REEF LIFE SURVEY

Image Annotation Protocol

Version 2. November 2025

Contents

Introduction

Reef Life Survey (RLS) is a non-profit global citizen science program in which trained SCUBA divers undertake standardised underwater visual surveys of reef biodiversity. The survey data collected includes visual census of fish and macroinvertebrates underwater along 50m transects [1]. At the same time, photographs of the seafloor habitat are taken every 2.5m along each transect (Figure 1). These photoquadrats (PQs) for each survey are available to view, annotate and download via the online platform Squidle+ and the RLS online image server. More information on RLS underwater methods is available via the methods manual, or visit www.reeflifesurvey.com, or email enquiries@reeflifesurvey.com

Squidle+ is used by Reef Life Survey (RLS) to access and annotate photoquadrat images in order to document habitat composition at sites and track changes in habitat cover indicators over time. Squidle+ is an online platform to manage, explore and annotate large volumes of underwater imagery in a collaborative fashion. It supports standardisation and translation of annotation data, QA/QC, data sharing, integration of machine learning algorithms, as well as efficient data export and compilation via an API.

Although various methods in image annotation are possible, this protocol provides a method of producing standardised habitat cover data compatible with previous work. This allows data synthesis over broad scales, contributing to downstream platforms for reef reporting, such as the Reef Life Explorer, and enhancing the Findability, Accessibility, Interoperability and Reusability (FAIR) of data.

Standardised annotation data from RLS photoquadrats can be integrated into our public dataset available through the Australian Ocean Data Network portal or by contact of the RLS imagery data officer or admin email.

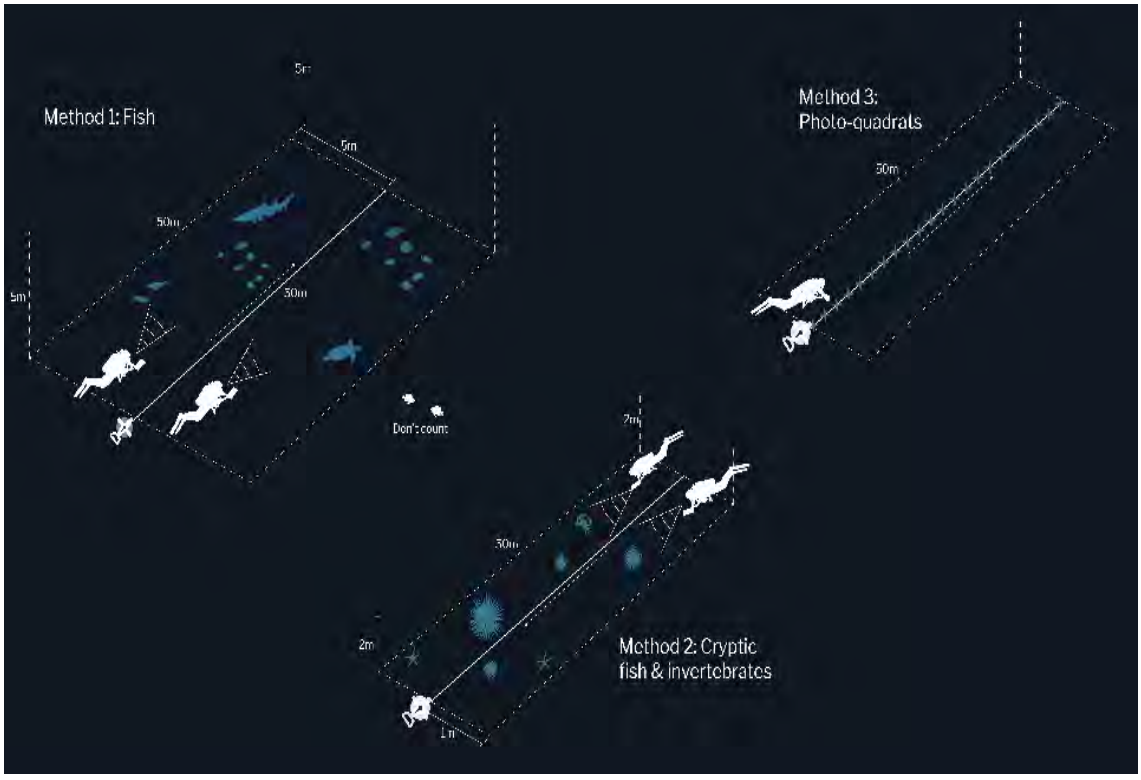

Figure 1 Reef Life Survey underwater visual census method overview

Annotation Guidelines

Data standardisation

With significant advances in the availability and use of benthic imagery there are a diversity of projects seeking to annotate Reef Life Survey photoquadrats. Squidle+ allows users to have flexibility to use annotation parameters applicable to their own project and create their own label schemes, whilst also providing tools for collation and standardisation of data across projects, such as label translation, data sharing, and bulk data export via an API.

Annotation parameters

The standard method used by Reef Life Survey to measure habitat composition is a point intercept method where the feature directly below a point overlayed on an image is labelled with the corresponding category from the RLS annotation scheme. Where multiple layers of biology are found under a point, the uppermost one is to be labelled. At least 100 points per survey should be scored, which is achieved by overlaying 5 points on each image. This amount aligns with the findings of Dumas et al. (2009)[4] who found a density of 9 points/m^2, or 99 points per transect, was sufficient to provide reliable quantitative descriptions of coral reef habitat. All points should be labelled when assessing habitat composition, which is referred to in Squidle+ as the **full-biodiversity** method of scoring.

Users may opt to increase the number of points per image or add additional tags or whole frame annotations without impacting the ability to standardise data. This could be prompted by project-specific needs, locational differences (given the heterogeneity of habitats covered by RLS surveys), or variation in image quality (as images are taken by volunteers with their own non-standardised camera equipment).

Another method of annotation is enabled in Squidle+ which is a **targeted scoring** method. For this only points overlaying a target group of taxa, commonly hard corals or canopy-forming macroalgae, are labelled and the rest of the points are left unlabelled. Some machine learning algorithms are available in in Squidle+ to assist with this type of scoring, though it is best to contact the RLS data officer if considering this option. Special care should be taken to QA/QC images in each annotation set to remove any irrelevant or unscorable images, ensuring that percentage covers are calculated correctly.

Label schemes

Prior to commencing the annotation workflow in Squidle+ it is important to review and consider using the existing available label schemes and tags used to extract information from imagery. Many of these are public and already have example images and mapping to standardised vocabularies. Several vocabularies are embedded into Squidle+'s translation processes, such as CATAMI, which is a hierarchical scheme designed for marine imagery that combines high-level taxonomy with morphology[2], and WoRMs the leading authoritative taxonomic database of species names[3].

For projects seeking information on general benthic habitat cover, Reef Life Survey recommends the use of its standard label scheme, found in Squidle+ as the **RLS Catalogue** (Figure 2, Appendix 1). Included are broad categories of macroalgae, coral, sessile invertebrate, and substrate. These are an extension of the widely used CATAMI scheme. Modifiers, or **tags**, are available to use and create to mark additional information such as bleaching or diseased coral. Where information is needed at a greater taxonomic or morphological resolution, it is possible to create an extended version of the RLS_Catalogue and add more labels under the RLS "parent" labels in existing hierarchy. This maintains compatibility and easy translation of data through "tree-traversal" and provides access

the exemplar images for the RLS labels during annotation. Care should be taken to avoid adding "side branches" to the hierarchy which may compromise mapping to existing standardised schemes. New labels should be mapped to Squidle+'s CATAMI vocabulary, as well as the WoRMS taxonomic vocabulary, and exemplar images should be added during the annotation process. Also please share schemes extending the RLS_Catalogue with the **RLS Schemes: editors & custodians** group.

Figure 2 Reef Life Survey standard label scheme

Annotation workflow overview – Squidle+

1. **Sign up**: a user account is needed in order to create or access annotation data
2. **Explore & Set up**:
    1. Explore and select imported survey images through the **Explore** interface.
    2. Save images into a **Media Collection**
    3. Save an **Annotation Set**, defining annotation parameters and a label scheme, outlined below.
    4. Curate images (ie. remove any non-usable images)
3. **Annotate**: open the Annotation Set and start annotating using the annotation tools, as described below.
4. **Share/collaborate:** use the dataset sharing and collaboration tools to add data to user groups.
    1. **QA/QC** collaboratively
    2. Release data publicly or share with RLS data sharing groups through the sharing tools.
5. **Export**: if desired, use the export tools to export your annotations in a format of your choice or access a publicly available collation of data from Reef Life Survey.

Signing up

This is simple process only requiring a username, email, affiliation, and (if desired) a short bio. Other members use this information to find and add you to groups where data is shared and people can collaboratively QA/QC annotations. A unique API key is available to each member allowing access to datasets that they have created or have been shared with them.

Exploring image repositories and setting up datasets

Selecting photoquadrats via the RLS Platform in Squidle+

RLS photoquadrats are accessible to browse and select via the Explore map interface on Squidle+. Filter for the **RLS Diver Photos** platform. Images are organised into campaigns based on location and year, and within each campaign there are several deployments. In Squidle+, each deployment has a deployment_key which is equivalent to an RLS survey_id, representing one 50m RLS transect. Deployments are easily found and selected by searching for survey_id, site_code, or date in the search text box or by browsing the map interface (Figure 3). It is useful to do this in conjunction with the RLS survey list, available on the Australian Ocean Data Network portal (by searching for "RLS" or "NRMN" in the keyword search), which contains all available survey metadata and can be used to compile a list of desired surveys to target.

Since Reef Life Survey has a smaller number (~20) of images per deployment than other platforms it is advised to select several deployments to include in each media collection in order to reduce time spent setting up media collections and annotation sets. Images for selected deployments can be previewed by clicking the "media" tab in the top bar (Figure 4).

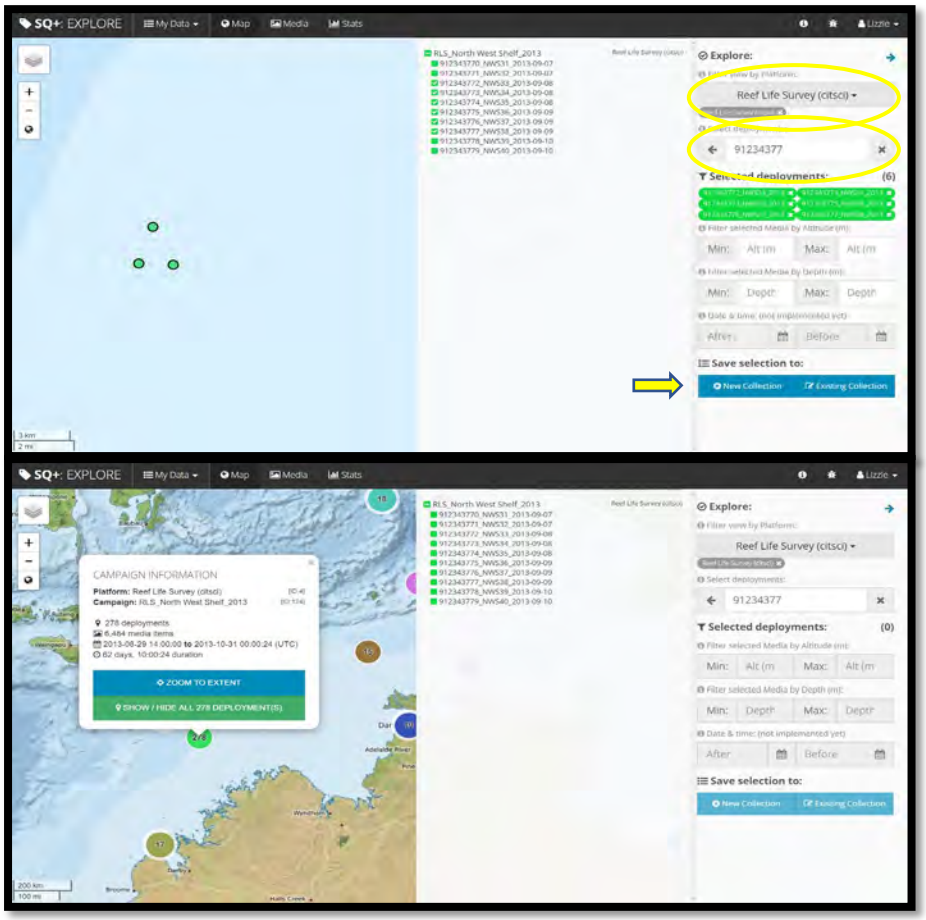

Figure 3 Exploring the map interface and searching for deployments/surveys in Squidle+

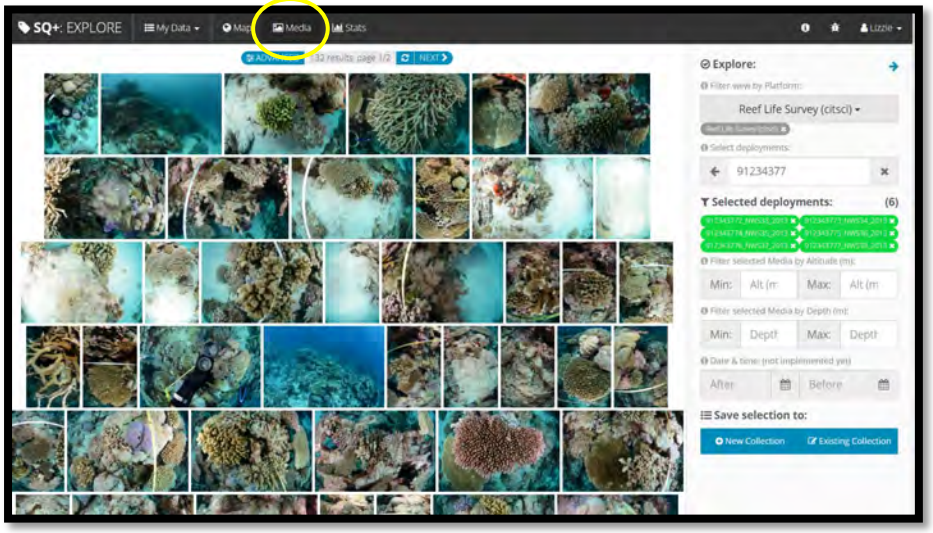

Figure 4 Browsing images from selected deployments in Squidle+

Create a Media Collection

Once surveys from RLS platform have been selected they can be saved to a **New Collection**. A suggested naming convention would be to include your name and the survey location and year (or other indication of how the surveys relate to each other) (Figure 5). Leave the sampling options as none (this option is for selecting a subset of the photos in each deployment).

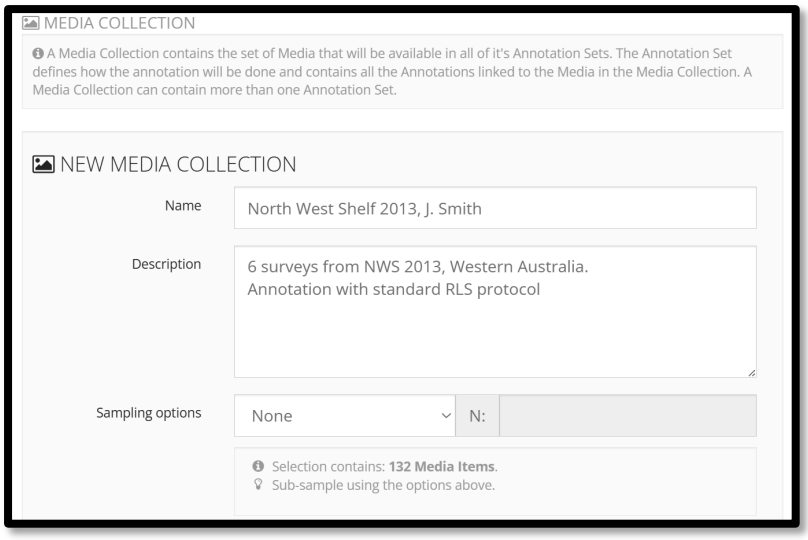

Figure 5 Creating a media collection in Squidle+

Create an Annotation Set

From the selected media collection, select “Create new Annotation Set” and fill out the relevant metadata (Figure 6). For the standardised method of analyses of RLS photoquadrats, select the **RLS Catalogue** as the label scheme), and the **five point quincunx point layout**. Be sure to allocate the scoring resolution and dataset purpose relating to your parameters (full biodiversity for the standard protocol). The default advanced options are usually appropriate: whole-frame annotation is disabled (you can still add them, but they are not auto-generated for each image) and manual point editing is allowed (enabling the user to create, delete and move points).

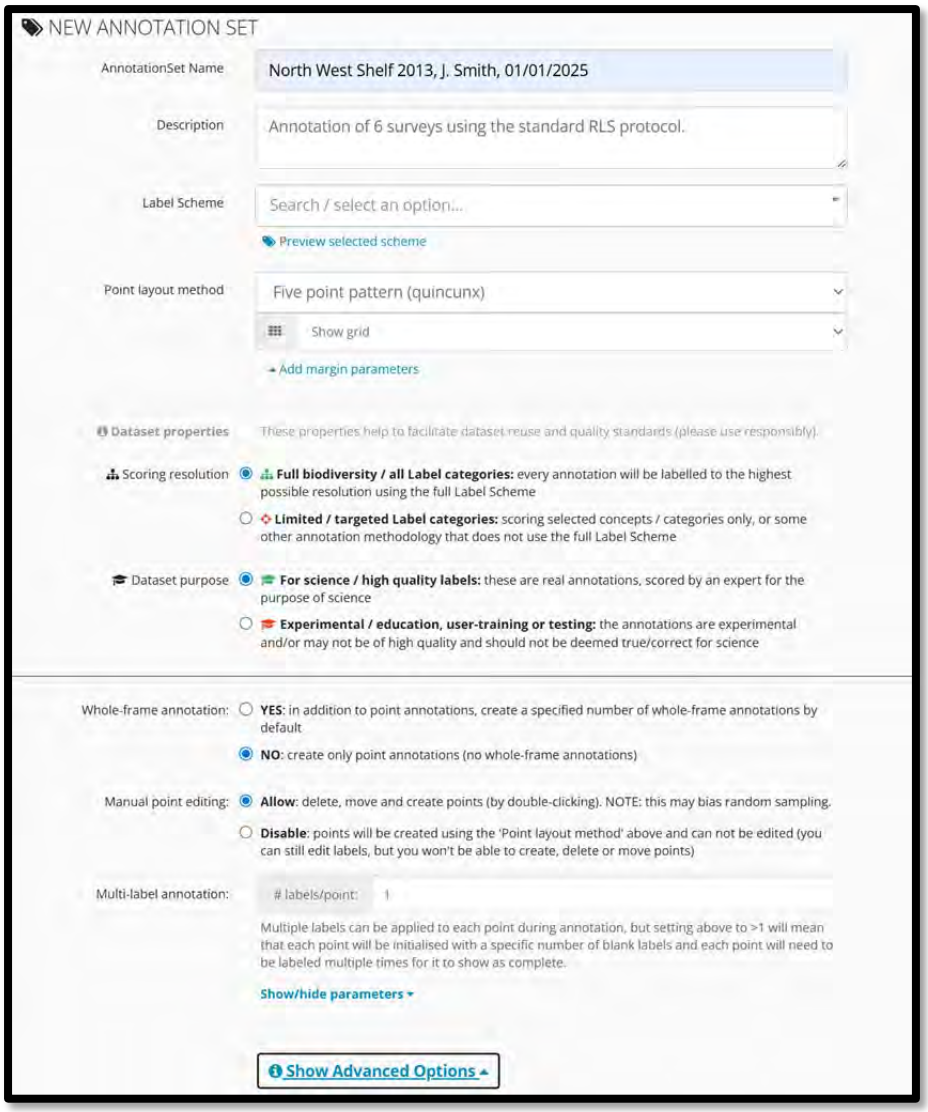

Figure 6 Creating an annotation set in Squidle+

Annotating photoquadrats

Upon opening an annotation set, the images appear as thumbnails ordered by deployment key (equivalent to RLS survey_id) and image number (Figure 7). From the top bar users can toggle between this **Annotate** view, the **QA/QC** view, and the **Export and Share** view, which are all important to use in the annotation process (these can also be opened concurrently in separate tabs). Sharing of data is recommended before finalising the annotations, to undergo collaborative QA/QC.

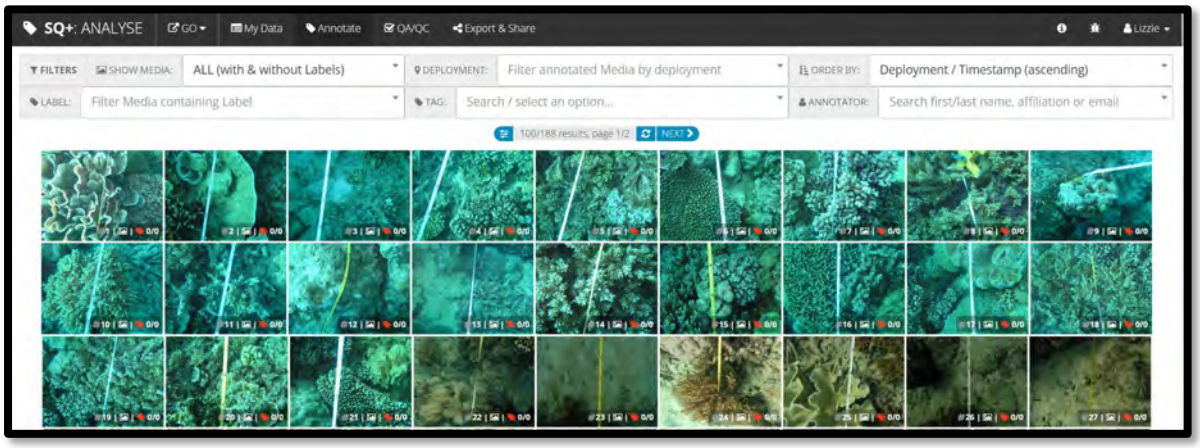

Figure 7 Annotation set view page

Various filtering options are available in the annotation view, but note that deployments can only be filtered from the drop-down menu once they have labelled points (as at November 2025). If a user wants to annotate a single survey at a time, then the following string must be pasted in the advanced query bar (click):

{"filters":[{"name":"deployment","op":"has","val":{"name":"key","op":"eq","val":"Insert SurveyID or deployment key"}}],"order_by":[{"field":"deployment_id","direction":"asc"},{"field":"timestamp_start","direction":"asc"}]}

Removing unwanted images

This is a desired step for standard full-biodiversity scoring (for which unlabelled points do not need to be exported), and an essential step for targeted method scoring (where unlabelled points must be exported to calculate percentage cover). Unwanted images may be poor quality, or images that aren't photoquadrats; commonly a picture of a dive computer, underwater datasheet, or a landscape photo along the transect. These are often taken by divers to ensure metadata are captured correctly when labelling images and are not removed during the cataloguing process due to the large number of incoming images. Removing image (one by one) by clicking on each unwanted image to open the annotation window then selecting the settings under in **media info/utils** section (Figure 8). Aim to keep 20 good quality photoquadrat images per survey, however if this is not possible additional points can be added to images during the annotation process to reach the goal of 100 labelled points per survey.

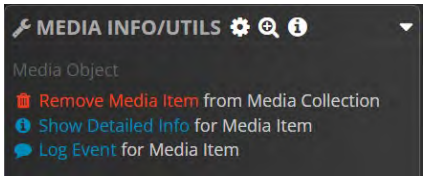

Figure 8 Removing a media item

Labelling Points

Clicking on a thumbnail opens the annotation window which is the main interface to work from (Figure 9). Learning the components and annotation options in this window is essential for efficient workflow. In the top right of the screen there are settings ⚙ to select different annotation modes. There is a zoom window in the bottom right corner where the level of zoom, brightness and contrast can be adjusted. The image file metadata is also displayed here by clicking the information icon ℹ. More information and keyboard shortcuts can be found in the Squidle+ wiki page.

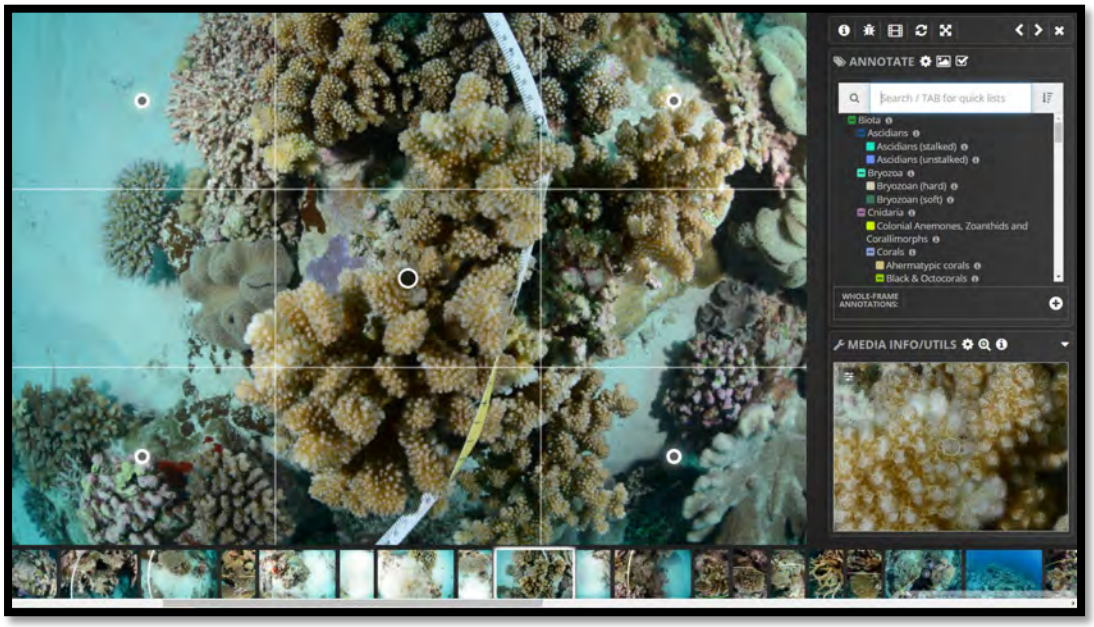

Figure 9 Squidle+ annotation window

The RLS category scheme appears on the right in a hierarchical list which can be expanded to show all the categories at once, filtered by entering a search term, or accessed via the recent and frequent lists. Selected points are labelled from this list by clicking the corresponding label.

Example images, and other category metadata are viewed in Squidle+ by clicking of the information icon ℹ next to each category name in the list. Alternately, if you SHIFT + RIGHT CLICK or SHIFT + DBL CLICK on an annotation point it opens up the exemplar preview (Figure 10). Take time to review these initially, and as necessary, as well as the RLS Catalogue document and the CATAMI visual guide which include examples and worded descriptions which are important for defining substrate labels.

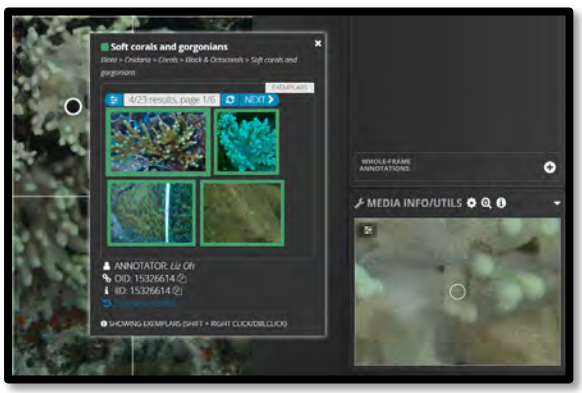

Figure 10 Accessing exemplar images by SHIFT + RIGHT CLICK or SHIFT + DBL CLICK on annotated point

Labelling guidelines

Where multiple layers of biology are found under a point, the uppermost one is to be labelled. For example, if a point lands on thick layer of epiphyte covering a kelp, then attribute the point's label to the epiphyte and not the kelp. The exception to this rule is for low to moderate fouling over a live sessile invertebrate, such as giant clam, mussel, or solitary ascidian. In this case the live sessile invertebrate is to be scored. Mobile invertebrates are not part of PQ scoring (and are covered in other RLS methods) so are considered "unscorable". Another special case is that there is a separate category for "Coral rubble with turf/encrusting algae".

Where no biota is present under the point, the bare substrate is scored (e.g. sand, coral rubble, gravel or bare rock). This can sometimes be unclear where there are gradients between substrate types or a matrix, so it is best to consistently choose what the dominant feature is (e.g. if sand covered rock is present and >50% of that part of the rock is covered in sand then choose sand). In order to achieve the best consistency and replicability using this categorical approach, it is important to familiarise yourself with the categories and their descriptions to begin with (See Figure 11 and the separate PQ Catalogue):

1) If there is a matt-forming covering of short filamentous algae intermixed with any **sediment** in it then it is considered "Turf" (this is often the most commonly used label),
2) If there is a matted mass of cyanobacterial slime, but with **no sediment** in it then it is considered "Slime" (usually covers dead coral),
3) If there are medium to large sized clumps or long strands of filamentous algae not forming a matt, but growing loosely over plants, invertebrates, or substrate they are considered "filamentous (red, green of brown) algae",
4) If the algae is medium sized and has a structure other than filamentous, ie. branching, sheet-like, or globular then the category assigned should be medium foliose (red, green or brown) algae. NB. There are also separate categories for certain green algae and canopy algae (Figure 2)

Utilise media tools if necessary. Consider using the zoom, brightness and contrast media tools. Because image data are sourced from a variety of cameras and camera operators and taken in variable water quality and diving conditions image quality can vary. When assessing images, consider differences in colour balance, resolution and scale that can occur. Reduced visibility from particulate matter or lack of ambient light may mean that images have a greenish tinge to them, have more backscatter if a flash is used, or if a flash is not used the red colours will not be as prominent. Consider the overall tone of the images in a deployment and between deployments, aiming to produce a set of scores as consistent as possible in detecting changes in the benthic habitat regardless of image quality.

Where a point overlays an unscorable feature, move the point. Points which overlay a transect tape, occurring on undecipherable blurred or heavily shadowed features should be moved. If a whole image is unusable due to poor image quality or is not a photoquadrat (eg. is a "seascape" photo, or image of a dive computer, slate or fish) please skip the image and remove it from the media collection. You may choose to label these points using the category "unscorable" to keep track of your work, however bear in mind that these will be counted in any tally you are using to track the number of labels per deployment (so will change the count you are aiming for to >100). To move a point right lick it and select "Move" (Figure 11). Move it to the closest scorable feature in its grid cell. If there are no options move it to the centre of an adjacent empty grid cell, and so on. Try not to overdo it, if this needs to be done a lot in for survey photos it reduces efficiency and also

indicates poor quality images – consider whether the diversity of habitat features are being captured properly (or if encrusting layers / substrate are being missed due to lack of focus or shadow. Surveys without enough quality images can be disregarded and recorded in the RLS Squidle+ error logs

Avoid assigning labels to parent (header) categories in the hierarchical list such as “Macroalgae”, “Cnidaria” or “Sponge”. Instead assign the greatest label resolution possible. For consistency of data, it is better to make a call on the major growth form and colour where applicable such as “Medium foliose green algae” or “Sub-massive corals” or “Erect sponge”.

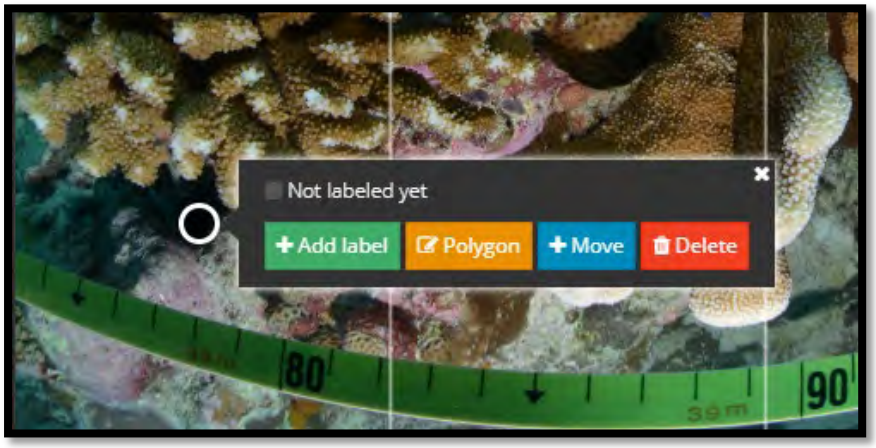

Figure 11 Right click point options

Assigning a label tag

If you need to add extra information to a labelled point that can be searched later and also exported in the data, you can “tag” it by right clicking on the point and selecting from the options. A useful tag to use is “Flagged for review” which you can use if you are unsure of your categorisation of a point or have a remarkable feature to be reviewed. You can also add further detail in the comments box, but these should have consistent wording if important to search for later. Tags and comments can later be searched for in the QA/QC filter options by anyone you share the dataset with and have given edit rights. Tags also exist for marking “bleached” or “recently dead” or “diseased” corals, “epiphytes”, and “unattached” (drift) biota. Tagging **bleached and recently dead corals** is part of the standard RLS protocol and these tags are included in published data. “Recently dead” is a rarely used tag and is only used if the deceased coral has not yet been fouled with other biota (commonly crustose coralline algae or turf).

Adding exemplar images

If a user comes across a good example or missing example of a label in the RLS Catalogue or their own extended scheme, they can add an exemplar by clicking the ticked icon in the top right of the annotation page (Figure 12). Ther can then double click to add a point in the centre of the feature, label it and click and drag from the point outwards to create a bounding box to frame the exemplar image. If you do not have access to the exemplar annotation set you can tag a point as an exemplar suggestion in the normal annotation pane and notify the RLS data officer.

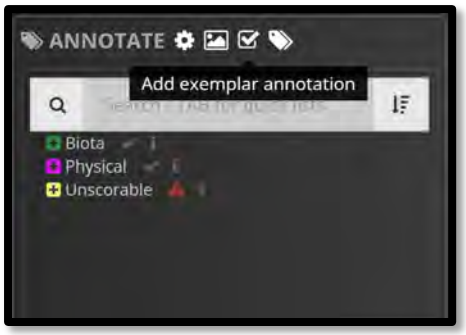

Figure 12 Adding an exemplar image

Reviewing label data

QA/QC

The QA/QC functionality is an essential tool for everyone to review the labels assigned within their annotation set before it is finalised and also to QA/QC their peers' annotations. Users can browse thumbnails image points the annotator(s) have assigned according to each label (Figure 12). Points can be selected, or multi-selected, and re-assigned with the category list on the right if upon review they need changing.

Filter options can be used to filter for annotators, tags, comments, or review flags, allowing collaborative review when annotation sets are shared between colleagues. To apply filters to more than one label you can SHFT or CTRL select multiple labels from the left panel after selecting the filters.

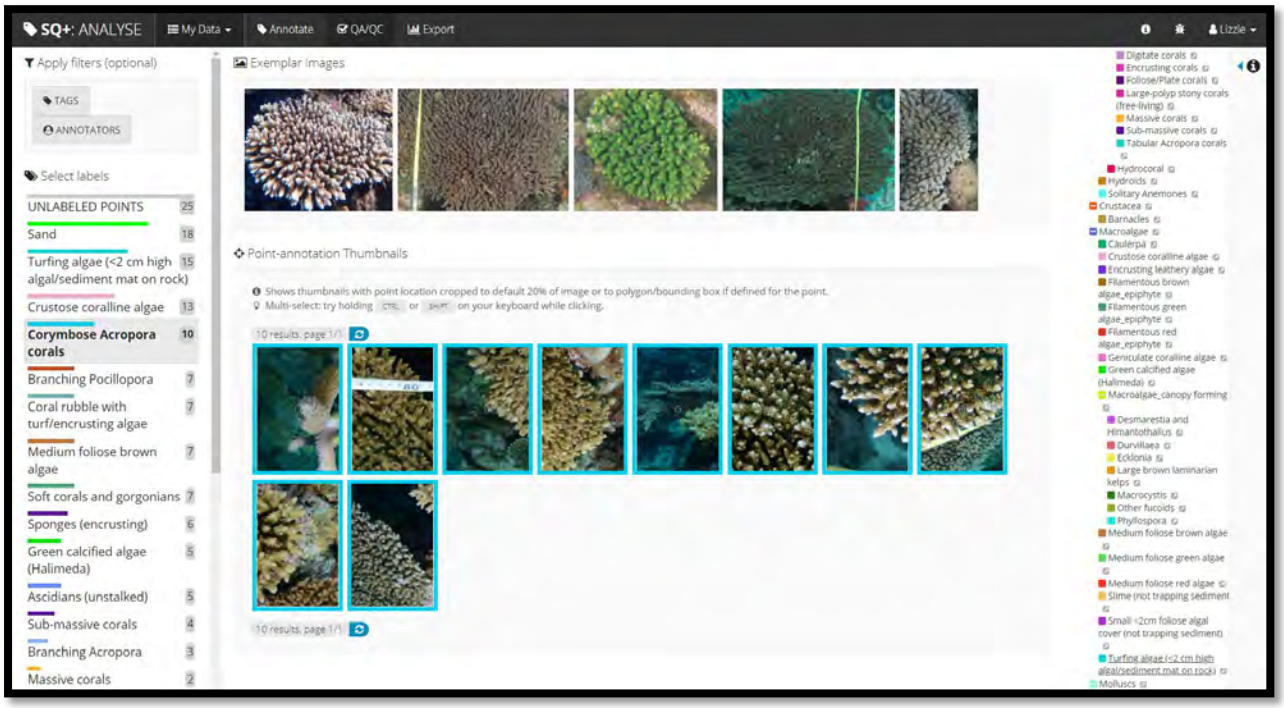

Figure 13 Squidle+ QA/QC page

Finalising annotation sets

As the number of images per survey does vary, the number of points per survey needs to be review during and after labelling to ensure the target of ~100 points is met. This can be done a number of ways. The annotation view page has a deployment filter which shows the number of points scored for each deployment/survey, and the export and sharing page also has an annotation tally (by label or deployment). Several pages can be kept opened in separate browser tabs and refreshed as needed.

Very old pre-2009 surveys may only have a collection of 10 photos each. For these add 4 extra points in the empty cells of the grid layout on each photo, to aim for a total of at least 90 points.

Sharing and Exporting data

Sharing data

Once labelling is finished, the annotation set should be marked as QA/QC' and finalised in the export and sharing page and shared with to the appropriate Squidle+ data sharing group (Table 1 RLS data sharing groups in Squidle+ for general use) so that the RLS team may review and/or export the data. If errors need to be corrected later you can still edit the data once it is shared as any data is published as versions "live data". RLS custodians of the group can review and export the data, but general users may only view the data.

Table 1 RLS data sharing groups in Squidle+ for general use

Group Name	***Description***
RLS Photoquadrat scores – finalised data	For annotators using the RLS catalogue to score RLS photoquadrats. Share your finished datasets here, where data can be extracted.
RLS Training datasets	For annotators training to use the RLS catalogue to score RLS photoquadrats. These media collections can be copied to your own collection to annotate and compare to the results.
Your own group which you add the users **nrmn admin** and **Liz Oh**	This will enable your data to be integrated and published with other RLS standardised annotations. Please email to notify that your project has finalised data (and ideally before commencing for any guidance needed)

Some projects will choose to create their own group to collaborate QA/QC processes between a selected private group and organise their media collections in one place. If this is the case then please add the RLS data officer (Liz Oh, elizabeth.oh@utas.edu.au) to the group and email to discuss sharing of data in the global RLS photoquadrats scores endpoints. Such projects may choose to use the RLS label scheme or an RLS extended label scheme to annotate where higher taxonomic or morphological resolution is required (see appendix for more information of label schemes).

Exporting data

Final point data can be exported through the **Export and Sharing** page, although if it is shared with the RLS finalised groups it will also be exported by the data officer and made available (at a standardised resolution) in our private data extracts. To export annotations independently, for use with other RLS survey data make sure the deployment key is an included field. If large amounts of data need to be extracted and compiled, Squidle+ provides some API reference documentation

whereby 3rd party programs can be used to extract data. RLS data officers can be contacted for help with this.

Contacts

For technical issues, RLS specific questions, species/category identification queries, or exported data collections email the RLS contacts provided below. Squidle+ was created and is managed by Ariell Friedman (Greybits Engineering), with support from the Schmidt Ocean Institute, the Integrated Marine Observing System and the Nectar science cloud. Ariell has created a shared file for reporting bugs and suggesting improvements, which RLS admin can report to.

Reef Life Survey Data Officers:

Elizabeth.Oh@utas.edu.au

Antonia.Cooper@utas.edu.au

Citation for this document:

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2. Althaus, F. *et al.* A Standardised Vocabulary for Identifying Benthic Biota and Substrata from Underwater Imagery: The CATAMI Classification Scheme. *PLOS ONE* **10**, e0141039 (2015).
3. WoRMS Editorial Board. World Register of Marine Species. Available from https://www.marinespecies.org at VLIZ. Accessed yyyy-mm-dd. VLIZ https://doi.org/10.14284/170 (2025).
4. Dumas, P., Bertaud, A., Peignon, C., Léopold, M. & Pelletier, D. A “quick and clean” photographic method for the description of coral reef habitats. *J. Exp. Mar. Biol. Ecol.* **368**, 161–168 (2009).

Appendices

Appendix 1. RLS Scheme and Exemplar images

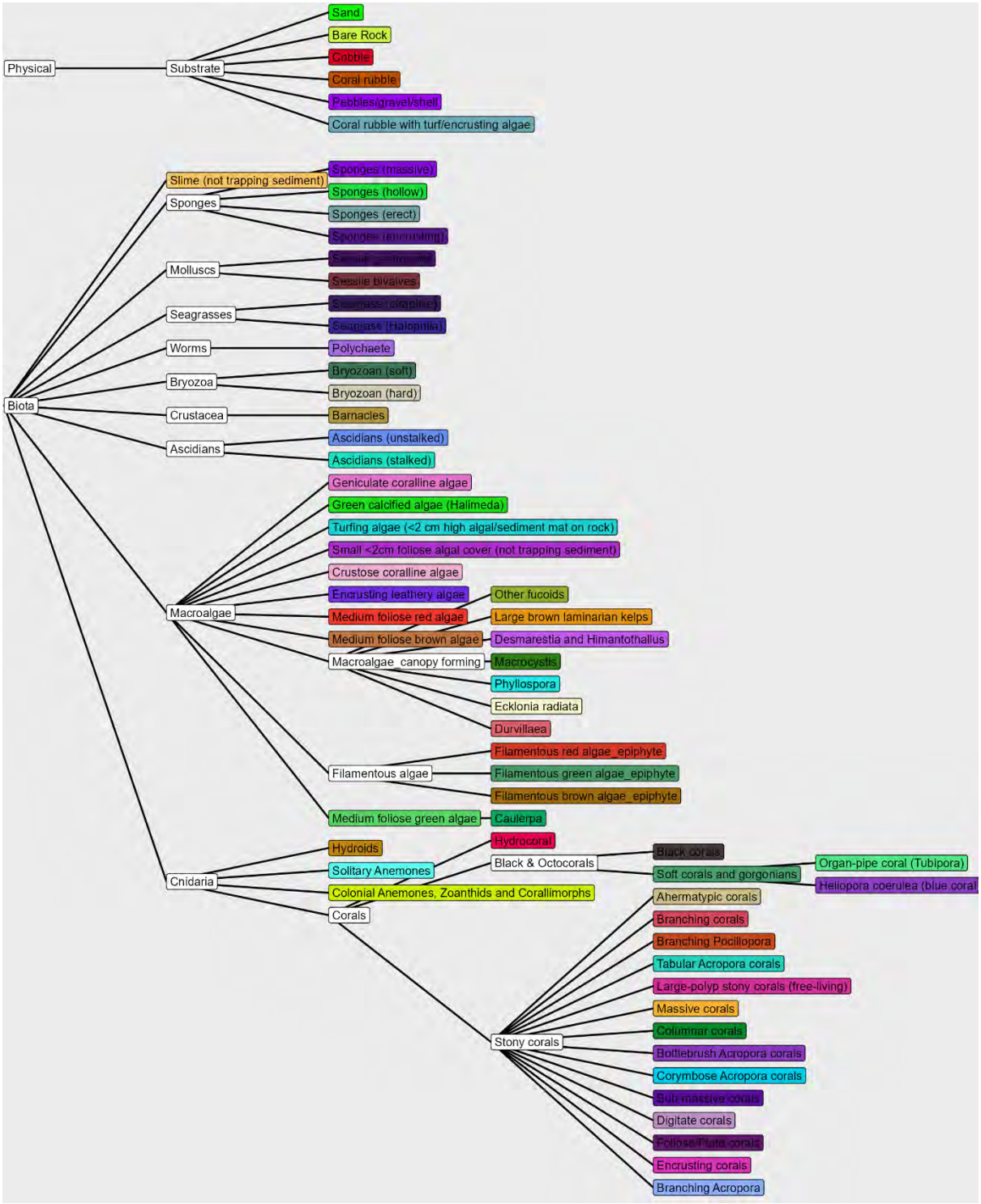
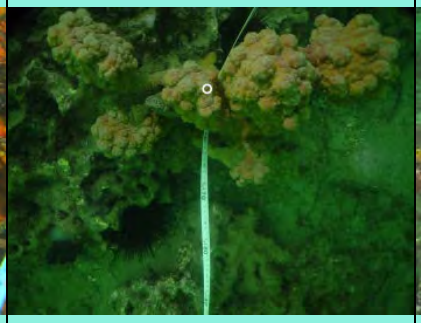
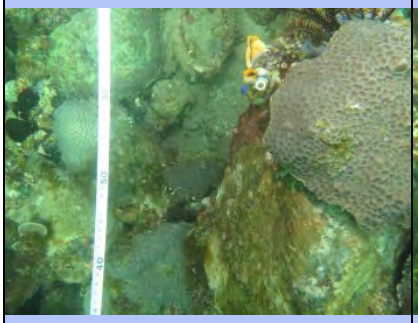
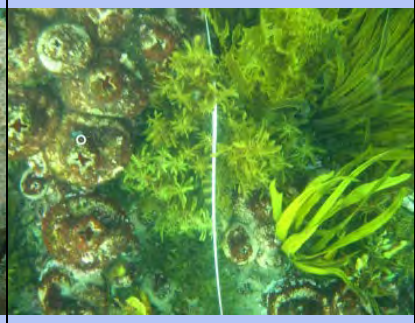
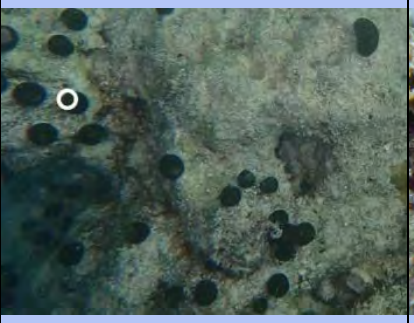
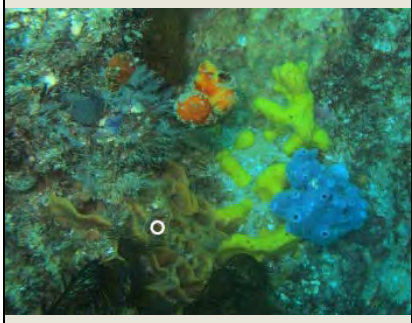
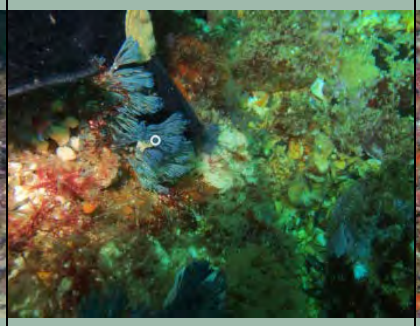


Figure 14 The "RLS Catalogue" hierarchical label scheme.

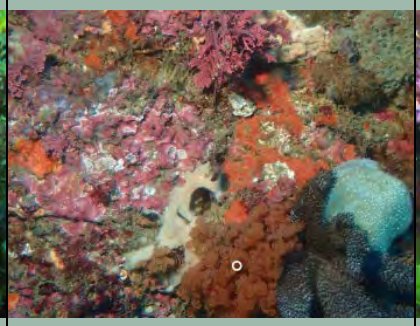
When annotating please avoid use of high-order labels in the hierarchy. Ie. only utilise the coloured labels in Figure 14. This ensures consistency in the data once aggregated.

Ascidians			
	Ascidians stalked	*Ascidians stalked*	*Ascidians stalked*
	**Ascidians**		
Ascidians stalked		*Ascidians unstalked*	*Ascidians unstalked*
			
Ascidians unstalked	*Ascidians unstalked*	*Ascidians unstalked*	*Ascidians unstalked*
		**Bryozoans**	
Ascidians unstalked	*Ascidians unstalked*		*Bryozoan hard*
			**Bryozoans**
Bryozoan hard	*Bryozoan hard*	*Bryozoan hard*	

Bryozoan soft

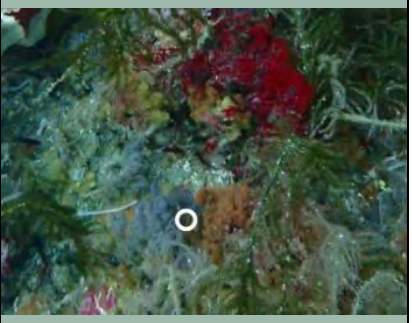


Bryozoan soft



Bryozoan soft

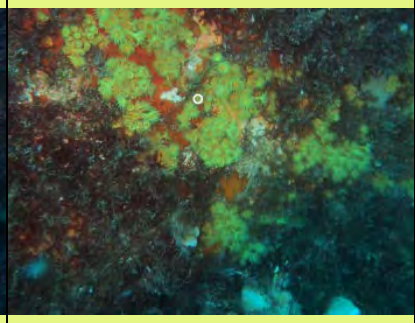
Bryozoan soft



Bryozoan soft

Anemones

Colonial anemones



Colonial anemones

Colonial anemones

Colonial anemones

Anemones

Solitary Anemones

Solitary Anemones

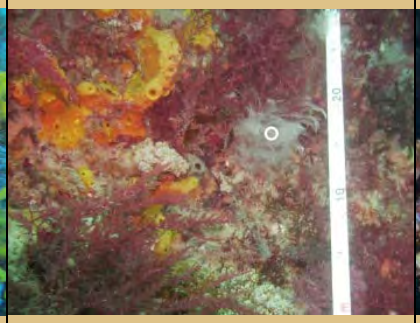
Solitary Anemones

Hydroids

Hydroids

Hydroids

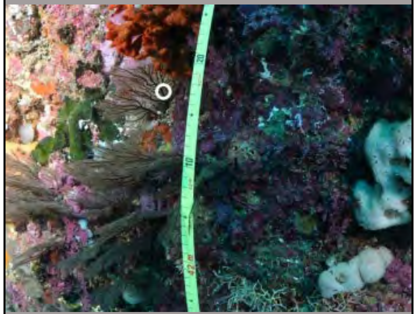
Hydroids



Hydroids

Hydroids

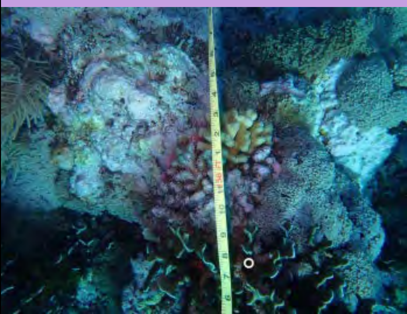
Black & Octocorals



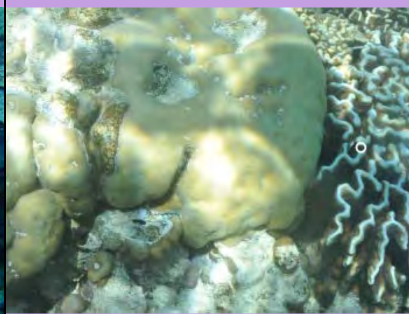
Black corals

Black & Octocorals

Heliopora coerulea blue coral



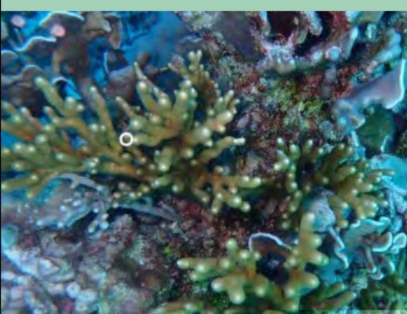
Heliopora coerulea blue coral



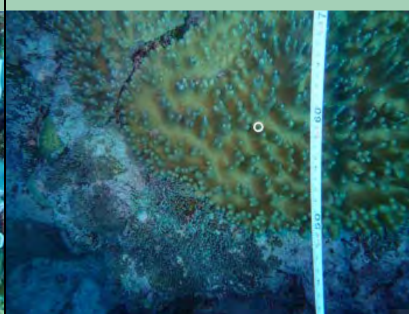
Heliopora coerulea blue coral

Heliopora coerulea blue coral

Black & Octocorals

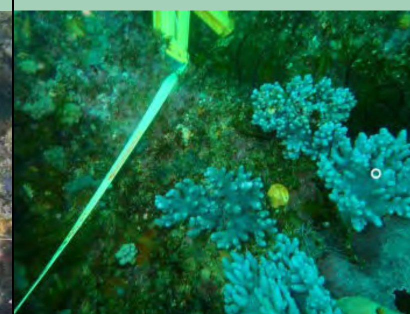


Soft corals and gorgonians

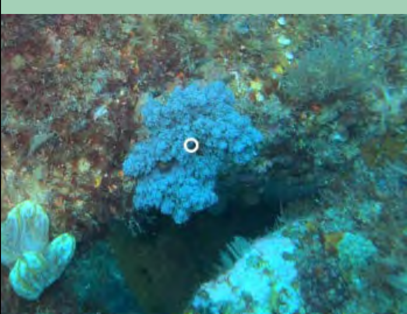


Soft corals and gorgonians

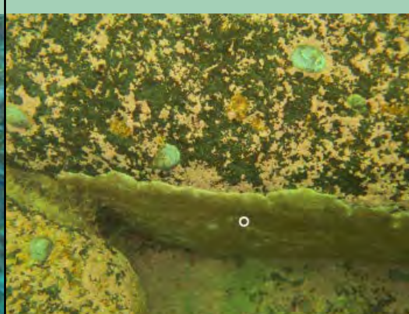
Soft corals and gorgonians



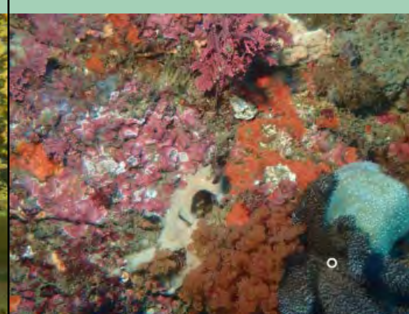
Soft corals and gorgonians



Soft corals and gorgonians



Soft corals and gorgonians

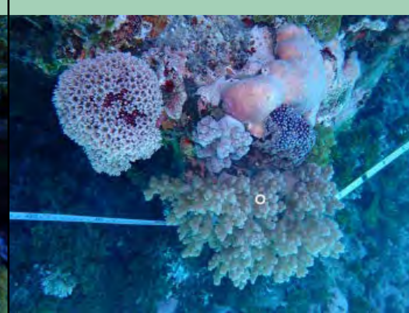


Soft corals and gorgonians

Soft corals and gorgonians

Soft corals and gorgonians

Soft corals and gorgonians



Soft corals and gorgonians

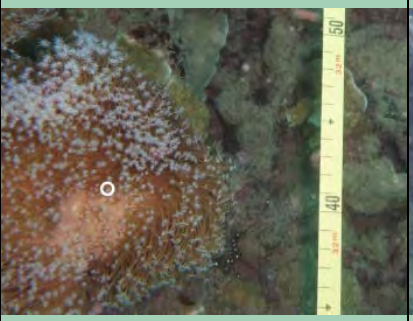
Soft corals and gorgonians

Soft corals and gorgonians

Soft corals and gorgonians

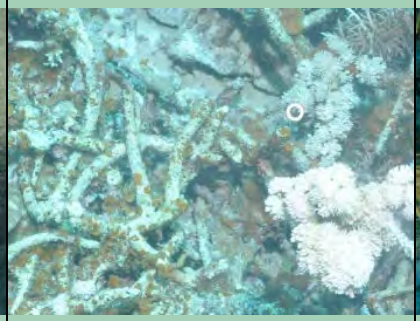
Soft corals and gorgonians

Soft corals and gorgonians



Soft corals and gorgonians

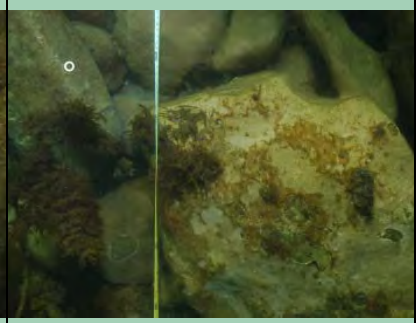
Soft corals and gorgonians



Soft corals and gorgonians

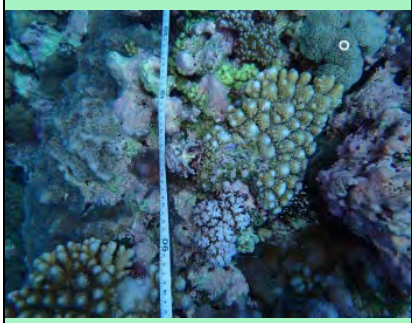
Soft corals and gorgonians

Soft corals and gorgonians

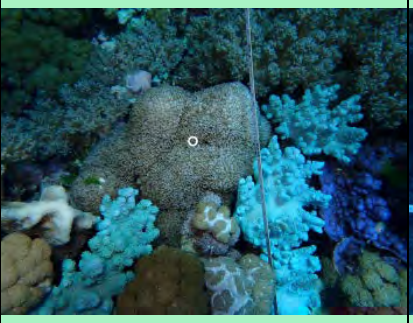


Soft corals and gorgonians

Black & Octocorals



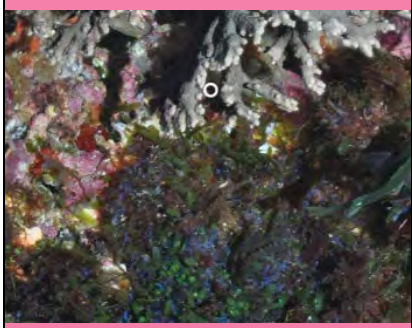
Organ−pipe coral Tubipora



Organ−pipe coral Tubipora

Organ−pipe coral Tubipora

Hydrocorals



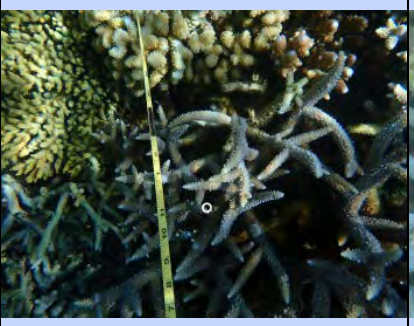
Hydrocoral

Hydrocoral

Stony corals

Branching Acropora

Branching Acropora



Branching Acropora

Branching Acropora

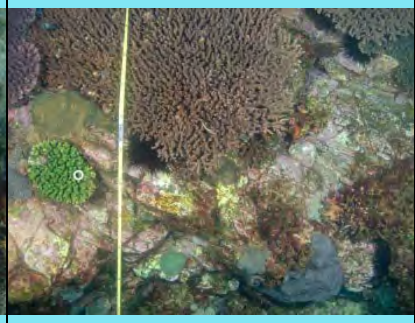
Stony corals

Corymbose Acropora corals

Corymbose Acropora corals

Corymbose Acropora corals

Corymbose Acropora corals



Corymbose Acropora corals

Stony corals

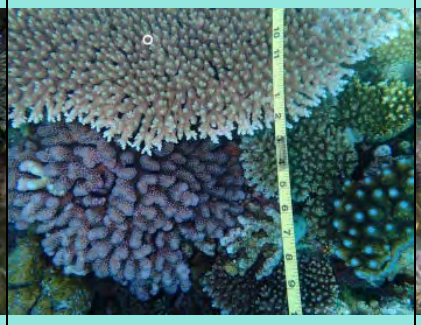
Bottlebrush Acropora corals

Stony corals

Tabular Acropora corals

Tabular Acropora corals

Tabular Acropora corals



Tabular Acropora corals

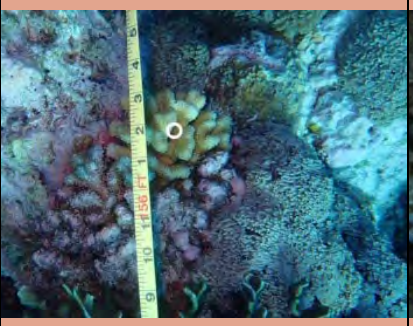
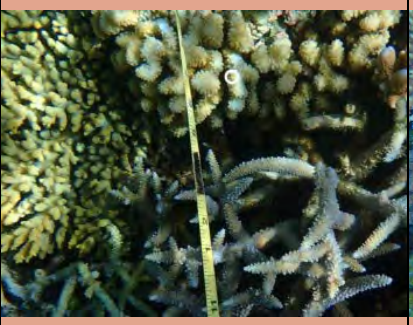
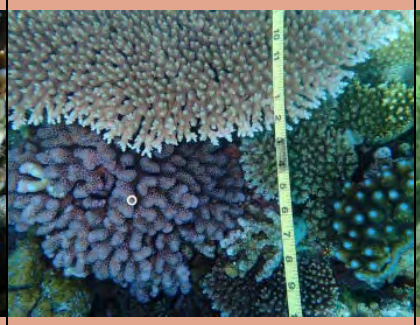
Tabular Acropora corals

Stony corals

Branching corals

Branching corals

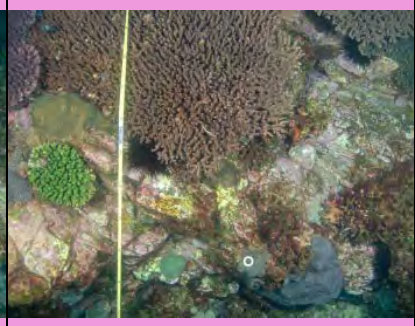
Branching corals

			**Stony corals**
Branching corals	*Branching corals*	*Branching corals*	
			**Stony corals**
Digitate corals	*Digitate corals*	*Digitate corals*	
			
Branching Pocillopora	*Branching Pocillopora*	*Branching Pocillopora*	*Branching Pocillopora*
			**Stony corals**
Branching Pocillopora	*Branching Pocillopora*	*Branching Pocillopora*	
			
Encrusting corals	*Encrusting corals*	*Encrusting corals*	*Encrusting corals*

Encrusting corals

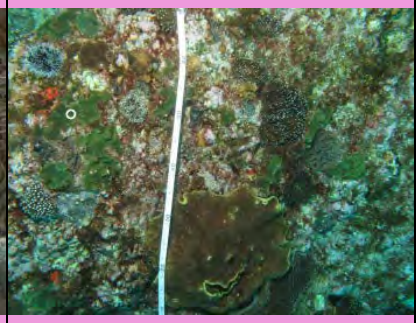
Encrusting corals

Encrusting corals



Encrusting corals

Encrusting corals



Encrusting corals

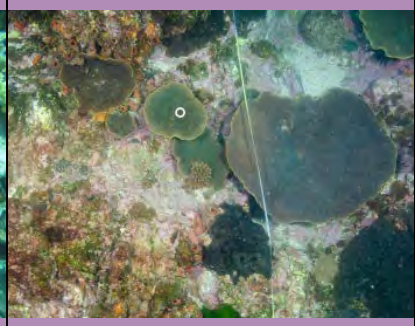
Stony corals

Foliose or Plate corals

Foliose or Plate corals

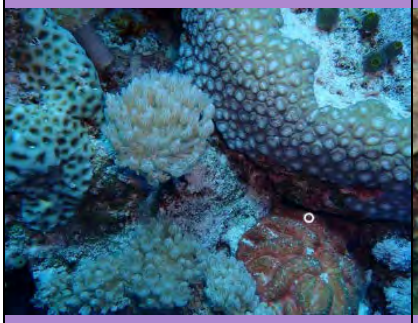
Foliose or Plate corals

Foliose or Plate corals

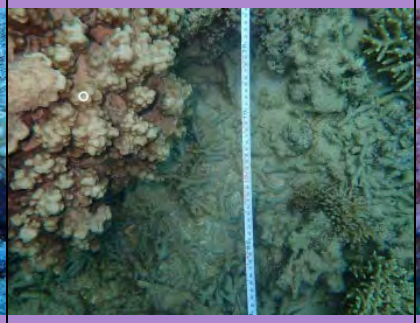


Foliose or Plate corals

Stony corals



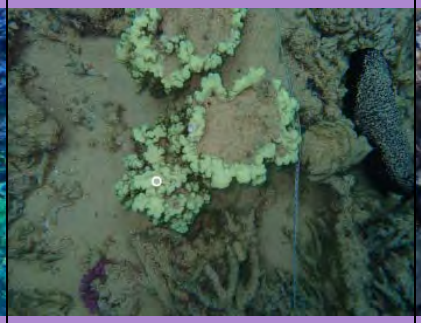
Sub−massive corals



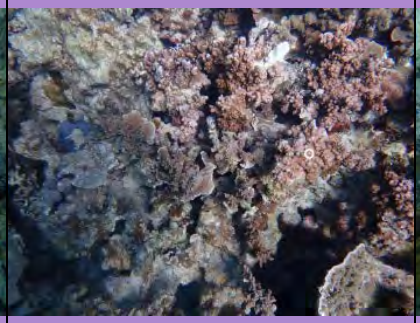
Sub−massive corals

Sub−massive corals

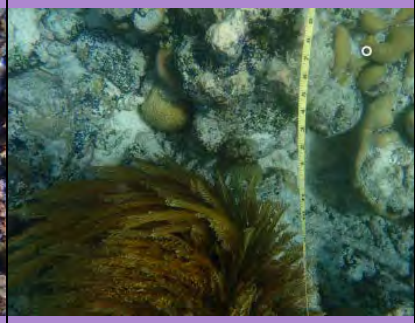
Sub−massive corals



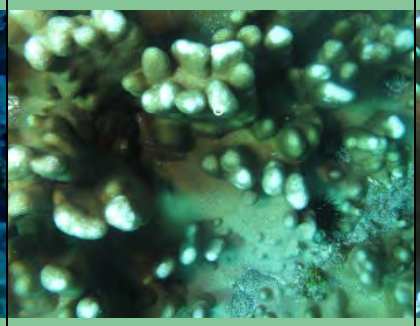
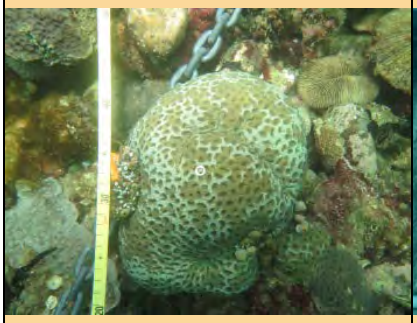
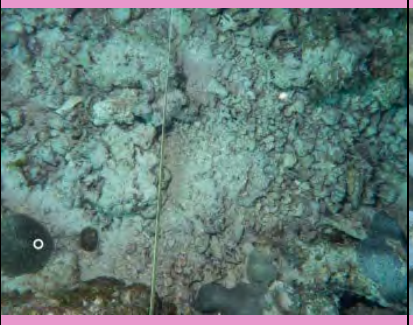
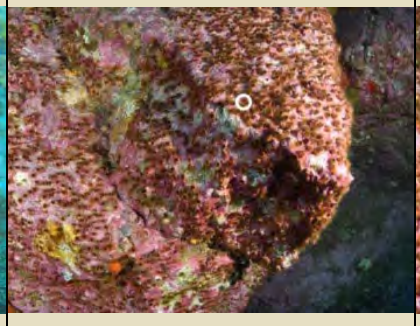
Sub−massive corals

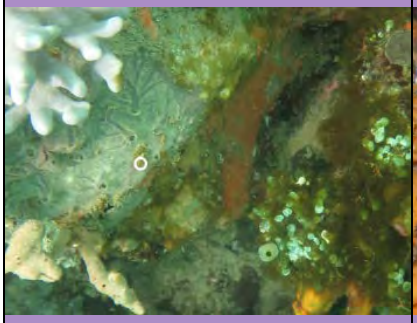
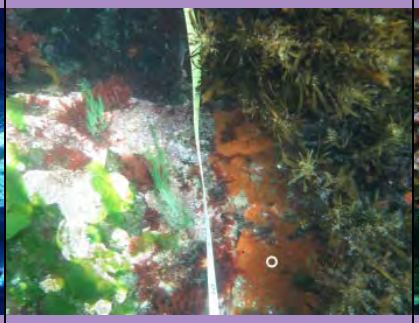
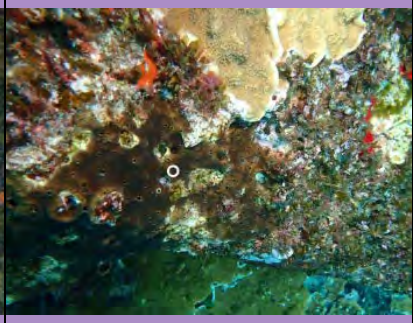
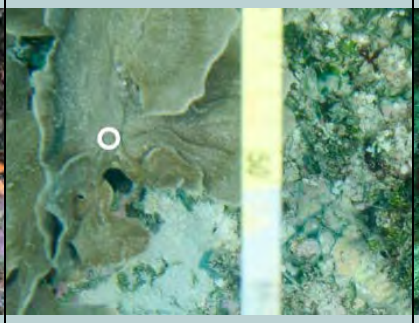


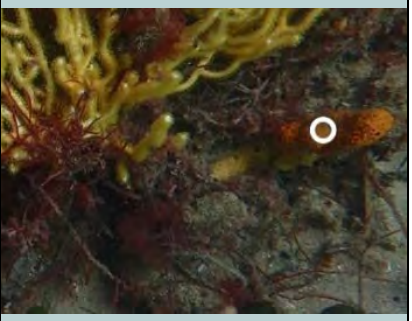
Sub−massive corals



Sub−massive corals

Stony corals			
	Columnar corals	*Columnar corals*	*Columnar corals*
Stony corals			
	Massive corals	*Massive corals*	*Massive corals*
		**Stony corals**	
Massive corals	*Massive corals*		*Large polyp stony corals*
		**Stony corals**	
Large polyp stony corals	*Large polyp stony corals*		*Ahermatypic corals*
			
Ahermatypic corals	*Ahermatypic corals*	*Ahermatypic corals*	*Ahermatypic corals*

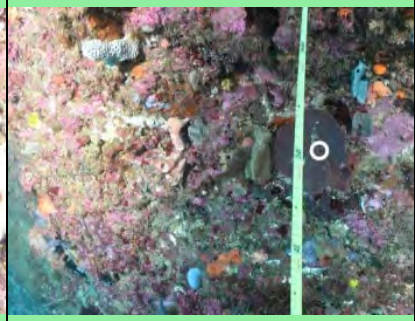
Sponges			
	Sponges encrusting	*Sponges encrusting*	*Sponges encrusting*
			
Sponges encrusting	*Sponges encrusting*	*Sponges encrusting*	*Sponges encrusting*
			**Sponges**
Sponges encrusting	*Sponges encrusting*	*Sponges encrusting*	
			
Sponges erect	*Sponges erect*	*Sponges erect*	*Sponges erect*
			
Sponges erect	*Sponges erect*	*Sponges erect*	*Sponges erect*



Sponges erect

Sponges

Sponges hollow



Sponges hollow

Sponges hollow

Sponges hollow

Sponges hollow

Sponges

Sponges massive

Sponges massive

Sponges massive

Sponges massive

Sponges massive

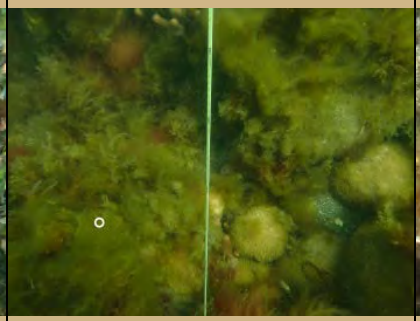
Crustacea

Barnacles

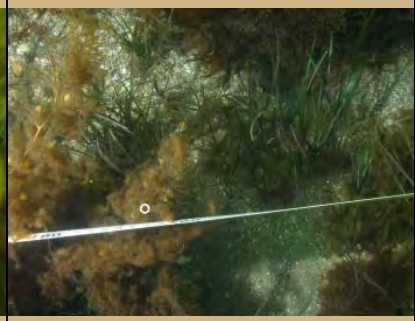
Filamentous algae

Filamentous brown algae_epiphyte

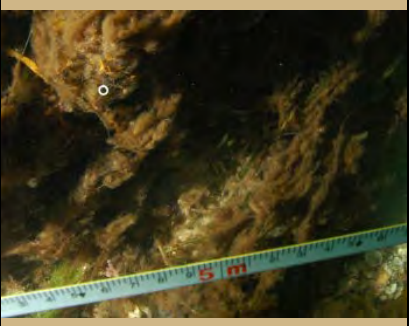
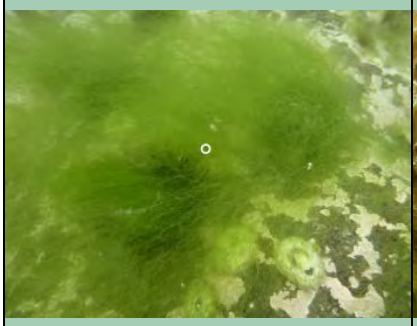
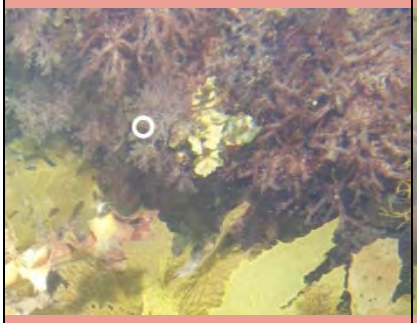
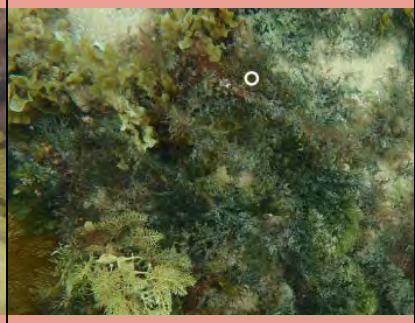
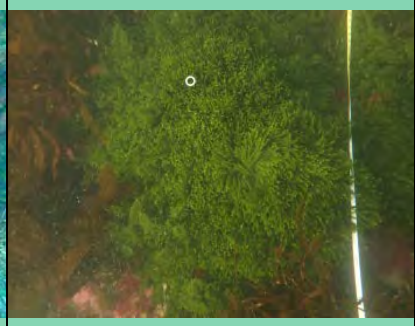
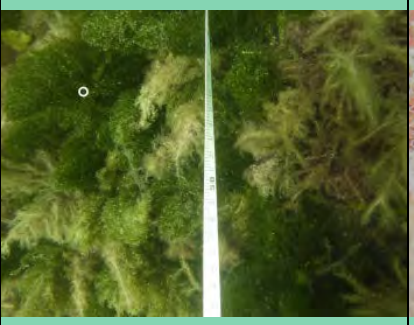
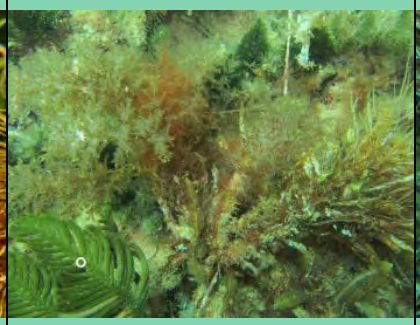
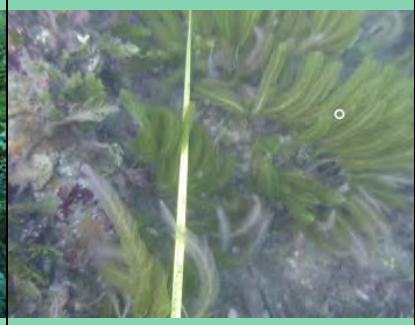
Filamentous brown algae_epiphyte

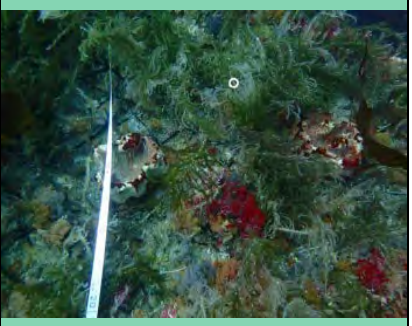
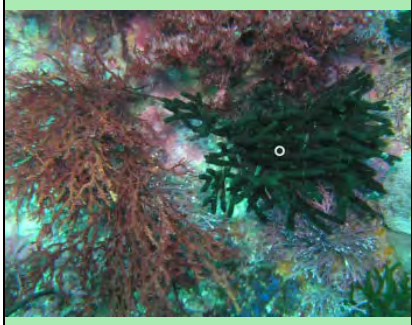
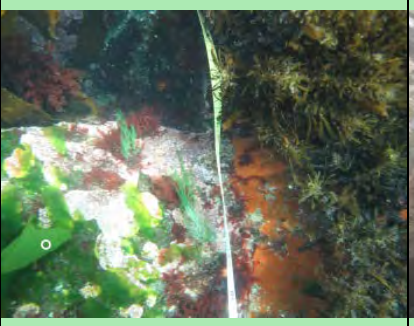
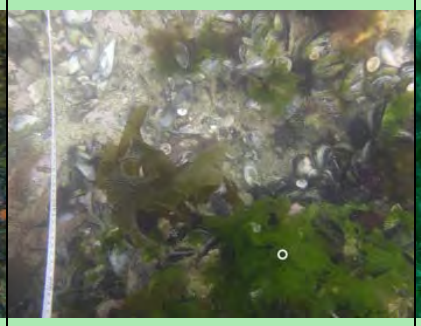
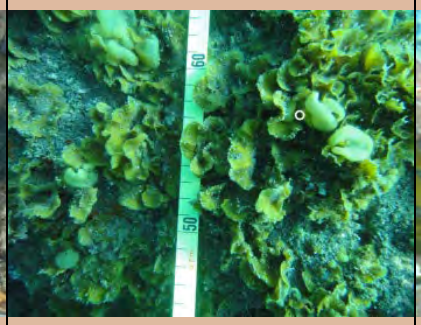
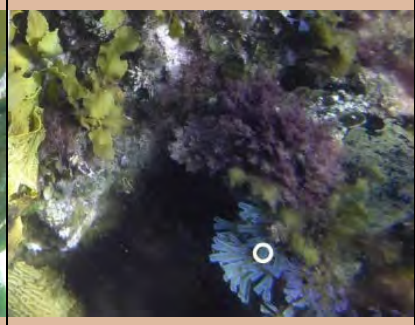


Filamentous brown algae_epiphyte



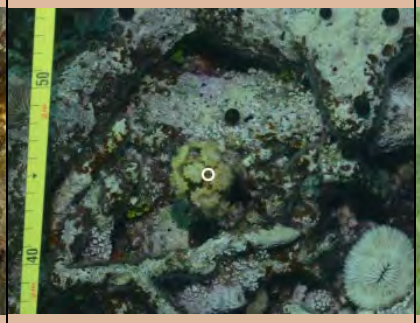
Filamentous brown algae_epiphyte

 *Filamentous brown algae_epiphyte*	**Filamentous algae**	 *Filamentous green algae_epiphyte*	 *Filamentous green algae_epiphyte*
Filamentous algae	 *Filamentous red algae_epiphyte*	 *Filamentous red algae_epiphyte*	 *Filamentous red algae_epiphyte*
Medium foliose green algae	 *Caulerpa*	 *Caulerpa*	 *Caulerpa*
 *Caulerpa*	 *Caulerpa*	 *Caulerpa*	 *Caulerpa*
 *Caulerpa*	 *Caulerpa*	 *Caulerpa*	 *Caulerpa*

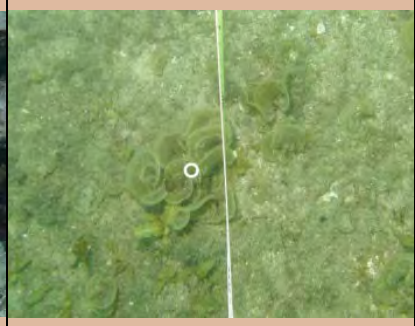
 *Caulerpa*	**Medium foliose green algae**	 *Green calcified algae Halimeda*	 *Green calcified algae Halimeda*
 *Green calcified algae Halimeda*	 *Green calcified algae Halimeda*	**Medium foliose green algae**	 *Medium foliose green algae*
 *Medium foliose green algae*	 *Medium foliose green algae*	 *Medium foliose green algae*	**Medium foliose brown algae**
 *Medium foliose brown algae*	 *Medium foliose brown algae*	 *Medium foliose brown algae*	 *Medium foliose brown algae*
 *Medium foliose brown algae*	 *Medium foliose brown algae*	 *Medium foliose brown algae*	 *Medium foliose brown algae*

Medium foliose brown algae

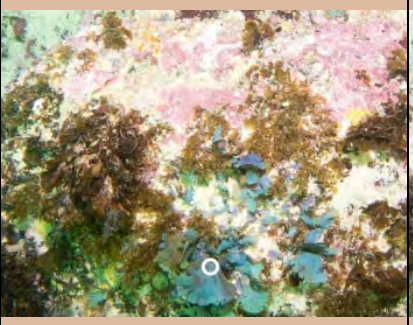
Medium foliose brown algae



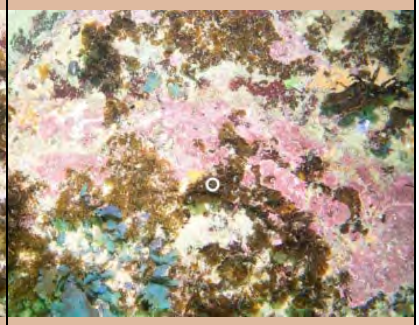
Medium foliose brown algae



Medium foliose brown algae



Medium foliose brown algae



Medium foliose brown algae

Medium foliose red algae

Medium foliose red algae

Medium foliose red algae

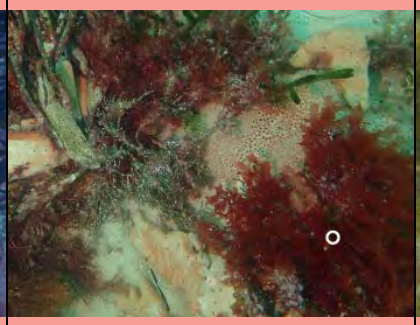
Medium foliose red algae

Medium foliose red algae

Medium foliose red algae

Medium foliose red algae

Medium foliose red algae



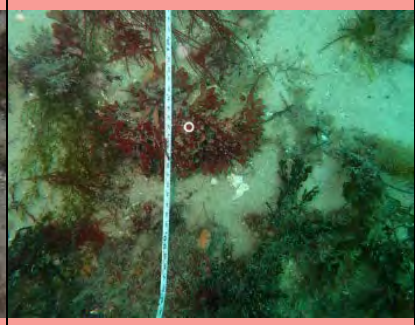
Medium foliose red algae

Medium foliose red algae

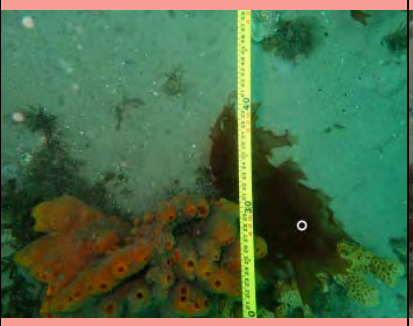
Medium foliose red algae

Medium foliose red algae

Medium foliose red algae



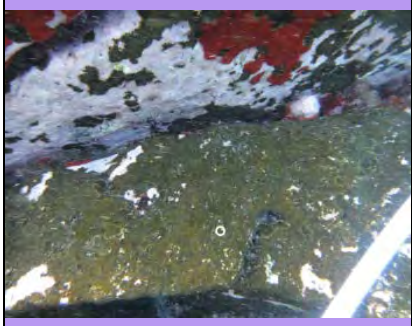
Medium foliose red algae



Medium foliose red algae

Medium foliose red algae

Encrusting leathery algae



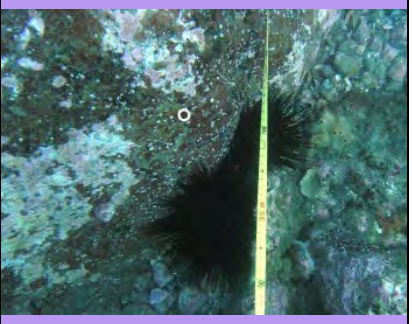
Encrusting leathery algae

Encrusting leathery algae

Encrusting leathery algae

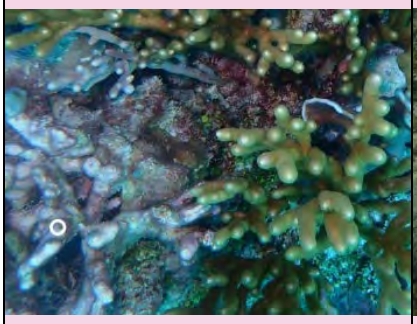
Encrusting leathery algae

Encrusting leathery algae

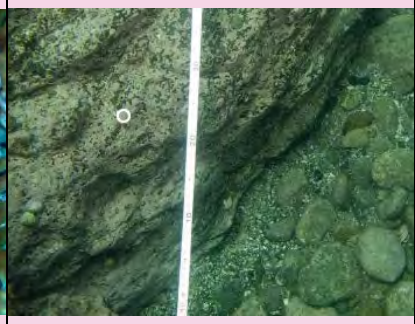


Encrusting leathery algae

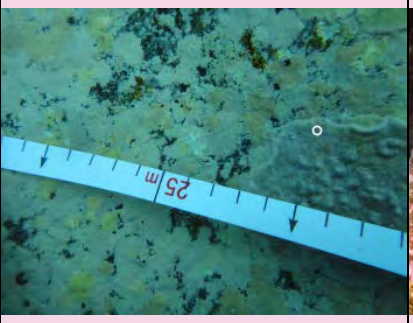
Crustose coralline algae



Crustose coralline algae



Crustose coralline algae



Crustose coralline algae

Crustose coralline algae

Crustose coralline algae

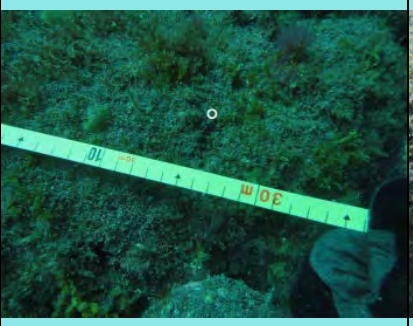
Crustose coralline algae

Crustose coralline algae

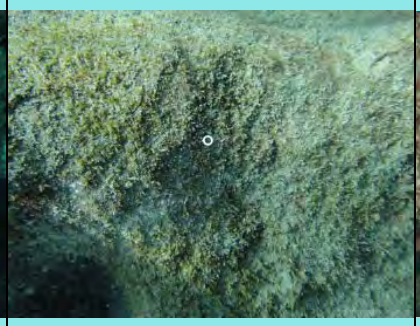
Crustose coralline algae

Turfing algae

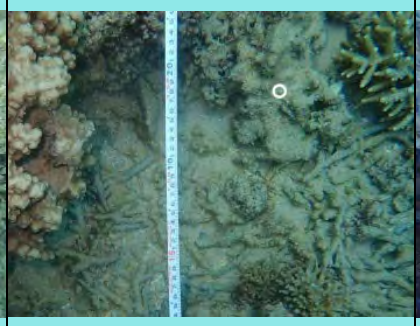
Turfing algae



Turfing algae



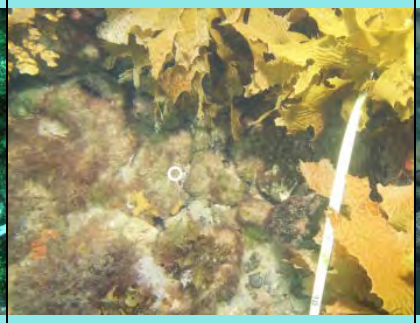
Turfing algae



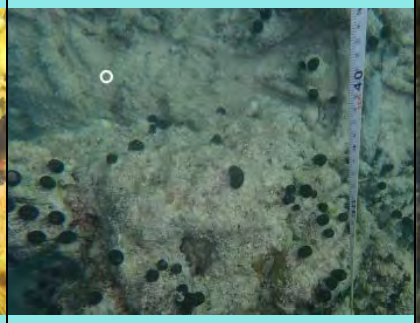
Turfing algae

Turfing algae

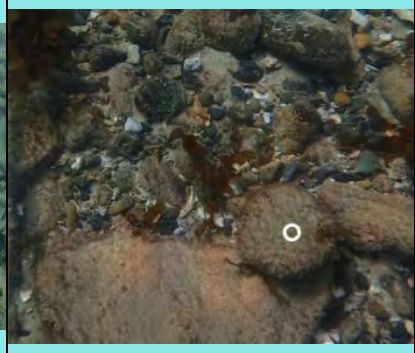
Turfing algae



Turfing algae



Turfing algae



Turfing algae

Turfing foliose algae

Foliose turfing algae

Foliose turfing algae

Geniculate coralline algae

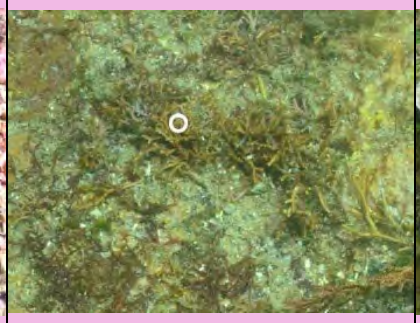
Geniculate coralline algae

Geniculate coralline algae

Geniculate coralline algae

Geniculate coralline algae

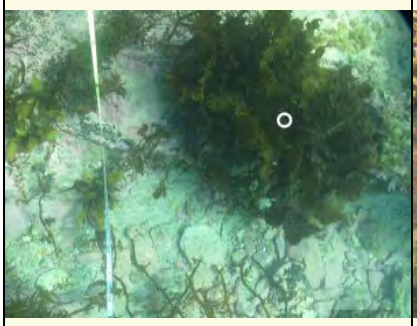
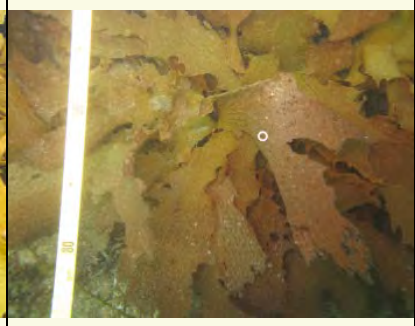
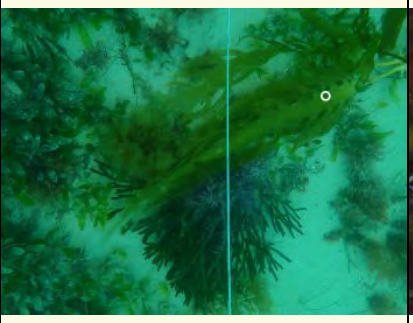
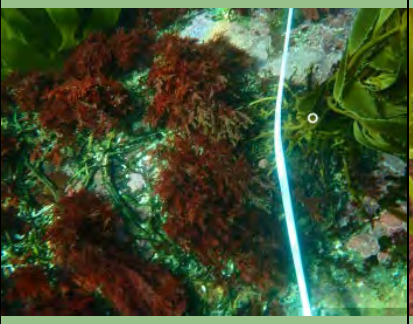
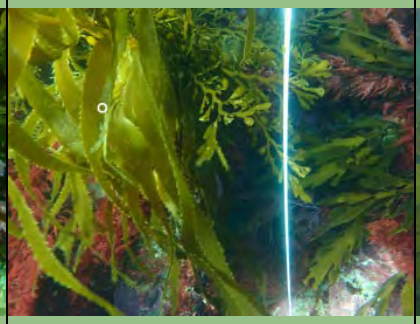
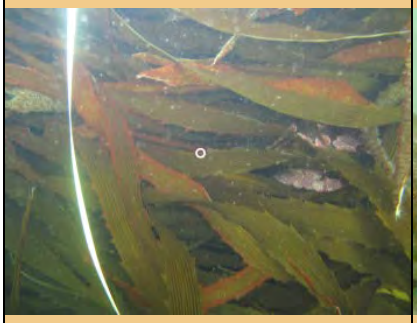
Geniculate coralline algae

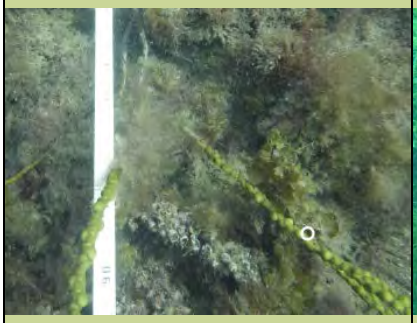
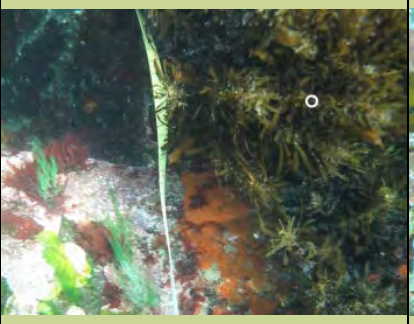
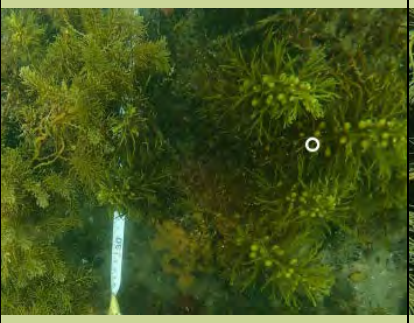
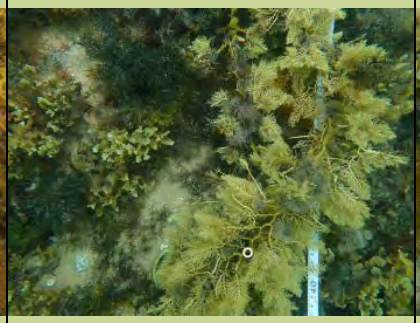
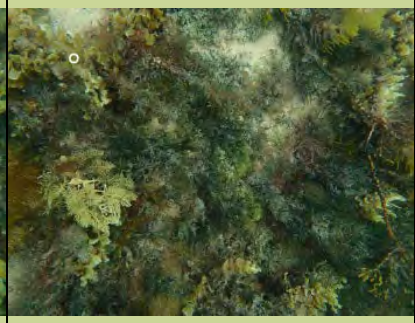


Geniculate coralline algae

Geniculate coralline algae

Geniculate coralline algae

Canopy forming algae	 *Ecklonia radiata*	 *Ecklonia radiata*	 *Ecklonia radiata*
 *Ecklonia radiata*	 *Ecklonia radiata*	**Canopy forming algae**	 *Macrocystis*
 *Macrocystis*	 *Macrocystis*	 *Macrocystis*	 *Macrocystis*
Canopy forming algae	 *Large brown laminarian kelps*	 *Large brown laminarian kelps*	**Canopy forming algae**
 *Phyllospora*	 *Phyllospora*	 *Phyllospora*	 *Phyllospora*

 *Phyllospora*	**Canopy forming algae**	 *Durvillaea*	 *Durvillaea*
 *Durvillaea*	**Canopy forming algae**	 *Other fucoids*	 *Other fucoids*
 *Other fucoids*	 *Other fucoids*	 *Other fucoids*	 *Other fucoids*
 *Other fucoids*	 *Other fucoids*	 *Other fucoids*	 *Other fucoids*
 *Other fucoids*	 *Other fucoids*	 *Other fucoids*	 *Other fucoids*

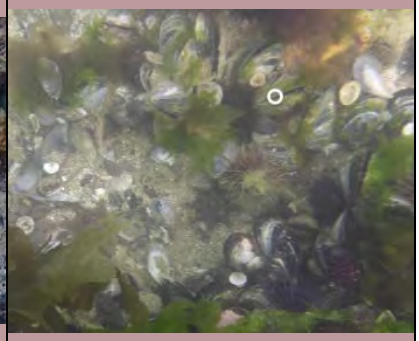
Other fucoids

Molluscs

Sessile bivalves

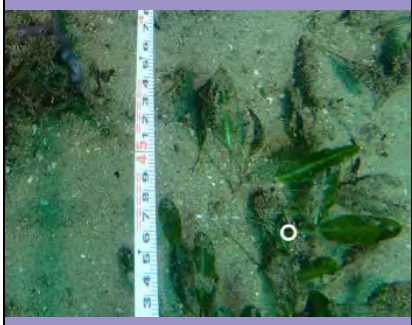
Sessile bivalves

Sessile bivalves

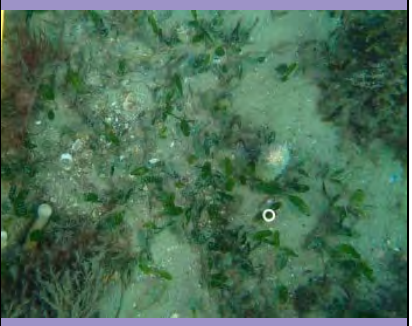


Sessile bivalves

Seagrasses

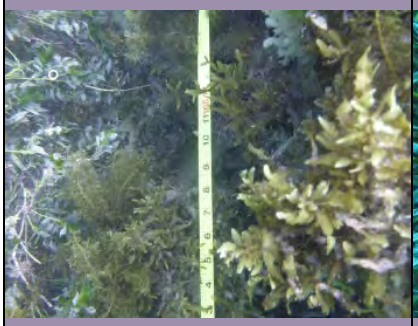


Seagrass Halophila

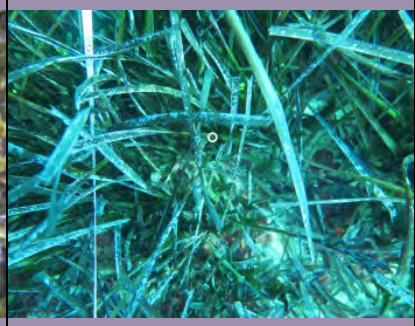


Seagrass Halophila

Seagrasses

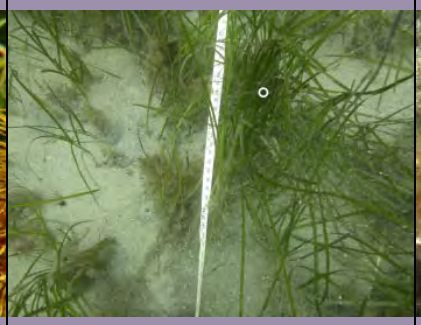


Seagrass straplike

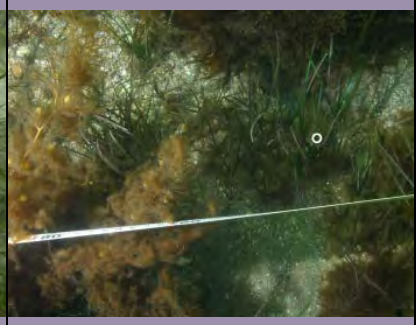


Seagrass straplike

Seagrass straplike

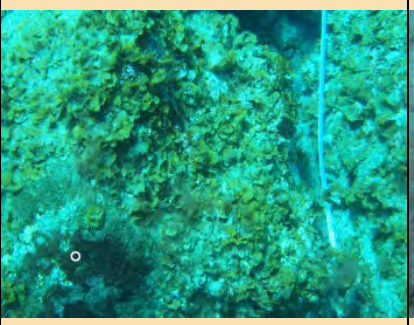


Seagrass straplike

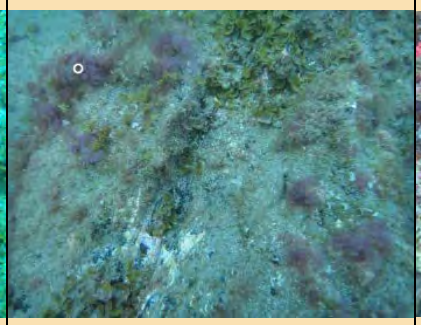


Seagrass straplike

Cyanobacteria

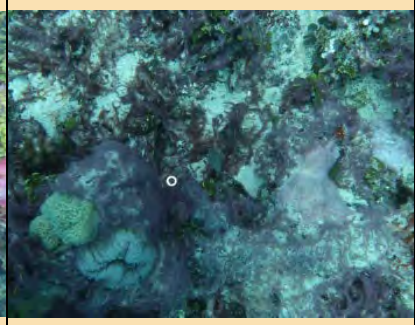


Slime not trapping sediment



Slime not trapping sediment

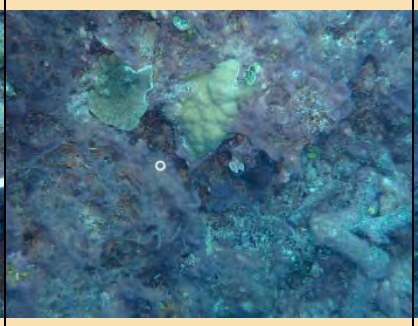
Slime not trapping sediment



Slime not trapping sediment

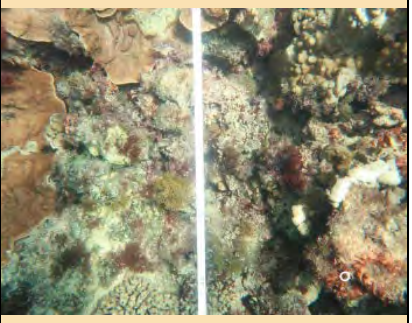
Slime not trapping sediment

Slime not trapping sediment



Slime not trapping sediment

Slime not trapping sediment

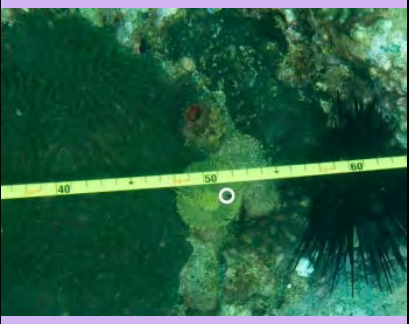


Slime not trapping sediment

Worms

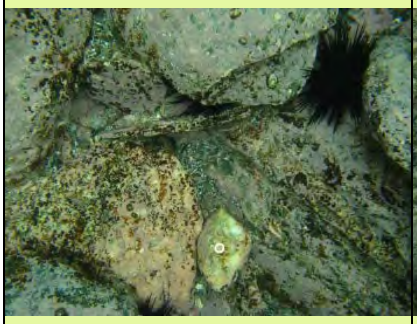
Polychaete

Polychaete

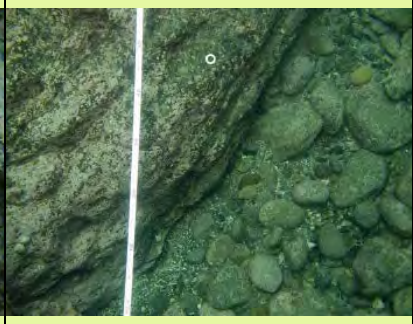


Polychaete

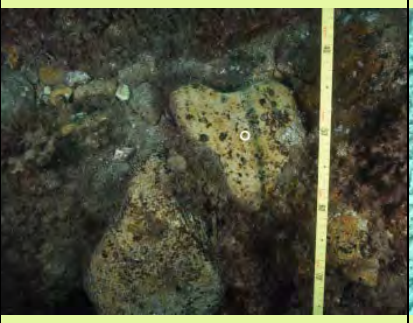
Substrate



Bare Rock



Bare Rock



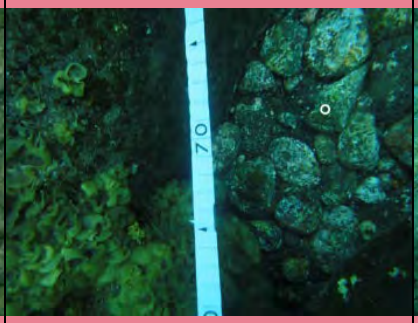
Bare Rock

Bare Rock

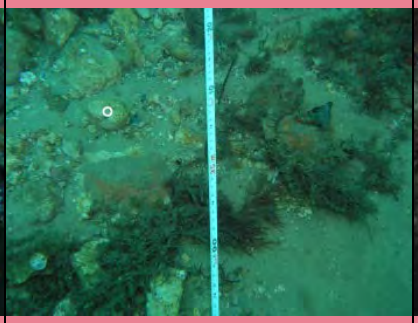
Bare Rock

Substrate

Cobble

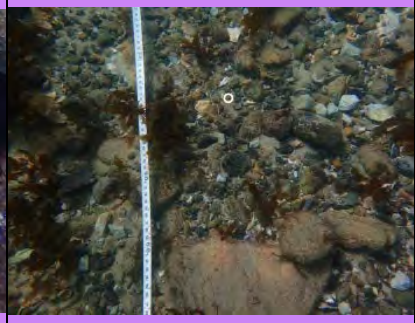
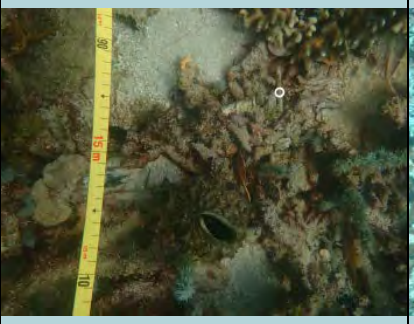
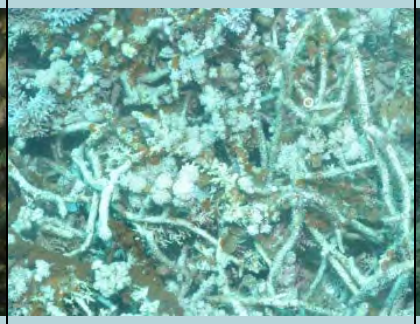
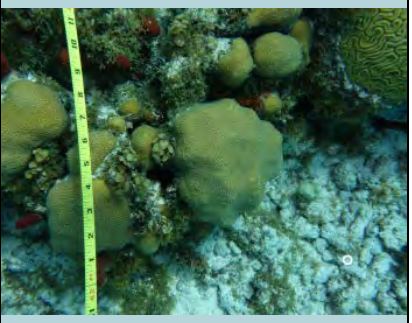


Cobble



Cobble

Cobble

Substrate			
	Pebbles or gravel or shell	*Pebbles or gravel or shell*	*Pebbles or gravel or shell*
Substrate			**Substrate**
	Coral rubble	*Coral rubble*	
			
Coral rubble with turf or encrusting algae	*Coral rubble with turf or encrusting algae*	*Coral rubble with turf or encrusting algae*	*Coral rubble with turf or encrusting algae*
	**Substrate**		
Coral rubble with turf or encrusting algae		*Sand*	

Appendix 2. Classification resources

In addition to the exemplar images in Squidle+ , the RLS Catalogue document, and the CATAMI catalogue the following resources are available.

Temperate and tropical reefs:

- Online taxonomic resources for macroalgae can be useful for familiarisation with the taxonomically based labels such as "fucoids", "laminarian kelps" and the green algae "caulerpa":
    - If working on Australian photos, " Algae revealed" http://www.flora.sa.gov.au/algae_revealed/index.shtml has useful links to some genera "at a glance" that could be useful to learn about the appearance of large brown algae, such as fucoid algae (one of the RLS Catalogue labels), eg. *Sargassum* spp. and *Cystophora* spp.
    - Algaebase: This is a global algal database of taxonomic, nomenclatural and distributional information. There is often a picture or drawing of each algae, and if you click on "detailed distribution" then it shows which countries the algae is found in. https://www.algaebase.org/
    - British Columbia macroalgae https://ibis.geog.ubc.ca/biodiversity/eflora/algae.html which provides a nice initial overview and examples of BC genera of Fucoids (eg. *Fucus* spp., *Sargassum* spp.)
    - Florabase has detailed descriptions for many endemic Western Australian algal species
- https://seanet.stanford.edu/kelp-forests has a good overview with images of algae and benthic invertebrates focussed on kelp forests off California

Tropical (coral) reefs:

- Corals of the world website. This site provides some information on coral growth forms and features for identification, as well as species pages, and taxonomic group overview
- Corals and sponges of Caribbean: https://coralpedia.bio.warwick.ac.uk/ . Even if you are scoring photos from outside the Caribbean, these nice images are organized by taxonomic group and shape, and can help you distinguish between sponges, hard or stony corals (scleractinians), and other types of cnidarians (anemones, gorgonians, zoanthids, etc).
- Caribbean octocorals/gorgonians: https://cnso.nova.edu/ncri/sofla_octocoral_guide/species_genus.html
- Caribbean coral reef inverts and algae (can also help with Pacific reef PQs too, especially in determining if algae are brown, green, or red: https://reefguide.org/carib/
- ID guide for Indo-Pacific coral reefs: http://myreefguide.com/page1/invertebrate-echinoderm-mollusc-crustacea-coral-marine-filepage1-full.html
- Algae guide for ETP reefs: https://biogeodb.stri.si.edu/pacificalgae/
- Corals of Panama: https://stricollections.org/portal/checklists/checklist.php?clid=82&pid=17

Appendix 3. RLS Catalogue label descriptions

Download link: PQ_RLS-Catalogue-scheme_2022.pdf - Google Drive

Brown Algae

Durvillaea potatorum

Class: Phaeophyceae

Order: Fucales

Family: Durvillaeaceae

Macrocystis pyrifera

Class: Phaeophyceae

Order: Laminariales

Family: Laminariaceae

Notes: Giant kelp forms iconic 'kelp forests'.

Fronds grows directly from float

Ecklonia radiata

Class: Phaeophyceae

Order: Laminariales

Family: Lessoniaceae

Phyllospora comosa

Class: Phaeophyceae

Order: Fucales

Family: Seirococcaceae

Large brown laminarian kelps (other)

Examples:

- *Undaria pinnatifida* (introduced kelp, edible "wakame"
- *Lessonia corrugata* (long straps, no floats, southern species)

Undaria pinnatifida *

Undaria pinnatifida

Lessonia corrugata

Fucoids (other)

Examples:

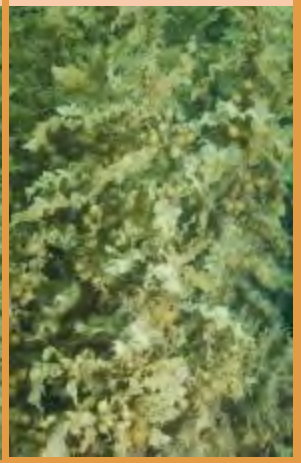
- *Seirococcus spp.*
- *Cystophora* spp. (usually zig-zag axis)
- *Sargassum* spp. (usually distinctive basal fronds)
- *Caulocystis* spp. (floats attached directly to axis)
- *Xiphophora* spp.
- *Acrocarpia* spp.
- *Carpoglossum confluens*

Carpoglossum confluens

Seirococcus axillaris

Saragassum verruculosum

Saragassum fallax



Cystophora monilifera

Cystophora moniliformis

Scaberia agardii

Caulocystis cephalornithos

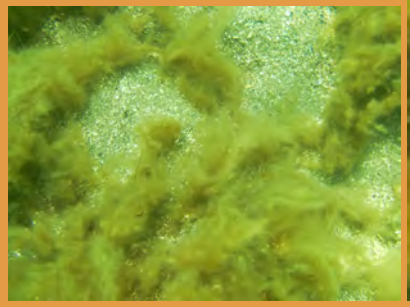
Xiphophora chondrophylla

Acrocarpia paniculata

Filamentous brown algae_epiphytic

Medium– to large sized strands or clumps of filamentous algae growing loosely over the substrate, plants or invertebrates .

No obvious structure, i.e. not branching, laminate or globular in growth form



Medium foliose brown algae

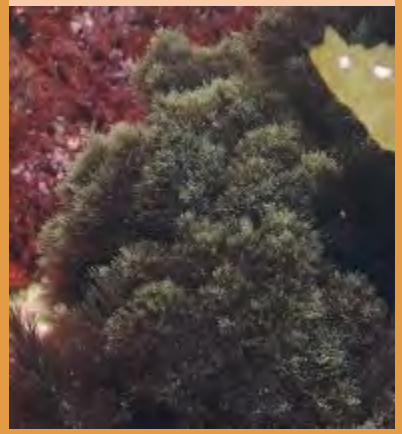
Examples:

- *Zonaria* spp.
- *Halopteris* spp.
- Dictyotales spp.

Zonaria turneriana/angustata

Dictyopteris muelleri

Halopteris paniculata



Carpomitra costata

Lobophora variegata

Perithalia caudata

Green Algae

***Caulerpa* spp.**

Caulerpa obscura

Caulerpa geminata

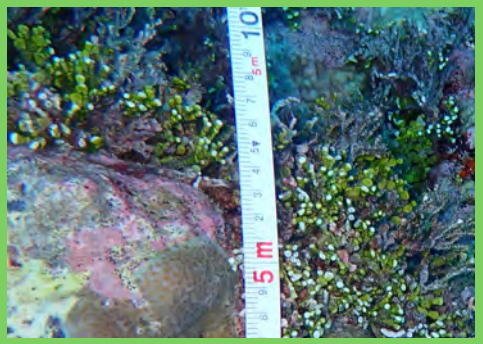
Caulerpa flexilis

C. remotifolia

Caulerpa trifaria

Caulerpa longifolia

Green calcified algae (Halimeda)



Medium foliose green algae

Examples:

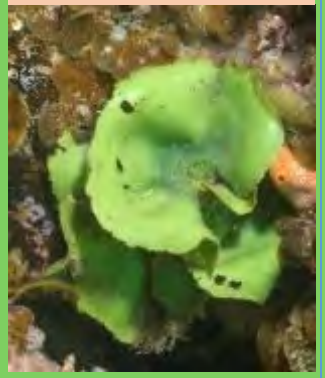
- *Ulva* spp.
- *Chaetomorpha* spp.
- *Codium* spp.
- *Dicyospheria* spp.
- *Bryopsis* spp.

Chaetomorpha

Ulva australis

Codium duthieae

Dictyosphaeria sericea



Filamentous green algae_epiphytic

Medium– to large sized strands or clumps of filamentous algae growing loosely over the substrate, plants or invertebrates . No obvious structure, i.e. not branching, laminate or globular in growth

Red Algae

Medium foliose red algae

Highly diverse and variable . Examples:

Plocamium spp., *Phacelocarpos* spp.

Pollexfenia lobata, flat bladed red algae,

Callophyllis spp. etc.

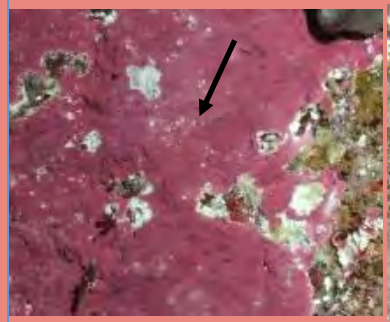
Geniculate coralline algae

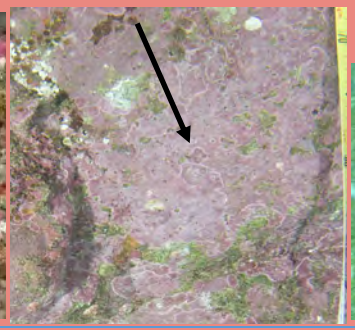
Calcareous articulated/branching algae,

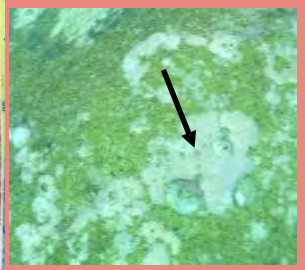
light pink in colour

Crustose coralline algae

Calcareous encrusting red algae. Sometimes appears white or yellow when dead/diseased. Often white edges, sometimes peeling back from the substrates. Includes several species.

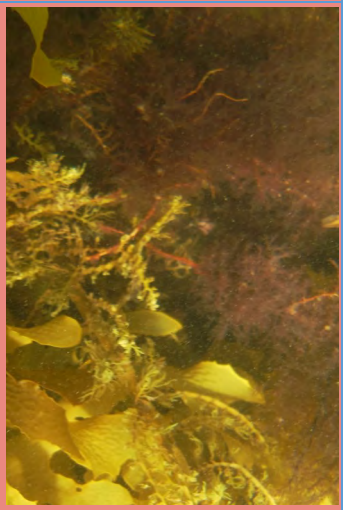






Filamentous red algae_epiphyte

Medium– to large sized strands or clumps of filamentous algae growing loosely over the substrate, plants or invertebrates . Sometimes yellowish in colour



Algae (other)

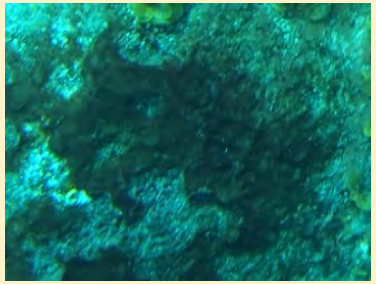
Turfing algae (<2 cm high algal/sediment mat on rock)

Most common algal covering on hard substrate.

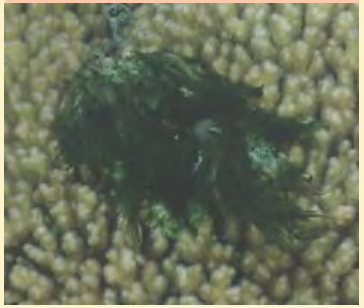
Short (<2cm) tufting filamentous algae covering bedrock or coral, trapping sediment and/or other biogenic matter into a matrix.

Slime (not trapping sediment)

Thin matted mass of slimey algae/cyanobacteria, with **no sediment** in it then it is considered "Slime" (usually covers dead coral)



Cyanobacteria example



Cyanobacteria example

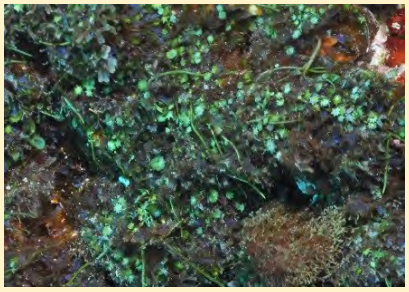
Cyanobacteria example

Small <2cm algal cover (not trapping sediment)

May be indistinguishable mix of species

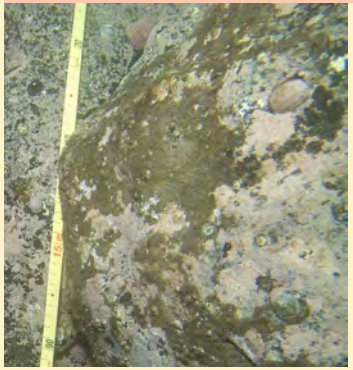
or turf forming but not forming matrix eg.

Dense low cover of *Dictyota* spp.

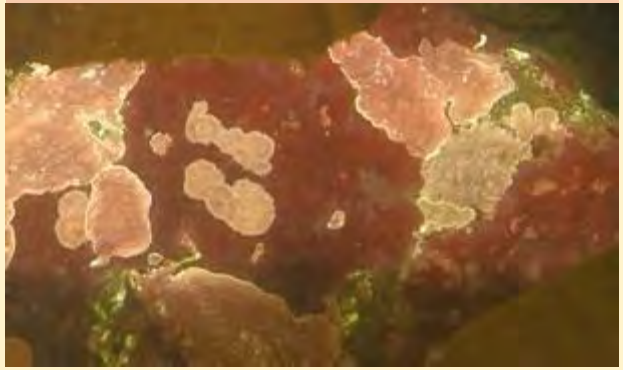


Encrusting leathery algae

Brown encrusting algae



Peyssonnelia spp. (red or orange)

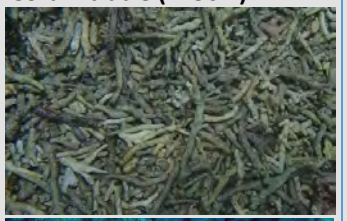
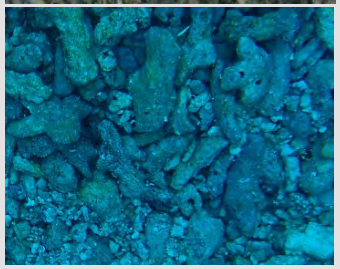


Other NB: Refer to CATAMI categories for more examples: https://github.com/catami/classification

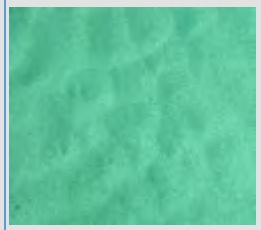
Substrate:

Bare Rock (includes boulders >255mm and unbroken unfouled dead coral structures)


Coral Rubble (<25cm)

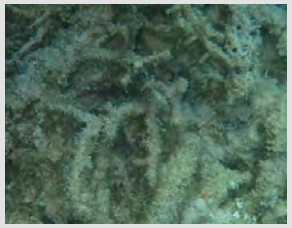
Sand (<2mm)



Pebbles/gravel/shell (2-64mm)

Cobble (65-255mm)

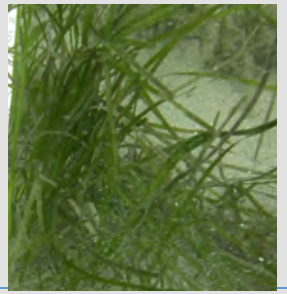
Coral Rubble with turf/encrusting algae




Seagrass:

Halophila spp.

Straplike:

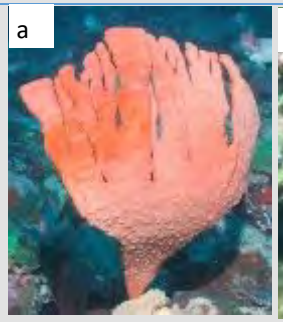
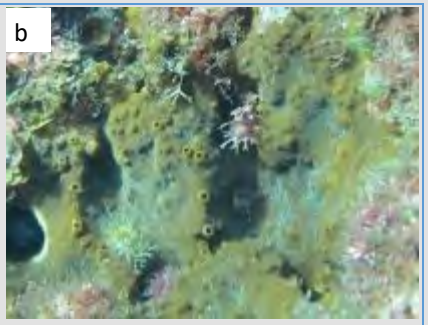



Sponges:

Erect (a)

Eg. palmate, finger

Encrusting (b)

Hollow (c)

Eg. barrel,

cup, tubes

Massive (d)


Bryozoans:

Hard:



Soft:


Molluscs: Sessile bivalves

Examples:

mussels, oysters, clams




Molluscs: Sessile Gastropods (Eg: Worm shells/ Vermetidae)

Serpulorbis sipho

Crustacea:

Barnacles


Worms:

Polychaetes

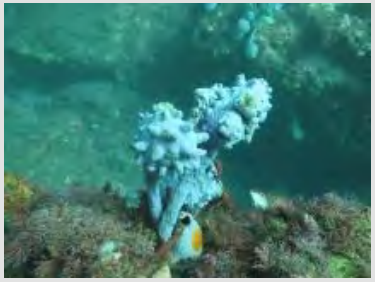
Diopatra dentata

Sabellid worm

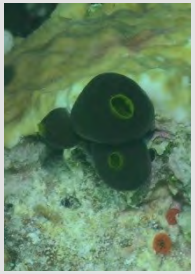
Filograna implexa

Serpulid worm

Ascidians: (stalked)



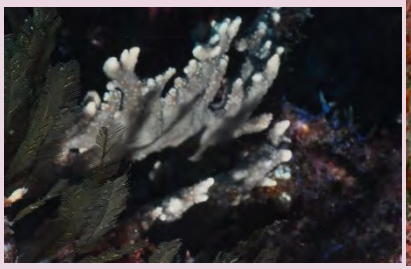
Ascidians: (unstalked)



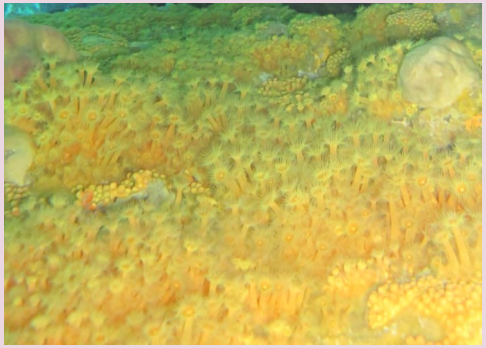
Cnidaria

Hydrocorals

Family Stylasteridae. Sometimes called false coarls as they look like some reef building corals from the Class Anthozoa but have a different polyp structure and are actualy hydrozoans



Colonial Anemones, Zoanthids, Corallimorphs



Hydroids

Solitary anemones

Cnidaria: Corals: Black & Octacorals

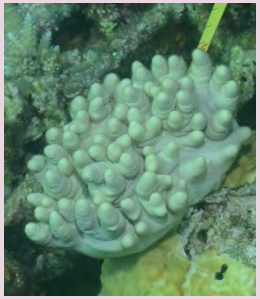
Softs corals and gorgonians

Includes gorgonian fans (eg. Mopsella sp.),

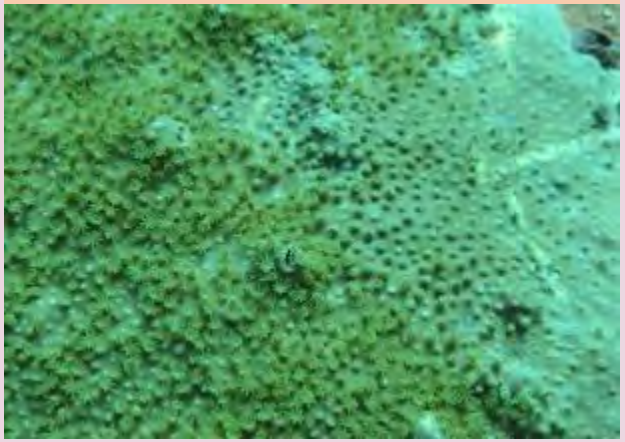
bamboo corals (Family: Isididae), sea whips, sea pens, black corals,

and all soft corals excepting Organ-pipe coral and Blue coral,

which have their own categories (see below)



***Erythropodium hicksoni* (an encrusting octacoral– common on temperate urchin barrens)**



"Bamboo coral"

Capnella goboensis

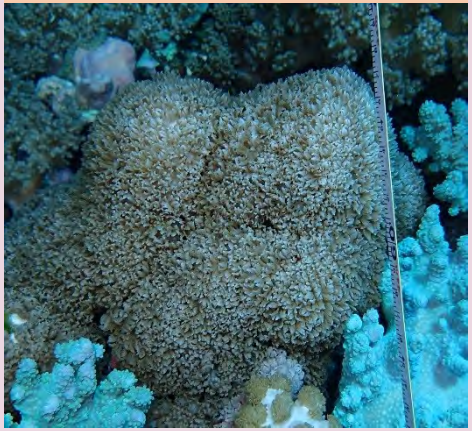
***Mopsella* spp.**

***Drifa* spp.**

Organ-pipe coral (Tubipora)

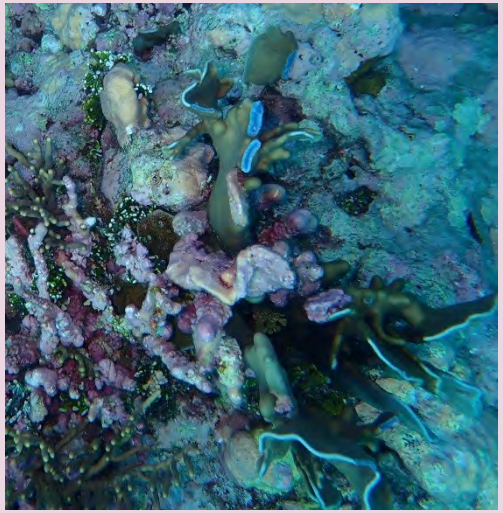
Tubipora musica

Tubipora musica



Heliopora coerulea (blue coral)

Foliose growth form, with blue internal skeleton (visible if broken)



Heliopora coerulea

Ahermatypic corals

Corals without zooxanthellae, often referred to as non-reef building corals . Eg. Tubastrea ("sun polyps")

Tubastrea

Culicia tenella (temperate species)

Hermatypic corals categories

Corals with symbiotic zooxanthellae. Most stony, reef building corals are included. This category is split into growth form categories (as with all categories here, please ensure you use the finest scale category and not the major group categories when assigning a label.

Acropora are a common and diverse genera of coral, and have their own recognised growth form categories. A defining feature of Acropora is a axial corallite from located at the branch tips (often giving them a pointy appearance) that differs form the other, radial corallites. Branching Pocillopora also has its own category. Pocillopora is usually branching, occasionally sub-massive, and has bumpy corallites and no axial corallite.

Corymbose Acropora corals
Bottlebrush Acropora corals
Tabular Acropora Coral
Branching Acropora
Branching Pocillopora
Branching corals
Encrusting corals
Foliose/plate corals
Digitate corals
Sub-massive corals
Columnar corals
Massive corals
Large-polyp stony corals (free-living)

Relevant "Tags":

Bleached
Dead (aka recently dead)

Bleached: Many hermatypic corals may appear bright white because, under stress eg. warming waters, they have lost the zooxanthellae that give them colour (as well as provide photosynthetic energy). These are considered bleached and must be labelled as so by assigning a "tag" (see RLS SQUIDLE+ instruction manual for details).

Dead: These corals are recently dead: they maintain their structure, and have not broken into coral rubble, over become completely overgrown, in the case of massive corals which become the basis of the reef structure. They may be lightly fouled in algal fuzz or slime, but with the main coral still persisting as the dominant feature.

Acropora Specific Growth forms

Branching Acropora

Common form of Acropora, also referred to as “staghorn” coral. Tree-like/arborescent with regular branching.

Corymbose Acropora

Irregular, dense branching ,appearing cushion-like. Forms complex habitat for juvenile reef fish and invertebrates.

Bottlebrush Acropora

Many small side branches to each main branch, resembling a bottlebrush

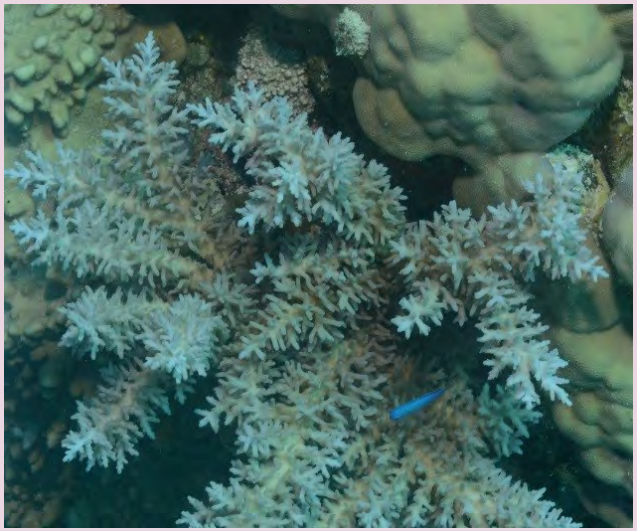
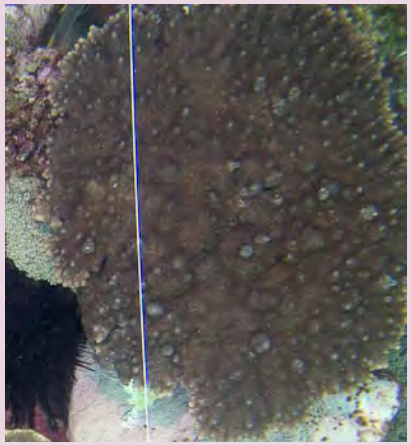
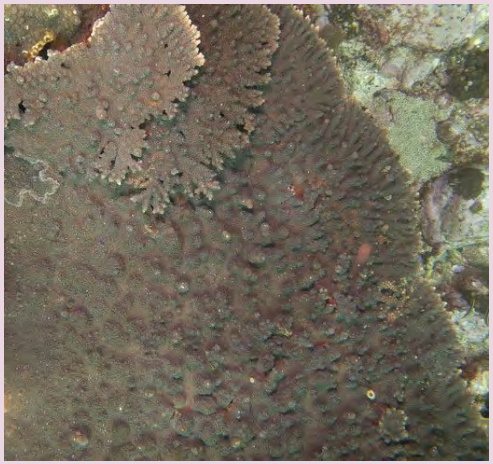


Table Acropora

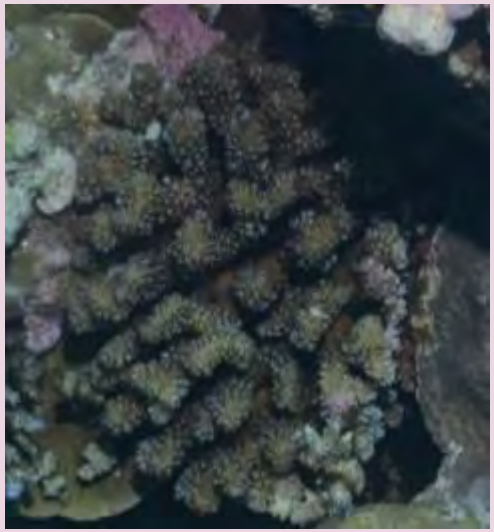
Acropora ranging from perforated plates, to branching in tabular form growing horizontally. May result from corymbose or digitate species growing horizontally into a table rather than vertically.





Branching Pocillopora

Pocillopora has characteristically bumpy corallites and no axial corallite



Branching Corals

Other than Acropora and Pocillopora

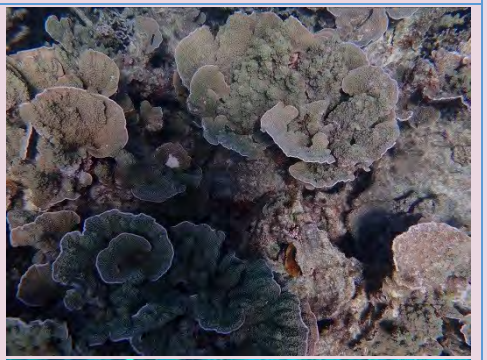
Digitate corals

Includes digitate Acropora growth forms.

Stumpy finger-like branches without side branches

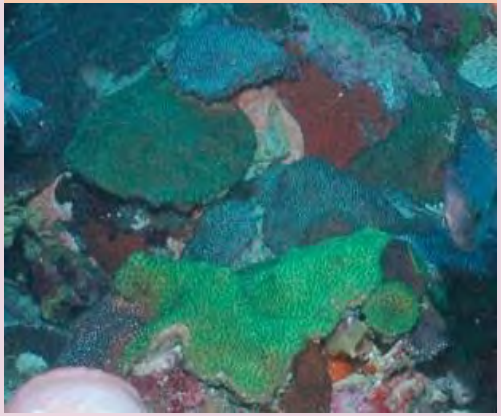
Foliose/Plate

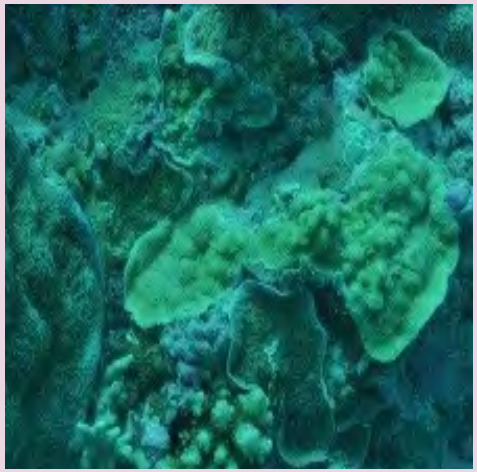
Laminar/plate coral that often have a wavy appearance



Encrusting corals

Plesiastrea versipora (temperate species)



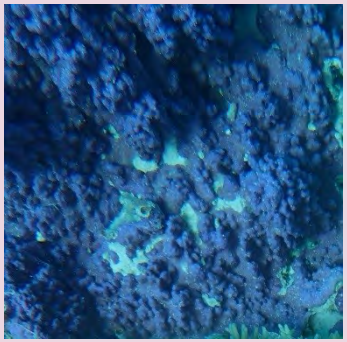


Massive corals

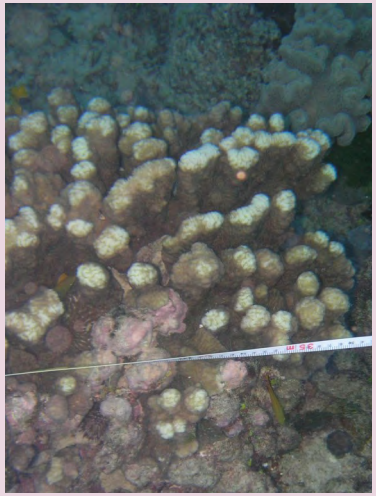
Also referred to as hemi-spherical corals

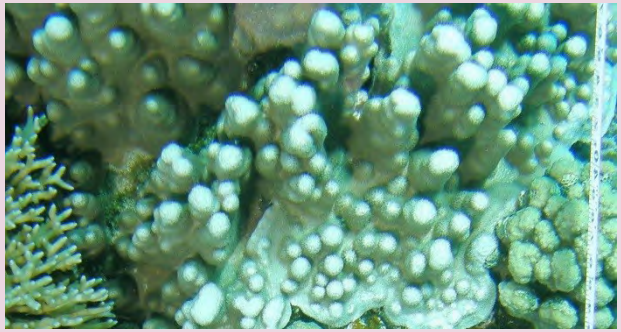
Submassive corals

Irregular shaped coral not fitting into a clear growth form



Columnar corals





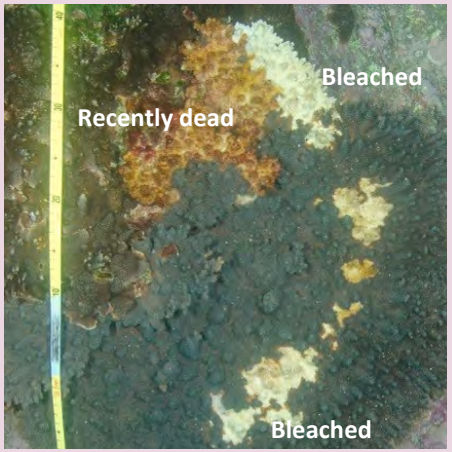
Large polyp stony corals (free-living)

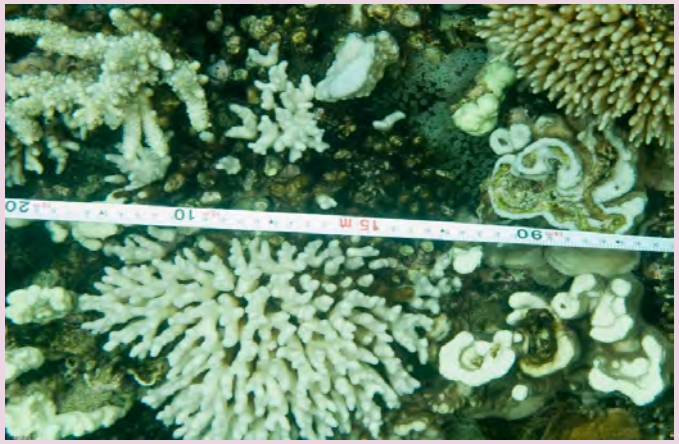
Free-living, non-attached corals, often referred to as mushroom corals. Often growing amongst coral rubble.

Tags : Bleached and Dead (Recently dead)

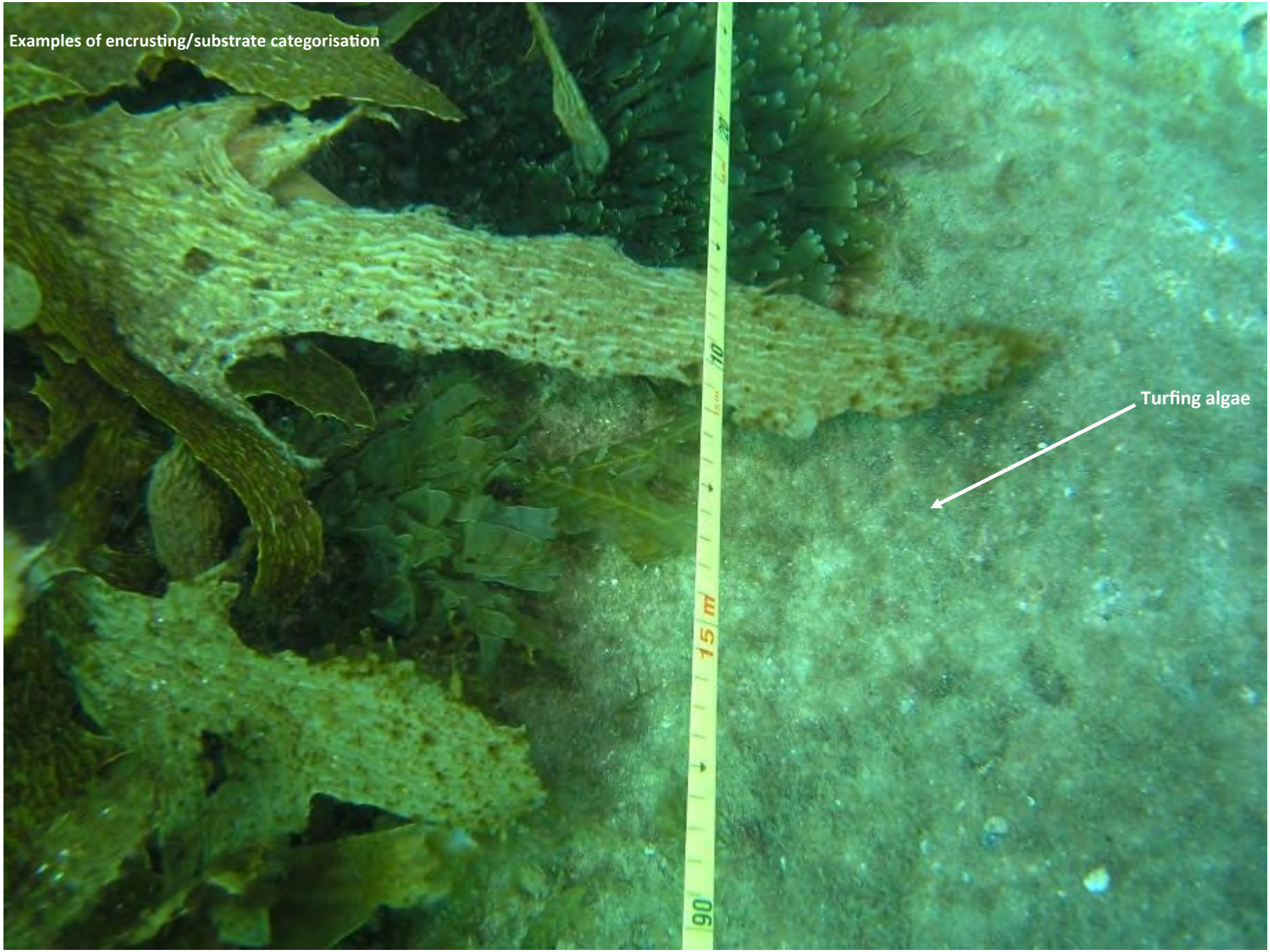
Bleached: Many hermatypic corals may appear bright white because, under stress eg. warming waters, they have lost the zooxanthellae that give them colour (as well as provide photo-synthetic energy). These are considered bleached and must be labelled as so by assigning a "tag" (see RLS SQUIDLE+ instruction manual for details).

Dead: These corals are recently dead: they maintain their structure, and have not broken into coral rubble, over become completely overgrown, in the case of massive corals which be-come the basis of the reef structure. They may be lightly fouled in algal fuzz or slime, but with the main coral still persisting as the dominant feature.

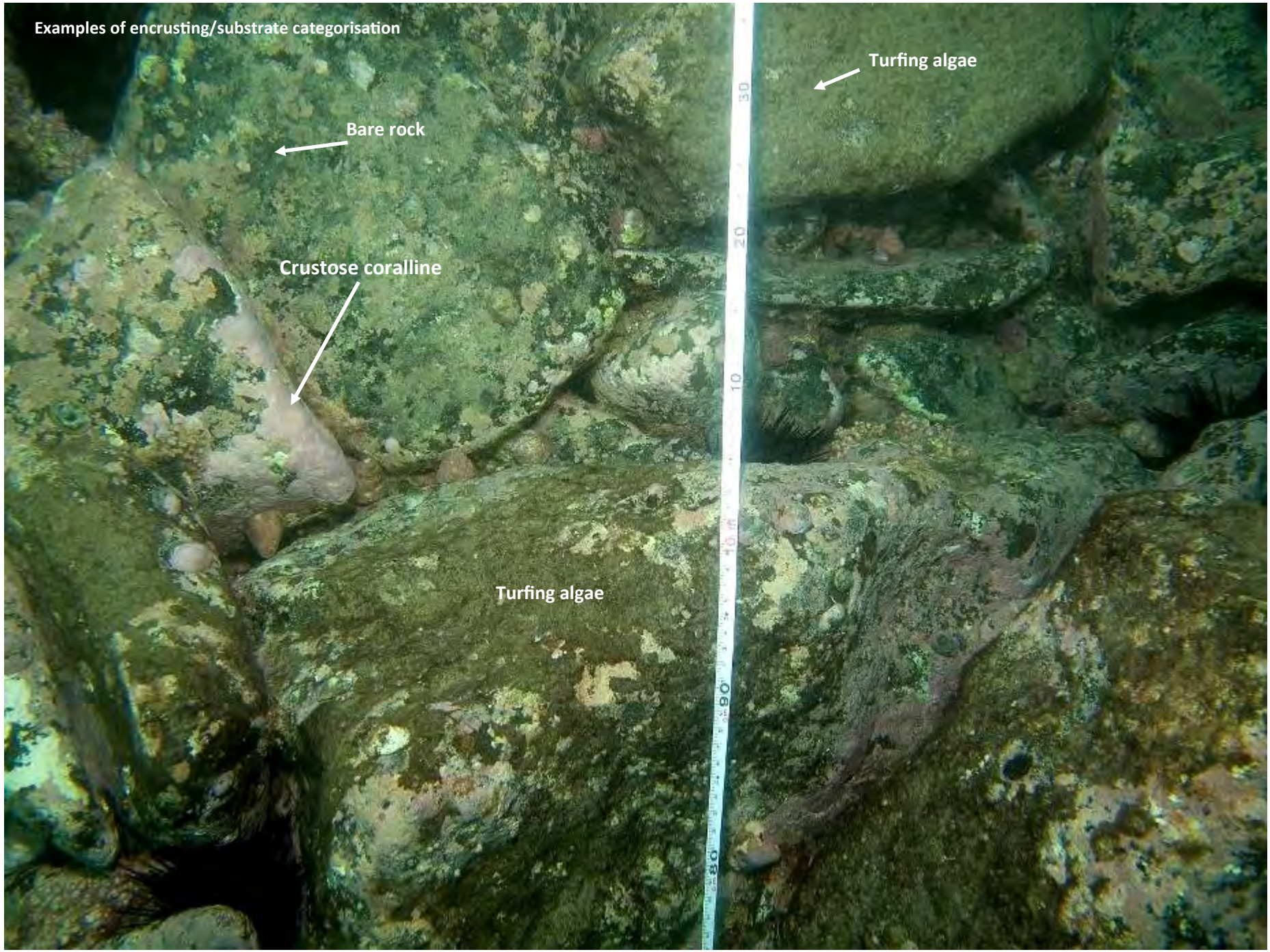




Photoquadrat examples of tricky categorisation (substrate and encrusting) :

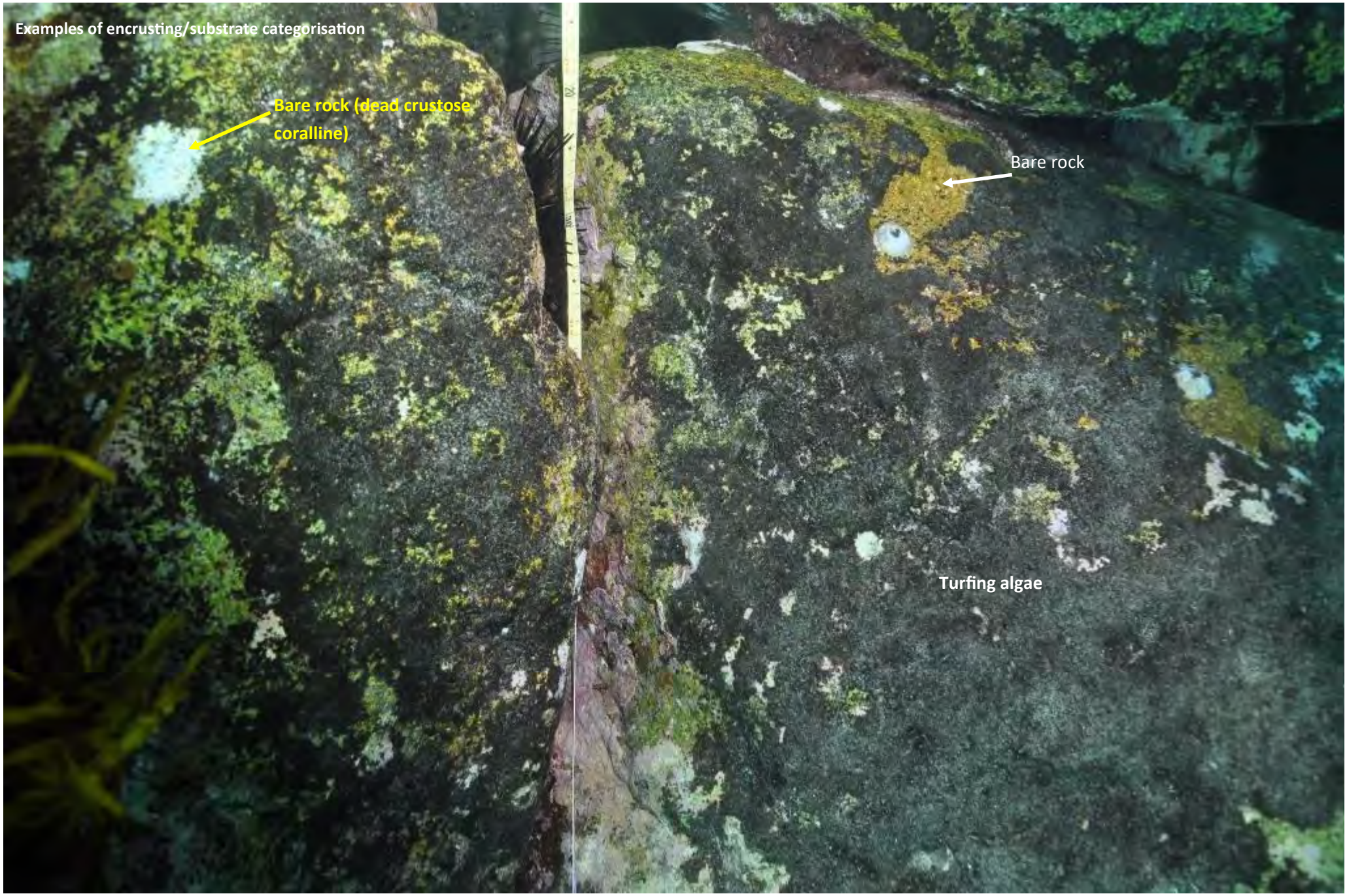

Examples of encrusting/substrate categorisation
Turfing algae

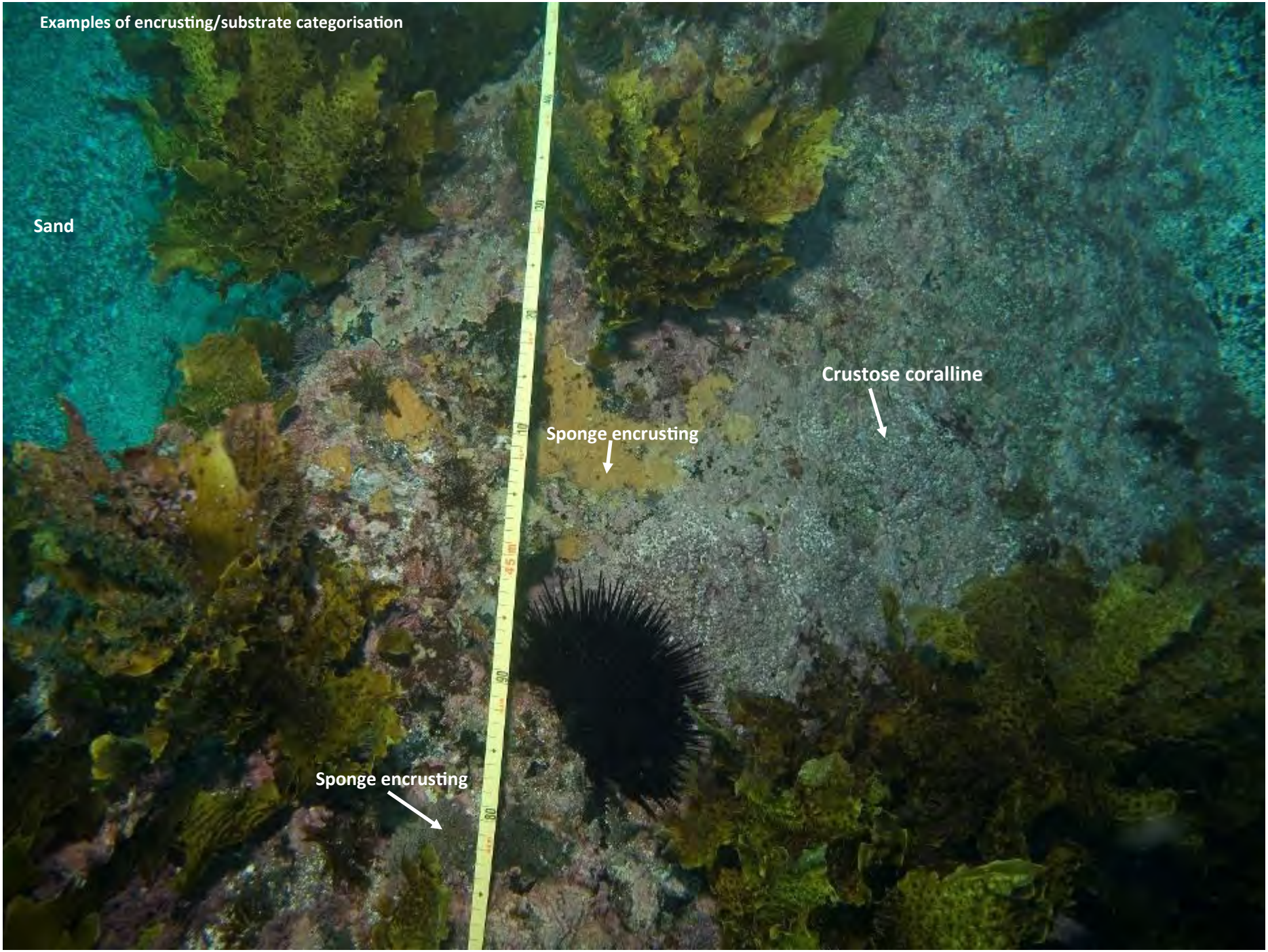

Examples of encrusting/substrate categorisation
Culicia (ahermatypic coral)
Crustose coralline

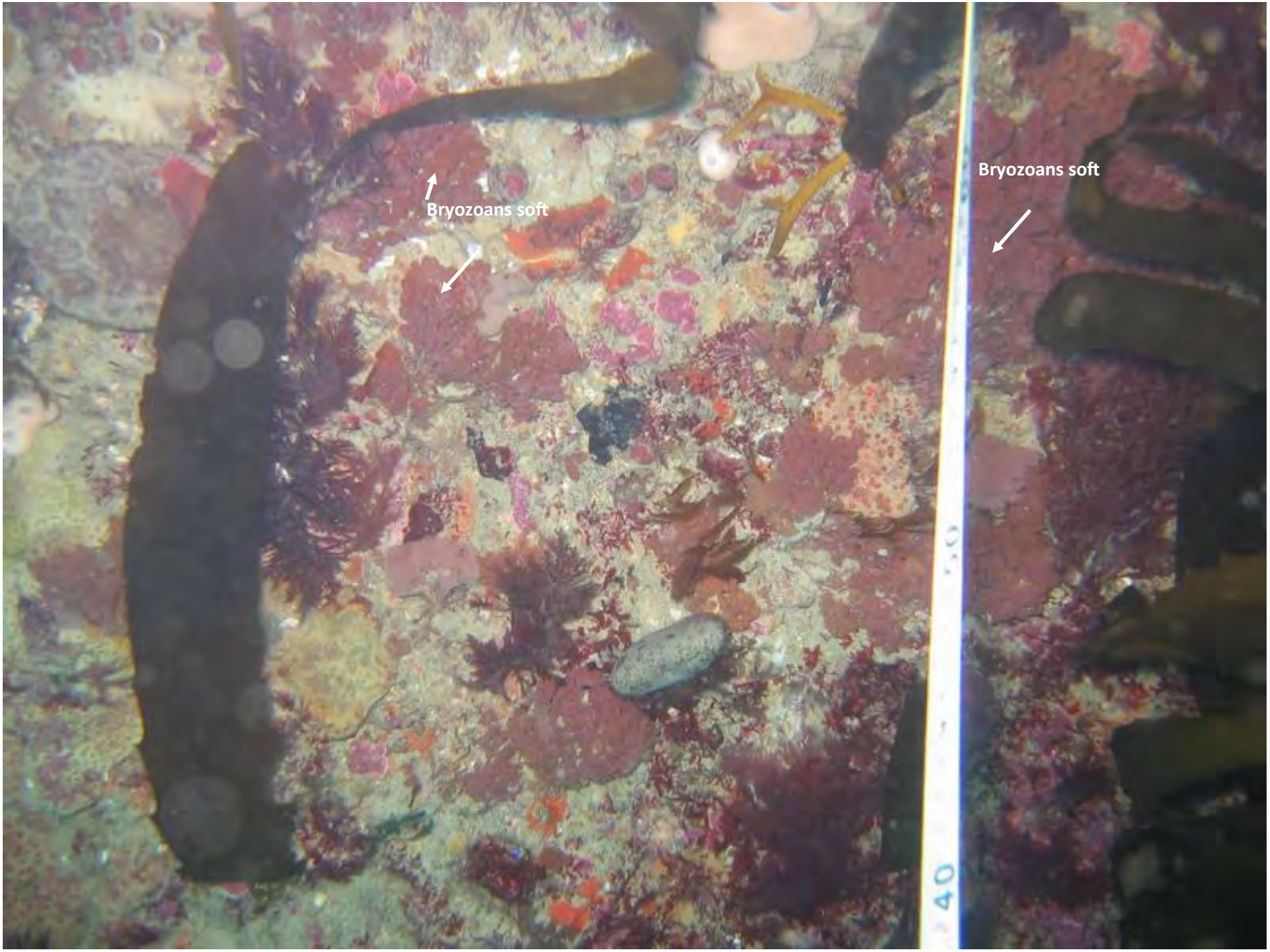

Examples of encrusting/substrate categorisation
Bare rock
Crustose coralline
Turfing algae
Turfing algae

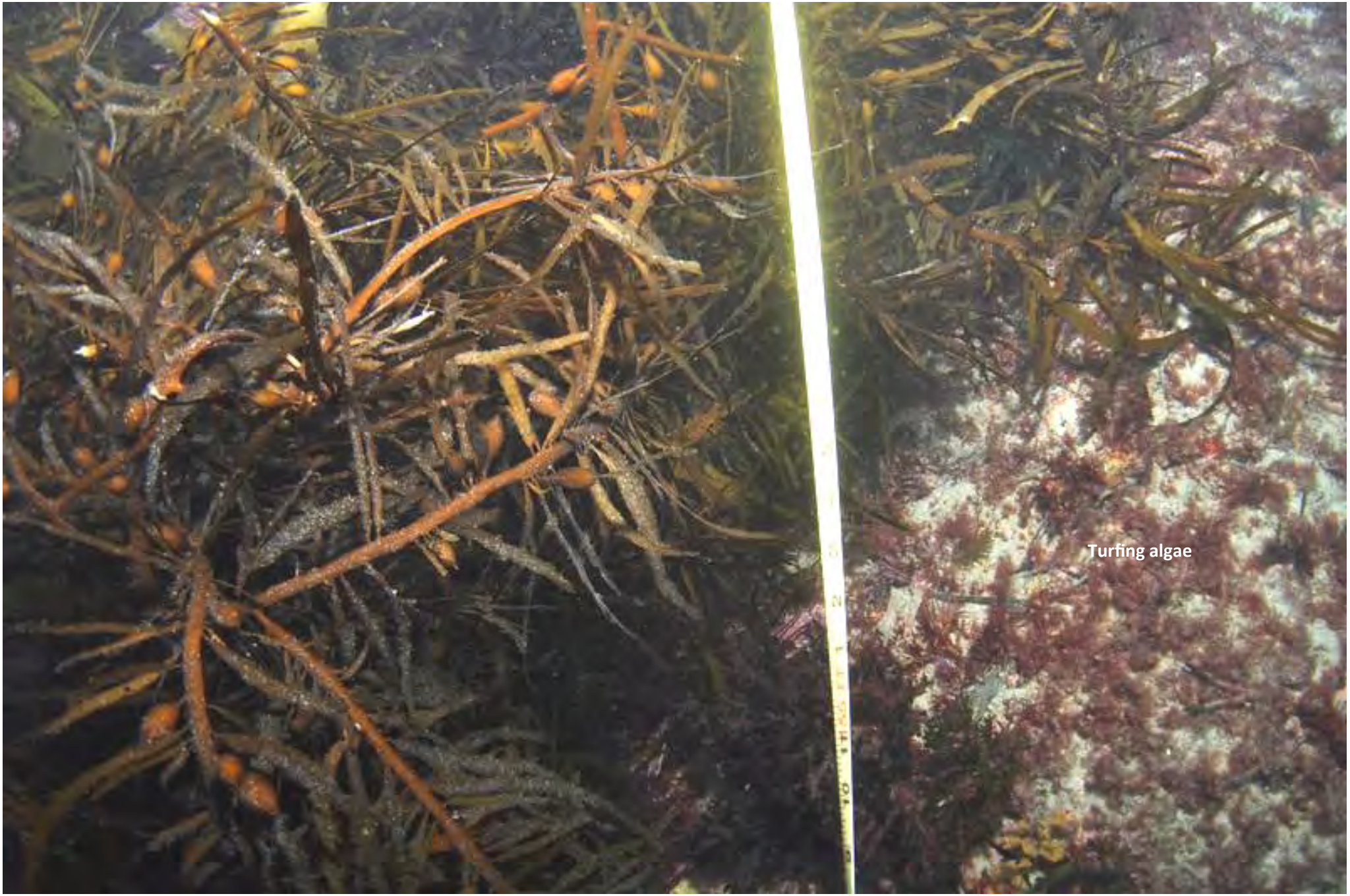

Examples of encrusting/substrate categorisation
Crustose coralline
Sponge encrusting
Turfing algae

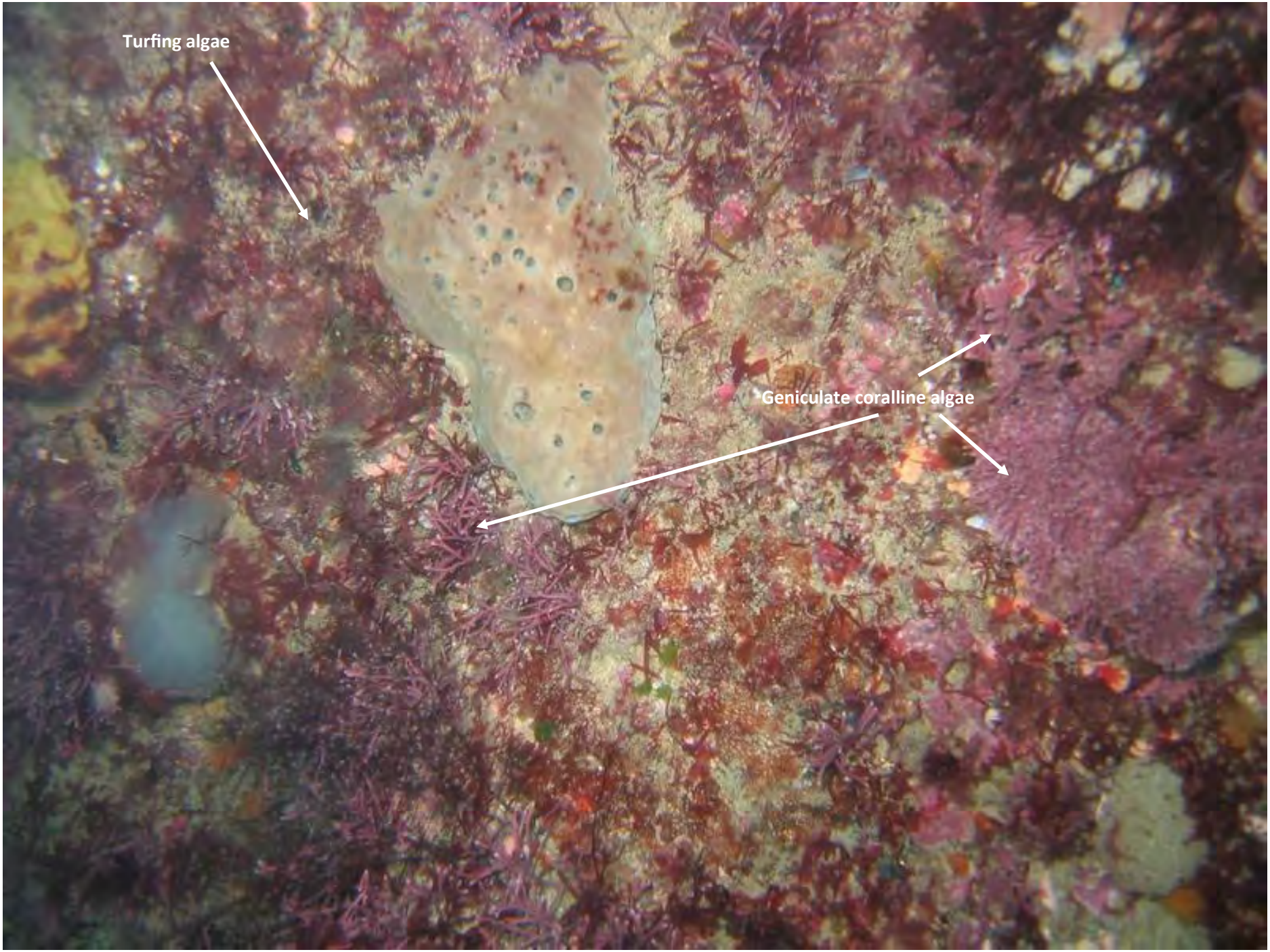

Examples of encrusting/substrate categorisation
Turfing algae
Erythropodium hicksoni
(encrusting octacoral)
Hydroid
Sponge massive
Turfing algae

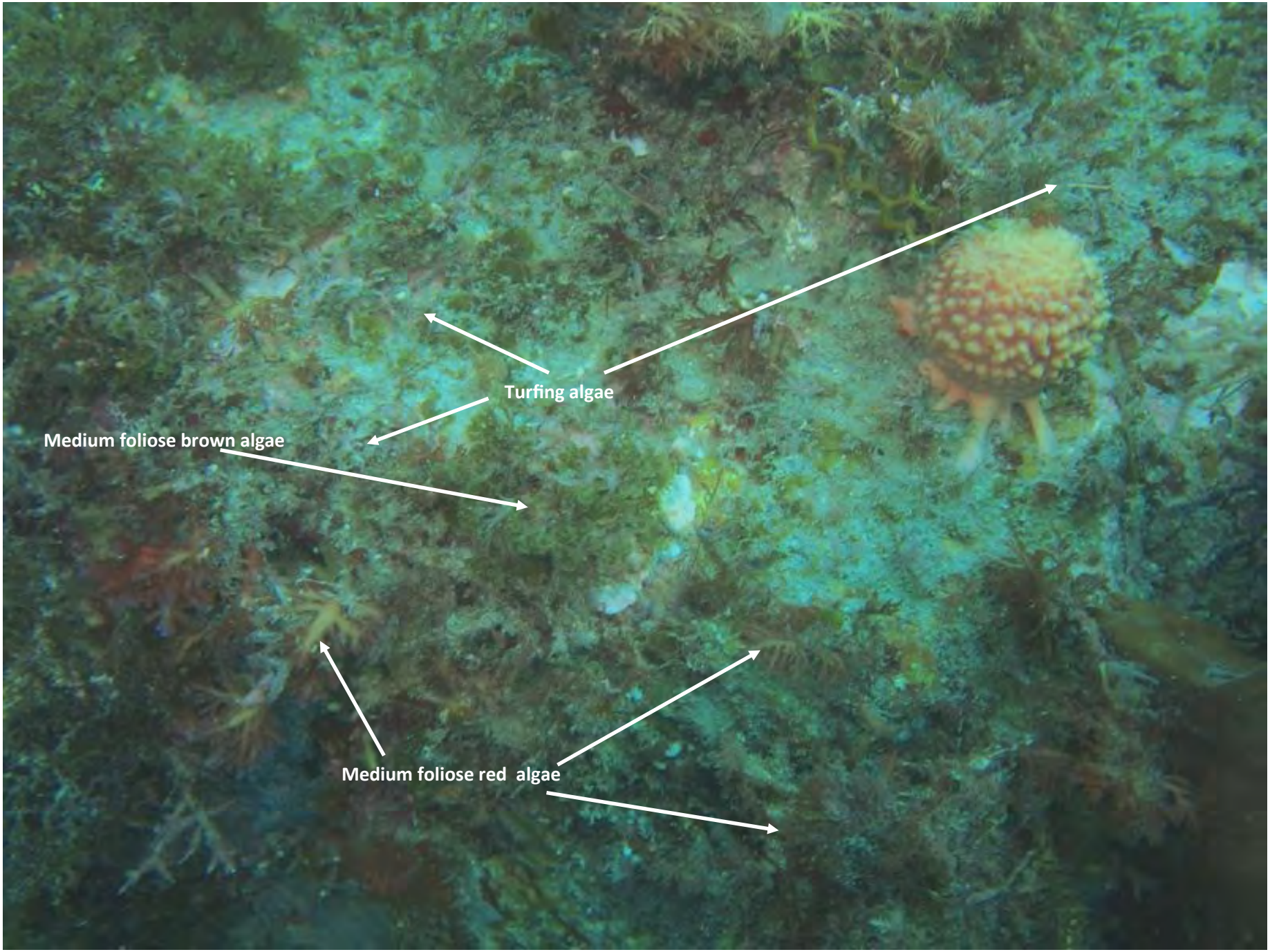

Examples of encrusting/substrate categorisation
Bare rock (dead crustose coralline)
Bare rock
Turfing algae


Examples of encrusting/substrate categorisation
Sand
Crustose coralline
Sponge encrusting
Sponge encrusting


Bryozoans soft
Bryozoans soft


Turfing algae


Turfing algae
Geniculate coralline algae


Turfing algae
Medium foliose brown algae
Medium foliose red algae