# Distribution and abundance of benthos in the Kimberley using digital photo imagery


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**WAMSI Kimberley Marine Research Program**

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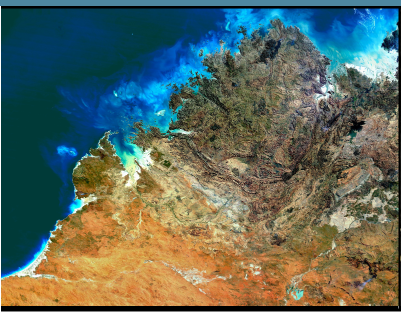


**WAMSI Kimberley Marine Research Program**

Initiated with the support of the State Government as part of the Kimberley Science and Conservation Strategy, the Kimberley Marine Research Program is co-invested by the WAMSI partners to provide regional understanding and baseline knowledge about the Kimberley marine environment. The program has been created in response to the extraordinary, unspoilt wilderness value of the Kimberley and increasing pressure for development in this region. The purpose is to provide science based information to support decision making in relation to the Kimberley marine park network, other conservation activities and future development proposals.



**Front cover images (L-R)**

Image 1: Satellite image of the Kimberley coastline (Image: Landgate)

Image 2: Large rooted Adeona spp. collected in sled sample from Southern region (Image: AIMS)

Image 3: Humpback whale breaching (Image: Pam Osborn)

Image 4: Northern region_ orange solitary free-living coral Heteropsammia cochlea at 21-23m (Image: AIMS)

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# Contents

## Executive Summary

The towed video system used for real-time, broad-scale habitat classification also incorporated a downward facing camera, which captured more detailed images of the seabed every 8-10m along each survey transect. The images provided an additional type of habitat sampling, at a much reduced scale but higher resolution than the forward facing video used for broad-scale habitat classification. A total of 212 transects were completed in the southern (107), central (57) and northern (48) regions, with over 40,000 downward-perspective photos captured. This report provides detail on the biota revealed by an analysis of approximately 39,000 of those images.

While many small organisms were revealed, the more common types of sessile biota captured in the images were the same as recorded by towed video and sled sampling, but the relative abundance, measured as percent cover of the seabed, differed between sampling methods. The most marked difference to the sled sampling results, was in the estimated abundance of bryozoan species. Low lying bryozoan species were widespread and much more abundant than other taxa, across all regions. Mean percent cover for the northern, central and southern regions ranged from 8.2-11.6%, up to ten times the cover of the next most abundant group, which was sponges. This disparity in estimated abundance is due to growth form, with many of the larger sponges growing vertically, whereas larger bryozoa often spread laterally and hence much more likely to be better represented in fine-scale, percent cover assessments of images taken with a camera oriented perpendicular to the seabed. Both the forward looking towed video classification and the epibenthic sled collection methods tend to more effectively sample the larger habitat-forming species such as sponges. The small size and fragility of bryozoans also predisposes those collected in a sled to fragmentation and loss through a collection net, resulting in a high probability of under-representation of biomass in sled samples.

The image analysis found that bare seabed, lacking visible epifauna (abiotic habitat), was overwhelmingly prevalent, contributing >85% of the seabed cover in all three regions. When biota were found and the data grouped as high level taxa, bryozoans were most abundant, with sponges and soft corals the next most common taxonomic groups, although contributing far less cover.

A cluster analysis at the transect level found 11 biological groups, all of which were present in the southern survey region, 9 shared with the central and 8 with the northern region. Across the three regions there were four groups with mean live cover of >10%. The abundance of biota in these groups at the transect scale (1.5 km) was mostly moderate, in the range of 10-30%. While each group was differentiated by the presence or absence of minor components, such as algae or coral, the fundamental characteristics shared by habitats with the most abundant biota were either an overwhelming contribution to cover by the bryozoa with a minor contribution from other taxa, or a more evenly mixed filter feeding habitat consisting of a majority of bryozoa but also sponges, soft coral and other organisms. Examples of mixed filter feeder habitats with mean cover in the range of 40-50% were found in all three regions. Those areas of higher abundance and diversity, which represented 10.4% of all transects, tended to be closer to shorelines or paleo channel edges. While comparable examples were found in all three regions, very high cover transects accounted for only 4.2 and 5.3% of transects in the northern and central survey regions respectively, but 15.9% of transects in the southern survey region. Those were mostly located around the island archipelago at the northern end of Lalang-garram/Camden Sound Marine Park or adjacent to the coast in the region of Hall Point.

# 1 Introduction

Image based classification of seabed biota is routinely used to assess and quantify benthic habitats. In tropical reef habitats, camera-based methods replaced the original *in situ* identification and measurement that was performed by diving marine biologists, as it was much faster and provided a permanent image archive for future reference. While achieving the level of control a diver has over camera positioning, exposure and perspective remains a challenge, especially in three dimensionally complex habitats. Continuous technical improvements have allowed cameras to be mounted on a variety of remotely deployed devices to successfully image the majority of habitats. Combination video and still camera systems are now routinely mounted on ROVs, AUVs and towed platforms, to capture images of seabed biota in habitats that are too deep or too difficult for divers to access. A number of surveys relying on towed camera systems have been conducted along inshore and offshore parts of the broader Kimberley region in the last decade (e.g. Fry *et al*. 2008; Heyward *et al*. 2011). Continual improvements in cameras, lighting and system configurations have resulted in the routine capture of informative imagery, even in high turbidity marine environments such as those frequently encountered along the Kimberley coast.

The habitat classification based on forward looking video occurs in real time, while the towed camera “flys” just above the seabed at 1-2 knots. The video allows relatively rapid assessment at scales of kilometres, but provides only fairly coarse level information at the habitat level. The classification schemes generally assess the perceived dominant biota within a habitat and apply some measure of relative abundance, e.g. “medium-density sponge habitat on low relief reef” or “low density soft coral on rubble” and so on. To augment the broad scale habitat mapping, each towed video transect also collected still photos every few meters using a downward facing camera. When analysed, finer level of classification is possible, as the still images usually provide much higher resolution and the high speed shutter used removes most of the blurring associated with movement of the towed camera platform. Comparison of the real-time towed video information with more detailed data extracted by point-intercept analysis of the still photos provides additional insight into the habitat composition of areas surveyed.

The data from still photos taken with a downward perspective, although grossly underestimating biomass of three dimensional growth forms with erect blade, fan or tube shapes, such as many sponges and soft corals, is much more effective in capturing data on the more two-dimensional, low lying or encrusting lifeforms. Point-intercept classification also provides a more quantitative measure, allowing changes in abundance to be resolved beyond the relative ” high-medium-low” density groups used during broadscale towed video habitat classifications. The more detailed image analysis also allows separation of and assignment of abundance values to key species or groups in mixed habitats, which often occurs.

# 2 Methods

To supplement the broadscale habitat characterisation (see 1.1.1.1 Chapter 3) the nearshore environment of the Kimberley coast was assessed using high resolution, downward-facing towed camera images collected during all four surveys. Surveys were constrained to three regions along the coast; the Northern (Cape Bougainville), Central (Bonaparte Archipelago) and Southern (Camden Sound) regions. The first two surveys were to the South and comprised 107 transects, followed by a single survey to each of the Central (57 transects) and then Northern regions (48 transects) (Figure 1).

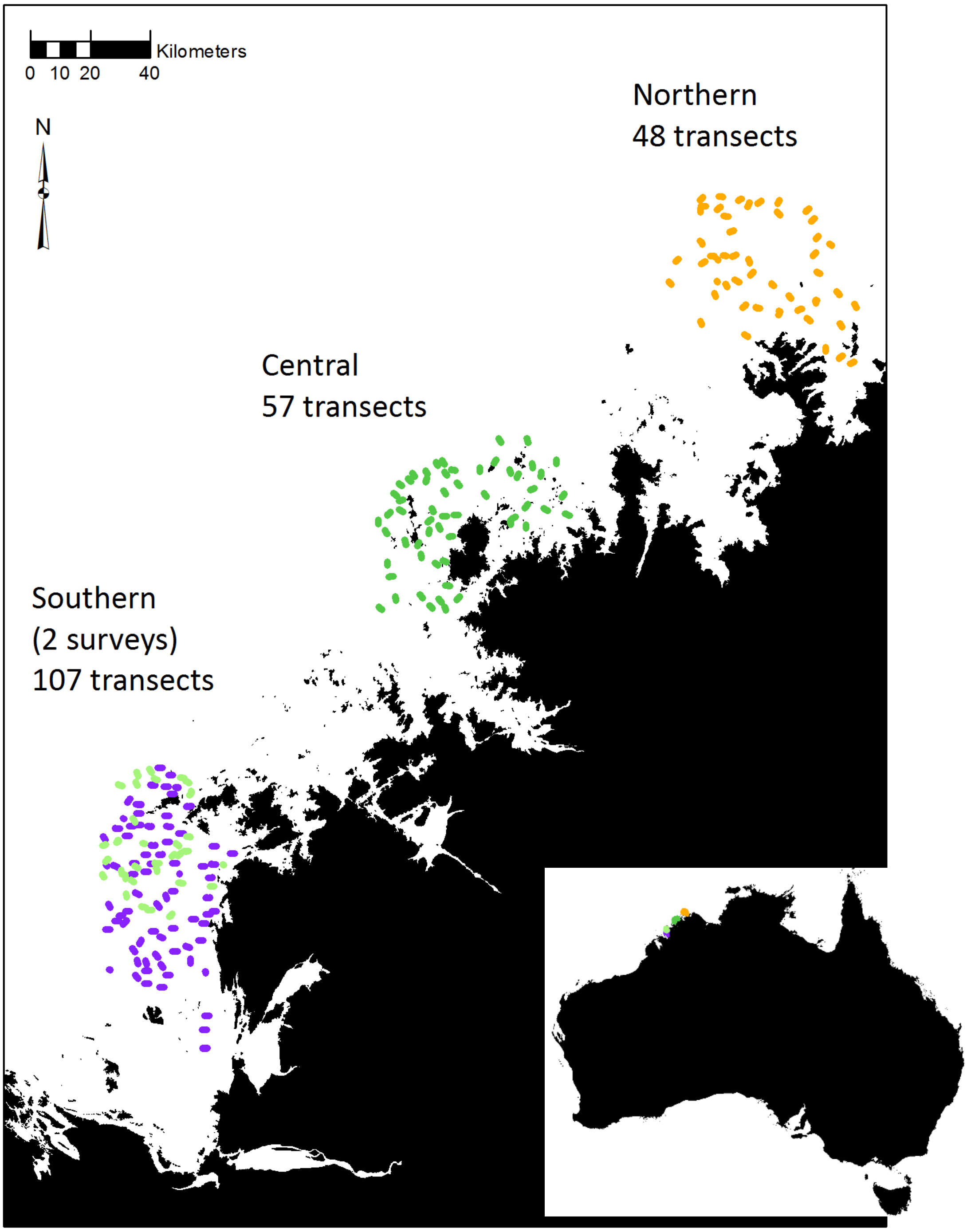


Figure 1. The Kimberley coast showing the three survey regions (Northern, Central, and Southern) and the location and number of transects. The two colours used in the southern survey area distinguish the two separate expeditions.

The images analysed were collected at regular intervals, every 10 seconds, as the camera system traversed along each transect. The sampling interval chosen was a compromise between adequate spatial detail and the number of images generated for analysis, which was based on previous experience of benthic habitats in the bioregion, e.g. Heyward *et al*. (2011). On average, transects were 1.5km in length. Image spacing varied from 6-10m, depending on vessel speed. The number of images collected and used in the analysis was proportional to the number and length of transects conducted (Table 1). After exploratory statistical analyses using all data, three transects were omitted from the final assessment as they comprised less than 30 images (i.e. transects were under 200m in length), which distorted some of the cluster analyses. Images were only included in the analysis if at least four of the five points overlaid on an image could be reliably classified (i.e. some images were clouded by sediment in the water making it impossible to identify the benthos).

Table 1. Summary by region of the transects and images used in the analysis.

| Region | Dates | Survey Trip # | Transects | Images taken | Images analysed |
|---|---|---|---|---|---|
| **Southern region** | Nov-2014 | 6,080 | | | |
| **(Camden Sound)** | Mar-2015 | 6,181 | 107 | 20,640 | 20,549 |
| **Central region (Bonaparte Archipelago)** | Dec-2015 | 6,352 | 57 | 11,650 | 10,701 |
| **Northern region** | | | | | |
| **(Cape Bougainville)** | Mar-2016 | 6,396 | 48 | 8,326 | 7,740 |
| | | | 212 | 40,616 | 38,990 |

The depth range of images for each region was similar (~15-65m) however the sampling intensity was approximately double for the Southern region compared to the Central and Northern regions (Figure 2) as it was surveyed on two occasions.

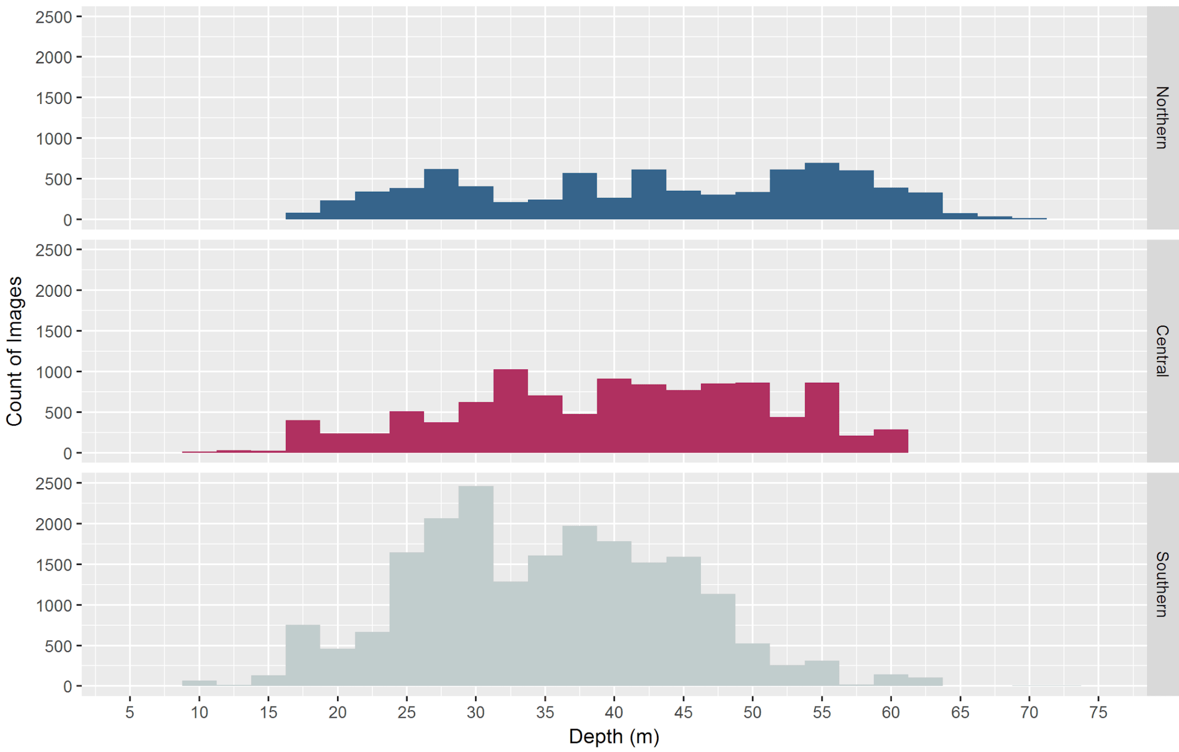


Figure 2. Histogram by region showing the depth distribution of images analysed.

## 2.1 Still-image analysis

Still images from the first two surveys to the Southern region (Camden Sound) were analysed using a point intercept method (see Heyward *et al*. for details, 2012). This analysis revealed very low abundance of macroscopic organisms, when expressed as a percentage covering the seabed, with over 85% of the benthos consisting of abiotic components (i.e. sand, bare substrate or substrate covered by turf/coralline algae). With this considered, image analysis protocols for the last two surveys to the Central and Northern region were adjusted to improve efficiency whilst optimising classification detail of biotic components. The approach involved a combination of auto-image classification (BenthoBot) and manual classification by marine biologists.

## 2.2 BenthoBot auto-image classification

BenthoBot is a computer algorithm developed to classify points on an image, based on spectral properties extracted from each image. It has been developed specifically by the Australian Institute of Marine Science (AIMS) to provide an efficient and consistent means of generating the point based broad-scale benthic classification data that underpins both our offshore shoals and shallow reef based long term monitoring programs. In recent years AIMS has used BenthoBot to classify images for a number of seabed biodiversity assessments (e.g. PTTEP, Radford *et al.* 2017).

For the WAMSI project, the BenthoBot model was fine-tuned using marine biologist derived classifications from the first two surveys to the Southern region (20,549 images with approximately 5 points per image = ~100,000 classified points). The process to develop the model was the same as described in Radford *et al.* (2017), with 80% of the pre-classified images used to train and test the model, and the remaining 20% used for validation. Image quality was typically poor in this study, i.e. the images were clouded by re-suspended sediment in the water and the limited biota present was often covered by a layer of sediment, making classification difficult. Due to low image quality and low biotic cover the resultant BenthoBot model (based on classifications from the first two surveys) could not be tuned to reliably predict anything other than the category “abiotic” (i.e. sand, substrate, substrate covered by turf/coralline algae). The f1-score for “Abiotic” was 0.92 which is very reliable (Table 4.2). “Other organisms” also had a fairly reliable f1-score (0.71), however the other biotic categories did not score well. Based on these results, it was prudent to rely on BenthoBot to identify only “abiotic” points on images (~88%), with points overlaying any biotic components (~12%) segregated out and re-analysed by marine biologists for detailed identification. In previous studies the BenthoBot model has been trained and tuned to reliably predict six or seven major categories of benthos. The performance of the BenthoBot model is determined largely by the quality of images used to train it, which can vary depending on image clarity, the type of benthos present, the number of training points available for each category and the consistency of classifications made by marine biologists on the training image set.

Table 2. Precision, Recall and F1 scores for each of the benthic categories based on the test data validation. Note: during this phase, the category “Other organisms” included “Bryozoa”. *Precision* measures relevancy i.e. the accuracy of the prediction made by the model. *Recall* measures how many relevant results were returned i.e. how much of the test data was positively predicted for a particular category. *f1-score* is a weighted average of precision and recall. *Support* is the number of points/patches used in the testing dataset for a particular benthic category. For this study BenthoBot was used to classify “Abiotic” benthos in the images, with all biotic categories classified manually by marine biologists.

| | **precision** | **recall** | **f1-score** | **support** |
|---|---|---|---|---|
| **Abiotic** | 0.90 | 0.94 | 0.92 | 1526 |
| **Algae** | 0.00 | 0.00 | 0.00 | 9 |
| **Hard coral** | 0.00 | 0.00 | 0.00 | 3 |
| **Other organisms** | 0.72 | 0.70 | 0.71 | 550 |
| **Soft coral** | 0.64 | 0.33 | 0.43 | 55 |
| **Sponge** | 0.54 | 0.49 | 0.51 | 123 |
| **avg / total** | 0.83 | 0.84 | 0.83 | 2266 |

## 2.3 Statistical Analysis

### *2.3.1 Benthic composition between and within regions*

All benthic codes from the scored images were aggregated to seven major taxonomic categories that were considered robust to benthic classification; abiotic, bryozoan, sponge, other organism, soft coral, macroalgae and hard coral. A summary of the benthic composition by region is presented in Table 3. The six biotic groups were further classified by marine biologists to highest taxonomic level and fine-scale category.

Bar charts were constructed to examine broad-scale differences in community composition and represent the proportion of scored points for a given region by the seven major categories. Stacked bar charts were also constructed to examine differences in community composition at the transect level for each region. Bar charts were constructed with ggplot2 (Wickham, 2009) in R (R Core Team, 2016).

We used multivariate analyses in PRIMER 6 (Clarke & Gorley, 2006) to quantify differences in benthic community composition between and within the regions. In particular we wanted to determine whether regions or locations within the study area were characterised by higher biotic cover and/or diversity. To do this, transect percentage cover estimates (by seven major categories) were square-root transformed to stabilize variances and a resemblance matrix constructed using the Bray-Curtis measure. Hierarchical cluster analysis was carried out by pair-wise comparisons of each transect using group average linking. A SIMPROF test was incorporated in the cluster analysis (run for 999 permutations at a significance level of 5%) to determine significant cluster groups.

The initial cluster analysis involved all major categories and resulted in 18 clusters being significant by the SIMPROF test. These clusters were not meaningful in terms of describing biotic community types, possibly due to inclusion of the dominant group “abiotic”. Since a study aim was to determine whether locations were characterised by different biotic types we decided to omit the category “abiotic” and re-run the cluster analysis with the six biotic categories only.

To avoid generating undefined values in the resemblance matrix from zero values in ten transects comprising 100% abiotic cover, a dummy value (0.1) close to the minimum value for the transformed data (0.28), was added to cover values.

The resulting analysis based on biotic categories only, produced 11 clusters. To provide detail about the biotic composition of each cluster, a shade plot of the biotic data (square root transformed) was paired with the cluster dendrogram (Figure 13). Transects in the shade plot transects were re-ordered to align with the dendrogram clusters.

ArcGIS (ESRI, 2011) was used to create a map overview of the study area showing the location of all transects comprising the analysis (Figure 1). Regional maps with transects colour-coded by cluster group were also created to highlight findings relating to the distribution of the clusters produced by the analysis. The benthic composition of each transect (untransformed data) within the region, was presented in stacked bar charts, grouped by cluster. The average composition of the 11 clusters and the number of transects comprising each were also graphed.

Table 3. Summary of benthic data classifications obtained from high resolution still images collected along each Towed Video transect. Percentage cover for each region is summarised by major category (values highlighted in red), fine-scale category and highest taxonomic level.

| Major category | Fine-scale category | Highest taxonomic level | North | Central | South |
|---|---|---|---|---|---|
| 1. Abiotic | Abiotic | Abiotic | 89.297 | 90.124 | |
| | Sand/Silt | Sand | | | 15.57 |
| | | Silt | | | 9.749 |
| | Consolidated reef | Coralline algae/turf | 0.108 | | 0.014 |
| | | Reefal substrate | | | 0.001 |
| | | Turf Algae on Consolidated | | | 1.051 |
| | Unconsolidated | Rubble | | | 0.711 |
| | | Shells | | | 0.031 |
| | | Turf Algae on Sand | | | 58.178 |
| | | | 89.405 | 90.124 | 85.305 |
| 2. Bryozoa | Bryozoa | Bryozoa | 8.168 | 8.418 | 11.585 |
| 3. Sponge | Encrusting | Encrusting: creeping/ramose | 0.124 | 0.008 | 0.219 |
| | | Encrusting: thickly | 0.24 | 0.044 | 0.28 |
| | | Encrusting: thinly | 0.15 | 0.042 | 0.162 |
| | Erect/branching | Branching/bush | | | 0.123 |
| | | Cups: goblet | 0.008 | 0.004 | 0.01 |
| | | Cups: incomplete/curled fan | 0.008 | 0.025 | 0.018 |
| | | Cups: table/disc | 0.005 | 0.004 | 0.005 |
| | | Laminar/fan | | | 0.233 |
| | | Simple | 0.066 | 0.027 | 0.107 |
| | | Sponge spp. | 0.305 | 0.148 | 0.076 |
| | | Stalked balls/clubs | 0.003 | 0.002 | |
| | | Tubes/chimney | | | 0.002 |
| | Massive | Balls | 0.024 | 0.002 | 0.021 |
| | | Barrels | 0.034 | 0.013 | 0.021 |
| | | Simple | 0.129 | 0.036 | 0.121 |
| | | | 1.094 | 0.355 | 1.398 |
| 4. Other organisms | Other organisms | Ascidian | 0.161 | 0.128 | 0.422 |
| | | Anemone | 0.013 | 0.002 | 0.002 |
| | | Corallimorpharia | | | 0.001 |
| | | Crinoid | 0.132 | 0.069 | 0.131 |
| | | Fish | 0.005 | | 0.003 |
| | | Gastropod Mollusc | 0.008 | | 0.001 |
| | | Holothurian | 0.005 | 0.004 | |
| | | Hydroid | 0.208 | 0.326 | 0.457 |
| | | *Millepora* spp. | 0.003 | | |
| | | Other organism unknown | 0.013 | 0.002 | 0.003 |
| | | *Prionocidaris baculosa* | 0.018 | 0.019 | 0.016 |
| | | Starfish (not *A.planci*) | 0.018 | 0.002 | 0.008 |
| | | *Trochus niloticus* | | | 0.006 |
| | | Urchin | 0.074 | 0.002 | |
| | | Zoanthid | 0.011 | | 0.001 |
| | | | 0.669 | 0.554 | 1.051 |

| Major category | Fine-scale category | Highest taxonomic level | North | Central | South |
|---|---|---|---|---|---|
| 5. Soft coral | Gorgonian | Gorgonian fan | 0.224 | 0.125 | 0.25 |
| | | *Junceella fragilis* | 0.147 | 0.142 | 0.102 |
| | | *Plexaura flava* | | | 0.001 |
| | | *Plumarella penna* | 0.018 | 0.011 | |
| | | *Rumphella* | | 0.002 | |
| | Soft coral | *Erythropodium* spp. | 0.005 | 0.004 | 0.002 |
| | | Family Nephtheidae | 0.084 | 0.038 | 0.102 |
| | | *Lobophytum* spp. | 0.003 | 0.011 | |
| | | Pennatulacea | 0.013 | 0.004 | 0.001 |
| | | Soft coral spp. | 0.029 | 0.029 | 0.109 |
| | | *Tubipora musica* | | | 0.001 |
| | | | 0.522 | 0.366 | 0.568 |
| 6. Macroalgae | Macroalgae | *Actinotrichia fragilis* | | | 0.001 |
| | | Algae Other | | | 0.001 |
| | | Algal spp. (Algal Assemblage) | | 0.008 | |
| | | Brown Algae Family | 0.008 | 0.019 | |
| | | Brown (erect fine branching) | | | 0.002 |
| | | Green Algae Family | | 0.004 | |
| | | Green (erect fine branching) | | | 0.001 |
| | | Macro Algae Other | 0.008 | 0.061 | 0.044 |
| | | Red Algae Family | 0.024 | 0.021 | 0.001 |
| | | Red (encrusting) | 0.042 | 0.019 | 0.016 |
| | | | 0.082 | 0.132 | 0.066 |
| 7. Hard coral | Branching | Non-Acropora coral | | 0.023 | 0.002 |
| | Branching *Acropora* | *Acropora florida* | | | 0.001 |
| | | *Acropora* spp. | | 0.002 | |
| | Encrusting | Favid spp. | | 0.002 | |
| | | *Favites* spp. | | 0.002 | |
| | | *Hydnophora* spp. | 0.003 | | |
| | Foliose | Non-*Acropora* coral | | 0.002 | |
| | | *Turbinaria* spp. | 0.005 | 0.004 | 0.006 |
| | Massive | *Coeloseris mayeri* | 0.003 | | |
| | | *Favia matthaii* | | 0.002 | 0.002 |
| | | *Goniopora* spp. | 0.003 | 0.006 | |
| | Solitary/free-living | *Heteropsammia cochlea* | 0.039 | | 0.013 |
| | Submassive/columnar | *Goniopora* spp. | | 0.002 | |
| | | Non-*Acropora* coral | 0.003 | 0.006 | |
| | | *Tubastraea* spp. | 0.003 | 0.002 | 0.004 |
| | | | 0.059 | 0.053 | 0.028 |

# 3 Results

Surveys in all three regions reveal a preponderance of abiotic components (sand, substrate, substrate with turf/coralline algae), representing average cover of 88% across all surveys (Figure 3). Of the 212 transects surveyed, 35 had > 99% cover by abiotic components (5 Northern, 8 Central and 22 Southern) with 10 of these having 100% abiotic cover (see stacked transect plots in Figures 14, 15, 16).

The most abundant biotic group was bryozoa which averaged 9.4% cover across surveys. The remaining five biotic groups (sponge, other organisms, soft coral, algae, and hard coral) had very low presence, contributing on average < 1% cover each across surveys. This pattern was consistent across the survey regions however there was variability at the scale of transects across regions.

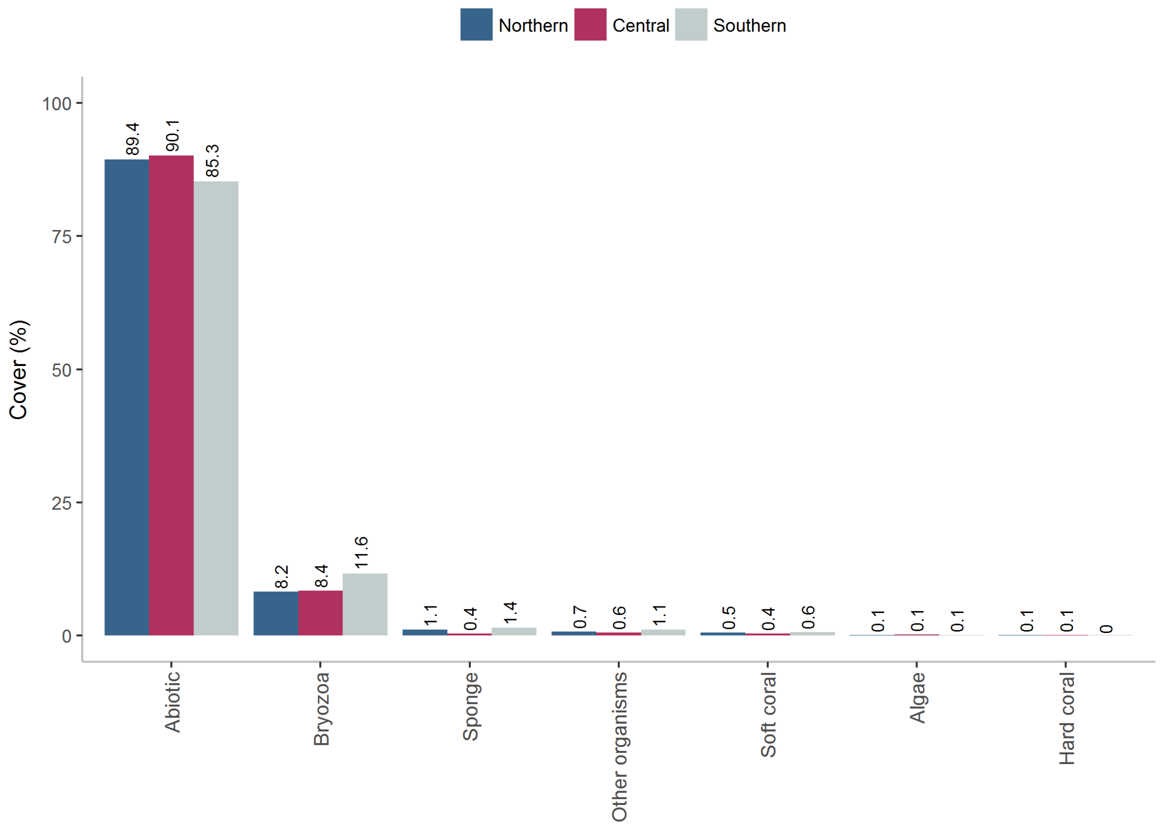


Figure 3. Abundance (% cover) of the seven major benthic categories derived from the still image analysis. Cover of these categories is summarised by region and labelled on the bar plot.

Bryozoa, the most prevalent biotic group by region, tended to be present in a low profile layer on hard substrate within many transects (Table 3 and Figure 4). During real-time surveys on the ship, bryozoans were not readily detected in the forward facing video due to their often neutral colour, low profile and more limited image resolution. The difference in detectability due to size, growth form and camera perspective, meant analysis of the high resolution downward-facing still images was required to ensure bryozoans were assessed more effectively. There is a need for caution with image based measures of very small organisms and it is probable that some bryozoa and other very small or indistinct biota were classified together in the "bryozoa" group. Hence the image classification may overestimate actual bryozoans. Nonetheless, cover was highest on individual transects in the Southern region (e.g. transects 182: 77% and 206: 75%, see Figure 4.17, stacked transects) and diverse genera were present.

Bryozoan specimens collected during the study from sled surveys, were examined to a limited extent by Dr. Robyn Cumming, bryozoan taxonomist and collection manager at the Museum of Tropical Queensland. In her summary of initial findings she stated "Impressive was the large, rooted *Adeona* sp. with kenozooidal stalk, and delicate fronds (Figure 4). Species of *Adeona* are one of the dominant in southern Australia, including the Great Australian Bight where they are amongst the few taxa that can occupy high energy wave zones. Interestingly, *Adeona* spp. are not known to be abundant in other parts of northern Australian, viz. the Great Barrier Reef, Gulf of Carpentaria, and Beagle Gulf.

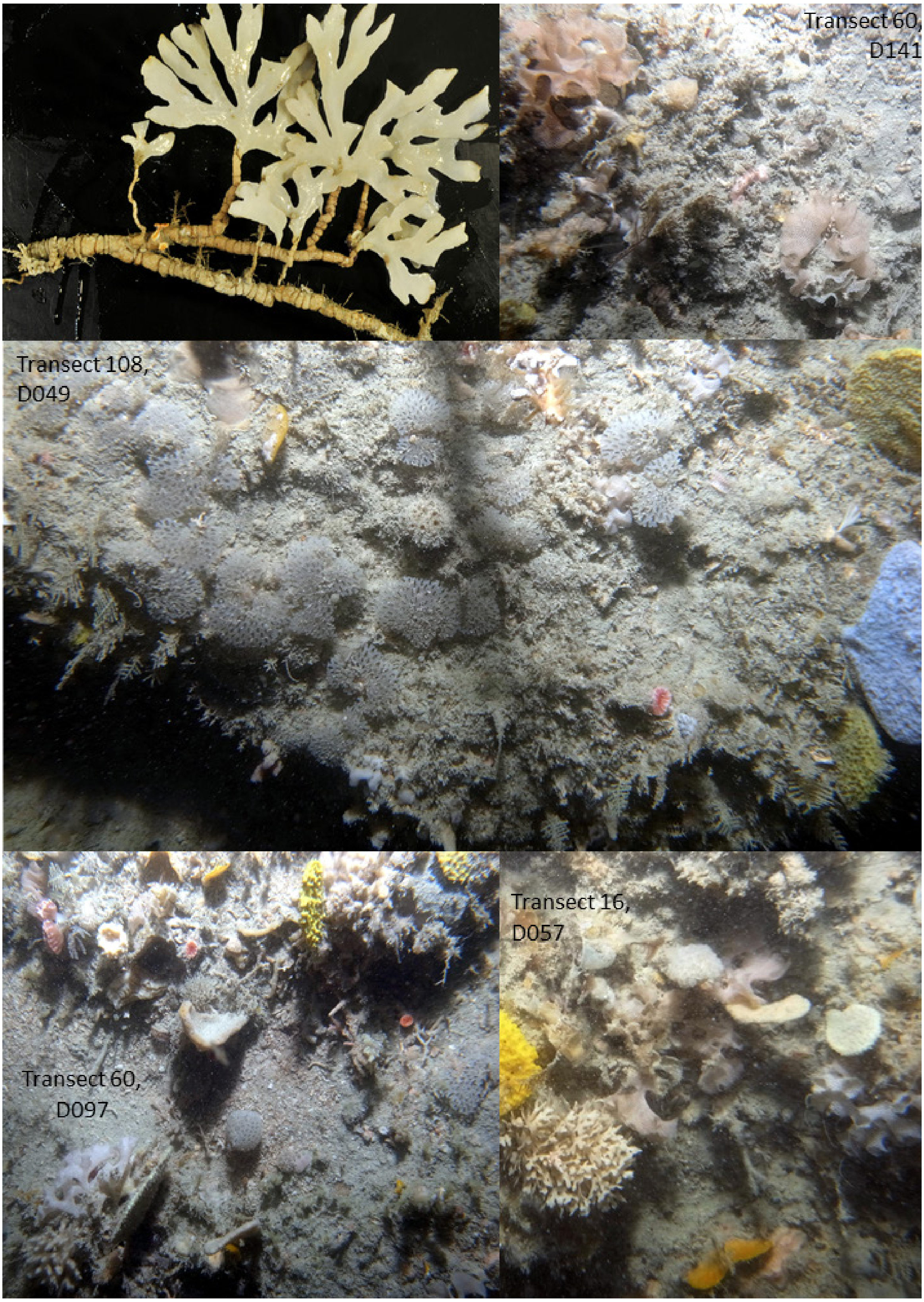


Figure 4. Top left: large rooted *Adeona* spp. collected in sled sample from Southern region, transect 50 (Photo: J. Keesing). Remaining images show the typical mix of bryozoan genera growing with other low profile biota, on hard substrate covered by a veneer of sand/sediment (Southern region).

Also abundant in the samples from the Southern region (Camden Sound) were various taxa typical of other northern Australian sites: the fenestrate *Triphyllozoon*, the branching *Porina, Adeonella* and *Celleporaria*, the foliaceous *Cigclisula*, various species of *Calyptotheca* and a tubular *Petraliella*. The taxa are mostly cheilostomes, with few ctenostomes or cyclostomes."

Sponge comprised the next most abundant biotic group, with growth forms predominantly encrusting, laminar and simple massive (Table 3). In some areas where hard substrate was present, erect and laminar sponges grew together with gorgonian fans, other soft corals and hydroids, to form short intervals of mixed filter feeders within the 1.5 km transect (Figure 5).

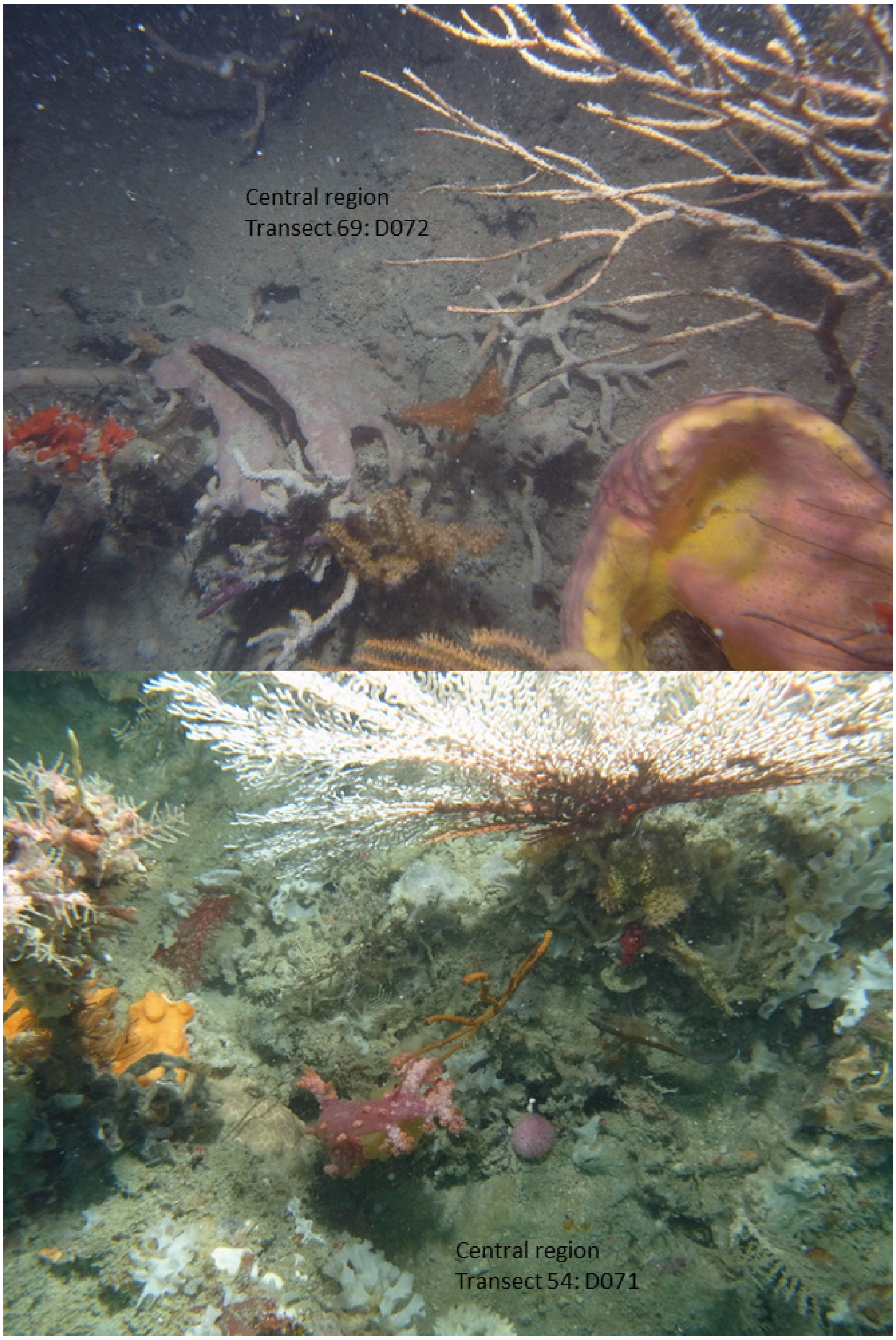


Figure 5. Mixed filter feeding communities occurred in patches along transects where hard substrate was present. Other biota included bryozoans and other encrusting organisms.

The biomass of this community type (mixed filter feeders), predominantly occupies space in the vertical rather than horizontal plane and consequently, abundance, when calculated as percentage cover, can greatly be under-estimated in downward-facing image analysis. This assertion is supported when comparing the biomass of sponges to bryozoans collected from sled sites within Towed Video transects (Figure 6).

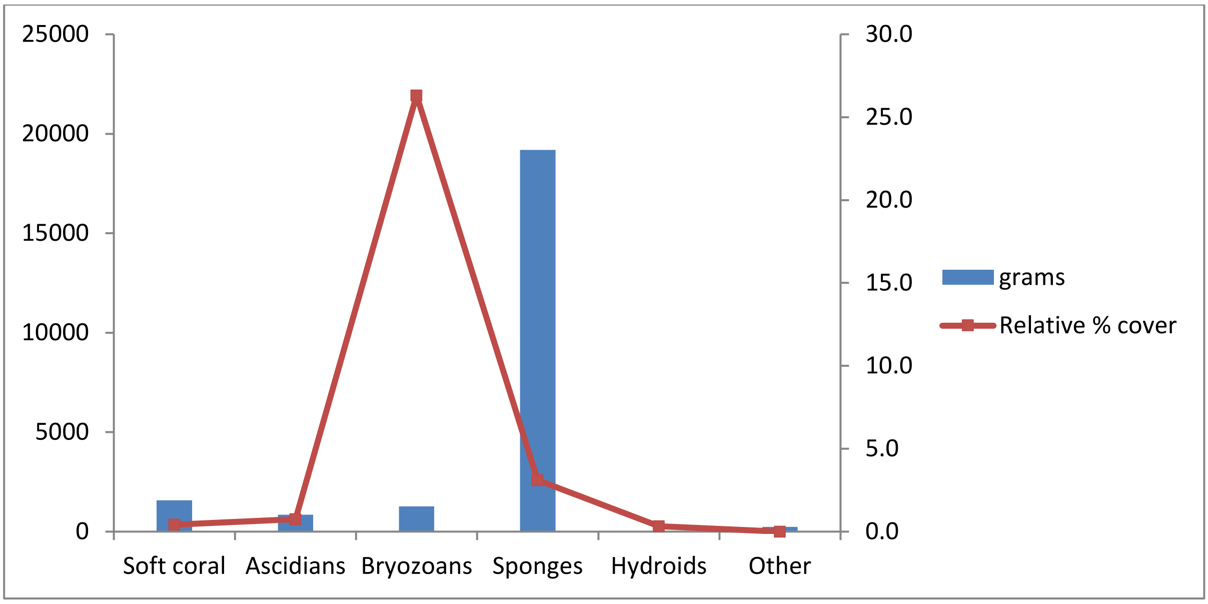


Figure 6. Comparison of sled catch biomass (blue bars, thousands of grams, left axis) versus percentage cover (red line, % cover, right axis) from downward-facing images for major biotic groups on the same transect in Camden Sound. Note the group Bryozoa includes bryozoans and other morphologically similar small organisms.

The group "other organisms", was represented mainly by hydroids, ascidians and crinoids (Table 3). Hydroids occurred as small, fine colonies mixed within low profile bryozoan habitats (Figure 4, central image, transect 108) as well as within filter feeding communities. Ascidians were represented by a range of growth forms, including encrusting and stalked (Figure 9), within numerous habitats. Soft corals were mostly represented by gorgonian fans, whips and genera from the family Nephtheidae. They co-occurred in patches on selected transects with other filter feeders, as seen in Figure 5. Whips were also found in stretches of open sandy areas with little other biota. Crinoids occurred on 64 transects mainly in the Southern and Northern regions and were mixed with other biota or sometimes on stretches of bare sand.

Noteworthy on five transects in the Northern region (labelled in green on the map, Figure 15), were burrowing heart urchins usually at depths between 30-55m. These urchins were particularly dense on transects 22, R14 and 18, however the still image analysis used data from the classification system that only scored "urchin" but not "urchin burrows". Hence the true urchin abundance was under-estimated as many urchins were burrowed just beneath the sediment surface. For example, the most densely populated transect (22), was scored as having 1.6% cover of urchins. While all 152 images along the transect contained what were likely to have been urchins in burrows, only 13 points fell directly on visible urchins (Figure 7). This result is a good reminder that infauna, including even larger organisms like burrowing molluscs and echinoderms, are likely to be poorly represented in the data.

Light dependent organisms, such as algae and hard corals, had low presence in the study area, due to the combination of strong light attenuation being observed regardless of region, and transects usually deeper than 15m. Algae was present on 25 transects and comprised red, brown or green groups with encrusting or fine branching growth form (Figure 8 and 9). On the shallowest transects, or transects with shallow portions, green and brown algal groups occupied depths around10-12m (Figure 8) with red genera often found deeper (Figure 9).

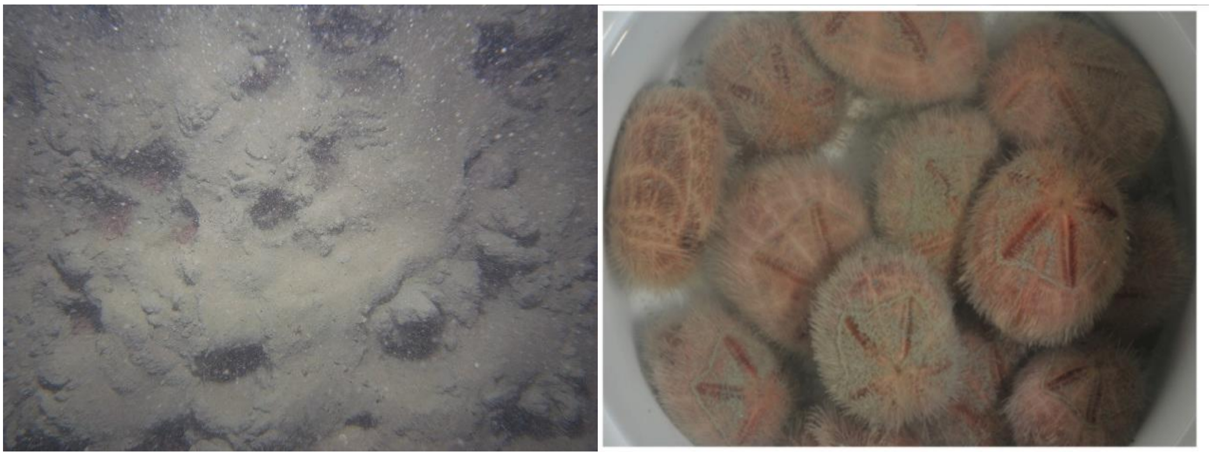

Figure 7. Heart urchins – left image from downward facing towed camera shows numerous urchin burrows, with only some partially visible. Right image is a laboratory photo, taken aboard RV Solander, of live heart urchins collected by sled. Photo: J. Keesing.

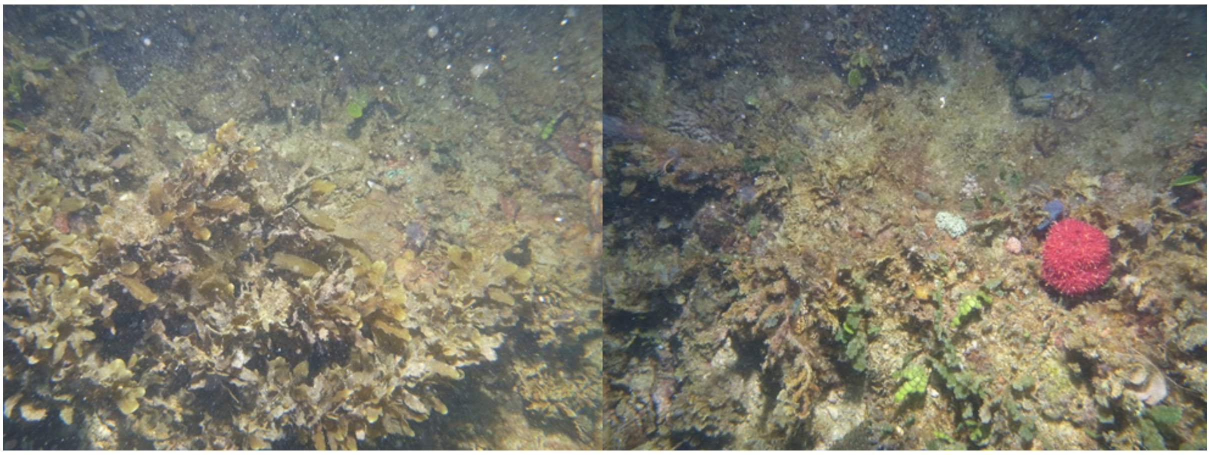

Figure 8. Central region - fleshy macroalgae: transect 28 had a total of 4.5% algal cover, found between 9.5-16.5m, predominantly brown/green/red algal assemblages.

Figure 9. Northern region – red algae examples: transect 37, had a total of 2.8% algal cover, found between 19-23m, predominantly red algae encrusting, and some red branching. Stalked ascidians can be seen in the background.

Hard coral was the least abundant of the major biotic categories, with highest cover of 1.6% reached on transect 666, one of the shallowest in the Southern region (see Figure 10). Coral on this transect comprised a few large colonies of *Turbinaria* species, which prefer turbid environments.

Figure 10. Southern region: transect 666 had hard coral cover of 1.6%, comprised of *Turbinaria* spp. It was a short transect with of only 74 images, at a depth range of 10.5-11.5m.

Hard coral in the Northern and Southern regions was predominantly comprised of *Heteropsammia cochlea* (Table 3), a small solitary free-living coral not fixed to the substrate, with diameter not exceeding 2.5cm (Figure 11). These corals are reported to be zooxanthellate in tropical localities but are possibly azooxanthellate in temperate locations and in deep water (Veron, 2000) or water with strong light attenuation (i.e. Kimberley Coast).

Figure 11. Northern region: transect 37, 0.8% cover of the orange solitary free-living coral *Heteropsammia cochlea* at 21-23m. It was also found at depths of 49m in the Southern region, transect 60.

In the central region hard coral was a minor component of the benthos along the towed camera transects, with cover typically <1%. The most abundant hard coral group was branching non-*Acropora*, with a few individuals found down to depths of approximately 30m. This coral group was present on four transects across the study at depths between 25 and 32m (Figure 12).

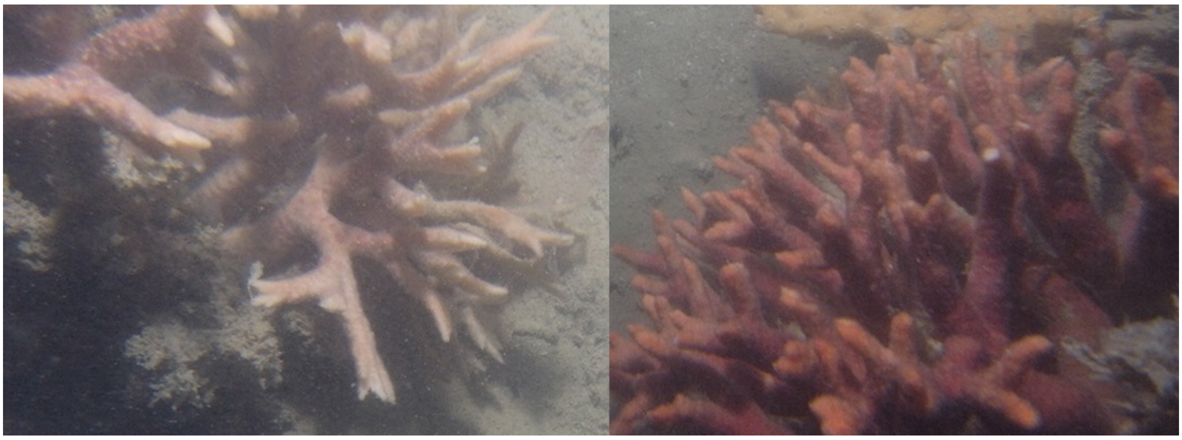

Figure 12: Central region, transect 29, 0.9% hard coral cover between 30-32m, identified in the image classification scheme as branching non-*Acropora* spp.

A cluster analysis was performed on the transformed data, to assess the distribution of transects grouped according to benthic composition. Eleven clusters (a-l) were found to be significant by the SIMPROF test (Figure 13, upper plot dendrogram). The regional distribution of transects within clusters, each designated a particular coloured symbol, is shown in Figure 14 (upper plot dendrogram). Bryozoans clearly dominate biotic cover (Figure 14 lower, shade plot). Areas of higher biotic diversity and abundance were grouped by the analysis into clusters f, h, and i. Those transects include mixed filter feeder groups, i.e. sponge, soft coral and other organisms (mainly hydroids), in addition to bryozoans. Noting the likely under-sampling of some of those groups from the downward-facing image analysis, the contribution of mixed filter feeders is probably higher than suggested by the % cover data. Five clusters (j, d, b, c and g) consist primarily of bryozoans and represent different levels of cover by this group. Two clusters (a, e) comprise transects from the Southern region only.

Transects were plotted by cluster to help visualise whether patterns existed in their distribution within and between regions (Figure 14, upper, map plot). Figure 14 (lower, bar plot) also shows the average biotic composition of each cluster, its colour and the number of transects comprising it. Clusters of biotic interest (i.e. filter feeders) were coloured red, dark red and purple, with the five bryozoan clusters coloured increasing shades of grey. In general, clusters were distributed across the survey regions with some clumping of filter feeder groups in the Southern region.

Regional level summaries of the cluster analysis can be seen in Figures 15-18 and include stacked bar plots showing the biotic composition of transects comprising each cluster. Focussing just on the three filter feeder clusters (red, dark red and purple), transects in the Northern region (Figure 15) occur mainly in the purple cluster (lower cover). By comparison the Central region (Figure 16) has fewer transects overall in any filter feeder cluster. The Southern region (Figure 17-18) has a high proportion of transects in filter feeders clusters, with the highest proportion in the red cluster (highest cover).

Appendix 2 provides a detailed summary of cluster group composition and Appendix 3, a summary of the transect level biotic data.

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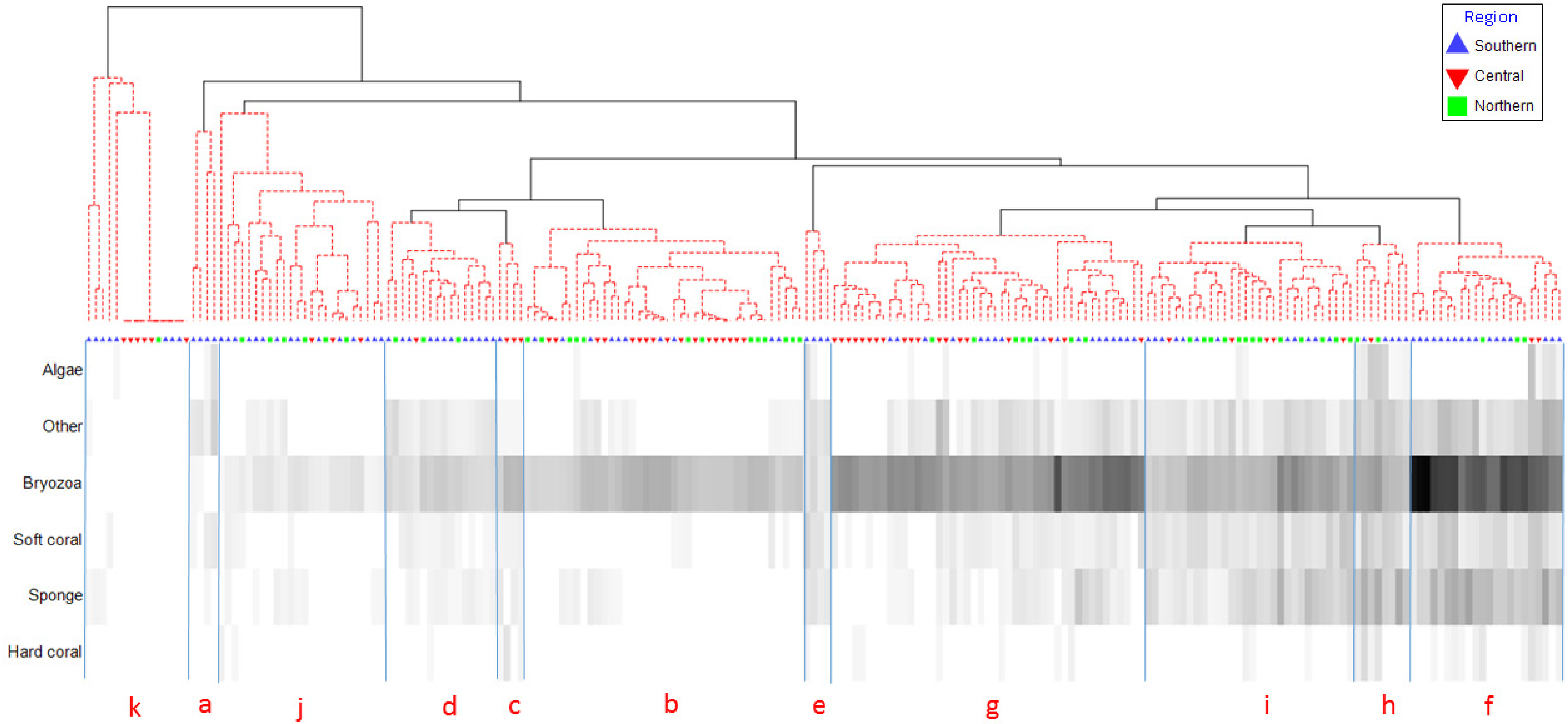


Figure 13. Dendrogram from the cluster analysis (top plot) showing SIMPROF groups, paired with a shade plot of the biotic data (bottom plot). Transects in the shade plot have been re-ordered to align with the dendrogram clusters (labelled in red) and are symbolized by region. Cluster analysis and shade plot based on square-root transformed data.

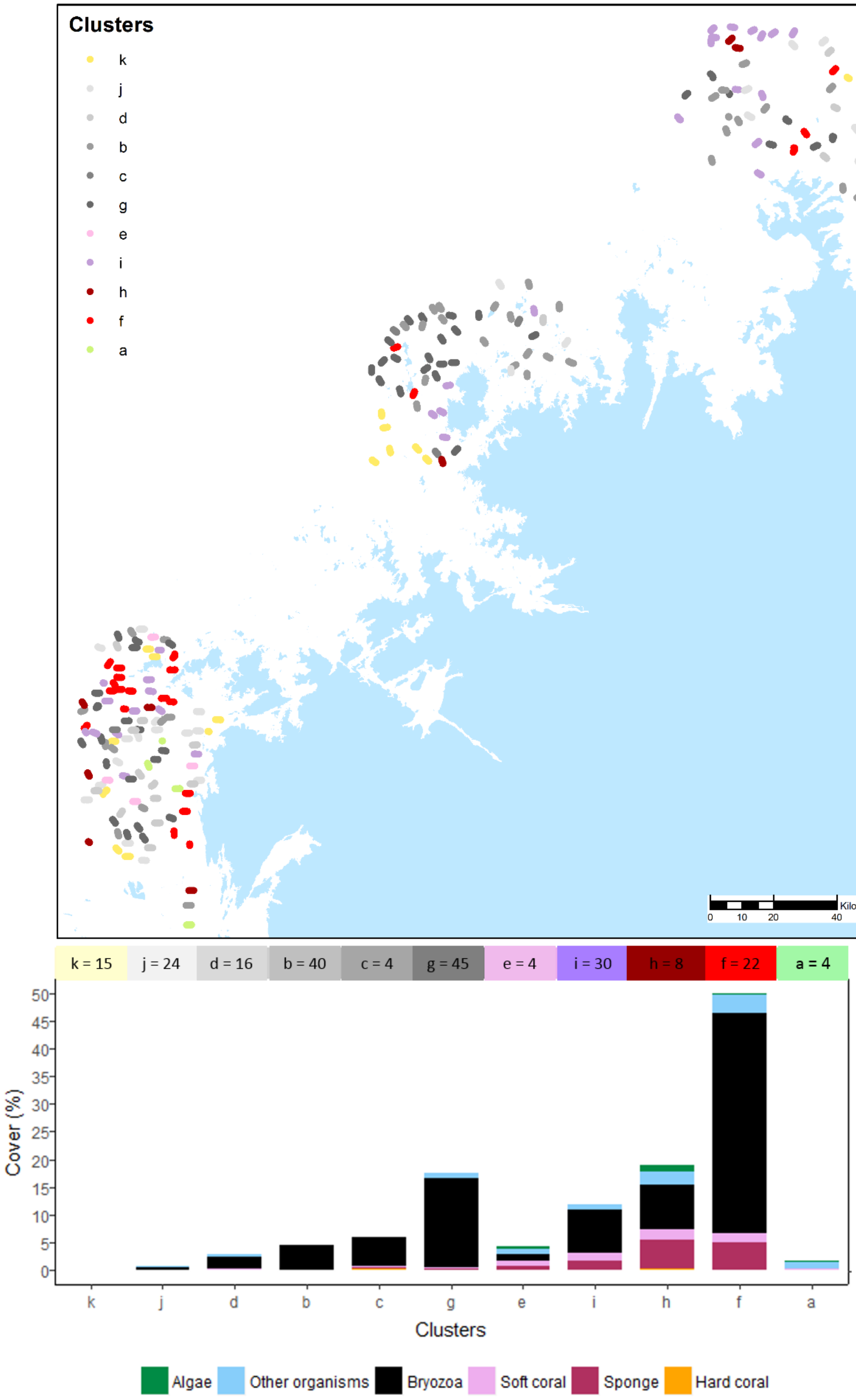


Figure 14. Map showing the distribution of the 212 transects (upper plot), coloured to match cluster groups (lower plot). The biotic composition of the 11 clusters groups is the average cover of all transects comprising the cluster (untransformed data).

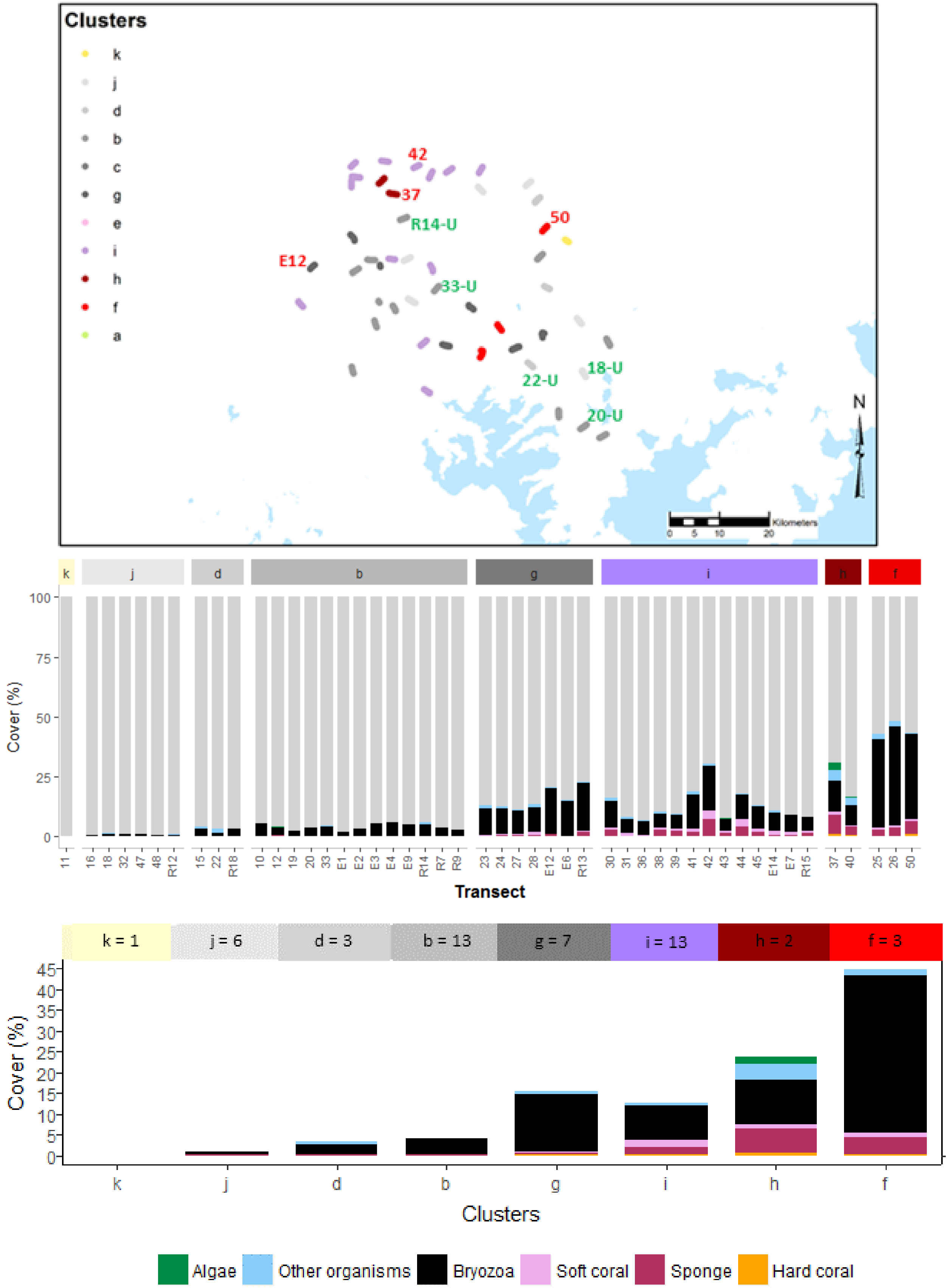


Figure 15. Northern region – Distribution of transects by cluster with transects of interest labelled (upper plot, green labels show transects with dense urchin burrows); cover of major benthic categories by transect (middle plot); bar plot showing the biotic composition of clusters from the northern region only (lower plot).

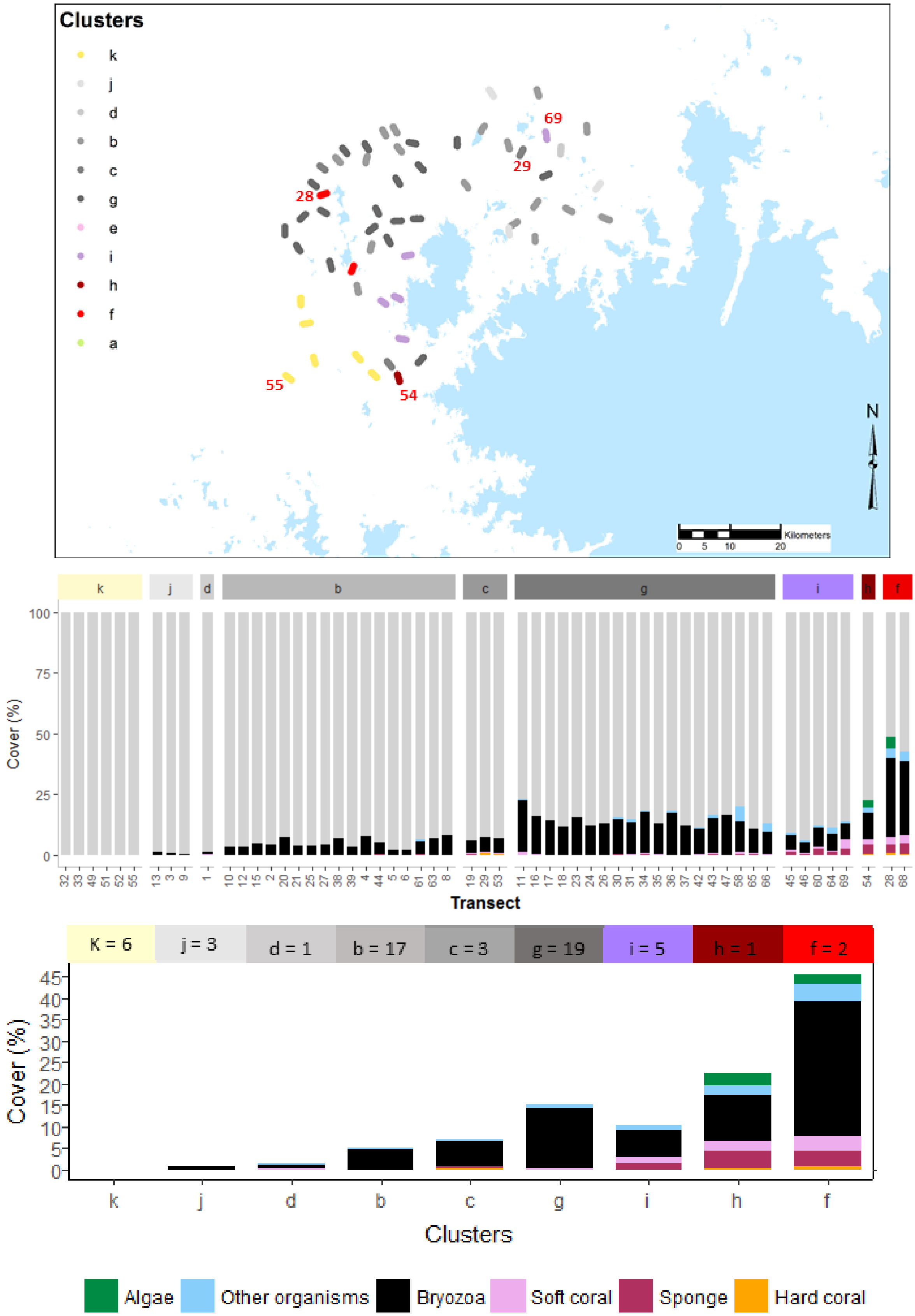


Figure 16. Central region – Distribution of transects by cluster with transects of interest labelled (upper plot); cover of major benthic categories by transect (middle plot); bar plot showing the biotic composition of clusters from the central region only (lower plot).

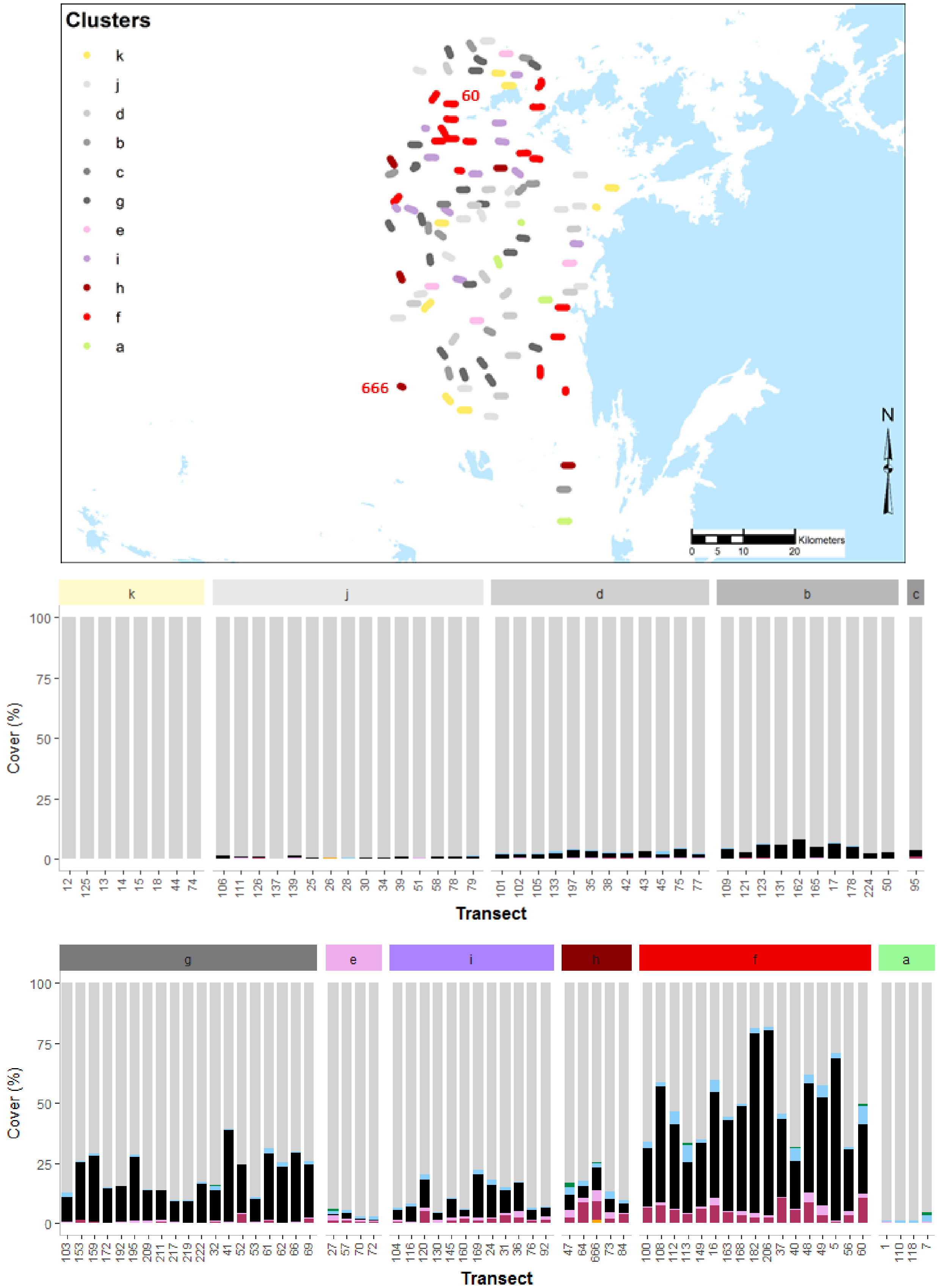


Figure 17. Southern region – Distribution of transects by cluster with transects of interest labelled (upper plot) and abundance of the major benthic categories by transect (% cover) derived from the still image analysis (lower 2 plots).

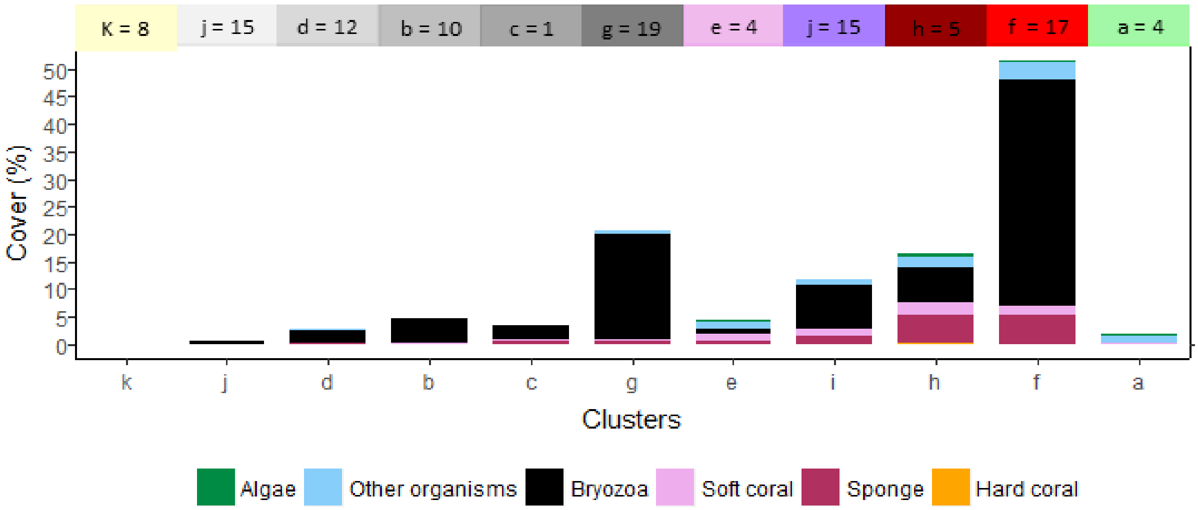


Figure 18. Southern region – Bar plot showing the biotic composition of clusters from the Southern region only (lower plot).

# 4 Discussion

Estimating abundance of biota as the percent of the seabed covered by living organisms, effectively a planar view equivalent to a diver looking at the substrate, has provided additional insight into the biodiversity present and compliments the data from the towed camera and sled sampling into the assessments. Although the major habitat forming species such as sponges are highly diverse and contribute an overwhelming proportion of the biomass, the high resolution images reveal a very diverse and abundant invertebrate community of smaller organisms. This biota is mostly growing close to the seabed and often lying underneath the canopy of the larger upright organisms.

Consistent with the real-time, broadscale habitat classification, the three survey regions along the Kimberley Coast were predominantly sand/mud areas with sparse epibenthic biota or burrowing infauna. Generally, the unconsolidated seabed sediments were smooth or rippled, but in some areas the sand formed steep underwater sand dunes reflecting strong currents at the seabed. The study area where the towed camera system was deployed did not support many light dependent organisms, with turbidity limiting the influence of light at the depths where most of the survey was conducted. More diverse habitats occurred in areas of harder ground, sometimes near islands but also possibly associated with persistent exposed substrate that might reflect the presence of old channels along the seafloor. More variable biota and habitats were observed around these channel features and near shorelines.

Filter feeder habitats, particularly those dominated by erect sponges and gorgonians, were the most noticeable macro-epibenthic communities, but low-lying fauna, featuring abundant bryozoan in particular, were also widespread. However, very extensive patches of consistent habitat type were rare. Transects typically consisted of many habitat types along their length (1.5km), or more accurately, habitats with high diversity and cover occurred as patchy sections of varying length and number within transects. Consequently the use of cluster analysis to group entire transects into meaningful habitat types needs to be treated with caution, as it does not resolve variability in habitat composition that might be occurring at scales of tens to hundreds of metres. Similarly, the spacing of the still photos at 8-10m limits detection of very fine-scale but dense patches of biota. Nonetheless, the cluster analysis identified four mixed filter feeder groups (g, i, h & f: see Figures 13 and 14) with varying biotic diversity and abundance, that contributed the majority of benthic cover. Biota in the four major clusters varied in the mix of functional groups and their relative abundance. They represented habitats with relatively more epibenthic life, with mean live cover >10%. These types of habitat occurred in all three survey regions and included the areas of most abundant life encountered, with the highest percent cover on individual transects in the range of 25%.

Cluster g (dominated by Bryozoan) vs Cluster f (Bryozoan + mixed larger filter feeders) showed some indication of spatial separation in all three regions, with transects in Cluster f often closer to shorelines or areas with rapidly changing bathymetry. This may reflect a greater availability or complexity of hard substrate, more suitable to more diverse sessile invertebrate communities, whereas Cluster g transects reflect habitats where benthic cover was lower but bryozoa featured as the dominant component. The results indicate that significant latent diversity remains to be sampled from Kimberley subtidal waters, in particular small, cryptic organisms and infaunal species. The bryozoa have been identified as a very important group in terms of cover, perhaps more so in this region than along the tropical Queensland coast. Further work on this group is currently constrained by a dearth of taxonomic expertise within Australia and if pursued in the future will also require more specialised sampling methods to collect these abundant, but low lying and usually fragile organisms.

The Southern region had proportionally more transects in the mixed filter feeder cluster groups and the regional summary table also indicated the Southern region as having slightly higher cover of most biotic categories. There may be somewhat of a pattern for more diverse biotic habitats to occur closer to coastlines and around islands, however the presence of hard substrate underpins community existence. The results are consistent with a widespread filter feeding or detrivore biota. As the majority of species do not appear to be dependent on light, the distribution of the sessile species is constrained by available hard substrate, more than by depth. The re-suspension and movement of sediments by tidal currents also comes into play, with steeper seabed slopes and higher current speeds, such as near drop-offs and channel edges, potentially reducing chronic sedimentation and maintaining outcropping substrate suitable for larval settlement. Areas of more extensive and complex hard substrate are likely to support diverse and abundant communities of both large and small filter feeders, for example sponges and bryozoa respectively. Hence the probability of more abundant seabed biodiversity associated with stronger gradients in bathymetry, such as near islands, shorelines and the edges of paleochannels. Areas of unconsolidated sand and mud generally had much lower levels of biota, although exceptions included some habitats featuring aggregations of echinoderms such as crinoids and heart urchins.

Management of this marine environment will be assisted by predicting and verifying the location of high diversity habitats. The results of this analysis confirm that some areas of elevated seabed biodiversity, featuring a mixed community of filter feeding species, occur where the seabed geomorphology is complex. However additional areas of abundant sessile epifauna, such as bryozoans, or mobile invertebrates such as echinoderms, occur in other areas where the association with seabed morphology or degree of consolidation is not well understood. This study demonstrates that high resolution imaging of the seabed, enabling a quantification of biota, is possible under most conditions encountered along the Kimberley coast. Imaging in combination with acoustic surveys therefore offer a non-destructive methodology, that may be progressively extended to new areas opportunistically or as resources permit, for future identification and management of biodiversity hotspots.

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# 6 Appendices

**APPENDIX 1**

## AIMS Towvid Standard Operating Procedure

**1. Usage**

Use for deployments of towed camera system to capture images of seabed biota along pre-determined transects.

**2. TOWVID Description**

The TOWVID is a custom designed and built tow body connected to a winch that is deployed from a vessel along survey lines and towed at speeds of approx. 1-2kts. It uses digital stills cameras with a time lapse setting to capture seabed images and a video camera sends forward facing images live to the surface where the winch controller maintains the height of the tow body above the seabed.

**3. Risk assessment**

Complete a Task Risk Assessment

**4. Equipment**

- Tow body
- Winch with underwater tow cable
- Cable roller sheave
- Underwater cameras
- Lights and Strobes
- USBL acoustic tracking
- Recording console

**5. Work instructions**

***Load Transfers***

Always:

- Effectively plan every lift and risk assess
- Load via mechanical assisted lift where possible
- Avoid manual load transfers unless access is straightforward and a risk assessment considers the activity to be low risk

## Towed camera system setup and testing

Prior to port departure allow enough time during trip mobilisation in case of unforeseen problems, in most cases it will be possible to complete all system tests and checks in a few hours. Conduct of prestart checks should be noted on the trip log and any test failures specifically recorded for later follow up. Detailed settings for each component should be referenced by the relevant operations manual, e.g. TOWVID operations manual, camera manuals, USBL operations manual.

***Testing***

Dry tests should include checks of the following:

- power
- lights and strobes
- cameras
- recording devices
- winch operation
- sea fastening

Wet testing should include checks of the following:

- power
- acoustic tracking system
- lighting and strobes
- cameras including a review of image quality

***Acoustic tracking setup***

- Set position of GPS receiver
- Deploy acoustic tracking transceiver, (pole, flange or mounted on moonpool)
- Measure offsets of transceiver head to GPS and put offsets into navigation system
- Ensure accurate vessel dimensions are obtained and entered into the vessel plan repository of the navigation software

***Stills camera time calibration***

- Calibrate the stills camera and video feed from GPS the video overlay relative to UTC time
- Time coding calibration should be applied at the commencement of a survey and checked for consistency at least once a day whilst the survey is in progress

## Conducting the towed camera surveys

***Prior to deployment***

- Ensure with vessel master that GPS tracks for deployment are accurate and the order of transect sampling is communicated
- Check weather forecast and make weather observations to ensure the sea state is acceptable
- Vessel master must approve each deployment and communicate to crew before launch
- A risk assessment should always be completed prior to deployment of equipment to ensure the operation can be completed safely, always take a precautionary approach
- Make sure all personnel understand their roles by conducting a TRA review and toolbox talk, incorporating risk assessment and appropriate PPE to be worn
- Prepare tow body on deck and ensure only essential personnel participate in the preparation and deployment

- Check for correct operation of cameras, lights and winch including watertight seals, power requirements, hydraulic power and hoses, time synchronisation (PC, USBL and still camera) and recording media
- Ensure winch clutch is adjusted to the correct tension prior to initial deployment

***Towed Camera deployment and retrieval***

- Vessel master to ensure the vessel is positioned at the start of the survey line
- Following the signal to deploy from the vessel Master, use the winch and A-Frame to lift and guide the tow body from the deck into the water as the vessel begins tracking the line
- Minimise the time taken from when the tow body is let out of reach to when it is lowered in the water so as to reduce potential swing and impact against vessel
- Check for cable loops or problems at the surface while the tow body is lowered into the water before losing sight below the waterline
- Lower the tow body to the seabed ensuring a watch is kept on the video monitor at all times
- Maintain a constant height above the seabed looking forward to avoid approaching obstacles and anticipate the need to come up on the winch so as to minimise the chance of a seabed hookup
- Ensure that data is being recorded where possible to determine, e.g. recording indicators, hard drive operating
- Monitor metocean conditions prior to and during deployment to maintain safe working environment
- Consider aborting operations if metocean conditions are marginal, visibility is poor or any fault develops that may interfere with the towed camera system operation
- When survey line is complete or if transect is being aborted advise Vessel Master of intention retrieve tow body
- Vessel Master to adequately hold vessel against waves or shift out of gear during tow body retrieval
- Watch for approach of tow body near surface ensuring only required personnel near open transom
- Use winch and A-Frame to guide tow body back onto deck with smooth winch and A-Frame control inputs
- Ensure crew grab hold of tow body as soon as safe to do so when the tow body leaves the water so it can be guided safely away forward of the transom and lowered to the deck

***Seabed hook-up procedures***

Potential hookup of the tow body is always a possibility when the ideal altitude for capturing quality still photos is less than 1m above the seabed. The following procedures should minimise the potential of a hookup occurring and lower the potential of damage to the tow body or total loss.

- Communication link between towvid winch station and bridge to maintained at all times, vhf or intercom.
- Bridge to monitor video feed from tow body whilst conducting tows
- At first sign of hookup, i.e. video image stationary over seabed, ensure forward speed of vessel is backed off to reduce tensile load on cable
- With crew monitoring position of the cable and directing master with regard to the position of the cable the vessel is to maneuverer back to a point directly over the hookup point to see if the tow body can be freed
- Cable tension should be taken up by the winch to ensure no loose cable enters the vessel propellers
- If the initial retrieval attempt from overhead fails, various points of the compass should be tested by the vessel to pull the tow body off the seafloor using only the winch ensuring enough cable remains
- If all options for retrieval have been exhausted the cable must be cut at the shortest possible point and the position recorded with GPS

- A substitute towbody and cable would need to be prepared for continuance of surveys

***Completion of operations***

Prior to any vessel movement or engine start-up operators should check:

- All equipment is clear of the water including acoustic tracking equipment if required
- All gear is safely stowed and powered down where appropriate
- Any servicing that requires the vessel to be stationary is completed
- When the TOWVID team is satisfied it is OK for the vessel to move on, an “All Clear to Move” command shall be given to Vessel Master
- Data collected from previous tows should be checked for integrity prior to deploying the towed system on further tows

***Download and store data***

Refer to SOP 01– Field Data Management procedure

## Related documents

SOP 02 – Task Risk Assessment (TRA) procedure

SOP 01 – Field Data Management procedure

## APPENDIX 2

Cluster analysis groups (a-l) ordered from high to low by Abiotic cover. Note the clusters analysis was calculated using square root transformed data, and a Bray-Curtis similarity matrix. The percent contribution of major categories shown here was calculated on the untransformed data of transects comprising each cluster. The number of transects in each cluster is listed.

| Cluster group | Abiotic | Algae | Other organisms | Bryozoa | Soft coral | Sponge | Hard coral | # of Transects |
|---|---|---|---|---|---|---|---|---|
| k | 99.95 | 0.01 | 0.01 | 0.00 | 0.01 | 0.03 | 0.00 | 15 |
| j | 99.24 | 0.00 | 0.06 | 0.60 | 0.03 | 0.05 | 0.01 | 24 |
| a | 98.16 | 0.36 | 1.11 | 0.04 | 0.30 | 0.02 | 0.00 | 4 |
| d | 97.06 | 0.00 | 0.59 | 2.07 | 0.15 | 0.13 | 0.00 | 16 |
| e | 95.66 | 0.38 | 1.08 | 1.02 | 1.08 | 0.75 | 0.02 | 4 |
| b | 95.35 | 0.00 | 0.10 | 4.48 | 0.02 | 0.05 | 0.00 | 40 |
| c | 94.01 | 0.00 | 0.10 | 5.07 | 0.22 | 0.31 | 0.29 | 4 |
| i | 88.01 | 0.01 | 0.90 | 7.98 | 1.27 | 1.81 | 0.02 | 30 |
| g | 82.53 | 0.01 | 0.78 | 15.99 | 0.30 | 0.37 | 0.02 | 45 |
| h | 80.95 | 1.16 | 2.56 | 7.94 | 1.94 | 5.07 | 0.37 | 8 |
| f | 50.11 | 0.30 | 3.13 | 39.76 | 1.64 | 4.91 | 0.16 | 22 |

## APPENDIX 3

Transects ordered by Region, showing composition of major category, cluster group, and other summary headings.

| Cluster group | Region | Transect # | Ave depth | # of Images | Abiotic | Algae | Other | Bryozoa | Soft coral | Sponge | Hard coral |
|---|---|---|---|---|---|---|---|---|---|---|---|
| d | Central | 1 | 32.5 | 182 | 98.7 | 0.0 | 0.2 | 0.8 | 0.2 | 0.1 | 0.0 |
| b | Central | 2 | 31.0 | 185 | 95.6 | 0.0 | 0.0 | 4.3 | 0.1 | 0.0 | 0.0 |
| j | Central | 3 | 25.6 | 133 | 99.2 | 0.0 | 0.0 | 0.8 | 0.0 | 0.0 | 0.0 |
| b | Central | 4 | 25.2 | 217 | 92.3 | 0.0 | 0.0 | 7.7 | 0.0 | 0.0 | 0.0 |
| b | Central | 5 | 31.4 | 179 | 98.0 | 0.0 | 0.0 | 2.0 | 0.0 | 0.0 | 0.0 |
| b | Central | 6 | 31.5 | 139 | 98.0 | 0.0 | 0.0 | 2.0 | 0.0 | 0.0 | 0.0 |
| b | Central | 8 | 24.6 | 151 | 91.8 | 0.0 | 0.0 | 8.2 | 0.0 | 0.0 | 0.0 |
| j | Central | 9 | 19.4 | 167 | 99.5 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 0.0 |
| b | Central | 10 | 19.0 | 198 | 96.4 | 0.0 | 0.0 | 3.6 | 0.0 | 0.0 | 0.0 |
| g | Central | 11 | 24.7 | 185 | 77.1 | 0.0 | 0.3 | 21.3 | 1.3 | 0.0 | 0.0 |
| b | Central | 12 | 45.7 | 195 | 96.4 | 0.0 | 0.0 | 3.6 | 0.0 | 0.0 | 0.0 |
| j | Central | 13 | 49.6 | 218 | 98.7 | 0.0 | 0.0 | 1.3 | 0.0 | 0.0 | 0.0 |
| b | Central | 15 | 38.6 | 189 | 95.4 | 0.0 | 0.0 | 4.6 | 0.0 | 0.0 | 0.0 |
| g | Central | 16 | 43.2 | 181 | 84.0 | 0.0 | 0.1 | 15.6 | 0.2 | 0.1 | 0.0 |
| g | Central | 17 | 48.0 | 194 | 85.7 | 0.0 | 0.0 | 14.1 | 0.0 | 0.0 | 0.1 |
| g | Central | 18 | 48.5 | 207 | 88.2 | 0.0 | 0.0 | 11.7 | 0.0 | 0.0 | 0.1 |
| c | Central | 19 | 59.7 | 195 | 93.8 | 0.0 | 0.1 | 5.5 | 0.2 | 0.4 | 0.0 |
| b | Central | 20 | 54.3 | 175 | 92.5 | 0.0 | 0.0 | 7.5 | 0.0 | 0.0 | 0.0 |
| b | Central | 21 | 54.9 | 173 | 96.2 | 0.0 | 0.0 | 3.8 | 0.0 | 0.0 | 0.0 |
| g | Central | 23 | 55.6 | 185 | 84.5 | 0.0 | 0.0 | 15.5 | 0.0 | 0.0 | 0.0 |

| Cluster group | Region | Transect # | Ave depth | # of Images | Abiotic | Algae | Other | Bryozoa | Soft coral | Sponge | Hard coral |
|---|---|---|---|---|---|---|---|---|---|---|---|
| g | Central | 24 | 55.6 | 182 | 88.0 | 0.0 | 0.0 | 11.8 | 0.1 | 0.0 | 0.0 |
| b | Central | 25 | 51.4 | 212 | 96.4 | 0.0 | 0.0 | 3.6 | 0.0 | 0.0 | 0.0 |
| g | Central | 26 | 50.8 | 207 | 87.2 | 0.0 | 0.0 | 12.8 | 0.0 | 0.0 | 0.0 |
| b | Central | 27 | 53.0 | 186 | 95.5 | 0.0 | 0.0 | 4.5 | 0.0 | 0.0 | 0.0 |
| f | Central | 28 | 40.5 | 163 | 51.5 | 4.5 | 4.0 | 32.5 | 3.3 | 3.2 | 1.0 |
| c | Central | 29 | 34.6 | 210 | 92.7 | 0.0 | 0.1 | 6.1 | 0.2 | 0.0 | 0.9 |
| g | Central | 30 | 57.5 | 221 | 84.2 | 0.1 | 0.9 | 14.6 | 0.0 | 0.2 | 0.0 |
| g | Central | 31 | 48.9 | 198 | 85.1 | 0.0 | 1.7 | 13.0 | 0.1 | 0.1 | 0.0 |
| k | Central | 32 | 43.3 | 178 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| k | Central | 33 | 43.3 | 164 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| g | Central | 34 | 41.3 | 207 | 81.8 | 0.1 | 0.3 | 16.9 | 0.5 | 0.4 | 0.0 |
| g | Central | 35 | 52.6 | 158 | 86.8 | 0.0 | 0.0 | 12.8 | 0.4 | 0.0 | 0.0 |
| g | Central | 36 | 40.0 | 169 | 81.9 | 0.0 | 0.6 | 17.5 | 0.0 | 0.0 | 0.0 |
| g | Central | 37 | 35.8 | 238 | 88.1 | 0.0 | 0.0 | 11.9 | 0.0 | 0.0 | 0.0 |
| b | Central | 38 | 40.4 | 216 | 93.0 | 0.0 | 0.1 | 6.9 | 0.0 | 0.0 | 0.0 |
| b | Central | 39 | 36.4 | 176 | 96.5 | 0.0 | 0.0 | 3.5 | 0.0 | 0.0 | 0.0 |
| g | Central | 42 | 44.4 | 217 | 88.8 | 0.0 | 0.3 | 10.7 | 0.1 | 0.1 | 0.0 |
| g | Central | 43 | 47.9 | 223 | 83.7 | 0.0 | 1.1 | 14.6 | 0.4 | 0.2 | 0.0 |
| b | Central | 44 | 38.1 | 227 | 94.7 | 0.0 | 0.0 | 5.1 | 0.0 | 0.2 | 0.0 |
| i | Central | 45 | 30.5 | 198 | 90.9 | 0.0 | 0.8 | 6.2 | 0.8 | 1.2 | 0.0 |
| i | Central | 46 | 36.1 | 168 | 94.2 | 0.0 | 0.7 | 4.3 | 0.5 | 0.4 | 0.0 |
| g | Central | 47 | 17.5 | 206 | 83.6 | 0.0 | 0.0 | 16.3 | 0.1 | 0.0 | 0.0 |
| k | Central | 49 | 40.1 | 165 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| k | Central | 51 | 46.0 | 153 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| k | Central | 52 | 34.5 | 145 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| c | Central | 53 | 32.3 | 203 | 93.1 | 0.0 | 0.1 | 6.1 | 0.3 | 0.2 | 0.2 |
| h | Central | 54 | 21.8 | 187 | 77.4 | 3.1 | 2.0 | 10.8 | 2.4 | 4.0 | 0.2 |
| k | Central | 55 | 45.7 | 181 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| g | Central | 58 | 44.4 | 191 | 80.3 | 0.0 | 5.9 | 12.8 | 0.7 | 0.2 | 0.1 |
| i | Central | 60 | 25.6 | 218 | 88.1 | 0.0 | 0.8 | 7.7 | 1.1 | 2.3 | 0.0 |
| b | Central | 61 | 39.6 | 199 | 93.7 | 0.0 | 0.9 | 5.1 | 0.0 | 0.3 | 0.0 |
| b | Central | 63 | 54.2 | 148 | 93.0 | 0.0 | 0.0 | 7.0 | 0.0 | 0.0 | 0.0 |
| i | Central | 64 | 31.6 | 147 | 88.9 | 0.0 | 2.7 | 6.7 | 0.7 | 1.1 | 0.0 |
| g | Central | 65 | 39.9 | 225 | 89.0 | 0.0 | 0.1 | 10.2 | 0.4 | 0.3 | 0.0 |
| g | Central | 66 | 33.6 | 229 | 86.9 | 0.2 | 3.3 | 9.3 | 0.3 | 0.1 | 0.0 |
| f | Central | 68 | 41.8 | 129 | 57.3 | 0.2 | 4.0 | 30.4 | 3.5 | 4.2 | 0.5 |
| i | Central | 69 | 30.2 | 209 | 86.1 | 0.0 | 1.0 | 6.6 | 4.0 | 2.4 | 0.0 |
| b | Northern | 10 | 45.0 | 200 | 94.5 | 0.0 | 0.0 | 5.5 | 0.0 | 0.0 | 0.0 |
| k | Northern | 11 | 57.1 | 63 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| b | Northern | 12 | 63.9 | 222 | 96.1 | 0.1 | 0.3 | 3.3 | 0.0 | 0.3 | 0.0 |
| d | Northern | 15 | 55.7 | 163 | 96.1 | 0.0 | 0.7 | 3.1 | 0.1 | 0.0 | 0.0 |
| j | Northern | 16 | 44.4 | 193 | 99.7 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 |
| j | Northern | 18 | 30.5 | 151 | 98.6 | 0.0 | 0.4 | 1.0 | 0.0 | 0.0 | 0.0 |
| b | Northern | 19 | 20.6 | 183 | 97.9 | 0.0 | 0.0 | 2.1 | 0.0 | 0.0 | 0.0 |

| Cluster group | Region | Transect # | Ave depth | # of Images | Abiotic | Algae | Other | Bryozoa | Soft coral | Sponge | Hard coral |
|---|---|---|---|---|---|---|---|---|---|---|---|
| b | Northern | 20 | 20.6 | 187 | 96.2 | 0.0 | 0.1 | 3.7 | 0.0 | 0.0 | 0.0 |
| d | Northern | 22 | 45.6 | 149 | 97.0 | 0.0 | 1.7 | 1.2 | 0.0 | 0.0 | 0.0 |
| g | Northern | 23 | 62.4 | 200 | 87.3 | 0.0 | 1.1 | 11.2 | 0.5 | 0.0 | 0.0 |
| g | Northern | 24 | 61.5 | 202 | 87.5 | 0.0 | 1.0 | 10.5 | 0.3 | 0.7 | 0.0 |
| f | Northern | 25 | 57.3 | 193 | 57.2 | 0.0 | 2.1 | 37.0 | 1.0 | 2.7 | 0.0 |
| f | Northern | 26 | 60.0 | 143 | 51.8 | 0.0 | 2.1 | 41.4 | 0.9 | 3.6 | 0.1 |
| g | Northern | 27 | 57.2 | 217 | 88.8 | 0.0 | 0.7 | 9.8 | 0.3 | 0.5 | 0.0 |
| g | Northern | 28 | 55.0 | 187 | 86.8 | 0.0 | 1.2 | 10.4 | 1.0 | 0.6 | 0.0 |
| i | Northern | 30 | 50.2 | 197 | 84.0 | 0.0 | 1.2 | 11.2 | 0.9 | 2.7 | 0.0 |
| i | Northern | 31 | 52.1 | 181 | 92.0 | 0.0 | 0.9 | 5.6 | 1.2 | 0.2 | 0.0 |
| j | Northern | 32 | 37.9 | 171 | 99.2 | 0.0 | 0.0 | 0.8 | 0.0 | 0.0 | 0.0 |
| b | Northern | 33 | 55.2 | 147 | 95.6 | 0.0 | 0.1 | 4.2 | 0.0 | 0.0 | 0.0 |
| i | Northern | 36 | 53.0 | 212 | 93.3 | 0.0 | 0.3 | 5.8 | 0.5 | 0.1 | 0.0 |
| h | Northern | 37 | 21.9 | 174 | 69.4 | 2.8 | 4.7 | 12.7 | 1.5 | 8.1 | 0.8 |
| i | Northern | 38 | 31.2 | 172 | 89.5 | 0.1 | 1.2 | 5.7 | 0.9 | 2.3 | 0.2 |
| i | Northern | 39 | 35.9 | 225 | 90.6 | 0.0 | 0.3 | 6.2 | 0.5 | 2.4 | 0.1 |
| h | Northern | 40 | 26.0 | 152 | 83.4 | 0.4 | 3.2 | 8.8 | 0.4 | 3.6 | 0.3 |
| i | Northern | 41 | 35.5 | 89 | 81.3 | 0.0 | 1.2 | 14.0 | 1.3 | 2.0 | 0.0 |
| i | Northern | 42 | 27.7 | 103 | 69.6 | 0.0 | 0.9 | 18.6 | 3.5 | 7.4 | 0.0 |
| i | Northern | 43 | 31.4 | 154 | 92.4 | 0.3 | 0.3 | 5.0 | 0.7 | 1.4 | 0.0 |
| i | Northern | 44 | 29.4 | 182 | 82.0 | 0.0 | 0.8 | 9.9 | 3.3 | 3.9 | 0.1 |
| i | Northern | 45 | 28.1 | 102 | 87.3 | 0.0 | 0.2 | 9.6 | 1.4 | 1.6 | 0.0 |
| j | Northern | 47 | 23.6 | 140 | 98.9 | 0.0 | 0.0 | 0.9 | 0.0 | 0.1 | 0.0 |
| j | Northern | 48 | 38.0 | 166 | 99.4 | 0.0 | 0.0 | 0.5 | 0.1 | 0.0 | 0.0 |
| f | Northern | 50 | 35.4 | 184 | 56.7 | 0.0 | 0.4 | 35.6 | 1.2 | 5.4 | 0.7 |
| b | Northern | E1 | 42.0 | 181 | 98.2 | 0.0 | 0.0 | 1.8 | 0.0 | 0.0 | 0.0 |
| g | Northern | E12 | 42.2 | 162 | 79.4 | 0.0 | 0.4 | 19.1 | 0.4 | 0.5 | 0.2 |
| i | Northern | E14 | 50.5 | 161 | 89.3 | 0.0 | 0.9 | 7.6 | 1.6 | 0.6 | 0.0 |
| b | Northern | E2 | 29.3 | 110 | 96.7 | 0.0 | 0.0 | 3.3 | 0.0 | 0.0 | 0.0 |
| b | Northern | E3 | 31.5 | 151 | 94.6 | 0.0 | 0.0 | 5.4 | 0.0 | 0.0 | 0.0 |
| b | Northern | E4 | 49.8 | 35 | 94.1 | 0.0 | 0.0 | 5.9 | 0.0 | 0.0 | 0.0 |
| g | Northern | E6 | 56.2 | 43 | 84.8 | 0.0 | 0.5 | 14.8 | 0.0 | 0.0 | 0.0 |
| i | Northern | E7 | 55.7 | 120 | 90.9 | 0.0 | 0.2 | 7.1 | 1.5 | 0.3 | 0.0 |
| b | Northern | E9 | 51.5 | 172 | 95.2 | 0.0 | 0.0 | 4.7 | 0.1 | 0.0 | 0.0 |
| j | Northern | R12 | 56.8 | 169 | 99.1 | 0.0 | 0.5 | 0.4 | 0.0 | 0.1 | 0.0 |
| g | Northern | R13 | 55.0 | 80 | 77.3 | 0.0 | 0.5 | 20.0 | 0.3 | 2.0 | 0.0 |
| b | Northern | R14 | 44.0 | 248 | 94.1 | 0.0 | 0.8 | 5.1 | 0.0 | 0.0 | 0.0 |
| i | Northern | R15 | 38.0 | 129 | 91.8 | 0.0 | 0.2 | 5.7 | 1.0 | 1.4 | 0.0 |
| d | Northern | R18 | 36.2 | 232 | 96.8 | 0.0 | 0.2 | 2.9 | 0.1 | 0.1 | 0.0 |
| b | Northern | R7 | 38.2 | 175 | 96.3 | 0.0 | 0.1 | 3.5 | 0.1 | 0.0 | 0.0 |
| b | Northern | R9 | 26.4 | 168 | 97.4 | 0.0 | 0.0 | 2.5 | 0.0 | 0.1 | 0.0 |
| a | Southern | 1 | 36.1 | 223 | 99.1 | 0.1 | 0.3 | 0.0 | 0.4 | 0.1 | 0.0 |
| f | Southern | 5 | 32.2 | 198 | 29.3 | 0.0 | 2.1 | 67.6 | 0.5 | 0.5 | 0.0 |
| a | Southern | 7 | 24.7 | 30 | 95.3 | 1.3 | 2.7 | 0.0 | 0.7 | 0.0 | 0.0 |

| Cluster group | Region | Transect # | Ave depth | # of Images | Abiotic | Algae | Other | Bryozoa | Soft coral | Sponge | Hard coral |
|---|---|---|---|---|---|---|---|---|---|---|---|
| k | Southern | 12 | 26.7 | 209 | 99.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 |
| k | Southern | 13 | 40.2 | 241 | 99.8 | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | 0.0 |
| k | Southern | 14 | 26.3 | 221 | 99.8 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 |
| k | Southern | 15 | 42.9 | 144 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| f | Southern | 16 | 34.4 | 184 | 40.2 | 0.0 | 5.2 | 44.1 | 3.1 | 7.2 | 0.1 |
| b | Southern | 17 | 24.3 | 220 | 93.4 | 0.0 | 0.3 | 6.4 | 0.0 | 0.0 | 0.0 |
| k | Southern | 18 | 17.4 | 214 | 99.9 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| i | Southern | 24 | 39.8 | 216 | 81.7 | 0.0 | 2.4 | 13.7 | 0.4 | 1.8 | 0.0 |
| j | Southern | 25 | 16.8 | 209 | 99.7 | 0.0 | 0.0 | 0.2 | 0.0 | 0.1 | 0.0 |
| j | Southern | 26 | 25.1 | 228 | 99.6 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.3 |
| e | Southern | 27 | 46.2 | 209 | 93.8 | 1.3 | 0.9 | 0.8 | 2.2 | 0.9 | 0.1 |
| j | Southern | 28 | 39.8 | 205 | 99.6 | 0.0 | 0.2 | 0.2 | 0.0 | 0.0 | 0.0 |
| j | Southern | 30 | 28.6 | 211 | 99.6 | 0.0 | 0.0 | 0.4 | 0.0 | 0.0 | 0.0 |
| i | Southern | 31 | 35.7 | 194 | 85.3 | 0.0 | 1.2 | 9.4 | 0.7 | 3.5 | 0.0 |
| g | Southern | 32 | 45.0 | 208 | 84.4 | 0.1 | 1.7 | 12.9 | 0.5 | 0.5 | 0.0 |
| j | Southern | 34 | 21.0 | 221 | 99.6 | 0.0 | 0.0 | 0.3 | 0.0 | 0.1 | 0.0 |
| d | Southern | 35 | 39.3 | 263 | 96.6 | 0.0 | 0.5 | 2.5 | 0.2 | 0.2 | 0.1 |
| i | Southern | 36 | 33.2 | 229 | 82.8 | 0.0 | 0.3 | 11.8 | 2.7 | 2.4 | 0.0 |
| f | Southern | 37 | 27.1 | 147 | 54.3 | 0.0 | 2.4 | 32.2 | 0.6 | 10.5 | 0.0 |
| d | Southern | 38 | 43.4 | 226 | 97.5 | 0.0 | 0.2 | 2.0 | 0.0 | 0.3 | 0.0 |
| j | Southern | 39 | 47.0 | 208 | 99.0 | 0.0 | 0.1 | 0.9 | 0.0 | 0.0 | 0.0 |
| f | Southern | 40 | 45.5 | 239 | 68.5 | 0.2 | 5.5 | 19.7 | 0.5 | 5.4 | 0.2 |
| g | Southern | 41 | 31.5 | 243 | 60.9 | 0.0 | 0.1 | 38.6 | 0.3 | 0.0 | 0.1 |
| d | Southern | 42 | 24.3 | 227 | 97.5 | 0.0 | 0.3 | 1.8 | 0.1 | 0.4 | 0.0 |
| d | Southern | 43 | 41.3 | 231 | 96.8 | 0.0 | 0.3 | 2.5 | 0.3 | 0.1 | 0.0 |
| k | Southern | 44 | 33.8 | 167 | 99.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| d | Southern | 45 | 26.2 | 193 | 97.0 | 0.0 | 1.0 | 1.7 | 0.1 | 0.2 | 0.0 |
| h | Southern | 47 | 34.6 | 180 | 83.2 | 2.0 | 2.8 | 6.7 | 2.8 | 2.6 | 0.0 |
| f | Southern | 48 | 28.6 | 204 | 38.2 | 0.0 | 3.5 | 45.5 | 4.2 | 8.5 | 0.2 |
| f | Southern | 49 | 34.6 | 206 | 42.5 | 0.0 | 5.1 | 45.2 | 4.1 | 3.2 | 0.0 |
| b | Southern | 50 | 32.0 | 210 | 97.3 | 0.0 | 0.2 | 2.5 | 0.0 | 0.0 | 0.0 |
| j | Southern | 51 | 29.8 | 211 | 99.4 | 0.0 | 0.0 | 0.3 | 0.2 | 0.0 | 0.1 |
| g | Southern | 52 | 50.2 | 225 | 75.4 | 0.0 | 0.4 | 20.2 | 0.2 | 3.8 | 0.0 |
| g | Southern | 53 | 27.6 | 217 | 89.3 | 0.0 | 0.6 | 9.5 | 0.5 | 0.1 | 0.0 |
| f | Southern | 56 | 31.0 | 193 | 68.2 | 0.0 | 1.0 | 25.8 | 1.9 | 3.0 | 0.0 |
| e | Southern | 57 | 29.1 | 238 | 94.5 | 0.2 | 1.4 | 2.0 | 1.0 | 1.0 | 0.0 |
| j | Southern | 58 | 24.3 | 241 | 98.9 | 0.0 | 0.0 | 1.1 | 0.0 | 0.0 | 0.0 |
| f | Southern | 60 | 42.9 | 234 | 50.5 | 0.8 | 7.8 | 28.8 | 1.7 | 10.1 | 0.3 |
| g | Southern | 61 | 28.5 | 215 | 68.8 | 0.0 | 2.1 | 27.7 | 0.5 | 0.9 | 0.0 |
| g | Southern | 62 | 30.3 | 240 | 74.8 | 0.0 | 1.5 | 23.7 | 0.0 | 0.0 | 0.0 |
| h | Southern | 64 | 19.7 | 187 | 82.4 | 0.1 | 1.8 | 5.4 | 1.6 | 8.7 | 0.0 |
| g | Southern | 66 | 26.9 | 238 | 70.2 | 0.0 | 0.3 | 28.9 | 0.3 | 0.3 | 0.0 |
| g | Southern | 69 | 36.9 | 216 | 74.4 | 0.0 | 1.3 | 21.9 | 0.6 | 1.9 | 0.0 |
| e | Southern | 70 | 30.8 | 221 | 97.2 | 0.0 | 0.8 | 0.6 | 1.0 | 0.5 | 0.0 |

| Cluster group | Region | Transect # | Ave depth | # of Images | Abiotic | Algae | Other | Bryozoa | Soft coral | Sponge | Hard coral |
|---|---|---|---|---|---|---|---|---|---|---|---|
| e | Southern | 72 | 38.2 | 180 | 97.1 | 0.0 | 1.2 | 0.8 | 0.2 | 0.7 | 0.0 |
| h | Southern | 73 | 28.1 | 229 | 86.7 | 0.1 | 3.2 | 5.5 | 2.4 | 2.1 | 0.0 |
| k | Southern | 74 | 25.4 | 176 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| d | Southern | 75 | 33.0 | 187 | 95.5 | 0.0 | 0.6 | 3.3 | 0.3 | 0.2 | 0.0 |
| i | Southern | 76 | 36.0 | 124 | 93.5 | 0.0 | 1.0 | 4.0 | 0.6 | 0.9 | 0.0 |
| d | Southern | 77 | 36.3 | 209 | 97.7 | 0.0 | 0.4 | 1.2 | 0.5 | 0.2 | 0.0 |
| j | Southern | 78 | 37.1 | 223 | 99.2 | 0.0 | 0.0 | 0.8 | 0.0 | 0.0 | 0.0 |
| j | Southern | 79 | 43.0 | 263 | 98.9 | 0.0 | 0.2 | 0.8 | 0.0 | 0.1 | 0.0 |
| h | Southern | 84 | 39.3 | 236 | 90.3 | 0.2 | 1.1 | 4.3 | 0.3 | 3.8 | 0.0 |
| i | Southern | 92 | 58.7 | 37 | 93.0 | 0.0 | 0.5 | 3.6 | 1.2 | 1.6 | 0.0 |
| c | Southern | 95 | 49.9 | 223 | 96.5 | 0.0 | 0.1 | 2.5 | 0.2 | 0.6 | 0.1 |
| f | Southern | 100 | 39.3 | 216 | 66.1 | 0.0 | 2.7 | 24.3 | 0.4 | 6.4 | 0.1 |
| d | Southern | 101 | 27.1 | 248 | 97.6 | 0.0 | 0.6 | 1.6 | 0.0 | 0.2 | 0.0 |
| d | Southern | 102 | 30.2 | 200 | 97.6 | 0.0 | 0.5 | 1.6 | 0.3 | 0.0 | 0.0 |
| g | Southern | 103 | 42.0 | 218 | 87.4 | 0.0 | 1.8 | 10.4 | 0.2 | 0.2 | 0.1 |
| i | Southern | 104 | 30.6 | 206 | 93.6 | 0.0 | 0.8 | 4.1 | 0.9 | 0.7 | 0.0 |
| d | Southern | 105 | 16.9 | 240 | 97.6 | 0.0 | 0.8 | 1.5 | 0.1 | 0.1 | 0.0 |
| j | Southern | 106 | 35.7 | 217 | 98.8 | 0.0 | 0.0 | 1.1 | 0.0 | 0.1 | 0.0 |
| f | Southern | 108 | 37.6 | 206 | 41.3 | 0.0 | 1.9 | 48.0 | 1.4 | 7.2 | 0.1 |
| b | Southern | 109 | 28.9 | 190 | 95.7 | 0.0 | 0.2 | 4.0 | 0.0 | 0.1 | 0.0 |
| a | Southern | 110 | 29.8 | 213 | 99.2 | 0.0 | 0.7 | 0.1 | 0.1 | 0.0 | 0.0 |
| j | Southern | 111 | 41.8 | 131 | 99.2 | 0.0 | 0.0 | 0.3 | 0.3 | 0.2 | 0.0 |
| f | Southern | 112 | 46.2 | 156 | 53.5 | 0.0 | 5.3 | 35.1 | 0.7 | 5.2 | 0.3 |
| f | Southern | 113 | 22.7 | 214 | 66.6 | 1.0 | 6.8 | 21.2 | 0.7 | 3.6 | 0.0 |
| i | Southern | 116 | 40.5 | 146 | 91.7 | 0.0 | 1.4 | 6.3 | 0.5 | 0.1 | 0.0 |
| a | Southern | 118 | 35.9 | 233 | 99.1 | 0.0 | 0.9 | 0.1 | 0.0 | 0.0 | 0.0 |
| i | Southern | 120 | 32.7 | 228 | 79.8 | 0.0 | 2.0 | 11.9 | 1.1 | 5.1 | 0.1 |
| b | Southern | 121 | 30.7 | 194 | 97.5 | 0.0 | 0.0 | 2.2 | 0.0 | 0.3 | 0.0 |
| b | Southern | 123 | 61.6 | 155 | 93.6 | 0.0 | 0.5 | 5.4 | 0.0 | 0.5 | 0.0 |
| k | Southern | 125 | 27.3 | 60 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| j | Southern | 126 | 42.7 | 161 | 99.1 | 0.0 | 0.1 | 0.5 | 0.0 | 0.2 | 0.0 |
| i | Southern | 130 | 46.9 | 143 | 95.2 | 0.0 | 0.6 | 2.9 | 1.0 | 0.3 | 0.0 |
| b | Southern | 131 | 45.4 | 242 | 94.2 | 0.0 | 0.0 | 5.7 | 0.1 | 0.0 | 0.0 |
| d | Southern | 133 | 36.1 | 160 | 96.8 | 0.0 | 1.1 | 2.1 | 0.0 | 0.0 | 0.0 |
| j | Southern | 137 | 26.9 | 132 | 99.8 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 |
| j | Southern | 139 | 45.2 | 174 | 98.7 | 0.0 | 0.0 | 0.9 | 0.1 | 0.2 | 0.0 |
| i | Southern | 145 | 30.0 | 222 | 89.5 | 0.0 | 0.5 | 7.7 | 1.5 | 0.8 | 0.0 |
| f | Southern | 149 | 44.5 | 240 | 65.1 | 0.0 | 1.5 | 26.3 | 1.2 | 5.9 | 0.0 |
| g | Southern | 153 | 48.2 | 161 | 74.0 | 0.0 | 0.7 | 23.7 | 0.2 | 1.3 | 0.0 |
| g | Southern | 159 | 41.7 | 142 | 71.1 | 0.0 | 0.8 | 27.5 | 0.1 | 0.4 | 0.0 |
| i | Southern | 160 | 15.6 | 154 | 94.0 | 0.0 | 0.6 | 2.5 | 0.8 | 2.1 | 0.0 |
| b | Southern | 162 | 47.2 | 183 | 92.2 | 0.0 | 0.0 | 7.8 | 0.0 | 0.0 | 0.0 |
| f | Southern | 163 | 37.7 | 176 | 55.9 | 0.0 | 1.1 | 38.1 | 0.5 | 4.5 | 0.0 |
| b | Southern | 165 | 46.4 | 126 | 95.1 | 0.0 | 0.2 | 4.3 | 0.5 | 0.0 | 0.0 |

| Cluster group | Region | Transect # | Ave depth | # of Images | Abiotic | Algae | Other | Bryozoa | Soft coral | Sponge | Hard coral |
|---|---|---|---|---|---|---|---|---|---|---|---|
| f | Southern | 168 | 37.8 | 132 | 50.5 | 0.0 | 0.9 | 43.5 | 2.0 | 3.1 | 0.0 |
| i | Southern | 169 | 30.1 | 202 | 77.9 | 0.0 | 1.6 | 18.0 | 1.4 | 1.1 | 0.0 |
| g | Southern | 172 | 23.3 | 174 | 84.9 | 0.0 | 0.5 | 14.6 | 0.0 | 0.0 | 0.0 |
| b | Southern | 178 | 21.4 | 225 | 94.8 | 0.0 | 0.1 | 5.0 | 0.0 | 0.1 | 0.0 |
| f | Southern | 182 | 39.4 | 53 | 19.0 | 0.0 | 1.9 | 75.0 | 1.9 | 2.3 | 0.0 |
| g | Southern | 192 | 44.3 | 184 | 84.4 | 0.0 | 0.2 | 15.1 | 0.2 | 0.1 | 0.0 |
| g | Southern | 195 | 28.2 | 181 | 71.5 | 0.0 | 1.0 | 26.5 | 0.8 | 0.2 | 0.0 |
| d | Southern | 197 | 44.0 | 177 | 96.1 | 0.0 | 0.3 | 3.2 | 0.1 | 0.2 | 0.0 |
| f | Southern | 206 | 54.5 | 229 | 18.2 | 0.0 | 1.4 | 77.3 | 1.0 | 2.1 | 0.0 |
| g | Southern | 209 | 44.5 | 201 | 85.9 | 0.0 | 0.5 | 12.7 | 0.6 | 0.3 | 0.0 |
| g | Southern | 211 | 42.1 | 161 | 86.3 | 0.0 | 0.0 | 12.4 | 0.6 | 0.7 | 0.0 |
| g | Southern | 217 | 46.0 | 55 | 90.5 | 0.0 | 0.4 | 8.7 | 0.4 | 0.0 | 0.0 |
| g | Southern | 219 | 54.5 | 123 | 90.3 | 0.0 | 0.5 | 9.0 | 0.2 | 0.0 | 0.0 |
| g | Southern | 222 | 41.9 | 185 | 82.9 | 0.0 | 0.6 | 16.2 | 0.1 | 0.1 | 0.0 |
| b | Southern | 224 | 44.3 | 185 | 97.7 | 0.0 | 0.0 | 2.3 | 0.0 | 0.0 | 0.0 |
| h | Southern | 666 | 10.9 | 74 | 74.7 | 0.5 | 1.7 | 9.5 | 4.3 | 7.7 | 1.6 |