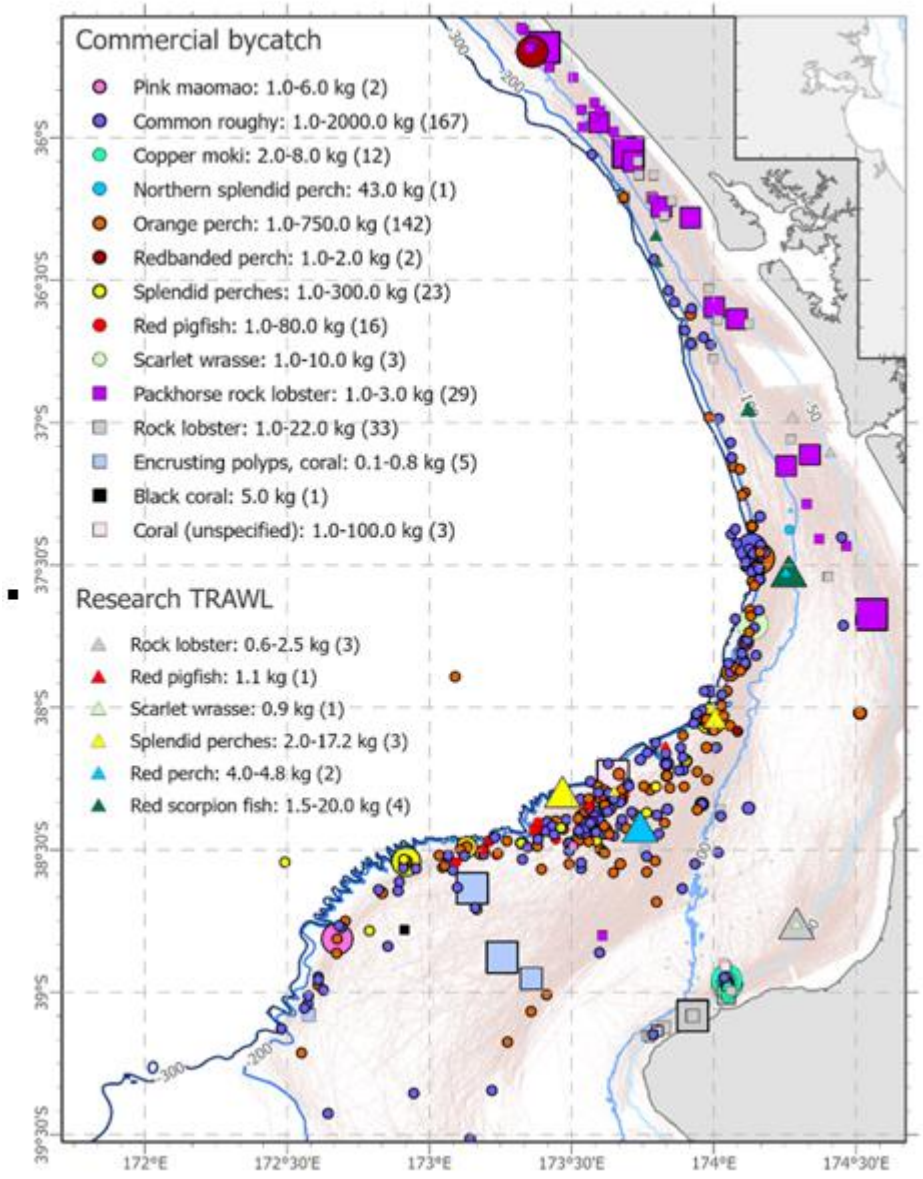

Figure B-69: Taranaki, commercial observer bycatch (kg) of reef-indicator species. The number of sites each species was present at are given in brackets.

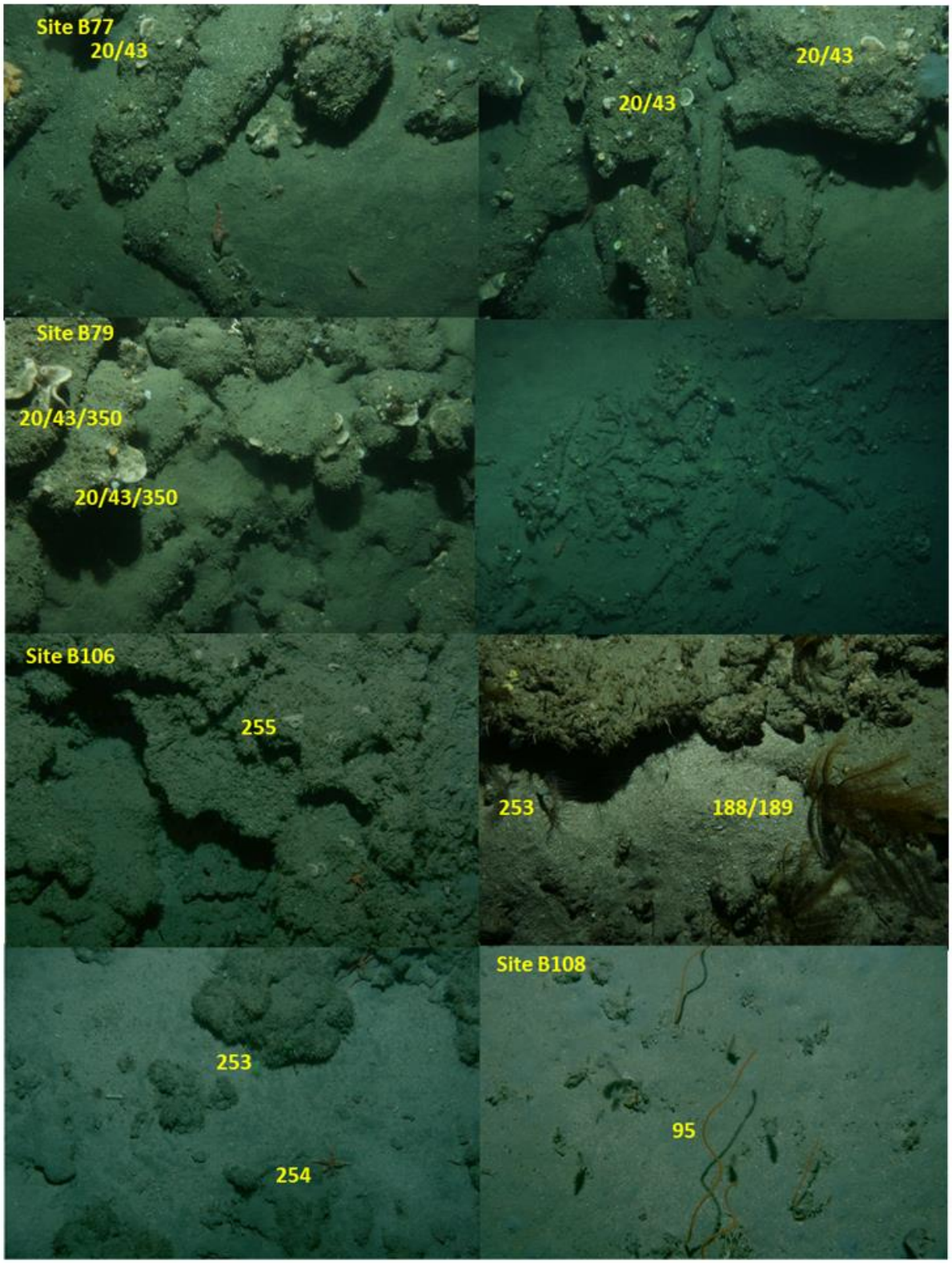

Figure B-70: Taranaki, TAN1105. Three Holes Canyon off Kaipara Harbour, sites B77 (200–240 m), B79 (210–220 m); "The Drop Off" off north Taranaki Bight, B106 (162 m), B108 (192 m). 95) Ellisellidae (soft coral), Anemones 253) Ceriantharia (tube dwelling anemones). Mobile invertebrates, Crinoids, 188) *Anneissia benhami*, 189) *Cenolia novaezelandiae*; Starfish, 254) *Sclerasterias mollis*.

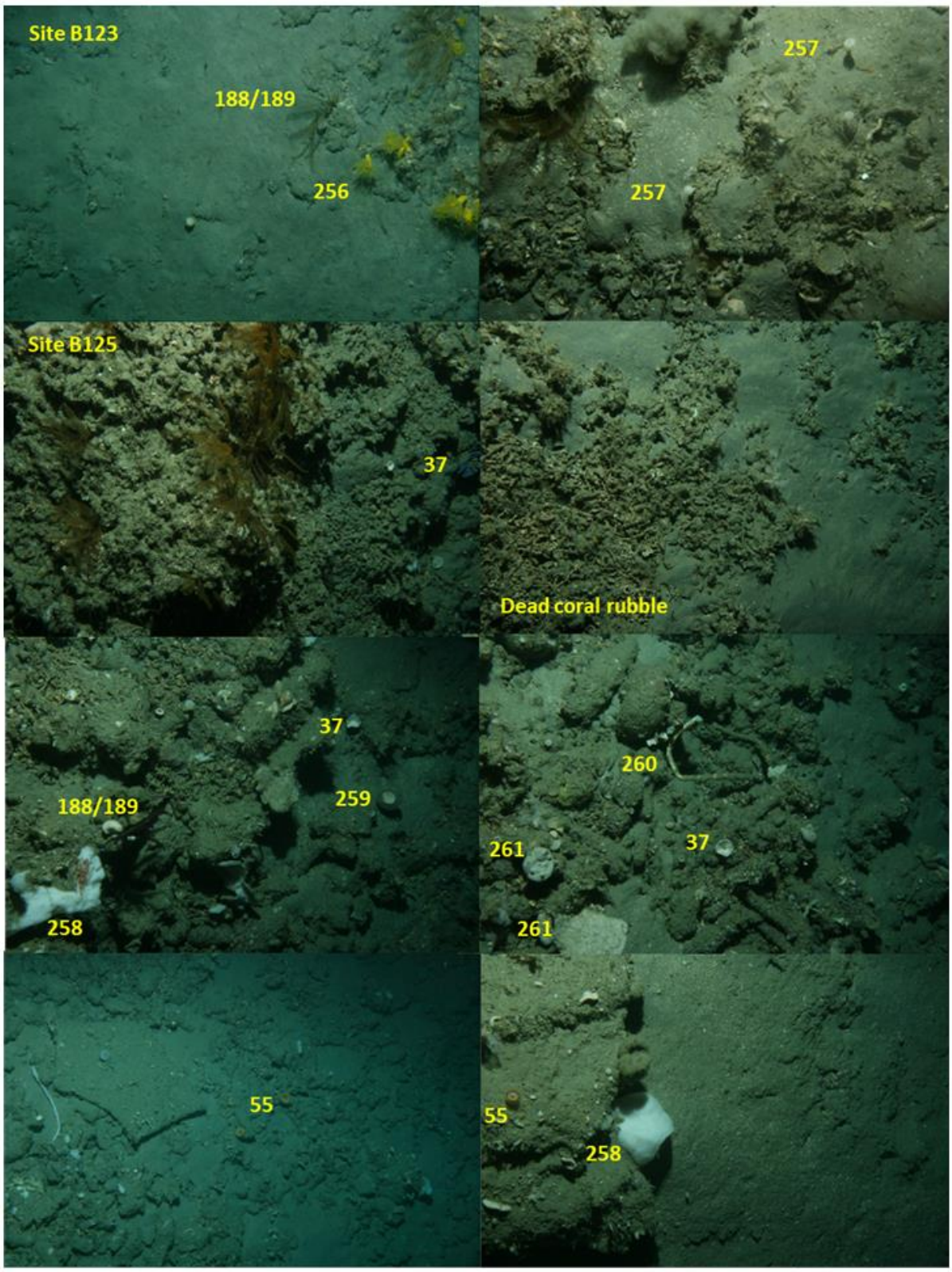

Figure B-71: TARANAKI, TAN1105, The Drop Off, off north Taranaki Bight, B123 (173 m), B125 (265 m). .

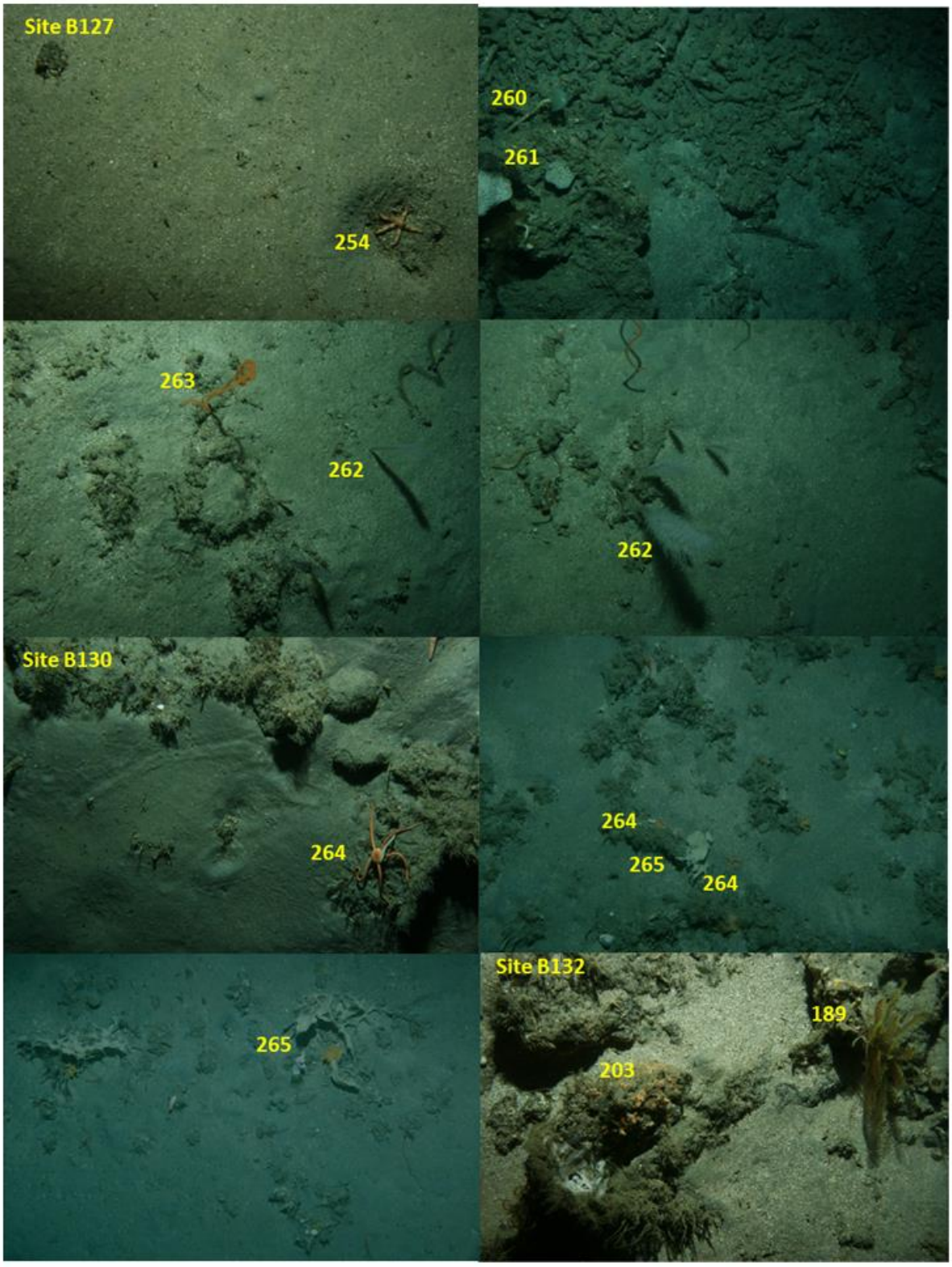

Figure B-72: Taranaki, TAN1105, The Coral Canyon, B127 (257 m), The Well, Site 132 (214 m). Sponges, 203) *Darwinella oxeata* Bergquist, 1961 (with vermetid gastropods), 108) Eleutherobia (soft coral), 262) *Stylopathes* sp., 263) Worms, 260) *Protula bispiralis*. Mobile invertebrates, Starfish, 254) *Sclerasterias mollis*; Ophiuroid, 264) *Ophiopsammus assimilis*.

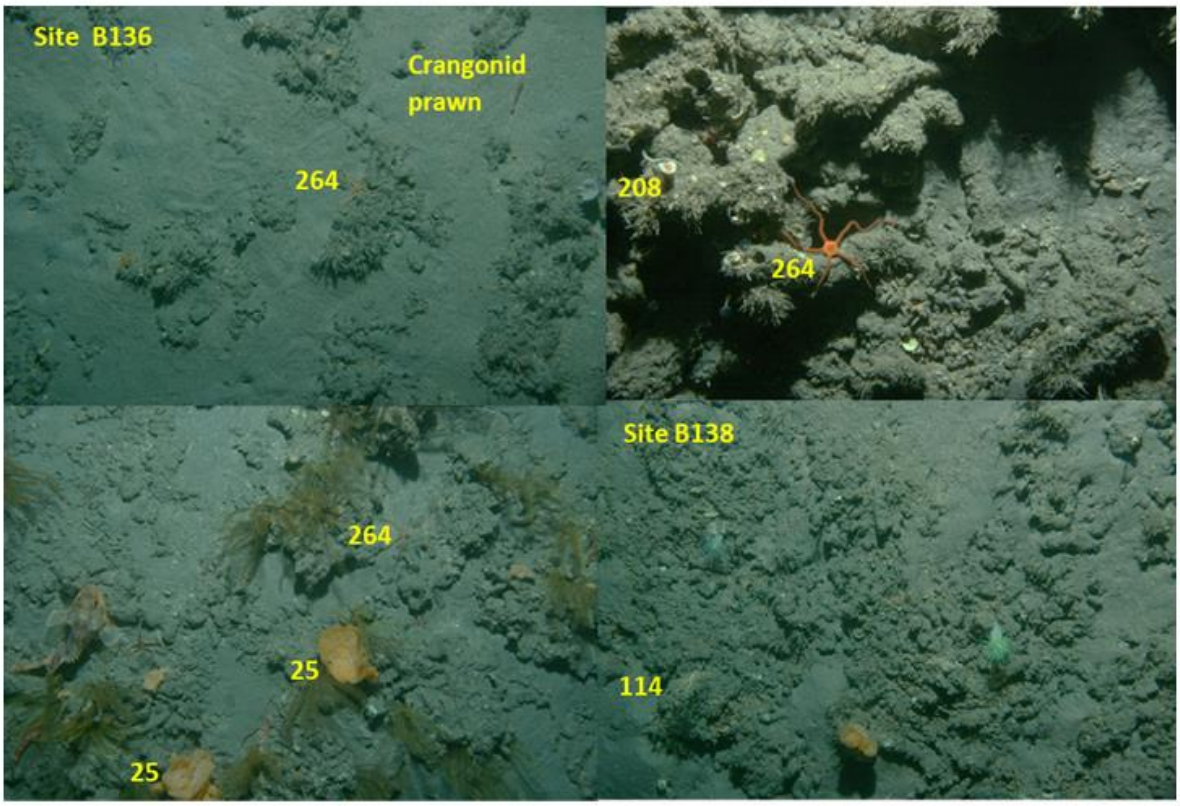

Figure B-73: Taranaki, TAN1105, off north Taranaki Bight, The Well, B136 (240 m), B138 (242 m). Sponge, 25) *Symplectella rowi*; Coral, 114) Plexauridae, 208) Caryophyllia sp. Mobile invertebrates, Ophiuroid, 264) *Ophiopsammus assimilis*.

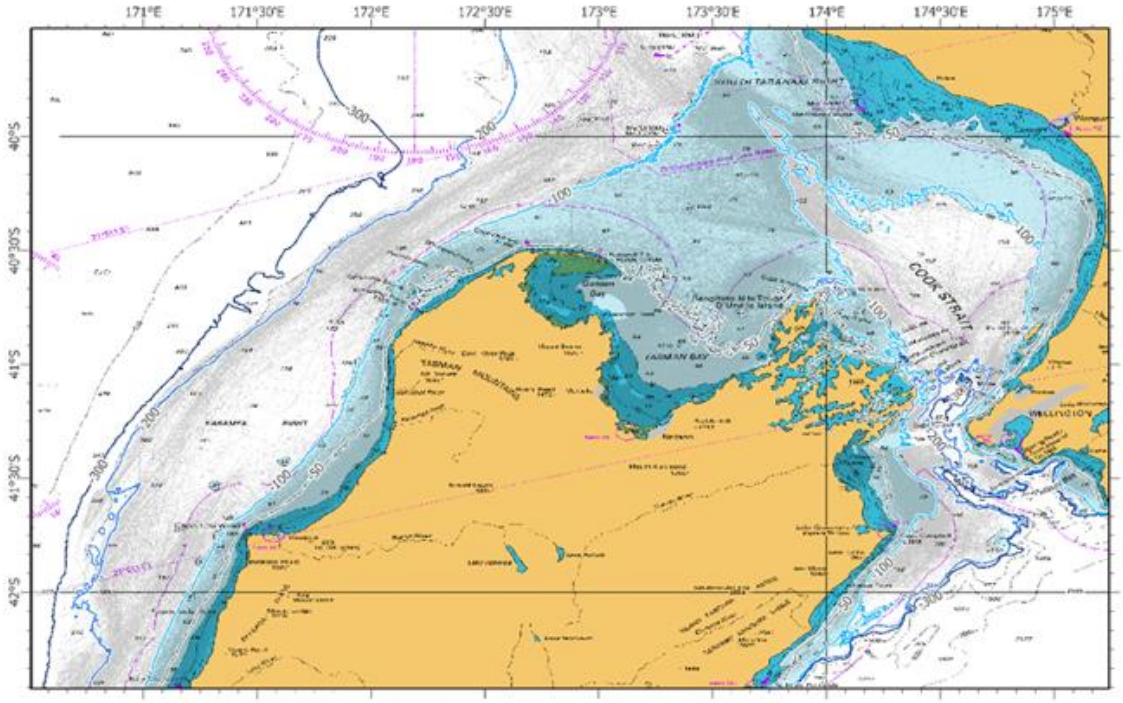

Figure B-74: Golden Bay, nautical chart. Nautical chart includes place names, bathymetry contours (dark blue line 300m depth contour; medium blue line 200 m contour; light blue line 100 m contour; grey line 50 m contour), and commercial trawl footprint (2003–2014) (grey lines are individual tows). Pink line with cross bars, territorial sea boundary (twelve nautical miles).

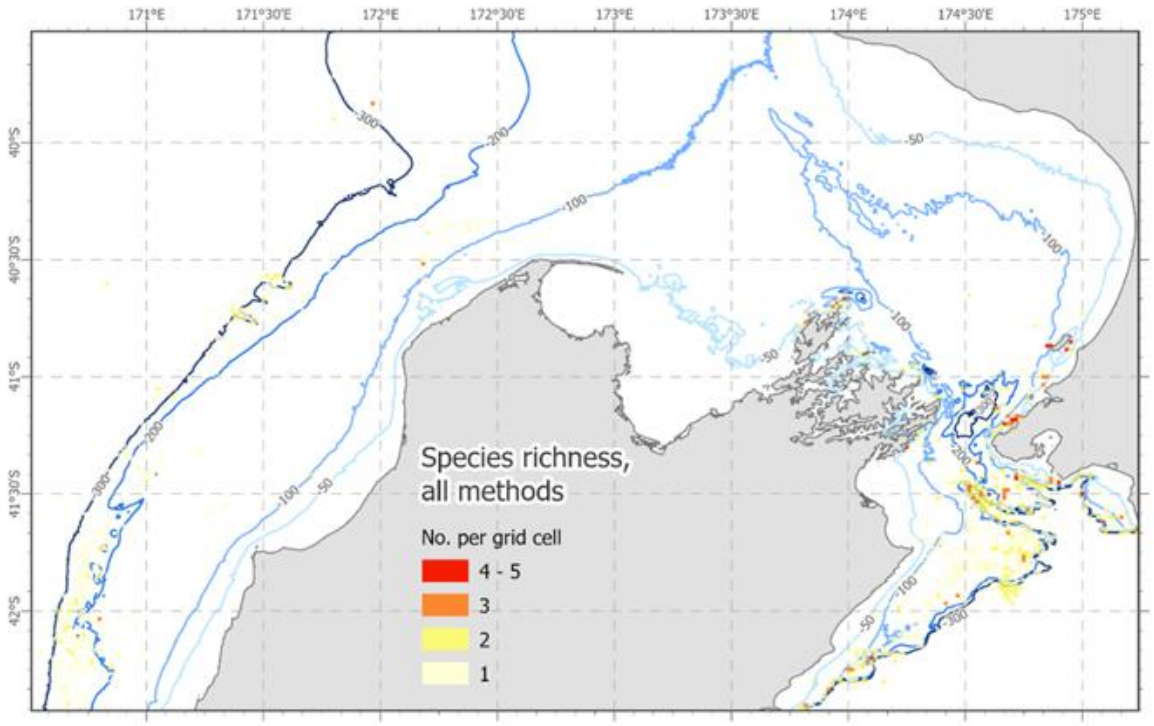

Figure B-75: Golden Bay, commercial catch of reef-indicator species: species richness.

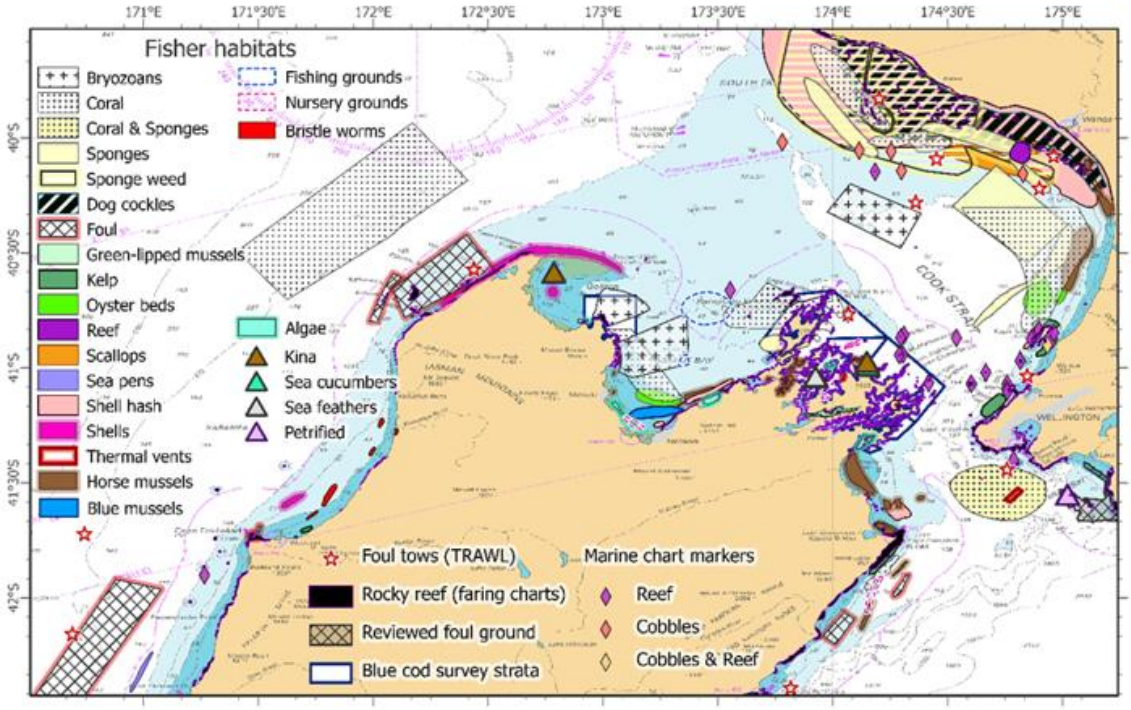

Figure B-76: Golden Bay, fisher habitats. Fisher habitats (LEK polygons) includes underwater video tows, foul trawl tows (from research trawling), foul definition areas (from research trawling), rocky reef (from charts), marine chart markers for sediment types (reef, cobble, cobbles and reef), DOC putative rocky reef polygons (<100 m water depth, purple coloured polygons).

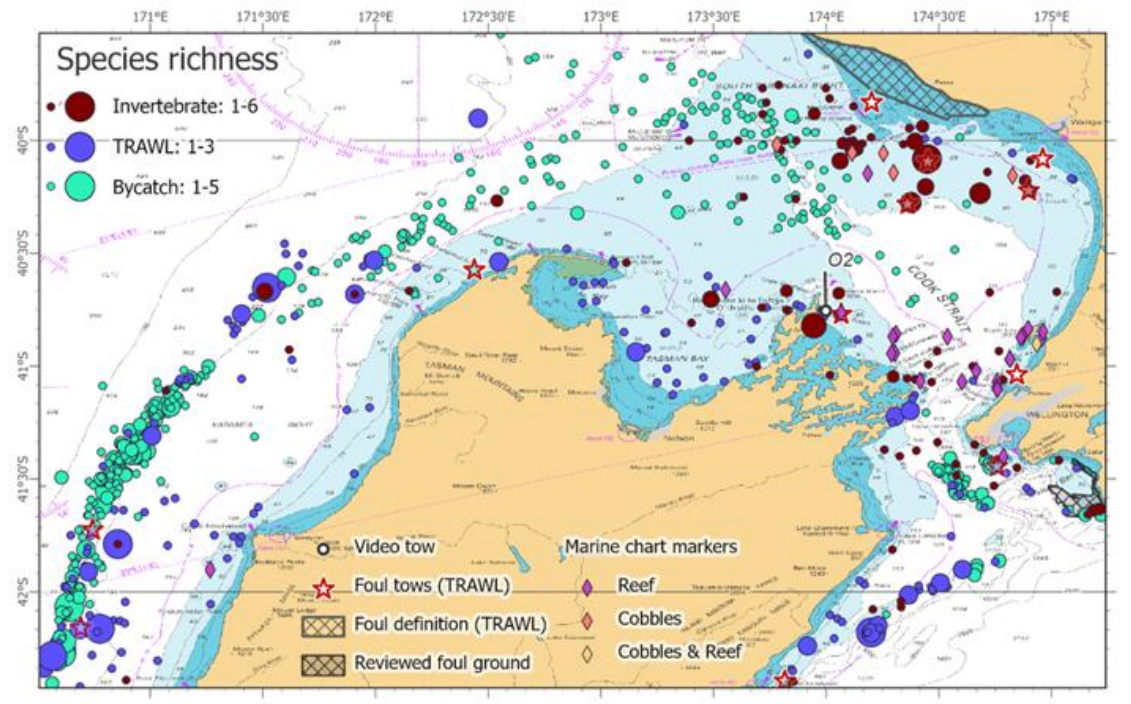

Figure B-77: Golden Bay, reef-indicator species richness for SPECIFY invertebrate, research TRAWL, and fisheries observer bycatch.

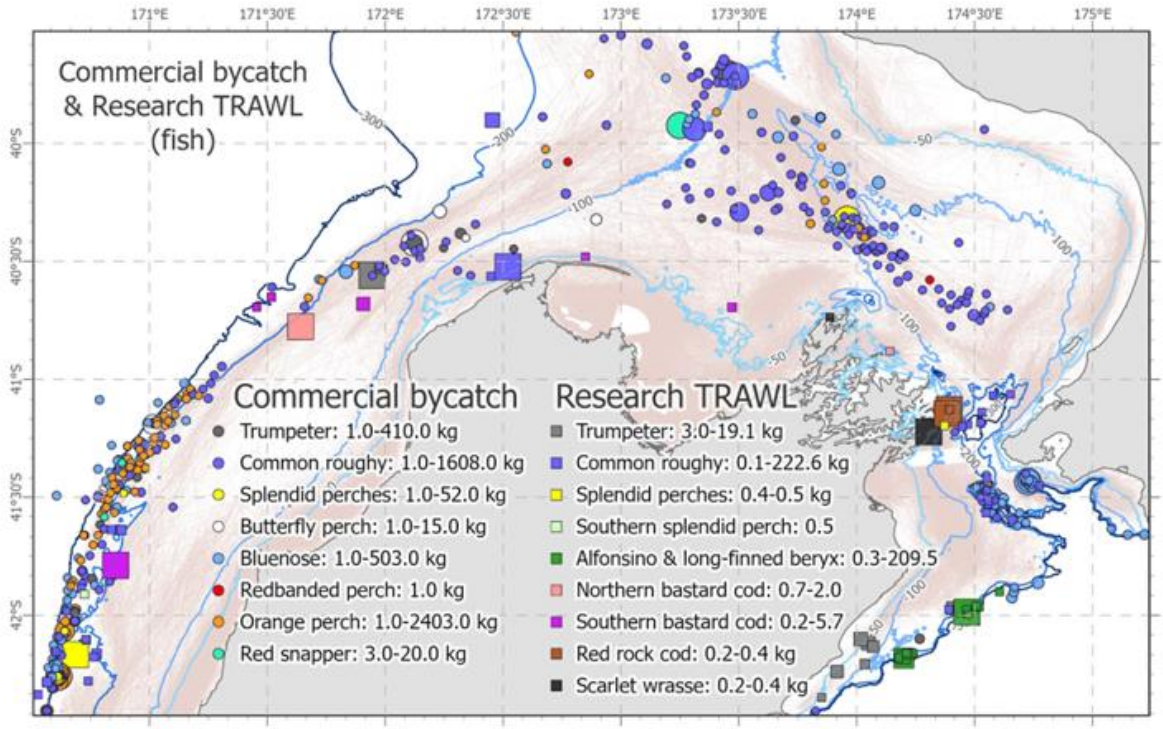

Figure B-78: Golden Bay, commercial fisheries observer and research TRAWL reef-indicator species catch (kg): for fish. The number of sites each species was present at are given in brackets.

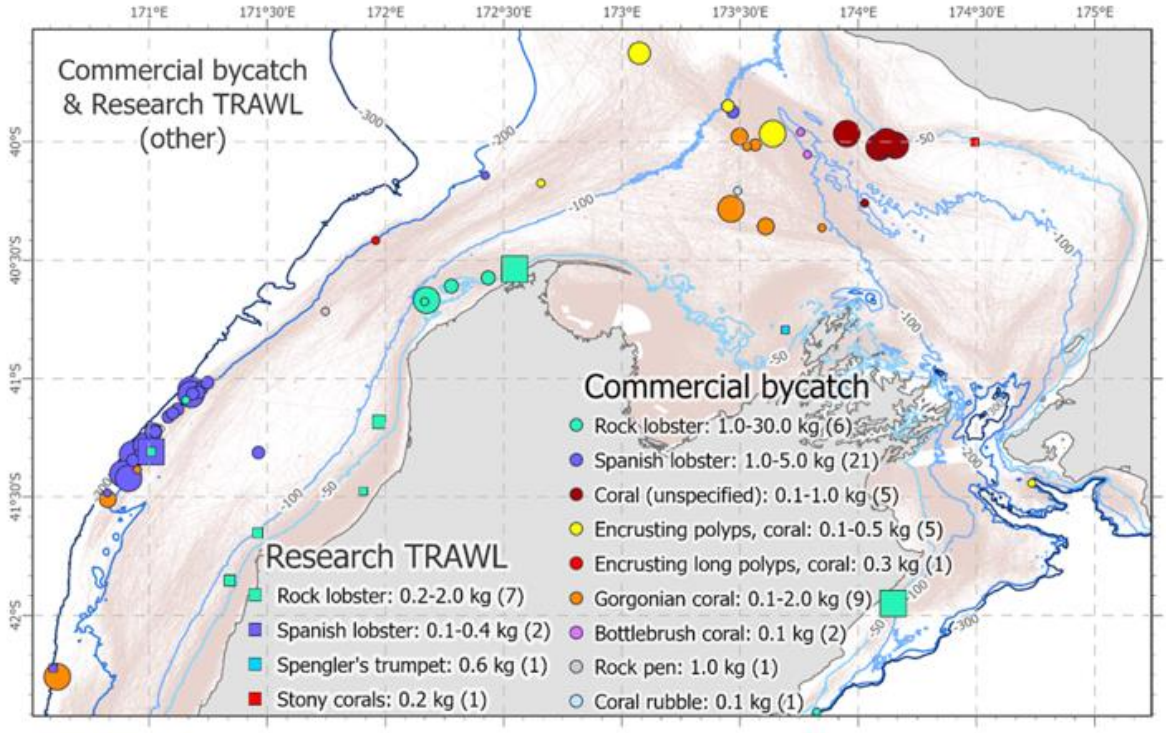

Figure B-79: Golden Bay, commercial fisheries observer and research TRAWL reef-indicator species catch (kg): for invertebrates. The number of sites each species was present at are given in brackets.

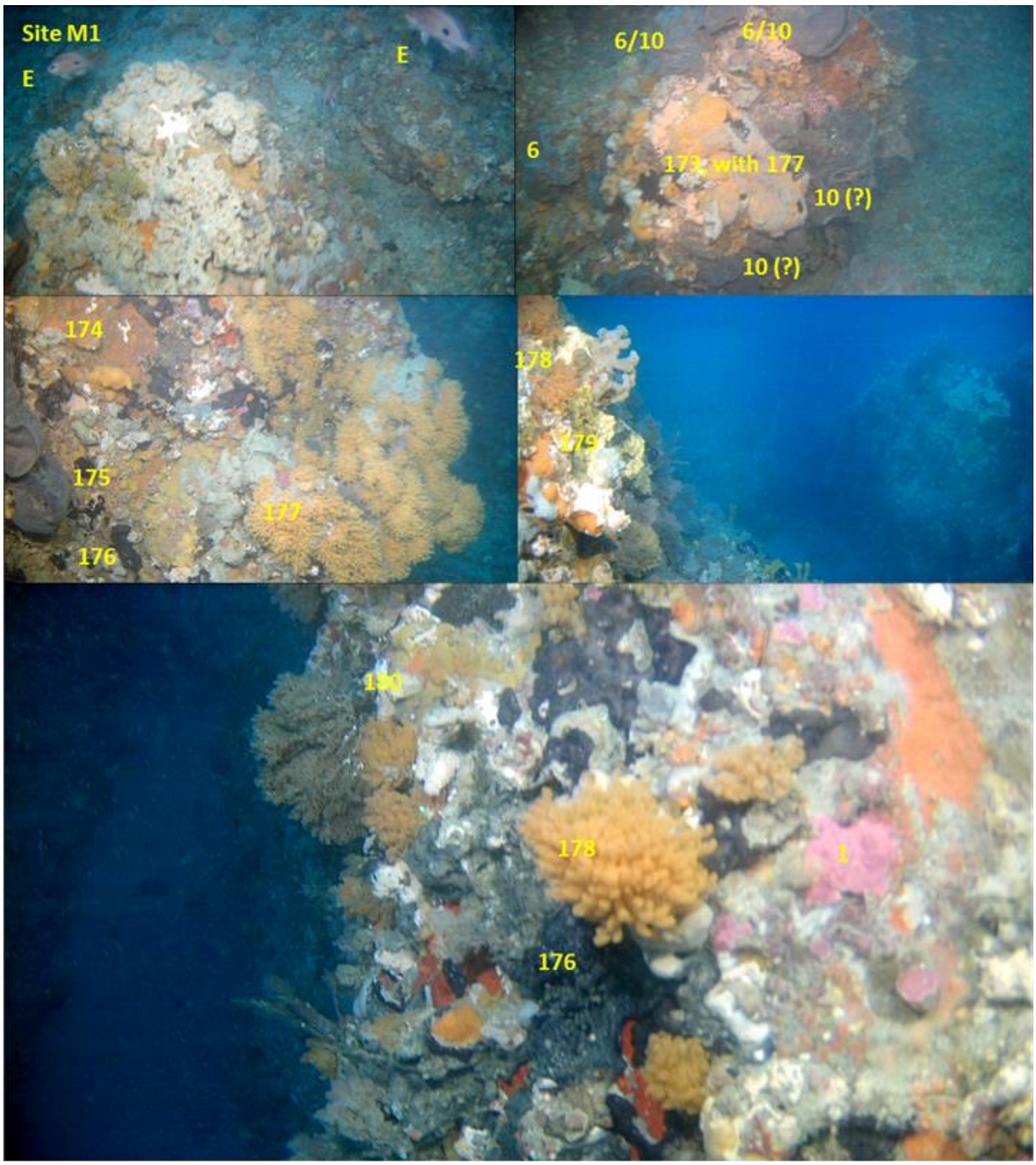

Figure B-80: Golden Bay, east Rangitoto Islands, off Marlborough Sounds. Site M1 (40–60 m). Image order runs left to right. Sponges 6) *Ecionemia alata*; 10) *Stelletta maori*, 173) *Cliona* cf *celata*; Ascidians 172) multiple colonial ascidian species, 174) *Aplidium knoxi* (orange colonial ascidian), 175) *Corynactis australis*, 176) *Didemnum jucundum* (black ascidian), 177) Epizoanthus sp., 179) Calcarea (lemon colour), 180) *Leptoclinides novaezelandiae*, Bryozoans, 178) Catenicellidae; Algae, 1) non-geniculate corallines. Fish A) butterfly perch.

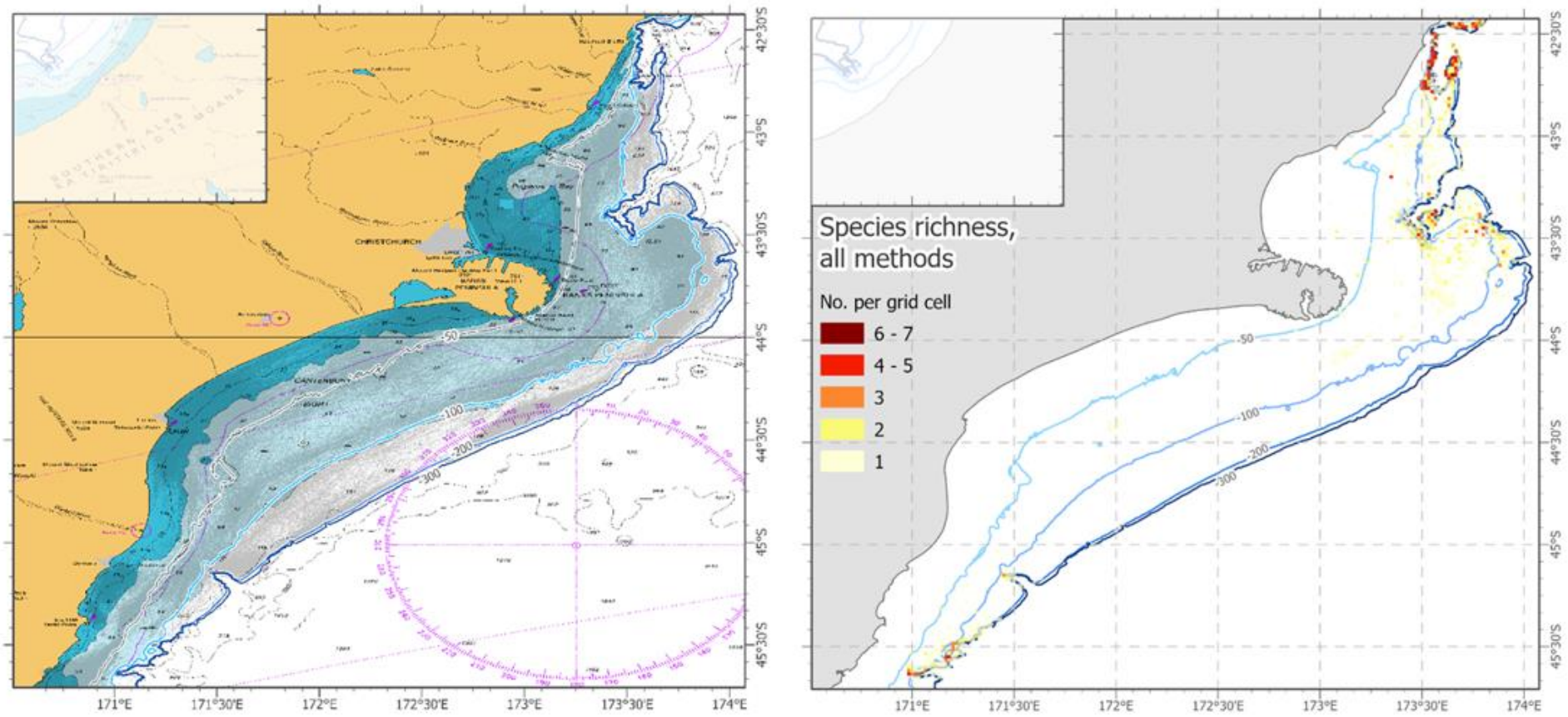

Figure B-81: Canterbury, left) nautical chart and right) commercial catch of reef-indicator species: species richness. Nautical chart includes place names, bathymetry contours (dark blue line 300m depth contour; medium blue line 200 m contour; light blue line 100 m contour; grey line 50 m contour), and commercial trawl footprint (2003–2014) (grey lines are individual tows). Pink line with cross bars, territorial sea boundary (twelve nautical miles).

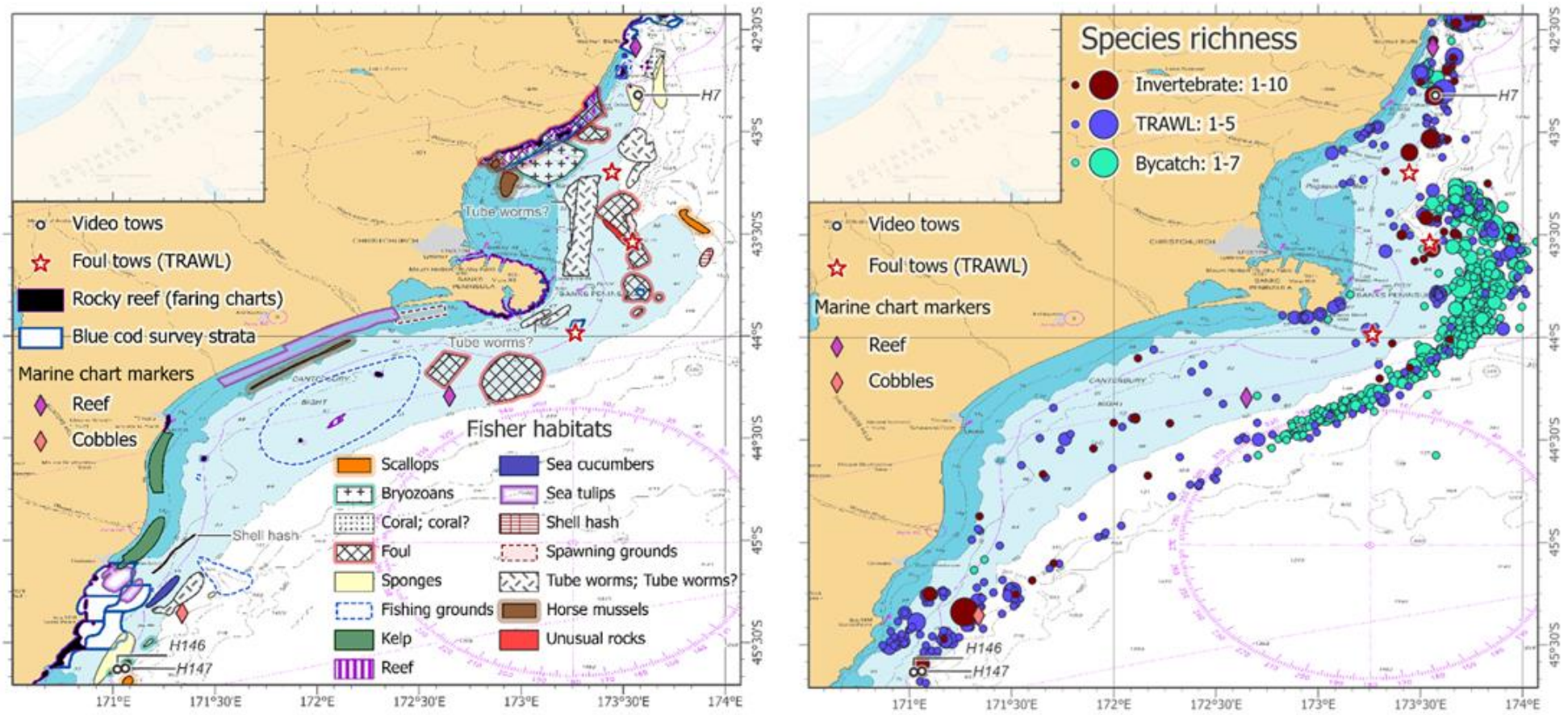

Figure B-82: Canterbury, left) fisher habitats and right) reef-indicator species richness for SPECIFY invertebrate, research TRAWL, and fisheries observer bycatch. Fisher habitats (LEK polygons) includes underwater video tows, foul trawl tows (from research trawling), foul definition areas (from research trawling), rocky reef (from charts), marine chart markers for sediment types (reef, cobble, cobbles and reef), DOC putative rocky reef polygons (<100 m water depth, purple coloured polygons).

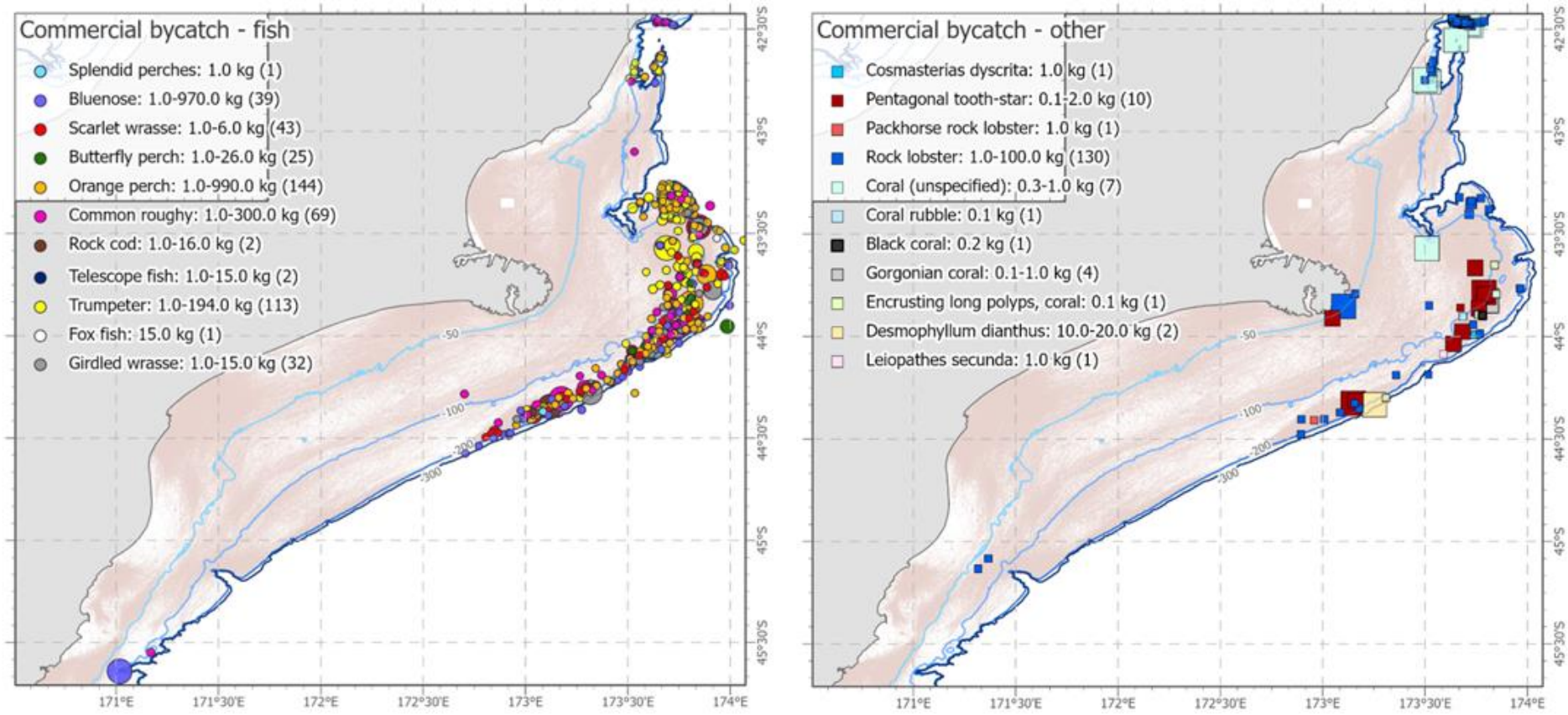

Figure B-83: Canterbury, fisheries observer bycatch of reef-indicator species catch (kg): left) fish; right) invertebrates. The number of sites each species was present at are given in brackets.

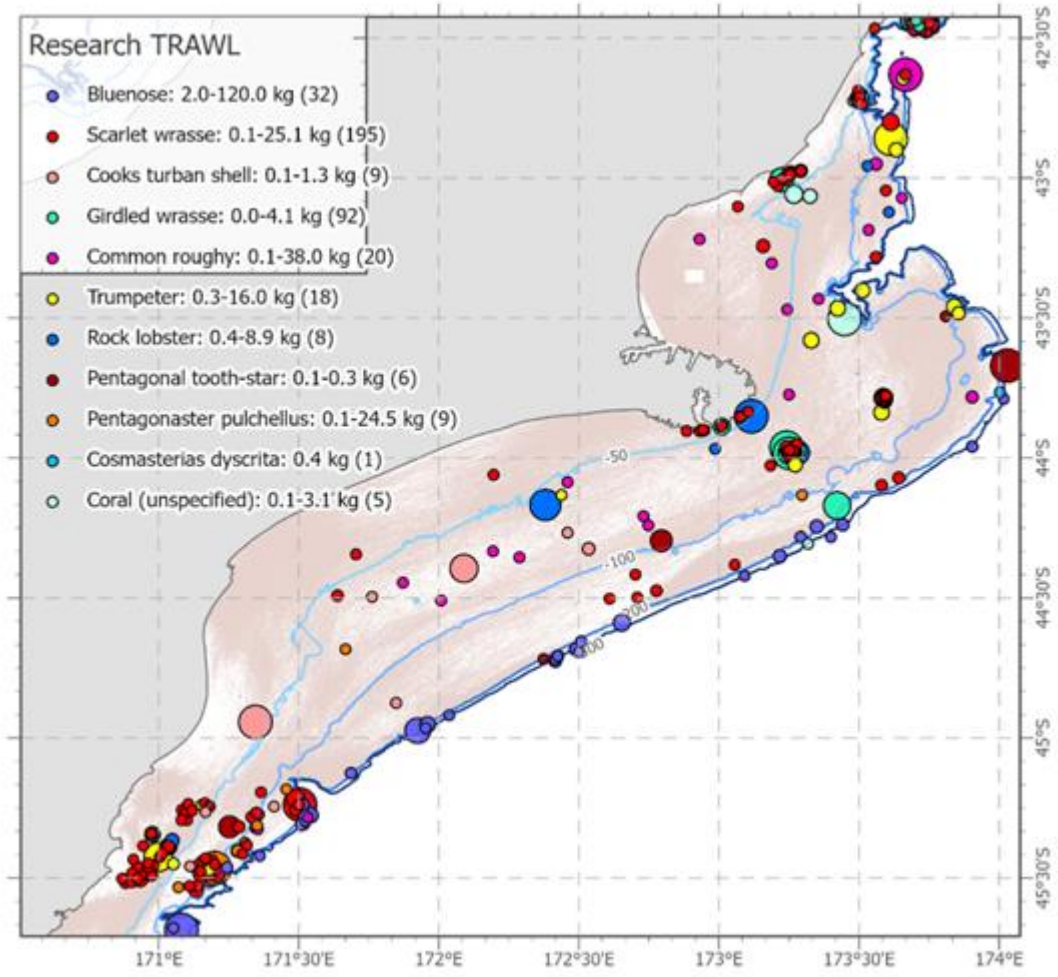

Figure B-84: CANTURBURY, research TRAWL reef-indicator species catch (kg). The number of sites each species was present at are given in brackets.

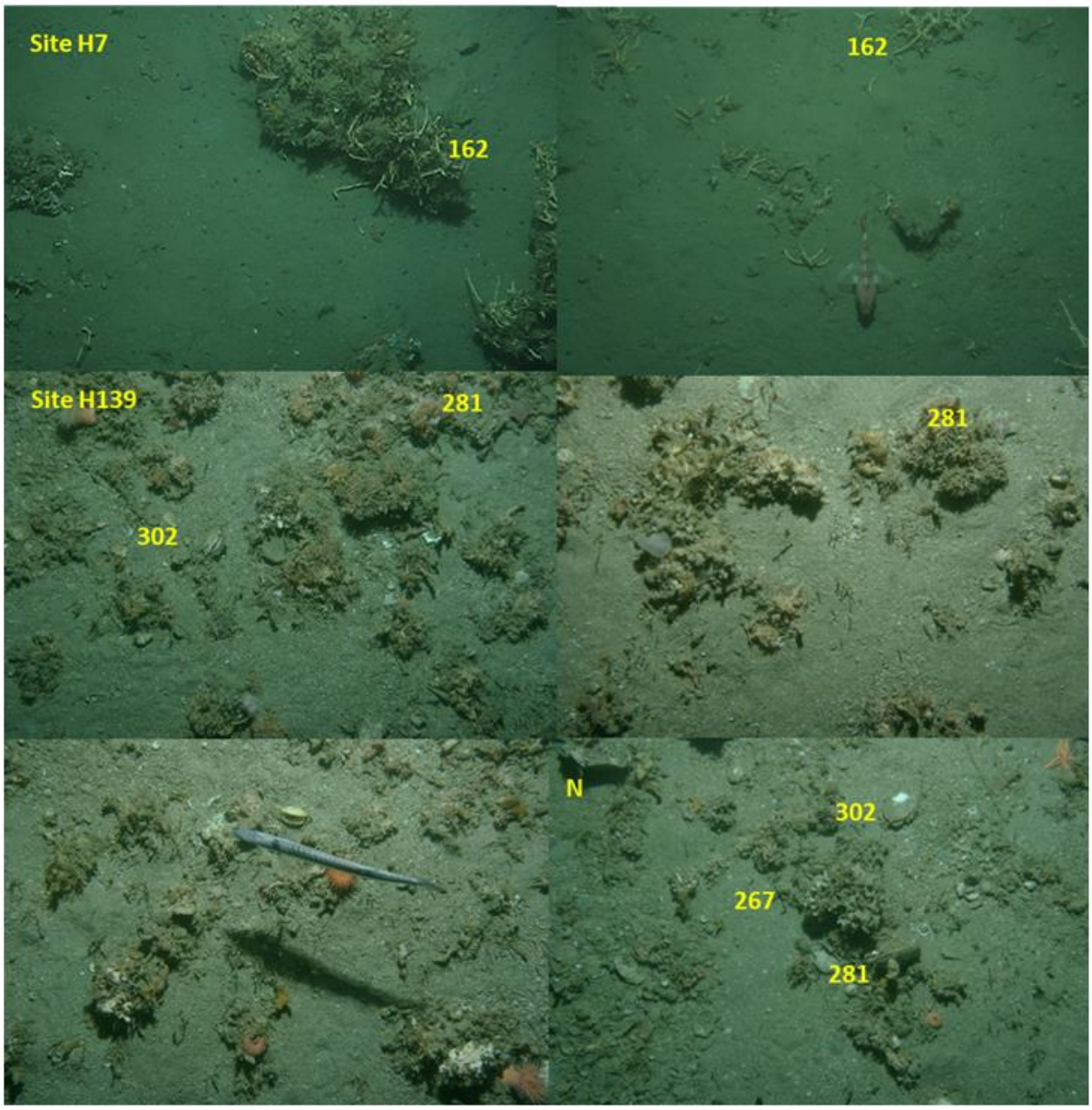

Figure B-85: Canterbury, TAN1108, top) Conway Ridge Site H7 (87 m) and bryozoan patch site H139 (93 m), adjacent to Cornish Head Canyon. Image order runs left to right. Sponges, 162) *Chondropsis* sp. (?); Bryozoans, 267) *Hippomenella vellicata*; Bivalves 281) horse mussel *Atrina zelandica*, 302) oyster *Ostrea chilensis*, Mobile invertebrates, starfish 281) *Pentagonaster pulchellus*, Fish, N) pigfish sp.

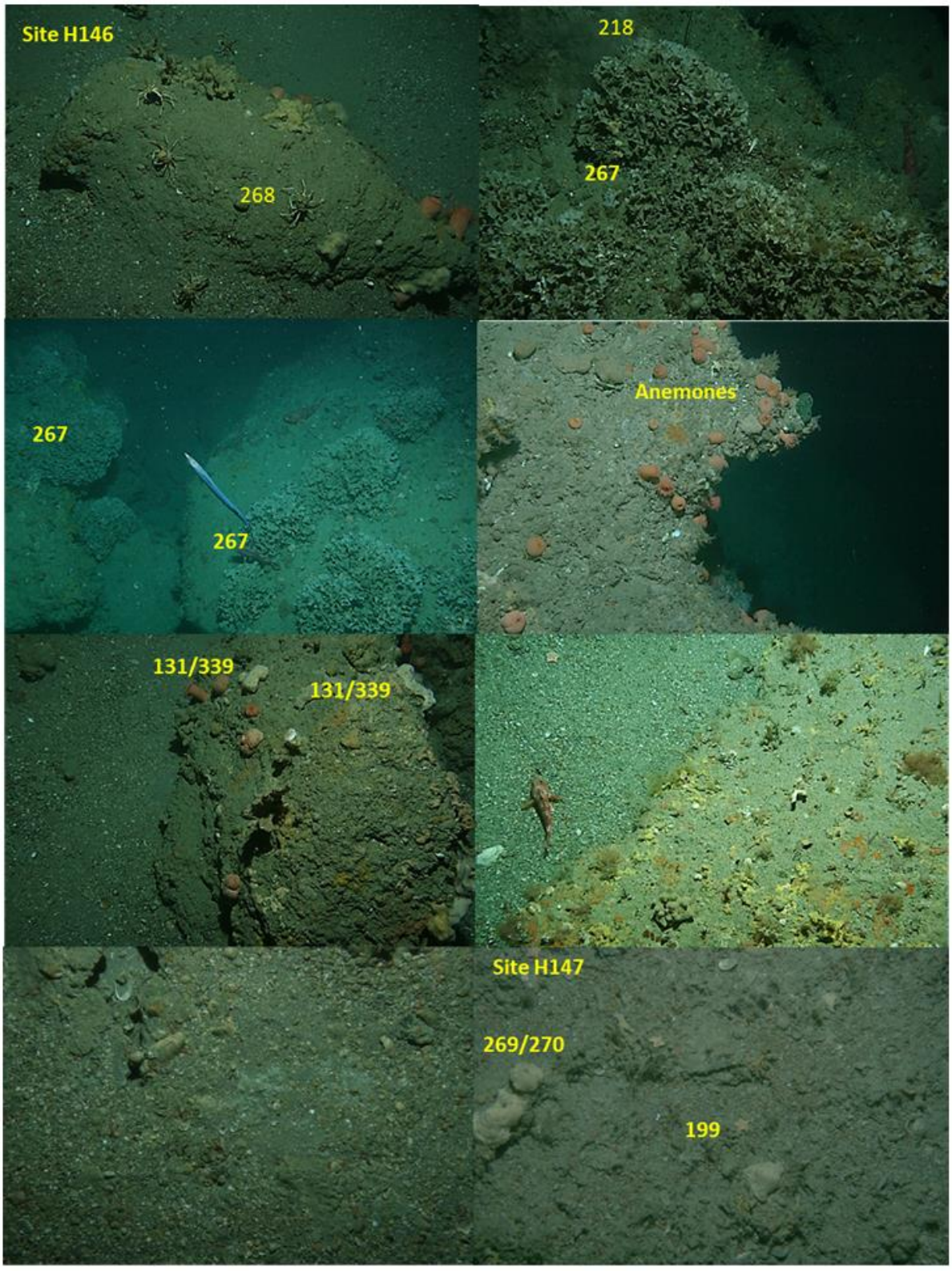

Figure B-86: Canterbury, TAN1108, Cornish Head Canyon, canyon edge, North Otago, sites H146 (170–350 m), H147 (200–325 m). Image order runs left to right. Sponges, 131) *Psammocinia* sp., 269) *Mycale* (*Paraesperella*) n sp 4, 270), *Hymeniacidon* n sp 4, 339) *Psammoclemma* sp. indet.; Bryozoans 267) *Hippomenella vellicata*; Mobile invertebrates, Crabs, 268) *Leptomithrax longipes*; Crayfish, 218) *Jasus edwardsii*; Starfish, 199) *Odontaster* sp.

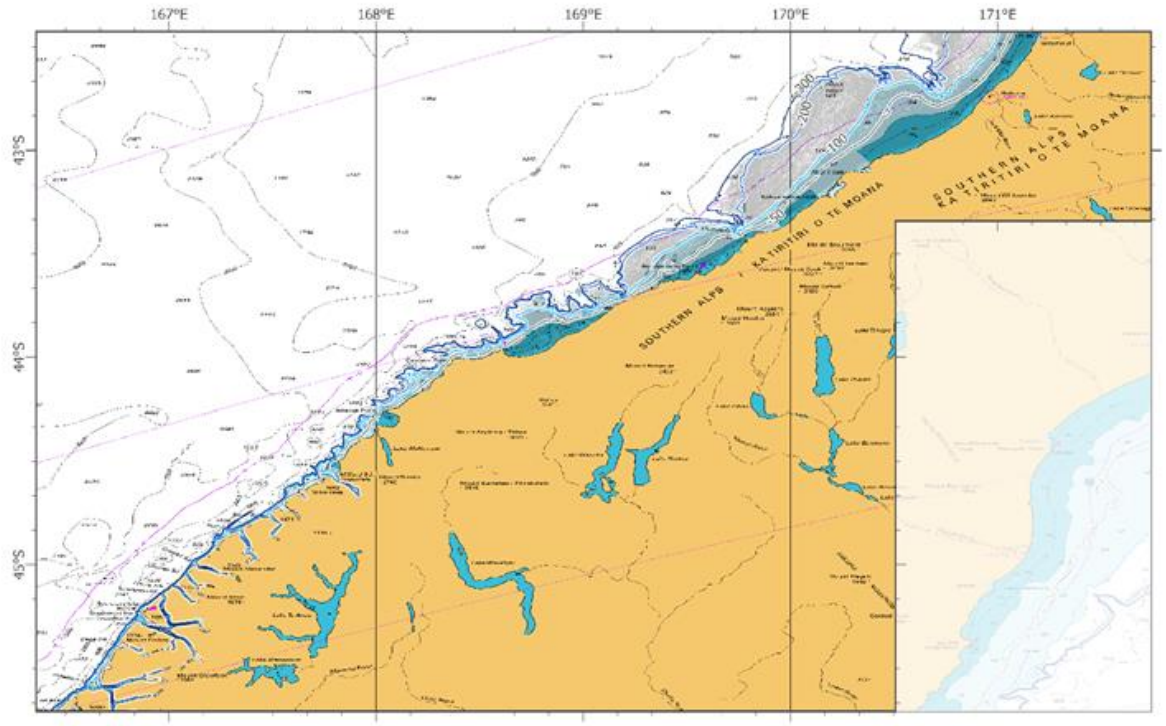

Figure B-87: Fiordland, nautical chart. Nautical chart includes place names, bathymetry contours (dark blue line 300m depth contour; medium blue line 200 m contour; light blue line 100 m contour; grey line 50 m contour), and commercial trawl footprint (2003–2014) (grey lines are individual tows). Pink line with cross bars, territorial sea boundary (twelve nautical miles).

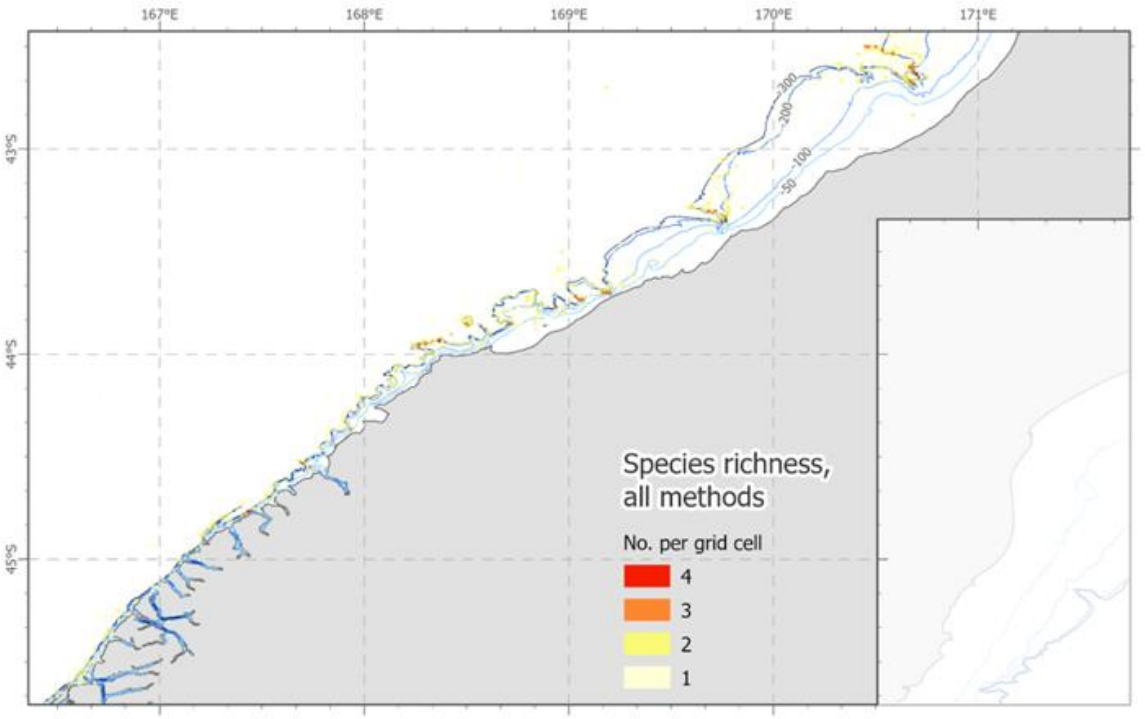

Figure B-88: Fiordland, commercial catch of reef-indicator species: species richness.

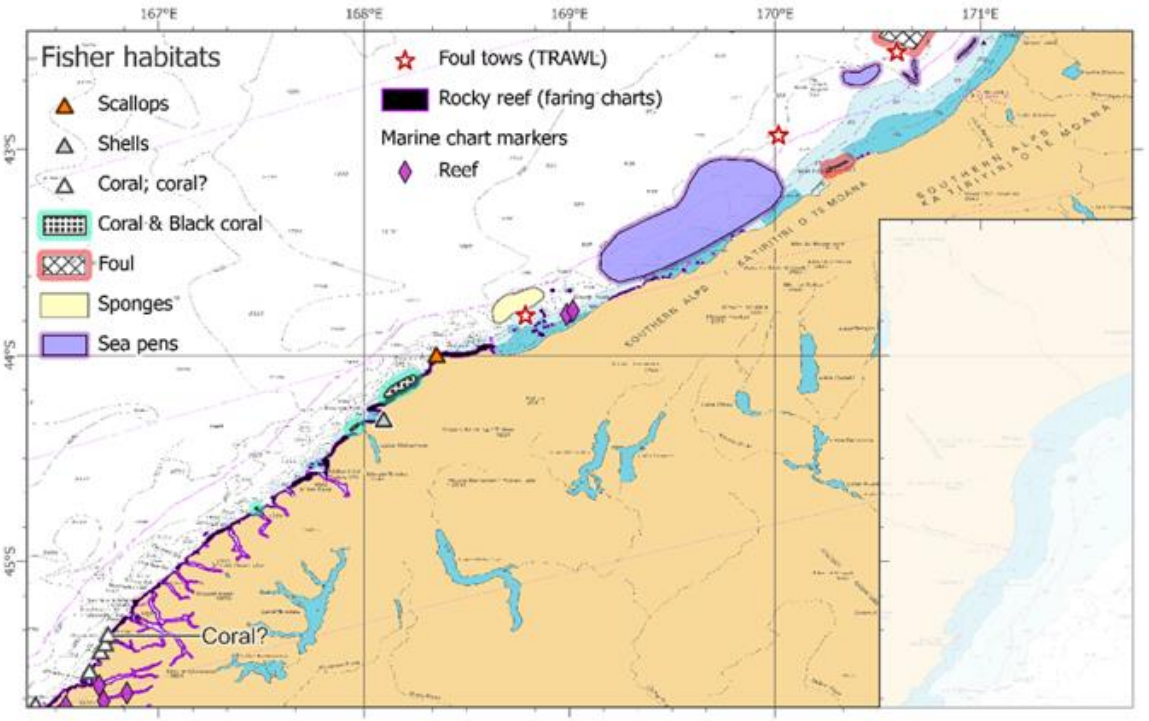

Figure B-89: Fiordland, fisher habitats. Fisher habitats (LEK polygons) includes foul trawl tows (from research trawling), foul definition areas (from research trawling), rocky reef (from charts), marine chart markers for sediment types (reef, cobble, cobbles and reef), DOC putative rocky reef polygons (<100 m water depth, purple coloured polygons).

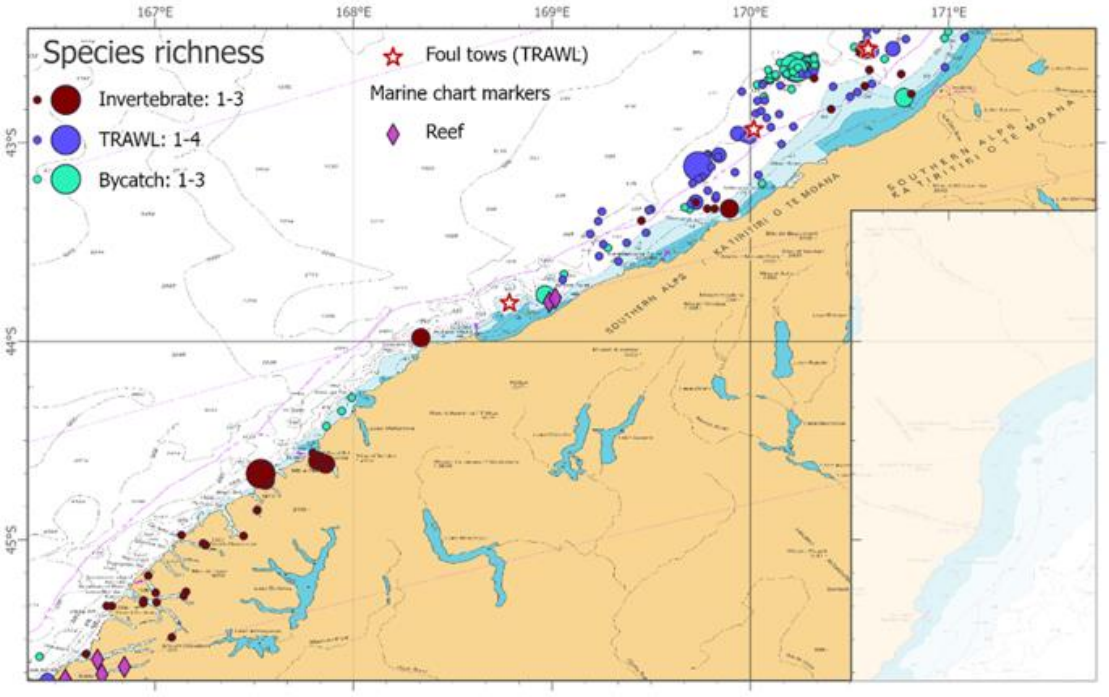

Figure B-90: Fiordland, reef-indicator species richness for SPECIFY invertebrate, research TRAWL, and fisheries observer bycatch.

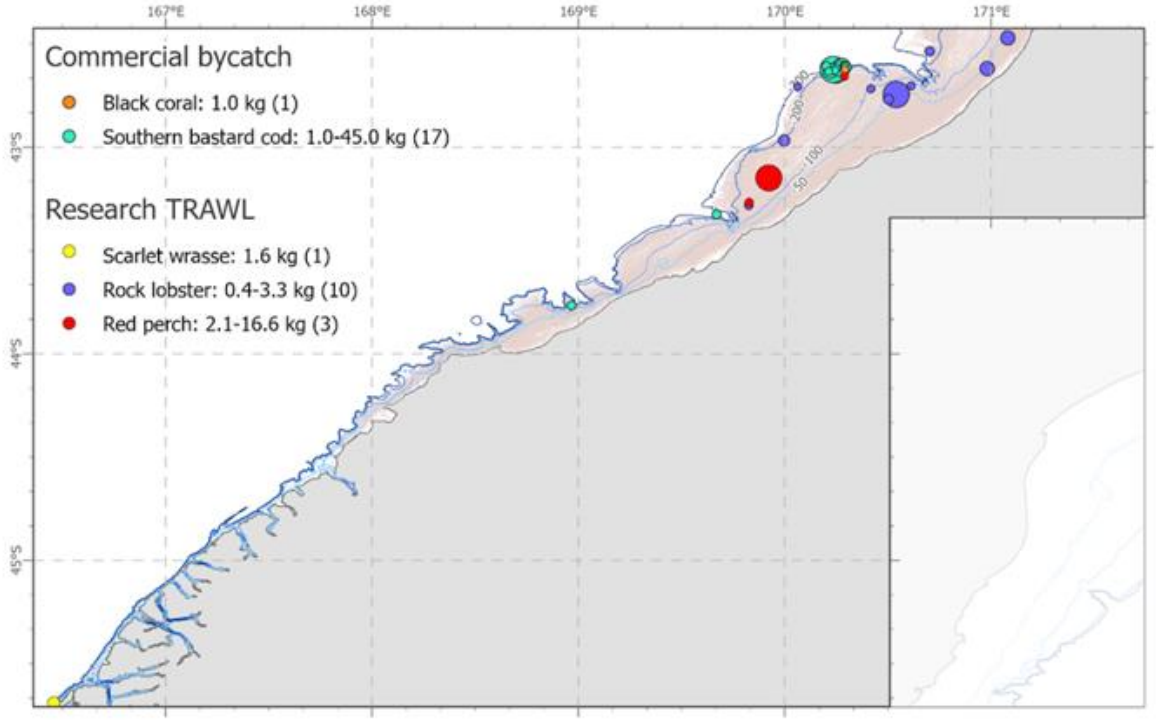

Figure B-91: Fiordland, research TRAWL reef-indicator species catch (kg): fish. The number of sites each species was present at are given in brackets.

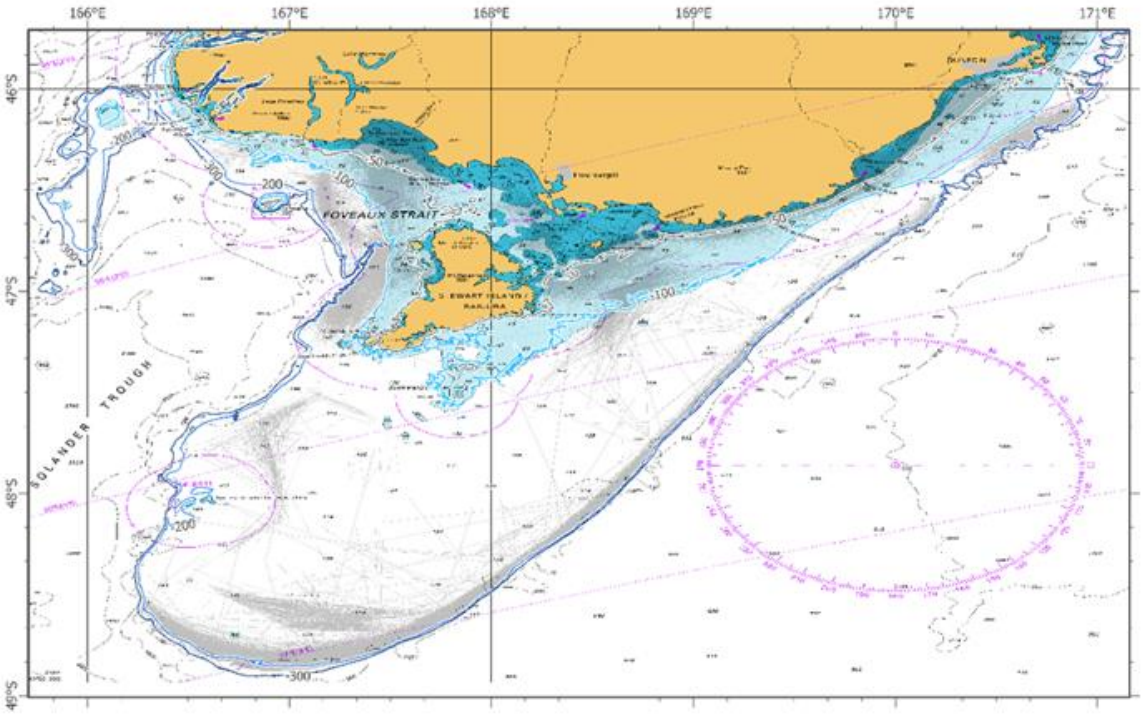

Figure B-92: Stewart, nautical chart. Nautical chart includes place names, bathymetry contours (dark blue line 300m depth contour; medium blue line 200 m contour; light blue line 100 m contour; grey line 50 m contour), and commercial trawl footprint (2003–2014) (grey lines are individual tows). Pink line with cross bars, territorial sea boundary (twelve nautical miles).

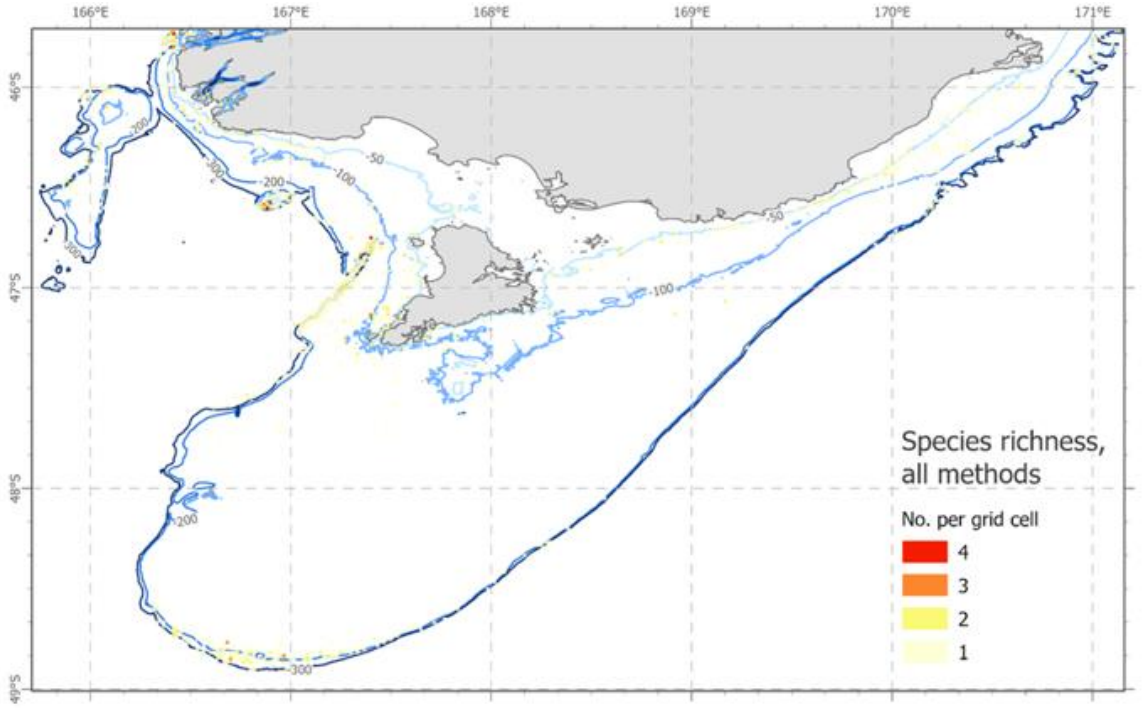

Figure B-93: Stewart, commercial catch of reef-indicator species: species richness.

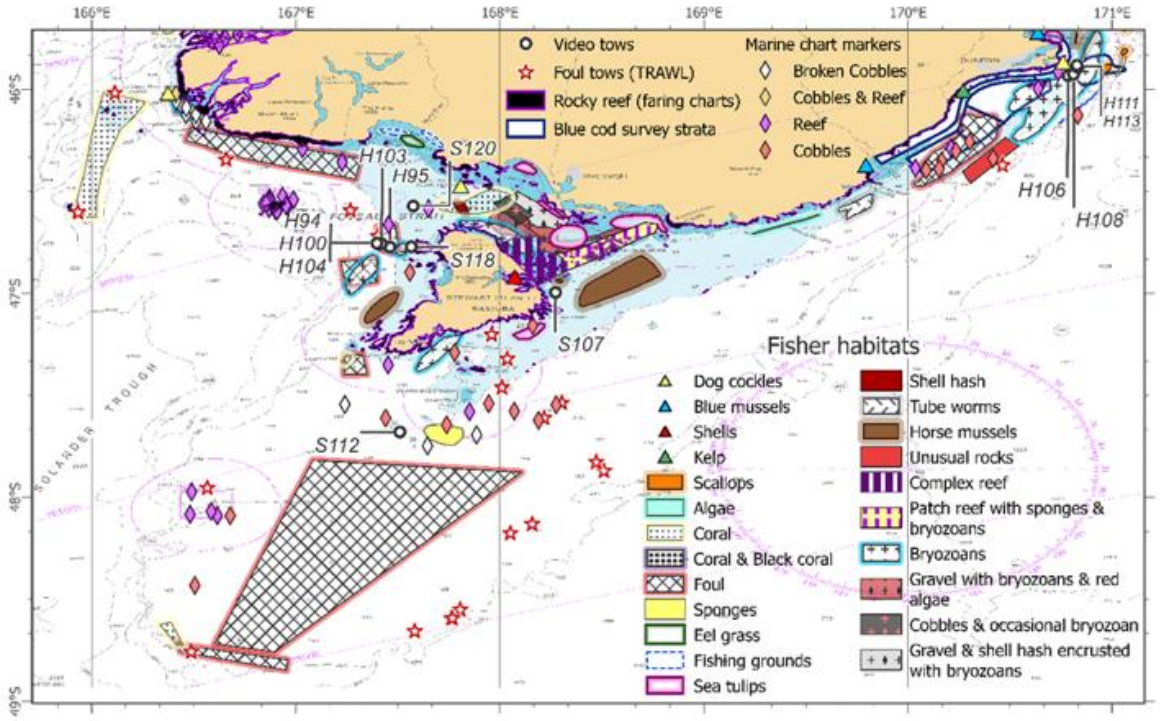

Figure B-94: Stewart, fisher habitats. Fisher habitats (LEK polygons) includes underwater video tows, foul trawl tows (from research trawling), foul definition areas (from research trawling), rocky reef (from charts), marine chart markers for sediment types (reef, cobble, cobbles and reef), DOC putative rocky reef polygons (<100 m water depth, purple coloured polygons).

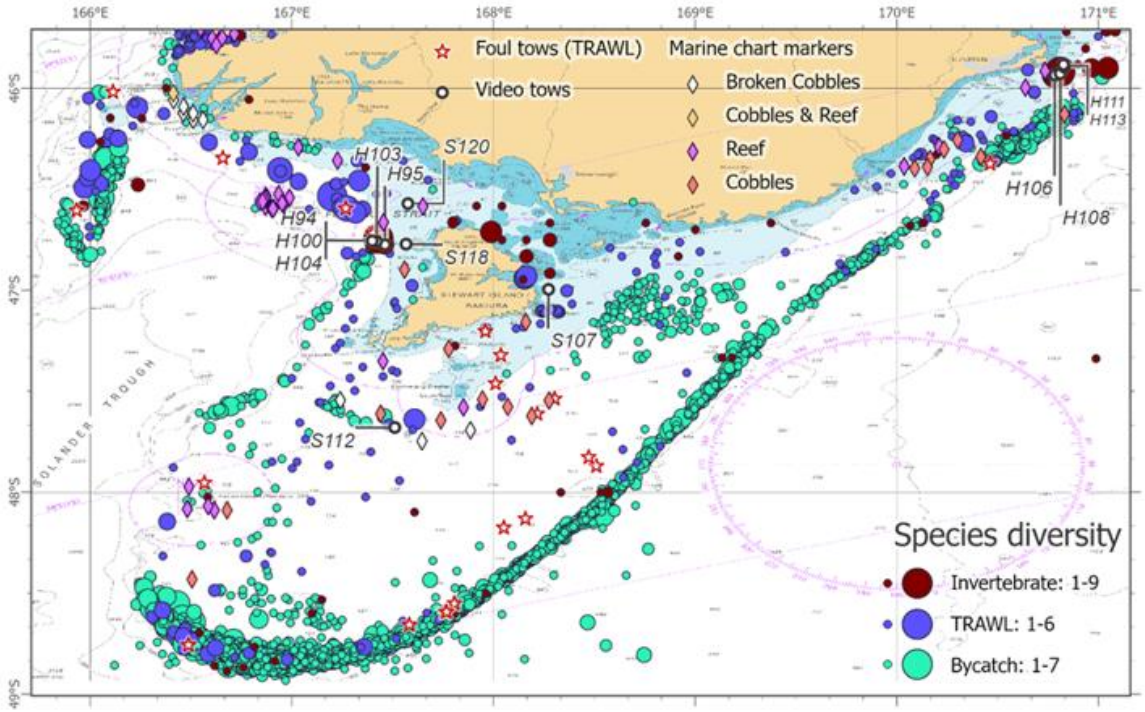

Figure B-95: Stewart, reef-indicator species diversity (richness) for SPECIFY invertebrate, research TRAWL, and fisheries observer bycatch.

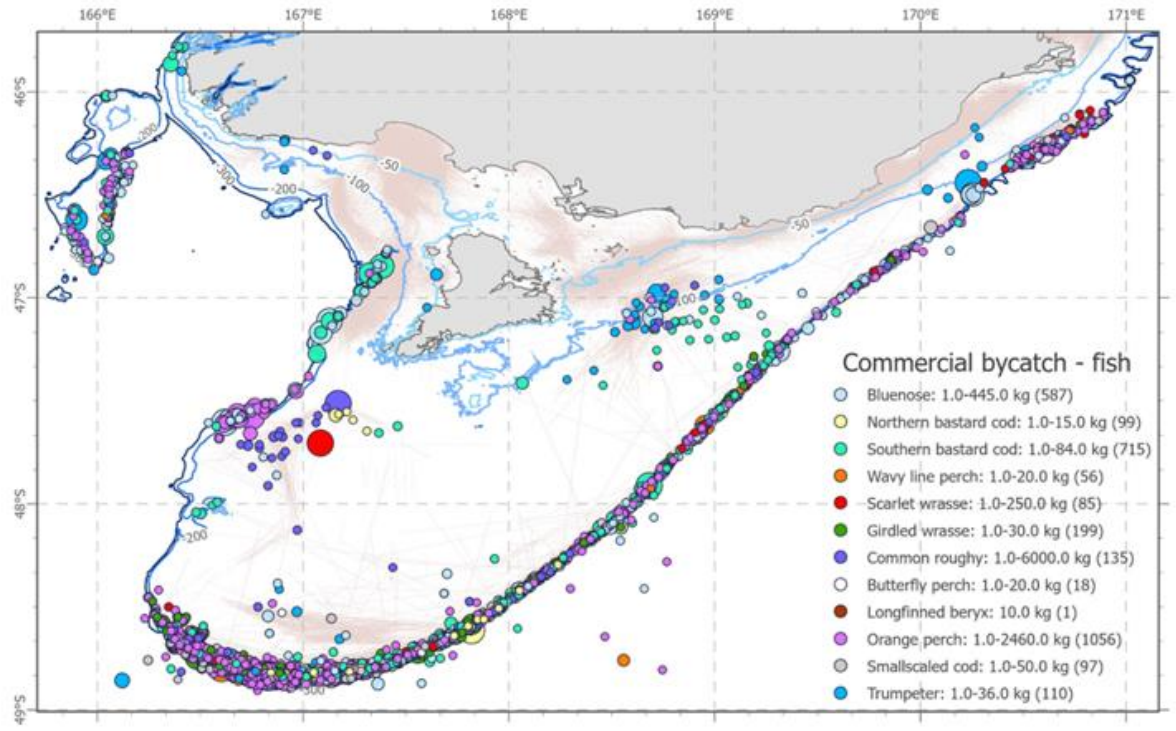

Figure B-96: Stewart, commercial fisheries observer bycatch (kg) of reef-indicator fish species. The number of sites each species was present at are given in brackets.

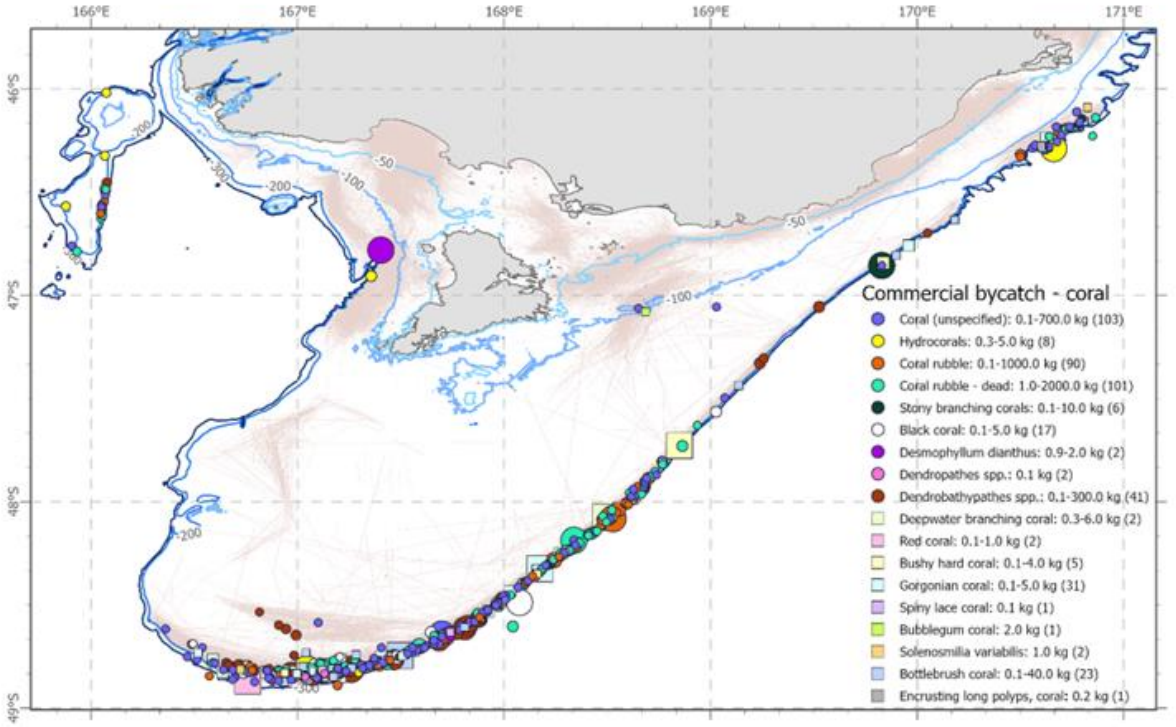

Figure B-97: Stewart, commercial fisheries observer bycatch (kg) of reef-indicator coral species. The number of sites each species was present at are given in brackets.

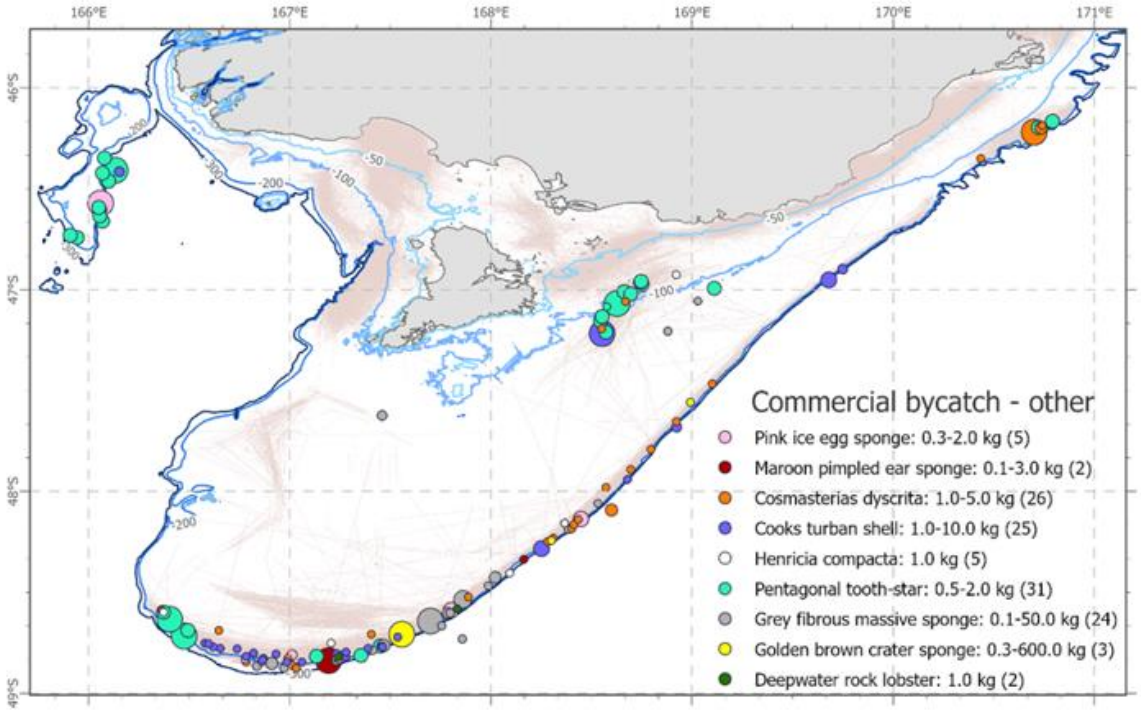

Figure B-98: Stewart, commercial fisheries observer bycatch (kg) of reef-indicator invertebrate species other than coral. The number of sites each species was present at are given in brackets.

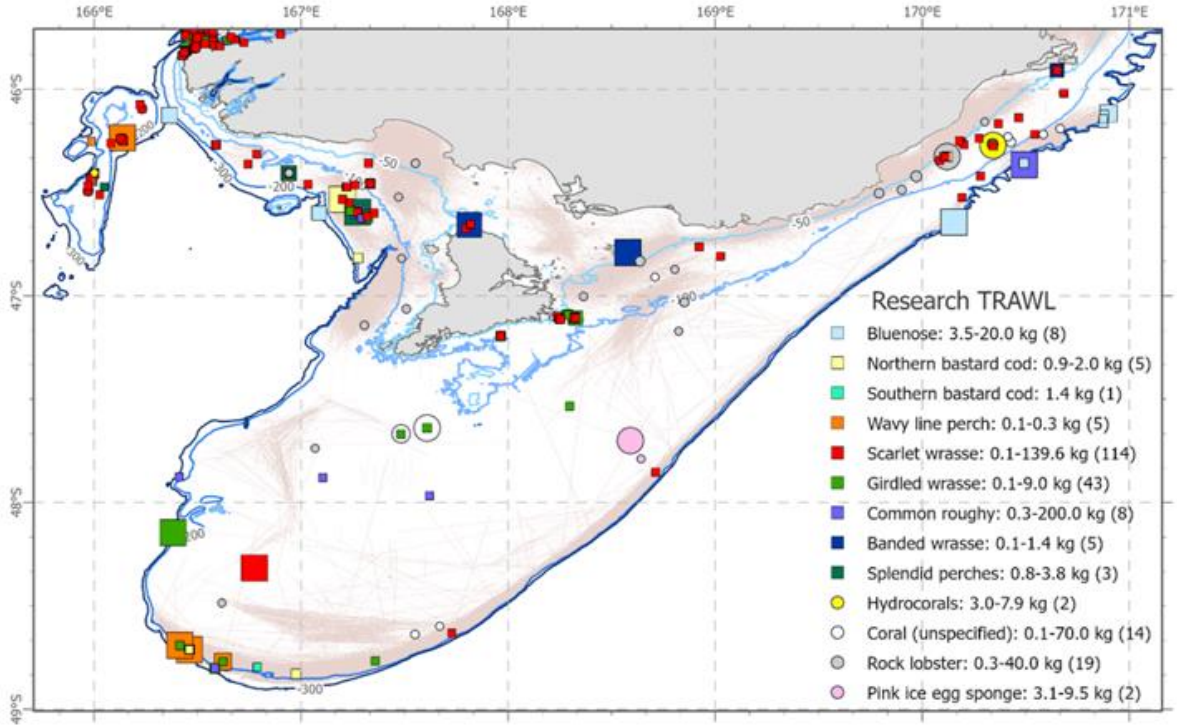

Figure B-99: Stewart, research TRAWL catch (kg) of reef-indicator species. The number of sites each species was present at are given in brackets.

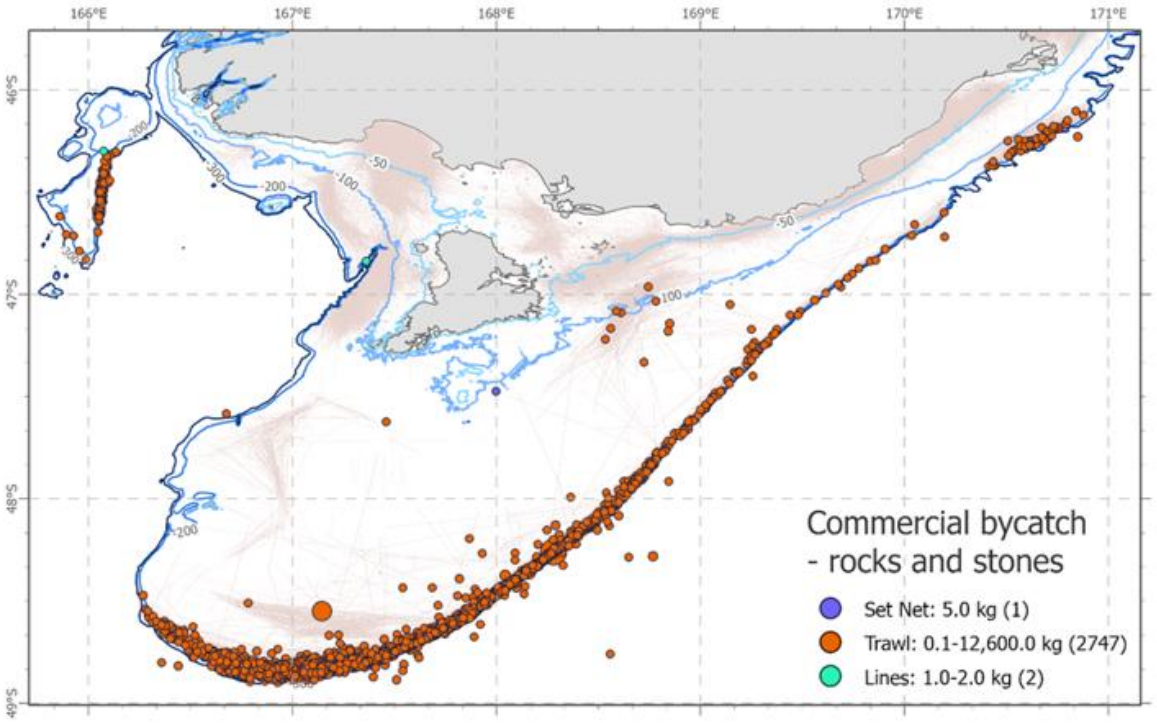

Figure B-100: Stewart, commercial fisheries observer catch (kg) of rocks and stones. The number of sites each species was present at are given in brackets.

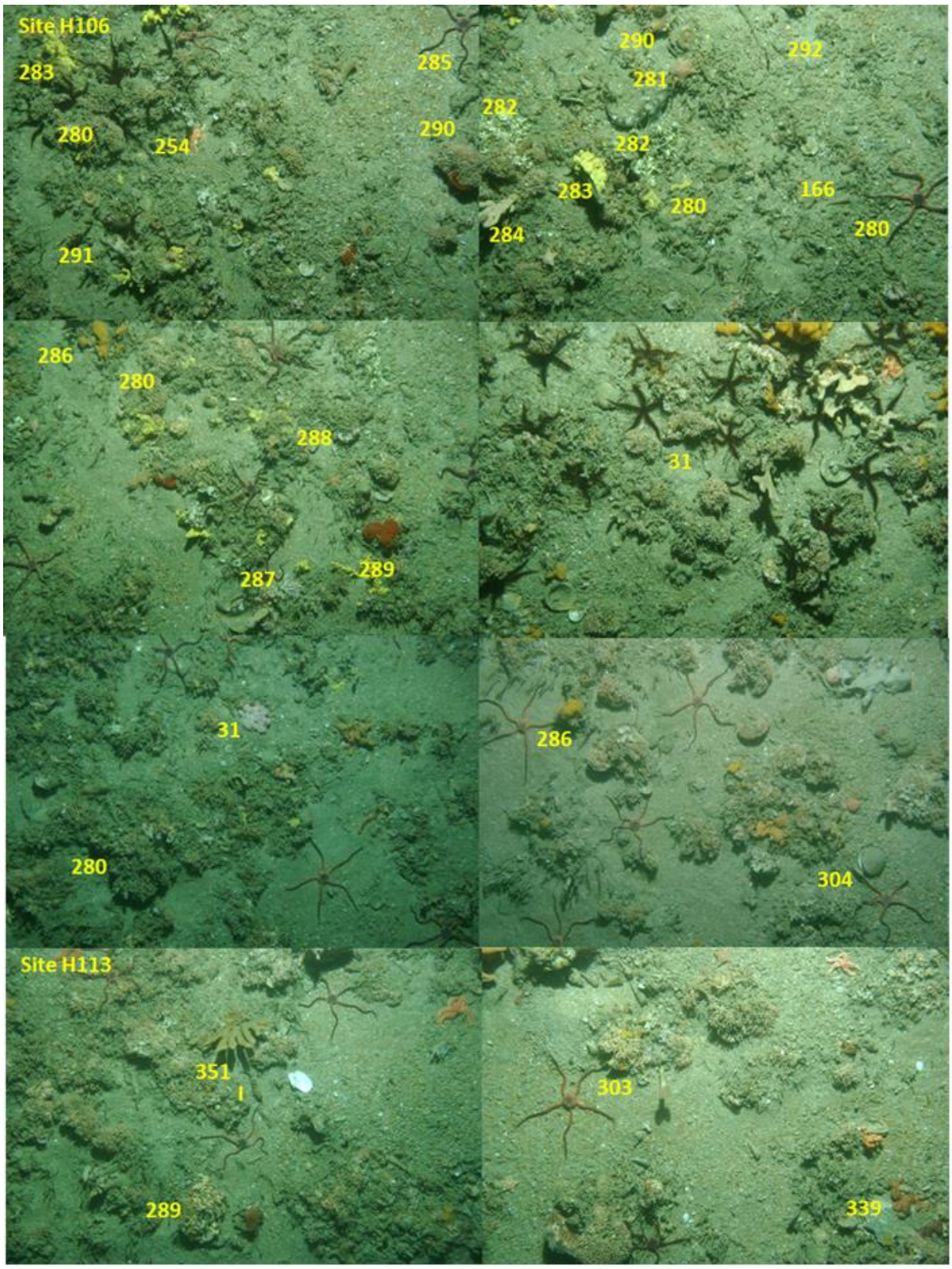

Figure B-101: Stewart, TAN1108, Otago Shelf bryozoan fields, Sites H106 (70 m), H111 (82 m), site H113 (73 m) not displayed but very similar to imagery shown. Image order runs left to right. Sponges 166) *Dactylia varia*, 282) *Dysidea* n sp. 11, 283) *Dendrilla* n. sp. 2 (yellow clump), 284) *Callyspongia* (*Callyspongia*) n sp. 11, 286) *Mycale* (*Paraesperella*) n sp 4, 292) *Lissodendoryx* (*Ectyodoryx*) n sp 4 (ropey pad), 339) *Psammoclemma* sp. indet.?, 351) *Callyspongia* sp. indet.; Bryozoan, 31) *Celleporaria agglutinans*, 280) *Cinctipora elegans*, 287) *Hornera* sp. 2, 288) *Hornera robusta*; Tubeworm, 303) *Protula* sp.; Ascidian, 289), *Diplosoma velatum*; Bivalve, 291) *Atrina zelandica*. Mobile invertebrates, Starfish, 254) *Sclerasterias mollis*, 281) *Pentagonaster pulchellus*; Ophiuroid, 285) *Ophiopsammus maculata*, 290) *Clarkcoma bollonsi*. Fish, I, Blue cod.

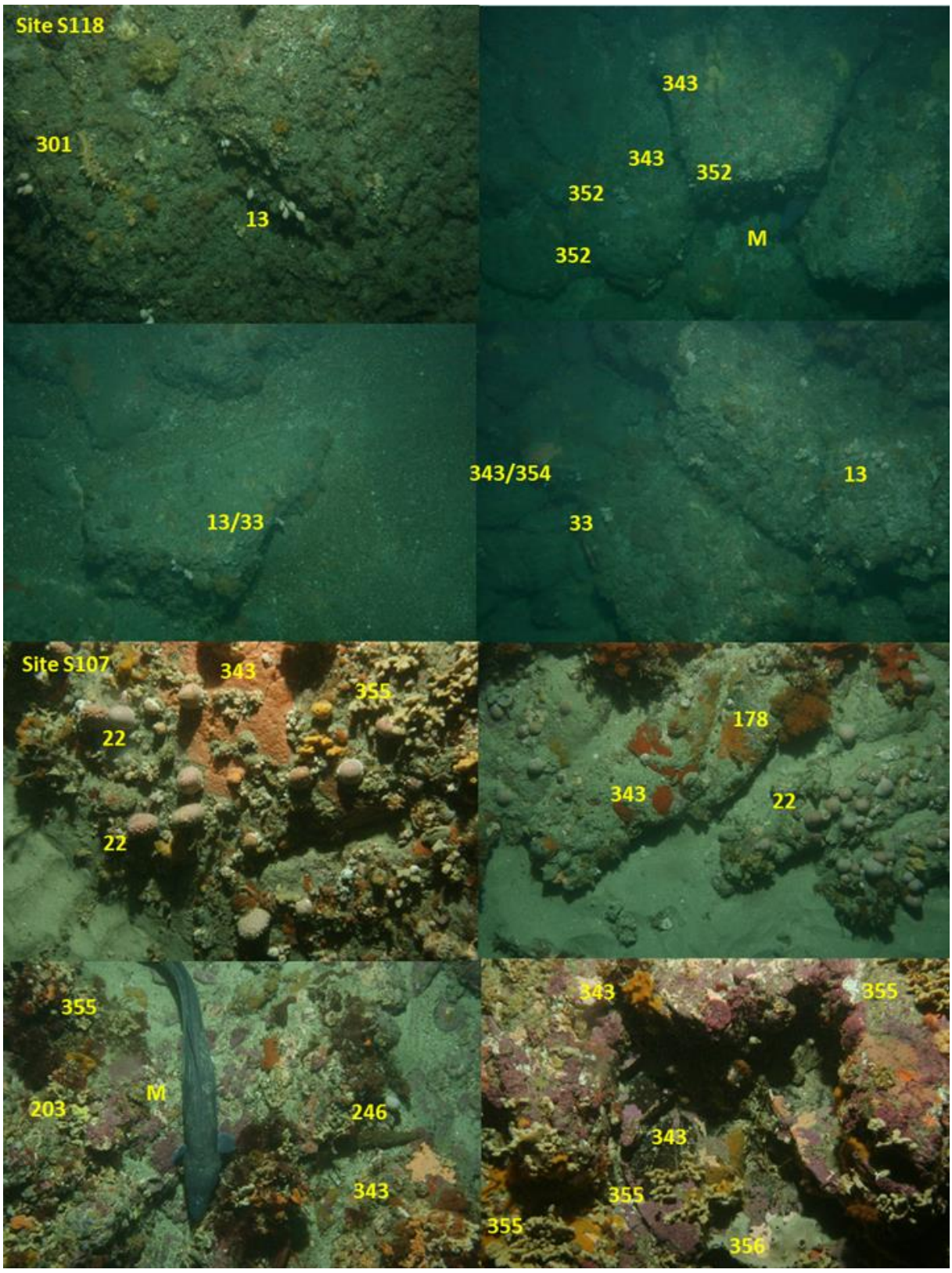

Figure B-102: Stewart, TAN1602, sites S118 (73–84 m), S107 (45–50). Image order runs left to right. Sponges 13) *Leucettusa lancifer*, 33) *Leucettusa tubulosa*, 203) *Darwinella oxeata* (?), 343) *Poecilosclerida* sp. indet., 352) *Leucosolenia rosea* (calcareous sponge), 354) *Polymastia* sp. indet., 355) *Fasciospongia turgida* (?), 356) *Strongylacidon conulosum*; Ascidians 22) *Hypsistozoa fasmeriana*, 246) *Didemnum* sp.; Mobile invertebrates 301*) Stichopus mollis*; Bryozoans, 178) Catenicellidae. Fish, M) Conger eel. Rk, bare rock.

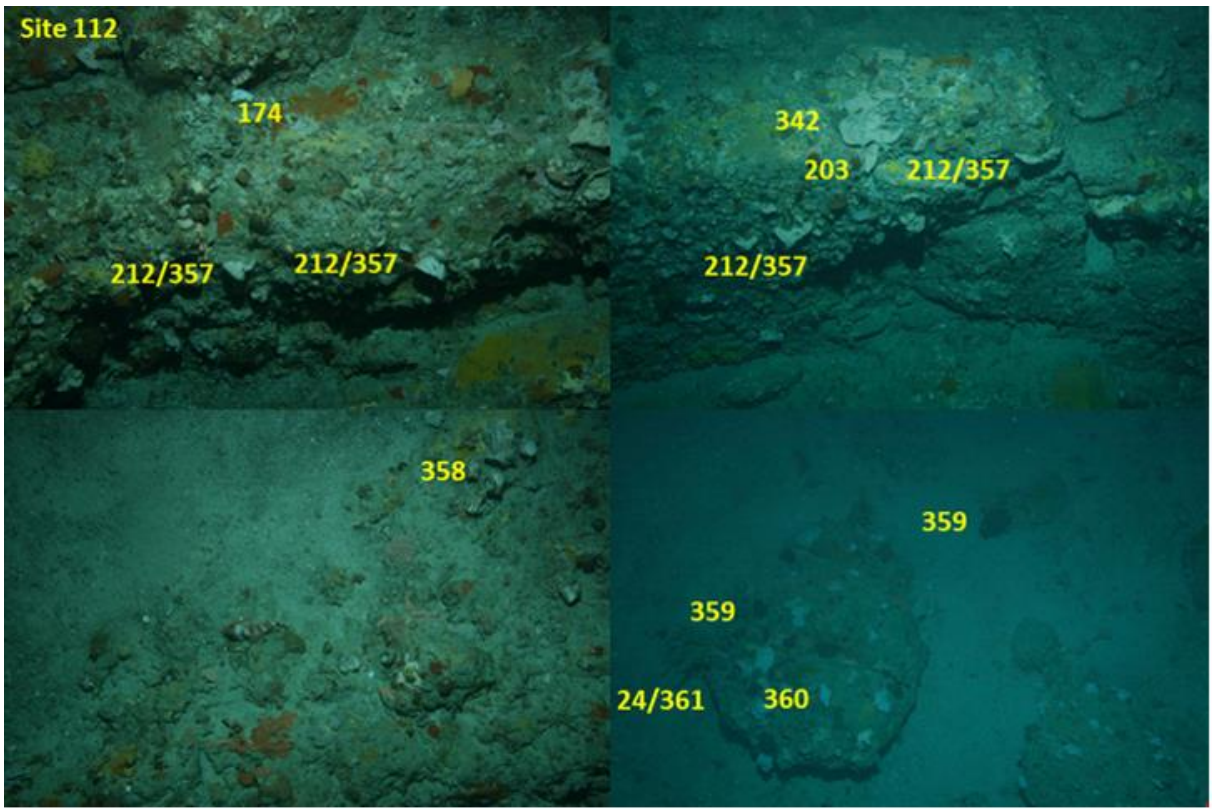

Figure B-103: Stewart, TAN1602, site S112 (129–132 m). Image order runs left to right. Sponges 24) *Callyspongia* sp., 203) *Darwinella oxeata* (?), 212) *Poecillastra laminaris*, 342) *Haplosclerida* sp. (?), 357) *Lissodendoryx* (*Ectyodoryx*) cf *bifacialis*, 358) *Lamellomorpha australis* (endemic genus with two species), 359 (*Latrunculia* sp.), 360) Farreidae (Hexactinellida) spp. (?), 361) *Myxilla* spp.; Ascidians, 174) *Aplidium knoxi* (orange colonial ascidian).

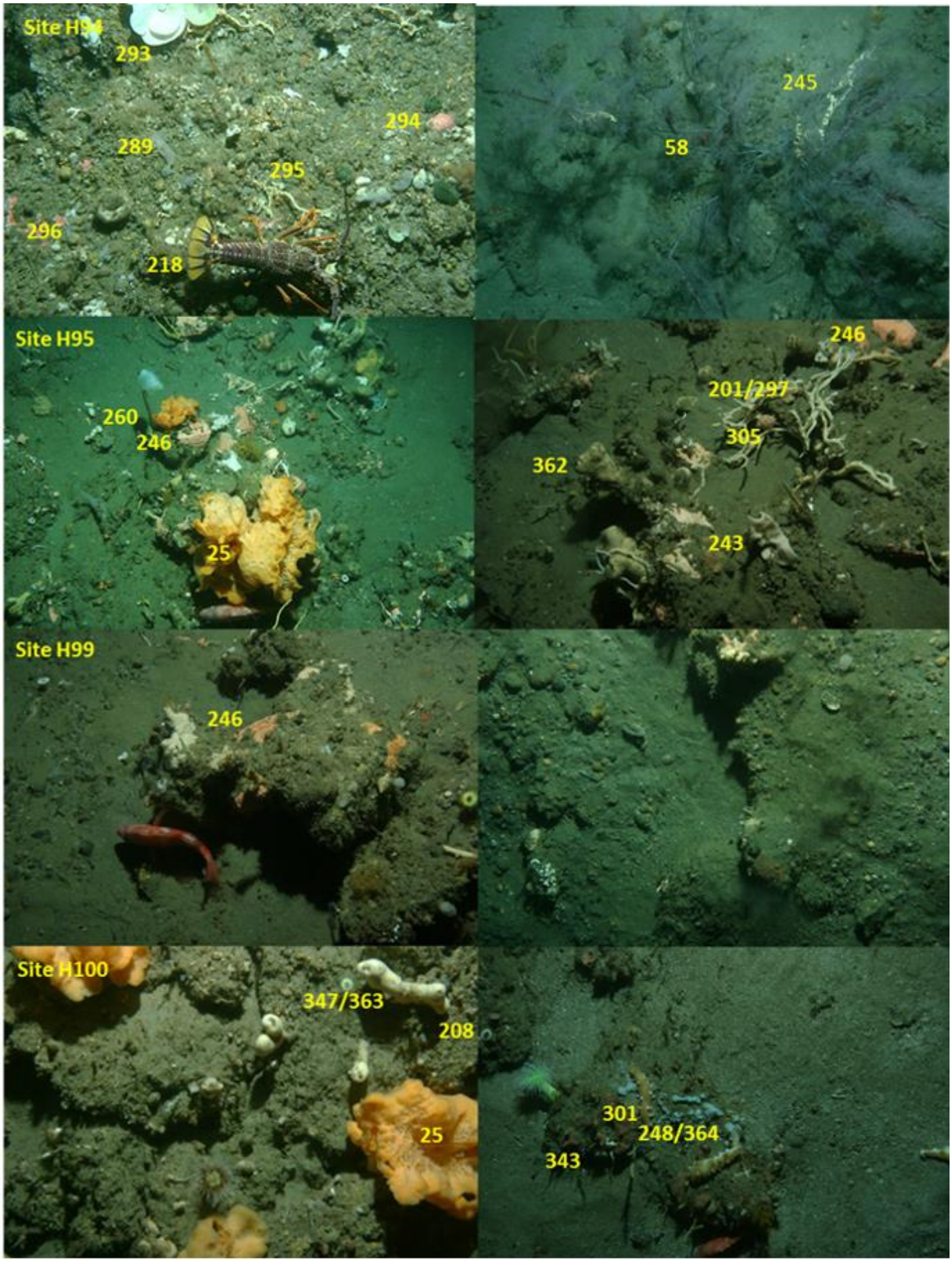

Figure B-104: Stewart, TAN1108, Mason Canyon, sites H94 (121 m), H95 (195 m), H99 (178 m), H100 (151 m). Image order runs left to right. Sponges, 25) *Symplectella rowi*, 201) *Haliclona* sp. indet., 243) *Xestospongia corallodies*, 248) *Spongia* sp. indet., 293) *Cymbastela lamellata*, 297) *Chondropsis* sp. indet., 343) *Poecilosclerida* sp. indet., 347) *Stelletta* sp. indet., 362) *Ecionemia novaezelandiae* (?), 363) *Stryphnus* sp. indet., 364) *Ircinia* sp. indet; Corals, 58) *Antipathella fiordensis*; 208) *Caryophyllia* sp.; Ascidians, 246) *Didemnum* sp., 294) *Didemnum lithostrotum*, 289) *Diplosoma velatum*, 295) Didemnidae (yellow clusters) 296) *Leptoclinides* sp. (grey): Tubeworm, 260) *Protula bispiralis* 218); Mobile invertebrates, Ophiuroid 245) *Astrobrachion constrictum* (this species has three colour morphs – yellow, dark red and black and white stripey – all three are present on this colony), Crayfish, 218) *Jasus edwardsii*, Sea cucumber 301) *Stichopus mollis*, gastropod, 305) *Semicassis pyrum*.

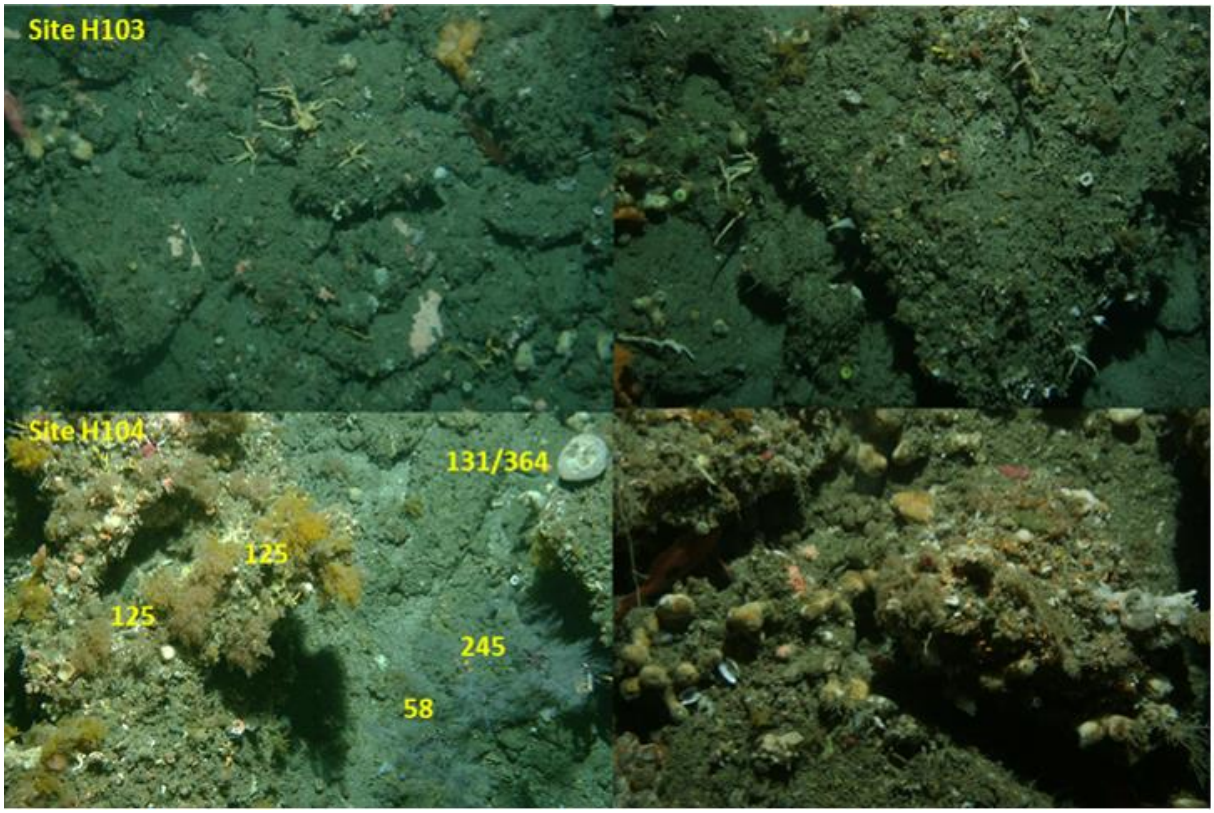

Figure B-105: Stewart, TAN1108, Mason Canyon, Sites H103 (130 m) and H104 (130 m). Image order runs left to right. Sponges 131) *Psammocinia* sp. indet., 364) *Ircinia* sp. indet.; Corals, 58) *Antipathella fiordensis*; bryozoans, 125) *Cornucopina* sp. (Bugulidae); Mobile invertebrates, Ophiuroid 245) *Astrobrachion constrictum*.

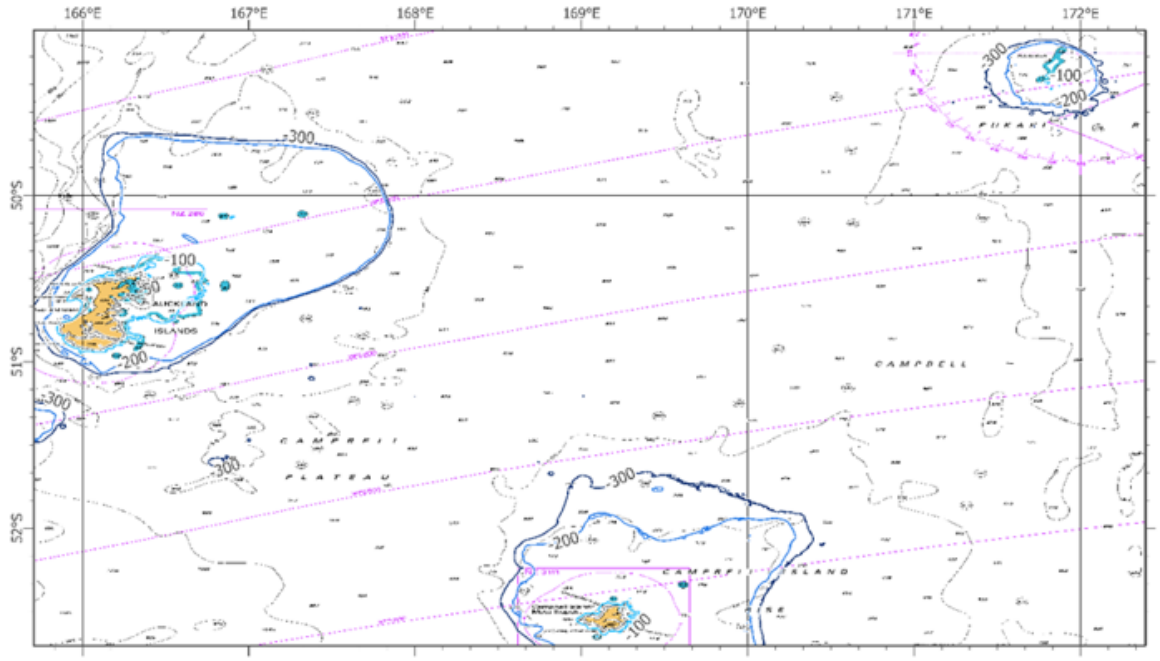

Figure B-106: Campbell, nautical chart. Nautical chart includes place names, bathymetry contours (dark blue line 300 m depth contour; medium blue line 200 m contour; light blue line 100 m contour; grey line 50 m contour), and commercial trawl footprint (2003–2014) (grey lines are individual tows). Pink line with cross bars, territorial sea boundary (twelve nautical miles).

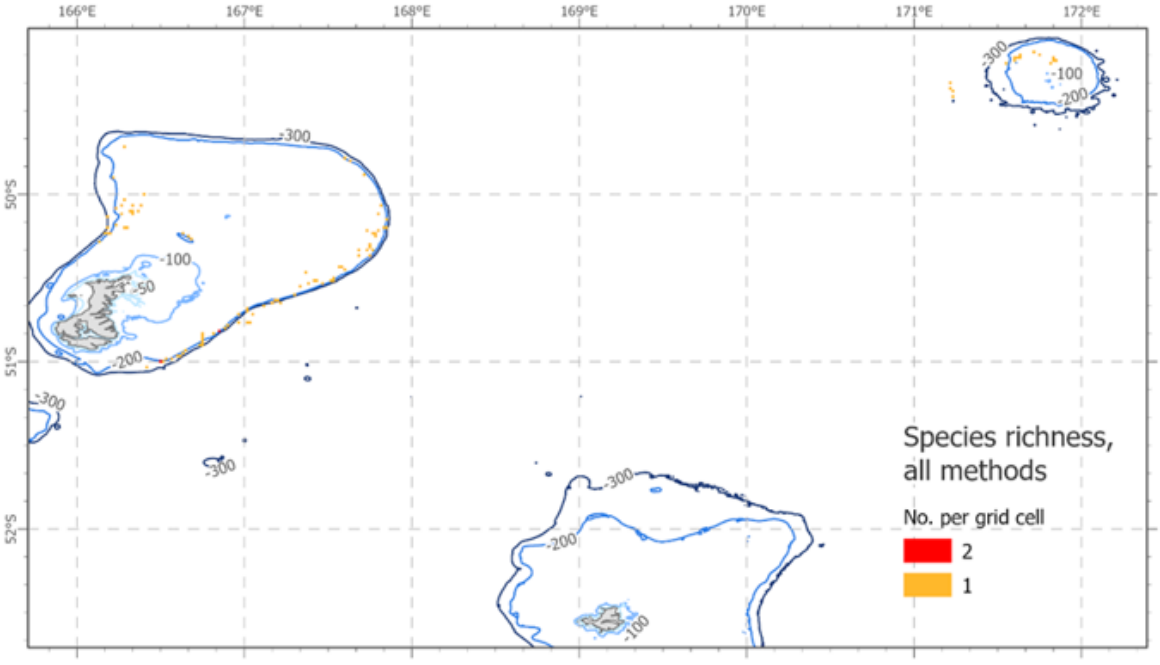

Figure B-107: Campbell, commercial catch of reef-indicator species: species richness.

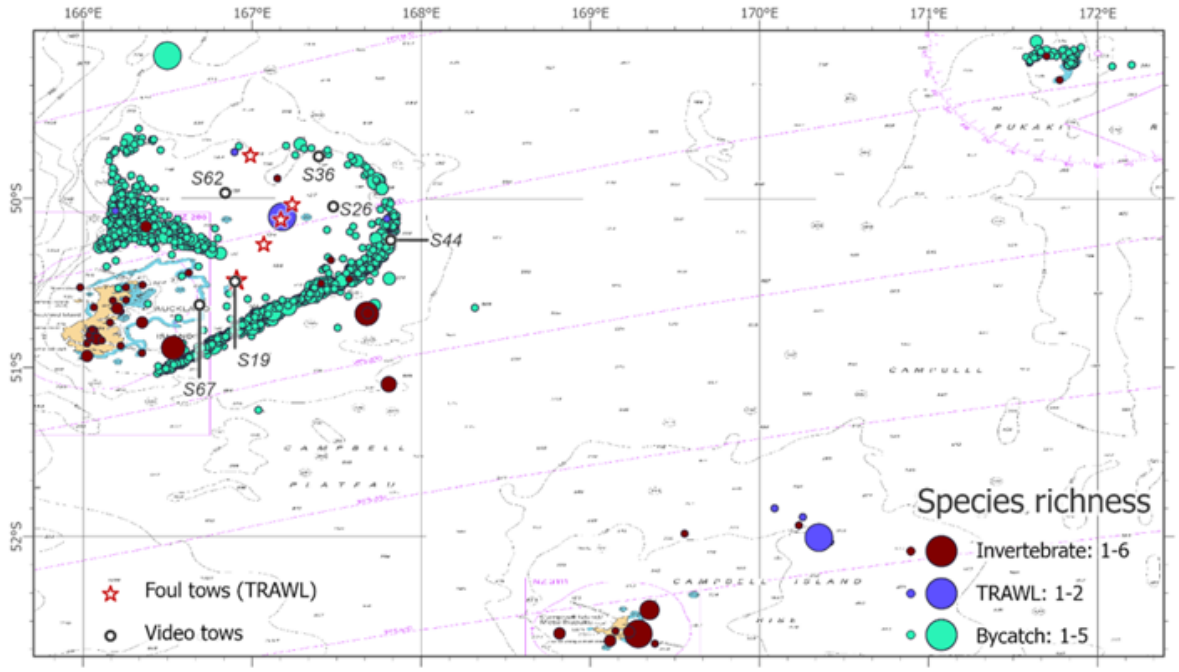

Figure B-108: Campbell, underwater video tows, foul trawl tows (from research trawling), reef-indicator species richness for SPECIFY invertebrate, research TRAWL, and fisheries observer bycatch.

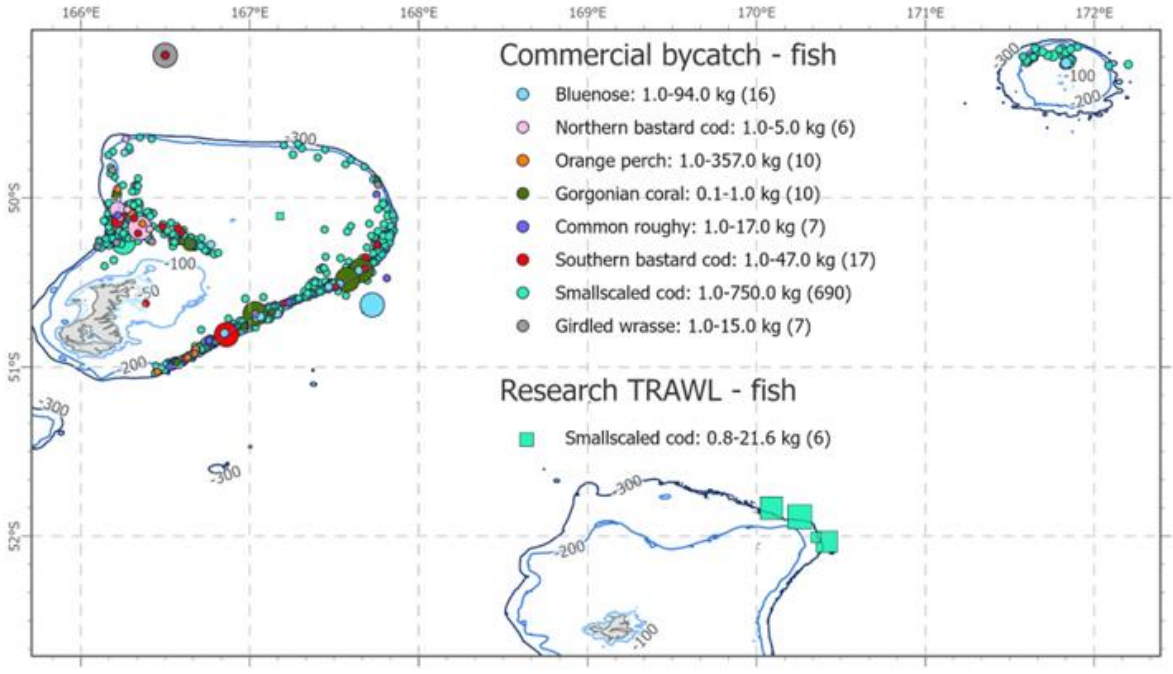

Figure B-109: SNARES, commercial observer bycatch and research TRAWL catches (kg) of reef-indicator fish species. The number of sites each species was present at are given in brackets.

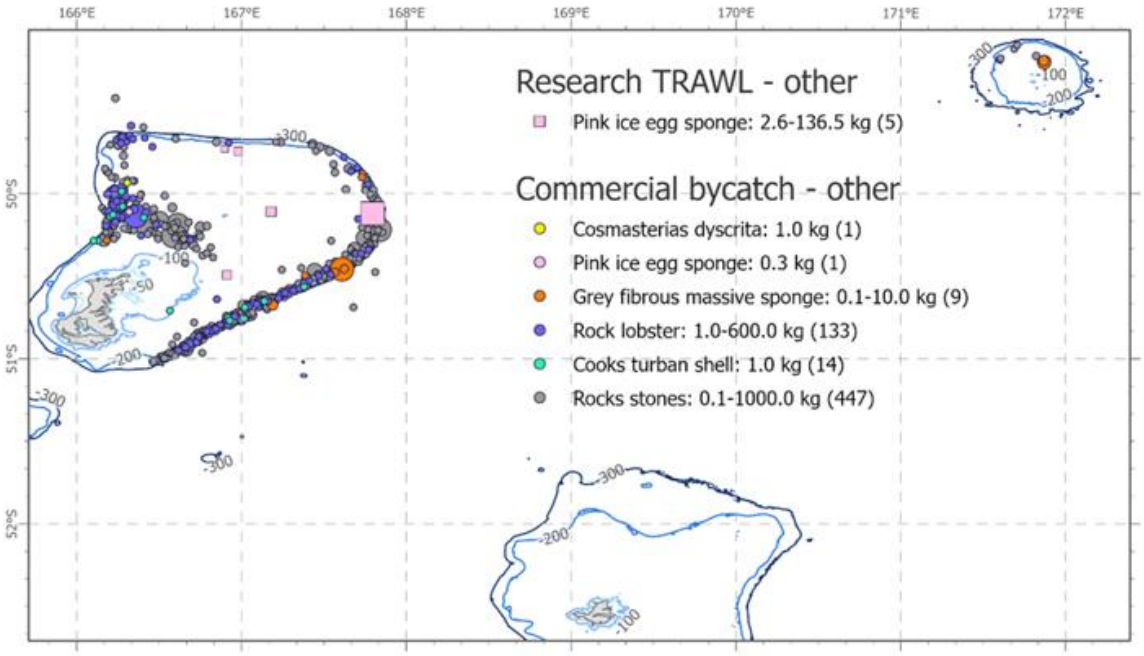

Figure B-110: SNARES, commercial observer bycatch and research TRAWL catches (kg) of reef-indicator species other than fish. The number of sites each species was present at are given in brackets.

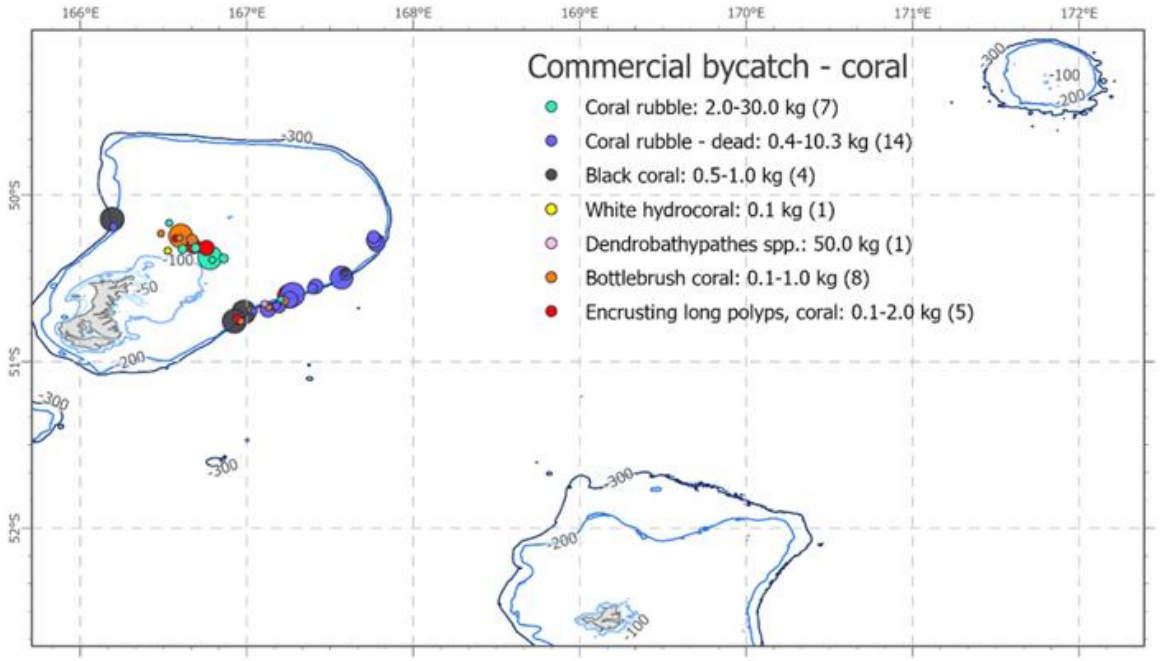

Figure B-111: Campbell, commercial fisheries observer catch (kg) of reef-indicator species: coral. The number of sites each species was present at are given in brackets.

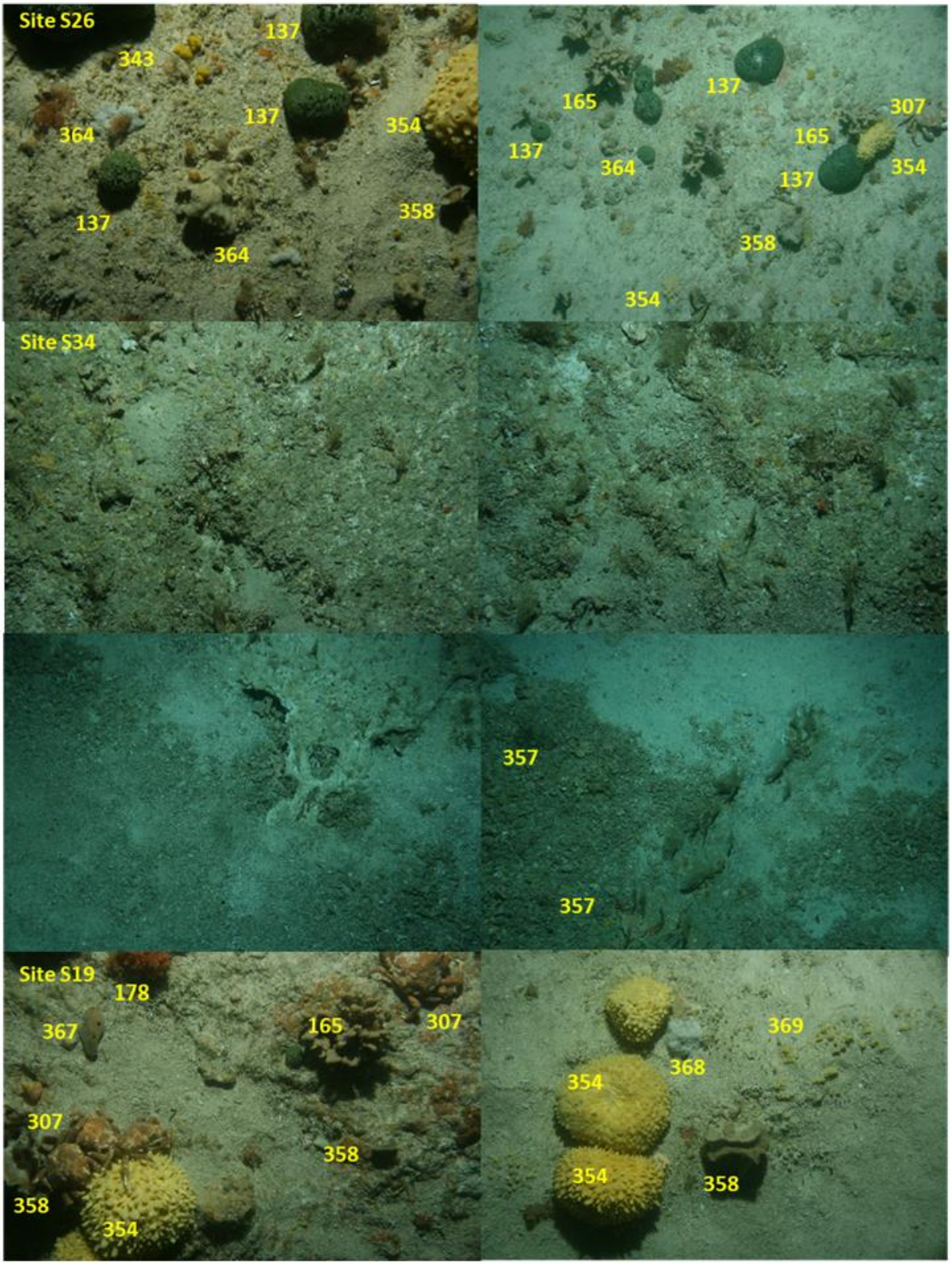

Figure B-112: Campbell, TAN1602, sites S26 (116–118 m), S34 (152–174 m), and S19 (141–146 m). Image order runs left to right. Sponges 165) *Dactylia varia* (?), 137) *Latrunculia* (*Biannulata*) *kaikoura* (?), 343) *Poecilosclerida* sp. indet., 354) *Polymastia* sp. indet., 357) *Lissodendoryx* (*Ectyodoryx*) cf *bifacialis*, 358) *Lamellomorpha australis*, 364) *Ircinia* sp. indet., 367) Suberitidae (?), 368) Chondropsidae gen. et sp. indet., 369) Suberitida, family Halichondriidae gen et sp. indet.; Bryozoans, 178) Catenicellidae; Mobile invertebrates, Gastropod, 306) *Maurea foveauxana*; Crabs 307*) Jacquinotia edwardsii*.

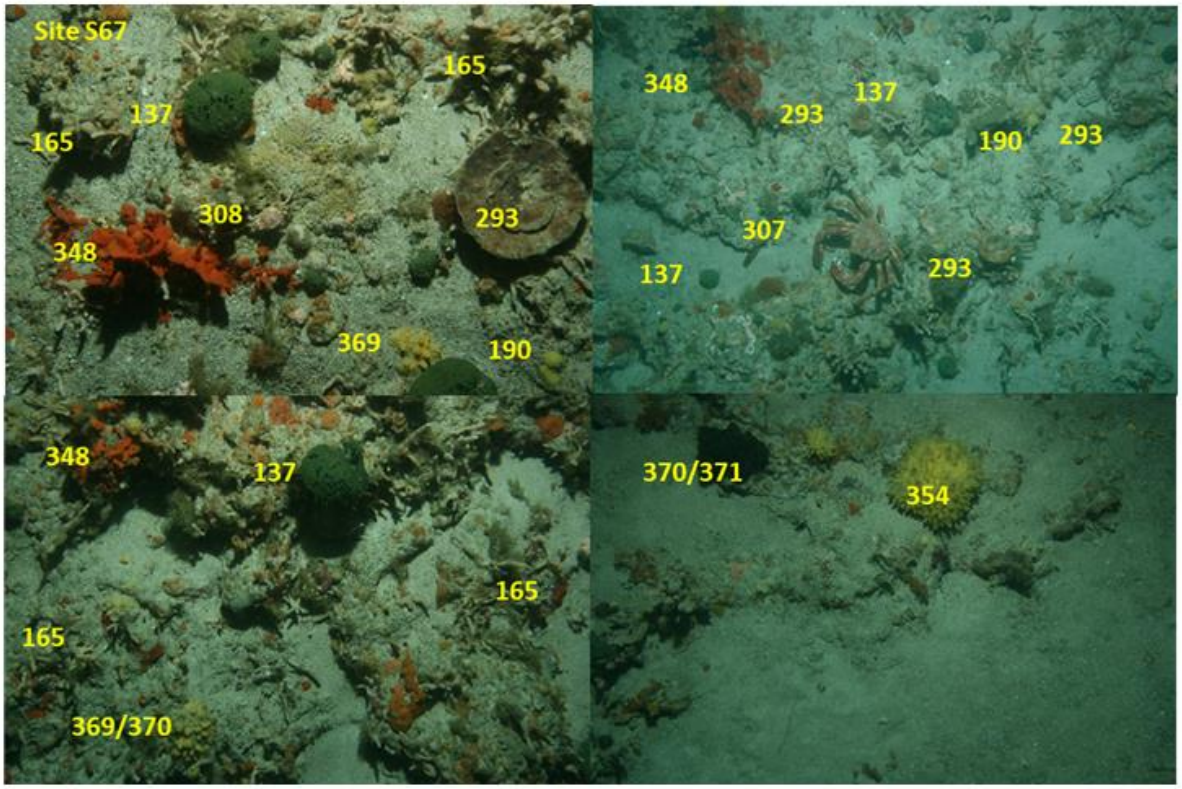

Figure B-113: Campbell, TAN1602, site S67 (100–102 m). Image order runs left to right. Sponges 137) *Latrunculia* (*Biannulata*) *kaikoura*, 165) *Dactylia varia* (?), 190) *Suberites* sp. indet. (?), 293) *Cymbastela lamellata*, 348) *Crella incrustans*, 354) *Polymastia* sp. indet., 369) Suberitida, family Halichondriidae gen et sp. indet., 370) *Topsentia* sp. indet., 371) Demospongiae sp. indet.; Mobile invertebrates, crabs) 307) *Jacquinotia edwardsii*, 308) *Nectocarcinus* sp.

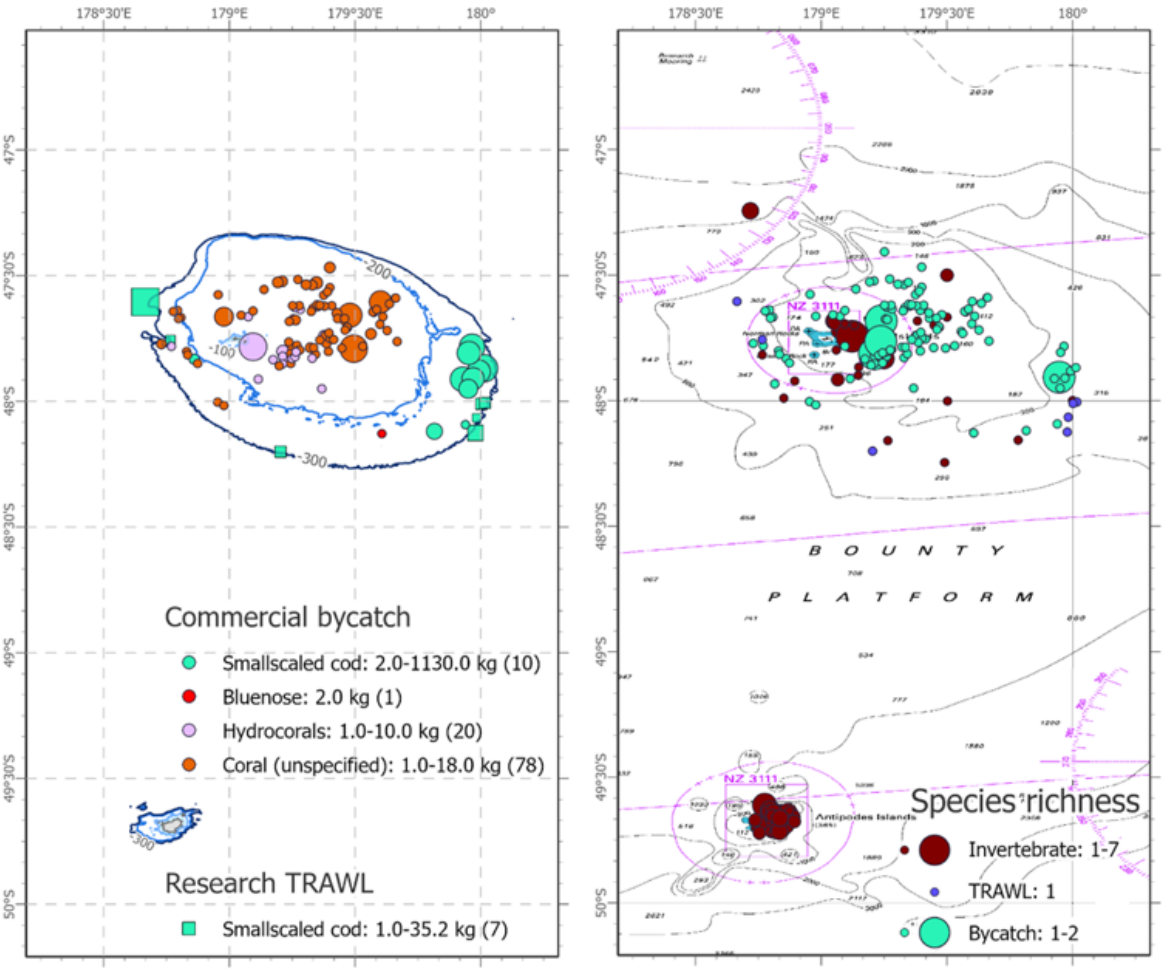

Figure B-114: Bounty, nautical chart with reef-indicator species richness for SPECIFY invertebrate, research TRAWL, and fisheries observer bycatch. The number of sites each species was present at are given in brackets.

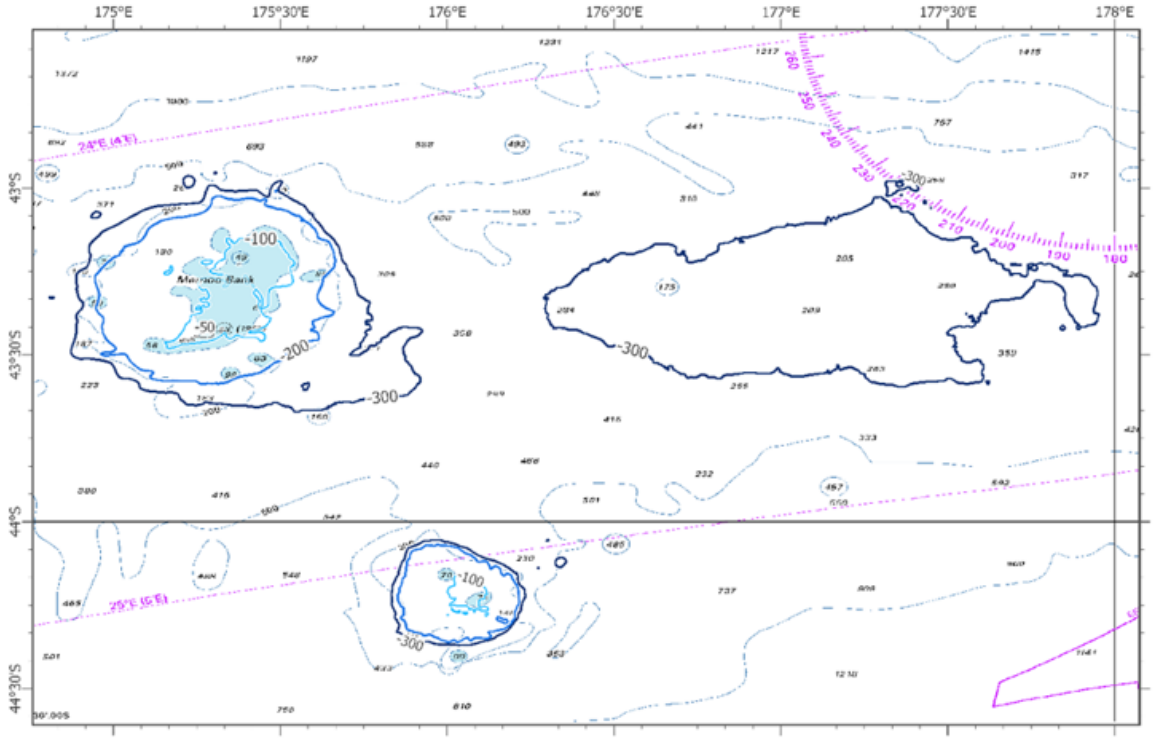

Figure B-115: Mernoo, nautical chart. Nautical chart includes place names, bathymetry contours (dark blue line 300m depth contour; medium blue line 200 m contour; light blue line 100 m contour; grey line 50 m contour). Commercial trawl footprint (2003–2014) not available.

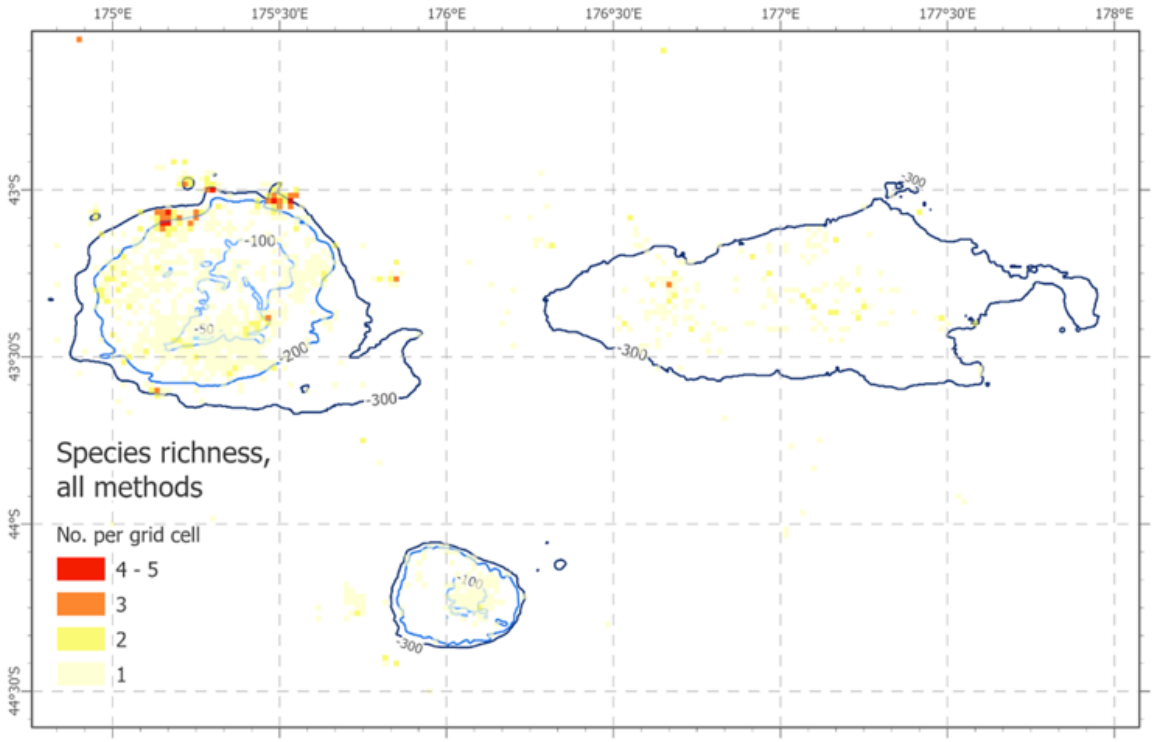

Figure B-116: Mernoo, commercial catch of reef-indicator species: species richness.

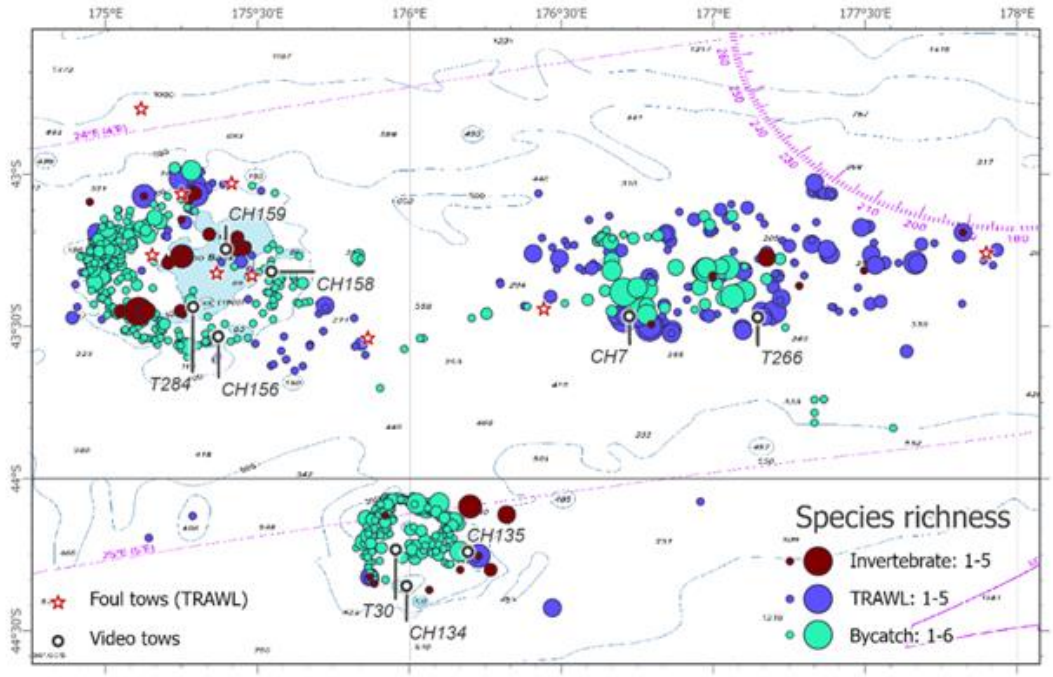

Figure B-117: Mernoo, underwater video tows, foul trawl tows (from research trawling), reef-indicator species richness for SPECIFY invertebrate, research TRAWL, and fisheries observer bycatch; and underwater video sites.

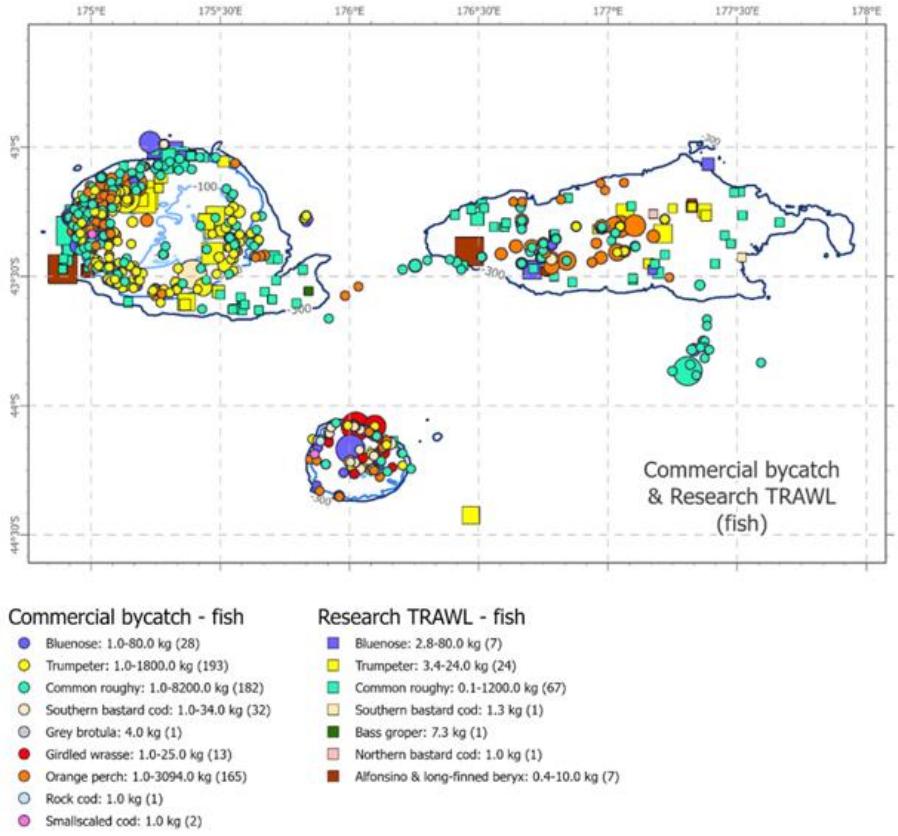

Figure B-118: Mernoo, commercial fisheries observer catch and research TRAWL reef-indicator species (kg): fish.

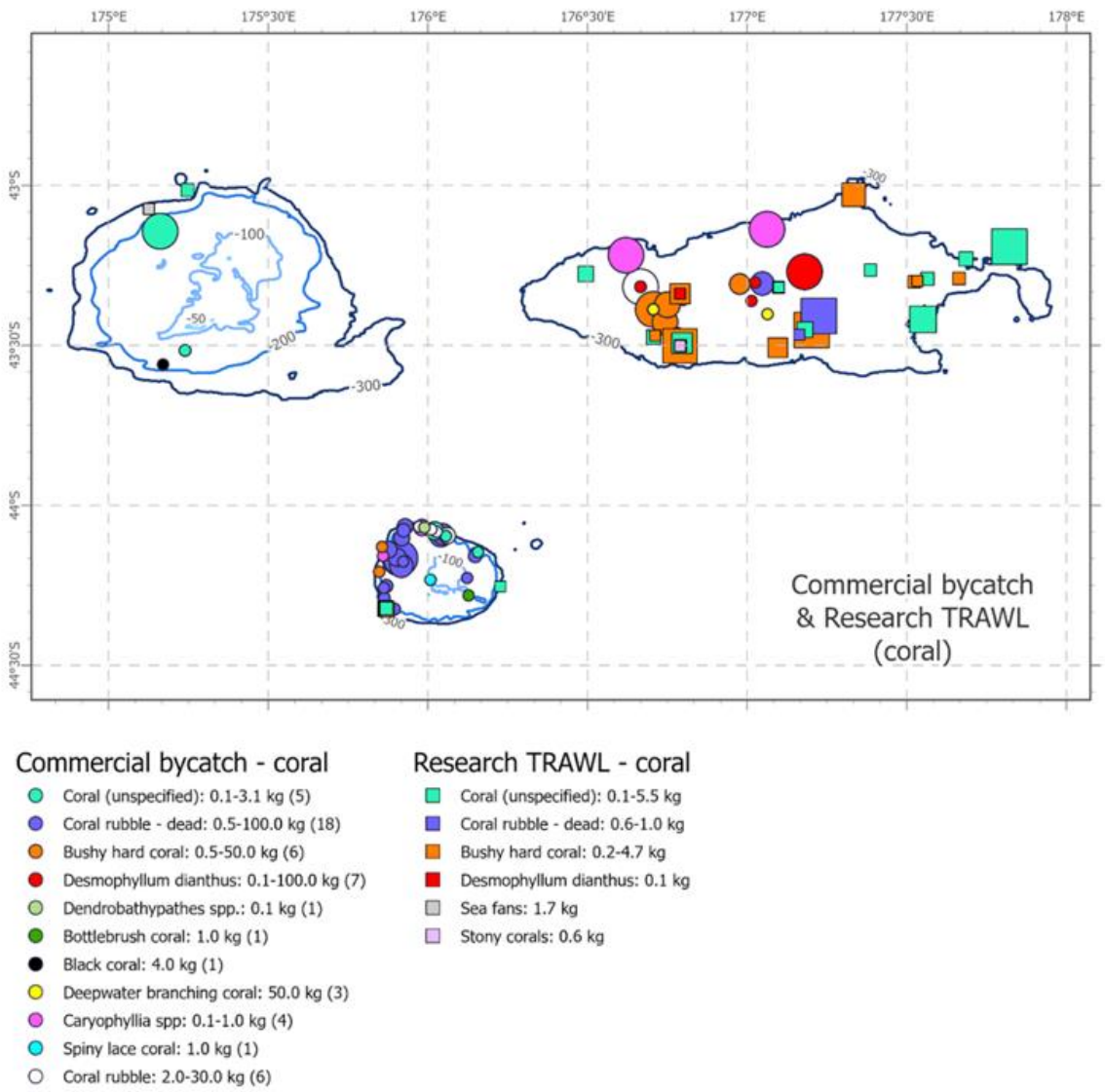

Figure B-119: Mernoo, commercial fisheries observer catch and research TRAWL reef-indicator species (kg): coral.

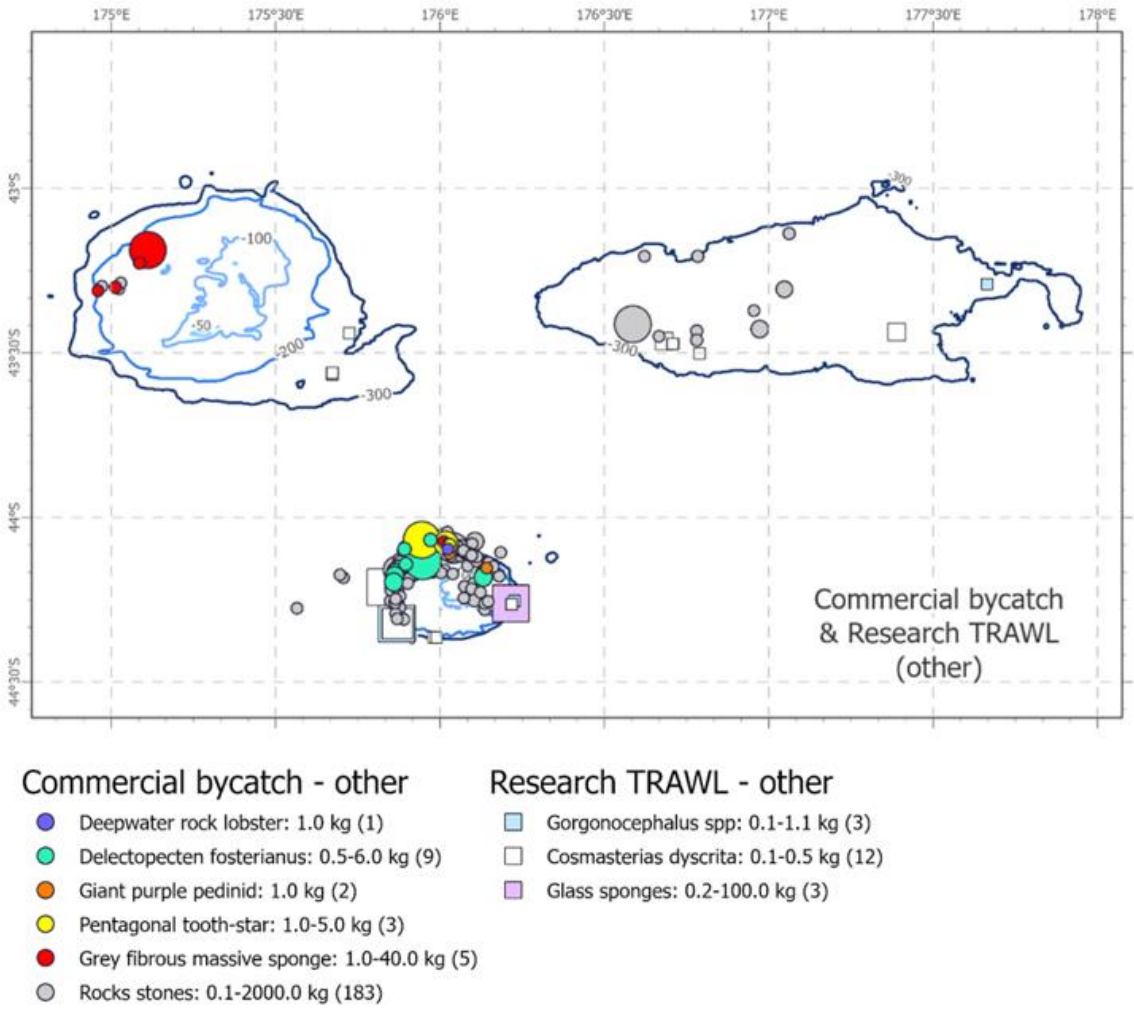

Figure B-120: Mernoo, commercial fisheries observer catch and research TRAWL reef-indicator species (kg): other species.

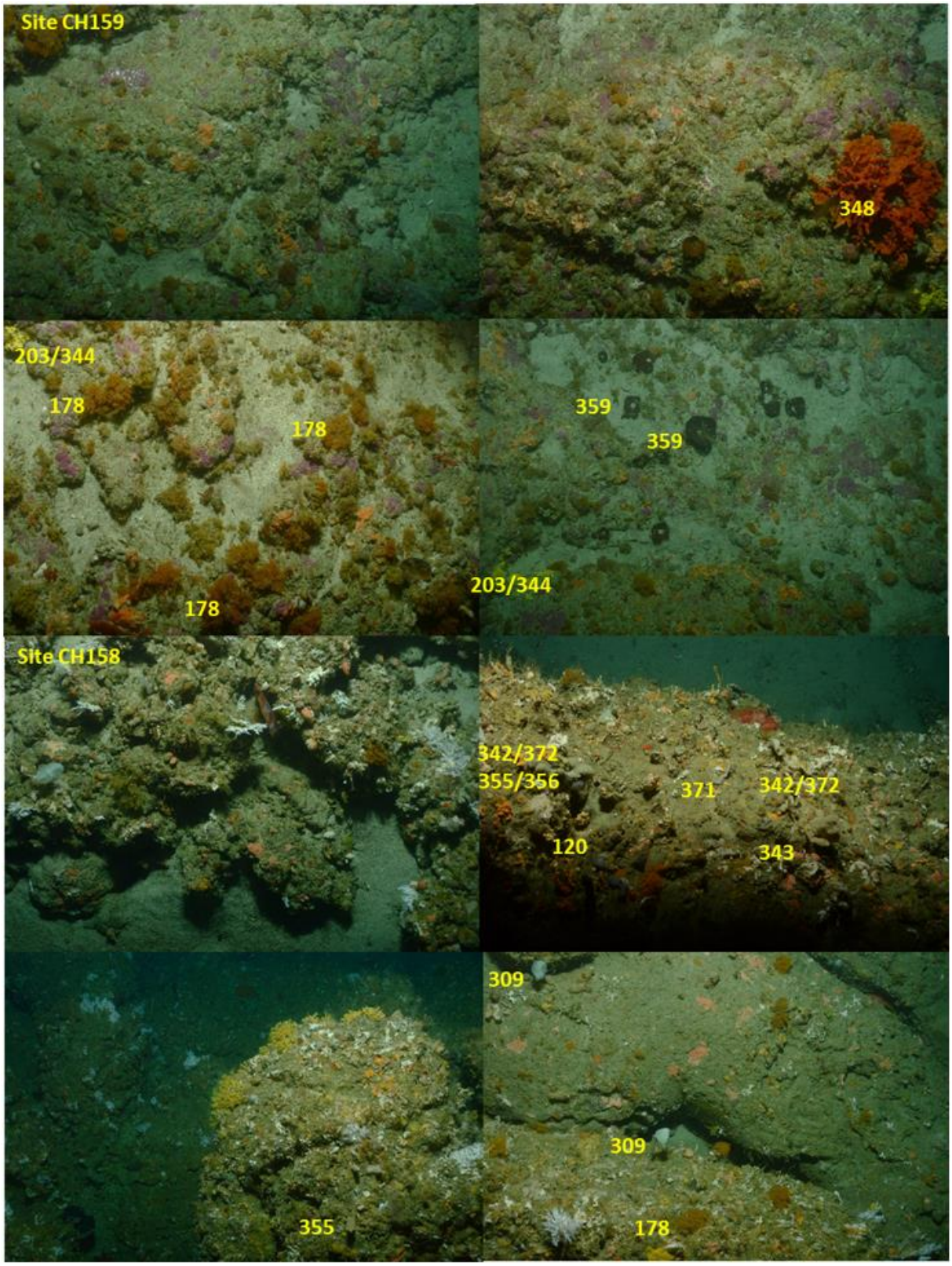

Figure B-121: Mernoo, TAN1701, Mernoo Bank, sites CH159 (53–73 m), CH158 (87–130 m). Image order runs left to right. Sponges 120) Tetractinellidae, family Ancorinidae, 203) *Darwinella oxeata* (?), 342) Haplosclerida, 343) *Poecilosclerida* sp. indet., 344) *Lissodendoryx* sp. indet., 348) *Crella incrustans*; 355) *Fasciospongia turgida*, 356) *Strongylacidon conulosum*, 359) *Latrunculia* sp., 371) Demospongiae sp. indet., 372) Chondrosiidae sp. indet.; (?) Bryozoans, 178) Catenicellidae (bryozoan); Worms, 309) Sabellidae.

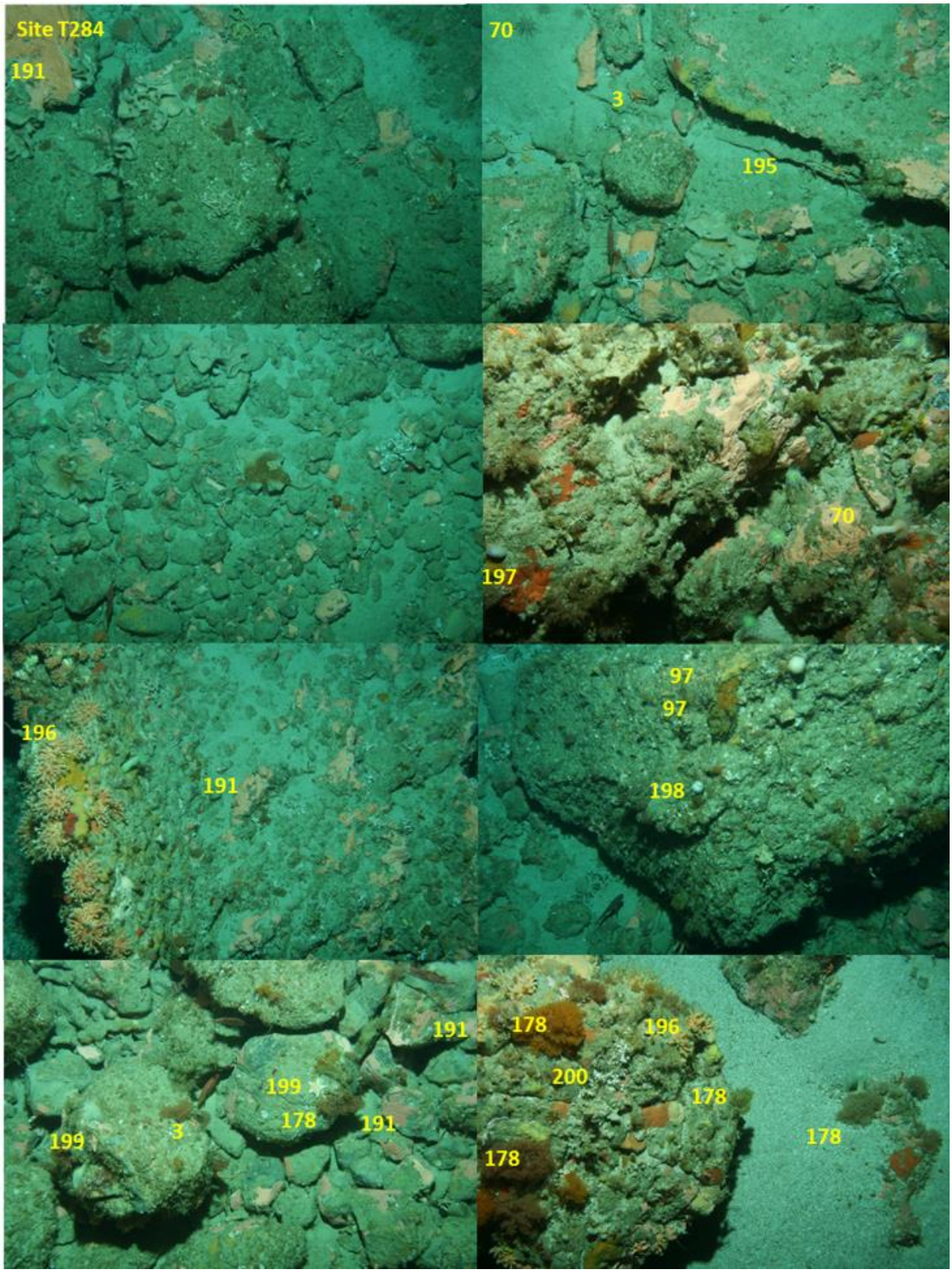

Figure B-122: Mernoo, TAN0705, Mernoo Bank, site T284 (42–58 m). Image order runs left to right. Sponges 66) *Haliclona* (*Gellius*) *petrocalyx*, 69) *Acanthella dendyi* (deepwater colourless form), 120) Tetractinellidae, family Ancorinidae, 192) *Xestospongia* sp. (Haplosclerida), 193) *Neopetrosia* sp. (Haplosclerida); Zooanthids 196) *Parazoanthus* sp., 194); Bryozoans 31) *Celleporaria agglutinans*, 97) bryozoan, 178) Catenicellidae, 200) Celleporid bryozoans on hydroids (white blobs), 195); Ascidians 191) *Didemnum densum*; Mobile invertebrates, Starfish 3) *Henricia* sp., 198) *Pseudechinus huttoni*, 199) Odontaster sp., Ophiuroid, 195) *Ophiopsammus* sp., Anemone, 70) Anemone, Sea slug 197) Sea slug.

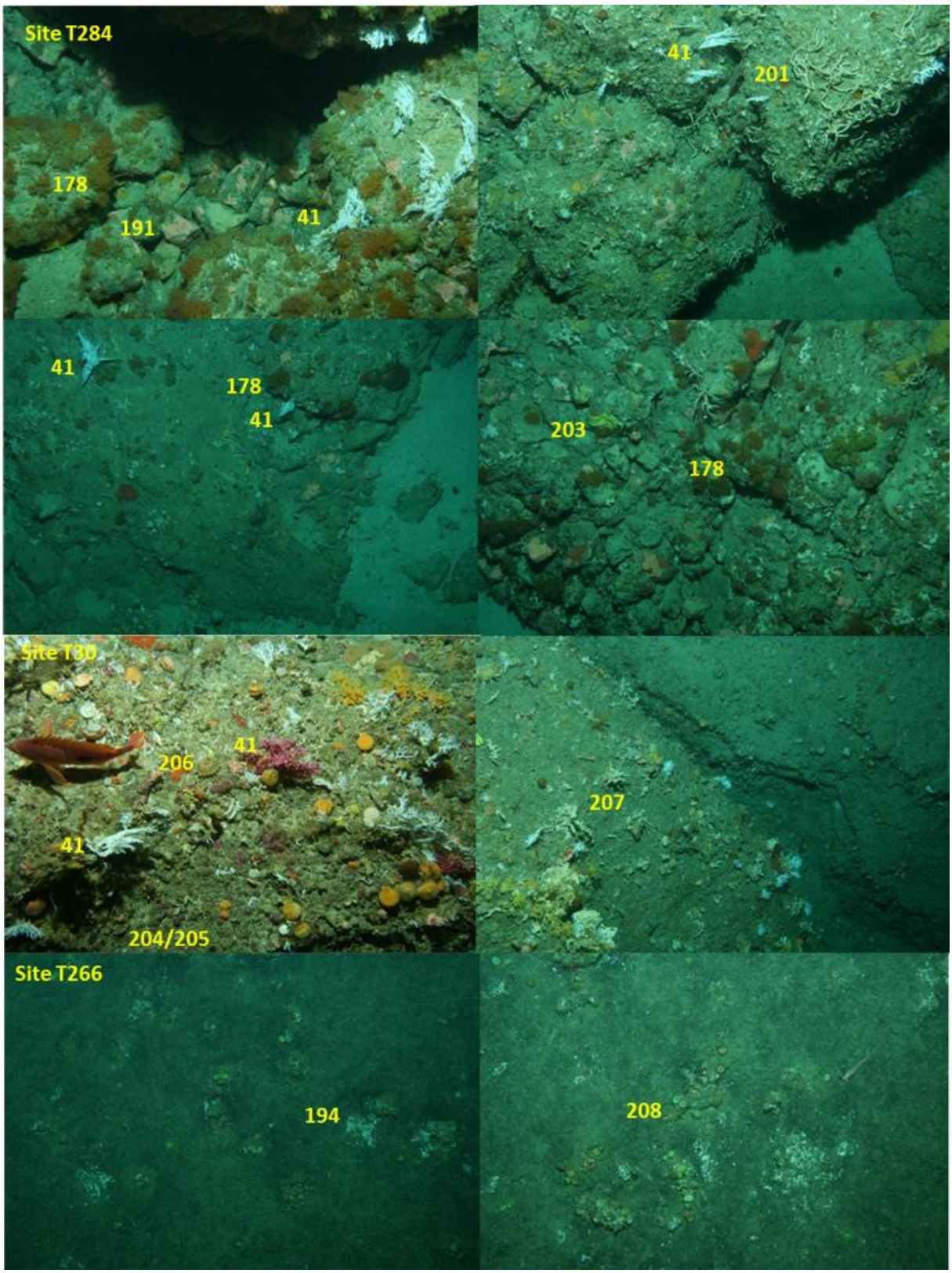

Figure B-123: Mernoo, TAN0705, sites T284 (42–58 m), T30 (115–124 m) T266 (246–250 m). Image order runs left to right. Sponges 201) *Haliclona* sp. Indet. 202) Hexactinellida, family Euretidae, 203) *Darwinella oxeata*, Corals 41) Stylasteridae, 208) small Bryozoans 178) Catenicellidae, 191) *Didemnum densum*; Ascidians 194) ascidian (white); Mobile invertebrates 204) *Buccinulum pertinax* (present in image), 205) *Maurea waikanae* (present in image), 206) *Astraea heliotropium*, 207) *Talochlamys gemmulata*.

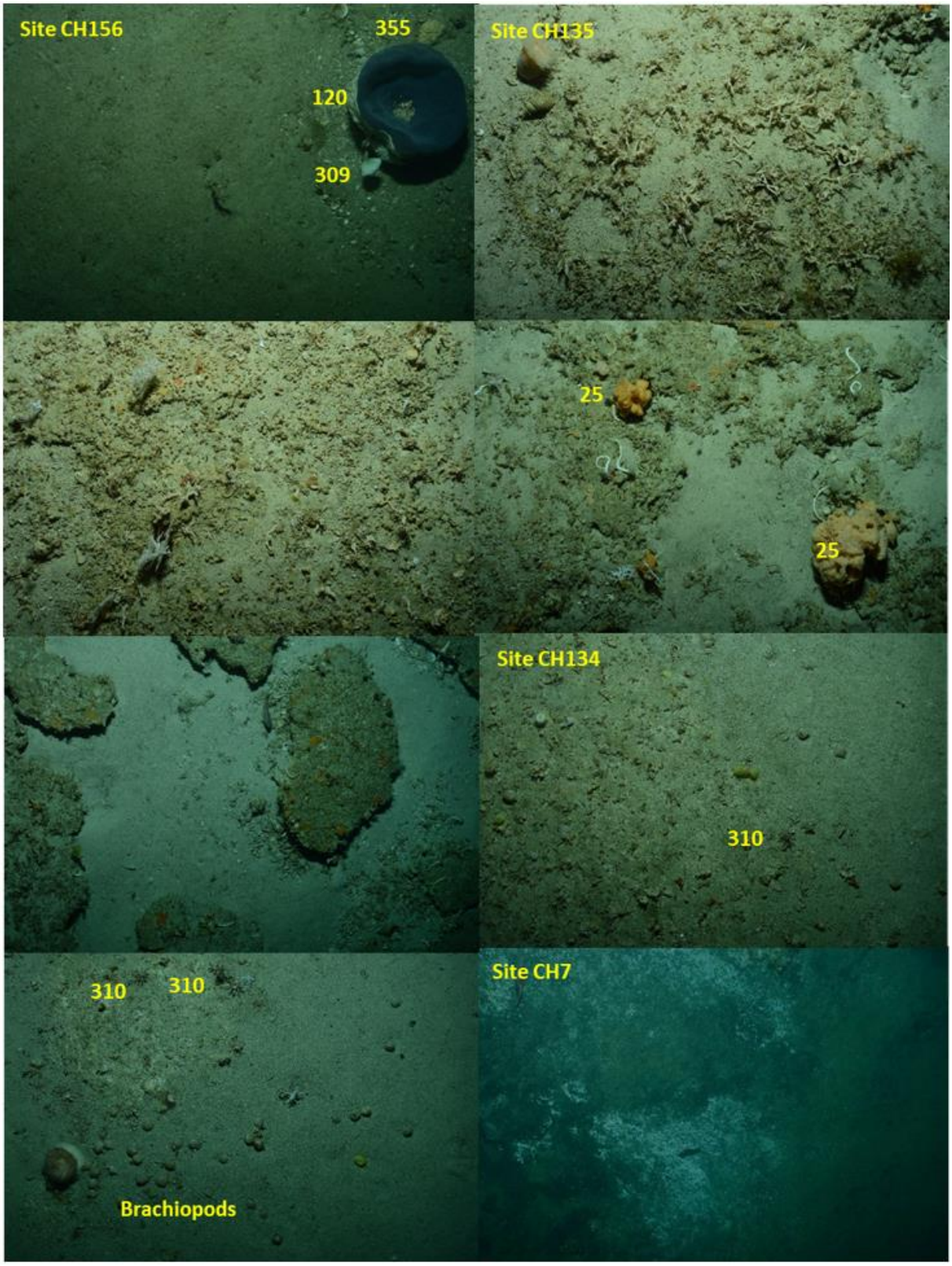

Figure B-124: Mernoo, TAN1701, sites CH156 (138–157 m), CH135 (142–150 m), CH134 (185–187 m), CH7 (255 m). Image order runs left to right. Sponges 25) *Symplectella rowi*, 120) Tetractinellidae, family Ancorinidae (with Chalinidae encrusting surface (white)), 355) *Fasciospongia turgida* (?), Worms, 309) Sabellidae; Mobile invertebrates, urchin, 310) *Goniocidaris parasol*.

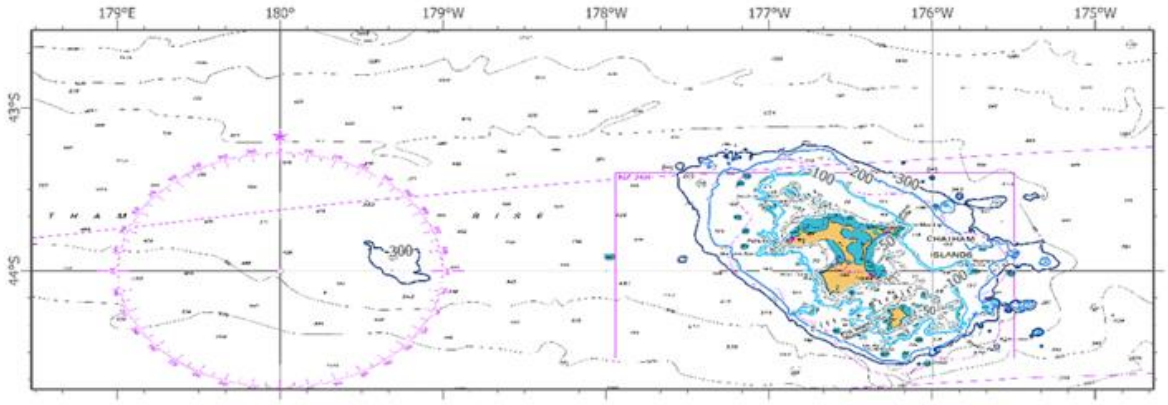

Figure B-125: Chatham, nautical chart. Nautical chart includes place names, bathymetry contours (dark blue line 300m depth contour; medium blue line 200 m contour; light blue line 100 m contour; grey line 50 m contour), and commercial trawl footprint (2003–2014) (grey lines are individual tows). Pink line with cross bars, territorial sea boundary (twelve nautical miles).

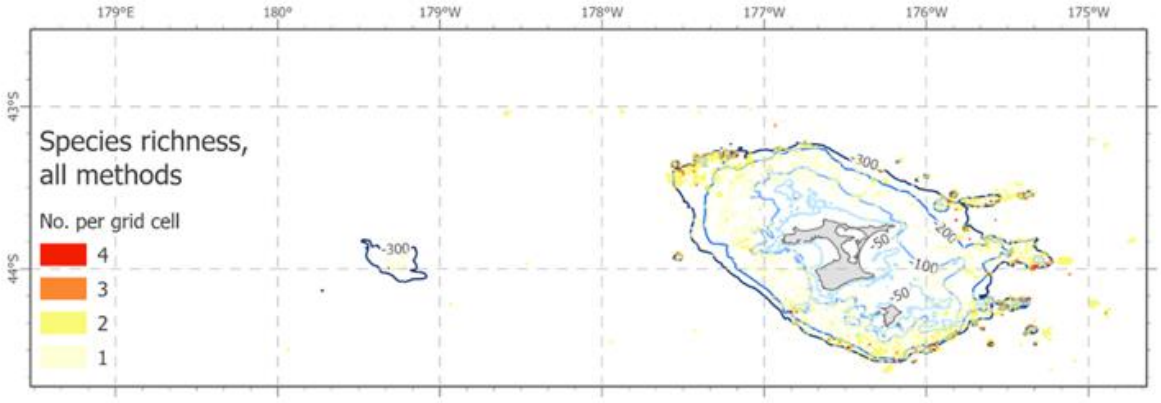

Figure B-126: Chatham, commercial catch of reef-indicator species: species richness.

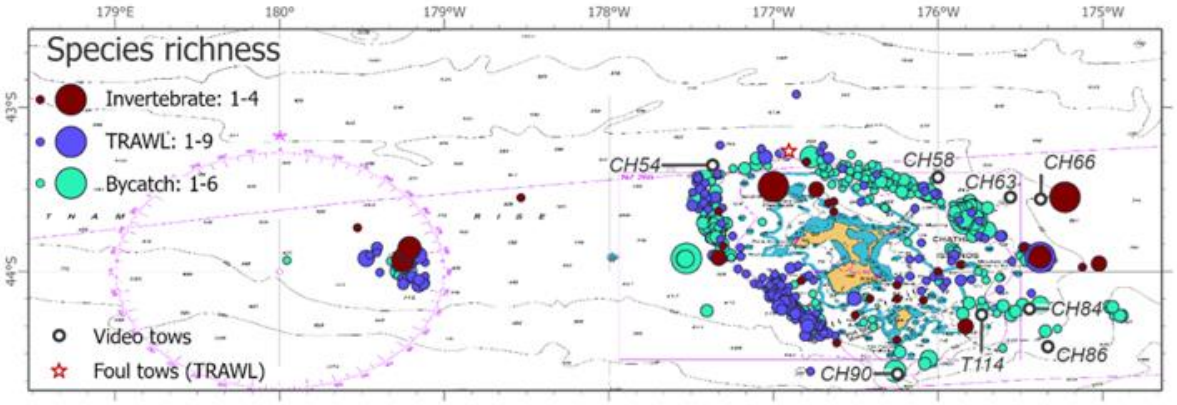

Figure B-127: Chatham, underwater video tows, foul trawl tows (from research trawling), reef-indicator species richness for SPECIFY invertebrate, research TRAWL, and fisheries observer bycatch.

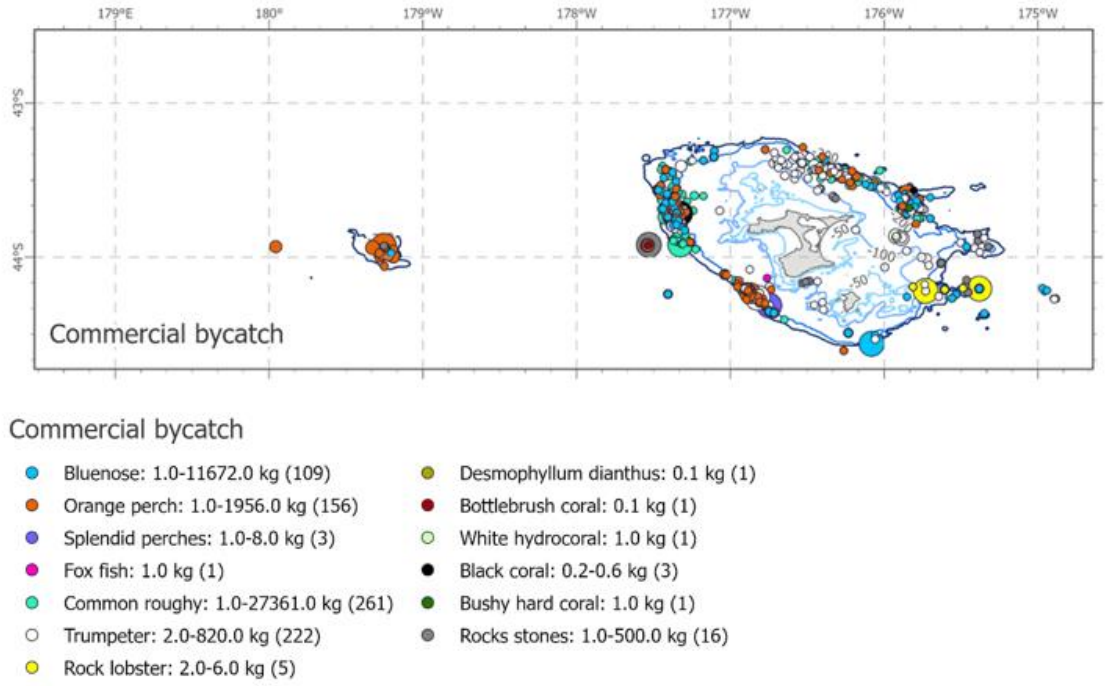

Figure B-128: Chatham, commercial fisheries observer catch (kg) of reef-indicator species. The number of sites each species was present at are given in brackets.

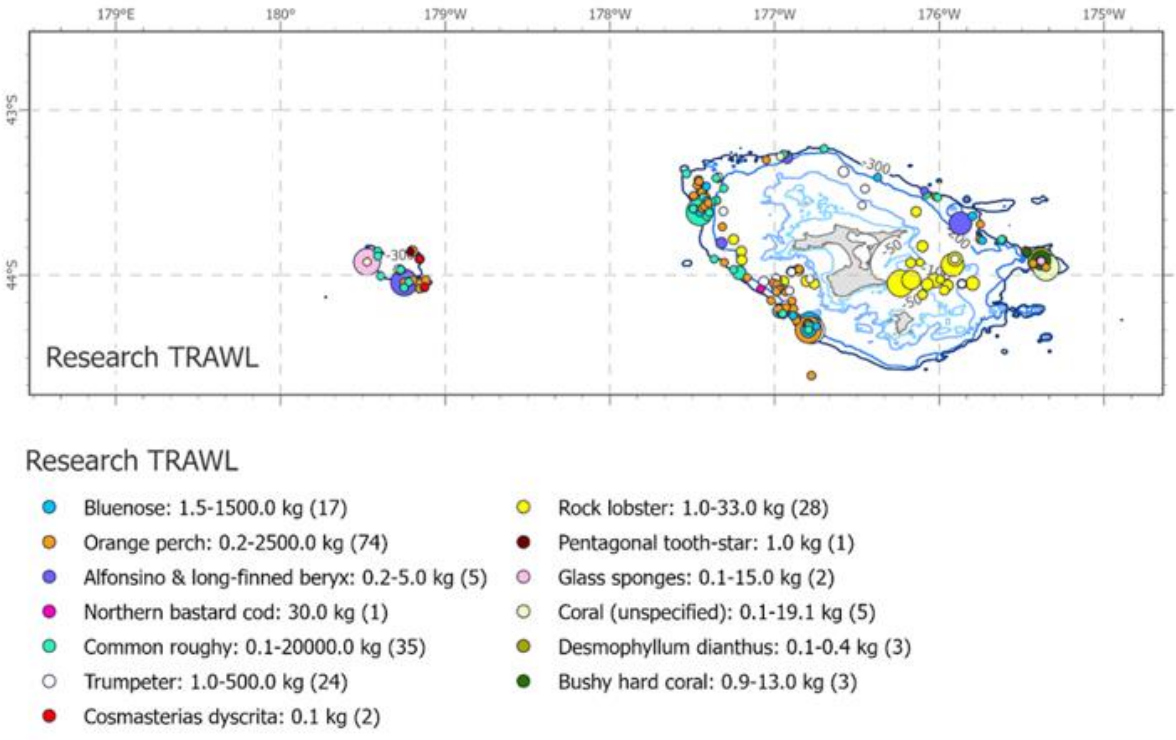

Figure B-129: Chatham, research TRAWL reef-indicator species (kg). The number of sites each species was present at are given in brackets.

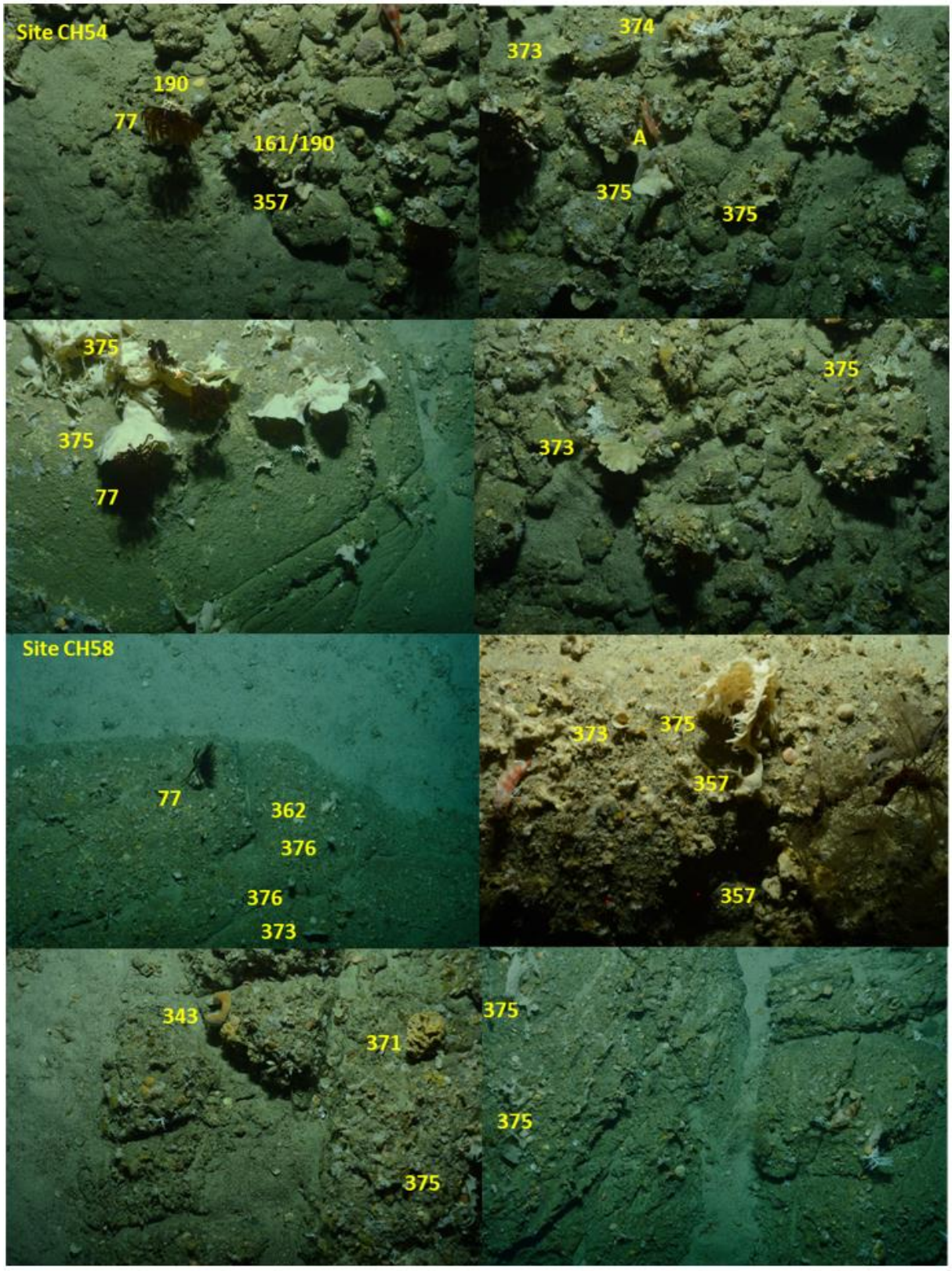

Figure B-130: Chatham, TAN1701, sites CH54 (181–212 m), CH58 (177–201 m). Image order runs left to right. Sponges 161) *Cinachyrella* sp. indet., 190) *Suberites* sp. indet., 343) *Poecilosclerida* sp. indet., 357) *Lissodendoryx* (*Ectyodoryx*) cf *bifacialis* (?), 362) *Ecionemia novaezelandiae* (?), 371) Demospongiae sp. indet. (lithistid) (?), 373) *Awhiowhio sepulchrum*, 374) *Desmacidon* sp. indet., 375) *Esperiopsis* sp. indet. (raggedy fan) (?), 376) *Antarctotetilla leptoderma* (?); Crinoid, 77) Comatulida. Fish, A) Butterful perch.

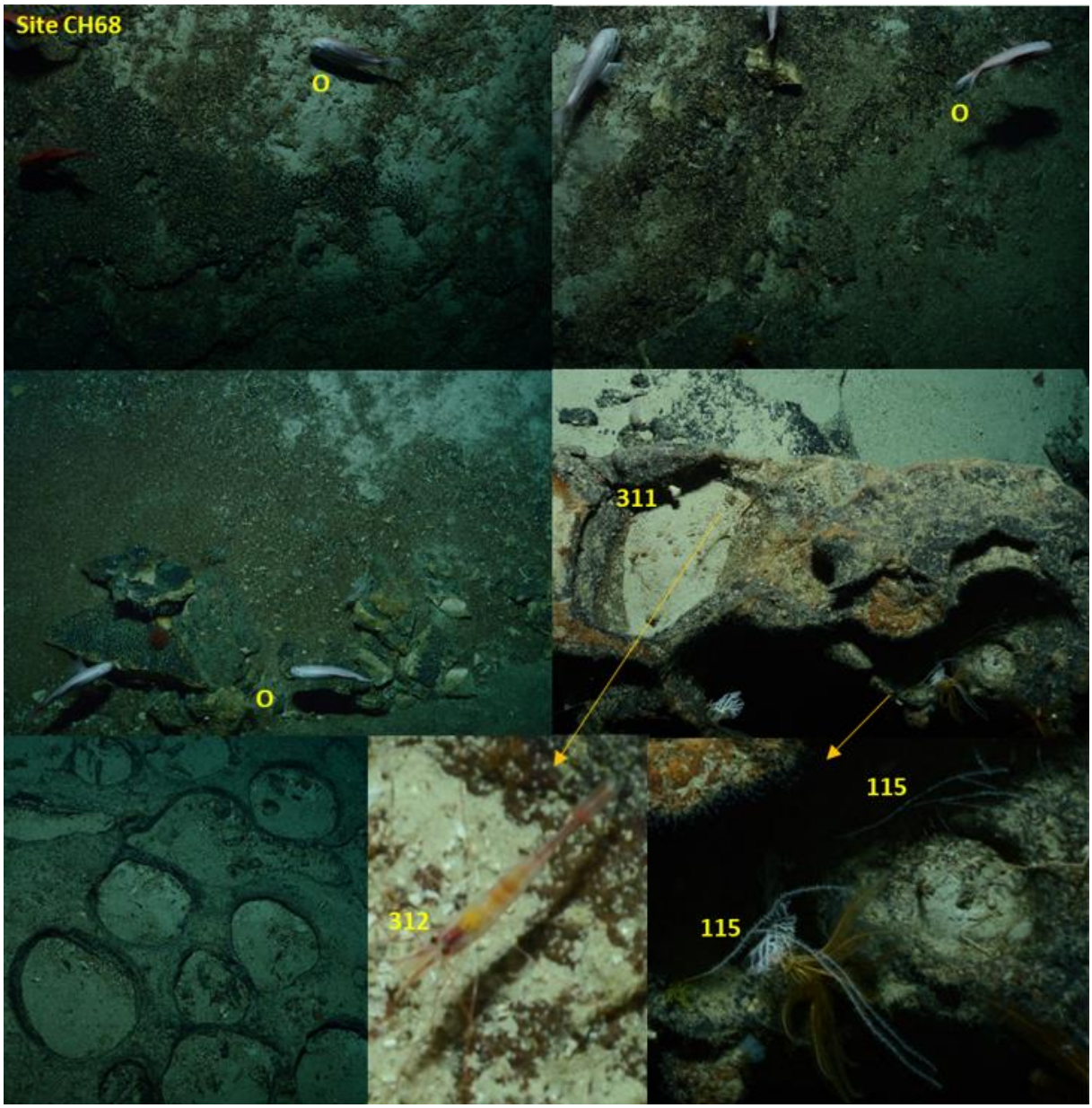

Figure B-131: Chatham, TAN1701, site CH68 (269–280 m). Image order runs left to right. Coral, 115) Isididae, 311) *Desmophyllum dianthus* (?), Mobile invertebrates, shrimp, 312) *Nematocarcinus* sp.; Crinoid, 77) Comatulida. Fish, O) *Hoplostethus atlanticus* (orange roughy).

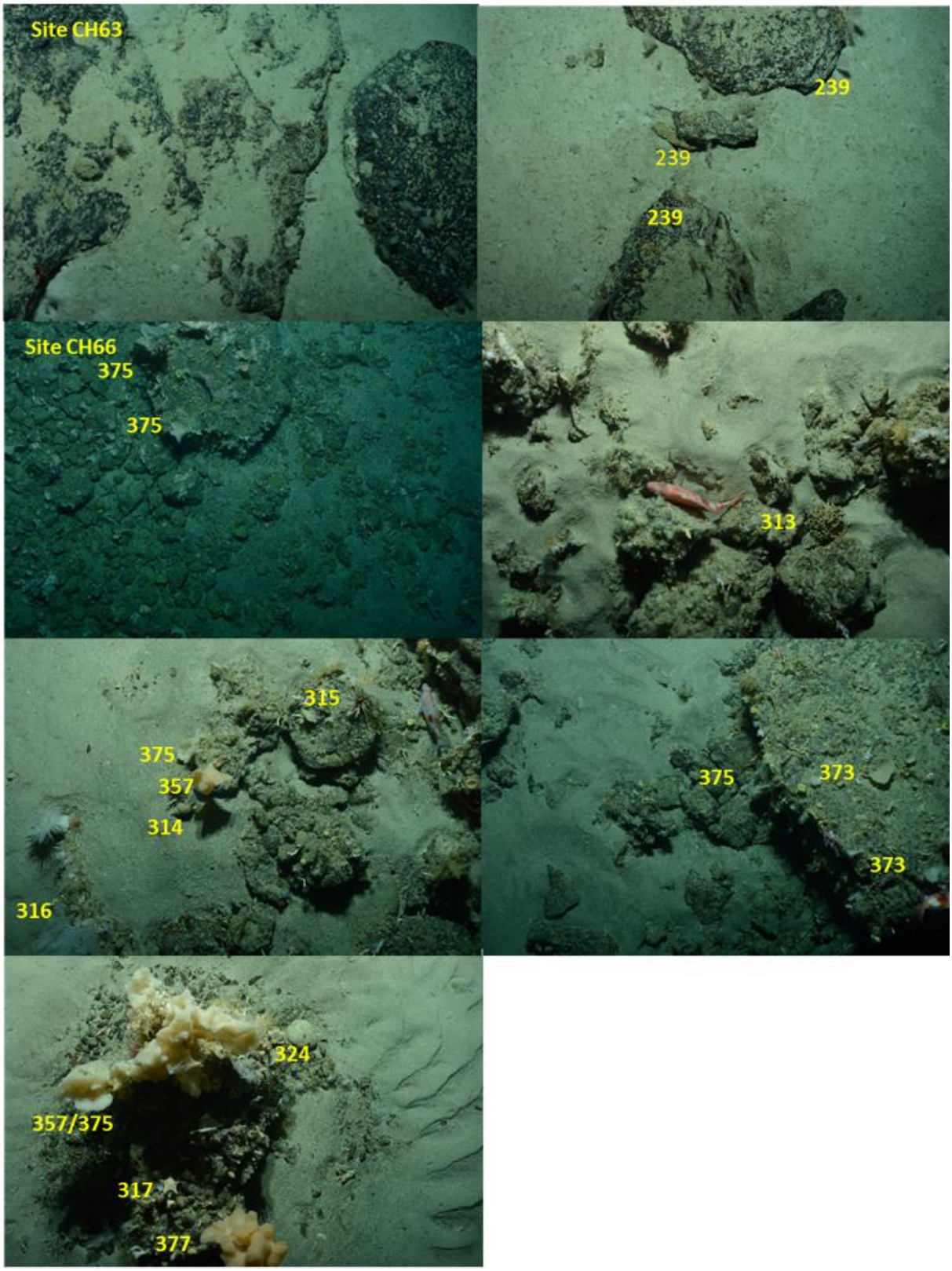

Figure B-132: Chatham's, TAN1701, sites CH63 (269–280 m), CH66 (279–290 m). Image order runs left to right. Sponges 357) *Lissodendoryx* (*Ectyodoryx*) cf *bifacialis*, 373) *Awhiowhio sepulchrum* (?), 375) *Esperiopsis* sp. indet. (raggedy fan) (?), 377) Hexactinellida (Lanuginelinae sp. indet.) (?); Coral, 239) Primnoidae (?), 316) Antipatharian; Bryozoan, 313) *Diaperoecia purpurascens*, 324) *Synoicum otagoensis*; Mobile invertebrates, gastropod, 314) *Fusitriton laudandus*; Urchin, 315) Cidaroid urchin, 317) *Diplodontias* sp.

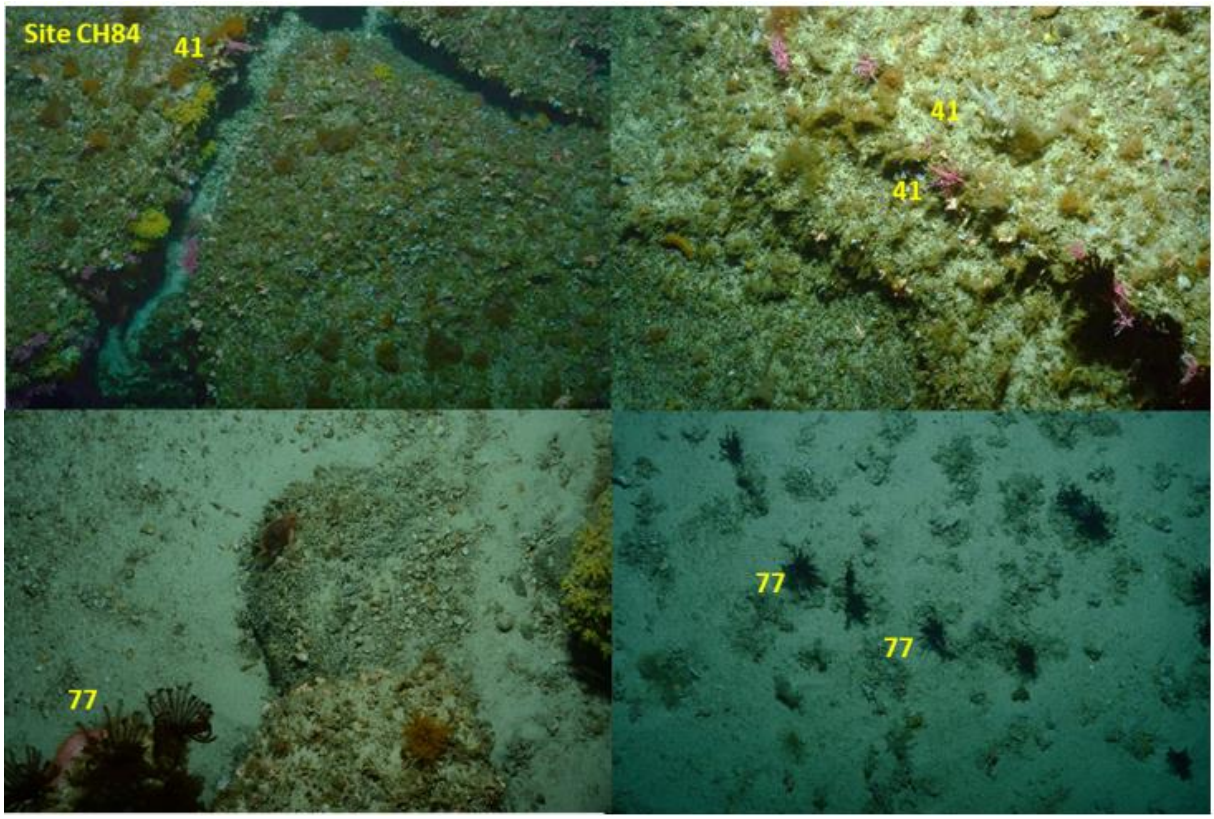

Figure B-133: Chatham, TAN1701, site CH84 (100–234 m). Image order runs left to right. Coral 41) Stylasteridae; Crinoid, 77) Comatulida.

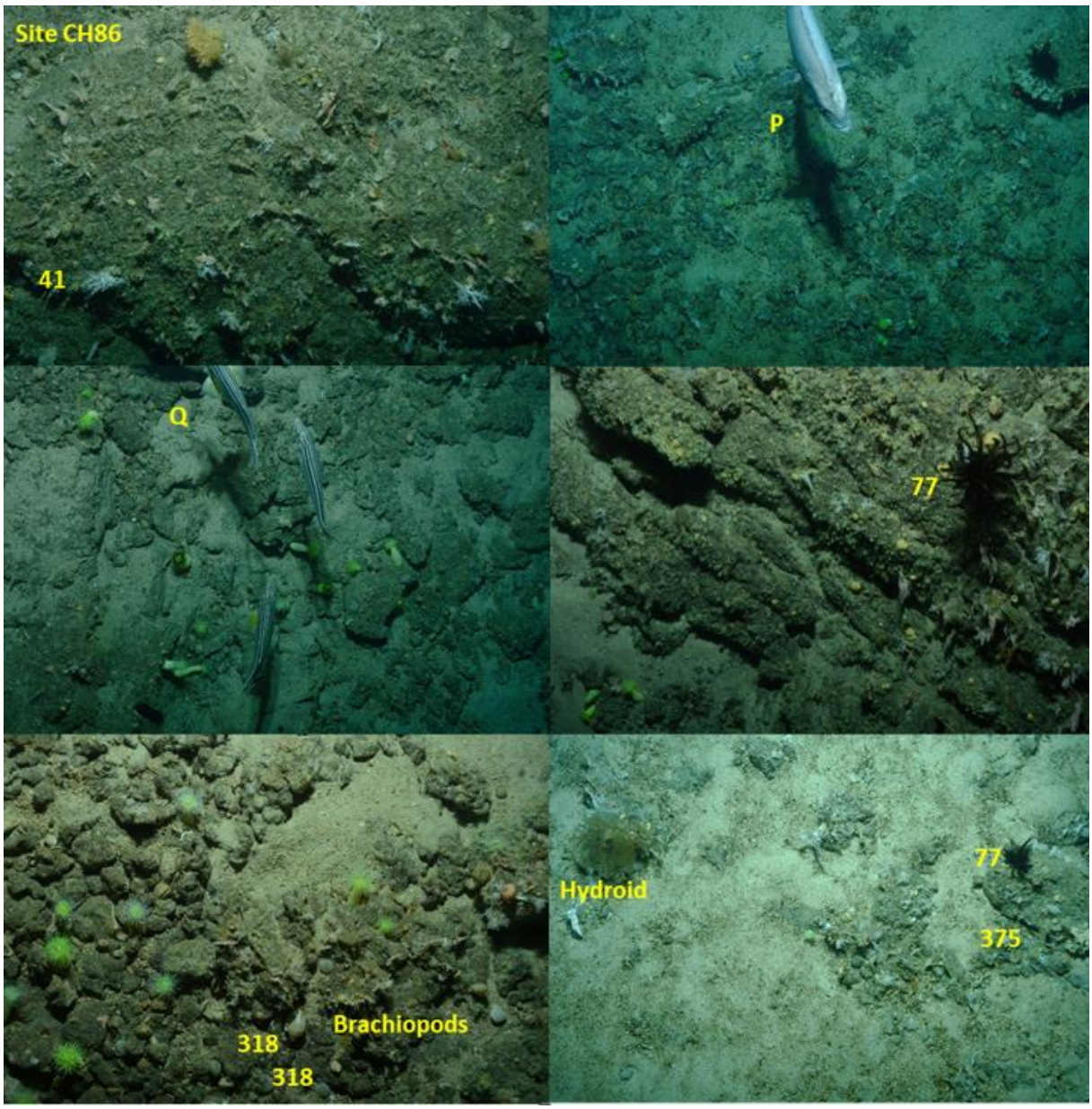

Figure B-134: Chatham, TAN1701, site CH86 (173–382 m). Image order runs left to right. Sponge 375) *Esperiopsis* sp. indet. (raggedy fan) (?); Coral 41) Stylasteridae; Mobile invertebrates, gastropod, 314) *Fusitriton laudandus*; 318) *Maurea* sp.; Crinoid, 77) Comatulida. Fish, P) *Polyprion oxygeneios* (hapuku), Q) *Latris lineata* (trumpeter).

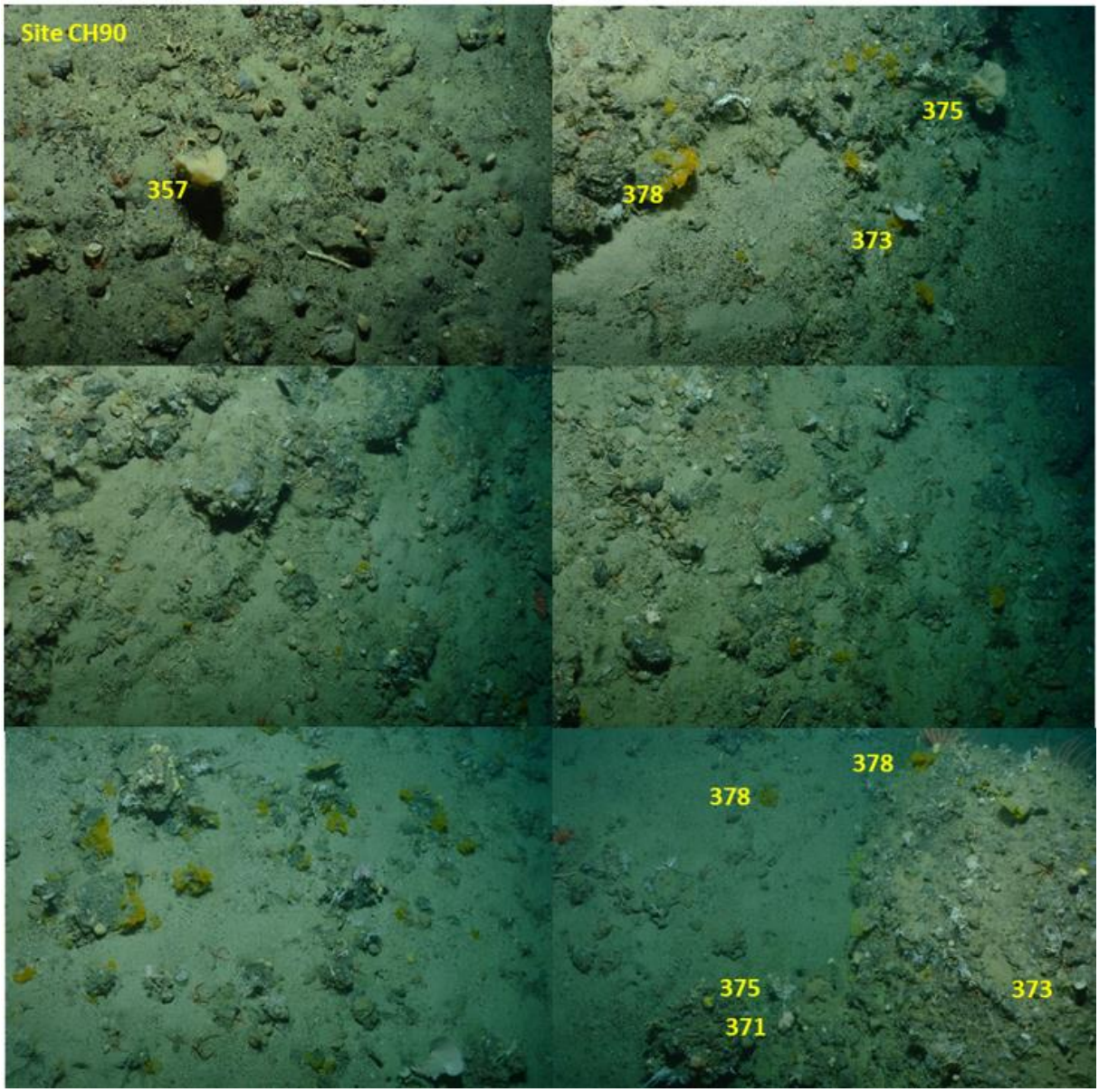

Figure B-135: Chatham, TAN1701, site CH90 (294–425 m). Image order runs left to right. Sponges 357) *Lissodendoryx* (*Ectyodoryx*) cf *bifacialis*, 362) *Ecionemia novaezelandiae* (?), 371) Demospongiae sp. indet., 373) *Awhiowhio sepulchrum* (?), 375) *Esperiopsis* sp. indet. (raggedy fan) (?), 378) *Lissodendoryx* sp. (yellow slimy) (or possibly an ascidian).

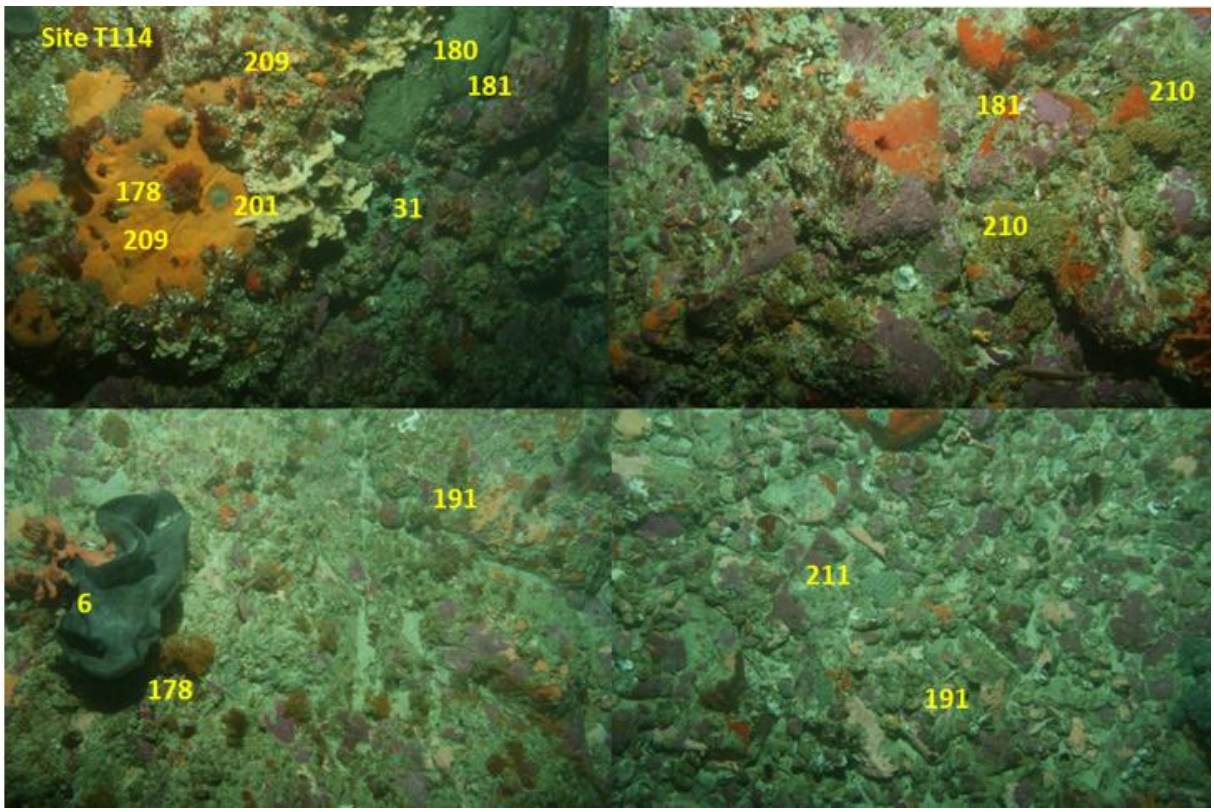

Figure B-136: Chatham, TAN0705, site T114 (85–186 m). Image order runs left to right. Sponges 6) *Ecionemia alata*, 201) *Haliclona* sp. Indet., 209) Unidentifiable poecilosclerida (possibly family Hymedesmiidae or Microcionidae); Bryozoans 31) *Celleporaria agglutinans*, 178) Catenicellidae, 191) *Didemnum densum*, 210) *Cinctipora elegans*; Ascidians 180) *Leptoclinides novaezelandiae*, 211) *Polyclinum novaezelandiae*; Algae 181) Non-geniculate corallines (pink).

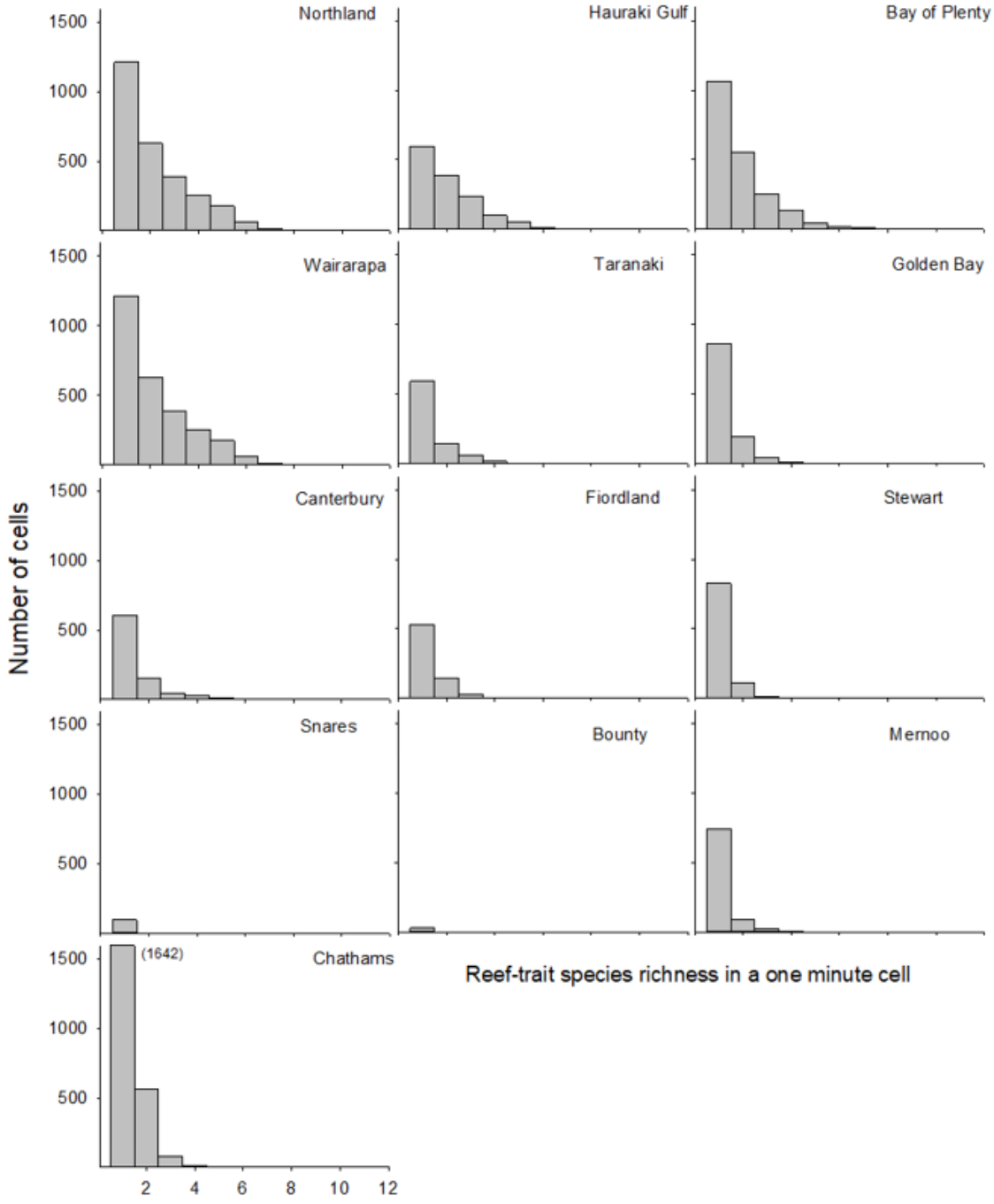

Figure B-137: Species richness value distributions within each of the 13 geographic regions. Cells are 1 second grids, noting that these decrease in size by about 15% from north to south in New Zealand.

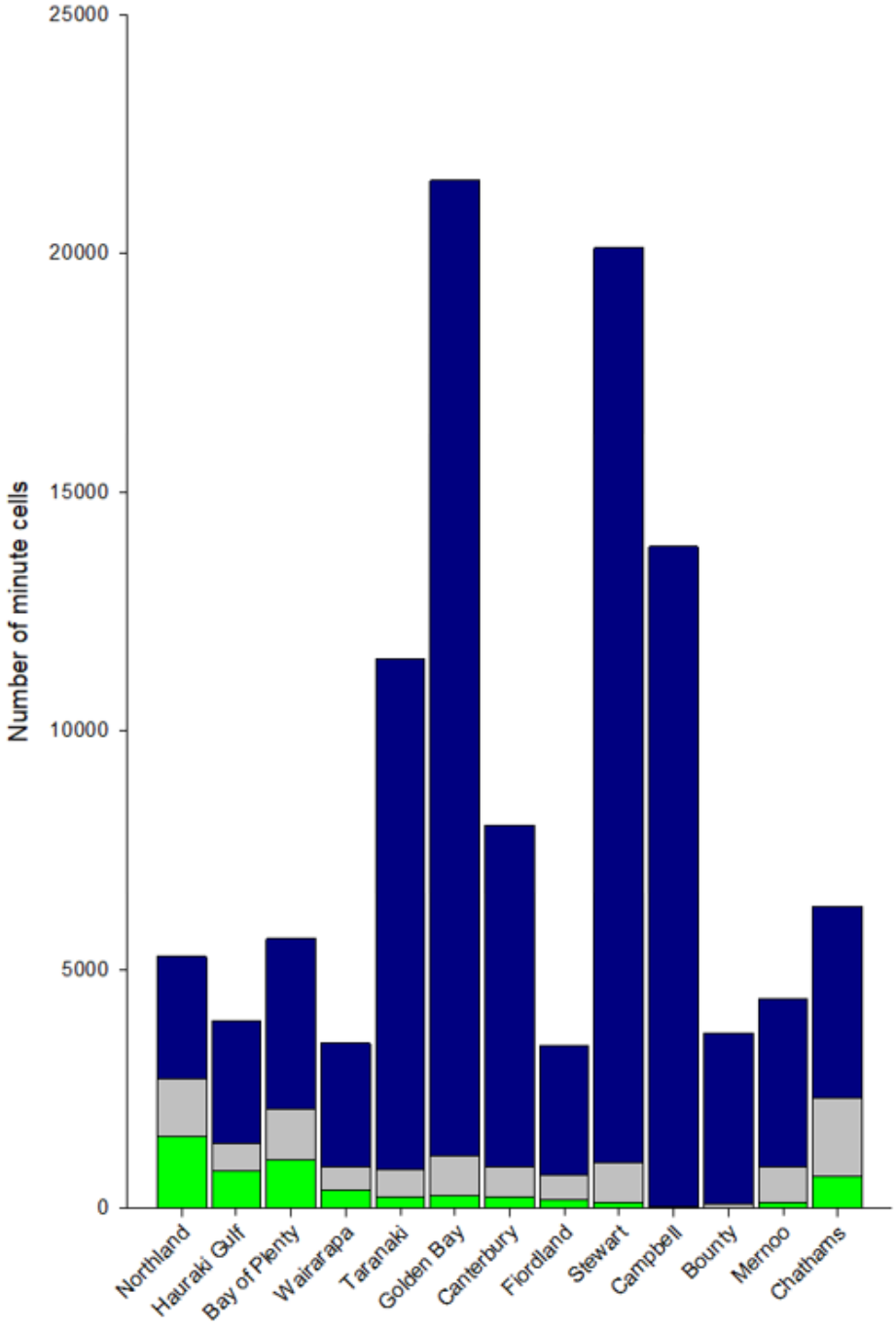

Figure B-138: Number of one-minute cells for each of the thirteen geographic regions. Number of one-minute cells is indicated by the blue bars. Within these, the number of one-minute cells holding 1 or more reef-indicator species is shown by the grey bars, or 2 or more reef-indicator species by the green bars. Stacks are cumulative (larger value classes are inclusive of the bars below them). See Table B-1 below.

Table B-1: Total number of grid cells, one or more reef trait species cells, and two or more reef trait species, by region. Local % is the percentage of all cells in a region occupied; national % is the percentage of reef trait species cells at the national scale occupied.

Region	All grid cells		1 or more reef-indicator species			2 or more reef trait species		
	No.	% National	No.	Local %	National %	No.	Local %	National %
Northland	5,264	4.8%	2,723	51.7%	18.5%	1,509	28.7%	27.6%
Hauraki Gulf	3,933	3.6%	1,373	34.9%	9.3%	777	19.8%	14.2%
Bay of Plenty	5,638	5.1%	2,076	36.8%	14.1%	1,010	17.9%	18.5%
Wairarapa	3,456	3.1%	866	25.1%	5.9%	387	11.2%	7.1%
Taranaki	11,493	10.4%	813	7.1%	5.5%	224	1.9%	4.1%
Golden	20,524	18.6%	1,113	5.4%	7.5%	250	1.2%	4.6%
Canterbury	8,017	7.3%	858	10.7%	5.8%	249	3.1%	4.6%
Fiordland	3,399	3.1%	707	20.8%	4.8%	176	5.2%	3.2%
Stewart	20,107	18.3%	949	4.7%	6.4%	121	0.6%	2.2%
Campbell	13,853	12.6%	29	0.2%	0.2%	-	0.0%	0.0%
Bounty	3,677	3.3%	96	2.6%	0.7%	2	0.1%	0.0%
Mernoo	4,391	4.0%	858	19.5%	5.8%	113	2.6%	2.1%
Chatham's	6,313	5.7%	2,295	36.4%	15.6%	653	10.3%	11.9%
TOTAL	110,065		14,756	13.4%		5,471	5.0%	