

Marlborough Sounds offshore deep reefs

Enhanced voyage report for four reef survey

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Executive summary

Over May–June 2025, four deep water reefs (30–290 m depth range) were surveyed with the towed camera array CoastCam, deployed from the RV Ikatere. This short, enhanced voyage report describes the survey, and the associated metadata created. A short narrative with selected imagery is given for each of the reefs, based on examination of the video files collected. The goal of this report is to provide a basic factual account of the survey, to accompany the associated seafloor imagery and GPS file being archived, so that at some future time when this imagery is quantitatively scored and analysed, the researchers have a good understanding of what was archived.

Two survey days, on 20 May and 26 June 2025, successfully completed 16 CoastCam tows across four separate deep reefs, with each reef receiving from two to six tows (stations). Tow distances ranged from 120 to 588 m in length, determined by the spatial scale and topography of each reef. Where possible, reef tows were placed to start off-reef and end off-reef, to capture any boundary associated biogenic habitats, and to quantify the soft sediments adjacent to the deep reefs. Two further CoastCam tows were unsuccessful with respect to sampling deep reef, due to gear damage from a hook-up at a reef's start, and a very strong tidal current preventing CoastCam from reaching the reef, respectively, but collected good imagery of the adjacent soft sediments.

Collectively, the four reefs held diverse assemblages of epifaunal invertebrates, with three of the reefs dominated by a range of sponge species, while the fourth appeared dominated by encrusting ascidians (probably; its range of small taxa and high percent cover need quantification to be definitive). The smallest reef (Reef B) was observed to have lower sessile invertebrate diversity and percent cover than the other reefs, with evidence of a fine sediment veneer on its rock surface. Its position directly off Queen Charlotte Sound (QCS) may expose it to land-derived fine sediments exported from QCS. Reef A held a more diverse range of habitats, and associated assemblages, including areas of larger bodied cup/bowl and finger sponges, and other areas of high cover of many small sessile species. The third reef, Witts Rock (with an east and a west reef system), held the greatest density and extent of larger sponges overall, particularly in association with its stepped wall and narrow terrace habitats, as well as diverse, high cover, small species assemblages on its flat summit areas. Those summit areas also supported good coverages of encrusting coralline algae, and coarse bladed red macro-algae, making it the only one of the four reef areas surveyed to extend up into the mesophotic zone (the Cape Jackson reef extends from the intertidal to over 300 m depth, but CoastCam sampling encompassed only the 173–289.5 m depth zone). The fourth reef, Cape Jackson, supported high densities and percent cover of small sessile invertebrate species, with larger sponges being relatively uncommon.

Visual evidence of fine sediments being present was the greatest at Reef B, with a light veneer over most of its rock surfaces, along with a more species limited faunal assemblage, dominated by snake stars and brachiopods. The higher elevation, more offshore Witts Rock and Reef B appeared the least effected, although fine sediment was sometimes present in the deeper flatter reef areas. Cape Jackson held some finer sediment cover, but this was only readily apparent when CoastCam touched the seafloor, and the resulting sediment plume was not excessive.

All four reefs showed evidence of fishing, ranging from a single lost cord-line at Cape Jackson, to a range of lost cord and finer nylon lines running across areas of the other three reefs, usually encrusted. Several old steel weights with attached cord were seen at Witts Rock, representative of

what is often used to hold longlines or droppers on the seafloor. Lost recreational fishing gear included occasional fishing jigs, and lead sinkers.

Carpet shark egg cases were regularly seen across all four reefs, either attached directly to the reef or to sessile invertebrates, over almost (30 to 281 m) the full depth range sampled (30 to 289.5 m). This finding was unexpected and suggests that these deep reefs may play an important role in reproduction for this species.

1 Introduction

The Department of Conservation (DOC) has a strong interest in learning more about mesophotic reefs (nominally 30–150 metres water depth), referred to as Temperate Mesophotic Ecosystems (TMEs) in cooler water regions to distinguish them from Tropical Mesophotic coral Ecosystems (MCEs). These systems are defined by the presence of light availability for photosynthesis, with the lower depth boundary set as the point at which light availability is 1% of that at the surface (Cerrano et al. 2019), below which primary producers (e.g., seaweeds and seagrass) are unable to survive and function. Beyond this lower depth limit, animal communities completely dominate the seafloor, called ‘animal forests’ by some authors. This 1% light availability depth limit will vary over time and space, with the dynamics of average conditions for a location likely to set the limit. In the New Zealand context, no quantitative measures of light availability over time have been recorded for any of its deep reef systems, so this definition is not quantitatively applied. In this report, the term ‘deep reef’ is used rather than TME’s, as the reefs may/may not occur in the mesophotic zone, whose boundaries remain unknown. Here, we arbitrarily define ‘deep’ as being 30–300 metres.

Deep reef systems are widespread around New Zealand, but are poorly known in terms of their location, extents, geology and environmental conditions, and the diverse ecological assemblages associated with them (Morrison et al. 2023a). Physical mapping of deep reef areas by multibeam sonar is limited to a few areas, with the largest mapped extents being East Northland (50–200 m continental shelf zone, Bay of Islands) (Morrison et al. 2023b), Hauraki Gulf (sub-areas of mid to outer Gulf/East Coromandel, Morrison 2023), and Hawkes Bay to East Cape (specific reefs) (Jones et al. 2018, Leduc et al. 2024). Smaller targeted blocks include localised sites at Middlesex Bank, the Three Kings Islands, Cape Reinga to North Cape, North Taranaki shelf edge, South Taranaki (Patea Bank), the outer Marlborough Sounds coast, Kahurangi Shoal (south of Cape Farewell Spit), offshore Oamaru (Cornish Head Canyon), and Stewart Island (Mason Canyon) (Jones et al. 2018, Morrison et al. 2022, 2023b). Limited sampling of deep reefs fauna and flora assemblages integrated with this multibeam sonar mapping has been undertaken at most of these sites/areas, using NIWA’s Deep Towed Imaging System (DTIS), CoastCam, and as of 2024, the new SwathCam array in the Hauraki Gulf Marine Park; and to a lesser extent, rock dredges to collect taxonomy samples (Jones et al. 2018). Processing and analysis of these surveys has been partially completed (i.e., for a subset of the sites/areas surveyed), limited by the funding resources available over time (Jones et al 2018, Morrison et al. 2022, 2023b). Collectively, these surveys (which also targeted soft sediment habitats) have revealed a wide range of reef geologies and morphologies, and diverse faunal and floral assemblages (‘biodiversity’), including previously unknown species of macro-algae, invertebrates, and fish. For example, the Biogenic Habitats on the Continental Shelf programme’s two 2011 RV Tangaroa voyages (funded by FNZ BRAG, in-kind DOC staff onboard, NIWA internal funds, and 42 Tangaroa Vessel Fund days) sampled soft sediment biogenic habitats and deep reefs (to varying degrees) around New Zealand in the 30–300 m depth zone. Over 1,000 species were encountered, with circa 10% being new to science/previously known but not described, as of 2018 (including macroalgae, invertebrates, and fish; Jones et al. 2018), with new species still continuing to be named and described as of 2025. Similarly, analysis of the OS2020 Bay of Islands/East Northland programme’s DTIS video survey in 2009 returned over 300 Operational Taxonomic Units (OTUs) (Morrison et al. 2023b).

As well as being biodiverse habitats, deep reefs support regionally important reef-focussed fisheries, including for lobster (two species), hapuka, snapper, tarakihi, and ‘red fish’ (multiple species) in northern New Zealand. Many are known to iwi as traditional fishing grounds, while recreational

fishing reach and intensity is increasing with the development of more capable recreational boats, and technologies such as GPS and electric reels.

Threats to deep reefs include overfishing, fishing gear impacts, warming ocean temperatures, and ocean acidification, though the biggest issue as seen in the deep reef towed video array surveys is sedimentation, assumed to be from human impacts on land catchments, and subsequent soil loss via rivers, and direct run-off to the sea (Morrison et al 2009, 2023). A strong gradient of increasing fine sediment cover of deep reef rock surfaces, and reduced epifaunal abundance and diversity has been observed for East Northland (North Cape to Tutukaka coast); and as a spatial mosaic for the Tairāwhiti (Gisborne District) to East Cape/Ranfurly Bank region (related to river mouth locations) (Jones et al. 2018, Leduc et al. 2024). Similarly, an extensive Hauraki Gulf Marine Park SwathCam survey in 2024 observed deep reefs in shallower more coastal settings (the mid-Gulf) to have more sediment veneered rock surfaces and less biodiversity than more offshore deep reefs (Morrison et al. in review; Morrison & Bennion, NIWA unpubl. data).

Our knowledge and understanding of New Zealand's deep reef ecosystems is poor and largely restricted to the east coast of the North Island (excluding Cape Kidnappers to Cape Palliser, and most of the Bay of Plenty). Even fundamental knowledge of where deep reefs occur, and the assemblages they hold, is lacking for most of New Zealand. What limited data has been collected shows that reef geologies, topographies, and fauna/flora assemblages are spatially diverse, at scales ranging from local to regional, to New Zealand's full latitudinal range. Any fundamental survey work outside of the North Island east coast (as defined above) offers significant advances in our basic understanding of deep reefs. Even small-scale surveys, conducted incrementally as opportunities arise and across various regions of New Zealand, will collectively contribute to a nationwide inventory of biodiversity and help guide appropriate management strategies.

In 2021, while the RV Kaharoa was returning to Wellington from mapping rocky reefs on Patea Bank, two small deep reefs off the Marlborough Sounds were serendipitously discovered by multibeam sonar (run on vessel transits to add to bathymetry coverage, albeit small). Each was fully mapped out by the survey team on discovery (as Reef A and Reef B), adding to the existing multibeam sonar coverage of coastal Marlborough Sounds (Figure 1-1).

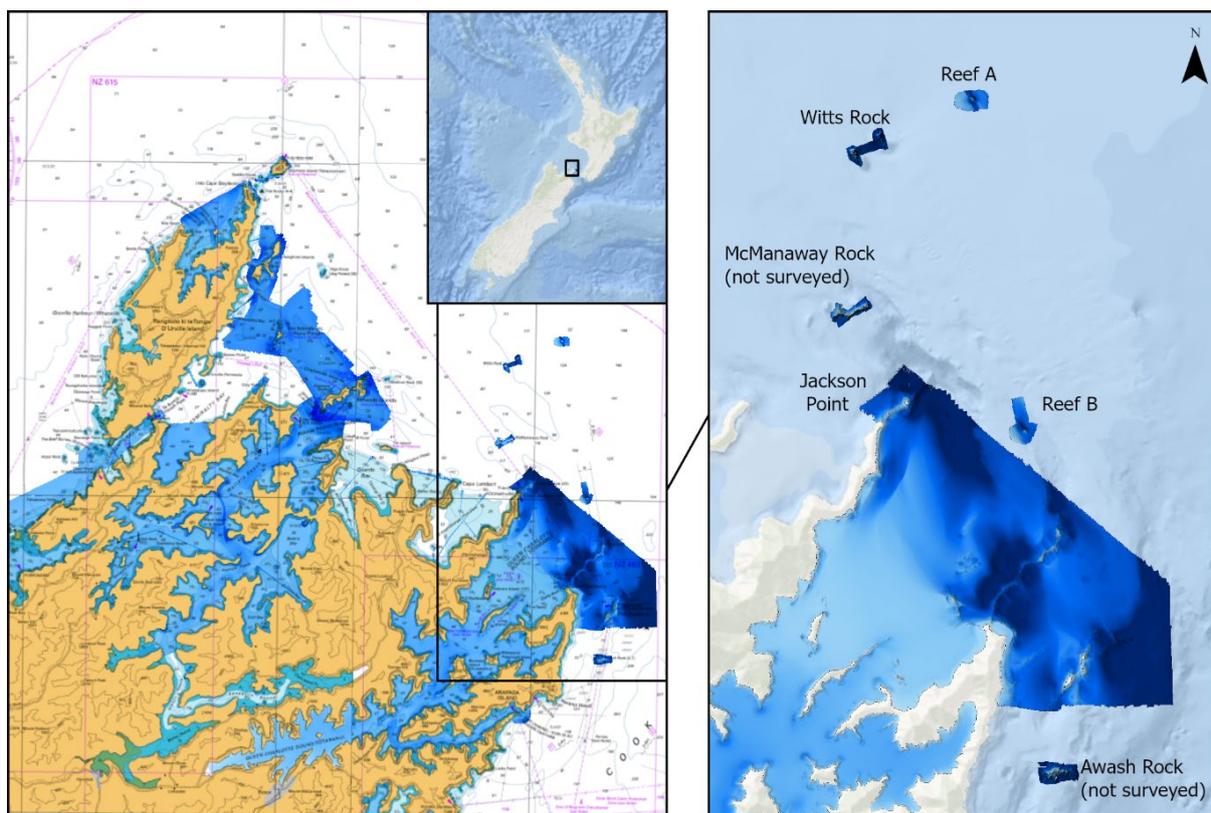


Figure 1-1: Survey region and site locations. Multibeam sonar coverage shown for the area of interest, and at regional scale

In 2025, the opportunity arose to assess these two deep reefs as a cost-effective (independently funded) add-on to a CoastCam survey being conducted as part of the MDC project Te Hoiere Ine Parumoana (inclusive of Pelorus Sound/Te Hoiere, Admiralty Bay, and French Pass). The Department of Conservation (DOC) was approached on the possibility of funding the extra survey day needed to cover Reef's A and B. DOC was able to fund two survey days, to add on two further deep reefs (Witts Rock, Cape Jackson) previously multibeam sonar mapped within the MDC/LINZ mapping programme for Queen Charlotte Sound.

This short, enhanced voyage report documents the two CoastCam survey days, to record what was done, provide some initial visual observations, and provide a metadata reference for the collected video and associated data sets (archived on NIWA systems, and provided in full to DOC).

2 Methods

2.1 CoastCam towed camera array

CoastCam is a towed video array that holds three cameras; a 30-degree tilted forward facing video camera, a downward facing video camera, and a downward facing stills camera. Video recording is continuous, while the stills camera takes an image at a fixed time interval (here set as 10 seconds). Each camera has its own lighting system, and lasers to estimate field of view and the size of objects. Where possible, the spatial position of CoastCam is logged using a GPS antenna on the survey vessel, integrated with an IBSL on CoastCam's frame. For this survey, no IBSL was available, so the GPS position of the vessel was logged (a 'layback' correction for depth, i.e., CoastCam's distance behind the survey vessel, as calculated by the cable required out relative to depth, will need to be applied to future scored video data¹). A depth gauge records CoastCam's depth, while an altimeter records its height above the seafloor (the sum of the two giving the water depth at time of sampling). A standalone RTK environmental probe is also attached to the CoastCam frame, which logs ten environmental variables at sub-second frequency – these include salinity (PSU), depth (m), turbidity (NTU), temperature (°C), and conductivity (mS/cm).

CoastCam is towed at less than one knot, with real time camera feeds to the surface support vessel. The system is controlled in real time by the system operator onboard the survey vessel. Video and still camera recording operations start once CoastCam reaches the seafloor, and end when retrieval to the surface commences. A remote-controlled winch drum runs the tow cable, which incorporates the data transmission cables, protected by a Kevlar sheaf. The ability to resolve smaller objects on the seafloor, while still allowing for a sufficiently wide field of view is the primary driver of tow height; modified as needed to allow for water visibility, seafloor roughness (impact hazards) and the surface swell effects.

2.2 Site selection and approach

The tidal regime of the survey area unsurprisingly is very strong, which limits the deployment of towed cameras to time windows around the turn of the tide, as current speed slows, reverses direction, and then picks up speed again. With appropriate selection of tide times, two turning tide windows (high, low) can be worked during daytime in a 12-hour day. Neap tide periods, where the tidal range (height) is the lowest, provide the lowest tidal speeds, as a lesser volume of water is being pulled by the moon.

With two survey days, four tide window sampling slots were possible. The four target reefs (Reef A, Reef B, Witts Rock, Cape Jackson) were each allotted one sampling slot. Each reef was allocated from two to five CoastCam stations (tow transects), based on reef size. Using the multibeam sonar bathymetry maps, transects were placed to collectively cover off the main reef features, its depth range, and its boundaries with surrounding soft sediments. The latter included sections of the adjacent soft sediment seafloor, as biogenic habitats can be associated with such boundary zones. Transects were limited to being around 15–20 minutes long, to allow available sampling effort to be spread more widely across the full reef (more stations), and to enable partial re-charging of

¹ The best approach for this data series is for each transect to visually find on the video when the boundary of a reef has been passed over by the CoastCam rig, locate that point on the multibeam sonar map (as it falls along the GPS tow path), and calculate the distance between that CoastCam position and the GPS vessel position. The distance to depth ratio, once calculated, can be applied to the rest of that station track to best estimate where the CoastCam rig is over the tow. Measuring this ratio for more than one reef/soft sediment boundary within a station will improve the accuracy. Calculating this for each individual tow will minimise the effects of variations of seafloor currents and surface conditions between stations, as these change over the tidal cycle and time of day.

CoastCam’s batteries whenever it was back on deck (to avoid power loss, driven by the recharge time being roughly 1:1 to recording time). All transects were set to broadly align with tidal current axis’s (as seen by seafloor scouring in the multibeam maps), to maximise tow control by the survey vessel, and to provide the best tow orientation with respect to the steep cliff slopes present on some of the reefs.

The original plan to bundle the deep reef survey days in with the MDC Te Hoiere Ine Parumoana project did not eventuate, due to a survey vessel mechanical issue, and the tides available not being ideal. A separate two-day survey was initiated on 20th May 2025, when tide times and heights were optimal. The first day of survey was largely completed, when late in the day, CoastCam hooked up on a steep reef face at Reef A, snapping the fibre optic cable. This required repair back on land. Once repairs were completed, the second day of sampling was rescheduled and completed one month later, on 26th June 2025, when tide conditions were again optimal.

Table 2-1 provides details of the four target reefs, derived from the multibeam sonar maps.

Table 2-1: Reef characteristics as observed by multibeam sonar mapping.

Reef	Depth range (m)	Reef height (m)	Reef area (m ²)	Description
Reef A	123 – 169	47	60 000	Elongated reef (two blocks) c 350 x 100/225 m, orientated NW/SE, with a smaller patch reef 200 m to the north-west.
Reef B	105 – 152	46	20 000	Single ridge block, c 225 x 150 m; orientated east/west.
Witts Rock (East)	39 – 147	108	330 000	Main reef c 800 x 200/400 m, orientated NW/SE, with a dominant ridge on the NE, and variable reef blocks on the SW. A smaller reef sits 400 m to the SSE, with smaller low patch reefs in the gap
Witts Rock (West)	19 – 98	98	290 000	Elongated reef (multiple high points along a broken ridge line) c 800 x 100/500 m, orientated NNW/SSE
Cape Jackson	0 – 291	291	1 090 000	Rocky reef extending NE of Cape Jackson; survey focussed on deeper eastern area. Ridge running NE/SW that narrows with increasing depth, down into a large seafloor depression (> 300 m depth) carved out by strong tidal currents.

3 Results

All four target reefs were successfully sampled. The Reef B transect, where the fibre optic cable was snapped in May, was re-done in June. One transect in June at Cape Jackson encountered very strong tidal currents on being deployed on the soft sediments adjacent to the reef, which proved too powerful to be towed against (with CoastCam being close to upside down when the tow was abandoned).

Table 3-1 gives a summary of the towed video coverage. Each reef's bathymetry, station (transect) tow paths, and associated screen grab positions are shown in Figure 3-1, Figure 3-5, Figure 3-8 and Figure 3-15, respectively. Note that as a layback for CoastCam's true position has not been applied, true station positions are 'further back' on the transect than the position marked. Only the downward facing video was viewed and used for the following narratives. Each of the three camera systems provides a different perspective of the seafloor – the downwards facing video camera gives the best continuous imagery of the seafloor, and shows the 2D spacing of objects, whereas the slightly forward facing (oblique) camera emphasize more the 'landscape' view of objects as a collective whole and is more suited for fish counts. The stills camera provides closer finer resolution detail of objects in 2D, but in a smaller spatial frame than the downward facing video.

Six video screen grab images are shown for each station (transect), selected to show some of the reef topographies and epifaunal/epifloral assemblages present (Figure 3-2 to Figure 3-19). Spatial scale varies across the imagery, driven by the height of CoastCam above the seafloor. To maximise the visibility of the imagery, images have been individually adjusted for brightness/contrast, and sharpness, as needed (at a basic level). The six images are referred to as A through to F in the associated captions, as read across the top three images, and then the bottom three. Letter codes are not shown on the images directly, to reduce clutter. Water depths are shown to aid interpretation.

A short descriptive narrative is provided in the screen grab figure captions (Figure 3-2 to Figure 3-19) informed by the reef level bathymetry maps. Identification and naming of taxa seen is beyond the scope of this enhanced voyage report, although a few species are mentioned in passing. A caveat to note is that the narrative is based on initial visual observation only. It also became apparent for a number of stations/parts of station on viewing, that CoastCam did not always tow in its normal full upright position; with the strong currents pushing it down/backwards into a tilted position, such that the seafloor was being viewed on an angle. Proxies to indicate when this was occurring included the orientation of taxa such as cup and bowl sponges, and water depth not changing despite the illusion of moving up a slope. These effects can be mitigated for during post-survey image processing. Avoiding their generation in the field is somewhat problematic; additional weight could be added to the CoastCam frame, but would create extra water flow resistance, and increase potential gear swing risk on the vessel during retrieval when sea conditions are not calm.

Collectively, these narratives and associated images are provided to help the reader gain a first impression of the four reefs, and to assist in any future decisions with respect to quantitatively scoring and analysis of the video and stills imagery (now archived). The RTK environmental probe data is not reported on here but has also been archived.

Table 3-1: CoastCam transects completed. Stations are identified by trip code/date, and then a station number within that. A separate trip code was used for each of the two sampling days, IKA2504 (20 May 2025) and IKA2505 (26 June 2025). All field codes used (e.g., station number) remain unchanged from those recorded on the camera imagery and associated data files. Depths are not tidally corrected. *, optic cable snapped at start of reef; **, strong tidal current prevented CoastCam reaching reef; ***, GPS logging froze after one third of tow completed, GPS position not logged for remaining two thirds; N/A, not logged. Note that most tows include areas of soft sediment adjacent to and/or within reefs (with the exception of Cape Jackson).

Reef	Date	Start time	Depth range (m)	Distance (m)	Duration
Reef A					
IKA2504 – Stn 1	20/05/2025	09:56:03	N/A	121	00:07:31
IKA2504 – Stn 2	20/05/2025	10:18:12	105.9–141.0	588	00:32:23
IKA2504 – Stn 3	20/05/2025	11:13:33	119.9–146.2	465	00:20:35
Reef B					
IKA2504 – Stn 10*	20/05/2025	16:51:12	150.6–167.7	225	00:09:59
IKA2505 – Stn 1	26/06/2025	08:12:56	126.3–169.0	546	00:25:25
IKA2505 – Stn 2	26/06/2025	08:58:01	128.7–173.8	280	00:14:04
Witts Rock					
IKA2504 – Stn 4	20/05/2025	11:13:45	120.2–147	113	00:07:36
IKA2504 – Stn 5	20/05/2025	12:10:39	44.3–131.7	445	00:23:20
IKA2504 – Stn 6	20/05/2025	13:28:03	93.9–113.4	323	00:16:19
IKA2504 – Stn 7	20/05/2025	14:06:16	29.7–102.9	311	00:15:59
IKA2504 – Stn 8	20/05/2025	15:25:21	89.0–119.5	313	00:13:01
IKA2504 – Stn 9	20/05/2025	15:55:15	113.5–139.3	378	00:17:05
Jackson Point					
IKA2505 – Stn 3**	26/06/2025	10:12:46	272.6–183.6	390	00:17:50
IKA2505 – Stn 4	26/06/2025	12:58:39	173–234	402	00:15:02
IKA2505 – Stn 5	26/06/2025	13:42:38	189.5–229.3	315	00:12:54
IKA2505 – Stn 6	26/06/2025	14:17:28	207.2–289.5	120***	00:17:59
IKA2505 – Stn 7	26/06/2025	15:20:15	225–242	260	00:11:34

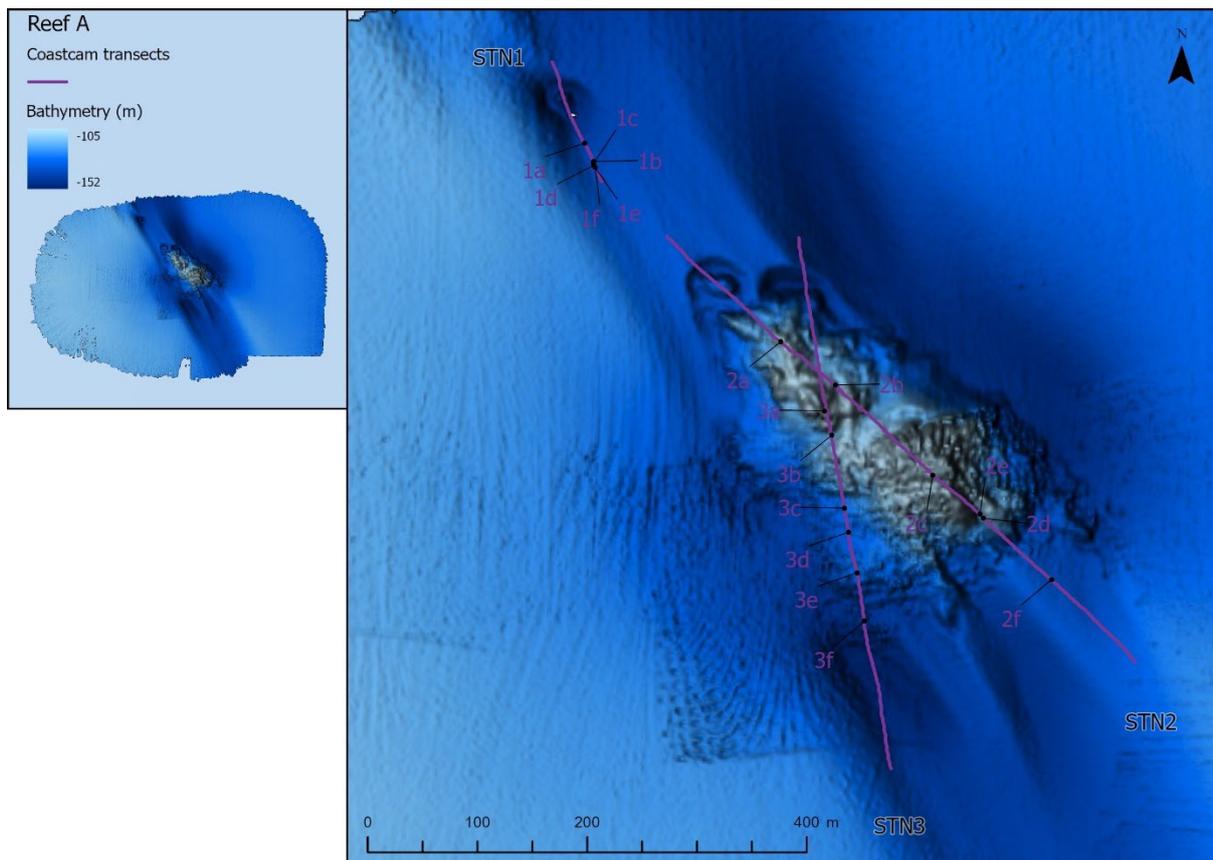


Figure 3-1: Reef A bathymetry, stations (transects) tow path, and selected image locations. Tripcode IKA2504, stations 1–3, surveyed 20/05/25

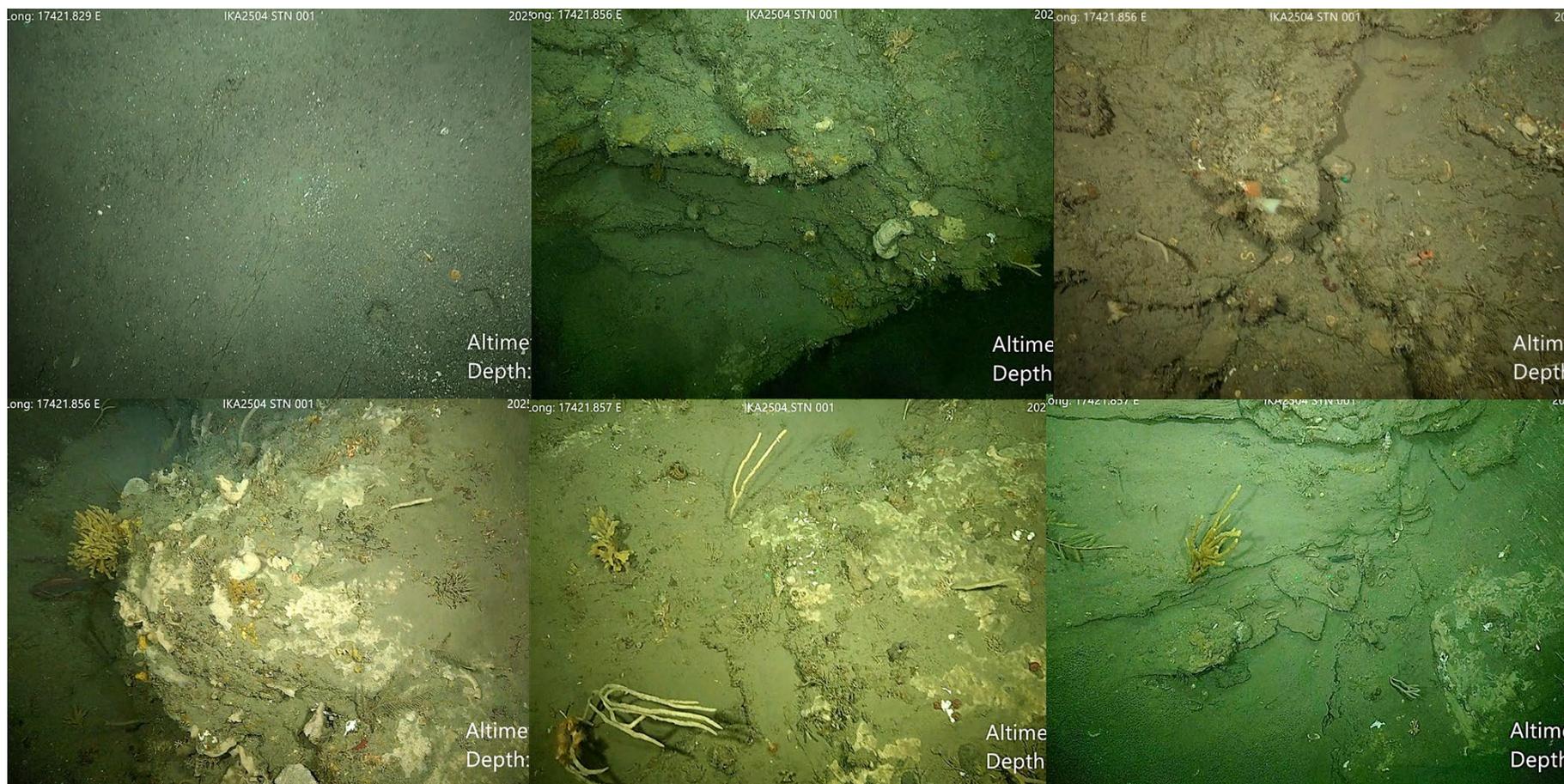


Figure 3-2: Reef A Stn 1 imagery. Transect ran south-east, across a small, isolated patch reef. Depths not available due to a gear issue but can be derived from the multibeam data. (a) starts on sand with some patches of low density long-bodied hydroids, transitions to muddier sediment over rock basement with some shells and limited small epifauna; b); reef appears as a stepped cliff wall; c-f) reef structured as low stepped platforms with some sediment cover/veneers, then ends as a transition to sand seafloor which sits flush with the reef. The reef fauna are not dense and are dominated by small upright and encrusting taxa (sponges, ascidians, bryozoans, hydroids), with scattered larger finger sponges and occasional calcareous tubeworms. Mobile fauna include a prawn, a crab, a half-banded perch, and a roughy. Fine sediment was present, seen as clouds disturbed by CoastCam's passage up the stepped reef wall. Panels (a-f) are read left to right across the top three images, and then the bottom three.

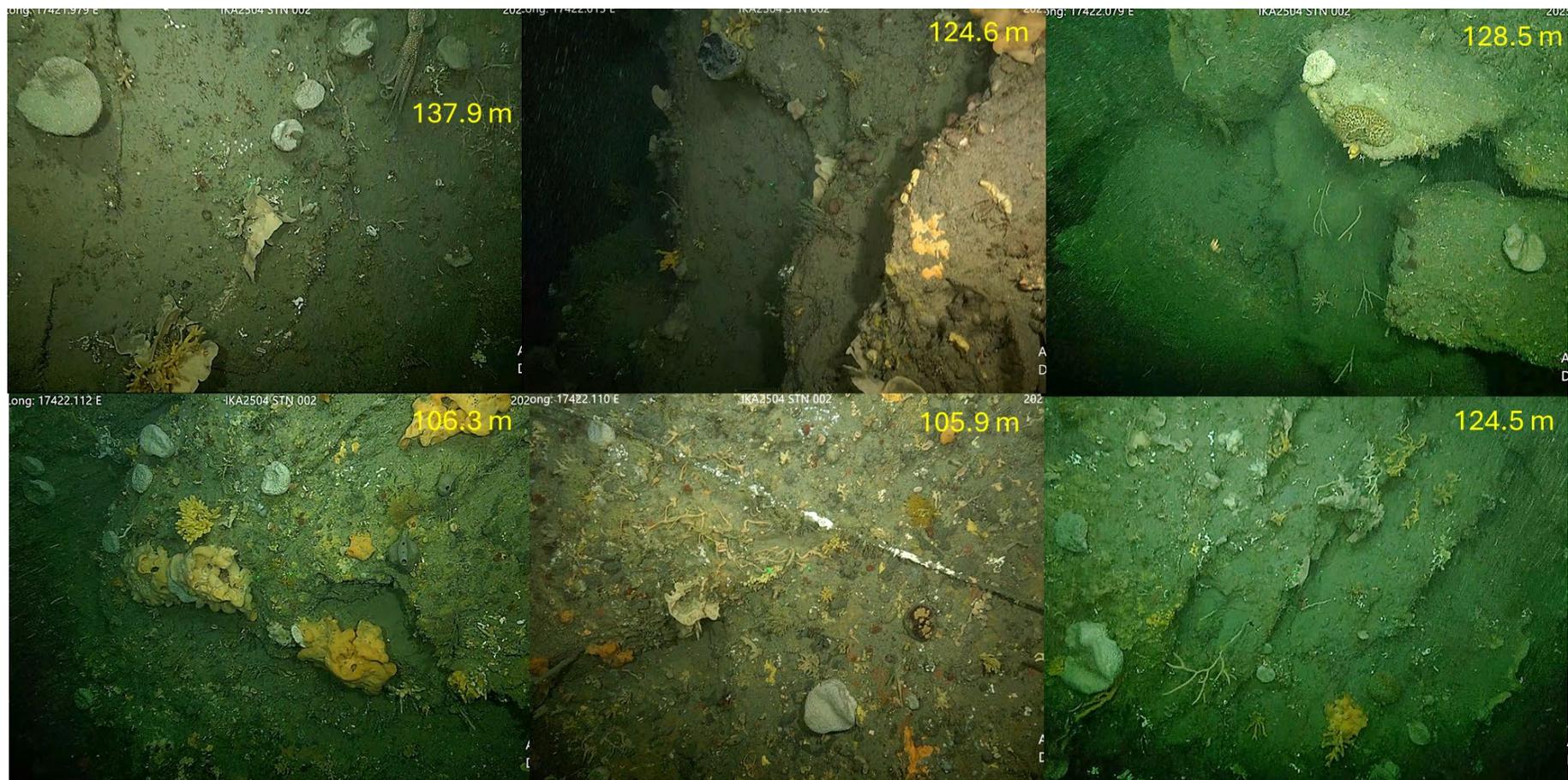


Figure 3-3: Reef A Stn 2 imagery. Transect ran northwest, along the reef’s main axis. At the start the seafloor was sand with some scattered small epifauna, with shell and small epifauna increasing, and then a narrow band of silt covered cobbles with cup corals, adjacent to the reef. The reef structure consisted of stepped walls (b, f), with terraces of variable width (a, note octopus) alternating with vertical faces of 1 to 3 metres, that occur on all sides of the reef. Large angular boulders (c) were present below some of the walls, presumed to be fallen eroded terraces. The fauna were diverse but variable in cover, with some areas being rich, while others had low fauna cover, associated with fine sediment veneers (not shown). Visually, some of these latter areas seemed associated with adjacent higher reef structure that may have provided some protection/deposition from the current. Areas of coarser soft sediments occurred in the reef structure, with the overall reef consisting of a single base rising from the surrounding soft sediments, which split into two separate ‘hills’. The top of these hills were narrow plateaus, where the fauna was dense and diverse (e, note lost fishing cord) with many smaller species contributing. At the south end, the reef bounded muddier sediments than on the north end. Panels (a-f) are read left to right across the top three images, and then the bottom three.

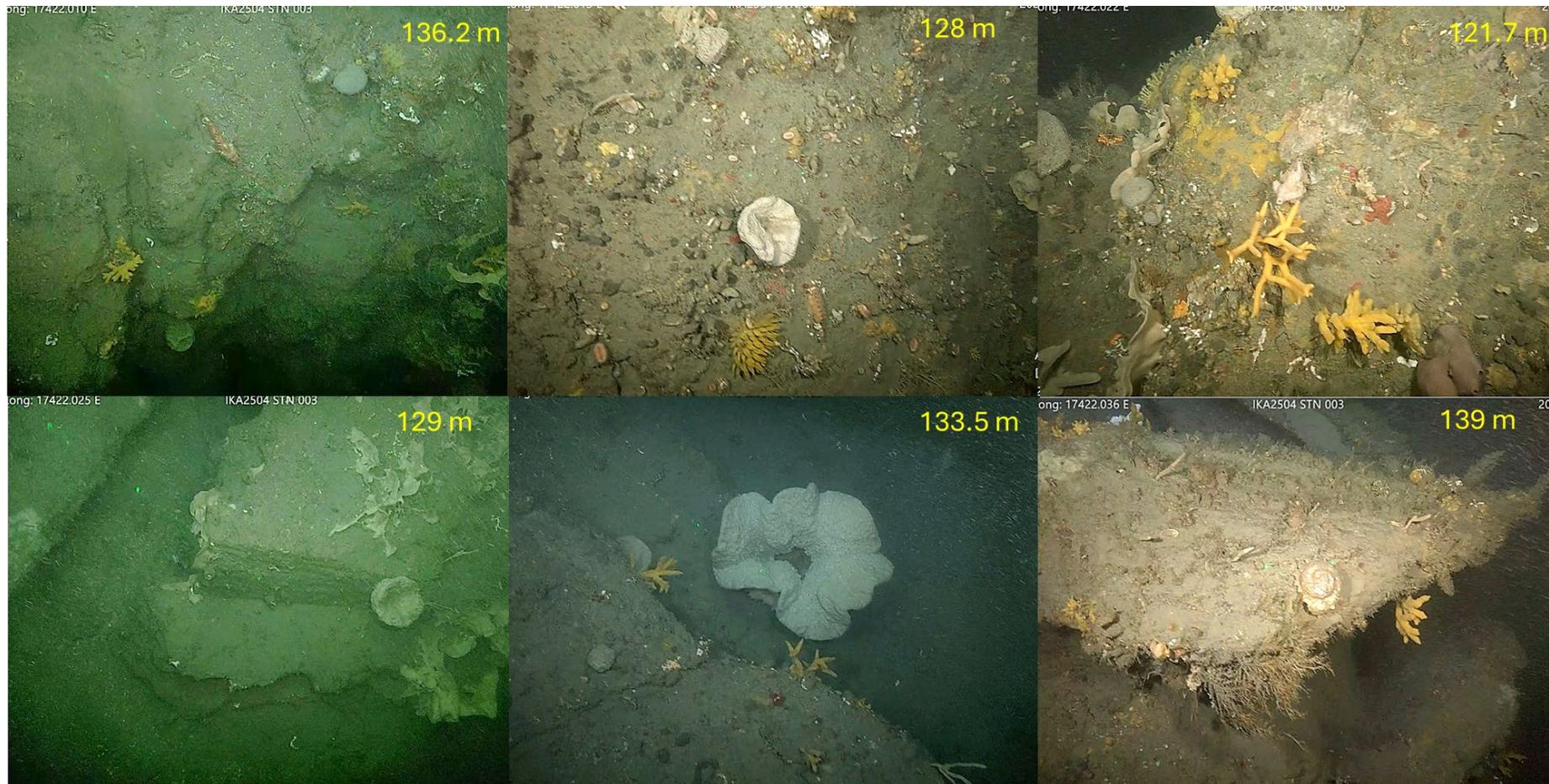


Figure 3-4: Reef A Stn 3 imagery. Transect ran south, diagonally across the main reef axis. Starting on coarser sand with shell fragments and little epifauna, then traversed a low height angular boulder field partially buried in muddy sand, before arriving at the northern hill of the reef (a). This hill was also crossed by station 2, and as with that station, the hills was structured as stepped walls and terraces (c), with a flat plateau/s on the top (b). Once past this hill, the seafloor slowly dropped away as less distinctive terraces with a higher degree of silty veneer (d, e), then to an elongated angular boulder field with little epifauna (f), before changing to a partially buried cobble field, then sand with decreasing whole shell content, and lastly to bare sand. This station has a much greater proportion of its length covering the deeper reef side areas (and corresponding much less upper reef/plateau cover), reflected by more reef area with lesser faunal cover and greater levels of silt veneer. As with transect 2, faunal cover, diversity and composition varied along the reef, with the reef plateaus to hold denser and more diverse fauna, with many smaller species contributing. Panels (a-f) are read left to right across the top three images, and then the bottom three.

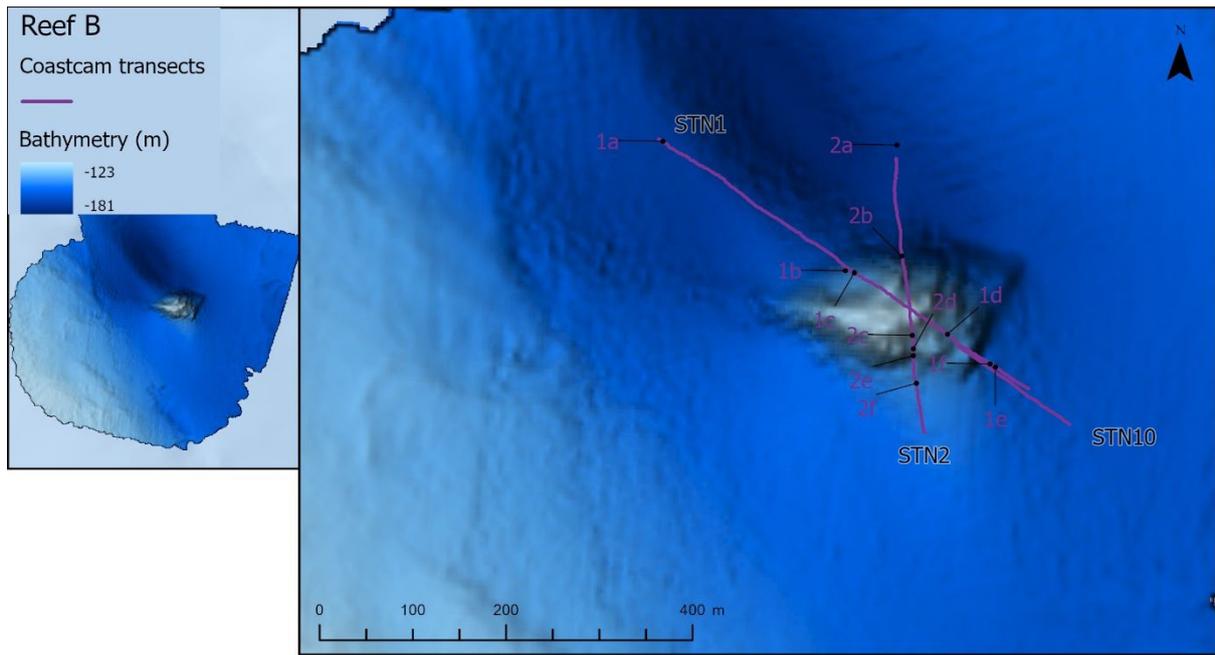


Figure 3-5: Reef B bathymetry, station (transect) tow path, and selected image positions. Tripcode IKA2505, stations 1–2, surveyed 26/06/2025. Tripcode IKA2504, station 10 (hooked up on reef edge), 20/05/20.

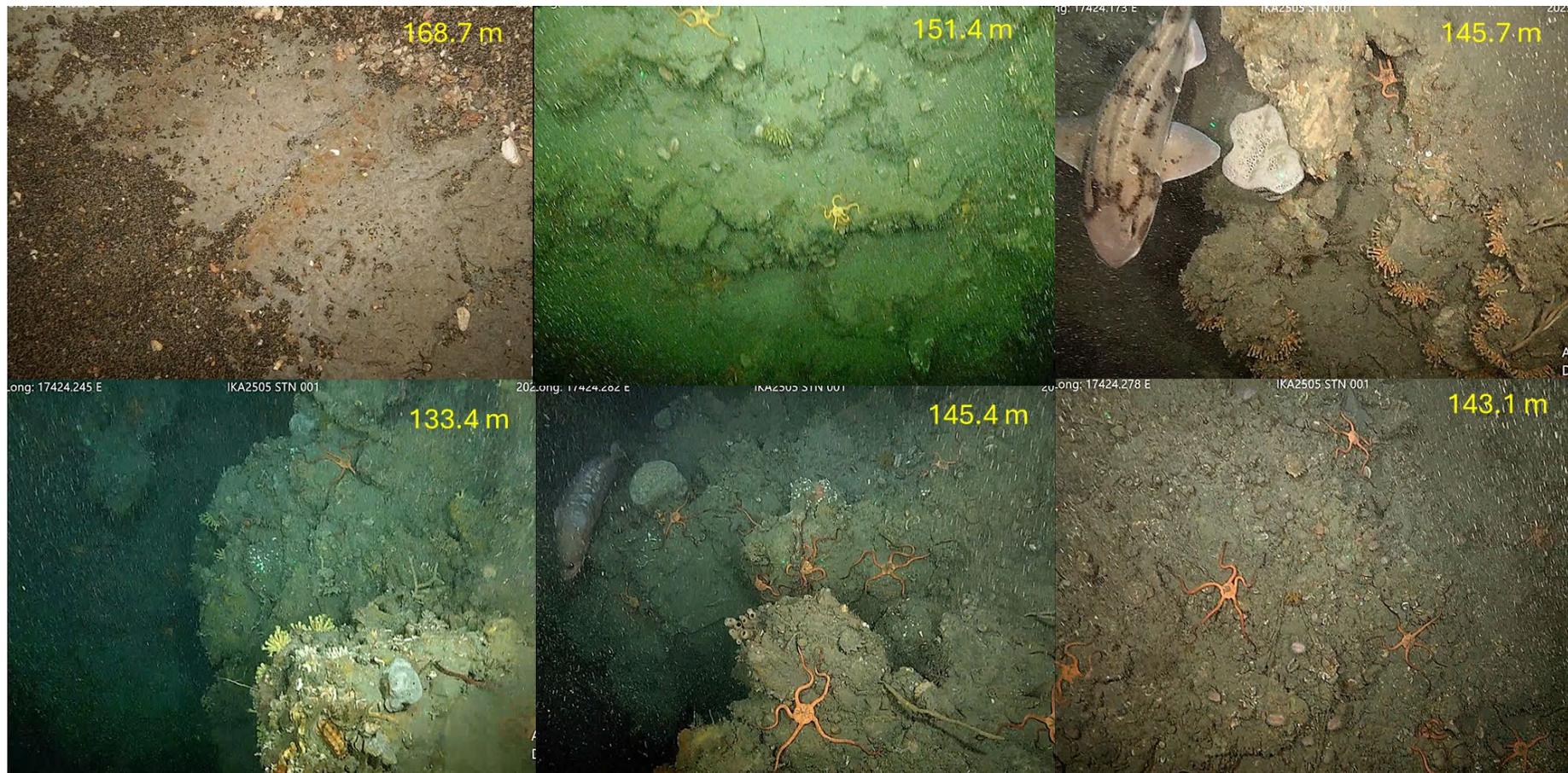


Figure 3-6: Reef B, stn 1 imagery. Transect ran south-east, diagonally along the main axis of the reef. Starting on low height (<10 cm) dark gravel waves (<80 cm) with exposed patches of flat bio-eroded rock (a), the transect passed over gravel, then mixed coarse and finer sand fine scale bedforms, to sand, and then to reef. The reef was a complex mix of irregular terraces, outcrops, walls and slopes (b–e), which increased in their relative size towards the summit (note, some of these components cannot be shown with a single video grab image, with CoastCam flown close to the seafloor (and water visibility rapidly degrading the imagery when CoastCam was flown higher off the seafloor). Softs sediments were a strong component of most of the reef area, occurring as sand pockets mosaiced with rock cover, and to a lesser extent as a coarser whole shell and sand flat in some spots. Where terraces occurred (c–e), they were much less orderly than those seen at Reef A. The fauna was quite patchy in distribution, with most areas dominated by brachiopods, along with small encrusting sponges/ascidians, soft bryozoans, goose barnacles, and other encrusters. Small more diverse patches (metres scale) of larger sponges and zooanthids occasionally occurred where rock outcrop edges extended out slightly (c, d). Towards the transect end, the reef was replaced by coarse rippled sand, and then small black pebbles embedded in a solid flat, pale hard clay-like surface. Fine, easily suspended sediments were present across the reef surfaces. Fish were not common, being limited to adult rock cod (e, *Lotella* sp.) in the more complex reef areas, and carpet sharks and small sea perch. Panels (a-f) are read left to right across the top three images, and then the bottom three.

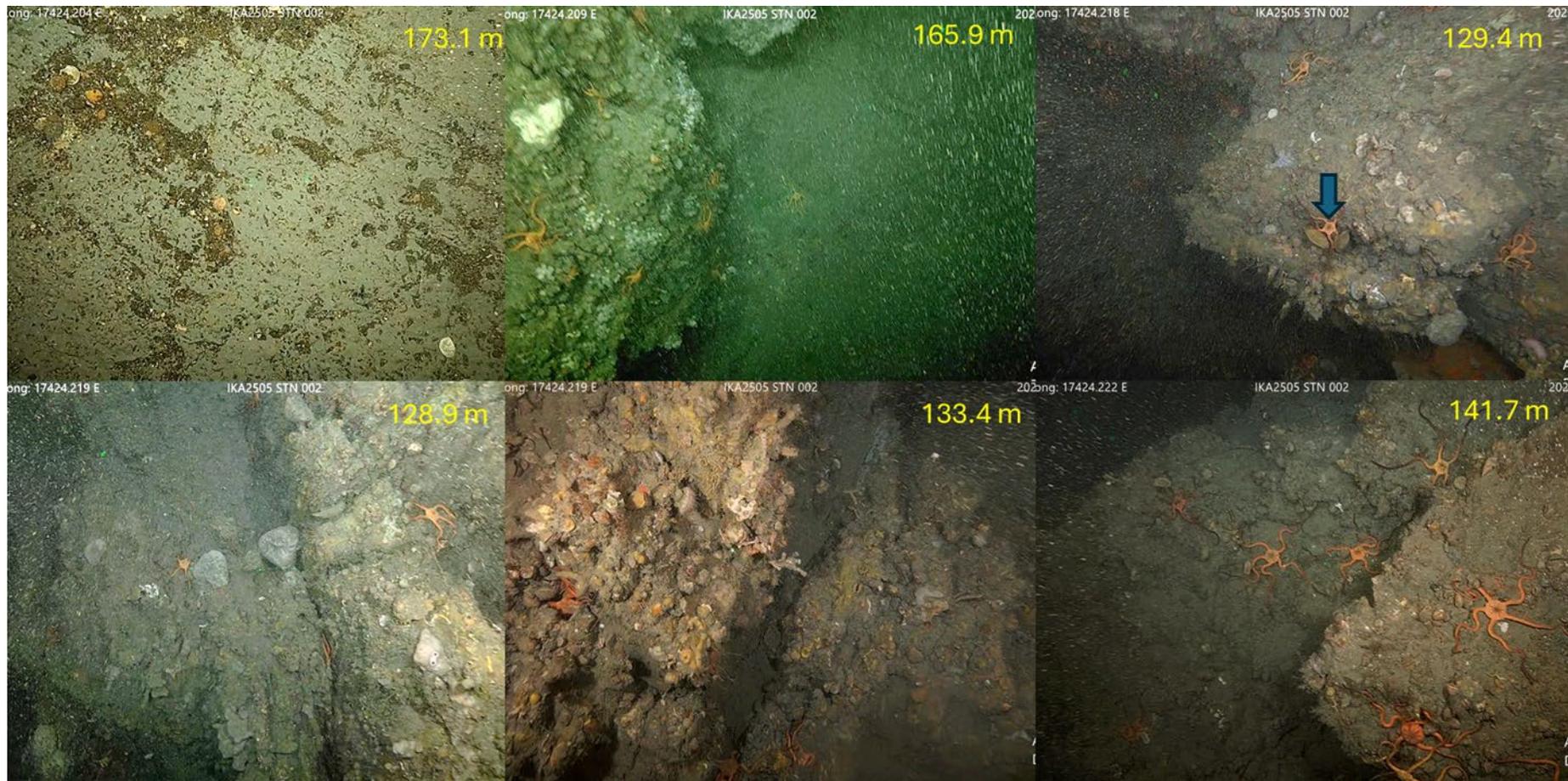


Figure 3-7: Reef B, stn 2. Transect runs south, perpendicular to the main reef axis. The transect starts on the same black pebble embedded in hard clay-like surface seen at the south-eastern end of station 1. Patches of flat bio-eroded rock appear (a), then are replaced with a slightly bumpy paler rock with ongoing small patches (< 50 cm) of embedded black pebble, with occasional low flat angular boulders (<50 cm) appearing on its surface, then by larger embedded pebbles with some surface bivalve shell, then whole shell and sand bedforms. The reef starts abruptly as a low wall (b), then continues to rise to its peak, similar to station 1 (complex mix of irregular terraces, outcrops, walls and slopes), although without soft sediment pockets. Continuing south, the transect dropped down the reef, passed over a low height field of flat rock slabs/boulders with cup corals and other small fauna, then across a flat sand-plane terrace area sitting on the reef. This sand plateau was bounded by slightly elevated reef, which dropped away as a series of rapidly dropping terraces to a soft sediment seafloor. The soft sediments started as embedded black pebbles in the clay-like surface, with larger pebbles and whole shells appearing on moving away from the reef, along with some low density patchy epifauna (snake stars, large anemones, goose barnacles, small low sponges). Overall, the reef fauna was dominated by small bodied species. [Blue arrow, two egg cases (probably carpet shark)]. Panels (a-f) are read left to right across the top three images, and then the bottom three.

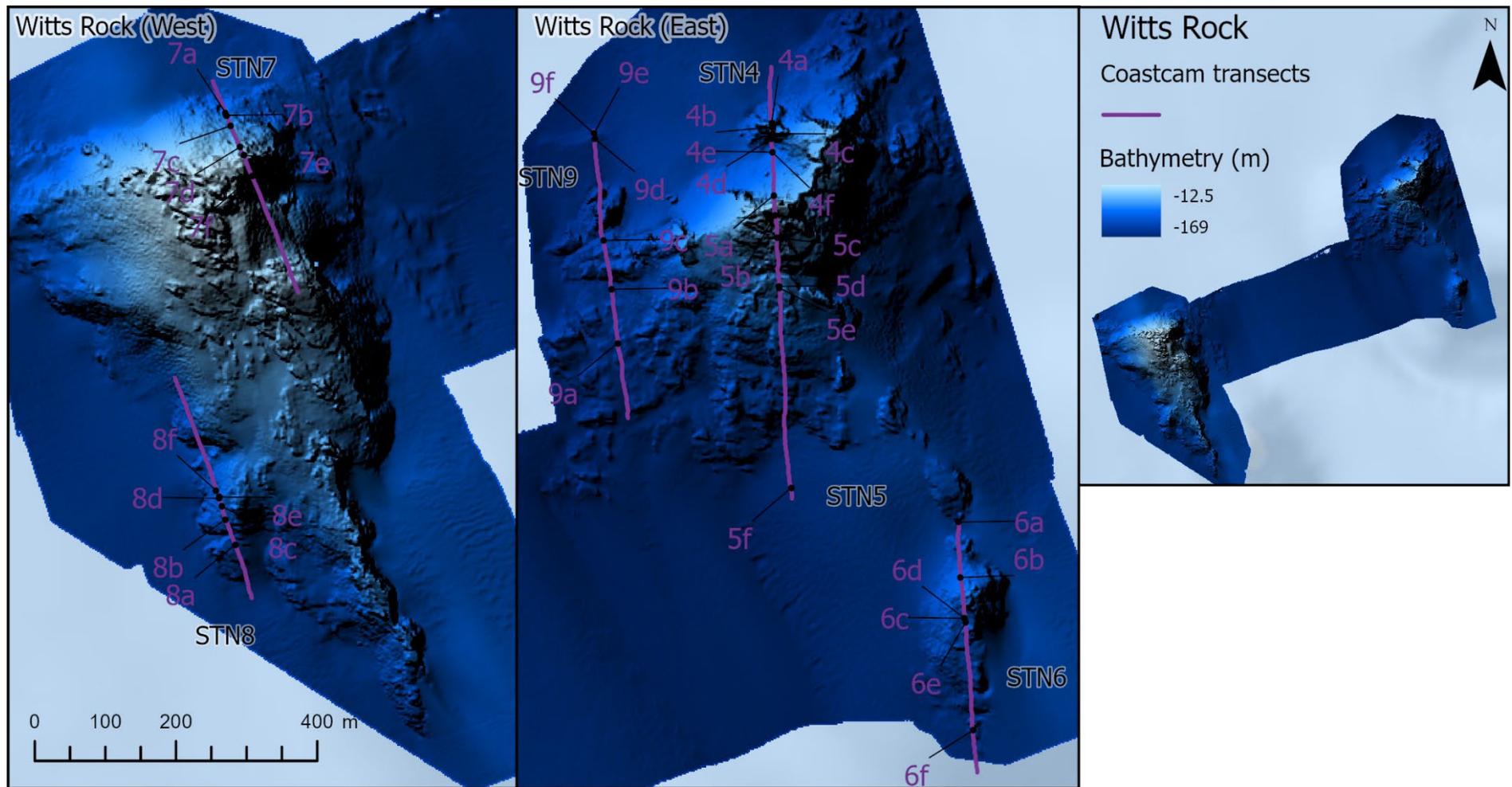


Figure 3-8: Wits Rock (east and west) bathymetry, station (transect) tow path, and selected imagery positions. Tripcode IKA2504, stations 4–9, surveyed 20/05/2025.

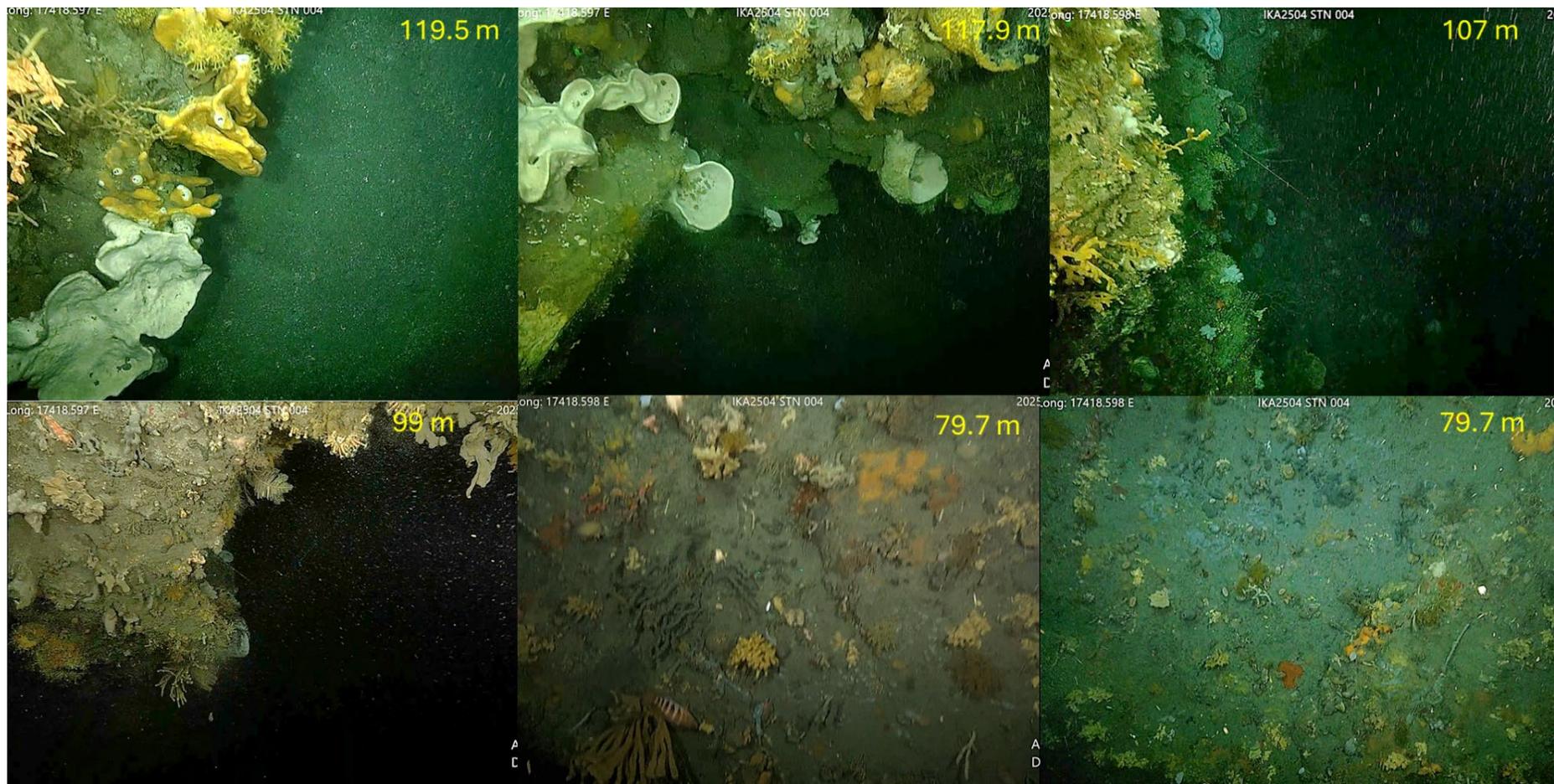


Figure 3-9: Witts Rock (East), stn 4. Transect ran south. Started on coarse sand with shell and carbonate debris including scaphopod shells, changed to coarse sand near the reef edge (a). The reef itself was a small discrete steep pinnacle partially attached to the main reef on its northern side. The transect rose steeply through a series of walls and narrow terraces (b–d), plateauing briefly at around 80 metres (e–f), before beginning to descend again. The transect ended here due to the RTR unit being knocked loose (station 5 links to this transect from the south). The reefs walls and terraces supported a sponge dominated assemblage of larger sized bowl, ridged, and to a lesser extent, finger sponges (a–d), as well as smaller hydroids and zoanthid colonies. On the flat surface plateau, a wider range of smaller species dominated, covering most of the available surface (e–f). Macroalgae and coralline algae were absent. Reef surfaces were relatively clear of fine sediments, and water clarity was good. Occasional carpet shark egg cases were attached to the reef. Panels (a–f) are read left to right across the top three images, and then the bottom three.

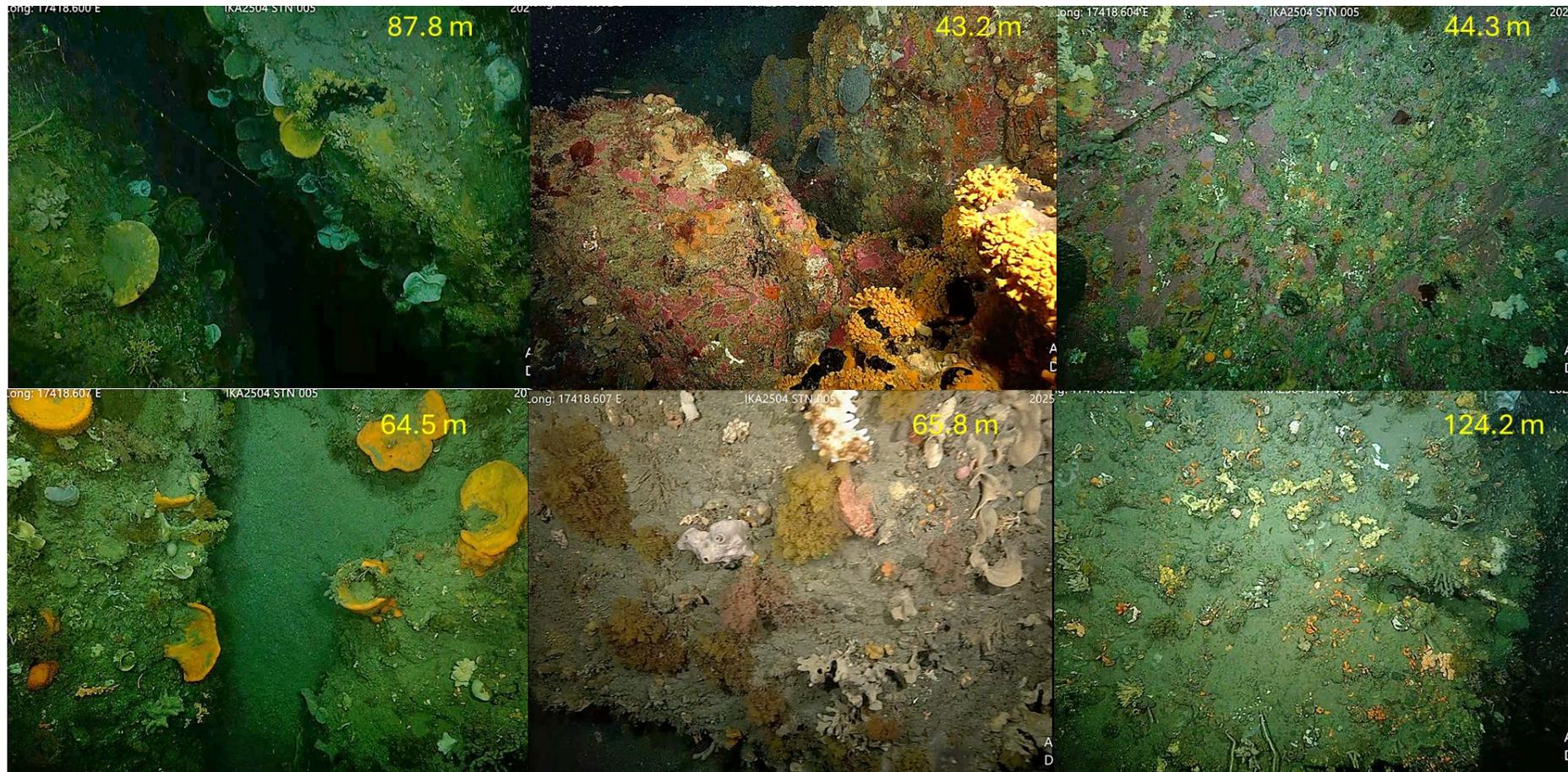


Figure 3-10: Witts Rock (East), stn 5. Transect ran north to join station 4. Starting on coarse sand with occasional small cobbles (<15 cm), the reef started as a slope of low height angular boulders/protruding bedrock loosely stacked on each other in step form, along with coarse sand. A low-density faunal assemblage of encrusting ascidian patches, small *Celliporaria agglutinans* bryozoan trees, soft bryozoans, and upright sponges occupied this boulder zone. The reef then shifted to large abutments/butresses (a), then dropped slightly in depth in the shallow valley between two reef peaks, then rose again as a mixture of low height rock slopes and coarse sand bands, which then changed to a steep wall of stepped ledges, with an associated assemblage of smaller sponge and other species. Approaching the reef plateau (b), yellow zooanthids became abundant, along with encrusting species, including encrusting coralline algae (b, c; the pink coloured rock). The flat plateau top held a mix of encrusting corallines and smaller faunal species, covering most of the available surface (c). The reef then dropped away, where rock slopes and terraces supported a wide range of sessile invertebrates, which changed in their composition with increasing water depth. As with station 4, the reef was relatively clear of fine sediment, and water clarity was good. Blue cod were seen to 87 metres depth, but most were seen at 40 metres and shallower. Juvenile butterfly perch were present in the upper areas of the reef. Panels (a-f) are read left to right across the top three images, and then the bottom three.

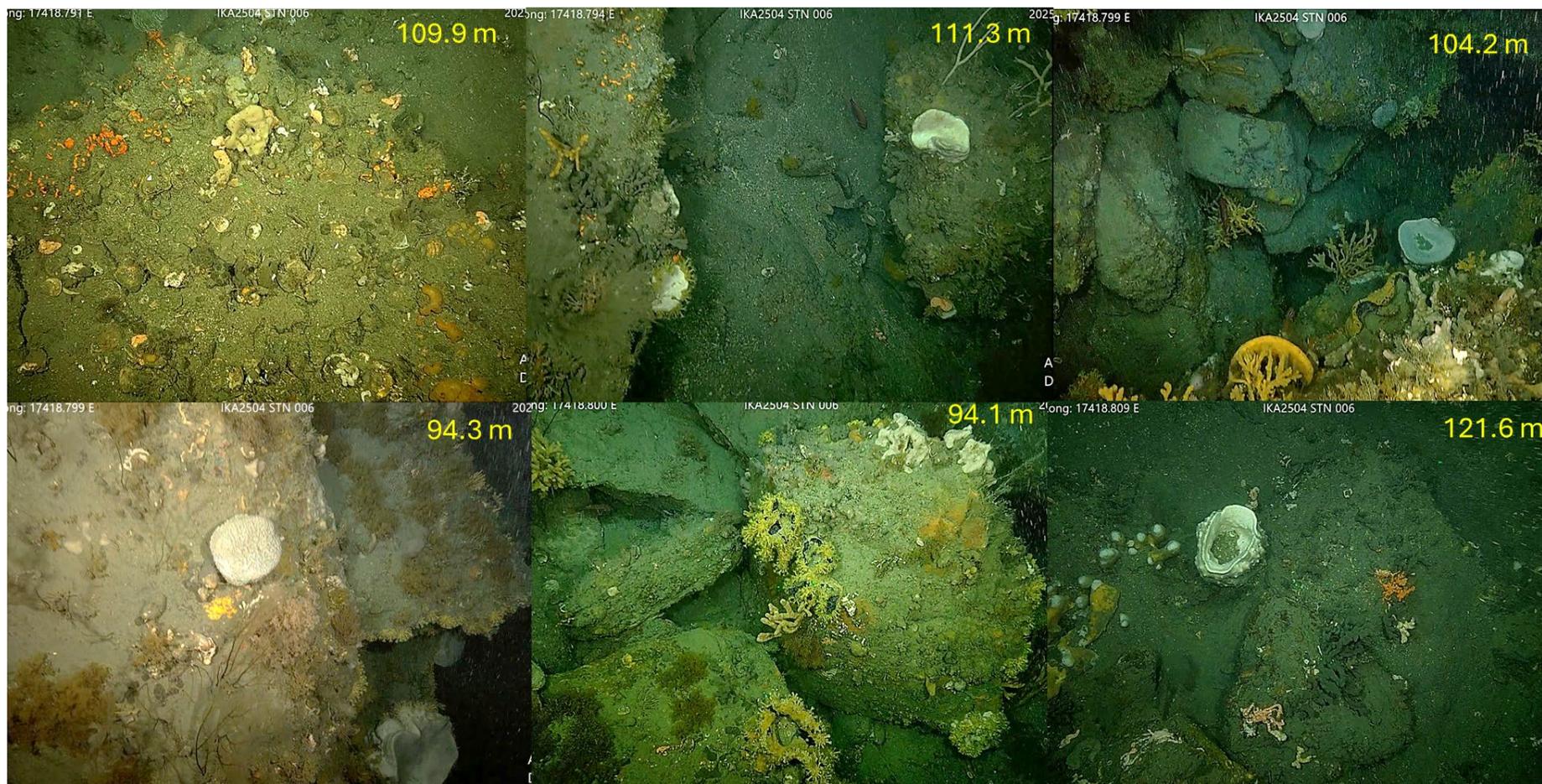


Figure 3-11: Witts Rock (East), stn 6. Transect ran south, across a discrete reef mound south of the main reef complex. The transect started on low height, flat surface, tilted rock platforms (a) which submerged under a coarse sand veneer (indicated by reef associated species presumed to be attached to the lightly buried rock surface) Coarse sand then dominated, with a few small rock patches with some rock, until the reef proper arrived, composed of a mix of wall terraces, flat rock, large angular boulders, and coarse sand which then changed to a stepped wall with terraces. From the top of the reef, the seafloor slowly dropped away as a mix of large angular boulder heaps, large embedded angular boulders/rock outcrops, sand veneered rock, and sand pockets (c–e). These slowly changed to low small rock outcrops (metres scale) on a coarse sand plain, which became slower and less common with increasing distance from the reef proper. Larger bowl sponges including *Ecionemia* (previously *Ancorina*) *elata* (f, as the white morph only seen in the Marlborough Sounds region) were regularly seen, as well as a rich fauna of sponges, ascidians, calcified and soft bryozoans, and hydroid trees, with no observations of fine sediment veneers. Roughy (b, c) was the main fish species present, along with several resting hagfish. Panels (a–f) are read left to right across the top three images, and then the bottom three.

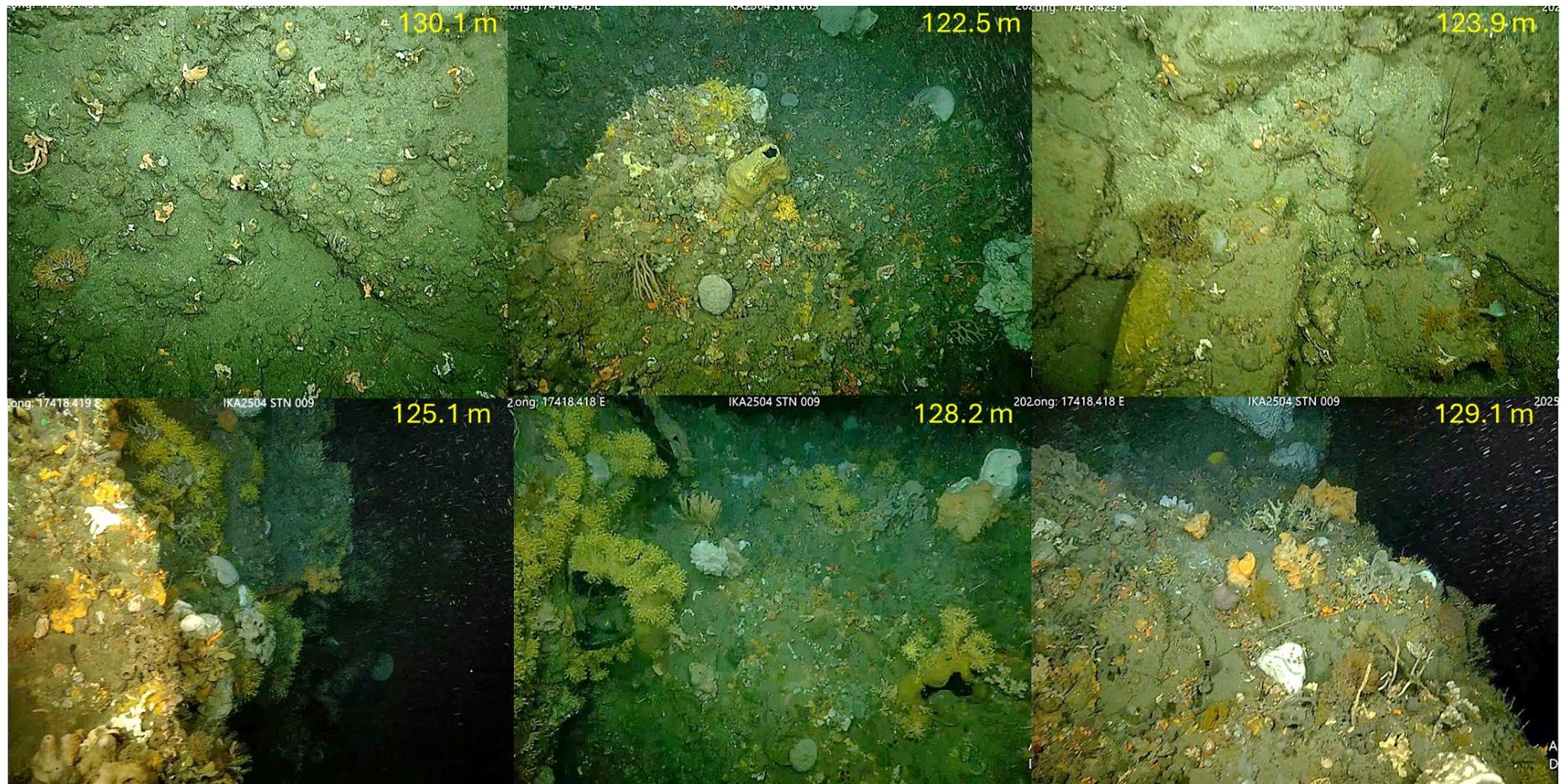


Figure 3-12: Witts Rock (east), stn 9. Transect ran north. Starting on soft sediments that varied from coarse sand to sand with a significant whole shell debris, the reef appeared as a series of low flat platforms, parts of which were exposed rock and others which appeared to have a coarse sand veneer, as well as mixed coarse sand and carbonate debris (a, b). A rich assemblage of smaller encrusting species occurred in variable cover across this mosaic. The amount of rock cover increased around halfway along the transect, becoming more dominant. After reaching its shallowest area, the reef sloped down as a mixture of stepped walls, boulder piles, and rock outcrops (d-f), eventually being replaced by coarse sand and whole shells. Encrusted fishing cords running across the reef were regularly encountered. Large fauna, dominated by sponges, were more abundant on the more rugose reef areas. Several resting hagfish were observed, along with butterfly perch, sea perch, banded perch, and yellow weavers. Panels (a-f) are read left to right across the top three images, and then the bottom three.

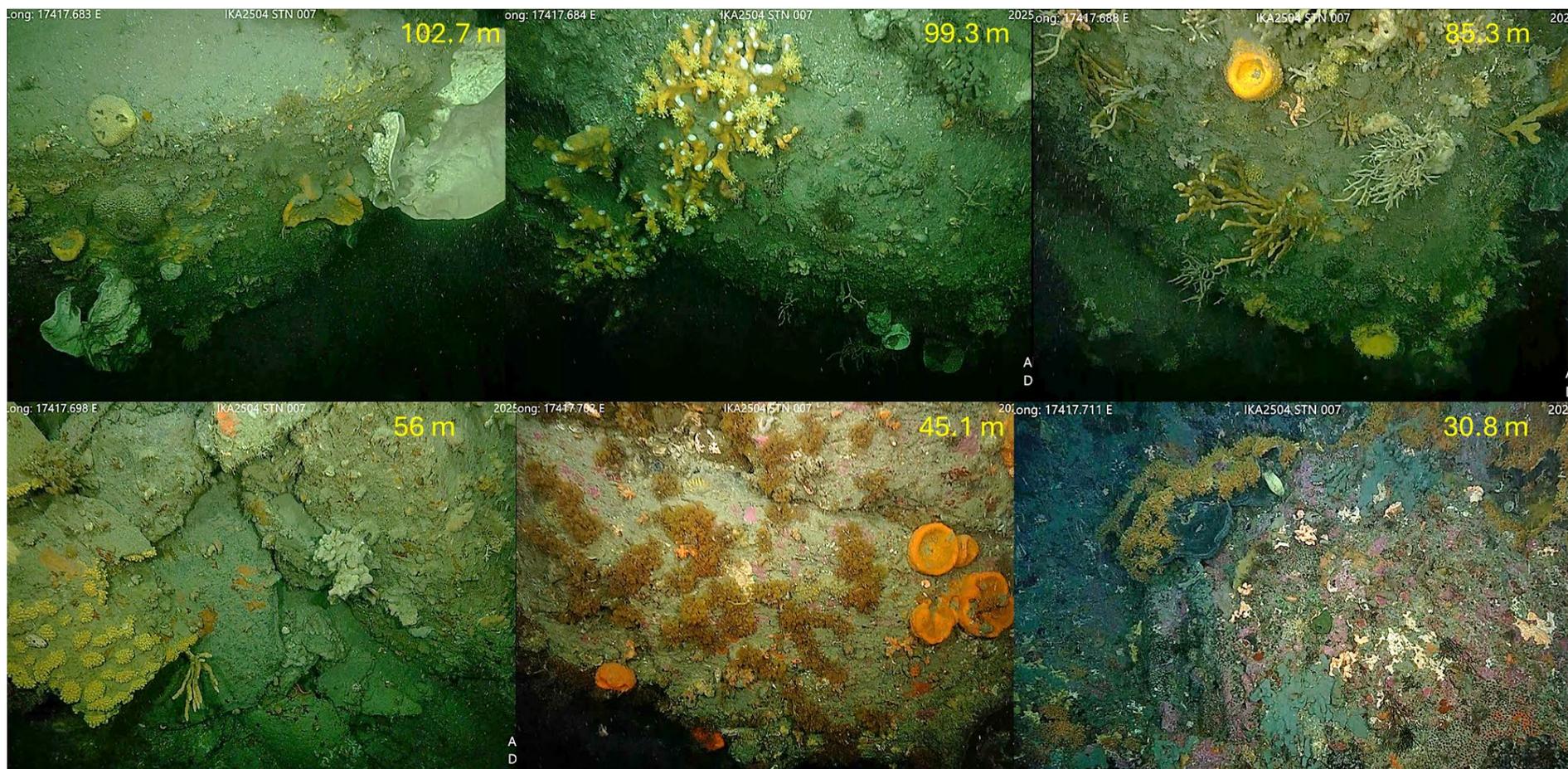


Figure 3-13: Wits Rock (west), stn 7. Transect ran SSE across the two dominant peaks of the western Wits Rock reef. Starting on a seafloor of coarse sand with some shell and cobble contributions, a few small reef patches appeared, and then the main reef. This rose as a mix of stepped walls, large angular boulders, rock 'spars' (long elongated boulders whose (presumed) ends were not visible, and coarse sand pockets. Encrusting corallines appeared at around 42 m depth, becoming more widespread as the depth decreased (e, f). Blue cod also appeared at this depth, with a sister species, the yellow weever, observed in deeper depths. Yellow zooanthids also increased in cover in shallower waters (d, f), as did soft uncalcified bryozoans (e). At 30 m on the top of the reef, coarse bladed red macroalgae were common as spaced individual plants, along with encrusting coralline algae. Carpet shark egg cases were also present across the reef (f). Panels (a-f) are read left to right across the top three images, and then the bottom three.

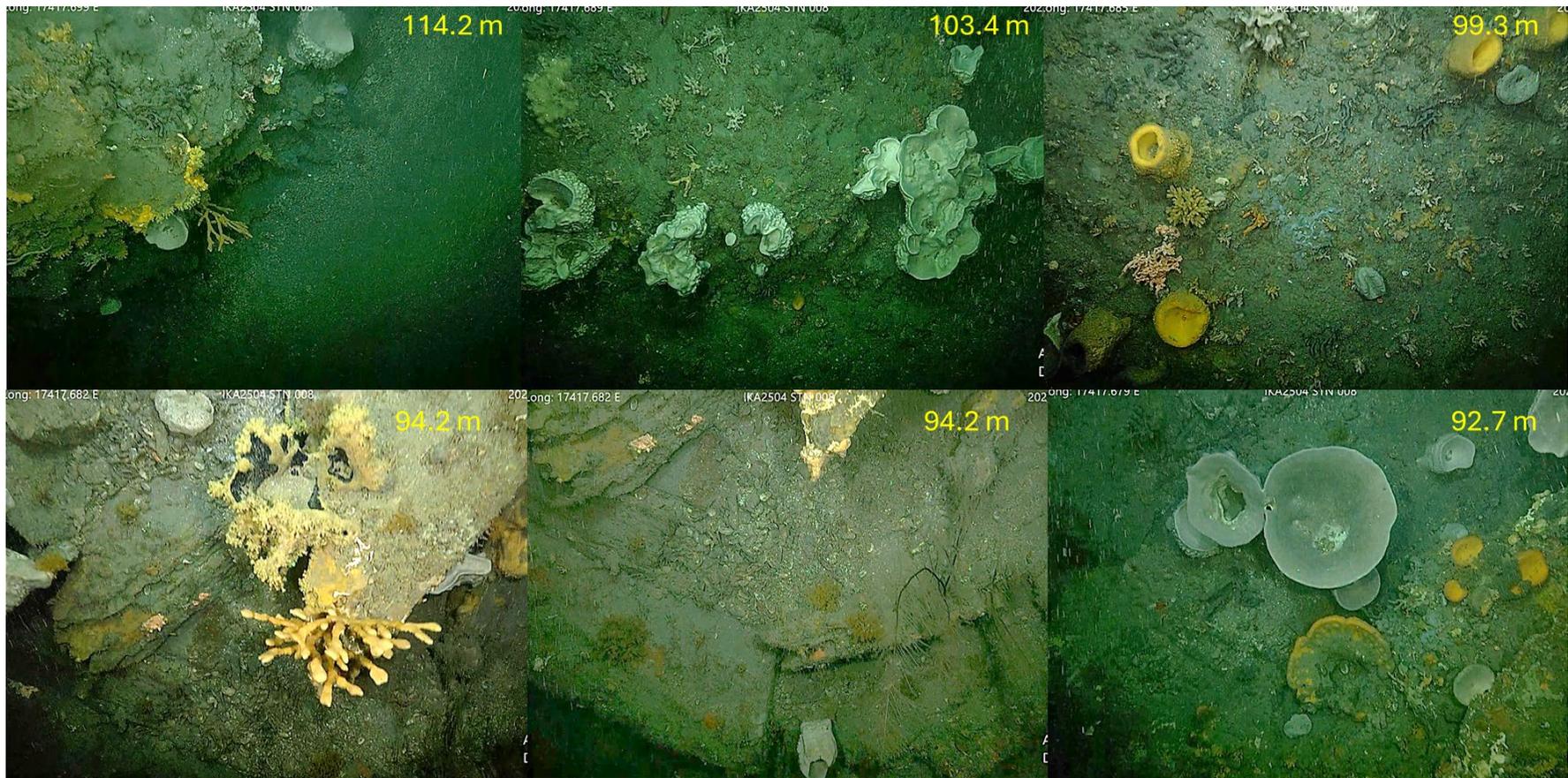


Figure 3-14: Witts Rock (west), stn 8. This station targeted the deeper rock outcrops on the south-west part of western Witts Rock. Starting on coarse sand with shell fragments and low-density carbonate debris with occasional fauna (cup corals, sponges), the reef first appeared as a low wall (a), after which a mixture of long flat reef platforms, boulders, reef outcrops, occasional walls and coarse sand patches were present, broadly undulating within a ten-metre depth range. A range of fauna body sizes were present, and no observations of fine sediment veneers were made. Macroalgae and encrusting coralline were absent. Several encrusted lost fishing cords were observed. Panels (a-f) are read left to right across the top three images, and then the bottom three.

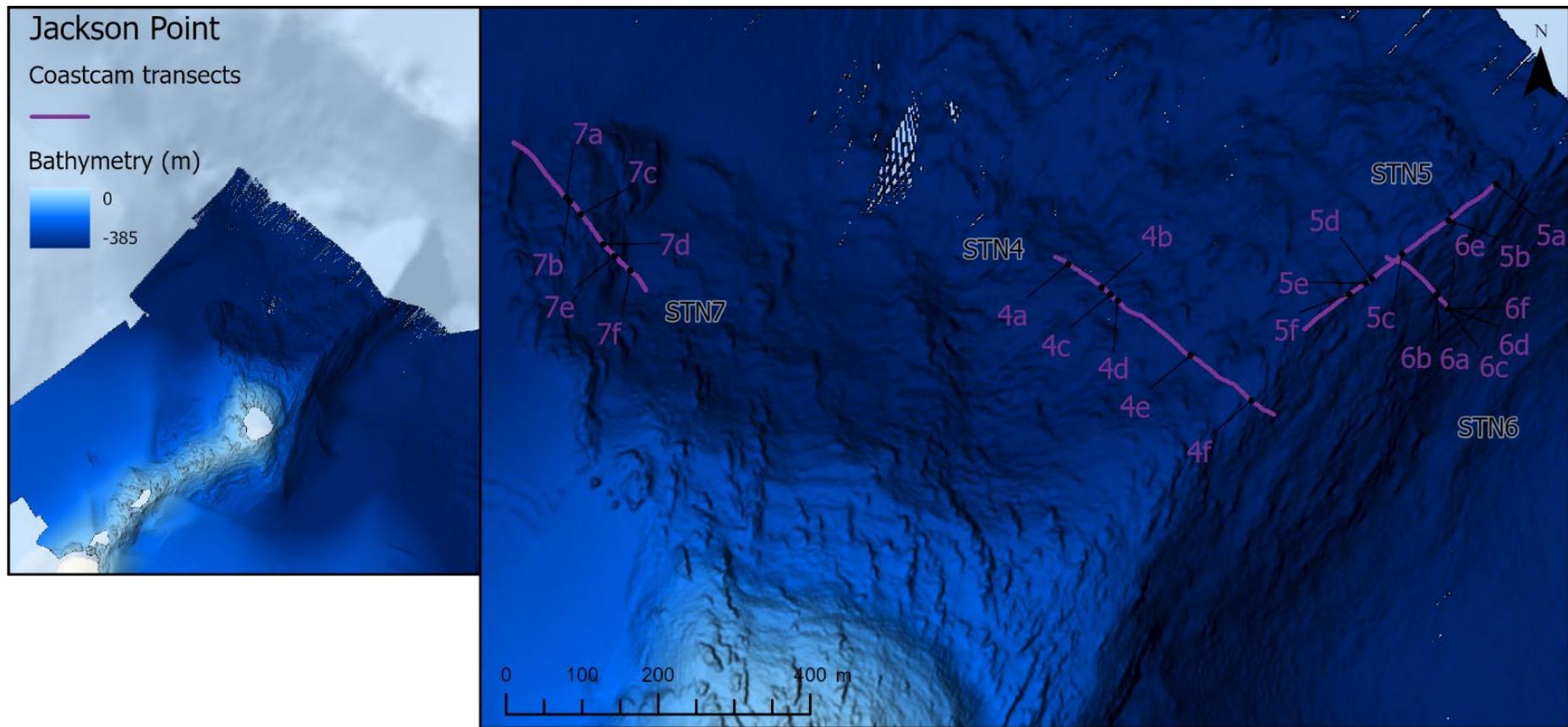


Figure 3-15: Cape Jackson bathymetry, station (transect) tow path, and selected image positions. Tripcode IKA2505, stations 4–7, surveyed 26/06/2025. Note that as Stn 6 stopped logging GPS position at approximately one-third into the two, not all of its distance is shown, and its associated imagery is assigned to the last logged position.

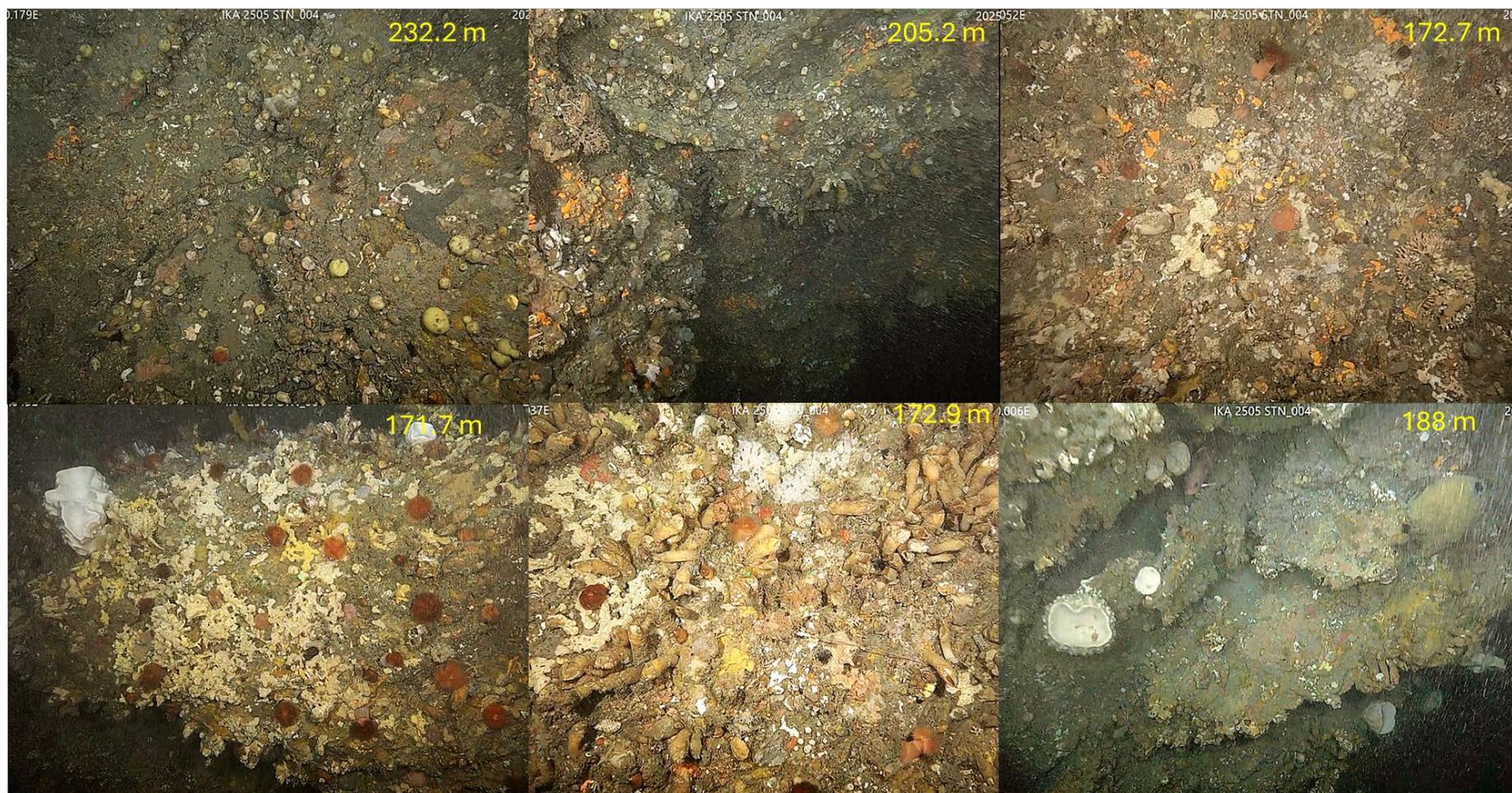


Figure 3-16: Jackson Point, stn 4. The transect started close to the top of the reef ridge at 234 m, crossed the ridge at a minimum depth of 173 m, and ended at 193 m on the other side of the ridge. The whole transect was occupied by reef habitat, with small, localised pockets of carbonate debris, with a topography of rugged rising slopes, meeting at the reefs defining ridge. A dense fauna was present, largely of smaller bodied low height species, dominated by encrusting ascidians, as well as sponges, calcified bryozoan colonies, gooseneck barnacles, and anemones. Mobile invertebrates were occasionally seen, including black chitons, and several starfish species. Panels (a-f) are read left to right across the top three images, and then the bottom three.

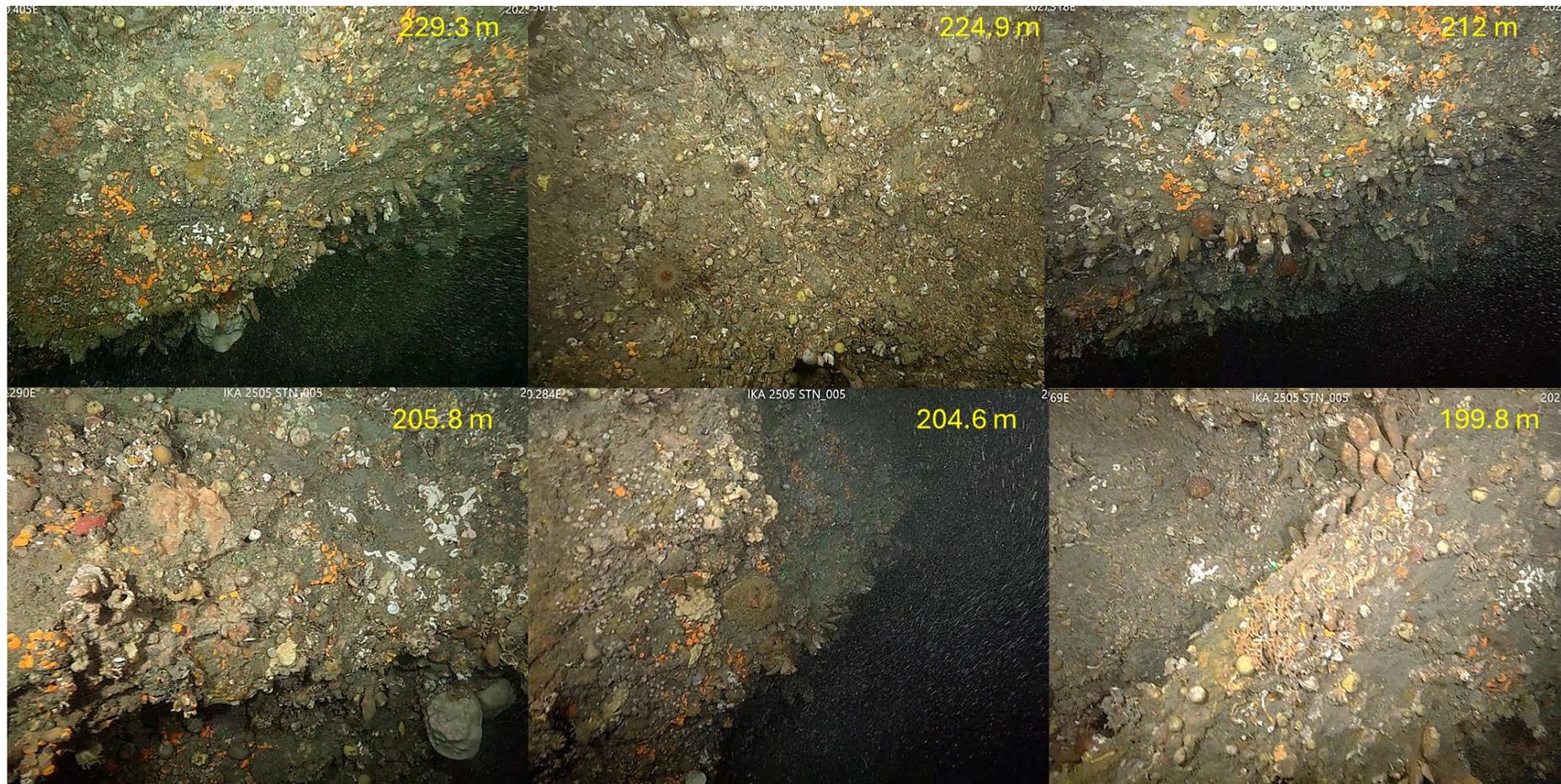


Figure 3-17: Cape Jackson, stn 5. The transect for this station ran along the main reef ridge from 229.3 to 189.5 m water depth. The transect held a greater proportion of flat(ish) rock than the other Cape Jackson sites. The faunal assemblage was consistent with the other stations, with some local variation such as not holding anemone patches. Panels (a-f) are read left to right across the top three images, and then the bottom three.

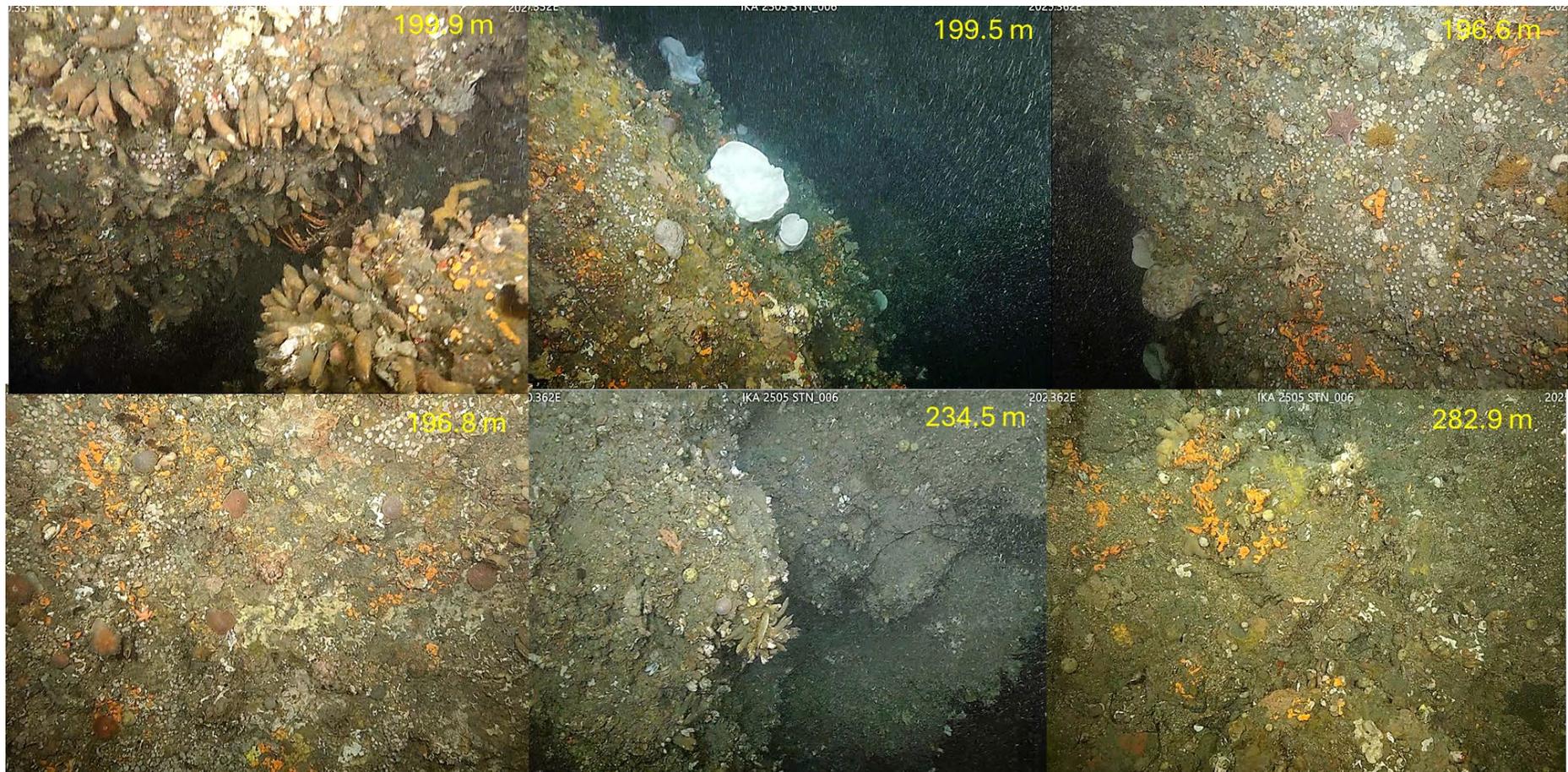


Figure 3-18: Cape Jackson, stn 6. The transect for this station ran down perpendicular from the crest of the main reef ridge, from 207.2 to 289.5 m water depth. The fauna was similar to other Cape Jackson reefs (a–f), with some change suggested beyond 250 metres water depth. An attached carpet shark egg case was observed at 281 m, as well as higher up the transect (e.g., image e above at 234.5 m). The only rock lobster seen during the deep reef survey was observed in a crevice on top of the ridge, at 199.9 m water depth (a). Old lost fishing cord was also seen on this transect. Panels (a–f) are read left to right across the top three images, and then the bottom three.

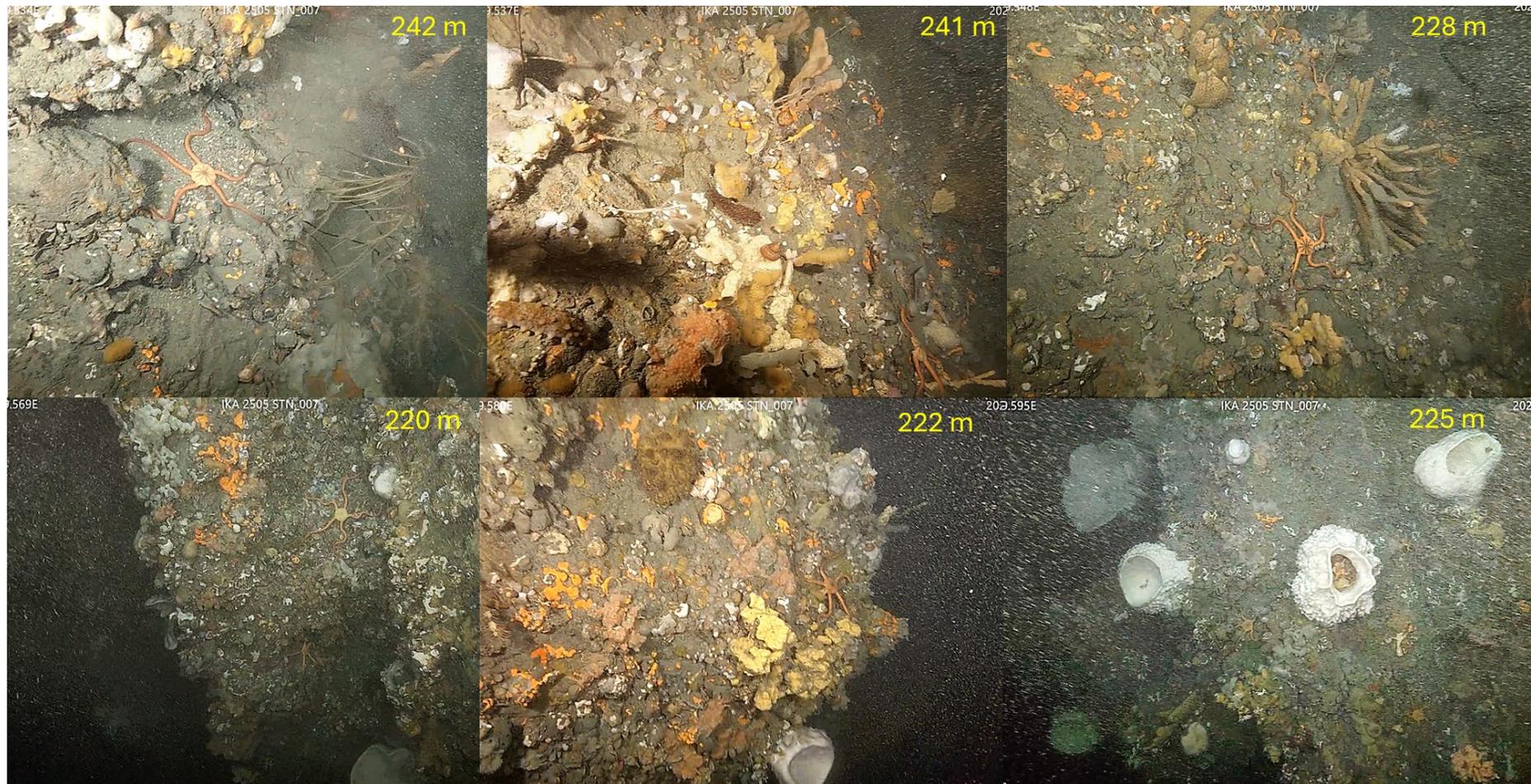


Figure 3-19: Cape Jackson, stn 7. The transect for this station started off the more northwest area of Jackson Point reef. The altimeter cable was broken during this tow, so the depths given are approximately one to two metres shallower than the true depths. The tow started on a soft sediment conglomerate of small black pebbles, yellow pebbles, and whole shells in/on a compacted solid flat, pale hard clay-like surface. Associated with this was a sparse fauna of snake stars, fan scallops, sponges, and cushion starfish. Rock first appeared as small, exposed basement patches flush with the soft sediments, following by small angular cobble and boulders on coarse sand, with an associated epifaunal assemblage of sponges, encrusting ascidians, hydroid trees, snake stars, brachiopods and solitary larger anemones. As slightly sloping rock platforms appeared at around 242–240 m depth, the characteristic more abundant, small body faunal species of the other Cape Jackson stations appeared, at very high percent cover. Fine sediment was not visually apparent, but the passage of CoastCam at time stirred up limited small clouds, which were moved off by the local currents. With distance, the terraces became shorter, and the height rises between them greater. The transect ended on soft sediment habitat very similar to the start, but with little associated fauna. Panels (a-f) are read left to right across the top three images, and then the bottom three.

4 Conclusions

Two days of field survey with the towed camera array CoastCam successfully imaged four deep reefs off the Marlborough Sounds. Collectively, a range of reef geologies and associated epifaunal assemblages were well covered, with numerous species apparent in the imagery. This imagery and the associated GPS path files have been archived, awaiting formal scoring and analysis at a later time.

The eventual addition of these four offshore Marlborough deep reefs' quantitative data will provide solid progress towards the greater goal of having a comprehensive understanding of deep reef habitats and their associated diverse species assemblages at the national scale. It clearly demonstrates that even modest survey efforts can yield substantial insights into deep reef ecosystems, provided they are conducted in a well-designed spatial framework.

The value of having high resolution multibeam sonar bathymetry of deep reefs to direct the placement of sampling effort cannot be over-stated. Multibeam sonar mapping of New Zealand's coastal waters, continental shelf and upper slope is gradually expanding, primarily driven by efforts to enhance safety in heavily trafficked marine navigation routes. Research and marine ecosystem management needs also drive the mapping of some areas, with the general Marlborough Sounds region and East Northland being particularly good examples. While the overall spatial area of New Zealand's continental estate is very large, currently unmapped deep reefs are especially amenable to having their general locations identified through Local Ecological Knowledge (LEK) (e.g., Jones et al. 2016), Mātauranga Māori (where appropriate), and opportunistic research survey data (e.g., the capture of reef-associated species, and fouled/hooked up trawls, within research trawl surveys, Morrison et al 2023a). Once their general locations are known, then multibeam sonar survey/s can be undertaken to find and map them, followed by ground-truthing and epifauna/epiflora assemblage quantification using towed video and/or other approaches. Such an approach was successfully used to map and quantify 14 rocky reefs on Patea Bank in 2021, with LEK kindly provided by local divers, fishers, and Citizen Scientists (Morrison et al. 2022).

Future efforts are best directed towards regions of New Zealand where little or no research effort has been undertaken on deep reef systems, to maximise the value of the information returns. Examples include the entire west coast of both islands (with the exception of several shelf edge canyons surveyed off North Taranaki and the Kaipara Harbour by Jones et al. 2016), the lower east coast of the North Island, and the South Island east coast from Dunedin to Foveaux Strait. Kahurangi Shoal, located on the shelf southwards of Farewell Spit, is one obvious example, with the entire reef system having already been recently multibeam sonar mapped as part of Land Information New Zealand's (LINZ) marine mapping programme.

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