Deep rocky and biogenic reef habitats of East Northland

Prepared for Department of Conservation

October 2023

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NIWA CLIENT REPORT No: 2023291AK
Report date: October 2023
NIWA Project: DOC22101

Revision	Description	Date
Version 1.0	Final version sent to client	14 October 2023

Quality Assurance Statement		
	Reviewed by:	Jennifer Beaumont
	Formatting checked by:	Rachel Wright
	Approved for release by:	Jonathan Moores

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Executive summary

DTIS video and multibeam sonar data collected along the East Northland coast as part of the Bay of Islands OS2020 programme was used to describe and quantify the extensive deep reef (50–200 metres water depth) systems present on the continental shelf. Thirty-eight DTIS stations were scored for their faunal densities (taxa 4 cm and larger), and a reef geomorphology classification developed and used to divide the reefs into different sub-habitats. Reefs were found to generally be arranged as mosaics interspersed over flat soft-sediment plains, low in height and relief. Over 300 associated Operational Taxonomic Units (OTUs) (fauna) were identified, although issues with resolving fauna due to poor video resolution meant many individuals could only be assigned to broad taxonomic groups. Sponges dominated the reef assemblages, followed by corals, hydroids, and bryozoans. Two broad rock types were present, a harder rock that occurred as flat and rugged surfaces, and a carbonate rock that formed low reefs (<40 cm) with pillow like structures with rounded edges, and with vertical holes extending down through these structures. These carbonate reefs were restricted to a narrow depth range of 108–115 metres. They are suspected to be relic biogenic structures formed by reef-building organisms in a past geological period. There were no differences in the faunal assemblages of these carbonate reefs compared to harder rock reefs in the same depth range, though corals were notably restricted to cup corals. An area of sand veneer over rock east of North Cape was also found to support biogenic habitat forming species. Hard rock faunal assemblage differences were seen for the factors of 'northness' and water depth overall, for sessile invertebrates and fishes, but finer scale pair-wise tests revealed only a few significant differences. Notably, differences between the 50–74 metre and the 100–124 metre depth bands were present for both sessile invertebrates and fishes, although why these differences were not also seen for other depth bands remains unclear.

1 Introduction

Deep reefs (defined as reefs in 50–300 metres water depth) are becoming recognised as important areas for marine biodiversity, as well as supporting a range of highly valued fisheries species. They may also offer a thermal refuge for many species as shallower waters warm. New Zealand's deep reefs are poorly mapped and ecologically described, despite increasing evidence that they may be widespread within New Zealand's Exclusive Economic Zone (EEZ) (Jones et al. 2016, 2018, Morrison et al. 2023). Multibeam sonar mapping is the 'gold standard' for detecting and mapping reef systems, but only small extents of deep reef have been mapped within New Zealand's EEZ to date. One of the areas that has been fully multibeam sonar mapped is the East Northland shelf (50–200 metres water depth), which was mapped by the R.V. Tangaroa in 2008 as part of the Bay of Islands OS2020 survey programme. A second R.V. Tangaroa voyage, also part of OS2020, deployed NIWAs Deep Towed Imaging System (DTIS) and other sampling gears across a range of stations, targeting soft sediment and reef habitats, and water column oceanography, in 2009. Around half of the DTIS stations were processed at that time, but only reported on at a broad taxonomic level (Bowden et al. 2010). Here, we build on the work of Bowden et al. (2010) by processing the remaining DTIS tows where rock/reef was encountered, and developing and using a reef geomorphology framework to describe the deep reefs present on the East Northland continental shelf. Our goal was to describe the deep reefs and their associated fauna using the OS2020 survey data.

A previous report assessed a range of potential proxies for rock (reef) presence at the national scale (Morrison et al. 2023), inclusive of the East Northland stations reported on here. Station numbers are the same between the two reports, with the addition of the prefix letter 'E' for the earlier report. In that report, still photographic images were marked up to illustrate a wide range of reef-dwelling species. The reader may find that report useful in visualising the species reported on here.

2 Methods

2.1 Field (2008, 2009)

In 2008 and 2009, two voyages were conducted, using NIWA's the R.V. Tangaroa, along the north-eastern New Zealand coast, from west of the Poor Knights Islands to North Cape. In the first voyage a multibeam sonar survey of the 50–200 m depth zone was completed, returning maps of bathymetry and backscatter (a measure of seafloor hardness). These maps were used for the second voyage in provisional form to assign seventy DTIS (Deep Towed Imaging System) sites across both hard (rock) and soft sediment seafloor targets. These were spread across the East Northland survey area to encompass as much variation as practical in both depth and backscatter, while also ensuring a good spatial spread from north to south. Other sampling methods were deployed at a subset of these stations, including sediment coring, a CTD (Conductivity, Temperature, Depth) probe, beam trawl, and rock dredge.

At each DTIS site, the system was towed at a speed of around a knot for one hour. Each transect covered about 1,800 metres distance, with an averaged transect width (width of field seen in the video) of approximately 1.85 metres. The DTIS system ran two high-definition video cameras (one facing obliquely forward and down, the other straight down), as well as high-definition downward facing stills camera, set to take an image every 15 seconds. Each camera system had its own scaling lasers to allow for the field of view to be calculated, as well as to measure the size of any objects of interest. Transect widths varied within and across transects depending on water clarity, which limited how high the system could be flown while still keeping the seafloor in view, and surface sea conditions. A Simrad HPR system was used to continuously transmit DTIS's position back to the survey vessel, allowing for its true position to be recorded accurately into a time-stamped GPS log.

Scaling lasers were used to estimate the width of field, while a time-stamped GPS position log was used to record position. DTIS tows were done during the hours of darkness, allowing for sleeping demersal fishes, and nocturnally emerging species such as small conger eels and morids, to be identified and counted (Morrison & Carbines 2006). Positional and seabed observation data were recorded continuously in real time using field counts of fauna and flora and point observations of bottom type (mud, sand, gravel, rock). All observations were recorded using the OFOP software package (Ocean Floor Observation System, www.ofop-by-sams.eu), linked to the RV Tangaroa's data acquisition system (DAS). A low-resolution real-time video feed enabled observations of benthic fauna and substrate type to be made during deployments. This allowed a video analyst to score the presence of objects while viewing the video, with an associated time-stamped GPS file being used to assign each object a spatial position (coordinates) in the associated OFOP file. However, post-processing of video and still images was required to generate high quality data on fauna and substrate suitable for analysis.

2.2 Post voyage video processing (OS2020, and present day project)

2.2.1 Multibeam sonar data

The OS2020 multibeam sonar data was available as cleaned bathymetry and backscatter. In addition, the bathymetry data was processed by DOC using the Benthic Terrain Model (BTM) software. The BTM model uses the bathymetric data to class the seafloor into landscape features (e.g., flat plains, slopes, ridges etc). These BTM classes were used as backdrops in map displays to help with interpretation of rock presence and reef structures. A bathymetric profile along each transect was generated by overlaying the DTIS track on the multibeam bathymetric grid (10 m pixel resolution) and each 20-second segment assigned a depth based on the average value for that cell. It should be noted that these depth estimates average out finer scale variation at the less than 10 m metre scale, including where small, low height and patchy reefs occur as fine-scale mosaics.

2.2.2 Video and still image processing: OS2020

Once onshore, the images from the video and still cameras were used to create a visual species/Operational Taxonomic Units (OTU) guide and associated name list, with the assistance of expert taxonomists for the different species groups. Video analysts analysed each video in OFOP using this master guide and scored (counted) all fauna and flora (>4 cm) discernible as discrete entities. This included both individual and colonial animals. This process was completed for a subset of DTIS transects (both reef and soft sediment dominated) and the proportional composition of the invertebrate fauna across stations reported on by Bowden et al. (2010). No estimation of habitat covers, or associated faunal densities, were made.

2.2.3 Video and still image processing: present day project

DTIS stations with OS2020 observations indicating the presence of rock were selected for analysis within this deep-reef project. One station that held many biogenic taxa over what appeared to be sandy sediments was also retained, as it was strongly suspected to be a station where a thin sand veneer lay over flat bedrock.

In addition, DTIS stations that were not previously processed in the OS2020 programme were also examined for rock presence by initial viewing of the videos. If rock was present, the video was analysed using the same approach as in the OS2020 work. These new data were combined with the station data from OS2020 into a master file, with some updating of species names that had changed in the intervening 13 years. The original voyage station numbers were retained, so that this report can be compared with others directly based on those, noting that the DTIS station numbers are not sequential.

One DTIS transect was found to have a corrupt GPS file, meaning that OFOP records with positional data could not be generated. That DTIS transect was discarded, leaving 38 DTIS rock associated stations in total.

For this report, as the survey area effectively ran along a north-south axis, all the DTIS stations were ordered by latitude, and presented running from south to north. To further assist with presentation and interpretation, the survey area was split into seven map boxes, also running from south to north (Figure 2-1).

2.2.4 Calculation of rock cover

The standard OFOP approach treats seafloor type as relatively simple geological classes (e.g., mud, sand, gravel, rock, etc), and the transect as a one-dimensional string. To convert taxa counts to densities, the distance travelled along the transect within a general seafloor type was multiplied by the average transect width (field of view). This is a straightforward approach for low variation seafloors.

Initial viewing of the rock associated stations revealed complicated spatial mosaics of rock and soft sediments over short spatial scales. This included different habitats being present side by side, e.g., soft substrate on one side and rock habitat on the other side, for a given field of view. This made treating the transect as a one-dimensional string problematic.

Within these rock/soft sediment mosaics, there was further variation in reef morphology (e.g., buried rock pavement, cobble fields, low flat/basement rock, higher broken rock). There were also at least two types of rock present, both of which were present on some transects. Almost all the invertebrate fauna observed were strongly rock associated (on, or directly adjacent to). Fish (sleeping and nocturnally foraging) were present on both rock and non-rock habitats, with those on the soft sediments being largely nocturnal foraging species known to utilise such habitats e.g., small-bodied conger eels, small morid cod and red bandfish (a daytime burrow dweller).

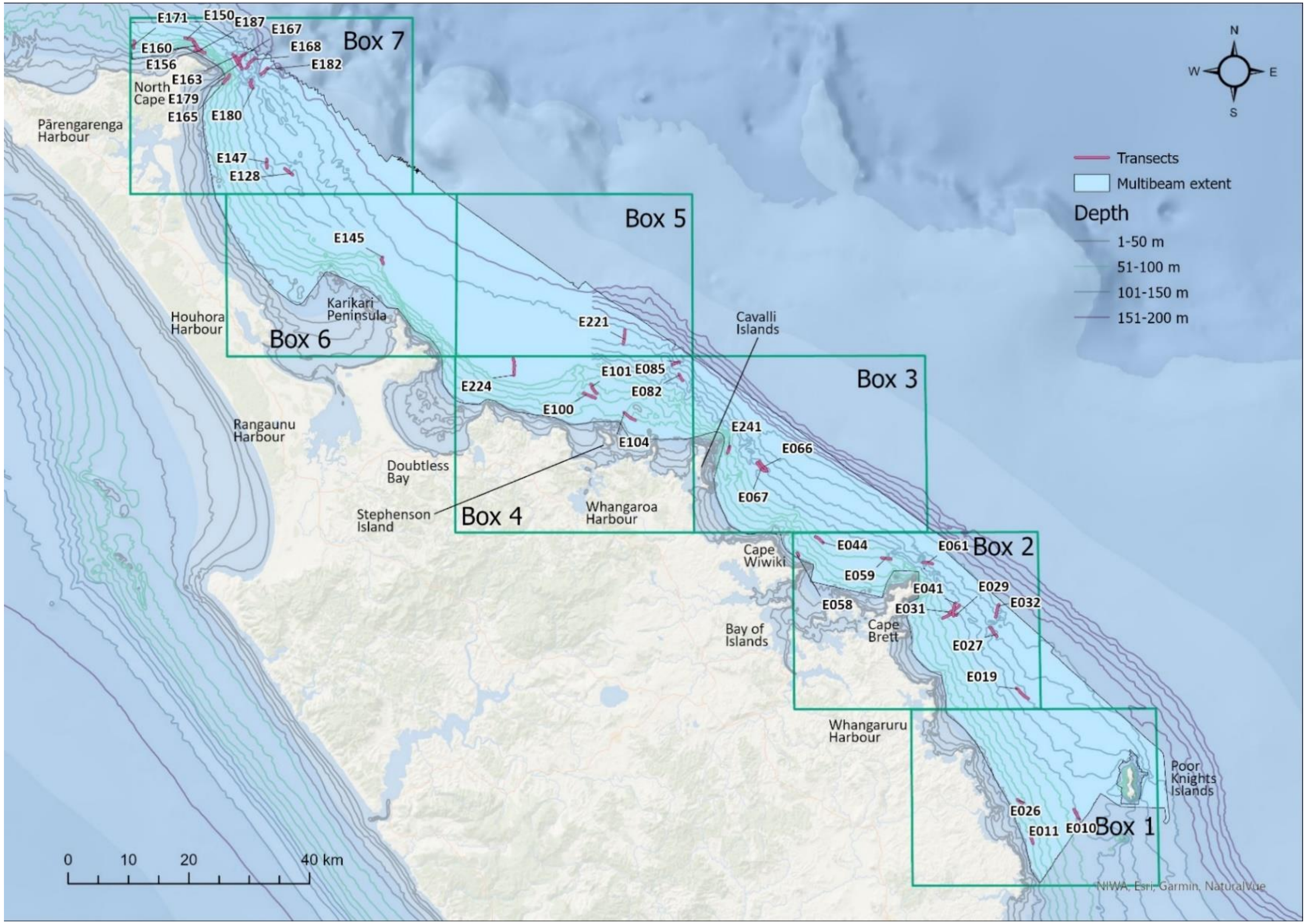

Figure 2-1: DTIS video transects along the east Northland coast, overlain on multibeam bathymetry displayed as shaded relief. Rock-associated transects (purple) are labelled with the station code assigned during collection. Soft sediment only transects (yellow) are also shown for context. The survey area is divided into seven map blocks for ease of presentation.

To allow for the estimation of rock associated OTU densities, it was necessary to calculate the area of rock habitat present, and to only retain individuals associated with that habitat. A method recently developed to address the same issue for Patea Bank reefs was applied to these East Northland deep reef mosaics (Morrison et al. 2022).

Each video transect was divided into twenty second segments, as the finest scale sampling unit for seafloor habitat. Broadly speaking, DTIS travelled around 10 metres over 20 seconds, with variation due to current speeds and other factors. Time was chosen as the unit of measure, as video time elapsed was able to be seen directly on the videos, was easy for the video analysts to keep track of and allowed each second passed to be used as a proxy for 5% of the video segment having been viewed. The alternative of using a fixed distance travelled as the base unit of measure (as a better statistical unit) was not possible as human video analysts are not able to work with consistently varying times for each segment length (in terms of percent cover estimation).

To estimate percent cover of the rock geomorphology classes (see below), each 20 second video segment was viewed by the video analyst and visually scored for the percent cover of each rock (and soft sediment) class present. Class intervals of 5% were used, with rarer elements being classed in 1% bins up to 5%.This was considered to match the likely visual estimation accuracy achievable by the analyst. The combined percent cover was required to add to 100%. Each segment was viewed as many times as necessary to estimate the geomorphology covers present. To calculate the spatial distance travelled for each 20 second segment, each segments start and end position was calculated by matching their time stamps with the concordant GPS file, and the distance between calculated in metres. The width of view was calculated using the scaling lasers, with multiple estimates being made along an individual transect, and the average of these applied to each segment, to calculate the area swept by each (m^2). The contribution of each habitat type (rock/reef morphology class) for a given segment was calculated by applying its percent cover (proportion) to the overall area swept. All segment observation and scoring was made by one video analyst only (MM), avoiding between-observer variation.

To generate a scoring scheme for rock and soft sediment geomorphologies, all video was initially viewed and a classification scheme developed to categorise the features and bottom type's present. Broadly speaking, this was arranged in order of increasing 'object size', using the Wentworth particle approach for sediments. For example, soft sediment types ranged from sands through gravels to shells; though these are not reported on in this report. Rock/reef morphology classes were created based on rugosity and 'patchiness' (Table 2-1). This was based on what could be seen in the local video field of view. For instance, the classes of low and high broken rock refer to the local rugosity of the rock, rather than the actual height of a reef structure. Base 'bare rock' was seldom seen, as it was covered by larger epifauna, fine sediment, and in what was likely to be low fine covers of tubeworms and/or other mat forming species (too small to be distinguished by video). Two general rock types were readily distinguishable from each other – a 'hard' looking rock that presented as flat and blocky surfaces, sometimes split with cracks, and a 'softer' looking rock that was thought to be a carbonate, which presented as rounded pillow-like forms, often with downward holes. A small fragment of this rock type recovered by dredge during the OS2020 survey, confirmed its carbonate nature. A further 'mudstone' rock type was seen at several sites but was uncommon.

Table 2-1: Seafloor geomorphology classes.

Group	Seafloor class	Description
Soft	Mud	Mud seafloor, often featureless
	Sand	Sand seafloor, often with fine ripples
	Sand with whole shell debris	Sand with a noticeable proportion of shell debris
	Gravel	Fine gravels, sometimes arranged in fine waves
	Carbonate debris	Occasionally seen around scoured patch reefs, and under *Oculina virgosa* coral on rock walls
Hard rock	Tell	Rock just emerging from soft sediments (small <0.1 m^2), often covered by sessile fauna
	Mixed irregular cobbles	Cobbles of various shapes and sizes, sometimes as pavements, but usually interspersed with sand. At several sites these were formed from large rhodoliths scattered over soft sediments (difficult to consistently separate from true cobbles). % cover estimated as the cover of actual rock surface present (for invertebrate attachment), rather than the extent of the cobble field per se (which was often sand dominated)
	Boulder	Angular larger rocks, high and often rounded in at the base, not obviously part of a larger buried rock mass; usually not touching others. Occasionally seen as heaps.
	Embedded boulder field	Boulders so close together that they formed a single layer boulder reef (seldom heaped) on soft sediment
	Low patch reef	Patches of emergent reef usually <25 cm high, <1 m^2 in maximum width, not part of adjacent larger reef blocks
	Buried basement	Basement under a thin sediment veneer, inferred from the presence of common reef-associated fauna
	Intermittent basement	As above, but with the basement seen to break the sediment surface on and off in places
	Flat basement	Exposed flat rock with little vertical complexity.
	Irregular rock small chunks	Some limited areas of small cm-scale rock 'chunks' at low density (<<1%) on soft sediments, no associated taxa seen, recorded for completeness but not included in rock calculations
	Flat basement on up-reefs	Flat basement rock on larger reef extents, elevated from the surrounding soft sediments (though it often start at the rock/sediment boundary. Gently sloping – 'flat' refers to the low relief surface, not slope.
	Low broken rock	Low relief rock with limited vertical variability, contributes to limited rock patches, low narrow raised mound terraces, large reef complexes

Group	Seafloor class	Description
	High broken rock	Higher relief rock, including low wall and canyon features (generally <1.5 metre in height), and rock that varies more in height over short distances.
Carbonate rock	Surface carbonate rock	Smooth edges – just showing above sediment surface, lacks the complexity of the next three classes
	Low carbonate rock	Smooth edges – raised above the sediment surface, some chimneys and swirl structure, but simple and basic
	Carbonate rock 3D	Smooth edges – complex structures including chimneys, swirls, and layering
	Carbonate rock High	Smooth edges – significantly complicated structures, up to 40–50 cm high. Rare
Mudstone	Mudstone	Rare. Low ridge shelves with underhang, less than 10 cm in height, smooth and featureless, extending at most two to three metres.
Veneer	Sand with veneer	Common reef-associated fauna across a mud/sand plain, inferred to be a thin sediment veneer on rock. Confirmed elsewhere by the occasional emergence of bare rock, sometimes with fauna bases attached.

2.3 Data integration

To combine the data streams (invertebrates/fish, geomorphology, multibeam variables, and BTM), the 20 second video segments were treated as the basic sampling building block (hereafter referred to as a segment). Code written in Python and R was used to take the multiple OFOP text files and integrate them into one master file. Each OFOP observation (an individual point record) was assigned to its respective 20-second video segment, using timestamp matching

Average depth and geomorphology class percent cover estimates were also added for each segment. The output was a single master file with each row representing a 20-second segment with all its associated variables.

To calculate the area of each seafloor type in each segment, the overall swept area (segment length x width of view) was multiplied by the proportion of each seafloor type. For example, if a segment was 11 m long and 1.85 m wide, then its swept area was 20.35 m^2. If the segment was 30% rock and 70% sand, then the area of each would be 6.1 m^2 and 14.24 m^2. These area calculations did not include any estimation of rugosity/height (third-dimension axis, with associated increasing surface areas).

These calculations allowed for the areal contributions of each of the different seafloor geomorphology classes to be summed at the transect level. However, as the OFOP observations were made as points along a one-dimensional string (the splined GPS coordinate transect track), it was not possible to assign each fauna record directly and uniquely to the geomorphology class in which it sat. For instance, for a given field of view, both a rock wall and a rock flat might be present, with say a coral occurring on the rock wall. These would be scored as a coral presence as it passed in line with the scaling lasers (as a spatial coordinate) but not be assigned to a particular geomorphology (with two being present, flat basement rock, and high broken rock) in the horizontal line of the scaling lasers. Subsequently, while it was possible to calculate the density of that coral in the 20-second segment, and of the different rock geomorphologies; it was not possible combine the two to calculate that coral's density for a given rock morphology. It was only possible to calculate that corals density relative to all rock cover geomorphologies combined, given the knowledge that that coral species was rock associated.

This spatial mismatch is an inherent problem in using the OFOP system and cannot be resolved without moving to a scoring analysis system that assigns each taxon record to a specific habitat polygon (the geomorphology classes). Currently such a system does not exist to our knowledge. To keep the OS2020 and present (2022) data comparable and able to be integrated, it was also necessary to use the same scoring approach for both.

To allow for the estimation of fauna densities for rock, all the 'hard' rock geomorphology class areas were summed and used as an estimate of rock (reef) cover. The carbonate rock type mostly did not co-occur with 'hard' rock over the segment level (and often not at the station level), and so was treated in the same way. Those few individual segments where both were present were excluded from these calculations. Cobbles (hard rock only) was one geomorphology class that occasionally occurred as a single entity in segments, and for stations where this occurred, was also calculated as separate densities. However, most cobble habitat was always associated with other rock types at the scale of individual segments.

For the purposes of statistical contrasts between stations, rock area was summed at the full station transect level, along with invertebrate fauna densities estimated at the station scale and standardised to 100 m^2. Only segments that held rock were included in these density estimates; segments composed entirely of soft-sediment habitats were excluded.

Fish were treated slightly differently, as scaling them to densities per segment based solely on rock area resulted in excessively high-density values. For instance, pink maomao settled to sleep at night on and adjacent to rock surfaces. Therefore, fish densities were estimated as the number of individuals seen in each segment where rock habitat was present, scaled to the overall area-swept by that segment, i.e., regardless of the rock cover in that segment.

This was done separately for the three rock types (hard, carbonate, mudstone), cobbles where discrete, and sand veneer on rock. It should be noted that this approach ignored the spatial structuring of rock habitat e.g., multiple areas of rock, each representing a local reef, might be summed together.

Distance to the north from the most southern station (station 11, set as distance zero) was estimated for all stations, expressed in metres. Each station was also assigned to a water depth band (25 metre intervals, starting at 50 metres water depth), and to a geographic box (see results) as a useful visualisation approach.

2.4 Statistical analysis

Each station was treated as a replicate and tested for differences in assemblage structure relative to box (a proxy of distance north) and depth (25 metre bands). Carbonate rock was restricted to the 100–124 metre depth band, including some stations where both rock types were present along the same transect. In these cases, the respective area of each rock type were treated as a replicate for that rock type. As cobble habitat largely occurred as mixed habitat with other rock geomorphologies at the segment scale, it was not possible to treat it as a separate rock class. It was also restricted in its depth distribution to the 50–74 metre depth band. Mudstone was too limited in spatial extent and occurrence to be included. The sand veneer over rock habitat occurred as a discrete continuous habitat between 100–149 metres depth in the most northern area only (Box 7), with only one comparable hard rock station in the same box. These stations were treated as hard rock stations.

Examination of the distribution of stations across box and depth band (Table 2-2) found the level of replication to be rather low, with many of the cells empty. Fauna were assigned to sessile invertebrates (habitat formers), mobile invertebrates or fishes. Each type was treated independently in the following statistical approaches.

For hard rock, the potential explanatory factors of box and depth were tested to see if they were correlated with assemblage composition. A minimum rock extent of 34 m^2 was assigned as the cut-off for inclusion of a station in the analyses. All OTUs with 10 or more individuals were included, with separate analyses for each of the three fauna types. All analyses were done in Primer 7 software. Densities were transformed using a fourth-order square root to down-weight the relative contribution of the most abundant groups and converted to Bray-Curtis distances.

Non-Metric Dimensional Scaling (nMDS) was used to visualise how the different stations grouped in 2-dimensional multivariate space, and how this was related to box and depth. Two-way PERMANOVAs were used to test for box and depth differences. If no significant interaction term was found, then one-way PERMANOVAs were run for the two factors separately, and where significant, pair-wise tests made to determine which groups were contributing to that significant difference. For significant pair-wise tests, SIMPER was used to determine which OTUs were driving those differences.

For carbonate rock, stations with this rock type were restricted to the 100–125 metre depth band. These stations were contrasted with hard rock stations that occurred in the same depth band. The same approach as above was used, but only using one-way PERMANOVAs, with the potential explanatory factor of rock type being tested.

Table 2-2: Summary of station numbers by map box (south to north), depth band, and rock type. HR, hard rock; Cob, cobbles; Ca, carbonate rock; MST, mudstone; Ven, sand veneer on rock.

		Rock type				
	Depth (m)	HR	Cob	Ca	MST	Ven
Box 1	50–74	2	1			
	75–99					
	100–124	1				
	125–149					
Box 2	50–74	1	1			
	75–99	2				
	100–124	4		1		
	125–149	3				
Box 3	50–74					
	75–99	1				
	100–124	2		2		
	125–149					
Box 4	50–74	2	1			
	75–99	1				
	100–124	2		1		
	125–149	1				
Box 5, 6	50–74					
	75–99					
	100–124	1				
	125–149	1				
Box 7	50–74	2				
	75–99	4				
	100–124	1		2	1	2
	125–149					2
	>175	1				

Species richness was not statistically assessed. Each individual station varied in area from 10s to 100s, to 1000s of m^2. Species richness increases with the area sampled (known as the Species Area Response, SAR), i.e., as more area is sampled at a station the number of OTUs seen increases. As these relationships are not linear, standardising species richness per unit area cannot be done directly. It requires approaches such as resampling to generate species accumulation curves. Such work was beyond the scope of this report, noting also that the wide variation in rock area sampled between different stations would add significant uncertainty to such approaches. Hence, species richness is presented in this report as the raw values only.

3 Results

3.1 Multibeam sonar mapping

Figure 3-1 and Figure 3-2 show the 38 rock associated DTIS transects analysed, over backgrounds of bathymetry, backscatter, and BTM classes. Large extents of deep rocky reef were present along much of the coast. From Tutukaka to Cape Brett, three large separate reef shelves extended from the 50 metres contour out to 80–90 metres depth, separated by soft sediment flats (Boxes 1, 2). In the Bay of Islands region (Box 2), deep reef extended out from Cape Brett, to seaward of Urapukapuka and associated islands, and off Cape Wikiwiki on the north side of the bay. A broad expanse of soft sediment flats off Taupo Bay separated the Cape Wikiwiki reefs from the next major expanse of deep reefs to the north, which stretched from east of the Cavalli Islands to north of Stephenson Island (Box 3, 4). Limited deep reef was then present until offshore of Rangaunu Bay, where expanses occurred in the 50–70 metre depth range (Box 6). Great Exhibition Bay (offshore from Houhora Harbour to Parengarenga Harbour) held larger expanses of offshore harder seafloor, which was more complicated in its rock types than other Box areas (Box 6, 7). Deep rocky reefs were also found around North Cape and extending around to offshore Tom Bowling Bay (Box 7).

The BTM (Benthic Terrain Model) landscape feature classes captured the different topographies of these rock systems as landscape features. The most dominant and widespread was that of numerous low height (<1m) reef patches interspersed with soft sediments, which were captured in the BTM class 'local ridges, boulders, pinnacles on broad flats'. This class was subject to some artefact issues, where the survey vessels transit line was seen where some adjacent survey lines were stitched together (mistaken as seafloor variation). It was not possible to remove these artefacts.

3.2 Geomorphology classes

An estimated 118,056 m^2 of seafloor was covered by the 38 DTIS transects (Table 3-1). Most of this area was composed of soft sediments (70%), dominated by sand and mud seafloors, which are not discussed further. The remaining 30% was composed of rock-based habitats, covering 35,000 m^2 of seafloor. Within this, 'hard' rock contributed 20,370 m^2 (17%), carbonate rock 4,595 m^2 (4%), mudstone rock 286 m^2 (<<1%), and sand veneer over rock 9,252 m^2 (8%).

Within the 'hard' rock type, low broken rock was the most dominant class (31%), closely followed by intermittent buried basement rock (32%) and buried basement rock (31%), and then flat basement (17%). These contributions reflect the generally very low relief of most of the reefs sampled, with little complex topography, and where present, limited to usually only a few metres range. High broken rock contributed 3% of cover. Other classes that also made more than a 1% contribution were mixed irregular cobbles (4% cover – noting that this is estimated rock surface, rather than the extent of cobble fields per se), boulders (2.4%), and low patch reefs (2.3%).

With the 'carbonate' rock type, of the four reef morphologies, most of the rock area occurred as low to more complex reef forms (38.9% and 50.1%). Surface carbonate rock forms contributed a lesser amount (10.9%), with the geomorphology class possibly being either eroded forms of the more complex reef, or largely sediment-buried more complex forms. Very complex, high quality carbonate reef forms were rare (<0.1%).

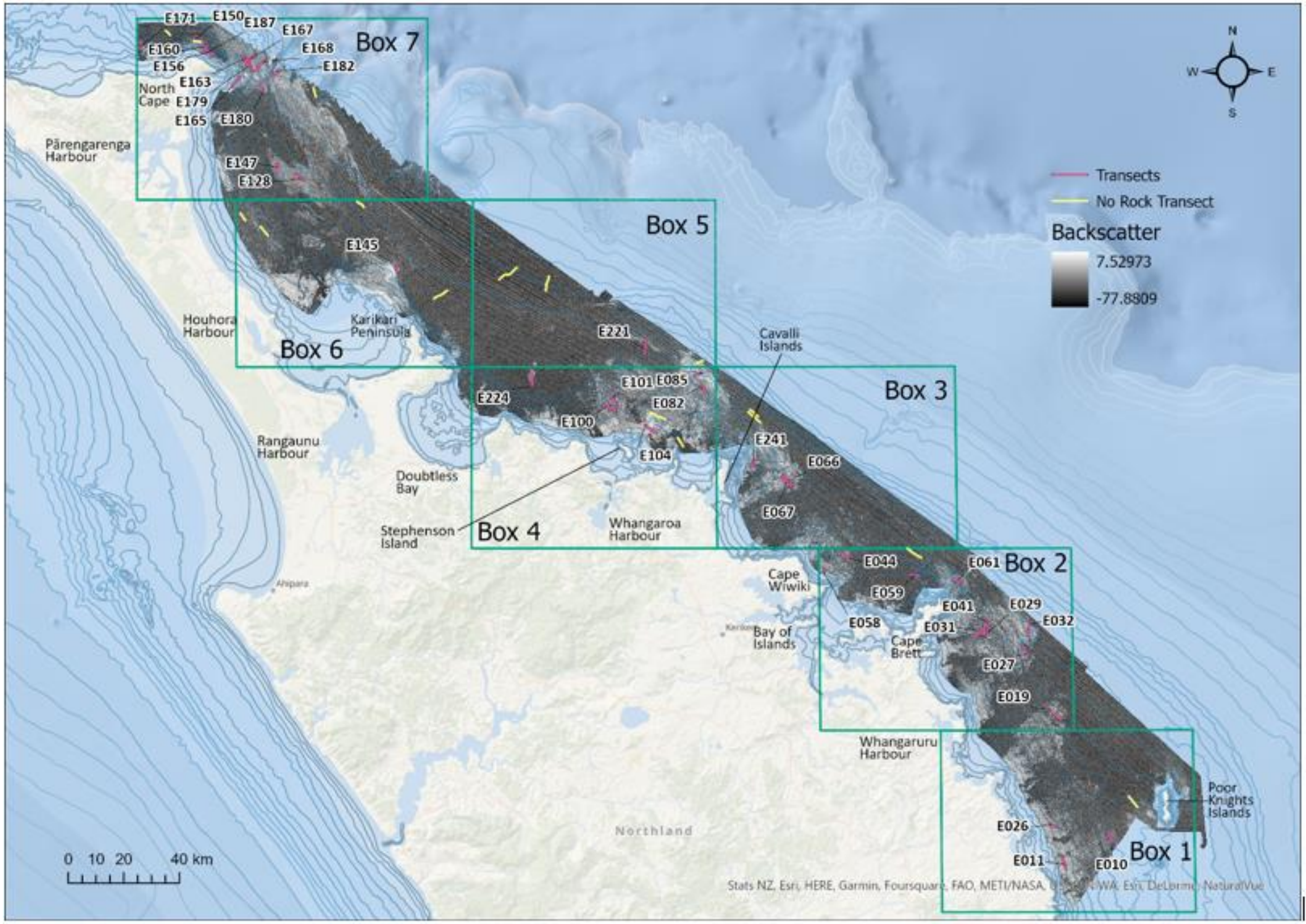

Figure 3-1: DTIS transects along the east Northland coast, overlain on multibeam backscatter. Backscatter is a measure of seafloor hardness (light grey is indicative of rock/harder seafloor), while darker colours are indicative of sand and mud. Rock-associated transects (purple) are labelled with the station code assigned during collection. Soft sediment only transects (yellow) are also shown, for context. The survey area is divided into seven map blocks for ease of presentation. The fine parallel lines within the backscatter imagery are artefacts of the stitching together of many multibeam transects.

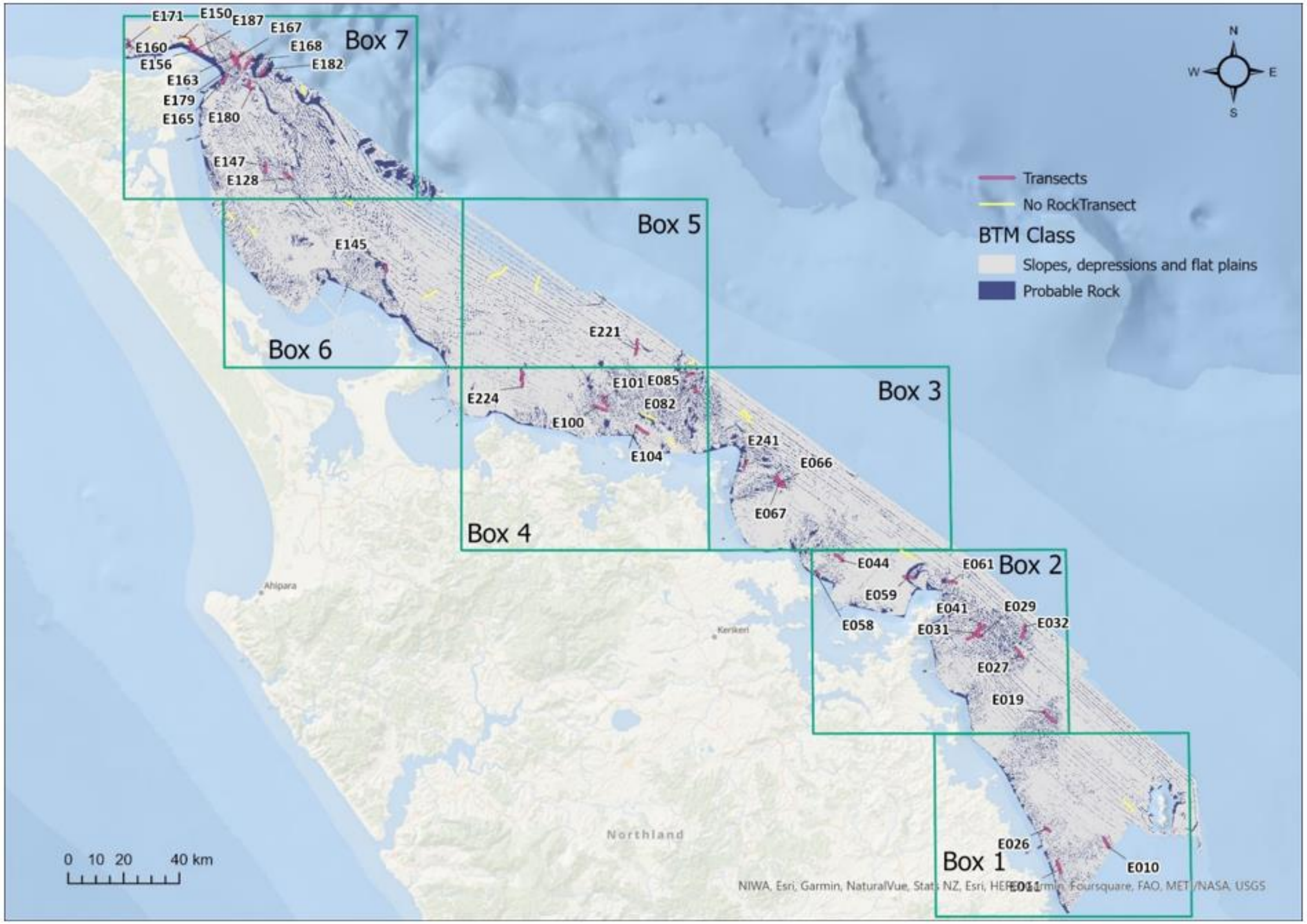

Figure 3-2: All 38 DTIS transects along the east Northland coast, overlain on multibeam BTM classes. Rock-associated transects (purple) are labelled with the station code assigned during collection. Soft sediment only transects (yellow) are also shown, for context. The survey area is divided into seven map boxes for ease of presentation.

Table 3-1: Area contribution (%) of the different rock geomorphic classes, by station. Values of <0.01 are indicated as a *. Stations are geographically ordered, running from south to north.

Box	Station	Depth (m)	Area (m^2)	Rock cover (m^2)	Transect %rock	Hard	Cobble	Carbonate	Mudstone	Veneer	Buried basement	Inter. Buried	Flat basement	Flat basement up	Low broken rock	High broken rock	Low patch reef	Embedded boulder	Boulder	Mixed irregular	Tell	Mudstone	Surface carbonate	Low carbonate rock	Pillow carbonate high	3D carbonate rock
1	10	105	3116	35	1%	35	-	-	-		-	-	-	-	0.01	-	*	-	-	-	-	-	-	-	-	-
1	11	59	3800	1624	43%	1496	128	-	-		0.02	-	0.03	-	0.30	-	*	-	0.01	0.03	-	-	-	-	-	-
1	26	63	1686	548	32%	547	1	0.1	-		0.12	-	0.05	-	0.16	-	*	-	-	*	-	-	-	*	-	-
2	19	125	4572	505	11%	505	-	-	-		-	-	*	-	0.09	0.02	*	-	-	-	-	-	-	-	-	-
2	27	134	3133	222	7%	222	-	0.4	-		-	-	0.01	-	0.04	0.02	*	-	*	-	-	-	-	*	-	-
2	29	98	4150	403	10%	363	-	39	-		-	-	0.05	-	0.04	-	*	-	-	-	-	-	-	*	-	0.01
2	31	108	3857	415	11%	184	-	230	-		-	-	*	-	0.05	-	-	-	-	-	-	-	-	0.03	-	0.03
2	32	143	1363	198	15%	198	0.02	-	-		0.00	-	0.02	-	0.12	-	*	-	-	*	-	-	-	-	-	-
2	41	107	3551	242	7%	232	-	10	-		0.00	-	0.03	-	0.04	-	*	-	-	-	-	-	-	0.00	-	*
2	44	89	2865	434	15%	434	-	-	-		-	-	*	-	0.15	*	*	-	-	-	-	-	-	-	-	-
2	58	55	882	574	65%	539	34	-	-		0.02	-	0.19	-	0.34	0.02	*	-	-	0.04	-	-	-	-	-	-
2	59	109	2663	61	2%	50	-	-	10		-	-	0.01	-	0.01	-	*	-	-	-	-	*	-	-	-	-
2	61	124	2867	115	4%	115	-	-	-		-	-	-	-	*	0.04	*	-	*	-	-	-	-	-	-	-
3	66	112	3911	925	24%	106	-	818	-		-	-	0.01	-	0.02	0.00	*	-	-	-	-	-	-	0.04	-	0.17
3	67	108	3975	1354	34%	125	-	1229	-		-	-	-	-	0.03	-	*	-	-	-	-	-	-	0.04	-	0.27
3	241	90	1861	782	42%	772	10	-	-		-	-	0.05	-	0.35	-	*	-	*	0.01	-	-	-	-	-	-
4	82	116	2207	514	23%	36	0.05	478	-		0.02	-	-	-	*	-	*	-	-	*	-	-	0.01	0.05	*	0.16
4	85	134	2366	495	21%	495	-	-	-		-	-	0.00	-	0.10	-	0.09	-	0.02	-	-	-	-	-	-	-
4	100	67	3547	1106	31%	1105	1	-	-		-	0.04	0.22	0.04	*	-	*	-	*	*	-	-	-	-	-	-
4	101	75	3724	1037	28%	1032	5	-	-		-	0.01	0.18	0.07	0.02	*	*	-	*	*	-	-	-	-	-	-
4	104	58	4213	732	17%	476	256	-	-		-	-	0.04	-	0.01	-	-	-	-	0.06	-	-	-	-	-	-

Box	Station	Depth (m)	Area (m^2)	Rock cover (m^2)	Transect %rock	Hard	Cobble	Carbonate	Mudstone	Veneer	Buried basement	Inter. Buried	Flat basement	Flat basement up	Low broken rock	High broken rock	Low patch reef	Embedded boulder	Boulder	Mixed irregular	Tell	Mudstone	Surface carbonate	Low carbonate rock	Pillow carbonate high	3D carbonate rock
4	224	103	5067	1007	20%	891	-	116	-		0.01	-	0.03	-	0.06	0.02	0.02	-	0.03	-	*	-	-	0.02	-	-
5	221	140	3810	125	3%	-	-	125	-		-	-	-	-	0.02	-	-	-	-	-	*	-	-	0.03	-	-
6	145	102	1348	410	30%	410	-	-	-		-	-	-	-	0.02	0.05	*	-	0.24	-	-	-	-	-	-	-
7	128	115	1998	633	32%	1	-	631	-		-	-	-	-	-	-	*	-	*	-	-	-	0.24	0.05	-	0.02
7	147	105	2396	1012	42%	9	-	1003	-		-	-	-	-	*	-	-	-	-	-	*	-	-	0.42	-	-
7	150	86	2046	69	3%	69	-	-	-		-	-	-	-	*	*	0.03	-	-	-	-	-	-	-	-	-
7	156	54	2823	205	7%	205	-	-	-		-	-	-	-	0.07	-	-	-	-	-	*	-	-	-	-	-
7	160	71	2470	124	5%	124	-	-	-		-	-	-	-	0.01	-	0.04	-	-	-	-	-	-	-	-	-
7	163	120	3484	1733	0%		-	-	-	1733	0.50	-	0.01	-	*	-	*	-	-	-	-	-	-	-	-	-
7	165	71	2993	1720	57%	1720	-	-	-		-	-	*	-	0.31	0.02	*	-	*	-	-	-	-	-	-	-
7	167	129	2460	2040	-		-	-	-	2040	0.83	-	*	-	-	-	*	-	-	-	-	-	-	-	-	-
7	168	135	3895	3180	-	-	-	-	-	3180	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	171	63	2014	201	10%	194	6	-	-	-	0.02	0.03	0.04	-	*	-	*	-	-	*	-	-	-	-	-	-
7	179	118	4097	2574	7%		-	-	276	2298	0.56	-	0.02	-	*	*	*	-	-	-	-	0.07	-	-	-	-
7	180	118	2889	948	33%	936	11	-	-	-	*	0.01	0.02	0.04	0.20	0.03	0.01	*	0.01	*	-	-	-	-	-	-
7	182	176	6883	6598	96%	6598	-	-	-	-	0.97	0.91	*	-	0.01	-	*	-	*	-	-	-	-	-	-	-
7	187	74	3075	60	2%	60	-	-	-	-	-	-	-	-	*	-	0.02	-	*	-	-	-	-	-	-	-
	Totals		118056		16%	20370	454	4595	286	9252																

Within the ‘hard’ rock type, low broken rock was the most dominant class (31%), closely followed by intermittent buried basement rock (32%) and buried basement rock (31%), and then flat basement (17%). These contributions reflect the generally very low relief of most of the reefs sampled, with little complex topography, and where present, limited to usually only a few metres range. High broken rock contributed 3% of cover. Other classes that also made more than a 1% contribution were mixed irregular cobbles (4% cover – noting that this is estimated rock surface, rather than the extent of cobble fields per se), boulders (2.4%), and low patch reefs (2.3%).

With the ‘carbonate’ rock type, of the four reef morphologies, most of the rock area occurred as low to more complex reef forms (38.9% and 50.1%). Surface carbonate rock forms contributed a lesser amount (10.9%), with the geomorphology class possibly being either eroded forms of the more complex reef, or largely sediment-buried more complex forms. Very complex, high quality carbonate reef forms were rare (<0.1%).

3.3 Species and taxa sampled – broad scale

Video quality was quite variable between stations, making the clear and constant identification of benthic organisms much more problematic than expected. Several factors contributed to this issue. A large storm event and associated swells (4–6 m) stirred up the seafloor sediments resulting in reductions in water clarity that persisted for a number of days. The large lift from the swells was also transmitted directly down the tow line to the DTIS when being towed, resulting in significant rising and falling of the system relative to the seafloor, with associated varying resolution (i.e., the camera could not be kept consistently close to the seafloor). The innate image resolution of the camera itself was also a limiting factor. Collectively, these issues meant that many organisms could only be assigned to a broad Operational Taxonomic Unit (OTU), such as Demospongiae (sponges), encrusting sponges, and bryozoans.

This lack of taxa differentiation varied across different transects, and within parts of transects, and could not be ‘parcelled out’ in the data sets generated. This was a major problem for comparison and formal analyses. For example, a bryozoan species might be identifiable to species in some transects, but only identifiable to the general class ‘bryozoans’ in other transects. In statistical analyses, if the data was used at this level, the results would be confounded by the variable identification levels between samples (transects). To partially mitigate this issue, some faunal groups were summed to group level only (e.g., bryozoans, and hydroids).

3.3.1 Invertebrates

Invertebrate species were the dominant fauna on East Northland deep reefs, with a total of 68,490 individuals/colonies, from 197 OTUs, being recorded on the 38 DTIS Transects (Table 3-2). Sponges dominated, with just under 49,000 being counted, across 95 OTUs. The most numerous group were Demospongiae (hence referred to as “unidentified upright sponges”) (15,577 individuals; 32% of sponges). A further 3,215 (7%) were identified as ‘encrusting sponges’.

Seven sponge species were represented by more than a thousand individuals: the yellow/orange glass sponge *Symplectella rowi* (8.5%), the fawn ridge *Neoschrammeniella fulvodesmus* (6.9%) the finger sponge *Axinella australiensis* (5.9%) and *Callyspongia* sp. (3.2%), the massive encrusting *Ecionemia alata* (previously *Ancorina*) (5.6%), and *Leucettusa* sp. (2.1%). A further 10 species/taxa returned between 500 to 1000 individuals (14.4%), 21 species/taxa from 100 to 500 individuals (10.4%), 27 species/taxa from 10 to 100 individuals (2%), and 27 species/taxa less than 10 individuals (<<1%).

Corals were also common, with 6,292 individuals/colonies being counted (Table 3-2). Desmophyllum / Caryophyllia cup corals were the most common, with 2,042 individuals observed (32% of all observations), followed by Stylasteridae (23%), Primnoidae (18%), Flabellum cup corals (13%) and Antipatheria black corals (7%). As with sponges, many fauna were only identifiable to higher taxonomic levels.

Mobile invertebrate numbers were lower, with 3,129 individuals counted. However, 2,171 of those (69%) were the feather star *Argyrometra* sp. from just one station. Excluding the feather-stars, 958 individuals were counted, dominated by the sea cucumbers *Holothuria integra* (13%) and *Australostichopus mollis* (11%), the starfish *Asterodiscides* sp. (9%) and *Henricia* sp. (7%).

Table 3-2: Summary of all invertebrate taxa seen as initial 'raw' video data, prior to being aggregated for analysis. Numbers given are the number of individuals/colonies seen.

OTU	Total	OTU	Total	OTU	Total	OTU	Total
Sponges		*Clathria* sp.	10	**Soft corals**		**Mobile invertebrates**	
Sponge (Demospongiae)	15577	*Dysidea cristigalli*	10	Alcyonacea (Soft Coral)	743		
Symplectella rowi	4164	*Lamellomorpha strongylata*	10	*Anthomastus* sp.	11	**Starfish**	
Neoschrammeniella fulvodesmus	3358	*Thorecta reticulata*	10	Ellisellidae	6	*Asterodiscides* sp.	104
Encrusting sponges	3215	*Dragmacidon australensis*	9			*Henricia* sp.	73
Axinella australiensis	2905	*Raspailia flaccida*?	9	**Hydroids**		*Astropecten polyacanthus*	62
Ecionemia alata	1894	*Neopetrosia* sp.	8	Hydroids	3115	Asteroid	44
Callyspongia sp.	1550	*Latrunculia* sp.	7	Hydroid uni 02 (BOI)	722	*Luidia* sp.	9
Aciculites pulchra	1152	Hymedesmiidae	6	Hydroid uni 05 (BOI)	221	*Asterodiscides truncatus*	6
Leucettusa sp.	1011	*Petrosia* sp.	6	Hydroid uni 06 (BOI)	59	Astropectinidae	4
Geodia vestigifera	914	*Haliclona* sp.	5	Hydroid uni 01 (BOI)	16		
Iophon laevistylus	892	*Darwinella oxeata*	4	Hydroid uni 04 (BOI)	14	**Sea cucumbers**	
Calyx imperialis	863	*Xestospongia* sp.	4	Hydroid uni 03 (BOI)	3	*Holothuria integra*	168
Axinellidae	737	*Aaptos globosum*	3	*Lytocarpia spiralis*	1	*Australostichopus mollis*	128
Sponge (Hexactinellidae)	671	Cladorhizidae	3			Holothurian	16
Polymastia sp.	665	*Stelletta maori*	*3*	**Bryozoaans**		*Holothuria integra*	1
Stelletta sp.	598	Poeciloscleridae	3	Bryozoans	2575		
Callyspongiidae	595	*Calyx* sp.?	2	Bryzoan - Lacy fan forms	1207	**Shrimps**	
Stelletta columna	578	Microcionidae sp. 1	2	*Phidolopora avicularis*	577	Shrimp	465
Dendrilla rosea	566	*Poecillastra* sp.?	2	*Bitectipora mucronifera*	299	Penaeidae	57

OTU	Total	OTU	Total	OTU	Total	OTU	Total
Poecilosclerida	471	*Clathria* (*Thalysias*) *coriocrassus*	1	Bryzoan - Branched coral-like form	214		
Tethya fastigata	434	Dictyoceratida	1	Bryozoan - Erect cheilostome	25	**Crabs**	
Stylocordyla borealis	427	Myxillidae	1	Bryozoan - Stylasterid look-alikes	15	*Eplumula australiensis*	15
Jaspis n. sp. 1	370	*Parahaphoxya* sp.	1	Bryzoan - Bushy form	7	Crab	6
Haplosclerid	360	*Phorbas aerolata*	1	*Adeonellopsis* sp.	3	*Nematocarcinus* sp.	4
Neopetrosia n. sp. 3	325	*Polymastia massalis*	1	*Celloporaria aggultinans*	1		
Iophon minor	274	*Psammocinia beresfordae*	1	*Mucropetraliella neozelanica*	1	**Crayfish**	
Axinella spp.	250	*Raspailia* (*Raspaxilla*) *inaequalis*	1	*Reteporella* sp.	1	*Jasus edwardsii*	1
Taonura marginalis	228	Coelosphaeridae	1				
Asteropus simplex	225			**Sea pens**		**Hermit crabs**	
Pachastrellidae	225	**Corals**		Pennatulacea	109	Hermit crab (pagurid)	25
Haliclona (*Gellius*) *petrocalyx*	217	Desmophyllum/ Caryophyllia	2148	Pennatulacea 1 (BOI)	107	*Diacanthurus rubricatus*	11
Mycalidae	212	Stylasteridae	1517	Pennatulacea 2 (BOI)	8		
Podospongia virga	201	Primnoidae	1154			**Gastropods**	
Herengeria vasiformis	187	Flabellum 01 (BOI)	577	**Sea whips**		Mollusc (gastropod)	73
Stelletta crater	178	Gorgonacea	434	Sea whip	1	*Astraea heliotropium*	9
Suberites sp.	153	Antipatheria	334			Volutidae	8
Tedania sp.	108	Flabellum	307	**Anemones**		Buccinidae	7
Psammocinia sp or *Ircinia* sp.	105	*Oculina virgosa*	214	Anemones	317	Turbinellidae	4
Ancorina stalagmoides	101	Cup corals (stalked)	168	*Aplousobranchia* sp.1	191	Gastropod unid 01 (BOI)	2
Leiodermatium linea	101	*Radicipes* spp	138	Actiniaria	159	*Coluzea* sp.	1
Microcionidae	86	Antipatheria 02 (BOI)	68	Anemone unid 01 (BOI)	51		

OTU	Total	OTU	Total	OTU	Total	OTU	Total
Poecilosclerid	71	*Lillipathes lilliei*	65	Anemone unid 02 (BOI)	20	**Crinoids**	217
Calyx sp. (tube)	68	Flabellum 02 (BOI)	48	*Ceriantharia* spp.	17	*Argyrometra* sp.	2
Axinella n sp. 6	66	*Primnoella* spp.	41			Crinoidea (motile)	5
Latrunculia kaakaariki	60	Antipatheria 01 (BOI)	39	**Scaphopods**		Comanthus sp.	4
Leucettusa lancifer	52	*Bathypathes* sp.	29	Scaphopod	161	Crinoidea (stalked)	1
Chondropsis sp.	47	Isididae	15			Comatulida	1
Ircinia sp.	47	Corals (hard)	13	**Bivalves**			
Petrosia hebes	46	Coral (intact)	8	*Chlamys* sp.	7	**Ophiurolds**	
Hymeniacidon hauraki?	45	*Corallium* spp.	8	Mollusc (bivalve)	2	Ophidiasteridae uni 01 (BOI)	67
Psammocinia sp.	42	*Metafannyella moseleyi*	7	Mussel	1	Ophiuroid	11
Ciocalypta penicillus	41	*Stephanocyathus* spp.	4			*Astrobrachion contrictum*	2
Pleroma menoui	39	Zoanthidea	4	**Barnacles**			
Chondropsis kirkii?	35	Paragorgiidae	3	Barnacles	2	**Sand dollars**	
Spirophorida	32	Cup coral 1	2			Clypeasteroida	12
Psammocinia hawere	29	Plexauridae	2	**Brachiopods**			
Polymastia croceus	26	*Antipathella* sp.	2	Brachiopods	16	**Urchins**	
Adocia venustina	17	*Taiaroa tauhou*	1			Echinasteridae	70
Crella incrustans?	17	White polyps	1	**Ascidians**		*Araeosoma thetidis*	17
Rossella ijimai	15	*Antipathella fiordensis*	1	Ascidians (solitary)	246		
Geodiidae	13	*Antipathes* sp.	1	Ascidians (clonal)	224		
Trachycladus stylifer	13	Chrysogorgiidae	1	Purple ascidians	1		
Raspailia topsenti	12						

3.3.2 Fishes

As all the DTIS stations were sampled during the hours of darkness the fishes observed included both sleeping day-time active species and nocturnally active species. As all fish within segments that held rock were included, a mixture of both reef-associated and soft-sediment associated species were present (Table 3-3). Pearl side (*Maurolicus australis*), a small pelagic species seen at one site, were excluded from all numerical calculations.

Pink maomao (*Caprodon longimanus*) was the most common species, contributing 1,591 (27%) of all 5,338 fish counted. This species is planktivorous and schools above reefs during day-light hours. The next most abundant OTU was 'unidentified bony fish' (1,147, 21%), which included small fishes that could not be clearly seen due to the camera resolution. Sea perch (*Helicolenus percoides*) contributed 677 individuals (13%), followed by silver conger eels (*Gnathophis* spp., 356, 7%). These eels were small and probably represented several species (see Taylor & Morrison 2010). They are known to be soft sediment associated but were included here as they were often present in and around the rock/soft sediment mosaics. Butterfly perch (*Caesioperca lepidoptera*), a species often seen around deeper reefs, was the fifth most common species (319, 6%), followed by red bandfish (*Cepola haastii*) (218 ind., 4%). Red bandfish, as with the silver conger eels, are a soft sediment-associated species, living in burrows during the day, and emerging during the hours of darkness to forage. They were observed foraging both around and on rock. Morid cod were also regularly seen (121, 3%), both on and off reef. The remaining fish OTU species were represented by less than 100 individuals each, with fished species including scorpionfish (*Scorpaena* spp.) (87, 2%), red mullet (*Upeneichthys porosus*) (64, 1%), leatherjacket (*Meuschenia scaber*) (51, 1%), trevally (*Pseudocaranx georgianus*) (33, <1%), tarakihi (*Nemadactylus macropterus*) (26, <1%), golden snapper (*Centroberyx affinis*) (25 ind., <1%), northern bastard cod (*Pseudophycis breviuscula*) (22, <1%), long-finned boarfish (*Zanclistius elevatus*) (12, <1%), and snapper (*Chrysophyrs auratus*) (11, <1%).

Other notable observations included two Lord Howe coralfish (*Amphichaetodon howensis*) associated with a more complex and higher deep reef, and yellow weavers (*Parapercis gilliesii*), a sister species to blue cod (*P. colias*), being present around deeper reef edges. Blue cod were rare (only two counted), as were red moki (*Chirodactylus spectabilis*) (3 adults counted) and blue maomao (*Scorpis violaceus*) (4 counted), likely due to the reef being largely beyond their distributional depth range. Other species commonly seen in shallower waters in East Northland (e.g., spotties *Notolabrus celidotus*, butterfish *Odax pullus*, porae *Nemadactylus douglasi*, marblefish *Aplodactylus* spp., parore *Girella tricuspidata*) were absent.

Table 3-3: Summary of fish taxa seen. *, small pelagic fish included for completeness.

Common name	Scientific name	Total
Pink maomao	*Caprodon longimanus*	1591
Bony fish		1506
Sea perch	*Helicolenus percoides*	893
Silver Conger Eel	*Gnathophis* spp.	536
Pearlside*	*Maurolicus australis*	395
Butterfly perch	*Caesioperca lepidoptera*	347
Red bandfish	*Cepola haastii*	342
Slender roughy	*Optivus elongatus*	322
Morid cods	Moridae	169
Eels		150
Jack mackerel sp.	*Trachurus* sp.	142
Cucumber fish	*Paraulopus novaeseelandiae*	141
Scorpionfish	*Scorpaena cardinalis*	105
Conger eel	*Conger* sp.	78
Red mullet	*Upeneichthys lineatus*	74
Silverside	*Argentina elongata*	65
Northern bastard red cod	*Pseudophycis breviuscula*	59
Leatherjacket	*Meuschenia scaber*	57
Splendid perch	*Callanthias* sp.	46
Opalfish	*Hemerocoetes* sp.	42
Trevally	*Pseudocaranx dentex*	37
Tarakihi	*Nemadactylus macropterus*	34
Yellow weaver	*Parapercis gilliesi*	33
Snipefish	*Macroramphosus scolopax*	32
Flatfish		31
Golden snapper	*Centroberyx affinis*	31
Common roughy	*Paratrachichthys trailli*	29
Snapper	*Pagrus auratus*	29
Snake eel	*Ophisurus serpens*	24
Scaly gurnard	*Lepidotrigla brachyoptera*	21
Ahuru	*Auchenoceros punctatus*	21
Triglidae (gurnards)		17
Orange perch	*Lepidoperca aurantia*	16
Longfinned boarfish	*Zanclistus elevatus*	13
Worm eel	*Scolechenchelys breviceps*	13
Red gurnard	*Chelidonichthys kumu*	12
Orange bellowsfish	*Notopogon xenosoma*	12

Common name	Scientific name	Total
Half-banded perch	*Ellerkeldia huntii*	7
Spot-tail perchlet	*Plectranthias maculicauda*	7
Rock cod		6
Spotted gurnard	*Pterygotrigla picta*	6
Eagle ray	*Myliobatis tenuicaudatus*	6
Kingfish	*Seriola lalandi*	5
Blue maomao	*Scorpis violacea*	4
Red cod	*Pseudophycis bachus*	4
Red pigfish	*Bodianus unimaculatus*	4
Norther spiny dogfish	*Squalus griffini*	4
John dory	*Zeus faber*	3
Juvenile red moki?	*Cheilodactylus spectabilis*	3
Porcupine fish	*Allomycterus pilatus*	3
Rat-tails		3
Red moki	*Cheilodactylus spectabilis*	3
Blue cod	*Parapercis colias*	2
Dwarf scorpionfish	*Scorpaena papillosus*	2
Red-banded perch	*Hypoplectrodes huntii*	2
Sandagers wrasse	*Coris sandageri*	2
Lord Howe Coralfish	*Amphichaetodon howensis*	2
Alfonsino	*Beryx splendens*	1
Big eyed fish		1
Butterfly perch (J)	*Caesioperca lepidoptera*	1
Yellow and black triplefin	*Fosterygion flavonigrum*	1
Japanese gurnard	*Pterygotrigla picta*	1
Kahawai	*Arripis trutta*	1
Long tailed stingray	*Dasyatis thetidis*	1
Rough skate	*Raja nasuta*	1
Sandfish	*Gonorynchus forsteri*	1
School shark	*Galeorhinus australis*	1
Small eel		1
Smooth skate	*Dipturus innominatus*	1
Stingray		1
Triplefin	Tripterygiidae	1
Crested flounder	*Lophonectes gallus*	1
Barracouta	*Thyrsites atun*	1
Carpet shark	*Cephaloscyllium isabellum*	1

Box 1 – offshore Tutukaka to Whangaruru

Stations 10, 11, and 26 were located within Box 1. This area contained extensive areas of deep reef, extending out from the 50-metre contour for up to 7 kilometres, to around 110 metres water depth (Figure 3-3, Figure 3-4). Three broad expanses of reef are separated by soft sediment flats. The multi-beam back-scatter analysis showed rock dominates between 50–70 metre depth, and then becomes increasingly mixed with sediments with increasing depth. The BTM analysis classed these extensive reef areas as 'local ridges, boulders, pinnacles on broad flats'. On the inner (50 metre) boundary of the multibeam sonar extent, the BTM returned more topographically diverse rocky reef, including 'rock outcrop highs, local ridges', 'steep slopes', and 'local ridges, boulders, pinnacles on slopes'. This suggests that a large-scale reef topography shift occurred just beyond the 50-metre depth contour, although unfortunately no DTIS tows were assigned to this inner boundary extent. This topography shift at around the 50 metre contour extended along the East Northland coast up to North Cape, as indicated by similar BTM patterns from most of the other Box blocks where reef was present in this depth range (Figure 3-2, later figures).

Stations 11 and 26

Stations 11 and 26 were within the 55–70 metre zone and had rock covers of 32–43%. The rock type was classed as 'hard rock', composed of a mix of flat and 'blockier' surfaces with reef heights never reaching more than a metre or so in height (Figure 3-5). These reefs were arranged as patch mosaics embedded within the dominant soft sediment plain; the percent cover within any given 20-second segment was variable and seldom reached 100%. Reef morphologies were dominated by flat and low broken rock classes (Table 3-1), with low levels of cobble contributions across station 11, as well as a short extent of boulder habitat characterised by smooth oblong blocks (Figure 3-6, segments 36–39). Station 11 had little bathymetric variation (three metre range), with alternating extents of rock and soft sediment at spatial scales of 30–50 metres (each segment being roughly 10 metres wide). Rock cover reduced slightly in the latter third (north end) of the transect. Station 26 also held little bathymetric variation and similar alternating reef versus soft sediment dominance; but with a change to buried basement rock in its northern half.

The rock surfaces at both stations were characterised by a cover of fine sediments with 'fuzzy' fine structure (possibly fine biogenic covers such as from tubeworms and/or bryozoans). Patches of pink coralline algal crusts were consistently present but no macroalgae were observed, aside from occasional drift plants. The epifaunal cover was dominated by sponges (Stn 11, 330 inds./100m^2, 41 OTU; Stn 26, 124/100m^2, 30 OTU), along with lower numbers of corals, bryozoans and hydroids (Table 3-4). Station 11 held higher densities and OTU richness, with the dominant sponge contributions made by upright and encrusting species including finger sponges (*Callyspongia* sp.), grey cup sponges (*Ecionemia alata*) and the pipe sponge *Iophon laevistylus.*

Mobile invertebrates were sparse, with overall densities of 0.6–1/100m^2, and OTU richness of 2–6/100m^2, largely contributed by singleton starfish, urchin and anemone OTUs (Table 3-4). Fish densities and richness were slightly higher (OTU densities 3.4 to 5.2, richness 12 to 19). Most fish OTUs were contributions by one or two singletons, including sea perch, pink maomao, slender roughy (*Optivus elongatus*), common roughy (*Paratrachichthys trailli*), red mullet, golden snapper, snapper, butterfly perch and morids.

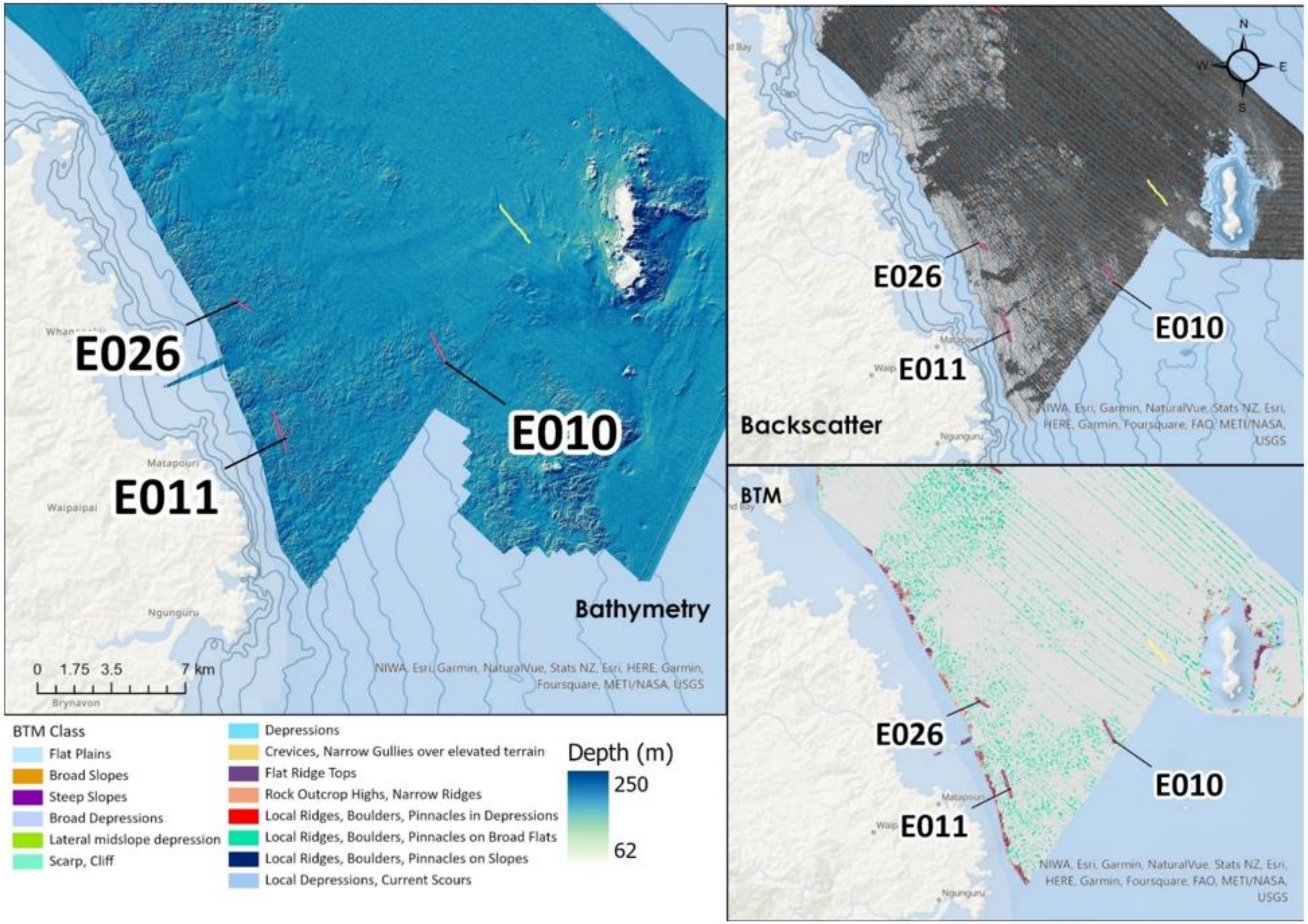

Figure 3-3: Box 1 broad scale bathymetry, backscatter, and BTM classification. Associated DTIS stations are E10, E11, and E26.

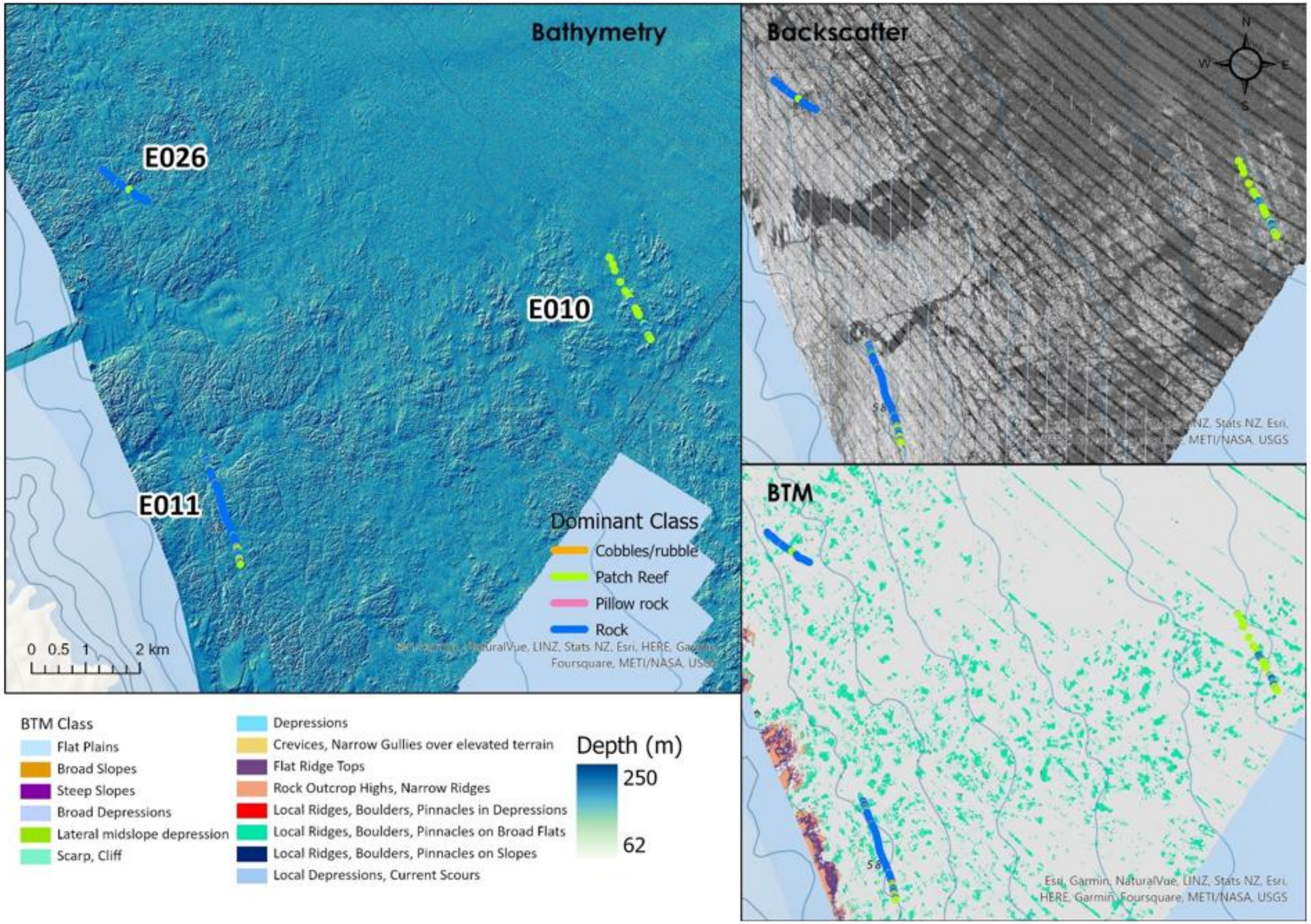

Figure 3-4: Box 1 finer scale bathymetry, backscatter, and BTM classification. Associated DTIS stations are E10, E11, and E26. The dominant rock type in each segment is plotted; hard rock is further split into rock, patch reef (inclusive of rock tells), and cobbles. Segments with no rock contribution are not plotted.

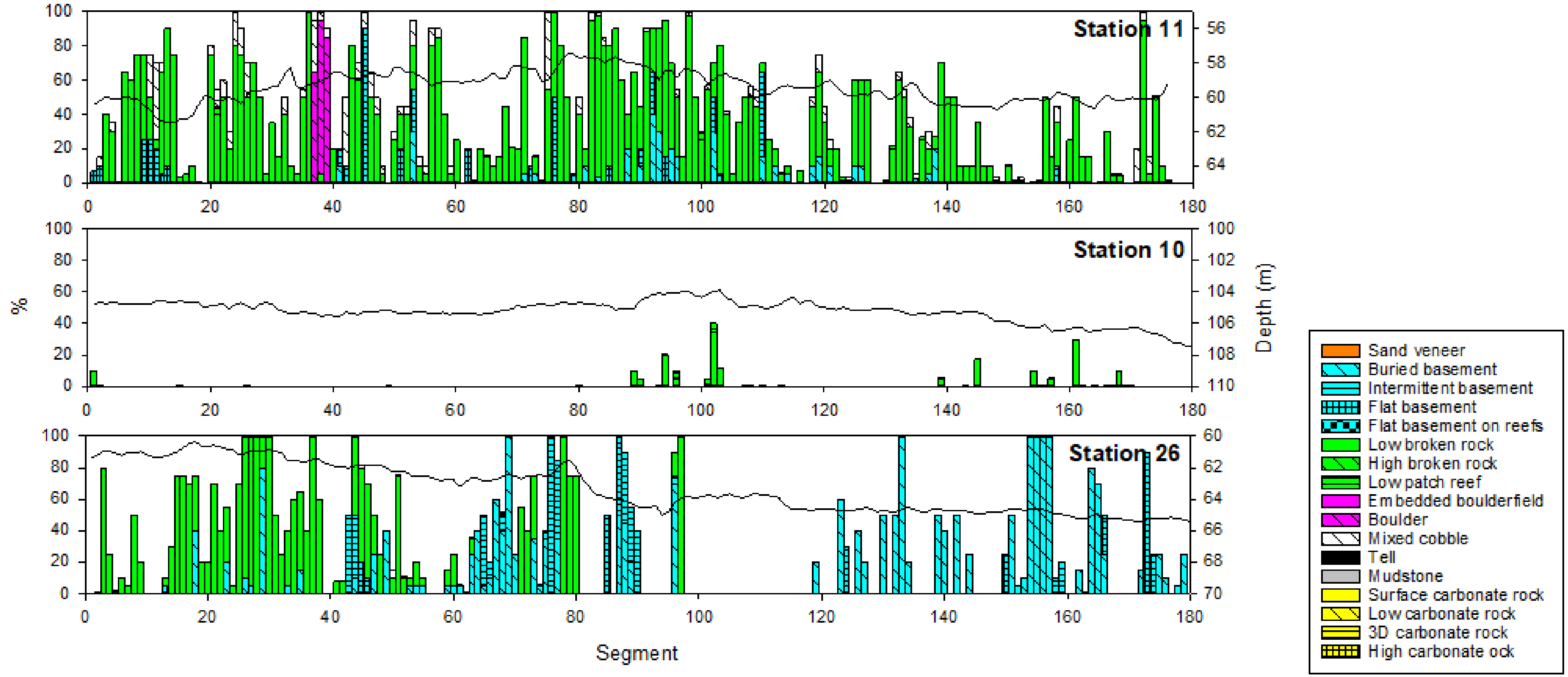

Figure 3-5: Along transect profiles (stations 10, 11, 26) showing rock geomorphology class contributions by 20-second segment and associated bathymetry profile. Left axis) %contribution). Right axis) average depth for each segment. To maximise ease of interpretation, all segments are shown as equal width stacked bar plots, rather than the true distance travelled. Bathymetry profile is shown as a line plot. Table 2-1 provides a description of each of the classes shown in the key. All transects are presented running south-to-north, west-to-east, regardless of vessels direction during collection.

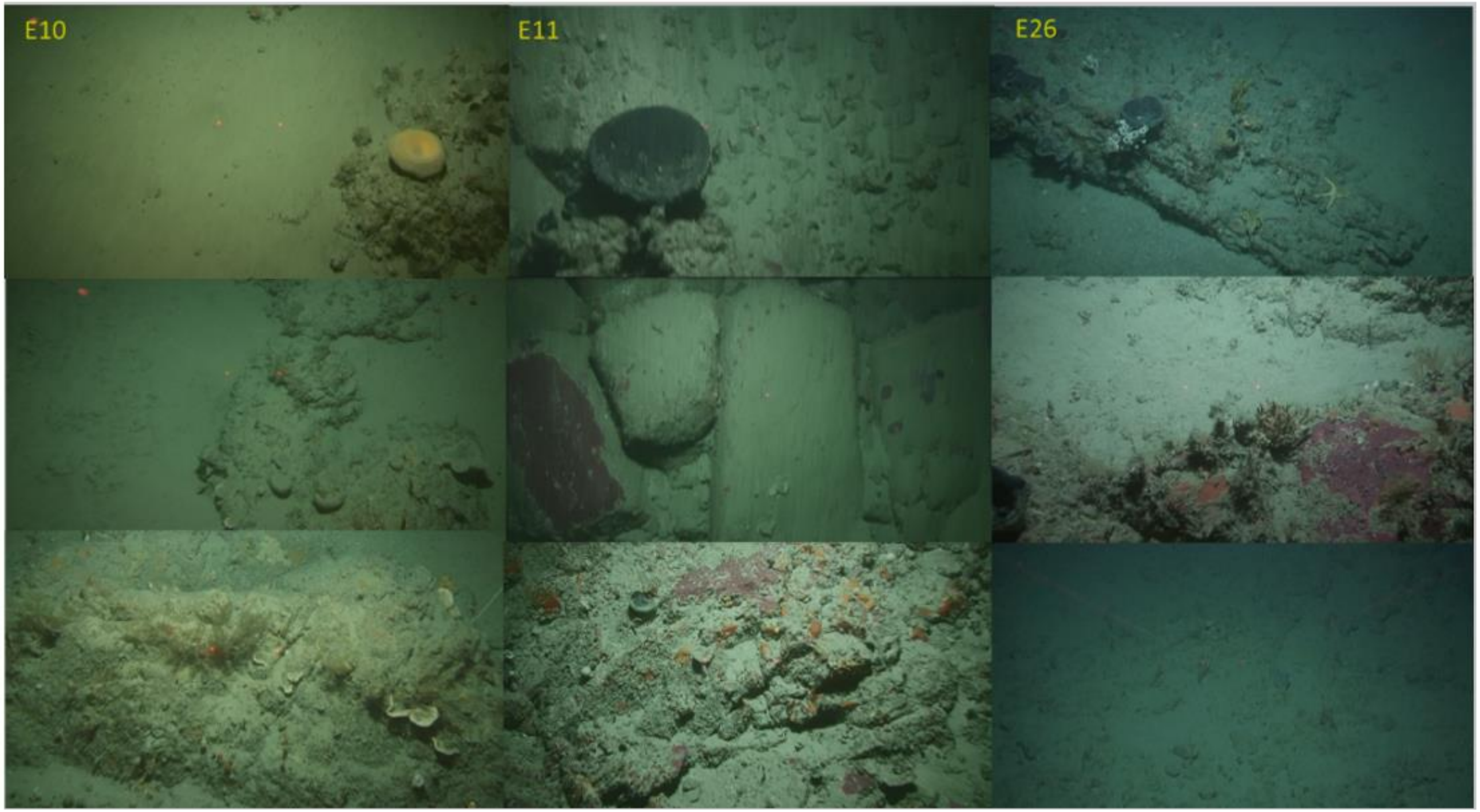

Figure 3-6: Box 1 seafloor imagery from stations 10, 11, and 26. Geomorphologies include patch reef, irregular cobbles, boulders, low broken rock, and basement reef. The purple patches are coralline algae.

Table 3-4: Box 1 abundance (inds./100 m²) of key/charactering mobile invertebrates, sessile invertebrates, and fish. The top ten OTUs for each station are colour coded as a rank; densities for the other stations are provided for comparison. Values are estimated abundance per 100 m² of rock habitat. Average density and species richness are given for sponges, corals, all sessile invertebrates, mobile invertebrates and fish. *, species also observed in soft sediment areas without rock.

Ranking scale (top 10 OTU)
1
2
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Mobile Invertebrates	Station	11	26	10
	Depth	59	63	105
	Rock (m²)	1624	548	35
OTU	Group			
Bryozoan	Bryozoan	19.6	-	231.3
Desmophyllum/ Caryophyllia	Coral	0.3	-	222.7
Sponge (Demospongiae)	Sponge	85.3	38.6	214.2
Hydroid	Hydroid	20.4	2.7	214.2
Encrusting sponges	Sponge	49.9	21.0	131.4
Gorgonacea	Coral	-	-	74.2
Ascidians (solitary)	Ascidian	-	0.5	71.4
Aciculites pulchra	Sponge	1.3	0.2	42.8
Callyspongia sp.	Sponge	34.4	1.1	42.8
Symplectella rowi	Sponge	-	-	34.3
Ecionemia alata	Sponge	42.3	17.9	8.6
Leucettusa sp.	Sponge	38.0	-	-
Iophon laevistylus	Sponge	34.0	9.9	2.9
Axinella australiensis	Sponge	6.2	9.7	31.4
Stelletta columna	Sponge	4.3	-	-
Polymastia sp.	Sponge	4.2	0.9	2.9
Haliclona (Gellius) petrocalyx	Sponge	3.3	-	-
Leucettusa lancifer	Sponge	-	8.6	-
Stelletta sp.	Sponge	1.3	3.3	28.6
Iophon minor	Sponge	2.5	2.2	-
Pennatulacea	Sea pen	-	-	2.9

Sessile invertebrates		11	26	10
OTU	Group			
Asteroid	Starfish	<0.1		5.7
Luidia sp.*	Starfish	-		5.7
Asterodiscides sp.	Starfish	<0.1	-	2.9
Ophidiasteridae	Brittle-star	-	-	2.9
Mollusc (gastropod)	Gastropod	-	-	2.9
Clypeasteroida*	Sand dollar	-	-	2.9
Echinasteridae	Urchin	0.5	-	-
Holothuria integra	Sea cucumber	0.1	-	-
Holothurian	Sea cucumber	<0.1	-	-
Henricia sp.	Starfish	-	0.4	-
	OTU	5	1	6
	Density	0.6	0.4	22.8

Fish	11	26	10
OTU			
Bony fish	0.4	0.4	4.6
Silver conger Eel*	-	1.5	4.3
Cucumber fish*	-	-	2.2
Jack mackerel sp.	-	-	1.6
Sea perch	0.2	0.5	1.1
Gurnard	-	-	0.9
Pink maomao	0.4	0.7	0.7
Conger eel*	0.6	-	0.7
Snake eel*	<0.1	-	0.6
Common roughy	0.1	0.0	0.5
Slender roughy	0.6	0.8	0.1
Red mullet	0.5	0.4	-
Scorpionfish	0.1	-	-
Leatherjacket	0.1	0.1	0.4
Snapper	0.1	-	0.1
Golden snapper	<0.1	0.3	-
Butterfly perch	<0.1	0.2	0.2
Moridae	<0.1	0.2	0.2

Mobile Invertebrates	Station	11	26	10	Sessile invertebrates	11	26	10	Fish	11	26	10
Ciocalypta penicillus	Sponge	-	1.8	-								
									OTU	19	12	22
All sponges	OTU	41	30	18					Density	3.4	5.2	19.6
	Density	330.1	124	613.9								
All corals	OTU	7	3	6								
	Density	63.5	19.2	365.5								
All species	OTU	54	37	34								
	Density	435.2	146.9	1510.5								

Station 10

One station was in the 100–110 metre zone and held a very low overall rock cover of 35 m^{2}. (1.1%) (Table 3-1), consisting of small, isolated areas of low broken rock reef (Figure 3-5). As with the two shallower stations, the rock type was classed as 'hard rock', composed of a mix of flat and 'blockier' surfaces, with reef heights never exceeding about 50 cm in height. These reefs were uncommon along the station transect, occurring as small groups in the central and north area (Figure 3-5). All were classed as low broken rock, suggestive of the general reef surfaces of Box 1 (extending out to 7 km from the 50-metre contour) slowly being covered by soft sediments with increasing distance from the shore.

As with the two shallower stations (stations 11 and 26), the (limited) rock surfaces were characterised by a cover of fine sediments with 'fuzzy' fine structure, but pink coralline algal crusts were absent (Figure 3-6). Epifaunal densities (1,505/100 m^2) were around 4 to 10 times greater than those of the adjacent shallower stations, while OTU richness was slightly less (noting that the reef area sampled was only 35 m^2 versus 545–1368 m^2 for the shallower stations, Table 3-1).

Faunal cover was dominated by sponges (614/100m^2, richness 18) and corals (364/100m^2, richness 6), along with lower amounts of bryozoans (231/100m^2), hydroids (214/100m^2), and ascidians (71/100m^2) (Table 3-4). The dominant sponge contributions were from upright and encrusting sponges, the half cup *Aciculites pulchra*, finger sponges *Callyspongia* sp. and *Axinella australiensis*, and the yellow/orange glass sponge *Symplectella rowi*. This station was halfway between the mainland and the Poor Knights Islands, whose reefs support high sessile invertebrate densities and diversity.

Mobile invertebrate densities were low (31/100 m^2) but still higher than on the shallower stations (maximum 1/100 m^2) (Table 3-4). However, this included soft-sediment associated species (e.g., the starfish *Luidea* sp., and Clypeasteroida sand-dollars). Fish OTU density (20/100m^2) was 4–6 times higher than that of the shallower reefs (3–5/100 m^2), with OTU richness (22) being similar (12–19). Again, this included soft sediment associated taxa (e.g., silver conger eels, cucumber fish *Paraulopus nigripinnis*, gurnard *Chelidonichthys kumu*, and snake eels *Ophisurus serpens*). No fish species was common, although unidentified bony fish and silver conger eels approached a density of 5/100m^2.

Box 2 – offshore Whangaruru to north Bay of Islands

South of Cape Brett, two large areas of deep reef were present (Figure 3-7) extending the reef series seen to the south in Box 1 (Figure 3-3). Off Mimiwhangata, an extensive deep reef extended out north-east for around 15 km, to approximately 140 metres water depth. Heading north-west, around five kilometres of soft sediment seafloor separated this reef from a larger reef complex, starting offshore of Whangaruru Harbour and extending to Cape Brett, interspersed with large soft sediment plains. In the deeper section of this area, which extended out 17 km from the 50-metre depth contour at its widest, the reef complex was dissected by several large soft sediment channels running north-west/south-east, for distances of up to seven kilometres.

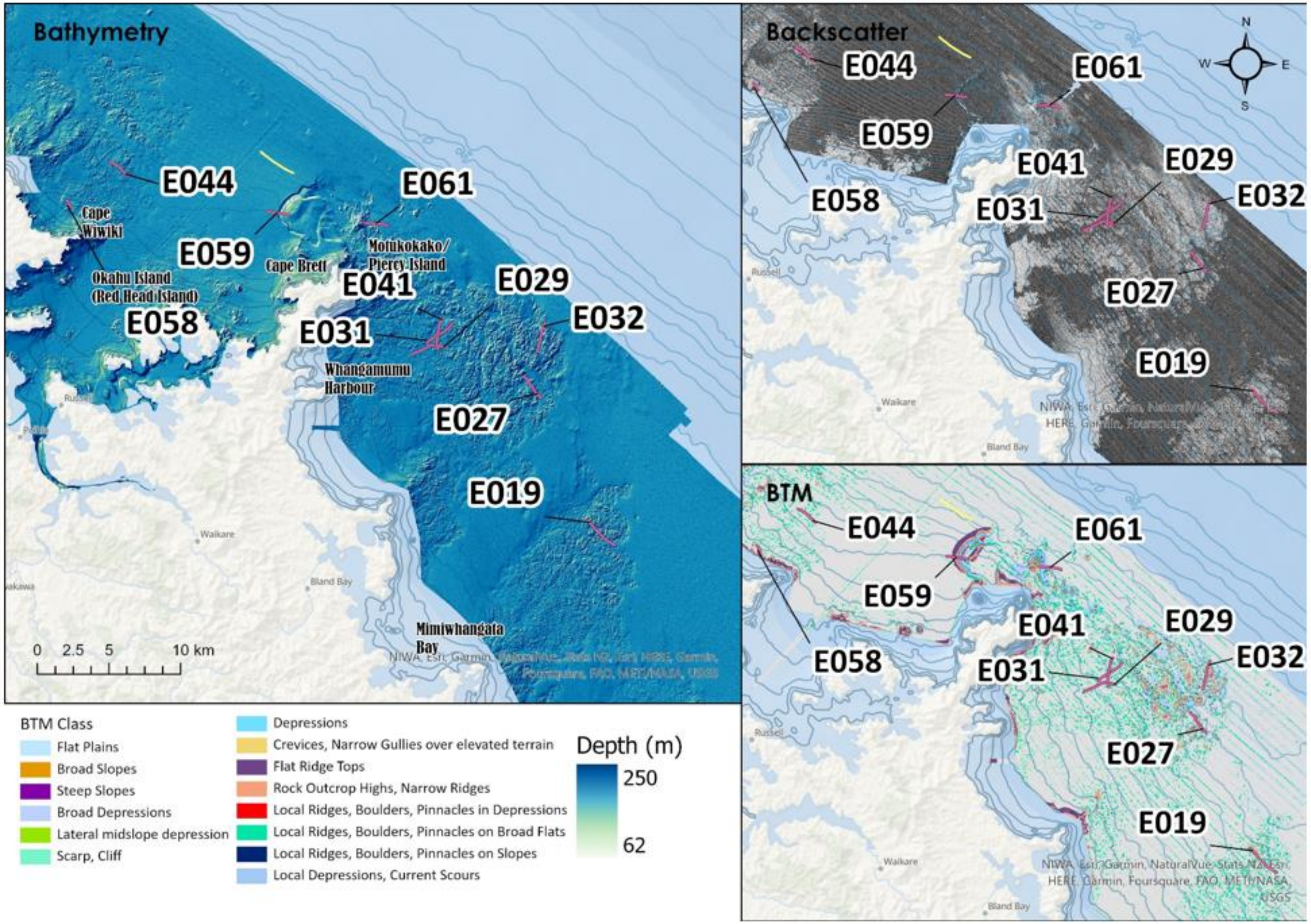

Figure 3-7: Box 2 broad scale bathymetry, backscatter, and BTM classification. Associated DTIS stations are 19, 27, 29, 31, 32, 41, 44, 58, 59, and 61.

As with the adjacent reefs of Box 1, the BTM analysis classed most of these extensive reef areas as 'local ridges, boulders, pinnacles on broad flats' (Figure 3-7). However, the deeper reef area holding the large soft sediment channels returned a more diverse classification, with the channels classed as depressions, and some of the reef as 'rock outcrop highs, local ridges'. Where the reefs extended to the inshore 50 metre water depth multibeam boundary (off Home Point, Whangamumu Harbour, and the west Cape Brett Peninsula) the same topography shifts as seen in Box 1 were also present (more diverse reef morphologies).

North of Cape Brett, deep reef extended out to the east and north of Motukokako/Piercy Island, while a bluff feature was present about seven km to the north-west. This bluff feature, as seen in the associated DTIS feature, was largely soft sediment based, but likely underpinned by rock, as seen in parts. In the Bay of Islands proper, deep reef (to circa 60 metres) was present north of Okahu Island. On the north side of the Bay of Islands, a further large area of deep reef was present north of Cape Wiwiki. Collectively, these areas were also largely classed by BTM as 'local ridges, boulders, pinnacles on broad flats', along with a more diverse class topography on the 50-metre boundary.

Station 19

This station was on the deep reef off Mimiwhangata around 124 metres depth (Figure 3-7, Figure 3-8). Reefs were composed of the same hard rock as in Box 1, and mainly presented as low broken rock, no more than one metre in height above the surrounding soft sediments (Figure 3-9). Rock cover was patchy, and only covered 11% of the transect (Table 3-1), with segments rarely exceeding 50% rock cover, and only one segment reaching 100% rock cover.

The rock surfaces were characterised by a cover of fine sediments and possibly fine biogenic cover (such as from tubeworms/bryozoans) (Figure 3-10). Epifaunal cover was dominated by sponges (190/100m^2, richness 18), along with bryozoans (75/100m^2) (Table 3-5). Corals (*Desmophyllum*/*Caryophyllia*, Stylasteridae, Antipatheria) were a minor component (density 11/100m^2, richness 7). The sponge assemblage was dominated by the fan sponge *Neoschrammeniella fulvodesmus* (53/100m^2) and the glass sponge *Symplectella rowi* (51/100m^2).

Mobile invertebrates were sparse, with overall densities of 3/100m^2, with four OTUs contributing (starfish *Asterodiscides* sp., sea cucumber *Australostichopus mollis*, a brittle-star and a gastropod). Fish densities and richness were slightly higher (7/100m^2, richness 10). Most fishes were unidentified bony fish, along with smaller numbers of sea perch (0.8/100m^2), pink maomao (0.7/100m^2), morid cod (0.5/100m^2), and others (Table 3-5).

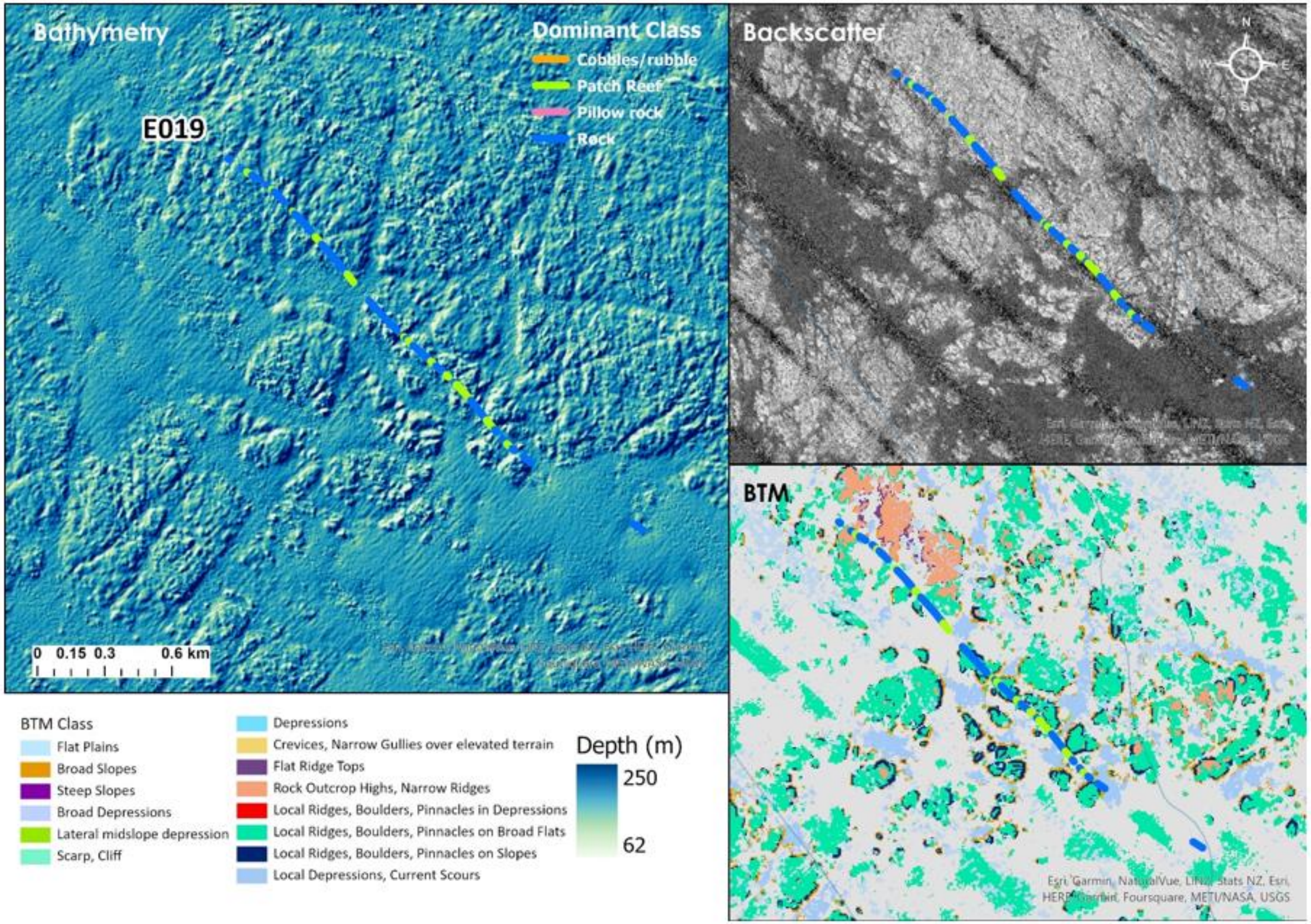

Figure 3-8: Box 2 finer scale map of bathymetry, backscatter, and BTM classification. The associated DTIS stations is 19. The dominant rock type in each segment is plotted; hard rock is further split into rock, patch reef (inclusive of boulders and rock tells), and cobbles. Segments with no rock contribution are not plotted.

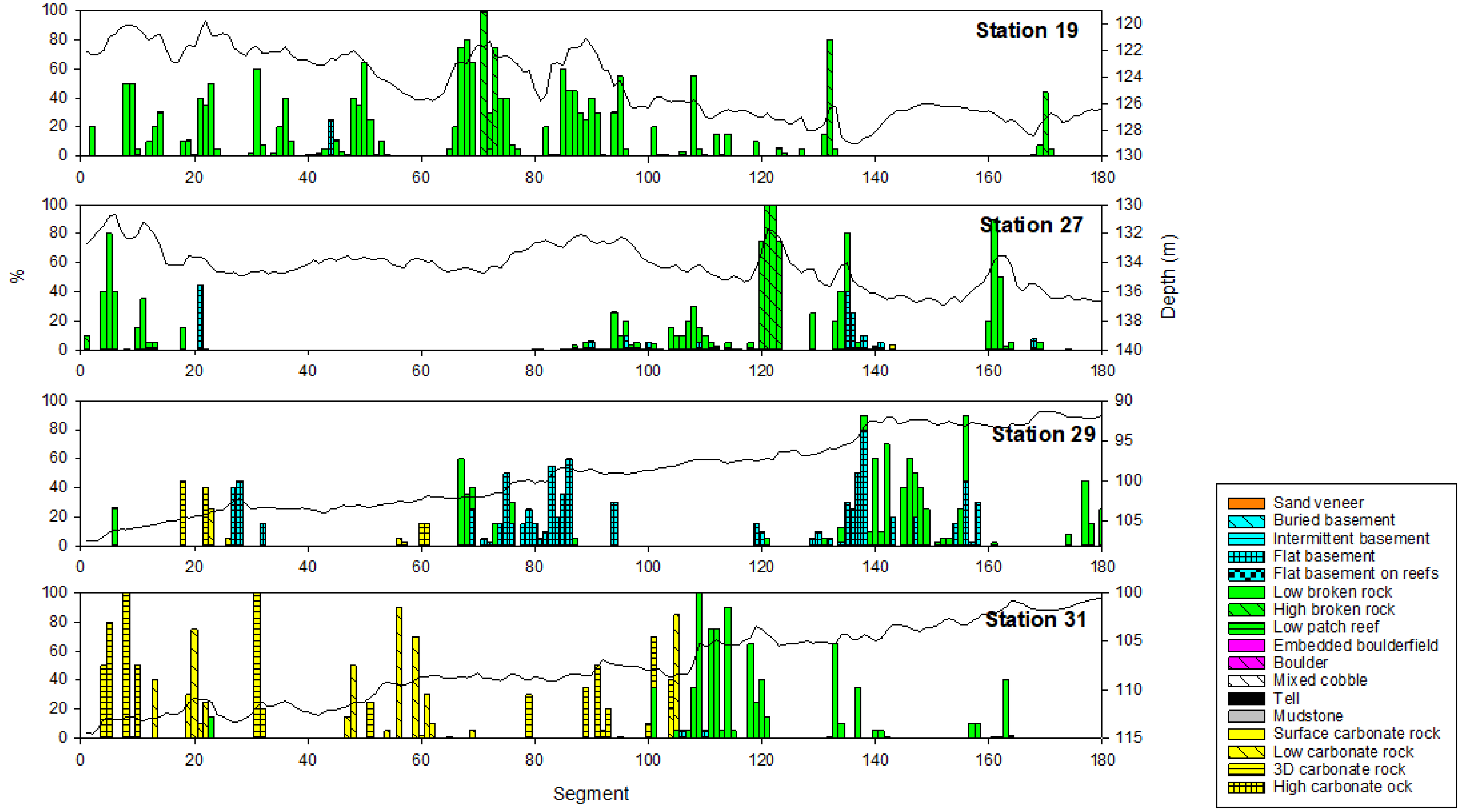

Figure 3-9: Along transect profiles (stations 19, 27, 29, 31) showing rock geomorphology class contributions by 20-second segment and associated bathymetry profile. Left axis) %contribution. Right axis) average depth for each segment. To maximise ease of interpretation, all segments are shown as equal width stacked bar plots, rather than the true distance travelled. Bathymetry profile is shown as a line plot. Table 2-1 provides a description of each of the classes. All transects are presented running south-to-north, west-to-east, regardless of vessels direction during collection.

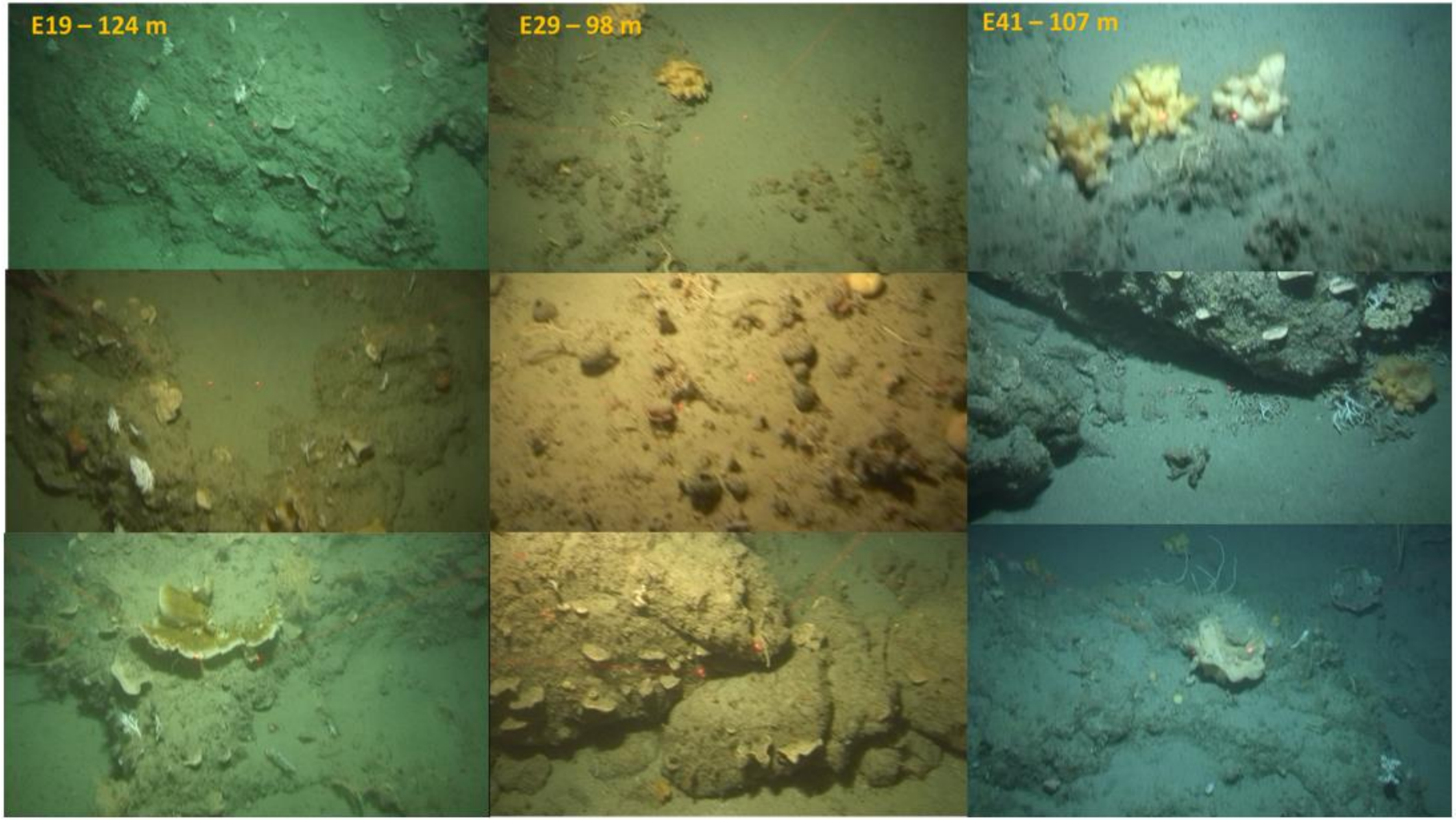

Figure 3-10: Box 2 seafloor imagery from stations 19, 29, and 41.

Table 3-5: Box 2 abundance (inds./100 m²) of key/charactering sessile invertebrates, mobile invertebrates, and fish. The top ten OTUs for each station are colour coded as a rank; densities for the other stations are provided for comparison. Values are estimated abundance per 100 m² of rock habitat. Average density and species richness are given for sponges, corals, all sessile invertebrates, mobile invertebrates and fish. Ca, carbonate rock; MST, mudstone. *, species also observed in soft sediment areas without rock.

Ranking scale (top 10 OTU)
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	Station	58	44	29		41	31		59		61	19	27	32
	Depth	55	89	98		107	108		109		124	124	134	143
	Rock area (m^2)	539	434	363	39	232	177	225	50	10	115	505	221	198
Sessile invertebrates														
OTU	**Group**				Ca			Ca		MST				
Sponge (Demospongiae)	Sponge	1.1	2.3	22.6	2.6	108.1	102.6	57.2	17.9		0.9	13.1	2.3	192.8
Hydroid	Hydroid	1.7	9.0	1.1	-	45.2	18.6	17.7	37.8	19.5	29.7	9.9	12.2	112.1
Desmophyllum/Caryophyllia	Coral	-	0.7	6.1	25.5	104.7	70.4	41.7	-		7.0	1.2	53.8	-
Bryozoan	Bryozoan	-	0.7	0.8	7.7	89.2	50.2	58.6	-		6.1	74.9	15.8	1.5
Symplectella rowi	Sponge	-	6.9	8.8	17.9	15.5	25.9	14.2	6.0		13.1	51.1	42.9	54.5
Axinella australiensis	Sponge	-	6.2	15.1		52.6	14.1	4.4	45.8		4.4	18.2	9.0	-
Neoschrammeniella fulvodesmus	Sponge	3.0	20.0	10.7	5.1	2.6	2.8		-		7.9	53.1	35.7	-
Stylasteridae	Coral	-	-	-		4.3	-		4.0		19.2	-	49.2	58.0
Callyspongia sp.	Sponge	-	0.7	4.7	2.6	23.7	86.8	11.1	-		-	7.5	-	-
Encrusting sponges	Sponge	0.4	1.6	8.0	2.6	24.1	24.2	16.4	-		3.5	2.4	-	-
Haplosclerid	Sponge	5.4	9.0	-		12.9	2.8		-		13.1	-	10.8	-
Suberites sp.	Sponge	-	-	-		1.3	3.4		37.8		-	-	2.7	-
Antipatheria	Coral	-	1.4	-	-	10.3	5.1	5.8	4.0		10.5	7.5	1.4	0.5
Dendrilla rosea	Anemone	0.6	0.2	1.1	-	-	0.6	0.9	-	-	-	3.4	1.8	26
Anemone	Sponge	0.2	21.2	6.6		3.0	3.4		-		-	-	0.5	-
Aciculites pulchra	Anemone	0.6	0.2	1.1		-	0.6		-		-	3.4	1.8	26
Oculina virgosa	Sponge	-	2.5	0.3		9.9	11.3		-		0.9	7.5	0.9	-
Iophon laevistylus	Coral	-	-	-		2.2	4.5		-		25.3	-	-	-
Ecionemia alata	Sponge	0.6	4.1	2.5		3.0	8.5		8.0		1.7	1.2	-	-
Clathria sp.	Sponge	23.0	-	2.8	2.6	-	-	-	-		-	-	-	-

	Station	58	44	29		41	31		59		61	19	27	32
Ascidians (clonal)	Sponge	-	-	-		-	-		19.9		-	-	-	-
Calyx imperialis	Ascidian	-	-	1.4		6.9	-		-		-	10.7	-	-
Axinellidae	Sponge	-	-	2.2		0.4	3.9		-		0.9	9.5	0.9	1.0
Primnoidae	Sponge	0.7	6.2	4.1	15.3	-	2.8	0.4	-		-	-	4.1	-
Dragmacidon australiensis	Coral	10.4	-	-		-	-		-		-	-	-	3
Leiodermatium linea	Sponge	-	-	-		-	-		11.9		-	-	-	-
Tethya fastigata	Sponge	-	-	0.6		-	0.6		-		-	9.5	-	-
Poecilosclerid	Sponge	0.2	-	5.5		-	2.8		-		-	2.0	-	-
Haliclona (*Gellius*) *petrocalyx*	Sponge	-	-	-		-	-		-		-	-	-	10
Stelletta sp.	Sponge	6.9	0.9	-		-	-		-		-	-	0.9	0.5
Jaspis n. sp. 1	Sponge	0.4	2.8	1.4		-	0.6		-		-	-	0.5	-
Geodiidae	Sponge	1.9	0.5	0.6	2.6	0.4	-	-	-		0.9	0.8	-	-
Pennatulacea	Sponge	-	-	-		-	-		-		-	-	-	4
Radicipes spp	Sea pen	-	-	-	2.5	0.4	-	-	-	-	-	-	-	-
Rossella ijimai	Coral	-	-	-		-	-		-		-	-	3.6	-
Petrosia hebes	Sponge	-	-	-		-	-		-		0.9	-	-	2
Ancorina stalagmoides	Sponge	1.7	-	-		-	0.6		-		-	-	-	-
Sponge (Hexactinellidae)	Sponge	1.9	-	-		-	-		-		-	-	-	-
	Sponge			2.2	2.6	0.9		0.4				1.98		0.5
Sponges														
	Density (100 m^2)	55.4	88.7	110.3	53.4	262.8	309.9	115.8	151.3	-	49.8	189.7	112.9	274.6
	OTUs	25	18	25	9	21	29	16	9	-	13	18	16	16
Corals														
	Density (100 m^2)	11.5	2.1	6.9	8.2	122.8	81.7	50.6	8.0	-	62.9	10.7	108.4	63.1
	OTUs	2	2	2	4	7	5	3	2	-	5	5	5	5
All														
	Density (100 m^2)	69.1	101.4	121.9	96.9	534.2	465.5	248.0	199.0	19.5	148.4	300	251.6	479.5
	OTUs	29	24	32	15	36	39	23	13	1	20	29	25	27

Ranking scale (top 10 OTU)

1
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10

Station		58	44	29		41	31		59		61	19	27	32
Depth		55	89	98		107	108		109		124	124	134	143
Rock area		539	434	363	39	232	177	225	50	10	115	505	221	198
Mobile invertebrates														
OTU	**Group**	55	89	98	Ca	107	108	Ca	109	MST	124	124	134	143
Asterodiscides sp.	Starfish	-	-	0.8	2.5	-	0.6	-	-	-		0.4	0.5	-
Henricia sp.	Starfish	3.0	0.2	-	-	-	-	-	-	-	0.9	-	-	-
Australostichopus mollis	Sea cucumber	-	0.2	-	-	-	-	-	-	-	0.9	1.2	0.9	-
Asterodiscides truncatus	Starfish	-	-	-	-	-	-	-	-	-	0.9	-	-	2.0
Ophidiasteridae	Brittle star	-	-	0.3	-	0.4	0.6	-	-	-	-	1.2	-	-
Comanthus sp.	Sea feather	-	0.2	0.3	-	-	-	-	-	-	1.7	-	-	-
Holothuria integra	Sea cucumber	-	-	-	-	-	1.7	-	-	-	-	-	-	-
Astraea heliotropium	Gastropod	-	0.7	-	-	-	-	-	-	-	0.9	-	-	-
Asteroid	Starfish	-	-	-	-	-	-	-	-	-	-	-	-	1.5
Mollusc (gastropod)	Gastropod	-	0.2	-	-	0.4	-	0.4	-	-	-	0.4	-	-
Ophiuroid	Brittle star	-	-	-	-	-	0.6	-	-	-	0.9	-	-	-
Astrobrachion contrictum	Brittle star	-	-	-	-	-	-	-	-	-		-	-	0.5
Echinasteridae	Urchin	-	-	-	-	0.4	-	-	-	-		-	-	-
Crustacean (crab)	Crustacean	-	-	-	-	0.4	-	-	-	-	-	-	-	-
Volutidae	Gastropod	-	0.2	-	-	-	-	-	-	-	-	-	-	-
Turbinidae	Gastropod	-	0.2	-	-	-	-	-	-	-	-	-	-	-
Density (100 m^2)		3.0	2.1	1.4	2.5	1.7	3.4	0.4	-	-	6.1	3.2	1.4	4.0
OTU's		1	7	3	1	4	4	1	-	-	6	4	2	3

Station	58	44	29		41	31		59		61	19	27	32
Depth	55	89	98		107	108		109		124	124	134	143
Swept area (m^2)	718	1139	1470	211	943	680	627	142	80	319	2577	1312	968
Fish													
OTU				Ca			Ca		MST				
Bony fish	0.1	0.1	2.1	5.23	1.2	<0.1	0.9	1.4		1.3	4.1	0.3	-
Pink maomao	0.8	1.0	0.7		-	1.2	1.9	2.8		2.2	0.7	0.5	-
Sea perch	0.1	1.4	1.2	0.95	0.5	1.5	0.2	0.7	3.8	2.5	0.8	2.4	-
Butterfly perch	4.6	-	0.1		0.1	0.1		0.7		0.6	0.1	0.2	-
Slender roughy	0.6	1.8	-		-	0.3	0.3	-		0.9	-	0.4	-
Leatherjacket	-	0.2	0.1		-	0.3		0.7		0.9	-	-	-
Red moki	0.1	-	-		-	-		1.4		-	-	-	-
Northern bastard red cod	-	0.2	-		-	-		-		0.9	-	0.4	-
Northern scorpionfish	-	0.2	-		-	-		-		0.9	-	<0.1	-
Silver conger eel*	0.0	0.2	0.2		-	-		-		0.6	-	-	-
Moridae	-	-	0.1	0.5	-	-	0.3	-		0.3	0.5	-	-
Red mullet	0.6	0.4	-		-	-		-		-	-	<0.1	-
Yellow weaver	-	-	-		0.1	-		0.7		-	-	<0.1	-
Splendid perch	-	0.2	-		-	-		-		0.3	-	0.2	-
Eels*	-	<0.1	-		-	-		-		0.3	0.1	<0.1	-
Scorpionfish	-	-	0.1		0.1	-	0.3	-		-	0.2	-	-
Common roughy	-	-	-		0.1	0.1	0.5	-		-	-	-	-
Snipefish*	-	-	-		-	0.3		-		-	0.2	0.2	-
Half-banded perch	-	-	-		0.3	-		-		-	-	-	-
Tarakihi	-	-	0.1		-	-				-	-	0.2	-
Cucumber fish*	-	-	-		-					-	-	0.2	-
Eagle ray*	-	-	0.1		-	0.1				-	0.1	-	-
Blue cod	0.1	-	-		-	-				-	-	-	-

Ranking scale (top 10 OTU)
1
2
3
4
5
6
7
8
9
10

Station	58	44	29		41	31		59		61	19	27	32
Yellow and black triplefin	0.1	-	-		-	-				-	-	-	-
Red gurnard*	-	-	-		-	-					0.1	-	-
Spotted gurnard*						-	0.2					<0.1	-
Density (100 m^2)	7.2	5.7	5.0	6.7	2.4	4.0	4.6	8.5	3.8	12.8	6.8	5.3	-
OTUs	10	13	12	3	8	8	8	7	1	15	10	17	-

Stations 27, 29, 31, 32, 41

Five stations were on the large deep reef area east of the Cape Brett Peninsula, ranging from 98–143 metres average depth (Table 3-6). Stations 29, 31, and 41 (depth range 98–108 metres) were placed close together, with station 41 running at a right angle across the other two (Figure 3-11). Hard rock covers were low, ranging from 7 to 11%, and composed of mainly low basement and low broken rock geomorphologies (Table 3-1, Figure 3-9, Figure 3-12)

Carbonate rock (Figure 3-13), occurred in all three stations, contributing from <1% to 6% of rock cover (10 to 230 m^2). Station 31 had the highest extent, split equally between the low and 3D carbonate rock classes (see Table 2-2 for definitions), and occurring on the eastern side of the three-station cluster. This carbonate rock occurred as small patches, at/below the spatial scale of single segments (circa 10 metres), and adjacent but separate to the hard rock cover areas (the two rock types were seldom intermixed) (Figure 3-9). For stations 29 and 31, carbonate rock appeared on their eastern side as the water depth sloped down, first presenting at 103–109 metres depth. Station 31 had an abrupt shift from hard rock to carbonate rock at about 109 metres water depth, while at Station 29 carbonate rock appeared around 103 metres water depth but had much lower spatial cover along with scattered patches of hard rock. Station 41 crossed these two stations at a right angle, with carbonate rock present in a single segment (0.4 m^2) at 107 metres water depth.

Stations 32 and 27 were placed over slightly deeper reef (134–143 m) around 6 km to the east and returned 7 to 15% hard rock cover. The reef morphologies were mainly composed of low broken rock clustered as small extents of reef (Figure 3-9), with the Station 27 transect also holding a high broken rock reef about 40 metres wide, two metres high and with 80–100% rock cover. No carbonate rock was seen at these two stations (Figure 3-14).

The hard rock type appeared the same for all five stations, matching that seen at Station 19 and across the Box 1 reefs. Sponges were the dominant epifauna, with densities ranging from 110 to 310 individuals per 100 m^2, and 16 to 29 OTU richness (Table 3-5). Coral contributions were more variable, ranging from 6.9 to 123 individuals per 100 m^2, and 2 to 7 OTU richness. Overall epifauna densities ranged from 122 to 534 individuals per 100 m^2, and 25 to 39 OTU richness. Other notable faunal groups included hydroids at station 32 (112/100 m^2) and bryozoans at stations 31 and 41 (50–90/100 m^2). At four of the five stations upright sponges dominated the sponge assemblage (density range 23–193/100m^2), along with variable contributions from the glass sponge *S. rowi*, the finger sponge *Axinella australiensis*, the fan sponge *Neoschrammeniella fulvodesmus*, and other species. Corals were dominated by *Desmophyllum*/*Caryophyllia* cup corals at stations 27, 31, and 41 (density 54–105/100m^2), and Stylasteridae at stations 27 and 32 (density 49–58/100m^2), Antipatheria black corals (density 0–10/100m^2) and *Oculina virgosa* (density 0–4/100m^2).

The carbonate rock class was more variable in areal cover than hard rock, making direct comparisons difficult. Sponge OTUs density for station 29 (39m^2 carbonate rock) was 53/100m^2, richness 9; coral OTUs density 8/100m^2, richness 4; and all fauna 97/100m^2, richness 15 (Table 3-5). Station 31 sampled 225 m^2 of carbonate rock cover and was more comparable in areal extent to hard rock stations, with a sponge OTU density of 116/100m^2, richness 9; coral OTUs density of 51/100m^2, OTU richness 4; and all fauna 248/100m^2, richness 23. Faunal contributions for both carbonate rock stations (station 41 held <10 m^{2}and was excluded) were largely driven by upright sponges, *Desmophyllum*/*Caryophyllia* cup corals, bryozoans, and the glass sponge *S. rowe*.

Mobile invertebrates were very sparse across the hard rock reefs, with overall densities of 1 to 4/100 m^2, and OTU richness of 2 to 3, largely contributed by a few starfish (*Asterodiscides truncatus*, *Asterodiscides* sp.) and sea cucumbers (*Australostichopus mollis*, *Holothuria integra*). For the carbonate rock reefs, a single unidentified gastropod was observed.

The hard rock stations returned fish OTU densities of 2 to 5, richness 8 to 17. The dominant contributing species were unidentified bony fish (<0.1–4/100 m^2), pink maomao (0–1/100 m^2), sea perch (<1–2/100 m^2), and butterfly perch (<0.1–1/100 m^2). Carbonate rock returned slightly higher fish OTU densities (5–7), but slight lower OTU richness (3–7).

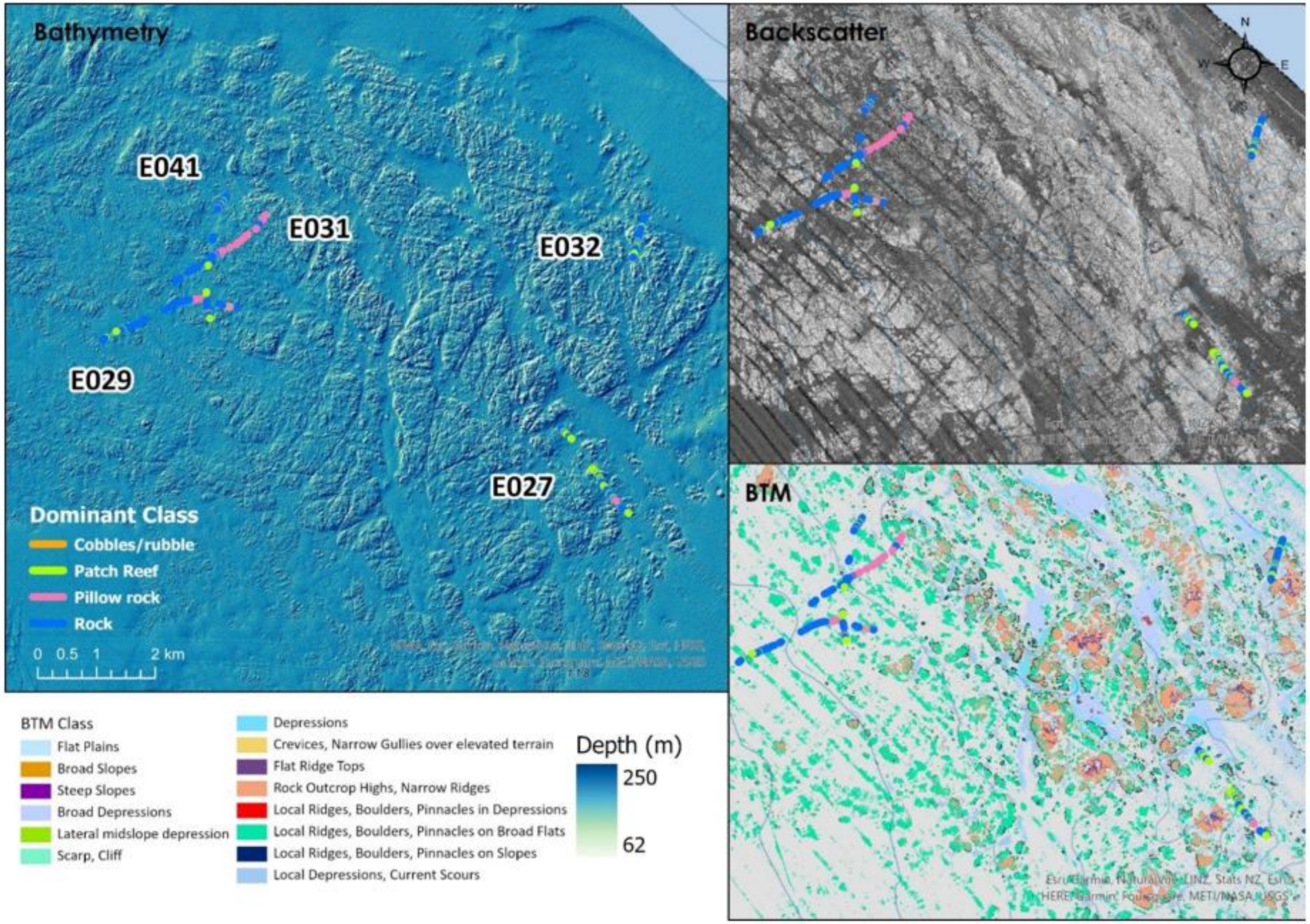

Figure 3-11: Box 2 finer scale map of bathymetry, backscatter, and BTM classification. The associated DTIS stations are 27, 29, 31, 32, and 41. The dominant rock type in each segment is plotted; hard rock is further split into rock, patch reef (inclusive of boulders and rock tells), and cobbles. Segments with no rock contribution are not plotted.

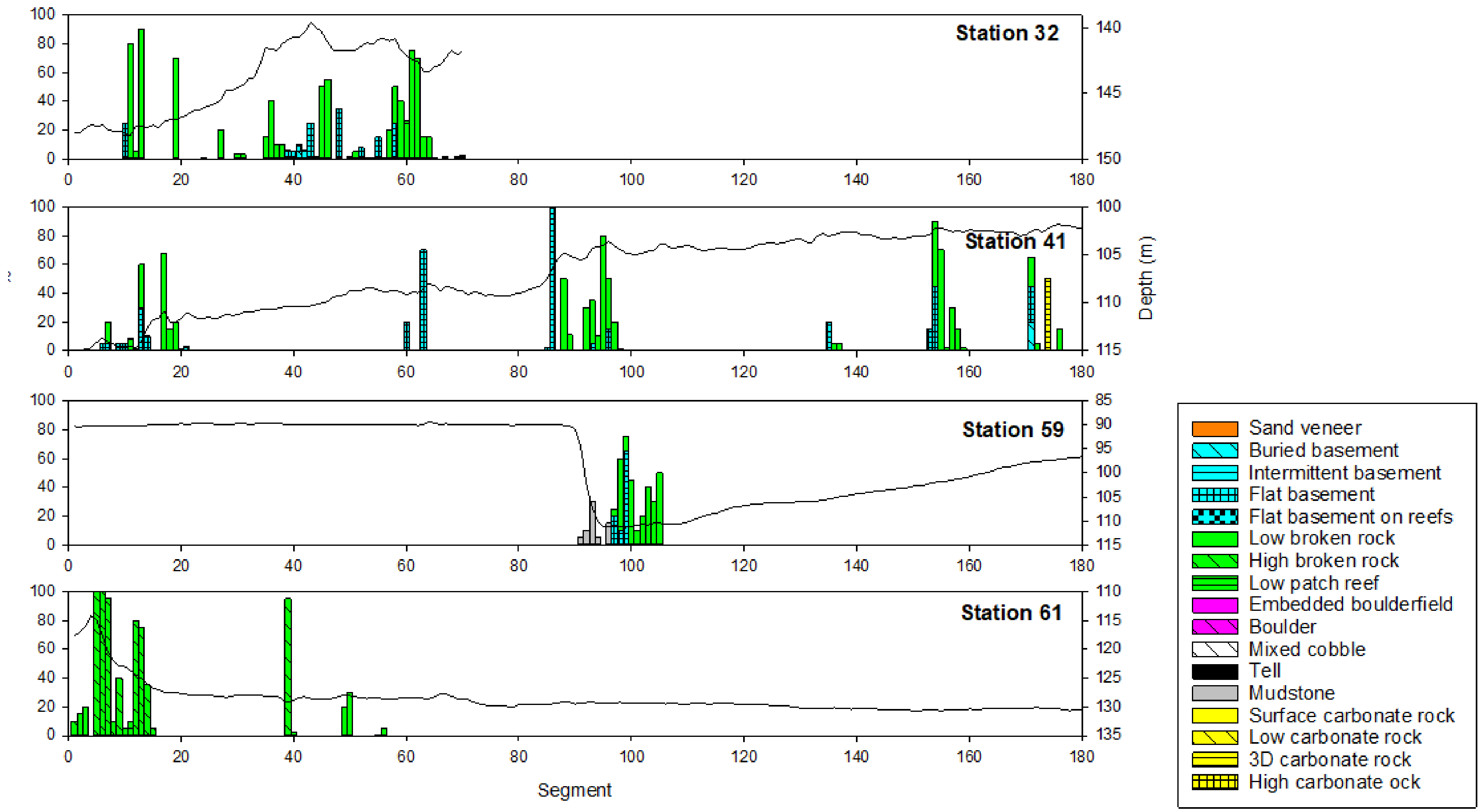

Figure 3-12: Along transect profiles (stations 32, 41, 59, 61) showing rock geomorphology class contributions by 20-second segment and associated bathymetry profile. Left axis) %contribution Right axis) average depth for each segment. To maximise ease of interpretation, all segments are shown as equal width stacked bar plots, rather than the true distance travelled. Bathymetry profile is shown as a line plot. Table 2-1 provides a description of each of the classes. All transects are presented running south-to-north, west-to-east, regardless of vessels direction during collection.

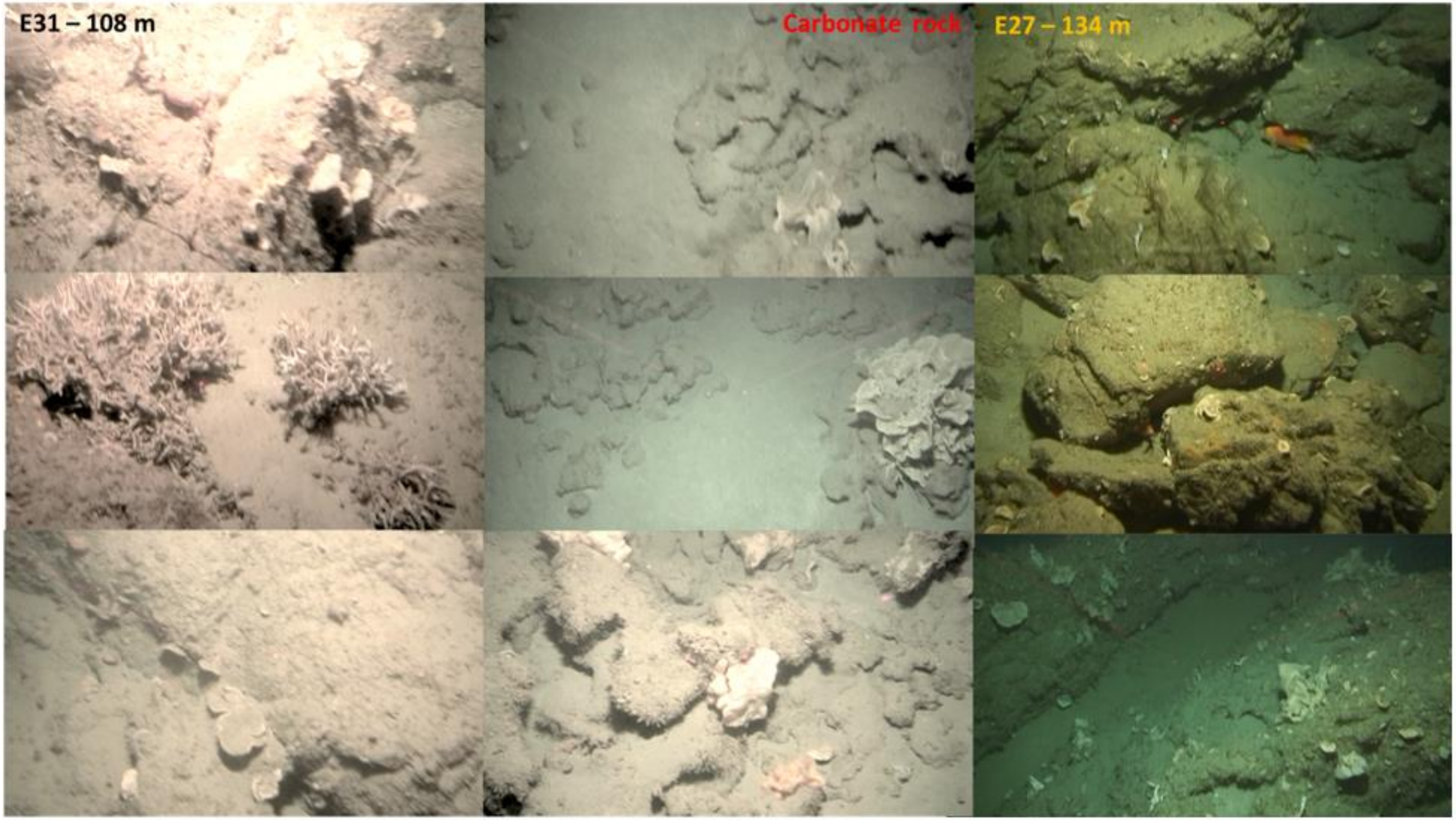

Figure 3-13: Box 2 seafloor imagery from stations 31 and 27.

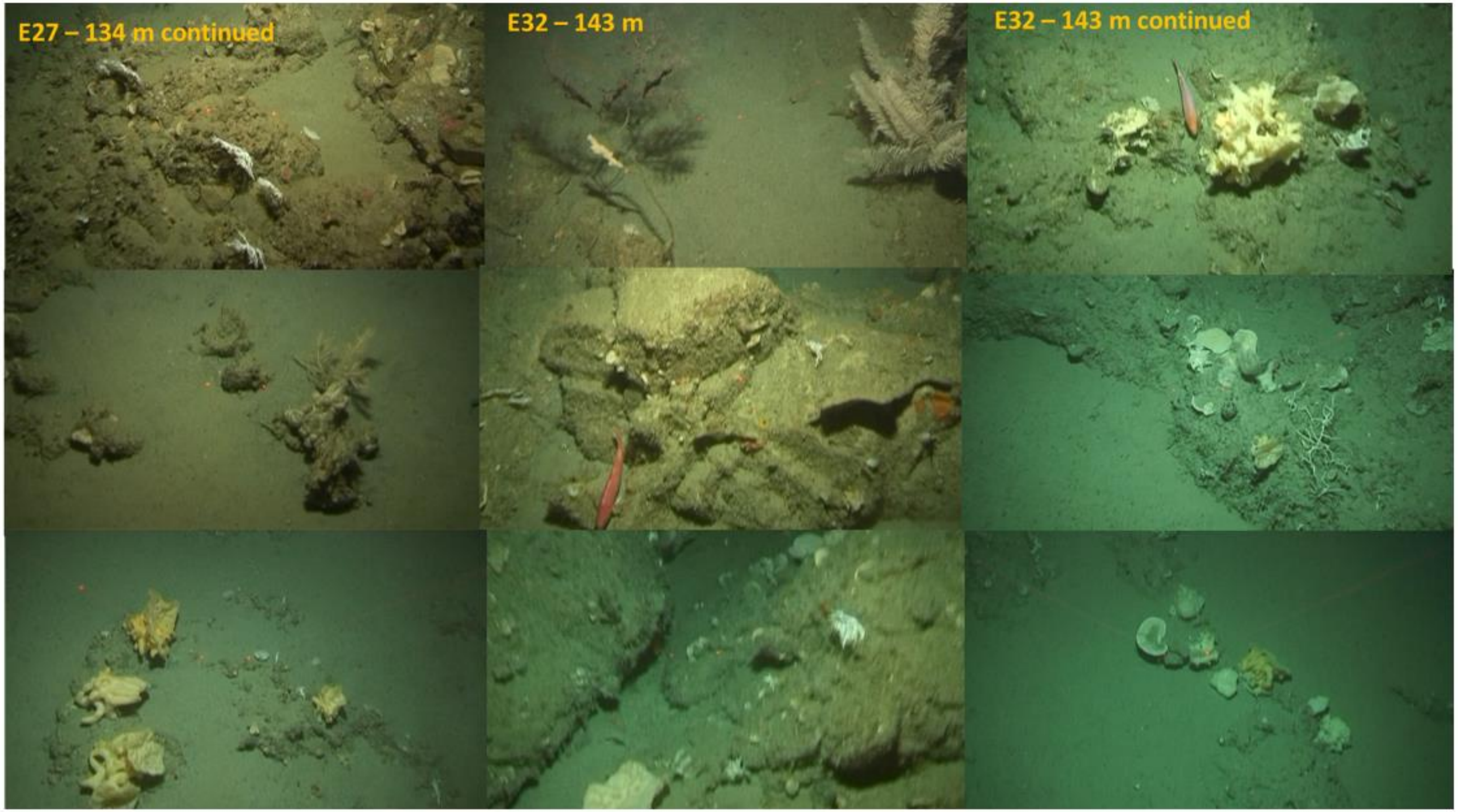

Figure 3-14: Box 2 seafloor imagery from stations 27 and 32.

Stations 61 and 59

Station 61 was off Cape Brett in 124 metres depth, near the outer edge of the deep reef complex, over an area classed by BTM as being predominately a depression (Figure 3-7, Figure 3-15). Reef was only present in the first third of the station transect (115 m^2, 4% overall cover), and was composed largely of semi-continuous high broken rock, sloping down around 10 metres over about a 100-metre distance to the rock/sand boundary (Figure 3-12). A few isolated low cover rock segments occurred offshore of this boundary. The rock type was the same as seen further south but was organised as large blocks and slabs (Figure 3-16). The rock surfaces were characterised by a cover of fine sediments and possibly fine biogenic cover, although sediment cover appeared to be less than that of reefs further south/inshore.

The epifauna was dominated by corals (63/100 m^2, richness 5), including *Oculina virgosa*, Stylasteridae, Antipatheria, and *Desmophyllum*/*Caryophyllia* (Table 3-5). Sponge density was 50/100m^2, richness 13. Dominant taxa included the glass sponge *S. rowe*, Haplosclerida, *N. fulvodesmus*, and *A. australiensis*. Mobile invertebrates were sparse, with overall densities of 6/100m^2, with six OTUs contributing (feather stars Comantulidae; probably *Cenolia spanoschistum* or *Anneissia benhami*, C. Duffy, DOC, pers. comm.) starfish *Henricia* sp. and *Asterodiscides truncatus*, sea cucumber *Australostichopus mollis*, circular saw shell *Astraea heliotropium*, and an ophiuroid). Fish densities and richness were also low (density 3/100m^2, richness 15), including contributions from sea perch (2/100m^2), pink maomao (2/100m^2), and unidentified bony fish (1/100m^2).

Station 59 was placed over a bathymetric bluff feature, where the soft sediment seafloor dropped down a crescent shaped steep drop from 90 metres to a deeper (110 metres) soft sediment plain (Figure 3-7, Figure 3-15). Rock was intermittently present in this feature, but most of the feature was composed of soft sediment (Figure 3-12). A mudstone rock was present as several narrow-eroded ridges as the towed camera descended the bluff, as well as for a short distance at the base of the bluff (Figure 3-12). This mudstone rock only occupied 0.3% (10 m^2) of the transect (Table 3-1) and was bare apart from some low-density hydroids (19/100m^2) and some sea perch associated with the bluff base (4/100 m^2). No invertebrates were seen on the mudstone, although scaphopods were present on some of the adjacent base sediment. A harder rock type was present at the bluff base, which was visually different from the hard rock seen further south, with an appearance of semi-regular angular ‘erosion faces’ on the rock surface (Figure 3-16, Figure 3-17). This rock was classed as basement and low broken rock and occupied only 1.9% (50 m^2) of the transect (Table 3-1). Sponges dominated the limited epifauna (151/100m^2, richness 9), with the main species being *Axinella australiensis*, *Suberites* sp., *Clathria* sp. and *Dragmacidon australiensis* (the latter two species not seen elsewhere in Box 2) (Table 3-5). Corals were rare (8/100m^2, richness 2), with equal contributions from Stylasteridae and Antipatheria. Hydroids contributed 38 individuals per 100 m^2, with an overall epifauna density of 199 individuals per 100 m^2, richness 13. No mobile invertebrates were seen, while fish were present at 8/100 m^2, richness 7. The contributors were pink maomao (3/100m^2), red moki, unidentified bony fish, sea perch, butterfly perch and yellow weaver (all circa 1/100 m^2).

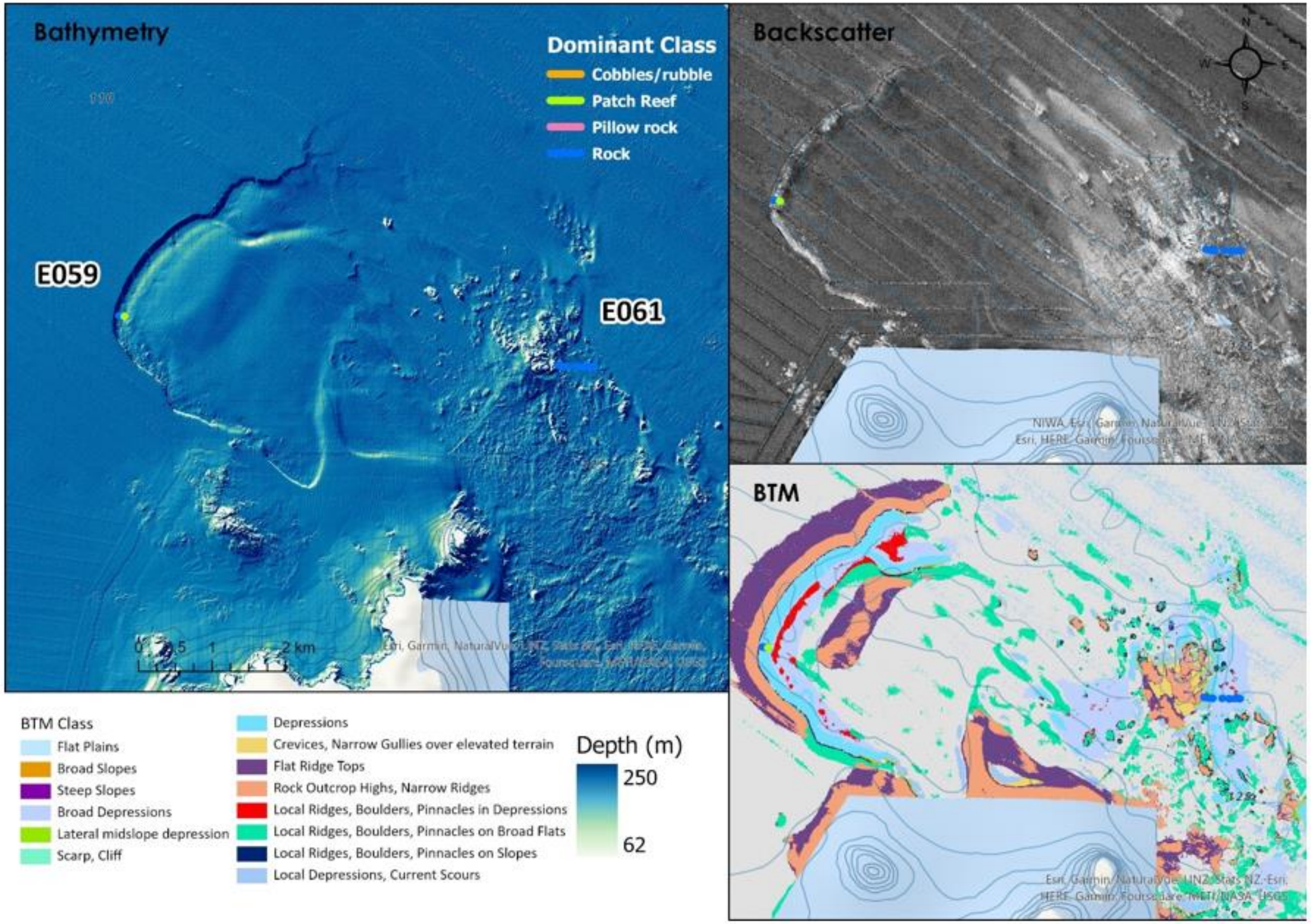

Figure 3-15: Box 2 finer scale map of bathymetry, backscatter, and BTM classification. The associated DTIS stations are 59 and 61. The dominant rock type in each segment is plotted; hard rock is further split into rock, patch reef (inclusive of boulders and rock tells), and cobbles. Segments with no rock contribution are not plotted.

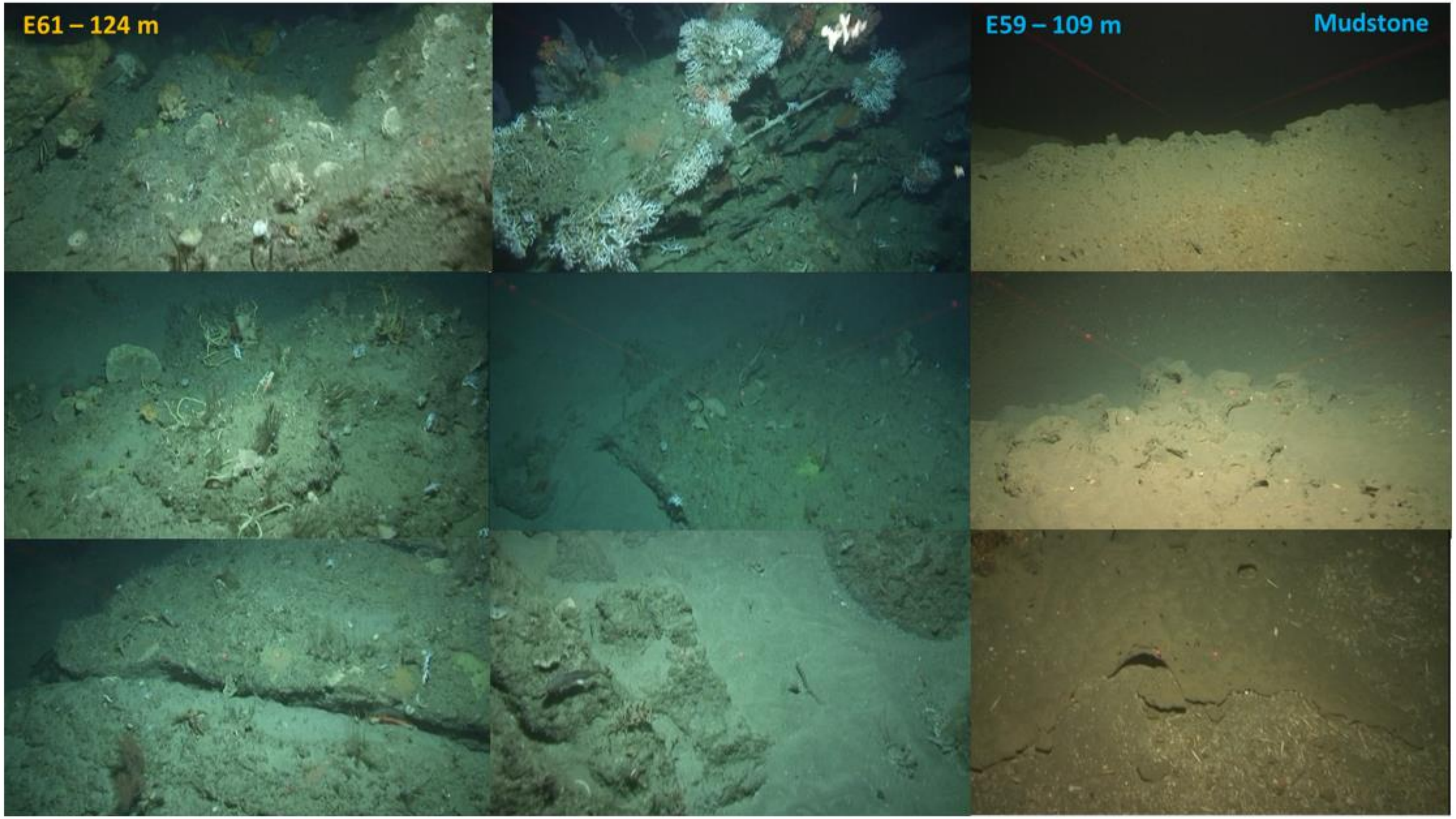

Figure 3-16: Box 2 seafloor imagery from stations 61 and 59.

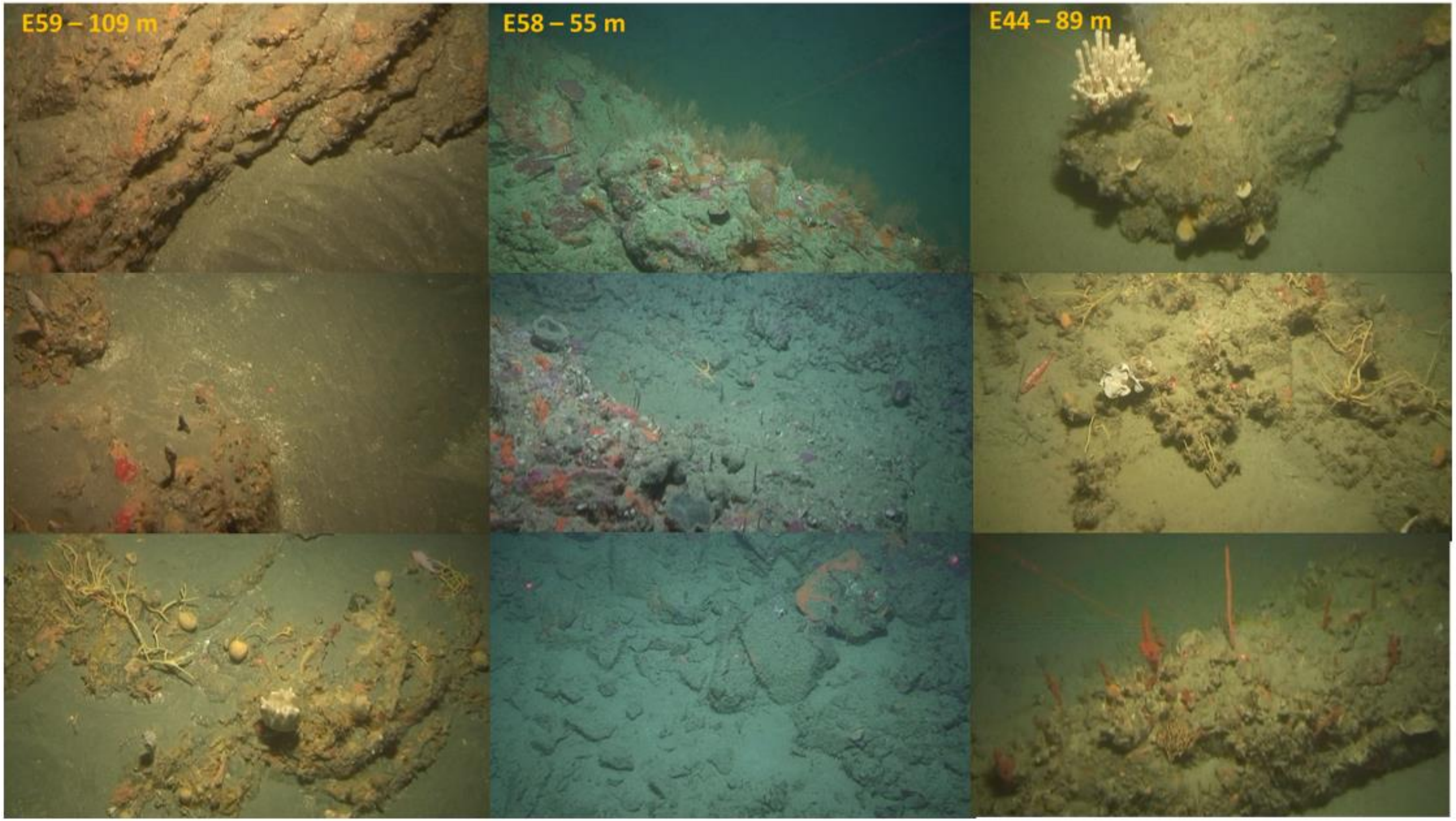

Figure 3-17: Box 2 seafloor imagery from stations 59 (continued), 58 and 44.

Stations 58 and 44

Stations 44 and 58 were sampled on the deep reefs offshore of Cape Wiwiki, on the northern side of the Bay of Islands (Figure 3-7, Figure 3-18). Station 58 was in 55 metres water depth, with the station transect spanning two semi-continuous areas of reef, separated by a soft sediment plain with some smaller reef areas (Figure 3-19). Overall, 57% of the transect held reef, with the rock type like that seen further south (Table 3-1). Most of the reef was composed of rock basement and low broken rock, along with a small cobble contribution towards the northern end (Figure 3-19).

Rock cover was high in the main two areas of reef, often reaching 100% in multiple adjacent segments, in strong contrast to the reefs seen further south. However, this difference may have been driven by the relatively proximity to the inner 50 metre multibeam survey boundary, where the reef BTM class complexity consistently increased for all the boxes, when rock was present.

Rock surfaces were characterised by a cover of fine sediments and possibly fine biogenic cover (such as from tubeworms/bryozoans), as well as widespread patches of purple coralline algal crusts (Figure 3-17). Epifaunal cover was more pronounced on raised ridges and higher reef areas, although faunal densities at the transect scale were lower than for the more southern reefs. Sponges dominated (55/100 m^2, richness 29), with the main species being the large cup sponge *Ecionemia alata* (23/100 m^2) (Table 3-5). Corals were uncommon (11/100 m^2, richness 2), with the dominant taxa being small Primnoidae (10/100m^2), which were largely found on exposed ridges. Overall epifauna density was 69 individuals per 100m^2, richness 29.

Mobile invertebrates were absent apart from the starfish *Henricia* sp. (3/100m^2). Fish density was 7/100m^2, richness 10, with the main species being butterfly perch (5/100m^2), pink maomao, slender roughy, and red mullet (all around 1/100m^2).

Station 44 was further offshore in 89 metres depth, where the reef was less continuous, occupying 15% of the station transect (Table 3-1). A larger area of reef was present towards the northern end with discrete reef patches occurring along the transect more broadly (Figure 3-19). The rock type here appeared to be like the more southern stations, although it often occurred as more vertically faced low ridge/block features (less than one metre height). Epifaunal densities (all 101/100m^2, richness 24) were slightly higher than the adjacent shallower station 59, and dominated by sponges (89/100m^2, richness 18). The main species were *Dendrilla rosea* (21/100m^2) and *N. fulvodesmus* (20/100m^2). Corals were rare (2/100m^2, richness 2).

Mobile invertebrates were uncommon (2/100m^2, richness 7) and included the circular saw shell *Astraea heliotropium*, the starfish *Henricia* sp., the sea cucumber *Australostichopus mollis*, and feather stars (Comantulidae). Fish density was 6/100m^2, richness 13, with the main contributors being slender roughy (2/100m^2), sea perch and pink maomao (both 1/100m^2).

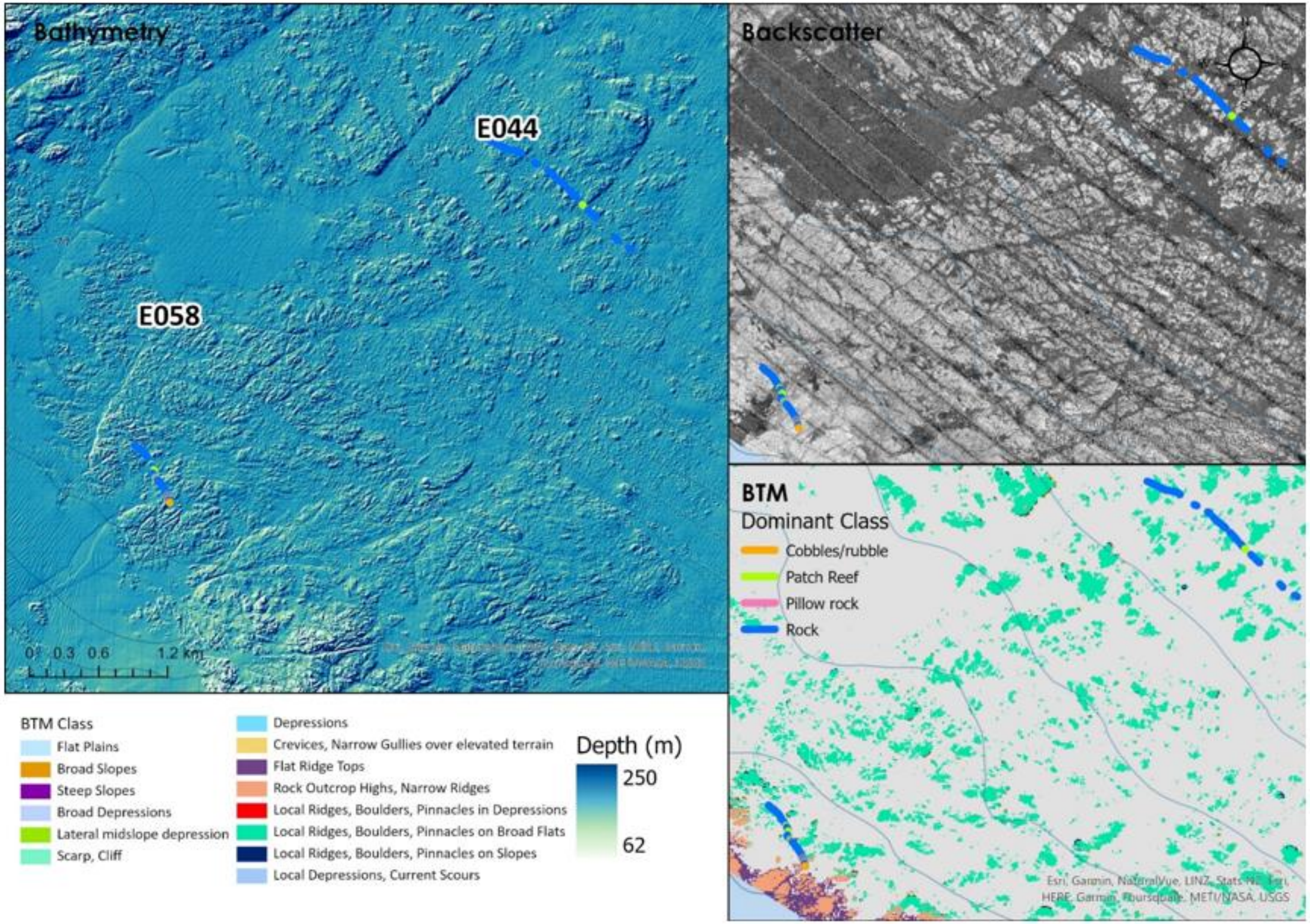

Figure 3-18: Box 2 finer scale map of bathymetry, backscatter, and BTM classification. The associated DTIS stations are 44 and 58. The dominant rock type in each segment is plotted; hard rock is further split into rock, patch reef (inclusive of boulders and rock tells), and cobbles. Segments with no rock contribution are not plotted.

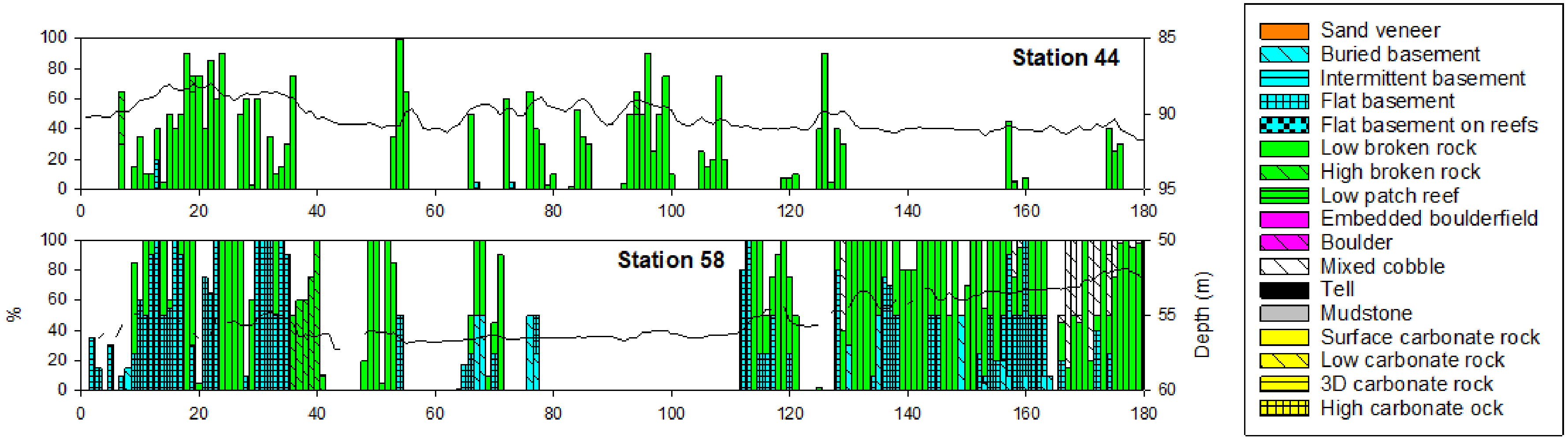

Figure 3-19: Along transect profiles (stations 44, 58) showing rock geomorphology class contributions by 20 second segment and associated bathymetry profile. Left axis) %contribution. Right axis) average depth for each segment. To maximise ease of interpretation, all segments are shown as equal width stacked bar plots, rather than the true distance travelled. Bathymetry profile is shown as a line plot. Table 2-1 provides a description of each of the classes. All transects are presented running south-to-north, west-to-east, regardless of vessels direction during collection.

Box 3 – east of Cavalli Islands

A large area of deep reef was present east of the Cavalli Islands, extending around 7 km out from the 50-metre depth contour, inclusive of a large soft sediment plain area between the main reef area and Motukawanui Island (Figure 3-20). The BTM analysis classed most of this deep reef as 'local ridges, boulders, pinnacles on broad flats'; but also identified more topographically complicated smaller areas within the overall reef extent. As seen in other Box blocks, more topographically complex areas were also present on the inner 50 metre depth boundary.

Station 241

Station 241 was east of the Cavalli Islands in 90 metres depth (Figure 3-20, Figure 3-21). The rock type was the same as previous transects (hard rock), occupying 42% of the transect station (Table 3). Reef was mainly present as low broken rock, along with basement rock, with reef cover increasing from south to north (figure 3-22). Reef widths varied, with some rising to two metres high over tens of metres, and extending for distances of up to 100 metres, with high rock cover.

The rock surfaces were characterised by a cover of fine sediments and possibly fine biogenic cover (such as from tubeworms/bryozoans) (Figure 3-23). Epifauna was dominated by sponges (409/100m^2, richness 39), with the main species being upright sponges (154/100m^2), *A. australiensis* (54/100m^2), *N. fulvodesmus* (35/100m^2), *Dendrilla rosea* (34/100m^2), encrusting sponges (21/100m^2), *Callyspongia* sp. (20/100m^2), and *Aciculites pulchra* (19/100m^2) (Table 3-6). Corals contributed a density of 97 individuals per 100 m^2, richness 7. The main species were *Flabellum* cup corals (66/100m^2) and *Oculina virgosa* (12/100m^2).

Mobile invertebrate densities were low, with overall densities of 12/100m^2, richness 11, and dominated by anemones (9/100m^2). Fish were less common (6/100m^2), richness 11, with the main species being sea perch (2/100m^2), unidentified bony fish, slender roughy and pink maomao (all 1/100m^2). Golden snapper and yellow weaver were also present.

Stations 66 and 67

These stations were parallel to each other and located further east in 108 to 122 metres depth. Carbonate rock dominated both stations (24–34% cover), with smaller contributions (3%) of hard rock (Table 3). The carbonate rock geomorphology was almost all classed as high, meaning that it had relatively high vertical structure, and associated vertical holes (Figure 3-24, Figure 3-25). Station 66 held one large hard rock reef, about 100 metres wide and rising to around 3 metres in height, with 80% or more rock cover (Figure 3-22). Station 67 hard rock/reef cover was more dispersed, with smaller reef widths, and lower rock cover.

The hard rock surfaces appeared to have less fine sediment cover than shallower/more southern reefs. The epifauna was dominated by corals at station 66 (93/100m^2, richness 7), and sponges at station 67 (66/100m^2, richness 12) (Table 3-6). Overall densities ranged from 96 to 163 individuals per 100 m^2, richness 18–20. The dominant species were bryozoans (26–50/100m^2), the glass sponge *S. rowe* (29–38/100m^2), *Flabellum* cup corals (0–25/100m^2), and the sponge *N. fulvodesmus* (6–16/100m^2).

Mobile invertebrate densities ranged from 2 to 4 per 100 m^2, with richness of 5 to 8. Anemones contributed most of the individuals (1–2/100m^2). Fish were more common (8–20/100m^2, richness 14–18), with the main contributors being red bandfish (0–7/100m^2), unidentified bony fish (2–

3/100m^2), sea perch (1/100m^2), and pink maomao (0–2/100m^2). Golden snapper and yellow weaver were also present.

The carbonate rock reefs were dominated by sponges (45–57/100m^2, richness 11–17), with the main species being the glass sponge *S. rowe* (26–40/100m^2) and *N. fulvodesmus* (7/100m^2) (Table 3-6). Mobile invertebrate densities ranged from 9 to 22 per 100 m^2, with richness of 5 to 10. Anemones (1–6/100m^2), unidentified echinoids (0–8/100m^2), the starfish *Asterodiscides* sp. (0–3/100m^2), unidentified gastropods (<1–2/100m^2), and the sea cucumber *Australostichopus mollis* (0–3/100m^2) contributed most of the individuals. Fish densities ranged from 8–20 individuals per 100m^2, richness 12–18, with the most common being unidentified bony fish (3/100m^2), sea perch (1/100m^2), pink maomao (1/100m^2) and butterfly perch (1–2/100m^2).

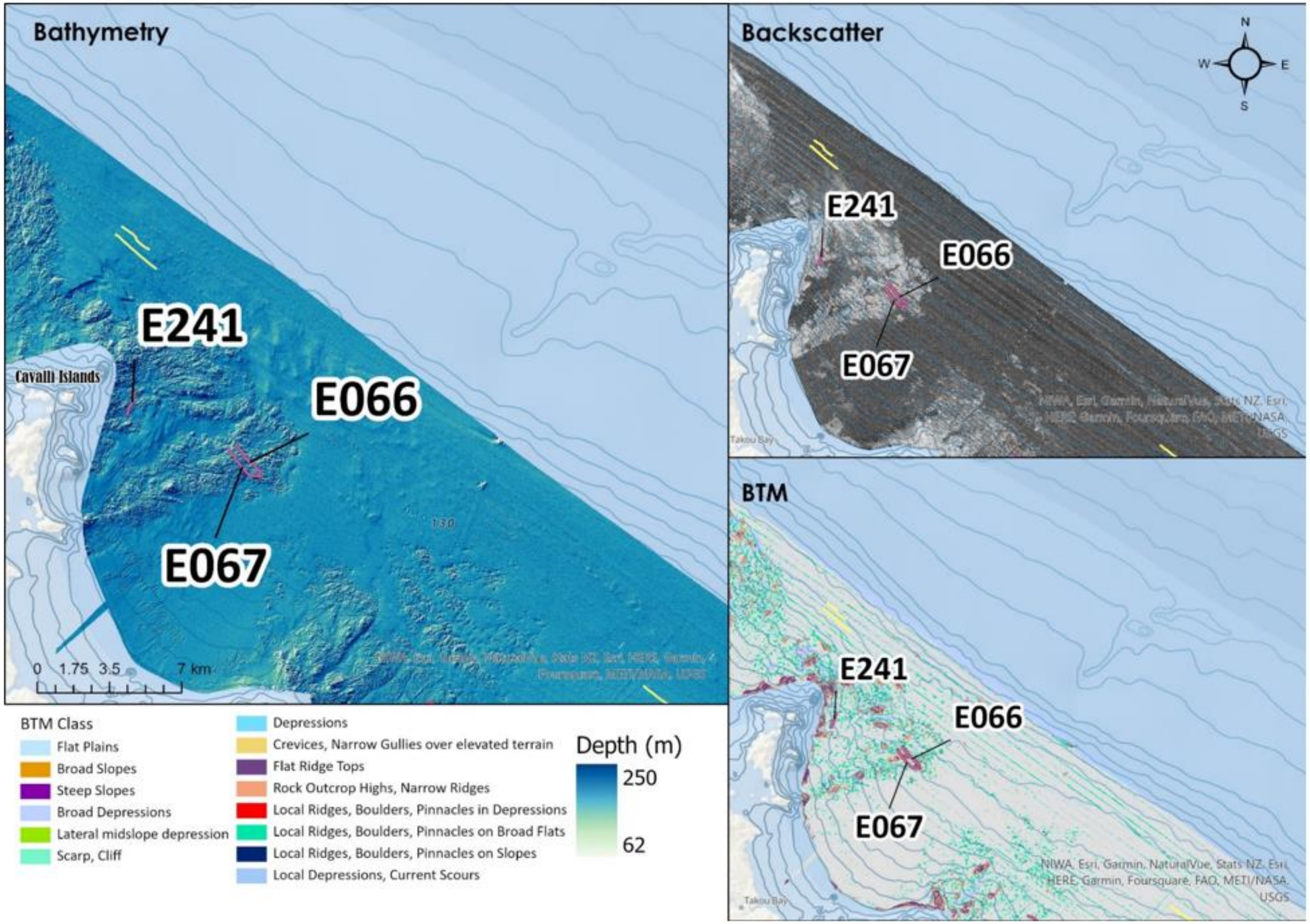

Figure 3-20: Box 3 bathymetry, backscatter, and BTM classification. Associated DTIS stations are 66, 67, and 241.

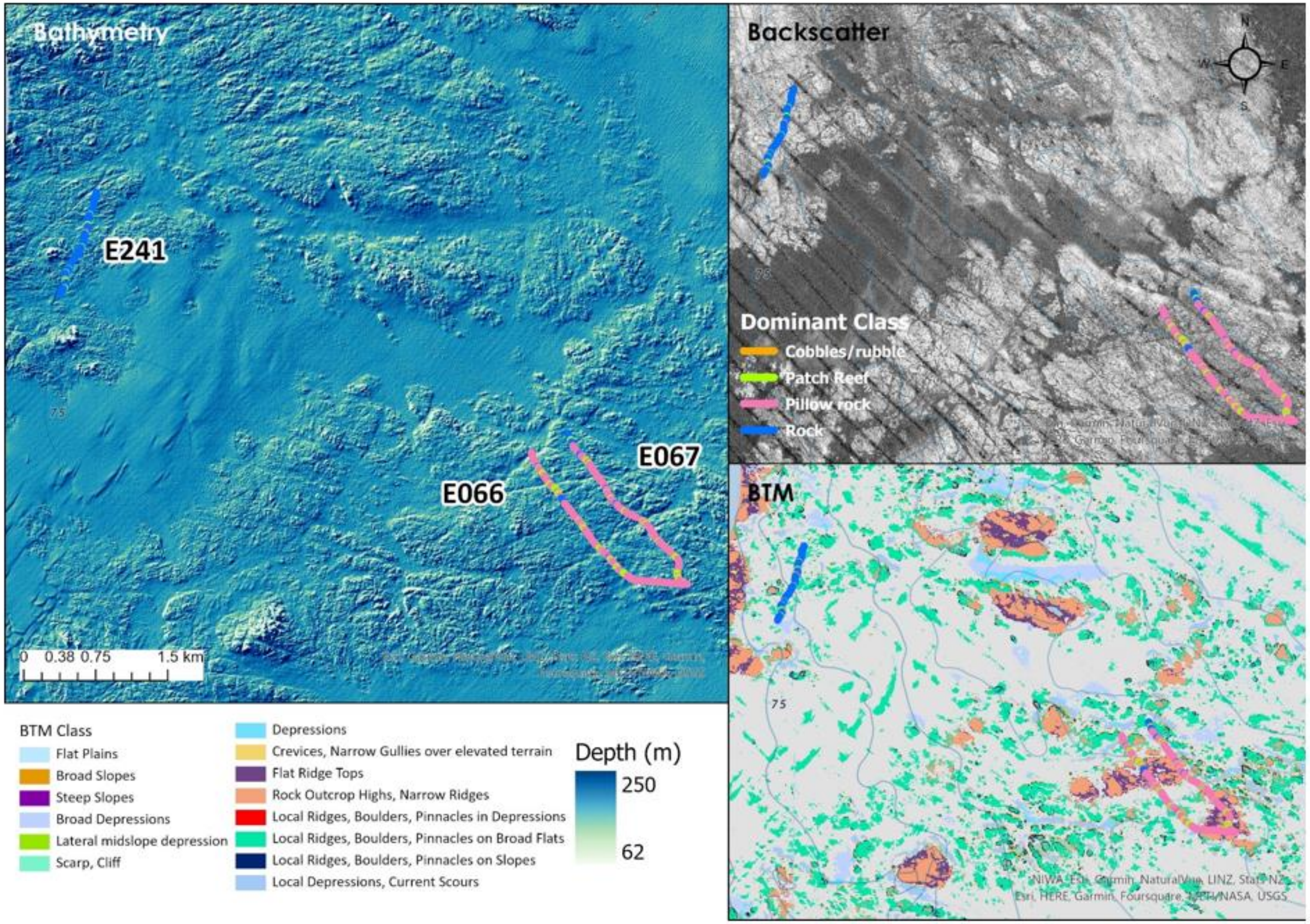

Figure 3-21: Box 3 finer scale map of bathymetry, backscatter, and BTM classification. The associated DTIS stations are 166, 67 and 241. The dominant rock type in each segment is plotted; hard rock is further split into rock, patch reef (inclusive of boulders and rock tells), and cobbles. Segments with no rock contribution are not plotted.

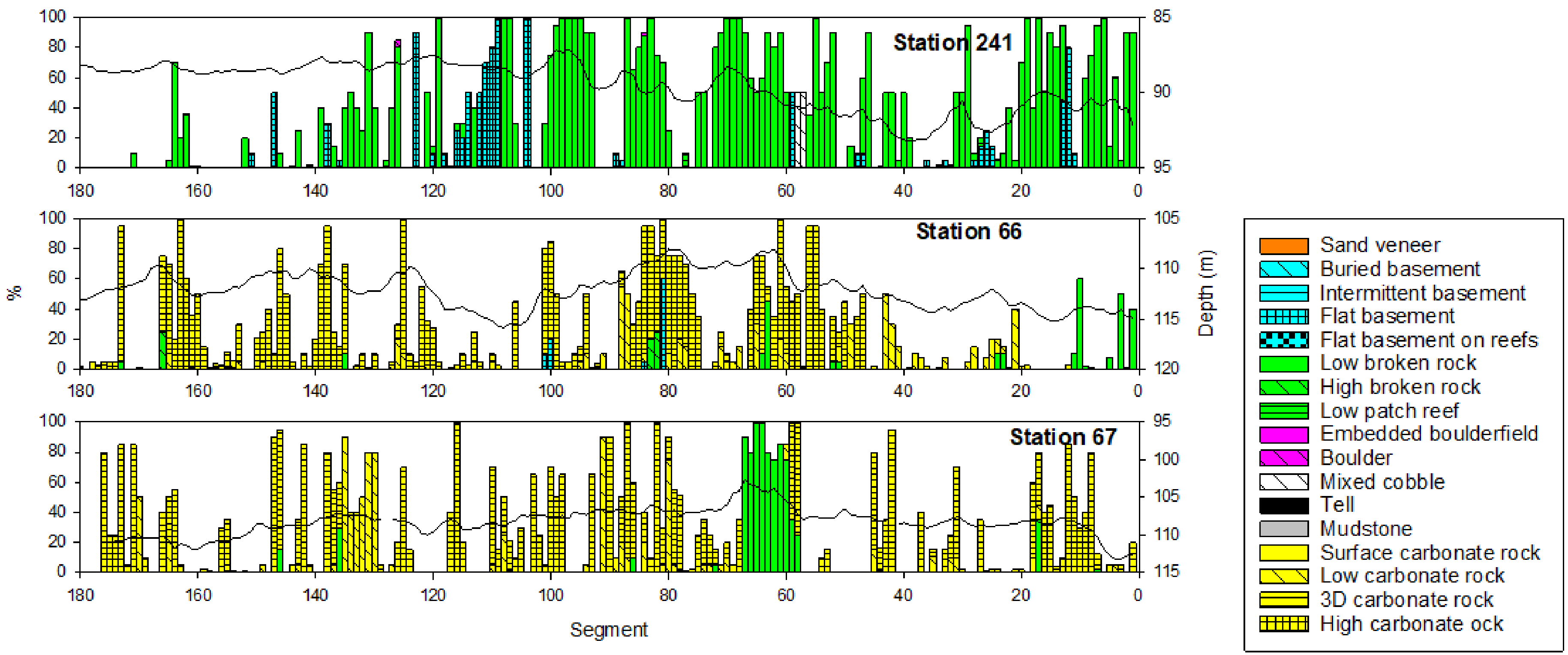

Figure 3-22: Along transect profiles (stations 241, 66, and 67) showing rock geomorphology class contributions by 20-second segment and associated bathymetry profile. Left axis) %contribution. Right axis) average depth for each segment. To maximise ease of interpretation, all segments are shown as equal width stacked bar plots, rather than the true distance travelled. Bathymetry profile is shown as a line plot. Table 2-1 provides a description of each of the classes. All transects are presented running south-to-north, west-to-east, regardless of vessels direction during collection.

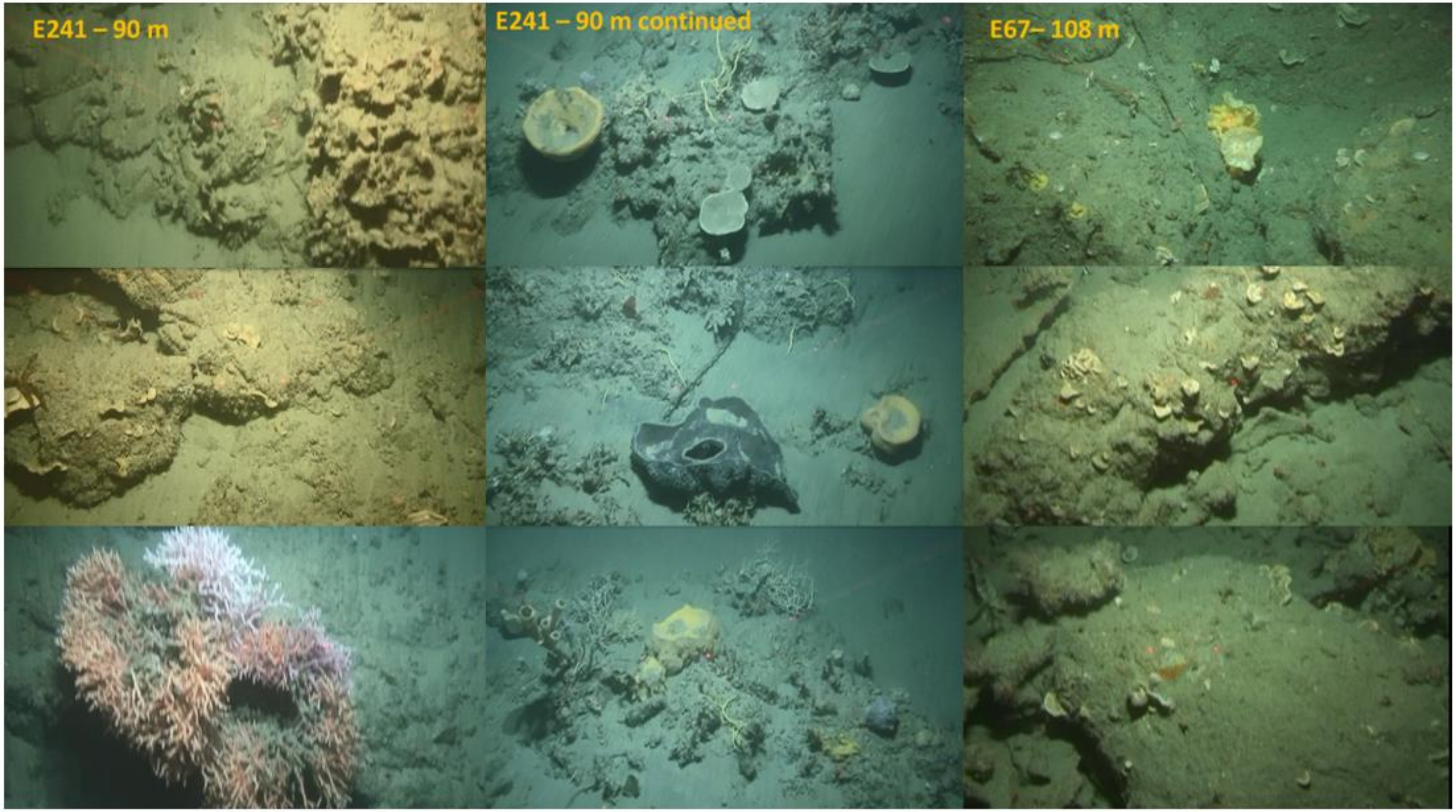

Figure 3-23: Box 3 seafloor imagery from stations 241 and 67.

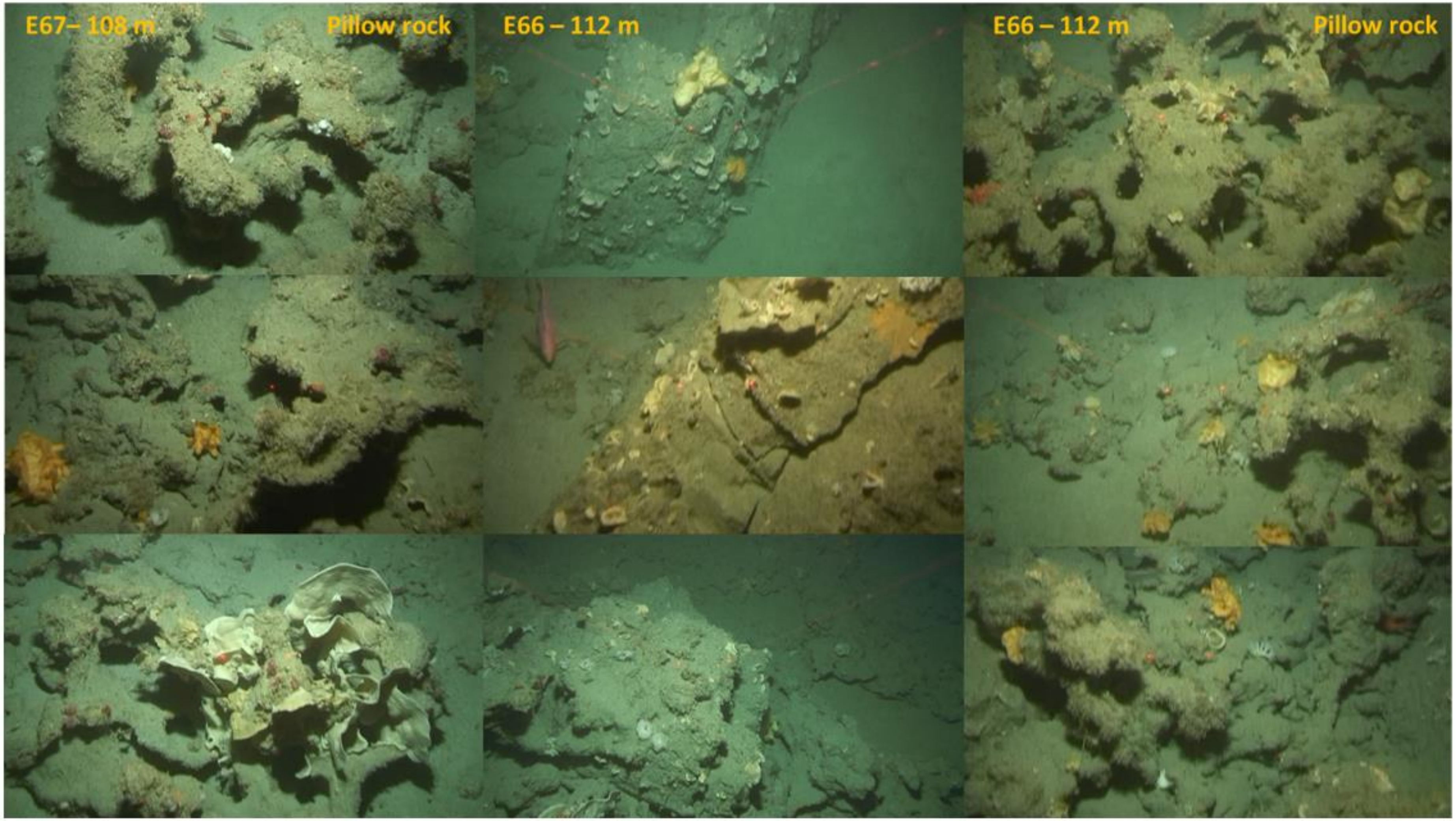

Figure 3-24: Box 3 seafloor imagery from stations 67 continued and 66.

Table 3-6: Box 3 abundance (inds./100 m^2) of key/charactering sessile invertebrates, mobile invertebrates, and fish. The top ten OTUs for each station are colour coded as a rank; densities for the other stations are provided for comparison. Values are estimated abundance per 100 m^2 of rock habitat. Average density and species richness are given for sponges, corals, all sessile invertebrates, mobile invertebrates and fish. Ca, carbonate rock. *, species also observed in soft sediment areas without rock.

		Station	**241**	**67**		**66**	
		Depth	90	108		112	
		Rock area (m^2)	762	223	581	106	640
Rankscale (top 10 OTU)	**Sessile invertebrates**						
	OTU	**Group**			Ca		Ca
	Sponge (Demospongiae)	Sponge	154.5	8.1	8.6	10.4	1.4
1	Bryozoan	Bryozoan	10.2	25.6	40.3	50.1	25.8
2	*Symplectella rowi*	Sponge	3.5	37.7	28.4	29.3	29.2
3	Flabellum	Coral	66.1	-	0.7	25.5	-
4	*Neoschrammeniella fulvodesmus*	Sponge	34.8	6.3	7.2	16.1	7.3
5	*Axinella australiensis*	Sponge	53.4	4.9	1.0	0.9	2.7
6	*Dendrilla rosea*	Sponge	34.0	-	-	-	-
7	Pennatulacea	Sea pen	5.4	-	-	-	25.5
8	Encrusting sponges	Sponge	20.6	0.9	3.3	-	-
9	Hydroid	Hydroid	12.1	0.9	0.9	6.6	3.0
10	*Callyspongia* sp.	Sponge	20.5	0.9	0.2	-	-
	Aciculites pulchra	Sponge	19.3	-	0.3	-	-
	Anemone	Anemone	9.2	2.2	6.3	0.6	0.9
	Desmophyllum/ Caryophyllia	Coral	6.4	-	1.9	5.7	0.6
	Sessile invertebrates	Group	Stn 241	Stn 67	Ca	Stn 66	Ca
	Calyx imperialis	Sponge	8.6	1.8	1	-	2.5
	Oculina virgosa	Coral	12.5	-		-	-
	Gorgonacea	Coral	0.8	2.2	1.0	3.8	0.3
	Stylasteridae	Coral	0.9	-		3.8	2.3

		Station	241	67		66	
	Jaspis n. sp. 1	Sponge	3.8	-	1.2	-	1.2
	Sponge (Hexactinellidae)	Sponge	0.5	2.2	2.9	-	-
	Ecionemia alata	Sponge	3.7	1.3	0.5	-	-
	Radicipes spp	Coral	-	0.9	-	2.8	0.5
	Antipatheria	Coral	0.1	-	-	-	1.4
	Sponge	Density (100 m^2)	408.9	65.9	56.6	61.4	45.1
		OTUs	39	12	17	7	11
	Coral	Density (100 m^2)	97.5	28.7	43.9	92.6	31.2
		OTUs	7	2	3	7	6
	All	Density (100 m^2)	534	98.9	111.9	164.2	105.7
		OTUs	53	20	24	22	21

Station	241	67		66	
Depth	90	108		112	
Area swept (m^2) – mobile invertebrates	762	223	581	106	640
Area swept (m^2) – fish	1471	746	1664	861	2126

Rankscale (top 10 OTU)
1
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Mobile invertebrates

OTU	Group	241	67	Ca	66	Ca
Echinoid	Urchin	-	-	-	-	8.5
Asterodiscides sp.	Starfish	0.4	0.2	-	0.3	2.8
Mollusc (gastropod)	Gastropod	0.9	-	0.4	0.2	1.9
Ophidiasteridae	Brittle star	0.3	0.5	1.3	0.3	0.9
Australostichopus mollis	Sea cucumber	-	-	-	-	2.8
Asteroid	Starfish	0.1	0.3	0.4	0.5	-
Ceriantharia spp.	Anemone	0.3		0.4	0.3	-
Henricia sp.	Starfish	-	-	-	-	0.9
Clypeasteroida*	Sand dollar	-	-	-	-	0.9
Luidia sp.*	Starfish	-	-	-	-	0.9
Buccinidae	Gastropod	-	-	-	-	0.9
Echinasteridae	Urchin	0.5	-	-	0.2	-
Goniasteridae	Starfish	0.1	-	-	-	-
Holothuria integra	Sea cucumber	0.1	-	-	-	-
Mobile invertebrates	Group	Stn 241	Stn 67	Ca	Stn 66	Ca
Turbinidae	Gastropod	0.1	-	-	-	-
Density (100 m^2)		2.9	1.0	2.7	1.7	20.8
OTUs		9	3	4	6	9
	-					

Fish

OTU	241	67	Ca	66	Ca
Silver conger eel*	-	3.8	-	-	7.1
Red bandfish*	-	7.5	-	-	4.6
Bony fish	1.1	1.9	3.4	2.8	2.9
Sea perch	2.4	1.5	1.2	1.2	0.5
Pink maomao	0.6	-	1.3	2.3	0.6
Butterfly perch	0.3	0.1	0.8	-	2.4
Eels*	-	2.6	-	-	<0.1
Scorpionfish	0.2	0.1	0.4	0.3	0.2
Slender roughy	0.7	-	-	0.1	0.3
Triglidae (gurnards)	-	1.0	-	-	-
Scaly gurnard*	-	-	-	0.1	0.7
Silverside	-	-	-		0.7
Northern bastard red cod	0.4	0.2	-	-	<0.1
Moridae*	-	-	0.5	0.1	-
Fish	Stn 241	Stn 67	Ca	Stn 66	Ca
Golden snapper	0.3	-	0.1	0.1	-
Cucumber fish*	-	0.5	0.1	-	-
Yellow weaver	0.1	0.2	-	0.1	-
Snipefish*	-	0.1	0.1	0.3	-
Snapper	-	-	-	0.4	-
Splendid perch	-	-	0.2	0.1	-
Worm eel	-	-	-	-	0.2

Station	241	67	66			Station	241	67	66		
						Rock cod	-	-	<0.1	0.1	-
						Density (100 m^2)	6.2	20.3	8.2	8.3	20.8
						OTUs	11	18	12	14	18

Box 4 – Mahinepua/Stephenson Island to Doubtless Bay

An extensive area of deep reef is present off Whangaroa Harbour (Figure 3-25). The BTM analysis classed most of this area as 'local ridges, boulders, pinnacles on broad flats'. Smaller areas of 'flat ridges' and 'slopes' were also present, along with limited areas of 'crevices, narrow gullies over elevated terrain'. A series of these features extend out from Motueka/Flat Island, with the BTM class 'depressions' also being present. As with other areas, these more diverse topographies were associated with the inshore 50 metre depth multibeam sonar survey boundary.

Stations 100 and 101

Stations 100 and 101 Two stations (65–80 metres depth) were located close together over an area classed by BTM as 'local ridges, boulders, pinnacles on broad flats', northwest of Mahinepua/Stephenson Island (Figure 3-25). These two stations had rock cover of 28–31%, dominated by intermittent buried basement (1–5%), flat basement (22–25%) and flat basement up reefs (5–8%) (Table 3-1). Occasional patch reef, low and high broken rock was also present (Figure 3-26). The rock type was visually different from other sites, with a spatial mixture of more angular rock, and rock that was 'bumpy', usually associated with coralline algal crusts (Figure 3-27). Large living rhodoliths were found as drifts off the reef (not shown), and it is possible that the bumpy nature of these reefs was in part due to calcareous algal growths. Of note, was the presence of a deep water green macroalgae, *Palmophyllum umbracola*, which was seen at several points along the station 101 transect. Most of the reefs were gently undulating low mounds around the 30 to 100 metres width, separated by soft sediment flats. Rock cover ranged up to 60 to 100% (Figure 3-27).

The rock surfaces were characterised by extensive covers of purple coralline algal crusts, and a filmy, orange encrusting sponge. Epifauna densities were relatively low and dominated by sponges (35–89/100m^2, richness 21–30), with the main contributors being upright (15–38/100m^2) and encrusting sponges (14–19/100m^2) (Table 3-7Table 3-6). Corals were rare (<1–2/100m^2, richness 2–3), and predominately primnoids. Overall faunal density was 41 to 98 individuals per 100m^2, richness 26–36. Mobile invertebrates were present in modest numbers (3–6/100m^2), with the main contributors being sea cucumbers (*Australostichopus mollis* 0–4/100m^2; *Holothuria integra* 0–2/100m^2), and the starfish *Henricia* sp. (0–1/100m^2). Fish density was 9–21/100m^2, richness 15, and the dominant taxa were pink maomao (5–15/100m^2), unidentified bony fish (<1–2/100m^2), silver conger eels (1–2/100m^2) and butterfly perch (<1–/100m^2).and upright sponges (64/100m^2) respectively.

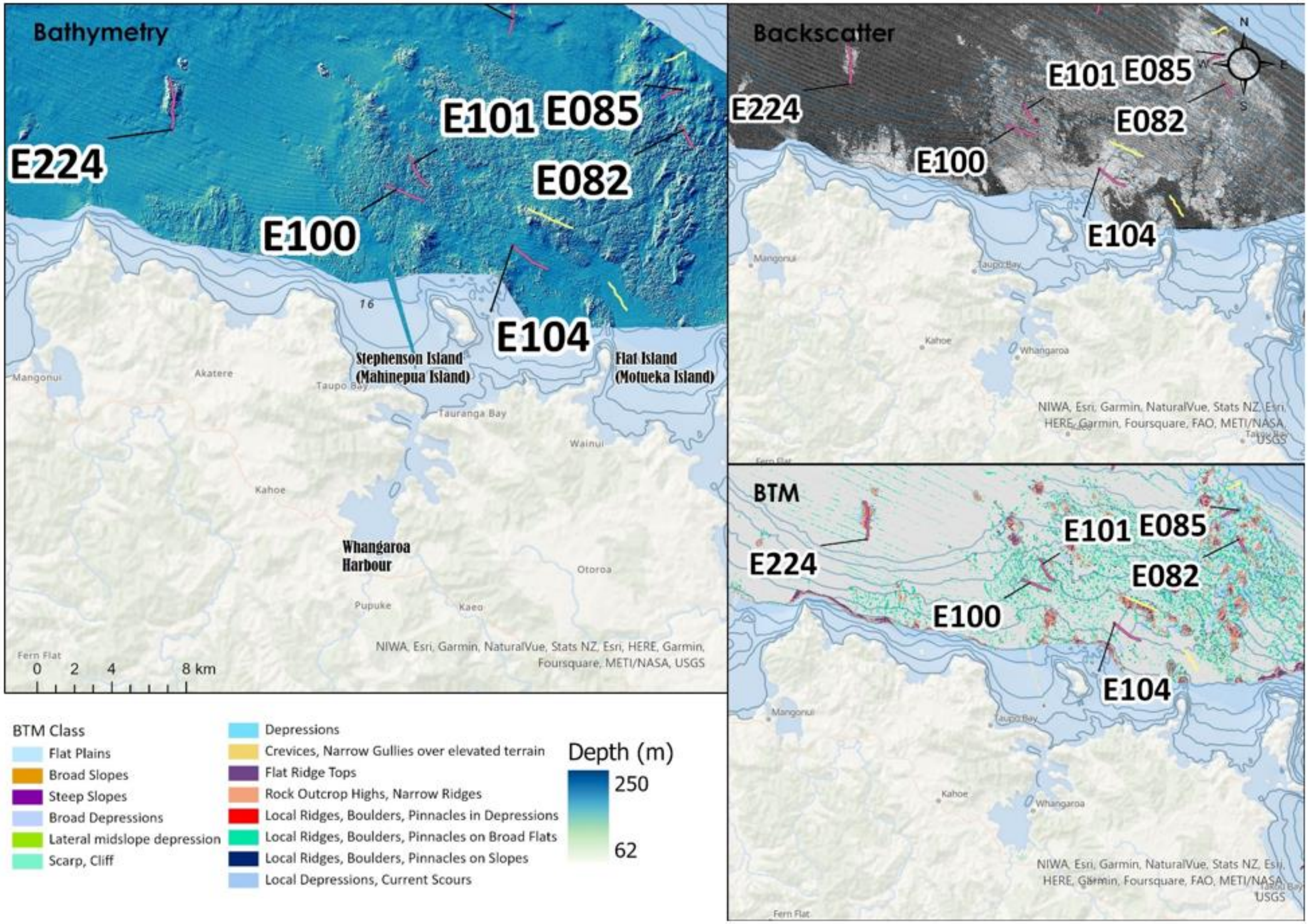

Figure 3-25: Box 4 bathymetry, backscatter, and BTM classification. Associated DTIS stations are 82, 85, 100, 101, 104, and 224.

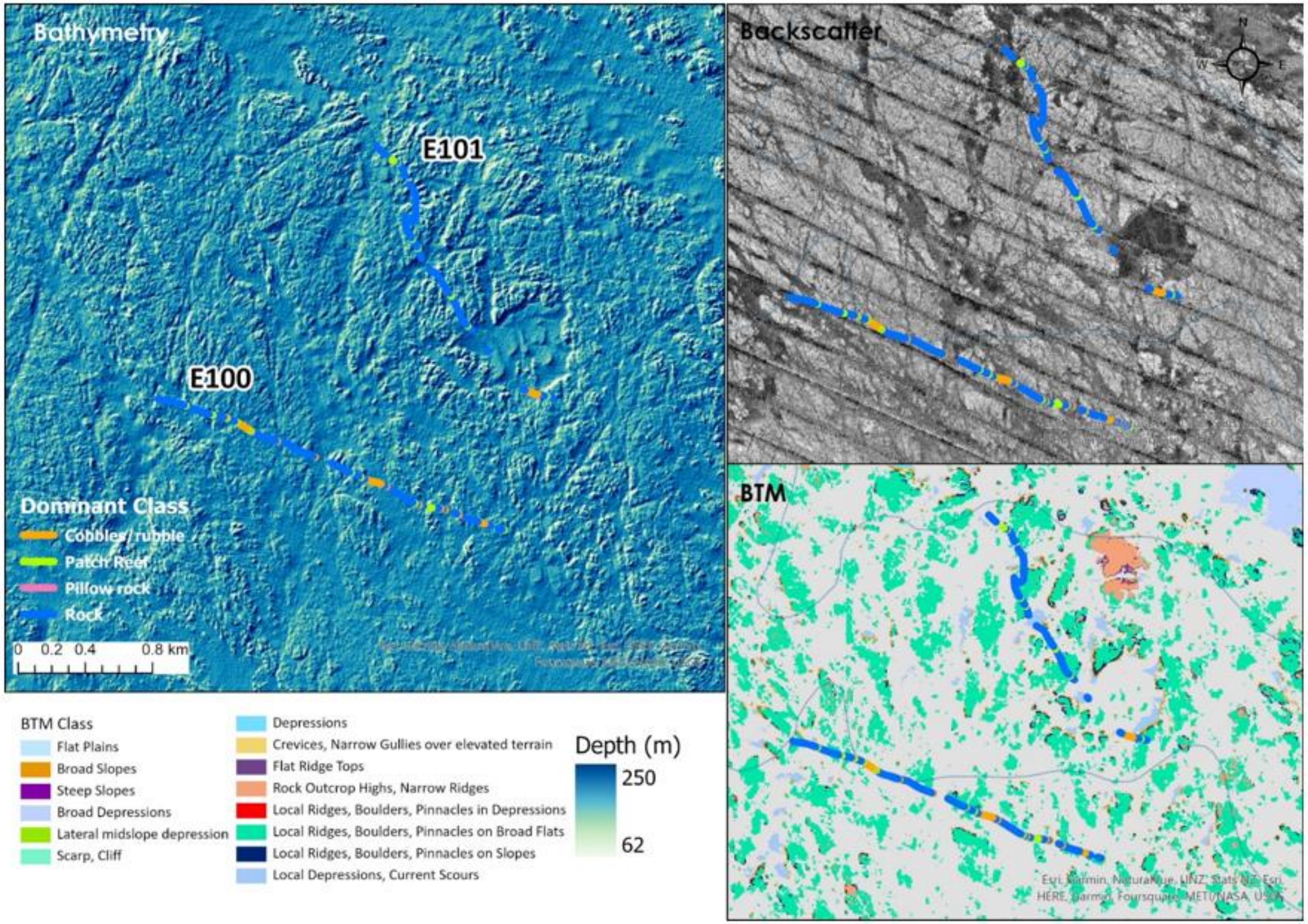

Figure 3-26: Finer scale map of Box 4 bathymetry, backscatter, and BTM classification. The associated DTIS stations are 100 and 101. The dominant rock type in each segment is plotted; hard rock is further split into rock, patch reef (inclusive of boulders and rock tells), and cobbles. Segments with no rock contribution are not plotted.

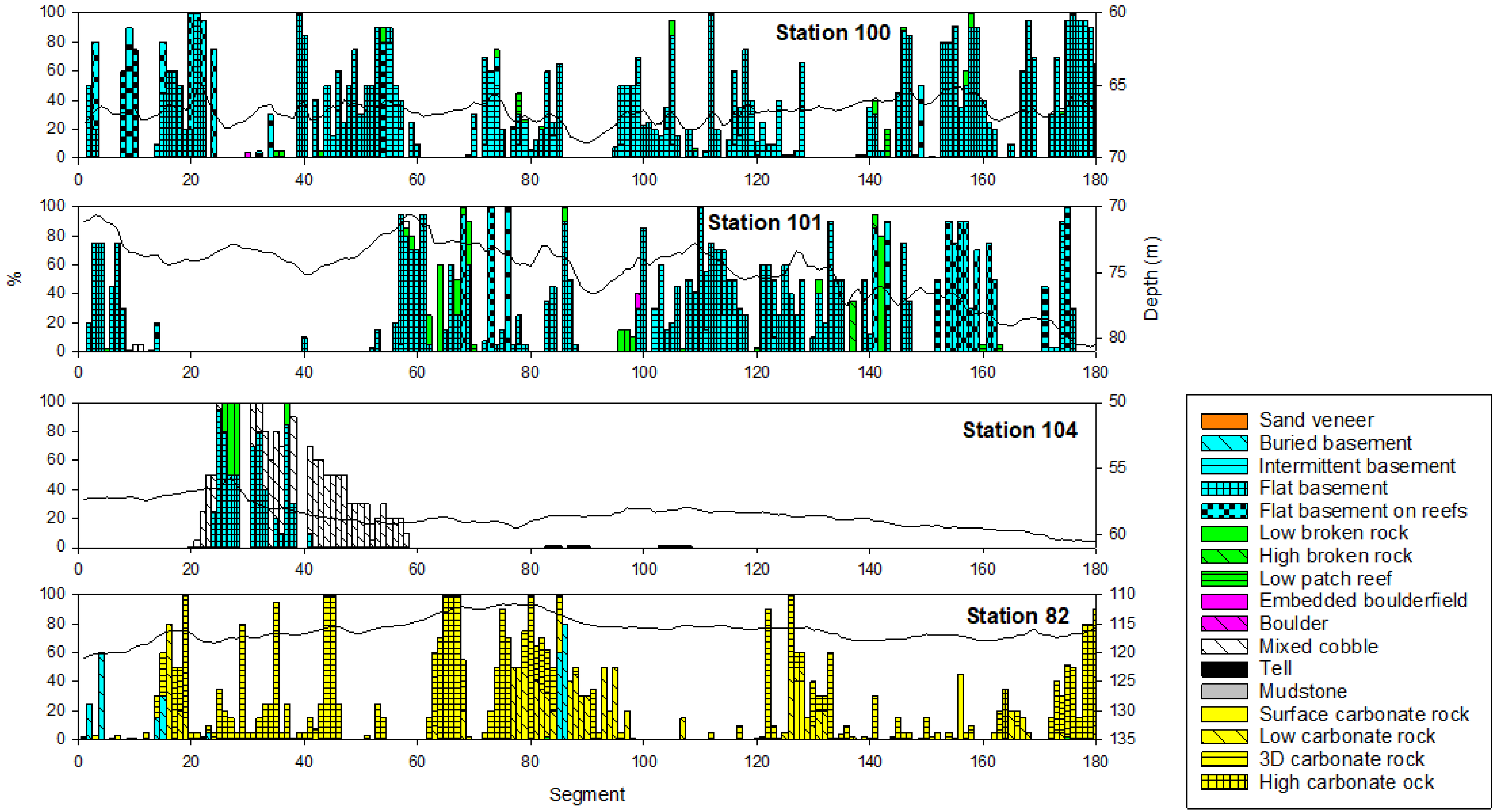

Figure 3-27: Along transect profiles (stations 100, 101, 104, 82) showing rock geomorphology class contributions by 20-second segment and associated bathymetry profile. Left) 5 contribution. Right) average depth for each segment. To maximise ease of interpretation presentation, all segments are shown as equal width stacked bar plots, rather than using distance travelled. Bathymetry is shown by a line plot.

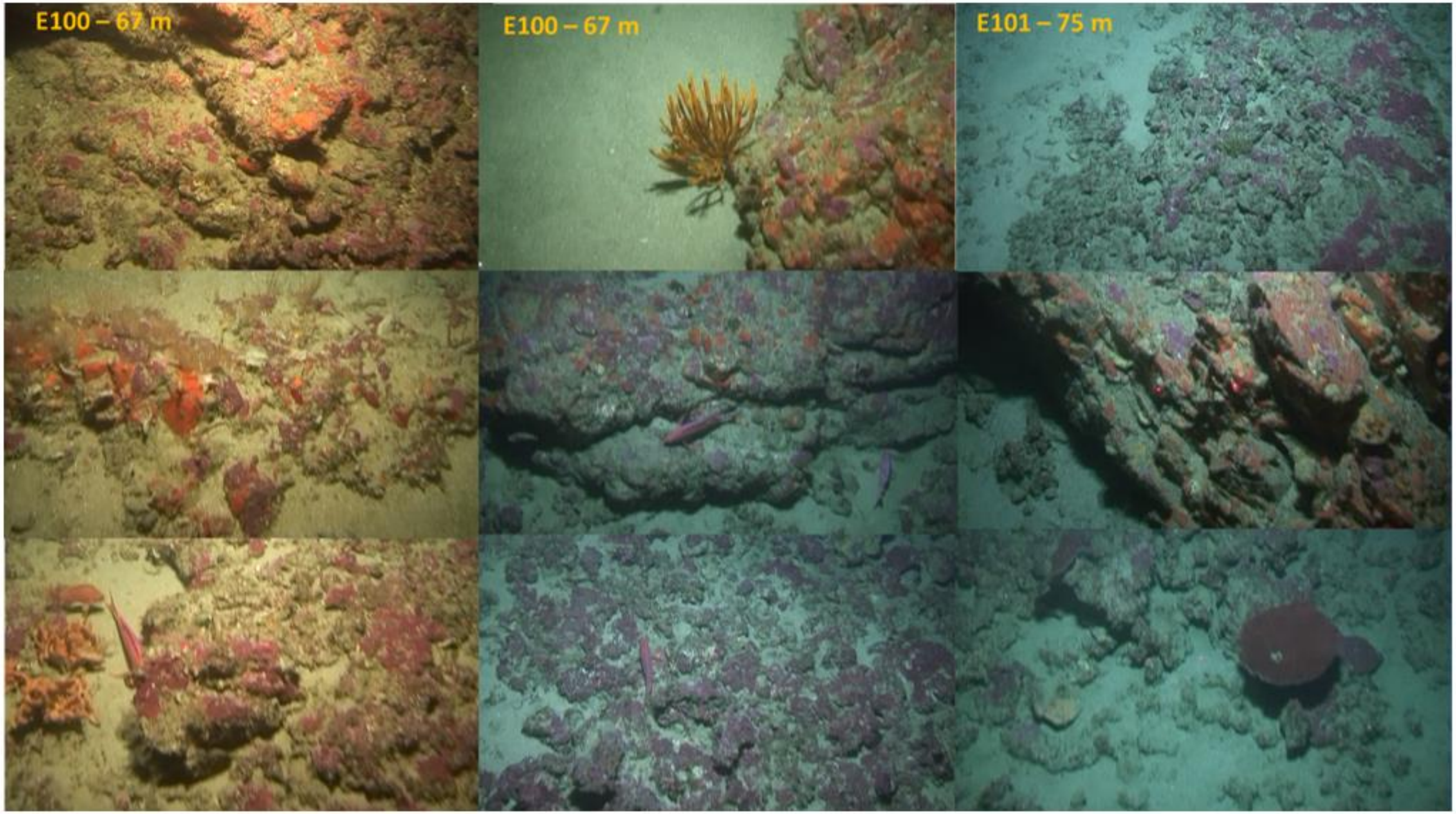

Figure 3-28: Box 4 seafloor imagery from stations 100 and 101.

Table 3-7: Box 4 abundance (inds./100 m^2) of key/charactering sessile invertebrates, mobile invertebrates, and fish. The top ten OTUs for each station are colour coded as a rank; densities for the other stations are provided for comparison. Values are estimated abundance per 100 m^2 of rock habitat. Average density and species richness are given for sponges, corals, all sessile invertebrates, mobile invertebrates and fish. Cob, cobbles; Ca, carbonate rock. *, species also observed in soft sediment areas without rock.

Station		104		100	101	224		82		85
Depth		58		67	75	103		116		134
Rock area (m^2)		306	167	1104	1028	748	49	23	467	495
Sessile invertebrates										
OTU	**Group**		Cob				Ca		Ca	
Sponge (Demospongiae)	Sponge	6.9	63.9	14.7	38.5	103.3	90.6	102.0	75.2	183.4
Bryozoan	Bryozoan	-	-	-	3.7	46.6	78.2	79.8	156.3	181.0
Symplectella rowi	Sponge	-	-	-	-	76.9	90.6	31.0	52.5	166.4
Axinella australiensis	Sponge	0.3	7.8	1.0	0.3	19.4	98.8	70.9	69.8	37.0
Hydroid	Bryozoan	-	1.2	1.9	5.4	24.1	49.4	70.9	59.7	52.5
Neoschrammeniella fulvodesmus	Sponge	-	-	-	0.4	67.4	70.0	-	27.8	85.8
Desmophyllum/ Caryophyllia	Coral	-	-	-	-	0.4	4.1	4.4	4.5	235.5
Stylasteridae	Coral	-	-	-	-	10.0	4.1	-	1.3	167.8
Poecilosclerida	Sponge	107.3	17.3	-	0.3	0.5		-	0.8	0.2
Encrusting sponges	Sponge	-	-	13.9	19.3	20.1	14.4	-	5.4	43.2
Calyx imperialis	Sponge	-	0.6	-	2.4	14.7	16.5	4.4	24.2	40.2
Callyspongia sp.	Sponge	-	-	-	3.3	5.2	4.1	31.0	36.8	18.8
Ecionemia alata	Sponge	25.2	0.6	0.2	2.3	2.3	4.1	4.4	5.3	3.4
Jaspis n. sp. 1	Sponge	-	-	-	0.6	0.1	2.1	8.9	6.2	27.1
Suberites sp.	Sponge	-	1.2	0.1	0.2	0.5	2.1	31.0	3.4	0.2
Aciculites pulchra	Sponge	-	-	-	-	20.1	8.2	-	1	6.9
Iophon laevistylus	Sponge	7.5	6.6	0.9	-	2.7	4.1	4.4	6.2	1.6
Axinellidae	Sponge	-	3.6	0.2	0.9	0.7		17.7	2.8	7.9
Iophon minor	Sponge	2.9	2.4	1.4	0.2	1.1		8.9	9.4	0.2

Ranking scale (top 10 OTU)
1.0
2.0
3.0
4.0
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7.0
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10.0

Station		104		100	101	224		82		85
Axinella spp.	Sponge	-	-	-	-	4.8	12.4	-	0.6	-
Leucettusa sp.	Sponge	0.7	0.6	-	14.4	0.3	-	-	-	0.2
Ascidians (solitary)	Ascidian	-	-	1.4	0.2	0.8	-	4.4	1.1	6.5
Anemone	Anemone	-	0.1	-	6.0	-	-	3.8	4	
Ascidians (clonal)	Ascidian	0.3	2.4	-	0.1	-	-	8.7	0.4	0.2
Pennatulacea	Sea pen	-	-	-	-	7.9	-	-	0.21	2.2
Petrosia hebes	Sponge	2.0	-	-	-	0.1	-	-	-	-
Primnoella spp.	Coral	-	-	1.0	0.1	0.9	-	-	-	-
Raspailia flaccida?	Sponge	-	1.8	-	-	-	-	-	0.2	-
Crella incrustans?	Sponge	0.7	0.6	0.2	0.1	0.3	-	-	-	-
Haliclona (*Gellius*) *petrocalyx*	Sponge	-	-	0.2	1.3	0.1	-	-	-	-
Primnoidae	Coral	-	-	1.0	-	0.4	-	-	-	-
Mycalidae	Sponge	-	-		1.0	-	-	-	-	0.2
Polymastia sp.	Sponge	-	-	0.8	-	-	-	-	-	-
Sponge	Density (100 m^2)	155.0	108.1	35.2	88.8	356.2	428.3	345.9	341.3	680.6
	OTUs	14	14	21	30	35	17	17	33	32
Coral	Density (100 m^2)	0	0	2.3	0.3	22.6	10.3	4.4	12	421.9
	OTUs	0	0	3	2	12	3	1	4	11
All	Density (100 m^2)	155.3	111.8	40.8	104.5	462.6	566.3	518.2	575.1	1344.9
	OTUs	15	17	26	37	51	21	23	42	47

Ranking scale (top 10 OTU)
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Mobile invertebrates

OTU	Group	104	Cob	100	101	224	Ca	82	Ca	85
Depth		58		67	75	103		116		134
Argyrometra sp.	Feather star	-	-	-	-	290.4	-	-	-	-
*Astropecten polyacanthus**	Starfish	-	-	-	-	7.9	-	-	-	0.2
Holothuria integra	Sea cucumber	-	-	-	1.6	5.8	12.4	-	1.1	0.6
Eplumula australiensis	Crab	-	-	-	-	2.0	-	-	-	-
Asterodiscides sp.	Starfish	-	0.6	0.4	0.3	1.7	6.2	-	0.9	0.2
Asteroid	Starfish	-	-	-	0.1	1.6	-	-	-	-
Clypeasteroida*	Sand dollar	-	-	-	-	0.9	-	-	-	-
Echinasteridae	Starfish	-	-	-	0.9	0.5	2.1	13.3	0.9	0.8
Ophidiasteridae	Brittle star	-	-	0.3	0.2	0.4	2.1	-	0.9	1.2
Astropectinidae	Starfish	-	-	-	-	0.1	-	-	-	-
Australostichopus mollis	Sea cucumber	-	-	3.9	-	0.4	-	-	-	0.2
Mollusc (gastropod)	Gastropod	-	-	0.1	-	0.1	-	-	-	-
Luidia sp.*	Starfish	-	-	-	0.1	-	-	-	0.2	-
Henricia sp.	Starfish	-	-	1.2	-	-	-	-	-	-
Echinoid	Urchin	-	-	-	-	-	-	-	0.4	0.2
Buccinidae	Gastropod	-	-	-	-	-	-	-	0.4	0.2
Turbinellidae	Gastropod	-	-	-	-	-	-	-		0.2
Ceriantharia spp.	Anemone	-	-	-	-	-	-	-	0.2	
	Density (100 m^2)	0	0.6	5.8	3.1	312.2	22.6	13.3	5.1	4.9
	OTUs	0	1	5	6	12	4	1	9	9

Station	104		100	101	224		82		85
Depth	58		67	75	103		116		134
Area swept (m^2)	345	501	2544	2244	2381	259	293	1555	2335
Fish									
OTU	HR	Cob	HR	HR	HR	CR	HR	CR	HR
Pink maomao	2.9	0.6	14.9	5.5	4.6	5.0	1.0	3.3	2.3
Bony fish	1.2	1.0	2.4	0.4	5.9	-	1.7	1.1	1.9
Sea perch	-	0.2	0.1	0.2	0.9	-	0.7	1.1	2.1
Silver conger eel*	-	0.4	1.6	0.8	-	-	-	0.4	0.2
Butterfly perch	-	-	0.7	0.4	1.0	-	-	0.5	0.5
Red bandfish*	-	-	-	-	2.8	-	-	0.3	-
Trevally	-	-	-	-	-	-	1.7	0.3	0.3
Moridae*	-	-	-	0.4	0.2	0.4	-	0.2	0.9
Slender roughy	-	-	0.3	0.9	0.4	-	-	0.3	<0.1
Jack mackerel sp.*	-	-	<0.1	<0.1	-	-	1.0	0.5	0.3
Scorpionfish	-	-	-	<0.1	0.3	-	-	0.6	0.2
Common roughy	-	-	-		0.2	0.4	-	-	0.1
Leatherjacket	-	-	0.4	<0.1	<0.1	-	-	0.1	-
Snipefish*	-	-	-	-	0.1	0.4	-	-	-
Rough skate*	-	-	-	-	-	0.4	-	-	-
Flatfish*	-	-	-	-	<0.1	-	0.3	-	-
Cucumber fish*	-	-	-	<0.1	0.2	-	-	-	0.1
Red cod	0.3	-	-	-	-	-	-	-	-
Splendid perch	-	-	0.2	-	-	-	-	-	-
Red mullet	-	-	0.2	<0.1	-	-	-	-	-
Snake eel*	-	-	0.1	-	<0.1	-	-	-	-
Density (100 m^2)	4.3	2.2	21.1	8.9	17.0	6.6	6.5	9.5	9.3
OTUs	3	4	15	15	20	5	6	20	20

Ranking scale (top 10 OTU)
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Station 104

Station 104 was north-east of Mahinepua/Stephenson Island in 58 metres depth (Figure 3-29). Rock cover was 17%, composed of mixed irregular cobbles (8%), flat basement (6%), and low broken rock (1%) (Table 3-1). Collectively, these comprised a single reef structure, with a hard rock centre around 150 metres in width, bounded on each side by mixed cobble fields, which graded into soft sediment flats (Figure 3-27).

The rock surfaces were characterised by soft sediment and fine biogenic species cover, along with widespread patches of purple coralline algal crust (Figure 3-30). The cobble field/s were partially embedded in fine sediment. Almost all epifauna on both the hard rock and the cobble field/s were sponges: 155/100m^2, richness 14; and 108/100m^2, richness 14 respectively (Table 3-7). The main taxa were Poecilosclerida (107/100m^2).

No corals were observed. Mobile invertebrates were restricted to the cobbles only, with the presence of the starfish *Asterodiscides* sp. at <1/100 m^2 (one individual). Fish density ranged from 2.2/100m^2, richness 4, to 4.3/100m^2, richness 3 (hard rock); with the main taxa being pink maomao (1–2/100m^2), and unidentified bony fish (1/100m^2).

Stations 82 and 85

Two stations were well offshore from Motueka/Flat Island on the more topographically diverse area in 116–134 metres depth (Figure 3-31). Station 82 traversed a BTM mixed feature of 'flat ridge tops' and 'broad slopes' in the middle of it's transect, surrounded by 'flat plains'. Rock cover was dominated by carbonate rock (15%), with a small amount of hard rock (1%) (Table 3). The carbonate rock was arranged as several discrete reef areas, with reef widths in the multiple tens of metres range and composed of 3D and/or low carbonate rock (Figure 3-27, Figure 3-32, Figure 3-33, Figure 3-34). Rock cover often reached 100% in the central area of these reefs. The largest reef extent was present in the central area of the transect, spanning around 300 metres, coincident with the BTM mixed feature composed of 'flat ridge tops/broad slopes' (Figure 3-31). This feature was a broad five-metre-high mound, although the carbonate rock itself extended to only about 30 cm in height (Figure 3-33).

The carbonate rock was dominated by sponges (341/100m^2, richness 33), with the main taxa being upright sponges (75/100m^2), the finger sponge *Axinella australiensis* (70/100m^2), and the glass sponge *S. rowe* (52/100m^2) (Table 3-7). Corals were rare (12/100m^2), with the most common OTU being *Desmophyllum*/*Caryophyllia* cup corals (4/100m^2). Overall, OTU density was 571/100m^2, richness 41, with important contributions from bryozoans (156/100m^2) and hydroids (60/100m^2). Mobile invertebrates were present at 3 individuals per 100 m^2, with the dominant taxa being the sea cucumber *Holothuria integra* (1/100m^2), the starfish *Asterodiscides* sp (1/100m^2), ophidiasterid brittle stars and echinasterid urchins (both 1/100m^2). Fish were present at 9/100m^2, richness 20, dominant species were pink maomao (3/100m^2), unidentified bony fish and sea perch (both 1/100m^2).

Hard rock (23 m^2) was also dominated by sponges (346/100m^2, richness 17), with the main OTU being upright sponges (102/100m^2), the finger sponge *Axinella australiensis* (71/100m^2), and the glass sponge *S. rowe* (31/100m^2) (Table 3-7). This dominance matched that seen on the adjacent carbonate reefs. Coral was rare (4/100m^2, richness 1), with a single record of one *Desmophyllum*/*Caryophyllia* cup coral. Mobile invertebrates were limited to three echinasterid urchins (13/100 m^2). Fish density was 6/100m^2, richness 6, with the main taxa being unidentified bony fish and trevally (both 2/100m^2), and pink maomao and jack mackerel (*Trachurus* sp.) (both 1/100m^2).

Station 85 was located on the BTM class of 'local ridges, boulders, pinnacles on broad flats', and 'flat plains' (Figure 3-31) and held 21% rock cover (all hard rock), with contributions from low broken rock (10%), low patch reef (9%), and boulders (2%) (Table 3-1). Most of the low broken rock was present as two areas of reef on the western side of the transect, from 50 to 100 metres wide, with rock cover of up to 60–100% (Figure 3-32). Smaller areas were also present on the western and eastern ends of the transect. The central transect area was occupied by patch reefs and lesser contributions of boulders, which spanned around 700 metres of seafloor, and reached cover of more than 70% in some segments.

The hard rock surfaces were characterised by fine biogenic fuzz cover and sediment (Figure 3-33, Figure 3-34). Sponge densities were high (681/100m^2, richness 32) (Table 3-7). The main contributors were unidentified upright sponges (183/100m^2), the glass sponge *S. rowe* (166/100m^2), *N. fulvodesmus* (86/100m^2), encrusting sponges (43/100m^2), *Calyx imperialis* (40/100m^2), and *Jaspis* n. sp. 1 (27/100m^2). Corals were also abundant (422/100m^2, richness 11), with the main contributors being *Desmophyllum*/*Caryophyllia* cup corals (235/100m^2), and Stylasteridae (168/100m^2). Bryozoans (181/100m^2) and hydroids (52/100m^2) were also common. Mobile invertebrates were present at 9 individuals per 100m^2, richness 10, with the main contributors being ophidiasterid brittle stars, echinasterid urchins and the sea cucumber *Holothuria integra* (all 1/100m^2). Fish density was 9/100m^2, with the dominant contributors being pink maomao, unidentified bony fish, and sea perch (all 2/100m^2) and morid cods(1/100m^2).

Station 224

One station (224) was on a discrete reef feature on the western side of Box 4, in 103 metres depth. The BTM class here was a mixed feature of 'flat ridge tops' and 'broad slopes', surrounded by depressions on the west and east sides, and sitting in a wider flat plain (Figure 3-35). Rock covered 20% of the transect, composed of both hard (18%) and carbonate (2%) rock contributing (Table 3-1, Figure 3-32, Figure 3-34). These rock types were arranged as a complicated mosaic (Figure 3-32).

The more extensive hard rock was dominated by sponges (356/100m^2, richness 35), with the main contributors being unidentified upright sponges (103/100m^2), the glass sponge *S. rowe* (77/100m^2), and the fan sponge *N. fulvodesmus* (67/100m^2) (Table 3-7). Corals were uncommon (23/100m^2, richness 12), and dominated by Stylasteridae (10/100m^2). Mobile invertebrate densities were very high at 318/100m^2 but this was driven by high densities of soft-sediment feather stars *Argyrometra* sp., which contributed 290 individuals per 100m^2. Less dominant species included the starfish *Astropecten polyacanthus* (8/100m^2), also a soft sediment species, anemones (6/100m^2), and the sea cucumber *H. integra* (6/100m^2). Fish density was 17/100m^2, richness 20, dominated by unidentified bony fish (6/100m^2), pink maomao (5/100m^2), red bandfish (3/100m^2) and butterfly perch (1/100m^2).

Carbonate rock (49 m^2) was also dominated by sponges (428/100m^2, richness 17), with the main contributors being the finger sponge *Axinella australiensis* (99/100m^2), unidentified upright sponges (91/100m^2), the glass sponge *S. rowe* (91/100m^2), and *N. fulvodesmus* (70/100m^2). Mobile invertebrates were present at 23/100m^2, richness 4, taxa being the sea cucumber *H. integra* (12/100m^2), the starfish *Asterodiscides* sp. (6/100m^2), and ophidiasterid brittle stars and echinasterid urchins (both 2/100m^2). Fish were present at 7/100m^2, richness 5, the most abundant species being pink maomao (5/100m^2).

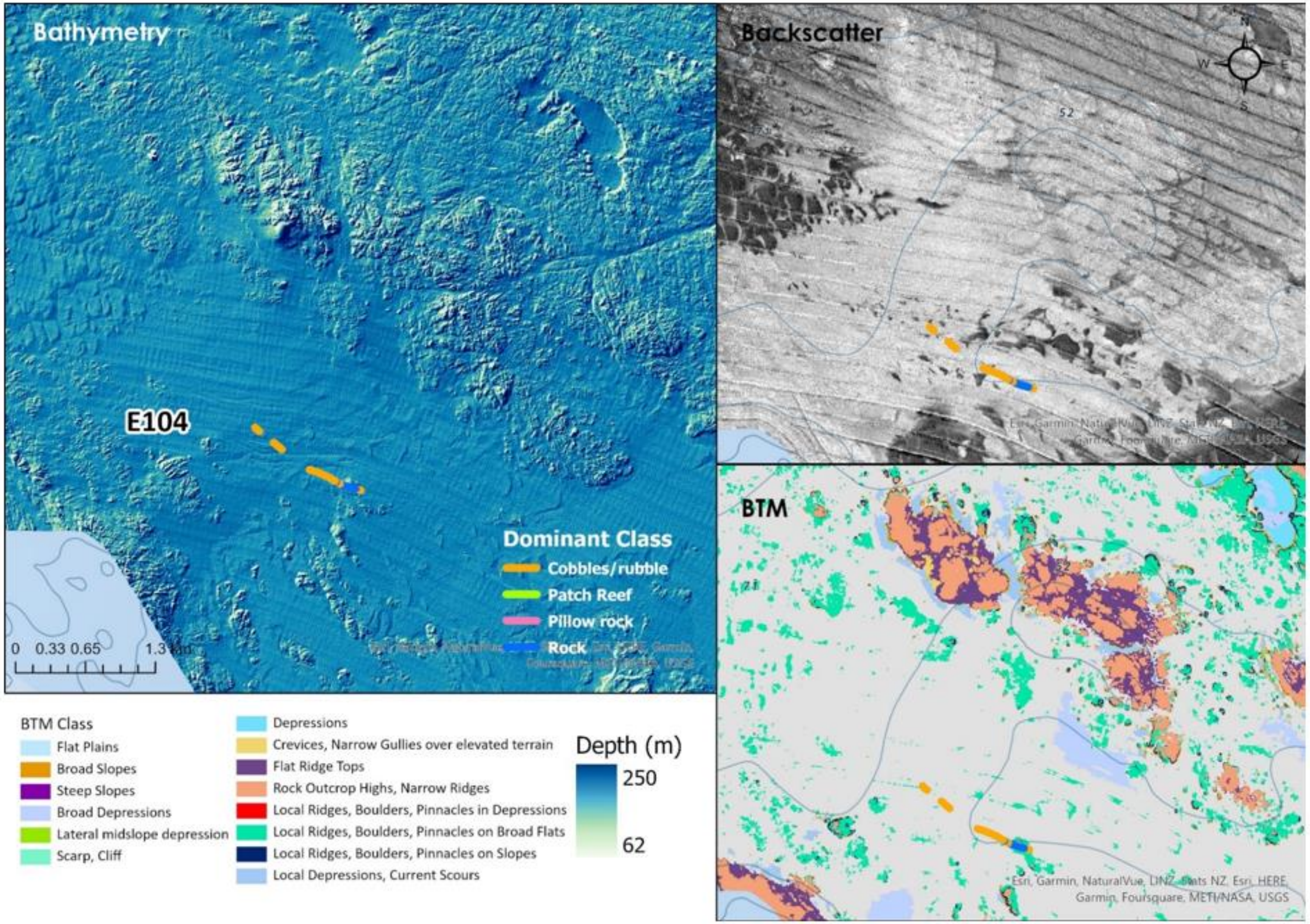

Figure 3-29: Finer scale map of Box 4 bathymetry, backscatter, and BTM classification. The associated DTIS stations are 104. The dominant rock type in each segment is plotted; hard rock is further split into rock, patch reef (inclusive of boulders and rock tells), and cobbles. Segments with no rock contribution are not plotted.

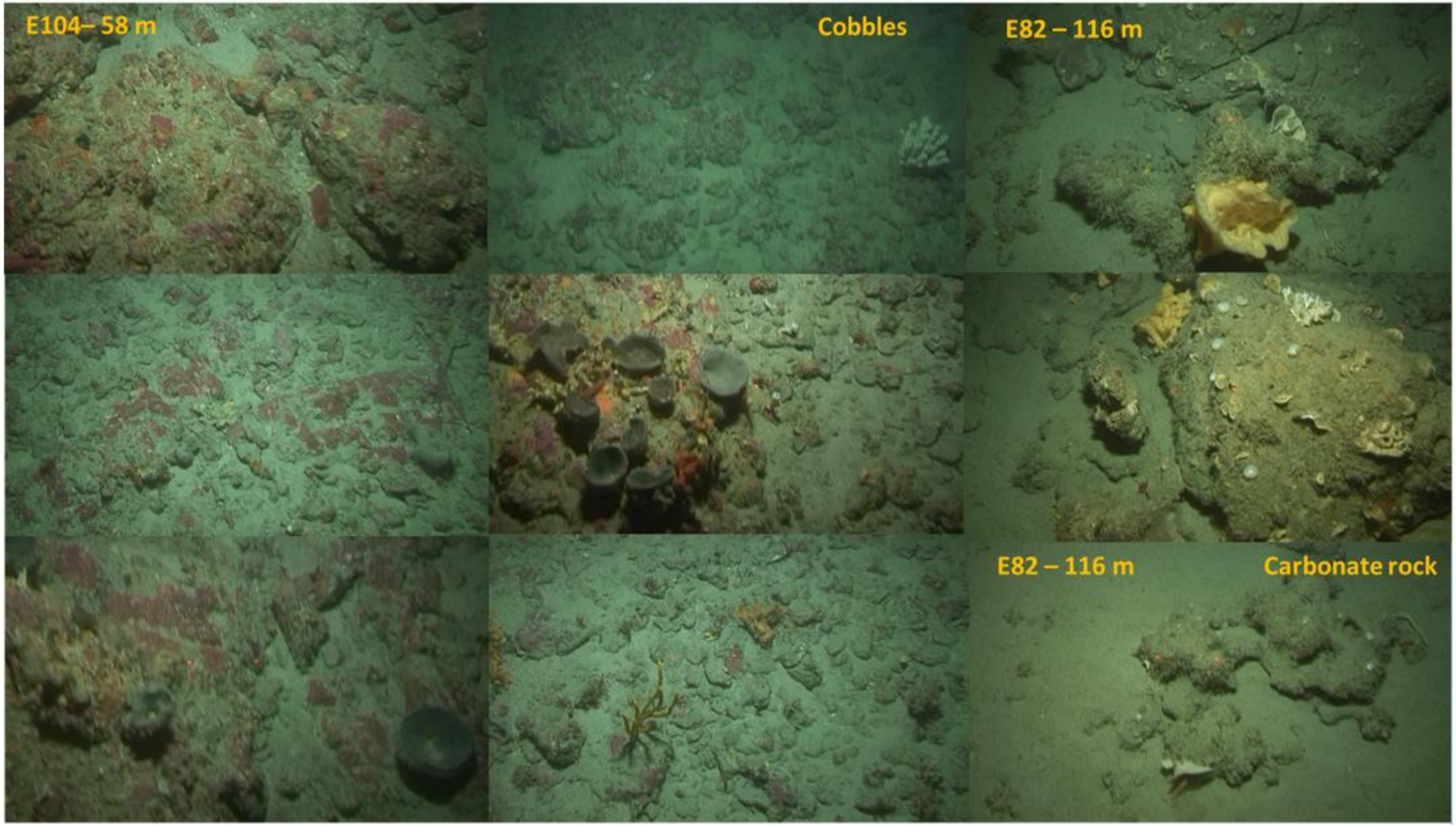

Figure 3-30: Box 4 seafloor imagery from stations 104 and 82.

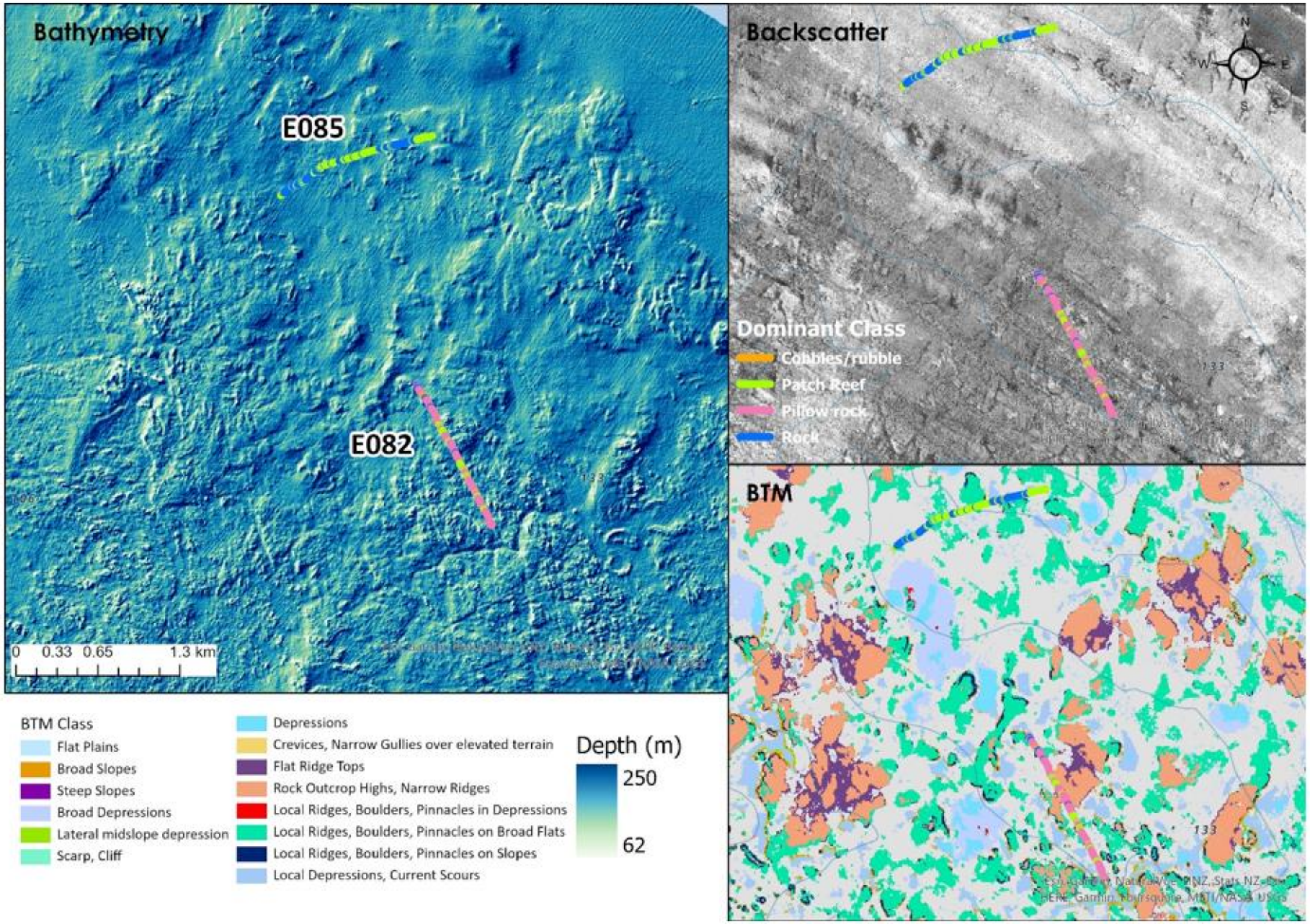

Figure 3-31: Finer scale map of Map 4 bathymetry, backscatter, and BTM classification. The associated DTIS stations are 82 and 85. The dominant rock type in each segment is plotted; hard rock is further split into rock, patch reef (inclusive of boulders and rock tells), and cobbles. Segments with no rock contribution are not plotted.

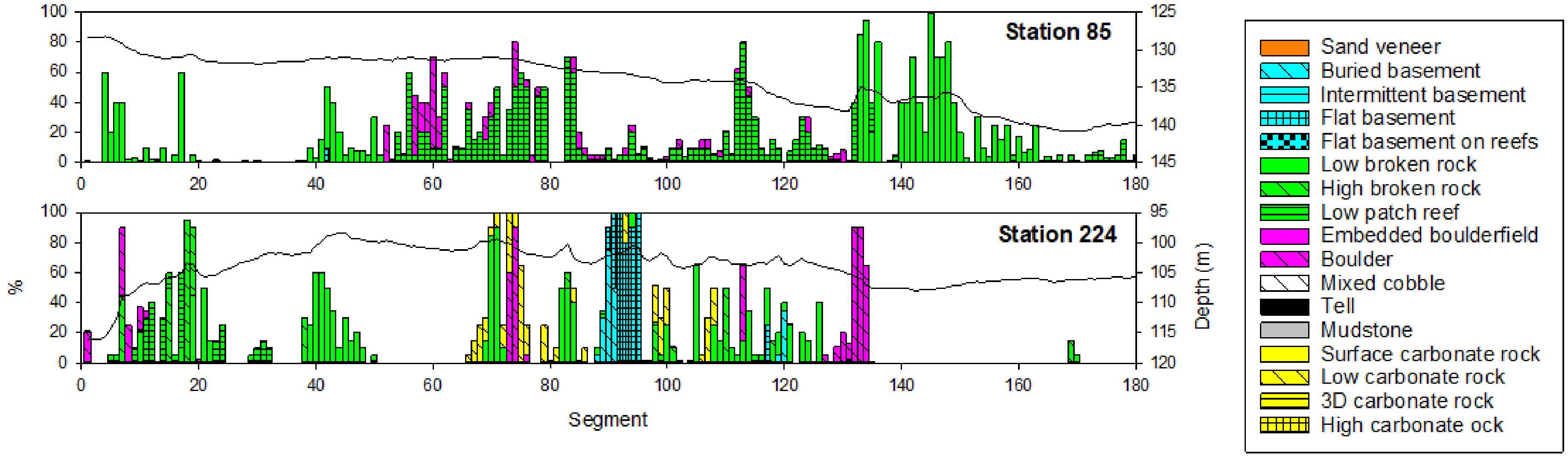

Figure 3-32: Along transect profiles (stations 85 and 224) showing rock geomorphology class contributions by 20-second segment an associated bathymetry profile. Left) % contribution. Right) average depth for each segment. To maximise ease of interpretation presentation, all segments are shown as equal width stacked bar plots, rather than using distance travelled. Bathymetry is shown by a line plot.

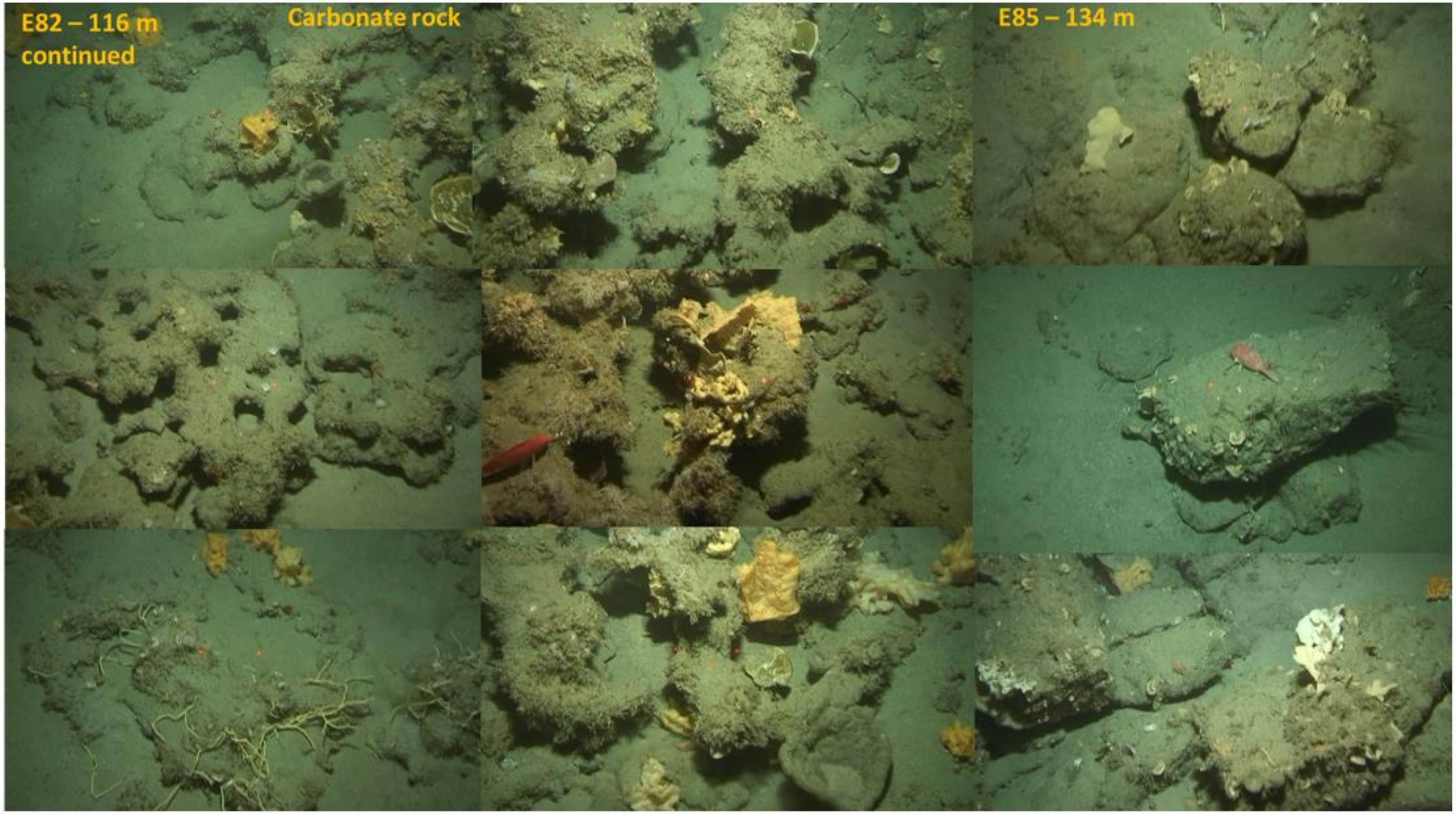

Figure 3-33: Box 4 seafloor imagery from station 82 continued, and 85.

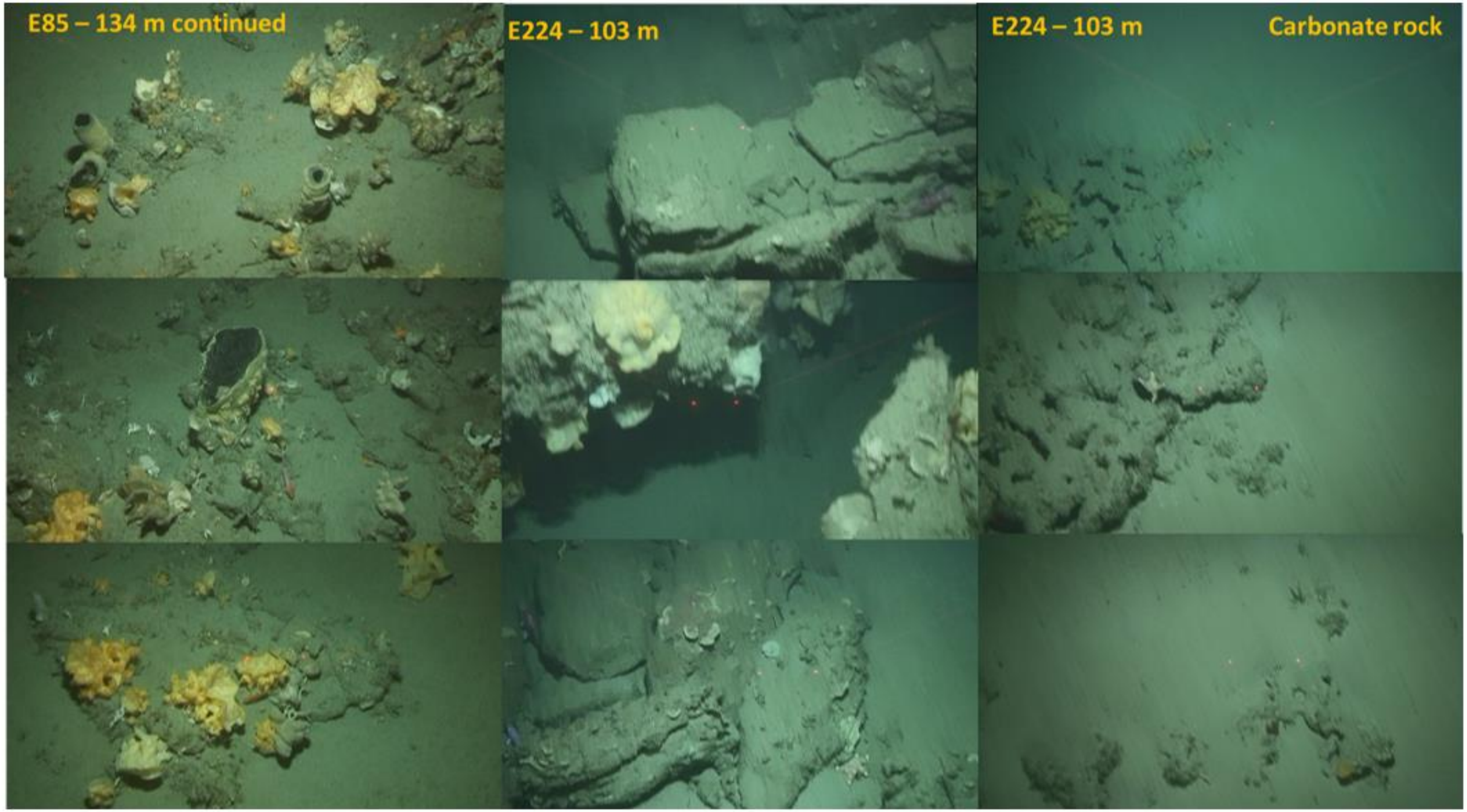

Figure 3-34: Box 4 seafloor imagery from station 85 continued, and 224.

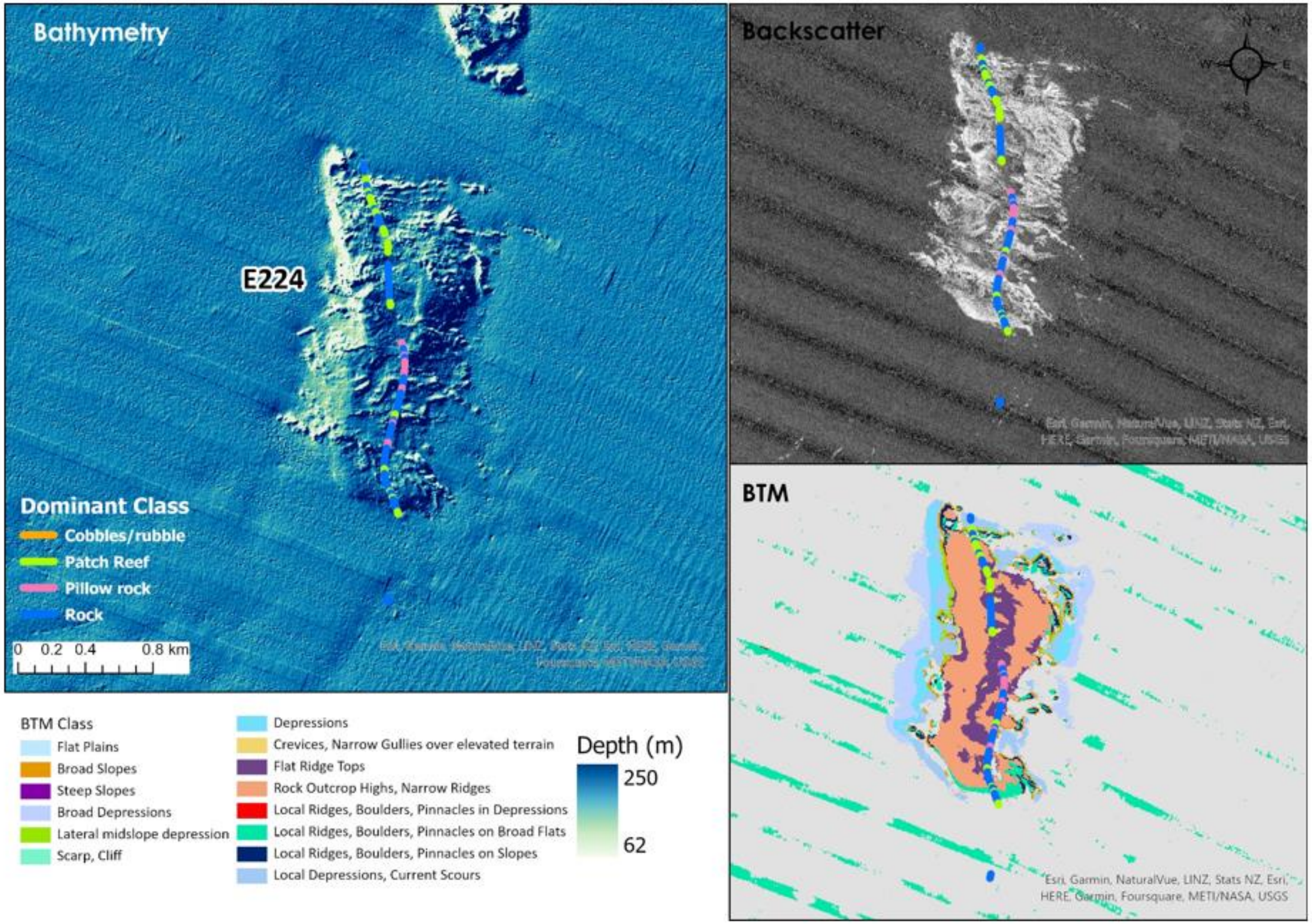

Figure 3-35: Box 4 finer scale map of bathymetry, backscatter, and BTM classification. The associated DTIS stations is 221. The dominant rock type in each segment is plotted; hard rock is further split into rock, patch reef (inclusive of boulders and rock tells), and cobbles. Segments with no rock contribution are not plotted.

Box 5 – offshore of Whangaroa Harbour

A single station (221) was located on an area of high backscatter (harder seafloor) well off Whangaroa Harbour (Figure 3-36). Rock cover was low at 125 m^2 (3% of the transect) (Table 3-1). The BTM analysis identified two features, the first classed as 'rock outcrop highs, narrow ridges' and the second as 'local ridges, boulders, pinnacles on broad flats', with 'flat plains' surrounding (Figure 3-36).

Station 221

Only carbonate rock was present at station 221 (Figure 3-37, Figure 3-38). Epifauna densities were relatively low and dominated by sponges (61/100m^2, richness 4), with the main taxa being unidentified upright sponges (35/100m^2), *Callyspongia* sp. (13/100m^2), and the glass sponge *S. lowe* (10/100m^2) (Table 3-8). Corals were uncommon (20/100m^2) and only represented by *Desmophyllum*/*Caryophyllia* cup corals. Hydroids and bryozoans contributed 20 and 10 individuals per 100 m^2 respectively, with an overall epifauna density of 114/100m^2 (richness 8). Mobile invertebrates were not seen. Fish density was 4/100m^2, with 3 OTUs, the most abundant being unidentified bony fish (3/100m^2).

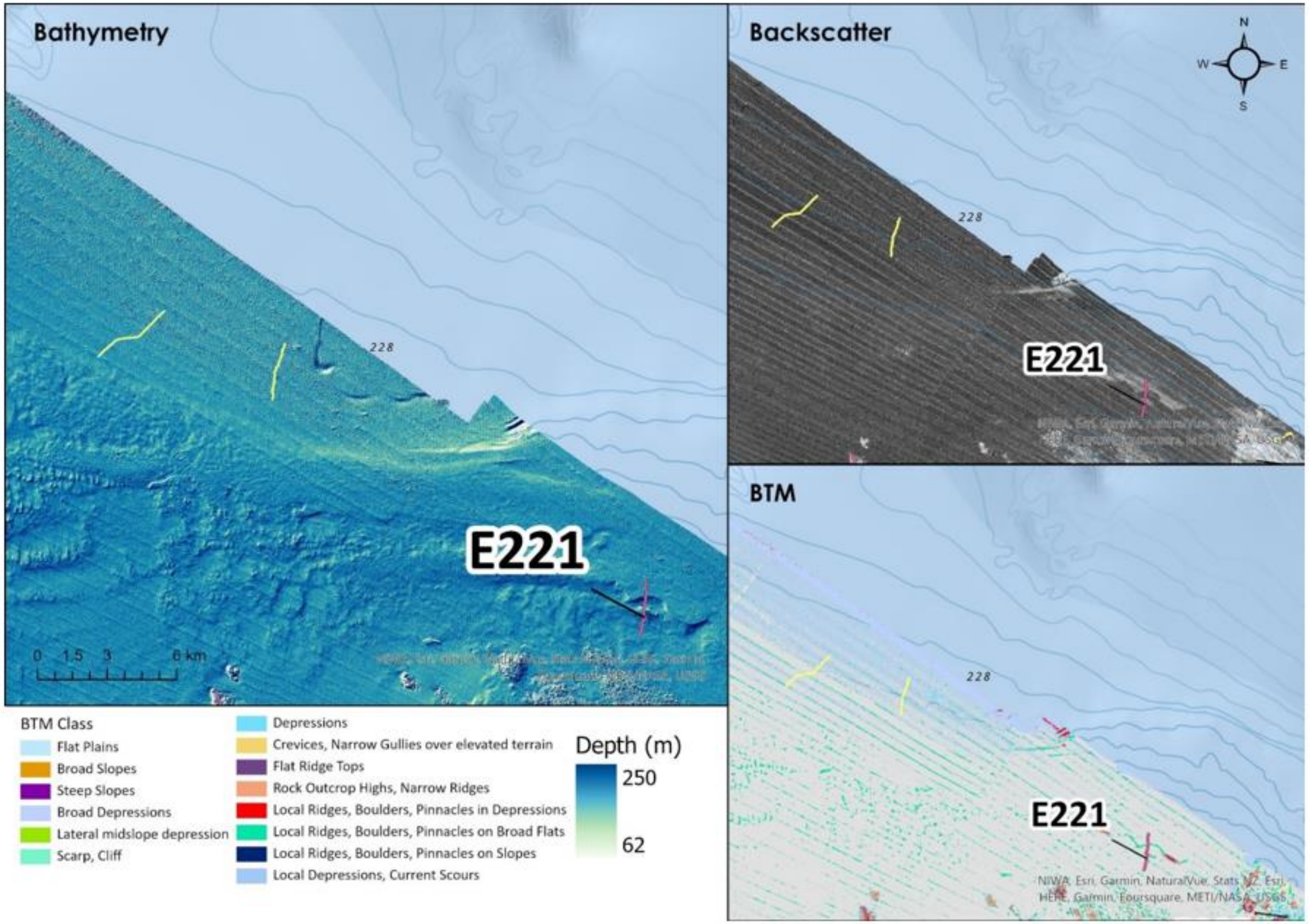

Figure 3-36: Box 5 finer scale map of bathymetry, backscatter, and BTM classification. The dominant rock type in each segment is plotted; hard rock is further split into rock, patch reef (inclusive of boulders and rock tells), and cobbles. Segments with no rock contribution are not plotted.

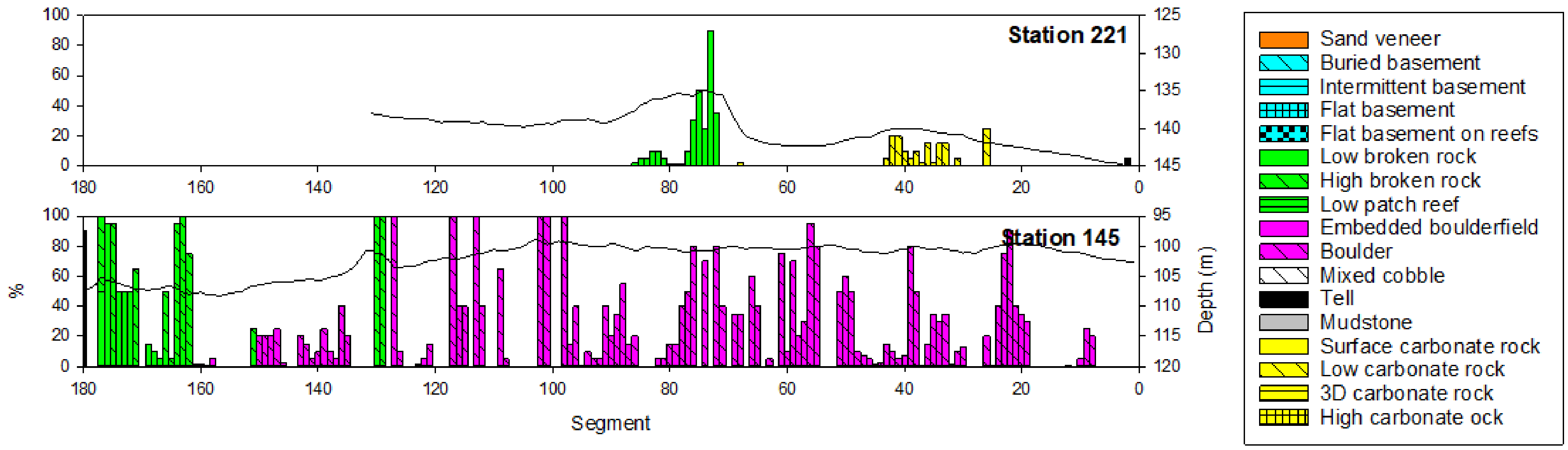

Figure 3-37: Along transect profile (stations 221, 145) showing rock geomorphology class contributions by 20-second segment and associated bathymetry profile. Left) % contributions. Right) average depth for each segment. To maximise ease of interpretation presentation, all segments are shown as equal width stacked bar plots, rather than using distance travelled. Bathymetry is shown by a line plot.

Figure 3-38: Box 5 seafloor imagery from station 221, and Box 6 seafloor imagery from station 145.

Table 3-8: Box 5 abundance (inds./100 m^2) of key/charactering sessile invertebrates, mobile invertebrates, and fish. The top ten OTUs for each station are colour coded as a rank; densities for the other stations are provided for comparison. Values are estimated abundance per 100 m^2 of rock habitat. Average density and species richness are given for sponges, corals, all sessile invertebrates, mobile invertebrates and fish. *, species also observed in soft sediment areas without rock.

Station		221			
Depth		140			
Rock area (m^2)		85			
Sessile invertebrates			No mobile invertebrates	**Fish**	
OTU	**Group**			**OTU**	
Sponge (Demospongiae)	Sponge	35.4		Bony fish	3.0
Hydroid	Hydroid	20.2		Opalfish*	0.8
Desmophyllum/ Caryophyllia	Coral	20.2		Sea perch	0.3
Callyspongia sp.	Sponge	12.6			
Symplectella rowi	Sponge	10.1			
Bryozoan	Bryozoan	10.1			
Encrusting sponges	Sponge	2.5			
Ascidians (solitary)	Ascidian	2.5			
Sponge	Density (100 m^2)	60.7		Density (100 m^2)	4.1
	OTUs	4		OTUs	3
Coral	Density (100 m^2)	20.2			
	OTUs	1			
All	Density (100 m^2)	113.8			
	OTUs	8			

Ranking scale (top 10 OTU)
1
2
3
4
5
6
7
8
9
10

Box 6 – Karikari Peninsula to offshore Houhora Harbour

An area of deep reef was present from the end of Karikari Peninsula, extending offshore of the Moturoa Islands, and east to offshore of Henderson Bay (Figure 3-39). The BTM analysis classed most of the deep reef extent as ‘local ridges, boulders, pinnacles on broad flats’, along with smaller more topographically complex areas along some of the seaward reef edge, and along the inner 50 metre depth multibeam sonar survey boundary.

Station 145

A single station was located on the edge of this deep reef system, due north of the Moturoa Islands (Figure 3-39). Hard rock occupied 31% of the station transect, dominated by boulders (24%), with a lesser cover of low (2%) and high (5%) broken rock (Table 3-1). The low and high broken rock was largely confined to the southern end of the transect, where it formed two reefs (<1m in height), each around 70 metres wide, with rock cover up to 100% (Figure 3-37). A further narrower reef was present to the north, spanning about 20 metres in width and about two metres in height, with 100% rock cover.

The boulder reef area was much more extensive, spanning around 85% of the transects length, and forming boulder clusters 10 to 50 metres wide, with heights around 50 cm or less. The hard rock was characterised by smooth surfaces and cracks on the larger reef components and cracked blocks/boulders forming smaller components of the reef (Figure 3-34). Epifauna was dominated by sponges (160/100m^2, richness 7), with corals being almost completely absent (Table 3-9). Dominant sponge taxa were unidentified upright sponges (134/100m^2), *Symplectella rowi* (12/100m^2), and *Aciculites pulchra* (10/100m^2). Overall faunal density was 211/100m^2, richness 10; with hydroids contributing 50/100m^2. Mobile invertebrates were rare (1/100m^2, richness 3). No fish were observed.

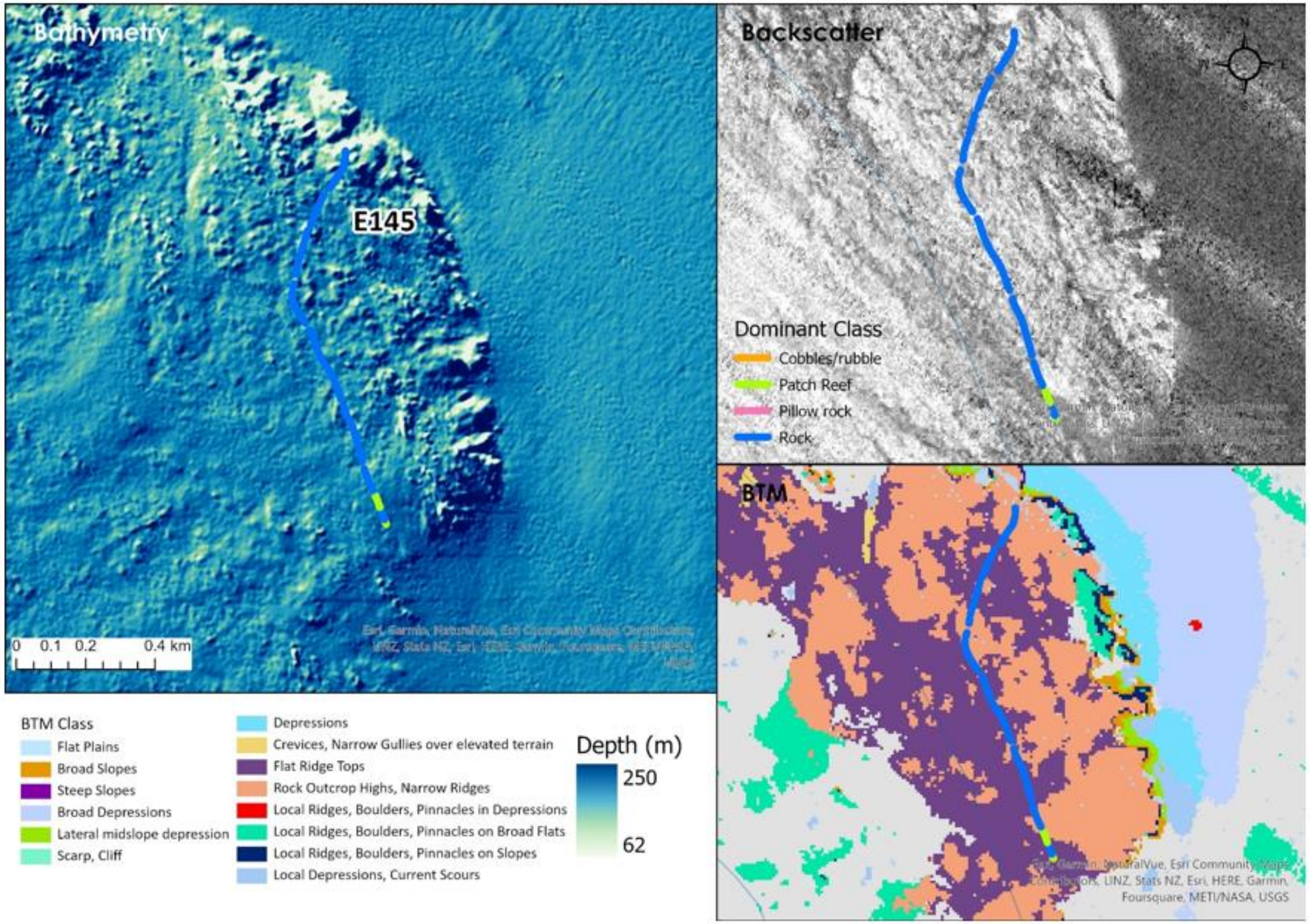

Figure 3-39: Box 6 finer scale map of bathymetry, backscatter, and BTM classification. The associated DTIS stations is 145. The dominant rock type in each segment is plotted; hard rock is further split into rock, patch reef (inclusive of boulders and rock tells), and cobbles. Segments with no rock contribution are not plotted. *, species also observed in soft sediment areas without rock.

Table 3-9: Box 6 abundance (inds./100 m²) of key/charactering sessile invertebrates, mobile invertebrates, and fish. The top ten OTUs for each station are colour coded as a rank; densities for the other stations are provided for comparison. Values are estimated abundance per 100 m² of rock habitat. Average density and species richness are given for sponges, corals, all sessile invertebrates, mobile invertebrates and fish.

	Station	145
	Depth	102
	Rock area (m²)	410

Ranking scale (top 10 OTU)
1
2
3
4
5
6
7
8
9
10

Sessile invertebrates

OTU	Group	145
Sponge (Demospongiae)	Sponge	134.3
Hydroid	Hydroid	49.6
Symplectella rowi	Sponge	12.0
Aciculites pulchra	Sponge	10.0
Poecilosclerid	Sponge	2.4
Bryozoan	Bryozoan	1.0
Iophon laevistylus	Sponge	1.0
Stelletta crater	Sponge	0.5
Ecionemia alata	Sponge	0.2
Primnoidae	Coral	0.2
Sponge	Density (100 m²)	160.4
	OTUs	7
Coral	Density (100 m²)	0.2
	OTUs	1
All	Density (100 m²)	211.2
	OTUs	10

Mobile invertebrates

OTU	Group		145
Asteroid	Starfish		0.2
Ophidiaster macknighti	Starfish		0.2
Comatulida	Feather star		0.2
Sponge		-	-
Coral		-	-
All			0.73
			3

No fish

Box 7 – offshore of Parengarenga Harbour to northwest of North Cape

An extensive area of harder seafloor with three-dimensional structure occurs off Parengarenga Harbour and extends past North Cape (Figure 3-2, Figure 3-40). The BTM analysis classed the majority of this area as 'local ridges, boulders, pinnacles on broad flats'. As in other areas, smaller localised patches of more diverse topography ('flat ridge tops', 'broad slopes', and 'depressions') were present inshore along the 50-metre depth multibeam sonar boundary, including right around North Cape. These localised areas also occurred out on parts of the continental shelf, as well as on the upper slopes and at the heads of five shelf edge canyons. A further BTM class, 'local ridges, boulders, pinnacles in depressions' formed the main bodies of these canyons. This class was also present in two small areas on the shelf northeast of North Cape, and well off Parengarenga Harbour entrance.

Stations 128 and 147

These two stations were on an area east of Parengarenga Harbour, classed by BTM as 'local ridges, boulders, pinnacles on broad flats' and 'flat plains' (Figure 3-40, Figure 3-41). Rock cover ranged from 32 to 42%, dominated by carbonate rock, with very nominal contributions of hard rock (1–9 m^2) (Table 3-1). Station 128 mainly had surface carbonate rock, with smaller amounts of low and 3D carbonate classes (Figure 3-42). Rock cover at the segment level ranged up to about 90%. The bathymetric profile was largely flat around 115 metres water depth, with a broad depression (max. 120 metres depth) three-quarters of the way along its length. This depression contained traces of low broken rock and boulders. Station 147 was dominated by low carbonate rock, with a flat bathymetric profile at around 105 metres depth (Figure 3-42). A trace of low broken rock was present midway along the transect.

The carbonate rock (Figure 3-43) was dominated by sponges (72–86/100m^2, richness 9–18), with the main contributors being the glass sponge *S. rowe* (7–47/100m^2), unidentified upright sponges (18–25 103/100m^2) and a hexactinellid sponge (<1–47/100m^2) (Table 3-10). Corals were uncommon (8–23/100m^2, richness 5–6), with most being *Flabellum* sp. (0–16/100m^2) and black corals (*Lillipathes lilliei*, 0–6/100m^2; unidentified Antipatheria, 0–??/100m^2).

Mobile invertebrate densities were low at 3–4/100m^2, richness 3–8, with the main contributors being unidentified gastropods (<1–4/100m^2) and the starfish *Astropecten polyacanthus* (1/100m^2), a soft sediment species. Fish density was 4–6/100m^2, richness 11–14, dominated by unidentified bony fish (1–2/100m^2), pink maomao (1/100m^2), silver conger eels (<1–3/100m^2) and butterfly perch (0–1/100m^2).

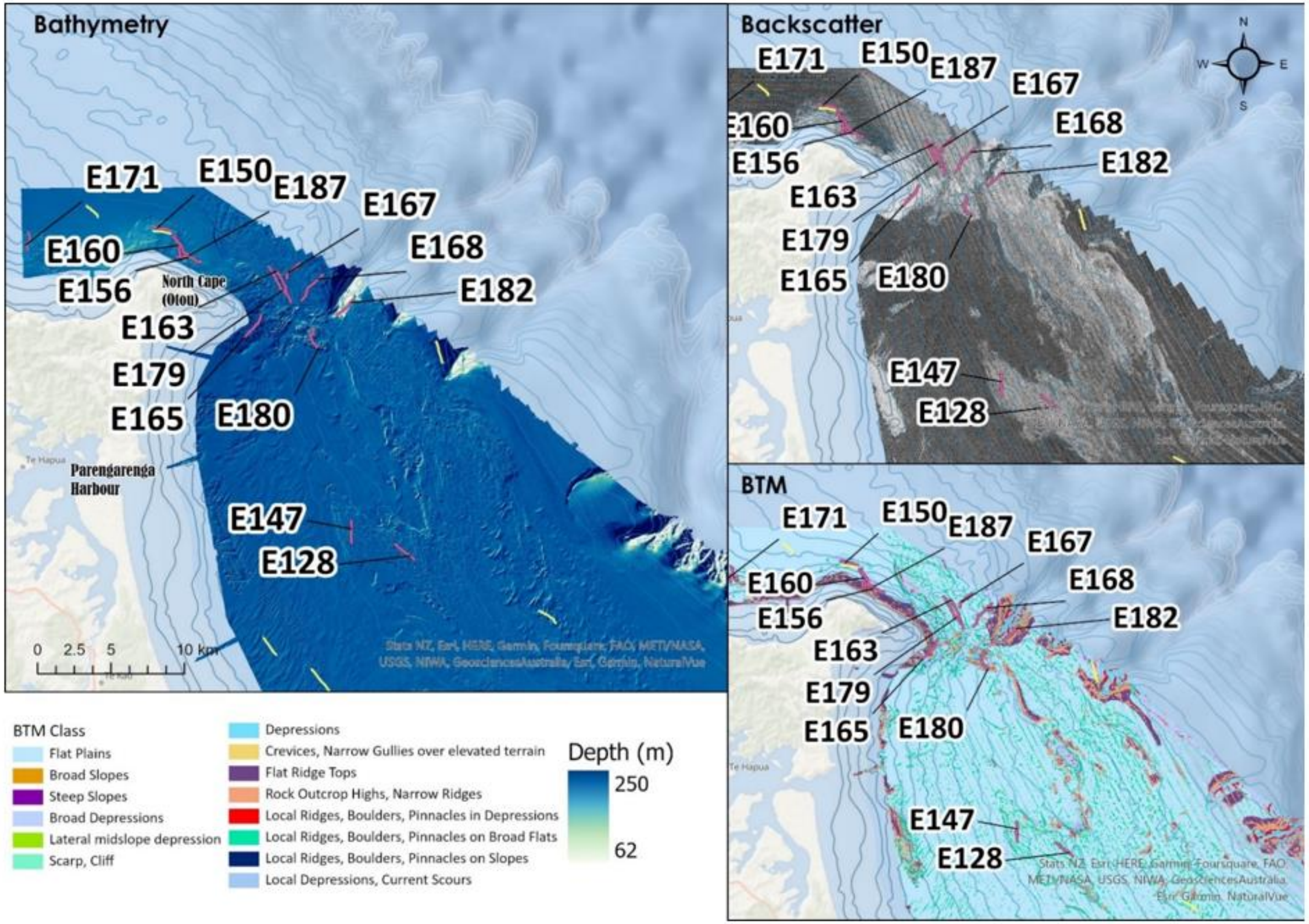

Figure 3-40: Box 7 bathymetry, backscatter, and BTM classification. Associated DTIS stations are 128, 147, 150, 156, 160, 163, 165, 167, 168, 171, 179, 180, 182, 187.

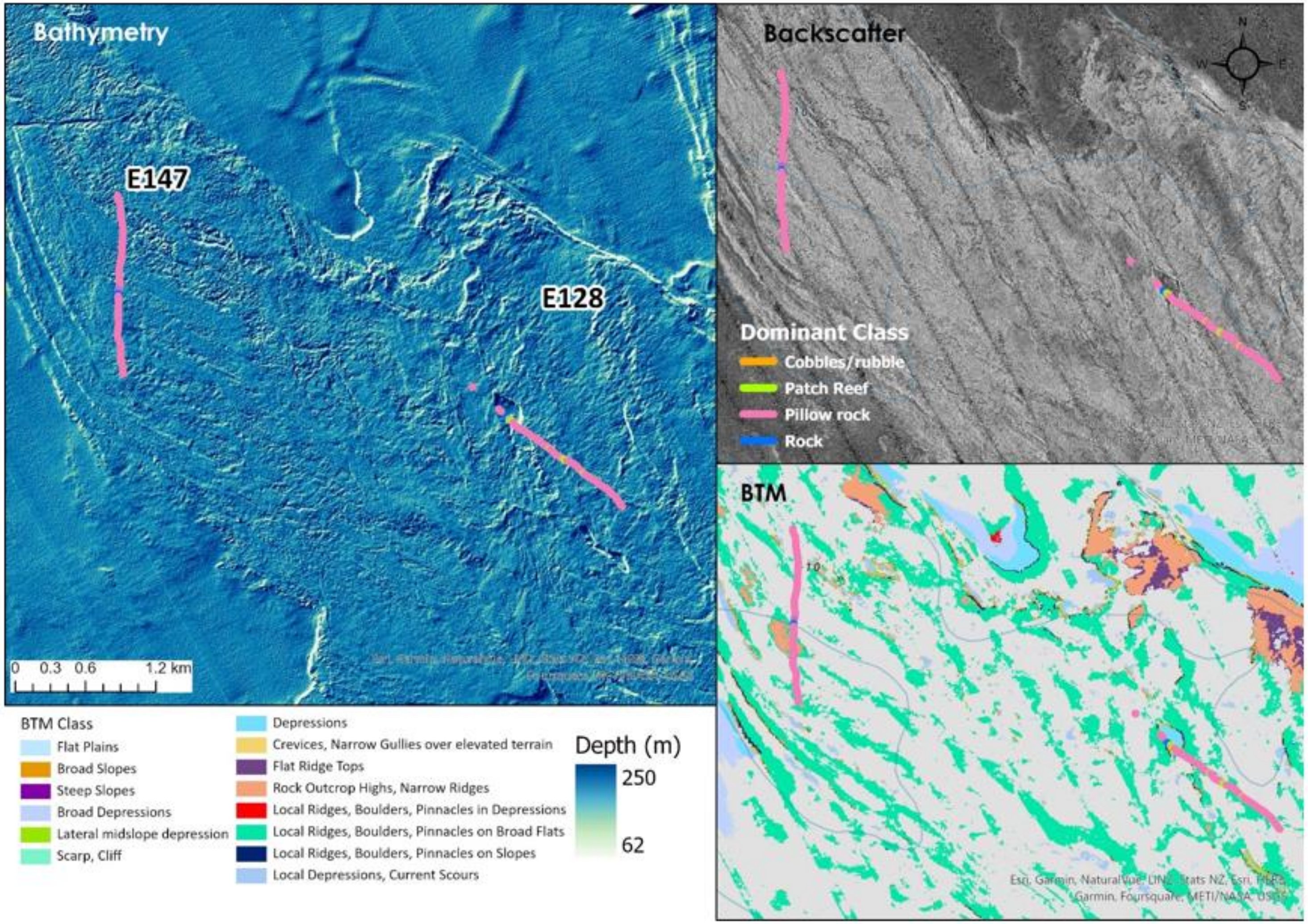

Figure 3-41: Box 7 finer scale map of bathymetry, backscatter, and BTM classification. Associated DTIS stations are 128 and 147.The dominant rock type/class in each segment is plotted, with all 'hard rock' classes summed together; the exceptions being cobbles/rubble (combined here) and patch reef, displayed independently to give an idea of general reef composition. Segments with no rock contribution are not plotted.

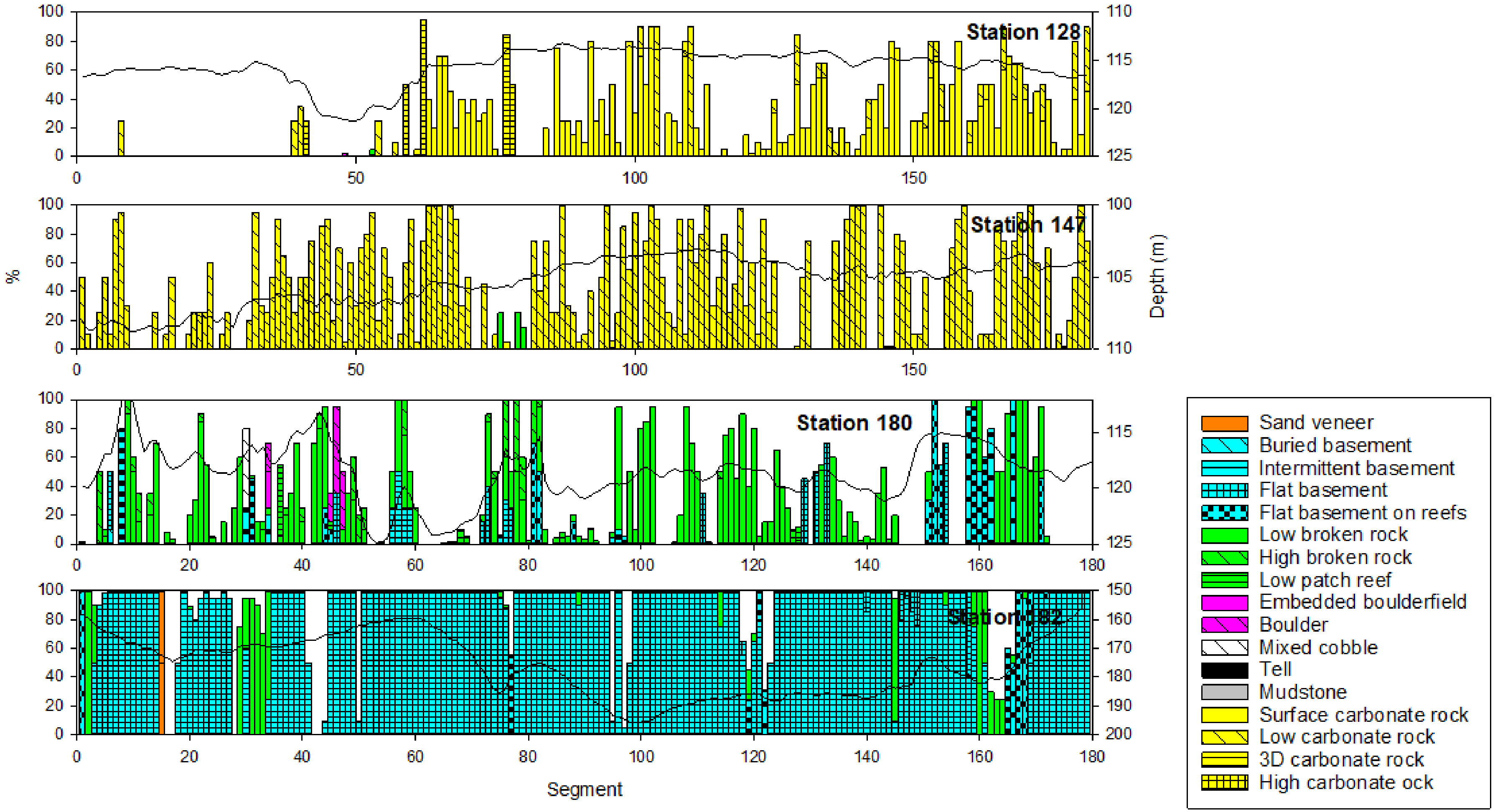

Figure 3-42: Along transect profiles (stations 128, 147, 180, 182) showing rock geomorphology class contributions by 20-second segment and associated bathymetry profile. Left) % contribution. Right)average depth for each segment. To maximise ease of interpretation presentation, all segments are shown as equal width stacked bar plots, rather than using distance travelled. Bathymetry is shown by a line plot.

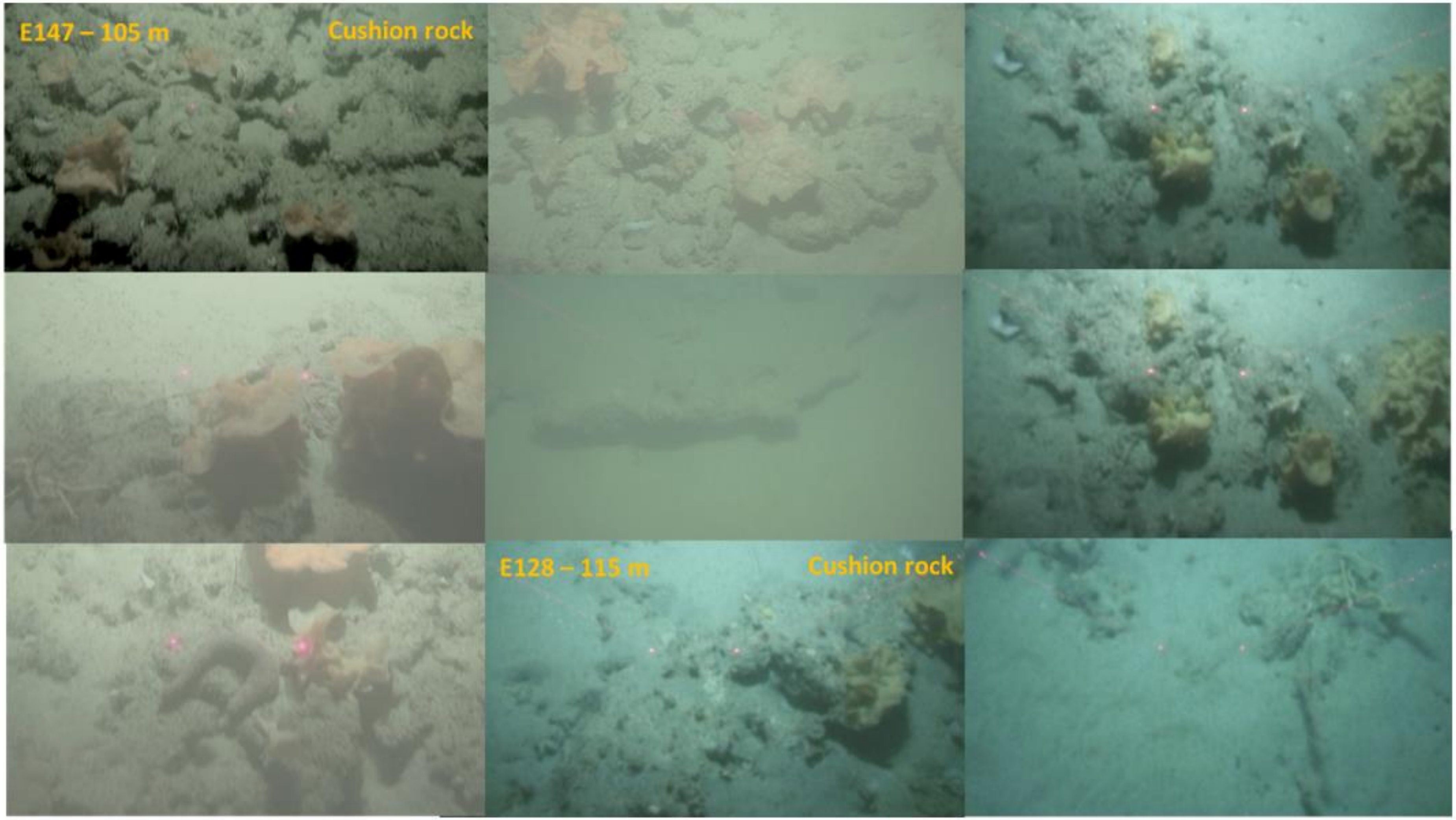

Figure 3-43: Box 7 seafloor imagery from stations 147 and 128.

Table 3-10: Box 7 abundance (inds./100 m^2) of key/charactering sessile invertebrates, mobile invertebrates, and fish. The top ten OTUs for each station are colour coded as a rank; densities for the other stations are provided for comparison. Values are estimated abundance per 100 m^2 of rock habitat. Average density and species richness are given for sponges, corals, all sessile invertebrates, mobile invertebrates and fish. Ca, carbonate rock; Ven, sand over rock; MST, mudstone.

Station		156	171	160	165	187	150	147	128	179		180	163	167	168	182
Depth		54	63	71	71	74	86	105	115	118		118	120	129	135	176
Reef area (m^2)		205	194	124	1286	60	69	1003	631	2381	183	936	1733	2040	3180	2545
Sessile invertebrates																
OTU	**Group**							Ca	Ca	Ven	MST		Ven	Ven	Ven	
Sponge (Demospongiae)	Sponge	76.6	93.8	186.9	64.7	179.0	135.6	17.8	24.9	39.6	22.4	18.1	28.9	77.2	31.5	7.0
Hydroid	Hydroid	9.3	26.8	164.4	4		134.1	0.4	0.5	1.4	1.6	13.6	4.6	3.9	9.6	2.6
Ecionemia alata	Sponge	82.5	44.3	56.4	47.9	49.7	62.7	0.2	-	4.7	6.5	0.6	1.4	1.4	4.5	-
Encrusting sponges	Sponge	58.6	25.8	61.2	39.6	36.5	20.4	0.6	-	0.1	0.5	-	0.3	0.5	0.1	-
Radicipes spp	Coral	-	-	-	-	-	-	-	0.3	-	-	0.9	-	-	-	2.4
Symplectella rowi	Sponge	-	-	-	-	-	-	46.9	7.4	<0.1	-	34.0	-	-	-	<0.1
Axinella australiensis	Sponge	-	3.1	26.6	5.8	43.1	17.5	0.1	-	-	-	3.3	0.7	3.9	18.5	6.8
Neoschrammeniella fulvodesmus	Sponge	-	-	-	1.8	-	1.5	4.0	3.8	-	-	95.8	0.2	1	0.5	0.9
Tethya fastigata	Sponge	14.2	8.2	11.3	1.5	21.5	46.7	-	-	5.7	3.8	-	2.7	1.9	0.4	-
Bryozoan	Bryozoan	4.4	-	-	0.1	-	-	8.2	5.5	<0.1	-	18.1	-	1.3	12.0	0.3
Callyspongia sp.	Sponge	1	8.2	12.1	12.8	1.6	17.5	-	0.2	7.1	6.0	0.5	0.2	1.3	7.9	<0.1
Sponge (Hexactinellidae)	Sponge	-	0.5	-	0.5	-	5.8	0.3	47.5	5.7	6.5	0.2	-	0.2	<0.1	0.1
Polymastia sp.	Sponge	-	13.4	9.7	1.8	5.0	16.0	-	-	6.0	1.6	-	5.1	3.4	4.1	-
Gorgonacea	Coral	-	0.5	4	0.4	-	16.0	0.3	0.5	4.8	6.0	1.8	0.2	0.9	0.5	4.2
Iophon minor	Sponge	15.6	7.7	12.1	-	9.9	10.2	-	-	-	-	0.3	-	0.1	0.5	0.1
Axinellidae	Sponge	22.0		0.8	4.2	-	-	0.2	1.0	0.2	-	1.1	0.1	3.2	1.7	7.3
Stelletta sp.	Sponge	1.5	1.5	3.2	16.4	3.3	11.7	0.4	0.3	6.3	3.8	0.2	0.2	-	1.7	-
Stylasteridae	Coral	-	-	-	2.6	8.3	20.4	-	-	<0.1	-	13.8	-	-	0.1	0.1
Aciculites pulchra	Sponge	0.5	1.5	-	18.8	-	1.5	-	-	5.6	4.9	2.7	2.9	3.4	1.3	0.1
Flabellum	Coral	-	2.1	1.6	-	-	5.8	-	16.0	2.8	4.4	4.9	0.3	1.4	0.1	0.1

Ranking scale (top 10 OTU)
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Station		156	171	160	165	187	150	147	128	179		180	163	167	168	182
Leucettusa sp.	Sponge	5.9	-	5.6	11.4	9.9	4.4	-	-	-	-	0.2	-	-	-	-
Ascidians (clonal)	Ascidian	0.5	12.9	11.3	-	-	8.7	-	-	<0.1	-	0.2	0.1	-	1.2	-
Ascidians (solitary)	Ascidian	0.5	8.2	3.2	0.2	-	20.4	0.5	0.2	-	-	0.5	0.1	0.3	0.3	-
Geodia vestigifera	Sponge	-	-	-	-	1.6	-	-	-	2	-	0.3	3.3	7.9	18.5	0.2
Lillipathes lilliei	Coral	-	-	-	-	-	-	5.6	-	-	-	-	-	-	0.1	-
Asteropus simplex	Sponge	0.5	-	-	15.4	3.3	1.5	-	-	<0.1	-	-	-	0.1	-	-
Alcyonacea	Soft coral	-	1	4	0.2	-	1.5	-	-	-	-	0.1	-	-	17.6	1.1
Antipatheria	Coral	1	-	1.6	0.3	-	8.7	0.1	5.1	0.1	0.5	2.3	-	<0.1	4.3	0.9
Neopetrosia n. sp. 3	Sponge	0.5	-	-	-	-	-	-	-	0.2	0.5	18.9	-	3.1	-	0.9
Pachastrellidae	Sponge	-	1.1	4.8	14.4	3.3	-	-	-	-	-	-	-	-	-	-
Desmophyllum/ Caryophyllia	Coral		5.1	5.6	1.2	-	2.9	1.5	0.6	0.1	-	-	1.6	-	3.6	-
Dendrilla rosea	Sponge	-	2.7	2.4	3.5	1.6	-	-	-	0.8	6.0	-	-	-	-	-
Calyx imperialis	Sponge	4.9	-	-	0.2	-	10.2	-	-	0.1	0.5	1.8	-	0.4	2.5	0.2
Latrunculia kaakaariki	Sponge	0.5	14.4	0.8	-	3.3	1.5	-	-	-	-	0.1	-	-	0.1	-
Tedania sp.	Sponge	-	2	5.6	3.6	6.6	1.5	0.1	-	0.1	-	-	0.1	0.1	0.5	-
Stelletta columna	Sponge	-	-	-	2.2	-		0.3	-	0.3	0.5	0.1	5.0	-	10.5	-
Axinella spp.	Sponge	-	0.5	2.4	1.2	-	7.3	-	-	1.3	2.2	-	0.2	0.2	-	3.4
Stylocordyla borealis	Sponge	-	-	-	-	-	-	-	-	0.2	-	-	-	5.7	9.3	-
Taonura marginalis	Sponge	-	-	0.8	0.3	-	4.4	-	-	2.2	0.5	-	1.2	0.5	2.8	-
Bathypathes	Coral	-	-	-	-	9.9	-	-	-	-	-	-	-	-	-	1.1
Mycalidae	Sponge	1.5	0.5	0.8	-	-	-	-	-	-	-	0.5		7.2	-	-
Stelletta crater	Sponge	-	-	-	4.2	-	-	0.3	0.8	1.1	1.1	1.9	0.17	-	<0.1	-
Oculina virgosa	Coral	-	-	-	3.1	3.3	-	-	-	-	-	2.8	0.1	-	<0.1	-
Psammocinia hawere	Sponge	-	-	-	-	-	-	-	-	<0.1	-	-	1.5	-	-	-
Pennatulacea	Sea pen	-	1.0	-	-	-	1.5	-	0.475	-	-	0.1	-	-	<.01	0.31
Sponge	Density (100 m^2)	304.6	262.3	413.4	286.6	386.1	398.0	72.3	86.2	92.3	67.6	182.2	54.8	129.2	129.7	28.2
	OTUs	24	34	22	40	19	25	18	9	33	16	25	25	41	35	21

Station		156	171	160	165	187	150	147	128	179		180	163	167	168	182
Coral	Density (100 m^2)	1.5	24.2	16.1	7.9	32.4	53.9	7.6	22.8	7.9	10.9	26.6	2.9	2.5	9.0	9.2
	OTUs	2	5	5	6	5	5	5	6	6	3	6	8	5	9	8
All	Density (100 m^2)	320.7	338	612.4	299	646.2	619.7	89	115.8	101.7	80.1	241.5	62.4	137.2	179.6	42.2
	OTUs	30	46	31	50	25	36	26	20	42	20	28	36	49	52	36

Station	156	171	160	165	187	150	147	128	179		180	163	167	168	182
Depth	54	63	71	71	74	86	105	115	118		118	120	129	135	176
Reef area (m^2)	205	194	124	1286	60	69	1003	631	2381	183	936	1733	2040	3180	2545

Mobile invertebrates

OTU	Group	156	171	160	165	187	150	147	128	179		180	163	167	168	182
								Ca	Ca	Ven	MST		Ven	Ven	Ven	
Holothuria integra	Sea cucumber		0.5	1.6	0.9	3.3	16.0	-	0.6	1.6	3.8	6.5	1.8	1.2	0.6	1.2
Mollusc (gastropod)	Gastropod	-	-	-	-	-	-	3.8	0.2	-	-	-	-	-	0.1	-
Astraea heliotropium	Gastropod	-	-	-	-	-	7.3	-	0.5	<0.1	-	0.3	-	0.1		<0.1
Asterodiscides sp.	Starfish	-	-	1.6		1.7	1.5	-	-	-	-	-	-	-	-	-
Australostichopus mollis	Sea cucumber	0.5	-	0.8	1.0	-	-	-	-	0.3	0.5	0.3	-	0.2	0.1	<0.1
Henricia sp.	Starfish	-	-	0.8	0.2	-	-	-	-	<0.1	-	1.1	-	0.0	-	0.1
Ophiuroid	Brittle star	-	-	-	1.4	-	-	-	-	-	-	0.2	-	0.1	-	0.3
Holothurian	Sea cucumber	-	-	-	-	-	-	-	-	-	1.6	-	-	0.0	0.0	0.2
*Astropecten polyacanthus**	Starfish	-	-	-	-	-	-	0.5	1.0	0.0	-	0.1	-	-	-	-
Ophidiasteridae	Brittle star	-	-	-	-	-	1.5	-	-	-	-	-	-	-	-	-
Ceriantharia spp.	Anemone	-	-	-	0.2	-	-	-	-	0.1	-	0.2	-	-	0.1	0.2
Turbinellidae	Gastropod	-	-	-	0.2	-	-	-	-	<0.1	-	0.1	0.2	-	-	0.1
Asteroid	Starfish	-	0.5			-	-	-	-	<0.1	-	-	-	-	-	-
Goniasteridae	Starfish	-			0.1	-	-	-	0.2	-	-	0.1	0.1	0.0	0.0	<0.1
Crustacean (crab)	Crab	-				-	-	-	0.2	-	-		0.2	-	-	-
Chlamys sp.	Scallop	-			0.1	-	-	-	-	-	-	0.1	0.2	-	-	-
Volutidae	Gastropod	-				-	-	-	-	-	-	-	-	-	-	0.3
Coluzea sp.	Gastropod	-	-	-	-	-	-	0.1	0.2	-	-	-	-	-	-	-
Luidia sp.*	Starfish	-	-	-	-	-	-	-	0.2	-	-	-	-	-	-	-
Nematocarcinus sp.	Crab	-	-	-	-	-	-	-	-	-	-		0.1	<0.1	0.1	-
Echinoid	Urchin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1
Echinasteridae	Urchin	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-
Crinoidea (motile)	Crinoid	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-

Ranking scale (top 10 OTU)
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	Station	156	171	160	165	187	150	147	128	179		180	163	167	168	182
Buccinidae	Gastropod	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1
	Density (100 m^2)	0.5	1.1	4.8	4.0	5	26.2	4.4	2.9	2.0	6.0	9.2	2.5	1.8	1.1	2.4
	OTUs	1	2	4	8	2	4	3	8	4	3	11	6	7	8	8

Ranking scale (top 10 OTU)
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Station	156	171	160	165	187	150	147	128	179		180	163	167	168	182
Depth	54	63	71	71	74	86	105	115	118		118	120	129	135	176
Swept area (m^2)	2432	194	819	1286	60	69	1003	631	2381	183	936	409	2040	3180	2545
Fish							Ca	Ca	Ven	MST		Ven	Ven	Ven	
Butterfly perch	0.2	3.4	0.6	0.1	2.8	3.8	0.8	-	0.2	0.5	-	0.1	0.2	0.1	
Bony fish	0.2	0.7	-	2.9	0.9	1.5	1.3	1.7	0.8	0.7	1.5	2.2	1.7	0.9	1.7
Sea perch	-	-	-	1.5	0.2	0.1	0.4	-	1.8	1.6	2.6	0.7	0.8	1.4	2.4
Pink maomao	1.2	0.6	0.3	6.1	0.2	3.6	0.5	0.9	0.5	0.5	0.9	0.2	0.5	0.4	0.4
Ahuru*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.7
Silver conger eel*	-	-	-	-	-	0.3	0.1	1.0	0.1	0.2	-	-	0.3	-	0.1
Red bandfish	-	-	-	-	-	-	-	0.4	0.1	-	-	0.1	-	-	0.1
Flatfish	-	-	-	-	-	-	-	0.1	-	-	-	<0.1	-	-	0.1
Cucumber fish*	-	-	-	<0.1	-	-	0.1	0.5	<0.1	-	0.2		-	0.2	<0.1
Eels	-	-	-	0.1	-	0.1	0.2	0.4	0.1	0.2	0.1	0.4	0.2	-	<0.1
Conger eel	-	-	-	<0.1	-	-	-		0.1	-	-	0.2	-	0.1	<0.1
Slender roughy	-	-	-	-	-	-	-		0.1	-	-	0.1	0.1	-	<0.1
Snake eel*	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-	<0.1
Long-finned worm eel*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1
Trevally	-	-	-	-	-	0.1	-	-	0.1	-	0.1	0.1	0.2	-	-
Scorpionfish	-	0.4	0.1	0.2	-	0.1	0.2	0.1	0.1	-	0.1	<0.1	-	-	-
Squalus griffini	-	-	-	-	-	-	0.1	-	-	-	<0.1	<0.1	-	-	-
Moridae	-	0.1	-	0.1	-	0.8	0.2	0.3	0.1	0.5	-	0.4	<0.1	0.2	-
Tarakihi	-	-	-	-	-	-	-	-	0.1	-	-	<0.1	<0.1	0.3	-
Golden snapper	-	-		0.2	-	0.1	-	-	0.1	-	-	-	-		-
Leatherjacket	-	0.1	0.2	0.1	-	0.7	-	-	<0.1	-	-	-	-		-
Longfinned boarfish	-	-	-	0.2	-	-	-	-	<0.1	-	-	-	-	<0.1	-
Orange perch	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-
Yellow weaver	-	-	-	-	-	-	0.2	-	-	-	-	0.2	-	0.1	-

Station	156	171	160	165	187	150	147	128	179		180	163	167	168	182
Opalfish*	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-
Splendid perch	-	-	-	0.9	-	-	-	-	-	-	-	<0.1	-	0.1	-
Plectranthias maculicauda	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-
Jack mackerel sp.	-	-	-	0.6	-	0.1	0.1	0.4	-	-	-	0.4	-	<0.1	-
Porcupine fish	-	-	-	-	-	0.1	-	-	-	-	-	-	-	<0.1	-
Red mullet	-	-	0.1	0.2	-		0.3	-	-	-	-	-	-	-	-
Bellowsfish*	-	-	-	-	-	-	0.1	-	-	-	-	<0.1	-	-	-
Red pigfish (wrasse)	0.2	-	0.1		-	-	-	-	-	-	-	-	-	-	-
Kingfish	-	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-
Density (100 m^2)	2.2	5.2	1.4	13.4	4	11.7	4.5	6	4.2	4.2	5.5	5.1	3.9	4.2	5.5
OTUs	4	5	5	13	3	12	14	11	13	6	7	11	7	12	7

Stations 180 and 182

Station 180 was on a large area of deep reef extending to the east of North Cape, with BTM classes of ‘flat ridge tops’, ‘broad slopes’, ‘depressions’, and ‘flat plains’ (Figure 3-41, Figure 3-44). Hard rock covered 33% of the transect (Table 3-1). Most of the reef morphology was low broken rock (Figure 3-45), with lesser contributions from flat basement. Boulders and cobble appeared in limited extent towards the transect end (Figure 3-42). The bathymetric profile was more variable that most other transects, ranging from 112–125 metres depth. Rock cover was up to 100% where the reefs spanned more than one segment, with individual reef areas approximately 50 to 100 metres in width (Figure 3-42).

The hard rock was dominated by sponges (182/100m^2, richness 25), with the main taxa being the fan sponge *Neoschrammeniella fulvodesmus* (96/100m^2), the glass sponge *S. rowe* (34/100m^2), and unidentified upright sponges (18/100m^2) (Table 3-10). Corals were uncommon (27/100m^2, richness 6), dominated by *Stylasteridae* (14/100m^2). Mobile invertebrate densities were low at 9/100m^2, richness 11, with the main species being the sea cucumber *Holothuria integra* (6/100m^2) and the starfish *Henricia sp.* (1/100m^2). Fish density was 5/100m^2, richness 7, and the dominant taxa were sea perch (3/100m^2) and unidentified bony fish (1/100m^2).

Station 182 was located on the southern edge of a canyon feature (Figure 3-44), with the seafloor being formed of flat basement, covered by a mixture of low ‘fluffy’ structure and fine sediment underpinned by rock, with occasional outcrops of hard low rock reef (Figure 3-46). Rock cover at the transect scale was 96% (Table 3-1). The rock basement held a low density of fauna (42/100m^2, richness 36), dominated by sponges (28/100m^2, richness 21) (Table 3-10). The main sponge species were unidentified upright sponges (7/100m^2), and *Axinella australiensis* and unidentified Axinellidae (both 7/100m^2). Corals were also present at low density (9/100m^2, richness 8), with the main taxa being Gorgonacea (4/100m^2), and sea whip *Radicipes* spp. (2/100m^2). Some coral colonies were relatively large (Figure 44). Mobile invertebrate densities were low at 2/100m^2, richness 8, and dominated by the sea cucumber *Holothuria integra* (1/100m^2). Fish density was 5/100m^2, richness 7, dominated by sea perch (3/100m^2) and unidentified bony fish (1/100m^2).

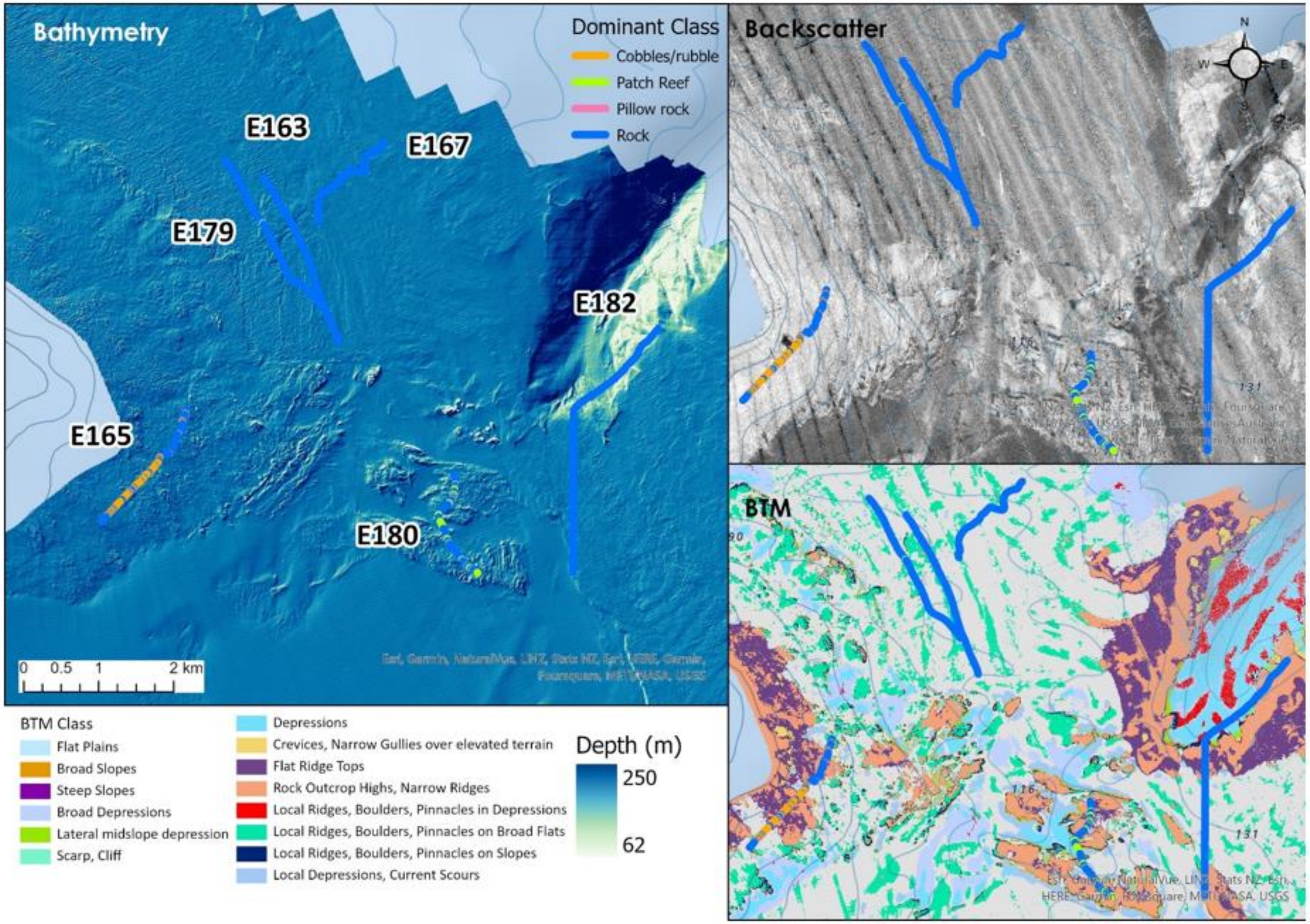

Figure 3-44: Box 7 finer scale map of bathymetry, backscatter, and BTM classification. Associated DTIS stations are 163, 165, 167, 179, 182. The dominant rock type/class in each segment is plotted, with all 'hard rock' classes summed together; the exceptions being cobbles/rubble (combined here) and patch reef, displayed independently.

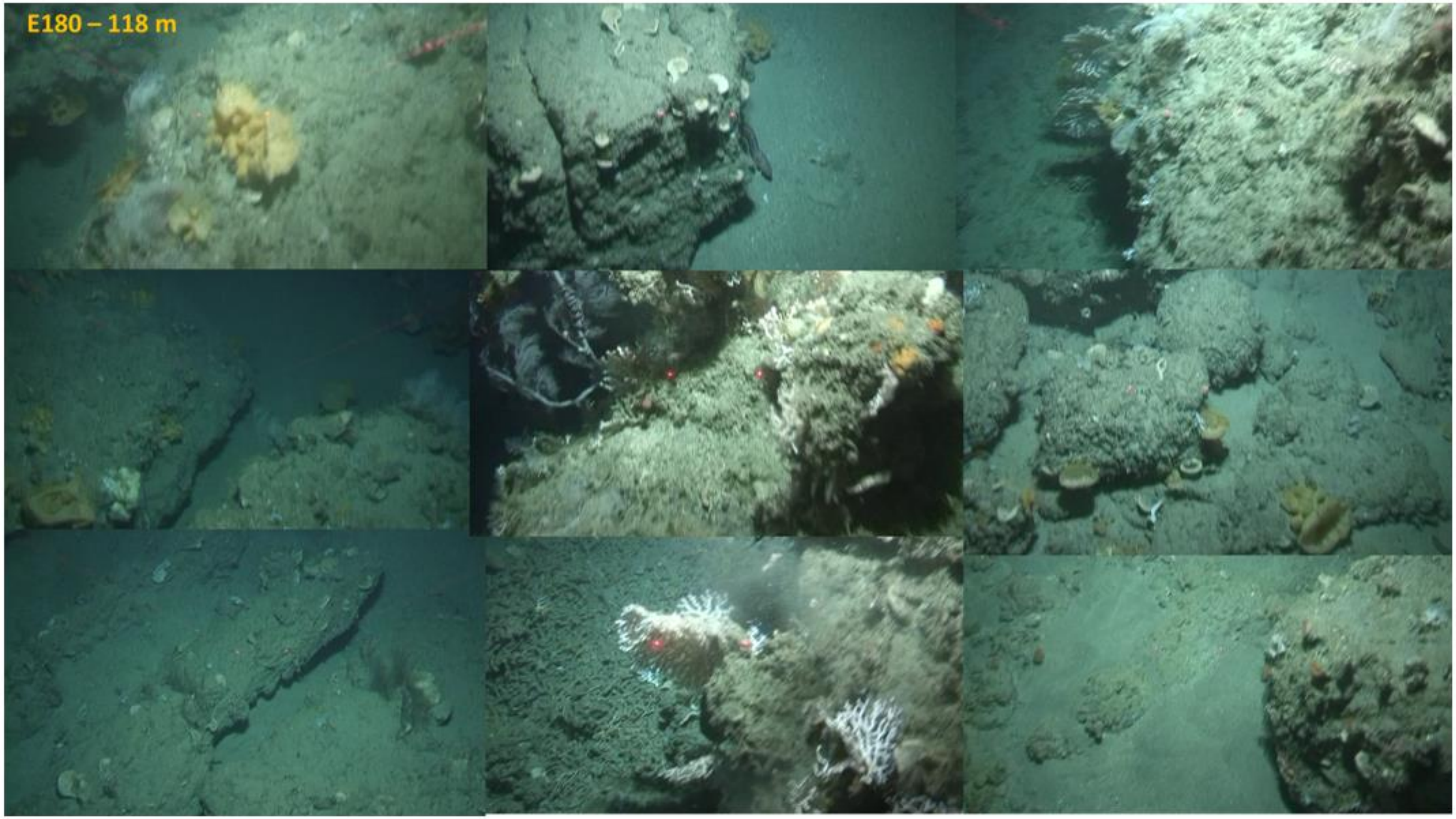

Figure 3-45: Box 7 seafloor imagery from station 180.

Figure 3-46: Box 7 seafloor imagery from station 182.

Stations 150, 156, 160, 165, 171, 187

Six stations (54–86 metres depth) sampled the shallower reef extending around North Cape to off Tom Bowling Bay (Figure 3-44, Figure 3-47). Hard rock cover was relatively low for five of the stations (2–10%), while station 165 had 43% cover (Table 3-1). Station 150 occurred on a flat bathymetric profile at around 87 metres water depth, which rose and fell slightly in the final quarter of the transect across a five-metre range (Figure 3-48). Small patch reefs occurred across the transect, with up to 40% cover at the segment scale. Station 165 was located east of North Cape, in 67–78 metre depth (Figure 3-44). Reef cover was semi-continuous and was dominant in the second half of the transect (Figure 3-48). BTM classed the area as a mixture of 'flat ridge tops', 'broad slopes', and 'flat plains'. Station 156 had a very limited area of rock seafloor, concentrated in a 150 metre transect section where the bathymetric profile sloped down from 50 metres to a flat plain at 60 metres. (Figure 3-48). Traces of a mudstone type rock were seen within the wider soft sediment plain. Station 160 was on a continuous slope, dropping from 45 to 80 metres water depth (Figure 3-48). Two discrete areas of low broken rock occurred on the upper slope; and a larger number of discrete areas of high broken rock on the lower slope area. Station 171 was located off western Tom Bowling Bay (Figure 3-49), with a bathymetric profile that sloped down from 55 to 75 metres water depth (Fig x). Buried and flat basement rock occurred down this slope as discrete clusters. Station 187 had a small number of very low relief patch reefs at 71–76 metres depth across a gentle slope (Fig x), that were associated with coarse shell material from current scouring.

Figure 3-49–Figure 3-56 show the range of fauna present across the six stations. The hard rock fauna was dominated by sponges (262–413/100m^2, richness 25–50), with the main taxa being unidentified upright sponges (65–187/100m^2), the large grey sponge *Ecionemia alata* (44–82/100m^2), unidentified encrusting sponges (20–61/100m^2), *Axinella australiensis* (0–43/100m^2), and the golf ball sponge *Tethya fastigata* (1–47/100m^2) (Table 3-10. Corals were uncommon at the four shallower stations, ranging from 1 to 24/100m^2, richness 2–6, but were relatively abundant at station 187, 54/100m^2, richness 5. The main taxa were Gorgonacea 0–16/100m^2, Stylasteridae 0–24/100m^2, and *Desmophyllum* / *Caryophyllia* cup corals (0–6/100m^2). Hydroids ranged from 4–164/100m^2, while bryozoans were rare (0–4/100m^2) and present at only two stations.

Mobile invertebrate densities were low at five of the size stations (1–5/100m2, richness 1–8), while density at station 150 (26/100m2) were elevated by a higher density of the sea cucumber Holothuria integra (16/100m2) and the circular saw shell Astraea heliotropium (7/100m2) Table 3-10). Fish density ranged from two to 12 per 100m2, richness 4–13, dominated by butterfly perch (<1–4/100m2), unidentified bony fish (0–3/100m2), and pink maomao (<1–6/100m2).

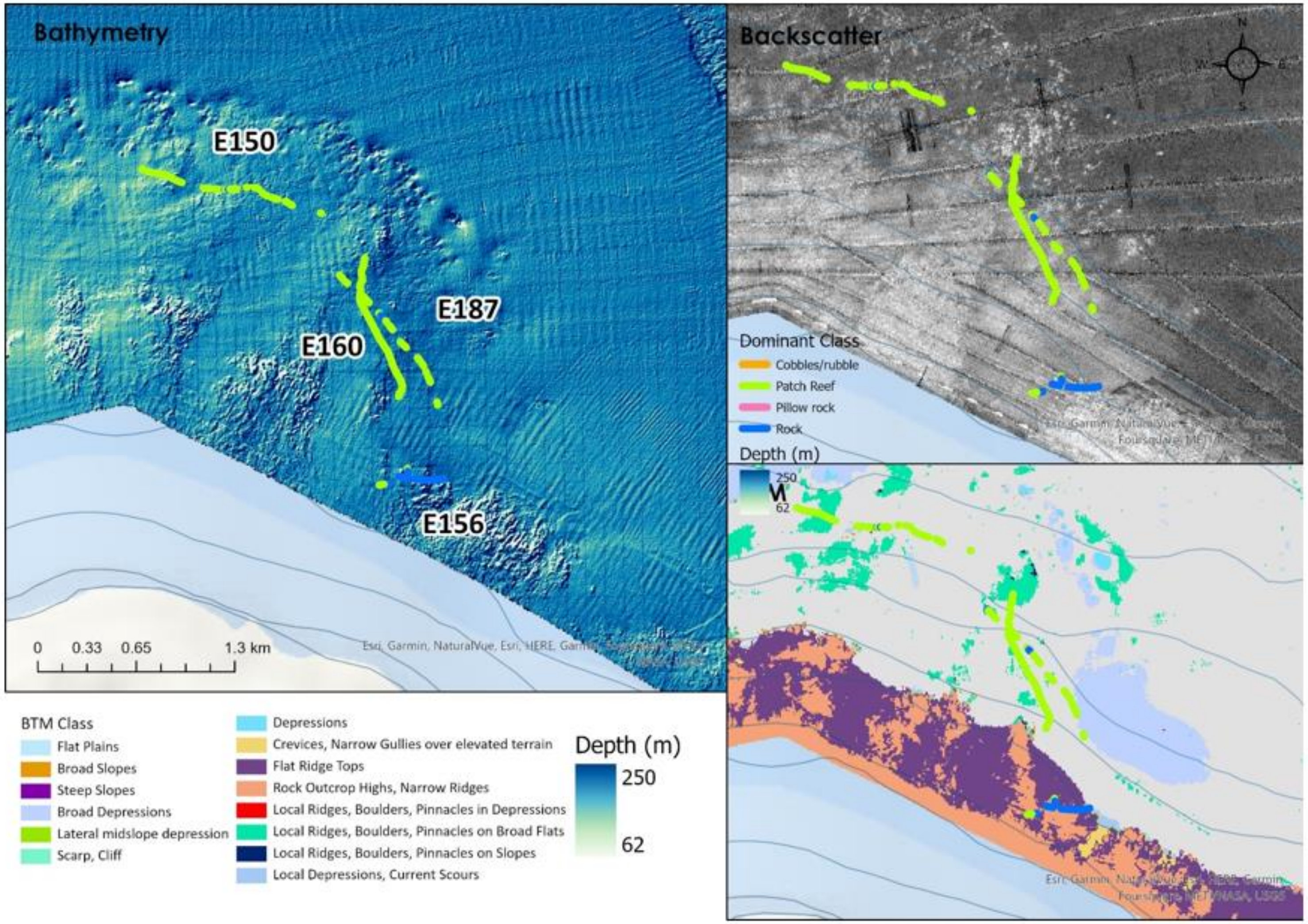

Figure 3-47: Box 7 finer scale map of bathymetry, backscatter, and BTM classification. Associated DTIS stations are 150, 156, 160 and 187. The dominant rock type/class in each segment is plotted, with all 'hard rock' classes summed together; the exceptions being cobbles/rubble (combined here) and patch reef, displayed independently to give an idea of general reef composition. Segments with no rock contribution are not plotted.

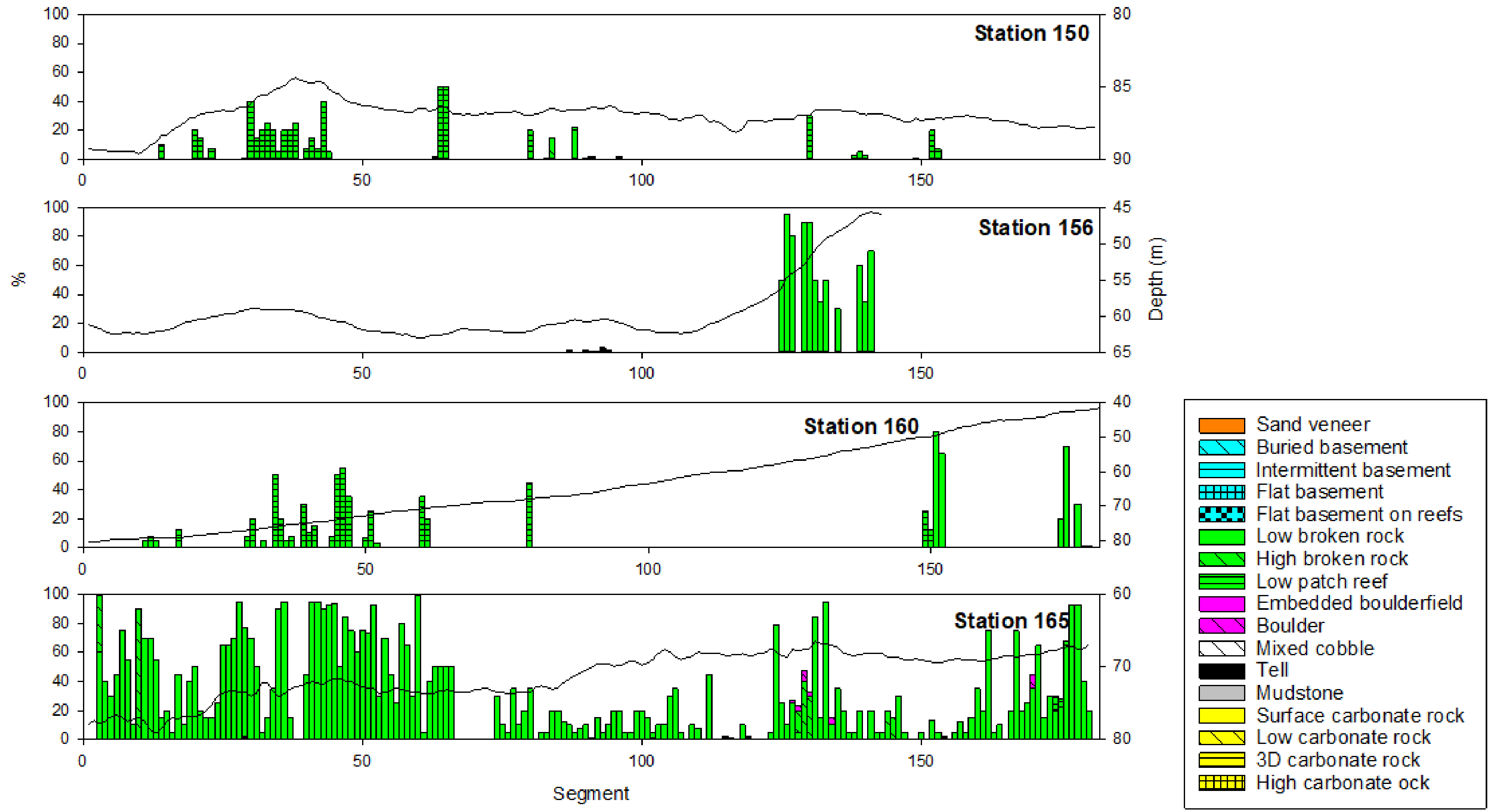

Figure 3-48: Along transect profiles (stations 150, 156, 160, 165) showing rock geomorphology class contributions by 20-second segment and associated bathymetry profile. Left) % contribution. Right) average depth for each segment. To maximise ease of interpretation presentation, all segments are shown as equal width stacked bar plots, rather than using distance travelled. Bathymetry is shown by a line plot.

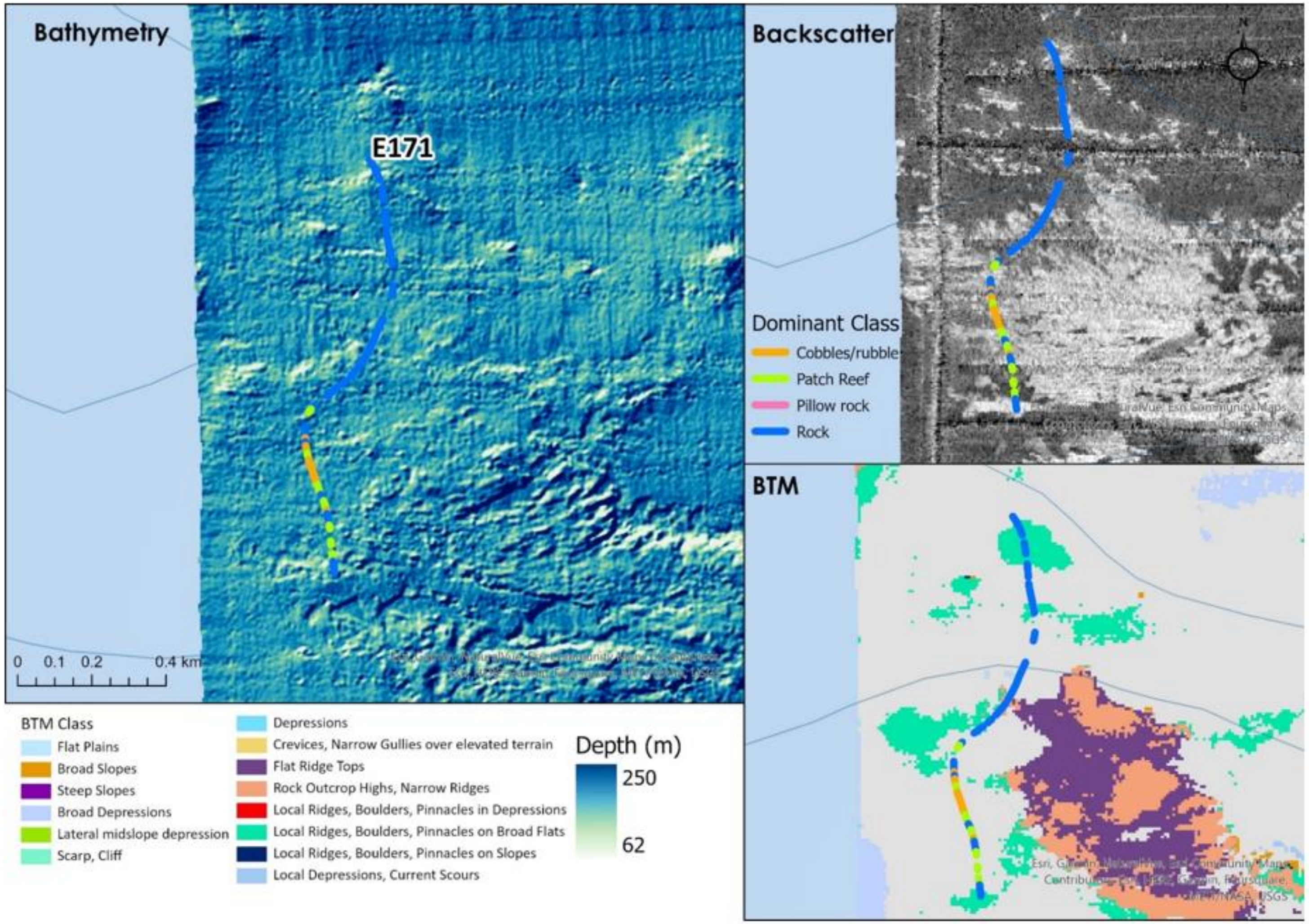

Figure 3-49: Box 7 finer scale map of bathymetry, backscatter, and BTM classification. Associated DTIS stations are E171. The dominant rock type/class in each segment is plotted, with all 'hard rock' classes summed together; the exceptions being cobbles/rubble (combined here) and patch reef, displayed independently to give an idea of general reef composition. Segments with no rock contribution are not plotted.

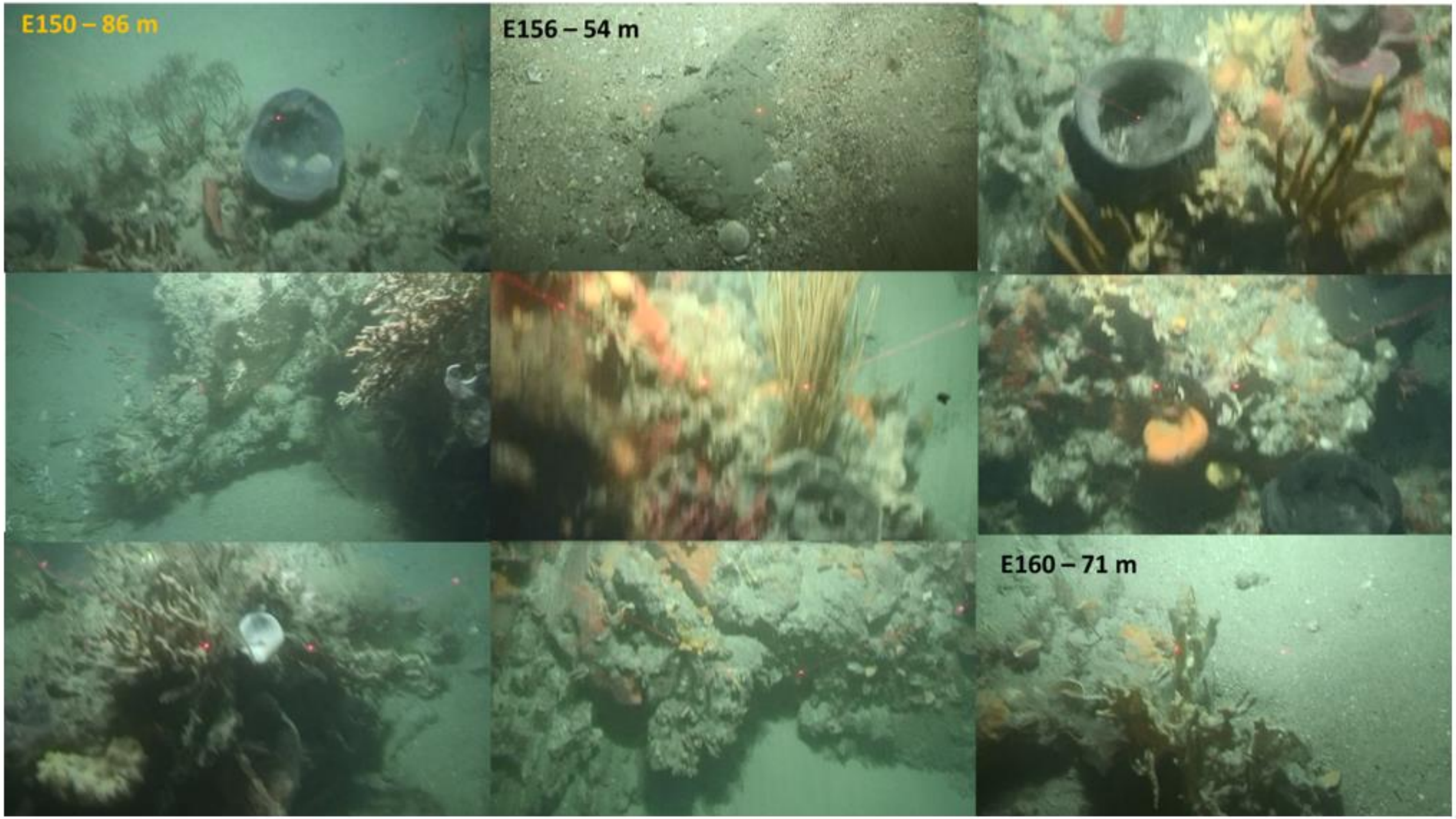

Figure 3-50: Box 7 seafloor imagery from stations 150, 156, and 160.

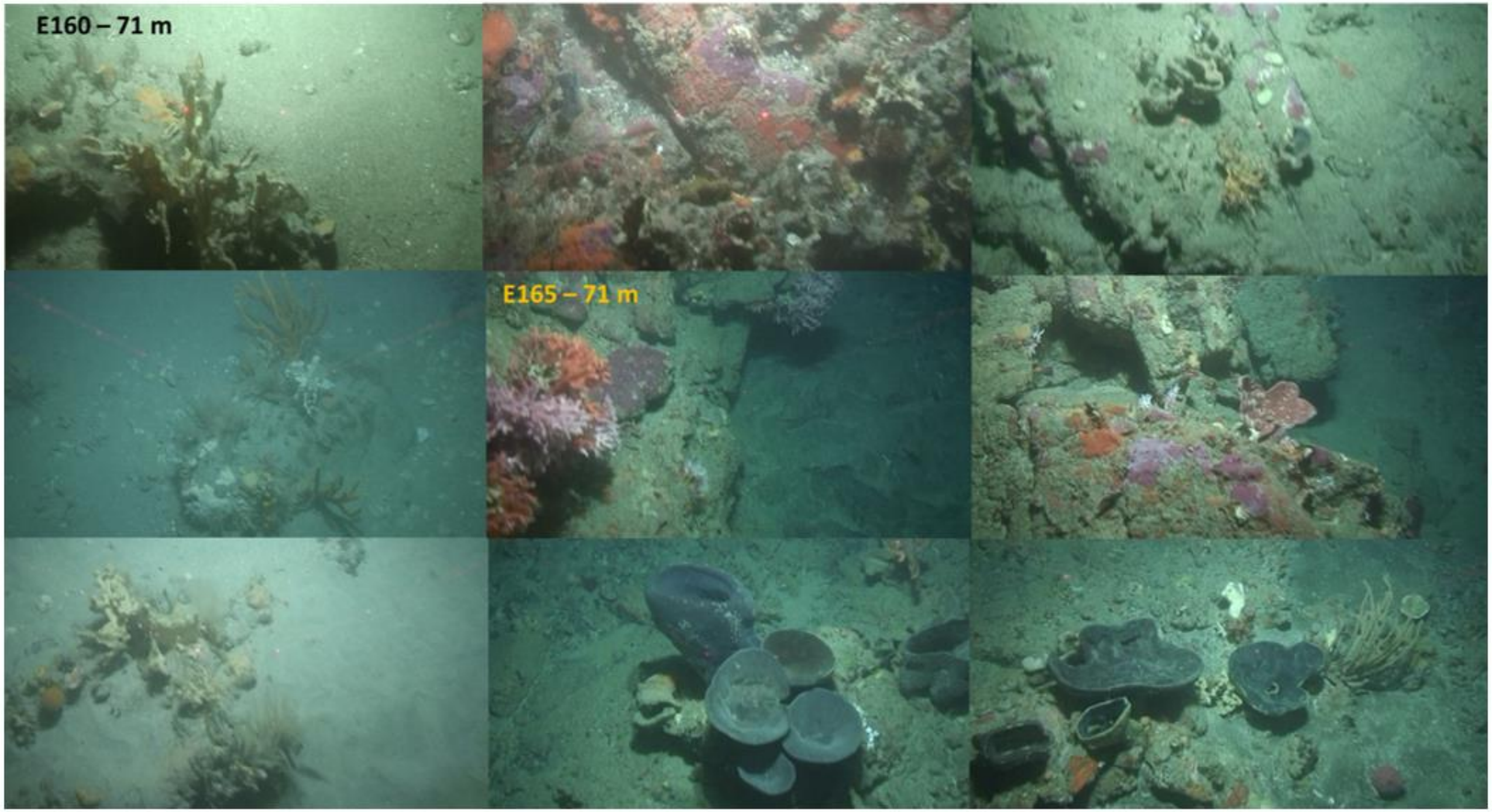

Figure 3-51: Box 7 seafloor imagery from station 160 continued, and station 165.

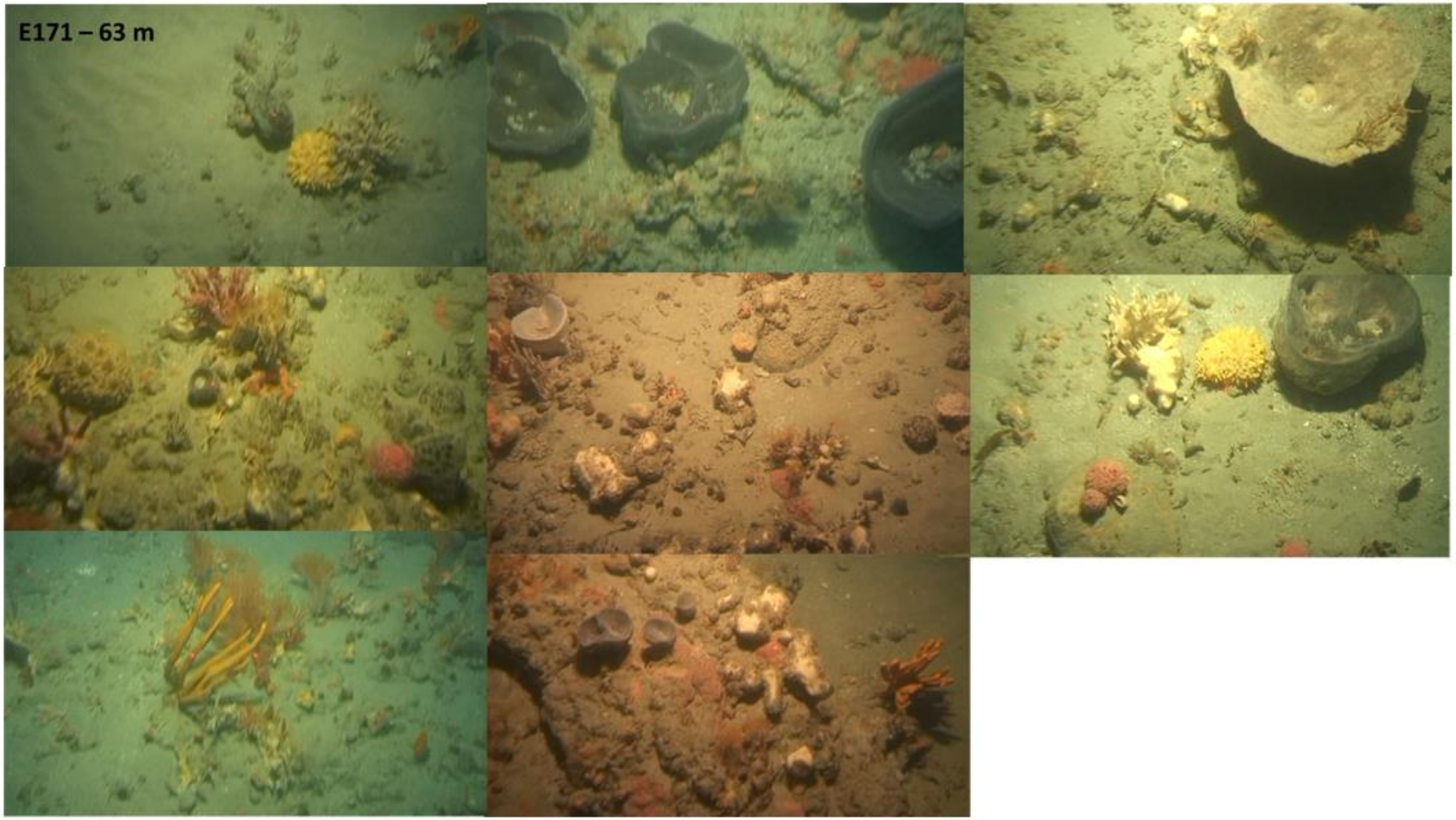

Figure 3-52: Box 7 seafloor imagery from station 171.

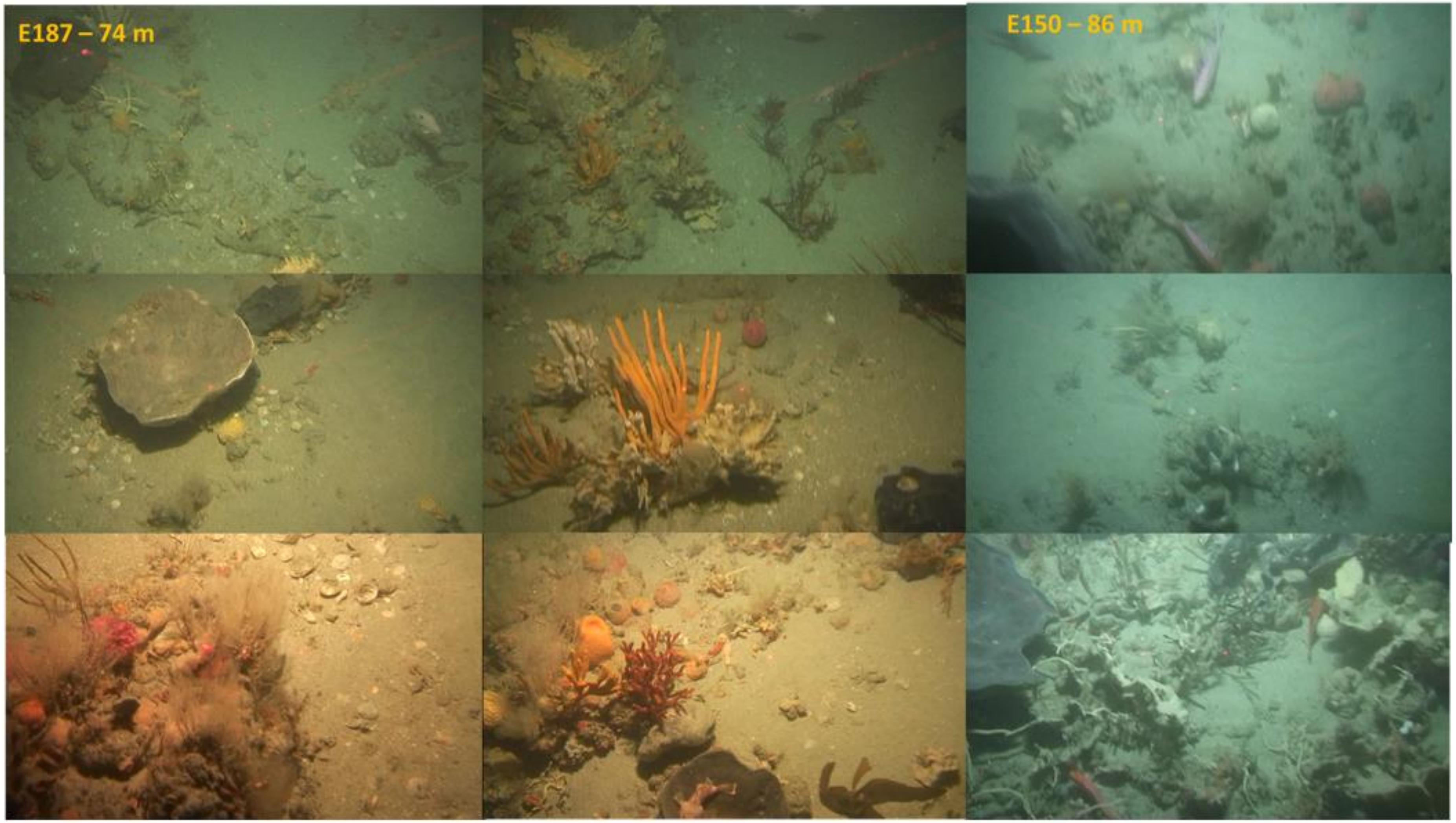

Figure 3-53: Box 7 seafloor imagery from station 187.

Stations 163, 167, 168, 179

Four stations were located on an area of intermediate strength backscatter return with low bathymetric variation east of North Cape (Figure 3-44). The BTM classed this area as largely 'flat plains', with some limited contribution of 'local ridges, boulders, pinnacles on broad flats'. However, most of this latter class was a data processing artefact, its distribution matching the survey vessel's north-south tracks (this artifact was also present in other Box regions). Rock cover was close to zero for these stations, with some very limited cover of low basement and low broken rock (0–4%) (Table 3-1, Figure 3-54). Site 179 had a mudstone rock class cover of 7%. Based on the widespread occurrence of rock associated epifauna and indications of rock buried under a sand veneer, a 'sand veneer on rock' class was used to capture this habitat type (see methods section). The sand veneer on rock cover ranged from 48 to 82% across the four stations.

Figure 3-55–58 show the range of fauna present across the four stations. The limited mudstone rock present at station 179 held relatively low epifaunal density (80/100m^2, richness 20), dominated by sponges (68/100m^2, richness 16) (Table 3-10). The main taxa were unidentified upright sponges (22/100m^2), with the grey sponge *Ecionemia alata*, the finger sponge *Callyspongia* sp., hexactinellid sponges and *Dendrilla rosea* (all 6/100m^2). Corals were uncommon, with a density of 11/100m^2, richness 3, with the main taxa being Gorgonacea (6/100m^2) and *Flabellum* (4/100m^2).

Mobile invertebrate densities were low at 6/100m^2, richness 3, with the three OTUS contributing all being sea cucumbers (*Holothuria integra* 4/100m^2, unidentified holothurian 2/100m^2, and *Australostichopus mollis* <1/100m^2). Fish density was 4/100m^2, richness 6, the dominant taxa being sea perch (2/100m^2). Unidentified bony fish, butterfly perch and pink maomao were all 1/100m^2.

The sand veneer over rock habitat generally held similar sessile epifauna densities (62–179/100m^2, richness 36–52) and was dominated by sponges (55–130/100m^2, richness 25–41). The main sponge taxa were unidentified upright sponges (33–77/100m^2), *Ecionemia alata* (1–5/100m^2), and *Axinella australiensis* 0–18/100m^2). Corals were uncommon (3–9/100m^2, richness 5–9), with the main contributors being Gorgonia (<1–5/100m^2).

Mobile invertebrate densities were low at 1–2/100m^2, richness 4–8, with the main species being the sea cucumber *Holothuria integra* (1–2/100m^2). Fish density ranged from 4–5/100m^2, richness 12– 13, dominated by unidentified bony fish (1–2/100m^2), sea perch (1–3/100m^2, and pink maomao 1–2/100m^2.

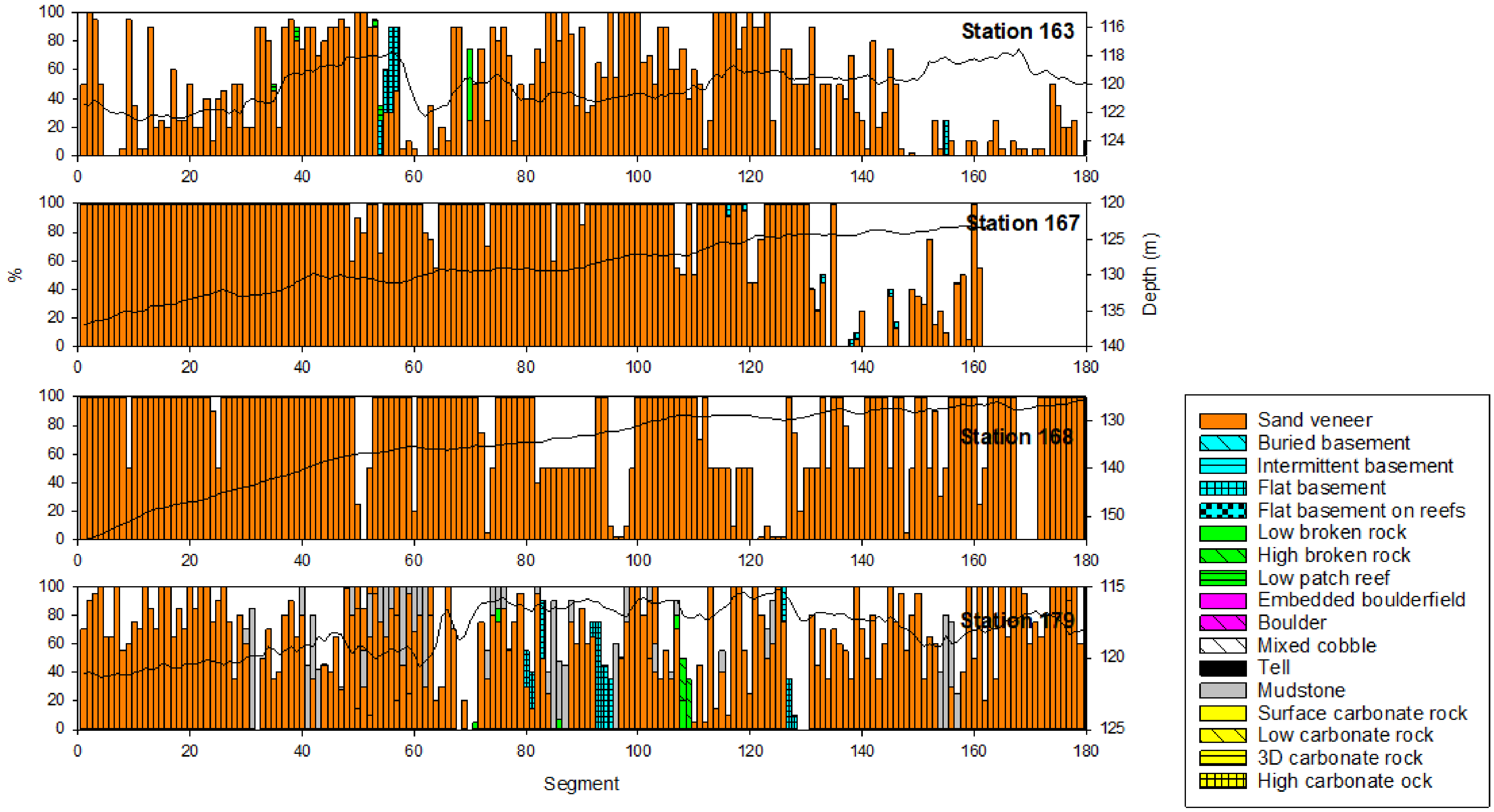

Figure 3-54: Along transect profiles (stations 163, 167, 168, 179) showing rock geomorphology class contributions by 20-second segment and associated bathymetry profile. Left) % contribution. Right) average depth for each segment. To maximise ease of interpretation presentation, all segments are shown as equal width stacked bar plots, rather than using distance travelled. Bathymetry is shown by a line plot.

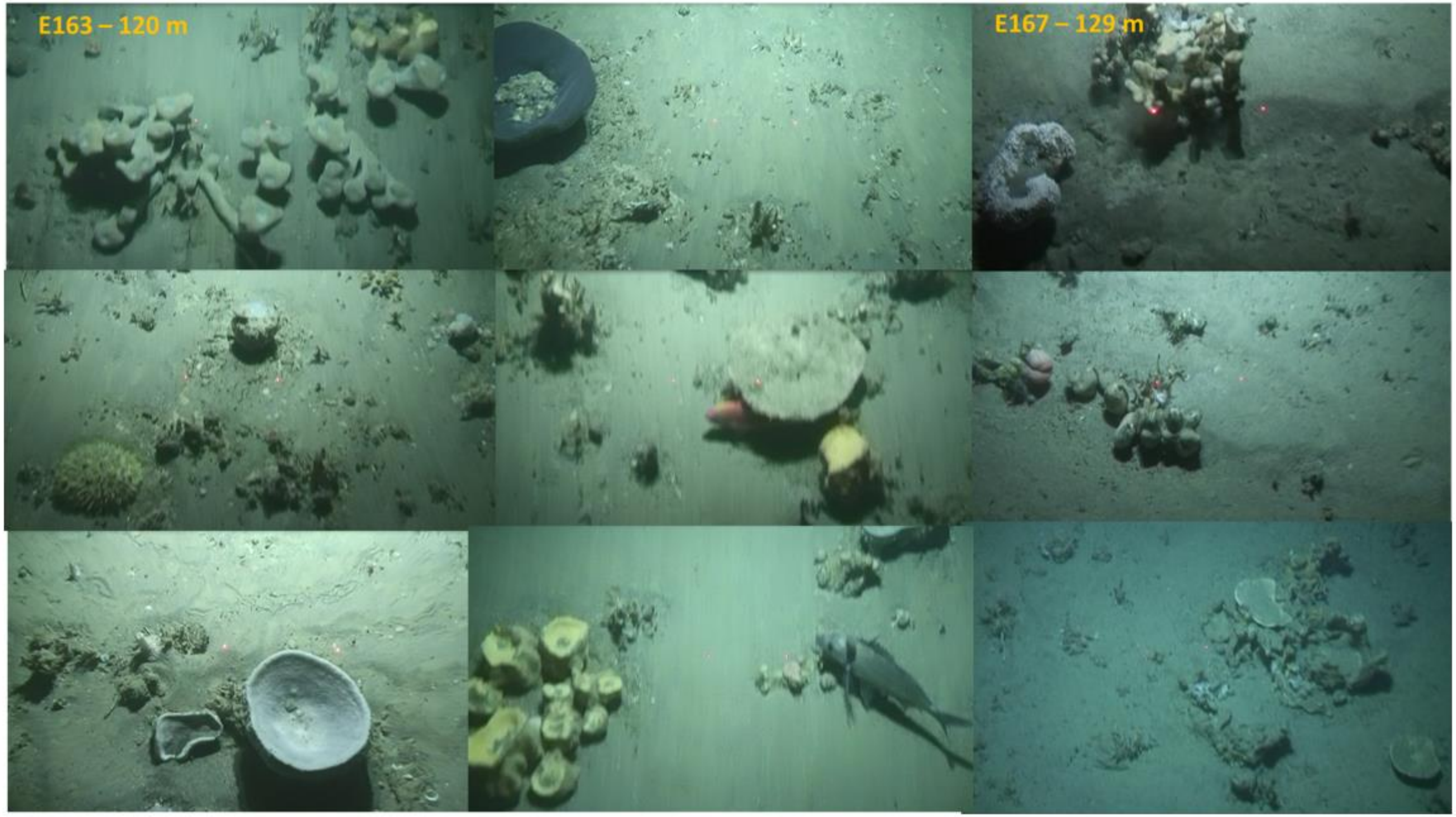

Figure 3-55: Box 7 seafloor imagery from stations 163 and 167.

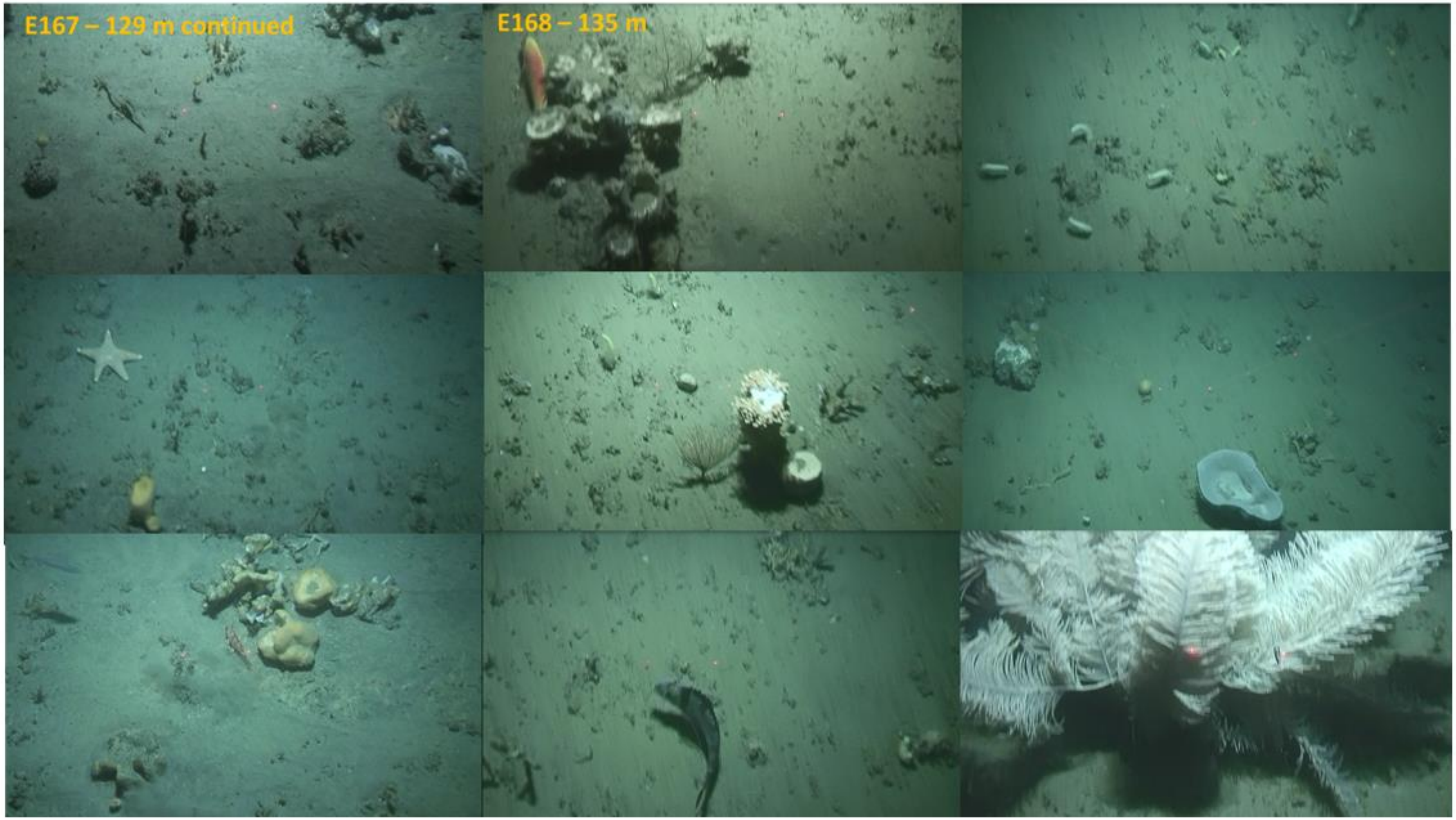

Figure 3-56: Box 7 seafloor imagery from station 167 continued and 168.

Figure 3-57: Box 7 seafloor imagery from station 179.

3.4 Individual OTU, and faunal assemblages across East Northland

Density and OTU richness plots by depth and distance north for sponges and corals, and for sessile invertebrates, mobile invertebrates, and fishes are given in Figure 3-58 and Figure 3-59 respectively. Figure 3-60 to Figure 3-65 show the relationships with depth and distance north for the most abundant species. No attempt to fit relationships was undertaken.

3.4.1 Sessile invertebrates

An nMDS plot of the sessile invertebrate assemblage is given in Figure 3-65, colour-coded by box and depth band respectively. Some separation of stations by both factors was apparent. A two-way PERMANOVA found significant differences for both box (Pseudo-F 1.5585, P 0.03) and depth band (Pseudo-F 1.781, P 0.028) factors, but not for their interaction (Pseudo-F 1.3373, P 0.11). Pair-wise tests for the factor box failed to find any significant differences for any of the comparisons between boxes (Table 3-11). Pair-wise tests for the factor depth band found only one significant difference, between the 50 to 74 m, and 100 to 124 m depth bands (Table 3-12). An examination of which OTUs contributed the most dissimilarity between the two depth bands identified thirteen species that contributed 2% or more, dominated by sponges (Table 3-13). The glass sponge *Symplectella rowi* was the greatest contributor, with higher densities in deeper water, with other OTUs also being more abundant in deeper water including the sponges *N. fulvodesmus*, *Aciculites pulchra,* and *Axinella australiensis*. Other OTUs more abundant in deeper water included bryozoans, hydroids, and the corals Desmophyllum/ Caryophyllia and S*tylasteridae*. OTUs more abundant in shallower water included the sponges *Ecionemia alata*, encrusting sponges, *Iophon minor*, and *Leucettusa* sp.

A comparison of the sessile invertebrate assemblages between carbonate rock stations, and hard rock stations that fell within the same depth band (100–124 m) showed no visual evidence of differences in the associated nMDS plot (Figure 3.65). A one-way PERMANOVA found no statistical difference between the two rock types (Pseudo-F 1.5585, P 0.03).

3.4.2 Mobile invertebrates

An nMDS plot of the mobile invertebrate assemblage is given in Figure 3-66, colour-coded by box and depth band respectively. No separation of stations by either factor was apparent. A two-way PERMANOVA found no significant differences for box (Pseudo-F 1.2943, P 0.165), depth band (Pseudo-F 0.6852, P 0.823), or their interaction (Pseudo-F 0.8645, P 0.700).

A comparison of the sessile invertebrate assemblages between carbonate rock stations, and hard rock stations that fell within the same depth band (100–124 m) showed no visual evidence of differences in the associated nMDS plot (Figure 3-66). A one-way PERMANOVA found no statistical difference between the two rock types (Pseudo-F 0.6960, P 0.776).

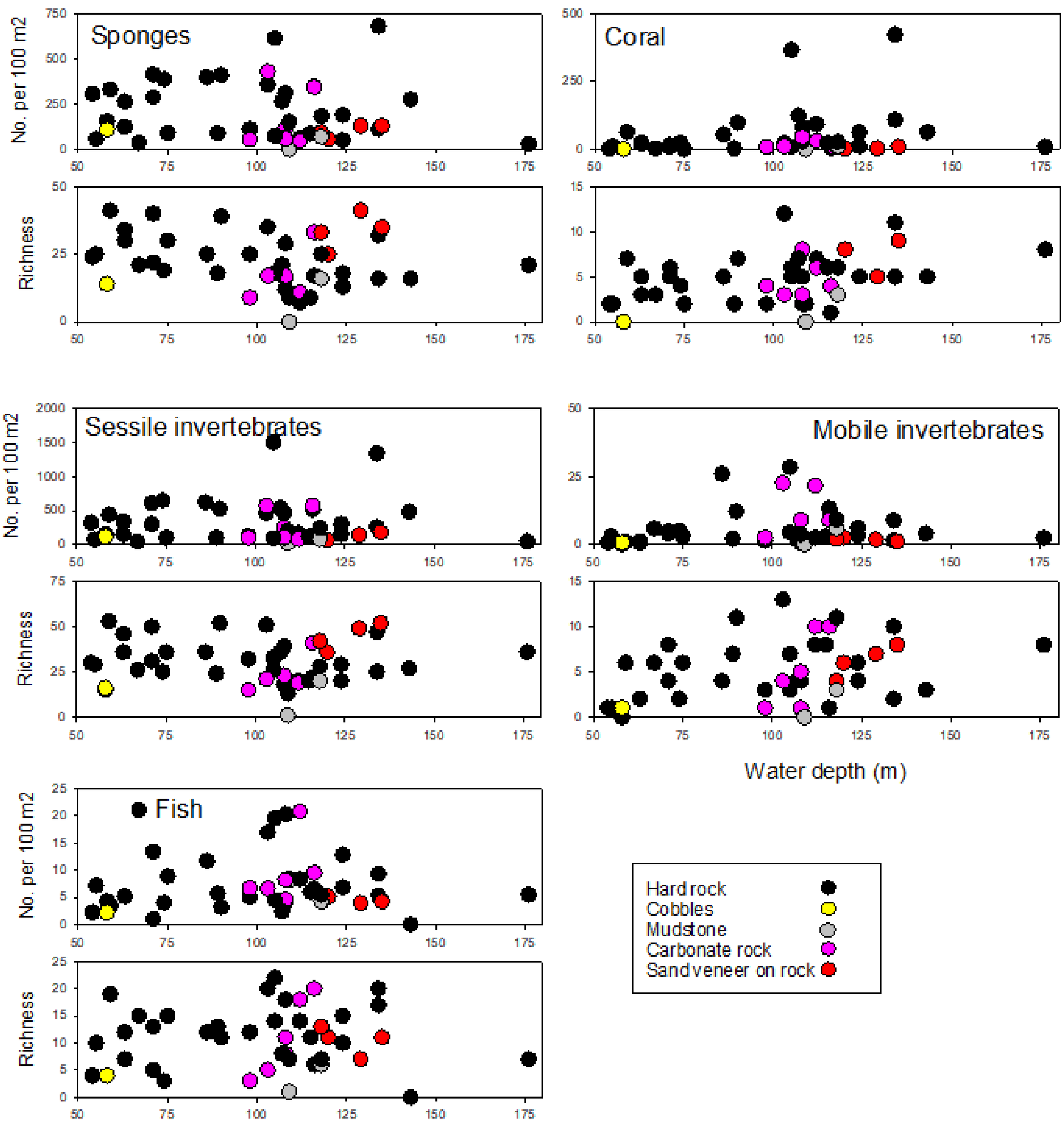

Figure 3-58: Density and OTU richness plots by depth (m): for sponge, coral, all sessile invertebrates, mobile invertebrates, and fish. Colours denote rock type. Densities are expressed as number per 100 m^2, while richness is the total number of unique OTU's seen at a station.

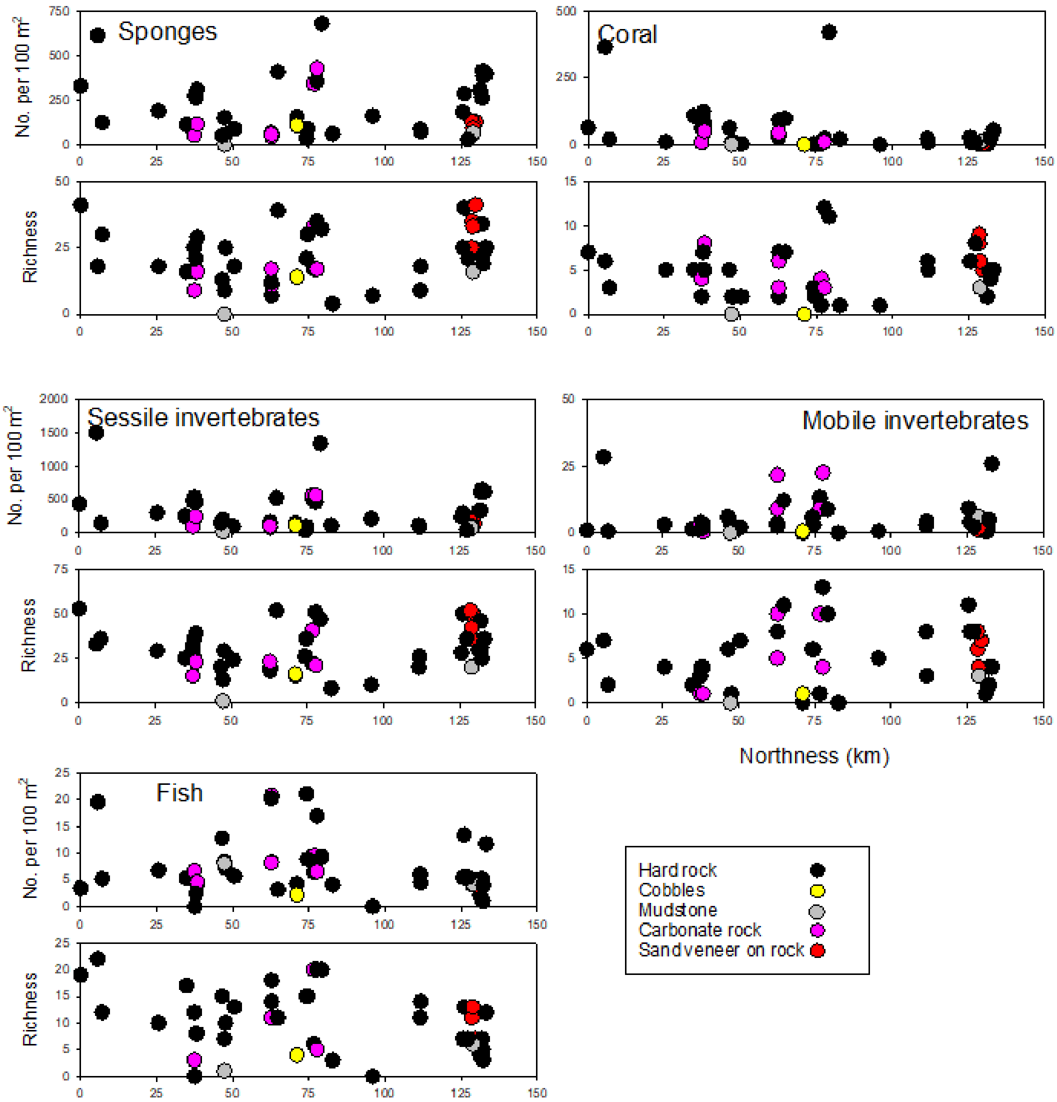

Figure 3-59: Density and richness plots by northness (km): for sponge, coral, all sessile invertebrates, mobile invertebrates, and fish. Colours denote rock type. Densities are expressed as number per 100 m^2, while richness is the total number of unique OTU's seen at a station.

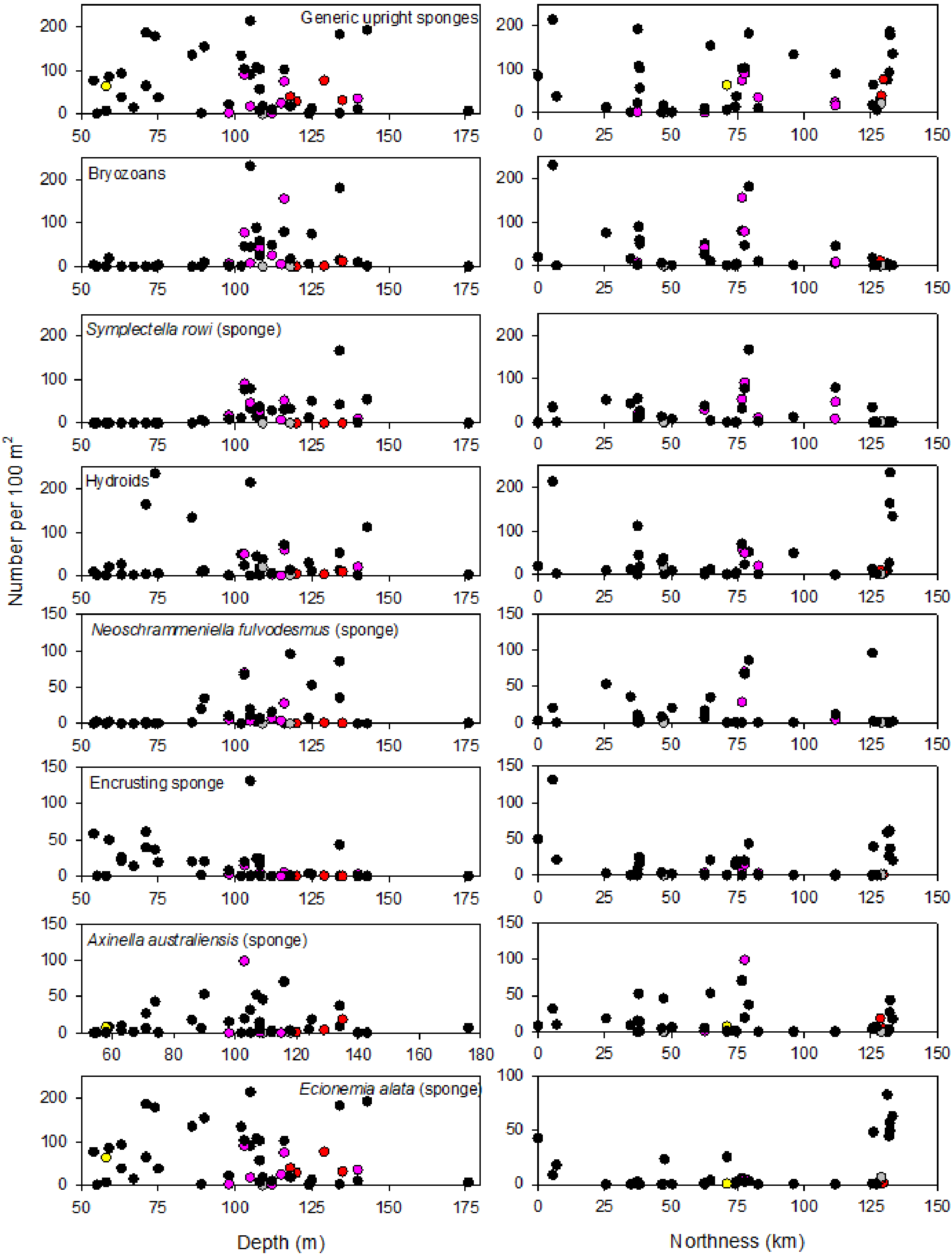

Figure 3-60: Density per 100 m² by depth (left) and northness (right), for the eight most abundant sessile invertebrate OTUs. Colours denote rock type. Densities are expressed as number per 100 m². See Figure 3-59 for rock type colour key.

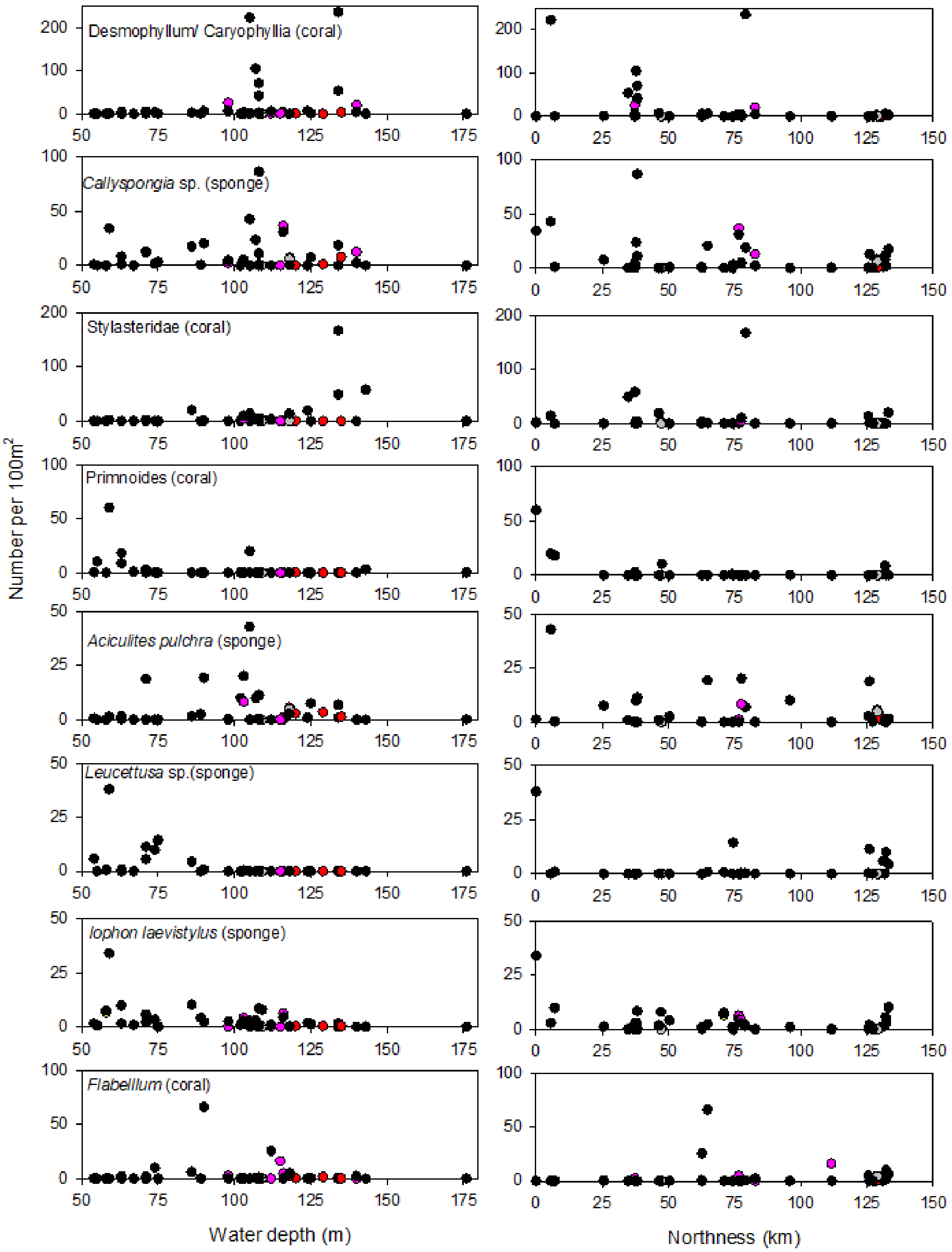

Figure 3-61: Density per 100 m^2 by depth (left) and northness (right), for the nineth to sixteenth most abundant sessile invertebrate OTUs. Colours denote rock type. Densities are expressed as number per 100 m^2. See Figure 3-59 for rock type colour key.

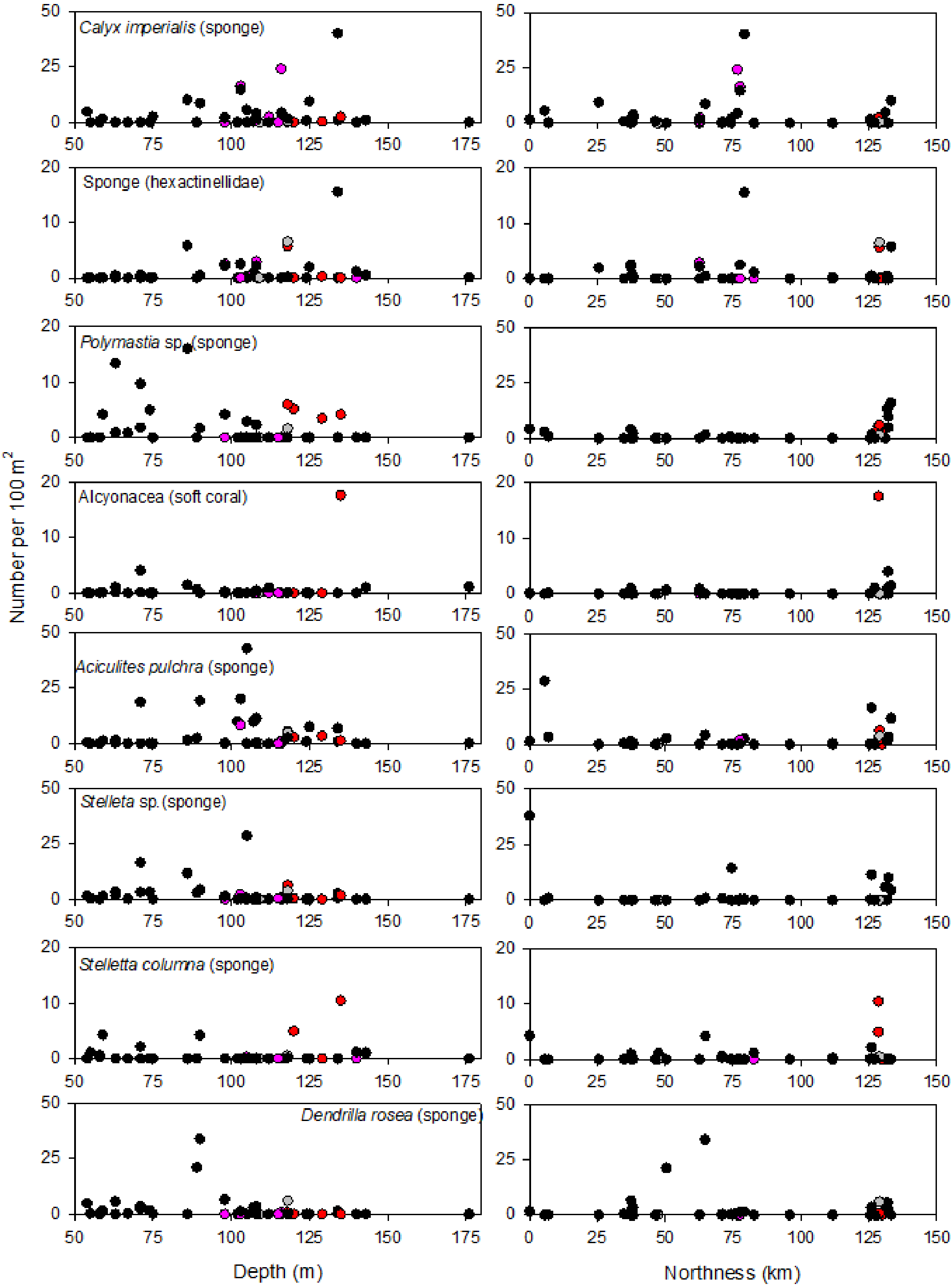

Figure 3-62: Density per 100 m² by depth (left) and northness (right), for the seventeenth to twenty fourth most abundant sessile invertebrate OTUs. Colours denote rock type. Densities are expressed as number per 100 m². See Figure 3-59 for rock type colour key.

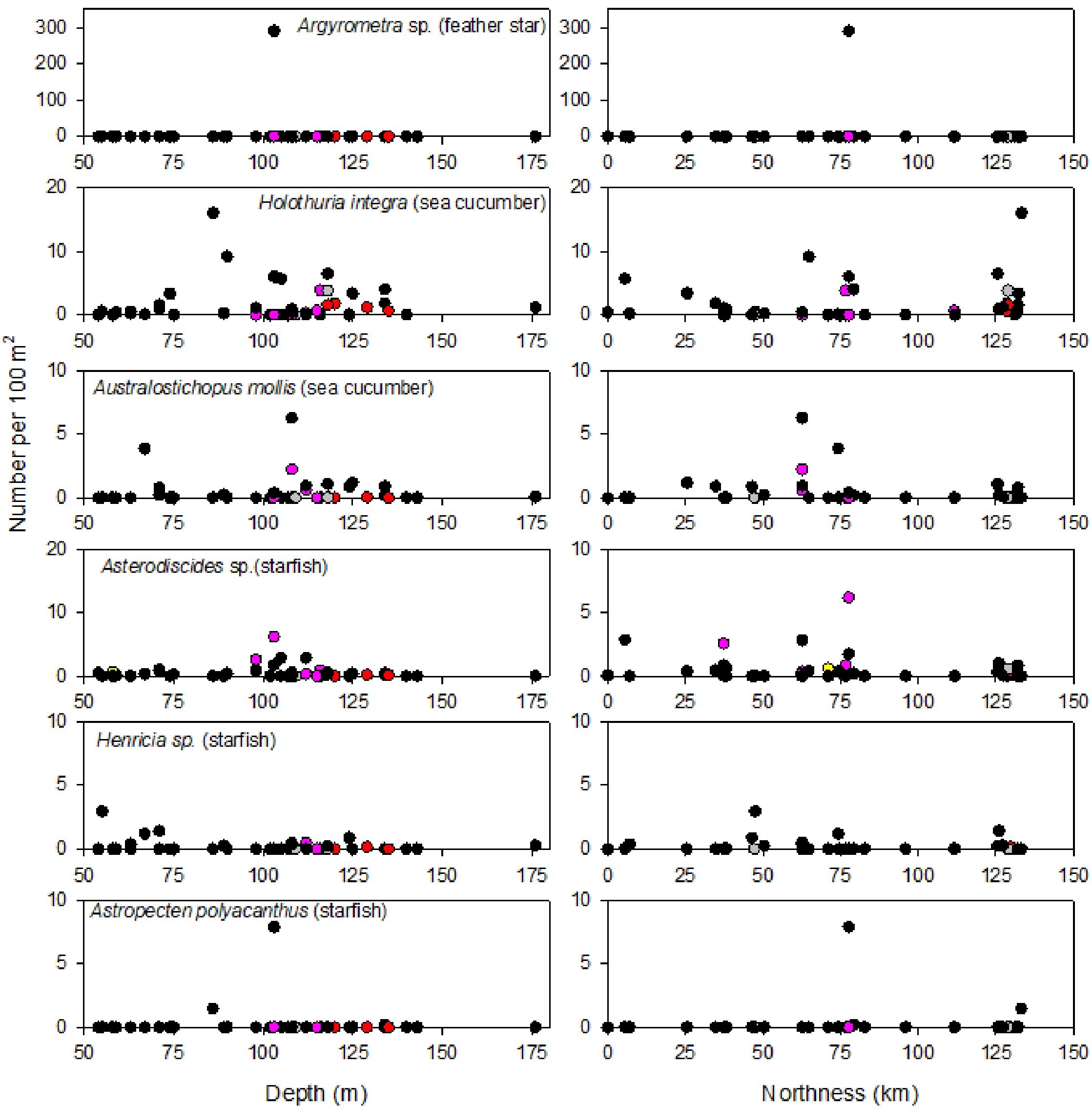

Figure 3-63: Density per 100 m^2 by depth (left) and northness (right), for the six most abundant mobile invertebrate OTUs. Colours denote rock type. Densities are expressed as number per 100 m^2. See Figure 3-59 for rock type colour key.

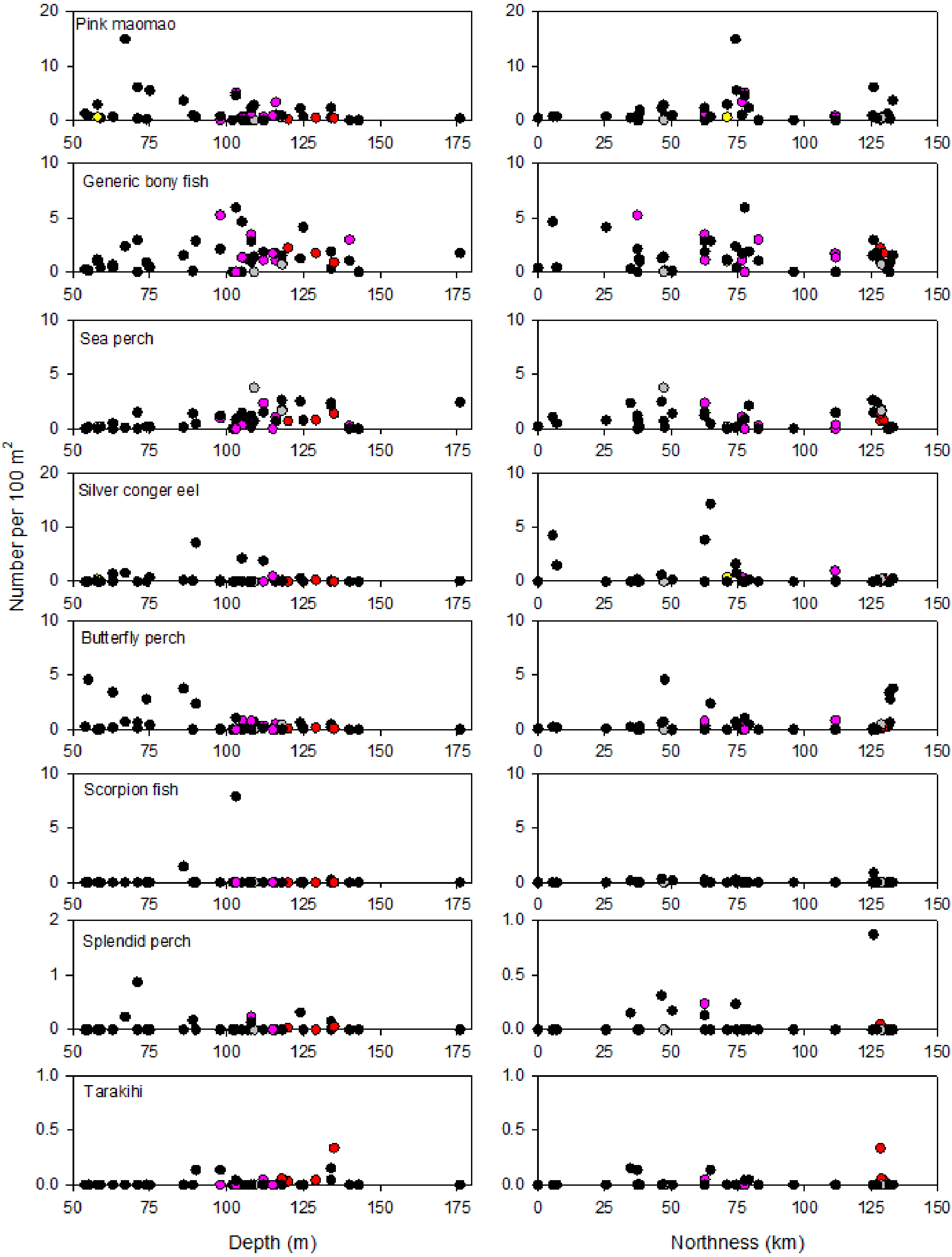

Figure 3-64: Density per 100 m^2 by depth (left) and northness (right), for the five most abundant fish OTUs, and the three most abundant fished species below that. Colours denote rock type. Densities are expressed as number per 100 m^2. See Figure 3-59 for rock type colour key.

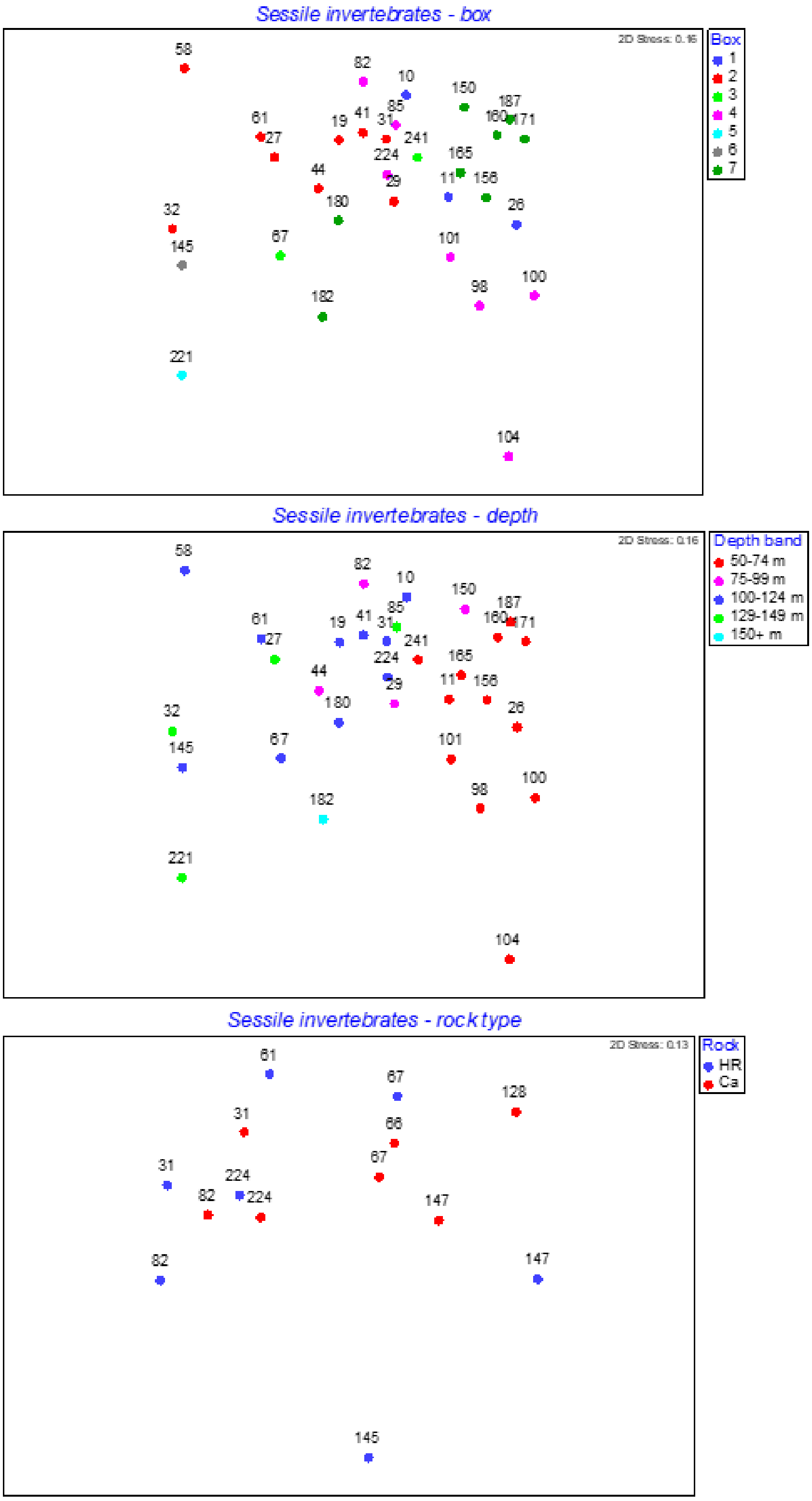

Figure 3-65: nMDS plots of sessile invertebrates by box, depth band and rock type. Top two plots) colour-coded by box and depth band respectively. Bottom plot) contrasting hard-rock and carbonate rock stations within the 100-124 metre depth band. HR, hard rock, Ca, carbonate rock. Station identifiers are shown.

Table 3-11: Pair-wise comparisons between boxes for sessile invertebrates. Significant differences are bolded. Perms, permutations.

Box comparisons	t	P(perm)	Perms
1, 2	1.0583	0.338	990
1, 3	1.1664	0.2	15
1, 4	0.90311	0.571	977
1, 5	No test, df = 0		
1, 6	1.5982	0.167	3
1, 7	1.0936	0.351	985
2, 3	1.2236	0.199	985
2, 4	1.2283	0.164	999
2, 5	1.3593	0.105	931
2, 6	1.4099	0.101	873
2, 7	1.1969	0.176	999
3, 4	0.7505	0.687	654
3, 5	No test, df = 0		
3, 6	No test		
3, 7	0.8965	0.584	811
4, 5	1.2928	0.23	235
4, 6	1.1367	0.334	241
4, 7	1.2039	0.238	998
5, 6	No test, df = 0		
5, 7	No test, df = 0		
6, 7	1.5441	0.083	408

Table 3-12: Pair-wise comparisons between depth bands for sessile invertebrates. Significant differences are bolded. Perm, permutations.

Group comparison		t	P(perm)	Perms
50-74 m	75-99 m	1.3575	0.116	999
50-74 m	100-124 m	1.6224	**0.008**	999
50-74 m	125-149 m	1.5035	0.116	999
50-74 m	150+ m	1.7388	0.058	998
75-99 m	100-124 m	1.0906	0.35	999
75-99 m	125-149 m	1.0642	0.461	597
75-99 m	150+ m	1.6657	0.181	15
100-124 m	125-149 m	0.69606	0.732	992
100-124 m	150+ m	0.99213	0.449	541
125-149 m	150+ m	No test, df = 0		

Table 3-13: Sessile invertebrate OTU contributions to dissimilarity between depth bands. Abundances are the fourth-root transformations of the original raw values (inds/100 m^2).

	Depth band	50-74 m	100-124 m				
Group	Species	Average abundance	Average abundance	Av. Diss	Diss/SD	Contrib. %	Cum.%
Sponge	*Symplectella rowi*	0.11	2.25	2.82	2.73	4.57	4.57
Sponge	*Ecionemia alata*	2.17	0.56	2.2	1.74	3.56	8.13
Bryozoan	Bryozoan	0.65	2.21	2.17	1.68	3.51	11.64
Sponge	*N. fulvodesmus*	0.47	1.66	1.82	1.37	2.95	14.59
Sponge	Encrusting sponges	2.15	1.35	1.75	1.23	2.83	17.42
Hydroid	Hydroid	1.81	2.28	1.54	1.13	2.5	19.91
Coral	Desmophyllum/ Caryophyllia	0.65	1.34	1.52	1.14	2.45	22.37
Sponge	*Iophon minor*	1.24	0.18	1.49	1.63	2.41	24.77
Sponge	*Aciculites pulchra*	0.65	1.4	1.44	1.34	2.33	27.1
Sponge	*Leucettusa* sp.	1.16	0.14	1.39	1.35	2.24	29.35
Sponge	*Callyspongia* sp.	1.3	1.28	1.36	1.34	2.21	31.55
Sponge	*Axinella australiensis*	1.43	1.8	1.31	1.24	2.12	33.67
Coral	Stylasteridae	0.29	1.06	1.28	1.09	2.06	35.73

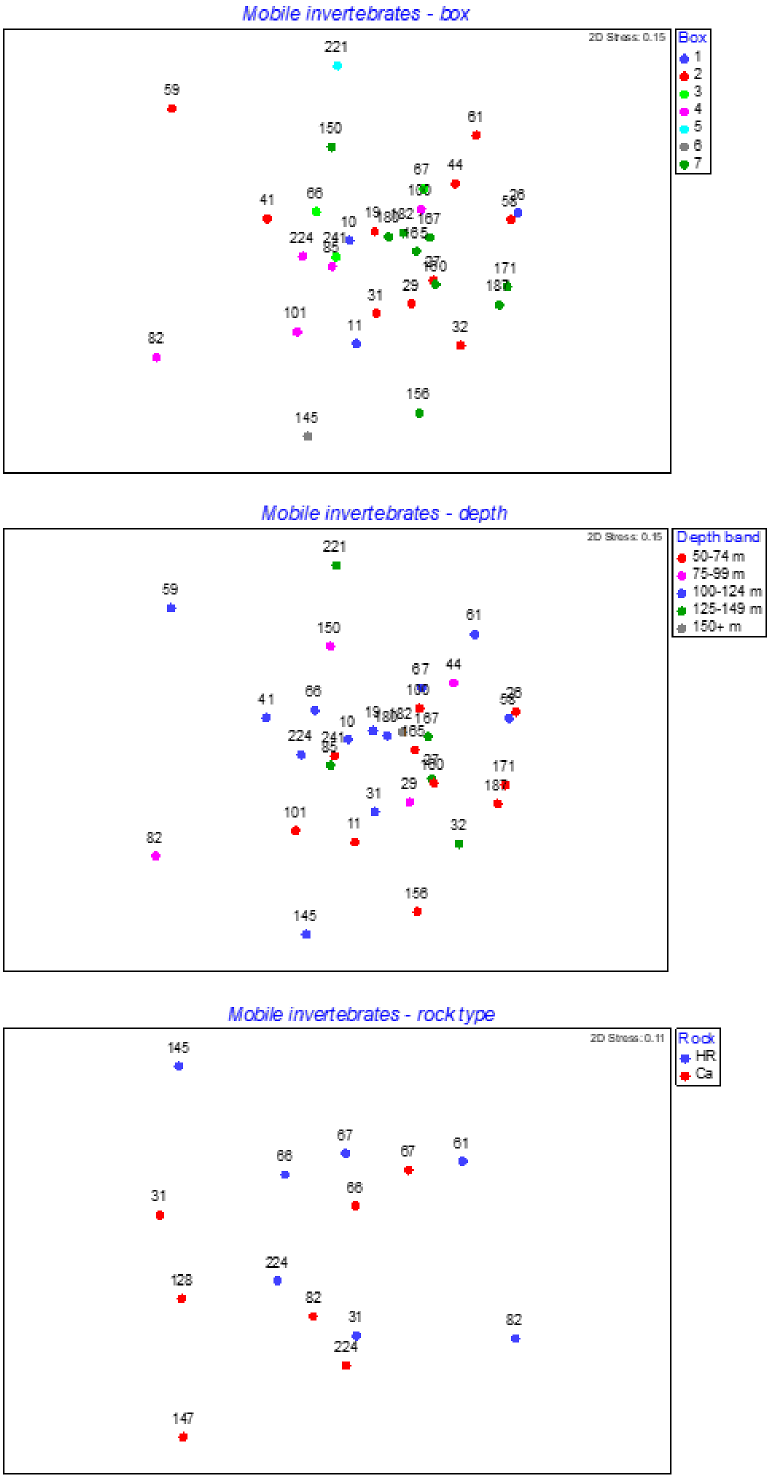

Figure 3-66: nMDS plots of mobile invertebrates by box, depth band and rock type. Top two plots) colour-coded by box and depth band respectively. Bottom plot) contrasting hard rock and carbonate stations, within the 100-124 m depth band. HR, hard rock, Ca carbonate rock. Station identities are shown.

3.4.3 Fishes

An nMDS plot of the fish assemblage is given in Figure 3-67, colour-coded by box and depth band respectively. Some separation of stations by both factors was apparent, especially with depth. A two-way PERMANOVA found significant differences for both box (Pseudo-F 1.8126, P 0.032) and depth band (Pseudo-F 1.6687, P 0.046) factors, but not for their interaction (Pseudo-F 0.6507, P 0.956). Pair-wise tests for the factor box failed to find any significant differences for any of the comparisons between boxes, possibly due to the limited number of unique permutations available (Table 3-14). Pair-wise tests for the factor depth band found only one significant difference, between the 50 to 74 m, and 100 to 124 m depth bands (Table 3-15) (the same as seen for sessile invertebrates). An examination of which OTUs contributed the most dissimilarity between the two depth bands identified fifteen species that contributed 3% or more (Table 3-16). Sea perch was the greatest contributor, with higher abundances in shallower water. Other species also seen in greater abundance in shallower water included bony fish, silver conger eels, and scorpion fish, while yellow weaver, red bandfish and cucumber fish were only seen in the shallower depth band. OTUs more abundant in the deeper depth band included butterfly perch, pink maomao, slender roughy, and leatherjackets. Red mullet was only seen in the deeper depth band.

A comparison of the fish assemblages between carbonate rock stations, and hard rock stations that fell within the same depth band (100–124 m) showed no visual evidence of differences in the associated nMDS plot (Figure 3-67). A one-way PERMANOVA found no statistical difference between the two rock types (Pseudo-F 0.4177, P 0.899).

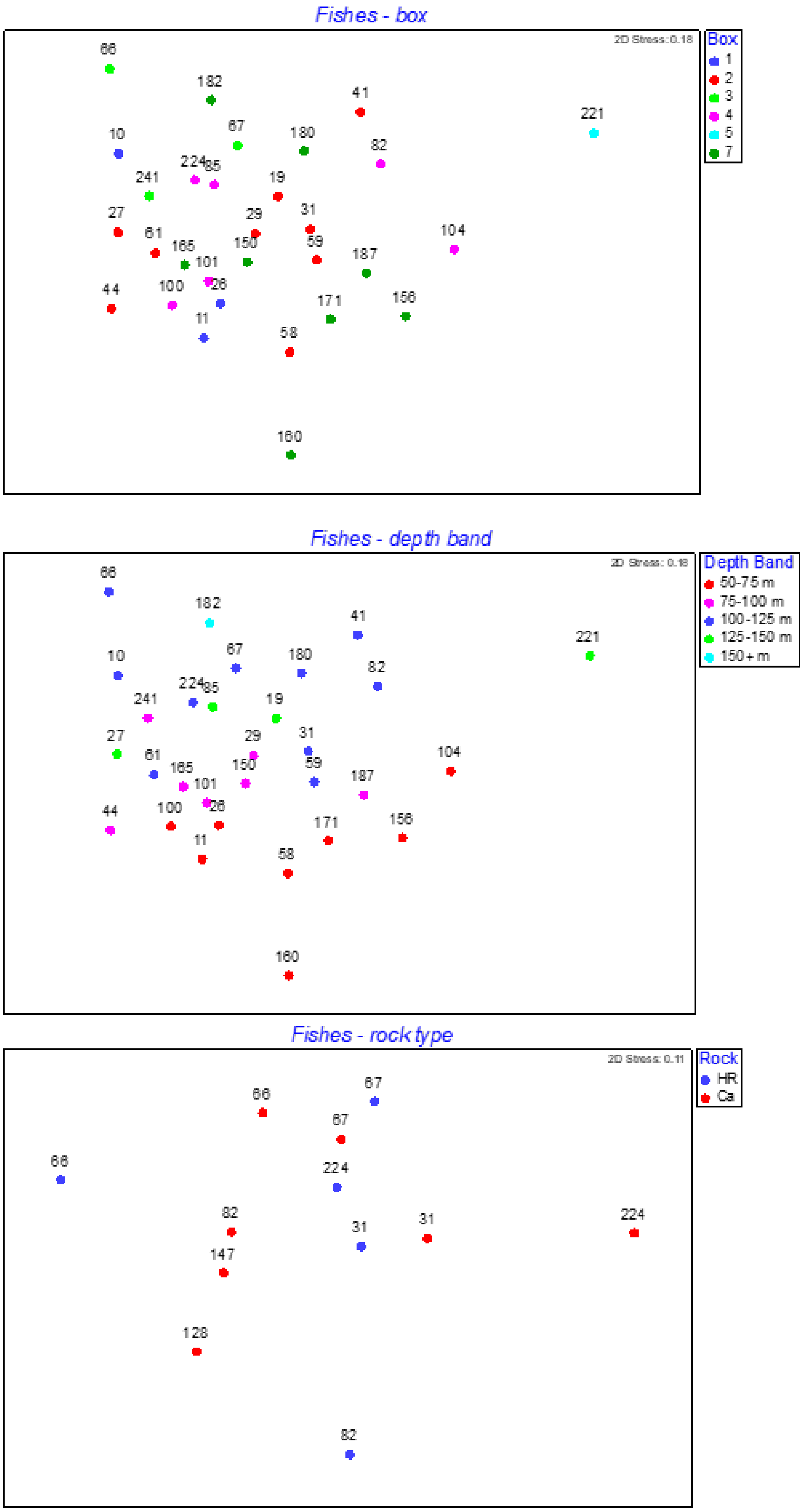

Figure 3-67: nMDS of fish by box, depth band and rock type. Two top plots) colour-coded by box and depth band respectively. Bottom plot) contrasting hard rock and carbonate rock stations, within the 100-124 m depth band. HR, hard rock, Ca, carbonate rock. Station identities are shown.

Table 3-14: Pair-wise comparisons between boxes for fishes. Significant differences are bolded. Perms, permutations.

Box comparisons	t	P(perm)	Perms
1, 2	1.2763	0.121	219
1, 3	1.2788	0.201	10
1, 4	1.1717	0.182	84
1, 5	2.1401	0.251	4
1, 7	1.4488	0.081	165
2, 3	1.1545	0.238	217
2, 4	1.0372	0.373	887
2, 5	1.8871	0.093	10
2, 7	1.0567	0.325	974
3, 4	1.2524	0.133	84
3, 5	1.7239	0.267	4
3, 7	1.5103	0.051	165
4, 5	1.6278	0.128	7
4, 7	0.9823	0.433	861
5, 7	1.6699	0.102	9

Table 3-15: Pair-wise comparisons between depth bands for fishes. Significant differences are bolded. Perms, permutations.

Group comparison		t	P(perm)	Perms
50-74 m	75-99 m	1.2898	0.129	916
50-74 m	100-124 m	1.8458	**0.001**	986
50-74 m	125-149 m	1.4594	0.052	429
50-74 m	150+ m	1.3957	0.116	9
75-99 m	100-124 m	1.1683	0.166	976
75-99 m	125-149 m	1.0943	0.267	319
75-99 m	150+ m	1.1815	0.228	8
100-124 m	125-149 m	0.70445	0.934	649
100-124 m	150+ m	0.99081	0.537	11
125-149 m	150+ m	0.82478	0.585	5

Table 3-16: Fishes OTU contributions to dissimilarity between depth bands. Abundances are forth-root transformations of the original raw values (inds./100m^2).

Depth band	50-74 m	100-124 m				
Species	Average abundance	Average abundance	Av. Diss	Diss/SD	Contrib. %	Cum.%
Sea perch	1	0.33	5.39	1.32	9.06	9.06
Butterfly perch	0.54	0.81	3.95	1.07	6.64	15.7
Pink maomao	0.92	1.08	3.47	0.99	5.83	21.53
Bony fish	1.2	0.76	3.4	1.1	5.71	27.24
Red mullet	0	0.47	3.07	1.14	5.15	32.4
Slender roughy	0.37	0.43	3.03	1.05	5.1	37.5
Leatherjacket	0.31	0.39	2.95	1.11	4.96	42.45
Silver conger eel	0.37	0.28	2.81	0.83	4.72	47.17
Scorpionfish	0.38	0.24	2.68	1.07	4.51	51.69
Yellow weaver	0.28	0	2.23	0.72	3.74	55.43
Red bandfish	0.36	0	2.17	0.62	3.64	59.07
Common roughy	0.28	0.07	2.11	0.78	3.54	62.61
Moridae	0.27	0.2	2	0.98	3.36	65.97
Cucumber fish	0.34	0	1.96	0.77	3.3	69.27
Trevally	0.17	0.07	1.87	0.51	3.13	72.4

4 Discussion

The East Northland OS2020 survey of 2008/09 revealed extensive areas of deep reef habitat on the continental shelf in 50–180 metres depth. These were present along the entire coast, interspersed with extensive soft sediment plains, and in some areas extended 7 to 14 kilometres offshore from the 50 metre depth contour. The dominant rock type was a ‘hard-looking’ rock, which formed both flat and more rugged surfaces, and occurred as patch reefs (<1 m^2), small boulders, flat basements both buried and emergent, and as low and high broken rock. A consistent feature of these reefs was their very patchy mosaiced nature, often dispersed as numerous small reefs within large flat sediment plains. Full rock cover (100%) was uncommon at the scale of the 20-second segments used as the base sample unit. The BTM model predominantly classed most of these areas as ‘local ridges, boulders, pinnacles on broad flats’, and reef heights seldom exceeded 1 metre (with some exceptions). Some processing artefacts were present for this BTM class, with the survey vessels path and associated stitching together of adjacent multibeam swathes creating ‘structures’ that were not real. Less common, but still seen regularly, was more diverse mixed seafloor topography, classed by the BTM as ‘flat ridges’ and ‘slopes’ that signified larger semi-continuous reef features. These occurred intermittently on the continental shelf, within wider areas of ‘local ridges, boulders, pinnacles on broad flats’. Higher reef complexity was often seen associated with the 50 metre depth zone, relative to reef further offshore, suggesting some fundamental change in the rock geomorphologies within the 50–60 metre depth zone.

Carbonate rock was recorded at eight stations from south of Cape Brett to off Parengarenga Harbour. This rock type had a restricted depth range, only occurring in 108–116 metres depth. Examination of a fragment retrieved by rock dredge suggested it is a calcareous matrix created by colonial animals. Its form on the seafloor when in good condition further supported this hypothesis. This rock was structured into semi-continuous low mounds up to 40 cm high, formed of multiple pillow-like rounded structures, and with vertical holes extending through it. All of the rock edges were smooth; it appeared that as these structures eroded slowly over time, this form becomes more broken and lower in height, and the vertical holes open to form ellipses rather than holes (inferred from different rock states across stations). It is tentatively suggested that these may be relic biogenic structures from a previous seascape, perhaps from when sea-levels were much lower, and/or water temperatures warmer.

East of Cape Brett, a relatively large area of biogenic habitat fauna was found growing on sand veneer over rock, in 100–150 metres depth.

Over three hundred OTU’s were seen on the DTIS video, with the sessile fauna dominated by sponges, corals, hydroids and bryozoans; the mobile invertebrate fauna by sea cucumbers, starfish and gastropods; and the fish fauna by pink maomao, unidentified bony fish, sea perch, and butterfly perch. Variable water clarity and/or video resolution required the use of OTUs that ranged from individual species to family and higher levels.

Comparisons between the carbonate rock reefs, and hard rock reefs within the same depth range, found these two rock types to hold ecological assemblages that were not distinguishable from each other. Comparisons across hard rock reefs did not show any clear consistent differences between boxes, or depth bands. Significant differences occurred between the 50–74 metre and the 100–124 metre depth bands were found for both sessile invertebrates and fish (but not for mobile invertebrates). No obvious explanation is apparent for why these particular two depth bands differed, but the other depth bands did not.

Evidence of likely fishing impacts was observed at a number of stations. Several transects showed clear visual evidence of the passage of trawl nets, through scrape marks on the soft sediment seafloor immediately adjacent to low height reefs. Lost longline backbone monofilament was commonly seen wrapped around or crossing raised rock areas, for both hard rock and carbonate reefs. Some of these lines were encrusted in places, suggesting their persistence in the marine environment for some times. Some larger lost ropes were also observed snagged on higher relief rock outcrops (e.g., off Cape Brett). Sedimentation impacts were inferred from the presence of fine sediments in greater quantities on some of the stations closer to likely land-based run-off, versus more distant stations such as at Cape Brett, Cavalli Islands, and North Cape.

A major and fundamental issue with the survey data was that many organisms could only be assigned to very generic groups such as ‘upright sponge’ or ‘encrusting sponge’, due in large part to poor visual resolution of the DTIS video. Undertaking the survey during a major storm event also meant the DTIS video was also adversely affected by reduced water clarity and large swell heave. Around North Cape, the speed-over-ground was excessive at times causing blurring of the video. This was likely driven by strong currents. Collectively, these effects reduced the taxonomic resolution (and likely associated statistical power) of the faunal data collected.

Since the OS2020 survey in 2009, video technology has significantly improved, and both the DTIS and the newer smaller CoastCam developed by NIWA are equipped with next-generation camera systems. None-the-less, storm events and associated loss of water clarity remain strong impediments to successful video surveys, and if possible surveys should be planned to avoid such events.

The DTIS station allocation to deep reefs was also modest, relative to the size of the East Northland coast. This was in part due to the Bay of Islands OS2020 Tangaroa survey addressing multiple objectives, which required the deployment of a range of sampling gears and targeting of both soft-sediment and rock habitats. BTM was also unavailable in 2009, with DTIS stations being broadly assigned based on seafloor rugosity and backscatter strength. For future surveys looking to quantify deep reef assemblages, if multibeam data is available, it should be processed for BTM classes, and combined with depth and geographic stratification to allocate sampling stations more evenly over the seafloor factors wanting to be tested. This does not negate the value of opportunistic sampling when available, especially in poorly known areas. The one hour DTIS deployments should also be shortened for reef deployments, with shorter, more numerous transects being preferable. The extra station replication from careful station allocations will more than outweigh the increased fixed cost of DTIS deployment and retrieval.

The mismatch between OFOP scoring as a single one-dimensional string, and the two-dimensional nature of the video (three with habitat height/rugosity) remains a fundamental block to generating faunal and floral densities by rock/reef geomorphology class. In this report, we were forced to calculate faunal densities at the scale of the entire transect only, averaging out finer variations due to rock geomorphologies. It was clearly apparent when processing the video footage that many species, and groups of species, were responding to finer scale habitat variation. For instance, individual colonies and thickets of the coral *Oculina virgosa* were largely confined to vertical rock walls; Prinomides spp. corals were predominantly found on the top of rock ridges; and the glass sponge *S. rowe* was most abundant on low reef sides, often associated with sediment. Localised hotspots of epifauna diversity were also seen at the scale of ones to tens of metres.

A technological solution is to move to towed camera systems that allow for video footage to be collected and processed in two dimensions. NIWA is currently building a swathe camera system that will use multiple video cameras mounted on a 'glider' to image a 10-metre wide seafloor swathe, with the ability to measure any objects position in two-dimensions. An associated new approach to video scoring will need to be developed, as OFOP will not be up to the task. Artificial intelligence is also an obvious tool to develop to help this approach, as well as reducing the high labour cost associated with video analysis.

Suggested work using this projects datasets

While the data generated in this project have limitations in terms of taxonomic resolution, a large dataset of spatially explicit faunal observations now exists, nested within the 20-second segments that quantify the relative contributions of different reef geomorphologies. In addition, there are multibeam sonar derived estimates of rugosity, slope, aspect and BTM classes, as well as backscatter strength. These data could be explored to identify the power of multibeam sonar derived variables to identify different fine scale reef habitats, and what ecological assemblages each holds. While taxon resolution was less than ideal, some stations/parts of stations were better due to water clarity and camera height. This subset could be identified, and new video scoring done at those locations to generate spatially explicit data for each geomorphology class. Available still images could also be incorporated into analyses. The power to scale up from these fine scale segment areas to the full reef landscape, based on BTM classes and continuous multibeam variables, could also be explored.

5 Acknowledgements

We thank the skipper, vessel crew, and science team who undertook the Tangaroa voyages in 2009. Previous identification by specialists of taxa from still images was very helpful in supporting the video scoring tasks. We gratefully thank the following taxonomists; Michelle Kelly (sponges), Dennis Gordon (bryozoans), Mike Page (ascidians), Diana Macpherson (hydroids), Di Tracey (corals), Owen Anderson (echinoids and crinoids), Kate Neill (asteroids, sea pens and algae), Sadie Mills (ophiuroids), Geoff Read (polychaetes), Jaret Bilewitch (corals), Rob Stewart (black corals), Peter Marriott (stylasterid corals), Niki Davey (holothuroids), Kareen Schnabel (decapods), Jeff Forman (prawns), Darren Stevens (squid), Rachael Peart (peracarid crustaceans), Wendy Nelson (algae), Roberta D'Archino (algae) - all at NIWA, plus Bruce Marshall (Te Papa, molluscs), Gustav Kessel (VUW/NIWA PhD student, soft corals), Jeffrey Robinson (University of Otago, brachiopods), Dennis Opresko (Smithsonian Institution, black corals), Stephen Cairns (Smithsonian Institution, corals), Phil Alderslade (CSIRO, corals) and Frederic Sinniger (University of the Ryukus, zoanthids) were consulted on a few of the images and we thank them for their expertise also. DOC, and in particular Mathilde Richer de Forges, are thanked for funding this work, and their patience in waiting for its delivery. We thank Jennifer Beaumont (NIWA) for internal review, and Clinton Duffy and Greig Funnell of DOC for providing external review on this report.

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